# STANDARD SPECIFICATIONS

# FOR

# BRIDGE CONSTRUCTION

Alberta Transportation

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**2017**

# STANDARD SPECIFICATIONS

# FOR

# BRIDGE CONSTRUCTION

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**STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION**

SUMMARY OF SECTIONS

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

# SECTION 1 EXCAVATION

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## 1.1 General

This specification is for the removal of all material necessary for the construction of the Work as shown on the Drawings and as determined by the Consultant. Excavation shall also include, but not be limited to, maintaining the stability of slopes, fills, or existing structures; designing, constructing and maintaining temporary access berms, cofferdams and dikes; and the protection, care of water, dewatering and maintenance of excavations, and disposal of excavated materials.

The Contractor shall maintain the integrity and stability of excavations at all times.

The Contractor shall provide acceptable provisions for the control and management of water and/or ice at all times.

Excavation elevations and dimensions shown on the Drawings shall be considered approximate only. The Consultant and the Department may require changes in final elevation and/or dimensions of excavations based on actual site conditions.

For projects in which the existing asphalt concrete pavement (ACP) surfaces are to be retained, the Contractor shall provide protection acceptable to the Consultant of the ACP during excavation, trimming, or other construction activities. Protection of the existing ACP will be considered to be incidental to the Work and no separate or additional payment will be made. Any damage to the ACP caused by the Contractor's operations shall be repaired at his expense and to the satisfaction of the Consultant.

The Contractor shall backfill all excavations after foundation and substructure components are acceptably constructed to the design elevations shown on the Drawings and with materials acceptable to the Consultant. Where no design elevation is shown, the excavation shall be backfilled to the original ground surface or streambed, or as determined by the Consultant. Backfilling of excavations shall be completed and will be paid for in accordance with Section 2, Backfilling. All costs associated with excavations made by the Contractor that are not shown on the Drawings or required by the Consultant and the Department shall be backfilled at his expense to the satisfaction of the Consultant.

## 1.2 Clearing

Clearing required for the completion of the bridge structure Work will be considered incidental to the Work and no separate or additional payment will be made.

## 1.3 Culvert and Bridge Structure Foundations

Excavated surfaces for culvert and bridge structure foundations shall be free of loose material, cleaned and cut to a surface condition acceptable to the Consultant. Seams contained within excavated surfaces shall be cleaned out, filled, and compacted with materials acceptable to the Consultant.

When excavated surfaces for culvert and bridge structure foundations are determined unacceptable by the Consultant, the Contractor shall continue the excavation to the elevation and dimensions determined by the Consultant and the Department. The excavation shall then be backfilled to the extents determined by the Consultant and the Department as shown on the Drawings and in accordance with Section 2, Backfill.

## 1.4 Temporary Access Berms, Cofferdams and Dikes

### 1.4.1 General

The Contractor shall design, construct, maintain and remove temporary access berms, cofferdams and dikes necessary to complete the Work.

The Contractor's design of temporary access berms, cofferdams and dikes shall include, but is not limited to, water and/or ice flows, height of temporary access berm, cofferdam and dike elevations, geometry, and materials.

Temporary access berms, cofferdams and dikes shall isolate instream construction activities and eliminate the flow of water through the construction area. The temporary access berms, cofferdams and dikes shall be installed and removed in a controlled manner to minimize the disturbance to the channel and banks.

The Contractor shall complete all Work in accordance with Subsection 1.2.50, Environmental Management, of the General Specifications. The Contractor's Environmental Construction Operations Plan (ECO Plan) shall include requirements for temporary access berms, cofferdams and dikes.

The Contractor shall establish a stream flow monitoring protocol that can provide several days advance warning of impending water and/or ice flows.

The Contractor shall test all temporary access berm and dike materials to confirm assumed design material properties. The Contractor shall provide material test reports to the Consultant upon request.

The Contractor shall submit design notes, drawings, construction sequencing, and an updated ECO plan, of proposed temporary access berms, cofferdams, and dikes to the Consultant for review and acceptance a minimum of 3 weeks prior to the commencement of the Work. The design notes, drawings and construction sequence shall be signed and sealed by a Professional Engineer, registered in the Province of Alberta.

The design notes, drawings, construction sequencing will be reviewed by the Consultant solely to ascertain general conformance with Contract requirements. The Consultant's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

### 1.4.2 Pre and Post Construction Channel Surveys

Prior to construction of temporary access berms and/or cofferdams, the Contractor shall complete a detailed elevation survey (3 m grid or finer) of the channel banks and streambed at all locations within the footprint of the access berm and cofferdam and a minimum distance beyond the footprint of 10 m on all sides where materials will be placed for the construction of the access berm and cofferdam. Additionally, the survey shall be completed at least 50 m downstream on the side of the channel banks and streambed where the access berm and cofferdam are to be located. The extent of the survey from the channel bank out into the channel shall extend a minimum of 10 m beyond the furthest projection into the channel of the access berm and cofferdam.

The channel banks and streambed shall be restored in accordance with Subsection 1.4.8, Site Restoration, prior to completing the post construction channel bank and streambed survey. The Contractor shall complete a post construction survey at the same locations as the pre construction survey within 5 days of restoration completion.

Pre and post construction survey results shall be submitted to the Consultant within 10 days of survey completion.

### 1.4.3 Turbidity Monitoring and Testing

Turbidity monitoring and testing shall be carried out in accordance with the Special Provisions of the Contract.

### 1.4.4 Fish Salvage

Fish salvage shall be carried out in accordance with the supplemental specifications of the Contract.

### 1.4.5 Cofferdam Dewatering

Cofferdams shall be sealed to prevent the ingress of water. The Contractor shall make every attempt necessary to obtain a dry work area prior to commencement of foundation construction. The work area will be considered dry when the seepage rate is less than 500 mm in depth per hour and the water can be controlled by pumps or other means to reduce the depth of accumulated water to 75 mm in depth or less at the time of concrete placement. Dewatering cofferdams shall be completed using means and methods acceptable to the Consultant such that water does not flow through plastic concrete.

Seepage water removed from the cofferdam shall be managed in compliance with all environmental regulations by discharging it into settlement tanks or ponds, or other methods acceptable to the Consultant. A seepage water management strategy shall be included in the Contractor’s ECO plan.

When conditions are encountered which in the opinion of the Consultant and the Department make it impracticable to dewater the cofferdam before placing concrete, construction of a concrete cofferdam seal below the elevation of the bottom of the foundation may be required. During the placing of the concrete cofferdam seal, the elevation of the water inside the cofferdam shall be controlled to prevent water flowing through the concrete cofferdam seal. No separate or additional payment will be made for the concrete cofferdam seal unless it is specified on the Drawings, in which case it will be paid for at the unit price bid for the class of concrete specified.

#### 1.4.6 Cofferdam Bracing

No cofferdam bracing shall be left in the completed Work without the written acceptance of the Consultant and the Department.

#### 1.4.7 Removal of Temporary Access Berms, Cofferdams and Dikes

Temporary access berms, cofferdams, and dikes shall be removed after completion of the Work and in accordance with the Special Provisions of the Contract. The Contractor shall take care not to disturb or damage the completed Work in any way during removal operations. Backfill required around the completed work shall be placed prior to removal of the temporary access berms, cofferdams, and dikes.

#### 1.4.8 Site Restoration

Upon removal of temporary access berms, cofferdams and dikes, the channel banks, streambed, and any areas disturbed from the construction of access roads shall be restored to the composition and elevation that existed at the time prior to construction and the pre construction channel survey and in accordance with the Drawings. Site restoration will be reviewed and accepted by the Consultant based on comparison of pre and post construction channel surveys and any other available information.

### 1.5 Disposal

Details of proposed excavated material disposal locations shall be submitted to the Consultant for review and acceptance prior to disposing of materials.

### 1.6 Measurement and Payment

#### 1.6.1 Excavation

##### 1.6.1.1 Excavation Classification

Excavation will be classified as follows:

Structural Excavation: Excavation related to foundations and substructure components; or

Channel Excavation: Excavation carried out to improve the alignment or carrying capacity of the stream channel.

Payment for structural and channel excavation will be at the unit price bid per cubic metre or lump sum price basis. The prices bid shall include the cost of all labour, material, equipment, and other items of expense necessary to complete the Work.

#### 1.6.1.2 Payment by Unit Price

Measurement for payment of excavation will be by the cubic metre of material acceptably excavated, measured to the nearest cubic metre.

The quantity of material paid for will be the actual volume of material excavated and placed or disposed of, as measured from the original ground surface or streambed to the neat lines shown on the Drawings as determined by the Consultant.

Payment will be made at the unit prices bid for “Excavation - Structural” and/or “Excavation - Channel”, as applicable, and will be full compensation for all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

All cost associated with the control and management of water and/or ice will be considered incidental to the Work, and no separate or additional payment will be made.

All costs associated with maintaining the stability of slopes, fills, or existing structures will be considered incidental to the Work, and no separate or additional payment will be made.

#### 1.6.1.3 Payment by Lump Sum

Payment will be made at the lump sum prices bid for “Excavation - Structural” and/or “Excavation - Channel”, as applicable, and will be full compensation for all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

When the required extents of excavation are greater than originally anticipated, as determined by the Consultant and the Department, the additional quantities of excavation may be paid for through a negotiated lump sum price, or as Extra Work in accordance with Specification 1.2, General Specifications, of the General Specifications, Specification Amendments and Supplemental Specifications for Highway and Bridge Construction.

All cost associated with the control and management of water and/or ice will be considered incidental to the Work, and no separate or additional payment will be made.

All costs associated with maintaining the stability of slopes, fills, or existing structures will be considered incidental to the Work, and no separate or additional payment will be made.

### 1.6.2 Temporary Access Berms, Cofferdams and Dikes

Payment will be made at the lump sum price bid for “Temporary Access Berms, Cofferdams and Dikes”, and will be full compensation for the design; construction; maintenance, including the control and management of water; removal; site restoration; and all labour, materials, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

All costs associated with pre and post construction channel surveys, and excavation through the depth of the berm to access the Work, including structural excavation, will be considered incidental to the Work, and no separate or additional payment will be made.

# SECTION 2 BACKFILL

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## 2.1 General

This specification is for the supply and placement of backfill materials necessary to complete the Work, including but not limited to, filling excavations; constructing approach fills, embankments and slopes, and channel banks as shown on the Drawings and as determined by the Consultant.

All materials shall be sourced and supplied by the Contractor. The Contractor shall be responsible for royalties, processing, loading, hauling, placing, compacting, quality control testing and any other incidentals required to supply these materials in place.

## 2.2 Materials

All material used for backfill, including native material, shall be of a quality acceptable to the Consultant and shall be in a thawed state when placing and compacting and be free from rocks, large or frozen lumps, wood, or other unsuitable material. No backfill material will be permitted to be placed on frozen substrate.

### 2.2.1 Compacted Non-Granular Material

Compacted non-granular material shall be inorganic soil such as clay. When reviewed and accepted by the Consultant and the Department, non-granular material can be substituted with crushed aggregate material.

Culvert clay seals shall be highly plastic clay as defined by ASTM D2487, Classification of Soils for Engineering Purposes and have a minimum Plasticity Index of 40.

### 2.2.2 Crushed Aggregate Material

Where crushed aggregate material is specified, it shall consist of clean sand and gravel, complying with the requirement of Table 2-1, Crushed Aggregate Material Requirements.

Des 2 Class 25 crush aggregate material can be used where Des 2 Class 40 has been specified. No separate or additional payment will be considered for the proposed substitution.

**Table 2-1: Crushed Aggregate Material Requirements**

| **Metric Sieve Size (CGSB 8 GP 2M)** (µm) | **Des 2 Class 40** (% Passing) | **Des 2 Class 25** (% Passing) |
|---|---|---|
| 80 000 | 100 | 100 |
| 50 000 | 100 | 100 |
| 40 000 | 100 | 100 |
| 25 000 | 70 - 94 | 100 |
| 20 000 | n/a | 82 - 97 |
| 16 000 | 55 - 85 | 70 - 94 |
| 10 000 | 44 - 74 | 52 - 79 |
| 5 000 | 32 - 62 | 35 - 64 |
| 1 250 | 17 - 43 | 18 - 43 |
| 630 | 12 - 34 | 12 - 34 |
| 315 | 8 - 26 | 8 - 26 |
| 160 | 5 - 18 | 5 -18 |
| 80 | 2 - 10 | 2 - 10 |
| % fractures by weight (2 faces) | 50+ | 60+ |
| Plasticity Index | NP - 6 | NP - 6 |
| L.A. Abrasion Loss Percent Maximum | 50 | 50 |

### 2.2.3 Backfill Material Tests

The Contractor shall be responsible for carrying out quality control testing at the frequencies specified in Table 2-2, Quality Control Testing Requirements. Testing shall be completed by an independent third party testing agency that is prequalified by the Department in the category of QA Testing Services (Grading, Base Paving).

The Contractor shall submit sieve analysis, percent fracture, laboratory/proctor density, plasticity index testing for the applicable proposed backfill materials to the Consultant for review and acceptance 2 weeks prior to commencement of the Work. Sampling and testing shall have been completed no more than 90 days prior to use unless otherwise reviewed and accepted by the Consultant.

**Table 2-2: Quality Control Testing Requirements**

| Description | Standard | Minimum Frequency |
|---|---|---|
| **Aggregates Tests** | | |
| Sieve Analysis | | |
| Crushed Aggregate | ATT-25 or ATT-26 | One per Source |
| Plasticity Index | AASHTO T90 | When requested by the Consultant |
| Percent Fracture (crushed aggregate) | ATT-50 | One per Source |
| L.A. Abrasion | AASHTO T96 | When requested by the Consultant |
| **Backfill Tests** | | |
| Moisture Density Tests (Laboratory/Proctor) | | |
| Crushed Aggregate (Des 2 Class 25) | ASTM D698 | One test per source |
| Non Granular Material (Soil) | ASTM D698 | One test for each soil type |
| Density of Materials (Field) | | |
| Crushed Aggregate (Des 2 Class 25) | ASTM D6938 | For culvert and bridge component backfill – 3 tests for: the first lift of backfill, every 4 lifts thereafter, and the final lift. |
| Crushed Aggregate (Des 2 Class 40) | ATT-58A (Control Strip Method) | Control strips shall be established for culverts and bridge components on the first lift of backfill, and at the ¼ and ½ height of the required backfill depth. For culverts, the controls strips shall be established on both sides of the pipe. |
| Non-Granular Material (Soil) | ASTM D6938 | For embankments and bridge components – 3 tests for: the first lift of backfill, every 10 lifts thereafter, and the final lift. |
| | | For culvert clay seals – 3 tests for: the first lift of backfill, every 4 lifts thereafter, and the final lift. |

Notes:

(1) ATT-58A, Control Strip Method may be used for field density testing of Des 2 Class 25 when reviewed and accepted by the Consultant.
(2) Location of density testing shall be reviewed and accepted by the Consultant.
(3) Compaction monitoring shall occur on all lifts of backfill.

Results of all quality control tests shall be submitted to the Consultant within 3 days of the test being completed.

## 2.3 Placement

All spaces excavated and not occupied by the permanent Work shall be backfilled and compacted with material acceptable to the Consultant and to the design elevations shown on the Drawings or as determined by the Consultant. Where no design elevation is shown, the excavation shall be backfilled to the original ground surface or streambed, or as determined by the Consultant.

All backfill material, regardless of type shall be placed in lifts not exceeding 150 mm in thickness of loose material. The rate of placing the backfill material shall be such that the specified level of compaction is achieved uniformly. Compaction of crushed aggregate and non-granular material shall be a minimum of 95% proctor density with optimum moisture content.

The compaction equipment proposed by the Contractor must be reviewed and accepted by the Consultant prior to commencement of the Work.

Compaction acceptance testing shall be completed in accordance with Table 2-2: Quality Control Requirements.

Backfill material shall not be placed against any concrete component until the Consultant has reviewed and accepted the timing of placement. Generally, backfill placement will not be permitted until 7 days after concrete placement or the compressive strength of the concrete has obtained 75% of the required 28 day strength.

Backfill material around culverts and concrete components shall be placed simultaneously on all sides of the culvert or concrete component. The elevation difference on any side shall not exceed 300 mm. Special precautions shall be taken to prevent any wedging action against the concrete and the slope bounding the excavation for abutments and wingwalls. The slope shall be stepped to prevent wedge action. Jetting of backfill material behind abutments and wingwalls will not be permitted.

The Consultant will carry out quality assurance testing if the Contractor's compaction methods and procedures are in the Consultant's opinion not meeting the specification requirements.

## 2.4 Measurement and Payment

### 2.4.1 Payment by Unit Price

Measurement for payment of backfill will be by the cubic metre of material acceptably placed and compacted, measured to the nearest cubic metre.

The quantity of backfill to be paid for will be the actual measured quantity of backfill acceptably placed and compacted as shown on the Drawings and to the satisfaction of the Consultant.

Payment will be made at the unit price or prices bid for "Backfill", for the types of material specified, and will be full compensation for the supply of material; placement and compaction; sampling and testing; and all labour, materials, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

### 2.4.2 Payment by Lump Sum

Payment will be made at the lump sum price or prices bid for “Backfill”, for the types of material specified, and will be full compensation for the supply of material; placement and compaction; sampling and testing; and all labour, materials, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

When the required extents of excavation are greater than originally anticipated, as determined by the Consultant and the Department, the additional quantities of backfill may be paid for through a negotiated lump sum price, or as Extra Work in accordance with Specification 1.2, General Specifications, of the General Specifications, Specification Amendments and Supplemental Specifications for Highway and Bridge Construction.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

# SECTION 3 FOUNDATION PILES

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## 3.1 General

This specification is for the supply and installation of plain and galvanized steel H-piles and pipe piles, timber piles, and cast-in-place concrete piles. It includes driven piles, drilled cast-in-place concrete piles, drilled cast-in-place concrete/steel pipe composite piles, and associated pile capacity test methods.

## 3.2 Materials

### 3.2.1 Steel Piling

Steel "H" piling shall meet the requirements of ASTM A36 or CSA G40.21M 350W.

Steel pipe piling shall meet the requirements of ASTM 252 Grade 2, except that hydrostatic testing is not required.

The boron content of steel piling shall not exceed 0.0008%.

Where metric dimensioned piling is specified, imperial dimensioned piling may be proposed and submitted to the Consultant for review and acceptance. At a minimum, the proposed imperial dimensioned piling shall have equivalent or greater section properties.

#### 3.2.1.1 Mill Test Reports

Mill test reports shall be provided for all foundation pile components in English.

Mill test reports shall be submitted to the Consultant for review and acceptance 2 weeks prior to commencement of the Work.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be certified to ISO/IEC 17025 by an organization accredited by the Standards Council of Canada for the tests required. Samples for testing shall be collected by personnel employed by the certified laboratory. A verification letter shall be provided by the certified laboratory that includes at a minimum, the applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the certified laboratory.

#### 3.2.1.2 Galvanizing

Galvanized piling shall be galvanized in accordance with Subsection 6.2.7.3, Galvanizing.

### 3.2.2 Timber Piling

Treated timber piling shall be fir or pine, and untreated timber piling shall be fir, spruce, pine or a species acceptable to the Department and the Consultant.

Timber piling shall conform to Section 23, Dimensional Structural Lumber and Piling, and shall be of the length specified on the Drawings.

#### 3.2.3 Pile Concrete

Concrete shall meet the requirements of Class Pile concrete as specified in Section 4, Cast-In-Place Concrete.

#### 3.2.4 Reinforcing Steel

Reinforcing steel shall meet the requirements of Section 5, Reinforcing Steel.

### 3.3 Handling

Piling shall be handled, hauled and stored in a manner that avoids damage to the piling materials. Loading and unloading shall be by crane, loader or other appropriate hoisting equipment.

Care shall be taken in order to prevent damage of galvanized pile surfaces. Fabric slings, wood blocking or other methods acceptable to the Consultant, shall be used to support and separate galvanized piling when handling, hauling or storing.

Special care shall be taken to avoid breaking through damaging the surface treatment of treated timber piles. The use of cant-hooks, dogs, or pike poles shall not be used in the handling of treated timber. Cuts or breaks in the surface of treated timber piles shall be given three brush coats of preservative material acceptable to the Department and the Consultant. Preservative material shall also be applied to all bolt holes.

### 3.4 Driven Piles

#### 3.4.1 Pile Driving Equipment

Diesel or hydraulic hammers shall be used for the driving of piling. When hydraulic hammers are proposed the Contractor shall ensure they are configured such that the stroke of the ram is visible and measureable during driving operations to the full satisfaction of the Consultant. Vibratory hammers may be utilized for temporary works or initial insertion of driven piles to achieve alignment and/or support prior to driving setup of diesel or hydraulic hammers.

Pile driving equipment shall be sized such that piles can be driven with reasonable effort to the specified ultimate bearing capacity without damaging the pile, but in no case shall the total energy developed be less than 35 kilojoules (kJ) per blow.

Pile driving equipment shall use fixed leads. The use of hanging leads is not permitted.

A driving cap or follower shall be provided to maintain alignment of the pile and hammer. The driving cap or follower shall be of adequate dimensions to allow driving the pile without trimming or reducing the cross section of the pile.

Driving extensions will only be permitted when reviewed and accepted by the Department and Consultant. When driving extensions are used, one pile from each group of 10 shall be a long pile driven without extensions, and shall be used as a test pile to determine the average capacity of the group. The use of gravity hammers will not be permitted except when the required pile capacity is less than 350 kilonewtons (kN) and the Consultant determines that the gravity hammer and leads are acceptable. Where the use of a gravity hammer is determined acceptable by the Consultant, the Contractor shall provide the Consultant acceptable proof of its weight including the weight of the follower.

### 3.4.2 Pile Driving Plan

A pile driving plan shall be submitted by the Contractor to the Consultant for review and acceptance a minimum of two weeks prior to the commencement of pile installation. At a minimum, the following information shall be contained in the pile driving plan:

- Specifications, setup and configuration of pile driving equipment including:
  - Hammer Data: Hammer type, manufacturer, model number, serial number, maximum rated energy and range in operating energy, stroke at maximum rated energy and range of operating stroke, ram weight, modifications;
  - Details of onboard equipment capable of energy monitoring;
  - Striker Plate Data: weight, diameter, thickness, composition;
  - Hammer Cushion Data: Manufacturers, area, thickness per plate, number of plates, total thickness, and composition;
  - Helmet Data: Weight, composition; and
  - Pile Cushion Data: Material, area, thickness per sheet, number of sheets, total thickness of cushion;
- Driving methods, procedure and driving sequence;
- Details and drawings of driving frames;
- Pile driving tools and accessories;
- Pile lengths, splicing details, and anticipated splicing locations;
- List of welders and proof of certification;
- Weld procedures;
- ECO plan that includes seepage water management strategy for open ended pipe piles;
- Cold weather protection methods; and
- When specified in the Contract, PDA testing procedures and contact information, and qualifications of independent testing agency.

If during the course of the Work, the required pile set criteria and tip elevations are not achieved, or the Work is not being completed in accordance with Contract requirements, the Contractor shall revise his pile driving plan and resubmit it to the Consultant for review and acceptance before any further pile driving occurs.

The Consultant's review and acceptance of the Contractor’s pile driving plan will not relieve the Contractor of his full responsibility for the methods and procedures required to achieve the pile capacity and tip elevations specified in the Contract.

### 3.4.3 Driven Pile Installation

The Contractor shall use steel driving frames for driven pile installations.

For monitoring pile installation, the Contractor shall apply permanent markings on each pile at 0.25 m intervals with a label at each 1.0 m interval starting from the toe of the pile.

#### 3.4.3.1 Pile Driving Set Criteria and Tip Elevation Requirements

The first driven pile for each foundation element will be considered a test pile. When the foundation element contains more than 15 piles the first two driven piles in that foundation element shall be considered test piles. Test piles shall be driven with the same type and size of equipment to be used for the entire foundation element and completed on the same working day. Information from the test pile installations will be used to confirm the pile design and acceptability of the pile driving equipment.

The Consultant will determine an estimated initial pile driving set criteria (blows per 25 mm) for each foundation element using the pile driving hammer information provided in the Contractor's pile driving plan and Wave Equation Analysis of Piles (WEAP).

Test piles shall be driven to the estimated initial pile driving set criteria determined by the Consultant prior to driving any of the other piles within the foundation element. The test pile elevations determined by the Consultant may vary from the tip elevation shown on the Drawings. Test piles shall be 15% longer in length than that shown on the Drawings.

The Consultant will review the estimated initial pile driving set criteria based on the actual pile driving data recorded during test pile driving and provide the Contractor with a pile driving set criteria and tip elevations for the remaining piles in the associated foundation element. The Contractor shall drive piles to both the tip elevation and pile driving set criteria determined by the Consultant.

Payment for test piles will be made at the same unit price bid for the other driven piles, in accordance with Subsection 3.7.1, Driven Piles.

The Contractor shall have no claim against the Department for any inconvenience or delay resulting from these requirements.

##### 3.4.3.1.1 Bearing Formulas

When specified in the Special Provisions of the Contract, pile driving set criteria will be determined by the Consultant using bearing formulas. For piles driven with diesel or hydraulic hammers the bearing formula will be as follows:

$$P = \frac{165xExF}{S+5}$$ , where

P = Pile service limit state (SLS) extreme load as defined on the Drawings (kilonewtons);

E = Rated energy output of hammer (kilojoules) at corresponding number of blows per minute based on published hammer data sheet;
F = Efficiency factor = 0.8 or as determined by the Consultant; and
S = Pile driving set criteria = the average penetration per blow for the last 10 to 20 blows (mm per blow).

The bearing formula for piles driven with diesel or hydraulic hammers will only be applied when:

- The head of the pile is not broomed, crushed, or deformed;
- The rate of penetration is acceptable to the Consultant; and
- A driving extension is not used.

3.4.3.2 Steel Piling

Steel pile heads shall be cut square and neat.

When specified in the Contract documents, pile tip reinforcement shall be installed in accordance with Standard Drawing S-1850, Standard Steel Pile Details.

When pipe piles are to be driven closed ended, pipe pile tips shall have welded end plates installed in accordance with Standard Drawing S-1850, Standard Steel Pile Details.

At the completion of driving open-ended pipe piles the thickness of accumulated material in the pipe pile shall be measured and recorded. Upon completion of the measurements and review and acceptance of the Consultant, the interiors shall be cleaned out to the required elevation. All material, either loose or adhering to the walls of the pipe piles shall be removed to the satisfaction of the Consultant prior to installing reinforcing steel or placing concrete. Driving of any type of piles within 3 m of a pipe pile or integral pile that contains concrete shall not be undertaken until the concrete has been placed and cured for a minimum of 3 days.

Pipe pile concrete shall not be placed until the pipe pile has been reviewed and accepted by the Consultant. Any reinforcing required projecting from the pipe pile shall be installed and secured prior to concrete placement. If water is observed to ingress into the pipe pile the concrete shall be placed in accordance with Subsection 4.22, Placing Concrete under Water, and Subsection 3.5.3.3, Pile Concrete, after the ingress of water has reached an equilibrium elevation as determined by the Consultant.

When damage at the driving end of the pile or buckling at any location occurs, the Contractor shall immediately stop pile driving and revise and resubmit his pile driving plan to the Consultant. The Contractor shall not continue pile driving until the revised pile driving plan has been reviewed and accepted by the Consultant. All costs and schedule impacts associated with the required modifications to the pile driving plan will be considered incidental to the Work and no additional or separate payment will be made. Modification may include, but are not limited to, reinforcing the driving end of the piling or utilizing different pile driving equipment or procedures. Damaged piles shall be addressed in accordance with Subsection 3.5.5, Defective Piles.

Steel piles shall be cut off level at the required elevation.

The Contractor shall cover all open pipe piles/drilled holes until concrete or backfill is placed. Coverings shall be designed, supplied, installed, secured and maintained by the Contractor, in a manner acceptable to the Consultant.

#### 3.4.3.3 Steel Piling Splices

Steel pile splices shall be in accordance with Standard Drawing S-1850, Standard Steel Pile Details. All field-welding shall be in accordance with Subsection 13.4.1, Field Welding of Structural Members.

The Contractor shall locate steel piling splices such that the final location of the splice is 1 m below ground level or at an elevation acceptable to the Consultant.

Where the upper portions of piling are specified to be galvanized, excess piling shall be removed from the ungalvanized portion of the piling to ensure that the galvanized portion extends to the elevation shown on the Drawings. Splicing within the galvanized portion of the piling shall be avoided. If splicing within the galvanized portion becomes necessary, the galvanizing shall be removed to the extent required to complete the splice in a manner acceptable to the Consultant. The spliced areas and any other damage galvanized areas shall be metallized in accordance with ASTM A780, Method A3 to a thickness of 180 µm and tested for adhesion. All costs associated with metallizing and testing will be considered incidental to the Work, and no separate or additional payment will be made.

For steel pipe piling, methods acceptable to the Consultant shall be used to match out-of-round piling. Weld procedures shall be suitable for any steel pipe pile where out-of-round conditions are present.

#### 3.4.3.4 Testing of Steel Piling Splices

The Contractor shall have all steel piling splice welds visually inspected by an independent welding inspector certified to Level 3 of CSA W178.2.

For each bridge component, the Contractor shall also perform ultrasonic testing for a minimum of 20% of all full penetration welded splices in compression.

The Contractor shall perform ultrasonic testing for 100% of full penetration welded splices in tension.

If visual inspection of the weld reveals the presence of potential defects, the Consultant will require the Contractor to complete additional ultrasonic testing to that already specified to confirm the acceptability of the weld. The Consultant will determine the scope of additional ultrasonic testing to be completed and the acceptability of the weld. If welds are determined unacceptable by the Consultant, the Contractor shall repair the weld at his expense to the full satisfaction of the Consultant and the Department.

All ultrasonic testing shall be completed by an independent testing company certified to CAN/CSA W178.1. Ultrasonic testing technicians shall be certified to Level 2 of Canadian General Standard Board (CGSB). A copy of test results shall be provided to the Consultant for his review within three days of the testing.

All costs associated with testing shall be included in the price bid for the Work and no separate or additional payment will be made.

3.4.3.5 Reinforcing Steel

Reinforcing steel shall be fabricated, shipped, handled, stored, placed, fastened and spliced in accordance with these specifications, Section 5, Reinforcing Steel, and as shown on the Drawings.

Reinforcing steel shall be positioned and braced to achieve placement tolerances specified in Section 5, Reinforcing Steel. Shoes or spacers shall be firmly attached to the reinforcement to ensure the reinforcement is kept in position during concrete placement and cover requirements are met.

Projecting reinforcing steel shall be located such that it is within a tolerance of ± 10 mm or as determined by the Consultant.

3.4.3.6 Pile Concrete

All Work shall be completed in accordance with Section 4, Cast-In-Place Concrete, and Subsection 3.5.3.3, Pile Concrete.

3.4.3.7 Timber Piles

Full length timber piles shall be used.

The Contractor shall provide and install collars, bands, or other devices to prevent timber piles from splitting or brooming.

When required, timber piles shall be installed with steel shoes that are designed and supplied by the Contractor.

Gravity hammers, when accepted by the Consultant for driving timber piles, shall weigh not less than 1.5 tonnes, and in no case shall the weight of the hammer be less than the combined weight of driving head and pile. The height of the fall shall be such that damage to the piles does not occur.

When a diesel hammer is used for driving of timber piles, the total energy of the hammer shall be greater than 15 kilojoules.

When the area of the head of any timber pile is greater than that of the face of the hammer, a follower shall be provided to distribute the blow of the hammer throughout the cross section of the pile.

Timber piles shall be cut to match the plane of the supporting timber caps as shown on the Drawings. The length of pile above the elevation of cut off shall be sufficient to permit the complete removal of all material injured by driving. All broomed, splintered or damaged material shall be completely removed.

#### 3.4.3.8 Driven Pile Installation Tolerances

Piles shall not be driven with a variation of more than 150 mm from the horizontal position shown on the Drawings, except for fully integral abutments the piles shall not be driven with a variation of more than 50 mm from the horizontal position. In addition, for fully integral abutments, the variation in position between the center of the pile casing and center of the pile shall not be more than 25 mm from the horizontal position shown on the Drawings.

Piles shall be driven with a variation not exceeding more than 20 mm per metre from the vertical alignment shown on the Drawings. Piles in exposed bents shall not be out of position by more than 50 mm at the ground line and 25 mm in the pier cap.

At the completion of driving of each pile within a foundation element, a control elevation shall be established on the pile by the Contractor to determine if heave has occurred after all piles for the foundation element have been driven. Piles that heave shall be re-driven to the depth and capacity required by the Contract or as determined by the Consultant.

If tolerances are not met, the Contractor shall make immediate changes to his piling procedures. Any pile out of the specified tolerance shall be corrected at the Contractor's expense to the full satisfaction of the Consultant.

### 3.4.4 Defective Piles

The equipment and methods used to drive piles shall not result in deformation of the steel, splitting, splintering or brooming of the wood, or crushing and spalling of the concrete, or any other damage.

Manipulation of piles to adjust position, considered by the Consultant to be harmful, will not be permitted.

Piles damaged by driving, or driven out of specified tolerance, orientation, or driven below the cut off elevation, shall be repaired by the Contractor at his expense. The Contractor shall submit a repair procedure to the Consultant for review and acceptance before any further piling is installed. The Contractor’s repair procedures, as a minimum, shall include one of the following:

- The defective piling shall be withdrawn and replaced with new, and if necessary, longer piles;
- Replacement piling shall be driven adjacent to the defective piles;
- The defective piles shall be spliced or built up; or
- A sufficient portion of the pile cap extended and reinforced.

Piling on which the galvanized coating has been damaged, as determined by the Consultant, shall be replaced or repaired by the Contractor at his expense. Where repair of damaged galvanizing is required, it shall be completed in accordance with Subsection 6.2.7.3, Galvanizing.

Splicing of defective timber piles will not be permitted.

## 3.5 Drilled Cast-In-Place Concrete Piles

### 3.5.1 Pile Drilling Equipment

Only screw rotary type augers shall be used.

Hydraulic oscillating equipment will be permitted for the installation of temporary or permanent casings.

Continuous flight auger equipment is not permitted.

### 3.5.2 Pile Drilling Plan

The Contractor shall have demonstrated experience related to the successful completion of projects with similar scopes of Work and ensure that the equipment used is in adequate in quantity, quality and in good operating condition.

A pile drilling plan shall be submitted by the Contractor to the Consultant a minimum of 2 weeks prior to the commencement of pile installation for review and acceptance. At a minimum, the following information shall be contained in the pile drilling plan:

- Summary of Contractor's experience related to the project scope of work;
    - Project personnel resumes; and
    - Client contact information;
- Specifications, setup and configuration of piling equipment;
- Drilling methods, procedure and drilling sequence (including methodology to address the presence of boulders, hard rock stringers, or occurrences of pile wall sloughing and/or ingress of water);
- List of drilling tools and attachments for belling and cleaning;
- List of proposed casing lengths and diameters to be available on site;
- Method of gas detection;
- Methods to install and remove temporary casing;
- Availability of borehole camera;
- Concrete mix design review letter in accordance with Section 4, Cast-In-Place Concrete;
- Reinforcing steel mill test reports in accordance with Section 5, Reinforcing Steel;
- Cold weather protection methods;
- ECO plan that includes seepage water management strategy; and
- Sample piling monitoring records.

If during the course of the Work, the required pile capacities and tip elevations are not achieved, or the Work is not being completed in accordance with the Contract requirements, the Contractor shall revise his pile drilling plan and resubmit it to the Consultant for review and acceptance before any further piling Work occurs.

The Consultant's review and acceptance of the Contractor's pile drilling plan will not relieve the Contractor of his full responsibility for the methods and procedures required to achieve the pile capacity and tip elevations specified in the Contract.

### 3.5.3 Drilled Pile Installation

Drilled pile holes shall be stabilized and sealed by means of temporary casings to prevent the possible collapse of the pile holes or ingress of water. The Contractor shall make every attempt necessary to obtain dry pile holes prior to placing pile concrete. At a minimum, the Contractor shall have on site casings of appropriate size and lengths, bailing buckets, final cleanout buckets and water pumps ready for use in the Work. A drilled pile hole will be considered dry when the seepage rate into the drilled pile hole is less than 300 mm per hour and the water can be controlled by pumps or other means to reduce the depth of accumulated water to 75 mm or less at the time of concrete placement.

Seepage water removed from pile holes shall be managed in compliance with all environmental regulations by discharging it into settlement tanks or ponds, hauling and disposing offsite, or other methods acceptable to the Consultant. A seepage water management strategy shall be included in the Contractor's ECO plan and submitted with the pile drilling plan.

Temporary casings, if used in drilling operations, shall be removed from the hole by vibration or hydraulic oscillation and of sufficient strength to withstand repeated use and any forces required to install or retrieve it. The internal diameter of casings shall the same size as the specified pile diameter and of sufficient length to permit drilling operations to proceed unimpeded. The bottom of the casing shall be maintained sufficiently below the top of the concrete during withdrawal and placing operations.

Pile hole tip elevations shown on the Drawings shall be considered approximate only, and the Consultant may determine further drilling is necessary to achieve satisfactory capacity of the piles. For dry holes, the Contractor shall provide borehole video inspection equipment when determined necessary by the Consultant. The borehole video inspection equipment shall be installed with lighting and resolution acceptable to the Consultant.

Where belling of the piles is specified, belling shall proceed only after the pile hole has been drilled to an elevation acceptable to the Consultant.

The walls and bottoms of the pile holes shall be cleaned to remove all loose and extraneous material. The Contractor shall determine if any noxious or explosive gas is present in the pile holes and shall provide whatever means and equipment necessary to ensure a safe work site.

Pile reinforcement and pile concrete shall not be placed without the acceptance of the pile holes by the Consultant. The Consultant shall be permitted full and safe access to the drill hole to allow inspection of drilling operations, evaluation of soil or rock cuttings, presence of water ingress or wall sloughing, tip elevations, or other reasons determined necessary by the Consultant. The time elapsed between the completion of the pile hole, reinforcement installation and concrete placement shall be acceptable to the Consultant.

The Contractor shall not proceed with the installation of adjacent piling, if for any reason the quality of the adjacent piling becomes compromised, as determined by the Consultant.

#### 3.5.3.1 Open Drilled Holes

The Contractor shall cover all open drilled holes until concrete or backfill is placed. Coverings shall be highly visible, designed, supplied, installed, secured and maintained by the Contractor, in a manner acceptable to the Consultant.

#### 3.5.3.2 Reinforcing Steel

Reinforcing steel shall be fabricated, shipped, handled, stored, placed, fastened and spliced in accordance with these specifications, Section 5, Reinforcing Steel and as shown on the Drawings.

Reinforcing steel shall be positioned and braced to achieve placement tolerances specified in Section 5, Reinforcing Steel. Shoes or spacers shall be firmly attached to the reinforcement to ensure the reinforcement is kept in position during concrete placement and cover requirements are met.

Projecting reinforcing steel shall be located such that it is within a tolerance of ± 10 mm or as determined by the Consultant.

#### 3.5.3.3 Pile Concrete

All Work shall be completed in accordance with Section 4, Cast-In-Place Concrete and this specification.

Suitable forms shall be used to maintain the specified dimensions of concrete piles above ground level. When the reinforcement has been acceptably placed, concrete shall be immediately deposited in the pile hole.

The Contractor shall remove all laitance, unsound concrete, or other deleterious material from concrete surfaces as determined by the Consultant by chipping or other means acceptable to the Consultant.

### 3.5.3.3.1 Pile Concrete Placed in the Dry

Pile concrete shall be placed by means of a hopper equipped with a center pipe drop tube. The pipe drop tube shall be a minimum of 200 mm in diameter and 2 m long. Concrete may be placed free fall, providing the fall is vertically down the center of the casing or drilled hole and there are no transverse ties or spacers. Pile concrete shall have a slump range of 130 ±30 mm at time of discharge. Concrete in the upper 3 m of the piles shall be consolidated by the use of an acceptable concrete vibrator.

### 3.5.3.3.2 Pile Concrete Placed under Water

If in the opinion of the Consultant and the Department all attempts to achieve a dry pile hole have been taken and proven unsuccessful, placement of pile concrete under water will be required.

When the Department and the Consultant accept pile concrete placed underwater, the pile concrete shall be placed in accordance with Subsection 4.22, Placing Concrete under Water and this specification.

The integrity of the pile shall be tested and verified using Crosshole Sonic Logging (CSL) as described in Subsection 3.5.3.3.3, Crosshole Sonic Logging.

### 3.5.3.3.3 Crosshole Sonic Logging

All piles with concrete placed under water shall have CSL completed to confirm pile integrity. The Contractor shall complete CSL testing in accordance with ASTM D6760, Standard Test Method for Integrity Testing of Concrete Deep Foundations by Ultrasonic Crosshole Testing and this specification.

The Contractor shall hire an independent CSL testing agency that has a minimum of three years’ experience in CSL testing. A Professional Engineer employed by the independent CSL testing agency and registered in the Province of Alberta shall supervise the CSL testing and prepare a CSL testing report.

CSL testing shall be completed within 3 to 7 days after concrete placement as determined by the independent CSL testing agency.

The Contractor shall supply and install one 50 mm inside diameter tube for each 0.3 m of pile diameter with a minimum of 4 tubes per pile. Tubes supplied shall be round PVC or steel material of a grade acceptable to the Consultant and have a regular internal diameter that is free from defects, obstructions and joints. Tubes shall be watertight, free of corrosion, have clean internal faces and roughened external faces to ensure a good bond between the concrete and the tubes. Tubes may be extended with watertight mechanical couplings and all coupling locations shall be recorded. Tubes shall be installed by the Contractor in a manner that the CSL probes pass through the entire length of the tube without binding.

The Contractor shall fit the tubes with a watertight shoe on the bottom and a removable cap on the top. Tubes shall be secured to the interior of the reinforcement stirrups a minimum of every 1.0 m along the length of the pile. Tubes shall be installed parallel to each other and equidistant around the circumference of the pile. Tubes shall be installed a minimum of 40 mm away from vertical bars. Tubes shall extend to within 150 mm of the drilled shaft bottoms, and shall extend a minimum of 600 mm above the drilled shaft tops or where they are accessible. Tubes shall be capped to prevent debris from entering the access tubes.

The Contractor shall ensure that CSL tubes are not damaged during the installation of the reinforcement. Tubes shall be filled with water to prevent damage during concrete placement. The water shall be a minimum of 4°C immediately prior to concrete placement. If testing equipment does not pass through the entire length of the CSL tube, a 50 mm diameter core hole shall be drilled. Special care must be taken to avoid tube debonding between the concrete and the tubes. If tube debonding occurs, the Contractor shall core drill a 50 mm diameter hole to the depth of debonding for each debonded tube.

The Contractor shall make CSL measurements at depth intervals of 50 mm from the bottom of the tubes to the top of each pile. Upon completion of testing and acceptance of the pile concrete, the tubes shall be filled with an approved grout mix having the same design strength and durability as the pile concrete.

The Contractor shall submit the CSL testing report to the Consultant and the Department within 5 days of CSL testing completion. The CSL testing report shall include test summaries, results, analyses, and an opinion of the pile concrete's integrity and suitability for the intended use. The Contractor shall not grout the CSL tubes or perform any further work on the CSL tested drilled piles until it has been demonstrated to the Consultant and the Department's satisfaction that the drilled pile is acceptable. Test summaries shall be in accordance with the criteria listed in Table 3-1, CSL Condition Ratings.

**Table 3-1: CSL Condition Ratings**

| Condition Rating | Velocity Reduction | CSL Results |
|---|---|---|
| Good (G) | ≤ 10% | Good quality concrete. |
| Questionable (Q) | >10% & <20% | Minor contamination or intrusion.<br>Questionable quality concrete. |
| Poor/Flaw (P/F) | ≥ 20% & <30% | Flaws exists, possible water/slurry contamination, soil intrusion and/or poor quality concrete. |
| Poor/Defect (P/D) | ≥ 30% | Defects exists, possible water/slurry contamination, soil intrusion and/or poor quality concrete. |
| No Signal (NS) | No Signal Received | Soil intrusion or other severe defect absorbed the signal. |

Velocity reduction criteria outlined in Table 3-1, CSL Condition Ratings, shall be from the highest measured signal velocity in the comparable zone.

Piles with condition ratings other than “G” will be considered unacceptable and will result in rejection of the pile. If the Contractor elects to carry out further investigation to provide supplemental information of the pile’s integrity, the flawed and/or defective zones shall evaluated using cross-hole tomography, concrete coring, and any other testing required by the Consultant. The Consultant in consultation with the independent CSL testing agency’s Engineer will determine the depth, location, diameter and number of cores to be extracted. If the Consultant determines the use of a borehole camera for inspection is also required, large diameter cores may be required. A minimum of two cores will be required to intercept the suspected flaw or defect zones.

When the Consultant and the Department determine a drilled pile is unacceptable, the Contractor shall submit a repair procedure with supporting design calculations and drawings signed and sealed by a Professional Engineer registered in the Province of Alberta to the Consultant and the Department for review and acceptance a minimum of 2 weeks prior to commencement of the repair work. The pile will not be considered acceptable until all repair work has been completed, reviewed and accepted by the Consultant and the Department.

#### 3.5.3.4 Cold Weather Conditions

When the ground temperature against which pile concrete is placed below -5 °C, the pile hole shall be hoarded and heated until the ground temperature is warmer than 10 °C or oversized by 100 mm. Immediately after placing and finishing the pile concrete, the top exposed surface shall be protected with insulated tarps or other means to adequately cure the concrete for a period of seven days. If the top of the pile extends above the ground surface it shall be protected in accordance with Section 4, Cast-In-Place Concrete.

#### 3.5.3.5 Drilled Pile Installation Tolerances

Piles shall be installed with a variation not exceeding more than 50 mm from the horizontal position shown on the Drawings.

Piles shall be installed with a variation not exceeding more than 20 mm per metre from the vertical alignment shown on the Drawings.

Projecting reinforcing steel shall be installed with a variation not exceeding more than 10 mm in any direction from the position shown on the Drawings.

If tolerances are not met, the Contractor shall make immediate changes to his piling procedures. Any pile out of the specified tolerance shall be corrected at the Contractor's expense to the full satisfaction of the Consultant.

### 3.5.4 Drilled Pile Capacity

Piles shall be drilled to the capacity and tip elevation shown on the Drawings or as determined by the Consultant. Pile capacities will be determined by the Consultant using geotechnical inspection and evaluation. When specified in the Contract, the Contractor shall complete pile capacity testing in accordance with Subsection 3.6, Pile Capacity Testing and Reporting, and the results reviewed and accepted by the Consultant.

### 3.5.5 Defective Piles

Manipulation of reinforcement to adjust position, considered by the Consultant to have the potential to damage the pile integrity, will not be permitted.

A decrease in concrete elevation at the top of a completed pile more than 2% of the pile diameter between the time of initial pour and set will be considered a damaged pile.

Piles damaged during drilling, reinforcing steel installation, or concrete placement shall be repaired by the Contractor at his expense. The Contractor shall submit a repair procedure to the Consultant for review and acceptance before any further piling is installed. The Contractor's repair procedures, as a minimum, shall include one of the following:

- The defective piling shall be re-drilled and replaced by new, and if necessary, longer piles;
- Concrete removal and replacement;
- The defective piles shall be built up; or
- A sufficient portion of the pile cap extended and reinforced.

## 3.6 Pile Capacity Testing and Reporting

### 3.6.1 Static Load Testing

When specified in the Contract, Static Load testing shall be completed by an independent testing agency specializing in this type of Work. The independent testing agency shall be engaged by the Contractor and supply and install all testing equipment and analyze the test results in accordance with this specification. The Contractor shall be responsible to coordinate and manage all associated static load testing activities.

Static load testing and reporting shall be completed in accordance with ASTM D1143 for piles subjected to axial loads and ASTM D3689 for piles subjected to axial tensile loads and as outlined in the Contract documents. As a minimum, the report shall include the following:

- Site plan showing locations of test pile and nearest test holes;
- Test hole logs and summary of subsurface conditions;
- Type and dimensions of test and anchor piles;
- Test pile material including basic specifications;
- Pile installation details;
- Final pile top and tip elevations;
- Ground surface elevation;
- Date and type of load test;
- Temperature and weather conditions during the test;
- Description of instrumentation used to monitor pile performance during testing including their locations;
- Description of test setup and testing procedures;
- Tabulation of time, load, and displacement readings;

- Interpretation and analyses of test results including failure load and the criterion used to estimate it, shaft friction, and end bearing resistance (as applicable);
- Pile load-movement curve; and
- Pile time-load and time-movement curves.

The static load test report shall be submitted to the Consultant for review and acceptance within 7 days of completion of testing.

Osterberg or Statnamic tests may be proposed by the Contractor in substitution for static load testing. Osterberg tests shall conform to ASTM D1143 Standard Test Method for Piles under Static Axial Load using the Quick Load Test Method for Individual Piles. Statnamic tests shall conform to ASTM D7383 Standard Test Methods for Axial Compressive Force Pulse (Rapid) Testing of Deep Foundations. The Contractor shall submit details of all proposed testing measures in his piling plan and the Consultant, at his sole discretion, will accept or reject the Contractor's substitution proposal.

The Contractor shall have no claim against the Department for any inconvenience or delay resulting from these requirements.

### 3.6.2 High Strain Dynamic Load Testing - Pile Driving Analysis (PDA Testing)

When specified in the Contract, PDA testing shall be completed by an independent testing agency that has specialized in this type of Work for a minimum of 5 years. The independent testing agency shall be engaged by the Contractor and supply and install all testing equipment and analyze the test results in accordance with this specification. The Contractor shall be responsible to coordinate and manage all associated PDA testing activities.

The Contractor shall provide the Consultant a minimum of two weeks advance notice of any scheduled PDA testing.

#### 3.6.2.1 Testing Requirements

PDA testing shall be completed in accordance with ASTM D4945.

The impact device used for PDA testing shall be acceptable to the Consultant and capable of mobilizing the ultimate pile capacity in a single blow without additional data interpretation.

The greater of 2 piles or 15% of the total production piles from each foundation element shall be PDA tested. For pile walls where more than 40 piles are to be installed the greater of 6 piles or 10% of the total production piles in each wall shall be PDA tested. The remaining pilings will have their capacities evaluated based on the field adjusted WEAP analysis produced from the PDA testing process.

Testing shall occur during complete installation of driven piles and upon re-strike when re-striking is specified in the Special Provisions of the Contract. The required pile set-up time until re-strike occurs and all associated details will also be outlined in the Special Provisions of the Contract.

The Contractor shall include any costs associated with re-striking in the unit price bid and shall have no claim against the Department resulting from any delays caused by these requirements. If re-striking test results do not meet the specified requirements, the Contractor shall continue pile driving until results acceptable to the Consultant is achieved.

Additional PDA testing may be required when driven piles exhibit lower capacity and/or shorter penetrations than specified, or cast-in-place piles encounter ground water, or piling equipment or procedures change. The Consultant will determine the scope and number of additional PDA tests to be completed and this additional testing will be paid for at the unit price bid.

If the Contractor demobilizes from the foundation element before the Consultant's acceptance is received, all remobilization and associated costs will be at the Contractor's expense.

The Contractor shall have no claim against the Department for any inconvenience or delay resulting from these requirements.

#### 3.6.2.2 Reporting Requirements

The independent testing agency shall provide a daily field log to the Consultant within 24 hours of testing, summarizing preliminary test results including driving stresses, transferred energy and estimated pile capacity. Upon review of the daily field log(s), tip elevations may be revised by the Consultant.

The independent testing agency shall also provide a summary letter report that includes complete PDA test results and analysis for each foundation element tested. The summary letter report(s) shall be prepared in accordance with the requirements of ASTM D4945 and these specifications. As a minimum, the summary letter report shall include the following:

- Pile and driving system information;
- Pile installation data;
- PDA testing equipment and procedure;
- Energy imparted;
- Maximum driving stresses;
- Hammer blow rate;
- Signal matching input parameters including quake and damping factors; and
- Shaft friction, end bearing and total pile capacity.

The summary letter report(s) shall be signed and sealed by a Professional Engineer employed by the independent testing agency. The summary letter report(s) shall be submitted to the Consultant within 3 days of PDA testing completion for each foundation element. The Consultant will provide the Contractor written acceptance, rejection, or a list of items requiring review and resubmission of the summary letter report within 3 business days of its receipt.

## 3.7 Measurement and Payment

### 3.7.1 Driven Piles

#### 3.7.1.1 Supply of Piling

Measurement for payment of supply of piling will be by the metre of piling acceptably supplied, measured to the nearest 0.1 m.

The quantity to be paid will be the length of piling acceptably driven and remaining in the completed structure. Where portions of steel piling are specified to be galvanized, only the specified lengths requiring galvanizing will be included in the quantity to be paid.

Payment will be made at the unit prices bid for “Supply of Piling”, for each type and size of piling specified, and will be full compensation for the supply of the piling; loading; delivery; and unloading of the material to the project site; and all labour, equipment, tools and incidentals necessary to complete the Work.

All costs associated with the supply, fabrication and installation of welded end plates for closed-ended pipe piles will be considered incidental to the Work, and no separate or additional payment will be made.

#### 3.7.1.2 Pile Set-up

Payment will be made at the unit prices bid per pile for “Pile Set-up”, for each specified type and size of piling, and will be full compensation for the supply, fabrication and installation of driving frames; pile set-up including setting the equipment over the pile ready to commence pile driving; and all labour, equipment, tools and incidentals necessary to complete the Work.

Payment will be made only once for each acceptably driven pile. All costs associated with pile set-up for pile restrikes, as determined necessary by the Consultant, will be considered incidental to the Work, and no separate or additional payment will be made.

#### 3.7.1.3 Pile Driving

Measurement for payment of pile driving will be by the metre of piling acceptably driven and remaining in the completed structure, measured to the nearest 0.1 m.

The quantity to be paid will be the actual measured length of piling acceptably driven and remaining in the completed structure.

Payment will be made at the unit prices bid for “Pile Driving”, for each specified type and size of piling, and will be full compensation for handling; driving; splicing; cutting; and all labour, equipment, tools, and incidentals necessary to complete the Work to the satisfaction of the Consultant.

3.7.1.4 Pile Tip Reinforcement

Payment will be made at the unit price bid per pile for “Pile Tip Reinforcement”, and will be full compensation for the supply and installation of pile tip reinforcements, including all labour, equipment, tools and incidentals necessary to complete the Work.

3.7.1.5 Pile Splicing

Where piles penetrate 20% deeper than the design pile tip elevation shown on the Drawings, splicing will be paid for at the assigned unit price for pile splicing and will include all labour, materials, equipment, tools and incidentals necessary to complete the work. Payment for splices will be made only once for each additional 12.0 m of pile length required per pile.

The unit price for pile splicing shall be as follows:

- H-Piles: $1,000 per splice;
- Pipe Piles: $1,200 per splice.

3.7.1.6 Restocking of Piling

When quantities of plain steel piling are reduced by 20% or more from that specified, the Department will make payment for verifiable re-stocking costs for each 12.0 m or longer length of piling incurred by the Contractor.

The Contractor shall present details including dates, quantities, supplier invoices, and all other supporting documentation requested by the Consultant. Payment will only be made at industry standard re-stocking rates, and shall be acceptable to the Consultant and the Department.

3.7.1.7 Pile Concrete

Payment for pile concrete will be made in accordance with Section 4, Cast-In-Place Concrete.

All costs associated with Crosshole Sonic Logging and any associated repair work required will be considered incidental to the Work, and no separate or additional payment will be made.

3.7.1.8 Reinforcing Steel

Payment for reinforcing steel will be made in accordance with Section 5, Reinforcing Steel.

3.7.2 Drilled Cast-In-Place Concrete Piles

3.7.2.1 Drill Rig Set-up

Payment will be made at the unit prices bid per pile for “Drill Rig Set-up”, for each specified type and size of drilled pile, and will be full compensation for setting the equipment over the pile ready to commence drilling; supply, installation and removal of temporary casings; and all labour, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

#### 3.7.2.2 Pile Installation

Measurement for payment of pile installation will be by the metre of drilled piles acceptably installed, measured to the nearest 0.1 m.

The quantity paid for will be the actual measured length from the pile tip to the underside elevation of the pile cap or abutment seat, as applicable.

Payment will be made at unit prices bid for “Pile Installation”, for each specified type and size of drilled pile, and will be full compensation for drilling pile holes to the elevations and dimensions shown on the Drawings; supply and installation of composite H-pile steel sections, if specified; removal and disposal of pile hole tailings; detection and purging of hazardous gases; borehole camera inspection; dewatering and cleaning of pile holes as required; and all labour, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

All costs associated with Crosshole Sonic Logging and any associated repair work required will be considered incidental to the Work, and no separate or additional payment will be made.

#### 3.7.2.3 Pile Concrete

Payment will be made in accordance with Section 4, Cast-In-Place Concrete.

#### 3.7.2.4 Reinforcing Steel

Payment will be made in accordance with Section 5, Reinforcing Steel.

### 3.7.3 Static Load Testing

Payment for static load testing will be made at the unit price bid per test for “Static Load Testing”, and will be full compensation for all labour, materials, equipment, tools and incidentals necessary to complete the testing to the satisfaction of the Consultant.

### 3.7.4 PDA Testing

Payment for PDA testing will be made at the unit price bid per test for “PDA Testing”, and will be full compensation for all labour, materials, equipment, tools and incidentals necessary to complete the testing to the satisfaction of the Consultant.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

## SECTION 4 CAST-IN-PLACE CONCRETE

TABLE OF CONTENTS

## 4.1 General

This specification includes requirements for the production, handling, sampling and testing, transporting, placing, curing, finishing and quality of cast-in-place concrete.

## 4.2 Materials

Materials originating from outside Canada or the United States of America intended for use in the production of concrete shall be tested to the required standard by a laboratory in Canada certified to CSA A283. A verification letter shall be provided by the certified laboratory and shall include references to the appropriate mill test report(s), material specification number(s), testing date(s), and statements indicating compliance of the material to the requirements of the Contract documents. Verification letters shall be signed and sealed by a Professional Engineer.

### 4.2.1 Hydraulic Cement

Hydraulic cement shall conform to the requirements of CSA Standard A3001. General Use (Normal) Type GU, or High Sulphate Resistant Type HS, or HSb shall be supplied unless otherwise specified.

As an alternative to Type HSb cement, concrete intended for placement in sulphate environments may be produced with combinations of Type GU cement and supplementary cementing materials provided current CSA A3004-C8 test data demonstrating compliance with CSA A3001 requirements for high sulfate resistance.

### 4.2.2 Supplementary Cementing Materials

#### 4.2.2.1 Silica Fume

Silica fume shall conform to the requirements of CSA Standard A3001 for a Type SF supplementary cementing material, with a minimum $SiO_2$ content of 85%, a maximum loss on ignition of 10% and maximum $SO_3$ content of 1%.

#### 4.2.2.2 Fly Ash

Fly ash shall conform to the requirements of CSA Standard A3001 for Type F fly ash with a maximum calcium oxide (CaO) content of 12%.

### 4.2.3 Water

Water to be used for mixing concrete, approved concrete patching materials, or concrete finishing materials, shall conform to the requirements of CSA Standard A23.1 and shall be free from harmful amounts of alkali, organic materials or deleterious substances. The Contractor shall not use slurry water, treated wash water or water from shallow, stagnant or marshy sources.

### 4.2.4 Aggregates

Fine and coarse aggregates shall conform to the requirements of CSA Standard A23.1.

### 4.2.5 Admixtures

Admixtures shall be compatible with all mix constituents. Water reducing agents and superplasticizers shall conform to ASTM C494. The addition of calcium chloride, air reducing agents or accelerators will not be permitted. Air entraining agents shall conform to ASTM C260.

The use of hydration stabilizing admixtures requires prior written acceptance of the Department and Consultant and their usage is limited to those projects where haul times are expected to exceed the specified times and/or projects which require hydration stabilization due to mass concrete placement considerations. Hydration stabilizing admixtures shall meet the requirements of ASTM C494 Type B and/or Type D.

Anti-washout admixtures shall conform to the US Army Corps of Engineers CRD-C 661.

### 4.2.6 Steel Fibres

When specified, the steel fibres shall be Novocon XR, Wiremix W50 or an acceptable equivalent. The fibres shall conform to ASTM A820/A820M-04 Type 1 or 5 and be 50 mm in length with the aluminum content no more than 0.020% by mass, when tested in accordance with test method Environmental Protection Agency (EPA) 3050B.

Steel fibres shall be free from balls and clumps at all times during their use in the work.

## 4.3 Storage of Materials

Cement, silica fume, fly ash and steel fibres shall be stored separately in a suitable weather tight building which shall protect these materials from moisture. Cement, silica fume and fly ash shall be free from lumps at all times during their use in the work.

Fine and coarse aggregates shall be stored separately. Aggregates secured from different sources shall be stored in separate stockpiles. The site of the stockpiles shall be cleaned of all foreign materials and shall be level and firm. If aggregates are placed directly on the ground, material within 150 mm of the ground level shall not be used and this material shall remain undisturbed to avoid contaminating the aggregate being used with the ground material.

All aggregates shall be handled in a manner that prevents segregation.

## 4.4 Class and Composition of Concrete

### 4.4.1 Class of Concrete

**Table 4-1: Classes of Concrete**

| Class of Concrete (4) | Minimum Specified Compressive Strength at 28 Days (MPa) | Nominal Maximum Aggregate Size(mm) | Range of Slump (6) (mm) | Total Air Content (5) (%) | Max. Water /Cementing Materials Ratio |
|---|---|---|---|---|---|
| C | 35 | 20 to 5 (1) | 100 ±30 | 5 - 8 | 0.40 |
| HPC (3) | 45 | 20 to 5 (2) | 120 ±30 | 5 - 8 | 0.38 |
| D | 30 | 14 to 5 | 100 ±30 | 5 - 8 | 0.42 |
| S | 20 | 20 to 5 (1) | 100 ±30 | 5 - 8 | 0.50 |
| Pile | 30 | 20 to 5 (1) | 130 ±30 | 5 - 8 | 0.42 |

Notes

(1) 28 to 5 mm nominal maximum coarse aggregate size may be utilized for Class C, Class S, or Pile concrete and shall be considered for mass concreting operations.

(2) When the thickness of deck overlay concrete is specified as 50 mm or less, the nominal maximum top size of aggregate shall be 14 mm.

(3) Class HPC concrete shall be used for all decks, deck overlays with internal reinforcement, curbs, barriers, medians, roof slabs, deck joint blockouts, approach slabs and MSE wall coping. Deck overlay concrete shall be Class HPC with steel fibres when no internal reinforcement exists.

(4) Fly ash shall not exceed 30% by mass of cementing materials. For High Performance Concrete (HPC) it shall be in accordance with Subsection 4.4.2, Class HPC and Class HPC with Steel Fibres. Fly ash may be used in concrete mixes where the aggregate is assessed to be potentially alkali-silica reactive.

(5) Range in air content to be in compliance with actual nominal maximum aggregate size as per Category 1, CSA A23.1 Table 4, Requirements for Air Content Categories.

(6) Slump ranges proposed by the Contractor that are outside those specified require acceptance from the Department.

(7) For MSE Wall panels, smaller aggregate may be required to suit panel design.

(8) Additional requirements for Class HPC and Class HPC with Steel Fibres are listed in Subsection 4.4.2, Class HPC and Class HPC with Steel Fibres.

(9) Sulphate resistance or other required durability properties will be outlined in the Special Provisions of the Contract.

### 4.4.2 Class HPC and Class HPC with Steel Fibres

Class HPC and Class HPC with Steel Fibres shall meet the following requirements:

(a) Mix shall include silica fume and fly ash as supplementary cementing materials in combination with compatible air entraining, water reducing and/or superplasticizing admixtures, as required.

(b) The gradation limits for the fine aggregate shall conform to CSA A23.1, except that the amount of material finer than 160 µm shall not exceed 5%.

(c) Coarse aggregate shall conform to CSA A23.1 and the maximum combination of flat and elongated particles (4:1 ratio), as determined by CSA A23.2-13A {Procedure A}, shall not exceed 10% of the mass of coarse aggregate.

(d) Minimum type GU cement content (excluding supplementary cementing materials) shall be 335 kg/m$^3$. Type HS cement shall not be used.

(e) Sum of silica fume and fly ash by mass of cementing materials shall be 17% to 20%.

(f) Silica fume by mass of cementing materials shall be 6% to 8%.

(g) Fly ash by mass of cementing materials shall be 11% to 15%.

(h) Resistance to chloride ion penetration shall be determined in accordance with ASTM C1202 on duplicate laboratory moist cured samples at 28 days. The average of all tests shall not exceed 1000 coulombs with no single test greater than 1250 coulombs. When only two test values are used to calculate the average coulomb rating, no test shall exceed 1000 coulombs. For HPC with steel fibres, testing shall be done without the presence of steel fibres.

(i) An air-void spacing factor shall be determined in accordance with ASTM C457, modified point-count method at 100 times magnification. The average of all tests shall not exceed 230 µm with no single test greater than 260 µm. When only two test values are used to calculate the average air-void spacing factor, no test shall exceed 230 µm.

(j) When Class HPC with steel fibres is specified, it shall contain 60 kg of 50 mm long steel fibres, per m$^3$. The Contractor shall provide test results of the aluminum content in the steel fibres, for the consultants review, a minimum of two weeks prior to placing concrete at site. When alternative steel fibres are proposed their equivalency and dosage rate shall be determined in accordance with ASTM C1609. The toughness ($T^{D}_{600}$) shall be greater than or equal to that determined for the specified fibre type and dosage rate.

### 4.4.3 Concrete Temperature at Discharge

The concrete temperature shall be between 10°C and 20°C, at discharge for Class HPC and Class HPC with steel fibres. The concrete temperature at discharge shall be between 10°C and 25°C for all other classes of concrete.

### 4.4.4 Concrete Mix Design Submission Requirements

The Contractor shall submit a concrete mix design review letter for each class of concrete specified in the Contract for the Consultant's review and acceptance a minimum of two weeks before concrete placement. A concrete mix design review letter is not required for concrete used in the construction of culvert collars or cut-off walls when culverts are less than three metres in diameter.

Concrete mix design review letters shall document compliance with all specification requirements for the associated class of concrete including an evaluation and summary of all mix constituents, material test reports, mix proportion quantities, and if applicable, trial batch test results, mass concrete design considerations, and portable batch plant batching procedures. The concrete mix design review letter shall be signed and sealed by a Professional Engineer registered in the Province of Alberta who is employed by a concrete testing laboratory certified to CSA A283.

When concrete suppliers request confidentiality of mix proportion quantities, the reviewing Professional Engineer, subject to a mutually agreeable confidentiality agreement with the concrete supplier, shall be granted full disclosure of mix proportion quantities such that a general mix proportioning discussion can be provided in the mix design review letter.

If in the Special Provisions of the Contract mass concrete mitigation measures are required, the Contractor shall develop and submit a mass concrete plan to the Consultant for review and acceptance. The mass concrete plan shall be submitted a minimum of two weeks before concrete placement and be signed and sealed by a Professional Engineer registered in the Province of Alberta. The mass concrete plan and the proposed mitigation measures shall be developed and consistent with the technical requirements outlined in the American Concrete Institute (ACI) 207.4R "Cooling and Insulating Systems for Mass Concrete". The mass concrete plan shall also describe the performance monitoring requirements and on-site response strategies to address varying thermal conditions.

Material test reports shall be current and fully represent materials to be used in production. For each mix design submission the source(s) of proposed aggregate(s) and aggregate analysis shall be provided as required in Table 4-2: Aggregate Analysis.

**Table 4-2: Aggregate Analysis**

| Aggregate Analysis | Standard | Required Frequency of Analysis (max. days prior to & during production) |
|---|---|---|
| Fine and Coarse Aggregate Sieve | (CSA A23.2-2A) (2) | 90 |
| Amount of material finer than 80 µm in aggregate | (CSA A23.2-5A) (2) | 90 |
| Organic Impurities in Sands for Concrete | (CSA A23.2-7A) (2) | 90 |
| Results of deleterious substances and physical properties of aggregates | (CSA A23.1 Table 12, CSA A23.1; A23.2-3A, A23.2-4A, A23.2-13A {Procedure A}, A23.2-23A, A23.2-24A A23.2-29A) (1) | 180 |
| Potential expansivity of aggregates | (CSA A23.2-14A) (1) | 24 months |
| Detection of alkali-silica reactive aggregate by accelerated expansion of mortar bars | (CSA A23.2-25A) (1) | 12 months |
| Petrographic Examination of Coarse and Fine Aggregate for Concrete | (CSA A23.2-15A) (1) | 180 |

Notes:

(1) Sampling and testing of aggregates shall be completed by a concrete testing laboratory certified to CSA A283.

(2) Sampling and testing of aggregates may be completed by a concrete testing laboratory certified to CSA A283 or by the aggregate supplier.

A break in production of a particular class of concrete shall not constitute the need for additional testing when the Contractor provides aggregate sieve analysis, organic impurities in sands for concrete, petrographic examination of aggregates, and letter of evaluation from the mix design review letter professional indicating that the material initially tested is still representative. Additional analyses shall be provided by the Contractor when requested by the Consultant to confirm that the mix constituents continue to meet specification requirements.

If the fine aggregate consists of a blend from more than one source, the fine aggregate sieve analysis shall show the gradation of the blended fine aggregates. Similarly in the case of blended coarse aggregates, the coarse aggregate sieve analysis shall indicate the gradation of the blended coarse aggregates.

Fine aggregate, tested in accordance with CSA Test Method A23.2-7A, “Organic Impurities in Sands for Concrete”, shall produce a colour not darker than the Standard colour (Organic Plate Number 3). Aggregate producing a colour darker than the Standard colour will be rejected in the absence of a satisfactory record of performance of a similar CSA exposure class of concrete (minimum 30 tests over the last 12 months); provisions 4.2.3.3.3.2 (a) & (b) of CSA Standard CAN A23.1-14 shall not apply. When testing in accordance with CSA Test Method A23.2- 2A and 5A fine aggregate shall not have more than 3.0% passing 80 µm sieve.

The potential for deleterious alkali-aggregate reactivity shall be assessed in accordance with CSA A23.2-27A. Test data less than 24 months after date of sampling shall be used to evaluate the potential alkali-silica reactivity of aggregates tested in accordance with CSA A23.2-14A or CSA A23.2-25A. Testing in accordance with CSA A23.2-28A may be utilized as part of the alkali-aggregate reactivity assessment. In the absence of test data, the aggregate shall be presumed to be highly reactive. The level of risk for alkali-aggregate reactivity assessment shall be for concrete exposed to humid air and the design service life shall be greater than or equal to 75 years (St4).

Petrographic analysis on the proposed fine and coarse aggregates shall be performed in accordance with CSA A23.2-15A by experienced personnel employed by a laboratory certified to CSA A283. The weighted petrographic number of the coarse aggregate shall not exceed 130, and the ironstone content shall not exceed 0.8%. Ironstone content in fine aggregate (material retained on the 2.5 mm sieve) shall not exceed 1.5% by total dry mass of fine aggregate for all classes of concrete except pile concrete. The petrographic analysis report shall be signed and sealed by a Professional Engineer, a Professional Geologist, or a Geological Engineer who is registered in the Province of Alberta.

### 4.4.5 Trial Batches

The Contractor is required to complete trial batch(es) for Class HPC, Class HPC with Steel Fibres, any class of concrete containing hydration stabilizing admixtures, and/or any class of concrete produced from a portable batch plant. The Contractor shall produce evidence satisfactory to the Consultant and the mix design reviewing Professional Engineer that the proportions selected will produce concrete of the quality specified. The trial batch(es) shall be performed a minimum of 35 days prior to placement of concrete at site. Each trial batch shall be a minimum of 3 $m^3$ or 50% of the rated mixer capacity (whichever is greater). The Contractor’s quality representative shall attend all trial batches. For multi-year projects, all trial batch testing shall be repeated annually.

#### 4.4.5.1 Class HPC and Class HPC with Steel Fibres

Slump retention shall be evaluated at 15, 30, 50, and 70 minutes after batching. Slump retention after 50 minutes shall be at least 50% of that measured at 15 minutes.

At 70 minutes from the time of batching, samples shall be cast to determine compressive strength at 7 and 28 days, rapid chloride ion penetration, and hardened air void system in accordance with the requirements of Subsection 4.4.2, Class HPC and Class HPC with Steel Fibres.

Shrinkage of the trial batch concrete shall be measured in accordance with CSA A23.2-21C. Shrinkage test results shall be submitted to the Consultant within seven days of test completion.

The trial batch concrete shall be placed into a 4.5 m x 4.5 m x 0.15 m thick form on grade. The Contractor shall consolidate, screed and finish the concrete such he can assess the mix's workability, finishability in accordance with all specification requirements.

#### 4.4.5.2 Hydration Stabilized Concrete Mixes

The design length of hydration stabilization shall be the difference of the project haul time and the specified allowable haul time (not exceeding 90 minutes) or that required by mass concrete pour considerations. The hydration stabilized mix design, including a detailed concrete batching procedure, shall be submitted and reviewed in accordance with Subsection 4.4.4, Concrete Mix Design Submission Requirements. The Contractor shall also submit a placement, finishing, and curing procedure with associated schedule details for the Consultants review and acceptance. Hydration stabilized concrete mixes demonstrating significant inconsistencies, as determined by the Consultant, shall require additional trial batch testing to demonstrate compliance.

Workability including, slump and air content, shall be assessed at 15 minutes after batching, quarter points of the design hydration stabilization period and at the design period. Testing to determine setting characteristics, compressive strength at 3, 7, and 28 days and hardened air void system shall be completed. Setting characteristics shall be determined in accordance with ASTM C403 and the time required to achieve penetration resistances of 0.5 MPa, 1.0 MPa and 3 MPa reported. Hardened air void systems shall meet the requirements of Subsection 4.4.2 (i), Class HPC and Class HPC with Steel Fibres. Trial batch(es) of Class HPC and Class HPC with steel fibres shall also meet the requirements for rapid chloride permeability. Shrinkage results shall be provided to the Consultant within seven days of test completion.

### 4.4.6 Mix Adjustments

If during the progress of the Work the concrete produced in accordance with the reviewed and accepted mix design is modified or found to be unsatisfactory on the basis of specification requirements, the Contractor shall resubmit a revised mix design review letter, in accordance with the requirements of Subsection 4.4.4, Concrete Mix Design Submission Requirements, to the Consultant for review and acceptance prior to continuing concrete operations. Discussion on the requirement for a new trial batch to address the issues identified shall be included in the revised mix design review letter.

## 4.5 Measurement of Materials

Coarse and fine aggregate materials shall be separated and measured separately by weighing, except as otherwise specified or where other methods are specifically authorized by the Consultant. The apparatus provided for weighing the aggregates and cement shall be suitably designed and constructed for this purpose. Each size of aggregate, and cementing materials, shall be weighed separately. The accuracy of all weighing devices shall be such that successive quantities can be measured to within one percent of the desired amount. The mixing water shall be measured by volume or by weight. The water measuring device shall be capable of control accurate to ±0.5% of the design quantity. All measuring devices shall be subject to acceptance. Unless otherwise accepted, air entraining agent and other admixtures shall be added to the mix in a water diluted solution; the dilution of the solution shall be accepted by the Consultant. For mix adjustments at the site, the Contractor shall maintain facilities to control the amount of superplasticizer and air entrainment so that the required tolerances can be met.

## 4.6 Mixing Concrete

### 4.6.1 General

Mobile continuous mixers or other such volumetric concrete supply equipment shall not be used.

Portable batch plants may only be used when reviewed and accepted by the Consultant and the Department. A comprehensive batching procedure shall be submitted to and reviewed by the mix design review professional in accordance with Subsection 4.4.4, Concrete Mix Design Submission Requirements. The concrete production rate shall be provided with the batching procedure.

Concrete shall be mixed thoroughly with all ingredients uniformly distributed. The Consultant may require that the uniformity of the mixed concrete be tested for conformance with CSA A23.1, Clause 5.2.3.5. The “Batch” is considered the quantity of concrete inside the mixer regardless of size of the mixer. The mixing period shall be measured from the time materials enter the mixing drum.

The Contractor shall in no case load the mixer above its rated capacity. The Contractor shall maintain the mixer in good condition. Inner surfaces of the mixer shall be kept free of hardened concrete and mortar. Mixer blades which are bent or worn down so as to affect the mixing efficiency shall be renewed. Any mixer, leaking mortar or causing waste of materials through faulty charging shall be taken out of service until repaired. The Contractor shall, at all times, operate the mixer at the speed recommended by the Manufacturer and shall, if requested, supply the Manufacturer's certification of the mixing capacity of the machine in use.

The mixer shall be fitted with an accurate and dependable means for measuring the water added, which is not affected by variation in pressure in the water supply line. All joints, valves and other parts shall be maintained so that there is no leakage of water into the mixer drum. Failure of the Contractor to have an accurately working and dependable water gauge on a mixer shall be cause for the Consultant to prohibit the mixer to be used.

Water shall be released first and continue to flow while other materials are entering the mixer. The water discharge pipe shall be so arranged and be of such size that the flow into the mixer is completed within the first quarter of the mixing time, and the water is delivered well within the mixer where it will be quickly mixed with the entire batch.

Air entraining agents and admixtures shall be placed in the mixer after the initial water is in the mixer drum but before the remaining materials are added. Superplasticizer shall be added after initial mixing and as per the Manufacturer's recommendation.

#### 4.6.2 Truck Mixing

Truck mixers, unless otherwise authorized by the Consultant, shall be of the revolving drum type, watertight, and so constructed that the concrete can be mixed to ensure uniform distribution of materials throughout the batch. All materials for the concrete shall be accurately measured in accordance with Subsection 4.5, Measurement of Materials and charged concurrently into the drum at the production plant, at the proportions satisfying the accepted mix design. Increases in the water to cementitious materials ratio will not be permitted.

Maximum size of the batch in truck mixers shall not exceed the maximum rated capacity of the mixer as stated by the manufacturer and stamped on the mixer. Truck mixing shall commence immediately upon introduction of ingredients into the drum and be continued for at least 70 revolutions with the mixing rate being in accordance with the Manufacturer's recommended rate, and shall be such as to thoroughly mix the concrete.

When adjustment to the mix by adding air entraining agent or superplasticizer at the site is authorized by the Consultant, the mixer shall rotate for a minimum of 70 additional revolutions to ensure homogeneity of the concrete before discharge. Discharge chutes shall be kept clean and free from hardened concrete and shall be wet prior to use.

#### 4.6.3 Time of Hauling

The maximum time allowed for all classes of concrete other than Class HPC and Class HPC with steel fibres including delivery to the site of the work and discharge shall not exceed 90 minutes after batching. For Class HPC and Class HPC with steel fibres this requirement is reduced to 70 minutes. In hot weather, or under conditions that accelerate setting of the concrete, these haul times may be reduced as determined by the Consultant. Batching of all classes of concrete is considered to occur when any of the mix ingredients are introduced into the truck mixer drum, regardless of whether or not the drum is revolved.

### 4.7 Delivery

The Concrete supplier shall have sufficient plant capacity and satisfactory transporting equipment to ensure continuous delivery at the rate required. The rate of delivery of concrete during concreting operations shall be such that cold joints do not occur. The methods of delivering and handling the concrete shall facilitate placing with a minimum of re-handling, and without damage to the structure or the concrete.

### 4.8 Pour Schedules

The Contractor shall inform to the Consultant of the proposed pour schedule and production rates for all concrete pours. If, in the opinion of the Consultant, the pour size is larger than can be poured with the methods proposed, the Contractor shall:

- Limit the amount to be poured at any time (using adequate construction joints); or
- Adjust his facilities in order to complete the proposed pour; or
- In case of continuous pouring, provide additional crews and have adequate lighting to facilitate proper placing, finishing and inspection.

### 4.9 Inspection and Testing

The Consultant shall be afforded full facilities for the random quality assurance inspection and testing that may be carried out relative to the concrete itself and/or the constituent materials. This includes at the worksite and any plant used for the manufacture of concrete wherever this may be situated. The facilities shall be adequate in the opinion of the Consultant to permit proper sampling of concrete, making of test cylinders and testing slump and air content. The proper storage of all site cast concrete cylinders in accordance with the relevant specifications is the responsibility of the Contractor.

The results of the quality assurance testing carried out by the Consultant will serve to monitor and review the quality control program of the Contractor.

The Contractor shall utilize ACI or CCIL/CSA certified testers with extensive related experience to test at site, the air content, density, slump and temperature of each batch; results of all such tests shall be provided to the Consultant. Additional tests will be required if the results are borderline or widely variable. In case of an unacceptable result, one check test will be permitted. The certified testers shall also cast the test cylinders as specified in Subsection 4.9.3, Test Cylinders.

The certified testers shall utilize the “Concrete Test Results” form contained at the end of this Section 4, Cast-In-Place Concrete. The completed forms shall accompany the concrete test cylinders to the testing laboratory.

The certification of the testers shall be current and available for examination by the Consultant.

The Contractor shall be responsible for all costs for concrete inspection and testing, including but not limited to making and curing test cylinders, transporting cylinders to an independent certified testing laboratory of his choice, storage, curing, strength testing, and providing written reports of the concrete test results to the Consultant.

### 4.9.1 Compressive Strength Tests

A compressive strength test shall consist of the four standard test specimens, sampled, made, cured, and tested in accordance with CSA Standards and as modified herewith. One cylinder shall be tested at 7 days. The 28 day test result shall be the average of the strengths of the remaining three specimens, except that if any specimen in a test showing distinct evidence of improper sampling, moulding or testing, shall be discarded and the remaining strengths averaged. Additional cylinders may be cast, at the discretion of the Consultant or Contractor.

For Class HPC the Contractor shall take a compressive strength test to represent each approximate 20 $m^3$ portion of the concrete pour, to a minimum of one compressive strength test for every two batches of concrete. For Class HPC with steel fibres the Contractor shall take a compressive strength test to represent each approximate 5 $m^3$ portion of the concrete pour or one compressive strength test for every batch of concrete, whichever is less. For all other concrete, the Contractor shall take a compressive strength test to represent each bridge element or portion of the element (i.e. abutment seat, abutment backwall, pier footing, pier cap etc.). On larger pours, a compressive strength test will be taken to represent each approximately 30 $m^3$ portion of the concrete pour, to a minimum of one compressive strength test for every three batches of concrete. Such tests shall be taken from representative batches as determined by the Consultant.

### 4.9.2 Sampling

Sampling of concrete shall be carried out in accordance with CSA Standard A23.2 1C, Sampling Plastic Concrete. When a concrete pump is used to place concrete, sampling shall be at the end of the discharge hose with the exception that when concrete is being placed underwater by tremie methods, sampling may occur at the pump’s hopper.

### 4.9.3 Test Cylinders

Making and curing concrete test cylinders shall be carried out in accordance with CSA Standard A23.2 3C, Making and Curing Concrete Compression and Flexural Test Specimens, except that the time for cylinders to reach the testing laboratory shall be between 20 and 48 hours. The test cylinders shall be cast by the Contractor in standard CSA approved heavy duty steel or plastic moulds. Plastic moulds shall have a wall thickness of at least 6 mm. The Contractor shall provide properly designed temperature-controlled storage boxes for test cylinders, as specified in Subsection 8.3.2.1 of CSA Standard A23.2 3C, Making and Curing Concrete Compression and Flexural Test Specimens, for a period of not less than 24 hours, and further protection, as required, from adverse weather and mishandling until removed from the site. The Contractor shall provide a max-min thermometer for each storage box and record site curing temperatures for all test cylinders. Storage in a portable building which will be used by Contractor's personnel or the Consultant during the first 24 hour storage period will not be permitted. Storage facilities shall be provided, installed, and accepted by the Consultant before any concrete is placed.

The Contractor shall be responsible to deliver the test cylinders to an independent CSA certified testing laboratory. Handling and transporting of the cylinders shall be in accordance with CSA Standard A23.2 3C, Making and Curing Concrete Compression and Flexural Test Specimens. No extra laboratory curing time shall be allowed for cylinders that are delivered late to the laboratory. For Class HPC and HPC with steel fibres, the ends of cylinders shall be ground flat prior to testing. A copy of the test results shall be forwarded to the Consultant and Concrete Producer within 2 days of the break date.

If the test cylinders exhibit frost etchings or were stored at temperatures below 10°C or above 25°C, or are otherwise mishandled resulting in unreliable compressive strength test results, the Department or Consultant may reject these portions of the Work, unless core testing, at the Contractor's expense confirms the in situ strength of the concrete.

The Contractor shall also be responsible for costs for supplying CSA approved heavy duty steel or plastic moulds, curing and delivering test cylinders cast by the Consultant, for quality assurance purposes to the same independent certified testing laboratory that he selects. Quality assurance testing may be carried out by the Consultant and costs for testing and provision of concrete test cylinder reports will be paid for by the Department.

#### 4.9.4 Slump Testing

Slump tests shall be carried out in accordance with CSA Standard A23.2 5C.

#### 4.9.5 Air Content and Density Testing

Air content and density testing shall be carried out in accordance with CSA Standard A23.2 4C and A23.2 6C respectively.

#### 4.9.6 Compressive Strength Testing

Compressive strength testing shall be carried out in accordance with CSA Standard A23.2 9C by an independent CSA certified engineering laboratory engaged by the Contractor.

#### 4.9.7 Failure to Meet Slump or Air Content Specifications

In the event that slump and/or air content are outside the specified tolerance range, as determined by the Contractor's or the Consultant's testing, the Consultant may, accept adjustments of the deficient condition as an alternate to rejection provided adjustments are made within the maximum time allowed as specified in Subsection 4.6.3, Time of Hauling. Concrete that does not meet the specifications will be rejected after the maximum time is exceeded.

The Contractor will be allowed to adjust only the quantities of superplasticizer and air entraining agent. In no case shall an accepted batch adjustment relieve the Contractor of his responsibility for the eventual durability, strength, and acceptability of the concrete concerned. The Department or Consultant reserves the right to reject any batch in the event of confirmed unacceptability, and to require immediate removal of any rejected concrete which might have already been placed in the structure.

#### 4.9.8 Portable Batch Plants

The Contractor shall provide full time experienced and competent personnel to operate, maintain and continuously monitor portable batch plant operations.

The Contractor shall provide the qualifications of the portable batch plant supervisor to the Consultant for review and acceptance. The portable batch plant supervisor shall monitor concrete production at the portable batch plant at all times.

## 4.10 Falsework and Formwork

### 4.10.1 General

Detailed falsework and formwork drawings shall be supplied to the Consultant for review and examination as to concept only. The drawings shall be submitted three weeks before construction commences. The drawings shall be sealed by a Professional Engineer registered in the Province of Alberta, who shall assume full responsibility to ensure that his design is being followed in construction of the falsework and formwork. Compliance with the Occupational Health and Safety Act and Regulations therein, shall be integral parts of the design. All falsework and formwork shall be fabricated in accordance with the drawings.

The Contractor shall make every effort to accurately position formwork against hardened concrete so as to avoid form lines and discontinuities at the construction joint. Construction tolerances for formwork misalignments are outlined in Subsection 4.24.1, Honeycomb, Cavities, Casting Defects.

### 4.10.2 Design

For the design of falsework and formwork, the density of fresh concrete shall be assumed to be 2400 kg/$m^3$. All forms shall be of wood, metal or other acceptable materials, and shall be designed and built mortar tight and of sufficient rigidity to prevent distortion due to the pressure of vibrated concrete and other loads incidental to the construction operation. The forms shall be substantial and unyielding, and shall be designed so that hardened concrete will conform to the design dimensions and alignments. The shape, strength, rigidity, water tightness and surface smoothness of re used forms shall be maintained at all times. Any warped or bulged formwork must be repaired or replaced before being used. Forms which are unsatisfactory in any respect shall not be used.

All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads without appreciable settlement or deformation. Falsework which cannot be founded on a satisfactory footing shall be supported on piling which shall be spaced, driven and removed in a manner acceptable to the Consultant.

For timber formwork, drawings shall specify the type and grade of lumber and show the size and spacing of all members. The formwork drawings shall also show the type, size and spacing of all ties or other hardware, and the type, size and spacing of all bracing.

When forms appear to be unsatisfactory in the opinion of the Consultant, either before or during the placing of concrete, the Consultant will order the work stopped until the defects have been corrected.

For narrow walls and columns, where the bottom of the form is inaccessible, removable panels shall be provided in the bottom form panel to enable cleaning out of extraneous material immediately before placing the concrete.

### 4.10.3 Formwork for Exposed Surfaces

Formwork for exposed surfaces which require a Class 1, Ordinary Surface Finish, shall be made of good quality plywood, or an acceptable equivalent, of uniform thickness, with or without a form liner.

Formwork for exposed surfaces requiring a Class 2, Rubbed Surface Finish or Class 3, Bonded Concrete Surface Finish, shall be all new material, made of coated formply, consisting of Douglas Fir substrate with resin-impregnated paper overlay and factory treated chemically active release agent. Formwork proposed for re use shall be free of holes or patched holes in plywood or form liner surfaces, bulging, delaminations, damage, or other imperfections that affect the trueness of the formed concrete surfaces.

Any proposed re use of formwork must be accepted by the Consultant.

All formwork material for exposed surfaces shall be full sized sheets, as practical.

All formwork for exposed surfaces shall be mortar tight, filleted at all sharp corners, and given a bevel or draft in the case of all projections. At the top edges of exposed surfaces, the chamfers are to be formed by chamfer strips.

For exposed concrete elements where the pour height is 1.5 m or less, the minimum formwork requirements shall be 18 mm approved plywood supported at 300 mm maximum on centres. Where the pour height is greater than 1.5 m, minimum formwork requirements shall be 18 mm approved plywood, “Coated Formply”, supported at 200 mm maximum on centres. The support spacing specified here assumes the use of new material. Closer spacing may be required in case of re used material. Strong backs or walers placed perpendicularly to the supports shall be employed to ensure straightness of the form.

Metal bolts or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 20 mm from the concrete surface. Break back type form ties shall have all spacing washers removed and the tie shall be broken back a distance of at least 20 mm from the concrete surface. All fittings for metal ties shall be of such design that, upon their removal, the cavities which are left will be of the smallest possible size. Torch cutting of steel formwork hardware at concrete surfaces will not be permitted. All cavities created from ties or associated hardware removal shall be filled with an approved concrete patching material from the Department’s Product List in the Vertical/Overhead (OH-V) category and placed in accordance with the manufacturer’s published product data sheet.

When plastic sleeves and removable inner rods are used, the plastic sleeve shall be removed for a distance of 100 mm from the face of the concrete except for curbs, barriers and medians where the entire plastic sleeve shall be removed. The cavity shall be filled with an approved non-shrink grout to 75 mm from the concrete surface and cured a minimum 24 hours. The remaining 75 mm of the cavity shall then be filled with an approved concrete patching material. When fibre reinforced polymer rods are used they shall be removed a distance of 75 mm back from the face of the concrete and filled with an approved concrete patching material from the Department’s Product List in the Vertical/Overhead (OH-V) category and placed in accordance with the manufacturer’s published product data sheet.

#### 4.10.4 Formwork for Unexposed Surfaces

The minimum acceptable formwork for unexposed concrete shall have 15 mm plywood supported at 400 mm maximum on centres.

#### 4.10.5 Standard Details

The Contractor shall use the standard details shown on Standard Drawings S-1412, Standard Construction Joints, S-1838, Standard Waterproofing System For Deck and Abutments - Sheet 1, S-1839, Standard Waterproofing System For Deck and Abutments - Sheet 2, and S-1840, Standard Waterproofing System For Deck and Abutments - Sheet 3.

#### 4.10.6 Deck Formwork

Where construction loads or loading conditions proposed by the Contractor vary from those shown on the Drawings, the Contractor shall be responsible for all measures required to maintain girder stability and alignment.

After girder elevations at the abutments, piers and splice locations have been reviewed and accepted by the Consultant, the Contractor shall survey all girders at locations corresponding with those detailed on the camber diagram and determine girder haunch dimensions required to achieve design grades. The survey data shall be submitted to the Consultant for review and acceptance of the calculated deck thickness, grades, and haunch dimensions a minimum of 3 days prior to the commencement of deck reinforcing steel placement. If the design haunch dimensions vary more than allowable girder fabrication tolerances, the Contractor may revise grades with the acceptance of the Consultant.

The Contractor shall design and install support brackets such that no damage to girder flanges and webs will result. Where required, deck formwork design shall include any additional bracing system to those shown on the Drawings. Effects of concentrated loads on thin webs shall be checked, and where necessary, sufficient means shall be provided to distribute or carry such concentrated loads to the supporting flanges or stiffeners. Where brackets bear against girder webs, the Contractor shall protect the contact surface with timber or neoprene softeners. No drilling of additional holes, or any other modifications including field welding, shall be made to the superstructure elements.

Formwork for decks, curbs, sidewalks and parapets shall be fabricated so that the lines and grades shown on the drawing are achieved, with adjustments made where necessary to compensate for variances in girder dimensions, positioning, alignment and sweep.

Formwork hangers or ties for exposed surfaces of decks, including underside surfaces, shall be removable threaded type. No portion of the hardware associated with deck or deck overhang formwork shall be visible after all formwork has been removed. All cavities resulting from threaded rod removal along the underside of deck overhangs shall be adequately prepared and filled with an approved concrete patching material from the Department's Product List in the Vertical/Overhead (OH-V) category. Deck overhang patches shall be placed level with adjacent surfaces and be similar in colour and texture. For interior bays, all cavities resulting from threaded rod removal shall be filled with Sikaflex 15LM or an approved equivalent. The caulked surface shall be placed level with adjacent surfaces and be similar in colour.

## 4.11 Protection of "Weathering" Steel Girders

Where steel girders are fabricated of "weathering" steel, it is essential that the uniformity of rust formation is not adversely affected by the Contractor's work.

The Contractor shall exercise utmost care and provide the necessary protection to prevent marking or staining of the girders. All joints between deck formwork and steel members (including interior girders, and diaphragms) shall be sealed to prevent leakage of cement paste or concrete. Polyurethane sealant or approved equivalent materials shall be used to achieve the seal.

If foreign material spills onto the girders despite the protection provided, the Contractor shall clean off, wash, and lightly abrasive blast the contaminated areas, to the satisfaction of the Consultant.

If the exterior fascia web and flanges of an exterior girder becomes contaminated with foreign material, stained or marked, the Contractor shall clean off, wash and abrasive blast the exterior fascia web and flanges and weather the surfaces such that uniformity of girder colour is achieved. Weathering shall be achieved by repeatedly fogging the exterior girder faces with clean water and then, allowing to dry. Fogging shall leave girder surfaces wet but not running wet, and be repeated when the girders are completely dry until a finish acceptable to the Department is achieved.

The cost of sealing and stain prevention shall be included in the unit price bid for the deck concrete; no separate or additional payment will be made for the cost of protecting the girders, nor for any cleaning, sandblasting or "weathering" made necessary by the Contractor's work.

## 4.12 Protection of Concrete Work and Bridge Elements from Staining

The Contractor shall take precautions to protect all concrete work and bridge elements from staining. If staining occurs it shall be removed to the full satisfaction of the Consultant. Stained concrete surfaces that have received a Class 3 finish shall have the entire surface face of the component sandblasted and the Class 3 finish reapplied. Stained concrete surfaces that have received a Class 2 finish shall have the entire surface face of the component refinished. There shall be no trace of staining after the specified concrete finishing is completed.

## 4.13 Removal of Falsework, Forms and Housing

Forms and their supports shall not be removed without the review and acceptance of the Consultant. In determining the time for the removal of falsework, forms and housing, and the discontinuance of heating, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the curing of the concrete, and the materials used in the mix.

The following guide for removal of forms and supports may be used if the temperature of the concrete is maintained at no less than 15°C and review and acceptance of the Consultant is received:

| Portion of Work | Age or Minimum Strength |
|---|---|
| Arches and girders | 14 days or 80% of 28 day strength |
| Pier caps and beams | 5 days or 50% of 28 day strength |
| Columns | 1 to 3 days |
| Decks & Slabs | 5 days or 50% of 28 day strength |
| Vertical faces less than or equal to 3 m in height | 12 to 24 hours |
| Vertical faces over 3 m in height | 2 days |

Supports and forms may be removed from arches, girders, deck, pier caps and beams earlier than the minimum curing periods specified above, with the Consultant's acceptance. In seeking acceptance the Contractor shall, at his own expense, furnish evidence satisfactory to the Department and Consultant that the strength of the concrete in place has attained the above noted percentage of the specified 28 day strength before removal.

Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.

All formwork shall be removed from the completed structure.

## 4.14 Handling and Placing Concrete

### 4.14.1 General

The Contractor shall provide the Consultant with a minimum of two days advance notice of a concrete pour date or a change to a pour date.

The method of concrete placement shall have a consistent, minimal impact on the concrete properties. All equipment proposed for use in mixing, conveying, placing and compacting the concrete shall be reviewed and accepted by the Consultant prior to its use. All the necessary equipment for any particular pour shall be on site and proven to be in working condition before the pour commences, with backup equipment on site as determined by the Consultant. The equipment shall be well maintained, suitable for the intended purpose and adequate in capacity for the work.

In preparation for the placing of concrete, all sawdust, wood chips and other construction debris and foreign materials shall be removed from the interior of forms. Struts, spreaders, stays, and braces, serving temporarily to secure the forms in correct shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the forms and not buried in the concrete.

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. When depositing concrete by mixer truck chute, concrete pump or crane and bucket, the free fall of the concrete shall not exceed 1 metre. Concrete placement in elements containing multiple layers reinforcing steel shall be completed such that the concrete is not deposited on upper layers of reinforcing steel.

Concrete for the structure shall be deposited in the forms in the order indicated on the Drawings, and each portion placed between construction joints shall be placed in one continuous operation. No other order of pouring shall be done unless otherwise accepted by the Consultant.

Concrete placing operations shall not work off, or transport concrete directly over concrete previously placed without the acceptance of the Consultant.

### 4.14.2 Consolidation

Concrete, during and immediately after depositing, shall be thoroughly consolidated. The consolidation shall be done by mechanical vibration, and subject to the following provisions:

- The vibration shall be internal unless special authorization of other methods is given by the Consultant, or the Consultant requests the use of other method(s);
- Vibrators shall be of a type and design acceptable to the Consultant. They shall be capable of transmitting vibrations to the concrete at frequencies of not less than 4500 impulses per minute;
- The intensity of vibration shall be such as to visibly affect a mass of concrete of 25 mm slump over a radius of at least 0.5 m;

- The Contractor shall provide a sufficient number of vibrators to properly compact each batch, immediately after it is placed in the forms;
- Vibrator operators shall be suitably instructed in the use of vibrators, and the importance of adequate and thorough consolidation of the concrete;
- Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and imbedded fixtures and into the corners and angles of the forms. Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted vertically and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued so as to cause segregation. Application of vibrators shall be at points uniformly spaced and not farther apart than the radius over which the vibration is visibly effective;
- Vibration shall not be applied directly or through the reinforcement of sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration;
- Vibrators shall not be used to transport concrete within forms or made to flow over distances resulting in segregation; Vibration shall be supplemented by spading as is necessary to ensure smooth and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators; and
- Once vibrated the Contractor shall not disturb the concrete, step into the concrete or add additional concrete after vibration.

### 4.14.3 Additional Requirements

When concrete placing is discontinued, for whatever reason, all accumulations of concrete or concrete paste deposited on projecting reinforcing steel and the form surfaces shall be removed. Accumulations shall be removed prior to the concrete or concrete paste becoming set. Care shall be taken during cleaning such that the concrete to steel bond is not adversely affected.

Concrete shall be placed while fresh and before it has taken its initial set. Partially hardened concrete shall not be tempered. Concrete that does not reach its final position in the forms within the time limits specified shall not be used.

After initial set of the concrete, the forms shall not be jarred or any strain placed on the ends of projecting reinforcing bars.

Concrete which would be adversely affected by the presence of freestanding water shall be protected to prevent its occurrence, and the Contractor shall take whatever steps may be necessary to prevent free water build up in the event of unexpected rainfall or similar occurrences for the first 24 hours.

Water used to keep equipment clean during the pour or to clean equipment at the end of the pour shall be discharged in a designated area acceptable to the Consultant.

#### 4.14.4 Pumping

The operation of the pump shall produce a continuous flow of concrete without air pockets. The equipment shall be so arranged such that the freshly placed concrete is not damaged by pump vibration. When pumping is complete, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination or segregation of the concrete.

## 4.15 Placing Pile Concrete

Pile concrete shall be placed in accordance with Section 3, Foundation Piles.

## 4.16 Placing HPC Concrete and HPC Concrete with Steel Fibres

### 4.16.1 General

HPC concrete and HPC concrete with steel fibres shall not be placed when the air temperature is below 5°C, or is expected to fall below 5°C during the curing period, or when the air temperature is above 25°C, or in the event of rain or excessive wind or dust, or when there are other conditions detrimental to the concrete as determined by the Consultant.

HPC concrete and HPC concrete with steel fibres shall be placed between the hours of 6:00 pm and 10:00 am of the following day, unless reviewed and accepted by the Department and Consultant. Lighting is required for night pours and shall be reviewed and accepted by the Consultant. HPC concrete and HPC concrete with steel fibres shall not be placed when the evaporation rate exceeds 0.5 kg/m$^2$/hr. The evaporation rate shall be determined using Figure D.1, of CSA A23.1 – Annex D. The rate of evaporation shall be recorded as concrete placing operations progress and the Contractor shall make all necessary adjustments to ensure the evaporation rate does not exceed the specified limit.

The temperature of the concrete during discharge shall be between 10°C and 20°C unless reviewed and accepted by the Consultant. The temperature of the mix shall be maintained below the 20°C maximum temperature by the inclusion of ice to the mix which shall not alter the design water cementing materials ratio. Prior to placing concrete, substrate surfaces shall be brought to a saturated surface dry condition with clean water meeting the requirements of Subsection 4.2.3, Water. Substrate surfaces shall be free of standing water.

A construction milestone meeting shall be scheduled by the Contractor for deck and deck overlay concrete. The Contractor shall submit a deck or deck overlay concrete procedure to the Consultant for review and acceptance a minimum of 2 weeks prior to the scheduled construction milestone meeting. The deck pour procedure shall include, but not be limited to, documentation outlining compliance with specification requirements. The Contractor's project manager, field superintendent, and concrete finishing supervisor shall attend a construction milestone meeting at a location determined by the Consultant a minimum of one week prior to commencement of concrete placement.

All deck concrete and deck overlay concrete shall be consolidated in accordance with Subsection 4.14.2, Consolidation, even when vibratory drum type placing/finishing machines are used.

All reinforcing steel projecting from deck surfaces (barriers, curbs, medians, and adjacent deck pour sequence stages) shall be covered during deck concrete placement, consolidation, screeding, and testing operations such that it is not contaminated with concrete or concrete paste.

Deck and deck overlay concrete shall be screeded using one of the following concrete placing/finishing machines or an equivalent acceptable to the Department:

- Terex Bidwell Models: 2450, 3600, 4800;
- Gomaco Models: C450, C750; or
- Allen Models: 4836 B, 6036 B, 6048 B.

The Contractor shall provide two work bridges, separate from the placing/finishing machine, of adequate length to completely span the width of the pour. The work bridges shall facilitate the operations of concrete finishing and placement of filter fabric and shall also be made available to the Consultant for straight edge checking. The work bridges shall be supported parallel to the concrete surface, between 250 mm and 600 mm above the concrete surface, and shall provide an unobstructed working surface that is wide enough to permit diverse uses concurrently and rigid enough that dynamic deflections are negligible, as determined by the Consultant. Work bridges shall include specialized work platforms to facilitate concrete finishing in front of curbs, barriers or medians.

### 4.16.2 Screed Guide Rails and Supports

Steel screed guide rails and supports shall be installed to suit the profile of the required surface and to ensure a smooth and continuous surface from end to end of the bridge. Guide rails shall extend beyond the end of the bridge and the entire deck surface shall be screeded with the deck placing/finishing machine. Guide rails and guide rail supports shall not be located within any concrete pour.

### 4.16.3 Dry-Run

The finishing machine shall be set-up to match the skew angle of the bridge, when the skew angle exceeds 15°. For skewed bridge structures on vertical curves this requirement may be altered to suit actual site conditions.

The deck finishing machine shall be dry-run and measurements taken to determine deck thickness and reinforcing steel cover at locations corresponding with those detailed on the camber diagram. Adjustment of the deck finishing machine and/or guide rails shall be completed such that the design grades, deck designed thickness and reinforcing steel concrete cover are achieved. The deck finishing machine or guide rails shall not be adjusted after the dry-run has been completed and the results have been reviewed and accepted by the Consultant. If the finishing machine is adjusted for any reason after acceptance, the dry-run, including all checks, shall be repeated.

Where screed rails are supported on cantilevered formwork that may deflect under the weight of the fresh concrete and the deck finishing machine, the Contractor shall pre-load a test section of the cantilevered formwork on each side of the bridge to determine deflections occurring during concrete placement. The formwork, machine and/or screed rails shall be adjusted to compensate for the expected formwork deflection.

#### 4.16.4 Screeding Concrete

Concrete shall be placed as close as practical ahead of the finishing machine, and at no time more than 6 m in front of the trailing end of the finishing machine's roller.

The screed shall be moved slowly and at a uniform rate. The direction of concrete placement shall be from the low end of the bridge to the high end. A roll of concrete shall be maintained along the entire front of the screed at all times to ensure the filling and consolidation of the concrete surface. The contractor shall also ensure that the required concrete thickness is being placed by continually probing the concrete behind the finishing machine.

Screeding shall be completed in no more than two passes.

Screeded surfaces shall not be walked on or otherwise damaged.

#### 4.16.5 Bull Floating/Surface Texturing

The concrete surface produced behind the finishing machine shall be manually bull floated with a magnesium bull float to ensure that the surface is free from open texturing, plucked aggregate and local projections or depressions. Bull floating and surface texturing shall follow as close as practically possible behind the screed. Concrete finishing shall be completed by an individual who has completed the ACI Concrete Flatwork Finisher Certification Program or under the direct supervision of a certified journeyman concrete finisher.

Evaporation reducer or water shall not be finished into the concrete at any time during finishing operations.

The Contractor shall check the concrete surface with a 3 m long expanded polystylene straight edge immediately after final bull floating and before texturing or application of evaporation reducer to ensure the required surface tolerances are met. Concrete surfaces that do not meet the surface tolerances described in Subsection 4.16.6, Surface Defects and Tolerances shall be corrected while the concrete is still plastic and before curing procedures are implemented.

#### 4.16.6 Surface Defects and Tolerances

The finished surface of the concrete shall conform to the design gradeline indicated on the Drawings. The details of any proposed gradeline modifications shall be submitted to the Consultant for review and acceptance. For any required corrective work the Contractor shall submit a repair procedure for review and acceptance by the Department and Consultant one week prior to commencement of the work.

The surface shall be free from open texturing, plucked aggregate and local projections.

Except across the crown, the surface shall be such that when checked with a 3 m long straight edge placed anywhere in any direction on the surface, there shall not be any gap greater than 3 mm between the bottom of the straight edge and the surface of the deck concrete. Areas with surface defects or do not meet the required surface tolerances will be clearly marked out by the Consultant and the Contractor shall at his expense:

- Remove and replace areas where the deviation exceeds 10 mm from the correct surface. As a minimum, the Contractor's repair procedure shall include saw cuts 25 mm deep in neat perpendicular lines and concrete removed to a depth of 35 mm below the top mat of reinforcing steel. Repair areas shall be roughened to remove all loose material and laitance. Exposed reinforcing steel shall be cleaned and repaired to its original condition. Repair areas shall be saturated with water for a period of 24 hours prior to concrete placement. Repair areas shall be free of standing water and surface dry immediately prior to placing class HPC concrete. Curing shall be in accordance with the requirements for class HPC concrete;
- Grind down any areas higher than 3 mm but not higher than 10 mm above the correct surface; or
- Correct any areas lower than 3 mm but not lower than 10 mm below the correct surface, by grinding down the adjacent high areas.

Concrete surfaces that are damaged in any way by construction operations, or show signs of distress or scaling shall be repaired or replaced by the Contractor at his expense.

## 4.17 Placing Approach Slab and Roof Slab Concrete

After properly placing and consolidating the concrete, it shall be struck off and screeded to conform to the required cross section and grade. Concrete placing shall be carried out in a manner such that the newly deposited concrete is continually placed against fresh concrete across the entire face of the pour and the formation of cold joints is avoided. A slight excess of concrete shall be kept in front of the screed at all times.

The screeded concrete surface shall then be manually bull floated longitudinally, transversely or in both directions as necessary to ensure that the surface is free from open texturing, plucked aggregates, and local projections or depressions. Evaporation reducer or water shall not be added to the concrete at any time during finishing operations.

The surface shall be such that it does not vary by more than 3 mm from the required lines, under a 3 m straightedge placed anywhere, in any direction except across the crown.

## 4.18 Concreting Shear Keys and Diaphragms

Form work for shear keys and diaphragms shall be designed to accommodate variations in girder dimensions, positioning, alignment, camber and sweep. Girder keyways and diaphragms shall be brought to a saturated surface dry condition prior to concrete placement. Saturation with water shall not be less than 30 minutes prior to blowing free of standing water. Concrete placed in the keyways shall be adequately consolidated and trowelled smooth and level with the top surfaces of the girders. Immediately after trowelling, two layers of clean Nilex 4504 white coloured filter fabric or an approved equivalent shall be placed on the shear keys and kept continuously wet for 72 hours.

## 4.19 Concrete Slope Protection

A minimum of one week prior to commencing concrete slope protection Work, the Contractor shall submit a detailed layout and forming plan to the Consultant for review and acceptance. The detailed layout and forming plan shall comply with Standard Drawing S-1409, Standard Concrete Slope Protection and these specifications.

All thickness measurements indicated herein are perpendicular to the top of concrete slope surface.

The slopes to be covered with concrete slope protection shall be trimmed and dressed by the Contractor to within 150 mm of the lines and grades shown on the Drawings. The Contractor shall supply and place Des 2 Class 25 crushed aggregate material to the thicknesses shown on the Drawing over the trimmed slopes. Crushed aggregate material shall conform to the requirements of Section 2, Backfill.

Where slopes have been constructed by others, and excavation exceeding 250 mm or fill exceeding 150 mm is required due to discrepancies in position of the original surface, excavation beyond the 250 mm tolerance limit and/or fill beyond the 150 mm tolerance limit will be considered to be Extra Work. Depending upon the circumstances of the particular project the Department and the Consultant may vary the specified concrete grades so as to minimize the amount of remedial trimming required. Excavation up to 250 mm and/or fill up to 150 mm will be considered as included in the bid price.

Concrete for slope protection shall be Class C.

Reinforcing steel shall plain reinforcing steel and in accordance with Section 5, Reinforcing Steel. The Contractor's method of securing and maintaining the reinforcing in its proper location shall be submitted and to the Consultant for review and acceptance a minimum of 1 week prior to commencement of the Work.

The concrete shall be placed in either horizontal or vertical courses, with one course being allowed to cure for at least 12 hours before the adjoining course is placed. Formwork shall be provided below and above the reinforcing to ensure proper slab thickness, correct positioning, and the formation of proper cold joints between courses. Vertical or horizontal joints shall be formed or grooved 50 mm to the depth of the reinforcing. All joints shall be finished with suitable edging and grooving tools and left unfilled. The concrete surfaces shall be given a Class 5 finish prior to edging and grooving. Finishing work shall be carried out by competent and experienced personnel only.

Backfill along the sides of concrete slope protection shall be non-granular, conforming to the requirements of Section 2, Backfill and shall not be placed until the completed concrete slope protection has been reviewed and accepted by the Consultant.

## 4.20 Construction Joints

### 4.20.1 General

Construction joints shall be made only where indicated on the Drawings unless reviewed and accepted by the Consultant.

If not detailed on the Drawings, or in the case of emergency, construction joints shall be installed in accordance with Standard Drawings S-1412, Standard Cast-In-Place Concrete Construction Joints or as determined by the Consultant. Shear keys or inclined reinforcement shall be used where necessary to transmit shear, or to bond the two sections together. Construction joints shall be located to allow a minimum of 60 mm concrete cover on reinforcing steel running parallel to the joint.

### 4.20.2 Bonding

Before depositing new concrete on or against concrete which has hardened, the forms shall be retightened and the surface of the hardened concrete shall be thoroughly cleaned to remove laitance or other foreign materials. The hardened concrete surface shall then be blown clean with compressed air and saturated with water meeting the requirements of Subsection 4.2.3, Water. Immediately prior to placement of new concrete against hardened concrete the saturated surface shall be blown clean with compressed air such that no standing water is present.

The placing of concrete shall be carried out continuously from joint to joint. The face edges of all joints which are exposed to view shall be carefully finished true to line and elevation.

## 4.21 Concreting in Cold Weather

In addition to the requirements of Subsection 4.23, Curing Concrete, when the air temperature is, or is expected to be below 5 °C as forecasted by the closest Environment Canada Meteorological Station during the placing and curing period, or when determined by the Consultant, a cold weather concreting plan shall be implemented. The Contractor shall submit details of his proposed cold weather concreting plan to the Consultant for review and acceptance a minimum of two weeks prior to any concrete placement. The Contractor's concreting plan shall incorporate the following requirements:

(1) All aggregate and mixing water shall be heated to a temperature of at least 20°C but not more than 65°C. The aggregates may be heated by either dry heat or steam; in the latter case the quantity of mixing water may need to be reduced. The temperature of the concrete shall be in accordance with Subsection 4.4.3, Concrete Temperature at Discharge, at the time of placing in the forms. In the case of mass pours, the Consultant may alter the temperature requirements to suit.

(2) The Contractor shall enclose the structure in such a way that the concrete and air within the enclosure can be kept at or above 15°C for a protection period of 7 days after placing the concrete. Enclosures shall be constructed with a minimum 300 mm clearance between the enclosure and the concrete.

For class HPC or HPC with steel fibres the 7 day protection period shall be increased to 17 days (14 days wet curing and 3 days of air drying). The enclosure for class HPC or HPC with steel fibres shall be constructed large enough to comfortably accommodate workers and equipment necessary to place, finish and cure the concrete. The underside of bridge decks shall be suitably enclosed and heated.

The relative humidity within the enclosure shall be maintained at not less than 85%. Heaters must be kept well clear of the formwork housing. Adequate ventilation is required to provide air for combustion, and to prevent the accumulation of carbon dioxide. The use of salamanders, coke stoves, oil or gas burners and similar spot heaters which have an open flame and intense local heat is prohibited without the Consultant's specific acceptance.

The system of heating, and positioning of steam outlets, heaters, and fans, shall be designed to give the most uniform distribution of heat possible.

(3) Before placing concrete, adequate pre heat shall be provided to raise the temperature of formwork, reinforcing steel, previously placed concrete, substrate surfaces, and/or soil to between 10°C and 20°C.

(4) When reviewed and accepted by the Consultant, fully insulated formwork may be considered an alternative to providing heat during the curing period. The Contractor shall design and insulate the formwork such that the initial heat of the mix and the heat generated during hydration processes will maintain the specified curing conditions throughout the curing period. If the insulated formwork fails to maintain the specified conditions, the Contractor shall immediately implement measures to restore them.

(5) Concrete curing shall be in accordance with the requirements of Subsection 4.23, Curing Concrete.

(6) The adequacy of protection shall be monitored and recorded a minimum of every 4 hours for the first 72 hours and every 8 hours for the remainder of the curing period, including measurement of internal and surface concrete temperatures. The protective measures shall be modified as necessary to maintain the specified conditions.

(7) Protection and heating, when used, shall be withdrawn in such a manner so as not to induce thermal shock stresses in the concrete. The temperature of the concrete shall be gradually reduced at a rate not exceeding 10 °C per day to that of the surrounding air. To achieve this, in an enclosure, the heat shall be slowly reduced. The temperature differential between the core of the element and the surface of the element shall not exceed 20 °C. In addition the temperature differential between the surface of the element and the ambient air shall not exceed 15 °C. Ambient air temperature is defined as the temperature at mid-height and 300 mm from the surface of the element. The Contractor shall measure the temperature of internal concrete, surface of the concrete and ambient air temperatures a minimum of every 4 hours, and shall make adjustments as necessary to keep the rate of cooling within the specified parameters.

The Contractor shall demonstrate to the satisfaction of the Consultant that the requirements of the cold weather concreting plan are met.

## 4.22 Placing Concrete under Water

Concrete shall not be deposited under water without the review and acceptance of the Consultant. Concrete placed under water shall be completed in the presence of the Consultant. Concrete to be deposited under water shall be of the specified class, with the mix design modified to provide 170 mm ± 30 mm slump without segregation and a 15% increase in cementing materials above the initial mix design quantity. Anti-washout admixtures incorporating viscosity modifiers may be used in the mix design. The modified concrete mix design for placement under water shall be submitted by the Contractor to the Consultant for review and acceptance in accordance with Subsection 4.4.4, Concrete Mix Design Submission Requirements. The concrete temperature at discharge shall be between 10°C and 25°C.

Concrete shall not be placed in water which is below 4°C or flowing at the point of discharge.

Formwork underwater shall be watertight.

To prevent segregation, concrete shall be placed in a compact mass, in its final position, by means of a concrete pump line and/or a tremie system reviewed and accepted by the Consultant. The use of non-rigid lines will not be permitted.

At a minimum a tremie system shall consist of a concrete pump line and/or a hopper connected to a rigid tube. If constructed in sections, the rigid tube shall have flanged couplings fitted with gaskets.

The discharge end of the concrete pump line and/or tremie system shall be lowered to the bottom of the form or pile hole. The discharge end shall be temporarily closed at the start of the Work to prevent water from entering the line. Water shall be kept out of the line at all times. The flow of concrete shall be induced by raising the discharge end of the line while keeping it a minimum of 1 m below the top of the deposited concrete. The placement of concrete shall be continuous until the Work is completed. The surface of the concrete shall be kept as horizontal as is practicable at all times.

Dewatering will not be permitted while concrete placement is in progress. Dewatering may proceed when the concrete has gained sufficient strength such that damage to the concrete will not occur.

The Contractor shall remove all laitance or other unsatisfactory material from exposed concrete surfaces by scraping, chipping or other acceptable means acceptable to the Consultant. The prepared concrete surfaces shall be reviewed and accepted by the Consultant prior to next sequence of the Work.

## 4.23 Curing Concrete

### 4.23.1 General

Freshly deposited concrete shall be protected from freezing, abnormally high temperatures or temperature differentials, premature drying, water damage and moisture loss for the curing period.

All concrete surfaces consisting of Class C or D concrete shall be wet cured. The Contractor shall cover the concrete surface(s) with two layers of clean Nilex 4504 white coloured filter fabric or an approved equivalent as soon as the surface will not be marred by so doing. The filter fabric shall be kept continuously wet for 72 hours. Where the formwork is left in place for 72 hours or more, no additional curing will be required. Curing compounds shall not be used on any concrete surface except as specified for concrete slope protection.

During the cure period the Contractor shall provide protection such that the temperature of the centre of the in-situ concrete does not fall below 10°C or exceed 70°C and the temperature differential between the centre and any surface does not exceed 20°C. In addition, the requirements of Table 20, Maximum Permissible Temperature Differential between Concrete Surface and Ambient to minimize Cracking, of CSA A23.1 shall apply.

When a concrete element has a minimum dimension of 1.5 m, the Contractor shall supply and install two thermocouples, one in the centre and one at the surface of the concrete for every 50 $m^3$ of concrete, at locations determined by the Consultant. The Contractor shall monitor and record the temperatures every four hours for the first 72 hours after concrete placement and every 8 hours thereafter for the specified cure period and until 24 hours after the maximum temperature has occurred. Daily temperature records shall be forwarded to the Consultant.

Concrete shall be cured for the specified time period and achieved a compressive strength acceptable to the Consultant, prior to being exposed to construction or traffic loads.

### 4.23.2 Curing Requirements for Concrete Slope Protection

Concrete slope protection shall receive 2 coats of a Type 2 curing compound meeting the requirements of ASTM C309 or ASTM C1315. The first coat is to be applied immediately after the concrete has been finished, and the second coat is to be applied within 3 hours after the application of the first coat. Each application shall be at a rate specified by the Manufacturer.

### 4.23.3 Curing Requirements for Class HPC and Class HPC with Steel Fibres

The Contractor shall prepare and submit details for his proposed curing procedures to the Consultant for review and acceptance a minimum of two weeks prior to the scheduled pour date. At a minimum, the details shall include a description of equipment, materials, and work methods/techniques employed to carry out the work.

The Contractor shall supply and install two thermocouples, one in the centre and one at the surface of the concrete, for every 100 $m^2$ of deck, at locations determined by the Consultant.

Immediately after final bull floating and/or surface texturing an evaporation reducer, such as “Confilm” manufactured by BASF or an approved equivalent, having a monomolecular film forming compound intended for application to fresh concrete for temporary protection against moisture loss, shall be applied by a hand sprayer with a misting nozzle at the manufacturer’s recommended concentration and application rate.

Two layers of white filter fabric, Nilex 4504 or an approved equivalent shall be placed on the concrete surface as soon as the surface will not be marred by its installation. The fabric shall be pre-wet or a fine spray of clean water immediately applied once placed. Edges of the filter fabric shall overlap a minimum of 150 mm and be held in place without marring the surface of the concrete. The filter fabric shall be kept in a continuously wet condition throughout the curing period by means of soaker hoses or other means reviewed and accepted by the Consultant. The use of polyethylene sheeting above the two layers of filter fabric to reduce moisture loss will only be permitted if the sheeting is manufactured with regular perforations to permit the adequate application of curing water from above and reduce the heat generated by greenhouse effects.

Wet curing shall be maintained for a minimum of 7 days for rehabilitation projects and 14 days for new bridge construction. When concreting in cold weather, curing with filter fabric and water shall be maintained for a minimum of 14 days followed by 3 days of air drying for both rehabilitation and new bridge construction projects.

When formwork is removed prior to the completion of the specified curing period, the resulting exposed concrete surfaces shall be wet cured for the remaining days.

Curb and barrier formwork shall be removed such that the concrete is not damaged by removal operations, but no later than 72 hours after concrete placement. Wet curing of the concrete surfaces exposed after formwork removal, shall commence immediately after formwork removal.

In the event that curing is unacceptable, or any portion of the HPC or HPC with steel fibres becomes surface dry during the curing period, the Consultant will have cause to reject the concrete.

## 4.24 Repairing Concrete Defects

Honeycomb, cavities, spalls, chips, cracking and other casting or construction defects shall be immediately reported to the Consultant. Repair procedures shall be developed by the Contractor and submitted for review and acceptance by the Department and Consultant prior to the commencement of the repair. Damaged concrete shall be repaired by the Contractor at his own expense to the satisfaction of the Consultant.

### 4.24.1 Honeycomb, Cavities, Casting Defects

Honeycomb, cavities and other deficiencies are defined as those areas that are greater than 30 mm in depth or 0.05 $m^2$ in area. Defects less than 30 mm in depth and 0.05 $m^2$ in area shall be repaired in accordance with Subsection 4.25.3, Class 2 Rubbed Surface Finish.

As a minimum, the Contractor's repair procedure shall include removing and replacing the defective concrete with the originally specified class of concrete. Repair extents shall be saw cut 25 mm deep in neat perpendicular lines and concrete removed to a depth of 35 mm below reinforcing steel. Repair areas shall be roughened to remove all loose material and laitance. Exposed reinforcing steel shall be cleaned and repaired to its original condition. Repair areas shall be saturated with water for a period of 24 hours prior to concrete placement. Repair areas shall be free of standing water and surface dry immediately prior to concrete placement. Curing shall be in accordance with the requirements for the class of concrete.

Formwork misalignment for highly visible elements, including medians, curbs, barriers, exterior deck fascia, pier shafts, and exterior faces of wingwalls shall be such that when checked with a 1.2 m long straight edge placed anywhere in any direction on the surface, there shall not be any gap greater than 3 mm between the bottom of the straight edge and the concrete surface. The gap for formwork misalignment of all other elements shall not be greater than 5 mm. Concrete elements with formwork misalignments exceeding the allowable tolerances shall be repaired or replaced as determined by the Department.

### 4.24.2 Cracks

For class HPC and HPC with steel fibres the Contractor and the Consultant shall jointly inspect and identify all cracks after the curing period and before opening to traffic. The Consultant will plot the width in millimeters and length in linear meters of cracks and report the findings to the Department. Cracks that are determined by the Department and Consultant to be design related shall be repaired by the Contractor as extra work. The Contractor shall complete all required crack repairs prior to opening to traffic. Cracks that develop after opening to traffic will not require repair.

The Contractor shall repair cracks with widths greater than or equal to 0.2 mm using the following procedure:

(1) Clean and dry cracks with oil-free compressed air.

(2) Seal cracks with a gravity flow concrete crack filler in accordance with the Manufacturer's recommendations. The crack filler shall maximize the penetration by taking into consideration the ambient temperature, substrate temperature, viscosity and pot life of the material. The crack filler shall be chosen from the Alberta Transportation Product List/Crack Treatment/Concrete Crack filler/Proven Products and have a viscosity less than 105 centipoises (cP).

(3) When cracks extend the full depth of the deck slab, barriers or curbs or extend partial depth of decks that are cast to grade, epoxy injection will be required. The epoxy resin shall meet the requirements of ASTM C881 Type IV, Grade 1, Class B or C and have a viscosity less than 500 cP. An injection procedure shall be submitted to the Consultant for review and acceptance prior to commencing repairs.

For all other classes of concrete, cracks 0.2 mm or greater in width identified prior to issuance of the construction completion certificate, shall be repaired by epoxy injection in accordance with the manufacturer's recommendations. The epoxy for crack injection shall meet the requirements of ASTM C881 Type IV, Grade 1, Class B or C. The viscosity shall not exceed 500 cP.

All costs associated with crack repairs will be considered incidental to the Work and no separate or additional payment will be made.

## 4.25 Concrete Surface Finish

### 4.25.1 General

Wood or magnesium tools shall be used for finishing concrete and be of a type and quality acceptable to the Consultant. Finishing aids are not permitted during any concrete finishing operations.

On exposed concrete surfaces to 600 mm below grade or, in the case of river piers, 600 mm below lowest water level, surface finishes shall be applied as follows:

Class 1 Ordinary Surface Finish

- All concrete surfaces unless other finishes are specified
- Top surfaces of pile caps, abutment seats, and pier caps

Class 2 Rubbed Surface Finish

- Piers except grade separation piers (all surfaces except top surfaces of pier caps)
- Traffic side surfaces of curbs, barriers, medians and sidewalks
- Top surfaces of curbs and barriers
- Cast-in-place concrete girders except exterior fascia.

Class 3 Bonded Concrete Surface Finish

- Abutment seats except top surface
- Exterior faces of curtain walls/wingwalls
- Cast-in-place walls, MSE wall panels, and wall copings
- Grade separation piers except top surfaces
- Exterior concrete girder faces
- Exposed end surfaces of cast in place concrete diaphragms
- Underside of the deck overhang to top flange of girder
- Exterior surfaces of deck slab, curb, barrier and sidewalk

Class 3 bonded concrete surface finishes shall only be applied to the above listed elements when specified in the Special Provisions of the Contract. When a Class 3 surface finish is not specified in the Special Provisions of the Contract, all above listed elements shall receive a Class 2 finish. When specified in the Special Provisions of the Contract the extents of the Class 3 bonded concrete surface finishes shall be in accordance with Standard Drawings S-1851, Standard Concrete Sealer Surface Treatment for Major Bridges and/or S-1852, Standard Concrete Sealer Surface Treatment for Standard Bridges.

Class 4 Floated Surface Finish

- Top surfaces of concrete deck, roof slabs, and approach slabs which are to receive waterproofing membranes and wearing surfaces

Class 5 Floated Surface Finish, Broomed Texture

- Top surfaces of sidewalks, medians, and pedestrian bridge decks
- Approach slab concrete which will be covered by a wearing surface only (without waterproofing membrane)
- Concrete slope protection
- deck joint blockout concrete top surfaces

Class 6 Floated Surface Finish, Surface Textured

- Top surfaces of deck, deck overlay, roof and approach slabs which will not be covered with either waterproofing membrane or wearing surface

### 4.25.2 Class 1 Ordinary Surface Finish

#### 4.25.2.1 Unformed Surfaces

Immediately following placing and consolidation, the concrete shall be screeded to conform to the required surface elevations, and then floated to ensure that the surface is free from open texturing, plucked aggregate, and local projections or depressions.

Concrete surfaces shall be such that when checked with a 1.2 m long straight edge placed anywhere in any direction on the surface, there shall not be any gap greater than 3 mm between the bottom of the straight edge and the concrete surface unless otherwise specified.

#### 4.25.2.2 Formed Surfaces

Immediately following the removal of forms, all fins and irregular projections shall be removed from all surfaces. On all surfaces the cavities produced by form ties, and all other holes, shall be thoroughly chipped out, cleaned, and shall be filled with an approved concrete patching material listed on the Department's Product List. The repair material shall be appropriate for the intended application and be placed in accordance with the manufacturer's published product data sheet. All repairs shall be wet cured for a minimum of 72 hours. Curing compounds are not permitted.

### 4.25.3 Class 2 Rubbed Surface Finish

Immediately following the removal of forms, all concrete fins and irregular projections shall be removed and concrete surfaces inspected for compliance with Subsection 4.24.1, Honeycomb, Cavities, Casting Defects. After review and acceptance of the Consultant, all surfaces shall be thoroughly exposed by brush abrasive blasting. Surfaces of piers, except grade separation piers and surfaces to receive a Class 3 surface finishes, may be thoroughly exposed by diamond grinding wheels or similar tools.

Surface voids greater than 19 mm diameter but less than 0.05 $m^2$ in area and less than or equal to 30 mm deep shall be filled with an approved concrete patching material listed on the Department's Product list in the Overhead/Vertical (OH-V) category and placed in accordance with the manufacturer's published product data sheet. Surface voids less than 19 mm in diameter and less than or equal to 30 mm deep may be filled with a pre-bagged sack rub material. Sack rub materials shall be placed over the entire prepared surface in accordance with the manufacturer's recommendations. Both sack rub and patching materials shall be wet cured for a minimum of 72 hours. When the patching and sack rub materials have adequately cured, a carborundum stone or method acceptable to the Consultant shall be used to finish the surface to a smooth, uniform and closed texture. Any voids or cavities opened during the stone rubbing process shall be re filled. Parging or surface patching to correct irregularities will not be permitted.

Class 2 concrete surfaces shall be such that when checked with a 1.2 m long straight edge placed anywhere in any direction on the surface, there shall not be any gap greater than 3 mm between the bottom of the straight edge and the concrete surface unless otherwise specified.

All prepared concrete surfaces, including all patching and sack rubbing shall be uniform in colour and texture. After the surface preparation has been completed to the satisfaction of the Consultant, the Contractor shall apply sealer as required in Subsection 4.26, Type 1c Sealer. If application of the Type 1c sealer is applied in a uniform and manner acceptable to the Consultant, any subsequent change in the uniformity of concrete surface colour will be acceptable.

### 4.25.4 Class 3 Bonded Concrete Surface Finish

Concrete surface finish shall be completed in accordance with Subsection 4.25.3, Class 2 Rubbed Surface Finish, except that uniformity in colour and Type 1c Sealer is not required.

After the surface finish has been completed to the satisfaction of the Consultant, the concrete surface shall be pressure washed to remove all dust, dirt, laitance and all other bond breaking materials. After the concrete surface has dried for a minimum of 24 hours and before becoming contaminated with dust or other bond breaking materials, the Contractor shall apply an approved pigmented concrete sealer that meets the requirements for a Type 3 sealer of the Material Testing Specifications for Concrete Sealers - B388.

The pigmented concrete sealer shall be applied in accordance with the manufacturer's specifications and as a minimum two applications totaling the Department's approved application rate of the pigmented sealer are required. The colour(s) of the proposed coating scheme, which typically shall be similar to the natural colour of cured concrete, must be acceptable to the Department and Consultant before application of the coating. If a colour scheme has been designed for the site it will be specified in the Special Provisions. When spray application is used the surface shall be back rolled. The Contractor shall ensure that no colour variation is visible, and shall match the colour of any previously sealed adjoining surfaces. Acceptance of the pigmented sealer used will not be considered to relieve the Contractor of full responsibility for its acceptable performance and appearance.

### 4.25.5 Class 4 Floated Surface Finish

Unless otherwise noted on the Drawings, concrete surfaces receiving a waterproofing membrane and a final wearing surface, shall be manually bull floated and float finished as necessary to provide a smooth surface.

Concrete surfaces shall meet the requirements of Subsection 4.16.6, Surface Defects and Tolerances.

### 4.25.6 Class 5 Floated Surface Finish, Broomed Texture

The concrete surface shall be float finished as necessary to produce a smooth surface. The surface shall not vary more than 3 mm under a 3 m long straight edge.

After the concrete has set sufficiently, the surface shall be given a transversely broomed finish using a coarse broom to produce regular corrugations to a maximum depth of 2 mm. A bronze edging tool shall be used at all edges and control joints.

Sidewalk and median control joints shall be installed at the same locations of curb/barrier control joints using a bronze grooving tool of sufficient gauge to produce control joints to a depth of a minimum one quarter of the slab thickness.

### 4.25.7 Class 6 Floated Surface Finish, Surface Textured

After the concrete has been manually bull floated, it shall be given texture with a “flat wire” texture broom having a single row of tines. The texture shall be transverse grooving which may vary from 1.5 mm width at 10 mm centres to 5 mm width at 20 mm centres, with a groove depth of 3 mm to 5 mm. This work shall be done at such time and in such manner that the texture is achieved while minimizing the displacement of coarse aggregates or steel fibres. The textured surface shall be uniform over the entire concrete surface.

Following surface texturing, a 300 mm width of concrete surface adjacent to the curb, barrier or median shall be trowelled smooth and the surface left closed.

Concrete surfaces shall meet the requirements of Subsection 4.16.6, Surface Defects and Tolerances.

### 4.25.8 Surface Finish under Bearings

Air voids created in concrete surfaces of grout pad recesses shall be filled with an approved concrete patching material listed on the Department’s Product List in the Normal Horizontal (NH) category and placed in accordance with the manufacturer’s published product data sheet. The concrete patching material shall reach a compressive strength equal to or greater than the substrate concrete, prior to the commencement of installation of bearings and girder erection.

Concrete, including air void patches, on which bearing plates, pads or shims are to be placed shall be finished or ground to a smooth and even surface. When checked with a straight edge placed anywhere in any direction on the concrete surface, there shall not be any gap greater than 1 mm between the bottom of the straight edge and the finished concrete surface.

This work shall be completed while the substrate concrete is at or above 5°C. When the substrate temperature is below 5°C, the Work shall be completed in accordance with Subsection 4.21, Concreting in Cold Weather.

### 4.25.9 Surface Finish under Baseplates

Concrete surfaces of grout pad recesses shall be bush hammered to a depth of 3 mm including all air voids prior to the installation of bridgerail post, luminaire, overhead sign structure or other baseplates. Bush hammering shall not occur within 25 mm of anchor rods. Anchor rods shall be protected from damage during the Work.

## 4.26 Type 1c Sealer

An approved Type 1c concrete sealer selected from the Alberta Transportation Products List shall be applied to all concrete surfaces which are to receive a Class 2, Class 5 and Class 6 surface finish. This shall include all concrete surfaces to 600 mm below grade or in the case of river piers 600 mm below lowest water level. Surfaces that are to receive a waterproofing membrane shall not have sealer applied. Sealer will not be required on the underside of bridge decks or on concrete diaphragms in the interior bay areas, however, the faces of the end diaphragms nearest the abutment backwalls, inside face of backwall and top surface of abutment seat, excluding bearing recess pockets, shall be sealed.

The sealer shall be applied in accordance with the Manufacturer's recommendations; however the application rate shall be increased by 30% from that indicated on the Alberta Transportation Products List and the substrate temperature shall be a minimum of 5°C. Before applying the sealer, the concrete shall be cured for at least 28 days. The concrete surface shall be dry, and air blasted to remove all dust and accepted by the Consultant prior to applying sealer. In order to ensure uniform and sufficient coverage rates the Contractor shall apply measured volumes of sealing compound to appropriately dimensioned areas of concrete surface, using a minimum of 2 coats. Asphalt concrete pavement surfaces and other elements shall be adequately protected from overspray and runoff during sealer application.

## 4.27 Measurement and Payment

### 4.27.1 Concrete

Measurement for payment of cast-in-place concrete will by the cubic metre of concrete acceptably placed, measured to the nearest 0.01 $m^3$.

The quantity of concrete paid for will be the volume of concrete remaining within the neat lines as shown on the Drawings, less the volume of concrete displaced by steel pipe piles, concrete piles, ducts and voids, and girder flanges and webs. The volume of concrete displaced by H-Piles, reinforcing steel, deck joint anchorages, and anchor rods will not be deducted from the quantity to be paid for.

When calculating the volume of pile concrete for drilled piles at locations where the pile holes are drilled larger than specified, the additional volume of concrete required to fill the oversize pile hole will not be included in the quantity of material to be paid for.

Payment will be made at the unit prices bid for “Concrete – Supply and Place” for the class of concrete specified less any applicable payment adjustments for compressive strength, and will be full compensation for falsework and formwork; curing; concrete surface finishing; the supply and application of concrete sealers; testing and inspection; and all labour, materials, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

All costs associated with concreting in cold weather, when required, will be considered incidental to the Work, and no separate or additional payment will be made.

80% of the unit price bid will be paid once the concrete has been acceptably placed and the 7 day concrete compressive strength tests indicate, in the opinion of the Consultant, that the concrete will achieve the specified strength. Initial payment will not constitute full acceptance of the concrete. The remaining 20% of the unit price bid will be made once concrete surface finishing has been acceptably completed, and the 28 day compressive strength test results have been reviewed and accepted by the Consultant.

The Department reserves the right to reject concrete that does not meet the specified requirements. The Department may, at its sole discretion, accept concrete that does not meet the specified 28 day concrete compressive strength at a reduced price. Payment adjustment may be made in accordance with Subsection 4.27.1.1, Compressive Strength Test Result Payment Adjustment.

#### 4.27.1.1 Compressive Strength Test Result Payment Adjustment

Payment adjustment may be applied to the volume of concrete represented by the compressive strength test results in accordance with Subsection 4.9.1, Compressive Strength Tests.

<u>Class C Concrete</u>

- 35 MPa and over, full bid price
- 34 MPa to 35 MPa, bid price less $30 per cubic metre
- 33 MPa to 34 MPa, bid price less $60 per cubic metre
- 32 MPa to 33 MPa, bid price less $90 per cubic metre
- 31 MPa to 32 MPa, bid price less $120 per cubic metre
- 30 MPa to 31 MPa, bid price less $160 per cubic metre
- 29 MPa to 30 MPa, bid price less $220 per cubic metre
- 28 MPa to 29 MPa, bid price less $300 per cubic metre
- 27 MPa to 28 MPa, bid price less $400 per cubic metre
- Less than 27 MPa, rejected

<u>Class HPC and Class HPC with Steel Fibres Concrete</u>

- 45 MPa and over, full bid price
- 44 MPa to 45 MPa, bid Price less $40 per cubic metre
- 43 MPa to 44 MPa, bid Price less $100 per cubic metre
- 42 MPa to 43 MPa, bid Price less $180 per cubic metre
- 41 MPa to 42 MPa, bid Price less $280 per cubic metre
- 40 MPa to 41 MPa, bid Price less $400 per cubic metre
- Less than 40 MPa, rejected

<u>Class D and Class Pile Concrete</u>

- 30 MPa and over, full bid price
- 29 MPa to 30 MPa, bid price less $30 per cubic metre
- 28 MPa to 29 MPa, bid price less $60 per cubic metre
- 27 MPa to 28 MPa, bid price less $90 per cubic metre

- 26 MPa to 27 MPa, bid price less $120 per cubic metre
- 25 MPa to 26 MPa, bid price less $160 per cubic metre
- 24 MPa to 25 MPa, bid price less $220 per cubic metre
- Less than 24 MPa, rejected

Class S Concrete

- 20 MPa and over, full bid price
- 18 MPa to 20 MPa, bid price less $30 per cubic metre
- 16 MPa to 18 MPa, bid price less $70 per cubic metre
- Less than 16 MPa, rejected

4.27.1.2 Coring

Coring to confirm or contest low concrete compressive strength test results will only be permitted when reviewed and accepted by the Department.

Sampling and testing of cores shall be completed by an independent laboratory certified to CSA A283 and in accordance with CSA A23.2 14C. Cores shall be extracted in the presence of the Consultant and tested within 7 days of the testing the 28 day cylinders that are being evaluated.

3 cores shall be extracted for each concrete compressive strength test result being evaluated. The core size shall be 100 mm diameter by 200 mm length or of a size acceptable to the Consultant.

Core hole locations will be determined by the Consultant. The Contractor shall use a reinforcing steel locator acceptable to the Consultant to locate reinforcing steel in the immediate vicinity of the core hole location and provide this information to Consultant. The Consultant will attempt to avoid reinforcing steel in his final determination of core hole locations. Core holes shall be repaired using a Department approved concrete patching product acceptable to the Consultant.

The average strength of each set of 3 cores will represent a concrete compressive strength test and shall be equal to or greater than the specified 28 day strength. CSA A23.1, Clause 4.4.6.6.2.2, Acceptance of Cores Drilled from a Structure, shall not apply. If the average cored concrete strength is greater than the averaged cylinder concrete strength, the concrete cored strength result will be used as the basis for acceptance and payment. If the averaged cored concrete strength is less than the averaged cylinder concrete strength, the averaged cylinder concrete strength will be used as the basis for acceptance and payment.

All costs associated with coring, testing, reporting and repairing core holes will be considered incidental to the Work, and no separate or additional payment will be made.

4.27.2 Concrete Slope Protection

Measurement for payment of concrete slope protection will by the square metre of concrete slope protection acceptably constructed, measured to the nearest 0.1 $m^2$.

The quantity to be paid for will be based on horizontal measurement of surface areas perpendicular to the slope specified. Vertical faces will not be measured.

Payment will be made at the unit price bid for “Concrete Slope Protection” less any applicable payment adjustments for compressive strength, and will be full compensation for preparation of the slopes; supply, placement and compaction of backfill; formwork; the supply and placement of reinforcing steel, the supply and placement of concrete; supply and application of curing compound; and all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

All costs associated with top and toe cutoff walls, edge swales, galvanized steel flashing, fasteners, and associated materials will be considered incidental to the Work, and no separate or additional payment will be made.

The Department reserves the right to reject concrete slope protection that does not meet the specified requirements. The Department may, at its sole discretion, accept concrete slope protection that does not meet the specified 28 day concrete compressive strength. Payment may be made in accordance with Subsection 4.27.2.1, Compressive Strength Test Result Payment Adjustment.

#### 4.27.2.1 Compressive Strength Test Result Payment Adjustment

Payment adjustment may be applied to the area of concrete slope protection represented by the compressive strength test in accordance with Subsection 4.9.1, Compressive Strength Tests.

<u>Class C Concrete</u>

- 35 MPa and over, full bid price
- 34 MPa to 35 MPa, bid price less $10 per square metre
- 33 MPa to 34 MPa, bid price less $20 per square metre
- 32 MPa to 33 MPa, bid price less $30 per square metre
- 31 MPa to 32 MPa, bid price less $40 per square metre
- 30 MPa to 31 MPa, bid price less $55 per square metre
- 29 MPa to 30 MPa, bid price less $75 per square metre
- 28 MPa to 29 MPa, bid price less $100 per square metre
- 27 MPa to 28 MPa, bid price less $150 per square metre
- Less than 27 MPa, rejected

Government of Alberta
Transportation

# Concrete Test Results

Bridge File #: ______________________________
Bridge Project: ______________________________
Location: ______________________________
Contract #: ______________________________
Contractor: ______________________________
Concrete Supplier: ______________________________
Plant Location: ______________________________
Consultant: ______________________________

Date Tested: ______________________
Weather: ______________ °C
Tested By: ______________________
Certification: ☐CSA ☐ ACI | Cert.# ________
Date of Certification / Expiry: __________ | __________
Cylinder Curing Facilities / Initial Temp: __________ | __________
Placing Method / Sampling Location __________ | __________
Volume of Pour: ______ $m^3$

| Specification Requirements | Concrete Class : | | Strength: MPa @ 28 Days | | | |
|---|---|---|---|---|---|---|
| | Slump (mm) | | Air Content (%) | | Number of Cylinder Sets Required | |
| | Min.: ____ | Max.: ____ | Min.: ____ | Max.: ____ | Min of 1 set per : ____ Trucks **or** | Min of 1 set per: ____ $m^3$ |

| Pour Location | Cylinder Identification Labels* | Delivery Ticket No. | Load Amount | Time | | | Slump | Air Content | Unit Weight | Temperature | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | ($m^3$) | Batched | Tested | Off-Load | (mm) | (%) | ($kg/m^3$) | Air (°C) | Conc (°C) |
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Sketch of Test Cylinder Location:

Comments:

pg. ___ of ___

* See Concrete Cylinder Coding Sheet for Suggested Cylinder Identification Label(s)

Government of Alberta Transportation

# Concrete Test Results

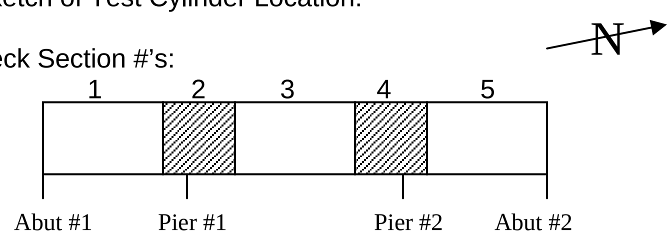
| | | | |
|---|---|---|---|
| Bridge File #: | 12345 | Date Tested: | June 12, 2012 |
| Bridge Project: | HWY 555 over HWY 5 Grade Separation | Weather: | Light Breeze, Cloudy 12 °C |
| Location: | Sometown | Tested By: | Joe Tester |
| Contract #: | 2222/08 | Certification: | ☒CSA ☐ACI Cert.# 12345 |
| Contractor: | ABC Contracting | Date of Certification / Expiry: | July 1, 2011 / July 1, 2014 |
| Concrete Supplier: | XYZ Concrete | Cylinder Curing Facilities / Initial Temp: | Curing Box / 17 - 23 °C |
| Plant Location: | Concrete Town | Placing Method / Sampling Location | Pump Truck / Hose End |
| Consultant: | AAA Consulting | Volume of Pour: | 80 $m^3$ |

| Specification Requirements | Concrete Class : HPC | | Strength: 45 MPa @ 28 Days | | | |
|---|---|---|---|---|---|---|
| | Slump (mm) | | Air Content (%) | | Number of Cylinder Sets Required | |
| | Min.: 90 | Max.: 150 | Min.: 5.0 | Max.: 8.0 | Min of 1 set per : 2 Trucks **or** | Min of 1 set per: 20 $m^3$ |

| Pour Location | Cylinder Identification Labels* | Delivery Ticket No. | Load Amount | Time | | | Slump | Air Content | Unit Weight | Temperature | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | ($m^3$) | Batched | Tested | Off-Load | (mm) | (%) | ($kg/m^3$) | Air (°C) | Conc (°C) |
| Deck pour over Pier #1. | DS2-1,2,3,4 | 1 | 10 | 20:00 | 20:45 | 20:50 | 120 | 6.5 | 2400 | 15 | 16 |
| Deck pour over Pier #1. | n/a | 2 | 10 | 20:30 | 21:20 | 21:25 | 110 | 6.8 | 2395 | 15 | 16 |
| Deck pour over Pier #1. | DS2- 5,6,7,8 | 3 | 10 | 21:00 | 21:40 | 21:50 | 125 | 7.2 | 2405 | 14 | 14 |
| Deck pour over Pier #1. | n/a | 4 | 10 | 21:30 | 22:15 | 22:20 | 130 | 5.6 | 2395 | 14 | 15 |
| Deck pour over Pier #2. | DS4- 9,10,11,12 | 5 | 10 | 22:00 | 22:35 | 22:45 | 140 | 5.8 | 2400 | 13 | 13 |
| Deck pour over Pier #2. | n/a | 6 | 10 | 22:30 | 23:10 | 23:15 | 125 | 6.7 | 2400 | 13 | 17 |
| Deck pour over Pier #2. | DS4-11,12,13,14 | 7 | 10 | 23:00 | 23:40 | 23:45 | 130 | 7.0 | 2405 | 13 | 16 |
| Deck pour over Pier #2. | n/a | 8 | 10 | 23:30 | 00:05 | 00:10 | 130 | 6.5 | 2402 | 12 | 15 |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

Sketch of Test Cylinder Location:

Deck Section #'s:




Comments:

Ticket No. 4 and 5 had 200 mL of superplasticizer added.
Superplasticizer used was EZY 123.



* See Concrete Cylinder Coding Sheet for Suggested Cylinder Identification Label(s)

# Concrete Test Results

## Suggested Concrete Cylinder Coding Identification Labels

### Abutments

| | |
|---|---|
| A1S | Abutment #1 Seat |
| A1BW | Abutment #1 Backwall |
| A1LW | Abutment #1 Left Wingwall |
| A1RW | Abutment #1 Right Wingwall |
| A1WZ | Abutment #1 Both Wingwalls |
| A1B&W | Abutment #1 Backwall and Wingwalls |
| A1GB | Abutment #1 Grade Beam |
| A1RS | Abutment #1 Roof Slab |
| A1AS | Abutment #1 Approach Slab |
| A1MC | Abutment #1 Median Curb |
| A1RD | Abutment #1 Right Drain |
| A1LD | Abutment #1 Left Drain |
| A1SP | Abutment #1 Slope Protection |
| A1LS | Abutment #1 Left Sidewalk |
| A1RS | Abutment #1 Right Sidewalk |

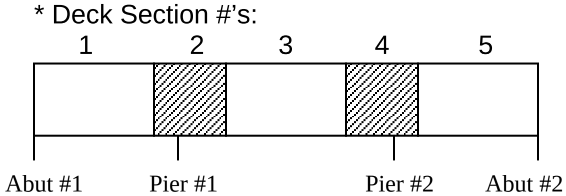
### Piers

| | |
|---|---|
| P1DP | Pier #1 Drilled Pile |
| P1PP | Pier #1 Pipe Pile |
| P1F | Pier #1 Footing |
| P1S | Pier #1 Shaft |
| P1LS | Pier #1 Lower Shaft |
| P1US | Pier #1 Upper Shaft |
| P1PC | Pier #1 Pier Cap |
| P1C | Pier #1 Columns |

### Decks

| | |
|---|---|
| DS1 | Deck Section #1 * |
| DS1RC | Deck Section #1 Right Curb |
| DS1LC | Deck Section #1 Left Curb |
| DS1RP | Deck Section #1 Right Parapet |
| DS1LP | Deck Section #1 Left Parapet |
| DS1MC | Deck Section #1 Median Curb |
| DS1RS | Deck Section #1 Right Sidewalk |
| DS1LS | Deck Section #1 Left Sidewalk |

* Deck Section #'s:




### Precast Units

| | |
|---|---|
| S1GK | Span #1 Girder Keyways |
| A1BK | Abutment #1 Blockout |
| Pier #1 | Pier #1 Diaphragm Beam |
| S1IDB | Span #1 Intermediate Diaphragm Beam |

### Box Culverts

| | |
|---|---|
| BCF | Box Culvert Floor Slab |
| BCW | Box Culvert Walls |
| BCRS | Box Culvert Roof Slab |
| BCUA | Box Culvert U/S Apron |
| BRDA | Box Culvert D/S Apron |
| BCUW | Box Culvert U/S Wingwalls |
| BCDW | Box Culvert D/S Wingwalls |
| BCUF | Box Culvert U/S Wingwall Footing |
| BCDF | Box Culvert D/S Wingwall Footing |

### S.P.C.S.P. Culverts

| | |
|---|---|
| SPF | Corrugated Metal Pipe Floor Slab |
| SPUC | Corrugated Metal Pipe U/S Collar |
| SPDC | Corrugated Metal Pipe D/S Collar |
| SPUA | Corrugated Metal Pipe U/S Apron |
| SPDA | Corrugated Metal Pipe D/S Apron |
| SPUCW | Corrugated Metal Pipe U/S Cut-off Wall |
| SPDCW | Corrugated Metal Pipe D/S Cut-off Wall |
| SPUW | Corrugated Metal Pipe U/S Wingwall |
| SPDW | Corrugated Metal Pipe D/S Wingwall |
| SPUF | Corrugated Metal Pipe U/S Footing |
| SPDF | Corrugated Metal Pipe D/S Footing |

### Arch Culvert

| | |
|---|---|
| ACLF | Arch Culvert Left Footing |
| ACRF | Arch Culvert Right Footing |
| ACB | Arch Culvert Barrel |
| ACFS | Arch Culvert Floor Slab |
| ACUC | Arch Culvert U/S Collar |
| ACDC | Arch Culvert D/S Collar |
| ACUA | Arch Culvert U/S Apron |
| ACDA | Arch Culvert D/S Apron |
| ACUCW | Arch Culvert U/S Cut-off Wall |
| ACDCW | Arch Culvert D/S Cut-off Wall |
| ACUW | Arch Culvert U/S Wingwall |
| ACDW | Arch Culvert D/S Wingwall |
| ACUF | Arch Culvert U/S Footing |
| ACDF | Arch Culvert D/S Footing |

# SECTION 5 REINFORCING STEEL

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## 5.1 General

This Specification is for the supply, fabrication, handling and placing of plain reinforcing steel, epoxy coated reinforcing steel, corrosion resistant reinforcing steel (CRR), and stainless reinforcing steel. All reinforcing steel shall be supplied and installed in the lengths and shapes shown on the Drawings. No substitution of bars or changes to bar details will be permitted without prior approval of the Consultant.

## 5.2 Material Types

### 5.2.1 Plain Reinforcing Steel

Plain reinforcing steel shall be Grade 400, meeting the requirements of CSA Standard G30.18M.

### 5.2.2 Epoxy Coated Reinforcing Steel

Plain reinforcing steel meeting the requirements of Subsection 5.2.1, Plain Reinforcing Steel, shall be used in the production of epoxy coated reinforcing steel.

Epoxy coated reinforcing steel shall be coated by a manufacturer certified under the Concrete Reinforcing Steel Institute (CRSI) Voluntary Certification program for Fusion Bonded Epoxy Coating Applicator plants. Proof of certification shall be submitted to the Consultant prior to delivery of the material.

Epoxy coated reinforcing steel shall be prepared and coated in accordance with the requirements of Ontario Provincial Standard Specification OPSS 1442, Material Specification for Epoxy Coated Steel Reinforcement for Concrete, and the requirements contained herein.

The film thickness of the epoxy coating, after curing, shall be 175 µm to 300 µm (7 to 12 mils). The epoxy coating material shall conform to the requirements of OPSS 1443, Material Specification for Organic Coatings for Steel Reinforcement.

### 5.2.3 Corrosion Resistant Reinforcing Steel

Corrosion resistant reinforcing steel (CRR) shall consist of either low carbon/chromium reinforcing steel or stainless reinforcing steel.

Low carbon/chromium reinforcing steel shall meet the requirements of ASTM A1035. The alloy type shall be CS and the minimum yield strength based on the 0.2% offset method shall be equal to 690 MPa.

Stainless reinforcing steel, if used, shall meet the requirements of Subsection 5.2.4, Stainless Reinforcing Steel.

Unless otherwise specified, only one type of CRR shall be supplied for use throughout the project.

### 5.2.4 Stainless Reinforcing Steel

Stainless reinforcing steel shall be of the following designations as defined by the Unified Numbering System (UNS):

- S31653
- S31803
- S32304

Stainless reinforcing steel shall meet the requirements of ASTM A276 and ASTM A955/A955M (including Annex 1.2 or 1.3). The minimum yield strength shall be 420 MPa.

Austenitic grades shall meet the requirements of with ASTM A262, Practice E. Duplex grades shall meet the requirements of ASTM A1084, Method C by demonstrating no presence of detrimental phases.

Stainless reinforcing steel shall be shotblasted and pickled at the production mill to remove all mill scale and surface oxidation.

Unless otherwise specified, only one type of stainless reinforcing steel shall be supplied for use throughout the project.

### 5.2.5 Plain and Deformed Welded Wire Reinforcing

Plain and deformed welded wire reinforcement shall meet the requirements of ASTM A1064, Grade 70 (fy = 485 MPa) with a minimum yield strength of 485 MPa based on 0.2% offset. Welded wire reinforcement shall be able to attain a minimum elongation of 4% at ultimate strength. Testing for elongation shall be in accordance with the Tension Test specified in ASTM A1064 with the following modifications:

- The minimum test gage length shall be 100 mm;
- 100% of the tests shall be across the welds; and
- The extensometer shall not be removed until 4% elongation has been attained.

The boron content shall not exceed 0.0008%.

## 5.3 Manufacture

Reinforcing steel bars shall be manufactured and tested in accordance with the applicable standard(s).

Mill test reports for each heat number shall be legible and provided in English to the Consultant a minimum of 2 weeks prior to shipping to site. The Contractor shall maintain a tracking system and records for all reinforcing steel fabricated and installed and provide this information to the Consultant upon request. Mill test reports at a minimum shall include: heat number, date, and location of production, compliance with production standards, chemical analysis, mechanical properties, and pickling process details for stainless reinforcing steel. Mill test reports shall be authenticated by the manufacturer.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be certified to ISO/IEC 17025 by an organization accredited by the Standards Council of Canada for the tests required. Samples for testing shall be collected by personnel employed by the certified laboratory. A verification letter shall be provided by the certified laboratory that includes at a minimum, the applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the certified laboratory.

The yield strength shall be determined using the offset method (0.2 %).

## 5.4 Fabrication

All bars requiring bends shall be cold bent at the fabrication facility. Heating of bars to facilitate bending will not be permitted.

Bars shall be cut by shearing or with fluid cooled saws. Torch cutting will not be permitted. Bars showing evidence of torch cutting will be rejected.

Unless otherwise specified, all hooks and bends shall be fabricated using the pin diameters and dimensions recommended in the Reinforcing Steel Institute of Canada (RSIC) Manual of Standard Practice. Bars shall conform accurately to the dimensions shown on the Drawings, and be within the fabricating tolerances detailed in the RSIC Manual of Standard Practice.

Fabrication of epoxy coated reinforcing steel bars after application of the coating shall be in accordance with the requirements of Ontario Provincial Standard Specification OPSS 1442.

Fabrication of stainless reinforcing steel shall be carried out such that bar surfaces are not contaminated with deposits of iron or other non stainless steels; or suffer damage due to straightening or bending. Stainless reinforcing steel fabrication facilities shall be exclusive to the fabrication of stainless reinforcing bars or in a facility that provides a permanent fixed physical barrier which fully isolates fabrication processes. Fabrication shall occur only on equipment dedicated solely to fabrication of stainless reinforcing steel bars. All machinery points that come into contact with stainless reinforcing steel bars shall consist of hardened steel to a minimum of 35 Rockwell, stainless steel, or nylon. All racking shall be protected with hardened steel to a minimum of 35 Rockwell, stainless steel, nylon or wood.

Reinforcing steel bars shall be fabricated without laminations or burrs.

## 5.5 Shipping, Handling and Storage

Reinforcing steel shall be covered and protected at all times during transportation.

Lifting of stainless steel reinforcing shall be completed with nylon strapping dedicated to stainless steel reinforcing bars. Fork trucks used in the handling of coil or straight stainless reinforcing steel shall have their forks covered with hardened steel to a minimum of 35 Rockwell, stainless steel, or nylon. Stainless steel reinforcing bar bundles shall be tied with plastic strapping or stainless steel tie wire and not with carbon steel or epoxy coated carbon steel strapping.

Polyethylene wrap shall be used to fully cover all stainless reinforcing steel bars and bundles for shipping. Stainless steel reinforcing bars shall also be tarped at all times during shipping with tarps dedicated for stainless steel reinforcing bars.

Reinforcing steel of differing material types shall be stored separately. Bar tags identifying the material type shall be clearly visible and shall be maintained in-place until installation of the material.

The Contractor shall store all reinforcing steel on platforms, skids, or other suitable means of support able to keep the material above the ground surface while protecting it from mechanical damage or deterioration.

Special care shall be taken when handling epoxy coated reinforcing steel to prevent damage to the epoxy coating. Epoxy coated reinforcing bars shall not be dropped or dragged, and shall be lifted with non-metallic slings. Protective measure shall be implemented to prevent bar to bar abrasion and excessive sagging of bundles.

On-site storage of epoxy coated reinforcing steel shall not exceed 120 days, and exposure to daylight shall not exceed 30 days. If the daylight exposure time is expected to exceed 30 days, the Contractor shall protect the reinforcing steel by covering with opaque polyethylene sheeting or equivalent protective material acceptable to the Consultant.

On-site storage of all other types of reinforcing steel shall not exceed 120 days unless protected with polyethylene sheeting or equivalent protective material acceptable to the Consultant.

The Contractor shall take all precautions necessary to prevent damage to the material during handling operations. Bundles shall be handled with spreaders and nonmetallic slings, or by other methods acceptable to the Consultant. Damaged materials shall be replaced by the Contractor at his expense.

## 5.6 Placing and Fastening

Reinforcing steel shall be accurately placed and fastened in the positions shown on the Drawings and securely tied and chaired before placing the concrete.

Reinforcing steel containing any loose rust, scale, dirt, paint, oil, concrete, concrete paste or other foreign materials shall be cleaned or replaced to the full satisfaction of the Consultant prior to being incorporated into the Work.

Bars shall be tied at all intersections except when the bar spacing is less than 250 mm in each direction, alternate intersections shall be tied. Specified distances from forms shall be maintained by supports, spacers, or other proposed means that have been reviewed and accepted by the Consultant.

Except as noted herein, tie-wire shall be manufactured from the same material type as the reinforcing steel being tied. Plastic coated tie wire may be used where low carbon/chromium reinforcing steel is being placed. Where stainless reinforcing steel is being placed, tie-wire shall be stainless steel of any grade listed in Subsection 5.2.4, Stainless Reinforcing Steel.

Welding of reinforcing steel will not be permitted.

### 5.6.1 Supports

Supports used to maintain the specified reinforcing steel concrete cover or for separation between layers of bars shall be of adequate strength, shape and dimension, and accepted for use by the Consultant. Supports shall be either plastic or precast concrete. Where additional reinforcing support bars are proposed by the Contractor they shall be of the same material type and grade used in the Work and installed meeting concrete cover requirements. Proposed supports and spacers fabricated from alternate material types may be used upon review and acceptance by the Consultant.

Plastic bolster slab supports shall be Aztec Strong Back Slab / Beam Bolster - PSBB manufactured by Dayton Superior or an equivalent acceptable to the Department. Bolster slab supports shall be staggered and configured to facilitate full concrete consolidation. Bolster slab supports of length not exceeding 100 mm shall be used for exposed faces of curbs, medians and barriers.

When precast concrete supports are used they shall have the compressive strength, rapid chloride permeability, and air content meeting the specification requirements for the class of concrete being placed and of a geometric configuration that minimizes dimensions and does not adversely affect concrete placement and consolidation processes. Brick or mortar chairs will not be permitted.

### 5.6.2 Field Modifications

Field bending of reinforcing steel, regardless of circumstance, will not be permitted unless specified on the Drawings.

Any proposed field cutting of epoxy coated reinforcing steel shall be carried out only where necessary and reviewed and accepted by the Consultant. Cuts shall be made by shearing or saw cutting only. The epoxy coating on sheared or saw cut ends shall be patched in accordance with the specifications contained herein.

### 5.6.3 Reinforcing Steel Tolerances for Cast-In-Place Concrete

Reinforcing steel for cast-in-place concrete shall be placed in conformance with the following tolerances:

- Concrete cover: ±10 mm, except concrete placed in contact with soil: ±25 mm;
- Location, where the smallest dimension of the element is:
  - 200 mm or less: ±8 mm;
  - Larger than 200 mm but less than 600 mm: ±10 mm;
  - 600 mm or larger: ±20 mm;
- Lateral spacing: ±30 mm;
- Longitudinal location of bends and ends of bars: ±50 mm; and
- Longitudinal location of bends and ends of bars at discontinuous ends: ±20 mm.
- The clear distance between reinforcement shall not be less than 1.5 times the nominal diameter of the reinforcement, 1.5 times the maximum coarse aggregate size, or 40 mm.

## 5.7 Splicing

Splicing of bars, unless shown on the Drawings or accepted in writing by the Consultant, will not be permitted.

Splices, where permitted, shall be staggered. For lapped splices, bars shall be placed in contact and tied together while maintaining the minimum required clear distance to other bars and the required minimum distance to the surface of the concrete.

## 5.8 Repair of Epoxy Coated Reinforcing Steel

The Contractor shall be responsible for the repair of all damage to epoxy coating up to the time the reinforcing steel is acceptably incorporated into the concrete. Where field cutting of the epoxy coated reinforcing steel is necessary and accepted by the Consultant, cutting shall be either shearing or saw cutting.

Repair of damaged coating and sheared or sawed ends shall be carried out using a two component epoxy coating patching material approved for use by the reinforcing steel Manufacturer.

Surface preparation and material application shall be completed in accordance with the patching material Manufacturer's written recommendations; the following requirements; and to the satisfaction of the Consultant. The areas to be repaired shall be cleaned by removing all surface contaminants and damaged coating before applying the patching material. Where rust is present, it shall be completely removed immediately prior to application of the patching material. The patching material shall be overlapped onto the original coating for a minimum distance of 25 mm or as recommended by the patching material Manufacturer. The dry film thickness of the patched areas shall be between 175 µm and 300 µm.

All costs associated with the repair of damaged epoxy coating will be considered incidental to the Work, and no separate or additional payment will be made.

### 5.9 Repair of Stainless Reinforcing Steel

Individual stainless reinforcing steel bars exhibiting any of the following defects shall be repaired or replaced by the Contractor at his expense:

- Any location of contamination from grinding or cutting slag;
- Any location of iron contamination greater than 100 mm in length;
- More than 10 discrete points(1) of iron contamination on bar deformations within any 1000 mm of bar length;
- More than 20 discrete points(1) of iron contamination on bar deformations per bar; or
- More than 5 discrete points(1) of iron contamination that are not located on bar deformations per bar.

Notes:

(1) A discrete point is defined as an area of contamination less than or equal to 5 $mm^2$. If any area of contamination is larger than 5 $mm^2$, the area shall be divided by 5 to determine the number of discrete points.

Bars exhibiting excessive staining, as determined by the Consultant, shall have the contaminants identified by energy dispersive x-ray analysis (EDXA). Contaminant identification shall be carried out by the Contractor at his expense.

Methods proposed for the repair of stainless reinforcing steel bars shall be reviewed and accepted by the Department and Consultant prior to implementation.

Stainless reinforcing steel bars exhibiting signs of mechanical damage shall be replaced.

## 5.10 Measurement and Payment

### 5.10.1 Measurement

Measurement for payment of reinforcing steel will be by the kilograms of reinforcing steel acceptably supplied and placed, measured to the nearest kilogram.

The quantity to be paid for will be based on the total computed mass for the size and length of bars as shown on the Drawings or reviewed and accepted by the Consultant.

Any proposed substitution of imperial reinforcing steel for metric reinforcing steel shall be reviewed and accepted by the Consultant prior to commencement of the Work. The nominal cross sectional area of metric and imperial bar sizes used for evaluating substitutions will be in accordance with ASTM A1035, ASTM A955/A955M and CAN/CSA G30.18, respectively.

The mass for all reinforcing steel will be calculated as follows:

| Metric Bar Designation | 10M | 15M | 20M | 25M | 30M | 35M | 45M | 55M |
|---|---|---|---|---|---|---|---|---|
| Imperial Bar Designation | 4 | 5 | 6 | 8 | 9 | 11 | 14 | 18 |
| Mass (kg/m) | 0.785 | 1.570 | 2.355 | 3.925 | 5.495 | 7.850 | 11.775 | 19.625 |

### 5.10.2 Payment

#### 5.10.2.1 Supply

Payment will be made at the unit prices bid for “Plain Reinforcing Steel – Supply”, “Epoxy Coated Reinforcing Steel – Supply”, “Corrosion Resistant Reinforcing Steel – Supply”, “Stainless Reinforcing Steel – Supply”, or “Plain and Deformed Welded Wire Reinforcing – Supply”, as applicable, and will be full compensation for the supply and fabrication of reinforcing steel; delivery to the project site; and all labour, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

When stainless steel is supplied for use where CRR is specified, payment will be made at the unit price bid for “Corrosion Resistant Reinforcing Steel - Supply” and no separate or additional payment will be made.

90% of the unit price bid will be paid once the reinforcing steel has been acceptably supplied and delivered to the project site. The remaining 10% of the unit price bid will be made as the reinforcing steel is acceptably placed and tied in the design position within the specified tolerances.

All costs associated with the handling, storage and protection of reinforcing steel will be considered incidental to the Work, and no separate or additional payment will be made.

5.10.2.2 Placement

Payment for the placement of reinforcing steel will be made at the unit price bid for “Reinforcing Steel - Place”, regardless of type, and will be full compensation for all labour, equipment, tools and incidental necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

Payment for the placement of reinforcing steel will only be made once the concrete of the component containing the reinforcing steel has been acceptably placed.

All costs associated with the supply and installation of tie wire, chairs or other materials used for supporting, placing and fastening the reinforcing steel in place will be considered incidental to the Work, and no separate or additional payment will be made.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

## SECTION 6 STRUCTURAL STEEL

TABLE OF CONTENTS

## 6.1 General

This specification is for the supply, fabrication, delivery and erection of structural steel. Structural steel shall include steel girders, trusses, diaphragms, bracing, fasteners, splice plates, deck drains, anchor rods, dowels, deck joint assemblies, buffer angles, connector angles, anchor rod sleeves, curb, barrier, and median cover plates, trough plates, pier nose plates, steel caps, capitals, pier bracing, miscellaneous components and associated materials.

## 6.2 Supply and Fabrication

A pre-fabrication meeting is required for the supply and fabrication of structural steel girders, trusses, cover plated v-seal and finger plate deck joint assemblies, or other specialized components as determined by the Consultant. The pre-fabrication meeting shall be held at the fabrication facility and the Contractor shall ensure that the fabrication superintendent, fabrication manager, and supervisors directly involved in the Work are in attendance. The meeting shall not occur until shop drawings, design notes and independent check notes (as applicable), and welding procedures have been reviewed and accepted by the Consultant. The date of the pre-fabrication meeting shall be reviewed and accepted by the Consultant and the Department and proposed a minimum of 2 weeks prior to the anticipated date.

### 6.2.1 Standards

Fabrication of structural steel shall conform to “AASHTO LRFD Bridge Construction Specifications” and the American Welding Society (AWS) - Bridge Welding Code D1.5.

All welding, cutting and preparation shall be in accordance with the AWS - Bridge Welding Code, D1.5. The fabrication of steel structures composed of structural tubing shall be in accordance with the American Welding Society (AWS) – Structural Welding Code D1.1.

### 6.2.2 Qualification

Structural steel shall be supplied and fabricated by a fabricator certified by the Canadian Welding Bureau (CWB) in accordance with W47.1 of the Canadian Standards Association (CSA) as follows:

Fabrication of steel girders, girder components and steel trusses ......................Division 1

All other bridge components.......................................................... Division 1 or Division 2

Field welding/repairs ................................................................... Division 1 or Division 2

Fabricators of steel girders, girder components and steel trusses shall also be certified by the Canadian Institute of Steel Construction (CISC) in the category of steel bridges.

The Contractor shall notify the Consultant and the Department of fabricators in his employ. The Contractor shall remain responsible for the Work of fabricators. All terms of the Contract shall apply to fabricators.

Welders, welding operators and tackers shall be CWB approved in the applicable category. Their qualifications shall be current and available for examination by the Consultant upon request.

### 6.2.3 Engineering Data

#### 6.2.3.1 Review of Plate Arrangement for Welded Girders

If modification to the splice locations or details specified on the Drawings are proposed, the Contractor shall submit design notes, check notes, and shop drawings signed and sealed by his design engineer of record and by an independent checker. The design engineer of record and the independent checker shall be Professional Engineers registered in the Province of Alberta. Design notes, independent check notes and shop drawings shall be submitted to the Consultant for review and acceptance a minimum of 4 weeks in advance of the commencement of fabrication. Review comments provided by the Consultant and/or the Department shall be incorporated into the design notes, independent check notes and shop drawings and resubmitted to the Consultant for review and acceptance prior to the commencement of fabrication. The design engineer of record and independent checker shall submit separate signed and sealed design notes and check notes. The design and independent check notes shall be presented in a legible and logical format, clearly identify material properties, and sufficiently detailed to allow a technical review of design concepts and assumptions used.

The independent checker may be employed by the same company as the design engineer of record. The independent check must be completed fully independent of the design engineer of record, including a complete re-analysis of all aspects of the design including calculations and engineering, preferably by a methodology or computer program other than that used by the design engineer of record. The design engineer of record and independent checker shall ensure that the shop drawings are complete and accurately convey the design criteria and assumptions used in their designs.

The design notes, independent check notes, and shop drawings will be reviewed by the Consultant solely to ascertain general conformance with codes and specifications. The Consultant's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

#### 6.2.3.2 Welding Procedures

Welding procedures, including welding procedure datasheets, shall be submitted for each type of weld proposed. The welding procedures shall bear the approval of the CWB and be reviewed and accepted by the Consultant and the Department a minimum of 4 weeks prior to the commencement of fabrication.

#### 6.2.3.3 Shop Drawings

Shop drawings shall be submitted to the Consultant for review and acceptance a minimum of 4 weeks in advance of the commencement of fabrication. Review comments provided by the Consultant and/or the Department shall be incorporated into the shop drawings and resubmitted to the Consultant for review and acceptance prior to the commencement of fabrication.

Shop drawings shall be electronic unlocked PDF format. Each shop drawing shall include the Department's shop drawing identification block and have a sufficient blank space for the Consultant's review stamp. The Department's shop drawing identification block will be provided to the Contractor upon request. As a minimum, the following information shall be included on shop drawing submissions:

- All dimensions shall be correct at 20 °C unless otherwise noted;
- Weld procedure identification shall be shown on the shop drawings in the tail of the weld symbols;
- All material splice locations shall be shown on the drawings;
- Bearings shall be centered at -5 °C;
- Shop assembly drawings shall indicate camber and splice joint offsets measured to the top of top flange at a maximum spacing of 4 m;
- Sizes of hardware, shear stud connectors, and any other material shown on the shop drawings shall be in the actual units (imperial or metric) of the material being supplied.

The shop drawings will be reviewed by the Consultant solely to ascertain general conformance with codes and specifications. The Consultant's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

The Contractor shall incorporate as-built construction conditions into shop drawings. One paper copy and one electronic copy (PDF format) of as-built shop drawings shall be submitted to the Consultant within 3 weeks of construction completion.

6.2.3.4 Proposed Fabrication Sequence and Equipment

The Contractor shall submit an outline of the proposed fabrication sequence and equipment that will be used to the Consultant for review and acceptance 4 weeks prior to the commencement of fabrication. The fabrication sequence shall include the order of fabrication, identification of witness points, details of shop assembly, and the details of surface preparation and coating.

The details of shop assembly shall include the method of assembly, support point locations, dimensional checks, methods of trimming to length, drilling and marking of splices.

If equipment causes repeated occurrences of damage, as determined by the Consultant and the Department, it shall be removed and replaced to the satisfaction of the Consultant.

6.2.3.5 Mill Test Reports

Mill test reports shall be provided for all materials in English.

Mill test reports shall be submitted to the Consultant for review and acceptance 4 weeks prior to the commencement of fabrication.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be certified to ISO/IEC 17025 by an organization accredited by the Standards Council of Canada for the tests required. Samples for testing shall be collected by personnel employed by the certified laboratory. A verification letter shall be provided by the certified laboratory that includes at a minimum, the applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the certified laboratory.

#### 6.2.3.6 Schedules

The Contractor shall provide and keep current a complete fabrication schedule in a form satisfactory to the Consultant.

### 6.2.4 Materials

#### 6.2.4.1 Structural Steel

Structural steel shall conform to the standard noted on the Drawings. Mill test reports and results of impact tests shall be provided to the Consultant for review and acceptance prior to shipment of material from the mill to provide sufficient time for replacement or for heat treating of material that does not meet the specification. If any material cannot be identified by mill test reports, coupons shall be taken and tested at a certified laboratory in Canada in accordance with Subsection 6.2.3.5, Mill Test Reports. Mill test reports shall be submitted to the Consultant for review and acceptance.

Repair of steel plates or rolled shapes by welding at the producing mill is not permitted.

Structural steel with a boron content exceeding 0.0008% will not be permitted.

#### 6.2.4.2 Bolts

All bolts shall conform to American Society for Testing and Materials (ASTM) Standard F3125 Grade A325/A325M heavy hex style. Nuts shall be heavy hex style and shall conform to ASTM A563/A563M. Hardened washers shall conform to ASTM F436/F436M.

Rotational capacity testing and reporting shall be performed in accordance with ASTM F3125 and submitted to the Consultant for review and acceptance.

#### 6.2.4.3 Stud Shear Connectors

All stud shear connectors shall conform to the chemical requirements of ASTM Standard A108, Grades 1015, 1018 or 1020. In addition, they shall meet the mechanical properties specified in AWS D1.5, Table 7.1 for Type B studs. Certified mill test reports for the stud material shall be provided.

Stud shear connectors with a boron content exceeding 0.0008% will not be permitted. The boron content of stud shear connectors shall be tested and results included with mill test reports.

#### 6.2.4.4 Bearings

Bearings shall be in accordance with Section 8, Bearings.

## 6.2.5 Welding

### 6.2.5.1 Filler Metals & Welding Processes

Low hydrogen filler, fluxes and low hydrogen welding practices shall be used throughout. The deposited weld metal shall provide strength, durability, impact toughness, and corrosion resistance equivalent to base metal. The low hydrogen covering and flux shall be protected and stored as specified by AWS Standard D1.5.

All electrodes, electrode/flux combinations, and electrode/shielding gas combinations shall be CSA certified.

Only the following welding processes and associated consumables shall be used:

#### 6.2.5.1.1 Submerged Arc Welding (SAW)

All flange and web groove welds shall be made by a semi or fully automatic submerged arc process acceptable to the Department.

All web to flange fillet welds and all longitudinal stiffener to web fillet welds shall be made by a fully automatic submerged arc process acceptable to the Department.

The Submerged arc welding process may be used for flat and horizontal position welds.

All electrodes and fluxes shall conform to the diffusible hydrogen requirements of AWS D1.5 filler metal hydrogen designator H8 or lower. Use of cored filler wires in the submerged arc welding process or shielding gas process will not be permitted.

#### 6.2.5.1.2 Shielded Metal Arc Welding (SMAW)

Shielded metal arc welding may be used for girder vertical stiffener to flange fillet welds, deck drains, bridge bearings, deck joint assemblies, pier nose plates, and buffer angles.

All electrodes and fluxes shall conform to the diffusible hydrogen requirements of AWS D1.5 filler metal hydrogen designator H4.

#### 6.2.5.1.3 Metal Core Arc Welding (MCAW)

Metal core welding may be used for vertical stiffeners and horizontal gussets of the girders and miscellaneous components such as deck drains, bridge bearings, deck joint assemblies, pier nose plates, hand rails, bridgerails and buffer angles.

All electrodes shall conform to the diffusible hydrogen requirements of AWS D1.5 filler metal hydrogen designator H4

Field welding using the metal core arc welding process is not permitted.

### 6.2.5.2 Cleaning Prior to Welding

Weld areas must be clean, free of mill scale, dirt, grease, and other contaminants prior to welding. For multi-pass welds, previously deposited weld metal shall also be thoroughly cleaned prior to depositing subsequent passes.

### 6.2.5.3 Tack and Temporary Welds

Tack and temporary welds shall not be allowed unless they are to be incorporated in the final weld. Tack welds, where allowed, shall be of a minimum length of four times the nominal size of the weld and length shall not exceed 15 times the weld size, and shall be subject to the same quality requirements as the final welds. Tack welds shall be sufficiently ground out prior to final weld in order to obtain a uniform weld bead. Cracked tack welds shall be completely removed prior to re-welding.

### 6.2.5.4 Run-off Tabs

Run-off tabs shall be used at the ends of all welds that terminate at the edge of a member. The thickness and shape of the tabs shall replicate the joint detail being welded and shall be a minimum of 100 mm long unless greater length is required for satisfactory work. They shall be tack welded only to that portion of the material that will not remain a part of the structure, or where the tack will be welded over and fused into the final joint. After welding, the tabs are to be removed by flame cutting, not by breaking off.

### 6.2.5.5 Preheat and Interpass Temperatures

Preheat and interpass temperature requirements shall be as per AWS D1.5, except that all welds on girder flanges shall be preheated to a minimum temperature of 100 °C unless a higher temperature is required by AWS D1.5 for the flange thickness. The preheat temperature of the web to flange joint shall be measured 75 mm from the point of welding on the side of the flange opposite to the side where the weld is being applied.

### 6.2.5.6 Welding at Stiffener Ends

To prevent notching effects, stiffeners and attachments fillet welded to structural members shall have the fillet welds terminate 10 mm short of edges.

### 6.2.5.7 Submission of Repair Procedures

The Contractor shall submit repair procedures for damaged base metal and unsatisfactory weldments to the Consultant and the Department for review and acceptance prior to commencement of the repair work. The repair procedures shall be signed and sealed by an experienced welding engineer registered as a Professional Engineer in the Province of Alberta.

### 6.2.5.8 Arc Strikes

Arc strikes will not be permitted. In the event of an isolated accidental arc strike, a repair procedure shall be submitted in accordance with Subsection 6.2.5.7, Submission of Repair Procedures. At a minimum, the repair procedure shall include the complete grinding out of the crater produced by the arc strike. The repair procedure shall also include MPI and hardness testing of the affected area. Hardness of the repaired area shall conform to the requirements of Subsection 6.2.8.11, Hardness Tests. These areas will be examined by the Consultant to ensure complete removal of the metal in the affected area.

### 6.2.5.9 Grinding of Welds

Flange groove welds shall be ground flush or to a specified slope on both sides. Web groove welds which are sufficiently smooth with a neat appearance and uniform profile as determined by the Consultant will not require grinding. Fillet welds shall be continuous with uniform size and profile. Locations which are not conforming to acceptable profile shall be ground to the proper profile without damaging of the base metal. Grinding shall be smooth and parallel to the line of stress. Caution shall be exercised to prevent over grinding. Over grinding that, results in reduced thickness of the base metal or size of the weld shall not be permitted. Acceptability of the welds without grinding will be determined by the Consultant.

### 6.2.5.10 Plug and Slot Welds

Plug welds or slot welds shall not be permitted.

### 6.2.5.11 Welding to Girder Flanges and Webs

With the exception of longitudinal web to flange welds, all stiffeners, gusset plates, or any other detail material welded to girder flanges shall be a minimum of 300 mm from any flange groove weld. Stud shear connectors shall not be installed within 50 mm of any flange groove weld.

With the exception of longitudinal web to flange welds and longitudinal stiffeners to web welds, all stiffeners, gusset plate, or any other detail material welded to girder webs shall be a minimum of 300 mm from any web groove weld.

## 6.2.6 Fabrication

Fabrication shall be performed in a fully enclosed area which is adequately heated. The shop temperature shall be at least 10 °C.

#### 6.2.6.1 Heat Number Transfer

As the plate is subdivided for webs and flanges, all heat numbers shall be transferred to each individual section. The numbers shall remain legible until such time as the material location in the final assembly has been recorded. Mill identification numbers stamped into the material shall be removed by grinding at an appropriate time.

#### 6.2.6.2 Marking Systems

Methods and medium of marking and the location of marks shall be accepted by the Consultant. Steel stamps shall not be used. The only exception is the match marking of splice plates, which may be steel, stamped using low stress stamps. The stamps and specific locations of such stamps must be shown on the shop drawings and accepted by the Consultant.

#### 6.2.6.3 Cutting of Plate

All plate material for main members, splice plates and any plate material welded to the main member shall be flame cut using an automatic cutting machine.

#### 6.2.6.4 Flange Stripping

All flange material shall be cut so that the direction of the applied stress will be parallel to the direction of the plate rolling.

#### 6.2.6.5 Flame Cut Edges

The flame cut edges of girder flanges shall have a maximum Brinell hardness in accordance with Subsection 6.2.8.11, Hardness Tests. The surface roughness of the flame cut edge shall not be greater than ANSI B46.1 500 µin. (12.5 µm) and be such that as to allow Brinell hardness testing without spot grinding. The Consultant will perform Brinell hardness tests at random on the as is flame cut edge. Tests will be taken at a minimum of three locations for each cut edge of the plate (at each end and mid-point along length of cut edge) before any flange butt splices are completed. If the hardness exceeds the requirements, the Contractor shall submit for review, his procedures for repairing the edges to meet the requirements. The surface of flame cut apertures shall be finished by grinding and shall be free of nicks and gouges.

The Contractor shall report all blow backs or signs of lamination or any other discontinuity detected on plate cut edges for tension members during the cutting of the material. In case of plate lamination, the Contractor at his expense shall arrange for a CAN/CSA 178.1 certified NDT company to determine the extent. The ultrasonic testing technician shall be certified to Level II of CGSB. The damage report and repair procedure shall be prepared by a Professional Engineer registered in the Province of Alberta indicating the material is suitable for the girder fabrication and shall be forwarded to the Consultant for review and acceptance of the material.

#### 6.2.6.6 Additional Material Splices

Additional splices, other than those shown on the shop drawings, will require review and acceptance of the Department and Consultant. The Contractor shall bear the cost of inspection of these splices.

#### 6.2.6.7 Vertical Alignment

The structure shall be fabricated to conform to the requirements of the deflection and vertical curve, as noted on the Drawings. For rolled shapes, advantage shall be taken of mill camber that may be inherent in the material.

#### 6.2.6.8 Shop Assembly

##### 6.2.6.8.1 Plate Girders

The Work shall conform to the submitted sequence outlined in Subsection 6.2.3.4, Proposed Fabrication Sequence and Equipment and this Subsection.

Shop assembly of girders shall be by the progressive assembly method according to AASHTO LRFD Bridge Construction Specifications, except that only two, instead of three, sections need to be assembled.

Each individual girder section shall meet the camber requirements for that particular length, with the splices between these sections falling on the theoretical camber line for the entire span. Correction for variation in flange thickness must be considered. When the camber of the girder fails to meet the required tolerance, the Contractor shall submit a proposed method of repair for review and acceptance by the Consultant and the Department. Adjustment for camber will not be allowed without the prior review and acceptance of the procedure and supervision of the repairs by the Consultant and the Department. The camber of each individual girder section must be known for the next two girder sections in the girder line prior to shop assembly of any particular girder section. This is to allow the Consultant to determine the best fit line to reduce the effect of any camber differences should it be deemed necessary. Camber for plate girders will be measured on the top of the top flange. The camber of plate girders shall be measured in the “no load” condition.

##### 6.2.6.8.2 Box Girders

The progressive shop assembly for box girders shall be as per Subsection 6.2.6.8.1, Plate Girders, with additional box girder specific items as described in this subsection.

The camber of box girders shall be measured on the top of the top flange, and each top flange of a box shall individually meet the required camber. Girder sections assembled for splicing shall be supported within 2 m of the end of each section. Girder sections shall be supported in such a manner as to provide the correct angular relationship at the splice between girder sections while the splices are being reamed or drilled. Shop drawings shall clearly indicate the expected dead load deflection of each section and the elevations of the sections while supported for the drilling or reaming of each splice.

#### 6.2.6.8.3 Drilling

All splices shall be drilled from solid material while assembled or shall be sub-punched or sub-drilled and then reamed to full size while in the shop assembly position. No reaming shall take place until acceptance of the assembly has been obtained from the Consultant.

### 6.2.6.9 Splice Plates

After shop assembly, splice plates and girders shall be clearly match marked to assure proper orientation and location of splice material for erection. All holes shall align with holes in the attached member. Splice plates shall then be removed, de-burred, solvent cleaned, to remove all oil and sandblasted to remove all mill scale, in order to provide a suitable faying surface acceptable to the Consultant. These plates shall then be securely ship-bolted to the girders. The match marking system shall be shown on the shop drawings.

### 6.2.6.10 Bolt Holes

Clause 11.4.8 of AASHTO LRFD Bridge Construction Specifications shall apply except that all bolt holes in load carrying segments of main members and any material welded to main members shall be drilled full size or sub-punched 5 mm smaller and reamed to full size.

Punching of full size holes for secondary members such as bracings, which are not welded to main member will only be permitted for material less than 16 mm thick. Diaphragm bracing members for kinked or curved girder bridges are considered primary structural members and therefore punching of full size holes will not be permitted.

Holes in girder splices and structural members shall be circular and perpendicular to the member. Cutting of slotted holes shall be done by plasma arc cutting. Holes shall be deburred inside and outside and free of nicks and gouges.

### 6.2.6.11 Dimensional Tolerances

Normal tolerance for structural steel fabrication and fitting between hole groups will be ±3 mm unless specified otherwise. The dimensional tolerances for structural members shall be within the AWS Standard D1.5, Section 3.5, except as otherwise noted below:

#### 6.2.6.11.1 Combined Warpage and Tilt

Combined warpage and tilt of flange at any cross section of welded I-shape beams or girders shall be determined by measuring the offset at the toe of the flange from a line normal to the plane of the web through the intersection of the centerline of the web with the outside surface of the flange plate. This offset shall not exceed 1/200 of the total width of the flange or 3 mm whichever is greater at bolted splice location. Bolted splices of main stress carrying members shall have parallel planes and the surfaces shall be in full contact without any gap.

6.2.6.11.2 Girder Camber

Camber of beams and girders shall be uniform, true and accurate to the centreline of the top flange. Permissible variation in camber shall be within ± (0.2Lt + 3) mm; where Lt is the test length in metres. This applies to fabricated pieces only, prior to shop assembly. During shop assembly, splice points shall be located on the theoretical camber line or at a specified amount from the line should the Consultant choose to correct for shop camber deviations.

Where field splices are eliminated by combining girder segments into longer girder lengths, the cambers of the girders at the eliminated splice points shall be within ±3 mm.

6.2.6.11.3 Box Girders

Tolerances for box girder camber, sweep and depth shall be measured relative to two imaginary surfaces: a vertical plane passing through the centre line of the girder, and a surface located at the theoretical underside of the top flanges following the theoretical camber of the girder.

6.2.6.11.4 Splices

Fill plates shall not be permitted at main girder field splices unless specified. The tolerance for girder depth or box girder geometry shall be as specified by AWS D1.5, except that the difference between similar dimensions of the adjoining sections being spliced shall not exceed ±3 mm.

6.2.6.11.5 Splice Gap Between Adjacent Girder Ends

At field splice locations, the gap between adjacent girder ends shall be 10 mm ± 5 mm.

6.2.6.11.6 Stiffeners

The bearing ends of bearing and jacking stiffeners shall be flush and square with the web and shall have at least 75% of this area in contact with the flanges. Fitted stiffeners may have a gap of up to 1 mm between stiffener and flange.

6.2.6.11.7 Facing of Flanges

Surfaces of flanges which are in contact with bearing sole plates shall have a flatness tolerance of 0.001 x bearing dimension.

6.2.6.11.8 Bearing to Bearing Dimension

Bearing to bearing distance is a set dimension and therefore has no tolerance.

6.2.6.12 Corner Chamfer

Corners of all flanges shall be ground to a 2 mm chamfer. Corners of structural sections, plates, and outside corners of stiffeners shall be ground to a 1 mm chamfer.

### 6.2.6.13 Stiffener Tolerances

The bearing ends of bearing and jacking stiffeners shall be square and flush with the web and shall have at least 75% of area in contact with the flanges. The remaining 25% of the area may have a gap of up to 0.05 mm. Fitted stiffeners may have a gap of 1 mm between stiffener and flange.

### 6.2.6.14 Web Panning

The maximum variation from flatness for webs shall be 0.01d where d, is the least dimension of the panel formed by the girder flanges and/or stiffeners. Should the panning in one panel convex and the panning in the adjacent panel concave then the sum of the panning in the two adjacent sections shall not exceed that allowed for one panel. Localized deformation in the web shall not exceed 3 mm in 1 m.

### 6.2.6.15 Field Weld Preparation

All material to be field welded shall be prepared in the shop. Field welding shall be performed in accordance with Section 13, Miscellaneous Iron.

### 6.2.6.16 Flame Straightening and Heat Curving

Flame straightening and heat curving shall not be performed on any material or member without a written request to the Department and the Consultant. The Contractor shall submit a procedure developed by a Professional Engineer stating location, temperatures and cooling rates, to the Department and the Consultant for review. Straightening or heat curving shall only be performed in the presence of the Consultant.

### 6.2.6.17 Stress Relieving

When stress relieving is specified, it shall be performed in accordance with AWS D1.5. Copies of the furnace charts shall be supplied to the Consultant.

### 6.2.6.18 Handling and Storage

All lifting and handling shall be done using devices that do not mark, damage, or distort the assemblies or members in any way. Girders shall be stored upright, supported on sufficient skids and safely shored to maintain the proper section without buckling, twisting or in any way damaging or misaligning the material.

## 6.2.7 Surface Preparation and Coating

### 6.2.7.1 Abrasive Blast Cleaning

Unless otherwise noted, all steel components shall be abrasive blast cleaned after fabrication in accordance with the Society for Protective Coating Standard (SSPC) No. SP6. The exterior face of the exterior girders shall be uniform in appearance as determined by the Consultant.

### 6.2.7.2 Coating

At all bearing locations, an organic zinc epoxy primer shall be applied to the underside of bottom flanges in contact with the bearing sole plate. The primer shall extend the full width of the flange and 15 mm beyond the projected contact surface of the bearing sole plate in the longitudinal direction.

At all deck joint locations a complete SF2, SF3 or SF4 approved bridge coating system from the Department's Product List shall be applied to the bottom flange surfaces (underside, top and edges), with the exception that the faying surface of the underside of bottom flange in contact with the bearing sole plate shall only receive the organic zinc epoxy primer. The coating system shall extend longitudinally from the girder end to a distance 100 mm beyond the bearing sole plate or 100 mm beyond the jacking stiffener, whichever distance is greater. The selected SF2, SF3 or SF4 coating system shall be applied to the full height of the bridge webs (both sides of web and including any applicable bearing/jacking stiffeners) and to the underside of the top flanges. The longitudinal extent of this coating shall be the same as described above. Faying surfaces of bolted connections shall only receive the organic zinc epoxy primer.

Any of the portions of the girder noted above that will be encased in cast in place concrete shall be left in the bare steel condition with no coating applied.

The approved organic zinc epoxy primer shall meet the requirements of a Class B coating, in accordance with the "Testing Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints" as described in Appendix A of the Research Council on Structural Connections "Specification for Structural Joints Using High-Strength Bolts". A certificate of compliance shall be provided to the Department for review and acceptance prior to application. The top coat colour shall conform to US Federal Standard 595C colour FS30045.

### 6.2.7.3 Galvanizing

The fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatters, and all welding flux residue from the steel components prior to galvanizing.

Factors contributing to galvanization-induced cracking shall be minimized. Galvanizing shall be by the hot dip method, after fabrication, in accordance with the current edition of ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and ASTM F2329 Standard Specification for Zinc Coating Hot-Dip Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners and as modified in this specification.

The cleaning and pickling procedure of high strength ASTM A193 Grade B7 anchor rods shall be modified as follows prior to hot-dip galvanizing:

- Brush blast to remove mill scale and oil after threading ends;
- Flash pickle up to 5 minutes; and
- Quick dry prior to hot-dip galvanizing (not stored in flux or acid rinse).

The modified anchor rod cleaning and pickling procedure shall be completed in the presence of the Consultant prior to hot-dip galvanizing.

Repair of galvanizing shall be completed in accordance ASTM A780, Method A3 “Metallizing” and will only be permitted when the repair areas are small and infrequent as determined by the Consultant. Repair areas less than 100 $mm^2$ in area may be completed in accordance with ASTM A780, Method A1 ”Repair Using Zinc-Based Alloy”. The thickness of the coating for both methods shall be 180 µm, and the repair tested for adhesion. A detailed repair procedure shall be submitted for review and acceptance by the Consultant prior to commencement of the work. Repairs may require complete removal of the galvanized coating and re-galvanizing. The finished appearance shall be similar to the adjacent galvanizing as determined by the Consultant.

Galvanized material shall be stacked or bundled and stored to prevent wet storage stain as per the American Hot Dip Galvanizers Association (AHDGA) publication “Wet Storage Stain”. Any evidence of wet storage stain shall be removed to the satisfaction of the Consultant.

Galvanized contact surfaces of bolted connections shall be hand wire brushed to a Class A slip coefficient surface condition. Slip coefficients surface conditions shall meet the requirements of Table 10.9 of CSA S6.

### 6.2.8 Testing and Inspection

#### 6.2.8.1 Access

The Contractor shall provide full facilities for the inspection of Work. The Consultant shall have full access to all parts of the Work at all times. When required by the Consultant, the Contractor shall provide needed manpower for assistance in checking layout and performing inspection duties.

#### 6.2.8.2 Responsibility

It is the Contractor’s responsibility to ensure that the Work is completed in accordance with the Contract requirements. Any inspection and/or testing completed by the Consultant, review and acceptance by the Consultant, shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract.

#### 6.2.8.3 Testing by the Consultant

The visual, radiographic, ultrasonic, magnetic particle, dye penetrant, hardness testing, and stud shear connector testing will be performed by the Consultant or his designated testing agencies. The Consultant may complete additional testing and inspection at his discretion and the Contractor shall provide full access to the Work as required by the Consultant.

The Contractor shall be responsible for all costs incurred by the Consultant to attend the pre-fabrication meeting and to inspect bridge girders, cover plated v-seal deck joints, and finger plate deck joints being fabricated outside the Province of Alberta. The Contractor shall also be responsible for the cost of the Department's representative to attend the pre-fabrication meeting and three additional trips to review the fabrication. For the cover plated v-seal and finger plate deck joints the number of additional trips required for the Department's representative will be reduced to one.

#### 6.2.8.4 Testing by the Contractor

The Contractor's testing and inspection records shall be open for examination by the Consultant upon request.

Testing, inspection and related costs incurred by the Consultant resulting from defective work or Contractor proposed connections and/or splices not specified on the Drawings shall be paid for by the Contractor.

#### 6.2.8.5 Witness Points

Inspection stations shall be set up at specific points during the course of fabrication for the Consultant to complete the required testing and/or inspection. At each witness point the Work shall be checked by the Contractor, tested and inspected by the Consultant, and all deficiencies corrected to the full satisfaction of the Consultant prior to the next sequence of fabrication. Witness points for plate and box girders shall be:

- Flange plates prepared;
- Web plates prepared;
- Web to flange welds completed prior to fitting any stiffeners;
- Completion of all welding prior to splicing;
- Splice set-up prior to drilling;
- Surface preparation and coating; and
- Final inspection and clearance to ship.

#### 6.2.8.6 Non-destructive Testing

Non-destructive testing (NDT) is to be completed in accordance with the following standards:

- Radiography - AWS Standard D1.5;
- Ultrasonic - AWS Standard D1.5;
- Magnetic Particle - ASTM Standard E-709;
- Dye-Penetrant - ASTM Standard E-165; and
- Hardness tests - ASTM Standard E-10.

### 6.2.8.7 Radiographic Inspection Schedule

Radiographic inspection of welded steel girders will be performed in accordance with the following schedule:

- 100% of all tension flange and stress reversal groove welds, all stiffener groove welds and all diaphragm groove welds, and any groove welded attachments to flange plates;
- A minimum of 25% of all other flange groove welds randomly selected by the Consultant for each structure;
- 100% of all web groove welds; and
- If defects are found during testing, additional testing will be completed.

For steel members 65mm thick and thicker, 25% of the welds will also be inspected by ultrasonic in addition to radiographic inspection requirements.

The radiographic inspection report and the film shall be submitted to the Consultant for review and acceptance within 48 hours of inspection completion.

### 6.2.8.8 Radiographic Inspection of Welds for Miscellaneous Material

Radiographic inspection of materials other than welded steel girders shall be performed by the Contractor in accordance with the following schedule:

- 100% of all tension members; and
- 50% of all other members.

For steel members 65mm thick and thicker, 25% of the welds shall also be inspected by ultrasonic to supplement the Radiographic inspection

The radiographic inspection report and the film shall be submitted to the Consultant for review and acceptance within 48 hours of inspection completion.

### 6.2.8.9 Magnetic Particle Inspection Schedule

Magnetic particle inspection of welded plate and box girders will be performed in accordance with the following schedule:

- 50% of the web to flange welds or any fillet welds placed on flange plates. The tests shall be in 1.5 m lengths including a 1.5 m length at each end of each web to flange weld;
- 20% of the stiffener to web welds;
- 100% of the stiffener and diaphragm connector plate to flange welds;
- 100% of the bearing sole plate to flange welds;
- 20% of the diaphragm connector plate welds to web;
- 100% of all manual (SMAW) welds; and
- 25% of all fillet welds for other bridge components.

#### 6.2.8.10 Dye Penetrant Inspection

Dye penetrant inspection will be performed in areas of the structure deemed necessary by the Consultant. In particular, the ends of the weld metal of all flange groove welds after the removal of runoff tabs will be inspected using this method. Dye penetrant inspection will be done for all flange plate edges regardless of whether or not the plates are cut before or after welding. Defects discovered by this inspection shall be repaired by the Contractor, and the suspect area re-inspected.

#### 6.2.8.11 Hardness Tests

Hardness tests will be performed on flame cut edges of girder flange plates prior to assembly. A minimum of three readings for each cut edge of the plate (at each end and mid-point along length of cut edge) will be taken.

Unless otherwise noted, the hardness of the flame cut edges shall not exceed a maximum Brinell as noted below:

- For carbon steels with a yield strength less than and including 300 MPa, the maximum Brinell shall be 200 BHN; and
- For carbon steels with yield strengths greater than 300 MPa, the maximum Brinell shall be 220 BHN.

Remedial work to the edges which exceed the specified hardness shall be performed and re-inspected prior to assembly.

#### 6.2.8.12 Testing Stud Shear Connectors

Stud shear connectors and their associated bend testing shall meet all requirements as outlined by AWS D1.5. When bend testing, the studs will be bent towards the centre of the girder. All the remaining studs will be tested by striking with a hammer. A dull sound indicates incomplete fusion and a bend test will then be required for a potentially defective stud to ensure the integrity.

#### 6.2.8.13 Inspection Schedules

The Contractor shall provide notice of scheduled inspection requirements to the Consultant and their representative(s). The amount of notice required will be provided to the Contractor by the Consultant and/or their representative(s).

#### 6.2.8.14 Notification to Ship

The Contractor shall notify the Consultant 72 hours prior to shipment to facilitate inspection and acceptance of the structural steel. Structural steel shall not be shipped until it has been reviewed and accepted by the Consultant. Review and acceptance of structural steel at the fabrication facility by the Consultant will not relieve the Contractor of his full responsibility to meet the requirements of these specifications.

Structural steel that has not been inspected at the fabrication facility will not be paid for until such material has been inspected, reviewed and accepted by the Consultant. The Contractor shall be responsible for all costs incurred by the Consultant for inspection of the structural steel not inspected at the fabrication facility.

6.2.8.15 Structural Steel Fabrication Outside of Canada

All testing and inspection requirements specified in Subsection 6.2.8, Testing and Inspection, shall be completed at the fabrication facility and all costs incurred by the Consultant and their designated testing agencies, and the Department shall be paid for by the Contractor.

All components fabricated outside of Canada shall be shipped to a shop located in Canada that is certified by CWB in accordance with CSA W47.1 to Division 1 and by CISC in the category of steel bridges for re-inspection and testing. The components shall be in a condition that facilitates all re-inspection and testing requirements. The re-inspection and testing at the Canadian shop shall be completed in accordance with Subsection 6.2.8, Testing and Inspection. The Contractor shall also arrange for inspection by a CSA 178.2 Level III certified welding inspector accredited with W47.1/W59 to inspect:

- All components to ensure that they were undamaged during transportation; and
- Shop assembly in accordance with Subsection 6.2.6.8, Shop Assembly.

Components shall not be shipped from the Canadian shop until all requirements have been met and the Work has been reviewed and accepted by the Consultant.

The Contractor shall be responsible for all re-inspection and testing costs, including all cost incurred by the Consultant and the Department.

The Contractor shall have no claim against the Department resulting from delays caused by these requirements.

6.2.8.16 Finger Plate and Cover Plated V-Seal Deck Joint Assemblies

Specified tolerances of finger plate and cover plated v-seal deck joints shall be measured and recorded at a minimum of 4 inspection hold points. The minimum 4 inspection hold points shall be:

(1) Prior to shipment from the fabrication facility. Measurement of tolerances at inspection hold point 1 shall occur with the deck joint fully assembled in a relaxed condition without shipping and erection angles installed and at the -5°C and +15°C ‘X’ gap settings. For cover plated v-seal deck joints, the cover plates shall be installed with bolts tightened;

(2) After installation of the deck joint into the blockout and prior to abutment side blockout concrete placement. Measurement of tolerances at inspection hold point 2 shall occur with the deck joint fully assembled, shipping angles and erection angles installed with bolts tightened;

(3) After the abutment side blockout concrete has been placed, cured and developed a minimum compressive strength of 20 MPa, and prior to deck side blockout concrete placement. Measurement of tolerances at inspection hold point 3 shall occur with the deck joint fully assembled, shipping angles and erection angles installed with bolts tightened; and

(4) For finger plate deck joints: immediately after completion of curing of abutment side and deck side blockout concrete.

For cover plated v-seal deck joints: after completion of curing of abutment side and deck side blockout concrete, epoxy injection is complete, v-seals are installed, and cover plates are reinstalled with bolts tightened.

Measurement of tolerances at inspection hold point 4 shall occur with the deck joint fully assembled and supported by the concrete with shipping angles and erection angles removed.

Gap tolerances between finger plates, cover plates and support plates shall be in accordance with the applicable Standard Drawings.

If the specified tolerances are not met at each inspection hold point, the Contractor shall repair the deck joint such that all specified requirements are met. The Contractor shall prepare and submit a repair procedure to the Consultant and the Department for review and acceptance prior to commencement of any repair work.

The climatic conditions shall be recorded at the time of tolerance measurements at each inspection hold point.

The Contractor shall notify the Consultant that the deck joint meets the specified tolerances at each inspection hold point and is ready for inspection. The Consultant will then measure and record all tolerances at similar climatic conditions to those in which the Contractor took his initial tolerance measurements. Deck joints shall not be released from an inspection hold point until the Consultant's acceptance of the deck joint has been received in writing.

## 6.3 Structural Steel Erection

The Contractor shall erect structural steel as shown on the Drawings, in accordance with these specifications and the Special Provisions of the Contract. Structural steel erection shall also include, but is not limited to the following:

- Erecting and removal of temporary supporting structures;
- Removal of anchor rod void formwork;
- Installing deck joints; and
- Coating touch up.

The Contractor shall not erect the structural steel until the substructure concrete has been cured a minimum of three days and achieved a minimum of 80% of the 28 day specified concrete strength requirement.

Cranes shall be used for the handling and erection of structural steel girders.

Lifting forces shall be vertical. Lifting devices shall not be welded to the girders or require the removal of any stud shear connectors for attachment to the girders. Drilling of additional holes or any other modifications, including field welding will not be permitted.

The Contractor shall maintain girder stability; location; and horizontal, vertical and longitudinal alignment at all times during construction.

Grout pads shall meet the requirements of Section 8, Bearings.

### 6.3.1 Transportation, Handling and Storing Materials

Girders shall be transported with girder webs in the vertical position.

If the Contractor proposes to transport the girders with webs in a position other than vertical, the Contractor shall submit a girder transportation assessment to the Consultant for review and acceptance a minimum of two weeks prior to shipping from the fabrication facility. The girder transportation assessment shall be signed and sealed by a Professional Engineer registered in the Province of Alberta. Review comments provided by the Consultant and/or the Department shall be incorporated into the transportation assessment and resubmitted to the Consultant for review and acceptance prior to shipping from the fabrication facility. The Consultant's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in a manner that does not, in the opinion of the Consultant and Department, damage the girders. All costs associated with the transportation assessment will be considered incidental to the Work and no separate or additional payment will be made.

The transportation assessment, at a minimum, shall include design notes, drawings, rationale for the proposed transport position, and statement indicating the proposed method will not damage the girders. Design notes shall include evaluation of the static and dynamic forces and associated stresses during handling, transportation, and storage using a dynamic load allowance of 100%. The stresses shall be in accordance with CSA S6, Clause 10.10, Beam and Girders, and the maximum cyclic stress range shall not exceed the constant amplitude fatigue threshold for the appropriate fatigue categories specified in CSA S6, Table 10.4, Fatigue life constants and constant amplitude threshold stress ranges

Structural steel shall be protected from dirt, road salts, slush or other contaminants during transportation, handling and storage.

Upon arrival at the site and prior to erection, the Contractor in the presence of the Consultant, shall inspect materials for cleanliness and presence of damage. The Contractor shall provide an adequate flat storage area and space between elements for the inspection. A detailed inspection report shall be provided to the Consultant for review and acceptance within three days of the inspection. Erection shall not commence until the detailed inspection report has been reviewed and accepted by the Consultant.

Structural steel that becomes contaminated with any dirt, road salts, slush or other contaminants, shall be cleaned and surfaces prepared to the satisfaction of the Consultant prior to erection or installation.

Any structural steel member damaged during transportation, handling, storing or erection shall be immediately reported to the Consultant and the Department. The Contractor shall provide an engineering assessment report and repair procedure prepared by a Professional Engineer registered in the Province of Alberta experienced in evaluation and inspection of damaged steel members. The assessment report and repair procedure shall be submitted to the Consultant and the Department for review and acceptance. The Consultant will also arrange to have an independent inspection and assessment performed on the damaged member by a Level III certified welding inspector as per CSA 178.2 accredited with W47.1/W59. The Contractor shall provide a minimum three days' notice for the inspection and facilitate all the activities associated with the inspection. All costs associated with the independent inspection will be the responsibility of the Contractor.

Material to be stored shall be placed on timber blocking. It shall be kept clean, free from dirt, grease, and any other foreign matter and stored in a properly drained area. Handling and lifting devices shall not mark, damage, or distort members. Softeners shall be used where chains or other tie down devices are in direct contact with the steel members. Girders and beams shall be shored, and stored in the vertical position. Long members, such as deck joint assemblies, buffer angles, columns and chords, shall be supported on timber blocking to prevent damage or distortion from deflection. Galvanized material shall be handled and stored in accordance with Subsection 12.2.8, Handling and Storage.

### 6.3.2 Bridge Girders

#### 6.3.2.1 Temporary Supporting Structures and Berms

The temporary supporting structures and berms shall be designed, constructed and maintained to safely support all loads.

Berms shall be constructed in a manner and of such materials that they will not be eroded by stream flow nor introduce silt into the watercourse.

The Contractor shall prepare and submit drawings that clearly indicate details of all temporary supporting structures and berms, sealed by a Professional Engineer registered in the Province of Alberta, for the Consultant's review and acceptance a minimum of four weeks in advance of the Work. The Contractor shall be fully responsible for the results obtained by the use of these sealed drawings, with the Professional Engineer also assuming responsibility, as the Contractor's Agent, for the results obtained.

The Consultant's review and acceptance shall not be considered as relieving the Contractor of the responsibility for the safety of his methods or equipment, nor from carrying out the work in full accordance with the Contract requirements.

Repair to any damage to property, such as earth fills and stream banks, resulting from the existence of berms, and all associated costs shall be the sole responsibility of the Contractor.

### 6.3.2.2 Girder Erection Procedure

The Contractor shall submit a detailed girder erection procedure to the Consultant for review and acceptance a minimum of 4 weeks in advance of erection. The erection procedure shall include drawings and supporting documents necessary to describe the following:

- Traffic Accommodation Strategy (TAS);
- Access to the Work, including temporary access berms and/or work bridges;
- Details of temporary works and supporting structures, including:
  - Location, elevation, and grade of support bearings;
  - Theoretical top of girder elevations at bearing and splice locations; and
  - Vertical, horizontal, and longitudinal position adjustment mechanisms;
- An as constructed survey of substructure elements, including:
  - Location and elevation of all bearing grout pad recesses including anchor rod voids;
  - Shim height required at each bearing location; and
  - Longitudinal and transverse measurements between centreline of bearings of all substructure elements;
- Superstructure layout plan, including installation details of reference lines and markings of substructure and bearing components used to determine final bearing and girder positions, and theoretical top of girder elevations at substructure bearings and splice locations;
- Type and capacity of cranes;
- Sequence of operation including position of cranes and delivery trucks;
- Position of cranes relative to substructure elements such as abutment backwalls, with details of load distribution of wheels and outriggers;
- Lifting devices and lifting points showing lifting forces;
- Girder stabilization details, methods of maintaining girder location and alignment, and details of blocking for girder and bearings;
- Diaphragm and bracing installation schedule and sequence;
- Bolt tightening schedule and sequence;
- Grout pad construction; and
- Temporary supporting structures release and removal.

Installation of bearings shall be in accordance with Subsection 8.4, Installation.

Girder layout and member identification contained in the erection procedure shall be consistent with the girder layout and member identification shown on the Drawings.

The girder erection procedure shall be signed and sealed by a Professional Engineer registered in the Province of Alberta. Safety and compliance with the Occupational Health and Safety Act and Regulations thereunder shall be an integral part of the procedure.

The Contractor shall not commence any erection work until review of the girder erection procedure by the Consultant has been completed and all comments arising from that review have been addressed to the satisfaction of the Consultant. The Contractor's project manager, field superintendent, and representatives directly involved in the supervision of the work, shall attend a construction milestone meeting prior to commencement of the Work.

The Consultant’s review and acceptance shall not be considered as relieving the Contractor of the responsibility for the safety of his methods or equipment, nor from carrying out the Work in full accordance with the girder erection procedure, drawings and specifications.

The Contractor shall follow the girder erection procedure at all times.

#### 6.3.2.3 Fall Protection for Girder Erection and Deck Forming

In order to provide a safe working area for girder erection and deck formwork, the Contractor shall provide 100% fall protection and a safe work procedure. The design of the fall protection and the safe work procedure shall be designed, signed and sealed by a Professional Engineer registered in the Province of Alberta. The Contractor shall submit the design and safe work procedure to the Consultant a minimum of two weeks prior to commencement the Work.

#### 6.3.2.4 Straightening Bent Material

Straightening of plates, angles or other shapes will not be permitted without the acceptance of the Department and the Consultant. In all cases, a detailed written procedure prepared by a Professional Engineer registered in the Province of Alberta must be submitted by the Contractor, and reviewed and accepted by the Consultant and the Department prior to any straightening being undertaken.

Following the accepted straightening of a bend or buckle, the surface of the metal shall be inspected for evidence of fractures, which may include nondestructive testing. The Consultant and the Department will determine the type of NDT required and arrange for the testing. All costs associated with straightening bent material shall be the responsibility of the Contractor.

#### 6.3.2.5 Assembly

Members shall be assembled as shown on the Drawings and all fabrication match marks shall be followed. The material shall be carefully handled to avoid damage. Hammering shall not damage or distort the members.

Contact surfaces of bolted connections shall be cleaned to the satisfaction of the Consultant before the members are assembled. Contact surfaces that have not been cleaned to the satisfaction of the Consultant shall be un-bolted and cleaned.

Splices and field connections shall have ½ of the holes filled with bolts and cylindrical erection pins (half bolts and half pins evenly distributed throughout the splice or connection) before bolting. Splices and connections carrying traffic during erection shall have ¾ of the holes filled.

Fitting up bolts, if used, shall be distinguishable from the final bolts and shall be of the same nominal diameter. Cylindrical erection pins shall be sized to accurately fit the holes.

When adjustments in elevation of the girder splices is required, only enough pins or bolts shall be removed to allow free rotation of the splice.

#### 6.3.2.6 High Tensile Strength Bolted Connections

##### 6.3.2.6.1 General

Bolted parts shall fit solidly together when assembled. Contact surfaces, including those adjacent to the washers, shall be de-scaled or carry the normal tight mill scale as determined by the Consultant. Contact surfaces shall be free of dirt, paint, oil, loose scale, burrs, pits and other defects that would prevent solid seating of the parts. Bolts in exterior girders shall be installed with the heads on the outside face of the girder web. Bolts located in the bottom flange of all girders shall have the heads installed on the bottom face of the lower splice plate unless noted otherwise. Nuts for bolts that will be partially embedded in concrete shall be located on the side of the member that will be encased in concrete.

Connections shall be assembled with a hardened washer under the bolt head or nut, whichever is the element turned in tightening. The smooth side of the hardened washer shall be placed against the structural steel. Surfaces of bolted parts in contact with the bolt head and nut shall be parallel.

For sloped surfaces, bevelled washers shall be used. The bevelled washers shall be designed to produce a bearing surface normal to the bolt axis.

Bolts shall be of new quality and stored in weatherproof containers to prevent loss of lubrication or accumulation of dirt.

The elevation and alignment of girders, including bracing and diaphragms, shall be reviewed and accepted by the Consultant prior to any bolt tightening.

##### 6.3.2.6.2 Bolt Tension

Each bolt shall be tightened so as to provide, when all bolts in the joint are tight, at least the minimum bolt tension shown in Table 6-1: Bolt Tension, for the size of bolt used.

**Table 6-1: Bolt Tension**

| Specified Bolt Size | Minimum Bolt Tension | | Equivalent Imperial Size | Minimum Bolt Tension | |
|---|---|---|---|---|---|
| (A325M Bolts) | Kilonewtons | pounds-force | (A325 Bolts) | Kilonewtons | pounds-force |
| M16X2 | 94 | 21,180 | 5/8 | 85 | 19,200 |
| M20X2.5 | 147 | 33,050 | 3/4 | 126 | 28,400 |
| M22X2.5 | 181 | 40,700 | 7/8 | 175 | 39,250 |
| M24X3 | 212 | 47,660 | 1 | 227 | 51,500 |
| -- | -- | -- | 1 1/8 | 251 | 56,450 |
| M30X3.5 | 337 | 75,760 | 1 1/4 | 319 | 71,700 |
| -- | -- | -- | 1 3/8 | 380 | 85,450 |
| M36X4 | 490 | 110,160 | 1 1/2 | 463 | 104,000 |

6.3.2.6.3 Turn of Nut Tightening

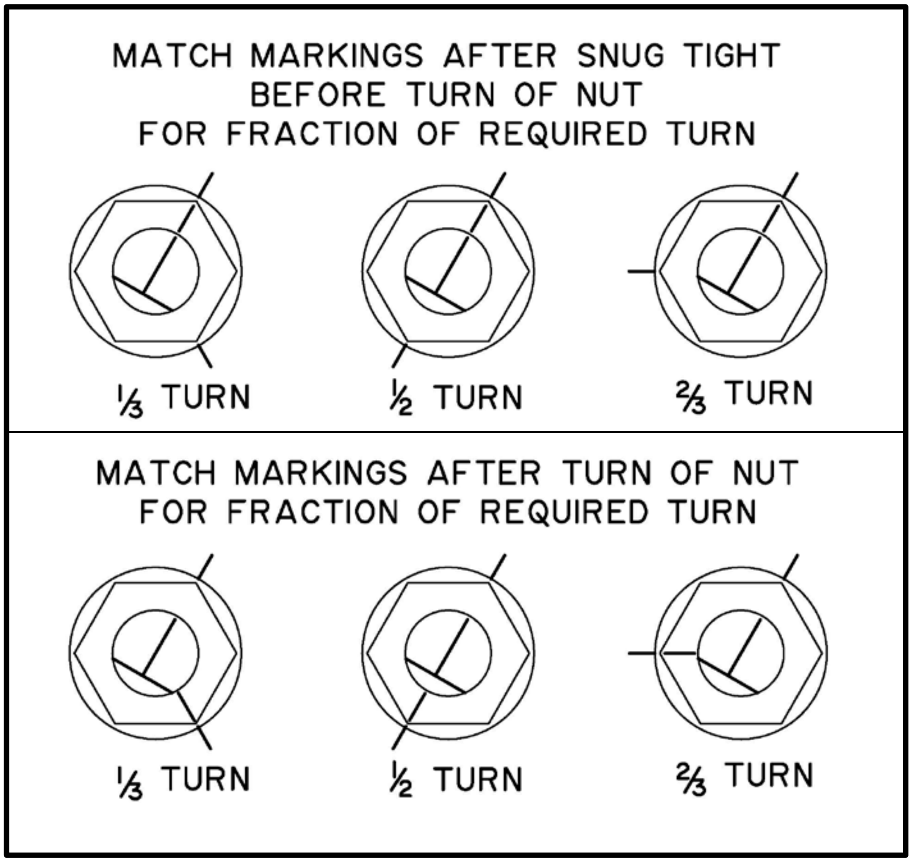
Tightening of all high strength bolts shall be by the turn-of-nut method. Before final tightening there shall be a sufficient number of bolts brought to a “snug tight” condition to ensure that the parts of the joint are brought into full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. After all bolts have been taken to the snug tight condition, the Contractor shall match mark the outer face of each nut and protruding end of bolt to have a common reference line to determine the relative rotation in accordance with Figure 6-1: Required Match Markings for Turn of Nut Tightening. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified below, with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

Amount of rotation of nut relative to bolt, regardless of which is turned:

- 1/3 turn where bolt length is 4 bolt diameters or less
- 1/2 turn where bolt length is over 4 bolt diameters and not exceeding 8 bolt diameters
- 2/3 turn where bolt length exceeds 8 bolt diameters

The rotational tolerance shall be +1/6 (60°), – 0 (nothing less than the minimum specified). The bolt length shall be measured from underside of the bolt head.

**Figure 6-1: Required Match Markings for Turn of Nut Tightening**




6.3.2.6.4 Reuse of Fasteners

High strength bolts shall be tensioned only once and shall not be reused. Retightening previously tightened bolts, which may have been loosened by tightening of adjacent bolts, shall not be considered as reuse.

6.3.2.6.5 Inspection

The Contractor shall provide safe and adequate access meeting Occupational Health and Safety requirements to all working areas, including all necessary scaffolding to enable the Consultant to carry out his inspection. The Contractor shall provide a competent workman to assist the Consultant in the checking of bolt tightening work.

The Contractor shall visually confirm all bolts have been tightened by the amount of relative match marking rotation. In addition, the Contractor shall confirm bolt tension of 10% of all bolts by calibrated wrench tightening in accordance with CSA S6, Annex A.10.1.6.8, Inspection of Turn of Nut Tightened Bolts. A minimum of three typical bolts of each diameter and length shall be tested from the bolts installed. The wrenches shall be calibrated at least once each working day in a device capable of indicating actual bolt tension.

#### 6.3.2.7 Misfits

Misfits shall be immediately reported to the Consultant. The Contractor shall submit a detailed repair procedure to the Consultant and the Department for review and acceptance to correct misfits. Repairs shall not be completed until the repair procedure has been reviewed and accepted by the Consultant and the Department. Repair procedures, including reaming of secondary members may be considered acceptable. Reaming of primary members will not be permitted.

#### 6.3.2.8 Girder Adjustment

Adjustment to girder position, bearing location and bearing elevation shall be completed to achieve the lines and grades shown on the Drawings or those reviewed and accepted by the Consultant.

The Contractor shall maintain the structural steel in correct alignment at all times during construction.

#### 6.3.2.9 Removal of Temporary Supporting Structures, Berms, and Clean-up

Upon completion of girder erection, the Contractor shall remove all earth material or temporary supporting structures used during construction. The Contractor shall remove all piling, excavated or surplus materials, rubbish and temporary buildings, replace or renew any damaged fences, and restore in an acceptable manner all property damaged during the execution of his work. Disposal of surplus materials shall be in a manner and location satisfactory to the Consultant.

The Contractor shall leave the bridge site, roadway and adjacent property in a condition acceptable to the Consultant. When required, the Contractor shall provide written evidence that affected property owners or regulatory agencies have been satisfied.

## 6.4 Strip Seal and Cover Plated V-Seal Deck Joints

After strip seals and v-seals have been installed to the satisfaction of the Consultant, they shall be tested by the Contractor in the presence of the Consultant for leakage. Any areas of leakage shall be repaired and retested. Defective or torn seals shall be removed and replaced.

The Contractor shall provide a written warranty for the performance of the deck joint assemblies for a period of five years. The warranty shall be provided to the Consultant prior to the issuance of the Construction Completion Certificate. The deck joint warranty shall provide for the replacement, installation and/or repair of the deck joint assemblies, including all concrete, reinforcing steel, and necessary traffic control should performance, unsatisfactory to the Department, occur during the five year period. The cost of furnishing all materials, labour, tools, equipment, and incidentals necessary to replace, install, and/or repair the deck joint assembly shall be included in the warranty.

## 6.5 Payment

### 6.5.1 Structural Steel

#### 6.5.1.1 Supply

Payment for the supply of structural steel will be made at the lump sum price bid for “Structural Steel – Supply” for the type and size specified, and will be full compensation for the supply and fabrication of structural steel; including all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

90% of the lump sum price bid will be paid once the structural steel has been acceptably supplied and delivered to the bridge site. The remaining 10% of the lump sum price bid will be paid once the structural steel has been acceptably installed.

#### 6.5.1.2 Delivery

Payment for the delivery of structural steel will be made at the lump sum price bid for “Structural Steel – Delivery” for the type and size specified, and will be full compensation for loading; hauling to the project site; unloading; and all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

All necessary approvals and permits, cleaning of girders to remove foreign materials will be considered incidental to the Work and no separator or additional payment will be made.

90% of the lump sum price bid will be paid once the structural steel has been acceptably supplied and delivered to the bridge site. The remaining 10% of the lump sum price bid will be paid once the structural steel has been acceptably installed.

#### 6.5.1.3 Erection

Payment for the erection of structural steel will be made at the lump sum prices bid for “Structural Steel – Erection” for the type and size specified, and will be full compensation for all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

### 6.5.2 Deck Joint Assemblies

#### 6.5.2.1 Supply and Delivery

Payment for the supply and delivery of deck joint assemblies will be made at the lump sum prices bid for “Deck Joint Assemblies - Supply and Deliver” for the types specified, and will be full compensation for the supply and fabrication of the deck joint assemblies; loading; hauling to the project site; unloading; and all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

90% of the lump sum price bid will be paid once the deck joint assemblies have been acceptably supplied and delivered to the bridge site. The remaining 10% of the lump sum price bid will be paid once the deck joint assemblies have been acceptably installed, concrete placement and curing has been completed, and all tolerances have been reviewed and accepted by the Consultant.

#### 6.5.2.2 Installation

Payment for the installation of deck joint assemblies will be made at the lump sum prices bid for “Deck Joint Assemblies – Install” for the types specified, and will be full compensation for all labour, equipment, tools and incidentals to install the deck joint assemblies as shown on the Drawings and to the satisfaction of the Consultant.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

## SECTION 7 PRECAST CONCRETE UNITS

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## 7.1 General

This specification is for the supply, delivery, erection, and post-tensioning of precast concrete units. 'Unit' and 'girder' shall be considered interchangeable throughout this specification.

Precast concrete units shall include girders, abutment and pier caps, bracing, fasteners, shoe plates, deck drains, anchor rods, dowels, buffer angles, anchor rod sleeves, miscellaneous components and associated materials as shown on the Drawings or specified in the Special Provisions of the Contract.

## 7.2 Supply and Manufacture

A pre-fabrication meeting is required prior to commencement of fabrication of precast concrete units. The meeting will be held at the fabrication facility and the Contractor shall ensure the plant superintendent and plant manager responsible for the Work and any fabricator's representatives directly involved in the Work are in attendance. The Consultant will conduct the pre-fabrication meeting at a mutually agreed upon date after the shop drawings and stressing calculations have been reviewed and accepted by the Consultant.

The Contractor shall be responsible for all costs incurred by the Consultant to attend the pre-fabrication meeting and to inspect precast concrete units fabricated outside the Province of Alberta. The Contractor shall also be responsible for the cost of the Department's representative to attend the pre-fabrication meeting and three additional trips to review the fabrication.

### 7.2.1 Standards

The manufacture of prestressed and precast concrete units shall be in accordance with The Canadian Standards Association (CSA) Standard A23.4 and the Precast/Prestressed Concrete Institute (PCI) Quality Control Manual MNL-116, with the most stringent of the requirements governing.

### 7.2.2 Qualification

The Contractor shall notify the Consultant and the Department of any subcontractors in his employ. The Contractor shall be responsible for the Work of all subcontractors. All terms of the Contract, such as right of access, shall apply to the subcontractor.

Precast concrete units shall be supplied and manufactured by a fabricator certified by the Canadian Precast/Prestressed Concrete Institute (CPCI) Certification Program in the applicable Product Group classification.

The fabrication of precast concrete units shall be done in a sufficiently large environmentally controlled permanent building capable of supplying and manufacturing products in a well-organized and continuous operation. The building temperature shall be maintained between 15 ºC and 30 ºC and prevent contamination and/or deterioration of materials.

### 7.2.3 Engineering Data

#### 7.2.3.1 Shop Drawings

Shop drawings shall be submitted to the Consultant for review and acceptance a minimum of 4 weeks in advance of the commencement of fabrication. Review comments provided by the Consultant and/or the Department shall be incorporated into the shop drawings and resubmitted to the Consultant for review and acceptance prior to the commencement of fabrication.

Shop drawings shall be electronic unlocked PDF format. Each shop drawing shall include the Department’s shop drawing identification block and have a sufficient blank space for the Consultant’s review stamp. The Department’s shop drawing identification block will be provided to the Contractor upon request. As a minimum, the following information shall be included on shop drawing submissions:

- Properties of all materials used;
- Dimensional information of all precast concrete units;
- Reinforcing steel;
- Prestressing strand;
- Steel diaphragms;
- Miscellaneous steel;
- Blockouts and Voids;
- Stressing system;
- Anchorage and hold down devices;
- Void support system; and
- Screed rail details.

The shop drawings will be reviewed by the Consultant solely to ascertain general conformance with codes and specifications. The Consultant’s review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

The Contractor shall incorporate as-built construction conditions into shop drawings. One paper copy and one electronic copy (PDF format) of as-built shop drawings shall be submitted to the Consultant within 3 weeks of construction completion.

#### 7.2.3.2 Design Notes and Independent Check Notes

The Contractor shall submit design notes and independent check notes of stressing calculations signed and sealed by the design engineer of record and by an independent checker. If modifications to the Contract requirements are proposed, the Contractor shall submit design notes, independent check notes, and shop drawings signed and sealed by his design engineer of record and by an independent checker.

The design engineer of record and the independent checker shall be Professional Engineers registered in the Province of Alberta. Design notes and independent check notes shall be submitted to the Consultant for review and acceptance a minimum of 4 weeks in advance of the commencement of fabrication. Review comments provided by the Consultant and/or the Department shall be incorporated into the design notes and independent check notes and shop drawings and resubmitted to the Consultant for review and acceptance prior to the commencement of fabrication. The design engineer of record and independent checker shall submit separate signed and sealed design notes and independent check notes. The design and check notes shall be presented in a legible and logical format, clearly identify material properties, and sufficiently detailed to allow a technical review of design concepts and assumptions used.

The independent checker may be employed by the same company as the design engineer of record. The independent check must be completed fully independent of the design engineer of record, including a complete re-analysis of all aspects of the design including calculations and engineering, preferably by a methodology or computer program other than that used by the design engineer of record. The design engineer of record and independent checker shall ensure that the shop drawings are complete and accurately convey the design criteria and assumptions used in their designs.

The design notes, independent check notes, and shop drawings will be reviewed by the Consultant solely to ascertain general conformance with codes and specifications. The Consultant's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

The Contractor shall incorporate and submit as-built design notes, check notes, and shop drawings for records at the completion of construction. One paper copy and one electronic copy (PDF format) of as constructed shop drawings, design and check notes, and supplier inspection construction records shall be submitted to the Consultant within 3 weeks of construction completion.

#### 7.2.3.3 Mill Test Reports

Mill test reports shall be provided for all materials in English. Mill test reports shall be submitted to the Consultant for review and acceptance 4 weeks prior to the commencement of fabrication.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be certified to ISO/IEC 17025 by an organization accredited by the Standards Council of Canada for the tests required. Samples for testing shall be collected by personnel employed by the certified laboratory. A verification letter shall be provided by the certified laboratory that includes at a minimum, the applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the certified laboratory.

#### 7.2.3.4 Product Data Sheets

Product data sheets shall be provided for all material. Product data sheets shall be submitted to the Consultant for review and acceptance 4 weeks prior to the commencement of fabrication.

All product data sheets shall be legible and provided in English.

#### 7.2.3.5 Prestressing Strand Load/Elongation Curve and Jack Calibration Certificates

A copy of the load/elongation curve for each lot of prestressing strand shall be submitted to the Consultant for review two weeks prior to manufacturing. All prestressing strand load/elongation curves shall be legible and in English.

Jack calibrations shall be completed no more than 6 months prior to stressing. Jack calibration certificates shall be provided to the Consultant for review and acceptance with stressing calculation design notes and independent check notes.

#### 7.2.3.6 Concrete Mix Design Submission Requirements

Concrete mix designs shall be submitted to the Consultant in accordance with Subsection 4.4.4, Concrete Mix Design Submission Requirements for review and acceptance.

The mix design shall specify the upper slump limit for the superplasticized concrete at which the mix is stable without any segregation. The slump of the concrete used in the production shall be 10 mm below the upper limit identified in the mix design.

The Contractor is required to complete a trial batch for each concrete mix. The trial batches shall be performed a minimum of 28 days prior to placement of concrete. The Contractor's quality representative shall attend all trial batches. All trial batch testing shall be repeated in conjunction with required aggregate testing. The trial batch shall include one microscopic air-void analysis performed by an independent CSA A283 certified testing laboratory in order to determine the spacing factor of the hardened concrete. The test sample shall be made from a trial concrete batch, vibrated into a cylinder mould so as to represent the level of vibration of the production concrete in the forms. If adjustments to the mix design are necessary, the air-void analysis shall be repeated.

Only the reviewed and accepted mix design shall be used. No changes to the reviewed mix design will be permitted. If changes are proposed by the Contractor, a new concrete mix design review letter shall be provided in accordance with Subsection 4.4.4, Concrete Mix Design Submission Requirements, and trial batches completed.

#### 7.2.3.7 Construction Data Sheets

Construction data sheets shall be kept up to date and made available for the Consultant's review throughout fabrication. Copies of the Construction Data Sheets shall be provided to the Consultant upon completion of the Contract. One copy of the stressing data sheets for each precast concrete unit shall also be submitted with the Construction Data Sheets.

### 7.2.4 Materials

#### 7.2.4.1 Hydraulic Cement

Hydraulic cement shall meet the requirements of CSA Standard A3001.

#### 7.2.4.2 Water

Water to be used for mixing concrete, concrete patching materials, or concrete finishing materials, shall conform to the requirements of CSA Standard A23.1 and shall be free from harmful amounts of alkali, organic materials or deleterious substances. The Contractor shall not use slurry water, treated wash water or water from shallow, stagnant or marshy sources.

#### 7.2.4.3 Silica Fume

Silica fume shall conform to the requirements of CSA Standard A3001, Type SF have a minimum $SiO_2$ content of 85%, a maximum loss on ignition of 10%, and no more than 1% $SO_3$ content.

#### 7.2.4.4 Aggregates

Fine and coarse standard weight aggregates shall meet the requirements of Subsection 4.4.4, Concrete Mix Design Submission Requirements.

The maximum coarse aggregate size shall be 14 mm.

#### 7.2.4.5 Air Entraining Agent

Air entraining agent shall conform to the requirements of the ASTM C260.

#### 7.2.4.6 Admixtures

Admixtures shall be compatible with all mix constituents.

Water reducing agents and superplasticizers shall conform to ASTM C494.

The addition of calcium chloride, retarders, accelerators or set controlling admixtures and air reducing agents will not be permitted.

#### 7.2.4.7 Concrete

Concrete shall consist of hydraulic cement, condensed silica fume, coarse and fine aggregates, water and admixtures. Concrete strength requirements will be specified on the Drawings.

10% silica fume by weight of cement (±0.5%) shall be used in all precast concrete.

Air content shall be in accordance with CSA A23.1 Table 4, based on the maximum aggregate size used.

The maximum air void spacing of hardened concrete shall be 230 µm.

#### 7.2.4.8 Reinforcing Steel

Reinforcing steel shall conform to Section 5, Reinforcing Steel.

#### 7.2.4.9 Prestressing Strand

Prestressing strand shall be uncoated Grade 1860, low relaxation 7-wire strand conforming to the requirements of the ASTM A416. Shop drawings and stressing calculations shall clearly show the type of strand to be used, and changes will not be allowed during production.

#### 7.2.4.10 Lifting Hooks

Prestressing strand used for fabricating lifting hooks shall conform to the requirements of the ASTM A416, and shall be fabricated in a manner that distributes the load evenly to all strands.

#### 7.2.4.11 Miscellaneous Steel, Steel Diaphragms and Fasteners

Miscellaneous steel shall conform to the requirements of CSA G40.21M Grade 300W or ASTM A36 or as specified on the Drawings. Steel diaphragm bracing members shall conform to CSA G40.21M Grade 300W or 350W. Steel with a boron content exceeding 0.0008% will not be permitted.

High strength bolts shall conform to the requirements of ASTM F3125 Grade A325/A325M heavy hex style. Rotational capacity testing is mandatory and shall be performed in accordance with ASTM F3125. A report meeting the rotational capacity test report requirements of ASTM F3125 Annex A2 shall be submitted to the Consultant for review and acceptance. Nuts shall be heavy hex style and shall be conform to ASTM A563/A563M. Hardened washers shall conform to ASTM F436/F436M.

High strength bolts installed between steel components shall be tightened by the turn of nut method in accordance with Subsection 6.3.2.6, High Tensile Strength Bolted Connections. All steel related fabrication shall conform to the requirements of Section 6, Structural Steel and these specifications.

#### 7.2.4.12 Anchor Rods for Bridgerail

Anchor Rods for bridgerail anchor assemblies shall meet the requirements of Subsection 12.2.4.2, Anchor Rods and be hot dip galvanized after fabrication. All nuts and washers shall be shop assembled on the anchor rods.

#### 7.2.4.13 Voids, Ducts, and Conduit

Details of all proposed void, duct and conduit materials shall be submitted to the Consultant for review and acceptance in accordance with Subsection 7.2.3.4, Product Data Sheets.

All voids, ducts, and conduits shall remain dimensionally stable during the casting and steaming of the precast concrete units. Voids shorter than 400 mm shall not be used unless noted on the Drawings.

Post-Tensioning ducts shall be corrugated, semi-rigid galvanized metal tubes and be capable of withstanding concrete pressures without excessive deformation or permitting the entrance of the cement paste during the placement of concrete. The ducts shall have sufficient rigidity to maintain the required profile between points of support. The interval between supports shall not exceed 1.0 m.

7.2.4.14 Bearings

Bearings shall be in accordance with Section 8, Bearings.

7.2.4.15 Galvanizing

The fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatters, and all welding flux residue from the steel components prior to galvanizing.

Factors contributing to galvanization-induced cracking shall be minimized. Galvanizing shall be by the hot dip method, after fabrication, in accordance with the current edition of ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and ASTM F2329 Standard Specification for Zinc Coating Hot-Dip Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners and as modified in this specification.

The cleaning and pickling procedure of high strength ASTM A193 Grade B7 anchor rods shall be modified as follows prior to hot-dip galvanizing:

- Brush blast to remove mill scale and oil after threading ends;
- Flash pickle up to 5 minutes; and
- Quick dry prior to hot-dip galvanizing (not stored in flux or acid rinse).

The modified anchor rod cleaning and pickling procedure shall be completed in the presence of the Consultant prior to hot-dip galvanizing.

Repair of galvanizing shall be completed in accordance ASTM A780, Method A3 “Metallizing” and will only be permitted when the repair areas are small and infrequent as determined by the Consultant. Repair areas less than 100 mm$^2$ in area may be completed in accordance with ASTM A780, Method A1 ”Repair Using Zinc-Based Alloy”. The thickness of the coating for both methods shall be 180 µm, and the repair tested for adhesion. A detailed repair procedure shall be submitted for review and acceptance by the Consultant prior to commencement of the work. Repairs may require complete removal of the galvanized coating and re-galvanizing. The finished appearance shall be similar to the adjacent galvanizing as determined by the Consultant.

Galvanized material shall be stacked or bundled and stored to prevent wet storage stain as per the American Hot Dip Galvanizers Association (AHDGA) publication “Wet Storage Stain”. Any evidence of wet storage stain shall be removed to the satisfaction of the Consultant.

Galvanized contact surfaces of bolted connections shall be hand wire brushed to a Class A slip coefficient surface condition. Slip coefficients surface conditions shall meet the requirements of Table 10.9 of CSA S6.

### 7.2.5 Manufacture

#### 7.2.5.1 Forms

Precast concrete units are to be fabricated in steel forms which are acceptable to the Consultant.

For all beam members the forms shall be designed to be removed without damaging the beam. For all “I” or “T” Beam members the side forms shall be designed to be removed without damaging the top flange of the beam. The forms shall be removed horizontally away from the beam by a method that prevents any contact of the form with the top flange after release of the form. The top flange shall not be subjected to a vertical force at any time.

Holes or voids cast into the top flange of “I” or “T” girders to accommodate deck formwork will not be permitted.

#### 7.2.5.2 Reinforcing Steel

Fabrication, handling, storage, and fastening of all steel reinforcement shall conform to Section 5, Reinforcing Steel.

Reinforcing steel placing tolerances shall be in accordance with Subsection 7.2.5.4, Void, Duct, Conduit and Reinforcement Placing Tolerances.

The Contractor shall place and fasten the reinforcement and have the Work inspected and accepted by the Consultant prior to placement of concrete.

#### 7.2.5.3 Prestressing Strand

Placement of prestressing strand and post tensioning ducts shall be in accordance with Subsection 7.2.5.4, Void, Duct, Conduit and Reinforcement Placing Tolerances.

Prestressing strand shall be free of corrosion, dirt, grease, rust, oil or other foreign material that may impede bond between the steel and the concrete. Prestressing strand shall be protected at all times during manufacture through to encasing in concrete or grout. Prestressing strand that has sustained physical damage at any time shall be rejected. Prestressing strand splices shall not be placed within a precast concrete unit.

The Contractor shall submit for review the methods, procedures and devices to accurately position the prestressing strand. The submission shall include strand anchorage, draping, hold downs, guides or any other required devices.

Prestressing strands shall not be stressed more than 36 hours prior to being encased in concrete. The force in each prestressing strand shall be measured by both elongation and pressure gauge.

Each prestressing strand shall be stressed to a calculated elongation, and a gauge pressure reading shall be taken as a check against the calculated force. During stressing, each prestressing strand shall first be pulled to a predetermined pre-pull gauge pressure to eliminate any slack and a reference mark be placed on the prestressing strand at the front of the stressing jack. A second mark shall be placed on the prestressing strand away from the first with a distance corresponding to the calculated elongation on the stressing sheet. Each prestressing strand shall then be pulled to the second reference mark and the gauge pressure reading taken.

This process may be reversed, i.e. each prestressing strand shall be stressed to a calculated force (Determined by a gauge pressure calibration chart) and the elongation shall be measured as a check against the calculated force. During stressing, each prestressing strand shall first be pulled to a predetermined pre-pull gauge pressure to eliminate any slack and a reference mark be placed on the prestressing strand at the front of the stressing jack. Each prestressing strand shall then be stressed to the gauge pressure corresponding to the stressing sheet and a second reference mark be placed on the prestressing strand at this gauge pressure. The elongation shall be the distance measured between the two reference marks.

At the completion of tensioning, the two control measurements, force and elongation, shall meet the verification requirements of Subsection 5.2.2, Tensioning of Tendons, of the PCI Quality Control Manual MNL-116.

Changes in prestressing strand temperature and slippage at prestressing strand anchorages shall be measured between stressing and concrete encasement and any changes in prestressing strand stress due to these effects shall be accounted for in the design. The stressing procedure and stressing calculations shall be submitted for review by the Consultant.

Prestressing strand with any broken or damaged wire shall be removed and replaced. All prestressing strands shall be checked for wire breaks and damage before placement of concrete. Prestressing strand damage includes nicks, gouges, and indentations.

The precast concrete unit ends shall have 15 mm deep prestressing strand termination recesses formed around the strands. All prestressing strands shall be cut flush with the bottom of the recesses, and the recesses shall then be filled flush with the ends of the girders with a moisture insensitive epoxy paste adhesive meeting the requirements of ASTM C881, Type IV, Grade 3, Class B or C. The paste shall be grey in colour. An approved Type 1c sealer shall be applied over the patched recessed areas as per Subsection 7.2.5.14, Type 1c Sealer. Sealer shall not be applied to the patched recessed areas when precast concrete unit ends are designed to be encased in field cast concrete.

### 7.2.5.4 Void, Duct, Conduit and Reinforcement Placing Tolerances

Voids, ducts, and conduits shall be placed as shown on the Drawings and must be tied and securely held in the required positions to prevent movement. Continuous ducts shall align precisely. The ends of the voids shall be sealed by methods accepted by the Consultant. Voids found to be distorted, damaged or of insufficient strength will be rejected. Blow holes caused by air expanding within the voids and rising to the surface, shall be repaired when the concrete is in the plastic state.

Reinforcing steel, prestressing strand, and post-tensioning ducts for precast concrete shall be placed within the following tolerances:

- Concrete cover: ± 5 mm;
- Vertical position of prestressing strand: ± 5 mm;
- Post-tensioning ducts: ± 10 mm, except ± 5 mm at splice points;
- Length of debond on prestressing strand: ± 50 mm;
- Stirrup spacing:
    - When spacing is 100 mm or less: ± 15 mm;
    - When spacing is greater than 100: ± 25 mm;
    - When spacing is 300 mm or greater: ± 30 mm;
- Location, where the smallest dimension of the element is:
    - 400 mm or less: ± 8 mm;
    - Larger than 400 mm but less than 800 mm: ± 12 mm;
    - 800 mm or larger: ± 20 mm;
- Longitudinal locations and ends of bars, except at ends or edges of elements: ± 50 mm; and
- Longitudinal location of ends of bars at ends or edges of elements: ± 20 mm.

The clear distance between reinforcement shall not be less than 1.5 times the nominal diameter of the reinforcement, 1.5 times the maximum coarse aggregate size, or 40 mm.

### 7.2.5.5 Identification of Precast Concrete Units

The fabricator’s name, year of manufacture, unit serial number and design loading shall be cast into the bottom of the precast concrete units in 50 mm letters approximately 1.0 m from the precast concrete unit end.

### 7.2.5.6 Concrete Measuring, Mixing and Placing

The procedures outlined in ACI Standard 304 “Guide for Measuring, Mixing, Transporting and Placing Concrete” shall be followed. The time from initial mixing of the concrete until placing the concrete in the forms shall not exceed one hour. The rate of concrete placement shall be such that cold joints do not occur.

### 7.2.5.7 Concrete Temperature

The concrete temperature shall be between 10 °C and 30 °C at the time of placing in the forms.

### 7.2.5.8 Finished Riding Surface

Where the top surface of the girder is designed to be the riding surface, the use of a continuous screed rail, independent of the top of the grout keys, shall be used. The top surface shall follow a smooth profile, which incorporates the required camber adjustments.

### 7.2.5.9 Camber Hubs

Three camber hubs shall be placed in each girder, located along the centerline of the girder at the midspan and 150 mm from each end. The camber hubs shall consist of 10 mm galvanized bars, of sufficient length to project vertically 10 mm above the girder top surface.

The Contractor shall store the members in such a manner as to provide access for measuring camber as determined by the Consultant. The Contractor shall provide personnel as requested to assist the Consultant with the camber readings. The Contractor shall record the girder camber at the midspan of each girder within 24 hours of girder destressing.

### 7.2.5.10 Concrete Finish

The exposed face of exterior girders shall have a Class 2 rubbed surface finish, unless specified otherwise. Except the top, all the remaining surfaces shall have a Class 1 ordinary surface finish.

#### 7.2.5.10.1 Class 1 Ordinary Surface Finish

##### 7.2.5.10.1.1 Unformed Surfaces

Immediately following placing and consolidation, the concrete shall be screeded to conform to the required surface elevations, and then trowelled to ensure that the surface is free from open texturing, plucked aggregate, and local projections or depressions.

Concrete surfaces shall be such that when checked with a 1.2 m long straight edge placed anywhere in any direction on the surface, there shall not be any gap greater than 3 mm between the bottom of the straight edge and the concrete surface unless otherwise specified.

##### 7.2.5.10.1.2 Formed Surfaces

This finish is essentially that obtained when concrete has been cast and adequately compacted in a properly oiled steel form. All fins, honeycomb, irregularities, cavities over 10 mm diameter or other similar defects shall be thoroughly chipped out. These areas shall be saturated with water for a period of not less than thirty minutes, carefully pointed and trued with mortar of a colour which will match the existing concrete. Mortar used for pointing shall be less than one hour old. The patches shall be properly cured by placing the repaired precast concrete unit in the steam cure for a period of four days immediately after patching.

The finished surfaces shall be true and uniform. All surfaces which cannot be repaired to the satisfaction of the Consultant shall be finished as specified for Class 2 at no expense to the Department.

#### 7.2.5.10.2 Class 2 Rubbed Surface Finish

Class 2 Finish shall be essentially the same as Class 1 except that all holes, cavities and defects shall be repaired so that the finished surface presents a smooth, true, dense, uniformly coloured, and non-stained appearance. The concrete surfaces shall be thoroughly exposed by brush abrasive blasting to expose any hole or cavity prior to repairs. Surface voids greater than 19 mm diameter but less than or equal to 0.05 $m^2$ in area and less than or equal to 30 mm deep shall be filled with an Department approved concrete patching material listed on the Department's Product list in the Overhead/Vertical (OH-V) category and placed in accordance with the manufacturer's published product data sheet. Surface voids less than 19 mm in diameter and less than or equal to 30 mm deep may be filled with a pre-bagged sack rub material. Sack rub materials shall be placed over the entire prepared surface in accordance with the manufacturer's recommendations. Both sack rub and patching materials shall be wet cured for a minimum of 72 hours if applied after curing of the precast concrete unit. When the patching and sack rub materials have adequately cured, a carborundum stone or method acceptable to the Consultant shall be used to finish the surface to a smooth, uniform and closed texture. Any voids or cavities opened during the stone rubbing process shall be re filled. Parging or surface patching to correct irregularities will not be permitted.

All of the prepared concrete surfaces, including all patching and sack rubbing shall be uniform in colour and texture. All residue of form oil shall be removed from the surface.

#### 7.2.5.10.3 Class 3 Bonded Concrete Surface Finish

The surface shall be prepared in accordance with the requirements of Class 2 Rubbed Finish except that it need not be of uniform colour. After the surface preparation has been completed to the satisfaction of the Consultant, the surface shall be pressure washed to remove all dust, dirt, laitance and all other bond breaking materials. After the concrete surface has dried for a minimum of 24 hours, the Contractor shall then supply and apply an approved pigmented sealer, which meets the requirements for a Type 3 sealer of the Material Testing Specifications for Concrete Sealer - B388.

The pigmented sealer shall be applied in accordance with the manufacturer's specifications. The colour(s) of the proposed coating scheme, which typically shall be similar to the natural colour of cured concrete, must be acceptable to the Consultant before application of the coating. A minimum of two applications of the pigmented sealer are required. When spray application is used the surface shall be back rolled. The Contractor shall ensure that no colour variation is visible and shall match the colour of any previously sealed adjoining surfaces. Acceptance of the pigmented sealer used will not be considered to relieve the Contractor of full responsibility for its acceptable performance and appearance.

#### 7.2.5.10.4 Class 4 Floated Surface Finish

After the concrete has been consolidated and the surface carefully screeded to the cross section and profile shown on the Drawings, it shall be floated and trowelled as necessary to provide a closed, uniformly textured surface without brooming.

#### 7.2.5.10.5 Class 5 Floated Surface Finish, Broomed Texture

After the concrete has been consolidated, the surface shall be carefully screeded to the cross section and profile shown on the Drawings. When the concrete has hardened sufficiently, the surface shall be finished with a broom of an accepted type. The broom strokes shall be perpendicular to the edge of the precast concrete unit, and extended from edge to edge, with adjacent strokes slightly overlapped producing corrugations of 2 to 3 mm in depth. Brooming shall be done when the concrete has set sufficiently to produce clear, crisp brooming marks which do not sag or slump, without tearing the surface or disturbing coarse aggregate particles. After final brooming the surface finish shall be free of porous spots, irregularities, depressions, pockets and rough spots and must not vary more than 5 mm when measured using a 3 m straight edge.

Accepted finishing and edging tools shall be used on all edges and expansion joints after brooming.

#### 7.2.5.11 Curing

All precast concrete units shall be cured at an elevated temperature. The curing of precast concrete units shall essentially be in accordance with CSA A23.4 unless otherwise specified. The ambient curing temperature shall be increased at a rate not exceeding 20 °C per hour until a maximum temperature of not more than 60 °C is attained. After curing, the temperature of the precast concrete units shall be reduced at a rate not exceeding 10 °C per hour until the temperature of the concrete has fallen to within 10 °C of the ambient air temperature outside the enclosure.

The Contractor shall record and provide “In the Form” and “After Removal from Form” curing data including ramp-up and ramp-down temperature changes to the Consultant. The Alberta Transportation bridge file number, precast concrete unit serial number, casting date, curing start date, additional curing days due to non-compliant days, and curing completion date shall be identified on the curing data submitted. A coloured graph documenting Time-Temperature-Humidity data throughout the curing phase shall be submitted as part of the curing data.

Care must be exercised to protect precast concrete units from thermal shock at all times until these precast concrete units have been fully cured.

Two continuously recording thermometers and two continuously recording hygrometers shall be provided for each curing enclosure to monitor the concrete ambient temperature and relative humidity. All time-temperature and time-humidity recordings shall be clearly shown on the graph.

7.2.5.11.1 Prestressed Precast Concrete Units

7.2.5.11.1.1 Curing in the Form

The initial application of heat shall commence only after the last of the freshly placed concrete has attained its initial set, normally 2 to 4 hours after casting. Heat shall not be applied directly to the concrete, but by a method that will produce a consistent ambient temperature throughout the entire form and enclosure. The increase in temperature and the holding temperature shall be monitored and permanently recorded on a chart at a minimum of 3 quarter points along the form.

7.2.5.11.1.2 Curing after Removal from the Form

Upon removal from the forms the precast concrete units shall be cleaned, patched, and finished within a period not exceeding 12 hours. The precast concrete units shall be placed in a manner that will facilitate any clean up or repair work, and that will allow full inspection of all surfaces. Within 24 hours of removal from the form, the precast concrete units shall be placed within a suitable enclosure, for curing.

The curing enclosure shall provide a minimum of 150 mm of free air space between the concrete surfaces and the coverings. Flexible coverings shall be secured to prevent any moisture loss.

The difference in ambient air temperature adjacent to the concrete at different locations within the enclosure shall not exceed 10 °C at any time.

The curing process shall be continued for a period of four days with one of the following methods:

1) <u>Steam Curing</u>

   Steam jets shall not directly impinge on the concrete surfaces. The steam must be in a saturated condition maintaining an atmosphere of 95% to 100% relative humidity and a uniform ambient temperature of 40 °C to 60 °C.

   For days with periods of 4 or more hours within a 24 hour period, where measured temperature or humidity levels do not meet the required limits, these days will not be counted as a full day of steam cure. An additional day of steam cure beyond the specified 4 days will be required for each non-compliant day.

2) Curing with Continuous Misting and Heat

Sufficient number of atomizing misting nozzles shall be strategically located to produce a fine mist with 95% to 100% relative humidity in the enclosure. The water shall be preheated to a temperature which will produce a misting temperature compatible with the ambient temperature inside the enclosure. The enclosure shall be heated with radiant heaters to a temperature of 40 °C to 60 °C. Dry heat shall never touch the concrete surface at any time. A control system shall be installed to shut off the heat when the humidity level drops below 95% in the enclosure. Should the temperature in the concrete rise above 40 °C without the misting, the precast unit will be rejected.

7.2.5.11.2 Non-Prestressed Precast Concrete Units

Curing of all non-prestressed precast concrete units shall be in accordance with one of the following methods:

7.2.5.11.2.1 Elevated Temperature Curing

The precast concrete units shall be cleaned, patched, finished and then cured in accordance with Subsection 7.2.5.11.1, Prestressed Precast Concrete Units.

7.2.5.11.2.2 Moist Curing

The precast concrete units may be moist cured in lieu of elevated temperature curing in accordance with the following:

Upon removal from the forms the precast concrete units shall be cleaned, patched, finished, and ready for inspection within a period not exceeding 12 hours. Patching shall be performed with an approved product and at an ambient temperature of 10 °C to 25 °C. After completion of patching and finishing, within 24 hours of removal from the form, the precast concrete units shall be placed under two layers of light coloured filter fabric at an ambient temperature of not less than 15 °C. The filter fabric or burlap shall be kept in a continuously wet condition throughout the curing period by means of a soaker hose or other means as reviewed and accepted by the Consultant. Curing with filter fabric or burlap and water shall be maintained for a minimum period of seven days.

7.2.5.12 Release of Prestressing Strand

The prestressing strand shall not be released until the specified concrete release strength is attained, and the release shall be in accordance with the accepted sequence.

Evidence of casting defects shall be reported to the Consultant prior to release of the prestressing strands.

7.2.5.13 Repairing Concrete Defects

Honeycomb, cavities, spalls, chips, cracking and other defects shall be immediately reported to the Consultant.

Repair procedures shall be developed by a Professional Engineer and submitted for review and acceptance by the Department and the Consultant prior to the commencement of the repair. All repairs shall be completed prior to curing of the precast concrete unit at an ambient temperature between 15 °C and 30 °C. Depending on the size and location of the defect, repairs may be required before or after girder de-stressing as outlined in this specification. Damaged concrete shall be repaired by the Contractor at his expense to the satisfaction of the Consultant. Precast concrete units shall be protected from dehydrating by maintaining a saturated surface dry condition during the implementation of any approved repair procedures.

The bearing area of an NU girder is defined as the portion of the girder bottom flange up to the underside, but not including the radius transition between the bottom flange and the web, directly above the bearing extending from the end of the precast concrete unit to 75 mm beyond the edge of the shoe plate.

The bearing area of a SL/SLW/SLC girder is defined as the thickness of the bottom soffit or 145 mm, whichever is greater, extending 500 mm from the end of the precast concrete unit.

The anchorage area of a girder is defined as the full height portion of the girder that is two times the girder depth from the end of the girder but is not in the bearing area.

#### 7.2.5.13.1 Cracks

The following cracks are unacceptable and will result in rejection of the precast concrete unit unless reviewed and accepted by the Consultant and the Department:

- Cracks in the bearing area of a girder;
- Cracks in the anchorage area of a girder exceeding 0.5 mm in width or longer than 300 mm; and
- Cracks outside of the girder bearing and anchorage areas exceeding 0.2 mm in width or longer than 300 mm.

All repairable cracks less than 0.2 mm in width shall receive two coats of a type 1c sealer unless the crack will be fully encased in a cast-in-place concrete diaphragm or the precast concrete unit requires a Class 3 finish on the surface where the crack is present.

All repairable cracks 0.2 mm or greater in width shall be repaired by epoxy injection in accordance with the epoxy manufacturer's instructions. The epoxy resin shall meet the requirements of ASTM C881 Type IV, Grade 1, Class B or C and have a viscosity less than 500 cP. An injection procedure shall be submitted by the Contractor to the Consultant for review and acceptance prior to commencing repairs. Coring shall be carried out to confirm the penetration of the epoxy into the cracks if requested by the Department.

The Contractor shall immediately notify the Department and the Consultant, if a crack that has a potential to be a shear crack exceeds 0.15 mm in width and longer than 0.25 times the girder depth. Crack length shall be measured along the horizontal axis and a crack will be considered to be a shear crack if inclined at an angle between 30° and 60° from horizontal.

7.2.5.13.2 Honeycombs and Spalls

The following conditions of honeycomb or spall are unacceptable and will result in rejection of the precast concrete unit unless reviewed and accepted by the Consultant and the Department:

- Any honeycomb or spall in the bearing or anchorage areas of the girder; or
- Honeycombs or spalls that are more than 30 mm deep or more than 0.05 $m^2$ in area located outside the bearing and anchorage areas of a girder.

When accepted by the Consultant and the Department, the Contractor's proposed repair procedure for honeycombs and spalls shall as a minimum, include removing and replacing the defective concrete with the originally specified class of concrete. Repair extents shall be saw cut 20 mm deep in neat perpendicular lines and concrete removed to a depth of 20 mm below reinforcing and prestressing strand. Repair areas shall be roughened to remove all loose material and laitance. Exposed reinforcing and prestressing strand shall be cleaned and repaired to its original condition. Repair areas shall be saturated with water prior to concrete placement. Repair areas shall be free of standing water and surface dry immediately prior to concrete placement. Repairs shall be completed before girder destressing.

Honeycombs or spalls less than or equal to 0.05 $m^2$ in area or 30 mm in depth, shall be repaired in accordance with Subsection 7.2.5.10.2, Class 2 Rubbed Surface Finish and may be completed after girder destressing.

7.2.5.14 Type 1c Sealer

The Contractor shall supply and apply an approved Type 1c sealer to the girder surfaces as shown on Standard Drawings S-1851, Standard Concrete Sealer Surface Treatment for Major Bridge and S-1852, Standard Concrete Sealer Surface Treatment for Standard Bridges.

Type 1c sealers shall meet the current Material Testing Specifications for Concrete Sealers - B388.

The sealer shall be applied on clean dry surfaces free of form oil, and in accordance with the manufacturer's recommendations however the application rate shall be increased by 30% from that indicated on the approved products list and the substrate temperature shall be a minimum of 5 °C. Before applying the sealer the concrete shall be cured for at least 14 days. Mortar patches shall be cured for a minimum of 2 days. The concrete surface shall be dry, and air blasted to remove all dust and accepted by the Consultant prior to applying sealer. In order to ensure uniform and sufficient coverage rates the Contractor shall apply measured volumes of sealing compound to appropriately dimensioned areas of concrete surface, using a minimum of 2 coats.

The Contractor shall ensure that the sealer is not applied in the grout pockets, lifting hook pockets or areas of the girders that will have field concrete cast against them. The Consultant reserves the right to sample and test the sealer supplied by the Contractor.

### 7.2.5.15 Sandblasting

The roughening of concrete surfaces in shear key, block out, diaphragm and girder end void locations shall be achieved by sandblasting or other acceptable methods proposed by the Contractor and reviewed and accepted by the Consultant. The roughening shall be sufficient to remove all laitance and uniformly expose the aggregate particles.

### 7.2.5.16 Dimensional Tolerances of Precast Concrete Units

The maximum dimensional deviation in mm, of cast precast concrete units from that specified on the Drawings shall not exceed the following:

- Length: ± 20 mm x length (m) ÷ 50;
- Width: ± 3 mm;
- Depth: ± 5 mm;
- Camber: ± 20 mm x length (m) ÷ 50;
- Sweep (NU Girders): 1 mm/m;
- Sweep (Other Units): deviation from true, 20 mm x length (m) ÷ 50;
- Projection of Stirrups from Top of Girder: ± 12 mm;
- Bearing Areas : out of flatness 3 mm;
- Bulkheads: warpage or tilt of ends, 5 mm;
- Rail Anchor Bolts: out of line, 5 mm; in spacing, 5 mm; in projection, 5 mm;
- Dowel Holes: out of plumb, 5 mm; and
- Void Location: surface to void dimension, ±15 mm after casting.

Dimensional tolerances for sweep shall be measured immediately prior to shipping to the project site.

### 7.2.5.17 Handling and Storage

Precast concrete units shall be handled by means of lifting devices which have been reviewed and accepted by the Consultant and at the designated locations. Precast concrete units shall be maintained in an upright position, supported near the ends and on stable foundations.

## 7.2.6 Testing and Inspection

### 7.2.6.1 Access

The Contractor shall provide full facilities for the inspection of Work. The Consultant shall have full access to all parts of the Work at all times. When required by the Consultant, the Contractor shall provide needed manpower for assistance in checking layout and performing inspection duties.

#### 7.2.6.2 Responsibility

It is the Contractor's responsibility to ensure that the Work is completed in accordance with the Contract requirements. Any inspection and/or testing completed by the Consultant, review and acceptance by the Consultant, shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract.

#### 7.2.6.3 Witness Points

Inspection stations shall be set up at specific points during the course of fabrication for the Consultant to complete inspection and/or testing. At each witness point the Work shall be checked by the Contractor, reviewed and accepted by the Consultant, and all deficiencies corrected to the full satisfaction of the Consultant prior to the next sequence of fabrication. Witness points for precast concrete units shall be:

- Form dimensions and set-up;
- Placement of reinforcing steel and prestressing strand;
- Placement of voids and hardware;
- Stressing;
- Concrete mixture and placement;
- Form stripping;
- Clean-up and repair;
- Finishing and application of sealer;
- Curing;
- Application of concrete finishes; and
- Storage of precast concrete units.

#### 7.2.6.4 Testing by the Contractor

Sampling, casting, curing and testing concrete specimens shall be completed by the Contractor in accordance with the requirements of the following CSA standards:

- Sampling - A23.2-1C;
- Concrete Test Cylinders - A23.2-3C;
- Testing Concrete Cylinders - A23.2-9C;
- Air Content - A23.2-4C;
- Density of Concrete - A23.2-6C; and
- Air Void Determination - A23.2-17C.

The Contractor's testing and inspection records shall be open for examination by the Consultant upon request.

Testing, inspection and related costs incurred by the Consultant resulting from defective work or Contractor proposed details not specified on the Drawings shall be paid for by the Contractor.

#### 7.2.6.5 Release Strength Test Cylinders

The Contractor shall make and complete concrete cylinder strength testing to determine that the required release strength as specified on the Drawings has been achieved prior to release of the prestressing strand.

When one or more precast concrete units are cast continuously, at minimum, two cylinders shall be taken that represent the last precast concrete unit cast to represent the release strength for all precast concrete units. These strength test cylinders shall be cured with the last precast concrete unit cast. Only testing of the first cylinder will be required if the specified release strength is achieved. In the event all cylinders are tested without the required strength being achieved, the Consultant shall review and accept the timing of release.

#### 7.2.6.6 28 Day Strength Testing

The Contractor shall cast concrete test cylinders to determine the 28-day strength. The Consultant will determine from which batch the test cylinders shall be taken. Samples for testing will be taken from the fresh concrete being placed in the forms at the rate of one set of cylinders for every three precast concrete units cast continuously. Additional cylinders may be cast at the discretion of the Consultant. A set shall consist of three cylinders. A strength test will be the average of the 28-day strengths of the three cylinders (one set). Continuous casting shall mean no break in the casting longer than one hour.

The Contractor shall be responsible for transporting the test cylinders to an independent CSA testing laboratory certified to CSA A283. The transportation and testing of concrete test cylinders shall be at the Contractor’s expense. These tests shall represent the strength of the cast concrete. Test results shall be forwarded to the Consultant within 24 hours of testing.

#### 7.2.6.7 Notification to Ship

The Contractor shall notify the Consultant 72 hours prior to shipment to facilitate inspection and acceptance of the precast concrete units. Precast concrete units shall not be shipped until they have been reviewed and accepted by the Consultant. Review and acceptance of precast concrete units at the fabrication facility by the Consultant will not relieve the Contractor of his full responsibility to meet the requirements of these specifications.

Precast concrete units that have not been inspected at the fabrication facility will not be paid for until such material has been inspected, reviewed and accepted by the Consultant. The Contractor shall be responsible for all costs incurred by the Consultant for inspection of the precast concrete units not inspected at the fabrication facility.

#### 7.2.6.8 Fabrication Outside of Canada

All testing and inspection requirements specified in Subsection 7.2.6, Testing and Inspection, shall be completed at the fabrication facility and all costs incurred by the Consultant and their designated testing agencies, and the Department shall be paid for by the Contractor.

All components fabricated outside of Canada shall be shipped to a shop located in Canada that is certified by CPCI in the applicable Product Group classification of the component for re-inspection and testing. The components shall be in a condition that facilitates all testing and inspection requirements. Precast concrete units fabricated outside of Canada shall be re-inspected by a Prestressed/Precast Concrete Institute (PCI) certified level II inspector. Testing and inspection shall be completed in accordance Subsection 7.2.6, Testing and Inspection. The PCI certified inspector shall also inspect all components to ensure that they were not damaged during transportation.

In addition three concrete cores shall be taken from each precast concrete unit, at locations determined by the Consultant, and tested by a laboratory certified to CSA A283 to determine that the concrete meets all Contract requirements.

Components shall not be shipped from the Canadian shop until all requirements have been met and the Work has been reviewed and accepted by the Consultant.

The Contractor shall be responsible for all re-inspection and testing costs, including all cost incurred by the Consultant and the Department.

The Contractor shall have no claim against the Department resulting from delays caused by these requirements.

### 7.2.7 Failure to Meet Strength Requirements

#### 7.2.7.1 Right of Rejection

The Department reserves the right to reject concrete that does not meet the specified requirements. The Department may, at its sole discretion, accept precast concrete units that does not meet the specified 28 day concrete compressive strength at a reduced price. Payment adjustment may be made in accordance with Subsection 7.2.7.3, Payment Adjustment Schedule.

#### 7.2.7.2 Coring

Coring to confirm or contest low concrete strength test results will only be permitted when reviewed and accepted by the Department. Sampling and testing of cores shall be completed by an independent laboratory certified to CSA A283 in accordance with CSA A23.2 14C. Cores shall be extracted in the presence of the Consultant and tested within 7 days of testing the cylinders being evaluated.

Three cores shall be extracted for each concrete strength test result being evaluated. Core locations will be determined by the Consultant. The core size shall be 100 mm diameter by 200 mm length or of a size acceptable to the Consultant. Core holes shall be repaired using a Department approved concrete patching product acceptable to the Consultant.

The average strength of each set of 3 cores from a precast unit will represent a concrete strength test and shall be equal to or greater than the specified strength. CSA A23.1, Clause 4.4.6.6.2.2, Acceptance of Cores Drilled from a Structure, shall not apply. If the average cored concrete strength is greater than the averaged cylinder concrete strength, the concrete cored strength result will be used as the basis for acceptance and payment. If the averaged cored concrete strength is less than the averaged cylinder concrete strength, the averaged cylinder concrete strength will be used as the basis for acceptance and payment.

All costs associated with coring, testing, reporting and repairing core holes shall be at the Contractor's expense.

#### 7.2.7.3 Payment Adjustment Schedule

When the specified 28-day concrete strength is not met, the precast concrete unit shall be paid in accordance with Table 7-1, Payment Adjustment Schedule:

**Table 7-1: Payment Adjustment Schedule**

| Strength below the specified 28-day strength | Percentage of Unit Price to be paid |
|---|---|
| 1 MPa or less | 95% |
| 1 MPa to 2 MPa | 90% |
| 2 MPa to 3 MPa | 85% |
| 3 MPa to 4 MPa | 80% |

In the event that the concrete tested is more than 4 MPa below the specified 28-day strength, the precast concrete units fabricated from the concrete represented by the test specimens shall be rejected. In the event that the precast concrete unit has been delivered and/or erected in the field, it shall be removed and returned to the Contractor's plant for replacement. The entire cost of replacement, including delivery and erection costs, shall be at the Contractor's expense.

## 7.3 Precast Concrete Girder Erection

### 7.3.1 General

The Contractor shall erect precast concrete girders as shown on the Drawings and these specifications. Erection of precast concrete girders shall also include, but is not limited to the following:

- Erection and removal of temporary supporting structures;
- Removal of anchor rod grout can void forms;
- Placing and grouting of connector bolts and diaphragms;
- Post-tensioning installation and grouting; and
- Cutting of lifting hooks, and repair of lifting holes and pockets.

The Contractor shall not erect the precast concrete girders until the substructure concrete has been cured a minimum of three days and achieved 80% of the 28 day specified concrete strength requirement.

Cranes shall be used for the handling and erection of precast concrete girders.

The Contractor shall maintain girder stability; location; and horizontal, vertical and longitudinal alignment at all times during construction.

Lifting forces shall be vertical. Precast concrete girders shall be erected using lifting devices that have been reviewed and accepted by the Consultant and at the designated locations only. Drilling or coring of additional holes or any other modifications will not be permitted.

Grout pads shall be constructed in accordance with Section 8, Bearings.

7.3.2 Transportation, Handling and Storing Materials

Girders with webs shall be transported with girder webs in the vertical position. If the Contractor proposes to transport the girders with webs in a position other than vertical, the Contractor shall employ a Professional Engineer registered in the Province of Alberta to prepare and submit a girder transportation assessment to the Consultant for review and acceptance a minimum of two week prior to shipping from the fabrication facility. Review comments provided by the Consultant and/or the Department shall be incorporated into the transportation assessment and resubmitted to the Consultant for review and acceptance prior to shipping from the fabrication facility. The Consultant's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in a manner that does not, in the opinion of the Consultant and Department, damage the girders.

Upon arrival at the site and prior to erection, the Contractor in the presence of the Consultant, shall inspect all components to ensure there is no damage and that specification requirements have been met. The Contractor shall provide an adequate flat storage area and space between elements for the inspection. A detailed inspection report shall be provided to the Consultant for review and acceptance within three days of the inspection. Erection work shall not commence until the detailed inspection report has been reviewed and accepted by the Consultant.

Precast concrete girders shall be protected from dirt, road salts, slush or other contaminants during transportation, handling and storage.

Any precast concrete girder damaged during transportation, handling, storing or erection shall be immediately reported to the Consultant and the Department. The Contractor shall provide an engineering assessment report and repair procedure prepared by a Professional Engineer registered in the Province of Alberta experienced in evaluation and inspection of damaged concrete members. The assessment report and repair procedure shall be submitted to the Consultant and the Department for review and acceptance. The Consultant will also arrange to have an independent inspection and assessment performed on the damaged member by a Precast/Prestressed Concrete Institute (PCI) level 2 certified inspector. The Contractor shall provide at least three days' notice for the inspection and facilitate all the activities associated with the inspection. All costs associated with the independent inspection will be the responsibility of the Contractor.

Precast concrete units that become contaminated with any dirt, road salts, slush or other contaminants, shall be cleaned and surface finishes re-instated to the satisfaction of the Consultant prior to erection or installation.

Material to be stored shall be placed on timber blocking. It shall be kept clean, free from dirt, grease, and any other foreign matter and stored in a properly drained area. Handling and lifting devices shall not mark, damage, or distort members. Precast concrete girders shall be shored and stored in the vertical position.

### 7.3.3 Temporary Supporting Structures and Berms

The temporary supporting structures and berms shall be designed, constructed and maintained to safely support all loads.

Berms shall be constructed in a manner and of such materials that they will not be eroded by stream flow nor introduce silt into the watercourse.

The Contractor shall prepare and submit drawings that clearly indicate details of all temporary supporting structures and berms, sealed by a Professional Engineer registered in the Province of Alberta, for the Consultant's review and acceptance a minimum of four weeks in advance of the Work. The Contractor shall be fully responsible for the results obtained by the use of these sealed drawings, with the Professional Engineer also assuming responsibility, as the Contractor’s Agent, for the results obtained.

The Consultant’s review and acceptance shall not be considered as relieving the Contractor of the responsibility for the safety of his methods or equipment, nor from carrying out the work in full accordance with the Contract requirements.

Repair to any damage to property, such as earth fills and stream banks, resulting from the existence of berms, and all associated costs shall be the sole responsibility of the Contractor.

### 7.3.4 Girder Erection Procedure

The Contractor shall submit a detailed girder erection procedure to the Consultant for review and acceptance a minimum of 4 weeks in advance of erection. The erection procedure shall include drawings and supporting documents necessary to describe the following:

- Traffic Accommodation Strategy (TAS);

- Access to the Work, including temporary access berms and/or work bridges;

- Details of temporary works and supporting structures, including:

    - Location, elevation, and grade of support bearings;
    - Theoretical top of girder elevations at bearing and splice locations; and

  - o Vertical, horizontal, and longitudinal position adjustment mechanisms;

- An as constructed survey of substructure elements, including:

  - o Location and elevation of all bearing grout pad recesses including anchor rod voids;
  - o Shim height required at each bearing location; and
  - o Longitudinal and transverse measurements between centreline of bearings of all substructure elements.

- Superstructure layout plan, including installation details of reference lines and markings of substructure and bearing components used to determine final bearing and girder positions, and theoretical top of girder elevations at substructure bearing locations;

- Type and capacity of cranes;

- Sequence of operation, including position of cranes and delivery trucks;

- Position of cranes relative to substructure elements such as abutment backwalls, with details of load distribution of wheels and outriggers;

- Lifting devices and lifting points showing lifting forces;

- Girder stabilization details, methods of maintaining girder location and alignment, and details of blocking for girder and bearings;

- Diaphragm and bracing installation schedule and sequence;

- Bolt tightening schedule and sequence as applicable;

- Post-tensioning procedures, including prestressing strand specifications, jack dimensions, pressures, forces and elongations, and grouting;

- Grout pad construction; and

- Temporary supporting structures release and removal.

Installation of bearings shall be in accordance with Subsection 8.4, Installation.

Girder layout and member identification contained in the erection procedure shall be consistent with the girder layout and member identification shown on the Drawings.

The girder erection procedure shall be signed and sealed by a Professional Engineer registered in the Province of Alberta. Safety and compliance with the Occupational Health and Safety Act and Regulations thereunder, shall be an integral part of the procedure.

The Contractor shall not commence any erection work until review of the girder erection procedure by the Consultant has been completed and all comments arising from that review have been addressed to the satisfaction of the Consultant. The Contractor's project manager, field superintendent, and representatives directly involved in the supervision of the work, shall attend a construction milestone meeting prior to commencement of the Work.

The Consultant’s review and acceptance shall not be considered as relieving the Contractor of the responsibility for the safety of his methods or equipment, nor from carrying out the Work in full accordance with the girder erection procedure, drawings and specifications.

The Contractor shall follow the girder erection procedure at all times.

### 7.3.5 Fall Protection for Girder Erection and Deck Forming

In order to provide a safe working area for girder erection and deck formwork, the Contractor shall provide 100% fall protection and a safe work procedure. The design of the fall protection and the safe work procedure shall be performed and certified by an individual who is competent in this specialized work. The Contractor shall provide this information to the Consultant a minimum of 2 weeks prior to commencement of the Work.

### 7.3.6 Girder Adjustments

Adjustment to girder position, bearing location and bearing elevation shall be completed to achieve the lines and grades shown on the Drawings or those reviewed and accepted by the Consultant.

The Contractor shall maintain the precast concrete units in correct alignment at all times during construction.

The Contractor shall minimize differential camber (girder to girder) and the sweep of the girders by jacking, loading of girders, or winching in a manner acceptable to the Consultant. Once girder position has been reviewed and accepted by the Consultant, the Contractor shall provide the necessary temporary attachments to maintain girder position.

The maximum dimensional deviation in mm, of erected precast concrete girders from that as detailed on the drawings shall not exceed the following:

- Sweep (NU Girders): 1 mm/m;
- Sweep (Other Precast Concrete Units): deviation from true, 20 mm x length (m) ÷ 50

### 7.3.7 Lifting Hooks and Lifting Holes

After the Consultant has reviewed and accepted the erected girder locations and positions, lifting hooks shall be cut off 50 mm below the concrete surface. All lifting holes and pockets shall be filled with a concrete patching product listed on Alberta Transportation’s Product List in the applicable category in accordance with the manufacturer’s recommendations specified on the published product data sheet.

### 7.3.8 Post-Tensioning System

#### 7.3.8.1 General

This Work consists of post-tensioning and grouting of cable ducts for cast-in-place and precast concrete components.

#### 7.3.8.2 Standards

The following standards shall be followed:

- CSA A23.1/23.2 - Concrete Materials and Method of Concrete Construction;
- CSA A23.4 - Precast Concrete Materials and Construction;
- Section 4, Cast-In-Place Concrete;
- Guide Specification Acceptance Standards for Post Tensioning Systems – Post-Tensioning Institute (PTI);
- Specifications for Grouting of Post Tensioned-Structures – PTI; and
- AASHTO LRFD Bridge Construction Specifications.

In the case of conflicting requirements the most stringent requirement shall govern.

#### 7.3.8.3 Qualification

The Contractor shall have extensive experience in this Work and shall utilize only fully trained, competent and experienced personnel. The Contractor shall ensure the site supervisor responsible for the post tensioning and grouting operations is at the site whenever these operations are being completed.

- The site supervisor of post tensioning and grouting operations shall be certified to PTI Level 2 Bonded PT Field Specialist;
- The foreman for each installation and stressing crew shall be certified to PTI Level 2 Bonded PT Field Specialist;
- The foreman for each grouting crew shall be certified to PTI Level 2 Bonded PT Field Specialist; and
- At least 25% of the members of each crew shall be certified in PTI Level 1 Bonded – Field Installation.

#### 7.3.8.4 Submittals

The Contractor shall submit post tensioning design notes, independent check notes and shop drawings in accordance with Subsection 7.2.3.2, Design Notes and Independent Check Notes, and this Subsection. As a minimum, the following information shall be included on shop drawings:

- Stressing system and where appropriate, design details and sequence of stressing; and
- Stressing calculations taking into account all applicable losses.

Mill test reports and load/elongation curves for the prestressing strand shall be provided a minimum of 5 days prior to the commencement of stressing.

7.3.8.5 Materials

7.3.8.5.1 Prestressing Strand

Prestressing strand shall conform to the requirements of Subsection 7.2.4.9, Prestressing Strand and Subsection 7.2.5.3, Prestressing Strand.

Corrosion inhibitor will be required when the stressing and grouting operations are not completed within 20 calendar days of the installation of the prestressing stand. The corrosion inhibitor, when required, shall be water-soluble and have no deleterious effect on the prestressing strand, grout, concrete, or bond strength of the prestressing strand to concrete.

7.3.8.5.2 Anchorages and Distribution

All prestressing strand shall be secured at the ends by means of permanent anchoring devices reviewed and accepted by the Consultant. These devices shall comply with CSA S6 Clause 8.4.4.1.

Steel distribution plates or assemblies may be omitted when the anchoring devices are sufficiently large and used in conjunction with an embedded steel grillage that effectively distributes the compressive stresses to the concrete.

7.3.8.5.3 Ducts

Post-Tensioning duct material shall be in accordance with Subsection 7.2.4.13, Voids, Ducts, and Conduit.

The Contractor shall provide mortar tight inlets and outlets in all ducts with a nominal diameter of 20 mm in the following locations:

- The anchorage area;
- All high points of the duct, when the vertical distance between the highest and lowest point is more than 0.5 m;
- Place an inlet at or near the lowest point; and
- Place free draining outlet at all low points of duct.

The Contractor shall provide inlets and outlets with valves, caps or other devices capable of withstanding the grouting pressure. The ducts and vents shall be securely fastened in place to prevent movement. The Contractor shall provide details of inlets and outlets on the shop drawings.

#### 7.3.8.5.4 Concrete

Concrete shall be supplied in accordance with Subsection 7.2.4, Materials and meet the following requirements:

- The minimum 28 day concrete compressive strength shall be 50 MPa unless otherwise specified; and
- The maximum nominal size of the coarse aggregate shall be in accordance with Subsection, 4.3.2.2, of CSA A23.1, Nominal Maximum Size of Aggregate.

#### 7.3.8.5.5 Grout

Grout shall be a Class C grout meeting the requirements described in Table 10.9.3-1 and the properties listed in Table 10.9.3-2 of the AASHTO LRFD Bridge Construction Specification. The wet density shall also be provided by the manufacturer in accordance with ASTM C138, Standard Test Method for Density.

The average minimum compressive strength of 3 cubes at 28 days shall be 50 MPa and measured in accordance with CSA A23.2-1B.

Pre-bagged grouts shall be packaged in plastic lined bags or coated containers, stamped with the date of manufacture, lot number and mixing instructions. Copies of the quality control data for each lot number and shipment sent to the job site shall be provided to the Consultant for review prior to grouting. Materials with a total time from manufacture to usage in excess of six months shall be retested and certified by the supplier before use, or shall be removed from the job site and replaced.

### 7.3.8.6 Equipment

#### 7.3.8.6.1 Stressing

Hydraulic jacks and pumps of sufficient capacity shall be used for tensioning of prestressing strands.

The force induced in the prestressing strand shall be measured using calibrated jacking gauges, load cells or a calibrated dynamometer.

The pressure gauge shall have an accurate reading dial at least 150 mm in diameter.

The forces to be measured shall be within 25% and 75% of the total graduated capacity of the gauge, unless calibration data clearly establishes consistent accuracy over a wider range.

The measuring devices shall be calibrated at least once every six months. The jack and the gauge shall be calibrated together. A certified calibration chart shall be kept with each gauge.

#### 7.3.8.6.2 Grouting

A high speed shear mixer shall be used that is capable of continuous mechanical mixing and producing grout that is free of lumps and undispersed cement. The water supply to the mixer shall be measured by an accurate gauge.

The holding tank shall be capable of keeping the mixed grout in continuous motion until it is used. The outlet to the pump shall have a screen with 3 mm maximum clear opening.

A positive displacement type pump shall be used which is capable of producing an outlet pressure of at least 1 MPa. A pressure gauge having a full-scale reading of no greater than 2 MPa shall be placed at some point in the grout line between the pump outlet and the duct inlet.

The Contractor shall have an additional backup pump shall be on site ready for use at all times during grouting operations.

Standby flushing equipment with water supply shall be available at the site prior to commencing grouting.

The grouting equipment shall be of sufficient capacity to ensure that grouting of the longest duct can be completed within 30 minutes after mixing.

Grout hoses and their rated pressure capacity shall be compatible with the pump output and the maximum grout pressure. All connections from the grout pump to the duct shall be airtight so that air cannot draw into the duct.

### 7.3.8.7 Construction

#### 7.3.8.7.1 Checking Post-Tensioning Ducts

Placement of post-tensioning ducts shall be in accordance with Subsection 7.2.5.4, Void, Duct, Conduit and Reinforcement Placing Tolerances.

Prior to placing prestressing strand, the Contractor shall demonstrate to the satisfaction of the Consultant that all ducts are unobstructed.

#### 7.3.8.7.2 Welding

Proposed welding of prestressing strand ends will require the Consultants review and acceptance. The greater of the length of the prestressing strands used within the electrical circuit or 1 m shall be cut off from the welded end prior to stressing.

#### 7.3.8.7.3 Post-Tensioning

Post-tensioning shall be carried out in accordance with the reviewed drawings and stressing calculations. The stressing and release of tendons shall be done in the sequence specified on the Drawings. All strands in each tendon shall be stressed simultaneously with a multi-strand jack. The force in the tendons shall be measured by means of pressure gauge and shall be verified by means of tendon elongation. All tendons shall be tensioned to a preliminary force as necessary to eliminate any slack in the tensioning system before elongation readings are started. This preliminary force shall be between 15% and 25% of the final jacking force.

Stressing tails of post-tensioned tendons shall not be cut off until the record of gauge pressures and tendon elongations are provided by the Contractor to the Consultant for review and acceptance. A record of the following post-tensioning operations shall be kept for each tendon installed:

- Project Name & File Number;
- Contractor/Subcontractor;
- Tendon location & size;
- Date tendon installed;
- Tendon pack/heat number;
- Modulus of elasticity (E);
- Date stressed;
- Jack and gauge identifier;
- Required jacking force and gauge pressures;
- Elongation (anticipated and actual);
- Anchor set (anticipated and actual);
- Stressing sequence;
- Witnesses to stressing operation;
- Grout information (Brand Name);
- Time for grouting each tendon; and
- Date grouted.

#### 7.3.8.7.4 Concreting

The anchorage recesses shall be concreted after tensioning but before grouting the tendons.

The concrete surface of the anchorage recesses shall be abrasive blasted. Prior to concrete placement, concrete surfaces shall be blown clean with compressed air and saturated with water meeting the requirements of Subsection 7.2.4.2, Water.

#### 7.3.8.7.5 Grouting

All ducts or openings shall be clean and free of all deleterious matter that would impair bonding of the grout to the ducts and prestressing strand. All ducts shall be thoroughly blown out with oil free compressed air. All inlets and outlets shall be checked for their capacity to accept injection of grout by blowing oil free compressed air through the system.

Before stressing and grouting internal or external tendons, the Contractor shall install all grout caps, inlets and outlets and test each duct with oil free compressed air to determine whether duct connections need repair. The Contractor shall pressurize each duct to 345 kPa (50 psi) and lock-off the outside air source and record pressure for one minute. A pressure loss of 170 kPa (25 psi) is acceptable for ducts up to 45 m long, and a pressure loss of 100 kPa (15 psi) is acceptable for ducts longer than 45 m. If the pressure loss exceeds the acceptable limit, the Contractor shall repair the leaking connections using methods acceptable to the Consultant, and then retest.

A thoroughly mixed grout, meeting all the requirements described in Subsection 7.3.8.5.5, Grout, shall be passed through a screen with 3 mm maximum clear openings before entering the pump. All grout vents shall be opened prior to commencement of grouting. The duct shall be completely filled by injecting grout from the lowest end of the tendon on an uphill direction. Grout shall be pumped continuously through the duct until no visible signs of water or air are ejected at the outlet. A fully operational grout pump shall be on site for all pumping procedures. A continuous, one way flow of grout shall be maintained at a rate of 5 to 15 lineal metres of duct per minute. The grouting of a tendon shall be completed within 30 minutes of mixing unless otherwise accepted by the Consultant.

Normal pumping pressure shall be between 0.1 to 0.4 MPa, measured at the inlet. The pumping pressure at the injection vent shall not exceed 1 MPa. If the actual pressure exceeds the maximum allowed, the injection vent shall be closed and the grout shall be injected at the next vent that has been or is ready to be closed as long as one way flow is maintained. Grout shall not be injected to a succeeding vent from which grout has not yet flowed. For each tendon, immediately after uncontaminated uniform grout discharge begins, a fluidity test shall be performed. The measured grout efflux time shall not be faster than the efflux time measured at the inlet or the minimum efflux time established. If the grout efflux time is not acceptable, additional grout shall be discharge from the discharge outlet. This cycle shall be continued until acceptable grout fluidity is achieved. In addition to fluidity test, the grout density shall be tested using the Mud Balance Test and the density at the final outlet shall not be less than the grout density at the inlet. Vents shall be closed in the designed sequence under pressure when the tendon duct is completely filled with grout. Valves and caps shall not to be removed until the grout has set.

Grouting will not be permitted when the air temperature is below 5 °C or above 25 °C, nor when there are other conditions judged by the Consultant to be detrimental to the grouting operations.

The Contractor shall provide 50 mm deep grout tube termination recesses formed around the tubes projecting from top of the deck concrete. After grouting, all tubes shall be cut flush with the bottom of the recesses, and the recesses shall then be grouted flush with the top of the deck concrete.

The Contractor shall complete grout testing in accordance with Subsections 7.3.8.7.5.1, Compressive Strength Test through 7.3.8.7.5.4, Mud Balance Test and ensure that the testing is witnessed by the Consultant. The grout testing shall be completed by ACI or CSA certified testers and review and accepted by the Consultant. Grout testing reports shall be submitted to the Consultant within 3 days of test completion.

7.3.8.7.5.1 Compressive Strength Test

- Precast Concrete Girders: One compressive strength test per girder line
- Cast-In-Place Girders: One compressive strength test for every four longitudinal ducts

The compressive strength test shall be completed by an independent testing laboratory certified to CSA A283 and in accordance with CSA A23.2-1B.

7.3.8.7.5.2 Bleed Test

At the beginning of each day's grouting operation, a wick induced bleed test shall be completed in accordance with ASTM C940 and with modifications noted in Table 10.9.3-2 of the AASHTO LRFD Bridge Construction Specifications.

7.3.8.7.5.3 Fluidity Test

At the inlet and outlet of each duct, a fluidity test shall be completed in accordance with the standard ASTM C939 flow cone test or the modified ASTM C939 test.

7.3.8.7.5.4 Mud Balance Test

A mud balance test shall be completed for each batch of grout in accordance with American Petroleum Institute (API) Mud Balance Test API Practice 13B-1: "Standard Procedures for Field Testing Water-based Drilling Fluids".

7.3.8.8 Inspection

The stressing and grouting will require the Consultant's presence. The Contractor shall ensure that adequate notice be given to the Consultant for these operations and access to the Work is provided at all times.

7.3.9 Removal of Temporary Supporting Structures and Site Clean-up

Upon completion of girder erection, including post-tensioning where specified, the Contractor shall remove all earth material or temporary supporting structures used during construction. The Contractor shall remove all piling, excavated or surplus materials, rubbish and temporary buildings, replace or renew any damaged fences, and restore in an acceptable manner all property damaged during the execution of his work. Disposal of surplus materials shall be in a manner and location satisfactory to the Consultant.

The Contractor shall leave the bridge site, roadway and adjacent property in a condition acceptable to the Consultant. When required, the Contractor shall provide written evidence that affected property owners or regulatory agencies have been satisfied.

## 7.4 Payment

### 7.4.1 Supply

Payment for the supply of precast concrete units will be made at the unit prices bid for "Precast Concrete Units – Supply" for the type and size specified less any applicable payment adjustments for compressive strength, and will be full compensation for supply and manufacture of precast concrete units; including all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

90% of the unit price bid will be paid once the precast concrete units have been acceptably supplied and delivered to the bridge site. The remaining 10% of the unit price bid will be paid once the precast concrete units have been acceptably installed.

### 7.4.2 Delivery

Payment for the delivery of precast concrete units will be made at the lump sum prices bid for "Precast Concrete Units – Delivery" for the type and size specified, and will be full compensation for loading; hauling to the project site; unloading; and all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

All necessary approvals and permits, cleaning of girders to remove foreign materials will be considered incidental to the Work and no separator or additional payment will be made.

90% of the lump sum price bid will be paid once the precast concrete units have been acceptably supplied and delivered to the bridge site. The remaining 10% of the lump sum price bid will be paid once the precast concrete units have been acceptably installed.

### 7.4.3 Erection

Payment for the erection of precast concrete units will be made at the lump sum prices bid for "Precast Concrete Units - Erection" for the type and size specified, and will be full compensation for all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

### 7.4.4 Post-tensioning and Grouting

Payment for post-tensioning and grouting will be made at the lump sum price bid for "Post-Tensioning and Grouting", and will be full compensation for supply and installation of post tensioning systems; the supply and placement of grout; and all labour, materials, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

All costs associated with grouting in cold weather, when required, will be considered incidental to the Work, and no separate or additional payment will be made.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

# SECTION 8 BEARINGS

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## 8.1 General

This specification is for the supply, fabrication, delivery and installation of plain and laminated elastomeric bearings, pot bearings and fixed steel plate rocker bearings. The laminated elastomeric bearing and pot bearing components between sole plates and base plates shall be designed by the bearing supplier in accordance with the requirements of the Drawings and these specifications. Design details of elastomeric bearings shall also be in accordance with Typical Detail Drawing T-1761, Typical Expansion Bearing Details.

## 8.2 Design Requirements

The design of bearings shall be completed by the bearing supplier.

Bearings shall be designed to accommodate the loadings, translations and rotations specified on the Drawings, in accordance with the requirements of CSA S6, and the exceptions noted in this specification.

Sole plates and base plates shall be supplied by the bearing supplier, and shall conform to the details shown on the Drawings. Any proposed adjustments of these details shall be submitted to the Consultant for review and acceptance prior to fabrication.

The entire bearing assembly, between the sole plate and base plate shall be replaceable without damage to the structure and without removal of any concrete, welds or anchorages permanently attached to the structure and without lifting the superstructure more than 5 mm. Bearings shall not be recessed into plates that are permanently attached to the structure.

Bearings shall be designed to prevent moisture and dirt from entering the internal surfaces. The bearings shall be fabricated from materials that are durable and are protected from corrosion so as to perform the intended function.

### 8.2.1 Elastomeric Bearings

#### 8.2.1.1 Sliding Surfaces

Sliding surfaces shall allow translation by sliding of a stainless steel surface against a flat mating polytetrafluoroethylene (PTFE) sheet. The flat PTFE sheet shall be recessed and bonded into a 2.5 mm deep recess in the top of a 10 mm thick galvanized steel plate. The galvanized plate shall be vulcanized to the top of the elastomeric pad. The galvanized steel plate shall have the same plan dimensions as the elastomeric pad and act as the top laminate in the elastomeric bearing.

#### 8.2.1.2 PTFE Element

The PTFE element shall be a 5.0 mm thick unfilled and unlubricated flat PTFE sheet.

#### 8.2.1.3 Self-Rocking Pintle

A single self-rocking pintle welded under the base plate shall be used to ensure uniform contact between the elastomeric bearing pad and the girder bottom flange. Where double pintles are shown on the Drawings, the pintles shall be centred beneath the bearing along a line perpendicular to the longitudinal axis of the girder. The pintle or pintles shall be supported on galvanized steel shim stacks of the appropriate thickness to achieve the correct bearing elevation.

### 8.2.2 Pot Bearings

#### 8.2.2.1 Loadings, Translations and Rotations

The average stress in the elastomer at serviceability limit state loads shall not exceed 30 MPa.

Provision for translation shall be through sliding of a stainless steel surface against a mating PTFE element. The translational capacity in an unrestrained direction shall be as specified on the Drawings.

Provision for rotation about any horizontal axis shall be by means of a single disc of confined elastomer. Brass rings shall not be considered in determining the effective thickness of the elastomeric disc. The effective thickness of the elastomeric disc to evaluate the rotational capacity shall be limited to the thickness of the disc excluding the brass rings.

The rotational capacity about any horizontal axis shall be as specified on the Drawings. The rotational capacity about the vertical axis through the centre of the bearing shall be as specified or ±1°, whichever is greater.

Rotational bearings shall be capable of resisting the specified lateral loads in any direction in combination with the applicable vertical loads.

Brass sealing rings shall be flat and smooth on all surfaces and conform to the requirements of CSA S6.

The depth of the pot wall shall be such that a minimum vertical distance of 2.5 mm remains between top of the pot wall and the closest point of contact of the brass sealing rings with the pot wall upon rotating the piston an amount equal to the specified rotation at ULS.

The pot and piston surfaces in contact with the confined elastomer shall be lubricated with silicone grease. The bearing shall be sealed by a one-piece continuous preformed closed-cell compressible ring against entry of dirt, dust, and moisture between the elastomer and the pot and piston contact surfaces. Any joint in the ring shall be bonded and the strength shall be at least equal to the strength of the ring.

### 8.2.2.2 Sliding Surfaces

Sliding surfaces shall allow translation by sliding of a metal surface against a mating PTFE element. For plain surfaces, the metal surface shall be stainless steel. The metal surface shall overlap the PTFE by at least 25 mm at extremes of movement on each side and, except for guides for lateral restraint, shall be positioned above the PTFE element.

Except when used as mating surfaces for guides for lateral restraint, the PTFE resin shall be virgin material and shall be used as unfilled sheets and shall contain spherical reservoirs for lubricant pressed into its surface. The diameter of the reservoirs shall not exceed 8 mm measured at the surface of the PTFE, and the depth shall not be less than 2 mm nor more than half the thickness of the PTFE. The reservoirs shall be evenly distributed across the surface of the PTFE and shall occupy 20% to 30% of the surface. PTFE used as mating surface for guides for lateral restraint shall not be dimpled or lubricated. All PTFE elements shall be fully bonded and recessed in a rigid backing material.

All PTFE surfaces except those that act as mating surfaces for guides for lateral restraint or that are subjected to a contact pressure of less than 5 MPa shall be permanently lubricated with silicone grease.

The average contact pressure for unfilled PTFE elements based on the gross area of the PTFE shall not exceed the values given in Table 8-1, Average Contact Pressure for unfilled PTFE Elements.

**Table 8-1: Average Contact Pressure for unfilled PTFE Elements**

| Limit State | Permanent Load, MPa | Total Load, MPa |
|---|---|---|
| Serviceability | 25 | 35 |
| Ultimate | 40 | 55 |

The maximum contact pressures at the extreme edges of flat and curved PTFE elements shall not exceed 1.2 times the values indicated above.

The average contact pressure at serviceability limit state loads for PTFE elements filled with up to 15% mass of glass fibers used to face mating surfaces of guides for lateral restraints shall not exceed 45 MPa.

The coefficient of friction between stainless steel sliding surfaces and lubricated virgin PTFE shall be as per clause 14.7.2.5 and Table 14.7.2.5-1 of the 2012 AASHTO LRFD Bridge Design Specifications.

#### 8.2.2.3 Fasteners, Anchorages, and Guides for Lateral Restraint

Fasteners, anchorages and translational elements with lateral restraints shall be capable of resisting either of the following lateral loads:

- For bearings with a capacity of 5,000 kN or less at serviceability limit state, 10% of the vertical load capacity.
- For bearings with a capacity over 5,000 kN at serviceability limit state, 500 kN plus 5% of the vertical load in excess of 5,000 kN.

Guides for lateral restraint shall be arranged to permit the required rotations about both the horizontal and vertical axis. The translational elements of guides for lateral restraint shall be faced with stainless steel and shall provide lateral restraint by sliding against mating surfaces faced with PTFE.

The beneficial effect of friction shall be neglected in proportioning fasteners and anchors, except for slip resistant connections which shall be designed to the requirements of CSA S6 Clause 10.18.2.

## 8.3 Supply and Fabrication

### 8.3.1 Standards

Fabrication of plain and laminated elastomeric bearings, pot bearings and fixed steel plate rocker bearings shall conform to:

- The American Association of State Highway and Transport Officials (AASHTO) LRFD Bridge Construction Specifications;
- AASHTO’s Standard Specifications for Transportation Materials and Methods of Sampling and Testing M251-06 Standard Specification for Plain and Laminated Elastomeric Bridge Bearings; and
- The American Welding Society (AWS) - Bridge Welding Code D1.5.

### 8.3.2 Qualification

Bearings shall be supplied and fabricated by a fabricator certified by the Canadian Welding Bureau (CWB) in accordance with W47.1 of the Canadian Standards Association (CSA) Division 1 or 2. Fabrication shall be performed in a permanent fully enclosed structure which is adequately heated. The shop temperature shall be at least 10 °C

The Contractor shall notify the Consultant and the Department of fabricators in his employ. The Contractor shall remain responsible for the Work of the fabricators. All terms of the Contract shall apply to the fabricators.

Welders, welding operators and tackers shall be CWB approved in the applicable category. Their qualifications shall be current and available for examination by the Consultant upon request.

### 8.3.3 Engineering Data

#### 8.3.3.1 Welding Procedures

Welding procedures, including welding procedure datasheets, shall be submitted for each type of weld proposed. The welding procedures shall bear the approval of the CWB and be reviewed and accepted by the Consultant and the Department a minimum of 3 weeks prior to the commencement of fabrication.

#### 8.3.3.2 Design Notes, Independent Check Notes, and Shop Drawing Submission Requirements

Design notes, independent check notes, and shop drawings shall be signed and sealed by the design engineer of record and by an independent checker. The design engineer of record and the independent checker shall be Professional Engineers registered in the Province of Alberta. Design notes, independent check notes and shop drawings shall be submitted to the Consultant for review and acceptance a minimum of 3 weeks in advance of the commencement of fabrication. Review comments provided by the Consultant and/or the Department shall be incorporated into the design notes, independent check notes and shop drawings and resubmitted to the Consultant for review and acceptance prior to the commencement of fabrication.

The design engineer of record and independent checker shall submit separate signed and sealed design notes and independent check notes. The design and independent check notes shall be presented in a legible and logical format, clearly identify material properties, and sufficiently detailed to allow a technical review of design concepts and assumptions used. All material properties shall be confirmed and documented by the design engineer of record and independent checker prior to the commencement to fabrication.

The independent checker may be employed by the same company as the design engineer of record. The independent check must be completed fully independent of the design engineer of record, including a complete re-analysis of all aspects of the design including calculations and engineering, preferably by a methodology or computer program other than that used by the design engineer of record. The design engineer of record and independent checker shall ensure that the shop drawings are complete and accurately convey the design criteria and assumptions used in their designs.

Shop drawings shall be electronic unlocked PDF format. Each shop drawing shall include the Department's shop drawing identification block and have a sufficient blank space for the Consultant's review stamp. The Department's shop drawing identification block will be provided to the Contractor upon request. As a minimum, the following information shall be included on shop drawing submissions:

- All material properties;
- Dimensions;
- Connection attachments;
- Fasteners and accessories;
- Bearing identification; and
- Load capacity information at serviceability and ultimate limit states as follows:
  - Maximum vertical permanent and total load;
  - Maximum lateral load and corresponding vertical load; and
  - Maximum rotational capacity about any horizontal axis and about the vertical axis at the centre of the bearing.

Design notes, independent check notes, and shop drawings shall be submitted for each bridge structure contained in the Contract.

The design notes, independent check notes, and shop drawings will be reviewed by the Consultant solely to ascertain general conformance with codes and specifications. The Consultant's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

The Contractor shall incorporate as-built construction conditions into design notes, independent check notes, and shop drawings. One paper copy and one electronic copy (PDF format) of as-built design notes, independent check notes, and shop drawings shall be submitted to the Consultant within 3 weeks of construction completion.

#### 8.3.3.3 Mill Test Reports

Mill test reports shall be provided for all materials in English and submitted to the Consultant for review and acceptance 3 weeks prior to commencement of fabrication.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be certified to ISO/IEC 17025 by an organization accredited by the Standards Council of Canada for the tests required. Samples for testing shall be collected by personnel employed by the certified laboratory. A verification letter shall be provided by the certified laboratory that includes at a minimum, the applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the certified laboratory.

### 8.3.4 Materials

All materials shall be new with no reclaimed material incorporated in the finished bearing.

#### 8.3.4.1 Steel

The steel laminates within laminated elastomeric bearings shall be rolled mild steel with minimum yield strength of 230 MPa. The steel for base plate, keeper bars, pintels, pot plates, piston plates, and shims shall conform to the requirements of CSA G40.21M Grade 300W or 350W. The steel for sole plates and fixed rockers shall be in accordance with the Drawings.

Steel with a boron content exceeding 0.0008% will not be permitted.

#### 8.3.4.2 Stainless Steel

Stainless steel sheets shall conform to the requirements of the American Iron and Steel Institute (AISI) Type 304, no. 8 mirror (0.2 µm) finish. The chemical and mechanical properties shall conform to the requirements of ASTM A240M. Stainless steel sheets shall have a minimum thickness of 3.2 mm.

#### 8.3.4.3 Brass

Brass sealing rings for pot bearings shall be according to ASTM B36M, half-hard.

#### 8.3.4.4 Elastomer

Cured elastomeric compounds shall be low temperature Grade 5 and meet the minimum requirements listed in Table X1 of AASHTO M251-06. Cured elastomeric compounds shall have 60 durometer hardness shore A for elastomeric bearing pads (laminated and plain) and 50 durometer hardness shore A for pot bearings (elastomeric disc).

Cured elastomeric compounds for fully integral abutments and piers shall be low temperature Grade 3, 4, or 5 and meet the minimum requirements listed in Table X1 of AASHTO M251-06. Cured elastomeric compounds for fully integral abutments and piers shall have 50 durometer hardness shore A.

Cured elastomeric compounds shall also meet the requirements of ASTM D2240 for low temperature crystallinity increase in hardness at an exposure of -25°C for 168 hours.

#### 8.3.4.5 PTFE

PTFE shall be unfilled, 100% virgin polymer conforming to Subsection 18.8.2.5, Unfilled PTFE Sheet of the 2010 AASHTO LRFD Bridge Construction Specifications including all interim revisions. Material used as the mating surface for guides for lateral restraint may be one of the following:

- Unfilled PTFE.
- PTFE filled with up to 15% by mass of glass fibres.

#### 8.3.4.6 Lubricant

Lubricant shall be silicone grease, effective to -40 °C, and comply with U.S. Department of Defense specification MIL-S-8660C.

#### 8.3.4.7 Adhesives

Adhesive for bonding PTFE to metal shall be an epoxy resin producing a bond with a minimum peel strength of 4 N/mm, when tested according to ASTM D429, Method B. Adhesives shall not degrade in the service environment.

#### 8.3.4.8 Anchor Rods and Connecting Bolts

Anchor rods and connecting bolts shall be in accordance with Table 8-2, Anchor Rod and Connecting Bolt Requirements.

**Table 8-2: Anchor Rod and Connecting Bolt Requirements**

| Description | Grades |
|---|---|
| For stainless steel bearing anchor rods in contact with black steel. | Stainless steel AISI Type 316 (Fy = 290 MPa based on 0.2% offset) |
| Galvanized mild steel anchor rods in contact with galvanized bearing plates. | Galvanized CSA G40.21M Grade 300W or ASTM A307 |
| Galvanized high strength anchor rods in contact with galvanized bearing plates | Galvanized ASTM A193 GRADE B7<br>(Fy=725 MPa, Fu=860 MPa). |
| Bolts connecting galvanized bearing components. | • Galvanized 22 mm diameter ASTM F3125 (rotational capacity testing required) Grade A325/A325M Type 1 heavy hex style bolts;<br>• Galvanized nuts ASTM A563/A563M; and<br>• Galvanized hardened washers ASTM F436/F436M |

### 8.3.5 Welding

#### 8.3.5.1 Filler Metals & Welding Processes

Low hydrogen filler, fluxes and low hydrogen welding practices shall be used. The deposited weld metal shall provide strength, durability, impact toughness, and corrosion resistance equivalent to base metal. The low hydrogen covering and flux shall be protected and stored as specified by AWS Standard D1.5. All electrodes, electrode/flux combinations, and electrode/shielding gas combinations shall be CSA certified.

Only the following welding processes and associated consumables shall be used:

8.3.5.1.1 Submerged Arc Welding (SAW)

All welds shall be made by a semi or fully automatic submerged arc process acceptable to the Department.

The submerged arc welding process may be used for flat and horizontal position welds.

All electrodes and fluxes shall conform to the diffusible hydrogen requirements of AWS D1.5 filler metal hydrogen designator H8 or lower. Use of cored filler wires in the submerged arc welding process or shielding gas process will not be permitted.

8.3.5.1.2 Shielded Metal Arc Welding (SMAW)

All electrodes and fluxes shall conform to the diffusible hydrogen requirements of AWS D1.5 filler metal hydrogen designator H4.

8.3.5.1.3 Metal Core Arc Welding (MCAW)

All electrodes shall conform to the diffusible hydrogen requirements of AWS D1.5 filler metal hydrogen designator H4

Field welding using the metal core arc welding process will not be permitted.

8.3.5.2 Cleaning Prior to Welding

Weld areas must be clean, free of mill scale, dirt, grease, and other contaminants prior to welding. For multi-pass welds, previously deposited weld metal shall also be thoroughly cleaned prior to depositing subsequent passes.

8.3.5.3 Tack and Temporary Welds

Tack and temporary welds shall not be allowed unless they are to be incorporated in the final weld. Tack welds, where allowed, shall be of a minimum length of four times the nominal size of the weld and length shall not exceed 15 times the weld size, and shall be subject to the same quality requirements as the final welds. Tack welds shall be sufficiently ground out prior to final weld in order to obtain a uniform weld bead. Cracked tack welds shall be completely removed prior to re-welding.

8.3.5.4 Run-off Tabs

Run-off tabs shall be used at the ends of all welds that terminate at the edge of a member. The thickness and shape of the tabs shall replicate the joint detail being welded and shall be a minimum of 100 mm long unless greater length is required for satisfactory work. They shall be tack welded only to that portion of the material that will not remain a part of the structure, or where the tack will be welded over and fused into the final joint. After welding, the tabs are to be removed by flame cutting, not by breaking off.

### 8.3.5.5 Preheat and Interpass Temperatures

Preheat and interpass temperature requirements shall be as per AWS D1.5, except that all welds to girder flanges shall be preheated to a minimum temperature of 100 °C unless a higher temperature is required by AWS D1.5 for the flange thickness. The preheat temperature shall be measured 75 mm from the point of welding on the opposite where the weld is being applied.

### 8.3.5.6 Grinding of Welds

Welds that are sufficiently smooth with a neat appearance and uniform profile, as determined by the Consultant, will not require grinding. Welds not conforming to an acceptable profile shall be ground to the proper profile without damaging of substantial removal of the base metal.

Grinding shall be smooth and parallel to the line of stress. Caution shall be exercised to prevent over grinding. Over grinding that results in reduced thickness of the base metal or size of the weld will not be permitted. Acceptability of the welds without grinding will be determined by the Consultant.

### 8.3.5.7 Submission of Repair Procedures

The Contractor shall submit repair procedures for damaged base metal and unsatisfactory weldments to the Consultant and the Department for review and acceptance prior to commencement of the repair work. The repair procedures shall be signed and sealed by an experienced welding engineer registered as a Professional Engineer in the Province of Alberta.

### 8.3.5.8 Arc Strikes

Arc strikes will not be permitted. In the event of an isolated accidental arc strike, a repair procedure shall be submitted in accordance with Subsection 6.2.5.7, Submission of Repair Procedures. At a minimum, the repair procedure shall include the complete grinding out of the crater produced by the arc strike. The repair procedure shall also include MPI and hardness testing of the affected area. Hardness of the repaired area shall conform to the requirements of Subsection 6.2.8.11, Hardness Tests. These areas will be examined by the Consultant to ensure complete removal of the metal in the affected area.

### 8.3.5.9 Plug and Slot Welds

Plug welds or slot welds shall not be permitted.

### 8.3.6 Fabrication

A pre-fabrication meeting is required for the supply and fabrication of bearings. The pre-fabrication meeting shall be held at the fabrication facility and the Contractor shall ensure that the fabrication superintendent, fabrication manager, and supervisors directly involved in the Work are in attendance. The meeting shall not occur until shop drawings, design notes and independent check notes, and welding procedures have been reviewed and accepted by the Consultant. The date of the pre-fabrication meeting shall be reviewed and accepted by the Consultant and the Department and proposed a minimum of 2 weeks prior to the anticipated date.

#### 8.3.6.1 Plain Elastomeric Bearings

Plain elastomeric bearing pads shall be moulded individually, cut from moulded strips or slabs of the required thickness, or extruded and cut to length.

#### 8.3.6.2 Laminated Elastomeric Bearings

Laminated elastomeric bearings shall be moulded under pressure as a single unit and heated in moulds that have a smooth surface finish.

The steel laminates shall be of uniform 3 mm nominal thickness without any sharp edges. The bond between the elastomer and the steel laminates shall be such that when a sample is tested for separation, failure shall occur within the elastomer and not between the elastomer and steel laminate. The top 10 mm galvanized laminate for sliding bearings shall have a 2.5 mm recess. The recessed surface shall be machined as per Subsection 8.3.6.5, Machining.

#### 8.3.6.3 Pot Bearings

Stainless steel sheets in contact with PTFE shall be continuously welded around the perimeter to its backing plate to prevent ingress of moisture. The weld shall be clean, uniform, and without overlaps and located outside the area in contact with PTFE.

The threaded portion of the bolts shall be coated with silicone grease prior to installation.

Virgin or glass filled PTFE elements shall be recessed in a rigid backing material and shall be bonded over the entire area with an adhesive. The rigid backing material shall be grit blasted and cleaned with oil free compressed air prior to applying the adhesive.

The PTFE elements used as mating surfaces for guides for lateral restraint shall extend to within 10 mm from the ends of the backing plates.

#### 8.3.6.4 Fixed Steel Plate Rocker Bearings

The curved surface of steel rocker bearings shall be machined as per Subsection 8.3.6.5, Machining.

8.3.6.5 Machining

Machining shall be done after welding. All metal to metal contact surfaces shall be machined.

For pot bearings, the pots and pistons shall be machined from solid metal plate or castings. There shall be no openings or discontinuities in the metal surfaces in contact with the confined elastomer or PTFE.

The surface finish of metal plate in contact with any metal plate or confined elastomer in pot and sliding laminated elastomeric bearings shall be machined to a surface finish of 6.4 µm and a flatness tolerance of 0.001 x bearing dimension.

8.3.6.6 Identification

Each bearing shall be marked with the fabricator's name, date of manufacture and unique identification number. The characters shall be not less than 10 mm in height.

8.3.6.7 Galvanizing

The fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatters, and all welding flux residue from the steel components prior to galvanizing.

Factors contributing to galvanization-induced cracking shall be minimized. Galvanizing shall be by the hot dip method, after fabrication, in accordance with the current edition of ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and ASTM F2329 Standard Specification for Zinc Coating Hot-Dip Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners and as modified in this specification.

The cleaning and pickling procedure of high strength ASTM A193 Grade B7 anchor rods shall be modified as follows prior to hot-dip galvanizing:

- Brush blast to remove mill scale and oil after threading ends;
- Flash pickle up to 5 minutes; and
- Quick dry prior to hot-dip galvanizing (not stored in flux or acid rinse).

The modified anchor rod cleaning and pickling procedure shall be completed in the presence of the Consultant prior to hot-dip galvanizing.

Pot and piston plates of pot bearings, except the surfaces in contact with the elastomer, shall be metallized in accordance with ASTM A780, Method A3. The thickness of metallizing shall not be less than 180 µm.

Galvanized contact surfaces of bolted connections shall be hand wire brushed to a Class A slip coefficient surface condition. Slip coefficients surface conditions shall meet the requirements of Table 10.9 of CSA S6.

Galvanized sole plates, slider plates and rocker plates bolted to the bottom flanges of weathering steel girders shall use galvanized ASTM F3125 Grade A325/A325M Type 1 heavy hex style bolts. The bolt layout, size and configuration shall be as detailed on the Drawings.

Repair of galvanizing shall be completed in accordance ASTM A780, Method A3 "Metallizing" and will only be permitted when the repair areas are small and infrequent as determined by the Consultant. Repair areas less than 100 $mm^2$ in area may be completed in accordance with ASTM A780, Method A1 "Repair Using Zinc-Based Alloy". The thickness of the coating for both methods shall be 180 µm, and the repair tested for adhesion. A detailed repair procedure shall be submitted for review and acceptance by the Consultant prior to commencement of the work. Repairs may require complete removal of the galvanized coating and re-galvanizing. The finished appearance shall be similar to the adjacent galvanizing as determined by the Consultant.

Galvanized material shall be stacked or bundled and stored to prevent wet storage stain as per the American Hot Dip Galvanizers Association (AHDGA) publication "Wet Storage Stain". Any evidence of wet storage stain shall be removed to the satisfaction of the Consultant.

#### 8.3.6.8 Base Plate Corrosion Protection

The bottom surface of each base plate shall be protected by a medium grey colour barrier coating accepted by the Consultant, to prevent contact between the zinc and the concrete. The galvanized surface must be roughened prior to application of barrier coating. The surface preparation of the galvanized surface and the dry film thickness (DFT) of the coating shall be in accordance with the coating Manufacturer's recommendations.

The Consultant will test the adhesion of fully cured coating as per ASTM D3359 "Standard Test Methods for Measuring Adhesion by Tape Test". The method selected for testing (Method A or B) shall depend on the dry film thickness of the coating. The coating manufacturer's product data sheets shall be provided to the Consultant prior to the application of the coating. The adhesion test result shall meet a minimum of "4B" classification i.e. a maximum allowable flaking of 5%.

#### 8.3.6.9 Tolerances

Plain and laminated elastomeric bearing fabrication tolerances shall meet the requirements of AASHTO M251-06.

Pot bearing fabrication tolerances shall be as follows:

- The deviation from flatness of PTFE surfaces shall not exceed:
    - 0.2 mm, when the diameter or diagonal is equal to or less than 800 mm.
    - 0.00025 of the diameter or diagonal when the diameter or diagonal is greater than 800 mm.

- The deviation from flatness of stainless steel in contact with PTFE for plain surfaces and from the theoretical surface for spherical surfaces shall not exceed:

    - 0.0003 LH mm for a rectangular PTFE element.
    - 0.0006 RH mm for a circular PTFE element

    where:
    L = the greater plan dimension for a rectangular bearing,
    R = the radius of a circular bearing, and,
    H = the free height of PTFE element

- For pot bearings, the tolerance of fit between the piston and the pot shall be +0.75 to +1.25 mm. The inside diameter of the pot cylinder shall be the same as the nominal diameter of the elastomer and shall be machined to a tolerance of:

    - 0 to +0.125 mm for diameters up to and including 500 mm.
    - 0 to +0.175 mm for diameters over 500 mm.

- The plan dimensions of the recess for PTFE shall be the same as the nominal plan dimensions of the PTFE and shall be machined to a tolerance of 0 to +0.2% of the diameter or diagonal.

    - Overall bearing plan dimension ± 3 mm
    - Overall bearing height ± 3 mm
    - Machined surface dimensions ± 0.4 mm

- Elastomeric components shall meet the following tolerances:

    - Diameter 0.0 to -1.5 mm for diameters ≤500 mm
      0.0 to -2.0 mm for diameters >500 mm
    - Thickness 0.0 to +1.0 mm

- Brass rings shall meet the following tolerances:

    - Difference between internal diameter of brass ring and diameter of recess in the moulded elastomer shall be 0 to + 0.5 mm.
    - Difference between sum of thicknesses of brass rings and recess depth in the moulded elastomer 0 to + 0.25 mm

- Recessed Guide Bars shall meet the requirements of the American Standard Clearance Locational Fit Class LC3 according to ANSI B4.1.

- Guides for lateral restraints shall have a 0.50 mm ± 0.25 mm gap between metal restraints surfaces and mating PTFE elements.

- PTFE components shall meet the following requirements:

    - The plan dimension of the PTFE shall be 0 to -0.2% of the diameter or diagonal.

- The thickness of the PTFE shall be within 0 to +10.0% of the design thickness.
- The depth of recess of the PTFE shall be 0 to +0.3 mm of the design depth

### 8.3.7 Testing and Inspection

#### 8.3.7.1 Access

The Consultant shall have full access to all parts of the Work at all times. When required by the Consultant, the Contractor shall provide needed manpower for assistance in performing inspection duties.

#### 8.3.7.2 Responsibility

It is the Contractor's responsibility to ensure that the Work is completed in accordance with the Contract requirements. Any inspection and/or testing completed by the Consultant, review and acceptance by the Consultant, shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Consultant to inspect bearings being fabricated outside the Province of Alberta. The cost shall also include for a Department's representative to attend the pre-fabrication meeting and one additional trip during the course of fabrication.

#### 8.3.7.3 Testing by the Contractor

The Contractor shall engage an independent CSA certified testing company at his expense to perform testing of bearing materials and the completed bearings.

The Contractor shall perform magnetic particle inspection of at least 25% of all fillet and partial penetration welds. Non-destructive examination by MPI shall be in accordance with ASTM Standard E-709.

Testing and inspection records shall be open to the Consultant for review upon request.

Testing, inspection and related costs incurred by the Consultant as a result of defective work shall be paid for by the Contractor.

##### 8.3.7.3.1 Elastomeric Bearings

Plain elastomeric bearings shall be tested in accordance with Section 8 of AASHTO M251-06; however the material shall conform to the specified requirements of Table X1. The testing specified in Subsections 8.8 and 8.9 of AASHTO M251-06 is not required for plain elastomeric bearings.

Laminated elastomeric bearings shall be tested in accordance with Section 8 of AASHTO M251-06; however the material shall conform to the specified requirements of Table X1. The testing specified in Subsection 8.9 of AASHTO M251-06 is not required for laminated bearings. A minimum of two sample laminated bearings shall be cut and tested for shear modulus. The increment in compressive deformation of laminated bearings shall not exceed 0.05 of the effective rubber thickness, when the bearing load is increased from an initial pressure of 1.5 MPa to a pressure of 7 MPa when tested as per the requirements of Subsection 9.1, of AASHTO M251-06. The dimensional tolerances for each bearing shall be checked and included with the testing report.

The hardness of elastomer shall be tested and the results included with the test report.

8.3.7.3.2 Pot Bearings

Testing of elastomeric compounds shall be in accordance with AASHTO M251-06. Testing of the completed bearings shall in accordance with the requirements of Subsection 18.3.4 of the 2010 AASHTO LRFD Bridge Construction Specifications including all interim revisions. The long-term deterioration test described in Subsection 18.3.4.4.3 is not required. The proof load test described in Subsection 18.3.4.4.4 shall be completed in accordance with the long-term proof load test requirements.

8.3.7.4 Testing by the Consultant

The Consultant may complete quality assurance testing and inspection and the Contractor shall accommodate all the Consultant requirements to complete testing and inspection.

8.3.7.5 Notification to Ship

The Contractor shall notify the Consultant 72 hours prior to shipment to facilitate inspection and acceptance of the bearings. Bearings shall not be shipped until they have been reviewed and accepted by the Consultant. Review and acceptance of bearings at the fabrication facility by the Consultant will not relieve the Contractor of his full responsibility to meet the requirements of these specifications.

Bearings that have not been inspected at the fabrication facility will not be paid for until they been inspected, reviewed and accepted by the Consultant. The Contractor shall be responsible for all costs incurred by the Consultant for inspection of the bearings not inspected at the fabrication facility.

8.3.7.6 Fabrication Outside of Canada

All testing and inspection requirements specified in Subsection 8.3.7, Testing and Inspection, shall be completed at the fabrication facility and all costs incurred by the Consultant and their designated testing agencies, and the Department shall be paid for by the Contractor.

All components fabricated outside of Canada shall be shipped to a shop located in Canada that is certified by CWB in accordance with CSA W47.1 to Division 1 or 2 for re-inspection and testing. The components shall be in a condition that facilitates all re-inspection and testing requirements. The re-inspection and testing at the Canadian shop shall be completed in accordance with Subsection 8.3.7, Testing and Inspection. The Contractor shall also arrange for inspection by a CSA 178.2 Level III certified welding inspector accredited with W47.1/W59 to inspect:

- All components to ensure that they were undamaged during transportation;
- 100% of all fillet and partial penetration welds using magnetic particle inspection in accordance with Subsection 8.3.7.3, Testing by the Contractor;

Components shall not be shipped from the Canadian shop until all requirements have been met and the Work has been reviewed and accepted by the Consultant.

The Contractor shall be responsible for all re-inspection and testing costs, including all cost incurred by the Consultant and the Department.

The Contractor shall have no claim against the Department resulting from delays caused by these requirements.

#### 8.3.8 Approved Pot Bearing Fabricators

Pot bearings shall be supplied and fabricated by one of the approved pot bearing fabricators listed on the Department's Product List.

## 8.4 Installation

### 8.4.1 General

The Contractor shall submit a detailed bearing installation procedure to the Consultant for review and acceptance 4 weeks prior to commencement of the Work. The installation procedure shall include drawings and documents necessary to describe the following:

- Survey information for location and elevation of grout pads and anchor rod voids;
- Placing of anchor rods and bearings;
- Grouting of anchor rods;
- Methods of forming, placing, curing, and sealing of grout pads;
- Enclosure and system of heating for grouting in cold weather;
- Setting expansion bearings for correct temperature; and
- Setting bearings to correct grade and elevation.

### 8.4.2 Bearing and Anchorage

Concrete surfaces on which bearing plates, pads or shims are placed shall be finished in accordance with Subsection 4.25.8, Surface Finish under Bearings.

The Contractor shall remove all materials used to form anchor rod voids. Foreign materials on concrete surfaces, such as oils, grease or other contaminants shall be removed by sandblasting prior to installation of anchor rods.

When bearings are detailed in conjunction with grout pockets in the substructure, the bearings shall be set accurately on galvanized steel shim plates. Galvanized steel shim plates shall be located such that a minimum of 75 mm of grout cover is provided from shims to the grout edge. When grout pockets are not detailed on the Drawings, the bearing shall be set on the finished concrete surface in exact position and have full and even bearing.

Base plates shall be set to the positions indicated on the Drawings. Anchor rods shall be positioned in accordance with the bearing setting tables shown on the Drawings and the girder temperature at the time of grouting. Where nuts are specified on top of expansion bearing anchor rods, they shall be adjusted to permit movement. Top of the bearing sole plate shall be within a tolerance of ± 3 mm of the correct elevation prior to girder erection.

Anchor rods and bearing grout pads shall not be grouted until girder erection of the entire superstructure is completed unless otherwise approved by the Consultant and the Department.

When required, field welding adjacent to elastomeric bearings shall be completed such that damage to the bearing does not occur. Damaged elastomeric bearings, as determined by the Consultant, shall be replaced by the Contractor at his expense.

Sole plates shall be bolted or welded to girders in accordance with the Drawings. Attachment of sole plates to girders by welding shall be in the longitudinal direction along the edge of the bottom flange or shoe plate. Transverse ends shall be sealed with Sikaflex 1a or an approved equivalent caulking material. Welding of the transverse edge will not be permitted.

Galvanizing or metallizing damaged during field operations shall be repaired by metallizing as per Subsection 8.3.6.7, Galvanizing.

### 8.4.3 Grouting of Anchor Rod Voids and Bearing Grout Pads

Grout used for the grouting of anchor rod voids and bearing grout pads shall be selected from the Alberta Transportation Product List, Non-Shrink Grout category.

Anchor rod voids and bearing grout pads shall be grouted after the entire superstructure has been erected and prior to casting deck concrete.

The method of forming and pouring the grout shall be submitted to the Consultant for review and acceptance. Dry-pack methods of constructing grout pads will not be accepted.

Grout shall be packaged in waterproof containers with the production date and shelf life of the material shown. It shall be mixed and placed in strict accordance with the manufacturer's recommendations stated on their published product data sheet.

The Contractor shall utilize experienced ACI or CSA certified testers to test the compressive strength of the grout in accordance with CSA A23.2-1B. A set of compressive strength cubes shall be taken to represent each days production or 0.25 $m^3$, whichever is more frequent. All test results shall be provided to the Consultant. The average minimum compressive strength of 3 cubes at 28 days shall be 30 MPa. Failure to meet the minimum specified compressive strength will result in the grout pad being removed and replaced at the Contractor's expense.

Grout shall be wet cured for a minimum of 3 days with two layers of clean, saturated Nilex 4504 white coloured filter fabric or an approved equivalent. Water used for wet curing shall be clean and acceptable to the Consultant.

Sealer shall be applied to the exposed grout pad surfaces in accordance with Subsection 4.26, Type 1c Sealer.

#### 8.4.3.1 Grouting in Cold Weather

When the daily minimum air temperature or the temperature of the girders, bearings or substructure concrete in the immediate area of the grouting is, or is expected to be below 5°C during the placing and curing period, the following additional requirements shall be included in the Contractor's bearing installation procedure:

- Before grouting, adequate preheat shall be provided to raise the temperature of the adjacent areas of the girders, bearings and substructure concrete to at least 15°C.
- Temperature of the grout during placing shall be between 10°C and 25°C.
- The grout pads shall be enclosed and kept at 15°C to 25°C for a minimum of five days. The enclosure shall meet the requirements of Subsection 4.21, Concreting in Cold Weather.

## 8.5 Warranty

The Contractor shall provide a written five year Warranty for the bearing assemblies. The Warranty period shall commence on the date of Contract Completion, and shall provide for complete replacement of the bearing assemblies including but not limited to, all necessary traffic control, superstructure jacking, grout pads, concrete, and attachments to girders as required at no cost to the Department if any portion of the bearing assembly fails to perform satisfactorily within the designed range of movement or loading.

## 8.6 Payment

### 8.6.1 Supply and Delivery

Payment for the supply and delivery of bearings will be made at the lump sum prices bid for "Bearings – Supply and Delivery" for the types and sizes specified, and will be full compensation for the supply and fabrication; loading; hauling to the project site; unloading; and all labour, equipment, tools and incidentals to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

90% of the lump sum price bid will be paid once the bearings have been acceptably supplied and delivered to the bridge site. The remaining 10% of the lump sum price bid will be paid once the bearings have been acceptably installed.

### 8.6.2 Installation

Payment for the installation of bearings will be made at the lump sum price bid for “Bearings - Install”, and will be full compensation for installation of the bearings; the supply and placement of grout; and all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

All costs associated with temporary supports and superstructure stabilization will be considered incidental to the Work, and no separate or additional payment will be made.

All costs associated with grouting in cold weather, when required, will be considered incidental to the Work, and no separate or additional payment will be made.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

# SECTION 9 DRAIN TROUGHS

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## 9.1 General

This specification is for the construction of concrete or heavy rock riprap drain troughs, including drain trough collectors, terminal protection, and all excavation, trimming and backfill, and restoration necessary to complete the Work as shown on the Drawings and Standard Drawing S-1841, Standard Drain Trough for Conventional Abutments, S-1842, Standard Drain Trough for Grade Separation Bridges with Integral Abutments, and S-1843, Standard Drain Trough for Water Crossing Bridges with Integral Abutments.

The slopes receiving the concrete drain troughs shall be excavated, trimmed and backfilled to the lines and grades shown on the Drawings or as determined by the Consultant. The subgrade shall be placed and compacted in accordance with Section 2, Backfill.

A minimum of one week prior to commencing the Work, the Contractor shall submit a detailed layout and forming plan to the Consultant for review and acceptance.

## 9.2 Concrete

Concrete shall be Class C concrete and meet all requirements of Section 4, Cast-In-Place Concrete.

## 9.3 Reinforcing Steel

Reinforcing steel shall be plain reinforcing and meet all requirements of Section 5, Reinforcing Steel.

## 9.4 Heavy Rock Riprap

Heavy Rock Riprap shall be Class 1M or Class 1 and meet all requirements of Section 10, Heavy Rock Riprap.

## 9.5 Geotextile Filter Fabric

Geotextile filter fabric shall be non-woven geotextile filter fabric and meet all requirements of Section 10, Heavy Rock Riprap.

The heavy rock riprap shall be placed so that the filter fabric is fully covered.

## 9.6 Site Restoration

Upon completion of the drain trough, the Contractor shall restore the site to the original condition and as determined by the Consultant. This shall include disposing of all surplus excavated materials, backfilling as required, supplying and placement of 50 mm minimum thickness of organic material on all disturbed areas and seeding.

### 9.7 Measurement and Payment

Measurement for payment of drain troughs will be by the metre of drain trough acceptably constructed, measured to the nearest 0.1 m.

The quantity to be paid for will be measured as the total length from the roadway edge adjacent to the drain trough collector to the end of terminal protection.

Payment will be made at the unit price bid for “Drain Troughs”, and will be full compensation for preparation of the slopes; the supply and placement of reinforcing steel, concrete, geotextile filter fabric and heavy rock riprap; construction of concrete drain trough collectors and terminal protection; site restoration; and all labour, materials, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

All costs associated with concreting in cold weather, when required, will be considered incidental to the Work, and no separate or additional payment will be made.

# SECTION 10 HEAVY ROCK RIPRAP

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## 10.1 General

This specification is for the supply, delivery, and installation of heavy rock riprap. This work shall include all necessary trimming, excavation, and backfill required to satisfactorily place the heavy rock riprap, such as:

- Excavation, trimming and shaping headslope;
- Excavation at headslope toe, and for rock apron;
- Excavation for heavy rock riprap in stream bank transition zone;
- Supply and placing of non-woven geotextile filter fabric;
- Supply and placing of gravel or granular bedding material; and
- Backfill over heavy rock riprap in stream bank transition zone to restore lines of natural bank.

## 10.2 Permits

The Contractor shall obtain whatever permits, agreements, and authorizations are necessary, prior to loading the heavy rock riprap. The Contractor shall advise the Consultant of any special provisions required under such permits, and must provide evidence satisfactory to the Consultant that the requirements of the permits have been fully complied with before final payment will be made.

## 10.3 Heavy Rock Riprap Material

The heavy rock riprap supplied shall be hard, durable and angular in shape, resistant to weathering and water action, free from overburden, spoil, shale or shale seams and organic material, and shall meet the gradation requirements for the class specified. In general, no sandstone will be permitted for all classes, however if the proposed material meets or exceeds the minimum requirements, consideration may be given to accepting the material. For these occurrences, further testing shall be done to ensure acceptability. This would include testing of the material in accordance with CSA A23.2-15A "Petrographic Examination of Aggregates". The minimum dimension of any single rock shall be not less than one third of its maximum dimension. The minimum acceptable unit weight of the rock is 2.5 $t/m^3$.

The Contractor shall provide the Consultant with evidence of the acceptability of the heavy rock riprap material. Reliable performance records of proposed material, other than fieldstone, will be considered evidence of acceptability. Angular fieldstone shall be considered to have a reliable performance record, and will be accepted if it meets the gradation requirements.

Sampling and testing are required for Class 2 and 3 heavy rock riprap for which no performance records are available. Sampling and testing are not required for Class 1 heavy rock riprap and field stone. Tests are based on the Durability Index and Durability Absorption Ratio as developed by the State of California, Department of Transportation. The Contractor shall submit samples of the proposed material to an independent certified testing laboratory of his choice and provide written reports of the test results to the Consultant. The reports shall be stamped by a Professional Engineer registered in the Province of Alberta. The Contractor shall be responsible for all associated costs for heavy rock riprap sample testing including, but not limited to, transporting samples to an independent certified testing laboratory, testing, disposing of samples after testing, and providing written reports to the Consultant.

A representative sample of 70 kg minimum is required for each type and source of rock to be tested, and shall contain a number of pieces ranging up to 25 kg mass. The acceptance of rock samples from a particular source or quarry site shall not necessarily be construed as constituting acceptance of all material from that location.

The material provided shall meet the requirements of Tables 10-1, Gradation Requirements and Table 10-2, Specific Gravity, Absorption and Durability Index Requirements.

**Table 10-1: Gradation Requirements (1)**

| **Gradation** | | **Heavy Rock Riprap Class** | | | |
|---|---|---|---|---|---|
| **Required Properties** | **Units** | **1M** | **1** | **2** | **3** |
| Nominal Mass<br>Nominal Diameter | kg | 7 | 40 | 200 | 700 |
| | mm | 175 | 300 | 500 | 800 |
| None greater than: | kg | 40 | 130 | 700 | 1800 |
| | mm | 300 | 450 | 800 | 1100 |
| 20% to 50% | kg | 10 | 70 | 300 | 1100 |
| | mm | 1200 | 350 | 600 | 900 |
| 50% to 80% | kg | 7 | 40 | 200 | 700 |
| | mm | 175 | 300 | 500 | 800 |
| 100% greater than: | kg | 3 | 10 | 40 | 200 |
| | mm | 125 | 200 | 300 | 500 |

Notes:

(1) Percentages quoted are by mass. Sizes quoted are equivalent spherical diameters, and are for guidance only.

**Table 10-2: Specific Gravity, Absorption and Durability Index Requirements (1)**

| Test Method | Requirement |
|---|---|
| California Department of Transportation Method of Test for Specific Gravity and Absorption of Coarse Aggregates (California Test 206) | Minimum Specific Gravity = 2.60<br>Maximum Absorption = 2.0 % |
| California Department of Transportation Method of Test for Durability Index (California Test 229) | Minimum Durability Index = 52 (1) |

Notes:

(1) Durability Index may be less than 52 if the durability absorption ratio (DAR) is greater than 23, where DAR = Durability Index / (Absorption % +1%)

### 10.4 Non-Woven Geotextile Filter Fabric

Where non-woven geotextile filter fabric is specified, the slope shall be graded to provide a smooth, uniform surface. All stumps, large rock, brush or other debris that could damage the fabric shall be removed. All holes and depressions shall be filled so that the fabric does not bridge them. Loose or unstable soils shall be replaced.

Non-woven geotextile filter fabric shall be used under all riprap and shall meet the minimum average roll value properties (MARV's) listed in Table 10-3, Non-Woven Geotextile Filter Fabric Requirements.

**Table 10-3: Non-Woven Geotextile Filter Fabric Requirements**

| Required Physical Property | Test Method | Minimum MARV Required |
|---|---|---|
| | | Class 1M, 1, 2, and 3 |
| Grab Strength | ASTM D4632 | 900 N |
| Elongation (Failure) | ASTM D4632 | 50% |
| CBR Puncture Strength | ASTM D6241 | 550 N |
| Trapezoidal Tear | ASTM D4533 | 350 N |

The non-woven geotextile filter fabric shall be laid parallel to the slope direction. It shall be placed in a loose fashion, however, folds and wrinkles shall be avoided. The minimum non-woven geotextile filter fabric lap shall be 400 mm, except where placed underwater the minimum lap width shall be 1 m. Overlaps shall be pinned using 6 mm diameter steel pins fitted with washers and spaced at 1 m intervals along the overlaps.

The top edge of the non-woven geotextile filter fabric shall be anchored by digging a 300 mm deep trench, inserting the top edge of the non-woven geotextile filter fabric and backfilling with compacted soil.

Care shall be taken to prevent puncturing or tearing the non-woven geotextile filter fabric. Any damage shall be repaired by use of patches that extend at least 1 m beyond the perimeter of the tear or puncture.

The non-woven geotextile filter fabric shall be covered by heavy rock riprap within sufficient time so that ultraviolet damage does not occur; in no case shall this time exceed 7 days for ultraviolet material and 14 days for ultraviolet protected and low ultraviolet susceptible polymer non-woven geotextile filter fabric.

Heavy rock riprap placement shall commence at the base of the blanket area and proceed up the slope. The height of drop of riprap shall be limited to 1.0 m or less, and the heavy rock riprap shall not be allowed to roll down the slope. Heavy equipment will not be permitted to operate directly on the geotextile.

## 10.5 Placing of Heavy Rock Riprap

The heavy rock riprap shall be handled, dumped or placed into position to conform to the specified gradation and to the cross section shown on the Drawings. The finished surface shall be reasonably uniform, free from bumps or depressions, and with no excessively large cavities below or individual stones projecting above the general surface.

## 10.6 Inspection of Heavy Rock Riprap

Control of gradation will be by visual inspection. The Contractor shall provide a minimum of two samples of heavy rock riprap, of the minimum sample size specified below. These samples shall be proven to acceptably conform to the required gradation by direct weighing of all the individual pieces with suitable scales; the mass of each piece in the sample shall be painted on the piece. These samples, located as required by the Consultant at the construction site and at the source or quarry site, may be incorporated in the finished riprap when they are no longer required for reference purposes. The samples shall be used for frequent reference in judging the gradation of the heavy rock riprap being loaded at the source and placed at the site. The minimum sample size in area shall meet the requirements of Table 10-4, Heavy Rock Riprap Inspection Sample Size Requirement.

**Table 10-4: Heavy Rock Riprap Inspection Sample Size Requirements**

| Heavy Rock Riprap Class | Inspection Sample Size |
|---|---|
| 1M | 1 m x 1 m |
| 1 | 2 m x 2 m |
| 2 | 3 m x 3 m |
| 3 | 4 m x 4 m |

The Contractor shall provide, at no additional cost to the Department, whatever facilities are required to assist the Consultant in checking gradation and measuring heavy rock riprap in place.

If, during the delivery of the material to the site, a particular load is found to be made up of pieces predominantly one size, or to be lacking in pieces of one size, it shall be dumped in a suitable location outside the area to be protected. Additional material as required to make up the deficient sizes shall be added to this load such that the combination can then be placed to ensure uniformity.

## 10.7 Measurement and Payment

Measurement for payment of heavy rock riprap will be by the cubic metre of heavy rock riprap acceptably placed, measured to the nearest 0.1 $m^3$.

The quantity to be paid for will be based on the thickness of heavy rock riprap specified on the Drawings multiplied by the actual measured surface area of ground covered with heavy rock riprap as determined by the Consultant and the Department. Heavy rock riprap placed outside of the plan limits on the Drawings will not be paid for unless placement in these additional areas has been reviewed and accepted by the Consultant and Department prior to the Work.

Payment will be made at the unit price bid for “Heavy Rock Riprap”, of the class specified, and will be full compensation for royalties; permits; sampling and testing; transportation; the preparation, weighing and inspection of sample sizes; excavation and subgrade preparation, including backfilling; the supply and placement of non-woven geotextile fabric; the supply and placement of heavy rock riprap; and all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

# SECTION 11 DUCTS AND CONDUITS

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## 11.1 General

This specification is for the supply and installation of all ducts and conduits, associated hardware, junction boxes, and anchorage assemblies as shown on the Drawings.

## 11.2 Material

All ducts and conduits shall be rigid PVC type DB2 meeting the requirements of CSA C22.2 No. 211.1 and in accordance with the Rules of the Canadian Electrical Code, Part 1. Coupling shall be solvent bell ends (SBE).

Expansion assemblies for PVC shall be Scepter type ‘O’ ring expansion joints or an approved equivalent.

Rigid conduit shall be as specified on the Drawings.

## 11.3 Installation

Ducts and conduits shall be installed as shown on the Drawings and firmly secured to prevent displacement.

Continuous pull wires shall be installed in all ducts and conduits unless specified otherwise. The pull wires shall be 12 gauge galvanized steel, unspliced, extending with a tight fit through the duct end caps and terminating one metre beyond in 300 mm loops. In lieu of the galvanized pull wire, an 8 mm mono poly rope or equivalent may be substituted in ducts over 75 mm diameter. The rope shall be unspliced, with the extra length of 300 mm each end coiled up inside the duct and the duct end caps secured in place.

The installation of electrical components shall be carried out by a fully qualified electrician. All runs of ducts and conduits shall be proven in the presence of the Consultant by passing through the entire length, a round object no less than 75% of the conduit area. Any required permits will be the responsibility of the Contractor.

## 11.4 Payment

All costs associated with the supply and installation of ducts and conduit will be considered incidental to the Work, and no separate or additional payment will be made.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

# SECTION 12 BRIDGERAIL

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## 12.1 General

This specification is for the supply, fabrication and installation of steel tube type bridgerail, thrie beam bridgerail, approach rail transition, and pedestrian/bicycle barriers. Bridgerail and pedestrian/bicycle barriers shall include all work constructed above the top of the bridge deck, curb, parapet, sidewalk, or culvert headwalls, and wing walls, and the supply and placing of anchor rod assemblies, end connection plates and connection angles. Approach rail transition shall include thrie beam or W-beam guardrail sections, W-thrie beam transition section, terminal connectors, steel or timber guardrail posts, spacers, and guardrail connection and wing end sections where specified.

## 12.2 Supply and Fabrication

A pre-fabrication meeting is required prior to commencement of fabrication of bridgerail. The meeting will be held at fabricator's plant and the contractor shall ensure the plant superintendent and plant manager responsible for the work and any manufacturer's representatives directly involved in the specialized work are in attendance. The consultant will conduct this meeting after the shop drawings have been approved and welding procedures and mill test reports have been reviewed. The contractor shall provide a minimum of 2 weeks' notice to the Consultant prior to the meeting.

### 12.2.1 Standards

The fabrication of bridgerail components shall conform to AASHTO LRFD Bridge Construction Specifications and the American Welding Society (AWS) - Bridge Welding Code D1.5.

All welding, cutting and preparation shall be in accordance with the American Welding Society (AWS) - Bridge Welding Code D1.5. The fabrication of bridgerail components composed of structural tubing shall be in accordance with the American Welding Society (AWS) – Structural Welding Code D1.1.

### 12.2.2 Qualification

The Contractor shall notify the Department and Consultant two weeks prior to fabrication of any subcontractors in his employ. The Contractor shall remain responsible for the work of the subcontractors. All terms of the contract, such as CWB approval, right of access, etc., shall apply to the subcontractor.

The fabricator shall be fully approved by the Canadian Welding Bureau (CWB) as per CSA Standard W47.1 in Divisions 1 or 2.

Only welders, welding operators and tackers approved by the Canadian Welding Bureau in the particular category shall be permitted to perform weldments. Their qualifications shall be current and available for examination by the Consultant.

### 12.2.3 Engineering Data

#### 12.2.3.1 Welding Procedures

Welding procedures, including welding procedure datasheets, shall be submitted for each type of weld proposed. The welding procedures shall bear the approval of the CWB and be reviewed and accepted by the Consultant and the Department a minimum of 3 weeks prior to the commencement of fabrication.

#### 12.2.3.2 Shop Drawings

Shop drawings shall be submitted to the Consultant for review and acceptance a minimum of 3 weeks in advance of the commencement of fabrication. Review comments provided by the Consultant and/or the Department shall be incorporated into the shop drawings and resubmitted to the Consultant for review and acceptance prior to the commencement of fabrication.

Shop drawings shall be electronic unlocked PDF format. Each shop drawing shall include the Department's shop drawing identification block and have a sufficient blank space for the Consultant's review stamp. The Department's shop drawing identification block will be provided to the Contractor upon request. As a minimum, the following information shall be included on shop drawing submissions:

- All dimensions shall be correct at 20 °C unless otherwise noted;
- Weld procedure identification shall be shown on the shop drawings in the tail of the weld symbols;
- All material splice locations shall be shown on the drawings;
- Sizes of hardware and any other material shown on the shop drawings shall be in the actual units (imperial or metric) of the material being supplied.

When bridgerail for more than one bridge is included in the Contract, individual shop drawings shall be submitted for each bridge structure.

The shop drawings will be reviewed by the Consultant solely to ascertain general conformance with codes and specifications. The Consultant's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

The Contractor shall incorporate as-built construction conditions into shop drawings. One paper copy and one electronic copy (PDF format) of as-built shop drawings shall be submitted to the Consultant within 3 weeks of construction completion.

#### 12.2.3.3 Mill Test Reports

Mill test reports shall be provided for all materials in English.

Mill test reports shall be submitted to the Consultant for review and acceptance 3 weeks prior to the commencement of fabrication.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be certified to ISO/IEC 17025 by an organization accredited by the Standards Council of Canada for the tests required. Samples for testing shall be collected by personnel employed by the certified laboratory. A verification letter shall be provided by the certified laboratory that includes at a minimum, the applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the certified laboratory.

### 12.2.4 Materials

#### 12.2.4.1 Steel

All steel shall conform to the standard noted on the Drawings.

Steel with a boron content exceeding 0.0008% will not be permitted.

The silicon content for various bridgerail and pedestrian/cyclist barrier components shall be as follows:

- Structural tubing less than 0.04%; and
- Structural sections, handrail bars, base plates less than 0.04% or between 0.15% and 0.25%.

#### 12.2.4.2 Anchor Rods

Anchor rods shall conform to the standard noted on the Drawings. The Contractor shall provide mill test reports indicating the physical properties of the material to the Consultant.

#### 12.2.4.3 Connection Plate and Angle

Steel for connection plate and angle shall conform to CSA Standard G40.21M Grade 300W or ASTM A36.

#### 12.2.4.4 Grout

Grout for post bases shall be selected from the Alberta Transportation Product List, Non-Shrink Grout category.

#### 12.2.4.5 Approach Rail Transition

Thrie beam or W-beam guardrail sections, W-thrie beam transition section, terminal connectors, steel or timber guardrail posts, spacers, and guardrail connection and wing end sections shall be in accordance with Section 14, Guardrail.

### 12.2.5 Welding

#### 12.2.5.1 Filler Metals

Low hydrogen fillers, fluxes and welding practices shall be used throughout. The low hydrogen covering and flux shall be protected and stored as specified by AWS Standard D1.5. Flux cored welding or use of cored filled wires in the submerged arc process or shielding gas processes will not be permitted.

All electrodes and fluxes shall conform to the diffusible hydrogen requirements of AWS D1.5 filler metal hydrogen designator H4 for the Shielded Metal Arc Welding (SMAW) and Metal Core Arc Welding (MCAW) processes. Deposited weld metal shall provide strength, durability, impact toughness, and corrosion resistance equivalent to base metal.

Field application of metal core arc welding is not allowed.

#### 12.2.5.2 Joint Preparation

Preparation of welded joints shall be as indicated on the Drawings. Weld areas shall be clean, free of mill scale, dirt, grease, paint and other contaminants prior to welding.

#### 12.2.5.3 Tack and Temporary Welds

Tack and temporary welds shall not be allowed unless they are to be incorporated into the final weld. Tack welds, where allowed, shall be of a minimum length of four times the nominal size of the weld, and shall be subject to the same quality requirements as the final welds. Cracked tack welds shall be completely removed prior to welding over.

#### 12.2.5.4 Backing Bars

Backing bars shall be fitted all around the inside of the joint. The separation of faying surfaces between the backing bars and material to be welded shall not exceed 1 mm, 100% fusion must be obtained into the backing bar including the corners of HSS members.

#### 12.2.5.5 Run-off Tabs

Run-off tabs shall be used at the ends of all welds that terminate at the edge of a member. The thickness and shape of the tabs shall replicate the joint detail being welded and shall be a minimum of 100 mm long unless greater length is required for satisfactory work. They shall be tack welded only to that portion of the material that will not remain a part of the structure, or where the tack will be welded over and fused into the final joint. After welding, the tabs are to be removed by flame cutting, not by breaking off.

#### 12.2.5.6 Arc Strikes

Arc strikes will not be permitted. If accidental arc strikes occur, a detailed repair procedure shall be submitted to the Department and Consultant for review and acceptance prior to the commencement of repair work. The repair procedure shall include the complete grinding out of the crater produced by the arc strike prior to repair. The Contractor shall complete magnetic particle inspection (MPI), and hardness testing of the repaired area. Hardness of the repaired area shall meet the requirements of Subsection 6.2.8.11, Hardness Tests. The repair procedure shall be signed and sealed by experienced welding Professional Engineer registered in the Province of Alberta.

All arc strike repairs shall be repaired to the full satisfaction of the Consultant and the Department.

#### 12.2.5.7 Methods of Weldment Repair

The Contractor shall submit repair procedures for damaged base metal and unsatisfactory weldments, prepared and stamped by an experienced welding engineer registered as a Professional Engineer in the Province of Alberta for review by the Department and Consultant prior to repair work commencing.

#### 12.2.5.8 Grinding of Welds

Post to base plate groove welds which are sufficiently smooth with a neat appearance and uniform profile as determined by the Consultant will not require grinding. Groove welds in rail splices shall be ground smooth and flush.

Fillet welds not conforming to an acceptable profile shall be ground to the proper profile without damaging of substantial removal of the base metal.

Grinding shall be smooth and parallel to the line of stress. Caution shall be exercised to prevent over grinding. Over grinding that results in reduced thickness of the base metal or size of the weld shall not be permitted. Acceptability of the welds without grinding will be determined by the Consultant.

#### 12.2.5.9 Preheat and Interpass Temperatures

Preheat and interpass temperature requirements shall be performed and maintained as per AWS D1.5, except that all post to base plate groove welds and post to base plate fillet welds shall be preheated to a minimum temperature of 100 °C and 60 °C respectively unless a higher temperature is required by AWS D1.5.

### 12.2.6 Fabrication

Fabrication shall be performed in a fully enclosed permanent structure which is adequately heated to be at least 10 °C.

12.2.6.1 Rail Fabrication

The Contractor shall radiograph all rail splices. A copy of the test results shall be provided to the Consultant within 1 week of testing completion. Splices shall be completed using properly fitted backing bars. Only one splice per rail section shall be permitted, and shall occur in an accepted location, clear of openings and connection holes. All splices shall be ground flush. Rail sections shall be orientated such that the tube seam is always located at the bottom, except for rectangular tube sections which shall have the tube seam oriented towards the bottom or the outside of the bridge. Edges of holes shall be smooth and free of notches or burrs.

12.2.6.2 Rail Sleeve Fabrication

Sleeves shall be square and be properly aligned in the rail end. Corners of the sleeves shall be rounded and smooth to ensure a good fit. Expansion joint sleeves shall be shop bolted to the appropriate rail section after galvanizing.

12.2.6.3 Post Fabrication

12.2.6.3.1 W Posts

Posts shall be perpendicular to the base plates, unless otherwise noted on the drawings.

Base plates for the posts shall be flat, have square cut edges and corners with no lips or gouges. Anchor rod holes shall be drilled accurately in size and location.

The Contractor shall complete magnetic particle inspection on 25% of all post to base plate fillet welds. A copy of the test results shall be provided to the Consultant within 1 week of testing completion.

12.2.6.3.2 HSS Posts

HSS posts and baseplates shall meet the requirements of Subsection 12.2.6.3.1, W Posts except as noted in this subsection.

The tube weld seam shall be kept on the back side of the post.

Bridgerail posts shall be butt welded to the base plate using a backing bar and a full penetration bevel groove weld. The backing bar shall be properly fitted and the post prepared to a sharp edged 45° chamfer. The groove weld shall be placed in a minimum of two passes with a root opening of 5 mm. A rod size, no greater than 4.0 mm, shall be used for the first pass. A reinforcing fillet weld shall be placed all around the joint.

The Contractor shall arrange to have all post to base plate full penetration welds inspected either by ultrasonic testing or radiographic inspection methods. A copy of the test results shall be provided to the Consultant within one week of testing completion.

Pedestrian/Cyclist barrier posts shall be fillet welded to baseplates. The Contractor shall complete magnetic particle inspection on 25% of all post to base plate fillet welds. A copy of the test results shall be provided to the Consultant within 1 week of testing completion.

Post caps shall be chamfered all around the top and match the contour of the post without burrs or overhang. The caps shall be attached to the posts in the shop after galvanizing. The caps shall fit tightly and include washers under the head of the cap attachment bolts.

#### 12.2.6.4 Anchor Rods

The threaded ends of all anchor rods shall be chamfered. All anchor rods, hardware and anchor rod templates shall be hot dip galvanized, after fabrication in accordance with ASTM F2329 Standard Specification for Zinc Coating Hot-Dip Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners. Galvanizing of high strength anchor rod material requires a special process. For details, see Subsection 12.2.6.7, Galvanizing. Nuts shall freely spin on the rod threads after galvanizing. The anchor rods shall be shop assembled in cages after galvanizing with bolts aligned square and plumb. Alignment nuts shall not exceed 16 mm in thickness.

#### 12.2.6.5 Tolerances

##### 12.2.6.5.1 Sleeve to Rail

Clearance between the rail sections and the sleeves shall be sufficient to ensure an easy fit after galvanizing. The maximum radial clearance allowed around the sleeve when fitted into the rail shall be 1 mm (2 mm total) after galvanizing with the tube seam removed.

Two sleeve test samples shall be made by the fabricator from the material to be used. Both test sleeves are to be galvanized, with one being retained by the galvanizing subcontractor and the other at the fabricator's plant. The sleeves shall be used to check the sleeve to rail fit of all rails. In the case of pedestrian/cyclist barrier panels, the test samples shall consist of a welded unit with top and bottom tube, and sleeve sections spaced to match the pedestrian/cyclist barrier.

##### 12.2.6.5.2 Posts

Post assembly lengths shall be within 3 mm of the specified length.

##### 12.2.6.5.3 Rails

Individual rail sections shall be straight and true with no evidence of kinks or dents and with a maximum variation from straightness not exceeding 3 mm over a 3 m length. Welded splices shall not be evident in the final product, and shall be straight, kink free and conform to the same section as the adjacent tubing. Bolted splices shall be straight with no offset due to loose fitting sleeves.

12.2.6.5.4 Anchor Rods

The rods in an anchor rod assembly shall fit in a template comprised of accurately located holes 2 mm greater in diameter than the anchor rods. The top of the rods in the assembly shall be ±3 mm from a level plane when the threaded portion is plumb. The threaded length shall not be less than specified, nor more than 15 mm greater than that specified.

12.2.6.6 Identification

To assist field erection, shop drawing mark numbers shall be stamped on the rails and posts. Rail mark numbers shall be stamped on the underside of the rail near the ends. Post mark numbers shall be stamped on the underside of the base plates. The areas to be stamped shall be ground to remove mill scale. Stamps shall be a minimum of 12 mm high, and the resulting marks shall be at least 1.0 mm deep to be legible after galvanizing.

12.2.6.7 Galvanizing

The fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatters, and all welding flux residue from the steel components prior to galvanizing.

Factors contributing to galvanization-induced cracking shall be minimized. Galvanizing shall be by the hot dip method, after fabrication, in accordance with the current edition of ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and ASTM F2329 Standard Specification for Zinc Coating Hot-Dip Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners and as modified in this specification.

The cleaning and pickling procedure of high strength ASTM A193 Grade B7 anchor rods shall be modified as follows prior to hot-dip galvanizing:

- Brush blast to remove mill scale and oil after threading ends;
- Flash pickle up to 5 minutes; and
- Quick dry prior to hot-dip galvanizing (not stored in flux or acid rinse).

The modified anchor rod cleaning and pickling procedure shall be completed in the presence of the Consultant prior to hot-dip galvanizing.

Lumps, globules or heavy deposits of zinc will not be permitted. All threaded holes or threaded couplings shall be retapped after galvanizing.

Handrails shall be free of any sharp protrusions or edges as determined by the Consultant.

Repair of galvanizing shall be completed in accordance ASTM A780, Method A3 “Metallizing” and will only be permitted when the repair areas are small and infrequent as determined by the Consultant. Repair areas less than 100 mm$^2$ in area may be completed in accordance with ASTM A780, Method A1 ”Repair Using Zinc-Based Alloy”. The thickness of the coating for both methods shall be 180 µm, and the repair tested for adhesion. A detailed repair procedure shall be submitted for review and acceptance by the Consultant prior to commencement of the work.

Repairs may require complete removal of the galvanized coating and re-galvanizing. The finished appearance shall be similar to the adjacent galvanizing as determined by the Consultant.

Galvanized material shall be stacked or bundled and stored to prevent wet storage stain as per the American Hot Dip Galvanizers Association (AHDGA) publication “Wet Storage Stain”. Any evidence of wet storage stain shall be removed to the satisfaction of the Consultant.

12.2.6.8 Base Plate Corrosion Protection

The bottom surface of each base plate shall be protected by a medium grey colour barrier coating accepted by the Consultant, to prevent contact between the zinc and the concrete. The galvanized surface must be roughened prior to application of barrier coating. The surface preparation of the galvanized surface and the dry film thickness (DFT) of the coating shall be in accordance with the coating Manufacturer’s recommendations.

The Consultant will test the adhesion of fully cured coating as per ASTM D3359 “Standard Test Methods for Measuring Adhesion by Tape Test”. The method selected for testing (Method A or B) shall depend on the dry film thickness of the coating. The coating manufacturer’s product data sheets shall be provided to the Consultant prior to the application of the coating. The adhesion test result shall meet a minimum of “4B” classification i.e. a maximum allowable flaking of 5%.

12.2.6.9 Schedule

The Contractor shall provide and keep current a complete fabrication schedule in a form satisfactory to the Consultant.

12.2.7 Testing and Inspection

12.2.7.1 Access

The Contractor shall provide full facilities for the inspection of Work. The Consultant shall have full access to all parts of the Work at all times. When required by the Consultant, the Contractor shall provide needed manpower for assistance in checking layout and performing inspection duties.

12.2.7.2 Responsibility

It is the Contractor’s responsibility to ensure that the Work is completed in accordance with the Contract requirements. Any inspection and/or testing completed by the Consultant, review and acceptance by the Consultant, shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract.

### 12.2.7.3 Testing by the Contractor

The Contractor shall arrange for NDT testing in accordance with the following:

- 100% of all full penetration welded rail splices shall be inspected by radiographic testing;
- 100% of all HSS post base to baseplate full penetration groove welds shall be inspected by radiographic or ultrasonic testing; and
- 25% of post to baseplate fillet welds for W-Beam bridgerail and HSS pedestrian/cyclist barrier shall be tested and inspected using magnetic particle testing.

NDT shall be completed by a technician employed by a company that is certified to CSA W178.1. Magnetic particle inspection, ultrasonic and radiographic testing technicians shall be certified to Level II of CGSB. The methods of non-destructive examination shall be in accordance with the following standards:

- Radiography - AWS Standard D1.5
- Ultrasonic - AWS Standard D1.5
- Magnetic Particle - ASTM Standard E-709
- Dye - Penetrant - ASTM Standard E-165

The Contractor's testing and inspection records shall be open for examination by the Consultant upon request.

NDT and other inspection may also be performed by the Consultant or his designated testing agencies. The Contractor shall ensure full access to the Work all times to the Consultant or his testing agencies. When required by the Consultant, the Contractor shall provide required manpower for assistance in checking layout and performing inspection duties.

Testing, inspection and related costs incurred by the Consultant as a result of defective work shall be paid for by the Contractor.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Consultant to inspect bridgerail being fabricated outside the Province of Alberta. The cost shall also include for a Department's representative to attend the pre-fabrication meeting and one additional trip during the course of fabrication.

### 12.2.7.4 Notification to Ship

The Contractor shall notify the Consultant 72 hours prior to shipment to facilitate inspection and acceptance of the bridgerail. Bridgerail shall not be shipped until it has been reviewed and accepted by the Consultant. Review and acceptance of bridgerail at the fabrication facility by the Consultant will not relieve the Contractor of his full responsibility to meet the requirements of these specifications.

Bridgerail that has not been inspected at the fabrication facility will not be paid for until such material has been inspected, reviewed and accepted by the Consultant. The Contractor shall be responsible for all costs incurred by the Consultant for inspection of the bridgerail not inspected at the fabrication facility.

#### 12.2.8 Material Handling and Storage

All lifting and handling shall be done using devices that do not mark, mar, damage or distort the galvanized members and assemblies in any way. Galvanized material shall be stacked or bundled and stored to prevent wet storage stain as per the American Hot Dip Galvanizers Association (AHDGA) publication “Wet Storage Stain”. Galvanized steel exhibiting heavy wet stain shall have the staining removed before installation of the steel member. Items exhibiting extreme wet staining shall be cause for rejection of the member. Refer to the AHDGA publication “Wet Storage Stain” for information regarding heavy and extreme staining. Delivery of a damaged product will be cause for rejection.

#### 12.2.9 Fabrication Outside of Canada

All testing and inspection requirements specified in Subsection 12.2.7, Testing and Inspection, shall be completed at the fabrication facility and all costs incurred by the Consultant and their designated testing agencies, and the Department shall be paid for by the Contractor.

All components fabricated outside of Canada shall be shipped to a shop located in Canada that is certified by CWB in accordance with CSA W47.1 to Division 1 or 2 for re-inspection and testing. The components shall be in a condition that facilitates all re-inspection and testing requirements. The re-inspection and testing at the Canadian shop shall be completed in accordance with Subsection 12.2.7, Testing and Inspection. The Contractor shall also arrange for inspection by a CSA 178.2 Level III certified welding inspector accredited with W47.1/W59 to inspect all components to ensure that they were undamaged during transportation.

Components shall not be shipped from the Canadian shop until all requirements have been met and the Work has been reviewed and accepted by the Consultant.

The Contractor shall be responsible for all re-inspection and testing costs, including all cost incurred by the Consultant and the Department.

The Contractor shall have no claim against the Department resulting from delays caused by these requirements.

### 12.3 Erection

Anchor rod assemblies shall be accurately positioned with anchor rod projections as shown on the Drawings.

The line and grade of the railing shall be true to that shown on the Drawings, and not follow any unevenness in the superstructure. It will be necessary to adjust the height and plumbness of each post, in order to compensate for normal superstructure variations, and achieve the desired line and grade on the bridgerail. Final railing elevations shall be set by instrument and the profile reviewed and accepted by the Consultant prior to grout placement.

Anchor rods shall project a minimum of 2 threads above the top anchor rod nut after tightening is complete. Anchor rods that do not meet the minimum projection requirement shall be repaired or replaced. Proposed repair procedures shall be submitted to the Consultant and the Department for review and acceptance 2 weeks prior to commencement of the repair work.

All structural bolts shall be tightened using the turn of nut method described in Subsection 6.3.2.6, High Tensile Strength Bolted Connections after the grout has been placed, cured and achieved a compressive strength acceptable to the Consultant.

### 12.3.1 Grouting of Base Plates

Grout used for the grouting of base plates shall be selected from the Alberta Transportation Product List, Non-Shrink Grout category.

The method of forming and pouring the grout shall be submitted to the Consultant for review and acceptance. Dry-pack methods of constructing grout pads will not be accepted.

Grout shall be packaged in waterproof containers with the production date and shelf life of the material shown. It shall be mixed and placed in strict accordance with the manufacturer's recommendations stated on their published product data sheet.

The Contractor shall utilize experienced ACI or CSA certified testers to test the compressive strength of the grout in accordance with CSA A23.2-1B. A set of compressive strength cubes shall be taken to represent each days production or 0.25 $m^3$, whichever is more frequent. All test results shall be provided to the Consultant. The average minimum compressive strength of 3 cubes at 28 days shall be 30 MPa. Failure to meet the minimum specified compressive strength will result in the grout pad being removed and replaced at the Contractor’s expense.

Grout shall be wet cured for a minimum of 3 days with two layers of clean, saturated Nilex 4504 white coloured filter fabric or an approved equivalent. Water used for wet curing shall be clean and acceptable to the Consultant.

Sealer shall be applied to the exposed grout pad surfaces in accordance with Subsection 4.26, Type 1c Sealer.

#### 12.3.1.1 Grouting in Cold Weather

When the air temperature is, or is expected to be below 5 °C as forecasted by the closest Environment Canada Meteorological Station during the placing and curing period, or when determined by the Consultant, a cold weather grouting plan shall be implemented. The Contractor shall submit details of his proposed cold weather grouting plan to the Consultant for review and acceptance a minimum of 2 weeks prior to any grout placement.

The following minimum requirements for grouting in cold weather shall be included in the cold weather grouting plan:

- Before placing grout, pre heat shall be provided to raise the temperature of formwork, anchor rods, and substrate surfaces to between 10 °C and 20 °C;
- Mixing water shall be heated to a temperature of at least 20 °C but not more than 65 °C;
- Temperature of the grout during placing shall be between 10 °C and 25 °C;
- Grout shall be wet cured a minimum of 72 hours;
- The Contractor shall enclose the structure in such a way that the grout and air within the enclosure can be kept at or above 15 °C for a protection period of 5 days after placing the grout. Enclosures shall be constructed with a minimum 300 mm clearance between the enclosure concrete and/or grout surfaces; and
- Protection and heating, when used, shall be withdrawn in such a manner so as not to induce thermal shock stresses in the grout. The temperature of the grout shall be gradually reduced at a rate not exceeding 10 °C per day to that of the surrounding air. To achieve this, in an enclosure, the heat shall be slowly reduced.

The Contractor shall demonstrate to the satisfaction of the Consultant that the requirements of the cold weather concreting plan are met.

#### 12.3.2 Approach Rail Transition

The installation of the approach rail transition including thrie beam or W-beam guardrail sections, W-thrie beam transition section, terminal connectors, steel or timber guardrail posts, spacers, and hardware as shown on the Drawings shall be in accordance with Section 14, Guardrail.

### 12.4 Payment

Payment for the supply and installation of bridgerail, including approach rail transitions and guardrail connections, will be made at the lump sum price bid for “Bridgerail – Supply and Install”, and will be full compensation for the supply, fabrication and installation of the bridgerail; supply and placement of grout; and all labour, materials, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

All costs associated with grouting in cold weather, when required, will be considered incidental to the Work, and no separate or additional payment will be made.

80% of the lump sum price bid will be paid once the bridgerail has been acceptably supplied and delivered to the bridge site. The remaining 20% of the lump sum price bid will be paid once the bridgerail has been acceptably installed and grouted.

# SECTION 13 MISCELLANEOUS IRON

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## 13.1 General

This specification is for the supply, fabrication, and installation of Miscellaneous Iron. Miscellaneous Iron shall include any of the following items and those listed in the Special Provisions of the Contract:

- Steel drain troughs;
- Pier drip sheets;
- Deck buffer angles;
- Dowels;
- Connector angles;
- Anchor bolt sleeves;
- Bridge plaques;
- Identification tags for culvert and overhead sign structures; and
- Bench mark tablets.

## 13.2 Supply, Fabrication and Installation

Miscellaneous Iron shall be supplied, fabricated, and installed by the Contractor in accordance with Section 6, Structural Steel, the Drawings and these specifications. In the case of conflicting requirements, the requirements of this section shall govern.

Plaques, identification tags, and bench mark tablets shall be supplied, fabricated and installed in accordance with the Drawings and the following Standard Drawings:

- S-1847, Standard Identification Plaques and Benchmark Tablet; and
- S-1848, Standard Identification Tags.

## 13.3 Galvanizing

The fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatters, and all welding flux residue from the steel components prior to galvanizing.

Factors contributing to galvanization-induced cracking shall be minimized. Galvanizing shall be by the hot dip method, after fabrication, in accordance with the current edition of ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and ASTM F2329 Standard Specification for Zinc Coating Hot-Dip Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners and as modified in this specification.

The cleaning and pickling procedure of high strength ASTM A193 Grade B7 anchor rods shall be modified as follows prior to hot-dip galvanizing:

- Brush blast to remove mill scale and oil after threading ends;
- Flash pickle up to 5 minutes; and
- Quick dry prior to hot-dip galvanizing (not stored in flux or acid rinse).

The modified anchor rod cleaning and pickling procedure shall be completed in the presence of the Consultant prior to hot-dip galvanizing.

Repair of galvanizing shall be completed in accordance ASTM A780, Method A3 “Metallizing” and will only be permitted when the repair areas are small and infrequent as determined by the Consultant. Repair areas less than 100 $mm^2$ in area may be completed in accordance with ASTM A780, Method A1 ”Repair Using Zinc-Based Alloy”. The thickness of the coating for both methods shall be 180 µm, and the repair tested for adhesion. A detailed repair procedure shall be submitted for review and acceptance by the Consultant prior to commencement of the work. Repairs may require complete removal of the galvanized coating and re-galvanizing. The finished appearance shall be similar to the adjacent galvanizing as determined by the Consultant.

Galvanized material shall be stacked or bundled and stored to prevent wet storage stain as per the American Hot Dip Galvanizers Association (AHDGA) publication “Wet Storage Stain”. Any evidence of wet storage stain shall be removed to the satisfaction of the Consultant.

## 13.4 Field Welding

Metal core arc welding (MCAW) will not be permitted for field welding.

Low hydrogen filler, fluxes and welding practices shall be in accordance with Subsection 6.2.5.1, Filler Metals & Welding Processes.

When the ambient air temperature is below 10 °C, all material to be welded shall be preheated to 100 °C for a distance of 80 mm beyond the weld and shall be sheltered from the wind. When the ambient air temperature is below 0 °C, welding will not be permitted unless hoarding and heating acceptable to the Consultant is provided.

### 13.4.1 Field Welding of Structural Members

Members other than those listed in Subsection 13.4.2, Field Welding of Non-Structural Members, will be considered structural members.

Welding procedures, including welding procedure datasheets, shall be submitted for each type of weld proposed. The welding procedures shall bear the approval of the CWB and be reviewed and accepted by the Consultant a minimum of 3 weeks prior to the commencement of field welding.

All welding, cutting and preparation of structural members shall be completed in accordance with the American Welding Society (AWS) - Bridge Welding Code D1.5.

Welders shall be CWB approved in the applicable category. Their qualifications shall be current and available for examination by the Consultant upon request.

### 13.4.2 Field Welding of Non-Structural Members

The following will be considered non-structural members:

- Type 1 strip seal deck joint splices;
- Culvert struts;
- Stitch welding of steel caps/corbels; and
- Field welding of the end bulkheads on culvert liners.

Weld procedures shall be signed and sealed by a Professional Engineer registered in the Province of Alberta. Welding procedures shall be submitted to the Consultant for review and acceptance 1 week prior to commencement of field welding.

Journeyman welders with Class B tickets will be permitted to perform weldments of non-structural members. Their qualification shall be current and available for examination by the Consultant;

## 13.5 Payment

Payment will be made at the lump sum price bid for “Miscellaneous Iron”, and will be full compensation for all labour, materials, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

# SECTION 14 GUARDRAIL

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## 14.1 General

This specification is for the supply, fabrication, delivery and installation of guardrail. Guardrail shall include modified thrie beam guardrail, strong post w-beam guardrail, weak post w-beam guardrail, connections, treated timber posts, steel posts, spacers, transitions, end terminals, Department approved crash-worthy end treatments, miscellaneous components and associated materials.

Drawings shall include Alberta Transportation reference drawings from Appendix B of the Roadside Design Guide for approach guardrails, Bridge Engineering Standard Drawings for bridgerails and bridgerail/approach rail transitions, drawings in the AASHTO-AGC-ARTBA publication “A Guide to standardized Highway Barrier Hardware”, and other Drawings provided in the Contract.

## 14.2 Materials

### 14.2.1 Rails and Terminal Elements

Thrie beam/W-beam guardrail shall consist of rail sections fabricated for installation to develop the continuous beam strength with the necessary safety and feature components.

All rail sections and other components shall match the design profiles and dimensions of the AASHTO/ARTBA hardware requirements for full interchangeability of similar components regardless of the source of manufacturer.

The rails and terminal elements shall be manufactured from open hearth, electric furnace or basic oxygen semi spring steel sheet, all in general accordance with the AASHTO Standard Designation M180 and shall conform to the Roadside Design Guide reference drawings or the drawings in the AASHTO-AGC-ARTBA publication “A Guide to Standardized Highway Barrier Hardware”.

Rails shall be punched for splice and post bolts in conformity with the AASHTO Standard to the designated number of and centre to centre spacing of posts. If holes are punched after galvanizing the galvanizing around the hole shall be repaired in accordance with Subsection 12.2.6.7, Galvanizing.

Curved W beam rails shall be formed to the radius specified in accordance with Reference Drawing TEB 3.54.

The rails and terminal elements shall be manufactured according to the following standards:

#### 14.2.1.1 Rail Base Metal

Physical properties of the base metal for the rails shall meet the requirements outlined in Table 14-1, Rail Base Metal Physical Property Requirements.

**Table 14-1: Rail Base Metal Physical Property Requirements**

| Physical Property | Minimum Required Value |
|---|---|
| Yield | 345 MPa |
| Tensile Strength | 483 MPa |
| Elongation | 12% in 50 mm length |

14.2.1.2 Sheet Thickness

The rails and terminal elements thickness shall be manufactured according to Table 2 (Type II) of AASHTO Standard M180.

14.2.1.3 Sheet Width

Sheet width for the W beam rail shall be 483 mm with a permissible tolerance of minus 3 mm.

Sheet width for the thrie beam rail shall be 750 mm with a permissible tolerance of minus 3 mm.

All welding required for the fabrication of terminal elements shall conform to the requirements of CSA W59M. Only welders, welding operators and tackers approved by the Canadian Welding Bureau in the particular category may be permitted to perform weldments.

All rails and terminal elements shall be galvanized in accordance with the current edition of ASTM A123/A123M.

A copy of the producer's certificate, conforming to Section 16 of CSA G40.20M, for each of the mechanical and chemical tests, including impact tests, shall be provided to the Consultant for review and acceptance.

14.2.2 Bolts, Nuts and Washers

All guardrail bolts, nuts and washers shall conform to AASHTO Standard Designation M180, unless noted otherwise on the Drawings, and shall be hot dip galvanized in conformance with the current edition of ASTM F2329. A copy of mill test reports shall be provided to the Consultant for review and acceptance.

14.2.3 Wood Posts

Posts and offset blocks shall be Douglas Fir, Hemlock, Lodgepole Pine or better and shall meet the current edition of the National Lumber Grades Authority (NLGA) for No.1 Structural Posts and Timbers graded conforming to the NLGA Standard Grading Rules for Canadian Lumber.

Posts shall be date stamped at the top of either side of the post not used for rail attachment with the last two digits of the year of installation. The stamp shall be 50 mm x 50 mm and have an indentation of 3 mm.

Posts and offset blocks shall be rough sawn and holes drilled to the finished dimensions shown in Drawing TEB 3.01. Surfacing shall be completed and incised prior to treatment with allowable tolerance of 1.5 mm.

Wanes on any face shall not exceed 25 mm above ground (including blocks) or 60 mm below ground.

Posts and offset blocks shall be pressure preservative treated in accordance with the current requirements of CSA Standard 080.

The retention of preservatives shall be as per assay and shall conform to the requirements of CSA Standard 080.14 Table 1, minimum retention of preservatives in pressure treated wood for highway construction, under the headings “Post Guardrail, Guide, Sign and Sight” for posts and “Bridge Hand Rails, Guard Rails and Posts” for timbers not in contact with the ground or water.

#### 14.2.4 Steel Posts

Steel for posts, spacers and hardware shall conform to the requirements of CSA Standard G40.21M Grade 350W or ASTM A36 and shall be hot dip galvanized after fabrication in accordance with ASTM A123/A123M. A copy of mill test reports shall be provided to the Consultant for review and acceptance.

### 14.3 Inspection of Materials

All guardrail materials shall be inspected and materials which fail to meet these specifications will be rejected, and shall be replaced or repaired at no cost to the Department.

#### 14.3.1 Guardrail Materials

The thickness of finished Type II materials shall be in accordance with AASHTO Designation M180 Table 2.

#### 14.3.2 Timber Material

Testing of the penetration of the preservative may be carried out by the Consultant.

Warped wood posts, as determined by the Consultant, shall be removed and replaced by the Contractor at his expense.

### 14.4 Installation

The guardrail shall be connected as shown on the Drawings.

Guardrail shall be accurately set to the required depth and alignment, in a manner resulting in a smooth continuous installation, as shown on the Drawings or as determined by the Consultant. Permissible tolerance for plumb and grade of posts shall be ± 20 mm.

Holes for the guardrail posts shall be excavated by auger. The diameter of the holes augered shall be of sufficient size to allow for pneumatic tamping. Surplus excavated material and debris shall be removed from the site in a location and manner acceptable to the Consultant.

Unsuitable material at the bottom of the holes excavated shall be replaced with granular material at the Contractor's expense, as determined by the Consultant. The Contractor shall thoroughly compact the bottom of the hole. The guardrail posts shall rest directly and solidly on the bottom of the hole at the time of installation.

Excavated material which is unsuitable for use as backfill shall be replaced with granular material in accordance with Section 2, Backfill. Backfill shall be thoroughly compacted, using pneumatic tampers, in layers not exceeding 150 mm, for the full depth of the excavation. Where posts are installed on paved surfaces, the backfill for the top 150 mm shall be completed using ACP in accordance with Section 17, Asphalt Concrete Pavement.

Any guardrail material requiring field modification to fit shall be reported to the Department and Consultant for their acceptance of the modification method use before work is to be carried out. Modification by flame cutting method is prohibited. Modification by cold cutting method is allowed. Field guardrail modification is considered incidental to the work. Adequate edge distances of guardrail material shall be maintained during the modification process.

Guardrail laps shall be in the direction of traffic flow. Bolts shall be tightened to a torque of 100 Nm. Metal reflectors (Scotchlite or equivalent) shall be supplied and attached to the top of every third guardrail post with two 50 mm ring nails.

The Contractor shall take all necessary precautions to eliminate damage to galvanizing. Minor abrasions and exposed steel areas, as determined by the Consultant, shall be repaired in accordance with ASTM A780 Method A2, Repair Using Paints Containing Zinc Dust. Major abrasions and exposed steel areas, as determine by the Consultant, shall be replaced with new material. Repairs shall be completed to the satisfaction of the Consultant.

## 14.5 Payment

Payment for the supply and installation of guardrail, excluding approach rail transitions and guardrail connections to approach rail transitions, will be made at the lump sum price bid for "Guardrail – Supply and Install", and will be full compensation for all labour, materials, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

Payment for approach rail transitions and guardrail connections to approach rail transitions will be made in accordance with Section 12, Bridgerail.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

# SECTION 15 NON-SKID POLYMER OVERLAY

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## 15.1 General

Resurfacing concrete bridge decks with non-skid polymer wearing surface consists of the repair of deck concrete, and application of a thin, flexible, multi layered, polymer aggregate wearing surface. This specification shall be used in conjunction with the “Specification for the Supply of Polymer Resins used in Polymer Overlays (B405)” and “Specification for Seed Aggregates used in Polymer Membranes and Overlays (B392)”. The work includes mobilization, traffic accommodation, surface preparation and patching.

The Degussa Degadur System (MMA) is an approved alternate for the polymer overlay as specified. The Degussa Degadur System (MMA) does not meet the compressive strength and physical requirements of the “Specification for the Supply of Polymer Resins used in Polymer Overlay (B405)”, and is applied in a different manner, but all other requirements of the specification shall still apply.

## 15.2 Materials

All polymer materials including aggregates shall be protected from moisture, dust, or other contaminants. Any wet or otherwise contaminated materials will be rejected.

### 15.2.1 Polymer

The polymer and the polymer mortar shall meet the requirements of the “Specification for the Supply of Polymer Resins used in Polymer Overlay (B405)”.

The following products are currently approved by the Department for use in this work:

- Flexolith
- Flexogrid Degadur System (MMA)

### 15.2.2 Degadur System (MMA)

The DEGADUR B71 primer, DEGADUR 330 basecoat, and DEGADUR 410 sealer resins shall have the specified properties at the age of seven days conforming to Table 15-1: Properties of Degadur Resins.

**Table 15-1: Properties of Degadur Resins**

| Property | Units | Primer | Basecoat | Sealer | Test Method |
|---|---|---|---|---|---|
| Density | $g/cm^3$ | 1.05 | 1.01 | 0.98 | -- |
| Viscosity @ time of mixing | cps | 220-330 | 1100-1300 | 450-550 | ASTM D2393 |
| Hardness | Shore D | 83 | 56 | 61 | ASTM D2240 |
| Water Absorption | % | 0.1 | 0.1 | 0.1 | ASTM D570 |
| Tensile Strength | MPa | 29 | 8 | 9 | ASTM D638 |
| Elongation @ Break | % | 3 | 300 | 140 | ASTM D638 |

15.2.2.1 Initiator (MMA)

The initiator for the MMA resins shall be a 50% Benzoyl Peroxide powder such as AKZO Chemicals Inc., CADOX BFF 50, or an approved equivalent. Dosage rates shall be in accordance with the MMA Manufacturer's recommendations issued in the Degadur Catalyst Design Table.

15.2.2.2 Promoter (MMA)

The promoter required for use with the MMA resins at application temperatures below 4°C shall be N, N Dimethyl-p-toluidine such as R.S.A. Corporation DMPT or an approved equivalent. Dosage rates shall be according to the MMA Manufacturer's recommendations.

15.2.2.3 Degadur Basecoat (MMA)

The basecoat shall have the specified properties at the age of seven days conforming to Table 15-2: Properties of Degadur Basecoat:

**Table 15-2: Properties of Degadur Basecoat**

| Property | Units | Required Value | Test Method |
|---|---|---|---|
| Compressive Strength (1) | MPa | 16-21 | ASTM C109 |
| Tensile Strength | MPa | 3-5 | ASTM D638 |
| Elongation @ Break | % | 6 | ASTM D638 |
| Flexural Strength | MPa | 9-10 | ASTM C580 mod |
| Freeze/Thaw Resistance | - - | Pass | ASTM C666 |
| Bond Strength to Concrete | MPa | 1.7 minimum | ACI 503R |
| Coefficient of Thermal Expansion | 10E-5/K | 7.9 | DIN |
| Vicat Temperature | °C | 50 | DIN |

Notes:

(1) Samples shall consist of 1 volume of Degadur Basecoat to 1 volume of Steilacoom.

The tests listed shall be conducted by a CSA approved testing lab, and shall include infrared and gas chromatography analysis (in accordance with BT008 Test Procedure for Finger Printing Sealers Using Infrared Spectroscopy and Gas Chromatographic Separation) for each component. All tests, including the spectro analysis, shall be done on the same samples of material.

## 15.3 Aggregates

### 15.3.1 Seed Aggregate

The overlay aggregate provided by the Contractor shall conform to the current "Specification for Seed Aggregates Used in Polymer Membrane and Overlays" (B392). The seed aggregates currently approved by the Department are Indag # 8 and Steilacoom 6X10 Bridge Topping.

### 15.3.2 Basecoat Filler Aggregate (Degussa Degadur System MMA)

Materials used in the basecoat shall consist of clean, dry (less than 0.2% moisture), angular grained silica sand and shall be free from dirt, clay, asphalt, and other organic materials. Materials sieve analyses shall conform to Table 15-3: Gradation of Basecoat Filler Aggregates (MMA):

**Table 15-3: Gradation of Basecoat Filler Aggregates (MMA)**

| Gradation | Basaltic Sand | Ground Silica Flour |
|---|---|---|
| **Sieve Size (mm)** | **% Passing** | **% Passing** |
| 4.750 | 99 – 100 | n/a |
| 2.360 | 92 – 100 | n/a |
| 1.000 | 61 – 70 | n/a |
| 0.600 | 45 – 65 | n/a |
| 0.300 | 10 – 20 | n/a |
| 0.150 | 0 – 10 | n/a |
| 0.045 | n/a | 90 - 100 |

## 15.4 Patching Materials

Type NH patching materials meeting the requirements of "Specification for the Supply of Bridge Concrete Patching Materials" (B391) may be used in place of concrete in partial depth repair provided they are used in accordance with the manufacturer's instructions.

Samples of the mixed patching material will be tested by the Contractor according to ASTM C109 and in compliance with the Frequency of Test Table included in Subsection 15.7.8, Testing and Strength Requirements. The average of three cubes will be used for acceptance and determination of payment range or rejection of the work as specified in Table 15-4: Patching Materials Payment Range.

**Table 15-4: Patching Materials Payment Range**

| 28 Day Minimum Compressive Strength as per Manufacturers Specified Strength Requirement | Amount of Payment |
|---|---|
| 100% and above | Full bid price |
| 90% to 99.9% | Bid price less $25.00 per square metre |
| 80% to 89.9% | Bid price less $50.00 per square metre |
| 70% to 79.9% | Bid price less $100.00 per square metre |
| 65% and below | Will be rejected |

The Contractor shall pay all costs for testing, including but not limited to making test cubes, transporting cubes to an independent certified testing laboratory of his choice, storage, curing, breaking and providing written reports of the test results to the Consultant.

All patches consisting of Type NH patching materials shall be cured for 14 days and tested for moisture in accordance with Subsection 15.7.3, Weather Conditions, Dryness of Concrete Substrate and Polymer Layers prior to the application of polymer overlay.

## 15.5 Crack Repair

All deck cracks more than 2 metres in length and greater than 0.3 mm wide shall be treated with a Type 1c sealer meeting the current “Material Testing Specifications for Concrete Sealers” (B388). Application of the sealer shall be prior to shotblasting of the concrete deck, and shall consist of a 100 mm strip applied at the coverage rate as shown on the Approved Type 1c Sealer List. Payment for crack repair will be considered incidental to the Contract and no separate or additional payment will be made.

## 15.6 Bridge Deck Repair

Bridge deck repair consists of; Surface Patching, Partial Depth Repair, or Full Depth Repair conforming to Table 15-5: Bridge Deck Repair Types, Depths, Materials and Description:

**Table 15-5: Bridge Deck Repair Types, Depths, Materials and Description**

| Type of Patch | Depth of Patch (mm) | Repair Material | Description |
|---|---|---|---|
| Surface Patching | 6 to 15 | Polymer Mortar | Removal of surface deterioration without exposing rebar |
| Partial Depth Repair | 15 to 200 | Concrete | Chipping below corroded rebar and sandblasting of rebar is required |
| Full Depth Repair | Full depth of deck | Concrete | Forming of the underside of the deck is required |

The concrete to be used for Partial and Full Depth Repair shall be Class HPC as specified in Section 4, Cast-In-Place Concrete.

### 15.6.1 Surface Patching

The Contractor shall patch surface voids and depressions in excess of 6 mm. The Consultant shall determine the area to be patched.

Polymer mortar, applied in accordance with the Manufacturer's instructions and these specifications, shall be used where surface patching is required. The patching polymer mortar shall consist of 3½-4½ volumes of an approved aggregate to each volume of polymer. The mortar shall yield a 40 MPa minimum compressive strength when tested at 7 days using 50 mm cube specimens, as described in Subsection 15.7.8, Testing and Strength Requirements.

Prior to placement of the polymer mortar, the surface of the concrete shall be shotblasted and/or sandblasted in accordance with Subsection 15.7.1, Surface Preparation.

The areas to be patched shall be primed with a 75 mm wide band of liquid polymer along their perimeter. The polymer mortar surface patch shall be placed while the liquid polymer primer is liquid or tacky, and to the original gradeline or as directed by the Consultant.

Measurement and mixing of polymer components and aggregates shall be done in accordance with Subsection 15.7.4, Batching and Mixing of Polymer.

Aggregate shall be placed over the fresh patch in sufficient quantity to ensure a rough surface for bonding to the polymer overlay. Smooth textured patches will be rejected.

When the Degussa Degadur System is used, the surface patching of the deck and curb shall be done with an approved 100% solids MMA mortar supplied by the Manufacturer of the methacrylate polymer overlay. Application shall be completed according to the Manufacturer's instructions.

Payment for Surface Patching will be made at the unit price bid per square metre of surface patching, which price shall include surface preparation, full compensation for the cost of furnishing all labour, equipment, materials, tools and incidentals necessary to complete the work.

15.6.2 Partial and Full Depth Repair

In areas where partial depth and full depth repair are required, Subsection 20.4.2, Partial Depth Repair and Subsection 20.4.3, Full Depth Repair shall apply.

All concrete shall be cured for 28 days and tested for moisture in accordance with Subsection 15.7.3, Weather Conditions, Dryness of Concrete Substrate and Polymer Layers prior to the application of polymer overlay.

15.6.3 Surface Defects and Tolerances

The requirements for all new surface patching, partial and full depth repair shall conform to Subsection 4.16.6, Surface Defects and Tolerances.

All patching and levelling requires acceptance by the Consultant prior to commencing the overlay. Failure to obtain acceptance may be cause for rejection of the overlay.

## 15.7 Polymer Construction

The polymer coverage rates shown in Table 15-6: Minimum Polymer Coverage Requirements, and Table 15-7: Minimum MMA Polymer Coverage Requirements for Degussa Degadur System (MMA) are based on undiluted polymer applied to a clean shotblasted deck surface or previously applied seeded polymer layer. Where the deck surface is spalled, scaled, or roughened by surface preparation, to depths up to 6 mm, the coverage rates shall be increased. Additional polymer material may also be required due to coarse texturing or grooving of the deck surface, or porosity of the concrete. The first layer shall extend up the full height of the vertical face of curbs and medians, and up 200 mm on the vertical faces of parapets. The Contractor shall obtain the Consultant's acceptance prior to increasing, for any reason, the minimum polymer coverage requirements. No separate or additional payment will be made for any additional polymer required.

**Table 15-6: Minimum Polymer Coverage Requirements**

| Wearing Surface Class | 1st Layer (ℓ/m$^2$) | 2nd Layer (ℓ/m$^2$) | 3rd Layer (ℓ/m$^2$) |
|---|---|---|---|
| A | 1.33 | 2.00 | 0.30 |
| B | 1.33 | 2.00 | N/A |
| C | 1.33 | 0.30 | N/A |

**Table 15-7: Minimum MMA Polymer Coverage Requirements for Degussa Degadur System (MMA)**

| Wearing Surface | Primer Layer (ℓ/m$^2$) | Premixed Basecoat Layer (ℓ/m$^2$) | Sealer Layer (ℓ/m$^2$) |
|---|---|---|---|
| Degussa Degadur System | 0.40 | 5.00 | 0.67 |

### 15.7.1 Surface Preparation

In order to prevent bond failures at overlay edges at high impact locations, 10 mm deep by 10 mm wide grooves shall be cut by router or saw and sandblasted in close proximity and parallel to all deck joints, snow slots, deck drains and all other transverse edges. These grooves or keys are intended to provide increased anchorage for the overlay and shall be filled with polymer and seeded in conjunction with application of the first layer. Rough spots exceeding 3 mm in height on or adjacent to, deck joints shall be ground to provide a smooth transition prior to placement of the overlay.

Proper surface preparation is essential to ensure adequate bond strength between the polymer wearing surface and deck concrete. The deck concrete surface shall be prepared by shotblasting to remove all bond inhibitors including concrete laitance, asphaltic material, sealers and oil, and to expose the coarse aggregate in the substrate concrete. Those areas which are inaccessible to shotblasting, such as the vertical faces of the curbs, medians, and parapets shall be similarly prepared by sandblasting.

If in the opinion of the Consultant, reblasting is required in the event of rain, delay in applying the overlay, or subsequent leakage onto the deck of other contaminants, it shall be done at the Contractor’s expense.

### 15.7.2 Deck Layout for the Overlay

Prior to the application of each layer, the Contractor shall submit a sketch to the Consultant showing the deck surface divided into segments which will be covered by each polymer batch. The length of each segment shall be determined by taking into account the overlay width, vertical faces, surface roughness, coverage rate, the amount of polymer in each batch, and losses in application equipment and containers.

After review of the sketches by the Consultant, the Contractor shall apply masking tape to the boundaries of the work area, except where these boundaries abut an existing polymer overlay mat of the same layer. The end of each overlay segment shall be marked at these boundaries. For the first layer only the layout area shall extend up the full height of the vertical curb and median faces and up 200 mm on the vertical faces of parapets. No overlay work shall commence until all layout by masking tape has been acceptably completed.

### 15.7.3 Weather Conditions, Dryness of Concrete Substrate and Polymer Layers

The work shall be done in suitable conditions of temperature, wind, dust, and moisture. If weather factors or moisture conditions of the substrate concrete are detrimental to the acceptable placement of overlay, the work shall be suspended until suitable conditions exist. Mixing, placing and curing of polymer shall be done at ambient air and substrate concrete temperatures between 10°C and 27°C.

The concrete substrate, including concrete patching and repairs shall be completely dry before the first layer of polymer is applied. Subsequent layers of polymer shall not be applied until previous layers are completely cured. Presence of moisture will be determined by the modified ASTM D4263, “Standard Test Method for Indicating Moisture in Concrete by Plastic Sheet Method”. This test shall be carried out on the concrete substrate as well as on previous placed polymer overlays. The Contractor shall place a minimum of four test windows, per application area, at different time periods. The test windows shall consist of three layers of clear and one layer of black heavy duty 6 mil poly, 1000 mm x 500 mm located in moisture prone areas. The test windows shall be heated at a temperature of 55°C continuously for a time period of 6 hours for each test and at a time duration, period and frequency of test, as determined by the Consultant. Timing of the test windows shall not start until the temperature of the concrete surface has reached 55°C. This will not relieve the Contractor from his responsibility to ensure that the overlay does not debond. The Contractor shall provide four, 500 watt halogen lamp and a portable electric generator (3500 watt) and carry out the required testing which will be considered incidental to the Contract and no separate or additional payment will be made.

Application of the first layer is recommended when there is sufficient evidence of declining deck concrete temperatures.

### 15.7.4 Batching and Mixing of Polymer

Batching and mixing shall be done in accordance with the Manufacturer's instructions. The polymer shall be completely and thoroughly mixed before being deposited onto the deck. Any polymer not meeting the specification will be rejected, removed, and replaced at the Contractor’s expense.

The temperature of the unmixed polymer constituents shall be between 10°C and 27°C. The polymer material shall be mixed in batches no larger than 20 ℓ. Each component shall be measured to within an accuracy of 3%. All containers shall be clean and free of contaminants of hardened polymer. Containers used for mixing and blending shall not be used for measuring.

In the absence of the Manufacturer's time limit for mixing, the minimum time for mixing shall be 3 minutes, however, for the Degussa Degadur System, the mixing time is a function of temperature. Attention shall be taken to blend the polymer adjacent to the mixing container surfaces. The presence of air, water bubbles or other contaminants in the mixed polymer will be cause for rejection of that batch.

The deck and adjacent areas shall be protected from spillage of polymer, solvents, and other materials. Any spilled materials shall be removed by the Contractor.

### 15.7.5 Application of Polymer Resin

Upon the Consultant's acceptance of the prepared deck surface and completion of the layout, the polymer shall be applied in accordance with the Manufacturer's instructions regarding mixing, blend time, temperature, time between layers, pot life, method of application, condition of substrate and any other requirements.

All cold joints in the overlay shall be offset 25 mm from cold joints of previous layers of the overlay. To ensure straightness, masking tape shall be applied along the perimeter of all areas to be overlay as well as along all steel deck joints, drains, curb faces or other edges of the layers of overlay. The first layer of polymer shall extend up the full height of the concrete curb and median faces and up 200 mm on the vertical faces of parapets. All masking tape used to define the boundaries of each segment shall be completely removed prior to gelling of the polymer.

The Contractor shall spread the polymer uniformly over the premeasured area using a squeegee and roller brush to carefully work the polymer into the surface and obtain the required coverage. Spiked footwear will be permitted for use by workers involved in the application work, but only prior to gelling of the polymer and with the constraint that all damage or defects in the surface will be repaired. Spreading and levelling of fresh polymer shall be completed while the material is in a state of low viscosity, and within seven minutes of batching. Failure to comply with the seven minute limit may result in rejection of the batch. Application of material which has begun to gel and increase in viscosity will not be permitted.

Application of the third layer of polymer (tie coat) shall be by airless spraying only. The polymer shall not be cut back with any solvents. This does not apply to the Degussa Degadur System, where the sealer layer may be applied with a roller.

The Contractor shall prevent or repair all bubbles, blisters, pinholes or other defects.

#### 15.7.5.1 Degadur Base Coat (MMA)

The basecoat mixture shall be prepared by blending the silica flour and basaltic sand components with the resin in a suitable container (e.g. 20 ℓ pail), followed by the addition and subsequent blending of the initiator. The mixture shall be applied over clean, dry, cured primer surfaces at the coverage rate specified in Subsection 15.7, Polymer Construction, using an approved spreading method. The applicator shall take care to allow the ridges between passes to self-level before broadcasting aggregate. Small areas may be touched up with a steel trowel.

The deck layout may be subdivided into coverage areas corresponding to a maximum of 150 ℓ of MMA mix rather than 20 ℓ as specified in Subsection 15.7.2, Deck Layout for the Overlay.

Applicators shall not walk on a polymer layer after 4 minutes from time of placement.

#### 15.7.5.2 Degadur Sealer (MMA)

The sealer mixture shall be applied to the cured and swept basecoat using paint rollers and brushes. Application shall be in a "dip and roll" manner from containers holding no more than 8 ℓ at a time; sealer shall not be poured directly onto the deck.

### 15.7.6 Seeding of Aggregate

The Contractor shall seed the first and second layer of polymer for Class A and B wearing surfaces and the first layer for Class C wearing surfaces. When the Degussa Degadur System (MMA) is used, the basecoat layer shall be seeded. The full height of the vertical face of curbs and median and up 200 mm of the vertical faces of the parapets shall not be seeded. The aggregate shall be seeded into the fresh polymer before gelling or increase in viscosity occurs. It shall be broadcast into the fresh polymer in such a manner that no ripples or waves are created and no segregation of the aggregate occurs. The aggregate shall impact the fresh polymer surface in a near vertical direction. Improper seeding technique will result in the work being suspended until proper methods are employed. The aggregate shall be placed so that an excess quantity covers the entire surface of the fresh polymer, no polymer is visible, and the surface has a dry appearance. As the aggregate settles into the fluid polymer, all "wet" spots which appear in the surface shall be promptly re-seeded before the polymer becomes viscous. At no time shall the Contractor disturb previously placed aggregate in an effort to cover "wet" surface spots. Once gelling begins, walking on the overlay will not be permitted until it has properly cured.

If insufficient aggregate has been placed and the "wet" areas harden to form glassy, resin rich areas, the Contractor shall remove these areas to sound concrete, redo the deck surface preparation and replace the overlay.

After curing of the previous placed overlay and on acceptance of the Consultant, all excess aggregate or other contaminants shall be removed by power sweeping and air blasting. After cleaning to the satisfaction of the Consultant, the subsequent layer of polymer shall be applied.

Additional cleaning will be required if application of the subsequent layer of polymer is delayed and the overlay surface has become contaminated.

In the event that any layer of polymer material is subjected to rain or any other form of damage, the contractor shall do vertical pull out tests to confirm the adequacy of the material. This test consists of bonding a 64 mm diameter sandblasted steel disk to the prepared substrate by using an approved polymer, and pulling it from the substrate by applying a vertical force.

The polymer overlay in question will not be accepted unless at least 75% of the bonded steel disk surface has retained substrate concrete exceeding 3 mm in depth. At the discretion of the Consultant the pull out test may be carried out on any polymer layer. The minimum acceptable bond strength on normal weight concrete shall be 3.0 MPa. The Contractor shall repair all bond test locations with polymer overlay in accordance with this specification. The pull out equipment and repair of the polymer overlay will be considered incidental to the Contract.

15.7.7 Smoothness of Overlay Surface

Larger smoothness defects of the bridge deck, as determined by the Consultant shall be repaired by surface patching. Minor defects inherent in the concrete deck shall be smoothened by the application of the polymer overlay.

Roughness attributable to the overlay will be tested with a 3 m long straight edge. When placed anywhere in any direction on the surface except across the crown, the gap between the bottom of the straight edge and the surface of the overlay shall not exceed 3 mm. Overlays not meeting the criteria will be rejected, removed and replaced at the Contractor’s expense.

The location and number of measurements taken will be at the discretion of the Consultant.

15.7.8 Testing and Strength Requirements

Two weeks prior to commencement of work, the Contractor shall be responsible for testing of infrared and gas chromatography analysis (in accordance with BT008) for each polymer component, compressive strength of the polymer mortar, modulus elasticity of the polymer, and grain size analysis of the aggregate. These results shall be provided to the Consultant for review.

During placement of the polymer, samples of the mixed polymer material will be randomly selected by the Consultant and the Contractor shall cast sets of three 50 mm cubes for compressive strength testing in accordance with test method ASTM C 109. These tests will be used for acceptance and determination of payment range or rejection of the work as specified in the applicable table below entitled “Partial Payment Schedule”. The test cubes will be cast at a ratio of 22 volumes of approved aggregate to 1 volume of mixed polymer and cured for seven days in dry lab conditions. When the Degussa Degadur System is used, the test cubes will be cast at a ratio of 1 part base coat and 1 part approved aggregate, by volume and cured for seven days.

The compressive strength will be the maximum load measured or the load causing a 2.5 mm deflection, whichever occurs first. (This modified ASTM C 109 test method will also be used for acceptance testing of proposed overlay materials.) The compression test will be done using a steady loading rate of 0.5 MPa ±0.05 MPa per second.

The acceptable range of 7 day compressive strength for the polymer shall be 40 MPa to 70 MPa.

The MMA product shall have a 7 day compressive strength range of 16 MPa or over.

The Department reserves the right to reject any overlay whatsoever which does not meet the applicable strength requirements. The Department may however, at the discretion of the Consultant, accept overlay which fails to meet the compressive strength range. In this case payment will be made in accordance with Table 15-8: Partial Payment Schedule for Low Strength Polymer and Table 15-9: Partial Payment Schedule for Low Strength MMA Overlay.

**Table 15-8: Partial Payment Schedule for Low Strength Polymer**

| 7-Day Compressive Strength (MPa) | Percentage of Unit Price |
|---|---|
| Between 40.0 and 70.0 | 100 |
| 38.0 to 40.0 or 70.0 to 72.0 | 90 |
| 36.0 to 38.0 or 72.0 to 74.0 | 80 |
| 34.0 to 36.0 or 74.0 to 76.0 | 70 |
| 32.0 to 34.0 or 76.0 to 78.0 | 60 |
| 30.0 to 32.0 or 78.0 to 80.0 | 50 |
| Below 30.0 or over 80.0 | Rejected |

**Table 15-9: Partial Payment Schedule for Low Strength MMA Overlay**

| 7-day Compressive Strength (MPa) | Percentage of Unit Price |
|---|---|
| 16 and Over | 100 |
| 15.0 to 15.9 | 90 |
| 14.0 to 14.9 | 80 |
| 13.0 to 13.9 | 70 |
| 12.0 to 12.9 | 60 |
| 11.0 to 11.9 | 50 |
| Below 11.0 | Rejected |

Compressive strength tests may be carried out on any layer of the overlay. If a test result of any layer is below that specified, the reduced unit price shall apply to the full overlay thickness. Where compressive strength tests have been done on more than one layer, the lowest strength test result will be used to determine adjustment of the unit price. Each test will represent the 100 $m^2$ area poured during that batching operation. The Consultant will determine the test location of each test. The Contractor shall cast a set of three cubes to the frequency of test listed in Table 15-10: Frequency of Test.

**Table 15-10: Frequency of Test**

| Deck Area ($m^2$) | No. of Tests (Set of 3 Cubes) |
|---|---|
| 1 - 500 | 4 |
| 501 - 1000 | 8 |
| 1001 - 2000 | 14 |
| 2001 - 3000 | 20 |
| 3001 - 4000 | 24 |

The Contractor shall pay all costs for testing, including but not limited to making test cubes, transporting cubes to an independent certified testing laboratory of his choice, storage, curing, breaking, and providing written reports of the polymer test results to the Consultant.

15.7.9 Opening to Traffic

The polymer overlay surfaces shall not be opened to traffic until a minimum of 60% of the 7 day compressive strength or 3.0 MPa of tensile strength is achieved based on the last batch of the day. It is recommended that the Contractor casts one additional set of cubes from the last batch of the day and have these tested at his cost. The cubes shall be cured in the field at ambient air temperature prior to testing.

No traffic will be allowed on the polymer overlay until all layers are acceptably placed and confirm to the strength requirement.

## 15.8 Payment

Measurement for payment of non-skid polymer overlay will be by the square metre of acceptably treated area, measured to the nearest 0.1 $m^2$.

Payment will be made at the unit price bid for “Non-Skid Polymer Overlay”, and will be full compensation for surface preparation; the supply and application of polymer overlay; and all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

# SECTION 16 WATERPROOFING

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## 16.1 General

This specification is for the supply and installation of hot applied asphalt waterproofing system. Waterproofing shall be carried out in accordance with the following specifications; as shown on the Drawings and Standard Drawings S-1838, Standard Waterproofing System for Deck and Abutments - Sheet 1, S-1839, Standard Waterproofing System for Deck and Abutments – Sheet 2, S-1840, Standard Waterproofing System for Deck and Abutments - Sheet 3.

## 16.2 Material

### 16.2.1 General

The materials supplied shall be able to withstand the heat generated during the waterproofing processes without affecting the performance of the material.

### 16.2.2 Submittals

The Contractor shall submit documentation indicating specification compliance of his proposed materials to the Consultant for review and acceptance a minimum of 2 weeks prior to the commencement of waterproofing installation operations.

### 16.2.3 Sampling and Testing

The Contractor is advised that the Consultant may carry out additional material testing to confirm compliance.

If requested by the Consultant or the Department, the Contractor shall provide sufficient additional quantities of the asphalt membrane, rubber membrane, membrane reinforcing fabric, and/or protection board from the materials being used on the project. Requested samples and all associated costs will be considered incidental to the Work and no separate or additional payment will be made.

### 16.2.4 Materials

#### 16.2.4.1 Asphaltic Primer

Asphaltic primer shall meet the requirements of CAN/CGSB 37 GP 9MA.

#### 16.2.4.2 Asphalt Membrane

Asphalt membrane materials shall be supplied in cakes that are sealed and labeled by the manufacturer.

Material for the asphalt membrane shall meet the requirements of the Ontario Ministry of Transportation's OPSS 1213 Specification.

#### 16.2.4.3 Rubber Membrane

Rubber membrane shall consist of 1.2 mm thick butyl and ethylene propylene diene monomer (EPDM) rubber. The membrane shall meet the requirements of CAN/CGSB 37.52M.

#### 16.2.4.4 Membrane Reinforcing Fabric

Membrane reinforcing fabric shall consist of spun bonded sheet structure composed of 100% continuous filament polyester fibres bonded together at their crossover points. The membrane shall be supplied in minimum widths of 300 mm.

#### 16.2.4.5 Wick Drain

Wick drain shall consist of composite polypropylene with a total thickness of 3.6 mm, supplied in 100 mm widths. The puncture strength shall be a minimum of 45 N measured in accordance with ASTM D4833.

#### 16.2.4.6 Waterproofing Protection Board

Waterproofing protection board shall consist of durable panels designed to provide a protective cushion between the hot mix asphaltic concrete pavement and the asphalt membrane.

The waterproofing protection board shall meet the requirements of the Ontario Ministry of Transportation's OPSS 1215 Specification for Protection Board.

## 16.3 Equipment

An approved heating and mixing kettle shall be used to heat the asphalt membrane. The kettle shall be a double boiler oil transfer type with a built in agitator, and shall be equipped with permanently installed dial type thermometers with an accuracy of ± 2 °C to measure the temperature of the melted compound and oil. A separate calibrated thermometer with an accuracy of ± 2 °C shall be available on site to verify material temperatures.

The unit shall be capable of keeping the contents continuously agitated, free flowing and lump free until the material is drawn for application.

## 16.4 Installation

### 16.4.1 General

The Contractor shall provide the Consultant with 48 hours advance notice prior to commencing any waterproofing operations.

Waterproofing operations shall only be carried out when the air and concrete surface temperatures are 5 °C or higher.

The Contractor shall carry out the operations involved in waterproofing in sequential order, and in such a manner that there are no delays between individual operations except those necessary to meet the requirements of these specifications.

Placement of the first asphalt concrete placement lift shall commence within 7 days of waterproofing installation or as determined by the Consultant based on anticipated exposure conditions.

#### 16.4.2 Traffic Restriction

Once surface preparation operations have commenced the Contractor shall restrict all traffic other than the construction equipment directly associated with waterproofing and bridge paving operations from traveling over the prepared areas.

These restrictions shall remain in place until such time that the asphalt concrete pavement has been placed and cooled to ambient temperature.

#### 16.4.3 Surface Preparation

##### 16.4.3.1 Grout Tubes

Grout tubes shall be cut flush with the concrete deck surface prior to surface preparation. If grout tubes project above the concrete after surface preparation, they shall be re cut flush with the concrete deck surface. A 450 mm by 450 mm piece of membrane reinforcing fabric, centered on the tube, shall be installed as described in Subsection 16.4.5, Waterproofing of Joints and Cracks.

##### 16.4.3.2 New Bridge Construction

Concrete surfaces to receive waterproofing shall be cured a minimum of 14 days and then allowed to dry a minimum of 3 days. Concrete surfaces shall be completely dry prior to commencing waterproofing operations. Drying of concrete surfaces by the use of torches or other means that, in the opinion of the Consultant, may be potentially harmful will not be permitted.

Once the concrete surfaces are completely dry, they shall be prepared for waterproofing installation by sandblasting or shotblasting to expose sound, laitance free concrete for the entire installation area. All dirt and debris shall be removed and disposed of leaving a prepared surface satisfactory for asphaltic primer.

##### 16.4.3.3 Bridge Rehabilitation

Concrete surfaces to receive waterproofing shall be ground, scabbled, or bush hammered to achieve a surface texture of 3 mm or less prior to sandblasting or shotblasting. Concrete surfaces shall also meet the requirements of Subsection 16.4.3.2, New Bridge Construction, prior to waterproofing installation.

New concrete overlays or concrete patches that are to receive waterproofing shall be cured for a minimum of 7 days unless otherwise specified and allowed to dry a minimum of 3 days.

### 16.4.4 Application of Asphaltic Primer

Asphaltic primer shall be applied wherever waterproofing membrane is required. Asphaltic primer and waterproofing installation shall not commence until the Consultant has inspected and accepted the surface preparation work.

All concrete surfaces shall have less than 6% moisture prior to application of the asphaltic primer. Testing shall be completed by the Contractor using a Hygrometer or Protimeter and the results reviewed and accepted by the Consultant.

After concrete moisture conditions have been determined acceptable by the Consultant and immediately prior to the application of the asphaltic primer, the concrete surface shall be blown clean with oil and water free compressed air to remove all dust and other foreign material. The asphaltic primer shall be cut back with an equal volume of gasoline type solvent or an alternative cut back asphalt product compatible with the asphalt membrane.

The asphaltic primer application shall be such that the asphaltic primer will be absorbed into the concrete, resulting in a surface that is dull and black in appearance. Excess application of asphaltic primer, indicated by a shiny black surface, shall be avoided. Asphaltic primer shall be applied at an approximate rate of 0.25 $\ell/m^2$.

Waterproofing equipment or material shall not be permitted on the asphaltic primer until it has fully cured and is completely tack free.

### 16.4.5 Waterproofing of Joints and Cracks

The Contractor shall pay particular attention to waterproofing installation over construction joints, lift hook pockets, grout tubes, patches and cracks.

After asphaltic primer application and prior to application of the primary hot asphalt membrane, a coat of hot asphalt membrane 3 mm to 4 mm thick and wide enough to extend 200 mm on either side of each joint or crack shall be applied in accordance with Subsection 16.4.6, Application of Asphalt Membrane. A strip of membrane reinforcing fabric material wide enough to extend 150 mm on both sides of the construction joint, lift hook pocket, grout tubes, patch or crack shall be applied while the asphalt membrane is still hot and tacky. The membrane reinforcing fabric shall then be covered with an additional layer of water proofing 2 mm to 3 mm thick. Membrane reinforcing fabric shall be overlapped for a minimum of 100 mm when multiple strips are used.

For areas along curbs, barrier walls, and deck drains, the asphalt membrane shall be applied to the height of the top of the hot mix ACP surface course and 150 mm onto the deck. Rubber membrane shall be applied into the first coat of asphalt membrane while it is still hot and tacky. The rubber membrane shall extend 50 mm up the vertical face and 100 mm onto the deck surface. Rubber membrane shall be overlapped for a minimum of 100 mm where multiple strips are used. A second coat of asphalt membrane shall then be applied to fully cover the rubber membrane.

### 16.4.6 Application of Asphalt Membrane

Cakes of asphalt membrane shall be melted in the heating and mixing kettle to a temperature not exceeding that recommended by the membrane Manufacturer.

The asphalt membrane shall not be applied until the asphaltic primer has cured completely.

The application temperature of asphalt membrane shall be within the range recommended by the Manufacturer. The membrane shall be applied in a uniform film having a minimum thickness of 4 mm and a maximum thickness of 6 mm.

Application of the asphalt membrane shall be carried out in a continuous manner to the extent practicable. Where joints are unavoidable, they shall be overlapped by a minimum of 150 mm. The membrane shall be applied over all waterproofed joints and cracks, and shall extend up the face of curbs, barrier walls, and deck drains, to the height of the top of the design hot mix asphalt surface course.

The Contractor shall conduct his operations in such a manner that plugging of deck drains and/or drainage tubes is avoided. Plugged deck drains or drainage tubes shall be cleaned out by the Contractor at his expense.

### 16.4.7 Wick Drain Installation

Wick drains shall be installed along the full lengths of the gutters, and shall be installed when the asphalt membrane is still hot and tacky. Special attention shall be given to waterproofing and wick drain modifications at deck drain pipe locations. Asphaltic primer shall not be applied to wick drains.

### 16.4.8 Protection Board Installation

The Contractor shall ensure that the asphalt membrane thickness meets the specified requirements prior to placing the protection board. Protection boards shall be laid on the asphalt membrane while the membrane is still hot, with the length of the board running transversely on the deck. The protection boards shall be placed with edges overlapping a minimum 12 mm and a maximum of 25 mm, both longitudinally and transversely. The protection board edge shall be within 5 mm of all wick drains, vertical faces of drains, and vertical faces of expansion joints.

Protection board shall be lapped to produce a shingling effect in both the longitudinal and transverse directions. Protection boards shall be placed such that the longitudinal (direction of traffic flow) joints are staggered a minimum of 150 mm. Boards shall be rolled using a linoleum or lawn type roller while the membrane is still warm to ensure good contact with the membrane. Holes shall be cut through the protection board to allow water to drain freely through the drainage tubes. At locations where the edges of the protection board have curled-up, the curled-up edges shall be cemented down using hot membrane material to the satisfaction of the Consultant.

Protection boards that are warped, distorted, or damaged in any way, whether by manufacture, storage, handling or exposure to the elements shall be replaced with new material.

### 16.5 Measurement and Payment

Measurement for payment of waterproofing will be by the square metre, measured to the nearest 0.1 $m^2$.

The quantity to be paid for will be based on horizontal measurement of surface areas where waterproofing has been acceptably installed. Vertical faces will not be measured.

Payment for waterproofing will be made at the unit price bid for "Waterproofing", and will be full compensation for traffic control; the preparation of concrete surfaces, including sandblasting and/or shotblasting; the supply and application of the asphaltic primer; the supply and installation of asphalt membrane, membrane reinforcing fabric, rubber membrane, wick drain, and protection board; including all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

All costs associated with waterproofing of vertical faces of curbs and barriers will be considered incidental to the Work, and no separate or additional payment will be made.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

# SECTION 17 ASPHALT CONCRETE PAVEMENT

TABLE OF CONTENTS

## 17.1 General

Asphalt Concrete Pavement (ACP) shall be mixed, placed, and compacted to the lines, grades, dimensions and cross section as shown on the Drawings and in accordance with these specifications. This specification applies to:

- ACP on bridge deck waterproofing described in Section 16, Waterproofing;
- ACP on polymer waterproofing membranes; and
- ACP on approach road transitions.

The Contractor shall submit an ACP Mixing and Placement Plan for each bridge and associated approach transition for the Consultant's review and acceptance a minimum of 2 weeks prior to commencement of paving operations. The ACP Mixing and Placement Plan shall include but not be limited to the following:

- Surface removal plan (if applicable);
- Source location of ACP;
- Asphalt mixing plant Certificate of Calibration;
- Asphalt mix design and job mix formula;
- Asphalt mixing plant production rate, haul route and distance, number of haul trucks and load size, paver production capacity;
- Placing, spreading and compaction temperature range(s);
- Direction of ACP placement (bridges with waterproofing protection board);
- Details of placement and compaction equipment;
- Quality control and testing plan including but not limited to material testing, details of control strip method (drawing outlining control density test locations and mat density test locations), and QC personnel;
- Details of environmental protection measures;
- Details of bridge component protection measures for barriers/curbs/medians, deck joint concrete blockouts, paving lips, and wick drains;
- Details of ACP longitudinal and transverse (if applicable) joint locations;
- Details of saw cut joint protection measures; and
- Schedule.

After the ACP Mixing and Placement Plan has been reviewed and accepted by the Consultant a preconstruction meeting shall occur prior to any operations. The Contractor's project manager, paving superintendent and foreman that will complete the Work shall attend the preconstruction meeting.

This specification shall be used in conjunction with the Standard Specifications for Highway Construction. In areas of conflict between this specification and the Standard Specifications for Highway Construction, this specification shall govern.

## 17.2 Materials

The Contractor shall supply Asphalt Cement and Aggregate in accordance with Subsection 3.50.2.1, Asphalt, and Subsection 3.50.2.2, Aggregate, of the Standard Specifications for Highway Construction.

Tack coat shall be SS 1 liquid asphalt diluted 50:50 with clean potable water. RC 30/70 may be considered an alternative tack coat to SS-1 when adverse weather conditions require its usage and determined acceptable by the Consultant. Tack coat materials shall conform to the Specifications listed in Tables ASPH6 and ASPH7 of Specification 5.7 of the Standard Specifications for Highway Construction.

A chemical warm mix asphalt additive from the Department's Products List may be used in the ACP mix when haul routes are greater than one hour.

## 17.3 Asphalt Mix Design and Job Mix Formula

The Contractor shall prepare and submit asphalt mix designs in accordance with Subsection 3.50.3, Asphalt Mix Design and Job Mix Formula, of the Standard Specifications for Highway Construction that is representative of materials to be used.

For bridges located on Provincial highways with a service classification designation 1 or 2 the asphalt mix shall be Type H2 with PG 58-28 asphalt cement grade.

For bridges located on Provincial highways with a service classification designation 3 or 4 the asphalt mix shall be Type M1 with PG 52-34 asphalt cement grade.

Any proposed modifications to asphalt cement grades shall be submitted to the Consultant and the Department for review and acceptance with the Asphalt Mix Design and Job Mix Formula submission.

## 17.4 Sampling and Testing

Sampling and testing procedures used to determine material characteristics shall be as outlined in the Subsection 3.50.4, Sampling and Testing, of the Standard Specifications for Highway Construction unless specified otherwise.

In addition to quality control testing completed by the Contractor described in Subsection 17.4.1, Quality Control Testing, quality assurance (QA) testing will be completed by the Consultant. QA testing will be completed on two 6 kg samples per lift (ATT-37) to determine the uncorrected asphalt content and aggregate gradation (ATT-26). The Consultant will use the Contractor's measured correction factor to establish the actual asphalt content. The actual asphalt content will be determined by test method ATT-12 or ATT-74, and includes the correction factor for asphalt binder lost due to absorption by the aggregate or aggregate loss. An inspection to identify any areas of segregation will be completed by the Consultant.

The Consultant shall have access to the Work at all times for taking samples. The Contractor shall provide any assistance necessary for taking samples and shall reinstate pavement lifts or other structures to the satisfaction of the Consultant at the locations where samples have been taken. Compensation for providing assistance with sampling and for reinstatement where samples are taken will be considered incidental to the Work and no separate or additional payment will be made.

The Consultant's review and/or acceptance of any materials or mixtures shall in no way relieve the Contractor from his obligation to provide materials, mixtures and workmanship in accordance with the specifications.

### 17.4.1 Quality Control Testing

Quality control testing shall be completed on Contracts that include more than 50 tonnes of ACP and in accordance with Table 17-1: Quality Control Testing Requirements. The Contractor shall be responsible for the coordination of all quality control testing and the associated costs. All testing shall be completed by an independent third party testing agency that is prequalified by the Department in the category of QA Testing Services (Grading, Base Paving). Results of all quality control tests shall be submitted to the Consultant within 7 days of the test being completed.

**Table 17-1: Quality Control Testing Requirements**

| TEST | TEST METHOD | MINIMUM FREQUENCY |
|---|---|---|
| **Aggregate Production** | As specified in the Standard Specifications for Highway Construction Subsection 3.2 | |
| **Asphalt Mix Plant Calibration** | ATT-17 | Once per calendar year or as requested by the Consultant |
| **Sample Testing** | | |
| 1. Tack, Prime and Fog Materials | ATT-42 | As determined by the Consultant |
| 2. Temperatures | ATT-30 | As specified in Subsection 17.6.5 |
| 3. Compaction Monitoring by Nuclear Density Gauge | ATT-11 | As specified in Subsection 17.6.5 |
| 4. Asphalt Cement | ATT-42 | As determined by the Consultant |
| 5. Mix | ATT-37 | Minimum of one per lift |
| 6. Mix Asphalt Content | AASHTO T-164, T287 or ATT-12 or ATT-74 | Minimum of one per lift |
| 7. Correction Factors | ATT-12, Part III or ATT-74, Part II | Once per mix design |
| 8. Mix Moisture Content | ATT-15 | Minimum of one per lift |
| 9. Aggregate Sieve Analysis (any combination of cold feed, extraction or ignition) | ATT-26 | Minimum of one per lift |
| 10. Marshall Briquettes | ATT-13 | Minimum of one per lift |
| 11. Void Calculations, Cores or Formed Specimens | ATT-36 | Minimum of one per lift |
| 12. Pavement Segregation | Paving Guidelines and Segregation Rating Manual | As specified in Subsection 17.6.6.2, Segregation |
| **Coring** | | |
| 13. Coring | ATT-5 | As specified by the Consultant and in accordance with 17.6.5 |
| i. ACP Density – Percent Compaction | ATT-67, ATT-5 | As determined by the Consultant |
| ii. Density Immersion Method, Saturated Surface Dry | ATT-7 | As determined by the Consultant |

## 17.5 Equipment and Methods

### 17.5.1 General

Equipment and methods used shall be adequate to meet all specification requirements. Any equipment or method which, in the opinion of the Consultant, contributes to work that does not meet specification requirements shall be immediately corrected by the Contractor to the full satisfaction of the Consultant.

### 17.5.2 Asphalt Mixing Plants

Asphalt mixing plants shall be used in the production of ACP and conform to the requirements of Subsection 3.50.5.1.2, Mixing Plant, of the Standard Specifications for Highway Construction. The Contractor shall provide the Consultant with a certificate of calibration which certifies that the plant has been calibrated to produce a uniform mixture in accordance with the Job Mix Formula.

### 17.5.3 Transportation of ACP

ACP shall be transported from the asphalt mixing plant directly to the paver hopper in end-dump trucks with smooth metal boxes capable of fully containing all materials until discharge. End-dump truck boxes shall be thoroughly cleaned of hardened ACP and all other foreign materials prior to being loaded at the asphalt mixing plant. Each end-dump truck shall be equipped with a tarpaulin of suitable material and of sufficient size to overhang the vehicle box when fully loaded. Tarpaulins shall be securely fastened on all sides of the truck box and only be removed immediately prior to discharging ACP into the paver hopper.

Excess truck box lubricants such as detergent or lime solutions shall not contaminate the mix. Petroleum based truck box lubricants shall not be used.

### 17.5.4 Pavers

Pavers shall be self-propelled, configured to receive ACP directly into a hopper from end-dump trucks, operated to maintain required profiles, cross-falls and joint matching. For new construction, bridge structures that have more than 3 travel lanes or longer than 75 m in length shall be paved with two or more pavers operating in simultaneous echelon such that the entire width of the ACP lift is completed at one time.

### 17.5.5 Compaction

The Contractor shall provide sufficient self-propelled equipment to obtain the specified degree of compaction. Compaction equipment shall be of a suitable size, weight and type as acceptable to the Consultant, such that displacement of the mat and/or disruption of underlying materials do not occur. The compaction capability of the equipment used shall equal or exceed the placing rate.

Compaction equipment shall be in proper mechanical condition and operated such that uniform and complete compaction is obtained throughout the entire width, depth and length of the ACP being constructed. Rollers shall leave a smooth, properly finished surface, true to grade and cross-section without ruts or other irregularities. All compaction equipment shall be equipped with methods of wetting the tires or drums to prevent adhesion or pickup of ACP.

At a minimum, the Contractor shall provide the following equipment for ACP compaction operations:

- One rubber tired roller (mass greater than 10 tonnes);
- One smooth steel drum type roller (mass greater than 10 tonnes);
- One compact tandem articulating smooth steel drum type roller (mass of 1 to 2 tonnes); and
- Specialized equipment to achieve adequate compaction and smoothness in tight corners at deck joints or other locations.

The compact tandem articulating roller shall be configured with a single arm full flush drum between 0.7 and 1 m in width and be solely dedicated to compacting ACP within 12 mm of barriers, curbs, deck joints and medians. The Department and the Consultant, at their sole discretion, will determine equivalency of proposed alternate roller equipment.

Vibrators on vibratory rollers shall not be activated on bridge decks, roof and approach slabs, or any structural element within 1 m of the bridge.

## 17.6 Construction

### 17.6.1 ACP Joints

All longitudinal and transverse joints shall be of the vertical butt joint type, made in a careful manner, well bonded and sealed, and shall be finished to provide a continuous, smooth profile across the joints.

Longitudinal joints of successive ACP mats shall be offset a minimum of 0.3 m, unless otherwise accepted by the Consultant. Longitudinal joints of final lift ACP shall not be located within wheel path areas.

For transition and/or approach road paving, the Contractor shall saw cut construction joints between existing ACP and new ACP. The construction joint shall be saw cut to a depth of the new ACP and on a 15° left hand forward (LHF) skew to the centreline of the roadway for the full width of the roadway. The construction joint shall be protected to prevent spalling, raveling or other damage. Joints that are damaged shall be re-saw cut at the Contractor’s expense.

### 17.6.2 Protection of the Environment and Bridge Components

The Contractor shall implement temporary measures to ensure no asphaltic materials are released into the environment. All deck drains and drainage components shall be adequately sealed to prevent leakage.

The Contractor shall protect all bridge components from splatter or staining from asphaltic materials. If splatter or staining occurs it shall be repaired to the full satisfaction of the Consultant and at the Contractor's expense. Prior to completing repairs the Contractor shall submit a repair procedure to the Consultant for review and acceptance. In addition to removing the splatter or staining of bridge components the repair procedure shall include removing and reinstating all specified concrete finishes to the satisfaction of the Consultant.

The Contractor shall provide temporary protection to deck joint concrete paving lips such that haul trucks, pavers or and compaction equipment access does not chip or spall the concrete or damage the waterproofing membrane system or any other bridge component. Any damage caused by equipment accessing the bridge shall be immediately repaired by Contractor to the satisfaction of the Consultant.

### 17.6.3 Mix Production

The Contractor shall produce ACP in accordance with Subsection 3.50.5.1.3, Mix Production, of the Standard Specifications for Highway Construction.

The Contractor shall maintain the ACP temperature within specified mixing temperature and under no circumstance shall it exceed 155 °C.

### 17.6.4 Tack Coat

After all temporary protection measures have been acceptably installed; tack coat shall be applied to all surfaces that receive ACP except bridge waterproofing wick drains. To prevent contamination, wick drains shall be covered with materials acceptable to the Consultant during application of the tack coat.

The surface to be tacked shall be dry and free of loose or deleterious material prior to the application of the tack coat.

Tack coat shall be applied in a uniform manner at an application rate of 0.5 $\ell/m^2$ and suitable temperature. The ambient air temperature at the time of application shall be 5 °C or higher.

The tack coat shall be protected from traffic or other damage. Damaged areas shall be retacked at the Contractor's expense to the full satisfaction of the Consultant.

### 17.6.5 Spreading and Compaction

#### 17.6.5.1 General

ACP shall only be placed on clean, dry, frost free substrate on which the tack coat has cured and when the ambient air temperature is 5 °C or higher. Prior to placement of ACP, all surfaces shall be cleaned of loose or foreign material.

ACP shall be spread and compacted during daylight hours.

Care shall be taken at all times to ensure that:

- ACP is not wasted over the side or onto the adjacent surface mat;
- Damage does not occur to the waterproofing membrane, curbs, barriers, medians, concrete paving lips, manholes, or drains;
- Damage does not occur to guide posts, guardrails, signs, power conduits or any other roadside appurtenances.

Any damage shall be repaired to the full satisfaction of the Consultant and at the Contractor's expense.

Each mat shall be spread, compacted, finished and allowed to cool down to 50 °C or less prior to placing subsequent lifts. Lifts of ACP shall not exceed 70 mm.

The crown of the bridge deck and approaches shall be maintained and the Contractor shall avoid operating compaction equipment on or across the crown. Compaction procedures and equipment shall be such that displacement of ACP does not occur. Compaction equipment shall be kept sufficiently wet with water to prevent ACP pickup.

17.6.5.2 Spreading

The ACP mix shall be spread at a temperature sufficient to achieve the specified compaction temperatures.

The manner of placing shall ensure safe accommodation of traffic, quality control and drainage. The longitudinal and transverse edges of each mat shall be straight in alignment, uniform, and of the same thickness as the adjoining pavement mat. Measures shall be implemented to protect exposed edges throughout the Work.

17.6.5.3 Compaction

ACP compaction shall be measured and monitored using the control strip method.

For each bridge structure, a control strip density shall be determined for each lift of ACP. The control strip density shall be determined on the first mat placed of each lift as follows:

- Control strip test locations shall be located every 20 m along length of the bridge. No test location shall be located within 200 mm of any curb, barrier, median, or mat edge.
- Once the ACP has been spread by the paver and the initial pass of the breakdown roller has been made, the control strip test locations shall be marked out on the ACP surface by outlining the nuclear density gauge using chalk;

- At each of the control strip test locations a nuclear density reading shall be taken following each pass of compaction equipment. Compaction shall continue until no further increase in density is achieved. The maximum density reading from each of the control strip test locations will be averaged to determine the Control Strip Density ($kg/m^3$) of the lift.

After the Control Strip Density has been determined, compaction testing for all remaining mats of the lift shall be as follows:

- Each mat shall be monitored and continuously tested for compaction using the nuclear density gauge; and

- Following compaction, density readings shall be taken and recorded at a minimum frequency of one per every 10 m of bridge length or 20 m of approach road transitions for each mat placed (minimum 2 tests per mat). The average of the readings taken by the nuclear gauge shall be considered the Average Mat Density. Density results shall be provided to the Consultant on the same day of testing.

All compaction testing shall be completed by an independent third party testing agency that is prequalified by the Department in the category of QA Testing Services (Grading, Base Paving). The testing agency shall maintain a minimum of two nuclear density gauges on site during compaction operations. Only one nuclear density gauge shall be utilized for each paving day and the other stored as a backup. Both nuclear density gauges shall be in good working order and their condition and calibration verified by the Contractor prior to commencement of any ACP placement. Verification of nuclear density gauge calibration shall immediately be provided to the Consultant upon request.

The minimum average density of each mat shall be 98% of the control density. If the minimum average mat density is less than 98%, but greater than 95% of the control density, the mat, at the sole discretion of the Department and Consultant, may be accepted at an adjusted price in accordance with Subsection 17.7.3, Payment Adjustment for Density.

Rejected ACP shall be removed and replaced by the Contactor at his expense to the full satisfaction of the Consultant. The Contractor shall submit a removal and replacement procedure to the Consultant for review and acceptance before the commencement of any removal.

#### 17.6.5.4 Hot-Applied Rubberized Asphalt Waterproofing Membrane System ACP

The following specific requirements are in addition to those stated elsewhere within this specification.

ACP shall be placed and compacted in two nominal 40 mm lifts. The first lift of ACP shall be spread by the asphalt paver in the direction of the protection board laps (downhill). In the event that paving cannot be carried out in the direction of the protection board laps, the Contractor shall submit a procedure to the Consultant for review and acceptance identifying all measures that will be taken to ensure that the protection board and waterproofing membrane will not be damaged during paving operations.

The paver shall not push the delivery end-dump trucks. All equipment shall perform all turning movements off the bridge. ACP shall be dumped directly into the paver hopper. Under no circumstance shall ACP be placed onto the protection board ahead of the paver or at other locations.

The allowable ACP temperature range at the start of compaction of ACP lifts on the hot-rubberized asphalt waterproofing membrane system shall be in accordance with Table 17-2: Allowable Compaction Temperatures for Hot-Applied Rubberized Asphalt Waterproofing Membrane ACP.

**Table 17-2: Allowable Compaction Temperatures for Hot-Applied Rubberized Asphalt Waterproofing Membrane ACP**

| | **COMPACTION TEMPERATURE RANGE** | |
|---|---|---|
| **ASPHALT GRADE** | **FIRST LIFT** | **SECOND LIFT** |
| PG58-28 | 95°C - 105°C | 128°C – 138°C |
| PG52-34 | 95°C - 105°C | 123°C – 133°C |

17.6.5.5 Polymer Waterproofing Membrane Systems ACP

The following specific requirements are in addition to those stated elsewhere within this specification.

The ACP wearing surface shall be placed and compacted in one nominal 50 mm thickness or as specified in the Contract documents.

The paver shall not push the delivery end-dump trucks. All equipment shall perform all turning movements off the bridge. ACP shall be dumped directly into the paver hopper. Under no circumstance shall ACP be placed onto the waterproofing membrane system ahead of the paver or at other locations.

The allowable ACP temperature range at the start of compaction of ACP on the polymer waterproofing membrane system shall be between 123°C and 138°C.

17.6.5.6 Approach Road Transition ACP

The following specific requirements are in addition to those stated elsewhere within this specification.

ACP shall be placed as shown on the Drawings, in the Special Provisions of the Contract, or as determined by the Consultant.

The ACP temperature at the start of compaction of ACP for approach road transitions shall be a minimum of 123°C.

17.6.5.7 Coring

When, in the opinion of the Consultant, compaction methods and/or procedures are not achieving specification requirements and nuclear density test measurements indicate that the specified compaction have not been achieved, the Consultant may require the Contractor to obtain cores for testing. The Contractor shall not take cores unless requested by the Consultant and Department. Core locations will be determined by the Consultant. Cores shall not be taken within the first lift of ACP in which waterproofing membranes are present below.

All coring and associated testing shall be completed by a third party independent testing agency that is prequalified to provide QA, mix design, and pavement smoothness testing services on Department projects.

The number of cores taken shall be the greater of five or one core for every 40 $m^2$ of ACP surface area. Cores shall have a diameter of either 100 mm or 150 mm. Contractors shall utilize core extraction methods that result in complete and undamaged cores.

Upon completion of coring the Contractor shall repair all core holes as follows:

- Core holes shall be completely de-watered, dried and liquid asphalt applied to the bottom and sides of the core hole and allowed to cure;

- ACP shall then be placed and compacted into the core hole until level with the surface of the adjacent pavement; and

- All repaired core hole locations shall be slurry sealed 100 mm beyond the core perimeter.

The Contractor shall submit core results to the Consultant within 3 days of core extraction.

All costs associated with ACP coring, testing and subsequent repairs shall be the responsibility of the Contractor and no additional or further payment will be made.

17.6.6 Surface Requirements and Material Tolerances

17.6.6.1 Smoothness

Except across the crown, the surface of the ACP shall be such that when tested with a 3 m long straight edge placed anywhere in any direction on the surface, there shall not be a gap greater than 3 mm between the bottom of the straight edge and the surface of the ACP. The surface of ACP shall be checked by the Contractor immediately after the final rolling. Any final lift ACP surface that does not meet the smoothness requirements shall be repaired by the Contractor to meet the requirements in a manner acceptable to the Consultant.

### 17.6.6.2 Segregation

Pavement segregation shall be classified in accordance with Subsection 3.50.4.7.2, Classifying Pavement Segregation, of the Standard Specifications for Highway Construction. The Department's manual for Paving Guidelines and Segregation Rating Manual shall be used as reference in classifying segregation severity.

During paving operations, the Contractor shall make every effort to achieve a finished surface that has a uniform closed texture and is free of segregated areas. At the end of paving each day or completion of a paving lift, the Consultant will perform an inspection of the paving to identify areas of pavement segregation. If segregation is present, the Contractor shall take immediate corrective action to the paving process to prevent any further occurrence of segregation. The Contractor, at his expense, shall repair segregated areas of all severities as follows:

- When slight or moderate segregation is identified in the bottom lift it shall be repaired using a slurry or hot mix patch.

- When any severe segregation is identified in the bottom lift, it shall be removed and replaced. Any damage to the bridge deck waterproofing system shall be repaired to the full satisfaction of the Consultant prior to subsequent paving operations. Subsequent lift(s) shall be modified to meet the specification requirements and approved by the Consultant.

- When any slight or moderate segregation, including centre of paver streak, is identified in top or final lifts it shall be repaired using a slurry patch or hot mix patch. The extent of slight or moderate segregation will be reviewed by the Department and Consultant to determine if patching is acceptable or if the entire lift requires removal and replacement.

- When severe segregation is identified in the top lift, the entire lift shall be removed and replaced.

### 17.6.6.3 Defects

All lifts of ACP shall be smooth, true to cross section and grade, and free from ruts, depressions, bumps, or other irregularities.

The finished surface of any lift shall have a uniform closed texture and be free of areas of excess or insufficient asphalt, improper matching of longitudinal and transverse joints, roller or tire marks, cracking or tearing, or sampling locations not properly reinstated.

### 17.6.6.4 Asphalt Content

The average asphalt content shall not be greater than ± 0.50% from the accepted mix design.

17.6.6.5 Aggregate Gradation

For each lift of ACP the difference between the average gradation and the Job Mix Formula gradation shall not exceed the amounts outlined in Table 17-3: Aggregate Gradation Variation.

**Table 17-3: Aggregate Gradation Variation**

| **Sieve Size (μm)** | **Maximum Permissible Variation Percent by Weight Passing (1)** |
|---|---|
| 5000 | ± 6 |
| 1250 | ± 4 |
| 630 | ± 3 |
| 315 | ± 3 |
| 160 | ± 2.5 |
| 80 | ± 2 |

Notes

(1) Average Gradation must meet the gradation requirements of Subsection 3.2, Aggregate Production and Stockpiling, of the Standard Specifications for Highway Construction.

17.6.7 Repair Procedures

If any repairs, or removal and replacement are required, as determined by the Consultant, the Contractor shall submit proposed methods of repair or removal and replacement to the Consultant for review and acceptance a minimum of one week before commencement of the repair or removal and replacement Work.

All costs associated with repairs or removal and replacement shall be at the Contractor's expense.

17.6.8 ACP Surface Removal

Surface removal of ACP shall be completed in accordance with Subsection 20.3.2, Surface Removal.

17.6.9 ACP Gradeline Profiling

The gradeline will be designed by the Consultant to provide a smooth riding surface for the finished ACP. The Contractor shall assist the Consultant with profiling of the bridge structure and approaches.

For new construction projects, profiling shall occur before and after ACP placement.

For rehabilitation projects, profiling shall occur before and after surface removal, and after ACP placement.

Gradeline profiles will be produced by the Consultant and shall be used by the Contractor in placement of ACP. The following will be provided by the Consultant to the Contractor:

- Three parallel profile lines the entire length of the bridge:

    - Line No. 1 will be located 1.0 m from curb face.
    - Line No. 2 will be located 0.3 m in from the edge of mat adjacent to the crown.
    - Line No. 3 will be located 1.0 m from curb face.

    The stations of Line No. 1, Line No. 2, and Line No.3 will be square to each other.

    Additional profile lines will be produced when determined necessary by the Consultant.

- Stations will be established at the edges of deck joints and at 3.0 m intervals along the length of the bridge.

- At a minimum, profiles will include 30 m of approach at each end of the bridge at 3.0 m intervals.

- Profile plots will be to the following scales:

    - Horizontal: 10 mm = 1 000 mm
    - Vertical: 1 mm (normal) or 1 mm = 5 mm (minimum)

- The proposed design gradeline will be a smooth line achieving a nominal thickness as shown on the Drawings or determined necessary by the Consultant.

The Contractor shall remove any deck surface temporary markings before placement that will adversely affect bonding of subsequently placed materials.

The Consultant will provide the summary of the proposed ACP thickness, to the nearest mm, at each control point. The Contractor is responsible for achieving the gradeline provided by the Consultant.

## 17.7 Measurement and Payment

### 17.7.1 Payment by Lump Sum

Payment for the supply and placement of asphalt concrete pavement will be made at the lump sum price bid for “Asphalt Concrete Pavement” for the applicable Mix Type less any applicable payment adjustments for density, and will be full compensation for preparation of the asphalt mix designs and job mix formula; protection of the environment and bridge components; surface profiling; the supply and processing of aggregate; the supply and application of tack coat; the supply of asphalt cement; processing, hauling, placing and compacting the mix; sampling and testing; construction of ACP joints; and all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

### 17.7.2 Payment by Unit Price

Measurement for payment of the supply and placement of asphalt concrete pavement will be by the tonnage of material acceptably placed, measured to the 0.1 tonne.

The quantity to be paid for will be calculated by the Consultant using the design profile and surface area shown on the Drawings or reviewed and accepted by the Consultant. The conversion factor from cubic metre volume to tonnage of asphalt concrete pavement will be 2.3.

Payment will be made at the unit price bid for “Asphalt Concrete Pavement” for the applicable Mix Type, less any applicable payment adjustments for density, and will be full compensation for preparation of the asphalt mix designs and job mix formula; protection of the environment and bridge components; surface profiling; the supply and processing of aggregate; the supply and application of tack coat; the supply of asphalt cement; processing, hauling, placing and compacting the mix; sampling and testing; and construction of ACP joints; and all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

### 17.7.3 Payment Adjustment for Density

The Department reserves the right to reject asphalt concrete pavement that does not meet the specified requirements. The Department may, at its sole discretion, accept asphalt concrete pavement that does not meet the specified density at a reduced price.

ACP will be considered acceptable at full payment or acceptable with payment reduction or rejection according to the values outlined in Table 17-4: Payment Adjustment for ACP Density (Measurement by Nuclear Gauge). Payment adjustment will be assessed for each mat of ACP placed. The Department may, at its sole discretion, reject all lift mats if any mat is found to be within rejection limits. Payment adjustment will be converted from a volume to tonnage basis using a factor of 2.3 tonnes per cubic metre.

**Table 17-4: Payment Adjustment for ACP Density (Measurement by Nuclear Gauge)**

| Average Mat Density / Control Density | Payment Reduction for ACP Density (% of Unit Price per tonne or Lump Sum) |
|---|---|
| ≥ 98% | Full Bid Price |
| ≥ 97% < 98% | Bid Price Less 15% |
| ≥ 96% < 97% | Bid Price Less 30% |
| > 95% < 96% | Bid Price Less 45% |
| ≤ 95% | Rejected |

When coring of ACP is required by the Consultant and the Department, ACP will be considered acceptable at full payment or acceptable with payment reduction or rejection according to the values outlined in Table 17-5: Payment Adjustment for ACP Density (Measurement by Core). Payment adjustment will be assessed for each mat of ACP placed. The Department may, at its sole discretion, reject all lift mats if any mat is found to be within rejection limits. Payment adjustment will be converted from a volume to tonnage basis using a factor of 2.3 tonnes per cubic metre.

**Table 17-5: Payment Adjustment for ACP Density (Measurement by Core)**

| Average Core Density / Marshall Briquette Density | Payment Reduction for ACP Density (% of Unit Price per tonne or Lump Sum) |
|---|---|
| ≥ 97% | Full Bid Price |
| ≥ 96% < 97% | Bid Price Less 15% |
| ≥ 95% < 96% | Bid Price Less 30% |
| > 94% < 95% | Bid Price Less 45% |
| ≤ 94% | Rejected |

### 17.7.4 ACP Surface Removal

Measurement for payment of ACP surface removal will be by the square metre, based on horizontal measurements to the nearest 0.1 $m^2$.

Payment will be made at the unit price bid for “ACP Surface Removal”, and will be full compensation for removal of the existing ACP to the depths specified; surface cleaning; disposal of debris; and all labour, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

# SECTION 18 CSP AND SPCSP STRUCTURES

TABLE OF CONTENTS

REFERENCE TABLES Table No.

## 18.1 General

This specification is for the supply, fabrication, delivery and installation of Corrugated Steel Pipe (CSP) and Structural Plate Corrugated Steel Pipe (SPCSP) with an equivalent diameter of 1500 mm or greater. All work shall be carried out in accordance with this specification, as shown on the Drawings and Standard Drawings S-1418, Installation of CSP and SPCSP Structures, S-1847, Standard Identification Plaques and Benchmark Tablet, and S-1848, Standard Identification Tags.

## 18.2 Supply and Fabrication

### 18.2.1 Standards

The supply and fabrication of all galvanized, polymer coated and aluminum coated Corrugated Steel Pipe including couplers and appurtenances and Structural Plate Corrugated Steel Pipe shall be in accordance with the current edition of Canadian Standards Association (CSA) Standard G401 with additions and exceptions as described in this specification.

Only welders, welding operators and tackers approved by the Canadian Welding Bureau (CWB) in the particular category shall be permitted to perform weldments. Their qualifications shall be current and available for examination by the Consultant.

### 18.2.2 Qualification

All CSP and SPCSP shall be supplied and fabricated by a fabricator certified to CSA G401. Certification shall be completed by an independent agency accredited by the Standards Council of Canada.

### 18.2.3 Engineering Data

#### 18.2.3.1 Shop Drawings

Shop drawings for SPCSP structures, beveled ends, elbows and any other component specified in the Special Provisions of the Contract shall be submitted to the Consultant for review and acceptance a minimum of 2 weeks in advance of the commencement of fabrication. Review comments provided by the Consultant and/or the Department shall be incorporated into the shop drawings and resubmitted to the Consultant for review and acceptance prior to the commencement of fabrication.

Shop drawings shall be electronic unlocked PDF format. Each shop drawing shall include the Department’s shop drawing identification block and have a sufficient blank space for the Consultant’s review stamp. The Department’s shop drawing identification block will be provided to the Contractor upon request. As a minimum, the following information shall be included on shop drawing submissions:

- Dimensions;
- Plate arrangements;
- Bolting details;

- Materials lists; and
- Assembly sequence.

The shop drawings will be reviewed by the Consultant solely to ascertain general conformance with codes and specifications. The Consultant's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

#### 18.2.3.2 SPCSP Plate Arrangement

For SPCSP structures, bolts in the corrugation valley of each longitudinal seam shall be closer to the visible plate edge than bolts located on the corrugation crest. Longitudinal seams shall be staggered a minimum of 2N, except where reviewed and accepted by the Consultant.

### 18.2.4 Materials

All pipe materials shall be new material supplied in accordance with CSA G401. CSP and SPCSP components shall be marked according to CSA G401.

#### 18.2.4.1 Mill Test Reports

Mill test reports and product data sheets shall be provided for all materials in English.

Mill test reports and product data sheets shall be submitted to the Consultant for review and acceptance 2 weeks prior to the commencement of fabrication.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards. The testing laboratory shall be certified to ISO/IEC 17025 by an organization accredited by the Standards Council of Canada for the tests required. Samples for testing shall be collected by personnel employed by the certified laboratory. A verification letter shall be provided by the certified laboratory that includes at a minimum, the applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the certified laboratory.

### 18.2.5 Fabrication

#### 18.2.5.1 Fabrication of CSP

##### 18.2.5.1.1 Sloped Ends

Sloped end sections are required for each culvert unless otherwise noted on the Drawing or the culvert order. When 2:1 sloped end sections are specified by the order, the attached Tables A and B will apply unless stated otherwise.

18.2.5.1.2 Termination of Lockseams

On pipes 1500 mm diameter or larger all lockseams terminating at the cut edges of a sloped or square end section shall have a 75 mm length of fillet weld run along both sides of the lockseam (staggered 300 mm apart) at each cut edge. The weld and surrounding area shall be zinc coated in accordance with CSA G401.

18.2.5.1.3 Cut Ends

All cut edges of a sloped or square end section shall be made smooth by grinding so that all the burrs are removed. Any damaged protective coating shall be recoated with appropriate material in accordance with CSA G401.

18.2.5.1.4 Recorrugated Ends

All corrugated steel pipes shall have ends recorrugated to provide annular corrugations for couplers.

18.2.5.1.5 Couplers

Only annular corrugated couplers will be accepted unless specified otherwise on the order. The couplers for pipes 1600 mm and over in diameter shall be a minimum of 600 mm width. There shall be a minimum of five bolts at every joint of every coupler.

18.2.5.2 Fabrication of SPCSP

18.2.5.2.1 Sloped Ends

Sloped end sections are required for each culvert unless otherwise specified on the Drawings. When 2:1 sloped end sections are specified Table C shall apply.

18.2.5.3 Standard Identification Plaques and Tags

Standard identification plaques and identification tags shall be supplied and installed in accordance with Section 13 Miscellaneous Iron, Standard Drawing S-1847, Standard Identification Plaques and Benchmark Tablet, and S-1848, Standard Identification Tags.

18.2.6 Shop Inspection

18.2.6.1 Inspection, Sampling and Testing

All materials shall be subject to inspection, sampling and quality assurance testing by the Consultant. The Contractor shall provide safe, convenient access acceptable to the Consultant for inspection and sampling of the materials, and shall cooperate in the inspection and sampling process when requested to do so.

Any material found unacceptable by the Consultant shall be replaced by the Contractor with acceptable material by the Contractor at the Contractor’s expense.

Testing, inspection and related costs incurred by the Consultant as a result of defective work shall be paid for by the Contractor.

18.2.6.2 Notification

Prior to shipment of CSP or SPCSP, the Contractor shall notify the Consultant a minimum of 72 hours in advance to facilitate inspection and acceptance. The Contractor shall be responsible for all costs incurred by the Consultant to inspect CSP and SPCSP at the construction site, due to the Contractor's failure to receive the Consultant's acceptance, prior to shipping from the fabrication facility.

18.2.7 Storage of Material

18.2.7.1 Stockpiles

All material shall be unloaded and stockpiled in a neat and orderly manner, so as to facilitate inspection and inventory, and in such a manner as to insure preservation of their quality and fitness for the work. Stockpiled materials, accepted on delivery as to quantity and observed condition, shall be subject to test, and shall meet requirements of the specifications at the time they are to be used in the work.

18.2.7.2 Storage Stains

SPCSP material is to be stored concave down.

Galvanized material shall be stacked or bundled to prevent wet storage stains as defined by the American Hot Dip Galvanizers Association (AHDGA) publication "Wet Storage Stain". Any evidence of wet storage stain shall be removed to the satisfaction of the Consultant.

18.2.8 Handling of Material

All culvert material shall be handled carefully and in such manner as to prevent bruising, scaling or breaking of the galvanized coating. Culvert material shall also be handled and unloaded without undue stress and in such a manner that the radii or dimensions of the pipes remain true. Coupling bands shall be shipped with all necessary hardware and fittings attached thereto, or in suitable shipping containers. All SPCSP bolts are to be shipped with plates. Where the material supplied is damaged, the Contractor shall immediately separate nested sections of plate or pipe to facilitate more detailed inspection. Culvert material designated by the Consultant as unacceptable, due to failure to meet specified requirements, shall be immediately repaired or replaced by the Contractor.

Where the Contractor's failure to satisfactorily stockpile, or to satisfactorily expedite repairs to damaged material, necessitates that the Consultant require this to be done separately, the cost of such work will be charged to the Contractor.

#### 18.2.9 Repair of Damaged Coatings

##### 18.2.9.1 Galvanizing

All damaged galvanized surfaces shall be repaired in accordance with CSA G401.

##### 18.2.9.2 Polymer

Components with damage to polymer surfaces of less than or equal to 50 mm shall be repaired as follows:

- At the fabrication facility, repairs for the outside or external side shall use RAN VAR TPC-515-7 or DENSO Butyl 35 tape. Repairs for the inside or internal side shall use DENSO Butyl 35 tape.
- At the project site, repairs for both external and internal sides shall use DENSO Butyl 35 tape.

Components with damage to polymer surfaces greater than 50 mm shall be rejected when identified at the fabrication facility.

Components with damage to polymer surfaces greater than 50 mm identified at the project site will be assessed by the Consultant and the Department. The Consultant and Department will determine whether the damage to the polymer surface is repairable. If damage is determined repairable the Contractor shall submit a detailed repair procedure to the Consultant for review and acceptance. Repair work shall not commence until acceptance has been received from the Consultant. If the damage is determined to be irreparable, new components shall be provided by the Contractor at his expense.

### 18.3 Installation

#### 18.3.1 General

Installation of CSP and SPCSP structures shall not proceed until the excavation, foundation, and bedding material placement has been reviewed and accepted by the Consultant.

The Contractor shall install CSP and SPCSP structures to the lines and grades as shown on the Drawings and as determined by the Consultant.

#### 18.3.2 Care of Water

In addition to ECO plan submission requirements, the Contractor shall also prepare and submit a separate care of water plan signed and sealed by a professional engineer registered in the Province of Alberta to the Consultant for review and acceptance a minimum of 2 weeks prior to the preconstruction meeting. The care of water plan shall outline the means and methods that will be used to control and manage water and/or ice at all times during the Work in accordance with all applicable environmental regulations.

The care of water plan will be reviewed by the Consultant solely to ascertain general conformance with environmental regulations, specifications and any applicable Special Provisions of the Contract. The Consultant's review and acceptance shall not be considered as relieving the Contractor of his full responsibility for the design, construction, monitoring, performance, and maintenance of the care of water plan.

### 18.3.3 Excavation

Excavations shall be carried out to the lines and grades shown on the Drawings, or as determined by the Department and Consultant, and in accordance with Section 1, Excavation, to permit placing of the bedding material.

Excavations shall be dewatered to the bottom of the excavation until all backfilling is acceptably completed.

### 18.3.4 Bedding

Where the bottom of the excavation lies at 600 mm or less below the pipe invert the fill material shall be compacted by the Contractor to a minimum of 95% of Standard Proctor Density at optimum moisture content. Where the bottom of the excavation extends more than 600 mm below the pipe invert, the fill material shall be compacted at the 600 mm level to a minimum of 95% of Standard Proctor Density at optimum moisture content. The structural fill shall be placed in lifts not exceeding 150 mm, prior to compaction. The Contractor shall use whatever materials, labour, equipment and incidentals necessary to achieve a stable bed.

The Contactor shall place woven geotextile filter fabric before placing granular backfill material, as shown on Standard Drawing S-1418, Installation of CSP and SPCSP Structures.

The supply and placing of the woven geotextile filter fabric will be considered incidental to the Work and no separate or additional payment will be made.

The physical properties and minimum requirements of woven geotextile filter fabric shall be in accordance with Table 18-1, Woven Geotextile Filter Fabric Requirements.

**Table 18-1: Woven Geotextile Filter Fabric Requirements**

| Physical Property | Minimum Requirement |
|---|---|
| Grab Strength (ASTM D4632) | 1275 N |
| Elongation (Failure) | 15% |
| CBR Puncture Strength (ASTM D6241) | 275 N |
| Trapezoidal Tear (ASTM D4533) | 475 N |

The minimum geotextile filter fabric lap shall be 1000 mm.

The crushed aggregate material within 150 mm of the bottom of pipe shall be placed in a loose uncompacted state. All other structural fill, including the clay seepage cutoffs, shall be compacted to a minimum of 95% of Standard Proctor Density at optimum moisture content.

The top of the bedding is that portion of the structural fill in contact with the bottom of the pipe and shall be constructed to the exact grade as shown on the Drawings. Where camber is specified, the top of the bedding shall be constructed on a gradual crest curve with no sudden breaks in the grade. Where preshaping is specified, the top of the bedding shall be constructed to the exact curvature of the bottom plates. The top of the preshaping shall be 200 mm to 300 mm below the horizontal seam which joins the sidewall to the bottom plates, or as shown on the Drawings.

### 18.3.5 Assembly

Assembly of CSP and SPCSP structures may proceed only after the excavation; foundation and bottom bedding material and shape have been reviewed and accepted by the Consultant.

The shape of CSP and SPCSP structures shall be maintained within 2% of design dimensions. When the Contractor supplies and installs devices and/or use methods to maintain the shape of the structure, they shall be such that no local distortions of the pipe or other signs of distress occur. Horizontal strutting shall not be used unless the Contractor obtains written acceptance from the Consultant. The Contractor shall continuously monitor the shape of the pipe during installation to ensure the specified design shape is achieved.

Assembly shall be completed in accordance with the reviewed and accepted shop drawings.

#### 18.3.5.1 CSP

CSP sections shall be laid so that the ends are in close contact. Couplers shall be well fitted and evenly tightened all around the pipe. Joints shall be sealed using non-woven geotextile.

CSP couplers shall be completely wrapped with a 2 m wide layer of non-woven geotextile, centered over the coupler prior to backfilling.

#### 18.3.5.2 SPCSP

SPCSP shall be assembled in accordance with the reviewed and accepted shop drawings and as follows:

- The pipe shall be assembled on the invert bed as shown on the Drawings and reviewed and accepted by the Consultant;
- All bolted seams shall be properly lapped and plates shall be in contact for the full width and length of the lap. The bolts in the valley of each longitudinal seam shall be nearer to the visible edge of the plate than the bolts in the crest;
- Assembly and loose bolting of the side arc and top arc plates may proceed, starting from the upstream end of the structure and progressing towards the downstream end;

- After two complete rings have been loosely assembled, the vertical dimensions shall be checked and where necessary adjusted with horizontal cables and/or supports to obtain design rise dimensions;

- Each adjacent ring shall then be assembled and adjusted in a similar manner until the entire structure is loosely assembled and conforms to design geometry with nested plates;

- The vertical axis shall be upright and the longitudinal seams shall be straight. Rotation of the pipe and/or spiraling of the longitudinal seams shall not be permitted;

- Adjustments shall be made to produce design dimensions with fully nested laps. When horizontal tie cables are used for shape adjustment, adequate means shall be taken to ensure distribution of concentrated forces at the pipe walls. Distortion of the pipe side walls at the cable points will not be tolerated;

- Bolts shall be torqued to not less than 200 Newton-metre (Nm) and not more than 340 Nm. This includes bolts which connect special features to the pipe. Where the supplier's specification for torque differs from this range the Contractor shall contact the Consultant for direction. Bolts shall be tensioned only once and shall not be reused;

- Distortion of bolt holes caused by over-torquing, or poor assembly methods will not be permitted. Proposed bolt holes additional to those shown on the shop drawings shall be reviewed and accepted by the Consultant and the Department. Any additional holes reviewed and accepted shall be drilled. Torch cutting of holes or welding on plate sections will not be permitted.

Where conflicting requirements exist between this specification and the manufacturer's shop drawings, the specification requirements shall govern.

### 18.3.6 Backfilling

The assembly of the structure must be accepted by the Consultant before backfilling with crushed aggregate material and/or non-granular materials as specified on the Drawings. Backfilling shall be in accordance with the current version of Standard Drawing S-1418 and Section 2, Backfill. In addition, the following requirements shall be met:

- Bedding material shall be crushed aggregate Des 2 Class 25;

- When the air temperature is below 0 °C, no backfilling is allowed unless otherwise accepted by the Department and Consultant. If backfilling is deemed acceptable due to extenuating circumstances, the Contractor shall submit a cold weather backfilling procedure to the Consultant for review and acceptance a minimum of 2 weeks prior to backfill placement. All backfill materials shall be in a thawed state when placed and compacted. No backfill material will be permitted to be placed on frozen substrate;

- The backfilling under the haunches shall be compacted in thin layers filling all corrugations and ensuring firm contact with the entire bottom surface of the pipe;

- The backfilling shall fill each corrugation, be free of voids and provide uniform support to the pipe. The backfill shall be placed such that the level of fill on one side of the pipe does not exceed the level of fill on the other side of the pipe by more than 300 mm;

- The backfill shall be placed and compacted by equipment moving parallel to the pipe with simultaneous handwork along the pipe. Large earth moving equipment and large compaction equipment shall not be permitted within 1.0 m of the pipe;

- The first 300 mm of the backfill over the pipe shall be placed, levelled and compacted without vibration. Subsequent fill over the pipe shall be placed and compacted by equipment moving perpendicular to the longitudinal axis of the pipe. The Contractor shall obtain the Consultant's acceptance before using any equipment above the pipe;

- The Contractor shall supply suitable material for the compacted non-granular backfill. Highly plastic clays or material with high silt content will not be permitted for use as non-granular backfill. The quality of the material, and the methods of placing and compacting, shall be reviewed and accepted by the Consultant before commencement of the Work; and

- Clay seal material shall be highly plastic clay with a minimum plasticity index of 40. Clay seal materials shall be classified in accordance with ASTM D2487.

#### 18.3.7 Strutting for Composite Concrete/SPCSP Structure

For composite concrete/SPCSP structures strutting and scaffolding shall be supplied and installed as shown on the Drawing.

#### 18.3.8 Installation Tolerances

The shape of CSP and SPCSP structures shall be within 2% of design dimensions during all stages of the Work and at construction completion.

## 18.4 Concrete Work

Where detailed and specified, the concrete work shall be constructed as shown on the Drawings and in accordance with Section 4, Cast-In-Place Concrete and Section 5, Reinforcing Steel.

## 18.5 Substrate Holders

Substrate holders shall be installed as shown on the Drawings and be fabricated in accordance with the specified Standard Specifications for Bridge Construction sections.

## 18.6 Heavy Rock Riprap

Heavy rock riprap, including non-woven geotextile filter fabric, shall meet the requirements of Section 10, Heavy Rock Riprap and shall be placed as shown on the Drawings.

## 18.7 Measurement and Payment

Payment for the following items will be made at the unit prices or lump sum prices bid:

- Detour Road - Construct and Maintain;
- Demolition, Disposal and Salvage of Existing Structure;
- Excavation;
- SPCSP – Supply;
- CSP with couplers – Supply;
- Backfill – Crushed Aggregate;
- Backfill – Non-Granular;
- SPCSP – Assembly;
- CSP – Assembly;
- Concrete End Treatment;
- Reinforcing Steel;
- Concrete;
- Substrate Holders;
- Heavy Rock Riprap;
- Miscellaneous Iron;
- Guardrail; and
- Roadway Work.

Such payments will be full compensation for all labour, materials, equipment, tools, and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

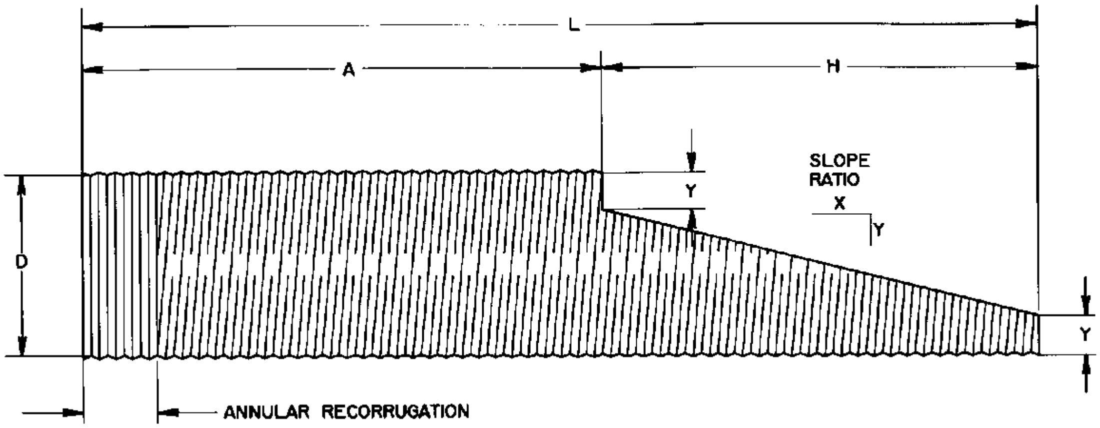
Unit price payments will be based on actual quantities acceptably completed and remaining in the Work, as determined by the Consultant.

Payment for "SPCSP – Supply" or "CSP with Couplers – Supply" will be made to a maximum of 90% of the lump sum or unit price bid once the materials have been acceptably supplied and delivered to the project site. The remaining 10% of the lump sum or unit price bid will be made once the structure has been acceptably backfilled and installation tolerances have been measured, reviewed and accepted by the Consultant.

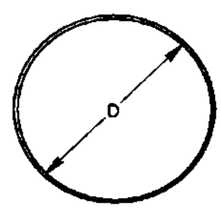
All costs associated with the supply and installation of geotextile filter fabric, when specified, will be considered incidental to the Work, and no separate or additional payment will be made.

All cost associated with the care of water will be considered incidental to the Work, and no separate or additional payment will be made.

# TABLE A
## DETAILS OF STANDARD 2:1 SLOPED END SECTIONS FOR CSP ROUND CULVERTS




| INSIDE DIAMETER "D" mm | SLOPE RATIO X:Y | "Y" mm | "A" m | "H" m | INVERT LENGTH OF SLOPED END SECTION "L" m |
|---|---|---|---|---|---|
| 1200 | 2:1 | 150 | 4.2 | 1.800 | 6.0 |
| 1400 | 2:1 | 200 | 4.0 | 2.000 | 6.0 |
| 1600 | 2:1 | 200 | 3.6 | 2.400 | 6.0 |
| 1800 | 2:1 | 300 | 3.6 | 2.400 | 6.0 |
| 2000 | 2:1 | 300 | 5.2 | 2.800 | 8.0 |
| 2200 | 2:1 | 300 | 4.8 | 3.200 | 8.0 |
| 2400 | 2:1 | 400 | 4.8 | 3.200 | 8.0 |
| 2700 | 2:1 | 400 | 6.2 | 3.800 | 10.0 |
| 3000 | 2:1 | 500 | 6.0 | 4.000 | 10.0 |
| 3300 | 2:1 | 500 | 5.4 | 4.600 | 10.0 |
| 3600 | 2:1 | 600 | 5.2 | 4.800 | 10.0 |




SECTION

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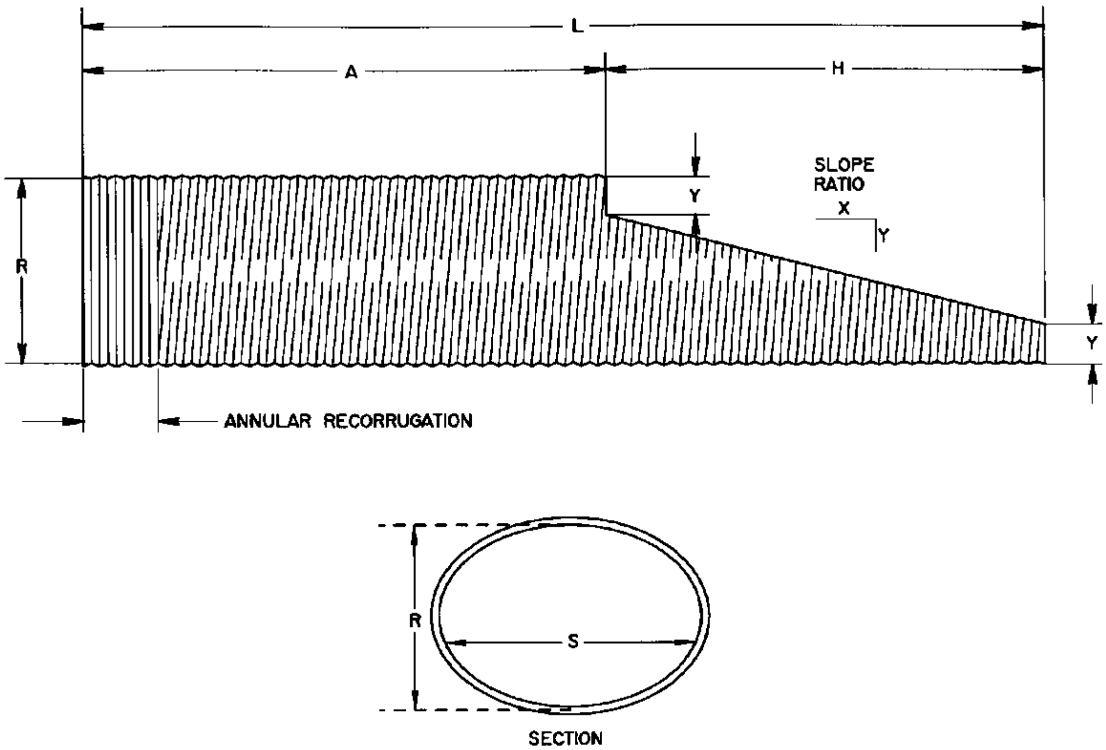
# TABLE B
## DETAILS OF STANDARD 2:1 SLOPED END SECTIONS FOR CSP ARCH CULVERTS




| EQUIVALENT INSIDE DIAMETER "D" mm | SPAN "S" mm | RISE "R" mm | SLOPE RATIO X:Y | "Y" mm | "A" m | "H" m | INVERT LENGTH OF SLOPED END SECTION "L" m |
|---|---|---|---|---|---|---|---|
| 1200 | 1390 | 970 | 2:1 | 150 | 4.660 | 1.340 | 6.0 |
| 1400 | 1630 | 1120 | 2:1 | 200 | 4.560 | 1.440 | 6.0 |
| 1600 | 1880 | 1260 | 2:1 | 250 | 4.480 | 1.520 | 6.0 |
| 1800 | 2130 | 1400 | 2:1 | 300 | 4.400 | 1.600 | 6.0 |

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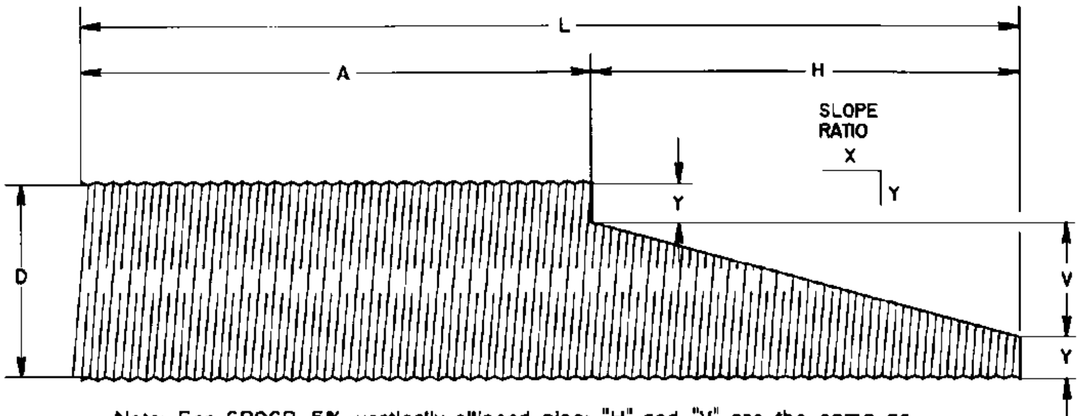
# TABLE C
## DETAILS OF STANDARD 2:1 SLOPED END SECTIONS FOR SPCSP ROUND CULVERTS




Note: For SPCSP 5% vertically ellipsed pipe: "H" and "V" are the same as for a round pipe of equivalent diameter; "Y" is variable with the increase in rise.

| INSIDE DIAMETER "D" mm | SLOPE RATIO X:Y | "Y" mm | "H" m |
|---|---|---|---|
| 1500 | 2:1 | 293 | 1.828 |
| 1660 | 2:1 | 373 | 1.828 |
| 1810 | 2:1 | 295 | 2.440 |
| 1970 | 2:1 | 375 | 2.440 |
| 2120 | 2:1 | 298 | 3.048 |
| 2280 | 2:1 | 378 | 3.048 |
| 2430 | 2:1 | 453 | 3.048 |
| 2590 | 2:1 | 533 | 3.048 |
| 2740 | 2:1 | 455 | 3.658 |
| 3050 | 2:1 | 610 | 3.658 |
| 3360 | 2:1 | 765 | 3.658 |
| 3670 | 2:1 | 920 | 3.658 |
| 3990 | 2:1 | 1080 | 3.658 |
| 4300 | 2:1 | 1235 | 3.658 |
| 4610 | 2:1 | 1390 | 3.658 |
| 4920 | 2:1 | 936 | 6.096 |
| 5230 | 2:1 | 1091 | 6.096 |
| 5540 | 2:1 | 1246 | 6.096 |
| 5850 | 2:1 | 1095 | 7.320 |
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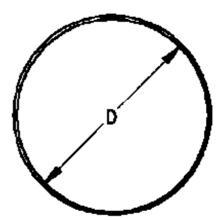
| 6780 | 2:1 | 1560 | 7.320 |
| 7090 | 2:1 | 1715 | 7.320 |
| 7400 | 2:1 | 1870 | 7.320 |
| 7710 | 2:1 | 2025 | 7.320 |
| 8020 | 2:1 | 2180 | 7.320 |

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# SECTION 19 PAINTED ROADWAY MARKINGS

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## 19.1 General

This specification is for the supply of all painting materials and the painting of roadway markings on bridge decks and approach roadways.

## 19.2 Materials

### 19.2.1 Paint and Glass Beads

The Contractor shall supply paint and glass bead materials that are on the Department's Products List and have been approved. The Contractor shall submit written confirmation from the manufacturer that the materials supplied shall meet all specified requirements.

The Contractor shall provide the Consultant with the following information prior to commencing the Work:

- Names and mailing addresses of the suppliers and manufacturers; and
- Paint formulation.

The Contractor shall advise the Consultant of any change in paint formulation. Paint shall not be diluted or mixed with a different formulation or with any other material without the specific acceptance of the Department.

The Contractor shall take all necessary steps to prevent contamination of the materials. Paint shall be protected from freezing.

## 19.3 Protection of Bridge Structure

The Contractor shall take due precautions against damaging or disfiguring any portion of the structure. The Contractor shall guard against spatters, overspray, splashes or smirches of paint or associated paint materials, and damages caused by fuel or lubricants used with his equipment.

## 19.4 Application

The Contractor shall paint lane lines, continuity lines, edge lines and directional arrows or dividing lines on the roadway and bridge deck to restore the painted markings as existed prior to the construction work, or as shown on the drawings, or as specified. Centrelines and shoulder lines shall be 100 mm wide. Broken centrelines shall be 3 m in length followed by a 6 m space. The Contractor shall ensure that painted lines match the existing lines exactly, unless otherwise determined by the Consultant.

The substrate surface shall be clean, dry and at least 10°C in temperature for waterborne paint during the paint application. All painted messages and lines shall be applied at the rate of 38 litres/km of solid 100 mm wide line and 0.4 litres/$m^2$ of actual painted area for painted messages. Glass beads shall be applied immediately following the paint application at a uniform application rate of 600 g/litre of paint. Messages and lines initially applied at less than the specified rate, as determined by the Consultant shall be repainted at the expense of the Contractor.

All painted markings shall be uniform in thickness with no spatter, excessive overspray, or other defects.

Construction and public traffic shall not be permitted to travel on the painted markings until after the paint has cured sufficiently to prevent damage or pickup.

### 19.4.1 Sampling and Testing

When requested by the Consultant, the Contractor shall supply the Consultant with quality assurance samples and the manufacturer's quality control test results. The manufacturer's quality control results shall include a minimum of Specific Gravity, Hiding Power, Dry to Traffic and Viscosity results. A minimum of one quality assurance sample per batch shall be taken for glass beads as per TLT-601, Sampling Glass Beads. A minimum of one quality assurance sample per color per batch shall be taken for paint as per TLT-636, Sampling Traffic Paint. Samples requested by the Consultant will be forwarded to the Department's designated quality assurance testing firm for third party quality assurance. The Consultant and the Department will review the quality assurance testing and determine the acceptability of the materials. If the materials supplied are determined not acceptable. The Contractor, at his expense, shall remove and replace any materials determined unacceptable, to the full satisfaction of the Consultant.

All materials are subject to inspection, sampling and testing by the Consultant, and the Contractor shall provide safe access and co-operate in the sampling and testing process when requested to do so.

## 19.5 Payment

All costs associated with the application of painted roadway markings, including the supply of materials, will be considered incidental to the Work, and no separate or additional payment will be made.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

# SECTION 20 DECK OVERLAY AND CONCRETE REHABILITATION

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## 20.1 General

Deck overlay and concrete rehabilitation may consist of, but not be limited to, surface removal, concrete repair, surface preparation, and/or deck overlay. The Work shall be completed as shown on the Drawings, in accordance with the requirements of this specification, Section 4, Cast-in-place Concrete, Section 5, Reinforcing Steel, and as described in the Special Provisions of the Contract.

Details of proposed material disposal locations shall be submitted to the Consultant for review and acceptance prior to disposing of materials.

## 20.2 Traffic Accommodation

Unless otherwise reviewed and accepted by the Consultant, all rehabilitation projects which include either a concrete or ACP overlay shall be completed in stages and a minimum of one undisturbed travel lane shall be available for the accommodation of public traffic at all times during construction.

Traffic accommodation shall be in accordance with the requirements of Subsection 7.1, Traffic Accommodation and Temporary Signing, of the Standard Specifications for Highway Construction and as described in the Special Provisions of the Contract.

## 20.3 Surface Preparation for Concrete Overlay

### 20.3.1 General

Surface preparation includes all work necessary to prepare the bridge for deck overlay concrete placement. This work includes, but is not limited to, the following:

- Surface removal;
- Removal and disposal of existing concrete paving lips;
- Partial depth repair;
- Full depth repair;
- Abrasive blasting of concrete surfaces to be overlaid; and
- Removal and reinstallation of bridgerail, as required, to accommodate screed rails.

Jack hammers heavier than nominal 14 kg class and chipping hammers heavier than nominal 7 kg class shall not be used for concrete removal.

### 20.3.2 Surface Removal

Surface removal shall be carried out in stages. The Contractor shall complete surface removal operations to the depth(s) shown on the Drawings or as described in the Special Provisions of the Contract. The Contractor shall submit details of his proposed surface removal methods to the Consultant for review and acceptance a minimum of one week prior to the scheduled commencement of the Work.

Surface removal shall be carried out as close as possible to all curbs, medians, barriers, drains, deck joints, and other bridge components without causing damage. Chipping equipment shall be used in these areas to complete removal operations. Concrete curb and deck joint paving lips within the limits of the surface removal area shall be removed, including the reinforcing steel projecting into these components. For bridges that do not have formal deck joints at the abutments, the Contractor shall saw cut through the full depth and width of the wearing surface at both ends of the bridge or at the transition paving limits prior to commencing removal operations.

When the specified removal depth includes more than 5 mm of concrete removal and cold milling methods are proposed by the Contractor, small milling machines having a maximum removal width of 1.2 m shall be used. Monitoring and making adjustments to the removal depth shall be carried out by the Contractor on an ongoing, as required basis to ensure an accurate depth of material removal is maintained throughout the milling operations. If the Contractor removes material in excess of 5 mm from that specified without prior approval from the Consultant, the costs associated with the additional material replacement quantities shall be at the Contractor’s expense.

The Contractor shall remove milling debris from behind the cold milling machine and clean the milled surface on a continuous basis, as close to the milling machine as is safely practicable. Debris removal and surface cleaning details shall be included in the Contractor’s proposed surface removal method submission.

Reinforcing steel or other bridge components damaged as a result of the Contractor’s surface removal operations shall be repaired or replaced by the Contractor at his expense.

Upon completion of surface removal operations, including thorough cleaning and drying of the deck surface and removal of all equipment, the Consultant will inspect the deck surface and identify areas of unsound concrete to be repaired. Repairs shall be carried out in accordance with Subsection 20.4, Concrete Repair.

### 20.3.3 Deck Surface Abrasive Blasting

Prior to deck overlay concrete placement the Contractor shall abrasive blast the entire deck surface and the vertical faces of the curb, median and parapet up to a height equal to the overlay thickness. Adequate shielding shall be provided to protect any repaired epoxy coated reinforcing steel or galvanic anodes. Blasting shall be carried out to a concrete surface profile 3 or 4 using the ICRI (www.icri.org) Guideline No. 310.2R-2013, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair that uniformly exposes fine aggregate.

Following blasting, the Contractor shall clean the deck surface so that it is free of all abrasive material, dust and other contaminants to the satisfaction of the Consultant.

Once accepted by the Consultant, the Contractor shall be responsible for maintaining the cleaned deck in satisfactory condition until placement of deck overlay concrete. Additional preparation or cleaning, including abrasive blasting, that may become necessary during this period shall be carried out by the Contractor at his expense.

## 20.4 Concrete Repair

### 20.4.1 General

Repair areas and limits of concrete removal will be determined by the Consultant.

The perimeter of repair areas shall be saw cut to a depth of 25 mm. When concrete cover above the reinforcing steel is less than 25 mm, the depth of the saw cut shall be modified such that the saw blade does not come within 6 mm of the reinforcing steel. All saw cuts shall be made in neat and perpendicular lines.

The Contractor shall remove the areas of unsound concrete by chipping, scabbling or other means reviewed and accepted by the Consultant. Removal operations at each location shall result in a sound surface suitable for bonding to the deck overlay concrete or repair material.

The Contractor shall contain all debris resulting from concrete removal operations. Methods of containment shall not result in damage to the existing bridge or surrounding areas.

Concrete used for partial depth or full depth repairs shall meet the minimum specified 28 day compressive strengths for the applicable class of concrete.

Patching materials shall meet the minimum 28 day compressive strength stated on the manufacturer's published product data sheet.

### 20.4.2 Partial Depth Repair

At partial depth repair areas, reinforcing steel shall be fully exposed and concrete shall be removed beyond the reinforcing steel to a depth the greater of 35 mm or 1.5 times the maximum aggregate size contained in the repair material that will be used to carry out the partial depth repair. If deterioration extends beyond this depth the Contractor shall remove concrete to the depth determined by the Consultant.

Exposed reinforcing steel and bonding surfaces shall be abrasive blasted and the areas blown clean with oil-free compressed air. Reinforcing steel shall be abrasive blasted to a white metal finish.

At partial depth repair areas containing epoxy coated reinforcing steel; the epoxy coating shall be completely removed by abrasive blasting. The exposed reinforcing bar shall then be protected by the installation of discrete galvanic anodes installed at a minimum of 1 anode per 300 mm of perimeter of the patch area, or the epoxy coating repaired in accordance with the requirements of Section 5, Reinforcing Steel. Galvanic anodes shall be a product selected from those listed on the Alberta Transportation Product List for Galvanic Corrosion Protection. Anodes shall be embedded in a low resistivity mortar and shall have the concrete cover specified on the Drawings, or as determined by the Consultant.

Additional reinforcing steel shall be installed at all locations where the existing reinforcing steel has suffered sectional loss greater than 20%, or as determined by the Consultant. Additional reinforcing steel shall be of the same type used in the original construction or a corrosion resistant reinforcing steel type acceptable to the Consultant. Splicing and/or development requirements will be determined by the Consultant.

Once a prepared area has been accepted by the Consultant and prior to placement of repair material, bonding surfaces shall be saturated with clean water for a minimum of 30 minutes. The area shall be blown free of any surface water immediately prior to placement of the repair material. Repairs shall be trowelled level with adjacent surfaces and given the applicable concrete surface finish.

Unless otherwise shown on the Drawings or directed by the Consultant, the Contractor shall re-establish the original design concrete cover at each repair location.

All partial depth repair areas located on the deck surface shall be poured monolithically with placement of deck overlay concrete unless otherwise accepted by the Consultant. Other partial depth repair areas shall be formed and recast with a concrete patching product listed in the applicable category on the Alberta Transportation product list extended with aggregates that meet the requirements of CSA 23.1 or ASTM C33. Concrete patching products that are proposed without the use of aggregates shall be reviewed and accepted by the Consultant and the Department.

Where the volume of concrete patching product required for an individual partial depth repair area exceeds the volume produced by three 25 kg bags, a rubber paddled mortar mixer of adequate size shall be used for mixing the product. The use of free fall mixers will not be permitted.

Where the repair area is large enough such that placement of a concrete patching product becomes impractical, concrete shall be used. Class C concrete shall be used for substructure elements and Class HPC for all other elements.

Partial depth repair procedures shall be in accordance with the product Manufacturer's recommendations and this specification. In the case of conflict, the more stringent requirements shall apply and will be determined by the Consultant.

Partial depth repairs shall be wet cured for a minimum of 7 days. Vertical surfaces of partial depth repairs for substructure elements shall be form cured or wet cured for a minimum of 7 days.

Partial depth repairs not poured monolithically with the overlay concrete shall be wet cured for a minimum of 7 days or until sufficient strength has been gained such that it is not adversely affected by subsequent placement of the deck overlay as determined by the Consultant.

Compressive strength testing of concrete patching materials or concrete used for partial depth repairs shall be completed a minimum of each production day, each 0.05 $m^3$ of material placed or as determined by the Consultant. Compressive strength testing of neat patching products shall be tested in accordance with CSA A3004-C2 or ASTM C109. Compressive strength testing of patching products extended with aggregates or concrete shall be tested by the Contractor in accordance with CSA A23.2-9C or ASTM C39/39M.

### 20.4.3 Full Depth Repair

Where concrete deterioration extends completely through the deck, curbs, or other elements as determined by the Consultant, all unsound concrete shall be removed and replaced with new concrete.

Reinforcing steel and bonding surfaces shall be abrasive blasted and the areas blown clean with oil-free compressed air. Reinforcing steel shall be abrasive blasted to a white metal finish.

For repair areas where epoxy coated reinforcing steel are exposed, the epoxy coating shall be completely removed by abrasive blasting. The exposed reinforcing bar shall then be protected by the installation of discrete galvanic anodes installed at a minimum of 1 anode per 300 mm of perimeter of the repair area, or the epoxy coating repaired in accordance with the requirements of Section 5, Reinforcing Steel. Galvanic anodes shall be a product selected from those listed on the Alberta Transportation Product List for Galvanic Corrosion Protection. Anodes shall be embedded in a low resistivity mortar and shall have the concrete cover specified on the Drawings, or as determined by the Consultant.

Additional reinforcing steel shall be installed at all locations where the existing reinforcing steel has suffered sectional loss greater than 20%, or as determined by the Consultant. Additional reinforcing steel shall be of the same type used in the original construction or a corrosion resistant reinforcing steel type acceptable to the Consultant. Splicing and/or development requirements will be determined by the Consultant.

The underside of the deck, curbs, and other areas requiring full depth repair shall be formed to neatly restore the original lines of the concrete. Forms shall not be hung or suspended from existing deck reinforcing steel.

Once a prepared area has been accepted by the Consultant and prior to concrete placement, bonding surfaces shall be saturated with clean water for a minimum of 30 minutes. The area shall be blown free of any surface water immediately prior to concrete placement. Repairs shall be adequately vibrated, trowelled smooth, leveled flush to adjacent surfaces, and given the applicable concrete finish. Concrete shall be cured in accordance with Subsection 4.23 Curing Concrete.

Full depth repairs located on the deck surface shall be recast monolithically with placement of deck overlay concrete. When conditions do not permit a monolithic pour with the deck overlay concrete, full depth repair concrete shall be placed to a depth such that, once the subsequent overlay concrete has been placed, the specified design overlay thickness is achieved.

Full depth repair concrete not poured monolithically with the overlay concrete shall be wet cured for a minimum of 7 days or until it has attained sufficient strength so it is not adversely affected by subsequent placement of the deck overlay as determined by the Consultant.

Class C concrete shall be used to repair substructure elements and Class HPC for all other elements.

Compressive strength testing shall be completed on each batch of concrete placed and in accordance with CSA A23.2-9C or ASTM C39/39M.

## 20.5 Deck Overlay

### 20.5.1 General

Deck overlay concrete shall be placed as shown on the Drawings; in accordance with the requirements of this specification and as determined by the Consultant.

### 20.5.2 Concrete

Deck overlay concrete shall be Class HPC or Class HPC with steel fibres as specified in the Contract.

### 20.5.3 Gradeline Profiles/Dry Run

The gradeline will be designed by the Consultant to provide a smooth riding surface for the finished overlay or ACP. The Contractor shall assist the Consultant with profiling of the bridge and approaches prior to and after surface removal. When developing the gradeline profiles, the Consultant will consider such items as rideability, concrete/ACP thickness/quantity, dead load deflection and deck drainage. The design gradeline will be used to determine the overlay thickness and the height of the screed above the existing concrete at each control point.

Gradeline profiles will be produced by the Consultant using the following guidelines:

- Two parallel profile lines the entire length of the bridge for each construction stage will be provided as follows:

    - Line No. 1 will be located 1.0 m from curb face.
    - Line No. 2 will be located 0.3 m in from the opposite edge of proposed pour.

    The Stations of Line No. 1 and Line No. 2 will be square to each other.

    Additional profile lines will be produced when determined by the Consultant.

- Stations will be established at 3.0 m intervals; and at the edges of existing deck joints to be retained and/or at new deck joint locations.

- Profiles will include 30 m of approach at each end of the bridge at 3.0 m intervals.

- Profile plots will be to the following scales:

    - Horizontal: 10 mm = 1 000 mm
    - Vertical: 1 mm (normal) or 1 mm = 5 mm (minimum)

- The proposed design gradeline will be a smooth line achieving a nominal overlay thickness as shown on the Drawings.

Temporary fluorescent paint shall be used to mark profile locations on the existing deck surface, curbs and approaches. The markings shall be approximately 40 mm in diameter. The Contractor shall remove all deck surface temporary markings before overlay placement and all curb and approach temporary markings after the Work is complete.

The Consultant will provide the summary of the proposed overlay thickness, to the nearest mm, at each control point prior to the Contractor setting the screed guide rails. The Contractor is responsible for properly setting the screed rails to match the gradeline provided by the Consultant.

Emphasis shall be placed on providing positive longitudinal and transverse drainage from the bridge deck. Depressions in the concrete surface resulting from deficient finishing procedures which may result in ponding water shall be repaired by the Contractor at his expense.

Screed guide rails shall be placed outside the area of concrete placement. The guide rails shall be horizontally and vertically stable. Hold down devices shot into the concrete will not be permitted. The finishing machine and guide rails shall be adjusted so that the height of the screed above the existing concrete at each point conforms to the profile requirements. Guide rails sufficient for the entire contemplated pour shall be set out, adjusted for height, and accepted by the Consultant prior to concrete placement.

To confirm proper adjustment of the machine and guide rails, the screed shall be "dry run" prior to the pour; and clearance measurements taken at each control point and provided to the Consultant for review and acceptance. Resetting of the machine and/or guide rails shall be done as necessary, to provide an acceptable dry run. Adjustments to the machine or the rails will not be permitted after an acceptable dry run has been made.

Proposed longitudinal overlay construction joint locations shall be submitted to the Consultant for review and acceptance prior to commencement of the Work. Typically, joints shall be located as close to the crown as possible. Where the crown is located at or near a connection joint between two adjacent girders, the longitudinal overlay construction joint shall be offset by a minimum of 300 mm. Longitudinal bulkheads shall be provided at overlay construction joint locations.

### 20.5.4 Cement/Silica Fume Slurry Grout

After all surface preparation has been completed and accepted by the Consultant, surfaces to be overlaid shall be continuously saturated with clean water for a minimum of 3 hours prior to concrete placement. Immediately prior to the commencement of concrete placement operations, surfaces shall be blown free of all excess water with compressed air, and a cement/silica fume slurry grout applied to enhance the bond between the prepared surfaces and the overlay concrete.

Slurry grout shall consist of 4% silica fume, 46% Type GU hydraulic cement and 50% sand (maximum 2.5 mm aggregate size) by weight, mixed with sufficient water to form a slurry. Slurry grout shall be mixed in a rubber paddled mortar mixer. The consistency of the mixed slurry grout shall be such that does not run or puddling in low spots.

The slurry grout shall be applied in a thin, even coat and worked into prepared surfaces with stiff bristled floor brushes acceptable to the Consultant. The rate of application shall be controlled to keep pace with the rate of concrete placement, and be limited such that slurry grout is applied immediately ahead of concrete placement. In no case shall the slurry grout be permitted to dry before concrete placement.

Slurry grout shall be continuously mixed to prevent segregation, and applied within 45 minutes of initial mixing. Slurry grout in excess of 45 minutes old shall be removed and replaced at the Contractor's expense.

Contractor shall have a minimum of two rubber paddled mortar mixers on site during overlay placement.

#### 20.5.5 Conveyance of Concrete on Deck

Generally, vehicles and equipment will not be permitted directly on the prepared bridge deck surface. However, unless otherwise determined by the Consultant and provided the deck surface is continually protected, concrete mixer trucks will be permitted onto the deck to discharge directly ahead of the finishing machine. Deck protection shall consist of plywood, heavy tarps or other protective devices acceptable to the Consultant.

Deck protection shall be sufficient to protect the saturated surface from becoming contaminated with water, oil, spilled concrete and/or other substances. The protection shall remain in place for as long as practicable prior to air blasting and slurry grout placement.

All costs associated with the provision of deck protection necessary for mixer truck access will be considered incidental to the Work, and no separate or additional payment will be made.

#### 20.5.6 Mixing Overlay Concrete

Deck overlay concrete shall be mixed at an acceptable concrete batch plant or at the bridge site in mixer trucks.

##### 20.5.6.1 Pre bagging for Site Batching

Fine and coarse aggregates, hydraulic cement, steel fibres, if applicable fly ash and silica fume shall be measured and pre-mixed together in the proportions conforming to the Contractor's reviewed and accepted concrete mix design review letter before being packaged into suitable bags.

Each bag delivered to the site shall be in good condition, free of holes or tears, and with all seams fully sealed. The bags shall be constructed of moisture proof material, and shall be securely closed after filling. The bags shall have adequate lifting hooks or straps attached to the tops, and shall be designed to suitably discharge the material from the bottom of the bag through a discharge opening with a minimum diameter of 460 mm. Each bag shall have a minimum nominal 1 100 kg capacity. Partially filled bags will not be accepted for use on the site.

Materials shall be proportioned by weight. The accuracy of all weighing devices shall be such that successive quantities can be measured to within one percent of the desired amount. As a minimum quantity, 1 100 kg of dry materials, in the correct proportions, shall be mixed together until the materials are fully dispersed before being placed in a bag.

The Department and Consultant shall be given full access to inspect all aspects of the mixing operation; including supply of materials, drying of aggregates, proportioning the constituents, mixing, bagging and storage. The Contractor shall take all precautions necessary to protect the bagged pre mix from exposure to the elements during hauling and storage at the site.

20.5.6.2 Mixer Trucks and Water Supply for Site Batching

Pre-bagged deck overlay concrete shall be mixed at the bridge site in mixer trucks.

The Contractor shall employ adequate equipment in order to mix concrete at a rate sufficient to ensure continuous concrete placement. A minimum of three mixer trucks shall be brought to the site prior to each overlay pour, and utilized in mixing operations. Mixer trucks shall be revolving drum type, watertight, and constructed so that concrete can be mixed to ensure uniform distribution of materials. Materials for the concrete shall be loaded into the drum at the bridge site.

The Contractor shall provide a suitable water source or tank for the dedicated purpose of batching concrete. The water supply shall have sufficient capacity for each pour. The water supply shall be equipped with an accurate water measuring device calibrated in 0.1 litre increments.

The mixing procedure and sequence, and the mixing time shall be completed in accordance with the requirements of the concrete mix design.

The water supply pipe shall be adequate to ensure that all remaining water addition into the mixer is completed within the first quarter of the mixing time and the outlet situated at a location within the mixer where the water will quickly mix with the entire batch.

The Contractor shall take all steps necessary to ensure that the full content of each pre-mix bag enters the mixer in an even and uniformly proportioned manner. Segregation, spillage and/or other loss of material will not be tolerated. Particular care shall be taken to avoid the loss of cement and silica fume. Batch constituent materials shall be accurately proportioned. Increases in water cement ratio will not be permitted.

The Contractor shall maintain the mixers in good condition at all times while the Work is being carried out. Inner surfaces of the mixer shall be kept free of hardened concrete and mortar. Mixer blades which are bent or worn to the point that mixing efficiency is affected shall be replaced or refurbished. Mixers leaking mortar or causing waste of materials through faulty charging shall be removed from service until the equipment has been repaired to the satisfaction of the Consultant.

The Contractor shall not load mixers with more than 3 $m^3$ of concrete or in excess of 85% of its rated capacity, whichever is less. The Contractor shall provide the Manufacturer's certification of the mixing capacity for each machine upon request. Mixers shall only be operated at the speeds recommended by the Manufacturer.

The Contractor shall record the bag production dates/numbers and test the air content, slump, and temperature of each batch at the mixing site. Results of all tests shall be provided to the Consultant. In the case of an unacceptable result, the Contractor will only be allowed to adjust the quantities of superplasticizer and air entraining agent. Adding additional water to the batch will not be permitted. All batch adjustments shall be completed at the batching site and will not be permitted on the deck or at the discharge area. The Department reserves the right to reject any batch in the event of confirmed unacceptability, and to require immediate removal of any concrete from a rejected batch that may have already been placed.

Concrete shall be discharged within 70 minutes after initial introduction of water to the pre-mixed material.

Discharge chutes shall be kept clean, free from hardened concrete, and wetted down prior to use. After each batch is discharged, the drum shall be thoroughly cleaned and excess water removed before a subsequent batch is mixed.

### 20.5.7 Inspection and Testing

Deck overlay concrete shall be sampled, inspected and tested in accordance with Subsection 4.9, Inspection and Testing.

### 20.5.8 Concrete Placement

#### 20.5.8.1 General

The Contractor shall carry out his concrete placement operations in such a manner that smooth riding surfaces within the tolerances specified in Section 4, Cast-In-Place Concrete, are achieved.

Lighting shall be provided in front and behind the placing/finishing machine. Additional portable tower light plants shall be placed at each end of the bridge and at the concrete testing area. Details of all proposed lighting and associated equipment shall be submitted as part of the Contractor’s deck overlay procedure to the Consultant for review and acceptance.

Concrete shall be placed in such a manner that segregation of materials does not occur. The concrete finishing machine shall meet the requirements of Subsection 4.16.1, General. Concrete placement shall be carried out in a continuous operation for the duration of the pour. No more than 5 minutes, or period acceptable to the Consultant, shall be allowed to elapse between individual truck mixer discharges. The width of the initial overlay section placed shall extend to the accepted construction joint location. Subsequent overlay pours shall not be placed until the initial pour has cured a minimum of 72 hours or as determined by the Consultant.

In the event of equipment breakdown and concrete placement for a respective section of bridge is suspended for a period of 60 minutes or more, further concrete placement for the affected section shall be discontinued and shall not resume for a minimum of 12 hours. Notwithstanding this restriction, concrete placement may continue on a subsequent section of the bridge provided a gap sufficient in length for the finishing machine to clear the previously placed concrete is left between the two sections. Prior to continuing concrete placement at a discontinued overlay section, the Contractor shall saw cut a clean, straight vertical edge satisfactory to the Consultant. Material beyond the saw cut shall be removed and disposed of. Concrete shall be placed in a gap section between 12 hour and 36 hours after suspension of the pour at the affected section.

#### 20.5.8.2 Surface Texture

Deck overlay concrete shall receive a Class 6 surface finish when the overlay concrete is the final wearing surface or a Class 4 surface finish where a waterproofing membrane will be applied. Following surface texturing, a 400 mm wide strip of overlay adjacent to the curb shall be troweled smooth and the surface left closed.

At locations where, in the opinion of the Consultant, a satisfactory finish has not been achieved and saw cutting of grooves will achieve the specified surface finish, the Contractor shall saw cut transverse grooves at his expense. Grooves shall be cut to the dimensions required for a Class 6 finish as outlined in Section 4, Cast-In-Place Concrete.

#### 20.5.8.3 End of Overlay

Concrete overlays shall terminate at a deck joints or locations determined by the Consultant. At locations where an overlay does not terminate at a deck joint, the overlay shall be extended for a distance of 150 mm beyond the required end of the overlay to a bulkhead. After adequate curing time, the 150 mm over pour shall be saw cut, material removed and disposed of, and the remaining surface prepared to the satisfaction of the Consultant for the final specified wearing surface.

All costs associated with installation of the bulkhead; saw cutting; and removal and disposal of over pour areas will be considered incidental to the Work, and no separate or additional payment will be made.

#### 20.5.8.4 Longitudinal and Transverse Overlay Construction Joints

The Contractor shall construct a bulkhead, acceptable to the Consultant, at each construction joint location to maintain horizontal and vertical alignments during concrete placing and finishing. The resulting vertical faces of concrete shall be sandblasted as described in Subsection 20.3.3, Deck Surface Abrasive Blasting.

For longitudinal and transverse construction joints, the top edge of the overlay concrete at the bulkhead and/or existing concrete shall be tooled to a depth of 12 mm and a width of 3 mm. Tooled grooves shall then be filled with a proven epoxy resin type gravity flow concrete crack filler listed on the Alberta Transportation Product List.

Prior to epoxy application, the grooves shall be blown clean to remove all deleterious materials and the concrete contact surfaces prepared in accordance with the epoxy Manufacturer's recommendations. Tooled grooves shall be completely filled with epoxy material to a level equal to the adjacent concrete and may require multiple applications of epoxy.

All costs associated with constructing longitudinal and transverse overlay construction joints including abrasive blasting, groove tooling, and application of gravity flow epoxy crack filler will be considered incidental to the Work, and no separate or additional payment will be made.

#### 20.5.8.5 Curing Concrete

Curing of overlay concrete shall be in accordance with Subsection 4.23.3, Curing Requirements for Class HPC and Class HPC with Steel Fibres.

If, in the opinion of the Consultant, the Contractor's wet curing procedures are deemed deficient in any way and/or any portion of the overlay becomes surface dry during the curing period, the overlay may be rejected.

#### 20.5.8.6 Application of Sealer

The Contractor shall supply and apply a Type 1c sealer to all areas where a Class 6 surface finish has been applied and along troweled gutter areas. Sealer shall be applied once the concrete has cured for a minimum of 14 days.

Sealer shall be applied in accordance with Subsection 4.26, Type 1c Sealer. In the event the deck overlay concrete surface becomes contaminated with dirt, debris or other deleterious material prior to sealer application, the Contractor shall clean the affected areas to the satisfaction of the Consultant.

All costs associated with the supply and application of sealer to deck overlay areas, including cleaning as required, will be considered incidental to the Work, and no separate or additional payment will be made.

#### 20.5.8.7 Opening to Traffic

The concrete overlay shall not be opened to traffic until the concrete has been cured in accordance with Subsection 20.5.8.5, Curing Concrete, and has reached a minimum strength of 35 MPa.

## 20.6 Measurement and Payment

### 20.6.1 Surface Removal

Measurement for payment of surface removal will be by the square metre, based on horizontal measurements to the nearest 0.1 $m^2$.

Payment will be made at the unit price bid for “Surface Removal” of the type specified, and will be full compensation for removal of the existing wearing surface(s) and/or concrete to the depths specified; deck surface cleaning; disposal of debris; and all labour, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

### 20.6.2 Partial and Full Depth Repairs

Measurement for payment of partial and full depth repair areas will be by the square metre of concrete acceptably repaired, regardless of depth, measured to the nearest 0.01 $m^2$.

Payment will be made at the unit prices bid for “Partial Depth Repair” or “Full Depth Repair” as applicable, for the locations identified, less any applicable payment adjustments for compressive strength, and will be full compensation for the containment and removal of concrete; abrasive blasting; disposal of debris; the supply and installation of additional reinforcing steel where required; epoxy coated reinforcing steel coating repairs where required; provision and removal of all formwork, scaffolding and falsework; repair material supply, placement and testing; and all labour, materials, equipment, tools and incidentals to complete the Work to the satisfaction of the Consultant.

80% of the unit price bid will be paid once the repair materials have been acceptably placed and the 7 day concrete compressive strength tests indicate, in the opinion of the Consultant, that the repair materials will achieve the specified strength. Initial payment will not constitute full acceptance of the repair. The remaining 20% of the unit price bid will be made once surface finishing, as applicable, has been acceptably completed, and the 28 day compressive strength test results have been reviewed and accepted by the Consultant.

The Department reserves the right to reject repair materials that do not meet the specified requirements. The Department may, at its sole discretion, accept repairs that do not meet the specified 28 day concrete compressive strength at a reduced price. Payment adjustment may be made in accordance with Table 20-1: Payment Adjustment Schedule.

**Table 20-1: Payment Adjustment Schedule**

| 28 Day Minimum Compressive Strength | Payment Adjustment |
|---|---|
| Equal to or greater than the specified strength | Full bid price |
| up to 2 MPa less than the specified strength | Bid price less $50.00 per square metre |
| between 2 MPa and 4 MPa less than the specified strength | Bid price less $100.00 per square metre |
| between 4 MPa and 5 MPa less than the specified strength | Bid price less $250.00 per square metre |
| more than 5 MPa less than the specified strength | Rejected |

20.6.3 Deck Surface Abrasive Blasting

Measurement for payment of deck surface abrasive blasting will be by the square metre of deck surface acceptably prepared based on horizontal measurements to the nearest 0.1 $m^2$. Vertical surfaces of curbs, barriers and medians will not be measured.

Payment will be made at the unit price bid for “Abrasive Blasting – Deck Surface”, and will be full compensation for abrasive blasting; cleaning of blasted areas; disposal of debris; and all labour, materials, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

All cost associated with deck surface abrasive blasting of vertical surfaces will be considered incidental to the Work, and no separate or additional payment will be made.

20.6.4 Deck Overlay Concrete

20.6.4.1 Supply of Deck Overlay Concrete

Measurement for payment for supply of deck overlay concrete will be by the cubic metre of concrete accepted, placed, and remaining in the Work; measured to the nearest 0.01 $m^3$.

The quantity of concrete to be paid for will be calculated by the Consultant using the accepted dry run values and surface area overlaid. Over pour concrete will not be paid for.

Payment will made at the unit price bid for “Deck Overlay Concrete – Supply”, less any applicable payment adjustments for compressive strength, and will be full compensation for the supply and delivery of the concrete to the bridge site; sampling, inspection and testing; and all labour, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

The Department reserves the right to reject concrete that does not meet the specified requirements. The Department may, at its sole discretion, accept concrete that does not meet the specified 28 day concrete compressive strength at a reduced price. Payment adjustment may be made in accordance with Subsection 4.27.1.1, Compressive Strength Test Result Payment Adjustment.

80% of the unit price bid will be paid once the concrete has been acceptably placed and the 7 day concrete compressive strength tests indicate, in the opinion of the Consultant, that the concrete will achieve the specified strength. Initial payment will not constitute full acceptance of the concrete. The remaining 20% of the unit price bid will be made once the concrete surface finishing and concrete sealer application has been acceptably completed, and the 28 day compressive strength test results have been reviewed and accepted by the Consultant.

#### 20.6.4.2 Placement of Deck Overlay Concrete

Measurement for payment for the placement of deck overlay concrete will be by the square metre of concrete accepted, placed and remaining in the Work, measured to the nearest 0.1 $m^2$.

Payment will be made at the unit price bid for "Deck Overlay Concrete – Place", and will be full compensation for falsework and formwork; supply and application of water for surface saturation; the supply and application of slurry grout; concrete placement; surface finishing and curing; the supply and application of concrete sealers; and all labour, equipment, tools and incidentals to complete the Work to the satisfaction of the Consultant.

80% of the unit price bid will be paid once the concrete has been acceptably placed and the 7 day concrete compressive strength tests indicate, in the opinion of the Consultant, that the concrete will achieve the specified strength. Initial payment will not constitute full acceptance of the placement. The remaining 20% of the unit price bid will be made once the concrete surface finishing and concrete sealer application has been acceptably completed, and the 28 day compressive strength test results have been reviewed and accepted by the Consultant.

The Department reserves the right to reject the concrete placement where the supply or placement of deck overlay concrete does not meet the specified requirements.

All costs associated with concreting in cold weather, when required, will be considered incidental to the Work, and no separate or additional payment will be made.

# SECTION 21 DEMOLITION, DISPOSAL AND SALVAGE OF BRIDGE STRUCTURES

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## 21.1 General

This specification is for the demolition, disposal and salvage of bridge structures. The Work shall be completed in accordance with the Contract and as determined by the Department and the Consultant.

Existing bridge structure materials are the property of the Department.

References to bridge structures within this specification shall also apply to culverts.

Materials to be salvaged will be specified in the Special Provisions of the Contract. The location and haul requirements associated with salvaged bridge structures and/or materials will also be specified in the Special Provisions of the Contract.

## 21.2 Demolition and Disposal

### 21.2.1 General

The Contractor shall remove the bridge structure including soil and foundations in accordance with the Contract, these specifications and as determined by the Department and the Consultant.

A construction milestone meeting shall be scheduled by the Contractor for demolition, disposal and salvage Work. A construction milestone meeting will not be required for the demolition, disposal and salvage of culverts. The Contractor's project manager, field superintendent, and any specialty Subcontractors shall attend the construction milestone meeting at a location determined by the Consultant.

Unless otherwise specified in the Special Provisions of the Contract, the Contractor shall submit a detailed demolition and disposal plan to the Consultant for review and acceptance a minimum of 2 weeks prior to scheduling the construction milestone meeting. The demolition and disposal plan shall be prepared, signed and sealed by a Professional Engineer registered in the Province of Alberta include drawings and supporting documents necessary to describe the following:

- Traffic Accommodation Strategy (TAS);
- Access to work, earth berms and work bridges;
- Temporary works and support structures including stabilizing details and measures;
- Type and capacity of equipment;
- Sequence of operation including position of cranes;
- Position of cranes relative to substructure elements such as abutment backwalls, with details of load distribution of wheels and outriggers;
- Lifting devices and lifting points showing lifting forces;

- Demolition sequence;
- Updated ECO plan to address all environment regulations and Contract requirements;
- Permitting approvals from regulatory authorities;
- Proposed disposal procedures and disposal locations;
- Temporary supporting structures removal; and
- Site restoration.

Safety and compliance with the Occupational Health and Safety Act and Regulations thereunder, shall be an integral part of the design of the demolition and disposal plan.

The Contractor shall continue to be fully responsible for the results obtained by the use of demolition and disposal plan, with the Professional Engineer also assuming responsibility, as the Contractor's Agent, for the results obtained.

The Consultant's review and acceptance shall not be considered as relieving the Contractor of the responsibility for the safety of his methods or equipment, nor from completing the Work in accordance with his demolition and disposal plan and these specifications. The Contractor shall not commence any Work until review and acceptance of the demolition and disposal plan by the Consultant has been obtained.

The extent of bridge structure removal, including excavation, shall be to an elevation of 0.6 metres below streambed for bridge piers and 1.0 m below existing ground for bridge abutments and all other bridge elements, unless otherwise specified in the Special Provisions of the Contract.

The extent of culvert removal, including excavation, shall be to the invert elevation for a width of the culvert plus 1.5 metres on either side.

### 21.2.2 Excavation

Excavation required for the removal of bridge structures shall be completed in accordance with Section 1, Excavation.

### 21.2.3 Site Restoration

Upon completion of the demolition, disposal and salvage of bridge structures, the Contractor shall restore the site to a condition similar to the natural ground, and as determined by the Consultant. This shall include disposing of all surplus excavated materials, backfilling as required, supplying and placement of 50 mm minimum thickness of organic material on all disturbed areas and seeding.

The Contractor shall restore excavated areas to the grade shown on the Drawings, in accordance with Section 2, Backfill and as determined by the Consultant.

## 21.3 Salvage

The Contractor shall perform his Work in a manner that prevents damage to or loss of bridge structures and/or materials listed for salvage. Where the Contractor causes damage to or loss of bridge structures and/or materials listed for salvage, the Contractor shall repair or replace these bridge structures and/or materials at his expense and to the satisfaction of the Consultant and the Department.

Torch cutting to remove hardware or to dismantle bridge structures and/or materials identified for salvage will not be permitted.

Structural plate corrugated steel pipe culverts shall be dismantled to achieve lengths not exceeding 8 metres. Corrugated steel pipe culverts shall be dismantled by removing the couplers to achieve the original fabricated lengths.

Precast concrete units shall be individually removed after disconnecting the units by removing the grout from shear keys and connector pockets, connector bolts, drift pins and other hardware. Precast concrete units shall be lifted only at the designed lifting points, with the top of each unit up at all times, and shall be allowed to rest only on the designed bearing areas.

The Contractor shall transport salvaged bridge structures and/or materials to the location designated in the Special Provisions of the Contract and in a manner that does not damage the salvaged bridge structures and/or materials in any way.

## 21.4 Measurement and Payment

### 21.4.1 Demolition and Disposal of Existing Bridge Structures

Payment for the demolition, removal and disposal of existing bridge structures will be made at the lump sum price bid for “Demolition and Disposal of Bridge Structure” for the specified bridge structure, and will be full compensation for demolition of the structure; breaking down, loading, hauling and disposing of debris at a location acceptable to the Consultant; and all labour, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

The Contractor shall provide the Consultant with written acceptance of the materials from the owner of the disposal site before payment for this Work will be made.

50% of the lump sum price bid will be paid once the removal and disposal of the superstructure and abutments has been acceptably completed. The remaining 50% of the lump sum price bid will be made once all substructure components have been removed to the extent required, and the site has been restored to a condition acceptable to the Consultant and the Department.

### 21.4.2 Salvage of Existing Bridge Materials

Payment for the removal and salvage of designated bridge structure materials will be made at the lump sum price bid for “Salvage of Existing Bridge Materials”, and will be full compensation for the removal and salvage of specified materials; loading, hauling, unloading, and stockpiling of the materials at the designated storage site(s); and all labour, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

# SECTION 22 PAINTING

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## 22.1 General

This specification is for field painting of structural steel bridges and for shop painting of newly fabricated structural steel for bridges.

Where Standards and Standard Specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is described. Metric versions are inferred, when available and relevant.

This specification describes requirements for several different methods of preparation and for several different approved coating systems which may be applied to bridge structures. Each painting contract shall have Special Provisions and/or Drawings which delineate the applicable area of the structure and the coating system to be applied to it.

## 22.2 Standards

- Society for Protective Coatings (SSPC) "Standard Procedure for Evaluating the Qualifications of Painting Contractors" SSPC-QP1.
- SSPC "Standard Procedure for Evaluating the Qualifications of Painting Contractors to Remove Hazardous Paint" SSPC-QP2
- SSPC Guide 6-Guide for Containing Debris Generated During Paint Removal Operations.
- SSPC SP 1 Solvent Cleaning.
- SSPC SP 2 Hand Tool Cleaning.
- SSPC SP 3 Power Tool Cleaning.
- SSPC SP 5 White Metal Blast Cleaning.
- SSPC SP 6 Commercial Blast Cleaning.
- SSPC SP 7 Brush-Off Blast Cleaning.
- SSPC SP 10 Near-White Blast Cleaning.
- SSPC SP 12 Surface Preparation and Cleaning of Steel and Other Hard Materials by High- and Ultrahigh-Pressure Water Jetting Prior to Re-coating.
- SSPC AB1 Mineral and Slag Abrasives.
- SSPC AB2 Cleanliness of Recycled Ferrous Metallic Abrasives.
- SSPC AB3 Newly Manufactured or Re-Manufactured Steel Abrasives.
- SSPC PA Guide No.11 Protecting Edges, Crevices, and Irregular Steel Surfaces by Stripe Coating
- SSPC PA 2 Measurement of Dry Coating Thickness with Magnetic Gauges
- Alberta Transportation "Fish Habitat Manual"
- Alberta Transportation "Bridge Load Evaluation Manual"

SSPC specifications are available at http://www.sspc.org

Alberta Transportation Product List – Approved Products "Bridge Coating Systems – Paint" available on the Department's website at:

http://www.transportation.alberta.ca/Content/docType253/Production/paintlist.pdf

## 22.3 Contractor Qualifications

One of the following four competency levels will be specified in the Special Provisions of the Contract.

CQ1 The Contractor or painting subcontractor must have certification in good standing with the Society for Protective Coatings (SSPC) under SSPC-QP2.

CQ2 The Contractor or painting subcontractor must have certification in good standing with the Society for Protective Coatings (SSPC) under SSPC-QP1.

CQ3 The Contractor or painting subcontractor acceptance will be based on submission of documented experience which should include but not be limited to: the names of owners, projects and dates of previous bridge painting projects where containment and disposal of blasting spoil was implemented, copies of any relevant environmental permits and any citations for failure to comply. A list of qualified personnel responsible for the actual paint removal and application will be required. Once accepted no personnel changes shall be made without the Consultant's written acceptance. Permission for the Consultant to interview the owners, environmental departments and personnel listed above. Falsifying information in the submission will be grounds for disqualification of the bid.

CQ4 No specific pre-qualification requirements.

Only Contractors having the specified level of competency, at the time of tender closing will be considered acceptable.

## 22.4 Materials

### 22.4.1 Supply

The Contractor or painting subcontractor shall supply all materials to satisfactorily complete the work.

### 22.4.2 Blasting Media

Contractors may choose the type of abrasive intended for use, taking into consideration the abrasive disposal and worker's health implications of each type. The abrasive selected shall comply with the applicable Society for Protective Coatings (SSPC) standard.

Blasting grit shall be free of corrosion producing contaminates and shall be free of any moisture, oils, greases or other elements which will reduce the adhesion of paint coatings. The blast cleaning abrasive used shall produce the minimum surface profile required by the paint manufacturer.

The use of pre-treatment coatings, blasting media additives or treatment of blasting spoil prior to, or subsequent to, disposal must be reviewed and accepted by the Department and Consultant.

### 22.4.3 Paint

The Contractor shall select an approved product from the Alberta Transportation Product List – Approved Products “Bridge Coating Systems – Paint”. The paint system shall be from the category specified in the Special Provisions of the Contract. The material data sheets and material safety data sheets of the chosen paint system shall be submitted with the Contractor’s work proposal. A single paint system shall be used throughout the entire project unless specified otherwise. The Contractor shall not change to another paint system once the initial paint system has been applied to any portion of the structure.

The paint shall be delivered in sealed, original, labelled containers bearing the Manufacturer’s name, type of paint, brand name, colour designation, batch number and instructions for mixing and/or reducing.

For each batch of paint used on the project, the Contractor shall have an independent laboratory carry out quality control tests for colour, gloss and formulation. The results shall be submitted to the Consultant for review and acceptance a minimum two weeks prior to the anticipated commencement of painting operations. No paint shall be applied to the structure prior to acceptance of the test results by the Consultant and Department.

Colour testing for the mixed top coat shall be carried out in accordance with ASTM D2244 with a CIE 1976 L*A*B, 2 degree observer, and a D65 illuminate.

Gloss testing for the mixed top coat shall be carried out in accordance with ASTM D523 at 60 degrees.

Infrared Spectroscopy (IR) shall be conducted on all individual components of the paint system prior to mixing, to confirm that the formulation conforms to that which was originally approved. A minimum 32 scans shall be taken with a Fourier transform infrared spectrometer between 4000 and 400 wave-numbers (CM-1) using the salt plate sandwich technique. The salt plate may be made from potassium bromide for non-aqueous paints. If the formulation contains water; appropriate, non-water soluble plates shall be used. Plate material shall be reported with each individual spectrum. The spectra shall be taken of vehicle portion of the coating without the pigment. For single component materials, a representative sample of the material shall be centrifuged to remove pigment and then analyzed. For plural component materials, each of the individual components shall be centrifuged to remove pigment and then analyzed separately. IR analysis of the mixed components is not required. The IR plots shall be completed with transmittance (0 – 100%) on the y-axis and Wave-numbers (4000 – 400; non-linear) on the x-axis. All peaks shall be labelled with the corresponding wave-number. The spectra shall be taken such that the largest peaks are at 50 – 0%T and the baseline is greater than 80%T. Materials with IR plots indicating a change in formulation from that which was originally approved will be rejected.

Each batch of paint may be subjected to additional testing by the Department or Consultant.

If requested, the Contractor shall provide four – 250 ml samples of paint from a pail or barrel chosen by the Department or Consultant. Samples shall be placed in suitable new, clean, metal containers; and sealed to avoid contamination of the paint.

## 22.5 Environmental Considerations

### 22.5.1 Emission Levels

The percentage of blasting spoil that must be recovered and the Class of containment required shall be as specified in the Special Provisions of the Contract and detailed in the SSPC-Guide 6.

Monitoring and acceptance criteria described in Subsection 5.5 of the SSPC-Guide 6, methods A to F, to monitor the quantity of emissions escaping the enclosure shall be specified in the contract Special Provisions of the Contract.

### 22.5.2 Environmental Regulations

The Contractor shall ensure that existing paint being removed, and any abrasive material used to accomplish the removal, is contained and properly and safely disposed of in accordance with the applicable laws and regulations.

The Contractor shall comply with all Federal, Provincial, and Municipal, air, soil and water contamination control regulations, when cleaning and repainting the structural steel and when disposing of any waste generated. These specifications set forth minimum requirements necessary to protect the environment. The Contractor shall perform additional work to modify containment or disposal procedures to ensure compliance with all applicable laws and regulations.

### 22.5.3 Fish Habitat

When working on structures over water inhabited by fish the Contractor shall conform to the requirements of the Alberta Transportation “Fish Habitat Manual”. This manual is available on the internet at:

http://www.transportation.alberta.ca/Content/docType245/Production/Complete_Fish_Habitat_Manual.pdf

### 22.5.4 Blasting Spoil Recovery

The containment system for the blast cleaning and painting shall be installed such that the minimum specified percentage of the blast spoil and paint removed, as listed in the Special Provisions of the Contract, is contained.

### 22.5.5 Protection of Property

During cleaning and painting procedures, the Contractor shall take necessary precautions to fully protect the environment, the workers, traffic, parked vehicles, adjacent property, and other portions of the structures from damage caused by cleaning debris, blast cleaning materials, dirt, dust, equipment oils, solvents, acids, burning matter and paint drifts, drops, or spray and spatter.

### 22.5.6 Quality Assurance

An Environmental Auditor may be retained by the Consultant to assure compliance with the requirements of the Environmental Permits and/or Screening Report and to monitor the performance of the containment system in particular and that of the Contractor in general.

### 22.5.7 Background Contamination Levels

Contamination of the environment shall be minimized at all times during the Work. The Contractor's operations may also be monitored by other agencies.

The Contractor shall identify locations in which to establish background soil, water/snow, and air contamination levels in his work proposal. After the Contractor's work proposal has been reviewed and accepted by the Consultant and prior to commencement of the work, the Contractor shall collect soil, water/snow, and air samples from the project site for analysis. Samples shall be collected in the presence of the Consultant and at locations most likely affected by the work, such as at the dust collector, recycling unit, key points along the spoil material transfer lines, and spoil material storage areas. As a minimum, three samples shall be collected at each location and sent to an accredited laboratory approved by the Consultant for analysis. Analysis shall be consistent with regulatory reporting requirements and results submitted to the Consultant.

The Consultant may require the Contractor to collect additional soil, water/snow, and air samples at the site for analysis during the course of the work if contamination is suspected. If requested, the Contractor shall immediately collect samples and have they analyzed at the approved laboratory. Results shall be forwarded to the Consultant within one week of collecting the samples.

The Contractor shall collect samples at all established background locations once painting operations are completed and equipment is removed from the site. As a minimum, two post construction composition tests shall be completed at each background location and results submitted to the Consultant for review and acceptance. Analysis shall be performed at the approved laboratory using the same test methods used for initial background analysis. If post construction analyses show that the Contractor's work has adversely affected the environment, site remediation will be required and shall be carried out to the full satisfaction of the Department and the Consultant.

All cost associated with soil, water/snow, and air sampling including any subsequent site remediation requirements will be considered incidental to the Work and no separate or additional payment will be made.

## 22.6 Permits, Licences and Approvals

The Contractor shall obtain the necessary permits, licences and approvals, and conform to all requirements of Environmental Screening Reports, Municipal bylaws, Provincial and Federal Environmental Protection laws, for all work carried out. The Contractor shall be familiar with and comply with all regulations, such as, but not limited to, Environmental permits, the Worker's Compensation Act, the Occupational Health and Safety Act, Regulation and Code which control the exposure of workers to chemical hazards.

## 22.7 Work Proposal

The Contractor shall submit his work proposal to the Consultant for review and acceptance a minimum of two weeks prior to the pre-construction meeting. The work proposal shall include, but not be limited to:

- Schedule;
- Sequence of operations;
- Traffic accommodation strategy;
- Site lay down plan including placement of equipment;
- Proposed sampling locations for establishment of background contamination levels;
- Surface cleaning strategy;
- Storage, handling and disposal of new and contaminated blasting material;
- Methods of weighing blasting material on and off the project;
- Method of separating hazardous and nonhazardous blasting spoil;
- Sample documentation for tracking the disposal of hazardous waste;
- The final destination of hazardous waste;
- Chosen coating system from the Alberta Transportation Product List - Approved Products “Bridge Coating Systems (Paint)”; and
- Bridge Load Evaluation Report.

The Contractor shall submit drawings signed and sealed by a Professional Engineer registered in the Province of Alberta detailing his containment structure, scaffolding, platforms, swing stages, and attachments for the Consultant’s review. All scaffolding, platforms, swing stages and material collection equipment shall be designed and operated in accordance with the authority having jurisdiction.

## 22.8 Work Site Health and Safety

The Contractor is fully responsible for the protection of his employees and any sub-contractor’s personnel, from exposure to lead. The Contractor shall develop and implement a Lead Health and Safety Program (LHASP) that meets all the requirements of the Occupational Health and Safety Act and Regulations (Attention is drawn to OH&S Bulletin MSB-06 and in particular the chemical requirements) and all other Municipal, Provincial and Federal Regulations that may apply when working in a hazardous environment.

The Contractor shall provide shower and change facilities for the work force in accordance with governing regulations and ordinances. The facilities shall be freely available for use by all personnel associated with the Contract.

Respirators shall be furnished by the Contractor and used when such equipment is necessary to protect the health of employees. Respirators shall be donned before entering the work area and shall not be removed until the worker has left the work area or has entered a decontamination area. Selection of the respirator type shall be based on the ability of the respirator to adequately filter air which is at the maximum air-lead level monitored in the locations where the worker may be exposed.

Extra protective clothing and clean respirators shall be available for use by visitors to the work site.

The Contractor shall supply employees, who are potentially exposed to lead, with clean, dry, protective work clothing and equipment, and with appropriate changing facilities. Appropriate protective work clothing can include coveralls or similar full body work clothing, gloves, hats, shoes or disposable shoe coverlets, face shields or vented goggles and, if applicable, blasting helmets.

The Contractor shall designate a Health and Safety officer, to act as the primary on site monitor of the program and to ensure that the LHASP is implemented on a daily basis and that all work on the site is in compliance with the LHASP.

## 22.9 Bridge Load Evaluation Report

The Contractor shall prepare and submit a bridge load evaluation report in accordance with the Alberta Transportation Bridge Load Evaluation Manual (BLEM) and this specification.

The load rating evaluation vehicles shall be the Alberta Transportation single unit vehicle (CS 28t), two-unit vehicle (CS2-49t) and vehicle train (CS3-63.5t).

Notwithstanding Clause 14.9.5.3, of the CHBDC, winds loads shall be considered when the Contractor’s containment system results in an increased wind loading on the bridge. Wind loads shall be incorporated in the evaluation with load combinations ULS3 and ULS4 as per Section 3. Design wind loads may be adjusted if a written work procedure for removing the screens/containment system at projected wind speeds is developed by the Contractor, adequately demonstrated, and reviewed and accepted by the Consultant and the Department.

Components of the bridge that shall be evaluated and rated include, but are not limited to, the bridge superstructure and bridge bearings. Bridge bearings shall be evaluated and rated in cases where the Contractor’s containment system results in an increased wind loading on the bridge in any direction or alternate means of load transfer are imposed on the bridge. Bridge substructure components are typically not included in the evaluation and rating, but may be required at some bridge sites. When required, rating of the bridge substructure will be specified in the Special Provisions of the Contract.

When containment systems include temporary structural elements to strengthen bridge components, details of the fabrication, installation and removal of the temporary structural elements shall be clearly detailed in the bridge load evaluation report.

In addition to the reporting requirements in the BLEM, the bridge load evaluation report shall also provide Live Load Capacity Factors, as described in Clause 14.15, of CSA-S6, for all three load evaluation vehicles under the ultimate limit state ULS1 and shall demonstrate that the bridge capacity is adequate under the ultimate limit states of ULS3 and ULS4. The capacity of the bridge will be considered acceptable if the Live Load Capacity Factors are greater than 1.0 and if the factored resistances exceed the factored load effects.

In addition to the reporting requirements in the BLEM, the bridge load evaluation report shall clearly identify the magnitude and direction of the imposed loads, where the loads from the containment system will be transferred to the bridge and the Contractor’s Bridge Load Evaluators and the Bridge Load Evaluation Checkers assessment in the ability of the bridge to accommodate these loads. The report shall be submitted to the Consultant for review and acceptance as part of the Contractor’s work proposal.

In case of conflicting requirements between this specification and the BLEM, this specification will govern.

The bridge load evaluation report shall be signed and sealed Professional Engineers (Bridge Load Evaluator and Bridge Load Evaluator Checker) registered in the Province of Alberta.

All costs associated with the preparation of the load evaluation report will be considered incidental to the Work and no separate or additional payment will be made.

## 22.10 Protection of Surfaces

The Contractor shall protect and maintain the painted surfaces until acceptance of the entire project.

The Contractor shall take due precaution against damaging or disfiguring any portion of the bridge with blast media, spatter, spray fog, splashes, smirches of paint or associated painting materials including the fuel and lubricants used with his equipment.

Tarps, polyethylene or other covering material shall be used to protect deck, sidewalks, piers, abutments, slope protection and other portions of the structure adjacent to areas being painted and subject to paint or other damage.

Any inadvertent damage or disfigurement which may occur by reason of the Contractors operations shall immediately be repaired to the satisfaction of the Consultant at the Contractor’s expense.

## 22.11 Areas Not To Be Painted

The following surfaces shall not be painted unless noted in the Special Provisions of the Contract:

- Surfaces which will be cast into concrete such as the top and sides of the top flange of girders or the side of expansion joints in contact with concrete;
- Sliding metal to metal contact bearing surfaces and mating surfaces of spherical bearings;
- Galvanized surfaces; and
- Concrete surfaces adjacent to painted steel surfaces such as sidewalks and the underside of bridge decks. Where painted items such as girder flanges are cast into concrete the paint applied to the flange may overlap the concrete by up to 25 mm on condition that this shall be a uniform straight line as produced by masking the remainder of the concrete surface. Any paint inadvertently applied to the concrete shall be removed immediately.

## 22.12 Work Execution

### 22.12.1 Temporary Attachments

To reduce the possibility of damaging the existing bridge components and painted surfaces, any clamps or other devices attached to the structure shall be padded or designed such that they do not mark or damage the surface to which they are attached.

No welding or tack welding to the structure will be permitted.

The removal and replacement of any bolts from the structure must be acceptable to the Consultant. No holes may be placed in the structure.

### 22.12.2 Containment System

The containment system’s purpose is to prevent the debris generated during surface preparation from entering into the environment and to facilitate the controlled collection of debris for disposal.

The containment system and its operation shall meet or exceed the class of containment specified in the Special Provisions of the Contract. When abrasive blast cleaning is used to clean and prepare the steel surfaces, the Contractor shall contain the paint chips, abrasive particles, and debris resulting from the operation. The containment system includes but is not limited to, such articles as cover panels, screens, tarps, scaffolds, supports, shrouds and ground sheets used to enclose the entire work area, and equipment to clean, transport, collect, and store blast media.

The materials used for screens shall be of a commercial brand designed specifically for the purpose of containing and facilitating collection of blasting and painting debris. If woven screens are used, the material shall contain no more than 15% voids with a mesh opening not exceeding 20 mils (500 microns). If monitoring detects leakage of dust through the woven screens, exceeding the allowable, then the screens shall be replaced with ones of a tighter weave which will meet the recovery requirements. All materials used for screens shall be adequately reinforced to prevent tearing or displacement when subjected to construction, wind or other environmental loads and their related conditions. The Contractor shall supply auxiliary lighting to improve visibility where necessary within enclosures.

### 22.12.3 Containment System Monitoring

#### 22.12.3.1 Abrasive Blasting

The containment system shall provide emission control effectiveness such that random escapes to the environment do not exceed 3% of the work day (e.g. 15 minutes over an 8 hour work shift). Operations shall cease immediately if the limits of emission control are exceeded. An enclosure which does not meet the specified criteria shall be modified at the Contractor's expense. Blasting shall not resume until the Contractor has modified his containment system and the modifications have been reviewed and accepted by the Consultant.

The Contractor shall maintain a documented reporting system to provide gross weights, tare of containers and the calculated weight of the material provided to and removed from the structure. The blasting spoil shall be protected from absorbing any moisture. Contaminated blasting spoil shall be in a dry condition prior to making the recovery calculation.

If the wind velocity is too excessive to effectively contain the blast debris within the enclosure, the Contractor shall suspend blast cleaning operations and protect the existing blasting spoil from the wind.

The Contractor shall take whatever measures are necessary to prevent the release of dust or spent material from the ground tarpaulins and other components of the containment enclosure during moving or removal. Debris collected on temporary work platforms, ground cloths, or walls of the containment structure, shall be removed each workday with a vacuum system equipped with high efficiency particulate air (HEPA) filters adequately sized to collect all spent material.

The Contractor shall contain all debris and waste materials as described herein and shall also provide a temporary platform located directly underneath the area enclosed for surface preparation cleaning, power tool cleaning, or blast cleaning and paint application. The platform shall be adequately sized to contain and/or filter debris, wash water and paint during the cleaning or application operation. The containment enclosure shall extend down to the level of the platform and shall be secured to prevent release of other than filtered material. The surface of the platform shall be constructed to ensure collection and filtration of spent waste materials or shall be designed to collect, funnel and discharge the spent waste materials into waste containers.

For bridges located over a navigable waterway the location of platforms, scaffolding, floating booms or other equipment shall not interfere with navigation.

The containment system must be properly maintained while work is in progress and shall not deviate from the approved working drawings without prior acceptance of the Consultant. If, at any time during execution of the work, the containment system fails to function properly, the Contractor shall immediately suspend surface preparation until modifications can be made to correct the deficiency.

Containment meeting these requirements may not necessarily provide adequate emission control or abrasive recovery rate. The Contractor may have to provide a higher containment standard to meet these other requirements.

22.12.3.2 Water Blasting

When High or Ultra High Pressure Water Jetting is specified the filtration or collection and treatment of water used in the cleaning shall be as specified in the Special Provisions of the Contract. The recovery of a certain volume of spoil will not be specified, but the waste water may have to be filtered through a cloth system of specified porosity and when the cleaning is completed the cloth filters shall be carefully folded to contain the debris collected and shall be disposed of as outlined in Subsection 22.16, Disposal of Blasting Spoil. The Contractor is responsible to perform additional work or to otherwise modify containment or disposal procedures to ensure compliance with all applicable laws and regulations.

22.12.4 Ventilation System

The ventilation system used shall be as specified in the Special Provisions of the Contract and described in the SSPC-Guide 6. The use of the minimum ventilation system as described herein does not assure control of emissions to the required level nor will it assure worker safety. Revisions to the ventilating system may be necessary and will be required to meet the health and emission requirements.

The minimum air movement specified in the Special Provisions of the Contract, for inside the Containment system may not be adequate for visibility of the work surface and may or may not be adequate for protection of the workers from health hazards such as lead. The Contractor may have to provide a higher standard of air movement to meet these requirements.

22.12.5 Assessing Emissions

Methods for Assessing the Quantity of Emissions shall be as specified in the Special Provisions of the Contract and as described in the SSPC-Guide 6.

The Contractor shall have monitoring equipment to ensure that the containment is performing to the required level.

## 22.13 Surface Cleaning

Prior to the commencement of any surface preparation operations, the Contractor shall carry out surface cleaning on all steel designated to receive a coating system and adjacent surfaces that could contaminate surfaces to be prepared. Surface cleaning shall consist of the hand removal of organic materials such as bird droppings and nests and other non-structural items adhered to the steel, and bridge washing.

Oil, grease and road tar shall be removed manually by solvent cleaning in accordance with SSPC Specification SP1. Remaining area contaminated with residual oil or grease shall be cleaned with an approved biodegradable detergent. The detergent shall be environmentally friendly and non-toxic. The Contractor shall supply copies of the MSDS sheets for the proposed cleaning products to the Consultant for review and acceptance prior to using these materials.

All areas to be coated shall be washed clean of road spatter, chlorides and other contaminates using water of sufficient pressure and volume to flush the contaminants from the structure.

Areas of cleaned steel shall be tested for chloride contaminants, soluble ferrous ions and sulphate contaminants. Chloride contamination shall be tested using Quantab Method or by Kitagawa Tube. Soluble ferrous ion contaminants shall be tested using ferrous ion test strips. Sulphate contaminates shall be tested using a barium chloride optical comparator or an alternative method accepted by the Consultant.

Cleaning shall result in surfaces with less than 7 $\mu g/cm^2$ of chloride ion contaminant, less than 10 $\mu g/cm^2$ of soluble ferrous ion contaminant, and less than 17 $\mu g/cm^2$ of sulphate contaminant. All testing shall be carried out by the Contractor and the results submitted to the Consultant for review and acceptance prior to commencing surface preparation operations.

Wash water shall be captured, filtered and disposed of in compliance with all applicable laws and regulations.

## 22.14 Surface Preparation

### 22.14.1 Abrasive Blast Cleaning

All compressed air sources shall have oil and moisture separators, attached and functional, properly designed and sized to allow delivered air at the blasting or painting nozzle to be free of oil and moisture and of sufficient pressure to accomplish the associated work efficiently and effectively. The tanks on the air compressors and the moisture separators shall, as a minimum, be drained at the end of each working shift. Prior to abrasive blast cleaning, the Contractor shall demonstrate to the Consultant that the air is moisture free. Air driven power tools shall be properly lubricated in accordance with the respective Manufacturer’s instructions, but in such a manner that lubrication is not deposited onto the surface being prepared.

Blast cleaning of steel surfaces in preparation for painting, shall be in accordance with the SSPC Surface Preparation Standards specified in the Special Provisions of the Contract.

Surface Preparation Standard SSPC-SP6 requires that the cleaned surface be free of all visible oil, grease, dirt, dust, mill scale, rust and paint.

Surface Preparation Standard SSPC-SP7 requires the removal of all loose coating, loose rust and loose mill scale. Mill scale, rust and paint are considered to be tightly adhered if they cannot be lifted with a dull putty knife.

The anchor pattern in the blasted steel shall be that specified by the manufacturer of the coating.

As work progresses a 150 mm wide strip of uncoated blasted steel shall be left between the newly coated surface and the nonblasted surfaces of the structure.

The Contractor shall grind all burs and sharp edges to the satisfaction of the Consultant. This requirement shall be measured using an “L” shaped metal gauge with a 1/32” (1.0 mm) radius at the point of intersection of the two 90° arms. The member will require grinding if the radius touches the member when both arms are in tight contact with the surfaces of the member.

The Contractor shall prepare only as much surface as can be coated with primer the same day. If unusual circumstances occur which prevent all prepared surfaces from being primed the same day, a light blast cleaning will be required over all un-primed surfaces prior to recommencement of painting.

Care shall be exercised to prevent contamination of blast-cleaned or coated surfaces prior to over coating. Compressed air cleaning of the members before coating application will generally be accepted. At the discretion of the Consultant, this operation may be requested in any area before the application of any coat of paint. The degree of surface preparation specified shall exist immediately prior to the coating material being applied. Paint shall be protected from contamination by blasting debris until it has cured sufficiently. Paint contaminated with blasting grit shall be removed and re-applied.

Prepared surfaces shall be kept clean at all times, before coating and between coats.

### 22.15 Pack Rust

Pack rust is the term used for the condition where two areas of steel have been held tightly together by rivets or bolts, and subsequent crevice corrosion has forced these areas apart with a build-up of corrosion products between them. Pack rust that forces plates or structural sections apart to form a gap of 2 mm or greater shall be cleaned to a depth of one half of the gap width, to a maximum depth of 6 mm, treated with an approved penetrant and caulked to form a water tight seal along the top edge and the two sides of plate involved. The bottom edge or lowest edge of the plate or member shall not be caulked.

The type of penetrant and caulking used must be compatible with the paint system used and shall be applied according to the Manufacturer’s instructions. No penetrant or caulking shall be used which has not been accepted by the Consultant. When only one plate edge is exposed, a fillet of caulking shall be applied when the pack rust gap is greater than or equal to 3 mm. The fillet is not required where there is no separation of the plates due to pack rust.

Regardless of whether pack rust is evident or not, all connection plates shall be treated with an approved penetrant and caulked as described. All costs associated with the penetrant treatment and caulking will be considered incidental to the Work and no separate or additional payment will be made.

## 22.16 Disposal of Blasting Spoil

The collection, storage and disposal of blasting residue shall be carried out in compliance with federal, provincial and municipal laws.

All waste residue collected during the surface preparation process shall be stored at the site in containers acceptable to the Consultant. The waste containers shall be stored in an acceptable area and shall be protected at all times with water-proof covers. Waste residues collected and stored in the waste containers will be sampled and tested by the Contractor in accordance with the Toxic Characteristic Leachate Procedure (TCLP) test. The test results will characterize the waste residue as a hazardous or non-hazardous material and the Contractor shall dispose of the blast residue accordingly. The representative test results, for each batch of blasting residue collected shall be provided to both the Consultant and the Department before disposal of waste can be undertaken.

It is the Contractor's responsibility to provide documentation to the Consultant that all hazardous waste was disposed of in conformance with all applicable regulations governing the disposal of such materials. Acceptable documentation shall consist of a certificate of disposal that will provide information such as the quantity of material, truck manifests, way bills, and other information necessary to clearly document the transportation of, and the final disposal method and disposal site used.

## 22.17 Priming and Painting

### 22.17.1 Stripe Painting

Stripe painting is a process whereby an additional layer of paint is applied to all sharp edges of the structure being painted to increase the thickness of the coating around the sharp edge. The Contractor shall apply stripe paint along all sharp changes in steel surfaces, including but not limited to, edges of flanges, stiffeners, bracing, plates, bolts, nuts, washers, rivets, plates, and sections with sharp profile. Stripe painting may be applied prior to the prime coat or after the prime coat to aid in preservation of the blast cleaned surface. Drying times and recoat conditions must be compatible with all other coats of the paint system. Paint systems using an intermediate coat shall also be stripe painted after each intermediate coat, but not after the top coat. Stripe coats when applied over the primer or intermediate coat shall be tinted to contrast the underlying coat.

### 22.17.2 Paint Application

Paint shall be applied in accordance with the Manufacturer's instructions. When required the coating Manufacturer's representative shall be available at the site, to provide guidance and solve problems.

The use of thinners will only be permitted when reviewed and accepted by the Consultant and the Department. Thinners will only be considered for use where the Contractor has CQ1 or CQ2 qualifications. Thinners shall be supplied by the manufacturer and formulated for the coat requiring thinning. The thinner shall only be used in accordance with and within the range stated on the manufacturers' published product data sheet. If no range is stated on the manufacturers published product data sheet, the use of thinners will not be permitted.

Paint shall not be applied when the air and/or steel temperatures are at or below 4 °C, nor when the metal has absorbed sufficient heat (above 50 °C) to cause the paint to blister and produce a porous paint film, nor when it is possible the air temperature may drop below 0 °C before the paint is dry. Variances from these requirements, due to paint supplier's recommendations or requirements, require the Consultants acceptance prior to usage.

Paint shall not be applied to damp or frosty surfaces, nor applied to surfaces when there is a risk of dew. Painting shall not commence unless the dry bulb temperature exceeds the wet bulb temperature by more than 5 °C and the ambient temperature is rising.

Only the anticipated quantity of paint required for one day's work is to be opened on that day. Left over paint shall not be left exposed to air. Any paint that becomes oxidized, thickened, ropy, lumpy or dirty shall be discarded.

The paint shall be mixed in a manner which will ensure breaking up of all lumps, complete dispersion of settled pigment, and provide a uniform composition. The paint shall be agitated often enough during application to keep the pigment in suspension.

After further evaluation of our qualification testing, and discussions with our committee, we would accept thinning required for application only under the following conditions:

Paint shall not remain in spray pots, painter's buckets, etc., overnight. Multi component paints which have been mixed for the duration of the Manufacturer's recommended pot life shall be discarded in a safe manner.

Paint shall be safely stored by the Contractor, in a location which keeps its temperature between 10 °C to 25 °C.

Paint shall be applied by spraying, brushing, rolling or a combination of these methods. On all surfaces which are inaccessible for brushes or rollers and where spraying cannot be employed, the paint may be applied with sheepskin mitts specifically manufactured for this purpose.

Finish coat paint shall not be applied over wet touched up primer.

All portions of the paint system shall be within the range of film thickness(es) in which it was originally approved. Bolts, rivets, edges of members and other changes in surface contour shall also receive the required film thickness(es).

To ensure that the proper dry film thickness is obtained, the wet film thickness shall be checked at the time the paint is applied. The minimum wet film thickness shall be equal to the dry film thickness divided by the percentage (expressed as a decimal) of solids in the paint used, with the result rounded up to the next full mil. Each painter shall have his own wet film thickness gauge and do frequent checks of the paint film as it is applied. Dry film thickness shall be verified with a Type 2 constant pressure probe magnetic gauge a defined by SSPC-PA 2. The magnetic gauge shall be calibrated in accordance with SSPC-PA 2.

## 22.18 Quality Control

To ensure that the work done meets the requirements of this specification, the Contractor shall have an experienced quality control person solely dedicated to actively monitoring and correcting the work of his employees whenever cleaning, surface preparation and coating application is taking place. The Consultant will provide a NACE certified quality assurance inspector to monitor and accept the Work. The Contractor shall provide him and all other representatives of the Consultant and Alberta Transportation, at their request, safe free access to all areas of the work in all stages of completion.

There shall be no application of coating materials until the cleaning, and surface preparation have been inspected and accepted by the Consultant. Failure to follow this requirement will necessitate the complete removal, by blast cleaning, of all coating placed over surfaces not inspected and accepted by the Consultant. Each coat must be thoroughly dry and the mil thickness of each coat accepted by the Consultant prior to applying an additional coat.

## 22.19 Authority of the Consultant

Non-compliance with any portion of this specification will result in the Consultant suspending the work until the infraction has been corrected. There will be no alteration to the completion date due to this suspension of the Work. Lane rental charges and site occupancy will continue to be assessed during periods of work suspension.

## 22.20 Acceptance

Painted surfaces will be rejected, if any of the following defects are identified:

- Runs, sags, holidays or shadowing;
- Evidence of poor coverage at bolts, plate edges, lap joints, crevices, pockets, corners and re-entrant angles;
- Surfaces which have been struck, scraped, spotted by rain or otherwise damaged;
- Surfaces which exhibit an objectionable texture such as orange peel, mud cracking, fish eyes, etc.; and
- Surfaces with over spray.

## 22.21 Repair

Areas requiring repair, shall be cleaned of all damaged paint and the system re-applied using all coats typical to the original paint system. Each coat shall be thoroughly dry before applying subsequent coats. The Contractor shall carry out all repairs to the satisfaction of the Consultant at no additional cost to the Department.

Support points for work platforms or containment structures shall be painted with the accepted paint system. Work platform designs shall consider the potential to adjust touch points so coatings can be applied as work progresses. The Contractor may submit proposed alternate paint systems and application procedures for the painting of touch points, however, any proposed alternate paint systems shall be equivalent in the protection provided, expected durability and the manner in which the system ages so visual uniformity is preserved over the life of the coating. The use of alternate materials and methods will be at the sole discretion of the Department and Consultant.

## 22.22 Site Clean-Up

The Contractor shall leave the entire site in a neat and tidy condition with all paint cans, masking materials and other debris removed from the site and disposed of in manner acceptable to the Consultant and the Department.

## 22.23 5 Year Bridge Painting Warranty

The Contractor shall warranty the Work against all defects in material and workmanship for a period of five years. The warranty period will commence on the date of the final acceptance of the Work. The Contractor shall execute the form entitled, “5 Year Bridge Painting Warranty”, a sample copy of which is contained in this specification.

During the warranty period, the Consultant and/or the Department will conduct yearly inspections of the coating system. A final inspection of the coating system will be carried out a minimum of sixty days prior to the expiration of the warranty period.

Failure of the coating system shall include, but not be limited to: Any de-bonding or failure of adhesion of the coating either to the structural steel or lack of inter-coat adhesion; the appearance of any rust stains on the structure due to loss of paint or due to leaking from joints between structural members; any loss of normal gloss or rapid change of colour of the coating. Damage to the coating due to vehicle impact or snow removal equipment will not constitute failure of the system.

Repair under warranty shall include, but is not limited to, all permitting, approvals, traffic accommodation, containment systems, labour, materials, equipment, tools and incidentals necessary to restore the coating to a condition acceptable to the Department at no cost to the Department.

Warranty repairs shall be completed within 60 days of notification or, in the event this would place the repair work period in winter weather conditions, by the following June 30.

**5 YEAR BRIDGE PAINTING WARRANTY**

______________________________________________________________
(Name of Contractor)

______________
(Contract Number)

_________________________________________________________________
(Bridge File Number and Name)

_________________________________________________________________
(Name of Paint Manufacturer)

_________________________________________________________________
(Paint System Name)

The undersigned party agrees to provide a 5 year warranty for the Work. The warranty period shall commence on the date of the Contract Completion Certificate is issued and shall include all labour, materials, equipment, tools and incidentals necessary to repair all defects and restore the coating to a condition acceptable to the Department, at no cost to the Department.

CONTRACTOR:

| | | |
|---|---|---|
| ____________________ | ____________________ | ____________________ |
| (Name of Company Officer) | (Corporate Position) | (Signature of Company Officer) |
| ____________________ | ____________________ | ____________________ |
| (Name of Witness) | (Signature of Witness) | (Date) |

## 22.24 Shop Coating of Structural Steel for Bridges

### 22.24.1 Fabrication Paint Shop

Paint shops or areas of fabrication shops where painting is performed shall be well lit, free of dust and drafts and maintained at the correct temperature and relative humidity for the coating being applied.

Compressed air for cleaning and painting shall be free of moisture and oil contamination.

### 22.24.2 Pre-Surface Preparation

Surfaces to be coated shall free of weld spatter, welding flux and cutting slag. All sharp corners and edges shall be lightly ground to a 1.0 mm chamfer to break the sharp edge and all holes shall be free of burrs and cutting chips. Oil and grease shall be solvent cleaned to meet the requirements of SSPC SP1 specification for solvent cleaning, prior to blast cleaning in preparation for coating.

### 22.24.3 Abrasives

Abrasives used in shop cleaning shall be free of chlorides and other contaminants which could affect the coating being applied, and shall produce the anchor pattern required by the coating system.

### 22.24.4 Blast Cleaning

Unless noted otherwise noted all fabricated surfaces shall be blast cleaned to meet the requirements of SSPC-SP10 Near White Blast Cleaning, which is a surface free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter. The surface roughness of the cleaned surface shall be from 5 to 15 µm. No paint shall be applied until the Consultant has inspected and accepted the cleaned surface. Surfaces which have been painted without acceptance of the cleaning shall have the paint removed by blast cleaning and must be accepted by the Consultant before the paint can be applied again.

### 22.24.5 Masking

All areas not to be painted shall be masked prior to applying paint. This includes portions of members within 100 mm of field weld locations. Unless noted otherwise, all faying surfaces and within 75 mm of open holes shall be masked to prevent application of coating. All clip angles and other detail material shall be applied after blast cleaning to assure a cleaned faying surface.

### 22.24.6 Paint

Unless noted otherwise, shop primer shall be an inorganic zinc rich primer from the Alberta Transportation Product List – Approved Products “Bridge Coating Systems – Paint”.

22.24.7 Paint Application

Paint shall be applied to the specified Dry Film Thickness (DFT) of 35 to 45 µm (100 -120 µm wet film thickness). Painters shall be equipped with wet film thickness gauges to assure proper application thickness. DFT shall be checked and accepted by the Consultant prior to shipping the work.

22.24.8 Intercoat Cleanliness

The initial blast cleaned surface and subsequent coats of paint shall be kept free of dust, dry spray, overspray, oil and grease prior to application of subsequent coats or shipping.

22.24.9 Recoat Time

The maximum and minimum recoat time for the coating system being applied shall be observed and required conditioning agents or surface roughing between coats shall be done.

22.24.10 Shipping Inspection

No product is to be shipped until the Consultant has inspected and accepted the coating. Subsection 22.20, Acceptance, shall apply. Material shipped without inspection by the Consultant, may be inspected at the receiving point with all costs of this inspection charged to the Contractor.

22.24.11 Shipping

The coating shall be protected from damage during shipping.

## 22.25 Measurement and Payment

22.25.1 Protection of the Environment

22.25.1.1 General

Protection of the environment consists of all required on site protection measures, including but not limited to:

- Measurement and monitoring of background contamination levels;
- Installation, maintenance, and removal of containment measures;
- Containment, treatment and disposal of wash water;
- Removal, containment and disposal of contaminates resulting from abrasive blast cleaning and other surface preparation operations;
- Monitoring and containment of emissions; and
- Site clean-up and restoration;

All costs associated with protection of the environment associated with work carried out in a shop or fabrication facility will be considered incidental to the Work, and no separate or additional payment will be made.

#### 22.25.1.2 Payment by Unit Price

Payment for protection of the environment will be made at the unit price bid per span for “Protection of the Environment”, and will be full compensation for all labour, materials, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

60% of the unit price bid will be paid once the containment structure has been installed and the Contractor is ready to commence surface preparation and painting. The remaining 40% of the unit price bid will be paid once all surface preparation and painting has been acceptably completed; all blasting spoil has been accounted for; the blasting spoil has been removed from the bridge site and the Contractor has provided the Consultant with written acceptance of the waste materials from the owner of the disposal site; the containment structure and equipment has been removed; and the area is returned to a condition acceptable to the Consultant.

#### 22.25.1.3 Payment by Lump Sum

Payment for protection of the environment will be made at the lump sum price bid for “Protection of the Environment”, and will be full compensation for all labour, materials, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

60% of the lump sum price bid will be paid once the containment structure has been installed and the Contractor commences surface preparation and painting. The remaining 40% of the lump sum price bid will be paid once all surface preparation and painting has been acceptably completed; all blasting spoil has been accounted for; the blasting spoil has been removed from the bridge site and the Contractor has provided the Consultant with written acceptance of the waste materials from the owner of the disposal site; the containment structure and equipment has been removed; and the area is returned to a condition acceptable to the Consultant.

### 22.25.2 Surface Preparation and Painting

#### 22.25.2.1 Estimated Surface Area

The Contractor is advised that the estimated quantity of surface area to be painted as specified in the Special Provisions of the Contract are approximate, and are provided for bidding and payment pro-rating purposes only.

The estimated quantities are based on as-built drawings, and are considered to be representative of the actual surface areas to be prepared and painted. However, the Department neither implies nor guarantees the complete accuracy of these quantities. The Contractor shall satisfy himself that the estimated quantities are representative of the Work to be carried out prior to submitting a bid; and he shall have no claim against the Department for any inaccuracies of these quantities.

#### 22.25.2.2 Payment

Payment will be made at the lump sum price bid for "Surface Preparation and Painting", and will be full compensation for all operations necessary to clean and prepare the surfaces for the application of coatings; the treatment of pack rust; stripe painting; the supply and application of coating systems; and all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

Progress payments will be based on the estimated percentage of the total surface area acceptably cleaned, prepared and coated as determined by the Consultant. Areas will not be measured for payment until all coats of the selected coating system have been applied and the areas inspected and accepted by the Consultant.

## SECTION 23 STRUCTURAL LUMBER AND PILING

TABLE OF CONTENTS

## 23.1 General

This specification is for the supply and treatment of dimensional structural lumber and round timber piles. Dimensions are metric, imperial dimensions are shown in parentheses.

## 23.2 Standards

The grading shall be as per National Lumber Grading Authority (NLGA) -2014 Standard Grading Rules for Canadian Lumber and CAN/CSA O141-05 - Softwood Lumber.

The round wood piles shall be as per CAN3-056-10 (R2015).

The treatment shall conform to CSA-080-15 Wood Preservation, CSA O80.2-15 Processing and treatment; CSA O80.3-15, Preservative formulations and American Wood Preservers Association (AWPA) Standard C1, C2, M4 and Supplementary Requirements to M4.

## 23.3 Material Specification

All material shall be full sawn unless otherwise noted in the Contract.

### 23.3.1 Planking (S1S1E Strip Deck)

The material shall be Species Group HEM-FIR conforming to the stress grade “No. 1 Structural Joists and Planks” (NLGA paragraph 124 b), allowing a maximum of 20% of the Board Measure (BM) to conform to the stress grade “No. 2” of each size length supplied.

### 23.3.2 Sheeting, Retainers, Nailers and S1S1E Subdeck

The material shall be Coast Douglas Fir or Pacific Coast Hemlock species conforming to the stress grade “No. 1 Structural Joists and Planks” (NLGA paragraph 124 b), allowing a maximum of 15% of the Board Measure (BM) to conform to the stress grade “No. 2 Structural Joists and Planks”, (NLGA paragraph 124 c).

### 23.3.3 Rough Caps

The material shall be Coast Douglas Fir species, conforming to the stress grade “Select Structural Posts and Timbers” (NLGA paragraph 131 a).

### 23.3.4 Framed Subcaps

The material shall be Coast Douglas Fir species, conforming to the stress grade “Select Structural Posts and Timbers” (NLGA paragraph 131 a). The 305 mm x 355 mm (12” x 14”) cap has a length of 4.6 m (15’). From the center of the 4.6 m (15’) length in both directions along the length, for the 355 mm (14”) depth, the cap is cut on a continuous 2% slope which results in an end depth of 310 mm (12¼”). The 305 mm (12”) width remains constant.

### 23.3.5 Wheelguards

The material shall be Coast Douglas Fir or Pacific Coast Hemlock species conforming to the stress grade “No. 1 Structural Beams and Stringers” (NLGA paragraph 130 b), allowing a maximum of 15% of the BM to conform to the stress grade "No. 2 Structural Beams and Stringers" (NLGA paragraph 130 c).

### 23.3.6 Rough Stringers

The material shall be Coast Douglas Fir species conforming to the stress grade “Select Structural Beams and Stringers” (NLGA paragraph 130 a), allowing a maximum of 10% of the BM to conform to the stress grade “No. 1 Structural Beams and Stringers” (NLGA paragraph 130 b).

### 23.3.7 Struts and Handrails Posts

The material shall be Coast Douglas Fir or Pacific Coast Hemlock species, conforming to the stress grade “Select Structural Post and Timbers” (NLGA paragraph 131 a) allowing a maximum of 15% of the BM conforming to the stress grade "No. 1 Structural Post and Timbers" (NLGA paragraph 131 b).

### 23.3.8 S1S1E Cleats

The material shall be Coast Douglas Fir or Pacific Coast Hemlock species, conforming to the stress grade “No. 2 Structural Joists and Planks” (NLGA paragraph 124 c).

### 23.3.9 Railing

The material shall be S4S and is to be of the Coast Douglas Fir or Pacific Coast Hemlock species conforming to the stress grade “No. 1 Structural Joists and Planks” (NLGA paragraph 124 b).

23.3.10 Piling

All piles shall be cut from sound trees of Douglas Fir or Pine. The piles shall be clean peeled soon after being felled. All bark shall be thoroughly removed and no pile shall be considered thoroughly peeled unless all the rough bark and all the inner bark have been removed. When a portion of pile is rough and convoluted, the inner bark may remain in the depressions, provided that any such depression is not more than 20 mm (¾”) in width and 205 mm (8”) in length.

23.3.10.1 Dimensions

Unless otherwise specified, the minimum diameter after the outer and inner bark has been removed and after seasoning, shall in accordance with Table 23-1, Sizes of Timber Piles and Table 23-2, Minimum Circumference.

**Table 23-1: Sizes of Timber Piles**

| **Length** | | **Tip Diameter** | | **Butt Diameter** | |
|---|---|---|---|---|---|
| (m) | (feet) | (mm) | (inches) | (mm) | (inches) |
| Up to 6.1 | 20 | 230 | 9 | 305 | 12 |
| 6.2 to 12.2 | 20, 25 to 40 | 205 | 8 | 305 | 12 |
| 12.3 to 18.3 | 40, 25 to 60 | 180 | 7 | 330 | 13 |

However, a pile may be 12 mm (½”) smaller in either or both tip and butt diameters in one axis provided that the minimum circumferences are as follows:

**Table 23-2: Minimum Circumference**

| **Diameter** (1) | | **Circumference** | |
|---|---|---|---|
| (mm) | (inches) | (mm) | (inches) |
| 180 | 7 | 535 | 21 |
| 205 | 8 | 610 | 24 |
| 230 | 9 | 685 | 27 |
| 305 | 12 | 940 | 37 |
| 330 | 13 | 1015 | 40 |

Notes:

(1) The maximum butt diameter shall not exceed 405 mm (16”).

23.3.10.2 Sapwood

The minimum thickness of the sapwood shall be 12 mm (½”) as measured on the small end of the pile. However, no pile will be rejected where the thickness of the sapwood falls below 12 mm (½”), but not lower than 10 mm (⅜”) for a distance of 150 mm (6”) as measured around the circumference, provided it is of the minimum thickness around the balance of the circumference.

23.3.10.3 Knots

Single knots will not be considered a defect unless they are loose or show signs of decay. A “knot cluster” that is the grouping of two or more knots together as a unit, with the fibres of the wood deflected around the entire unit, shall be reason for rejection of the pile. All knots shall be trimmed close to the body of the pile.

23.3.10.4 Straightness

A line drawn from the centre of the butt and to the centre of the tip shall lie within the body of the pile. Piles shall be free from short bends in which the distance from the centre of the pile to a line stretched from the centre of the pile above the bend to the centre of the pile below the bend exceeds 4% of the length of the bend, or 65 mm (2½”).

23.3.10.5 Pitch Streaks

Pitch streaks that extend through the length of the pile shall be cause for rejection.

## 23.4 Air Seasoning

Air seasoning shall be as per Clause 1.7 of CSA 080.M1-97 (Guide for Purchasers and Specifiers of Treated Wood). Moisture content shall not be more than 19% prior to treatment.

## 23.5 Kiln Drying

The material may be kiln dried in lieu of air seasoning as per Clause 1.10 of CSA 080.M1-97 (Guide for Purchasers and Specifiers of Treated Wood). The moisture content shall not exceed 19% prior to treatment. The supplier shall ensure that the material is stacked to allow maximum ventilation between lumber and reduce any warping or checking.

## 23.6 Incising

The material shall be incised on all four sides and all around for round piles prior to treatment by a method that will provide at least the minimum penetration specified without any damage and with the least loss of strength.

## 23.7 Creosote Treatment

Material shall be seasoned and incised as per Subsection 23.4, Air Seasoning, Subsection 23.5, Kiln Drying, and Subsection 23.6, Incising, and pressure treated using 100 % creosote treatment.

Creosote treatment shall conform to CSA-080.2-97 - Preservative Treatment of Lumber, Bridge Ties, and Mine Ties by Pressure Process and AWPA Standard C1 and C2. The retention shall be 96 kg/m$^3$ (6 lb/ft$^3$) by gauge, 128 kg/m$^3$ (8 lb/ft$^3$) by assay.

## 23.8 Chromate Copper Arsenate (CCA) Treatment

Material shall be seasoned and incised as per Subsection 23.4, Air Seasoning, Subsection 23.5, Kiln Drying, and Subsection 23.6, Incising, and pressure treated using a waterborne preservative Chromate Copper Arsenate (CCA).

CCA treatment shall conform to CSA-080.2-97 - Preservative Treatment of Lumber, Bridge Ties, and Mine Ties by Pressure Process and AWPA Standard C1 and C2. The retention and penetration shall be 6.4 kg/m$^3$ (0.4 lb/ft$^3$) and 10 mm (0.4”), respectively by assay.

## 23.9 Handling, Storage and Care of Wood

Wood shall be kept free of dirt and shall be stored in a location which will not create an excessive increase in temperature (greenhouse effect) resulting in rapid drying of the material. Wood shall be stored in a manner, which will prevent ponding or trapping of excess moisture between surfaces where it cannot dry readily.

Where oil treatment is used, the wood shall be given three coats of creosote oil to repair all cuts, abrasions and holes made after the pressure preservative treatment. Each coat shall be allowed to dry before the next coat is applied.

Repair of cuts, abrasions and holes in material treated with water-borne preservative shall conform to CSA 080 and AWPA.

## 23.10 Inspection

The supplier shall provide for inspection of the material by an independent inspector who is qualified and has a minimum of 10 years of experience for this type of inspection. All material shall be inspected prior to and after the treatment. All material shall be stamped by the inspector identifying the inspection date and that the material meets or exceeds the required specifications. The stamp shall be placed at the end of each member in a location that is clearly visible even when the material is in a large stockpile. A written report from the inspector along with his experience and qualifications indicating the material meets the specifications with a “Certificate of Compliance” shall be forwarded to the Consultant.

### 23.11 Acceptance

All materials shall be subject to inspection, review and acceptance of the Consultant prior to usage.

Where S1S1E or S4S Size is specified the material shall be not more than 6 mm (¼") scant per side.

When for example 15% “No. 1” or 15% “No. 2” grade is allowed, this shall mean 85% must be the specified grade and not more than 5% of the 15% is below “No. 1” or “No. 2” grade or there will be grounds for re-inspection.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

## SECTION 24 OVERHEAD SIGN STRUCTURES AND PANELS

TABLE OF CONTENTS

## 24.1 General

This specification is for the design, supply, fabrication, erection and all associated work pertaining to bridge support or cantilever type overhead sign structures and sign panels.

The underground utilities located on the Drawings are approximate and are to be confirmed by the Contractor in the field.

## 24.2 Overhead Sign Structures

### 24.2.1 Design

#### 24.2.1.1 Design Standards

The design of overhead sign structures and panels shall be completed by the Contractor using the information contained on the Drawings and in accordance with these specifications.

The design of overhead sign structures and panels shall be in accordance with the requirements of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (AASHTO Standard Specifications), unless noted otherwise in these specifications. The design equation 3-1 referenced in Clause 3.8.1, of AASHTO Standard Specifications shall be modified as follows:

$P_z = 2.5qK_zC_d$ , where; q shall be determined from CSA S6 Table A3.1.1 for a return period of 50 years.

The design ice thickness for ice accretion shall be the value given in CSA S6 Figure A3.1.4.

The Fatigue Importance Factors in AASHTO Standard Specifications Table 11.6-1 shall be based on Fatigue Category I for the design of all cantilever type overhead sign structures.

Further to Subsection 11.7, Fatigue Design Loads, of the AASHTO Standard Specifications, a dynamic analysis of the structure will not be accepted in lieu of using the equivalent static pressures provided in the specifications.

Further to Subsection 11.7.1.1, Galloping, of the AASHTO Standard Specifications, the Department will not accept the use of vibration mitigation devices in lieu of designing to resist periodic galloping forces. Furthermore, the Department requires that the galloping loads be part of the fatigue design of all cantilevered type overhead sign structures regardless of their configuration.

Further to Subsection 11.8, Deflection, of the AASHTO Standard Specifications, the vertical deflection for overhead sign structures shall not exceed 200 mm regardless of their configuration.

Design sign panel area shall be taken as the largest of:

- Actual sign panels shown on the drawings;

- Future sign panels shown on the drawings; and
- Area of 3.5 m x 60% of horizontal span length (span length includes portion of arm over clear zone), placed in any position along the span that will produce the most critical loading conditions in the structure.

Overhead sign structures shall have a minimum permanent vertical camber of L/200 under a loaded condition, where L is the span of the horizontal arm of the sign structure.

Cantilever arm lengths shall not exceed 20 m.

The top of the concrete foundations shall project from 700 mm to 850 mm above the adjacent ground surface on the traffic side. The exposed portion of the concrete foundation shall be of circular cross section.

The minimum vertical “as constructed” clearance measured to the bottom edge of sign panel of overhead sign structures shall be 6.0 m. The bottom edge of the structural framing for the sign shall be at least 0.6 m higher than the bottom edge of the sign panels.

#### 24.2.1.2 Foundations

The Contractor shall undertake a geotechnical investigation to facilitate foundation design of the overhead sign structure. All costs associated with the geotechnical investigation will be considered incidental to the Work and no separate or additional payment will be made.

Any proposed adjustments to the locations of overhead sign structures foundations shall be submitted to the Consultant and the Department for review and acceptance prior to commencement of the Work.

Concrete shall be Class C, utilize Type HS or HSb hydraulic cement, and be in accordance with Section 4, Cast-In-Place Concrete.

All reinforcing steel shall be plain reinforcing steel and be in accordance with Section 5, Reinforcing Steel.

Grout pads shall be utilized under column base plates and shall be between 50 mm and 75 mm total thickness. Grout pad recesses shall be 25 mm in depth below the top of concrete surface.

### 24.2.2 Supply and Fabrication

#### 24.2.2.1 Standards

Fabrication of overhead sign structures shall conform to AASHTO LRFD Bridge Construction Specifications and the American Welding Society (AWS) Bridge Welding Code D1.5.

All welding, cutting and preparation shall be in accordance with the American Welding Society (AWS) Bridge Welding Code D1.5 and D1.1.

24.2.2.2 Qualification

24.2.2.2.1 Certification

Overhead sign structures and panels shall be supplied and fabricated by a fabricator certified by the Canadian Welding Bureau (CWB) in accordance with CSA Standard W47.1 to Division 1 or 2.

The Contractor shall notify the Consultant and the Department of fabricators in his employ. The Contractor shall remain responsible for the Work of fabricators. All terms of the Contract shall apply to fabricators.

Welders, welding operators and tackers shall be CWB approved in the applicable category. Their qualifications shall be current and available for examination by the Consultant upon request.

24.2.2.2.2 Quality Management System

A quality management system that includes design, material procurement, manufacturing, testing, transportation and delivery shall be maintained.

24.2.2.3 Engineering Data

24.2.2.3.1 Welding Procedures

Welding procedures including welding procedure datasheets shall be submitted for each type of proposed weld. Weld procedures shall be approved by the CWB and submitted to the Consultant and the Department for review and acceptance a minimum of 3 weeks prior to commencement of the Work.

24.2.2.3.2 Overhead Sign Structure Design Notes, Independent Check Notes, and Shop Drawing Submission Requirements

Design notes, independent check notes, and shop drawings shall be signed and sealed by the design engineer of record and by an independent checker. The design engineer of record and the independent checker shall be Professional Engineers registered in the Province of Alberta. Design notes, independent check notes and shop drawings shall be submitted to the Consultant for review and acceptance a minimum of 3 weeks in advance of the commencement of fabrication. Review comments provided by the Consultant and/or the Department shall be incorporated into the design notes, independent check notes and shop drawings and resubmitted to the Consultant for review and acceptance prior to the commencement of fabrication.

The design engineer of record and independent checker shall submit separate signed and sealed design notes and independent check notes. The design and independent check notes shall be presented in a legible and logical format, clearly identify material properties, and sufficiently detailed to allow a technical review of design concepts and assumptions used. All material properties shall be confirmed and documented by the design engineer of record and independent checker prior to the commencement to fabrication. As a minimum, design notes and independent check notes shall include analysis and design calculations of the following:

- Moment, shear and axial force envelopes for serviceability and fatigue criteria;
- Columns;
- Horizontal arm or truss;
- Column or arm flange bolted connections;
- All welded connections, stiffeners, etc.;
- Anchor rods; and
- Foundations.

The independent checker may be employed by the same company as the design engineer of record. The independent check must be completed fully independent of the design engineer of record, including a complete re-analysis of all aspects of the design including calculations and engineering, preferably by a methodology or computer program other than that used by the design engineer of record. The design engineer of record and independent checker shall ensure that the shop drawings are complete and accurately convey the design criteria and assumptions used in their designs.

Shop drawings shall be electronic unlocked PDF format. Each shop drawing shall include the Department's shop drawing identification block and have a sufficient blank space for the Consultant's review stamp. The Department's shop drawing identification block will be provided to the Contractor upon request. As a minimum, the following information shall be included on shop drawing submissions:

- Bridge file and structure number(s), A Ident numbers, and project name;
- Design criteria meeting the requirements of Subsection 24.2.1.1, Design Standards, for each individual overhead sign structure, including:
    - AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals latest Edition and Interims;
    - Initial sign panel area and/or minimum design sign panel area;
    - Design wind pressure;
    - Fatigue category and fatigue loadings;
    - Design ice thickness;
    - Other dead loads;
    - Vertical camber in loaded and unloaded conditions;
    - Design temperature range;
    - Foundation soils parameters; and
    - Critical anchor rod forces.
- Each individual shop fabricated section or assembly shall be shown separately with complete and clearly identified welded or bolted details;

- Number, spacing and locations of the aluminum T sections required for each sign panel(s);
- Weld procedure identification shall be shown on the shop drawings in the tail of the weld symbols;
- All material splice locations shall be shown on the drawings;
- Location and details of identification marks;
- Complete material list;
- Erection procedure including any temporary supports, tightening procedure for anchor rod nuts and grouting of base plates; and
- Assembly and mounting details of panel.

The design notes, independent check notes, and shop drawings will be reviewed by the Consultant solely to ascertain general conformance with codes and specifications. The Consultant's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

The Contractor shall incorporate as-built construction conditions into design notes, independent check notes, and shop drawings. One paper copy and one electronic copy (PDF format) of as-built design notes, independent check notes, and shop drawings shall be submitted to the Consultant within 3 weeks of construction completion.

24.2.2.3.3 Proposed Fabrication Sequence

Prior to commencement of fabrication, the Contractor shall present for review and acceptance an outline of the fabrication sequence and equipment being used that clearly describes the order of makeup and assembly of all the component parts, as well as shop assembly, and inspection stations.

24.2.2.3.4 Mill Test Reports and Product Data Sheets

Mill test reports and product data sheets shall be provided for all materials in English.

Mill test reports and product data sheets shall be submitted to the Consultant for review and acceptance 3 weeks prior to the commencement of fabrication.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be certified to ISO/IEC 17025 by an organization accredited by the Standards Council of Canada for the tests required. Samples for testing shall be collected by personnel employed by the certified laboratory. A verification letter shall be provided by the certified laboratory that includes at a minimum, the applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the certified laboratory.

24.2.2.3.5 Schedules

The Contractor shall provide and keep current a complete fabrication schedule in a form satisfactory to the Consultant.

24.2.2.3.6 Material Traceability

A list of all material, including hardware, shall be provided for each structure showing the component designation from the shop drawings and the associated mill test report heat numbers. The structure number shall be noted on the hardware mill test reports.

24.2.2.4 Materials

All materials shall be new.

The use of aluminum and aluminum alloy will not be permitted.

Steel materials including hardware and anchor rod assemblies shall be hot dip galvanized.

24.2.2.4.1 Steel

Structural steel plate material shall conform to either CSA G40.21M Grade 300W or 350W or ASTM A572 Grade 50.

The yield strength of the steel plate shall be limited to 300 MPa when designing for strength regardless of the material used.

Steel with a boron content exceeding 0.0008% will not be permitted.

The silicon content shall be less than 0.04% for the shafts, whereas for flanges, tenons, and base plates the silicon content shall be either less than 0.04% or 0.15 to 0.25% inclusive.

All other structural shapes except HSS incorporated in the design shall conform to CSA G40.21M Grade 300W or 350W with silicon content less than 0.04%.

Steel shafts, structural flange plates, base plates and any material welded to the structure shall meet a Charpy V-Notch minimum average absorbed energy of 20 Joules (J) at -20 °C. Charpy V-Notch testing shall be in accordance with CSA G40.20M on a per plate frequency.

Hollow structure steel (HSS) members shall conform to CSA G40.21M Grade 350W Class H with silicon content less than 0.04%; however, the yield strength of the HSS shall be limited to 300 MPa when designing for strength regardless of the material used. The steel for HSS members shall meet a Charpy V-Notch minimum average absorbed energy of 20 J at -20 °C. Charpy V-Notch testing shall be in accordance with CSA G40.20M on a per plate frequency.

24.2.2.4.2 Bolts

All bolts shall conform to American Society for Testing and Materials (ASTM) Standard F3125 Grade A325/A325M Type 1 heavy hex style. Nuts shall be heavy hex style and shall be conform to ASTM A563/A563M. Hardened washers shall conform to ASTM F436 /F436M. Rotational capacity testing is mandatory and shall be performed in accordance with ASTM F3125.

24.2.2.4.3 Anchor Rods

Anchor rods shall be manufactured from smooth rods conforming to the requirements of ASTM F1554 Grade 55 (Fy=380 MPa) including supplementary requirement S4. The anchor rod assembly shall consist of, but not limited to: anchor rods complete with nuts and washers, top temporary templates c/w clamping nuts, bottom anchor plates c/w anchor nuts and clamping nuts.

24.2.2.5 Welding

24.2.2.5.1 Filler Metals

Low hydrogen filler, fluxes and low hydrogen welding practices shall be used throughout. All electrodes and fluxes used in the Shielded Metal Arc Welding (SMAW) and Metal Core Arc Welding (MCAW) processes shall conform to the diffusible hydrogen requirements of AWS D1.5 filler metal hydrogen designator H4. All electrodes and fluxes used in the Submerged Arc Welding process (SAW) shall conform to the diffusible hydrogen requirements of AWS D1.5 filler metal hydrogen designator H8 or lower. The low hydrogen covering and flux shall be protected and stored as specified by AWS Standard D1.5. Flux cored welding or use of cored filler wires in the submerged arc process or shielding gas processes are not considered as conforming to low hydrogen practice. These methods will not be permitted. The deposited weld metal shall provide strength, durability, impact toughness and corrosion resistance equivalent to the base metal.

Field application of metal core arc welding is not allowed.

24.2.2.5.2 Cleaning Prior to Welding

Weld areas must be clean, free of mill scale, dirt, grease, and other contaminants prior to welding.

For multi-pass welds, previously deposited weld metal shall also be thoroughly cleaned prior to depositing subsequent passes.

24.2.2.5.3 Longitudinal Seams

All longitudinal seams shall be made by an approved semi or fully automatic submerged arc or metal core welding process.

24.2.2.5.4 Weld Penetration

The column to base plate and flange to horizontal arm full penetration welds shall be completed using backing bars. All other full penetration welds shall be made by using backing bars or backgouged to sound metal. The longitudinal seams shall have a minimum 60% penetration. Backing bars will not be allowed for longitudinal seam welds.

The following welds shall have 100% penetration:

- Column to base plate;
- Horizontal arm to flange plate;
- Longitudinal seam welds within 150 mm of circumferential welds and 150 mm beyond hand holes (when provided) shall be full penetration groove welds. Transition between full and partial penetration welds shall be ground smooth;
- Backing bar splices. Backing bars for splices shall have the minimum dimensions of 8 mm x 30 mm for full penetration welds and be acceptably fitted and welded all around top and bottom of the member. The groove weld shall be placed in a minimum of two passes. A reinforcing fillet weld shall be placed all around the joint; and
- Flange plate to gusset plate.

24.2.2.5.5 Preheat and Interpass Temperatures

Preheat and interpass temperatures shall be as per AWS D1.5. All full penetration welds shall be preheated and interpass temperature maintained to a minimum of 100 °C unless a higher temperature is required by AWS D1.5 Table 12.3 for the material thickness. The preheat temperature shall be measured 75 mm from the point of welding.

24.2.2.5.6 Tack and Temporary Welds

Tack and temporary welds shall not be allowed unless they are to be incorporated in the final weld. Tack welds, where allowed, shall be of a minimum length of four times the nominal size of the weld, and shall be subject to the same quality requirements as the final welds. Cracked tack welds shall be completely removed prior to re-welding.

24.2.2.5.7 Run off Tabs

Run-off tabs shall be used at the ends of all welds that terminate at the edge of a member. The thickness and shape of the tabs shall replicate the joint detail being welded and shall be a minimum of 100 mm long unless greater length is required for satisfactory work. They shall be tack welded only to that portion of the material that will not remain a part of the structure, or where the tack will be welded over and fused into the final joint. After welding, the tabs are to be removed by flame cutting, not by breaking off.

#### 24.2.2.5.8 Methods of Weldment Repair

Repair procedures for damaged base metal and unsatisfactory weldments shall be prepared by a welding engineer registered as a Professional Engineer in the Province of Alberta. Repair procedures shall be submitted to the Consultant and the Department for review and acceptance prior to commencement of the repair.

#### 24.2.2.5.9 Arc Strikes

Arc strikes will not be permitted.

If accidental arc strikes occur, a repair procedure shall be prepared by a welding engineer registered as a Professional Engineer in the Province of Alberta. The repair procedure shall be submitted to the Consultant and the Department for review and acceptance prior to commencement of the repair. At a minimum, the repair procedure shall include the complete grinding out of the crater produced by the arc strike prior to repair and magnetic particle inspection, and hardness testing of the repaired area. Hardness of the repaired area shall meet the requirements of Subsection 6.2.8.11, Hardness Tests.

#### 24.2.2.5.10 Plug and Slot Welds

Plug welds or slot welds will not be permitted.

### 24.2.2.6 Fabrication

Fabrication, including all repairs, shall be performed in a fully enclosed area which is adequately heated. The shop temperature shall be at least 10 °C. Field welding will not be permitted.

#### 24.2.2.6.1 Pre-fabrication Meeting

A pre-fabrication meeting is required for the supply and fabrication of overhead sign structures and panels. The pre-fabrication meeting shall be held at the fabrication facility and the Contractor shall ensure that the fabrication superintendent, fabrication manager, and supervisors directly involved in the Work are in attendance. The meeting shall not occur until shop drawings, design notes and independent check notes, and welding procedures have been reviewed and accepted by the Consultant. The date of the pre-fabrication meeting shall be reviewed and accepted by the Consultant and the Department and proposed a minimum of 2 weeks prior to the anticipated date.

#### 24.2.2.6.2 Cutting of Plate

All plate material for main members and any plate material welded to the main member shall be flame cut using an automatic cutting machine. Shearing is not allowed.

Corners of plates and structural sections shall be ground to a 1 mm chamfer.

24.2.2.6.3 Material Splices

If modification to the splice locations shown on the shop drawings are proposed, the Contractor shall submit design notes, check notes, and shop drawings signed and sealed by his design engineer of record and by an independent checker in accordance with Subsection 24.2.2.3.2, Overhead Sign Structure Design Notes, Independent Check Notes, and Shop Drawing Submission Requirements.

24.2.2.6.4 Fabrication Detail Requirements

Fabrication detail requirements shall be as follows:

- Each column, arm, extension, clamp and bracket shall be fabricated from one or two piece(s) of sheet steel. Each piece of sheet steel shall be the full length of the section being fabricated. A maximum of one longitudinal seam weld shall be used when the section is fabricated from a single piece of sheet steel. A maximum of two longitudinal seam welds shall be used when the section is fabricated from two pieces of sheet steel. Laminating of plates will not be permitted;

- Horizontal members greater than 12 m may have a bolted splice. Intermediate circumferential butt welds will not be permitted;

- Columns, arms, extensions and clamps shall be brake press formed or roll formed. The brake press knife shall have a radius suitable for the thickness of the material and nature of the bend. The minimum bend radius for all cold formed sections shall be 100 mm;

- All plates and structural sections shall be free of notches and gouges;

- The depth or projection of any imperfections on the inner or outer surfaces shall not exceed 15% of wall thickness. Any depth or projection up to 33% of wall thickness may be repaired by welding. Any excessive projecting weld metal shall be removed;

- The diameter of bolt holes in base plates shall be sized in accordance with CSA S6 Clause 10.18.4.2(a). The nominal diameter of all other bolt holes shall be 2 mm greater than the nominal bolt size;

- Punching of full size holes will not be permitted. The holes shall be circular and perpendicular to the member and shall be deburred to ensure a proper faying surface;

- Hand holes with cover plates on top and bottom of columns are to be provided for illuminated overhead sign structures or when specified in the Special Provisions of the Contract;

- Hand holes, when specified, shall be stiffened by providing a reinforcing rim with semi-circular ends. The rim shall be welded to the member with a full penetration groove weld supplemented with an all-around fillet weld;

- Only low stress stamps shall be used for identification marks; and
- Stiffeners will not be permitted for column to base plate and horizontal arm to flange plate connections.

24.2.2.6.5 Dimensional Tolerances

Dimensional tolerances shall be measured and recorded by the fabricator.

24.2.2.6.5.1 Straightness

The straightness tolerance shall not exceed the overall length divided by 300 from the surface at any point. This shall be measured with a straight line and the surface shall then be measured to determine the straightness.

24.2.2.6.5.2 Twisting

The twist in the overall length of any column, arm, or extension shall not exceed 7 degrees.

24.2.2.6.5.3 Length

The specified length of any item shall be within 0 to 60 mm or 0 to + 5% (whichever is less) with the exception of sign bridge spans which shall be within 5 mm of the specified dimensions in an unloaded condition. The tolerance for height shall be 0 to +60 mm.

24.2.2.6.5.4 Across the Flat Dimensions

Regular Polygonal Cross-sections: The average of all across the flat dimensions from a given cross section shall be within 1% of the specified dimension. In addition, the ratio of the maximum to minimum across the flat dimensions shall be less than or equal to 1.05.

Irregular Polygonal Cross-sections: The across the flat dimensions of the minor and major axis shall be within 2% of the specified dimensions and the sum of the minor and major axis across the flat dimensions must be within 1% of the specified dimensions.

24.2.2.6.5.5 Flatness Tolerance of Column Base Plates and Flange Plates

Surfaces of column base plates shall be flat to within 3 mm tolerance in 305 mm, and to within 5 mm tolerance overall. Faying surfaces of flange plates shall be flat to within 2 mm tolerance overall for each surface.

24.2.2.6.5.6 Arm Rise

The minimum armrise (vertical camber) shall within a tolerance of ± 15 mm from the theoretical design value for the unloaded condition.

24.2.2.6.6 Pre Assembly

After welding and fabrication, but prior to galvanizing, the Contractor shall pre-assemble all overhead sign structures, including welded sign clamps, to check the fit and geometry. The pre-assembled overhead sign structures will be inspected, reviewed and accepted by the Consultant. Overhead sign structures shall be disassembled after the Consultant review and acceptance prior to galvanizing.

24.2.2.6.7 Galvanizing

The fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatters, and all welding flux residue from the steel components prior to galvanizing.

Factors contributing to galvanization-induced cracking shall be minimized. Galvanizing shall be by the hot dip method, after fabrication, in accordance with the current edition of ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and ASTM F2329 Standard Specification for Zinc Coating Hot-Dip Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners and as modified in this specification.

Repair of galvanizing shall only be done if bare areas are infrequent, small, and suitable for repair. A detailed repair procedure shall be submitted to the Consultant and the Department for review and acceptance 3 days prior to commencement of the repair work. Repairs shall meet the requirements of ASTM A780, Method A3, Metallizing. For areas not exceeding 100 $mm^2$, repairs may be carried out in accordance with ASTM A780, Method A1, Repair Using Zinc-Based Alloy. The thickness of the coating, regardless of repair method, shall be 180 µm, and the repair tested for adhesion. The finished appearance shall be similar to the adjacent galvanizing. The Consultant will determine the acceptability of repaired areas.

Galvanized material shall be stacked or bundled and stored to prevent wet storage stain as per the American Hot Dip Galvanizers Association (AHDGA) publication “Wet Storage Stain”. Any evidence of wet storage stain shall be removed to the satisfaction of the Consultant.

24.2.2.6.8 Base Plate Corrosion Protection

The bottom surface of each base plate shall be protected by a medium grey colour barrier coating accepted by the Consultant, to prevent contact between the zinc and the concrete. The galvanized surface must be roughened prior to application of barrier coating. The surface preparation of the galvanized surface and the dry film thickness (DFT) of the coating shall be in accordance with the coating Manufacturer’s recommendations.

The Consultant will test the adhesion of fully cured coating as per ASTM D3359 “Standard Test Methods for Measuring Adhesion by Tape Test”. The method selected for testing (Method A or B) shall depend on the dry film thickness of the coating. The coating manufacturer’s product data sheets shall be provided to the Consultant prior to the application of the coating. The adhesion test result shall meet a minimum of “4B” classification i.e. a maximum allowable flaking of 5%.

### 24.2.2.7 Testing and Inspection

#### 24.2.2.7.1 General

The Contractor's testing and inspection records shall be open for examination by the Consultant upon request.

All costs associated with testing and inspection requirements shall be the responsibility of the Contractor.

The Contractor shall ensure full access to the Work all times to the Consultant or his testing agencies. When required by the Consultant, the Contractor shall provide required manpower for assistance in checking layout and performing inspection duties. Non-destructive testing and other inspection may also be performed by the Consultant or his designated testing agencies.

Testing, inspection and related costs incurred by the Consultant resulting from defective work or Contractor proposed connections and/or splices not specified on the Drawings shall be paid for by the Contractor.

The Contractor shall be responsible for all costs incurred by the Consultant to attend the pre-fabrication meeting and inspect the Work being fabricated outside the Province of Alberta. The cost shall also include for a Department's representative to attend the pre-fabrication meeting and one additional trip during the course of fabrication.

#### 24.2.2.7.2 Welds

The Contractor shall visually inspect all welds.

The Contractor shall test and inspect all full penetration welds by ultrasonic or radiographic methods.

The Contractor shall test and inspect partial penetration seam welds by ultrasonic method. The frequency of partial penetration welds shall be three random locations per weld. The length of ultrasonic inspection at each location shall be 200 mm at each weld.

The Contractor shall arrange to have 25% of all fillet welds inspected by magnetic particle testing.

Non-destructive testing (NDT) shall be completed by a technician employed by a company certified to CSA W178.1. Magnetic particle inspection, ultrasonic and radiographic testing technicians shall be certified to Level II of CGSB. Ultrasonic testing procedures shall be prepared by a CGSB Level III U/T inspector and signed and sealed by a Professional Engineer.

Non-destructive testing shall be in accordance with the following standards:

- Radiography - AWS Standard D1.5
- Ultrasonic - AWS Standard D1.5
- Magnetic Particle - ASTM Standard E-709

Calibration blocks shall be prepared for each thickness of material and used for ultrasonic methods to establish sensitivity levels and acceptance criteria. Proposed acceptance criteria shall be reviewed and accepted by the Consultant.

A copy of testing and inspection results shall be provided to the Consultant within 5 days of completion. Testing and inspection results for partial penetration welds shall also include the percentage of weld penetration.

The Contractor shall not commence with subsequent stages of fabrication until all submitted testing and inspection seam weld results have been reviewed and accepted by the Consultant.

24.2.2.7.3 Witness Points

The Contractor shall obtain the Consultant's review and acceptance at the following stages of fabrication prior to commencing with subsequent stages of fabrication:

- Material identification and traceability;
- Fitting and complete joint penetration weld testing of backing bar;
- Completion of all welding prior to shop assembly;
- NDT completed;
- Pre-assembly;
- Galvanizing and base plate corrosion protection; and
- Acceptance prior to shipment.

24.2.2.8 Identification Tag

The Contractor shall supply and install an identification tag on one column of each overhead sign structure located at 2.4 m above the base plate. The column shall be drilled and tapped for 2 - 10 mm diameter attachment bolts. The identification tag shall be in accordance with Section 13, Miscellaneous Iron, and Standard Drawing S-1848, Standard Identification Tags.

24.2.2.9 Notification to Ship

The Contractor shall notify the Consultant 72 hours prior to shipment to facilitate inspection and acceptance of the overhead sign structures. Overhead sign structures shall not be shipped until they have been reviewed and accepted by the Consultant. Review and acceptance of overhead sign structures at the fabrication facility by the Consultant will not relieve the Contractor of his full responsibility to meet the requirements of these specifications.

Overhead sign structures that have not been inspected at the fabrication facility will not be paid for until such material has been inspected, reviewed and accepted by the Consultant. The Contractor shall be responsible for all costs incurred by the Consultant for inspection of the overhead sign structures not inspected at the fabrication facility.

#### 24.2.2.10 Fabrication Outside of Canada

All testing and inspection requirements specified in Subsection 24.2.2.7, Testing and Inspection, shall be completed at the fabrication facility and all costs incurred by the Consultant and their designated testing agencies, and the Department shall be paid for by the Contractor.

All components fabricated outside of Canada shall be shipped to CSA W47.1, Division 1 or 2 certified shop in Canada for re-inspection and testing. The components shall be in a condition that facilitates all re-inspection and testing requirements. The re-inspection and testing at the Canadian shop shall be completed in accordance with Subsection 24.2.2.7, Testing and Inspection. The Contractor shall also arrange for inspection by a CSA 178.2 Level III certified welding inspector accredited with W47.1/W59 to inspect all components to ensure that they were not damaged during transportation.

Components shall not be shipped from the Canadian shop until all requirements have been met and the Work has been reviewed and accepted by the Consultant.

The Contractor shall be responsible for all re-inspection and testing costs, including all cost incurred by the Consultant and the Department.

The Contractor shall have no claim against the Department resulting from delays caused by these requirements.

### 24.2.3 Foundation Construction

#### 24.2.3.1 General

The foundations of overhead sign structures shall be completed in accordance with Section 3, Foundation Piles, Section 4, Cast-In-Place Concrete, and Section 5, Reinforcing Steel.

The Contractor shall coordinate placement of the street light cable and conduit around the sign support foundation.

#### 24.2.3.2 Anchor Rod Installation

Anchor rods shall be installed true and plumb in one complete assembly. The assembly shall be accurately positioned and secured to prevent movement or displacement during concreting procedures. Welding of components will not be permitted.

### 24.2.4 Erection

#### 24.2.4.1 General

The Contractor shall maintain the stability, safety and integrity of the overhead sign structure until grout pads have achieved the specified strength and anchor rod nuts are fully tightened.

The Contractor shall provide traffic accommodation until grouting and anchor rod nut tightening has been completed. Temporary traffic accommodation strategy requirements for overhead sign structure erection shall be submitted to the Consultant for review and acceptance a minimum of 1 week prior to commencement of the Work.

Any product damaged in shipping or during erection shall be replaced at no cost to the Department.

The Contractor shall not erect the overhead sign structure until the foundation concrete has been cured a minimum of three days and achieved 80% of the 28 day specified concrete strength requirement.

All components shall be handled with care to prevent stress to the components through bending or twisting. The use of steel chains as slings shall not be permitted. Any damage to the components through overstress, scratching or denting shall be repaired or replaced at the Contractor's expense and to the satisfaction of the Consultant.

After the top temporary template for the anchor rod assembly and clamping nuts are completely removed, the overhead sign structure shall be set accurately on galvanized shims on top of the concrete foundation. Shim plates shall be located such that a minimum of 75 mm of grout cover is provided from shims to the grout edge.

The method of forming and placing grout pads shall be acceptable to the Consultant and in accordance with Subsection 24.2.4.2, Grout Pads.

Hand hole bolts shall be coated with anti-seize lubricant.

#### 24.2.4.2 Grout Pads

Grout shall be selected from the Alberta Transportation Product List, Non-Shrink Grout category.

The grout pad recess shall be 25 mm deep and the total grout thickness shall be as shown on the Drawings. The top of finished grout pads shall not be higher than the underside of the column base plate.

The method of forming and pouring the grout shall be submitted to the Consultant for review and acceptance. Dry-pack methods of constructing grout pads will not be accepted.

Grout shall be packaged in waterproof containers with the production date and shelf life of the material shown. It shall be mixed and placed in strict accordance with the manufacturer's recommendations stated on their published product data sheet.

The Contractor shall utilize experienced ACI or CSA certified testers to test the compressive strength of the grout in accordance with CSA A23.2-1B. A set of compressive strength cubes shall be taken to represent each days production or 0.25 m3, whichever is more frequent. All test results shall be provided to the Consultant. The average minimum compressive strength of 3 cubes at 28 days shall be 30 MPa. Failure to meet the minimum specified compressive strength will result in the grout pad being removed and replaced at the Contractor's expense.

Grout shall be wet cured for a minimum of 3 days with two layers of clean, saturated Nilex 4504 white coloured filter fabric or an approved equivalent. Water used for wet curing shall be clean and acceptable to the Consultant.

Sealer shall be applied to the exposed grout pad surfaces in accordance with Subsection 4.26, Type 1c Sealer.

24.2.4.2.1 Grouting in Cold Weather

When the air temperature is, or is expected to be below 5 °C as forecasted by the closest Environment Canada Meteorological Station during the placing and curing period, or when determined by the Consultant, a cold weather grouting plan shall be implemented. The Contractor shall submit details of his proposed cold weather grouting plan to the Consultant for review and acceptance a minimum of 2 weeks prior to any grout placement. The following minimum requirements for grouting in cold weather shall be included in the cold weather grouting plan:

- Before placing grout, pre heat shall be provided to raise the temperature of formwork, anchor rods, base plate, and substrate surfaces to between 10 °C and 20 °C;

- Mixing water shall be heated to a temperature of at least 20 °C but not more than 65 °C;

- Temperature of the grout during placing shall be between 10 °C and 25 °C;

- Grout shall be wet cured a minimum of 72 hours;

- The Contractor shall enclose the structure in such a way that the grout and air within the enclosure can be kept at or above 15 °C for a protection period of 5 days after placing the grout. Enclosures shall be constructed with a minimum 300 mm clearance between the enclosure concrete and/or grout surfaces; and

- Protection and heating, when used, shall be withdrawn in such a manner so as not to induce thermal shock stresses in the grout. The temperature of the grout shall be gradually reduced at a rate not exceeding 10 °C per day to that of the surrounding air. To achieve this, in an enclosure, the heat shall be slowly reduced.

The Contractor shall demonstrate to the satisfaction of the Consultant that the requirements of the cold weather concreting plan are met.

24.2.4.3 High Tensile Strength Bolted Connections

Bolted parts shall fit solidly together when assembled. Contact surfaces shall be free of dirt, grease, burrs, pits and other defects that would prevent solid seating of the parts. Connections shall be assembled with a hardened washer under the bolt head or nut, whichever is the element turned in tightening. Surfaces of bolted parts in contact with the bolt head and nut shall be parallel.

24.2.4.3.1 Bolt Tension

All structural bolts shall be tightened using the turn of nut method described in Subsection 6.3.2.6, High Tensile Strength Bolted Connections.

24.2.4.4 Anchor Rod Nut Tightening

Anchor rod nuts shall be tightened using the turn of nut method described in Subsection 6.3.2.6, High Tensile Strength Bolted Connections, except that anchor rod nuts shall be tightened to 1/3 turn past the snug-tight condition after the grout has attained sufficient strength regardless of anchor bolt length or diameter.

The top anchor rod nuts shall be in full contact with the top of the column base plate.

Nuts will not be permitted under base plates. All voids including the slots and annular space around anchor rods in the base plate shall be filled with a corrosion inhibiting paste acceptable to the Consultant.

## 24.3 Sign Panels

The Contractor shall supply and install overhead sign panels as shown on the Drawings and in accordance with this specification.

24.3.1 Sign Panel and Connection Design Notes, Independent Checker Notes and Shop Drawing Submission Requirements

Sign panel and connection design notes, independent check notes and shop drawing submission requirements shall be in accordance with Subsection 24.2.2.3.2, Overhead Sign Structure Design Notes, Independent Check Notes, and Shop Drawing Submission Requirements and this Subsection. As a minimum, the following information shall be included on sign panel shop drawing submissions:

- Number, spacing and locations of the aluminum T sections required for each sign panel(s);
- Assembly and mounting details;
- Method of attaching sign panels to the sign support; and
- Location and number of slip arrest bolts.

### 24.3.2 Materials

Extruded aluminum panels shall be manufactured in accordance with Subsection 5.18, Supply of Permanent Highway Signs, Posts and Bases, Standard Specifications for Highway Construction, except as noted herein.

Mill test reports for all materials shall be provided in accordance with Subsection 24.2.2.3.4, Mill Test Reports and Product Data Sheets, to the Consultant for review and acceptance.

#### 24.3.2.1 Sheeting Materials

Reflective sheeting materials used on all overhead sign structures shall be in accordance with Subsection 5.18.2.8.2, Supply of Permanent Highway Signs, Posts and Bases, Standard Specifications for Highway Construction.

#### 24.3.2.2 Backing

Each panel shall be fabricated from a number of rows of extruded aluminum sections bolted together. Each row of a panel shall be fabricated from a single piece of extruded aluminum up to a maximum length of 6 m. Sign panels with a length in excess of 6 m can be split into multiple sections with a vertical joint that runs the vertical distance of the panel. The location of the vertical joint shall be chosen to minimize the number of letters/symbols split between the two sections. The number of sections for a panel shall be minimized.

A 1.0 cm wide x 2.5 cm long slotting shall be located on both edges of the extruded aluminum panels. The slotting shall be centered on the identification groove running longitudinally with the first slot centered 76 mm from the end of the section. The slotting shall be spaced on 152 mm centres for the entire length of the section.

#### 24.3.2.3 Extruded Aluminum Preparation

The extruded aluminum panels shall be clean of dust, dirt and/or grease. The method used for cleaning must not damage the anodized finish of the extruded aluminum panels or prevent the adhesion of the sheeting material to the extruded aluminum sections.

The ends of the extruded aluminum sections shall be checked to ensure that they are cut square to ensure flush joints between both panels and sections of a panel. The maximum allowable gap between two adjacent sections or panels shall be 5 mm. All excess material found along the slots and edges of the panels shall be removed.

The joint between two sections of a single panel shall be connected together with a T stiffener when installed on the sign support structure. Care should be taken in choosing the vertical joint location to avoid conflicts between the joint T stiffeners and the T stiffeners used to attach the sign panels to the sign support structure.

Adjacent sign panels shall not be connected together by a joint T stiffener or the T stiffener used to attach the sign panel to the sign support structure.

#### 24.3.2.4 Application of Sheeting Materials

The sheeting material (lettering, symbols, borders, background, etc.) shall be applied to the extruded aluminum sections as required by the sheeting manufacturer and as shown on the Plans. The horizontal line of lettering/copy across a joint between panels, or sections of a sign panel, shall be less than 8 mm.

Each panel, as shown on the Plans, shall be fabricated as an individual piece to facilitate future modifications. Large individual panels may be fabricated in multiple pieces as noted herein.

For sign panels where the background sheeting material is green and/or yellow, the sheeting is to be wrapped securely around the top and bottom horizontal edges of each extruded aluminum sub panel section. The outer edges of sheeting are to be neatly trimmed flush with the vertical edges of the sign panel.

### 24.3.3 Construction

Signs shall be shipped, stored and installed in a manner to prevent damage to the sign panels. Any damaged signs shall be repaired or replaced at no cost to the Department.

The Contractor shall erect the sign panels onto the overhead sign structures as shown on the Drawings to ensure that the signs are located correctly over the indicated lanes and that the correct vertical clearance is maintained.

The Contractor shall provide the T stiffeners, J clips, bolts, flat washers, nylon insert lock nuts, slip arresting bolts and all of the necessary hardware to securely assemble the sign and connect the sign panels to the overhead sign structure as detailed on Alberta Transportation drawing TCS-A4-335A and shown on the accepted shop drawings.

Individual extruded aluminum sign sub panels shall be fastened together using stainless steel 10 mm diameter x 25 mm long bolts, nylon insert lock nuts, and with a washer under both the bolt head and the nut. The last slot of each joint between sections shall be bolted.

The bolting of the joint between the extruded aluminum sections shall be staggered between the rows of slots, except for the last slots at either end of the section or panel.

Sign panels shall be attached to the T stiffeners using J clip assemblies. The J clip assembly consists of a J clip bolt whose square head fits into the channels that run along either edge of an extruded aluminum section, a J clip, a washer and a nylon insert lock nut. J clip assemblies shall be placed where the edge/joint of the extruded aluminum sections meets a T stiffener. The J clip assemblies shall alternate sides of the T stiffeners.

19 mm diameter x 38 mm long stainless steel slip arresting bolts shall be provided with each sign in accordance with Table 24-2, Slip Arresting Bolts Requirements

**Table 24-2: Slip Arresting Bolts Requirements**

| Number of Standard Height Sub Panels In Sign | Overall Maximum Sign Height (mm) | Number of Slip Arresting Bolts Per Each End of Each Sign |
|---|---|---|
| < 9 | 2745 | 2 |
| 10-13 | 3965 | 4 |
| 14-17 | 5185 | 6 |

Stainless steel slip arresting bolts and nuts shall meet the requirements of Type 316 ASTM F593H and Type 316 ASTM F594H respectively with a minimum yield strength of 310 MPa and a minimum tensile strength of 585 MPa. A stainless steel washer shall be provided under the nut side of the bolt. Slip arresting bolts shall have nuts tightened to a torque of 181 Nm.

All joiner bolts and J clip nuts must be tightened to a torque of 26.5 Nm within a tolerance of ±0.5 Nm.

The face of the sign panels shall be cleaned to the satisfaction of the Consultant.

## 24.4 Clean Up

All overhead sign structures and panels shall be left clean and free of oil, grease, mud, dust, road spray or other foreign matter.

## 24.5 Measurement and Payment

### 24.5.1 Overhead Sign Structures

Payment will be made at the lump sum price bid for “Overhead Sign Structure – Supply and Install”, for the applicable bridge file, and will be full compensation for the design, supply and fabrication of the structure; construction of the foundation; erection of the structure; installation; supply and installation of grout; and all labour, materials, equipment, tools, and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

80% of the lump sum price bid will be paid once the foundations have been acceptably installed and the overhead sign structure has been acceptably supplied and delivered to the project site. The remaining 20% of the lump sum price bid will be paid once the overhead sign structure has been acceptably installed and grouted.

All costs associated with grouting in cold weather, when required, will be considered incidental to the Work, and no separate or additional payment will be made.

### 24.5.2 Sign Panels

Measurement for payment of sign panels will be by the square metre of panel installed, measured to the nearest 0.1 $m^2$.

Payment will be made at the unit price bid for “Sign Panels – Extruded Aluminum – Supply and Install”, for the applicable sign panels, and will be full compensation for the design, supply and fabrication; installation of the sign panels; and all labour, materials, equipment, tools, and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

# SECTION 25 MECHANICALLY STABILIZED EARTH WALLS

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## 25.1 General

This specification is for the design, supply, fabrication and construction of single stage mechanically stabilized earth (MSE) retaining walls with precast concrete fascia panels. MSE retaining walls shall include, but not be limited to, excavation for the wall, concrete leveling pads, precast concrete fascia panels, compacted granular backfill, soil reinforcement, inspection wires, perforated drain pipe complete with filter fabric sock, geotextiles, geomembranes, surface drains, cast-in-place concrete wall coping cap, permanent safety railing, hardware and all associated materials.

Two stage MSE retaining walls are not permitted.

The precast concrete fascia panels, soil reinforcement, connections, inspection wires, hardware and associated materials shall be supplied from a single MSE wall supplier.

## 25.2 Design

### 25.2.1 General

Location, layout, geometry control, short and long term global stability, allowable rate of fill placement, and allowable bearing capacity requirements shall be as specified in the Contract documents. The Contractor's design responsibility shall include internal and external stability (sliding and overturning), tensile resistance, pullout resistances, and all other elements for a complete MSE wall system. The Contractor shall confirm the global stability design using actual soil properties of the backfill that will be used in the Work.

If the wall system selected by the Contractor requires modification to any component of the project, the Contractor will be solely responsible for all associated costs required to complete the change. Proposed changes shall be submitted to the Consultant and the Department for review and acceptance a minimum of 3 weeks prior to commencement of detailed design.

The most stringent requirements of the following standards shall be met:

- Alberta Transportation Bridge Structures Design Criteria;
- CSA S6 – Canadian Highway Bridge Design Code (CHBDC);
- AASHTO LRFD Bridge Design Specifications; and
- Alberta Transportation Roadside Design Guide.

The Federal Highway Administration (FHWA) publication, Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Volumes 1 and 2 FHWA-NHI-10_024 and FHWA-NHI-10_025, is a recommended design reference.

MSE wall embedment depths shall not be less than provided in Table C11.10.2.2.1 "Guide for Minimum Front Face Embedment Depth" in the AASHTO LRFD Bridge Design Specifications Commentary, and in addition shall not be less than 1 m.

The design life for all MSE wall system components shall be 100 years.

### 25.2.2 Drainage

All galvanized steel soil reinforcement shall be protected from exposure to roadway de-icing salt by an impermeable geomembrane placed above the top layer of soil reinforcement. This shall include soil reinforcement directly below a roadway, as well as immediately adjacent to the roadway for a minimum of 5 m measured perpendicular from the outer edge of roadway shoulder. In addition, for MSE walls that run parallel to the roadway, impermeable geomembrane shall be provided to intercept any drainage from the roadway base layer and direct it away from all MSE walls.

Geomembranes shall be sloped at a minimum of 5% to drain away from the bridge and wall and be connected to an outlet beyond the MSE soil mass. A non-woven geotextile filter fabric layer shall be placed below and above the geomembrane to prevent puncture. In all cases the geomembrane material shall be made continuous and water-tight, and shall extend a minimum of 500 mm beyond the extent of the steel soil reinforcement. Any necessary seams shall be shingled in the direction of drainage and welded or bonded to prevent leakage. Specific designs may warrant the use of roughened surface impermeable geomembranes.

Weep drains consisting of flexible perforated 150 mm diameter pipe complete with filter sock shall be provided near the front and the back bottom corner of the MSE soil mass. Weep drains shall be day lighted or connected to an outlet to establish positive drainage.

Downspouts shall be provided for deck joint and deck wick drain drainage directly in front of the MSE wall precast concrete fascia panels. Downspouts shall be rigid PVC type DB2 conduit meeting the requirements of CSA C22.2 No. 211.1. Couplers shall be solvent bell ends (SBE). Downspouts shall have a vertical slip joint with a dished top drain inlet cast into the cast-in-place wall coping cap. Downspouts shall not be directed through the mechanically stabilized earth mass. Down spouts shall be recessed full height in a chase formed into the front of precast concrete fascia panels or by using special fascia panels and covered with a 10-gauge or 2.6 mm thick steel plate. The plate shall be shop painted with a system selected from the SS1 or SS2 category of the Department’s list of approved coating systems. Surface preparation shall be in accordance with the selected coating systems published product data sheet.

Grassed swales with a non-degradable erosion control mat shall be provided behind the top of MSE cast-in-place concrete wall coping cap, beyond the footprint of the bridge deck, and shall have a minimum width of 600 mm, a minimum depth of 150 mm, and a minimum longitudinal (parallel to the face of the wall) slope of 0.5%.

Concrete swales of the same dimension as grassed swales shall be provided behind the top of MSE cast-in-place concrete wall coping cap within the footprint of the bridge deck. Closed cell foam of adequate thickness to accommodate thermal movements shall be provided between concrete swales and integral concrete bridge abutments. The closed cell foam shall be of a density that will not cause damage to adjoining components and meet all design service life requirements. A 10 mm thick asphalt impregnated fibre board shall be placed between the concrete swale and semi-integral or conventional concrete bridge abutments. Swales shall have a bottom liner of impervious geomembrane.

### 25.2.3 Geometric Requirements

All MSE walls shall be designed so that in the final position, they will be battered back against the retained soil from a vertical plumb line by a ratio of 50 vertical units to 1 horizontal unit. MSE precast concrete fascia panels shall be fully supported by compacted backfill without voids on the non-exposed side.

The geometry of MSE walls, including associated headslopes and embankments, shall be sloped so that all drainage is directed away from bridge abutments.

MSE wall backfill shall extend a minimum of 0.5 m beyond the end of the soil reinforcement.

Concrete leveling pads shall be used and project a minimum of 75 mm beyond both sides of the precast concrete fascia panels. Precast concrete fascia panels shall be centered on the concrete leveling pad. For stepped leveling pads, the maximum elevation difference between adjacent steps shall not exceed 1250 mm. The minimum length of each stepped section shall be 2500 mm.

Acute corners less than 70° (measured between backfill sides of precast concrete fascia panels) are not permitted. Special corner panels shall be used to maintain the 20 mm nominal design joint gap along the front face of panels on either side of the bend line.

Soil reinforcing details shall be designed to accommodate the requirements in Subsection 25.5.5, Backfilling, for overlapping reinforcing.

### 25.2.4 Vertical Slip Joints

In instances where a continuous length of MSE wall cannot be built all at the same time as a result of an existing obstruction (e.g. existing bridge, or existing roadway, etc.), the continuous length of MSE wall may be divided into multiple sections and some or all of the sections constructed at different times. In such instances, a full height vertical slip joint, acceptable to the Consultant and the Department, shall be provided between adjacent MSE wall sections. This manner of staging MSE wall construction shall not be confused with two stage MSE wall construction, which is not permitted.

The cast-in-place concrete wall coping cap shall be designed with vertical joints in line with the precast concrete fascia panel joints, and with horizontal reinforcement in the cap made discontinuous at these vertical joints.

### 25.2.5 Obstructions

Obstructions within the mechanically stabilized earth mass, such as foundation piles and associated casings, casings for future pile installations, or other obstructions, shall be accommodated with appropriate arrangement of soil reinforcing around such obstructions. For those MSE wall systems that splay the soil reinforcement, the splay angle shall not exceed 15° from the perpendicular of the precast concrete fascia panel. For other MSE wall systems, coverage ratios of soil reinforcement shall be specifically developed for each wall location within the Contract and design calculations included in the design notes and check notes submissions.

### 25.2.6 Precast Concrete Fascia Panels

Precast concrete fascia panels shall have a minimum thickness of 140 mm, excluding any additional thickness required for aesthetic surface treatments. The minimum cover to reinforcing steel shall be 50 mm from all faces, and steel reinforcing bars shall be electrically isolated from steel connection hardware and/or steel soil reinforcement.

Joints between panels shall have a lip and recess (ship lap) configuration. Butt joints may be used if a precast HPC concrete backing block with filter fabric is designed and installed along the joint to prevent soil infiltration. Backing blocks shall overlap adjacent panels a minimum of 150 mm and have a minimum thickness of 140 mm.

Precast concrete fascia panels shall be designed to accommodate a differential settlement of 100 mm in 10 m of length along the wall. The gap spacing between adjacent precast concrete fascia panels shall be designed to be 20 mm nominal.

To facilitate construction of the cast-in-place concrete wall coping cap pre-formed holes in precast concrete fascia panels are permitted provided the holes are located a minimum of 100 mm above the cast-in-place wall coping cap soffit.

A minimum 300 mm wide strip of filter fabric shall be installed behind all precast concrete fascia panel joints. Adhesive shall be used to hold the fabric securely against the panels centered on the vertical and horizontal joints. Details proposed shall be submitted to the Consultant for review and acceptance prior to commencement of the Work. At MSE wall corners, the fabric shall be installed in one piece crossing the corner joint.

### 25.2.7 Cast-In-Place Concrete Wall Coping Cap

A cast-in-place concrete wall coping cap is required on the top of all MSE walls, unless the section of MSE wall requires a cast-in-place concrete barrier slab.

The top of the cast-in-place wall coping cap shall be smooth, have no steps or abrupt changes in height, and a 3% wash slope towards the MSE soil mass. Control joints and drip grooves shall be detailed in accordance with Standard Drawing S-1680, Standard Curb Details. Control joints shall be located at the centerline of the precast concrete fascia panel joints, perpendicular to the wall direction and in no case exceed 4 m spacing. At control joints, longitudinal reinforcing in the cast-in-place wall coping caps shall be discontinuous and have a 50 mm concrete cover measured from the center of the joint.

The MSE wall and cast-in-place wall coping cap shall be designed to fully resist the loads specified on the Drawings that are applied to the roadway barriers, railings or any attachments.

### 25.2.8 Inspection Components

An inspection access walkway shall be provided full width of the bridge superstructure in front of the abutment seat and on top of MSE abutment walls. The inspection access walkway shall have a minimum vertical clearance of 1200 mm under the girders and a minimum clear width of 1000 mm.

Galvanized steel inspection wires shall be provided in all MSE wall systems in addition to the soil reinforcement design requirements. One inspection wire shall be provided for each 25 $m^2$ of wall area. Inspection wires shall be placed in vertically distributed sets of 2 or 3 depending on the wall height. Two locations shall be provided where the wall height is less than 6 m and three locations provided where the wall height is greater than 6 m. Vertical distribution shall be such that a single inspection wire is placed within the center of the bottom wall precast concrete fascia panel, center of the top wall precast concrete fascia panel, and in the center wall precast concrete fascia panel when three locations are required. Sets of inspection wires shall be evenly distributed along the length of the wall.

Inspection access ports, wire removal and centering devices shall be detailed in accordance with the California Department of Transportation standard bridge detail sheet XS13-020-3. Inspection access ports shall be cast as voids in the panels at the panel manufacturing facility and the remaining cavity placed and filled with an approved type OH-V patching product in accordance with the manufacturer's recommendations. All inspection access ports shall be marked with a 25 mm diameter galvanized or plastic survey target anchored into the patching material and flush with the wall surface. Adhesively mounted survey targets will not be permitted. Survey targets shall not receive pigmented sealer.

### 25.2.9 Design Notes, Independent Check Notes, and Shop Drawing Submission Requirements

Design notes, independent check notes, and shop drawings shall be signed and sealed by the design engineer of record and by an independent checker. The design engineer of record and the independent checker shall be Professional Engineers registered in the Province of Alberta. Design notes, independent check notes and shop drawings shall be submitted to the Consultant for review and acceptance a minimum of 3 weeks in advance of the commencement of fabrication. Review comments provided by the Consultant and/or the Department shall be incorporated into the design notes, independent check notes and shop drawings and resubmitted to the Consultant for review and acceptance prior to the commencement of fabrication.

The design engineer of record and independent checker shall submit separate signed and sealed design notes and independent check notes. The design and independent check notes shall be presented in a legible and logical format, clearly identify material properties, and sufficiently detailed to allow a technical review of design concepts and assumptions used. All material properties shall be confirmed and documented by the design engineer of record and independent checker prior to the commencement to fabrication.

The independent checker may be employed by the same company as the design engineer of record. The independent check must be completed fully independent of the design engineer of record, including a complete re-analysis of all aspects of the design including calculations and engineering, preferably by a methodology or computer program other than that used by the design engineer of record. The design engineer of record and independent checker shall ensure that the shop drawings are complete and accurately convey the design criteria and assumptions used in their designs.

Shop drawings shall be electronic unlocked PDF format. Each shop drawing shall include the Department's shop drawing identification block and have a sufficient blank space for the Consultant's review stamp. The Department's shop drawing identification block will be provided to the Contractor upon request. As a minimum, the following information shall be included on shop drawing submissions:

- Wall layout plan and elevation complete with dimensions and elevations, and typical wall cross-sections;
- Precast concrete fascia panel reinforcing, connection and hardware detailing;
- Cross references to relevant bridge design Drawings;
- Design criteria and list of material properties;
- Backfill properties;
- All component and connection details;
- MSE wall drainage details; and
- Construction procedures and construction sequencing.

The design notes, independent check notes, and shop drawings will be reviewed by the Consultant solely to ascertain general conformance with codes and specifications. The Consultant's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

The Contractor shall incorporate as-built construction conditions into design notes, independent check notes, and shop drawings. One paper copy and one electronic copy (PDF format) of as-built design notes, independent check notes, and shop drawings shall be submitted to the Consultant within 3 weeks of construction completion.

## 25.3 Materials

### 25.3.1 Mill Test Reports

Mill test reports shall be provided for all steel fabricated components, steel soil reinforcement, connections, and associated hardware in English. Material test reports shall be provided for geosynthetic soil reinforcement and impermeable geomembrane. Mill and material test reports shall be submitted to the Consultant for review and acceptance prior to being incorporated in the Work.

The Contractor shall maintain a tracking system and complete set of records for all steel fabricated components. Mill test reports at a minimum shall include: heat number, date, location of production, compliance with production standards, chemical analysis, mechanical properties, including galvanizing processes. Mill test reports shall be authenticated by the manufacturer.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be certified to ISO/IEC 17025 by an organization accredited by the Standards Council of Canada for the tests required. Samples for testing shall be collected by personnel employed by the certified laboratory. A verification letter shall be provided by the certified laboratory that includes at a minimum, the applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the certified laboratory.

### 25.3.2 Concrete

Concrete for leveling pads shall be Class C. Concrete for precast concrete fascia panels, anchor blocks, backing blocks, cast-in-place concrete wall coping caps, and all other concrete components shall be Class HPC. Concrete shall conform to the requirements of Section 4, Cast-In-Place Concrete. The maximum aggregate size for HPC concrete used in panel production shall suit the panel design and the requirements of CSA S6 and CSA A23.1.

### 25.3.3 Reinforcing Steel for Concrete

Reinforcing steel shall be in accordance with the requirements of Section 5, Reinforcing Steel.

### 25.3.4 Steel Soil Reinforcement, Connections and Hardware

Steel soil reinforcement consisting of welded wire reinforcement shall meet the requirements of ASTM A1064. Steel soil reinforcement consisting of steel strip reinforcement shall meet the requirements of ASTM A572. Inspection wires shall meet the requirements of ASTM A1064. Connections and hardware shall meet the specified design life of 100 years.

Steel with a boron content exceeding 0.0008% will not be permitted.

#### 25.3.4.1 Galvanizing

Steel soil reinforcement, connections and associated hardware shall be galvanized in accordance with ASTM A123 and F2329. Safeguarding measures to prevent embrittlement and testing to detect embrittlement shall be completed in accordance with ASTM A143 for all lots of steel soil reinforcement, connections and associated hardware.

Repair of galvanizing shall be completed in accordance ASTM A780, Method A3 “Metallizing” and will only be permitted when the repair areas are small and infrequent as determined by the Consultant. Repair areas less than 100 mm$^2$ in area may be completed in accordance with ASTM A780, Method A1 ”Repair Using Zinc-Based Alloy”. The thickness of the coating for both methods shall be 180 µm, and the repair tested for adhesion. A detailed repair procedure shall be submitted for review and acceptance by the Consultant prior to commencement of the work. Repairs may require complete removal of the galvanized coating and re-galvanizing.

Galvanized material shall be stacked or bundled and stored to prevent wet storage stain as per the American Hot Dip Galvanizers Association (AHDGA) publication “Wet Storage Stain”. Any evidence of wet storage stain shall be removed to the satisfaction of the Consultant.

### 25.3.5 Geosynthetic Soil Reinforcement

Geosynthetic soil reinforcement shall meet AASHTO LRFD Bridge Design Specifications Clause 11.10.6.4.3b. The requirements “for applications involving severe consequences of poor performance or failure” shall apply. Product specific durability studies shall be carried out to determine the product-specific long term strength reduction factor (RF) and shall be submitted for the Consultant’s review and acceptance. These studies shall be used to estimate the short term and long term effects of the environment factors on the strength and deformational characteristics of the geosynthetic reinforcement throughout the specified design life.

Geosynthetic reinforcing materials shall satisfy the requirements of the following tests with the understanding that the test methods are current at the time of construction:

- ASTM D7737-11, Standard Test Method for Individual Geogrid Junction Strength;
- GG 2-87, Standard Test Method for Geogrid Rib Junction Strength;
- ASTM D5262 - 07(2012), Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics;
- GG4-05, Standard Practice for Determination of the Long Term Creep Design Strengths of Geogrids;
- GG4(a) Revised 2012, Standard Practice for Determination of the Long-Term Design Strength of Stiff Geogrids;
- GG4(b) Revised 2012, Standard Practice for Determination of the Long-Term Design Strength of Flexible Geogrids; and
- ASTM D6706 - 01(2013), Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil.

Geosynthetic reinforcing materials shall contain stabilizers or inhibitors to prevent degradation of properties due to ultraviolet light exposure.

The nominal long-term reinforcement design strength (Tal) values for specific products shall be determined by third party agencies such that as the Highway Innovative Technology Evaluation Centre (HITEC) or AASHTO National transportation Product Evaluation Program (NTPEP) and product lines shall be re-tested every 3 years at a minimum.

### 25.3.6 Safety Railings

Steel components of safety railings shall be fabricated and galvanized in accordance with Section 12, Bridgerail. Safety railings shall conform to CSA G40.21M Grade 300W.

### 25.3.7 Backfill

Backfill for construction of MSE walls shall be crushed aggregate material conforming to the gradation requirements listed in Table 25-1, Backfill Gradation Requirements, and shall be free of organic matter and other deleterious materials.

**Table 25-1: Backfill Gradation Requirements**

| **Metric Sieve Size (CGSB 8-GP-2M)** | **Designation/Class** | | |
|---|---|---|---|
| | **Crushed Aggregate Material Des 2 Class 20** | **Crushed Aggregate Material Des 2 Class 25** | **Crushed Aggregate Material Des 2 Class 40** |
| **Sieve Size µm** | **Percent Passing** | **Percent Passing** | **Percent Passing** |
| 40 000 | 100 | 100 | 100 |
| 25 000 | 100 | 100 | 70 - 94 |
| 20 000 | 100 | 82 - 97 | n/a |
| 16 000 | 84 - 94 | 70 - 94 | 55 - 85 |
| 10 000 | 63 - 86 | 52 - 79 | 44 - 74 |
| 5 000 | 40 - 67 | 35 - 64 | 32 - 62 |
| 1 250 | 22 - 43 | 18 - 43 | 17 - 43 |
| 630 | 14 - 34 | 12 - 34 | 12 - 34 |
| 315 | 9 - 26 | 8 - 26 | 8 - 26 |
| 160 | 5 - 18 | 5 - 18 | 5 -18 |
| 80 | 2 - 10 | 2 - 10 | 2 - 10 |
| % fractures by weight (2 faces) | 60+ | 60+ | 50+ |
| Plasticity Index | NP - 6 | NP - 6 | NP - 6 |
| L.A. Abrasion Loss Percent Maximum | 50 | 50 | 50 |

Laboratory density testing shall be completed in accordance with ASTM D698 on the selected backfill source(s) and provided in the submission requirements outlined in Subsection 25.2.9, Design Notes, Independent Check Notes, and Shop Drawing Submission Requirements.

The physical properties of the MSE wall backfill material selected by the Contractor from Table 25-1 shall be used by the MSE wall supplier in his detailed design of the MSE wall.

In no case shall any backfill placed within 2.0 m of the precast concrete fascia panels have more than 5% passing the 0.080 mm (80 µm) sieve size.

Soil filters between soil zones shall be designed based on the properties of the adjacent materials.

The selected backfill shall also meet the requirements of Table 25-2 or Table 25-3, based on soil reinforcement type used in the MSE wall system.

**Table 25-2: Backfill Requirements for Galvanized Steel Soil Reinforcing**

| **Backfill Requirement** | | **Test Method (ASTM)** | **Test Method (AASHTO)** |
|---|---|---|---|
| Resistivity | ≥3000 ohm-cm | G57 | T 288 |
| pH | 5 - 10 | G51 | T 289 |
| Chlorides | ≤100 ppm | D512 | T 291 |
| Magnesium Sulphate Soundness | Loss less than 30% after four cycles | D5240 | T 104 |
| Sulphates | ≤200 ppm | D516 | T 290 |
| Organic Content | ≤1.0% | D2974 | T 267 |

**Table 25-3: Backfill Requirements for Geosynthetic Soil Reinforcing**

| **Backfill Requirements** | | **Test Method (ASTM)** | **Test Method (AASHTO)** |
|---|---|---|---|
| pH | 3 - 12 | G51 | T 289 |
| Organic Content | ≤1.0% | D2974 | N/A |
| Design Temperature at Site | ≤30°C | N/A | N/A |

Collection of samples for testing shall be from proposed stockpiles at the top, middle and bottom portions, approximately 0.6 m in from the face of the stockpile. Resistivity testing shall be completed on 6 samples (2 top, 2 middle, 2 bottom). PH, chloride, sulphate, and organic content testing shall be completed on 9 samples (3 top, 3 middle, 3 bottom).

25.3.8 Geotextile Filter Fabric

Non-woven geotextile filter fabric shall meet the requirements specified in Table 25-4, Non-woven Geotextile Filter Fabric Requirements.

**Table 25-4: Non-woven Geotextile Filter Fabric Requirements**

| Physical Property | Test Method (ASTM) | Minimum Required Value |
|---|---|---|
| Grab Strength | D4632 | 650 N |
| Elongation – Failure | D4632 | 50 % |
| CBR Puncture Strength | D6241 | 250 N |
| Trapezoidal Tear | D4533 | 275 N |

The minimum fabric lap length shall be 300 mm.

25.3.9 Impermeable Geomembrane

Impermeable geomembrane shall be PVC, HDPE or LLDPE with a minimum thickness of 0.75 mm, and meet the physical property requirements outlined in Table 25-5, Impermeable Geomembrane Requirements.

**Table 25-5: Impermeable Geomembrane Requirements**

| Physical Property | Test Method (ASTM) | Minimum Required Value |
|---|---|---|
| Tear Strength | D1004 | 45 N |
| CBR Puncture Strength | D6241 | 140 N |

25.3.10 Type 1c Concrete Sealer

Type 1c sealer shall be applied to exposed concrete surfaces in accordance with Section 4, Cast-In-Place Concrete.

25.3.11 Precast Concrete Fascia Panel Installation Shims

All proposed permanent shims used in precast concrete fascia panel installation shall meet the specified design life of the MSE wall.

## 25.4 Precast Concrete Fascia Panel Fabrication

The fabrication of precast concrete fascia panels shall be in accordance with Section 7, Precast Concrete Units, CSA A23.4, and this section. In the case of conflicting requirements the hierarchy of governing requirements shall be as follows: Section 25, Mechanically Stabilized Earth Walls, Section 7, Precast Concrete Units and CSA A23.4.

The concrete materials used in the fabrication of precast concrete fascial panels shall meet the requirements of Subsection 25.3.2, Concrete.

All edges of precast concrete fascia panels shall be chamfered.

Geosynthetic reinforcing embedded into precast concrete fascia panels shall be facilitated using structural steel jigs to maintain alignment and projection lengths. Geosynthetic reinforcing embedded into precast concrete fascia panels shall exit perpendicular to the precast concrete fascia panel unless otherwise reviewed and accepted by the Consultant and the Department. Geosynthetic reinforcing tabs exiting precast concrete fascia panels shall have uniform projection length.

Concrete shall have a minimum strength of 18 MPa prior to formwork removal.

Exposed precast concrete fascia panels shall be finished in accordance with Section 4, Cast-In-Place Concrete with the exception that all required surface cavities shall be filled with a Department approved concrete patching material. The entire exposed panel fascia finish texture shall be a form finish and not a washed or rubbed finish.

Precast concrete fascia panels with the following defects shall be rejected:

- Units with variation in precast concrete fascia panel face trueness for any line across a precast concrete fascia panel face from a straight edge more than 2 mm over 1 m;

- Units with honeycombing, cracks, spalls or broken corners;

- Units with more than 10 surface cavities per $m^2$ with cavity diameters from 2 mm up to 5 mm;

- Units with more than three surface cavity per $m^2$ with cavity diameter from 5 mm up to 10 mm; and

- Units with any surface cavities greater than 10 mm in diameter.

Inspection and assessment of surface cavities shall be carried out by the Contractor immediately after stripping of forms. Surface cavities of 5 mm or less on precast concrete fascia panels meeting the above criteria will not require further repair.

Repair of surface cavities shall be completed in a sheltered environment with a minimum ambient temperature of 10°C. Saturation of the face of the precast concrete fascia panels in preparation for the repair of surface cavities shall begin immediately after stripping. During repair of surface cavities, and up to the start of elevated temperature curing or moist curing, panel faces shall be kept in a continuously saturated surface dry condition. As an alternative to moist curing with filter fabric, precast concrete fascia panels may be moist cured in an enclosure with controlled temperature and humidity such that all exposed concrete surfaces remain saturated for the duration of the curing period. If stacked during curing, sufficient space shall be maintained between panels to permit airflow and inspection of surfaces.

## 25.5 Construction

### 25.5.1 General

The Contractor shall employ qualified personnel experienced in constructing MSE walls to supervise and perform the work. Construction of the MSE wall system shall conform to the shop drawings supplier's submitted construction procedures and construction sequencing, and these specifications.

The Contractor shall also require the supplier of the MSE wall system to provide a full-time qualified representative on site during construction to advise the Contractor's personnel regarding construction procedures and to monitor that construction is being completed in accordance with the shop drawings and the supplier's submitted construction procedures and construction sequencing.

A milestone construction meeting for MSE wall construction shall be held prior to the commencement of the Work. The agenda shall be developed by the Contractor and MSE wall supplier and reviewed and accepted by the Consultant prior to scheduling the meeting. The Contractor's project manager, MSE wall construction superintendent, MSE wall design engineer of record, MSE wall supplier construction representative, and any other personnel directly involved in supervision of the Work shall attend the milestone construction meeting.

The Contractor shall provide the Consultant with a weekly summary report detailing daily construction activities and compliance. Work that is not in compliance with the accepted shop drawings, construction sequencing and procedures, shall be corrected immediately to the full satisfaction of the Consultant.

### 25.5.2 Conformance Criteria

The Contractor and MSE Wall design engineer of record shall provide formalized documentation, sealed and signed by the Professional Engineer registered in the Province of Alberta, for each of the following construction phases confirming compliance with all Contract requirements:

- Foundation base preparation;
- On-site delivery of all MSE wall components;
- Backfill requirements;
- Alignment of precast concrete fascia panels; and
- Wall alignment and tolerance measurements.

The Contractor shall maintain soil reinforcing placement records, soil compaction records, and precast concrete fascia panel alignment and tolerance measurement records throughout MSE wall construction.

MSE wall components that are damaged during any construction operation shall be repaired or replaced at the Contractor's expense as outlined in these specifications and completed to the full satisfaction of the Consultant.

### 25.5.3 Excavation

Excavation for the MSE wall shall be carried out in conformance with Section 1, Excavation, and these specifications. In the case of conflicting requirements the requirements of this specification shall govern.

The Contractor shall establish the locations and extents of all existing underground services in the work area prior to commencement of work. All underground service locations shall be clearly marked and protected during the course of construction. Damages to existing services resulting from the Contractor's operations shall be repaired at the Contractor's expense.

Excavation shall be completed to the design grades shown on the design drawings, shop drawings, and as determined by the Consultant. The Contractor shall proof roll the foundation subgrade after excavation to identify any soft spots. Soft material, as determined by the Consultant, shall be removed and replaced with compacted crushed aggregate material to the satisfaction of the Consultant. Any temporary excavation support required shall be the full responsibility of the Contractor and no separate or additional payment will be made.

The Contractor shall not commence further construction of the MSE wall until the excavation, ground improvements, and foundation base preparation have been completed and the sealed and signed formalized documentation has been submitted to the Consultant and his geotechnical engineer for review and acceptance. The Consultant's review and acceptance of the foundation base preparation shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with these specifications.

### 25.5.4 Concrete Leveling Pads

Construction of concrete leveling pads shall conform to the requirements of Section 4, Cast-In-Place Concrete. Concrete leveling pad elevations shall be set by instrument. The deviation from the detailed design profile shall not exceed 3 mm over a 3 m length. After erection of the first row of precast concrete fascia panels, any openings between leveling pad steps shall be formed and filled with Class C cast-in-place concrete in a manner acceptable to the Consultant.

Concrete leveling pads that are not constructed to the elevations shown on the Drawings and/or within the specified tolerances shall be removed and replaced. After removal of the concrete leveling pads, the foundation base shall be prepared, inspected, reviewed and accepted in accordance with Subsection 25.5.2, Conformance Criteria before proceeding with recasting.

### 25.5.5 Backfilling

Backfill shall be placed and compacted in accordance with Section 2, Backfill, the MSE wall supplier's recommendations and these specifications. In the case of conflicting requirements the most stringent requirements shall govern.

All backfill shall be placed in lifts not exceeding 150 mm in thickness of loose material.

The Contractor shall not place backfill on frozen substrate.

Backfill shall be placed such that soil reinforcement is fully supported for the entire length of the soil reinforcement. At precast concrete panel fascia panel connections small, localized pockets may be present to facilitate connection hardware installation. The extent of the small, localized pockets shall be in accordance with the supplier's recommendations and acceptable to the Consultant.

No equipment shall be allowed to run directly on soil reinforcement. Backfill compaction shall be performed such that equipment moves parallel to the precast concrete fascia panels and away from the precast concrete fascia panels toward the end of the soil reinforcement. Only hand operated power tampers and vibrators shall be used for compaction within 1000 mm of the precast concrete fascia panels. At the completion of each day's work the Contractor shall slope the last level of backfill away from the precast concrete fascia panels to direct potential run-off away from the precast concrete fascia panels.

Backfill placement and compaction shall closely follow erection of each course of precast concrete fascia panels. Backfill shall be placed in such a manner as to avoid any damage or disturbances of the MSE wall components or misalignment of the precast concrete fascia panels. All MSE wall components that are damaged during backfill placement shall be removed and replaced at the Contractor's expense. Any misalignment or distortion of the precast concrete fascia panels due to placement of backfill shall be corrected by the Contractor at his expense before continuing with the Work.

For any wall layout where overlap of geosynthetic reinforcement occurs, a minimum 75 mm of compacted backfill shall be placed between geosynthetic reinforcement layers.

A control strip density shall be established on the first lift and every 900 vertical millimetres of backfill placed thereafter (once every 6 lifts) for every 45 metres of wall or part thereof and not less than once per day. The control strip density shall be measured in accordance with Alberta Transportation Test Method ATT-58A, Density Test Control Strip Method. All backfill lifts shall be compacted to a minimum of 98% of the control strip density and shall be measured in accordance with Alberta Transportation Test Method ATT-11, Density Test In-Place Nuclear Method. Compaction testing results shall be provided to the Consultant at the end of each day or as requested by the Consultant.

Sieve analysis shall be completed on backfill being placed at the beginning and end of each day for each zone of backfill containing soil reinforcing. Results shall be submitted to the Consultant at the end of each day or as requested by the Consultant. The Contractor shall also complete sampling and testing of the backfill during construction in accordance with Table 25-6, Backfill Sampling and Testing Requirements during Construction, to demonstrate continued compliance.

**Table 25-6: Backfill Sampling and Testing Requirements during Construction**

| Range of Resistivity (ohm-cm) | Sample Interval for Resistivity Testing ($m^3$) | Sample Interval for PH, Chlorides, Sulphates, Organic Testing ($m^3$) |
|---|---|---|
| >5000 | 3000 | 1500 |
| <5000 and ≥3000 | 1500 | 750 |

If any test result does not meet specification requirements, the Contractor shall stop backfilling operations immediately and resample and test the backfill. Additional testing of material already placed may be required and will be determined by the Consultant. Test results shall be submitted to the Consultant within 3 days of completion. Backfilling operations shall not continue until all testing is completed and any non-compliant backfill removed and replaced. All costs associated with sampling and testing, including removal and replacement of non-compliant backfill, and the replacement of any damaged MSE wall components shall be at the Contractor's expense.

### 25.5.6 Precast Concrete Fascia Panel Installation

The height of shims at any location shall not exceed the specified precast concrete fascia panel installation tolerances.

Any precast concrete fascia panel damaged during installation, including cracks, spalls or broken corners, shall be rejected, and new precast concrete fascia panels provided.

All precast concrete fascia panel lifting hook pockets shall be patched with an approved type NH or HEH concrete patching material. The approved concrete patching material shall be placed in accordance with the manufacturer's recommendations.

Precast concrete fascia panels shall be installed to the following tolerances:

- The out-of-flatness of wall surfaces measured in any direction shall not exceed 25 mm under a 3 m straight edge;
- The offset of adjacent panel edges at joints shall not exceed 10 mm;
- The overall out-of-vertical alignment of the completed wall shall not exceed 4 mm/m of the total MSE wall height; and
- The joint gap width shall be between 10 mm and 30 mm.

For any precast concrete fascia panel that does not meet the specified installation tolerance, the backfill shall be removed and the precast concrete fascia panel reset to the specified tolerance before continuing construction.

### 25.5.7 Cast-in-Place Concrete Wall Coping Caps

Construction of cast-in-place concrete wall coping caps and surface finishes shall conform to the requirements of Section 4, Cast-In-Place Concrete and Section 5, Reinforcing Steel. Cast-in-place concrete wall coping cap elevations shall be set by instrument.

Galvanized anchor bolt assemblies for safety railings shall be cast into the concrete.

Cast-in-place concrete wall coping cap sections located at corners shall be isolated from contact with other concrete components with 12 mm thick closed cell foam.

### 25.5.8 Impermeable Geomembrane

Seams of impermeable geomembranes shall be placed parallel to the MSE wall and lapped in the direction of positive drainage to produce a shingling effect. The membrane shall be installed in accordance with the manufacturer's recommendations and in weather conditions acceptable to the Consultant.

### 25.5.9 Safety Railings

All steel components of safety railings shall be erected in accordance with Section 12, Bridgerail.

### 25.5.10 Material Storage

The Contractor's lay-down area shall be graded level to ensure precast concrete fascia panels are safely and uniformly supported on timber bearing blocks with plastic separators. Precast concrete fascia panels shall be stacked on timber planks or pallets and separated by timber blocks with dimpled plastic separators designed by a Professional Engineer.

Precast concrete fascia panels shall be stored such that the uniform color of the panels is maintained and protected from staining or discoloration. Panels with stained, discoloured, or damaged front faces shall not be incorporated into the wall.

All materials shall be stored above ground, covered and protected from rain, snow, dirt, and ultraviolet light. Any damage identified by the Consultant shall be repaired to the full satisfaction of the Consultant.

### 25.5.11 Drainage Management during Construction

The Contractor shall construct, maintain and modify temporary drainage features to prevent adverse amounts of surface run-off from entering the MSE wall construction area. Any erosion or other adverse effects, resulting from inadequate drainage management shall be immediately addressed by the Contractor and repaired to the full satisfaction of the Consultant.

## 25.6 Measurement and Payment

Measurement for payment of mechanically stabilized earth walls will be by the square metre of wall acceptably installed, measured to the nearest 0.1 $m^2$.

Payment will be made at the unit price bid for "Mechanically Stabilized Earth Walls", and will be full compensation for the design; supply; fabrication; delivery; installation; testing and inspection construction; and all labour, materials, equipment, tools, and incidentals necessary to complete the Work as shown on the Drawings, shop drawings, and to the satisfaction of the Consultant.

90% of the unit price bid will be paid once the MSE precast concrete panels have been acceptably installed and backfilled. The remaining 10% of the unit price bid will be made once the cast-in-place concrete wall coping caps have been placed and received surface finishes, handrails have been installed, drainage systems are functional, and the specified construction documentation has been submitted, reviewed and accepted by the Consultant.

# SECTION 26 RCP AND PBC STRUCTURES

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## 26.1 General

This specification is for the supply, manufacture, delivery, and installation of Reinforced Concrete Pipe (RCP) and Precast Box Culvert (PBC) structures.

The Work shall be carried out as shown on the Drawings and in accordance with the following specifications. The requirements of this specification shall govern over all referenced standards in the case of conflicting requirements.

## 26.2 Supply and Manufacture

### 26.2.1 Reinforced Concrete Pipe

Indirect designed RCP including flared end pipe sections shall be supplied and manufactured in accordance with CSA A257 or ASTM C76M and this specification.

Direct designed RCP structures shall be supplied and manufactured in accordance with ASTM C1417M and this specification.

When specified on the Drawings, maintenance access holes (manholes) shall be supplied and manufactured in accordance with ASTM C478M.

### 26.2.2 Precast Box Culvert

The supply and manufacture of all PBC shall be in accordance with ASTM C1433M and this specification.

### 26.2.3 Qualification

The Contractor shall notify the Consultant of any subcontractors in his employ. The Contractor shall remain responsible for the work of the subcontractors. All terms of the contract, such as right of access, shall apply to subcontractors.

RCP and PBC sections shall be supplied and manufactured by a precast fabricator that is certified under the Plant Prequalification Program (PPP) as outlined in the publication, Prequalification Requirements for Precast Concrete Drainage Products.

The fabrication of RCP and PBC structures shall be completed in a sufficiently large environmentally controlled permanent building capable of manufacturing products in a well-organized and continuous operation. The building shall be capable of maintaining a controllable temperature and humidity to meet fabrication requirements and prevent material contamination and/or deterioration.

### 26.2.4 Engineering Data

A minimum of two weeks prior to the commencement of fabrication, shop drawings, mill test reports, product data sheets, and the concrete mix design shall be submitted to the Consultant for review and acceptance.

26.2.4.1 Shop Drawings

Shop drawings shall be submitted to the Consultant for review and acceptance a minimum of 4 weeks in advance of the commencement of fabrication. Review comments provided by the Consultant and/or the Department shall be incorporated into the shop drawings and resubmitted to the Consultant for review and acceptance prior to the commencement of fabrication.

Shop drawings shall be electronic unlocked PDF format. Each shop drawing shall include the Department's shop drawing identification block and have a sufficient blank space for the Consultant's review stamp. The Department's shop drawing identification block will be provided to the Contractor upon request.

The shop drawings will be reviewed by the Consultant solely to ascertain general conformance with codes and specifications. The Consultant's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

The Contractor shall incorporate as-built construction conditions into shop drawings. One paper copy and one electronic copy (PDF format) of as-built shop drawings shall be submitted to the Consultant within 3 weeks of construction completion.

Shop drawings are not required for RCP manufactured in accordance with ASTM C76M or CSA A257.

26.2.4.2 Design Notes and Independent Check Notes

If modifications to the Contract requirements are proposed, the Contractor shall submit design notes, independent check notes, and shop drawings signed and sealed by his design engineer of record and by an independent checker.

The design engineer of record and the independent checker shall be Professional Engineers registered in the Province of Alberta. Design notes and independent check notes shall be submitted to the Consultant for review and acceptance a minimum of 4 weeks in advance of the commencement of fabrication. Review comments provided by the Consultant and/or the Department shall be incorporated into the design notes and independent check notes and shop drawings and resubmitted to the Consultant for review and acceptance prior to the commencement of fabrication. The design engineer of record and independent checker shall submit separate signed and sealed design notes and independent check notes. The design and check notes shall be presented in a legible and logical format, clearly identify material properties, and sufficiently detailed to allow a technical review of design concepts and assumptions used.

The independent checker may be employed by the same company as the design engineer of record. The independent check must be completed fully independent of the design engineer of record, including a complete re-analysis of all aspects of the design including calculations and engineering, preferably by a methodology or computer program other than that used by the design engineer of record. The design engineer of record and independent checker shall ensure that the shop drawings are complete and accurately convey the design criteria and assumptions used in their designs.

The design notes, independent check notes, and shop drawings will be reviewed by the Consultant solely to ascertain general conformance with codes and specifications. The Consultant's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

The Contractor shall incorporate and submit as-built design notes, check notes, and shop drawings for records at the completion of construction. One paper copy and one electronic copy (PDF format) of as constructed shop drawings, design and check notes, and supplier inspection construction records shall be submitted to the Consultant within 3 weeks of construction completion.

#### 26.2.4.3 Mill Test Reports and Product Data Sheets

Mill test reports and product data sheets shall be provided for all materials used in the manufacture of RCP and PBC structures in English.

Mill test reports shall be submitted to the Consultant for review and acceptance 3 weeks prior to commencement of fabrication.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be certified to ISO/IEC 17025 by an organization accredited by the Standards Council of Canada for the tests required. Samples for testing shall be collected by personnel employed by the certified laboratory. A verification letter shall be provided by the certified laboratory that includes at a minimum, the applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the certified laboratory.

#### 26.2.4.4 Concrete Mix Design Submission Requirements

Concrete mix design submission requirements shall be provided in accordance with Subsection 4.4.4, Concrete Mix Design Submission Requirements.

### 26.2.5 Pre-fabrication Meeting

A pre-fabrication meeting is required prior to the commencement of fabrication of PBC and direct designed RCP structures. A pre-fabrication meeting is not required for indirect designed RCP structures. The pre-fabrication meeting shall be held at the fabrication facility and the Contractor shall ensure that the fabrication superintendent, fabrication manager, and supervisors directly involved in the Work are in attendance. The meeting shall not occur until shop drawings, design notes and independent check notes (as applicable), and welding procedures have been reviewed and accepted by the Consultant. The date of the pre-fabrication meeting shall be reviewed and accepted by the Consultant and the Department and proposed a minimum of 2 weeks prior to the anticipated date.

### 26.2.6 Materials

#### 26.2.6.1 Hydraulic Cement

Hydraulic cement used in the manufacture of RCP and PBC shall be Type HS or HSb and conform to the requirements of CSA A3001.

#### 26.2.6.2 Reinforcing Steel

Reinforcing steel for RCP structures shall conform to the requirements of ASTM C76M or ASTM C1417M.

Reinforcing steel for PBC structures shall conform to the requirements of ASTM C1433M and Section 5, Reinforcing Steel.

The boron content of reinforcing steel shall not exceed 0.0008%.

#### 26.2.6.3 Rubber Gaskets and Flexible Joint Sealants

Rubber gaskets for RCP structures shall conform to the requirements of CSA A257.3.

Flexible joint sealants for PBC structures shall conform to the requirements of ASTM C990.

Rubber gaskets for PBC structures shall conform to the requirements of ASTM C1619.

### 26.2.7 Testing and Inspection

#### 26.2.7.1 Access

The Contractor shall provide full facilities for the inspection of Work. The Consultant shall have full access to all parts of the Work at all times. When required by the Consultant, the Contractor shall provide needed manpower for assistance in checking layout and performing inspection duties.

#### 26.2.7.2 Responsibility

It is the Contractor's responsibility to ensure that the Work is completed in accordance with the Contract requirements. Any inspection and/or testing completed by the Consultant, review and acceptance by the Consultant, shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract.

#### 26.2.7.3 Witness Points

Inspection stations shall be set up at specific points during the course of fabrication for the Consultant to complete inspection and/or testing. At each witness point the Work shall be checked by the Contractor, reviewed and accepted by the Consultant, and all deficiencies corrected to the full satisfaction of the Consultant prior to the next sequence of fabrication.

Witness points for RCP and PBS Structures shall be:

- Form dimensions and set-up;
- Placement of reinforcement;
- Placement of voids and hardware;
- Concrete mixture and placement;
- Form stripping;
- Clean-up and repair;
- Curing;
- Storage of units.

26.2.7.4 Testing by the Contractor

Sampling, casting, curing and testing concrete specimens shall be completed by the Contractor to demonstrate specification compliance. The Contractor's testing and inspection records shall be open for examination by the Consultant upon request.

Testing, inspection and related costs incurred by the Consultant resulting from defective work or Contractor proposed details not specified on the Drawings shall be paid for by the Contractor.

26.2.8 Section Identification Markings

26.2.8.1 Reinforced Concrete Pipe

All classed and indirect designed RCP sections shall be marked with waterproof paint or have markings cast into the sections as follows:

- Pipe classification and manufacturing standard;
- Nominal inside diameter;
- Date of manufacture;
- Name or logo of manufacturer;
- Plant identification; and
- Installation orientation markings, if required.

All direct designed RCP sections shall be marked with waterproof paint or have markings cast into the sections as follows:

- Pipe designation:
    - Di_______, T______, H______- _______where,
    - Di = designated pipe nominal inside diameter, mm;
    - T = installation type;
    - H = (minimum)-(maximum) fill height, m;
- Manufacturing standard;
- Date of manufacture;
- Name or logo of manufacturer;
- Plant identification;
- Pipe identification number; and

- Installation orientation markings, if required.

When RCP sections are marked by casting identification into concrete, the minimum specified cover shall be maintained.

26.2.8.2 Precast Box Culvert

All PBC sections shall be marked with waterproof paint or have markings cast into the sections as follows:

- Box designation:
  - o S________, R______, H______- ________where,
  - o S = designated box section span, mm,
  - o R = designated section rise, mm,
  - o H = (minimum)-(maximum) fill height,
- Manufacturing standard;
- Date of manufacture;
- Name or logo of manufacturer;
- Plant identification;
- Box identification number; and
- Installation orientation markings showing the top of slab up on both inside and outside faces.

When PBC sections are marked by casting identification into concrete, the minimum specified cover shall be maintained.

26.2.9 Standard Identification Plaques

Standard identification plaques shall be supplied and installed in accordance with Section 13, Miscellaneous Iron and Standard Drawing S-1847, Standard Identification Plaques and Benchmark Tablet.

26.2.10 Defects

Defects in RCP or PBC identified either at the fabricator's plant or at the construction site shall be repaired by the Contractor at his expense to the satisfaction of the Consultant.

Honeycomb, cavities, spalls, chips, cracking and other defects shall be immediately reported to the Consultant. Repair procedures shall be developed by the Contractor and submitted for review and acceptance by the Department and Consultant prior to the commencement of the repair. Repair procedures may vary for the RCP and PBC structures and the Contractor shall consider the physical dimensions and properties of the element being repaired. The Consultant shall be notified a minimum of 24 hours before the commencement of any repair.

In cold weather conditions this work shall be carried out in accordance with Subsection 4.21, Concreting in Cold Weather.

### 26.2.10.1 Honeycomb, Cavities, Chips, Spalls, and Casting Defects

As a minimum, the Contractor's repair procedure for repairing defects less than 30 mm in depth shall include:

- Roughening the repair area to remove all loose material and laitance;
- Filling the repair area with an approved concrete patching material listed on the Department's Product list in the Overhead/Vertical (OH-V) category;
- Placing the repair material in accordance with the manufacturer's published product data sheet;
- Wet curing the repair material for a minimum of 72 hours; and
- Finishing the repair area to achieve a surface uniform in color and texture to the surrounding concrete.

As a minimum, the Contractor's repair procedure for repairing defects greater than 30 mm in depth shall include:

- Saw cutting the repair extents in neat perpendicular lines;
- Removing the concrete to a depth beyond the reinforcement by a minimum of 1.5 times the maximum concrete aggregate used in the concrete mix;
- Roughening the repair area to remove all loose material and laitance;
- Repairing and cleaning reinforcement to its original condition;
- Saturating the repair area with water for a period of 3 hours prior to concrete placement;
- Cleaning and drying the repair area with oil-free compressed air;
- Placing and curing the replacement concrete in accordance with the requirements of this specification; and
- Finishing the repair area to achieve a surface uniform in color and texture to the surrounding concrete.

### 26.2.10.2 Cracks

All cracks will be measured, mapped, and documented in the fabrication inspection report by the Consultant. Cracks shall be monitored, repaired or sections replaced as follows:

- Sections with cracks 0.3 mm in width or greater shall be replaced with new sections;

- Cracks greater than 0.2 mm and less 0.3 mm in width shall be assessed by the Contractor and a repair or replacement strategy developed. The repair or replacement strategy shall be submitted to the Department and Consultant for review and acceptance prior to the commencement of the repair or replacement work; or

- Cracks equal to or less than 0.2 mm in width shall be monitored throughout construction and if crack width growth occurs they shall be repaired or sections replaced in accordance with the requirements of these specifications.

### 26.2.11 Handling and Storage

All materials shall be stored in a neat and orderly manner to facilitate testing and inspection.

Rubber gaskets and sealants shall be stored in accordance with the manufacturer's recommendations.

All RCP and PBC sections shall be handled carefully and in such a manner as to prevent cracking, gouging, chipping, or any other damage to the concrete surfaces.

RCP and PBC sections shall be stored at ground height with supports acceptable to the Consultant and shall not be stacked vertically.

RCP and PBC sections designated by the Consultant as unacceptable, due to failure to meet the specified requirements, shall be immediately repaired in accordance with Subsection 26.2.10, Defects, or replaced by the Contractor at his expense.

### 26.2.12 Notification to Ship

The Contractor shall notify the Consultant 72 hours prior to shipment to facilitate inspection and acceptance of the RCP and PBC structures. RCP and PBC structures shall not be shipped until they have been reviewed and accepted by the Consultant. Review and acceptance of RCP and PBC structures at the fabrication facility by the Consultant will not relieve the Contractor of his full responsibility to meet the requirements of these specifications.

RCP and PBC structures that have not been inspected at the fabrication facility will not be paid for until such material has been inspected, reviewed and accepted by the Consultant. The Contractor shall be responsible for all costs incurred by the Consultant for inspection of the RCP and PBC structures not inspected at the fabrication facility.

### 26.2.13 Fabrication Outside of Canada

All testing and inspection requirements specified in Subsection 26.2.7, Testing and Inspection, shall be completed at the fabrication facility and all costs incurred by the Consultant and their designated testing agencies, and the Department shall be paid for by the Contractor.

All components fabricated outside of Canada shall be shipped to a shop located in Canada that meets the qualification requirements specified in Subsection 26.2.3, Qualification, for re-inspection and testing. The components shall be in a condition that facilitates all testing and inspection requirements. RCP and PBC structures fabricated outside of Canada shall be re-inspected by a Prestressed/Precast Concrete Institute (PCI) certified level II inspector. Testing and inspection shall be completed in accordance Subsection 26.2.7, Testing and Inspection. The PCI certified inspector shall also inspect all components to ensure that they were not damaged during transportation.

In addition three concrete cores shall be taken from each precast concrete unit, at locations determined by the Consultant, and tested by a laboratory certified to CSA A283 to determine that the concrete meets all Contract requirements.

Components shall not be shipped from the Canadian shop until all requirements have been met and the Work has been reviewed and accepted by the Consultant.

The Contractor shall be responsible for all re-inspection and testing costs, including all cost incurred by the Consultant and the Department.

The Contractor shall have no claim against the Department resulting from delays caused by these requirements.

## 26.3 Construction

### 26.3.1 General

Construction of RCP and PBC structures shall be in accordance with Subsection 7.8.15, Construction, of the CSA S6 Canadian Highway Bridge Design Code, and these specifications. RCP structures shall also be constructed in accordance with ASTM C1479M.

The structure shall be kept dewatered to the full extent of the excavation until all backfilling is completed.

Cranes shall be used for the handling and erection of PBC sections and RCP sections that are 2.0 m or larger.

### 26.3.2 Care of Water

In addition to ECO plan submission requirements, the Contractor shall also prepare and submit a separate care of water plan signed and sealed by a professional engineer registered in the Province of Alberta to the Consultant for review and acceptance a minimum of 2 weeks prior to the preconstruction meeting. The care of water plan shall outline the means and methods that will be used to control and manage water and/or ice at all times during the Work in accordance with all applicable environmental regulations.

The care of water plan will be reviewed by the Consultant solely to ascertain general conformance with environmental regulations, specifications and any applicable Special Provisions of the Contract. The Consultant’s review and acceptance shall not be considered as relieving the Contractor of his full responsibility for the design, construction, monitoring, performance, and maintenance of the care of water plan.

### 26.3.3 Excavation

Excavation shall be completed to the lines and grades shown on the Drawings or as determined by the Consultant, and in accordance with Section 1, Excavation.

Excavations shall be dewatered to the bottom of the excavation until all backfilling is acceptably completed.

### 26.3.4 Erection Procedure

The Contractor shall submit a detailed erection procedure for RCP structures with a diameter of 2 metres or greater and for all PBC structures to the Consultant for review and acceptance a minimum of three weeks in advance of the scheduled start of installation. The erection procedure shall be stamped by a Professional Engineer registered in the Province of Alberta. Safety and compliance with the Occupational Health and Safety Act and Regulations thereunder shall be integral parts of his design.

At a minimum the erection procedure shall include drawings and documentation necessary to acceptably communicate the following:

- Access to work;
- Type and capacity of equipment;
- Sequence of operation, including traffic accommodation, haul or transport truck, and crane positions;
- Detailed crane position on the ground with details of load distribution on wheels and outriggers;
- Details of section lifting, showing forces at lifting pins/lugs; and
- Details of temporary works for positioning and alignment of precast concrete sections.

The Contractor shall continue to be fully responsible for the results obtained by the use of the stamped erection procedure, with the Contractor’s Professional Engineer also assuming responsibility, as the Contractor's Agent, for the results obtained. The Consultant's acceptance shall not be considered as relieving the Contractor of the responsibility for the safety of his methods or equipment, nor from carrying out the work in full accordance with the drawings and specifications.

### 26.3.5 Installation

#### 26.3.5.1 General

Installation of RCP and PBC structures shall not proceed until the excavation, foundation, and bedding material placement has been reviewed and accepted by the Consultant.

The Contractor shall install RCP and PBC sections to the lines and grades as shown on the Drawings, in accordance with the manufacturer’s instructions and as determined by the Consultant.

RCP and PBC structures shall be installed from the lowest bedding elevation to the highest bedding elevation.

The tolerance from the grades shown on the Drawings or established by the Consultant shall not exceed ±15 mm. The Contractor shall implement appropriate measures to control the grades to meet the tolerance requirements.

Under no circumstance shall the Contractor use an excavator or any other mechanical device or piece of equipment to push, pull, pound or rock RCP or PBC sections to achieve alignment. Sections shall not be dropped, dragged or rolled along the ground at any time.

The ends of each precast section shall be clean and dry of all dirt, oil, grease, and any foreign materials before joining sections together. Sections shall be firmly drawn together in a manner that results in a continuous, watertight conduit with a smooth and uniform interior surface. The joined sections shall accommodate for expansion, contraction, settlement, or lateral displacement requirements.

Allowable joint gap spacing between joined sections shall not exceed 13 mm for RCP structures and 20 mm for PBC structures.

If installed sections do not meet the specified alignment requirements, the sections shall be completely disassembled, bedding material adjusted, rubber gasket or sealants replaced and sections re-joined to the satisfaction of the Consultant

Defects identified at site shall be addressed in accordance with Subsection 26.2.10, Defects.

#### 26.3.5.2 Reinforced Concrete Pipe

Installation of RCP shall include a rubber gasket at each joint between sections. The Contractor shall follow the rubber gasket manufacturer's storage and installation requirements.

The Contractor shall use lifting clutches with 3-legged chain sling (wire or link) for RCP sections with a diameter of 1050 mm or greater.

#### 26.3.5.3 Precast Box Culvert

Installation of PBC shall include a flexible joint sealant or rubber gasket at each joint between sections. The Contractor shall follow the rubber gasket manufacturer's storage and installation requirements.

The Contractor shall use embedded lifting anchors, lugs, or pins for PBC section installation. All lifting cavities shall be filled with an Overhead/Vertical (OH-V) concrete patching material listed on the Department's Product List once installation has been completed, reviewed and accepted by the Consultant.

### 26.3.6 Backfilling

When installation of the structure has been accepted by the Consultant, backfilling with the material(s) specified on the Drawings may commence. Backfilling shall be in accordance with the Drawings and Section 2, Backfill. In addition, the following requirements shall be met:

- When the ambient air temperature is below 0 °C, no backfilling will be permitted unless otherwise accepted by the Department and the Consultant. When acceptance is granted, all backfill material shall be in a thawed state when placed and compacted. Backfill material shall not be permitted;

- Backfilling under the haunches shall be compacted to achieve the density specified;

- Backfilling shall be free of voids and provide uniform support to the structure. The backfill shall be placed such that the level of fill on one side does not exceed the level of fill on the other side of the structure by more than 300 mm;

- The backfill shall be placed and compacted by equipment moving parallel to the structure with simultaneous handwork along the structure. Large earth moving equipment and large compaction equipment shall not be permitted within 1 m of the structure. Any damage to the structure from compaction equipment used shall be repaired by the Contractor at his expense to the full satisfaction of the Consultant;

- The first 300 mm of backfill over the structure shall be placed, levelled and compacted without vibration. Subsequent fill over the structure shall be placed and compacted by equipment moving perpendicular to the longitudinal axis of the structure. The Contractor shall obtain the Consultant's acceptance before using any equipment above the structure.

- For compacted non-granular backfill materials, the quality, methods of placement and compaction, shall be submitted to the Consultant for review and acceptance prior to the commencement of the Work. Highly plastic clay or material with high silt content will not be permitted.

- Clay seal material shall be highly plastic clay with a minimum plasticity index of 40. Clay seal materials shall be classified in accordance with ASTM D2487.

## 26.4 Substrate Holders

Substrate holders shall be fabricated, installed and constructed as shown on the Drawings and as outlined in the Special Provisions of the Contract.

## 26.5 Heavy Rock Riprap

Heavy rock riprap shall be placed as shown on the Drawings and shall conform to the requirements of Section 10, Heavy Rock Riprap.

## 26.6 Post-Installation Inspection

The Contractor and the Consultant shall jointly carry out a post-installation inspection after all backfilling is complete.

Joint gap measurements will be taken and recorded by the Consultant at all section joints.

All cracks will be identified, measured in width and length by the Consultant.

All defects shall be noted, recorded, and repaired or replaced by the Contractor in accordance with the requirements of this specification and to the satisfaction of the Consultant prior to the stream being re-routed through the new structure or being opened to pedestrian traffic.

### 26.6.1 Reinforced Concrete Pipe

A post-installation inspection will only be required for RCP structures with diameters of 1500 mm or larger.

Joint gap measurements inside the RCP structure will be taken and recorded by the Consultant at the locations of minimum and maximum gap at each section joint.

### 26.6.2 Precast Box Culvert

A post installation inspection will be required for all PBC structures.

Joint gap measurements inside the PBC structure will be taken and recorded by the Consultant at the locations of minimum and maximum gap along of the top, bottom, and both side surfaces at each section joint.

The inside alignment along the top, bottom, and both side surfaces at each section joint will be measured and recorded by the Consultant.

## 26.7 Measurement and Payment

Payment for the following items will be made at the applicable unit price or lump sum prices bid:

- Detour Road - Construct and Maintain;
- Demolition, Disposal and Salvage of Existing Structure;
- Excavation;
- RCP– Supply;
- PBC – Supply;
- Crushed Aggregate Backfill – Des 2 Class 25 or Des 2 Class 40;
- Non-Granular Backfill;
- RCP – Install;
- PBC – Install;
- Substrate Holders;
- Guardrail;
- Roadway Work; and
- Heavy Rock Riprap.

Such payments will be full compensation for all labour, materials, equipment, tools, and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Consultant.

Unit price payments will be based on actual quantities acceptably completed and remaining in the Work, as determined by the Consultant.

Payment for “RCP – Supply” and “PBC – Supply” will be made to a maximum of 90% of the lump sum or unit price bid once the materials have been acceptably supplied and delivered to the project site. The remaining 10% of the lump sum or unit price bid will be made once the structure has been acceptably backfilled and installation tolerances have been measured, reviewed and accepted by the Consultant.

All costs associated with the supply and installation of geotextile filter fabric, when specified, will be considered incidental to the Work, and no separate or additional payment will be made.

All cost associated with the care of water and/or ice will be considered incidental to the Work, and no separate or additional payment will be made.