SPECIFICATIONS

FOR

BRIDGE CONSTRUCTION

Alberta
Transportation

2010

SPECIFICATIONS

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Prepared by
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SUMMARY OF SPECIFICATIONS

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 1

EXCAVATION

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1.1 General

Excavation is the removal of all material, of whatever nature, necessary for the construction of foundations, substructures or other works, in accordance with the drawings or as determined by the Department and Consultant. Excavation shall include the construction of all cribs, cofferdams, dikes, berms or other devices necessary for the work, or necessary for maintaining the stability of adjacent headslopes, fills, or existing structures, the protection, dewatering and maintenance of the excavated region, and the disposal of excavated material not required or not suitable for backfill as determined by the Consultant. If any excavation or dredging is made at the site of the structure, the Contractor shall, without extra charge, after the foundation base is in place, backfill all such excavation to the original ground surface or river bed with material satisfactory to the Consultant. Material deposited within the stream area from foundation or other excavation, or from any other operations, shall be removed and the stream area freed from obstruction.

Where necessary the excavations shall be shored, braced or protected by cofferdams in accordance with approved methods. Whatever method is employed, the Contractor shall be responsible for maintaining the integrity and stability of existing adjacent headslopes and fills.

For projects where the existing ACP approach road surface is to be retained as is, the Contractor shall provide suitable and adequate protection for the existing ACP during excavation/trimming procedures or other construction activities. This may consist of placement of filter fabric and sand or road crushed granular material or other means over the existing ACP. This protection work will be considered to be incidental, and no extra payment will be made. The Contractor shall be responsible to correct any damages, to the Consultant's acceptance which occurs to the existing ACP.

1.2 Clearing

Any clearing that may be required for the completion of the Bridge portion of the Work under this contract shall be considered incidental and shall be done by the Contractor.

1.3 Depth of Footings

The elevations of the bottoms of the footings as shown on the drawings shall be considered as approximate only; the Department and Consultant may order such changes in dimensions or elevations of footings as may be necessary to secure a satisfactory foundation.

1.4 Preparation of Foundations for Footings

All rock or other hard foundation material shall be free from all loose material, cleaned and cut to a firm surface either level, stepped, or roughened, as may be determined by the Consultant. All seams shall be cleaned out and filled with concrete, mortar or grout.

When concrete is to be cast on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation, and the final removal of the foundation material to grade shall not be made until just before the concrete is to be placed.

In the case of concrete culverts or certain spread footings, when a firm foundation is not attained at the grade established, the foundation shall be deepened to an elevation determined by the Department and Consultant and backfilled with suitable clay or granular material as described under Section 2, “Backfill”.

In the case of spread footings the lower part of the excavation, for a depth corresponding to the height of the footings, shall be made neat to the same plan dimensions and shape as the footing, and the concrete shall be poured therein without forms. Seepage water shall be collected and drained or pumped away before it can enter the neat portion of the excavation.

1.5 Cofferdams, Dikes and Berms

1.5.1 General

All cofferdams, dikes and berms constructed by the Contractor for foundation construction shall be carried to adequate depths and heights, be safely designed and constructed of good standard materials, and be made as watertight as is necessary for the proper performance of the work which must be done inside them. Their dimensions shall give sufficient clearance for the construction and inspection of forms, and to permit pumping of water outside of the forms.

No separate payment will be made for the supply, construction or removal of cofferdams, dikes or berms. Full compensation for the cost of such material and labour shall be considered to be included in the price bid for the specified work to be carried out inside the cofferdam, dike or berm.

1.5.2 Drawings Required

For substructure work, the Contractor shall submit drawings or sketches showing the proposed method of cofferdam, shored excavation, dike or berm construction, and other details left open to his choice. Drawings for cofferdam or shored excavations shall bear the stamp of a Professional Engineer, registered in Alberta. Such drawings shall be submitted to the Consultant before construction is started on work governed by them. The Consultant shall review the drawings as to intent only, and any acceptance of such drawings by the Consultant shall in no way relieve the Contractor of full responsibility for the success or failure of the work described by or related to those drawings.

1.5.3 Concrete Seal

When conditions are encountered which in the opinion of the Department and Consultant make it impracticable to dewater the foundation before placing concrete, he may require or allow the construction of a concrete foundation seal below the elevation of the bottom of the footing, of such dimensions as may be necessary. The foundation shall then be pumped out and the balance of the concrete placed in the dry. During the placing of a foundation seal, the elevation of the water inside the cofferdam shall be controlled to prevent any flow through the seal and if the cofferdam is to remain in place, it shall be vented or ported at low water level. All costs incurred in the construction of the seal shall be the responsibility of the Contractor, unless the seal is called for on the drawings, in which case the seal concrete will be paid for at the tendered price.

1.5.4 Removal of Bracing

No timber or bracing shall be left in the cofferdams in such a way as to extend into the substructure concrete, without written permission of the Department and Consultant.

1.5.5 Pumping of Water

Pumping from the interior of any cofferdam shall be done in such a way as to preclude the possibility of the flow of water through any fresh concrete. No pumping will be permitted during the placing of concrete or for a period of 24 hours after, unless the pumping is done from a suitable sump separated from the concrete by a watertight wall or other effective means. Pumping to dewater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure. In cases where turbid water is to be pumped from any excavation, a suitable settling basin shall be provided to ensure that only water free from suspended material finds its way into any stream.

1.5.6 Removal of Cofferdams, Dikes and Berms

Cofferdams, dikes and berms shall be removed after completion of the substructure for which they were placed, care being taken not to disturb or otherwise injure the finished works. Backfill required around the permanent work shall be placed prior to the removal of cofferdams, dikes or berms.

The Department and Consultant reserves the right to require the Contractor to remove all materials from the streambed at any time to prevent stream pollution or adverse environmental effects, including bank erosion, or effects on adjacent structures or any other installations or property. If the Contractor fails to comply with this requirement, the Department and Consultant further reserves the right to make immediate separate arrangements to remove such materials at the Contractor's expense. The Contractor shall be responsible for all costs incurred by the Department and Consultant to remove such material and/or all damages incurred.

1.6 Inspection of Excavation

After the excavation is completed to the elevation shown on the drawings, the Contractor shall notify the Consultant. The Consultant shall review and accept the depth of the excavation and the character of the foundation material before any further work can proceed.

The Department and Consultant may then order test pits, test drilling, further excavation, or other work as necessary to obtain an acceptable excavation.

Test pits and test drilling shall be paid for in accordance with 1.2.25 “Extra Work” of the General Specifications.

1.7 Classification of Excavation

Excavation shall be classified as follows:

Structural Excavation - Excavation related to the foundations and substructures,

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

1.8 Measurement and Payment

Payment for **Excavation** will be either at the unit price bid per cubic metre or lump sum price basis. Such price shall include the cost of all labour, material, equipment, and other items of expense necessary for the successful completion of the excavation.

Payment will be determined as follows:

1.8.1 Unit Price per Cubic Metre

When payment is to be on unit price basis, the quantity to be paid for will be the actual number of cubic metres in the natural condition, of material acceptably excavated in conformity with the drawings or as determined by the Consultant. No quantity of excavation will be included in the measurement for payment which is outside the neat lines of the footing. The top and bottom limits of the computed volume shall be the original ground surface and the bottom of the completed footing, with no payment to be included for the removal of water and ice.

1.8.2 Lump Sum Price

When payment is to be on lump sum price basis, the lump sum price shall include full payment for the excavation of all material necessary in conformity with the drawings or as determined by the Consultant.

When it is necessary, in the opinion of the Department and Consultant, to carry the foundations below the elevations shown on the drawings, the additional quantity of excavation will be paid by a negotiated lump sum price or in accordance with 1.2.25 “Extra Work” of the General Specifications as determined by the Department and Consultant.

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 2

BACKFILL

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2.1 General

Backfill shall include material required to fill excavations adjacent to various bridge components or culvert installations. Backfill shall also include the supply and placing of materials necessary for construction of approach fills, roadway embankments, slopes, channel banks, and berms.

All materials shall be sourced and supplied by the Contractor. The Contractor shall be responsible for royalties, processing, loading, hauling, placing, compacting, QC 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 non-organic soil such as clay. When reviewed and accepted by the Consultant, non-granular material can be substituted with granular material.

Material used for the construction of the “clay seals” shall be highly plastic clay (exhibiting putty-like properties with considerable strength when dry). Material with very high swelling potential such as bentonite clays will not be permitted. When the proposed material characteristics for clay seals are in question the Consultant may require the Contractor to classify the material using Test Method ASTM D2487 - Classification of Soils for Engineering Purposes. Material shall have a minimum Plasticity Index of 40.

2.2.2 Gravel Material and Crushed Aggregate Material

Where Gravel Material or Crushed Aggregate Material is specified, it shall consist of clean sand and gravel, complying with the following requirements:

	Designation/Class		
Metric Sieve Size (CGSB 8-GP-2M)	***Gravel Material Des 6 Class 80**	**Crushed Aggregate Material Des 2 Class 40**	**Crushed Aggregate Material Des 2 Class 25**
Sieve Size µm	**Percent Passing**	**Percent Passing**	**Percent Passing**
125 000	--	--	
80 000	100	--	
50 000	55 - 100	--	
40 000	--	100	
25 000	38 - 100	70 - 94	100
20 000	--	--	82 - 97
16 000	32 - 85	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	6 - 30	8 - 26	8 - 26
160	--	5 - 18	5 -18
80	2 - 10	2 - 10	2 - 10
% fractures by weight (2 faces)	N/A	50+	60+
Plasticity Index	NP - 8	NP - 6	NP - 6
L.A. Abrasion Loss Percent Maximum	N/A	50	50

*Note: Native Gravel Material may require processing in order to meet the gradation requirements.

2.2.3 Backfill Material Tests

The Contractor shall submit for the Consultant’s review two weeks before placing of the granular material, a sieve analysis representing the material to be used at site. The sampling and testing shall have been done no more than 90 days prior to usage, unless otherwise approved by the Consultant. For non-granular material, the source and material shall be approved by the Consultant, two weeks prior to usage.

The Contractor shall be responsible for costs associated to carry out the appropriate testing procedures to confirm specification requirements. The Contractor shall use professional engineering services and a qualified testing firm licensed in the Province of Alberta for all quality control work associated with backfilling procedures.

The Contractor shall be totally responsible for production of aggregate that meets all the specified requirements. Des 2 Class 25 Crushed Aggregate material can be used where Des 2 Class 40 material has been specified with no cost to the Department.

Results of all quality control tests shall be submitted to the Consultant as they become available.

Unless otherwise specified, the latest edition of the following standard Alberta Transportation Test methods (ATT) will be used to determine material characteristics.

Test methods and minimum frequencies are shown in Table 2.2.3 Quality Control Testing Requirements.

Table 2.2.3

Quality Control Testing Requirements

Description		Standard	Minimum Frequency
Aggregates Tests			
Sieve Analysis			
1.	Crushed Aggregate	ATT-25 or ATT-26	One per Source
2.	Gravel Material	ATT-25	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 (Proctor)			
1.	Crushed Aggregate (Des 2 Class 25)	ASTM D689	One test per source
2.	Non Granular Material (Soil)	ASTM D689	One test for each significant soil type
Density of Materials (In-place)			
1.	Crushed Aggregate (Des 2 Class 25)	ASTM D2922 ATT 8 or 9	Three tests on Culvert Bedding taken at invert level Three tests for every four lifts of backfill
2.	Crushed Aggregate (Des 2 Class 40) or Gravel Material	* ATT-58A (Control Strip Method)	For Culverts, control established on top lift of bedding material at invert level and the first lift of backfill material for each Bridge Component For Culverts, control re-established on each side of culvert at the 1/3 and mid-point of culvert backfill, and the mid-point of backfill for each Bridge Component Monitor for minimum number of passes on all other lifts
3.	Non Granular Material (Soil)	ASTM D2922 ATT 8 or 9	Embankment - Three tests per 2 m height of embankment, each side One test on clay seal at each end of Culvert

* At the Contractor's option, the Control Strip Method can be used for Des 2 Class 25 material.

2.3 Placing

All spaces excavated and not occupied by permanent work shall be backfilled with compacted material up to the elevation indicated on the drawings or determined by the Department and Consultant. Compacted material may also be required in other locations as shown on the drawings or as required by the Department and Consultant.

All backfill material, regardless of type shall be placed in layers not exceeding 150 mm in thickness of loose material, and each layer shall be mechanically tamped with pneumatic tampers or the equivalent. The rate of placing the backfill material shall be such that the tamper can compact thoroughly and uniformly. Compaction of Crushed Aggregate (Des 2 Class 25) and Non Granular Material (Soil) shall be a minimum of 95% Proctor density with optimum moisture content. Compaction acceptance of Gravel Material and Crushed Aggregate (Des 2 Class 40) shall be done using the Control Strip Method with a Nuclear Gauge.

On projects where Control Strips are being established, compaction equipment proposed by the Contractor must be reviewed and accepted by the Consultant.

Backfill material shall not be placed against any concrete abutment, wingwall or culvert until permission has been given by the Consultant, generally not until the concrete has been in place at least 7 days or the compressive strength of the concrete is 75% of the required 28 day strength.

Backfill material around culverts and concrete elements shall be placed simultaneously on both sides to the same elevation to avoid unbalanced loading. 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 altered by stepping to prevent wedge action. Jetting of backfill material behind abutments and wingwalls will not be permitted.

The Consultant may 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

Payment for **Backfill** of the type(s) specified will be either at the unit price bid per cubic metre or lump sum price basis. Such price shall include the cost for all labour, material, equipment, and other items of expense that may be necessary for the successful completion of the backfill.

Payment will be determined as follows:

2.4.1 Unit Price per Cubic Metre

When payment is to be on unit price basis, the quantity to be paid for shall be the volume, in cubic metres, of the compacted, in place backfill incorporated into the work, based on the dimensions/elevations, indicated on the drawings, or as determined by the Department and Consultant. The quantity will be determined by measuring the volume of the excavation.

2.4.2 Lump Sum Price

When payment is to be on lump sum price basis, the lump sum price shall include full payment for the fill of all structural excavations and other areas specified in conformity with the drawings or specifications.

When excavations are taken below specified elevations at the Department and Consultant's request, the additional backfill quantity will be paid by a negotiated lump sum price or in accordance with 1.2.25 "Extra Work" of the General Specifications as determined by the Consultant.

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 3

BEARING PILES

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REFERENCE DRAWINGS — Drawing No.

3.1 General

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

3.2 Materials

3.2.1 Steel “H” Piling

Steel "H" piling shall meet the requirements of Specification ASTM A36 or CSA G40.21M 350W. Where piling is designated in metric dimensions, imperial equivalent piling will be acceptable. Mill certificates shall be provided to the Consultant for review prior to pile installation.

Splice plates shall be fabricated to the dimensions shown on Standard Drawing S-1415 “Standard H-Pile Splice”.

3.2.2 Steel Pipe Piling

Steel pipe piling shall meet the requirements of Specification ASTM 252 Grade 2, except that hydrostatic testing is not required. Although piling is designated in metric dimensions, imperial equivalent piling will be acceptable. Mill certificates shall be provided to the Consultant for review prior to pile installation. Some out-of-roundness of the pipe is acceptable provided an acceptable splice can be completed.

Galvanized piling shall be galvanized by the hot dip method, in accordance with the current edition of the ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

Splice backup rings and closed pipe pile end plates shall be fabricated as shown on Standard Drawing S-1414 “Standard Pipe Pile Splice” and Standard Drawing 1479 “Standard Closed Pipe Pile End Plate”.

3.2.3 Timber Piling

Treated timber piling shall be fir or pine, and untreated timber piling shall be fir, spruce, pine or a species that is equal to or better as determined by the Consultant. Timber piling shall conform to Section 23 - “Dimensional Structural Lumber and Piling”, and shall be of the length specified on the drawings.

Timber pile splices shall be fabricated as shown on Standard Drawing S-1413 “Standard Timber Pile Splice”.

3.2.4 Pile Concrete

Concrete shall meet the requirements of Pile Concrete as specified in Section 4 “Cast-In-Place Concrete”.

3.2.5 Reinforcing Steel

Steel reinforcement incorporated in the pile concrete shall meet the requirements specified in 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 damaging the galvanized surface on galvanized piling. Fabric slings, wood blocking or other approved methods shall be used to support and separate galvanized piling when handling, hauling or storing. Piling on which the galvanized coating has been damaged shall be replaced or repaired as determined by the Consultant, at the Contractor's cost. Where repair of damaged galvanizing is required, the repair shall be by metallizing in conformance with ASTM A780, Method A3, to a thickness of 180 µm.

Special care shall be taken to avoid breaking through the surface treatment of treated piles, and cant-hooks, dogs, or pike poles shall not be used. Cuts or breaks in the surface of treated piles shall be given three brush coats of creosote oil of approved quality, and creosote oil shall be poured into all bolt holes.

3.4 Driven Bearing Piles

3.4.1 Equipment and Driving Methods

All pile driving equipment, driving methods and procedures shall be reviewed by the Consultant before any driving is started. Acceptable driving equipment includes diesel hammers, hydraulic hammers, vibratory hammers, driving frames or other equipment as may be required by the Consultant. The use of multi-component drop hammers will not be permitted under any circumstances. The use of gravity hammers will not be permitted except when the required bearing value is less than 350 kN, and the Consultant deems the gravity hammer and leads to be suitable. Where the use of a gravity hammer is acceptable, the Contractor shall furnish to the Consultant acceptable proof of its weight including the weight of the follower.

The driving of piles with driving extensions shall be avoided if practicable, and shall be done only under written permission of the 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 bearing power of the group. For the special types of piling, driving heads, mandrels, or other devices in accordance with the manufacturer's recommendations shall be provided so that the pile may be driven without damage and without unnecessary trimming.

The Contractor shall take adequate precautions to ensure that the piles are in proper alignment, including the use of installation frames, fixed leads or other means as are necessary. The method of alignment and maintaining alignment shall meet the acceptance of the Consultant.

For pile installation monitoring purposes, the Contractor shall paint 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.

Piles shall be driven with a variation of not more than 20 mm per metre from the vertical or from the batter shown on the drawings, except that piles in exposed bents shall not be out of position at the ground line by more than 50 mm and shall not be out of position more than 25 mm in the pile cap. Foundation piles shall not be out of the position shown on the drawings more than 150 mm after driving.

3.4.2 Bearing Values

The piles shall all be driven to the tip elevations shown on the drawings, or lower, to achieve the required stability and specified minimum bearing capacity. The pile bearing capacities shall be estimated by the Bearing Formulas of this Specification.

After the pile driving operations have been started, the Department and Consultant may revise the required pile tip elevations, if necessary, using the pile driving data and the Bearing Formulas as a guide.

In the event pile tip elevations are not given on the drawings, the pile bearing capacities shall be estimated by any or all of the methods outlined under Bearing Formulas Test Piles, or Pile Capacity Test Methods, as determined by the Consultant.

In the case of friction piles, the piles shall be driven to the tip elevations shown on the Drawings, or lower, in order to achieve the required stability and design load carrying capacity.

<u>Bearing Formulas</u>
When not driven to practical refusal, the bearing values of piles may be required to be determined by test methods as specified above. In the absence of the above noted tests, the safe bearing values for piles shall be determined by the following formulas:

<u>For Diesel and Hydraulic Hammers</u>

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

Where
P - Pile reaction at Service Limit State (SLS) (kilonewtons)
E - Energy output of hammer (kilojoules)
F - Efficiency factor
S - The average penetration per blow for the last 10 to 20 blows (mm per blow)

The Consultant will determine the efficiency factor of the hammer at site by comparing the actual recorded blows per minute to data provided by the manufacturer of the hammer.

The above formula is applicable only when:

(1) The head of the pile is not broomed, crushed, or deformed.
(2) The penetration is reasonably quick and uniform.
(3) A driving extension is not used.

For Gravity Hammers (When accepted for use by the Consultant)

$$P = \frac{1650xWxH}{S + 25}$$

Where P - Safe bearing value (kilonewtons)
W - Weight of striking parts of hammer (tonnes)
H - Height of fall (metres)
S - The average penetration per blow for the last 5 to 10 blows.

The above formula is applicable only when:

(1) The hammer has a free fall.
(2) The head of the pile is not broomed, crushed, or deformed.
(3) The penetration is reasonably quick and uniform.
(4) There is no sensible bounce after the blow, or twice the height of the bounce shall be deducted from “H” to determine its value in the formula.
(5) A driving extension is not used.

The Contractor shall provide performance specifications for the type of hammer to be used. He will be required to demonstrate that the hammer is performing within the specified limits.

Test Piles
Test piles shall be driven where they are specified on the drawings or as required by the Consultant. Test piles shall be longer than the length assumed in design, in order to provide for variations in soil conditions and to explore conditions below the tips of permanent piles. Other dimensions of test piles shall be the same as permanent piles, and shall be driven with the same type and size of equipment.

3.4.3 Steel Piles

Steel piles shall consist of structural steel shapes or pipes of the section shown on the drawings or otherwise specified.

When pipe piles are to be driven closed-ended, one section of pipe for each proposed pile shall be supplied with the end-plate welded-on, in conformity with Standard Drawing S-1479 “Standard Closed Pipe Pile End Plate” included with these Specifications.

When pipe piles are to be driven open-ended and the interiors cleaned out, a power screw rotary auger, acceptable to the Consultant shall be used to remove the required material. All loose material and all material adhering to the walls of the piles shall be removed.

After installation closed ended or open ended pipe piles shall be filled with pile concrete.

The total energy developed by the hammer shall be sufficient to achieve the required bearing value or tip elevation, but in no case shall the total energy developed be less than 35 kJ per blow.

The head shall be cut squarely and a driving cap or follower shall be provided to hold the axis of the pile in line with the axis of the hammer. The follower shall be of adequate dimensions to allow driving the pile without trimming or reducing the cross-section of the pile. When damage or buckling is evident at the driving end of the pile in order to obtain the desired bearing capacity or penetration of the pile, the Contractor shall at his own expense reinforce the driving end of the piling, or provide other suitable equipment or procedures, to prevent such damage.

Piles shall be cut off level at the required elevation. If capping is required, the connection shall be made according to details shown on the drawings.

The Contractor shall supply and secure temporary caps on all open pipe piles or drilled holes.

3.4.3.1 Steel Pile Splices

When splicing, the Contractor shall employ whatever means necessary to match out-of-round piling. Exposed pile splices shall be avoided. Refer to Standard Drawing S-1415 “Standard H-Pile Splice” and Standard Drawing S-1414 “Standard Pipe Pile Splice” included with these Specifications. All welding in the field shall be in accordance with section 13.4.1.

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; however if splicing becomes necessary due to unforeseen circumstances, the damage galvanized area shall be metallized by the Contractor at his cost.

The Contractor shall advise his staff and his welding personnel of the hazardous fumes which are generated during welding or cutting of the galvanized steel.

3.4.3.2 Testing by the Contractor

The Contractor shall perform Ultrasonic testing for a minimum of 20% of all full penetration compression splice welds for all piles for each bridge component. Ultrasonic testing shall be done for welds for which visual inspection may indicate having some defect. Additional testing may be required for the full penetration compression splice welds to ensure the integrity of the structure. In addition, the Contractor shall inspect 100% of the full penetration tension splice welds, as defined on the Detailed Designs. The NDT shall be done by a company certified to CAN/CSA W178.1. Ultrasonic testing technicians shall be certified to Level II 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 inspection. The Consultant may require additional inspection if deemed necessary.

All costs associated with non-destructive inspection of welds shall be the responsibility of the Contractor.

3.4.4 Timber Piles

Gravity hammers when accepted for driving timber piles shall weigh not less than 1.5 t, and in no case shall the weight of the hammer be less than the combined weight of driving head and pile. The fall shall be so regulated as to avoid injury to the piles and in no case shall exceed 3 m. When a diesel hammer is used total energy developed by the hammer shall be not less than 15 kJ per blow.

The pile head shall be cut squarely and a driving cap or follower shall be provided to hold the axis of the pile in line with the axis of the hammer. The follower shall be of adequate dimensions to allow driving the pile without in any way trimming or reducing the cross-section of the pile.

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

When the area of the head of any timber pile is greater than that of the face of the hammer, a suitable follower shall be provided to distribute the blow of the hammer throughout the cross-section of the pile and thus avoid splitting or shattering the pile.

Timber piles shall be pointed where soil conditions require it. When necessary, the piles shall be shod with metal shoes, supplied by the Contractor, of a design satisfactory to the Consultant, the points of the piles being carefully shaped to secure an even and uniform bearing on the shoes.

Full length piles shall be used where practicable. In exceptional circumstances splicing of piles may be permitted. The method of splicing shall be as shown on the drawings or as reviewed and accepted by the Consultant. Refer to Standard Drawing S-1413 “Standard Timber Pile Splice” included with these Specifications.

The tops of all piling shall be trimmed to a true plane at the elevation shown on the drawings or fixed by the Consultant. Piles which support timber caps or grillage shall be sawed to conform to the plane of the bottom of the super-imposed structure. In general, the length of pile above the elevation of cut-off shall be sufficient to permit the complete removal of all material injured by driving, but piles driven to very nearly the cut-off elevation shall be carefully trimmed and freed of all “broomed", splintered or otherwise injured material.

3.4.5 Defective Piles

The procedure incident to the driving of piles shall not subject them to excessive and undue abuse producing deformation of the steel, injurious splitting, splintering and brooming of the wood, or crushing and spalling of the concrete. Manipulation of piles to force them into proper position, considered by the Consultant to be excessive, will not be permitted. Piles damaged by improper driving, or driven out of proper location, or driven below the cut-off elevation, shall be corrected, at the Contractor's expense, by one of the following methods accepted by the Consultant:

(a) The piles shall be withdrawn and replaced by new and, if necessary, longer piles, or

(b) Replacement piles shall be driven adjacent to defective or low piles, or

(c) The piles shall be spliced or built up, as otherwise provided herein, or a sufficient portion of the footing extended to properly embed the piles. Timber piles shall not be spliced without specific permission of the Consultant. All piles, pushed up by the driving of adjacent piles or by any other cause, shall be driven down again.

In case the required penetration and bearing capacity are not obtained, the contractor shall provide a hammer of greater energy, as applicable, or when accepted by the Consultant/Department, resort to pre-drilling. This will be considered incidental to the work of achieving acceptable penetration and bearing capacity, and not claimable as extra work.

3.4.6 Measurement and Payment

Supply of Piling

Payment for **Supply of Piling** will be made on the basis of the unit price per metre bid for each type of piling supplied, which price shall include full compensation for the cost of furnishing and delivering the material to site. The unit prices shall include full compensation for the cost of all labour, tools, equipment and other necessary or incidental costs of handling, loading and hauling the piling.

The number of metres of piling to be paid for shall be the total number of metres acceptably driven and remaining in the completed structure. Where portions of steel piling are specified to be galvanized, only the lengths requiring galvanizing will be included in supply of galvanized steel piling. All steel piling below the level of the galvanized piling length shown on the drawings will be included in supply of plain steel piling.

Re-stocking Steel Piling

When quantities of plain Steel Pipe or H Piles are reduced by 15% or more due to conditions beyond the Contractor's control, the Department will reimburse the “re-stocking” costs for 6.0 metre lengths or longer, incurred by the supplier to the Contractor.

The Contractor shall present vouchers giving details as to dates, quantities, rates, third party invoices, and such other supporting documentation to the Consultant. Payment will be made on the cost of “re-stocking” and based on the invoices excluding labour burden, overhead and profit.

Pile Set-up

Payment for **Pile Set-up** will be made on the basis of the unit price per pile bid, which price shall include the expense and time to set the equipment over the pile, ready to commence driving. Payment will be made only for piles acceptably driven as determined by the Consultant.

Pile Driving

Payment for **Pile Driving** will be made on the basis of the unit price per metre bid, which price shall include full compensation for the cost of furnishing all labour, tools, and equipment, and other necessary or incidental costs of handling, driving, splicing, cutting off of piles, reinforcement of pile heads and all other incidental work connected therewith. It shall also include full compensation for all drilling, blasting, splice plates, splice rings, or other work or materials necessary to obtain the required penetration or bearing values of piles.

The number of metres to be paid for shall be the total number of metres of piling acceptably driven and remaining in the completed structure.

Pile Tip Reinforcement

When the Contract contains a bid item for **Pile Tip Reinforcement**, payment will be made on the basis of the unit price bid, which price shall include full compensation for all labour, materials, equipment, tools and all incidentals necessary to complete the work.

Pile Splicing
When the Contract contains a bid item for **Pile Splicing**, piles which penetrate in excess of 20% of the estimated length, 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. Only one splice for each additional length of pile, up to twelve metres, will be paid for.

Pile Concrete
Pile Concrete shall be measured and paid for in accordance with Section 4 “Cast-In-Place Concrete”.

Reinforcing Steel
Reinforcing Steel incorporated in the piling will be paid for in accordance with Section 5 “Reinforcing Steel”.

Test Piles
Test piles retained in the structure will be paid for at the bid price of other piling used.

If, however, piling is not used in the structure, the test piles will be paid for as Extra Work, due to consideration being given to the cost of bringing the pile driver to the site and removing it from the work.

3.5 Drilled Cast-in-place Concrete Bearing Piles

3.5.1 General

In addition to drilled cast-in-place concrete bearing piles this section shall include drilled cast-in-place concrete/steel pipe composite bearing piles. The work shall include drilling and belling the holes, as required, supplying and placing the steel pipe and reinforcing steel, and supplying, placing, protecting and curing the concrete.

3.5.2 Equipment and Drilling Methods

Due to the nature of the work, the Department requires that the drilling subcontractor have adequate equipment and a proven record of competence in this work.

All pile drilling equipment, drilling methods and procedures shall be reviewed by the Consultant before drilling is started. Unless otherwise specified only powered screw rotary type augers will be acceptable.

The Contractor shall not proceed with the installation of further piling, if for any reason the quality of the adjacent piling is compromised due to the effects of vibration or other reasons.

3.5.3 Cast-In-Place Pile Bearing Values

Where cast-in-place piles are designed based on the use of semi-empirical methods, supported by a geotechnical investigation with soil strength parameters determined by laboratory, field testing and local experience, and with appropriate levels of construction monitoring and verification the ultimate bearing capacity may be adjusted for Limit State Design by a geotechnical resistance factor of 0.4. If working state design methods are used the allowable loads shall be as determined by the Consultant.

3.5.4 Drilling Pile Holes

The drilled pile holes shall be stabilized and sealed by means of temporary casings or other methods 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 the pile concrete.

Temporary casing, if used in drilling operations, shall be removed from the hole as pile concrete is being poured. The bottom of the casing shall be maintained below the top of the concrete during withdrawal and pouring operations unless otherwise permitted by the Consultant. Separation of the concrete during withdrawal operations shall be avoided by hammering or otherwise vibrating the casing.

The elevations shown on the drawings of the bottoms of the pile holes shall be considered approximate only, and the Department and Consultant may order further drilling as necessary to secure satisfactory bearing of the piles.

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 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.

3.5.5 Open Drilled Holes

The Contractor shall be responsible for covering all open drilled holes on the site until the time they are filled with concrete or otherwise properly backfilled. The covers shall be of adequate strength and securely fitted so that machinery and workmen are protected against cave-in and surface water is prevented from running into the pile hole.

3.5.6 Reinforcement

Steel reinforcement shall be fabricated in the sizes and to the dimensions shown on the drawings and shall be placed, centered and braced in the pile hole to the acceptance of the Consultant.

Particular care shall be taken in locating projecting “column dowel bars”, to a tolerance not exceeding 10 mm in any direction, and pouring will not be permitted until the Consultant is satisfied that adequate provisions have been made.

Adequate “shoes” or spacers shall be firmly anchored to the reinforcement to ensure the reinforcement is kept centered in the concrete.

3.5.7 Concrete Placement

When the reinforcement has been acceptably placed, concrete shall be immediately deposited in the pile hole. The concrete shall be “Pile Concrete” and the provisions of Section 4 “Cast-In-Place Concrete” shall apply.

Suitable forms shall be used to maintain the specified dimensions of concrete piles above ground level.

Pile concrete placed under water will require validation by Crosshole Sonic Logging (CSL) in accordance with section 4.15.3 “Concrete Placed under Water”.

3.5.8 Cold Weather Conditions

In cold weather, which shall be considered to exist if nighttime low temperatures are expected to be below 0°C, heated concrete shall be used. Such concrete shall have a temperature of between 15°C and 25°C when placed.

When the ground against which pile concrete is placed is below -5°C, the concrete shall be protected from heat loss. The pile boring shall be made oversize down to the depth of 2 m, and the concrete shall be poured in an insulated form. Concrete at the top of the pile is to be insulated. After four days the form and insulation may be removed, and the space is to be backfilled immediately with compacted non-granular fill or lean concrete to the elevation of top of pile.

In a region where the ground temperature is above -10°C but below -5°C, the hole may be bored 100 mm diameter oversize, and filled directly with pile concrete, as an alternative to the procedure described above. Concrete at the top of the pile is to be insulated.

If the top of the pile extends above the existing ground surface, in cold weather, it is to be adequately protected from the cold for a period long enough to ensure proper curing.

3.5.9 Pile Tolerance

Piles shall be accurately located, and shall be installed plumb or at the batter specified on the drawings. The maximum tolerance allowed shall be 50 mm for variation off the centre of any pile at the cut-off elevation, and no pile shall be out of plumb or specified batter by more than 20 mm per metre. Any pile out of centre or plumb beyond the tolerances specified shall be corrected at the Contractor's expense.

3.5.10 Measurement and Payment

<u>Drill Rig Set-up</u>
Payment for **Drill Rig Set-up** will be made on the basis of the unit price per pile bid which shall include full compensation for the cost to set up the drilling equipment over the pile location ready to commence drilling, and the cost to supply, install and remove temporary casing as required. Payment will be made only for piles acceptably constructed, as determined by the Consultant.

<u>Pile Installation</u>
Payment for **Pile Installation** will be made on the basis of the unit price per lineal metre bid which shall include full compensation for the cost of supplying all materials including piles, drilling, dewatering and cleaning out the holes to the dimensions shown, removal and disposal of the augered material, detection and purging of any gas hazard, and providing safe inspection access. The quantity to be paid for **Pile Installation** shall be the number of lineal metres required to install

the piles in accordance with the drawings and specifications (measured from the pile tip to the underside of pile/pier cap). Drilling will be considered as part of pile installation and no separate or additional payment will be made.

Pile Concrete
Pile Concrete will be measured and paid for in accordance with Section 4 “Cast-In-Place Concrete”.

Reinforcing Steel
Reinforcing Steel incorporated in the piling will be paid for in accordance with Section 5 “Reinforcing Steel”.

3.6 Pile Capacity Test Methods

3.6.1 Static Load Testing

When specified in the Special Provisions, the load carrying capacity of piles shall be determined by static load tests. In general static load tests can be performed on any pile type. Static load tests shall consist of the application of a test load on a suitable platform supported by the pile, or through the use of adjacent reaction piles, with suitable apparatus for accurately measuring the test load and the settlement of the pile under each increment of load. Tests shall be in general conformance with ASTM D3689-90 (1995). Osterberg or Statnamic tests may be used in place of static load tests.

Where sufficient static load testing has been done to satisfy Limit State Design, Load and Resistance Factor Design (LRFD), or reliability-based design statistical requirements, the factored geotechnical resistance may be taken as 0.6. Where allowable or working state design methods are used in the design, or where the requirements of Limit State Design are not fulfilled, the allowable load shall be considered as 50% of that load which, after a continuous application of 48 hours, produces a permanent settlement not greater than 6 mm measured at the top of the pile. This maximum settlement shall not increase by a continuing application of the test load for a further period of 60 hours or longer. At least one pile for each group of 100 piles shall be tested unless a different testing frequency is specified in the Special Provisions. The frequency of testing shall be increased to account for changing soil conditions, pile sections and types, and construction methods.

3.6.2 Dynamic Load Testing / Pile Driving Analyzer (PDA) Testing

Dynamic Load Testing provides useful data on piling stresses and can be used as part of a quality control method during pile installation. Pile Driving Analyzer (PDA) testing can be used as an alternate or supplemental test method to static load tests for the determination of pile capacity. This method involve installing instruments on the pile head with accelerometers and strain gauges, then impacting the pile head using a pile driving hammer or similar device over a very short period of time (3-4 milliseconds). The impact imparted on the pile should be sufficient to fully mobilize the pile skin friction and end bearing resistances of the pile. In general, this requires that a net permanent set per blow of at least 3 mm (and not greater than 8 mm) be achieved upon impact from the pile hammer.

The PDA test can be conducted on either driven or cast-in-place piles. For driven piles, the PDA test shall be conducted at the end of the initial driving stage, such that the end bearing and skin friction resistances can be determined upon initial installation of the pile. Where time dependant changes in the soil conditions are anticipated, such as pile setup or relaxation, additional tests shall be conducted upon re-strike on a sample of previously tested piles to determine the bearing parameters after driving induced pore pressures have dissipated. The re-strike should be conducted approximately one to two weeks or longer after initial driving, as directed by the Consultant. It is permissible to initially drive piles to a capacity below the required ultimate capacity and rely on pile setup to produce the required capacity. Where the capacity of the pile at re-strike is relied upon for design, a minimum of one third of piles tested during initial drive should be tested again during re-strike.

If dynamic testing is only undertaken upon re-strike, then a minimum of 10% to15% of all piles shall be PDA tested on re-strike.

The hammer energy used during PDA tests at the end of initial drive and during re-strike driving shall be such that the required ultimate pile capacity can be mobilized in a single blow without additional data interpretation.

For cast-in-place piles, the PDA test should be conducted at least one week after the installation of the pile, as directed by the Consultant.

The results of the test can be processed in the short term using the Wave Equation Analysis of Piles (WEAP) method to provide real time monitoring of pile stresses, pile integrity, hammer performance, and pile capacity; and in some cases can be used to confirm pile termination depths when borehole information is not available. This method should only be used as an initial determination of bearing capacity though, and where the test is being used to determine the capacity of the pile for design methods, a signal matching analysis using a Case Pile Wave Equation Program (CAPWAP) should be utilized.

To ensure good quality data resulting from the PDA test, ASTM D4945-08 should be followed. In addition, at least two accelerometers on a driven pile and four accelerometers on a cast-in-place pile should be installed. All accelerometers and transducers should be calibrated and inspected to ensure proper attachment to the pile.

Since the PDA test method indirectly calculates the load and settlement characteristics of the pile based on strain and acceleration measurements, PDA testing is deemed secondary in accuracy to Static Load Tests. As a result, where the PDA methods are used strictly as a QA/QC tool, a minimum of 5% to10% of production piles should be monitored dynamically. When used as a design or confirmatory tool, a minimum of 10% to15% of piles (including tests at such substructure associated with the project or where soil conditions are expected to vary) should be tested, or as required for statistic validation of a LRFD design whichever is greater. The piles selected for testing should be representative of other piles in the same structure. Where driven piles exhibit lower driving resistances and/or shorter penetrations than normal, or where cast-in-place piles experience extraneous soil, ground water, and/or installation conditions, additional tests over and above minimum number of tests specified earlier may be required. Further, additional tests should accompany changes in piling equipment, procedure and pile requirements.

In the situation where one pile in a pile group does not meet capacity requirements, additional tests may be necessary to confirm that this pile is an isolated case. In such case, it may be permissible to rely on group effects to compensate for the lower pile capacity. The geotechnical and structural consultants will have final say in this situation. Under no circumstances will superposition of axial and shaft capacity from different strikes, re-strikes or any combination thereof be permitted.

Where sufficient dynamic load testing has been done to satisfy Limit State Design, LRFD or reliability-based design statistical requirements, the geotechnical resistance factor for design of pile foundations may be taken as 0.5.

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. Approval of the pile driving equipment by the Consultant will be based on the WEAP analysis and/or PDA testing. The Contractor shall submit details of the proposed pile driving equipment for review by the Consultant a minimum of 14 days prior to the commencement of pile installation. The information provided shall include the following:

- 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.
- 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
- Pile Cushion Data: Material, area, thickness per sheet, number of sheets, total thickness of cushion

The PDA testing agency shall prepare a daily field report summarizing the preliminary test results including driving stresses, transferred energy and estimated pile capacity to the Consultant within 24 hours of testing. The final test results shall be presented to the Department within 7 days of testing. The testing report shall be prepared in accordance with the requirements of ASTM D4945-08. As a minimum, the report shall include the following:

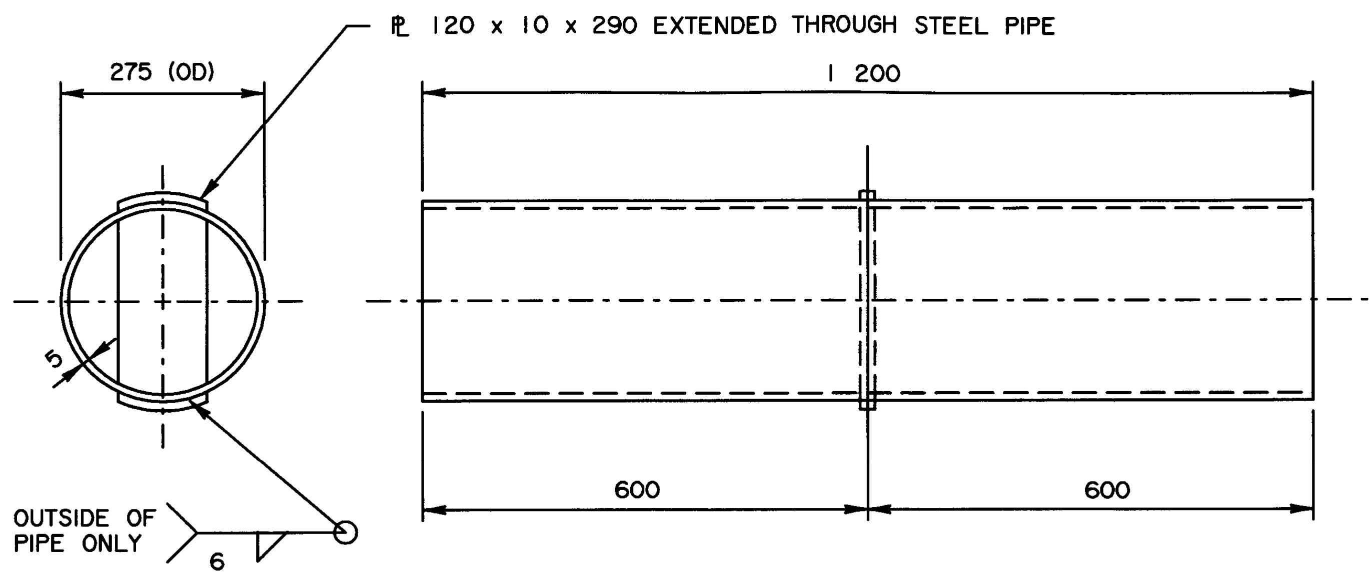
- Pile and driving system information
- Pile installation data
- PDA testing equipment and procedure
- Energy imparted
- Maximum driving stresses
- Hammer blow rate
- CAPWAP input parameters including quake and damping factors
- Shaft friction, end bearing and total pile capacity

The Consultant will use the test results to determine the subsequent termination criteria, requirements for modification of driving procedures or equipment, and pile acceptance. Any work done on the foundation elements (pile caps, cut-off, welding, etc) prior to received approval of test results from the Consultant will be at the Contractor’s own risk.

3.6.3 Measurement and Payment

When the contract contains a bid item for **Static Load Testing,** payment will be made at the unit price bid and will be full compensation for static load testing and all labour, equipment, tools and incidentals to complete the work.

When the contract contains a bid item for **Dynamic Load Testing/Pile Driving Analyzer (PDA) Testing**, payment will be made at the unit price bid and will be full compensation for dynamic load testing and PDA testing, pile set up for re-strike, pile re-striking and all labour, equipment, tools and incidentals necessary to complete the work.



PIPE SLEEVE DETAIL

GENERAL NOTES

- DIMENSIONS ARE GIVEN IN mm. DETAILS ARE NOT TO SCALE.
- 2 STEEL SHALL CONFORM TO ASTM A36 OR CSA G40.21M 300W.

REQUIREMENTS AND PROCEDURE FOR SPLICING TIMBER PILES

1. THE PILE ENDS BEING SPLICED SHALL HAVE DIAMETERS OF 280 mm OR GREATER.
2. DRIVING OF THE BOTTOM PILE SHALL BE STOPPED APPROXIMATELY 600 mm ABOVE GROUND OR WATER LINE.
3. DAMAGED PILE ENDS SHALL BE TOTALLY REMOVED BY MAKING SQUARE CUT-OFFS.
4. THE PIPE SLEEVE SHALL BE CENTRED, AND TAPPED PARALLEL, THE FULL 600 mm DISTANCE ONTO THE PILE.
5. THE UPPER PILE END SHALL BE SQUARED, CENTERED ON THE TOP OF THE PIPE SLEEVE, AND TAPPED DOWN INTO THE SLEEVE, KEEPING THE UPPER PILE ALIGNED WITH THE LOWER PILE.
6. THE TOP OF THE PILE SPLICE SHALL END UP NOT LESS THAN 2500 mm BELOW GROUND LINE.

5

DRAFTING STANDARDS PAGE: 3.8

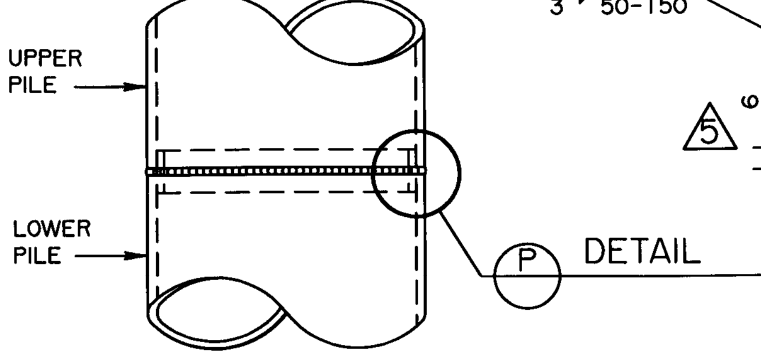
NO	DATE	REVISIONS	BY
4			
3	99-03-29	BEB CHANGED TO TSB	RY
2	94-11-30	GENERAL NOTES AND PAGE NUMBER	RJR
1	87-03-05	REDRAWN FROM S-1413	DHQ

Alberta TRANSPORTATION AND UTILITIES
TECHNICAL STANDARDS BRANCH

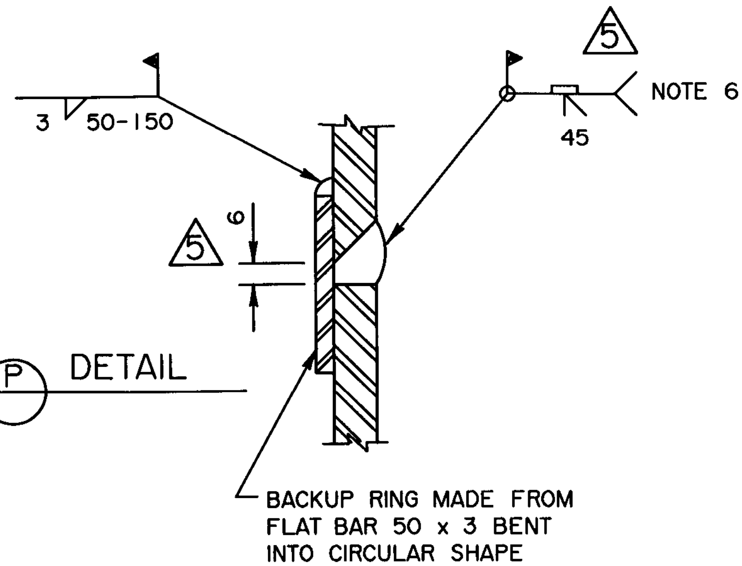
STANDARD
TIMBER PILE SPLICE

DESIGNED	DRAWN	DATE	APPROVED	SIGNATURE	DATE	PAGE 2	DRAWING
DHQ	MIK	87-03-05	EXECUTIVE DIRECTOR		May 8/87	3.19	S-1413-87

PLOTTED MAR 29 1999 S1413X87 .RV3



ELEVATION



P DETAIL

GENERAL NOTES

- DIMENSIONS ARE GIVEN IN mm. DETAILS ARE NOT TO SCALE

2

REQUIREMENTS AND PROCEDURE FOR SPLICING PIPE PILES

4

1. FIELD WELDING SHALL BE IN ACCORDANCE WITH SECTION 13.4
2. THE LOWER PILE SHALL BE TRIMMED TRUE AND SQUARE.
3. THE BEVEL ON THE UPPER PILE SHALL BE FLAME CUT USING A MECHANICAL PIPE BEVELLING MACHINE.
4. THE BACKUP PLATE SHALL BE WELDED TO THE UPPER PILE.
5. THE UPPER PILE SHALL BE POSITIONED WITH THE BACKUP RING FITTED INTO THE LOWER PILE.
6. SPLICE WELD SHALL PENETRATE BACKUP RING. TWO PASSES ARE REQUIRED IF THE PILE WALL IS GREATER THAN 8 mm. GRIND WELD SMOOTH IF THE SPLICE IS LOCATED ABOVE GROUND LEVEL.

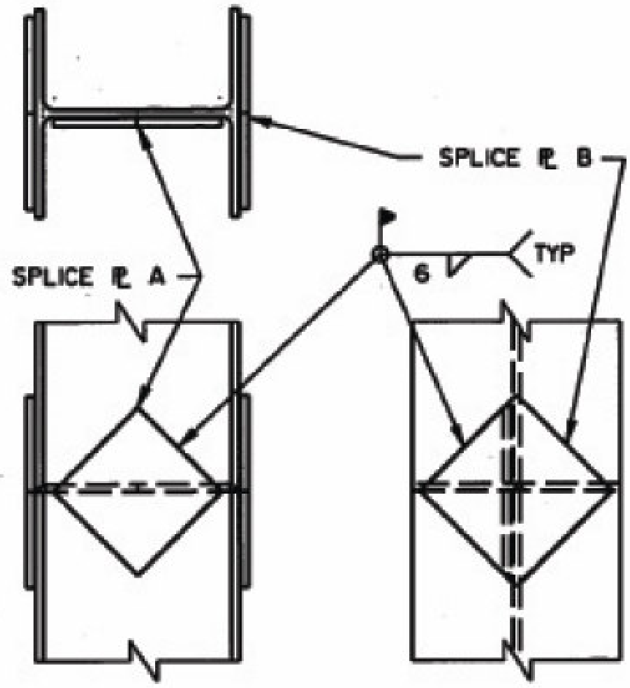
NO	DATE	REVISIONS	BY
5	2005-05-19	DETAIL "P" REVISED	AW AW
4	2001-06-19	GENERAL NOTES	AW
3	99-03-29	BEB CHANGED TO TSB	RY
2	94-11-30	GENERAL NOTES	RJR
1	87-03-09	REDRAWN FROM S-1414	DHQ

Alberta TRANSPORTATION AND UTILITIES
TECHNICAL STANDARDS BRANCH

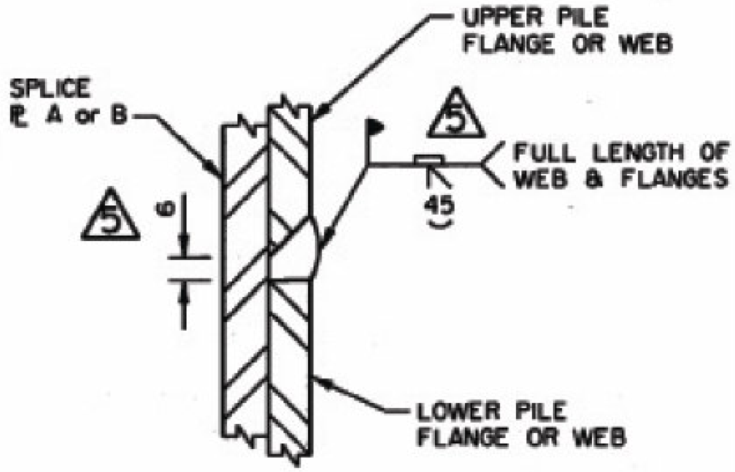
STANDARD
PIPE PILE SPLICE

DESIGNED	DRAWN	DATE	APPROVED	SIGNATURE	DATE	PAGE	DRAWING
DHQ	MIK	87-03-09	EXECUTIVE DIRECTOR	[signature]	May 8/87	3.15	S-1414-87

PLOTTED MAY 19, 2005 S1414X87 .RV5



SPLICE DETAILS



FLANGE & WEB WELDS

PILE DESIGNATION	SPLICE PLATE DIMENSIONS	
	PLATE A (WEB)	PLATE B (FLANGE)
HP 310 x 79	12 x 160 x 160	12 x 200 x 200
HP 310 x 94	12 x 160 x 160	12 x 200 x 200
HP 310 x 110	12 x 160 x 160	12 x 200 x 200
HP 310 x 125	12 x 160 x 160	12 x 200 x 200
HP 360 x 108	12 x 190 x 190	12 x 250 x 250
HP 360 x 132	12 x 190 x 190	12 x 250 x 250

6

GENERAL NOTES

- DIMENSIONS ARE GIVEN IN mm. DETAILS ARE NOT TO SCALE.
- 6 STEEL SHALL CONFORM TO ASTM A36 OR CSA G40.21M 350W.

REQUIREMENTS AND PROCEDURE FOR SPLICING H-PILES

4 1. FIELD WELDING SHALL BE IN ACCORDANCE WITH SECTION 13.4

2. PILE ENDS TO BE SPLICED SHALL BE FLAME CUT USING A STEEL GUIDE TO OBTAIN A SQUARE AND EVEN CUT. BEVEL CUTS SHALL BE MADE AT 45°.

3. SPLICE PLATES A & B SHALL BE WELDED TO THE UPPER PILE BEFORE POSITIONING IT.

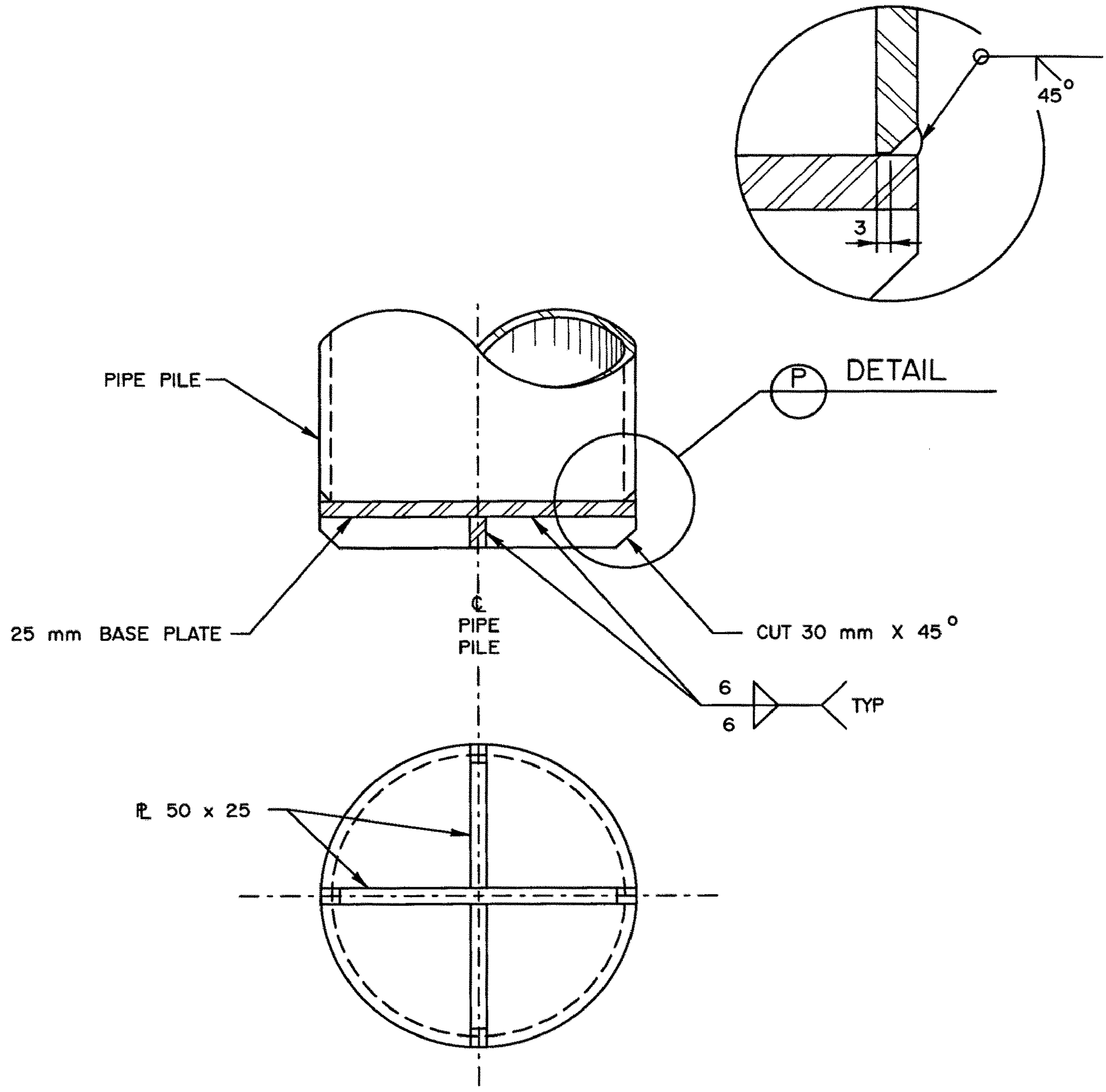
4. THE UPPER PILE SHALL BE POSITIONED ON AND THE SPLICE PLATES WELDED TO THE LOWER PILE; BUTT WELDS SHALL THEN BE MADE.

NO	DATE	REVISIONS	BY
6	2009-05-21	PILE TYPES ADDED TO CHART	CM
5	2005-05-19	FLANGE & WEB WELDS REVISED	AW
4	2001-06-19	GENERAL NOTES	AW
3	99-03-29	BEB CHANGED TO TSB	RY
2	94-11-30	GENERAL NOTES	RJR
1	87-03-11	REDRAWN FROM S-1415	DHO

Alberta TRANSPORTATION AND UTILITIES
TECHNICAL STANDARDS BRANCH

STANDARD H-PILE SPLICE

DESIGNED	DRAWN	DATE	APPROVED	SIGNATURE	DATE	PAGE	DRAWING
DHO	MIK	87-03-11	EXECUTIVE DIRECTOR		May 8/87	3.13	S-1415-87



GENERAL NOTES

- DIMENSIONS ARE GIVEN IN mm. DETAILS ARE NOT TO SCALE. (Revision 1)
- STEEL SHALL CONFORM TO ASTM A36 OR CSA G40.21M 300W.
- SHOP WELDING SHALL BE IN ACCORDANCE WITH SECTION 6 (Revision 3)

4

DRAFTING STANDARD PAGE: 3.9

NO	DATE	REVISIONS	BY
4			
3	2001-06-19	GENERAL NOTES	AW
2	99-03-29	BEB CHANGED TO TSB	RY
1	94-11-30	GENERAL NOTES AND PAGE NUMBER	RJR

Alberta TRANSPORTATION AND UTILITIES
TECHNICAL STANDARDS BRANCH

STANDARD CLOSED PIPE PILE END PLATE

DESIGNED	DRAWN	DATE	APPROVED	SIGNATURE	DATE	PAGE (Revision 1)	DRAWING
DHQ	MIK	87-03-30	EXECUTIVE DIRECTOR	[signature]	May 8/87	3.17	S-1479

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SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 4

CAST-IN-PLACE CONCRETE

TABLE OF CONTENTS

4.1 General

This specification prescribes the quality requirements, the sampling and testing of the materials and concrete, the methods of producing and handling the constituent materials, the batching, mixing, handling, transporting, placing and curing as outlined, which constitute good and acceptable construction practice in structural and similar work. The Contractor shall supply all necessary materials.

Where Standards and Standard Specifications are referred to, the version current at time of tendering shall govern. Metric versions are inferred, when available and relevant.

4.2 Materials for Concrete

Concrete shall consist of hydraulic cement, aggregates, water and admixtures or additives which shall conform to the requirements as specified below:

Cement - Hydraulic cement shall conform to the requirements of CSA Standard A 3001. General Use (Normal) Type GU, or High Sulphate Resistant Type HS or HSb, shall be supplied unless otherwise specified.

Silica Fume - Condensed silica fume shall conform to the requirements of CSA Standard A 3001 for a Type SF supplementary cementing material, with a SiO_2 content of at least 85%, a maximum loss on ignition of 10% and no more than 1% SO_3 content.

Fly Ash - All fly ash shall conform to the requirements of CSA Standard A3001 for Type F or Type CI fly ash.

Water - Water to be used for mixing concrete or mortar shall conform to the requirements of CSA Standard A23.1 and shall be free from injurious amounts of alkali, organic materials or deleterious substances. The Contractor shall not use water from shallow, stagnant or marshy sources.

Aggregates - Fine and coarse aggregates shall conform to the requirements of CSA Standard A23.1 and shall be stockpiled separately.

Admixtures - All approved admixtures, such as water reducing agents, air entraining agents and superplasticizers shall conform to ASTM C494 and be compatible with all other constituents including cement, silica fume and fly ash. The addition of calcium chloride, air-reducing agents or accelerators will not be permitted.

Hydration Stabilizing Admixtures (HSA's) shall meet ASTM C494 requirements for Type D water reducing and retarding admixtures. The maximum allowable time of set retarding shall be three hours, as measured from the time of mixing. The appropriate dosage rates are to be verified with trial batch tests. The use of HSA's requires the approval 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 retardation due to structural considerations.

Air Entraining Agent - Air Entraining Agent shall be added to all concrete and shall conform to the requirements of ASTM C260.

Steel Fibres - When specified, steel fibres shall be Novocon XR, Wire Mix 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.

4.3 Storage of Materials

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

All aggregates shall be handled so as to prevent segregation and to obtain uniformity of materials. The separated aggregates, and aggregates secured from different sources, shall be piled in separate stockpiles. The site of the stockpiles shall be cleaned of all foreign materials and shall be reasonably level and firm. If aggregates are placed directly on the ground, material shall not be removed from the stockpile within 150 mm of the ground level. This material shall remain undisturbed to avoid contaminating the aggregate being used with the ground material.

4.4 Class and Composition of Concrete

4.4.1 Class of Concrete

Class of Concrete [4]	Minimum Specified Compressive Strength at 28 Days (MPa)	Nominal Maximum Aggregate Size (mm)	Range of Slump (mm)	Total Air Content [5] (%)	Max. Water/ Cementing Materials Ratio
B	25	28 to 5	50 to 70	4 - 7	0.45
C	35	20 to 5 [1]	60 to 80	5 - 8	0.40
HPC [3]	45	20 to 5 [2]	90 to 150	5 - 8	0.38
D	30	14 to 5	50 to 70	5 - 8	0.42
S	20	28 to 5	50 to 70	4 - 7	0.50
Pile	25	28 to 5	100 to 140	4 - 7	0.45

Notes

1. The size of coarse aggregate shall be 28 to 5 mm for Class C concrete when used in mass pours such as piers and abutments.
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, approach slabs and MSE wall coping. Deck overlay concrete shall be Class HPC with steel fibres when no internal reinforcement exists.
4. The fly ash shall not exceed 30% by mass of cementing materials, however for High Performance Concrete (HPC) it shall be in accordance with 4.4.2. 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 maximum aggregate size as per CSA A23.1 Table 4.

4.4.2 Class HPC and Class HPC with Steel Fibres

(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, shall not exceed 10% of the mass of coarse aggregate.

(d) Minimum cement content (excluding supplementary cementing materials) shall be 335 kg/m^3

(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) Slump retention of trial mix after 45 minutes shall be at least 50% of initial slump. The initial slump of the trial mix shall be measured after an elapsed time from batching of not more than 15 minutes.

(i) Rapid 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. For HPC with steel fibres, testing shall be done without the presence of the steel fibres.

(j) 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.

(k) 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.

(l) The temperature of the centre of the in-situ concrete shall not fall below 10°C or exceed 60°C and the temperature difference between the centre and the surface shall not exceed 20°C. In addition, the requirements of Table 21 of CSA A23.1 shall apply.

(m) Trial batch(es) shall be performed at least 35 days prior to placement of concrete at site to verify that requirements pertaining to compressive strengths at 7 and 28 days, rapid chloride ion penetration and air void system parameters of hardened concrete have all been met. The shrinkage of the trial batch concrete shall be measured in accordance with ASTM C157 except that drying shall commence after 7 days of curing and shrinkage determined after 28 days of drying. Shrinkage test results shall be submitted to the Consultant within seven days of test completion.

4.4.3 Temperature

The temperature of all classes of concrete not containing silica fume shall be between 10°C and 25°C at discharge. Temperature requirements for Class HPC and Class HPC with steel fibres shall be between 10°C and 20°C at discharge.

4.4.4 Aggregate Tests and Concrete Mix Design

The Contractor shall submit the mix design he proposes for each proposed class of concrete including applicable material test reports for the Consultant's review two weeks before scheduled placing of concrete. Aggregate tests and concrete mix design shall not be required for concrete used for the construction of culvert collars or cut-off walls when culverts are 3 metre diameter or smaller.

For each mix design the following aggregate analysis shall be provided:

- Source(s) of proposed aggregate(s)
- Fine and Coarse Aggregate Sieve (CSA A23.2-2A)
- Amount of material finer than 80 µm in aggregate (CSA A23.2-5A)
- Organic Impurities in Sands for Concrete (CSA A23.2-7A)
- Results of deleterious substances and physical properties of aggregates included in Table 12, CSA A23.1-04 (Test Methods A23.2-3A, A23.2-4A, A23.2-23A, A23.2-24A and A23.2-29A)
- Assessment of Potential for Deleterious Alkali-Aggregate Reactivity (AAR) (CSA A23.2-27A)
- "Petrographic Examination of Coarse Aggregate for Concrete" shall be required for Class HPC and Class HPC with steel fibres (CSA A23.2-15A)

The analysis of the aggregates shall be current and fully represent the material to be used in production. All sampling and testing shall have been done no more than 120 days prior to concrete production, except for sieve analysis, material finer than 80 µm and organic impurities in sand which shall be no more than 90 days and petrographic examination of coarse aggregate for concrete which shall be no more than 180 days. Additional analyses of more recent sampling shall be provided as required to confirm that the aggregates continue to meet requirements. A break in production of a particular class of concrete shall not constitute the need for additional testing when the Contractor provides conclusive evidence that the material initially tested, is still representative.

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 class of concrete (minimum 30 tests over the last 12 months); provisions 4.2.3.3.3.2 (a) & (b) of CSA Standard CAN3-A23.1-04 shall not apply.

The potential for deleterious alkali-aggregate reactivity shall be assessed in accordance with CSA A23.2-27A. This assessment shall include the risk level associated with structure size and environment, the level of prevention related to service life requirements and the determination of the appropriate preventative measures, including testing in accordance with CSA A23.2-28A. For bridge structures, the service life is considered to be 75 years. Current (less than 18 months old) test data evaluating the potential alkali-silica reactivity of aggregates tested in accordance with CSA A23.2-14A or CSA A23.2-25A is required. In the absence of current test data and outside of areas of known highly reactive aggregate, the aggregate shall be presumed to be moderately reactive.

Petrographic analysis on the proposed coarse aggregates shall be performed in accordance with CSA A23.2-15A by experienced personnel employed by CSA certified laboratory. The (weighted) petrographic number shall not exceed 130, and the ironstone content shall not exceed 0.8%. The Petrographic analysis report shall be stamped by either, a Professional Engineer, Professional Geologist, or a Geological Engineer registered in the Province of Alberta.

The sampling and testing of aggregates, and the concrete mix design shall be completed by an independent CSA certified and qualified concrete testing laboratory which shall have a permit to practice in the Province of Alberta. Concrete mix designs including sampling and testing of the aggregates may be completed by the concrete supplier, with the condition that documentation is stamped by a Professional Engineer registered in the Province of Alberta. For either situation, the mix design, including sampling and testing, shall be reviewed and stamped for compliance with respective specifications, by an independent CSA certified and qualified concrete testing laboratory having a permit to practice in the Province of Alberta. For either case, the testing laboratory shall provide an engineering opinion that concrete aggregate and mix designs are suitable for the intended use and are expected to perform to specified standards.

For Class HPC and Class HPC with steel fibres, the Contractor shall produce evidence satisfactory to the Consultant that the proportions selected will produce concrete of the quality specified. This shall include the preparation of satisfactory trial mixes, before the concrete is used. The trial mix shall be a minimum of 3 m^3 or 50% of the rated mixer capacity (whichever is greater) and simulate the anticipated placing procedures at site. In preparing the trial mixes the workability and slump retention characteristics shall be assessed at 30, 45 and 60 minute intervals. In addition the concrete from the trial mixes shall also satisfy the rapid chloride ion penetration requirement in accordance with section 4.4.2(i).

Concrete mixes that will be placed by concrete pump shall be designed for pumping.

4.4.5 Mix Adjustments

For all classes of concrete other than HPC and HPC with steel fibres, in case, during the progress of the work, the mix design is found to be unsatisfactory for any reason including poor workability, the Contractor shall make the necessary adjustments, but only with the prior acceptance of the Consultant. Notwithstanding the Consultant's review of the mix design, it remains the Contractor's responsibility that the concrete meets all the requirements of this Specification.

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 the cement, 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

Mobile continuous mixers or other such concrete supply equipment will not be accepted for use.

4.6.1 General

All 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 as the quantity of concrete inside the mixer regardless of size of the mixer. The mixing period shall be measured from the time all materials are in the mixer 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 mass. All materials for the concrete shall be accurately measured in accordance with Section 4.5, and charged concurrently into the drum at the production plant, at the proportions satisfying the accepted mix design. Increases in water-cementing materials ratio will not be permitted.

The maximum size of batch in truck mixers shall not exceed the maximum rated capacity of the mixer as stated by the manufacturer and stamped in metal on the mixer. Truck mixing shall commence immediately upon introduction of ingredients into the drum and be continued for at least 50 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 water, air entraining agent or superplasticizer at the site is authorized by the Consultant, the mixer shall rotate for a minimum of 20 additional revolutions to ensure homogeneity of the concrete before discharge. Discharge chutes shall be kept clean and free from hardened concrete and shall be wetted down 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. 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. For Class HPC and Class HPC with steel fibres this requirement is reduced to 70 minutes. In hot weather, or under conditions contributing to quick setting of the concrete, these times may be reduced as determined by the Consultant and such deviations will be addressed in the Special Provisions.

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 the development of cold joints does not occur. The methods of delivering and handling the concrete shall facilitate placing with a minimum of rehandling, and without damage to the structure or the concrete.

4.8 Pour Schedules

The Contractor shall outline to the Consultant the proposed pour schedule for any particular pour. If in the opinion of the Consultant the amount of pour is deemed larger than can be poured with the facilities outlined, the Contractor shall either:

(a) Limit the amount to be poured at any time (using adequate construction joints), or

(b) Augment his facilities in order to complete the proposed pour, or

(c) 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 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 section 4.9.3 “Test Cylinders”.

The certified testers shall utilize the “Concrete Testing Summary at Site” forms contained at the end of this section. 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.

4.9.1 Strength Tests

A "Strength Test" shall consist of the compression tests of four standard test specimens, sampled, made, cured, and tested in accordance with CSA Standard Specifications and as modified herewith. One cylinder shall be tested at seven 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, molding 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 and Class HPC with steel fibres, the Contractor shall take a strength test to represent each approximate 20 m^3 portion of the concrete pour, to a minimum of one strength test for every two batches of concrete. For all other concrete, the Contractor shall take a 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 strength test will be taken to represent each approximately 30 m^3 portion of the concrete pour, to a minimum of one 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. When a concrete pump is used to place concrete, sampling shall be at the end of the discharge hose.

4.9.3 Test Cylinders

Making and curing concrete test cylinders shall be carried out in accordance with CSA Standard A23.2-3C, 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 Section 8.3.2.1 of CSA Standard A23.2-3C, for a period of at least 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. No extra laboratory curing time will 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 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 be responsible for all costs for concrete 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.

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

Slump tests shall be conducted in accordance with CSA Standard A23.2-5C.

4.9.5 Air Content and Density

Air content and density tests shall be conducted in accordance with CSA Standard A23.2- 4C and A23.2-6C respectively.

4.9.6 Testing Cylinders

Test cylinders will be tested in compression 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 section 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.

4.10 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 of the work begins. The drawings shall bear the Seal of 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. Alberta Safety and compliance with the Occupational Health and Safety Act and Regulations thereunder, shall be integral parts of his design. All falsework and formwork shall be fabricated in accordance with the drawings.

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 finished concrete will conform to the design dimensions and contours. 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 Forms for Exposed Surfaces

Forms 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. Forms 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. “ULTRAFORM”, or “POURFORM 107”, are acceptable formwork panels, however other forming panels will be considered if approved equal. All form material for exposed surfaces shall be full-sized sheets, as practical. The re-use of any forms must have the acceptance of the Consultant.

All forms 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.

The minimum acceptable forming for all exposed concrete where the pour height is 1.5 m or less, shall have 18 mm approved plywood, supported at 300 mm maximum on centres. Where the pour height is greater than 1.5 m, the minimum acceptable forming for all exposed concrete shall have 18 mm approved plywood, “Coated Formply”, supported at 200 mm maximum on centres. The support spacing specified here assumed 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 hangers and ties will not be permitted. Formwork hangers or ties for exposed surfaces of decks, curbs and barriers shall be an acceptable break-back type with surface cone, or removable threaded type. As practicality, internal ties for the construction of curb and barriers should not be used. All cavities created from ties or associated hardware removal shall be filled with an approved non-shrink grout and the surface left sound, smooth, even and uniform in color. The use of plastic sleeves and removable inner rods shall be discouraged and only when approved by the Department and the Consultant. If approved for certain applications, the plastic sleeve shall be removed for a distance of 100 mm from the face of the concrete. The inside of the resulting surfaces shall then be roughened by wire brushing or other acceptable means. The entire cavity shall be filled with an approved non-shrink grout.

4.10.4 Forms for Unexposed Surfaces

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

4.10.5 Standard Details

Refer to Standard Drawing S-1411 “Standard Concrete Joints” and Standard Drawing S-1412 “Standard Construction Joints”, included with these Specifications, for details of joints.

4.10.6 Deck Formwork

Unless otherwise noted, diaphragms and girders will be designed for construction loads during deck concrete pour in accordance with CSA-S6-06 Clause 3.16, and the loads assumed for such design shall be shown on contract drawings. Where construction loads or loading conditions proposed by the Contractor vary from those shown, the Contractor shall be responsible for maintaining girder stability and alignment until the deck concrete has gained sufficient strength. Where required, deck formwork design shall include any additional bracing system to those shown on the contract drawings. Care shall be taken in the design and installation of support brackets to avoid damage to girder flanges and webs. Where such brackets bear against girder webs, the girder webs shall be protected by timber or neoprene softeners. No drilling of additional holes or any other modifications including field welding shall be made to the superstructure elements. 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.

Formwork for decks, curbs, sidewalks, and parapets shall be fabricated so that the lines and grades shown on the drawings are achieved. Girders will be erected to normally accepted industry standards of tolerance; it shall be necessary to adjust the formwork to compensate for variances in girder dimensions, positioning, alignment, and sweep.

Prior to commencing deck formwork, the Contractor shall profile all the girders at stationing corresponding to the camber diagram, as applicable and determine the girder haunch dimensions required to achieve the specified gradeline. This information shall be provided to the Consultant prior to commencing any deck formwork.

In the event that actual girder camber values vary significantly from the estimated values indicated on the drawings, the Consultant may require the Contractor to raise or lower the gradeline accordingly.

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 operation.

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. Caulking, duct tape, ethafoam, or any other suitable means or material, shall be used to achieve the seal.

Should foreign material spill onto the girders despite the protection provided, the Contractor shall clean off, wash, and sandblast the contaminated areas, to the satisfaction of the Consultant. Additionally, should the exterior face of an exterior girder become stained or marked, the entire exterior face of the girder line shall be lightly sandblasted and “weathered” so that uniformity of girder color, in the opinion of the Consultant, is achieved.

“Weathering” shall be achieved by repeatedly fogging the exterior girder faces with clean water and allowing them to dry. Fogging should leave the girders wet but not “running wet”, and should be repeated when the girders are completely dry.

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 operation.

4.12 Protection of Substructure Units from Rust Staining

The substructure will be subject to staining, during the period from erection to casting of the concrete deck. The Contractor shall be responsible either to take suitable measures to coat or cover the piers and abutments before erection, or to adequately remove all staining so that the required concrete finishes may be applied with no trace of stain remaining. Final acceptance of pier finish will not be given until after all deck and curb concrete is in place.

This work will be considered incidental to the application of the specified concrete surface finish, and no separate payment will be made.

4.13 Removal of Falsework, Forms and Housing

Forms and their supports shall not be removed without the 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:

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 of supported elements	12 to 24 hours
Walls over 3 m high	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 must be removed from the completed structure. For certain special situations, formwork may remain in place, when the Contractor's formal request is approved by the Consultant and Department.

4.14 Handling and Placing Concrete

4.14.1 General

The Contractor shall give the Consultant 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 in kind and adequate in capacity for the work.

In preparation for the placing of concrete, all sawdust, chips and other construction debris and extraneous matter shall be removed from the interior of forms. Struts, stays, and braces, serving temporarily to hold 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 placing operations would involve free drop of concrete by more than 1 m, it shall be deposited through metal or other acceptable pipes.

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 already placed, when this concrete is less than 48 hours old, no matter what system of runways, supports or protection is used on the surface of the concrete already placed if it is subjected thereby to live or dead loads. Concrete more than 48 hours old but of less than the specified 28-day strength shall not be loaded 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 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 vibration 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. Vibration shall not be continued at any point to the extent that localized areas of grout are formed. 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. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms.
- Vibration shall be supplemented by such spading as is necessary to ensure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

4.14.3 Additional Requirements

When concrete placing is discontinued, for whatever reason, all accumulations of mortar splashed on the reinforcing steel and the form surfaces shall be removed. Dried mortar chips and dust shall not be puddle into the unset concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to injure or break the concrete-steel bond at and near the surface of the concrete, while cleaning the reinforcing steel.

Concrete shall be placed while fresh and before it has taken its initial set. Tempering of partially hardened concrete with additional water will not be permitted. No concrete shall be used which does not reach its final position in the forms within the time stipulated under 4.6.3 “Time of Hauling”.

After initial set of the concrete the forms shall not be jarred and no strain shall be placed on the ends of reinforcing bars which project.

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 clear of the structure and water crossing.

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 that the impact on the plastic air content of the concrete shall not vary by ± 0.5% and that the freshly placed concrete is not damaged by any form of vibration. When pumping is completed, 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 of the concrete or separation of the ingredients.

4.15 Placing Pile Concrete

4.15.1 General

The Contractor shall make every attempt to obtain a “Dry” pile hole prior to placing pile concrete. In the event that all reasonable attempts at obtaining a dry hole fail, the Consultant may permit the placement of pile concrete under water.

4.15.2 Concrete Placed in the Dry

Pile concrete shall be placed by means of a hopper equipped with a centre 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 centre of the casing or drilled hole and there are no transverse ties or spacers. Pile concrete shall have a slump range of 100 - 140 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.

4.15.3 Concrete Placed under Water

Placement of pile concrete under water shall be in accordance with Section 4.21 of this Specification and also with the following additional requirements:

<u>Crosshole Sonic Logging</u>
In order to test for voids or other abnormalities in the concrete, all drilled pile shafts cast under water shall be equipped with PVC or steel access tubes to permit inspection by Crosshole Sonic Logging (CSL). The Contractor shall submit the proposed method for the Consultant’s review two week before beginning drilled pile work. The Contractor shall supply and install four 50 mm inside diameter tubes in each drilled pile with a diameter of 1.5 m or less and six tubes in each pile with a diameter of greater than 1.5 m.

Tubes supplied shall be round, have a regular internal diameter that is free from defects, obstructions and joints. Tubes shall be watertight, free from corrosion and have clean internal and 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 cage a minimum of every 1.2 m along the length of the pile. Tubes shall be installed uniformly and equidistantly around the circumference of the pile such that each tube is spaced parallel for the full length. 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 cage. 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 65 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.

Qualification

The testing agency hired by the Contractor shall have a minimum of 3 years experience in CSL testing and have a Professional Engineer registered in the Province of Alberta supervising the testing and interpretation of results. The Contractor shall provide written evidence of successful completion of CSL tests by the testing agency on drilled piles in the Province of Alberta. The Contractor's submission shall also include personnel qualifications and equipment description.

CSL Results

The Contractor shall submit two original copies of CSL report to the Consultant within 5 working days of completion of CSL testing. CSL test results provided by the Contractor will be reviewed according to the criteria listed in the table below:

Concrete Condition Rating Criteria

Rating	Velocity Reduction *	CSL Results
Good (G)	≤ 10%	Good quality concrete
Questionable (Q)	>10% & <20%	Minor contamination or intrusion Questionable quality concrete
Poor/Defect (P/D)	≥ 20%	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

* From highest measured signal velocity in the comparable zone

CSL test results with ratings other than "G" may require further investigation by the Contractor as determined by the Consultant. Edge defects are critical and any defects that expose the rebar are not acceptable. The Contractor shall not grout the CSL tubes or perform any further work on the CSL tested drilled piles until the Consultant determines whether the drilled pile is acceptable.

The Contractor shall perform Crosshole Tomography in order to further investigate and delineate the boundaries of any defective/unconsolidated zones. Any further tests deemed necessary by the Consultant in order to determine the acceptability of the drilled pile will be determined after reviewing the CSL test report. Additional test or analysis options include 3D tomographic imaging, single-hole sonic testing, sonic echo or impact response tests and concrete coring.

The Consultant will determine the depth, location, diameter and number of core holes when concrete coring is required. If the Consultant is concerned about concrete strength or requires the use of a borehole camera for inspection, large diameter cores may be required. Minimum of two cores would be required to intercept the suspected defect zones.

Correction of Unacceptable Drilled Pile
When the Consultant determines a drilled pile is unacceptable, the Contractor shall submit a remedial action plan with supporting calculations for the Department and the Consultant's approval. The remedial action shall be designed by the Contractor and stamped by a Professional Engineer registered in the Province of Alberta. No compensation will be made for remedial work or losses or damages due to remedial work of drilled piles found defective or not in accordance with the Specifications.

Measurement and Payment
CSL will be considered incidental to the Work and no additional or separate payment will be made for procurement, conducting the CSL testing, reporting of results and incidentals necessary to complete the work including any other test required to determine the acceptability of the drilled pile.

4.16 Placing HPC Concrete and HPC Concrete with Steel Fibres

4.16.1 General

Concrete placing will not be permitted when the air temperature is below +5°C or above 25°C, nor in the event of rain or excessive wind or dust, nor when there are other conditions judged by the Consultant to be detrimental to the concrete. Deck, roof slab, approach slab and deck overlay concrete placing shall be between the hours of 6:00 pm and 10:00 am except with specific acceptance of the Department and Consultant. Night pours shall require proper lighting as reviewed and accepted by the Consultant. The temperature of the concrete during discharge shall be between 10°C and 20°C unless reviewed and accepted otherwise by the Consultant. The temperature of the mix shall be maintained below the 20°C maximum temperatures by the inclusion of ice to the mix which shall not alter the design water-cementing materials ratio. Immediately prior to placing concrete, the substrates shall be thoroughly wetted down with clean water.

The Contractor's project manager and field superintendent may be required to attend a pre-construction meeting at a location determined by the Consultant, prior to commencement of any field work.

All deck concrete and deck overlay concrete shall be consolidated in accordance with Section 4.14.2 even when vibratory drum type finishing machines are used.

Placing/Finishing Machines
For all deck concrete and deck overlay concrete, screeding shall be by concrete placing/finishing machines as follows or acceptable equivalents:

- Bidwell Model RF200, 364, 2450, 3600 and 4800
- Gomaco Model C450

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 will facilitate the operations of concrete finishing and placing of filter fabric or wet burlap, and shall also be made available to the Consultant for straight-edge checking. The work bridges shall be supported essentially parallel to the concrete surface, between 250 mm and 600 mm above the concrete surface, and shall be at least 800 mm wide to permit diverse uses concurrently, and be rigid enough that dynamic deflections are insignificant.

4.16.2 Screed Guide Rails

Acceptable steel screed guide rails 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 must be located outside of the finished surface of the pour for overlay concrete and also for deck concrete, unless specified otherwise in the Special Provisions. All rails and supports shall be removed with minimum disturbance to the concrete.

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 finishing machine and guide rails shall be adjusted so that the height of the screed will finish the concrete to the design gradeline and crown. To confirm the adjustment of the machine and guiderails, the screed shall be dry-run prior to the pour and clearance measurements taken at each of the girder tenth points, and provided to the Consultant for review and acceptance. Re-setting of the machine and/or screed rails shall be done as necessary, to obtain an acceptable dry-run. Adjustments to the machine or screed rails will not be permitted after an acceptable dry-run has been completed.

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

4.16.4 Fog Misting and Wet Cure Systems

The Contractor shall prepare details of the fog misting and wet cure systems. Details of the fog misting and wet cure systems shall be provided to the Consultant for review and acceptance three weeks prior to the scheduled pour date. Details shall include information with regards to the type and description of equipment and materials being used and work method/techniques employed to satisfactorily carry out the work. The fog misting and wet cure systems shall be demonstrated for adequacy and suitability, a minimum of 24 hours prior to placing HPC concrete.

4.16.5 Screeding Concrete

The screed shall be moved slowly and at a uniform rate. In general, the direction of pouring should 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 surface concrete. The contractor shall also ensure that the required concrete thickness is being placed by randomly probing the concrete behind the finishing machine.

Screeding shall be completed in no more than two passes. The screed shall not be allowed to run except when screeding is actually in progress. The screeded surface shall not be walked on or otherwise damaged.

4.16.6 Bull Floating/Surface Texturing

The concrete surface produced behind the finishing machine shall be magnesium floated the minimum amount necessary to ensure that the surface is free from open texturing, plucked aggregate and local projections or depressions. It is imperative that competent workers be employed to carryout bull floating and surface texturing.

4.16.7 Surface Defects and Tolerances

The finished surface of the concrete shall conform to the design gradeline profiles as indicated on the drawings and/or as determined on site.

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

Except across the crown, the surface 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 deck anywhere below the straight edge.

The surface shall be checked by the Contractor, as described above, immediately after final bull floating and before texturing.

The surface shall again be checked by the Contractor at the end of the curing period in the same manner and to the same tolerance.

Areas that do not meet the required surface accuracy shall be clearly marked out and the Contractor shall, at his own expense:

(a) Grind down any areas higher than 3 mm but not higher than 10 mm above the correct surface.

(b) Correct any areas lower than 3 mm but not lower than 10 mm below the correct surface, by grinding down the adjacent high areas.

(c) When the deviation exceeds 10 mm from the correct surface, the deck slab shall be removed and replaced in accordance with Section 20.3.2 “Partial Depth Repair”, resulting in a product that is in no way inferior to the adjacent undisturbed slab. Replaced areas shall be at the Contractor’s expense.

Grinding shall be carried out by an approved machine, of a type and capacity suitable for the total area of grinding involved, until the surface meets the specified requirements.

All corrective work will require the Contractor to submit a proposal for review and acceptance by the Department and Consultant, prior to commencement of any work.

If the surface is damaged in any way by construction operations, or if the deck shows signs of distress or scaling prior to the final acceptance of the deck, it shall be repaired or replaced by the Contractor at his own 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 surface shall then be 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. The surface shall be such that it does not vary more than 5 mm from the required lines, under a 3 m straightedge.

4.18 Concreting Shear Keys and Diaphragms

Precast concrete girders will be erected to normally accepted industry standards for tolerance. Forming of shear keys and diaphragms shall be designed to accommodate variations in girder dimensions, positioning, alignment, camber and sweep. Before concreting, the girder keyways must be saturated with water for a period not less than 30 minutes, and must be coated with an approved bonding agent immediately ahead of the concrete. Concrete placed in the keyways shall be adequately vibrated and trowelled smooth and flush to the girders. Immediately after trowelling, wet burlap or white filter fabric shall be placed on the shear keys and kept continuously wet for the next 72 hours.

4.19 Construction Joints

4.19.1 General

Construction joints shall be made only where indicated on the drawings or shown in the pouring schedule unless otherwise reviewed and accepted by the Consultant.

If not detailed on the drawings, or in the case of emergency, construction joints shall be installed as determined by the Consultant and according to the standard drawing. 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 50 mm minimum concrete cover on reinforcing steel running parallel to the joint. Refer to Standard Drawing S-1412 "Standard Construction Joints" included with these Specifications.

4.19.2 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 and saturated with water, with all free standing water removed. 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.

4.20 Concreting in Cold Weather

The Contractor shall accept full responsibility for the protection of concrete during adverse weather conditions. In addition to the requirements stated below, all concrete shall be cured in accordance with Section 4.22.

When the ambient air temperature is, or is expected to be below 5°C during the specified minimum curing period, or when determined by the Consultant, the following requirements for cold weather concreting shall be put in place:

(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 Section 4.4.3 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 above 15°C for a period of 7 days after placing the concrete. Where elements being cast consist of HPC concrete, the seven day period is increased to 14 days. Additionally, for deck construction, the Contractor shall submit to the Department and the Consultant, details of the enclosure structure, describing how the HPC concrete will be placed, finished and cured. For casting of HPC concrete, an enclosure structure is mandatory and no alternatives will be considered. The enclosure shall be constructed so that a minimum 300 mm clearance exists between the enclosure and the concrete. To prevent overheating, the air temperature within the enclosure shall be monitored frequently, especially during the first 24 hours.

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 which can be harmful to the concrete. 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, is to be designed to give the most uniform distribution of heat possible, and is subject to the review and acceptance of the Consultant.

(3) Before placing concrete, adequate pre-heat shall be provided to raise the temperature of formwork, reinforcing steel, previously-placed concrete, and/or soil to at least 10°C. The Contractor shall be responsible to make all arrangements for heating, and to ensure continuous protection from unsatisfactory temperature and moisture conditions during the curing period. The Consultant's acceptance of the Contractor's arrangements shall be obtained and it will be a requirement that pre-heat is adequate, in the Consultant's opinion, to ensure that no portion of the fresh concrete is damaged by freezing, or curing retarded by cold temperatures.

(4) Fully insulated formwork may be proposed as an alternative to provision of further heat during the curing period. Such formwork shall be designed and insulated with approved materials so that the initial heat of the mix, and the heat generated during the hydration of the cement, is retained to provide the specified curing conditions. The adequacy of the protection is the Contractor's responsibility.

(5) Protection and heating, where 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 a heated housing, 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 of the element and 300 mm from the surface of the element.

The Contractor shall demonstrate to the satisfaction of the Consultant that the temperature and relative humidity requirements are met by continuously monitoring and recording air temperature and relative humidity within the curing enclosure.

4.21 Depositing Concrete under Water

Concrete shall not be deposited in water except as specified and with the acceptance of the Consultant and under his immediate supervision. Anti-washout admixtures incorporating viscosity modifiers (whelan gum, etc.) may be used when specifically reviewed and accepted by the Consultant.

Concrete to be deposited in water shall be of the specified class, with mix design modified to yield 170 mm ± 30 mm slump, and with an excess of 15% of the cement quantity added beyond this designed amount. The concrete temperature shall be between 10°C and 25°C.

To prevent segregation, concrete shall be carefully placed in a compact mass, in its final position, by means of a concrete pump. When specifically reviewed and accepted by the Consultant, a properly designed and operated tremie may be used. The concrete shall not be disturbed after being deposited. Still water shall be maintained at the point of deposit and the forms underwater shall be watertight.

The discharge end of the concrete pump line shall be lowered to the bottom of the form or hole. Pumping shall then proceed with the end of the discharge line being continually buried no less than 500 mm below the surface of fresh concrete at all times, to maintain a seal until the form or hole is completely filled with fresh uncontaminated concrete.

A tremie, when reviewed and accepted, shall consist of a rigid tube having a diameter between 200 mm and 300 mm, and if constructed in sections it shall have flanged couplings fitted with gaskets. The discharge end shall be closed at the start of the work to prevent water entering the tube. The tremie tube shall be kept full to the bottom of the hopper, and water shall be kept out at all times. When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end, always keeping it in the deposited concrete. The flow shall be continuous until the work is completed. Sufficient tremies shall be used to place the concrete under water such that it is not necessary to move any of the tremies from one portion of the pour to another. The use of non-rigid tremie tubes will not be permitted.

Concrete shall not be placed in water which is below 4°C.

The surface of the concrete shall be kept as nearly horizontal as is practicable at all times. The discharge end of the tremie shall be kept buried at least 300 mm in previously placed concrete.

Dewatering will not be permitted while concrete is being placed. Dewatering may proceed when the concrete seal is sufficiently hard and strong. All laitance or other unsatisfactory material shall be removed from the exposed surface by scraping, chipping or other means which will not injure the surface of the concrete.

4.22 Curing Concrete

4.22.1 General

Freshly deposited concrete shall be protected from freezing, abnormally high temperatures or temperature differentials, premature drying, excessive moisture, and moisture loss for the period of time necessary to develop the desired properties of the concrete.

All concrete surfaces consisting of Class B, C or D concrete shall be moist cured. The Contractor shall cover the concrete surface(s) with a single layer of clean, soaking wet burlap or light colored filter fabric as soon as the surface will not be marred by so doing. The burlap or light colored 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 requirements for Class HPC and Class HPC with steel fibres are stated in Section 4.22.3.

4.22.2 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 satisfactorily 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. In cases, where premature drying is severe or is anticipated to be severe, then moist curing, as specified in 4.22.1, will also be required.

4.22.3 Curing Requirements for Class HPC and Class HPC with Steel Fibres

Curing methods and procedures shall be reviewed and accepted by the Consultant prior to scheduling placement of Class HPC or HPC with steel fibres concrete. Equipment and materials necessary for the fog mist and wet cure systems shall be demonstrated prior to scheduling placement of Class HPC or HPC with steel fibres concrete.

During the cure period the Contractor shall provide protection to ensure that the difference between the concrete temperature and the ambient air temperature at the site remains within the limits specified in 4.4.2(l). 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. The Contractor shall monitor and record the temperatures every four hours for the first 3 days after concrete placement and every 12 hours thereafter for the remainder of the specified cure period. Daily temperature records shall be forwarded to the Consultant and Department.

Fog mist shall be applied continuously from the time of screeding until the concrete is covered with filter fabric or burlap, in such a way as to maintain high relative humidity above the concrete and prevent drying of the concrete surface. Water shall not be allowed to drip, flow or puddle on the concrete surface during fog misting, when placing the filter fabric or burlap, or at any time before the concrete has achieved final set. Fog misting will not be required for casting of curbs, barriers, medians and MSE wall coping.

Two layers of light colored filter fabric or burlap shall be placed on the concrete surface as soon as the surface will not be marred as a result of this placement. A fine spray of clean water shall be immediately applied to the filter fabric or burlap. Edges of the filter fabric or burlap shall overlap a minimum of 150 mm and shall be held in place without marring the surface of the concrete. The filter fabric or burlap shall be 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 7 days for deck overlay Concrete and reconstruction projects where traffic is being impeded and 14 days for all new bridge construction.

In the event that the wet curing is unacceptable, and 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.

When Class HPC is used for concrete paving lips and deck joint blockouts, the wet cure can be reduced to 3 days followed by the application of a Type 2 curing compound meeting the requirements of ASTM C309 or ASTM C1315.

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

4.22.4 Class HPC and Class HPC with Steel Fibres – Crack Identification/Repair

After the curing period and before opening to public traffic, the Contractor and the Consultant shall jointly inspect the dry concrete surface(s) to identify all cracks. The Consultant will plot the width in mm and length in linear m of cracks per m^2 and report the findings to the Department. The Contractor shall repair the cracks at his own expense if crack width is 0.2 mm or more. The following procedure shall be used in the treatment of the same:

(a) Blow out cracks clean and dry with a jet of oil-free compressed air.

(b) Seal cracks with a gravity flow epoxy in accordance with the Manufacturer's instructions. The gravity flow epoxy shall maximize the penetration by taking into consideration the ambient temperature, substrate temperature, viscosity and pot life of the material. The gravity flow epoxy material shall be chosen from the List posted at following Alberta Transportation website path: Alberta Transportation Product List/Crack Treatment/Concrete Crack filler/Proven or Potential.

(c) When cracks extend the full depth of the deck slab, barriers or curbs or to the top layer of reinforcement of decks that are cast to grade, epoxy injection will be required. The epoxy material and injection procedure shall be submitted by the Contractor for acceptance of the Consultant and Department.

4.23 Concrete Finishing Under Bearings

All concrete areas on which bearing plates or pads are to be placed are to be at the required elevation, and are to be finished or ground to a smooth and even surface in preparation for bearing plates or pads. The finished surface shall not vary more than 1 mm over an area whose dimensions exceed the dimensions of the bearing plates by 60 mm. Air voids created by forming grout-pad depressions shall be filled with an approved patching material, well in advance of girder erection. In cold weather conditions this work shall be completed while the concrete is still warm.

4.24 Concrete Surface Finish

4.24.1 General

Surfaces requiring concrete finishing shall conform to the requirements of section 4.16.7, "Surface Defects and Tolerances". All mortar patches shall be cured as specified in section 4.22, "Curing Concrete".

On unexposed concrete surfaces all cavities, honeycomb, and other deficiencies shall be thoroughly chipped out, cleaned, and after having been kept saturated with water for a period of not less than 30 minutes, shall be filled with cement mortar.

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 exposed concrete surfaces unless other finishes are specified
- top surfaces of abutment seats and pier caps

Class 2 Rubbed Surface Finish
- solid shaft river piers
- inside surfaces of curb, barrier, median and sidewalk

Class 3 Bonded Concrete Surface Finish
- abutment seats except top surface
- pier caps except top surface
- exterior faces of curtain walls/wingwalls, cast-in-place walls and MSE wall copings
- grade separation piers except top surfaces
- exterior concrete girder faces (when specified)
- 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 4 Floated Surface Finish
- top surfaces of concrete deck and roof slabs which are to receive waterproofing membranes and wearing surfaces

Class 5 Floated Surface Finish, Broomed Texture
- top surfaces of curbs, sidewalks, and medians
- approach slab concrete which will be covered by a wearing surface only (without waterproofing membrane)
- concrete slope protection

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

Only approved wood or magnesium floats shall be used for finishing concrete.

4.24.2 Class 1 Ordinary Surface Finish

Unformed Surfaces -Immediately following placing and compacting, 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.

Formed Surfaces -Immediate 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, honeycomb areas, broken corners or edges and other defects, shall be thoroughly chipped out, cleaned, and after having been kept saturated with water for a period of not less than 30 minutes, shall be filled with cement mortar. Mortar shall be not more than one hour old. The mortar patches shall be cured as specified in 4.22 “Curing Concrete”. All concrete joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.

4.24.3 Class 2 Rubbed Surface Finish

Immediately following the removal of forms, all fins and irregular projections shall be removed from all surfaces. All lines that are not true must be corrected by chipping, grinding or patching as necessary. Parging to correct irregularities will not be permitted. On all surfaces, the cavities produced by form ties, air bubbles and all other holes, honeycomb areas, broken corners or edges and other defects, shall be thoroughly exposed by wire brushing with a stiff bristled, powered, wire brush. The cleaned surface, after having been kept saturated with water for a period of not less than 30 minutes, shall be filled with cement mortar. Mortar shall be not more than one hour old. The mortar patches shall be cured as specified in section 4.22 “Curing Concrete”. All concrete joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges. The small surface voids formed by air bubbles must be filled by rubbing a thin grout composed of bonding agent, water, clean fine sand and cement into the moistened surface. When the patching and filling have adequately hardened, a carborundum stone shall be used to finish the surface to a smooth, uniform and closed texture. Any voids opened during the stone rubbing process shall be re-filled.

It is essential that the prepared concrete surface, including all patching and filling be uniform in colour and texture. All portions of bridge elements, including those cast in more than one pour, shall be of the same colour and texture. Any staining caused by cement, water, weather, or other conditions shall be prevented, removed, or covered by methods and materials acceptable to the Consultant. After the surface preparation has been completed to the satisfaction of the Consultant, the Contractor shall apply sealer as specified in section 4.25 “Type 1c Sealer”.

If uniformity of colour is not achieved to the satisfaction of the Consultant, the Contractor, rather than applying the sealer as specified in section 4.25 “Type 1c Sealer”, shall supply and apply an approved pigmented concrete sealer as specified for Class 3 “Bonded Concrete Surface Finish”.

4.24.4 Class 3 Bonded Concrete Surface Finish

Surface preparation shall be done as specified for Class 2, “Rubbed Surface Finish”, except that uniformity in colour is not required.

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 apply an approved pigmented concrete sealer, which 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. 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 painted 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.

4.24.5 Class 4 Floated Surface Finish

Unless otherwise noted on the drawings, concrete which is to receive a waterproofing membrane and a final wearing surface, shall be floated and trowelled as necessary to provide a smooth surface.

4.24.6 Class 5 Floated Surface Finish, Broomed Texture

The concrete surface shall be floated and trowelled as necessary to produce a smooth surface. The surface shall not vary more than 3 mm under a 3 m long straightedge.

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. An edging tool shall be used at all edges and expansion joints. Where indicated on the drawing, sidewalk surfaces shall be laid out in blocks using an acceptable grooving tool.

4.24.7 Class 6 Floated Surface Finish, Surface Textured

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

Following the surface texturing, a strip of the concrete along the inside curb line, shall be trowelled smooth and the surface left closed.

4.25 Type 1c Sealer

An approved Type 1c sealer shall be applied to all concrete surfaces which are susceptible to deterioration by water and de-icing salts. This shall include all concrete surfaces to 600 mm below grade, or in the case of river piers 600 mm below lowest water level, or as specified and shall include all surfaces which are to receive a Class 2, Class 5 and Class 6 Surface Finish. This does not apply to surfaces covered with waterproofing membrane and ACP wearing surface, drain troughs and concrete slope protection. Sealer will not be required on the underside of bridge decks and 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.

Type 1c sealers shall meet the current Material Testing Specifications for Concrete Sealers - B388.

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 approval list. Before applying the sealer, the concrete shall be cured for at least 28 days. Mortar patches shall be cured for at least two 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.

4.26 Concrete Strength Requirements

The Department reserves the right to reject any concrete whatsoever which does not meet all the requirements for that class of concrete. The Department may however, accept concrete, the strength of which falls below the specified strength requirements. In this case, payment will be made in accordance with 4.26.1. The bid price can either be unit price or lump sum.

4.26.1 Payment Scales

<u>Class B Concrete, Class Pile Concrete, 25 MPa</u>

Strength Test Results	
25 MPa and over	Full bid price
24 MPa to 25 MPa	Bid price less $30 per cubic metre
23 MPa to 24 MPa	Bid price less $60 per cubic metre
22 MPa to 23 MPa	Bid price less $90 per cubic metre
21 MPa to 22 MPa	Bid price less $120 per cubic metre
20 MPa to 21 MPa	Bid price less $160 per cubic metre

<u>Class C Concrete, 35 MPa</u>

Strength Test Results	
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

<u>Class HPC and Class HPC with Steel Fibres Concrete, 45 MPa</u>

Strength Test Results	
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

<u>Class D Concrete, 30 MPa</u>

Strength Test Results	
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

Class S Concrete, 20 MPa

Strength Test Results

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

The reduced payment shall apply to the volume of concrete represented by the strength test as defined in Section 4.9.1.

Concrete will be rejected with strengths below the scales shown;

i.e. - Class B and Pile concrete below 20 MPa
- Class C concrete below 27 MPa
- Class HPC and Class HPC with steel fibres concrete below 40 MPa
- Class D concrete below 24 MPa
- Class S concrete below 16 MPa

4.26.2 Open to Traffic

The bridge shall not be opened to traffic until the deck or overlay concrete has attained minimum compression strength of 70% of the design strength. The concrete shall be cured in accordance with Section 4.22 of the specification. The Contractor shall be responsible for all costs associated with any additional testing that may be required to satisfy the strength requirement.

4.26.3 Coring for Compressive Strength Testing

Coring to confirm or contest low concrete strength test results shall be reviewed and accepted by the Department. When coring is acceptable, arrangements shall be made by the Contractor to employ an independent, certified testing service, all at the expense of the Contractor. The cores shall be taken and tested within seven days of the testing of the twenty-eight day cylinders representing the concrete in question. Where practical, three 100 mm Ø cores shall be taken for each strength test previously taken, and there shall be no doubt that the cores taken, and the cylinders under consideration represent the same batch of concrete. Cores may not be taken unless the Consultant's representative is present. Cores shall be tested by an independent CSA certified laboratory and in accordance with the requirements of CSA Standard A23.2-14C. The average strength of the cores as reported by the independent testing service shall constitute a test.

In cases where the concrete strength, as indicated by the cores, is higher than the strength based on the concrete cylinder results, the core results shall be used as the basis for acceptance of and payment for the concrete. If the core strengths are lower than the strength from the concrete cylinder tests, the cylinder tests shall govern.

4.27 Measurement and Payment

Payment will be made on the basis of the actual volume within the neat lines of the structures as shown on the drawings or revised by authority of the Department and Consultant, except deductions will be made for volume of concrete displaced by ducts and voids, girder flanges/webs and by timber, pipe, or concrete piles. No deduction will be made for the volume of concrete displaced by steel reinforcement, expansion material or steel H-piles, nor for fillets and chamfers.

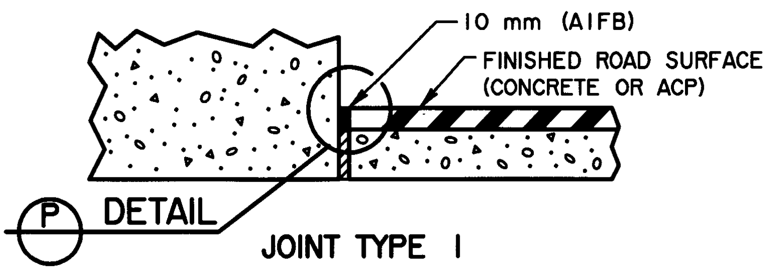
When it is specified on the drawings that concrete in footings is to be placed against undisturbed soil or set in rock, and where the excavation is made wider than the neat lines of the footing as shown, the Contractor shall supply and place the excess volume of concrete at his own expense.

In the case of drilled cast-in-place concrete piles where the drilled holes are made larger than required by the drawings, the additional volume of pile concrete required to fill the enlarged hole shall be supplied and placed by the Contractor at his expense.

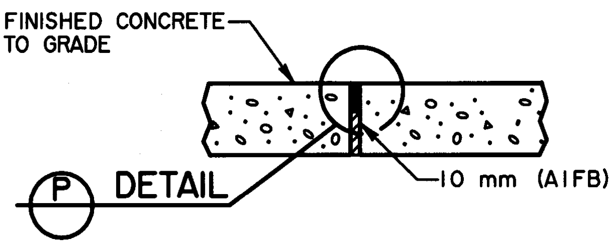
An interim payment in the amount of 80% of full value will be made if the concrete has been placed acceptably, and the 7 day test cylinder strength indicates that the concrete will reach the acceptance range of specified strength. Partial payment in advance of 28 day test results will not be deemed to constitute acceptance of the concrete, nor operate to limit in any way the requirements of Section 4.26 of these specifications or Section 1.2.24 of the General Specifications.

Final payment will not be made until the specified concrete finish is acceptably completed, and the 28 day strength tests show that the concrete meets the strength requirement of the specification, or indicate what deduction is to be made for under-strength concrete.

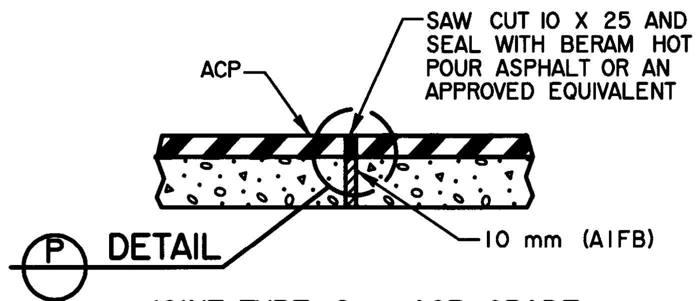
The payment for concrete shall include full compensation for the cost of furnishing all material, tools, equipment, falsework, forms, bracing, labour, curing, heating, surface finish including application of Type 1c sealer and/or Type 3 pigmented sealer and all other items of expense required to complete the concrete work shown on the drawings, and as outlined in the specifications.



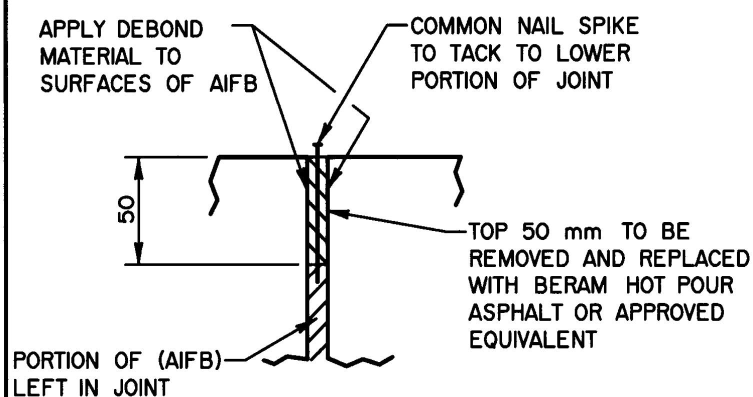
JOINT TYPE 1



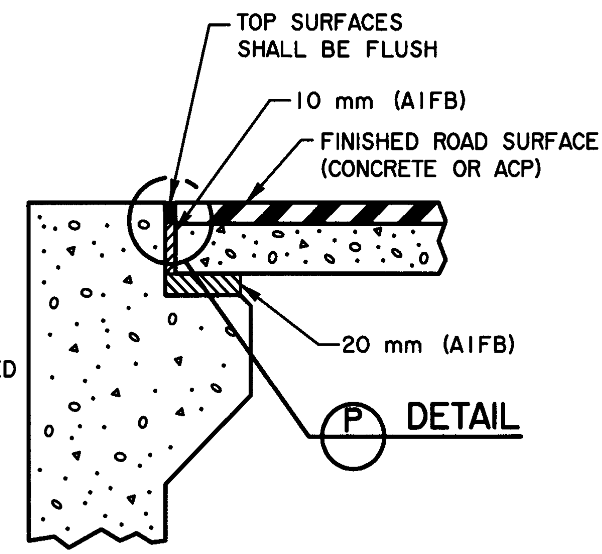
JOINT TYPE 2 - CONCRETE GRADE



JOINT TYPE 2 - ACP GRADE



P DETAIL



JOINT TYPE 3

GENERAL NOTES

- DIMENSIONS ARE GIVEN IN mm. DETAILS ARE NOT TO SCALE.
- ASPHALT IMPREGNATED FIBREBOARD (AIFB) SHALL CONFORM TO THE CURRENT ASTM SPECIFICATION D1751 FOR PREFORMED EXPANSION JOINT FILLERS.

NO	DATE	REVISIONS	BY
5	2003-04-17	REVISED JOINTS TO INCLUDE ACP SURFACE	RY
4	99-04-14	REVISED JOINT 3	RY
3	99-03-29	BEB CHANGED TO TSB	RY
2	94-11-30	PAGE NUMBER	RJR
1	87-03-04	REDRAWN FROM S-1411	DHQ

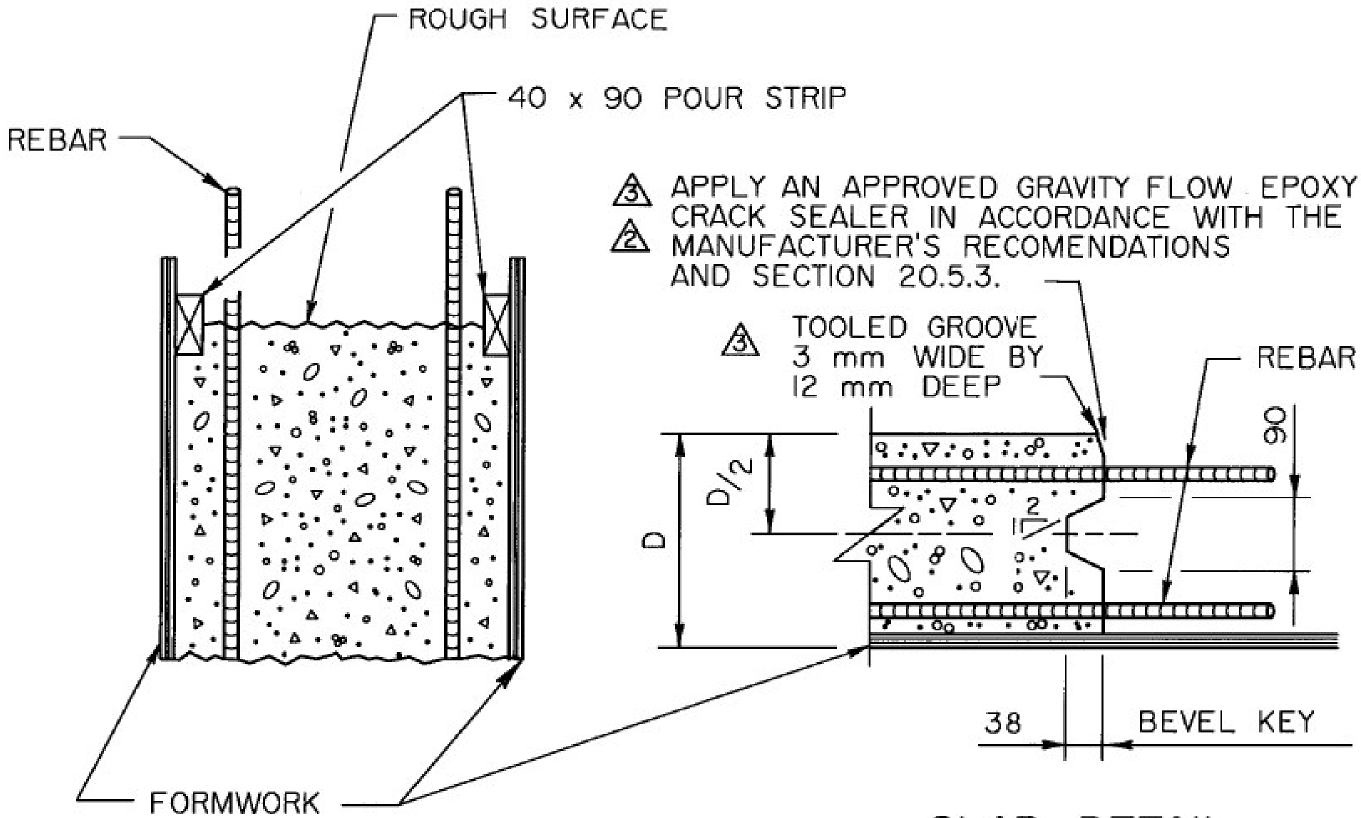
7

Alberta TRANSPORTATION AND UTILITIES
TECHNICAL STANDARDS BRANCH

STANDARD CONCRETE JOINTS

DESIGNED	DRAWN	DATE	APPROVED	SIGNATURE	DATE	PAGE 2	DRAWING
DHQ	MIK	87-03-04	EXECUTIVE DIRECTOR	mm Boyd	May 8/87	4.33	S-1411-87

PLOTTED APR 17, 2003 S1411X87 .RV5



SLAB DETAIL

WALL OR PIER SHAFT DETAIL

GENERAL NOTES

- DIMENSIONS ARE GIVEN IN mm. DETAILS ARE NOT TO SCALE.
- SURFACES OF HORIZONTAL JOINTS SHALL BE THOROUGHLY CONSOLIDATED AND INTENTIONALLY LEFT IN A ROUGHENED CONDITION.
- JOINTS SHALL BE CLEANED OF SURFACE LAITANCE AND OTHER FOREIGN MATERIALS PRIOR TO PLACING NEW CONCRETE.
- 3 REFER TO ALBERTA TRANSPORTATION'S PRODUCT LIST UNDER "CRACK TREATMENT/CONCRETE CRACK FILLER" FOR APPROVED FLOW EPOXY PRODUCTS.

NO	DATE	REVISIONS	BY
4			
3	2010-01-21	SLAB DETAIL & GENERAL NOTES REVISED	DB
2	01-06-06	SLAB DETAIL JOINT REVISED	RY
1	99-04-12	REDRAWN FROM S-1412-98 REV 1	RY

Alberta TRANSPORTATION AND UTILITIES
TECHNICAL STANDARDS BRANCH

STANDARD
CONSTRUCTION JOINTS

DESIGNED	DRAWN	DATE	APPROVED	SIGNATURE	DATE	PAGE	DRAWING
RY	WS	99-04-12	EXECUTIVE DIRECTOR		May 8/07	4.35	S-1412-99

Alberta Transportation

Concrete Testing Summary at Site

Bridge File #: ____________________ Date Tested: ____________________

Bridge Project: ____________________ Weather: ____________ °C

Location: ____________________ Tested By: ____________________

Contract #: ____________________ Certification: ☐CSA ☐ ACI

Contractor: ____________________ Date of Certification / Expiry: __________ __________

Concrete Supplier: ____________________ Cylinder Curing Facilities / Initial Temp: __________ __________

Plant Location: ____________________ Placing Method / Sampling Location __________ __________

Consultant: ____________________ 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)

Sketch of Test Cylinder Location: Comments:

Deck Section #'s:

pg. ____ of ____

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

Alberta Infrastructure and Transportation

Concrete Testing Summary at Site

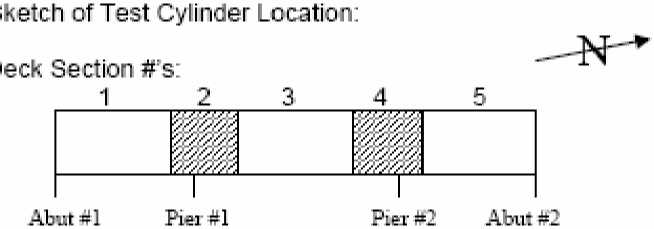
Bridge File #:	12345	Date Tested:	January 10, 2008
Bridge Project:	HWY 555 over HWY 5 Grade Separation	Weather:	Light Breeze, Cloudy 12 °C
Location:	Sometown	Tested By:	Joe Tester
Contract #:	2222/08	Certification:	☒ CSA ☐ ACI
Contractor:	ABC Contracting	Date of Certification / Expiry:	July 1, 2007 / July 1, 2010
Concrete Supplier:	XYZ Concrete	Cylinder Curing Facilities / Initial Temp:	Curing Box / 17 °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 (m^3)	Time Batched	Time Tested	Time Off-Load	Slump (mm)	Air Content (%)	Unit Weight (kg/m^3)	Temperature Air (°C)	Temperature 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)

Alberta Transportation

Concrete Testing at Site

Suggested Concrete Test Cylinder Coding

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

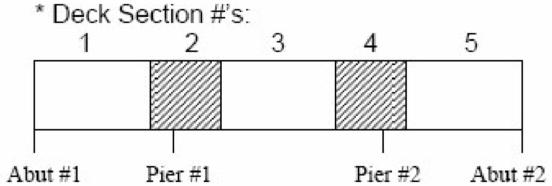
Piers

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

Concrete Cylinder Coding Sheet for Suggested Cylinder Identification Labels

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 5

REINFORCING STEEL

TABLE OF CONTENTS

5.1 General

This specification is for the supply, fabrication, handling and placing of reinforcing steel. Reinforcement bars shall be supplied in the lengths and shapes, and installed as indicated on the drawings. All reinforcing steel shall meet the requirements of the current edition of Reinforcing Steel Institute of Canada Manual of Standard Practise. The Bar Lists in the drawings are provided for estimating purposes only. No substitution of bars or changes to bar details will be allowed without the prior acceptance of the Consultant.

5.2 Certification

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.

5.3 Fabrication

Reinforcing steel shall conform to the requirements of the CSA Standard G30.18M Grade 400. All hooks and bends shall be bent using the pin diameters and dimensions as recommended in The Reinforcing Steel Institute of Canada (RSIC), Manual of Standard Practice, 1 Sparks Avenue, Willowdale, Ontario M2H 2W1, Phone: 416-499-4000, unless specified otherwise. Reinforcing bars shall conform accurately to the dimensions shown on the drawings and within the fabricating tolerance as shown in the RSIC, Manual of Standard Practice.

Epoxy-coated reinforcing steel shall be prepared and coated according to the requirements of ASTM A775 and the Ontario Provincial Standard Specification OPSS 1442, Material Specification for Epoxy-coated Steel Reinforcement for Concrete with additions and exceptions as described in this specifications. Film thickness of the 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.

Mesh reinforcement shall be supplied in flat sheets only.

5.4 Handling and Storage

The Contractor shall store steel reinforcement above the surface of the ground, upon platforms, skids, or other supports, and protect it from mechanical injury and surface deterioration caused by exposure to conditions producing rust. Steel reinforcement incorporated in the work shall be free from loose rust, scale, dirt, paint, oil, and other foreign material.

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. Bar-to-bar abrasion and excessive sagging of bundles must be prevented, and bundles shall be handled with spreaders and non-metallic slings.

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

5.5 Field Repair of Epoxy Coating

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

Repair of damaged coating, sheared or sawed ends shall be done to the Consultants acceptance using the epoxy coating supplier's approved patching material and in accordance with the patching material manufacturer's written recommendations regarding surface preparation and patching material application. At a minimum the areas to be repaired shall be cleaned by removing all surface contaminants and damaged coating before applying patching material. Where rust is present, it shall be entirely removed immediately before applying the patching material. The patching material shall be overlapped onto the original coating for 25 mm or as recommended by the manufacturer. The dry film thickness of the patched areas shall be between 175 µm to 300 µm. When the field repairs result in a total bar surface area covered by patching material that exceeds 5% of the bar surface area, the bar shall be replaced.

5.6 Placing and Fastening

All steel reinforcement shall be accurately placed in the positions shown on the plans, and firmly tied and chaired before placing the concrete. When placed in the work it shall be free from dirt, detrimental rust, loose scale, paint, oil or other foreign material. Bars shall be tied at all intersections, except where spacing is less than 250 mm in each direction, when alternate intersections shall be tied. Tack welding of reinforcing steel shall not be allowed.

Distances from the forms shall be maintained by means of stays, spacers, or other approved supports. Reinforcing cover shall not be less than the minimum specified on the drawings. Spacers for securing reinforcement from contact with the forms or for separation between layers of bars shall be plastic chairs, precast concrete supports, galvanized metal or epoxy-coated metal; of acceptable shape and dimensions. Precast concrete supports shall be used for all exposed faces of curbs, medians and barriers. Precast concrete supports shall have compressive strengths equal to or exceeding the placed concrete. Tie-wire for epoxy coated reinforcing shall be plastic coated. Any metal chairs protruding through the surface of the hardened concrete shall be cut back at least 25 mm, and the holes filled in accordance with section 4.24.2, unless otherwise reviewed and accepted by the Consultant. Metal chairs shall not be used to support reinforcement on surfaces which are to be exposed or are to be finished; where possible, this reinforcement is to be supported entirely from above.

5.7 Splicing

Splicing of bars, unless shown on the plans, is prohibited except with the written acceptance of the Consultant. Splices, where possible, shall be staggered.

For lapped splices, the bars shall be placed in contact and wired together in such a manner as to maintain a clearance of not less than the required minimum clear distance to other bars, and the required minimum distance to the surface of the concrete. In general, suitable lap lengths will be achieved by the placing of bars of the lengths as detailed. Where the lap length cannot be determined, a minimum of 35 bar diameters lap length shall be provided.

Sheets of mesh or bar mat reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than one mesh in width.

5.8 Measurement and Payment

Steel reinforcement incorporated in the concrete will be measured in kilograms, based on the total computed mass for the size and length of bars as shown on the drawings or authorized by the Consultant.

The mass of bars will be calculated as follows:

Bar Designation	10M	15M	20M	25M	30M	35M	45M	55M
Mass (kg/m)	0.785	1.570	2.355	3.925	5.495	7.850	11.775	19.625

No allowance will be made for tie wire, chairs, and other material used in fastening the reinforcing steel in place. If bars are substituted upon the Contractor's request, and as a result more steel is used than specified, only the amount specified shall be included.

Payment for the supply of **plain reinforcing steel** and the supply of **epoxy-coated reinforcing steel** will be made on the basis of the unit price bid per kilogram acceptably supplied and delivered to the site. When the materials are delivered to the site, payments for the supply of **plain reinforcing steel** or **epoxy-coated reinforcing steel** will be made to a maximum of 90% of the cost of the materials based upon the unit price bid. Payment for the remainder of the price bid for supply will be made as the materials are acceptably installed. Payment for the placing of reinforcing steel will be made on the basis of the unit price bid per kilogram acceptably placed and remaining in the work, which price shall include full compensation for the cost of furnishing all labour, equipment, tools and incidentals necessary to complete the work.

Mesh reinforcement shall be supplied and placed by the Contractor, and its cost included with the tendered unit price for the relevant portion of the Contract.

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 6

STRUCTURAL STEEL

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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, splice plates, deck drains, structural bearings, anchor bolts, dowels, deck joint assemblies, buffer angles, connector angles, anchor bolt sleeves, curb and median cover, trough plates, pier nose plates, steel caps, capitals pier bracing and miscellaneous components.

6.2 Supply and Fabrication

A pre-fabrication meeting is required prior to commencement of fabrication of structural steel girders, trusses, finger plate deck joint assemblies or when any other specialized construction is included in the Contract. 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 Department/Consultant will conduct this meeting after the shop drawings have been approved and welding procedures have been reviewed. The Contractor shall provide two weeks notice to the Department/Consultant prior to the meeting.

6.2.1 Standards

Fabrication of structural steel shall conform to "The American Association of State Highway and Transport Officials (AASHTO), Standard Specifications for Highway Bridges" and the American Welding Society (AWS) - Bridge Welding Code, D1.5.

Where imperial/metric conversions are necessary, The National Standard of Canada, CAN3-Z234.1-79 shall be used as the basis of conversion.

All welding, cutting and preparation shall be in accordance with the AWS - Bridge Welding Code, D1.5.

6.2.2 Qualification

The Contractor shall notify the Department and 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 Canadian Welding Bureau (CWB) approval and right of access shall apply to the subcontractor.

The Fabricator shall operate a recognized steel fabricating shop accepted by the Consultant.

The Fabricator shall be fully approved by the CWB as per Canadian Standards Association (CSA) Standard W47.1 in the following Divisions:

Fabrication of steel girders, girder components and welded steel trusses……….Division 1
All other bridge components……….Division 2

Only welders, welding operators and tackers approved by the CWB in the particular category shall be permitted to perform weldments. Their qualifications shall be current and available for examination by the Consultant.

6.2.3 Engineering Data

6.2.3.1 Review of Plate Arrangement for Welded Plate Girders

Prior to the placing of material orders, the Contractor shall submit to the Department and Consultant for review and acceptance, three copies of sketch drawings showing the general description of the proposed fabrication scheme. This shall include the general arrangement of plates or shapes, the location of all shop and field splices and such other information as may be requested by the Department and Consultant to permit an assessment of the acceptability of the proposal.

6.2.3.2 Welding Procedures

Welding procedures shall be submitted for each type of weld used in the structure. The procedures shall bear the approval of the CWB and shall also be reviewed by the Department prior to use on the structure.

6.2.3.3 Shop Drawings

Five copies of the shop drawings showing all details shall be prepared by the Contractor and submitted to the Consultant for review and acceptance prior to fabrication. The shop drawings shall be legible and of adequate quality to be reproduced and microfilmed. Each drawing shall have a sufficient blank space for the Consultant's acceptance stamp. The Consultant's acceptance of the shop drawings shall not be construed as relieving the Contractor from his responsibility for errors or omissions. All shop drawings will be stamped as follows:

"This acceptance applies to general arrangements and details of design but not to dimensions or details of fabrication and is subject to the requirements of specifications and to such corrections as may be marked here on."

Fabrication shall not commence prior to the review and acceptance of the shop drawings.

In addition to specific details, the shop drawings shall include the following:

(a) Drawings showing details of connections designed by the Contractor shall bear the signature and stamp of a Professional Engineer registered in the Province of Alberta.

(b) All dimensions shall be correct at 20°C unless otherwise noted.

(c) Weld procedure identification shall be shown on the shop drawings in the tail of the weld symbols.

(d) All material splice locations shall be shown on the drawings.

(e) Bearings shall be centered at -5°C.

(f) Shop assembly drawings shall indicate camber and splice joint offsets measured to the top of top flange at a maximum spacing of 4 m.

(g) Alberta Transportation bridge file number and project name shall be shown on all the shop drawings.

6.2.3.4 Proposed Fabrication Sequence

Prior to commencement of fabrication, the Contractor shall present for review and acceptance an outline of the fabrication sequence that clearly describes the order of make-up and assembly of all the component parts, as well as shop assembly, inspection stations, and surface preparation.

6.2.3.5 Mill Certificates

Mill certificates shall be provided for all material before fabrication commences.

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. Interpretation of equivalent steels will be as per Appendix “A” of the CSA Standard G40.21 (1976 only). Mill certificate data 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.

6.2.4.2 Bolts

All bolts, nuts and washers shall conform to American Society for Testing and Materials (ASTM) Standard A325 or shall meet property class 8.8 of the Industrial Fasteners Institute for metric high strength structural bolts, nuts and washers. Metric bolts shall be marked with the symbol A325M and those of a “weathering” steel shall have the A325M symbol underlined. Metric nuts shall be marked with three circumferential lines with an “M” between two of them or shall be marked with a “3” if made of a weathering grade. Washers shall be identified as metric preferably by having an “M” indented in the surface or a “3” for weathering grades. Certified mill test reports for the fastener material shall be provided.

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.

6.2.4.4 Bearings

Certified mill test reports for all bearing material shall be provided prior to installation.

(a) Stainless Steel
Stainless Steel shall conform to the requirements of American Iron and Steel Institute (AISI) Standard Type 304, No. 8 Mirror Finish.

(b) Elastomer
Elastomer shall conform to Section 18 “Bearings” Division II of the AASHTO Standard Specifications for Highway Bridges 2002 edition. Elastomer compound shall conform to low temperature AASHTO grade 5 material testing requirements in Table 18.4.5.1-1A and -1B at the specified hardness.

(c) Teflon
Teflon shall be unfilled, 100% virgin polymer.

(d) Base Plate Corrosion Protection
Bearing base plate corrosion protection shall be as per section 12.2.6.8.

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. Flux cored welding or use of cored filler wires in the submerged arc process or shielding gas process are not considered as conforming to low hydrogen practice. These methods will not be permitted.

(a) Submerged Arc Welding (SAW)
Submerged arc welding process is allowed for all flat and horizontal position welds. All flange and web butt joints shall be made by an approved semi or fully automatic submerged arc process. All web to flange fillet welds and all longitudinal stiffener to web fillet welds shall be made by an approved fully automatic submerged arc process.

(b) Shielded Metal Arc Welding (SMAW)
Shielded metal arc welding is allowed for girder vertical stiffener to flange fillet welds and for miscellaneous components such as deck drains, bridge bearings, deck joint assemblies, pier nose plates and buffer angles.

(c) Metal Core Arc Welding (MCAW)
Metal core welding process utilizing low hydrogen consumables with AWS designation of H4 is allowed for vertical stiffeners and horizontal gussets of the girders and miscellaneous components such as deck drains, bridge bearings, deck joint assemblies, pier nose plates and buffer angles.

Field application of metal core arc welding is not allowed.

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.

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 welding over.

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 tab 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

Preheat requirements shall be performed and maintained 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 Methods of Weldment Repair

Repair procedures for unsatisfactory weldments shall be submitted for review and acceptance by the Department and Consultant prior to repair work commencing.

6.2.5.8 Arc Strikes

Arc strikes will not be permitted. In the event of accidental arc strikes, the Contractor shall submit to the Department and Consultant for review and acceptance a proposed repair procedure. The repair procedure shall include the complete grinding out of the crater produced by the arc strike. 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 butt welds shall be ground flush or to a specified slope on both sides. Web butt welds which are sufficiently smooth with a neat appearance and uniform profile as determined by the Consultant will not require grinding. Fillet welds not conforming to acceptable profile shall be ground to the proper profile without 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. 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 of 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 the flange butt welds.

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 the web butt welds.

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 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. Shearing is not allowed.

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 as stated by section 6.2.8.10. 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 Contractor shall report all blow backs or signs of lamination observed during the cutting of the material. The Consultant will perform Brinell hardness tests at random on the as is flame cut edge. If the hardness exceeds the requirements, the Contractor shall submit for review and acceptance, 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.

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

(a) Plate Girders
Shop assembly of girders shall be by the progressive assembly method according to AASHTO, except that only two, instead of three, sections need to be assembled. The detailed method of assembly, including points of support, dimensional checks, method of trimming to length, drilling and marking of splices, shall be to the procedure submitted and accepted by the Consultant as per section 6.2.3.4. 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 Department. No flame cambering will be allowed without prior acceptance and supervision of the Consultant. 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 call for 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.

(b) Box Girders
The progressive shop assembly for box girders shall be as per section 6.2.6.8(a), items described in this section are specific to box girders.

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.

(c) Drilling
All splices shall be drilled from solid material while assembled or shall be subpunched 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. These plates shall then be securely ship-bolted to the girders. The match marking system shall be shown on the drawings.

6.2.6.10 Bolt Holes

Clause 11.4.8 in Division II of AASHTO 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 subpunched 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 is allowed for material less than 16 mm thick. All holes in girder splices shall be circular and perpendicular to the member and shall be deburred to ensure a proper faying surface.

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:

(a) Combined Warpage & 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.

(b) 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.

(c) 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.

(d) 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.

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

(f) Bearing to Bearing Dimension
Bearing to bearing distance is a set dimension and therefore has no tolerance.

(g) Deck Joint Assemblies
Deck joint assemblies shall be assembled for inspection in a relaxed condition with erection angles removed. Acceptance of the assembly is required prior to application of the erection angles. Tolerances for straightness shall be considered over the length of the assembly between the crown and gutter line both before and after galvanizing. Deviation from straightness in a vertical plane shall not exceed ± 6 mm. Horizontal sweep or variations in gap setting shall not be greater than 3 mm.

6.2.6.12 Flange Corner Chamfer

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

6.2.6.13 Milling Tolerances

Tolerance for milled to bear stiffeners shall be 0.05 mm with at least 75% of the area in bearing.

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.

6.2.6.16 Flame Straightening

Flame straightening 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 stating location, temperatures and cooling rates, to the Department and the Consultant for review and acceptance.

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 Blast Cleaning

Unless otherwise noted, all steel components shall be blast cleaned after fabrication in accordance with the Society for Protective Coating Standard (SSPC) No. SP6. Essentially this is a surface from which all oil, grease, dirt, rust, foreign matter, mill scale and old paint have been completely removed except for slight shadows, streaks or discolorations caused by rust stain or mill scale oxide binder. The exterior face of the exterior girders shall be uniform in appearance as determined by the Consultant.

6.2.7.2 Galvanizing

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 A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware with additions and exceptions as described in this specification. The Fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatter and all welding flux residue from the steel components prior to galvanizing.

Repair of galvanizing shall only be done if bare areas are infrequent, small, and suitable for repair. A detailed repair procedure shall be submitted for review and acceptance prior to its use. It should be noted that repairs may require complete removal of the galvanized coating and regalvanizing. Repair shall be in compliance with ASTM A780, Method A3 Metallizing. The thickness of the metallizing 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.

6.2.8 Testing and Inspection

6.2.8.1 Access

The Contractor shall provide full facilities for the inspection of material and workmanship. Free access shall be allowed to the Consultant to all parts of the works. When required by the Consultant, the Contractor shall provide needed manpower for assistance in checking layout and performing inspection duties.

6.2.8.2 Testing by the Consultant

The visual, radiographic, ultrasonic, magnetic particle and any other inspection that may be specified or required will be performed by the Consultant or by his testing agencies at the Consultant's expense.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Consultant to inspect bridge girders and finger plate deck joints being fabricated outside the Province of Alberta. The cost shall also include for a Department's representative to attend the prejob meeting and three additional trips to oversee the inspection of girders during the course of fabrication. This requirement for attending the prejob meeting will also apply for the finger plate deck joint, however the additional trip requirement will be reduced to one for the Department's representative.

6.2.8.3 Testing by the Contractor

The exception to section 6.2.8.2 is that inspection made necessary for any repair work during the course of fabrication or handling, and additional unspecified material splices shall be paid for by the Contractor. Any test records made by the fabricating shop in the course of normal quality control shall be open to the Consultant for inspection.

6.2.8.4 Inspection Station

To insure that each stage of inspection is performed in an orderly manner, during the fabrication of major structures, Inspection Stations will be set up at specific points. Sub-assemblies of the work will then be checked by the Contractor, confirmed and tested by the Consultant, and all deficiencies shall be corrected, prior to the work being sent to the next stage of fabrication.

Typical check points for a plate girder are:

- 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.
- Clearance to ship.

6.2.8.5 Non-destructive Methods of Examination

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
- Hardness tests - ASTM Standard E-103

6.2.8.6 Radiographic Inspection Schedule

Unless otherwise noted, radiographic inspection of welded plate girders will be performed in accordance with the following schedule:

(a) 100% of all tension flange and stress reversal butt welds, all stiffener butt welds and all diaphragm butt welds, and any groove welded attachments to flange plates.

(b) A minimum of 25% of all other flange butt welds randomly selected by the Consultant for each structure. Additional testing may be required to ensure the quality of welds.

(c) All web butt welds in tension and stress reversal zones plus additional 300 mm of web butt weld in compression zone at the end of the web.

6.2.8.7 Radiographic Inspection of Miscellaneous Material

Unless otherwise noted, radiographic inspection of miscellaneous material will be performed by the Contractor in accordance with the following schedule:

(a) 100% of all tension members.

(b) 50% of all other members.

The radiographic inspection report and the film shall be provided to the Consultant within 48 hours of the completion of inspection.

6.2.8.8 Magnetic Particle Inspection Schedule

Unless otherwise noted, magnetic particle inspection of welded plate girders will be performed in accordance with the following schedule:

(a) 50% of the web to flange welds or any fillet welds placed on flange plates

(b) 10% of the web to stiffener welds

(c) 100% of the stiffener to flange welds

(d) 100% of the bearing sole plate to flange welds

(e) 20% of the diaphragm connector plate welds

6.2.8.9 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 butt welds after the removal of runoff tabs will be inspected using this method. Defects discovered by this inspection shall be repaired by the Contractor, and the suspect area re-inspected.

6.2.8.10 Hardness Tests

Hardness tests will be performed by the Consultant on the flame cut edges of the girder flange prior to assembly. Unless otherwise noted, the hardness of the flame cut edges shall not exceed a maximum Brinell as noted below:

(a) For carbon steels with a yield strength less than and including 300 MPa, the maximum Brinell shall be 200 BHN.

(b) For carbon steels with a yield strength 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.

6.2.8.11 Testing Stud Shear Connectors

Stud shear connectors shall meet all requirements as outlined by AWS D1.5. When bend testing, the studs shall be bent towards the centre of the girder.

6.2.8.12 Inspection Schedules

The Contractor shall ensure that adequate notice of scheduled inspection requirements be given to the Consultant and inspection agencies, and that access to the work is provided at all times. The Contractor shall provide the Consultant with his sequence of fabrication in order that the inspection program can be properly integrated and agreed to, prior to commencement of fabrication.

6.2.8.13 Testing of Deck Joint Strip Seal

The installation of strip seal shall be tested by the Contractor in the presence of the Consultant for leakage. The failed areas shall be corrected and retested. The defective or torn seal shall be replaced at the Contractor's expense.

6.2.8.14 Notification

The Contractor shall notify the Consultant 48 hours prior to contemplate shipment to facilitate final inspection of the materials. Material that has not been inspected in the fabrication plant will not be paid for until such material has been inspected and accepted. The Contractor may be charged with all expenses incurred for inspection of the material at the site.

6.3 Structural Steel Erection

The Contractor shall erect the structural steel, remove any temporary construction and do all work required to complete the erection in accordance with the drawings and these specifications. No drilling of additional holes or any other modifications including field welding shall be made to steel elements other than deck joints. Lifting devices shall not be welded to the girders. The Contractor shall not erect the structural steel until the substructure concrete has been cured a minimum of three days and achieved 80% of the 28 day specified concrete strength requirement. Without restricting generality, erection includes:

- placing of anchor bolts and bearings
- erecting of temporary supporting structures
- erecting of structural steel
- placing of expansion assemblies
- grouting of anchor bolts
- placing and sealing of grout pads
- touching up painting as required

6.3.1 Transportation, Handling and Storing Materials

Girders and beams shall be transported in the vertical position. However these elements may be transported in other positions provided:

- A Professional Engineer registered in the Province of Alberta performs the analysis and provides a written statement that the proposed method will not damage the elements.

- Upon arrival at the site and prior to erection, the elements shall be checked by the Contractor in the presence of the Consultant to ensure all tolerances are met. The Contractor shall provide an adequate flat storage area for the inspection.

Any structural steel member damaged during transportation, handling, storing or erection shall be immediately reported to the Department and the Consultant. The Contractor shall provide an engineering assessment report prepared by a Professional Engineer experienced in evaluation and inspection of damaged steel members.

The Consultant will also arrange to have an independent inspection and assessment performed on the damaged member. The Contractor shall provide at least three working 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, and stored in a properly drained area. Girders and beams shall be placed upright and shored. Long members, such as deck joint assemblies, buffer angles, columns and chords, shall be supported on timber blocking to prevent damage from deflection. Galvanized material shall be handled and stored as per section 12.2.8.

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 water. The Contractor shall prepare and submit drawings for the Consultant's review and acceptance for temporary supporting structures and berms where applicable. Acceptance of the Contractor's drawings shall not be considered as relieving the Contractor of any responsibility. All drawings submitted shall bear the seal of a Professional Engineer registered in Alberta.

Temporary supporting structures and/or berms will not be permitted to remain in any stream channel during spring breakup or runoff periods, unless all necessary approvals have been obtained from pertinent agencies and prior written acceptance obtained from the Consultant.

Repair to any damage to property, such as earth fills and stream banks, resulting from the existence of berms, shall be the responsibility of the Contractor.

6.3.2.2 Review of Erection Procedure

The Contractor shall submit to the Consultant, for record purposes and for examination four copies of the detailed erection procedure four weeks in advance of the scheduled start of erection. The erection procedure shall include all drawings and documents necessary to describe the following:

(a) Traffic Accommodation Strategy (TAS), as applicable.

(b) Access to work, earth berms and work bridges.

(c) Type and capacity of equipment. Cranes shall be used for handling and erecting structural steel girders.

(d) Sequence of operation including position of cranes, trucks with members.

(e) Position of cranes relative to substructure elements such as abutment backwalls, with details of load distribution of wheels and outriggers.

(f) Lifting devices and lifting points.

(g) Details of temporary works, supporting structures drawings including proposed methods to be used to ensure the required splice elevations and structure shape prior to bolt torquing, method of providing temporary supports for stability, top of girder elevations at each bearing and each splice location where appropriate.

(h) Bolt tightening sequence.

(i) Grout Pad Construction. Refer to section 6.3.2.10 of these Specifications.

(j) Details of release of temporary supporting structures.

(k) Provide an "As-Constructed" detailed survey of the substructure showing the following:
- location and elevation of all bearing grout pad recesses including anchor bolt voids,
- shim height at each bearing location,
- top of girder elevations at each bearing and each splice location where appropriate.
- longitudinal measurements between centreline of bearings of all substructure elements.

The erection procedure shall bear the Seal of a Professional Engineer registered in Alberta, who shall assume full responsibility to ensure that his erection procedure is being followed. Safety and compliance with the Occupational Health and Safety Act and Regulations thereunder, shall be an integral part of the design.

The Contractor shall continue to 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.

Site work shall not commence until acceptance of the proposal by the Consultant has been obtained. The Contractor's project manager and field superintendent may be required to attend a pre-job meeting at a location determined by the Consultant prior to commencement of any field work.

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.

Before erection begins the Contractor shall do a complete superstructure layout by means of chalk lines and markings applied to all substructure units, showing bearing and girder positions in accordance with the contractor's accepted layout plan.

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.

6.3.2.4 Bearings and Anchorage

Masonry bearing plates shall not be placed upon bridge seat bearing areas which are improperly finished, deformed or irregular. Bearing plates shall be set level in their exact position.

The Contractor shall remove anchor bolt void forming materials, and accurately set the anchor bolts, except where the bolts were cast into the concrete. Any residues on the concrete surfaces, such as oils, grease or other contaminants, shall be removed by sandblasting. All methods and materials for setting anchor bolts and constructing bearing pads shall be subject to the Consultant's review and acceptance. The location of the anchor bolts, in relation to the slotted holes in the expansion shoes, shall correspond with the temperature at the time of erection. The nuts on the anchor bolts, at the expansion ends of spans, shall be adjusted to permit free movement of the spans.

When steel bearings are employed in conjunction with grout pockets in the substructure, the bearings shall be set accurately on galvanized steel shims, and grouted as detailed on the drawings, after the girder erection has been completed. The shims must be located so that a minimum of 75 mm grout coverage is provided. When grout pockets are not detailed, the bearing plates shall be set on the properly finished bearing areas in exact position and shall have a full and even bearing on the concrete.

When required, field welding adjacent to elastomeric pads shall be performed with care to avoid damage to the Elastomer. The temperature of the steel adjacent to the Elastomer should be kept below 120°C. The distance between the weld and the Elastomer should be at least 40 mm.

6.3.2.5 Straightening Bent Material

Straightening of plates, angles or other shapes will not be permitted without the acceptance of the Department and Consultant. In all cases a detailed procedure in writing must be submitted by the Contractor, and accepted prior to any straightening being undertaken.

Following the accepted straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fractures, which may include nondestructive testing. All costs shall be the responsibility of the Contractor.

6.3.2.6 Assembly

The parts shall be accurately assembled as shown on the drawings and all match-marks shall be followed. The material shall be carefully handled to avoid damage. Hammering, which will injure or distort the members, shall not be permitted. Bearing surfaces and surfaces to be in permanent contact shall be clean before the members are assembled.

Splices and field connections shall have one half 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 three-fourths of the holes filled.

Fitting-up bolts shall be of the same nominal diameter as the bolts, and cylindrical erection pins shall be sized to accurately fit the holes.

Should adjustments in elevation of the girder splices become necessary, to allow free rotation of the joint, only enough pins or bolts shall be removed.

6.3.2.7 High-Tensile-Strength Bolted Connections

(a) 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. 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 and on the bottom faces of lower flanges unless otherwise noted. 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. 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.

All girders shall be erected with elevations and alignments checked by the Consultant, prior to any bolt tightening unless otherwise accepted by the Department and the Consultant.

(b) 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 the following table for the size of bolt used:

Table 1 BOLT TENSION

Specified Bolt Size (A325M Bolts)	Minimum Bolt Tension		Commonly Supplied Equivalent Imperial Size (A325 Bolts)	Minimum Bolt Tension	
	Kilonewtons	pounds-force		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

(c) 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. 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

Notes
- tolerance 1/6 turn (60°) over, nothing under
- length of bolt measured from underside of head

(d) 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.

(e) 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.

6.3.2.8 Misfits

The correction of minor misfits involving any reaming, cold cutting and chipping for secondary members may be allowed. However, if reaming is considered required, it shall be immediately reported to the Department and the Consultant. The Contractor shall submit a repair procedure to the Consultant for review. If accepted, the repairs shall be made in the Consultant''s presence.

6.3.2.9 Girder Adjustment

It is essential that the girders are erected with utmost attention being given to girder positioning, alignment, and elevation. Adjustment to girder position, bearing location and bearing elevation shall be done in order to achieve as closely as possible the lines and grades shown on the drawings.

The Contractor shall ensure that the structural steel is maintained in correct alignment until the adjoining or encasing concrete components have been completed.

6.3.2.10 Grout Pockets and Grout Pads

The Contractor shall fill the grout pockets and construct the grout pads using Sika 212 flowable grout or approved equivalent. Filling of grout pockets and construction of grout pads shall be done by workers competent in this work.

Grout shall be packaged in waterproof containers with the production date and shelf life of the material shown. It shall be mixed, placed, and cured in strict accordance with the manufacturer's recommendations.

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.

Sealer shall be supplied and applied to the exposed grout pad surfaces in accordance with section 4.25 “Type 1c Sealer”.

6.3.2.11 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 falls below 5°C, the following provisions for cold weather grouting shall be effected:

(a) 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 10°C.

(b) Temperature of the grout during placing shall be between 10°C and 25°C.

(c) The grout pads (or girders where appropriate) shall be enclosed and kept at 10°C to 25°C for at least five days. The system of heating shall be designed to prevent excessive drying-out of the grout.

6.3.2.12 Removal of Temporary Supporting Structures, Berms, and Clean-Up

Upon completion of the erection and before final acceptance, the Contractor shall remove all earth material or temporary supporting structures placed in the stream channel or elsewhere during construction. He 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 neatly restored and presentable condition, satisfactory to the Consultant. When required, he shall provide written evidence that affected property owners or regulatory agencies have been satisfied.

All steel shall be left clean and free of oil, grease, mud, dust, road spray or other foreign matter.

6.4 Payment

Supply of Structural Steel Girders and Associated Material will be paid for on the basis of the lump sum price bid. Items to be included in **Supply of Structural Steel** shall be as listed in the Special Provisions.

Supply and Delivery of Bearings will be paid for on the basis of the lump sum price bid. Items to be included in **Supply of Bearings** shall be as listed in the Special Provisions.

Installation of Bearings including grouting will be paid for on the basis of the lump sum price bid. Items to be included in **Installation of Bearings** shall be as listed in the Special Provisions.

Supply and Delivery of Deck Joint Assemblies will be paid for on the basis of the lump sum price bid. Items to be included in **Supply of Deck Joint Assemblies** shall be as listed in the Special Provisions.

Installation of Deck Joint Assemblies will be paid for on the basis of the lump sum price bid. Items to be included in **Installation of Deck Joint Assemblies** shall be as listed in the Special Provisions.

Payment for **Delivery of Girders** will be made on the basis of the lump sum price bid. It shall include full compensation for the costs to deliver all structural steel and associated materials to the bridge site, and shall include the costs to obtain the necessary approvals and permits from the Motor Transport Board and/or the appropriate local road authorities to transport these materials. Payment for **Delivery of Girders** shall also include the costs to remove all road dirt and spray.

Payment for **Erection of Girders** will be made on the basis of the lump sum price bid which price shall include full compensation for the cost of furnishing all labour, tools, equipment, and incidentals necessary to acceptably erect the structural steel and complete site clean-up.

When materials are delivered to the work site, payments for:
Supply of Structural Steel girders and Associated Materials,
Supply and Delivery of Bearings,
Supply and Delivery of Deck Joint Assemblies, and
Delivery of Girders
will be made to a maximum of 90% of the bid price of the materials and delivery. Payment for the remainder of the prices bid for supply and delivery will be made as the materials are acceptably installed.

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 7

PRECAST CONCRETE UNITS

TABLE OF CONTENTS

7.1 General

This specification is for the supply, manufacture, delivery and erection of prestressed and precast concrete bridge units and miscellaneous precast components.

7.2 Supply and Manufacture

A pre-fabrication meeting is required prior to commencement of fabrication of precast concrete elements. 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 Department/Consultant will conduct this meeting after the shop drawings have been approved. The Contractor shall provide two weeks notice to the Department/Consultant prior to the meeting.

7.2.1 Standards

The manufacture of prestressed and precast concrete bridge units shall be in accordance with The Canadian Standards Association (CSA) Standard A23.4.

Where imperial/metric conversions are necessary, The National Standard of Canada, CAN3-Z234.1-79 shall be used as the basis of conversion.

7.2.2 Qualification

The Contractor shall notify the Department and 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 the subcontractor.

The fabricator shall operate a recognized precast concrete fabricating plant and be fully certified by the Canadian Precast/Prestressed Concrete Institute (CPCI) Certification Program.

7.2.3 Engineering Data

7.2.3.1 Shop Drawings

Five copies of the shop drawings showing all necessary fabrication details of the precast units, such as reinforcing steel, blockouts, stressing system, anchorage devices, void support system and screed rail shall be submitted to the Consultant for review and acceptance prior to manufacturing. The shop drawings shall be legible and of adequate quality to be reproduced and microfilmed. Each drawing shall have a sufficient blank space for the Consultant's acceptance stamp. The Consultant's acceptance of the shop drawings shall not be construed as relieving the Contractor from his responsibility for errors or omissions. All shop drawings will be stamped as follows:

"This acceptance applies to general arrangements and details of design but not to dimensions or details of fabrication and is subject to the requirements of specifications and to such corrections as may be marked here on."

Fabrication shall not commence prior to the acceptance of the shop drawings.

Alberta Transportation bridge file number and project name shall be shown on shop drawings.

7.2.3.2 Stressing Calculations

Four copies of the stressing calculations showing elongations and gauge pressures as well as the strand release sequence data shall be submitted to the Consultant for review and acceptance prior to manufacturing. Jack calibrations, performed within the previous six months, shall be included.

7.2.3.3 Stressing Steel Certificate

A copy of the load/elongation curve for each lot of stressing steel shall be submitted to the Consultant for acceptance prior to manufacturing.

7.2.3.4 Concrete and Grout Mix Design

A copy of the concrete mix design and the grouting mortar mix design shall be submitted to the Consultant for acceptance prior to manufacturing. The mix design shall indicate the design strength, proportions of the constituent materials, type and brand of cement, type and brand of silica fume, origin of aggregates and brand names of all admixtures.

The sampling and testing of aggregates, and the concrete mix design shall be completed by an independent CSA certified and qualified concrete testing laboratory which shall have a permit to practice in the Province of Alberta. Concrete mix designs including sampling and testing of aggregates may be completed by the concrete supplier, with the condition that documentation is stamped by a Professional Engineer registered in the Province of Alberta. For either situation, the mix design, including sampling and testing, shall be reviewed and stamped for compliance with the respective specifications by an independent CSA certified and qualified concrete testing laboratory having a permit to practice in the Province of Alberta. For either case, the testing laboratory shall provide an engineering opinion that the concrete aggregate and mix designs are suitable for the intended use and are expected to perform to specified standards.

The mix design shall include one microscopic air-void analysis performed by an independent 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 accepted mix design shall be used to cast units. Changes in cement type, and/or decreasing cement content shall be construed as a change in mix design and will not be allowed.

7.2.3.5 Other Data

The Consultant may request test data to prove conformance to the standards for other materials including cement, silica fume, aggregate and admixtures.

7.2.3.6 Construction Data Sheets

During manufacture, the Construction Data Sheets shall be kept up to date and available for the Consultant's inspection. Copies of the data sheets shall be provided to the Consultant upon completion of the contract. One copy of the stressing data sheets for each bridge unit shall also be submitted with the Construction Data Sheets.

7.2.4 Materials

7.2.4.1 Cement

Hydraulic cement conforming to the requirements of CSA Standard A3001 shall be used.

7.2.4.2 Water

Water to be used for mixing concrete or mortar shall conform to the requirements of CSA Standard A23.1 and shall be free from injurious amount of alkali, organic materials or deleterious substances. The Contractor shall not use water from shallow, stagnant or marshy sources.

7.2.4.3 Silica Fume

10% condensed silica fume by weight of cement (± 0.5%) shall be used in all precast concrete. Condensed silica fume shall conform to the requirements of CSA Standard A3001 for a Type SF supplementary cementing material, with a SiO_2 content of at least 85%, a maximum loss on ignition of 10% and no more than 1% SO_3 content. An acceptable, compatible, superplasticizing admixture shall be used together with the silica fume.

7.2.4.4 Aggregates

Aggregate tests shall be performed and submitted to the Consultant for review with the concrete mix design as per section 4.4.4.

(a) Standard Weight Aggregates
Fine and coarse standard weight aggregates shall conform to the requirements of CSA Standard A23.1, with maximum aggregate size of 14 mm.

(b) Lightweight Aggregates
Fine and coarse lightweight aggregates shall conform to the requirements of the ASTM Standard C330, with maximum aggregate size of 14 mm.

7.2.4.5 Air Entraining Agent

Air entraining agent shall conform to the requirements of the ASTM Standard C260.

7.2.4.6 Chemical Admixtures

Chemical admixtures shall conform to the requirements of ASTM Standard C494 and shall be accepted by the Consultant. All chemical admixtures must be suitable for use in precast concrete, be supplied by the same manufacturer as the air entrainment agent, and be compatible with each other. The addition of calcium chloride, retarders, accelerators or set controlling admixtures and air reducing agents will not be permitted.

Acceptable admixtures are air-entraining agents, superplasticizers and water-reducing agents.

7.2.4.7 Concrete

Concrete shall consist of hydraulic cement, condensed silica fume, aggregates, water and acceptable admixtures. The type of concrete to be used will be specified on the drawings.

The density, entrained air and air void spacing requirements for the various types of concrete are specified in Table 7.1.

Table 7.1

Type of Concrete	**Aggregates**	**Concrete Unit Weight (in plastic state) kg/m^3**	**Minimum Entrained Air %**	**Maximum Air Void Spacing (hardened concrete) mm**
Standard Weight	Fine and Coarse Standard Weight	--	5	0.23
Lightweight	Fine and Coarse Lightweight	1680 ± 5%	6	0.23
Semi-Lightweight	Fine Standard Weight & Coarse Lightweight	1920 ± 5%	6	0.23

7.2.4.8 Reinforcing Steel

Plain and epoxy coated reinforcing steel shall conform to the Bridge Construction Specifications – Section 5 - Reinforcing Steel.

7.2.4.9 Stressing Strand

Stressing strand shall be uncoated Grade 1860, low relaxation 7-wire strand conforming to the requirements of the ASTM Standard 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

Lifting hooks made of stressing strand shall conform to the requirements of the ASTM Standard A416, and shall be fabricated in a manner that distributes the load evenly to all strands.

7.2.4.11 Miscellaneous Steel

Miscellaneous steel shall conform to the requirements of the CSA Standard CAN/CSA G40.21M-300W or ASTM Standard A36 or as specified on the drawings. The Consultant may request the Contractor to provide mill certificates to prove conformance to the standard. Fabrication shall conform to the Bridge Construction Specifications - Section 6 - Structural Steel.

7.2.4.12 Bridgerail and Anchor Bolts

Bolts for bridgerail anchor assemblies shall be as per section 12.2.4.2. The assemblies shall be hot dip galvanized after fabrication. All nuts and washers shall be shop assembled on the anchor bolts.

7.2.4.13 Voids and Ducts

All void and duct material must be accepted by the Consultant and remain dimensionally stable during the casting and steaming of the units. Voids shorter than 400 mm should be eliminated except when noted otherwise on the drawings.

7.2.4.14 Bearings

Certified mill test reports for all bearing material shall be provided prior to installation.

(a) <u>Stainless Steel</u>
Stainless Steel shall conform to the requirements of American Iron and Steel Institute (AISI) Standard Type 304, No. 8 Mirror Finish.

(b) <u>Elastomer</u>
Elastomer shall conform to Section 18 “Bearings” Division II of the AASHTO Standard Specifications for Highway Bridges 2002 edition. Elastomer compound shall conform to low temperature AASHTO grade 5 material testing requirements in Table 18.4.5.1-1A and -1B at the specified hardness.

(c) <u>Teflon</u>
Teflon shall be unfilled, 100% virgin polymer.

(d) <u>Base Plate Corrosion Protection</u>
Bearing base plate corrosion protection shall be as per section 12.2.6.8.

7.2.4.15 Galvanizing

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 A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware with additions and exceptions as described in this specification. 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.

Repair of galvanizing shall only be done if bare areas are infrequent, small and suitable for repair. A detailed repair procedure shall be submitted and accepted prior to its use. It should be noted that repairs may require complete removal of the galvanized coating and regalvanizing. Repair shall be in compliance with ASTM A780, Method A3 Metallizing. The thickness of the metallizing 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.

7.2.5 Manufacture

7.2.5.1 Forms

Precast concrete units are to be manufactured in steel forms accepted by 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, placement and fastening of all steel reinforcement shall conform to the Bridge Construction Specifications - Section 5 - Reinforcing Steel.

Reinforcement shall be placed, secured and inspected for acceptance by the Consultant prior to placement of concrete.

7.2.5.3 Stressing Strand

Stressing strand shall be free of corrosion, dirt, grease, rust, oil or other foreign material that may impede bond between the steel and the concrete. Stressing strand shall be protected at all times from manufacture to encasing in concrete or grouting. Stressing strand that has sustained physical damage at any time shall be rejected. Stressing strand splices shall not be placed within a precast concrete unit.

The Contractor shall submit for review and acceptance the methods, procedures and devices to accurately position the stressing strand. The submission shall include strand anchorage, draping, hold downs, guides or any other required devices.

Stressing strands shall not be stressed more than 36 hours prior to being encased in concrete. The stress in the stressing strands shall be measured both by jacking gauges and by elongation of the strands. The maximum allowable discrepancy between jack pressure and elongation shall be within 5%, or the factors contributing to the difference must be identified and corrected before proceeding. Changes in strand temperature and slippage at strand anchorages shall be measured between stressing and concrete encasement and any changes in strand stress due to these effects shall be accounted for in the design.

Seven wire stressing strand with any broken wire shall be removed and replaced. All stressing strands shall be checked for wire breaks before placement of concrete.

The precast unit ends shall have 15 mm deep strand termination recesses formed around the strands. All strands shall be cut flush with the bottom of the recesses, and the recesses shall then be cement mortar grouted flush with the ends of the precast units. An approved Type 1c sealer shall be applied over the patched recessed areas as per section 7.2.5.14. Sealer shall not be applied to the patched recessed areas when precast unit ends are designed to be encased in field cast concrete.

The Contractor shall be responsible for recording and reporting the elongation, and tension of each strand during the stressing operation.

7.2.5.4 Void and Duct Placement

Voids and ducts 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.

7.2.5.5 Identification of Units

Fabricator’s name, year of manufacture, unit serial number and design loading shall be cast into the bottom of the units in 50 mm letters about 1.0 m from the unit end.

7.2.5.6 Concrete Measuring, Mixing and Placing

The procedures outlined in the 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 elapsed time between the successive placing of concrete onto previously placed concrete shall not exceed 45 minutes.

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 employed. 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 midpoint 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 riding 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 midpoint of each girder within 24 hours of girder destressing.

7.2.5.10 Concrete Finish

The exterior concrete girder faces shall have a Class 2 Rubbed Surface Finish, unless specified otherwise. Except the top, all the remaining surfaces shall have a Class 1 Form Surface Finish.

(a) Class 1 Form Surface Finish
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 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.

(b) 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 wire brushed to expose any hole or cavity prior to repairs. All residue of form oil shall be removed from the surface.

(c) 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 painted adjointing surfaces. Acceptance of the pigmented sealer used will not be considered to relieve the Contractor of full responsibility for its acceptable performance and appearance.

(d) 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.

(e) 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 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 prestressed concrete units shall be cured at an elevated temperature. The curing of prestressed 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 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 temperature of the outside air.

Care must be exercised to protect prestressed and non-prestressed concrete units from thermal shock at all times until these units have been fully cured.

(a) Prestressed Concrete

(i) 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 two to four 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.

(ii) Steam Curing after Removal from the Form

Upon removal from the forms the units shall be cleaned, patched, finished within a period not exceeding 12 hours. The 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 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℃ at any time.

The curing process shall be continued for a period of four days with one of the following methods:

1) Steam Curing
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℃ to 60℃.

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 count 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. The enclosure shall be heated with radiant heaters to a temperature of 40℃ to 60℃. 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 90% in the enclosure. Should the temperature in the concrete rise above 40℃ without the misting, the unit will be rejected.

Two continuously recording thermometers and two continuously recording hygrometers are to 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.

(b) Non-Prestressed Concrete

Curing of all non-prestressed concrete shall be in accordance with one of the following methods:

(i) Elevated Temperature Curing

Upon removal from the forms the units shall be cleaned, patched, finished and elevated temperature cured for four days as per section 7.2.5.11(a) “Prestressed Concrete”.

(ii) Moist Curing

The units may be moist cured in lieu of elevated temperature curing in accordance with the following:

Upon removal from the forms the 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 15°C to 30°C. After completion of patching and finishing, within 24 hours of removal from the form, the units shall be placed under two layers of light colored filter fabric or burlap 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 Department. Curing with filter fabric or burlap and water shall be maintained for a minimum period of seven days.

7.2.5.12 Release of Stressing Strand

The stressing 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 strands.

7.2.5.13 Repairing Damaged Concrete

Serious damage, honeycomb and other casting defects shall be immediately reported to the Department and Consultant. Repair procedures shall be developed by a Professional Engineer and submitted for review and acceptance by the Department and Consultant prior to the commencement of the repair. All repairs shall be completed prior to curing of the unit at an ambient temperature of 15°C to 30°C.

Repairs to defects such as cracks, honeycombs or spalls shall be carried out in accordance with this section. Any unacceptable cracks, honeycombs or spalls will result in rejection of the unit.

In this section the "bearing area" of a girder is defined as the portion of the girder bottom flange up to the underside, but not including the radiused transition between the bottom flange and the web, directly above the bearing. The bearing area extends from the end of the unit to 75 mm beyond the edge of the shoe plate. 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.

(a) Cracks

The following cracks are unacceptable and may result in rejection of the 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.
- Cracks outside of the girder bearing and anchorage areas exceeding 0.2 mm or longer than 300 mm.

All cracks 0.2 mm or greater in width shall be repaired by epoxy injection in accordance with the manufacturer's instructions. 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.

(b) Honeycombs and Spalls

The following conditions of honeycomb or spall are unacceptable and may result in rejection of the unit unless accepted and signed off by the Design Engineer and reviewed by the Department:

- Any honeycombs or spalls in the bearing or anchorage areas of the girder
- Major honeycomb or spall in areas outside the bearing and anchorage areas of a girder. Major honeycombs and spalls are described as honeycombs and spalls that are more than 30 mm deep or more than 0.1 m^2 in area.

When accepted by the Consultant and the Department, repairs for honeycombs and spalls may be made using a cementitious material. Repairs of minor honeycombs and spalls may be made after destressing of the girder. However major honeycombs and spalls shall be repaired before destressing the girder.

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 Drawing S-1637 "Type 1c Sealer for Precast Girders" included with these specifications.

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 list. Before applying the sealer the concrete shall be cured for at least 14 days. Mortar patches shall be cured for at least two 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 concrete surfaces in shear key, block out, diaphragm and girder end void locations shall be sandblast roughened by the Contractor to the acceptance of the Consultant. The blasting shall be sufficient to remove all laitance and uniformly expose the aggregate particles.

7.2.5.16 Dimensional Tolerances of Cast Units

The maximum dimensional deviation in mm, of cast units from that as detailed 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	
Top of Girder	± 12 mm
Bearing Areas	out of flatness of bearing areas, 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
Void Location	surface to void dimension, ± 15 mm after casting

7.2.5.17 Handling and Storage

Precast units shall be handled by means of accepted lifting devices at designated locations. 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 the Consultant with suitable and safe access to the works for the purposes of testing and inspection. The Contractor shall provide the following:

(a) Heated laboratory space, minimum of 3 m x 3 m, capable of being locked, located in the proximity of the work

(b) A work bench 1 m x 3 m x 1 m high

(c) Cylinder storage chest with temperature control and a max/min thermometer, as per CSA Standard A23.2-3C

(d) A sump and a water supply suitable for cleaning all testing equipment

(e) A calibrated weigh scale.

7.2.6.2 Inspection

The Contractor shall be responsible for quality control. Inspection of the units by the Consultant will not relieve the Contractor of his responsibility for quality control.

The following stages of manufacturing require the Consultant's acceptance:

(a) Form dimensions and set-up
(b) Placement of reinforcing steel
(c) Placement of voids and hardware
(d) Stressing
(e) Concrete mixture and placement
(f) Form stripping
(g) Clean-up and repair
(h) Finishing and application of sealer
(i) Curing
(j) Application of Class 3 finishes
(k) Storage of units

7.2.6.3 Test Methods

Sampling, making, curing and testing concrete specimens shall be 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
- Air Void Determination - A23.2-17C

7.2.6.4 Testing by the Contractor

The Contractor shall provide testing equipment, facilities and personnel to ensure that the concrete supply meets all requirements of the specifications. He shall maintain the required air entrainment by testing and making adjustments to the mix prior to and during the placing of concrete in the forms. The Consultant may test the air content to ensure that this is being correctly maintained however testing of concrete by the Consultant will not relieve the Contractor of his overall responsibility for control of the quality of concrete.

7.2.6.5 Release Strength Test Cylinders

The Contractor shall make and test concrete cylinders to prove that the required release strength as stated on the drawing has been attained prior to release of the stressing strand. When one or more units are cast continuously, at least two cylinders shall be taken from the concrete of the last unit poured to represent the release strength for all units. These cylinders shall be cured with the bridge unit. Only testing of the first cylinder will be necessary if the required release strength is obtained. In the event all cylinders are tested without the required strength being obtained, the Consultant shall be contacted and his acceptance obtained for the release of the units.

7.2.6.6 28 Day Strength Testing

The Contractor shall make 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 bridge 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. The transportation and testing of concrete test cylinders will 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.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Consultant to inspect prestressed and precast concrete bridge units and miscellaneous precast components being fabricated outside the Province of Alberta. Also included shall be the costs for a department representative to attend the prejob meeting and three additional site visits during the course of fabrication.

7.2.6.7 Fabrication of Prestressed/Precast Units in Cold Weather

The Contractor shall accept full responsibility for the protection of prestressed/precast concrete units when fabricating in adverse weather conditions.

When the ambient temperature is, or is expected to be, below 5°C during fabrication the following provisions for cold weather casting shall be put in place:

(a) The Contractor shall construct an enclosure capable of maintaining an ambient temperature within the structure of between 15°C and 30°C. The enclosure shall be sufficiently sized to accommodate steel forms, workers and the casting equipment. The enclosure temperature shall be constantly monitored and shall be maintained within the specific range.

(b) The heating system shall be designed to provide uniform distribution of heat and the combustion by-products shall be kept out of the enclosure.

(c) Before casting concrete, adequate preheat shall be provided to raise the temperature of the formwork, reinforcing steel, stressing strand, miscellaneous iron, etc. to at least 10°C.

(d) The fabricated units shall be kept in the enclosure until they are patched, repaired and transferred to the curing enclosure.

7.2.7 Failure to Meet Strength Requirements

7.2.7.1 Right of Rejection

The Consultant reserves the right to reject any concrete whatsoever which does not meet the specified strength determined in accordance with this Specification. The Consultant may, however, at his discretion, accept concrete which does not meet the specified strength requirements, and in such case payment will be made in accordance with section 7.2.7.2.

7.2.7.2 Percentage Payment Schedule

When the specified 28-day concrete strength is not met, the precast bridge unit shall be paid as per the following percentage of the unit price:

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 bridge units fabricated from the concrete represented by the test specimens shall be rejected. In the event that the 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.

7.2.7.3 Coring

If any concrete tested fails to meet the specified strength, the Contractor may request permission to core. If the coring is accepted by the Consultant, the Contractor shall make arrangements, through the Consultant, to employ an independent, qualified testing service, at the Contractor's expense.

The Consultant will specify the location of the coring to ensure that the cores represent the same concrete as the cylinders. The average of three adjacent cores taken from one bridge unit shall constitute a test. The cores shall be taken and tested in accordance with CSA Standard A23.2- 14C within seven days of the date of testing the 28-day cylinders. The core test will represent all bridge units represented by the strength test. Alternatively, the Contractor may choose to take a core test from each of the other units in question, in which case each of these core tests will then represent a bridge unit.

Where the concrete strength as indicated by the cores is higher than the strength based on the 28-day concrete cylinder tests, the core results shall be used as the basis for acceptance and payment of the concrete. If the core strengths are lower than the strength of the 28-day concrete strength cylinder tests, the cylinder tests shall govern.

7.3 Erection of Precast Concrete Girders

7.3.1 General

The Contractor shall erect the girders, remove any temporary construction, and do all work required to complete the erection in accordance with the drawings and these specifications. Drilling, coring or the installation of any fasteners or anchoring systems or any other modifications shall not be made to the concrete elements. 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 requirements.

Without restricting generality, erection includes:

- removing anchor bolt grout can lid
- placing and grouting anchor bolts and bearings
- erecting the girders
- placing and grouting of connector bolts and diaphragms
- post-tensioning
- placing and sealing grout bearing pads
- cutting-off lifting hooks, and grouting lifting holes on exterior girders and all lifting hook pockets

7.3.2 Handling and Storing Materials

Precast concrete units to be stored shall be placed upright and shored on timber blocking and kept clean and properly drained.

7.3.3 Temporary Supporting Structures and Berms

The temporary supporting structures and berms shall be properly designed and substantially constructed and maintained for the forces which may come upon them. 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 water. The Contractor shall prepare and submit to the Consultant, for review and acceptance, drawings for temporary supporting structures and berms, and for traffic control and accommodation where applicable. Acceptance of the Contractor's drawings shall not be considered as relieving the Contractor of any responsibility. All drawings submitted shall bear the seal of a Professional Engineer registered in Alberta.

Temporary supporting structures and/or berms will not be permitted to remain in any stream channel during spring break-up or run-off periods, unless all necessary approvals have been obtained by the Contractor from pertinent agencies.

Incidental damage to other property, such as fills and stream banks, resulting from the existence of berms, shall be the responsibility of the Contractor.

7.3.4 Review of Erection Procedure

The Contractor shall submit to the Consultant, for record purposes and for examination as to concept only, four copies of a detailed erection procedure three weeks in advance of the scheduled start of erection. The erection procedure shall include all drawings and documents necessary to describe the following:

(a) Access to work, earth berms and work bridges.

(b) Type and capacity of equipment. Cranes shall be used for handling and erecting precast concrete units.

(c) Sequence of operation, including position of cranes, trucks with girders, and traffic accommodation.

(d) Detailed crane position on the ground, particularly adjacent to substructure elements, such as abutment backwalls, with details of load distribution on wheels and outriggers.

Details of crane position on the structure, showing wheel loads and axle spacing of equipment moving on structure.

(e) Loads and their position from crane wheels and outriggers during all positions of lifting when crane is on structure.

(f) Details of temporary works, supporting structures drawings, including proposed methods to be used to ensure the required splice elevations and structure shape prior to placing concrete, and/or post-tensioning and method of providing temporary supports for stability.

(g) Details of lifting of units, showing vertical forces at lifting hooks.

(h) Provisions for control and adjustment of errors for width and positioning of curbs or exterior units.

(i) Complete details of blocking for bearings where necessary to constrain movements due to horizontal forces and/or gravity effects.

(j) Details of post-tensioning procedures, including strand specifications, jack dimensions, pressures, forces and elongations, and grouting.

(k) Grout pad construction. Refer to section 7.3.6 of these Specifications.

(l) Details of release of temporary supporting structures.

(m) Provide an “As Constructed” detailed survey of the substructure showing the following:
- location and elevation of all bearing grout pad recesses,
- shim height at each bearing location,
- top of girder elevations at each bearing (and each splice location where appropriate).

The erection procedure shall bear the Seal of a Professional Engineer registered in Alberta, who shall assume full responsibility to ensure that his design is being followed. Safety and compliance with the Occupational Health and Safety Act and Regulations thereunder, shall be integral parts of his design.

The Contractor shall continue to 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.

Work shall not commence until the Consultant's acceptance of the proposal has been obtained. The Contractor's project manager and field superintendent may be required to attend a prejob meeting at a location determined by the Consultant prior to commencement of any field work.

Before erection begins the Contractor shall do a complete superstructure layout by means of chalk lines and markings applied to all substructure units, showing bearing and girder positions in accordance with the accepted layout plan.

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.

7.3.5 Girder Adjustments

It is essential that the girders be erected with utmost attention being given to girder positioning, alignment, and elevation. The Contractor shall adjust girder position, bearing location and bearing elevation in order to achieve as closely as possible the lines and grades shown on the drawings. The Contractor shall minimize any differential camber (girder to girder), and the sweep of the girders by jacking, loading of girders, winching, or whatever means are necessary, and shall provide the necessary temporary attachments to hold the girders in position.

The maximum dimensional deviation in mm, of erected precast concrete units from that as detailed on the drawings shall not exceed the following:

Sweep (NU Girders)	1 mm/m
Sweep (Other Units)	deviation from true, 20 mm x length (m) ÷ 50

7.3.6 Grout Pockets and Grout Pads

The Contractor shall construct grout pads using Sika 212 flowable grout or approved equivalent. Filling of grout pockets and construction of grout pads shall be done by workers competent in this work.

Grout shall be packaged in waterproof containers with the production date and shelf life of the material shown. It shall be mixed, placed, and cured in strict accordance with the manufacturer's recommendations.

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.

Sealer shall be applied to the exposed grout pad surfaces in accordance with section 4.25 "Type 1c Sealer".

7.3.7 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 falls below 5°C, the following provisions for cold weather grouting shall be effected:

(a) 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 10°C.

(b) Temperature of the grout during placing shall be between 10°C and 25°C.

(c) The grout pads (or girders where appropriate) shall be enclosed and kept at 10°C to 25°C for at least five days. The system of heating shall be designed to prevent excessive drying-out of the grout.

7.3.8 Bearings and Anchorage

The Contractor shall remove all anchor bolt void forming materials prior to grouting. Any residues on the concrete surface, such as oils, grease or other contaminants that can reduce bonding characteristics, shall be removed by sandblasting.

Anchor bolts shall be set accurately and grouted with a non-shrink cement grout accepted by the Consultant. All methods and materials for setting anchor bolts and building bearing pads shall be subject to the Consultant's acceptance. The location of the anchor bolts, in relation to the slotted holes in the expansion shoes, shall correspond with the temperature at the time of erection. The nuts on the anchor bolts, at the expansion ends of spans, shall be adjusted to permit free movement of the spans.

When steel bearings are employed in conjunction with grout pockets in the substructure, the bearings shall be set accurately on galvanized steel shims, and grouted as detailed on the drawings, after the girder erection has been completed. The shims must be located so that a minimum of 75 mm grout coverage is provided. When grout pockets are not detailed, the bearing plates shall be set on the properly finished bearing areas in exact position and shall have a full and even bearing on the concrete.

When required, field welding adjacent to elastomeric pads shall be performed with care to avoid damage to the Elastomer. The temperature of the steel adjacent to the Elastomer should be kept below 120°C. The distance between the weld and the Elastomer should be at least 40 mm.

7.3.9 Assembly

The parts shall be accurately assembled as shown on the drawings. The material shall be carefully handled so that no parts will be distorted, broken or otherwise damaged. Bearing surfaces, and surfaces to be in permanent contact, shall be cleaned before the members are assembled. Diaphragms shall be erected as indicated on the drawings.

7.3.10 Lifting Hooks and Lifting Holes

After the Consultant has approved the erected positions of the girders, all lifting holes on exterior girders shall be filled with an accepted grout. All lifting hooks shall be cut off 50 mm below surface, and all lifting hook pockets shall be filled with an accepted grout.

7.3.11 Painting of Metal Parts

All non-galvanized metal parts, including bearing surfaces not in contact, shall be painted two field coats of paint. Any such painting will be considered as incidental to the work.

7.3.12 Post-Tensioning System

7.3.12.1 General

This work consists of post-tensioning and grouting of cable ducts for cast-in-place and precast concrete.

7.3.12.2 Standards

Applicable requirements of the current edition of 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 of the Specifications for Bridge Construction
- Guide Specification Acceptance Standards for Post Tensioning Systems - PTI
- Specifications for Grouting of Post Tensioned-Structures - PTI
- AASHTO LRFD Bridge Construction Specifications

7.3.12.3 Qualification

The Contractor or the Sub-contractor shall have extensive experience in this work and shall utilize only fully trained, competent and experienced operators. The Contractor shall ensure the site supervisor responsible for the tensioning and grouting operations is at the site whenever these operations are being carried out.

7.3.12.4 Submittals

The Contractor shall submit the following information for the Consultant's review and acceptance at least four weeks prior to commencement of post-tensioning work:

- Five sets of post tensioning drawings illustrating the stressing system and where appropriate, design details and sequence of stressing.
- Five sets of stressing calculations taking into account all applicable losses.

Information for mill reports and stress strain curves for the stressing strand shall be provided at least 5 days prior to stressing.

7.3.12.5 Materials

(a) Stressing Strand
Stressing strand shall conform to the requirements of sections 7.2.4.9 and 7.2.5.3.

Corrosion inhibitor is required when the stressing and grouting operations are not completed within 20 calendar days of the installation of the stressing steel. The corrosion inhibitor, when required, shall be water-soluble and shall have no deleterious effect on the steel, grout or concrete, or bond strength of the steel to concrete.

(b) Anchorages and Distribution
All stressing steel shall be secured at the ends by means of permanent anchoring devices accepted by the Consultant. These devices shall comply with S6-06 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.

(c) Ducts
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
- 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.

(d) Concrete
Concrete shall be supplied in accordance with section 7.2.4 however the maximum size of coarse aggregate shall be 10 mm and 28 day minimum compressive strength of 50 MPa unless otherwise specified.

(e) Grout
Grout shall be Class C as described in Table 10.9.3-1 and the properties as described in Table 10.9.3-2 of the AASHTO LRFD Bridge Construction Specification. In addition to the requirements noted in the tables, a test for wet density shall also be performed in accordance with the ”Standard Test Method for Density” ASTM C138. 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. 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.

The average minimum compressive strength of 3 cubes at 28 days shall be a minimum of 50 MPa as per CSA A23.2-1B. The results for bleed test and fluidity test shall meet the requirements noted in Table 10.9.3-2 of the AASHTO LRFD Bridge Construction Specifications.

The Contractor is responsible to perform all grout testing in the field at his cost and he shall ensure that the testing is witnessed by the Consultant. The testing shall be completed by a qualified and experienced technician. The frequency of grout strength testing shall be as follows:

Strength Test

Precast Concrete Girders:	One strength test per girder line
Cast-In-Place Girders:	One strength test for every four longitudinal ducts

The strength test shall be done by an independent CSA certified testing lab.

Bleed Test
At the beginning of each day’s grouting operation, perform a wick induced bleed test in accordance with ASTM C940 and with modifications noted in Table 10.9.3-2 of the AASHTO LRFD Bridge Construction Specifications.

Fluidity Test
At the inlet and outlet, perform fluidity test in accordance with the standard ASTM C939 flow cone test or the modified ASTM C939 test.

Wet Density Test
Perform wet density test in accordance with American Petroleum Institute (API) Mud Balance Test API Practice 13B-1: “Standard Procedures for Field Testing Water-based Drilling Fluids”.

7.3.12.6 Equipment

(a) Stressing
- Hydraulic jacks and pumps of sufficient capacity shall be used for tensioning of strands.
- The force induced in the stressing 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 percent 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 as a unit. A certified calibration chart shall be kept with each gauge.

(b) 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 1.0 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. A spare fully functional pump shall also be on site.
- 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.

7.3.12.7 Construction

(a) Checking Post Tensioning Ducts
Prior to placing post-tensioning steel, the Contractor shall demonstrate to the satisfaction of the Consultant that all ducts are unobstructed.

(b) Welding
Welding of stressing tendons shall not be permitted. Stressing tendons shall not be used as an electrical “ground”. Where the ends of strands are welded together to form a tendon so that the tendon may be pulled through the ducts, the length of the strands used as an electrical “ground” or 1 m, whichever is greater, shall be cut off from the welded end prior to stressing.

(c) Tensioning

Post-tensioning shall be carried out as per reviewed and accepted 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
- Date grouted

(d) 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. The recesses shall be thoroughly wetted and covered with a thin cement scrub coat immediately before placing fresh concrete.

(e) 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 stressing steel. All ducts shall be thoroughly flushed out with water and blown out with compressed oil free air. All inlets and outlets shall be checked for their capacity to accept injection of grout by blowing compressed oil free air through the system.

A thoroughly mixed grout, meeting all the requirements described in 7.3.12.5(e) 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 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. Grout efflux time shall be tested. This cycle shall be continued until acceptable grout fluidity is achieved. In addition to fluidity test, check the grout density using the Wet Density Method. The density at the final outlet shall not be less than the grout density at the inlet. To ensure the tendon remains filled with grout, the ejection and injection vents shall be closed in sequence, respectively under pressure when the tendon duct is completely filled with grout. Valves and caps are 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.

Check grouted tendons in accordance with AASHTO LRFD Bridge Construction Specifications to ensure no leakage exist. If leaks are present, the Contractor shall submit a proposed method of repair for review and acceptance by the Consultant and the Department.

The Contractor shall provide 50 mm deep grout tube termination recesses formed around the tubes projecting from top of the deck. 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.

7.3.12.8 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.

7.3.13 Removal of Temporary supporting structures and Site Clean-up

Upon completion of the erection and before final acceptance, the Contractor shall remove all earth material or temporary supporting structures placed in the stream channel or elsewhere during construction. He 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 neatly restore, and presentable condition, satisfactory to the Consultant; when required, he shall provide written evidence that affected property owners or regulatory agencies have been satisfied.

7.4 Payment

Payment for the **Supply of Girders** and associated material will be made on the basis of the unit prices bid per girder, and in accordance with section 7.2.7, “Failure to Meet Strength Requirements”. The unit prices bid shall include full compensation for the cost of furnishing all materials, labour, tools, equipment and incidentals necessary for fabrication.

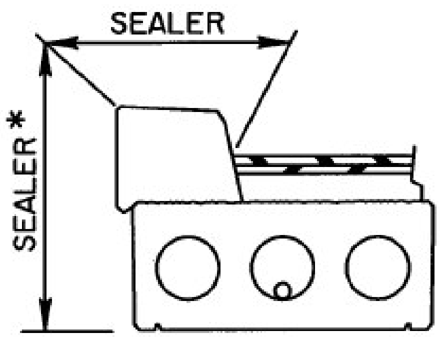
Supply and Delivery of Bearings will be paid for on the basis of a lump sum price bid. Items to be included in **Supply of Bearings** shall be as listed in the Special Provisions.

Payment for **Delivery of Girders** will be made on the basis of the lump sum price bid. It shall include full compensation for the costs to deliver all girders and associated materials, and shall include the costs to obtain the necessary approvals and permits from the Motor Transport Board and/or the appropriate local road authorities to transport the girders. Also included shall be the costs to remove all road dirt and spray.

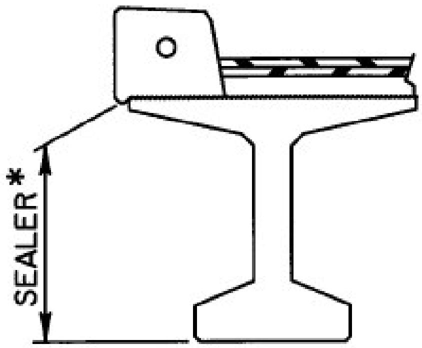
Payment for **Erection of Girders** will be made on the basis of the lump sum price bid which price shall include full compensation for the cost of furnishing all materials, labour, tools, equipment, transportation and incidentals necessary to acceptably complete the erection and site clean-up. For the purposes of payment, installation of such items as bearing plates, anchor bolts, connector bolts, and other accessories and specified items, will be considered incidental and no separate payment will be made therefore.

When materials are delivered to the worksite, payments for:
Supply of Girders,
Supply of Bearings, and
Delivery of Girders
will be made to a maximum of 90% of the price bid of the materials and delivery. Payment for the remainder of the prices bid for supply and delivery will be made as the materials are acceptably installed.

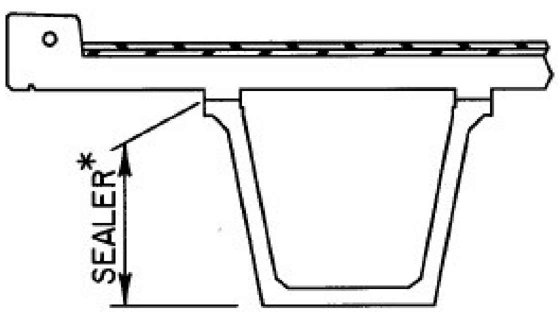
Payment for **Post-Tensioning and Grouting** will be made on the basis of the lump sum price bid which price shall include full compensation for the cost of furnishing all materials, labour, tools, equipment and incidentals necessary to acceptably complete the post-tensioning and grouting process and clean-up.



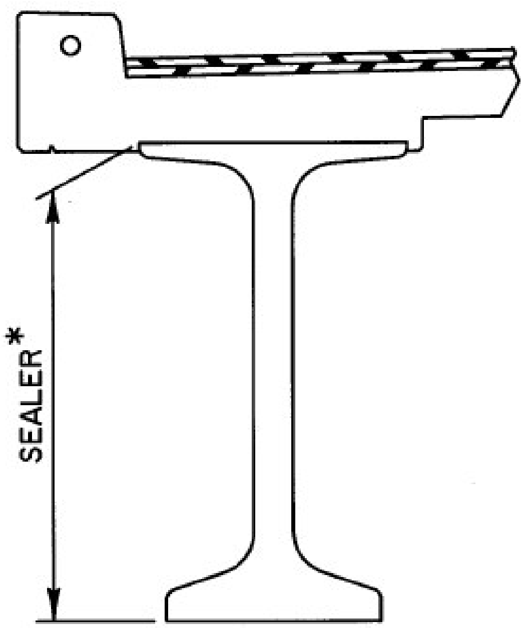
COMPOSITE SLC GIRDERS



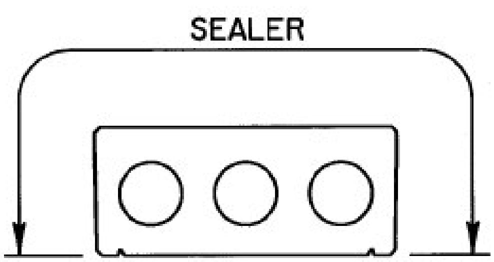
COMPOSITE BULB-TEE GIRDERS



COMPOSITE TUB GIRDERS



COMPOSITE NU GIRDERS



STANDARD SL-510 GIRDERS

* NOTE:
TYPE Ic SEALER EXCEPT
WHEN PIGMENTED SEALER
IS SPECIFIED

NO	DATE	REVISIONS	BY
4			
3	2010-01-19	SEALER NOTE REVISED	CM
2	2001-05-01	NU GIRDER ADDED & DEPARTMENT NAME	RY
1	99-03-29	BEB CHANGED TO TSB	RY

Alberta TRANSPORTATION
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TYPE Ic SEALER FOR PRECAST GIRDERS

DESIGNED	DRAWN	DATE	APPROVED	SIGNATURE	DATE	DRAWING
RY	WS	97-12-01	EXECUTIVE DIRECTOR			S-1637-97

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 8

CONCRETE SLOPE PROTECTION

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8.1 General

The slopes to be covered by slope protection, unless otherwise specified, will have been trimmed to the lines and grades specified on the drawings, with a tolerance of plus or minus 150 mm. Concrete Slope Protection shall include fine-grading the slope surface to a plane 100 mm below the specified grades, filling with 100 mm of Crushed Aggregate Material Designation 2 Class 25, and placing 100 mm of reinforced concrete as specified below.

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, however, the Department and 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.

All thickness measurements indicated herein will be made perpendicular to the slope surface.

Refer to Standard Drawing S-1409 "Standard Concrete Slope Protection" included with these specifications.

8.2 Materials

The provisions of Section 4 of the Specifications, "Cast-In-Place Concrete", shall apply.

Concrete for slope protection shall meet all the requirements of Class B concrete, as defined in Section 4.4.

Wire mesh reinforcement shall be 152 x 152 MW 25.8 x 25.8, flat welded wire mesh sheets.

8.3 Placing

Before starting concrete slope protection work, the Contractor shall submit a detailed layout and forming plan to the Consultant for review.

The slopes to be covered by concrete slope protection shall be trimmed and dressed by the Contractor to lines and grades acceptable to the Consultant. The Contractor shall supply and place Crushed Aggregate Material Designation 2 Class 25 to a minimum thickness of 100 mm over the trimmed slopes. If top and/or toe cut-off walls are specified on the drawings, trenches shall be dug to suit. Granular fill shall conform to the requirements of the "Backfill" Specification, section 2.2.2 (Designation 2, Class 25).

Sheet reinforcing mesh shall be placed in accordance with Section 5 – "Reinforcing Steel". The method of securing and maintaining the wire mesh in its proper location shall be reviewed and accepted by the Consultant.

The concrete shall be handled and placed in accordance with section 4.14 – "Handling and Placing Concrete".

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 wire mesh to ensure proper slab thickness, correct positioning of the mesh, and the formation of a proper cold joint between courses. Vertical or horizontal joints, as the case may be, shall be formed or grooved 50 mm to the depth of the reinforcing mesh. All joints shall be finished with a sidewalk type edging tool and left unfilled. The surfaces enclosed by joints shall be given a Class 5 finish as specified for curbs and sidewalks in section 4.24.6 of Specification for "Cast-in-Place Concrete." Finishing work shall be carried out by competent, fully experienced personnel only.

Curing shall be performed as specified in section 4.22 of Specification for “Cast-In-Place” Concrete.

Backfill at the toe, top or edges shall be non-granular, conforming to the requirements of “Backfill” Specification, section 2.2.1, and shall not be placed until the slope protection has been reviewed and accepted by the Consultant.

8.4 Measurement and Payment

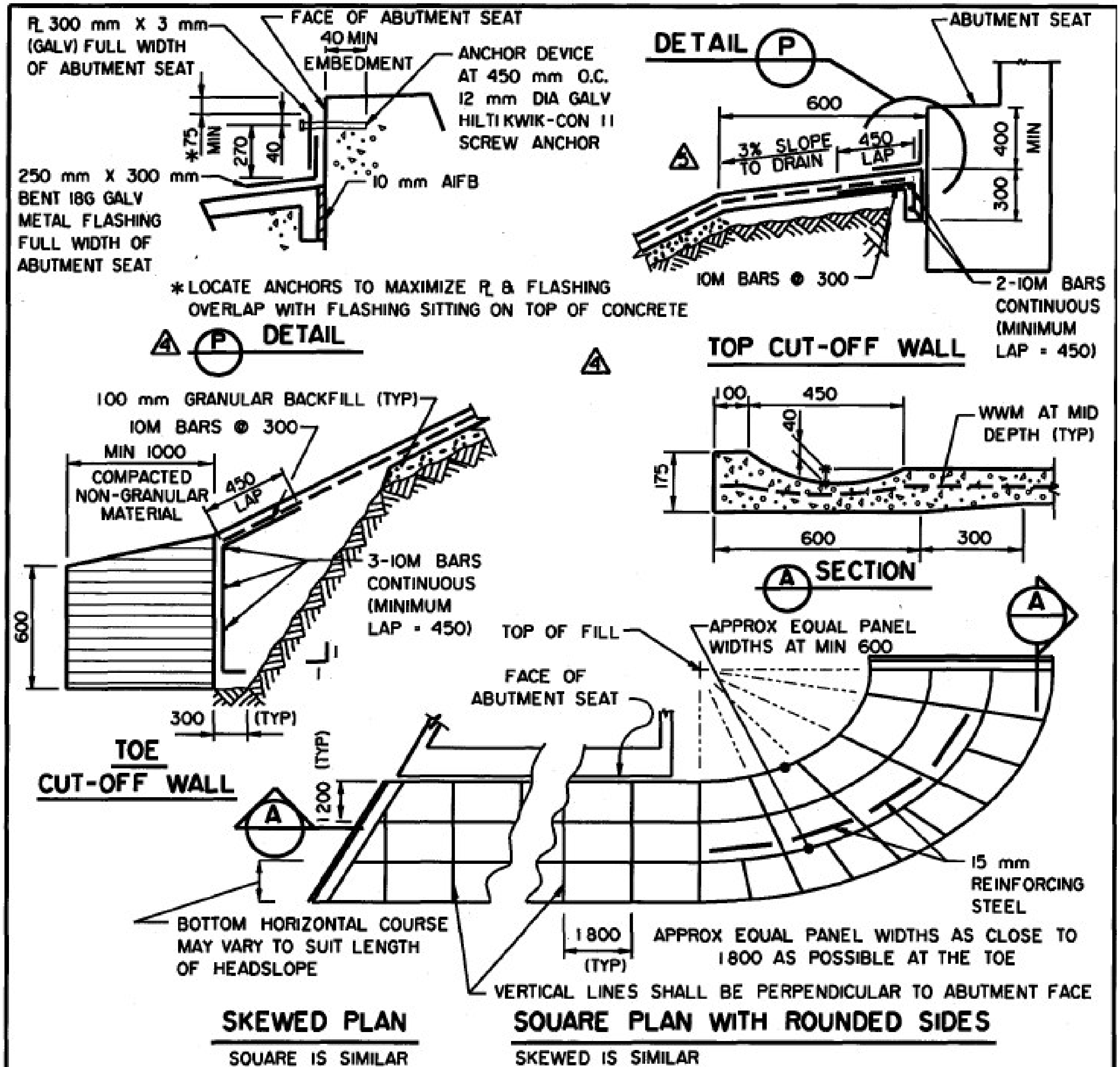
Payment for **Concrete Slope Protection** will be made at the unit price bid per square metre, and shall include full compensation for the cost of furnishing all tools, labour, equipment, materials, and incidentals necessary for the completed work, including the preparation of the slopes, supply and placing of reinforcing steel, steel mesh, concrete, and backfilling. The quantity to be paid for will be the number of square metres satisfactorily placed, and shall include trough drains adjoining the slope protection and the vertical surfaces of toe cut-off walls. No payment will be made for top cut-off walls or edge walls.

The Department reserves the right to reject any concrete whatsoever which does not meet the strength requirements for Class B concrete as tested in accordance with the requirements of Section 4 “Cast-In-Place Concrete”.

The Department may however, at the discretion of the Consultant, accept concrete which does not meet the specified strength requirement and in such case payment for concrete slope protection shall be made in accordance with the following scale:

25 MPa and over	-	Full bid price
23 MPa to 25 MPa	-	Bid price less $10 per square metre
21 MPa to 23 MPa	-	Bid price less $20 per square metre
19 MPa to 21 MPa	-	Bid price less $30 per square metre

All concrete below 19 MPa in slope protection will be rejected.



GENERAL NOTES

- DIMENSIONS ARE GIVEN IN mm. DETAILS ARE NOT TO SCALE.
- WELDED WIRE MESH (WWM) SHALL BE 152 x 152 MW25.8 x 25.8, SUPPLIED IN FLAT SHEETS, LAPPED A MINIMUM OF 152 mm AND SHALL BE SUPPLIED BY THE CONTRACTOR.
- ALL CONCRETE SHALL BE PLACED IN ALTERNATE HORIZONTAL (OR VERTICAL) COURSES. FIRST COURSES SHALL HAVE SET UP PRIOR TO PLACING ADJOINING COURSES.
- ALL JOINTS SHALL BE FORMED USING A SIDEWALK TYPE GROOVING TOOL.
- (3) SLAB SHALL BE GIVEN A CLASS 5 FINISH.

NO	DATE	REVISIONS	BY
5	2009-05-21	CUT-OFF WALL REVISED	CM CM
4	2007-09-12	DETAIL P ADDED - GALV FLASHING	RY
3	2006-06-01	GENERAL NOTES - CONCRETE FINISH	GW
2	2005-06-01	TOE CUT-OFF WALL DETAIL REVISED	RY
1	99-04-20	REDRAWN FROM S-1409-87	RY

Alberta TRANSPORTATION AND UTILITIES
TECHNICAL STANDARDS BRANCH

CONCRETE SLOPE PROTECTION

DESIGNED	DRAWN	DATE	APPROVED	SIGNATURE	DATE	PAGE	DRAWING
DHO	WS	99-04-20	EXECUTIVE DIRECTOR	[signature]	May 8/87	8.5	S-1409-99

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 9

DRAIN TROUGH TERMINAL PROTECTION

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REFERENCE DRAWINGS — <u>Drawing No.</u>

9.1 General

Drain trough terminal protection shall be constructed with burlap or reinforced polyethylene bags filled approximately two-thirds full of fresh Class B Concrete and placed on a shaped and prepared foundation.

Refer to Standard Drawing S-1410 “Standard Drain Trough Terminal Protection” included with these Specifications.

9.2 Materials

All materials shall be supplied by the Contractor. The bags shall be approximately 400 x 700 mm in size. The concrete shall be as specified under Section 4 – “Cast-In-Place Concrete”.

9.3 Preparation and Placing

A depression shall be formed at the toe of the drain trough as shown on Standard Drawing S-1410. The depression shall be compacted, and have the shape of a dish approximately 450 mm deep and 3 m in diameter.

The bags shall be two-thirds filled with fresh concrete. Bags shall be sewed, stapled or folded to form a straight-edge closure, and immediately placed in the work. The first bag shall be placed in the centre (bottom) of the dish with subsequent bags placed in a circular direction around the first bag. Each bag shall overlap the closed end of the bag previously placed, and also the bag beside it, so that a shingled effect is produced.

Folded bags must be handled so as to avoid spillage, and the folded part is to be on the underside when in place. The bags shall be rammed and packed against each other so as to obtain a closed and uniform surface. The placed drain trough terminal protection shall have an average thickness of 130 mm.

The outer edge of the concrete-filled burlap bags of the completed drain trough terminal shall be level.

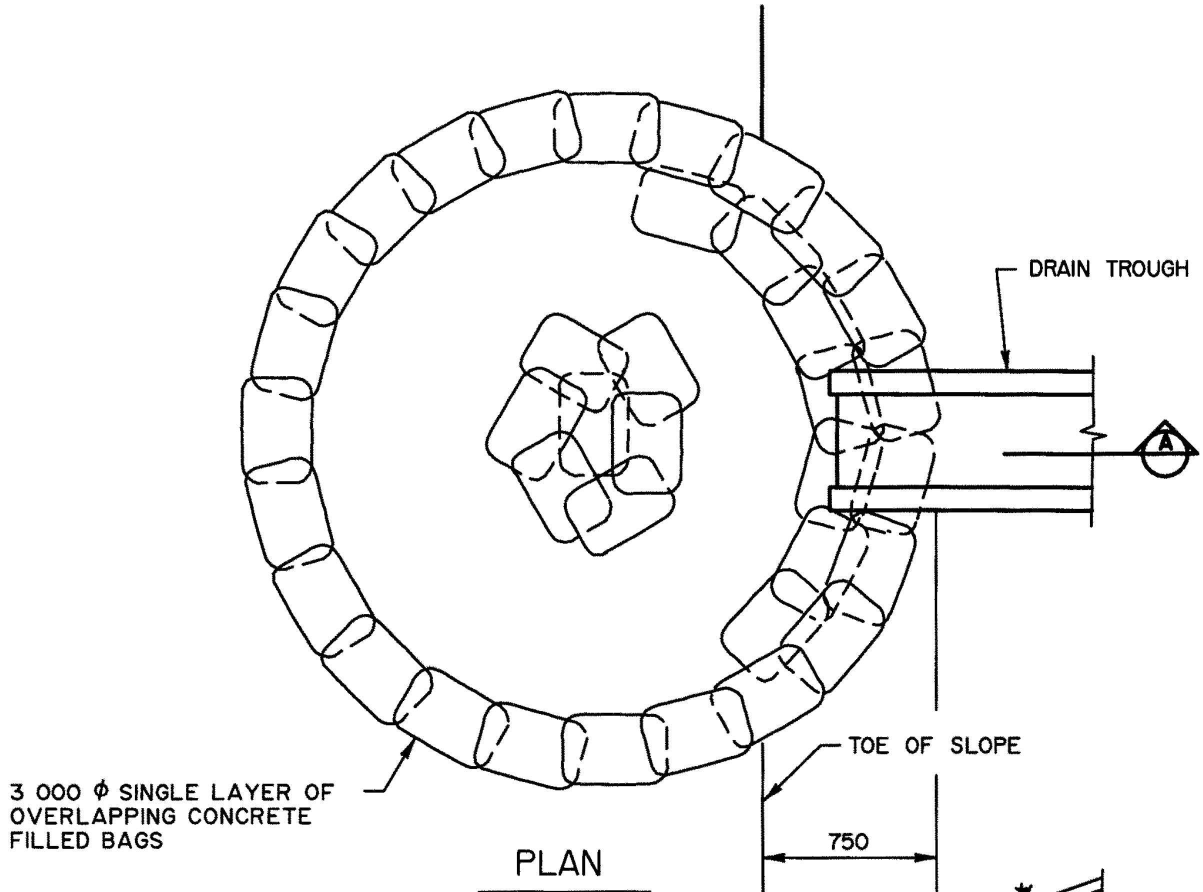
9.4 Rock Riprap Alternate

In lieu of bags filled with concrete, the Consultant may approve Class 1M rock riprap placed to a minimum depth of 350 mm. The size of the terminal dish shall be the same as for bagged concrete terminal protection with the bed shaped to the extent that the dimension from the level surface to the top of rock riprap is 320 ± 100 mm.

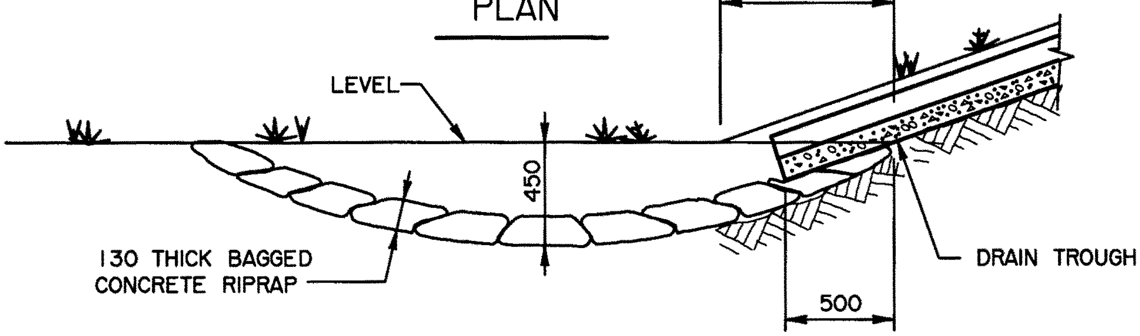
The dish formed in the subgrade shall be covered with Terrafix 270R or approved equivalent filter fabric. The filter fabric shall be keyed 300 mm into the subgrade at the perimeter of the dish in order to anchor the fabric. The rock riprap shall be placed so that the filter fabric is fully covered.

9.5 Measurement and Payment

The construction of drain trough terminal protection, including the supply of all required materials, will be incidental to the Contract, and no separate or additional payment will be made.



PLAN



A SECTION

GENERAL NOTES

- DIMENSIONS ARE GIVEN IN mm. DETAILS ARE NOT TO SCALE.
- 4 PLACING OF BAGGED CONCRETE RIPRAP SHALL START AT THE BOTTOM CENTRE OF THE DISHED AREA AND SHALL PROCEED IN A CIRCULAR LAYERED FASHION UPWARD UNTIL THE ENTIRE DISH IS COVERED. EACH CONCRETE FILLED BAG SHALL LAP OVER THE EDGES OF THE PREVIOUSLY PLACED BAGS.

2

7

NO	DATE	REVISIONS	BY
4	2003-03-21	GENERAL NOTES	JT
3	99-03-29	BEB CHANGED TO TSB	RY
2	94-11-30	GENERAL NOTES	RJR
1	91-01-29	REDRAWN FROM S-1410-87	DHQ

Alberta TRANSPORTATION AND UTILITIES
TECHNICAL STANDARDS BRANCH

STANDARD DRAIN TROUGH TERMINAL PROTECTION

DESIGNED	DRAWN	DATE	APPROVED	SIGNATURE	DATE	PAGE	DRAWING
DHQ	MIK	91-01-29	EXECUTIVE DIRECTOR	Boyd		9.3	S-1410-91

PLOTTED MAR 21, 2003 S1410X91.RV4

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 10

HEAVY ROCK RIPRAP

TABLE OF CONTENTS

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 fill required to satisfactorily place the rock riprap, such as:

- excavation, trimming and shaping headslope
- excavation at headslope toe, and for rock apron
- excavation for rock in stream bank transition zone
- supply and placing of geotextile filter fabric
- supply and placing of gravel or granular bedding material
- backfill over rock 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 riprap. He 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 Rock Material

The rock 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 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 Class 3 rock riprap for which no performance records are available. Sampling and testing are not required for Class 1 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. The Contractor shall be responsible for all associated costs for 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 for each class specified shall have a gradation that conforms to the following:

		CLASS			
		1M	**1**	**2**	**3**
Nominal Mass (kg)		**7**	**40**	**200**	**700**
Nominal Diameter (mm)		**175**	**300**	**500**	**800**
None greater than:	kg or mm	40 300	130 450	700 800	1800 1100
20% to 50%	kg or mm	10 200	70 350	300 600	1100 900
50% to 80%	kg or mm	7 175	40 300	200 500	700 800
100% greater than:	kg or mm	3 125	10 200	40 300	200 500

Percentages quoted are by mass.
Sizes quoted are equivalent spherical diameters, and are for guidance only.

Riprap shall meet the following minimum requirements for specific gravity, absorption and durability:

Method of test	**Requirements**
California Department of Transportation Method of Test for Specific Gravity and Absorption of Coarse Aggregate (California Test 206)	Minimum Specific Gravity = 2.60 Maximum Absorption = 2.0 percent
California Department of Transportation Method of Test for Durability Index (California Test 229)	Minimum Durability Index = 52 Durability Index may be less than 52 if DAR* > 23

* Durability Absorption Ratio (DAR) = Durability Index / (Absorption % + 1%)

10.4 Geotextile Filter Fabric

Where 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 in accordance with the following table of minimum average roll value properties (MARV's) for each specific Class of riprap:

Non-Woven Geotextile Filter Fabric		
Specifications and Physical Properties		
	Class 1M, 1 and 2	Class 3
Grab Strength	650 N	875 N
Elongation (Failure)	50%	50%
Puncture Strength	275N	550 N
Burst Strength	2.1 MPa	2.7 MPa
Trapezoidal Tear	250 N	350 N
Minimum Fabric Lap to be 300 mm		

The non-woven geotextile filter fabric shall meet the specifications and physical properties as listed above.

The fabric shall be laid parallel to the slope direction. It shall be placed in a loose fashion, however folds and wrinkles shall be avoided. Adjacent strips of fabric shall be overlapped a minimum of 300 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 filter fabric shall be anchored by digging a 300 mm deep trench, inserting the top edge of the fabric and backfilling with compacted soil.

Care shall be taken to prevent puncturing or tearing the geotextile. Any damage shall be repaired by use of patches that extend at least 1 m beyond the perimeter of the tear or puncture.

The fabric shall be covered by 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 geotextiles.

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 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 Rock

The rock 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 Rock

Control of gradation will be by visual inspection. The Contractor shall provide a minimum of two samples of rock, 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 riprap being loaded at the source and placed at the site. The minimum sample size in area shall be as follows:

Class	Minimum 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 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

The quantity of heavy rock riprap to be paid for will be measured in place. The volume of rock paid for will be calculated from the thickness of the riprap as shown on the drawings, and the actual area covered. Overages in thickness or area beyond the limits shown on the drawings will not be paid for unless these changes were requested by the Consultant.

Payment will be made at the unit price bid per cubic metre of **Heavy Rock Riprap** acceptably in place, which price shall include full compensation for all necessary materials, royalties, permits, haul of materials, equipment, tools, labour and incidentals necessary to complete the work, including the preparation of the subgrade for the riprap, geotextile filter fabric, bedding material, trimming, excavation, backfill as required, and labour for measurement.

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 11

DUCTS AND VOIDS

TABLE OF CONTENTS

11.1 General

This specification is for the supply and installation of all ducts, conduits or voids as set out in the drawings and these specifications. Included are the following:

- utility ducts and voids
- rigid conduits, end caps, conduit expansion joints, junction boxes
- lamp standard anchorage assemblies

11.2 Material

All utility ducts and voids, fittings and accompanying hardware, to be incorporated in or erected on the structure, 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). Rigid conduit shall be bent only with a standard conduit bender.

Expansion assemblies shall be Scepter type ‘O’ ting expansion joints or approved equivalent.

11.3 Installation

The various components shall be erected or placed in the locations shown on the drawings.

Ducts, conduits and voids shall be firmly secured to prevent floating during casting.

Continuous pull wires shall be installed in all service 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. In this case, 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.

When specified, lamp standards shall be properly bedded, securely bolted, and painted with two field coats.

The installation of any electrical equipment shall be carried out to completion by a fully qualified electrician, tested and left in good working order. All runs of conduit or duct shall be proven in the presence of the Consultant to be clear 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

Unless **Ducts** is listed in the Unit Price Schedule of the Tender pages, this work shall be considered incidental to the Contract and no separate or additional payment will be made. When **Ducts** is listed in the Unit Price Schedule this work will be paid on the basis of the lump sum price bid which shall include full compensation for the cost of furnishing all material, labour, equipment, tools and incidentals necessary to acceptably complete the work.

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 12

BRIDGERAIL

TABLE OF CONTENTS

12.1 General

This specification is for the supply, fabrication and installation of steel tube type bridgerail, thrie beam bridgerail, approach rail transition, and handrail. Bridgerail and handrail 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 bolt 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 Department/Consultant will conduct this meeting after the shop drawings have been approved and welding procedures have been reviewed. The Contractor shall provide one week notice to the Department/Consultant prior to the meeting.

12.2.1 Standards

The fabrication of bridgerail components shall conform to "The American Association of State Highway and Transport Officials (AASHTO), Standard Specifications for Highway Bridges" and the American Welding Society (AWS) - Bridge Welding Code, D1.5.

Where imperial/metric conversions are necessary, the National Standard of Canada, CAN3 - Z234.1 - 79 shall be used as the basis of conversion.

All welding, cutting and preparation shall be in accordance with the American Welding Society (AWS) - Bridge Welding Code, D1.5.

12.2.2 Qualification

The Contractor shall notify the Department and 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 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 bearing the approval of the Canadian Welding Bureau shall be submitted for each type of weld to be used. The welding procedures shall be reviewed by the Department before welding proceeds.

12.2.3.2 Shop Drawings

Shop drawing requirements shall be as per section 6.2.3.3.

When railing for more than one bridge is included, individual shop and erection drawings shall be submitted for each bridge. Shop drawing mark numbers must be unique for each bridge.

12.2.3.3 Mill Certificates

Mill certificates shall be provided for all material before fabrication commences.

12.2.4 Materials

12.2.4.1 Steel

All steel shall conform to the standard noted on the drawings. The silicon content for various bridgerail and handrail components shall be as follows:

- Structural tubing less than 0.04%
- Structural sections, handrail bars, base plates less than 0.04% or between 0.15% to 0.25%

If substitutions are required they must be accepted by the Department and Consultant. In these cases interpretation of equivalent steel will be as per Appendix "A" of the CSA Standard G40.21 (1976 only).

12.2.4.2 Anchor Bolts

Anchor bolts shall conform to the standard noted on the drawings. The Contractor shall provide mill 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 G40.21 Grade 300W or ASTM A36.

12.2.4.4 Grout

Grout for post bases shall be Sika 212 flowable grout or approved equivalent.

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 as specified in 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.

Metal core welding process utilizing low hydrogen consumables with AWS designation of H4 is allowed. The 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. They shall be tack welded only to the 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 shall be removed by flame cutting, not by breaking off.

12.2.5.6 Arc Strikes

Arc strikes are not permitted.

12.2.5.7 Methods of Weldment Repair

Repair procedures for unsatisfactory weldments shall be submitted for review and acceptance by the Department and Consultant prior to repair work commencing.

12.2.5.8 Grinding of Welds

Fillet welds not conforming to acceptable profile shall be ground to the proper profile without 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. Acceptability of welds without grinding will be determined by the Consultant.

12.2.6 Fabrication

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

12.2.6.1 Rail Fabrication

All rail splices will be radiographed. Splices shall be completed using properly fitted backing bars. Only one splice per rail section will 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

(a) 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 bolt holes shall be drilled accurately in size and location.

The rail post to base plate shall be welded by using 60°C preheat.

(b) HSS Posts
The following requirements shall apply to HSS posts, in addition to the requirements noted under W Posts:

- The tube weld seam shall be kept on the back side of the post.

- The rail post 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 tube prepared to a sharp edged 45 degree chamfer. The groove weld shall be placed in a minimum of two passes by using 100°C of preheat and maintain 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.

- Acceptability of the post to base plate weld shall be confirmed by sectioning one fabricated post, chosen at random by the Department and Consultant, for every 50 posts fabricated. In each bridge structure at least one post shall be tested. The Contractor shall be responsible for sectioning and to provide the additional posts to replace those selected for destructive testing.

- 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 Bolts

The threaded ends of all anchor bolts shall be chamfered. All anchor bolts, hardware and anchor bolt template shall be hot dip galvanized, after fabrication in accordance with ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware. Nuts shall freely spin on the bolt threads after galvanizing. The anchor bolts 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

(a) 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 handrail panels, the test samples shall consist of a welded unit with top and bottom tube, and sleeve sections spaced to match the handrail.

(b) Posts
Post assembly lengths shall be within 3 mm of the specified length.

(c) 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.

(d) Anchor Bolts
The bolts in an anchor bolt assembly shall fit in a template comprised of accurately located holes 2 mm greater in diameter than the anchor bolts. The top of the bolts 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

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 A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware with additions and exceptions as described in this specification.

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. The galvanized finish shall meet the aesthetic requirements of the application and shall have a continuous outer free zinc layer without any significant zinc-iron alloy showing through the outside surface. Lumps, globules or heavy deposits of zinc will not be permitted. Handrails shall be free of any sharp protrusions or edges.

Double dip galvanizing is not advised but will be accepted if a surface finish similar in appearance, colour and quality to that of single dip galvanizing is produced. The lapped area of the double dip shall be straight, the coating smooth, adherent and free of uncoated areas, blisters, flux deposits, dross inclusions, acid and black spots.

Repair of galvanizing shall only be done if bare areas are infrequent, small, and suitable for repair. A detailed repair procedure shall be submitted for review and acceptance prior to its use. It should be noted that repairs may require complete removal of the galvanized coating and regalvanizing. Repair shall be in compliance with ASTM A780, Method A3 Metallizing. The thickness of the metallizing 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 lapped or repaired areas.

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 Testing by the Consultant

Visual, radiographic, ultrasonic, magnetic particle and any other inspection that may be specified or required will be performed by the Consultant or his testing agencies at the Consultant's expense.

The Contractor shall ensure that adequate notice for inspection and testing be given to the Consultant and that access to the work is assured at all times. When required by the Consultant, the Contractor shall provide needed manpower for assistance in checking layout and performing inspection duties.

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 prejob meeting and one additional trip during the course of fabrication.

12.2.7.2 Non-destructive Testing

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

12.2.7.3 Testing by the Contractor

The Contractor shall be responsible for sectioning and macro-etching the post to base plate weld as specified in "HSS Posts".

Testing and inspection made necessary by the repair of faulty work shall be paid for by the Contractor. All of the Contractor's records made in the course of quality control shall be open for examination by the Consultant.

12.2.7.4 Notification

The Contractor shall notify the Consultant 48 hours prior to contemplate shipment to facilitate final inspection of the materials. Material that has not been inspected in the fabrication plant will not be paid for until such material has been inspected and accepted. The Contractor may be charged with all expenses incurred for inspection of the material at the site.

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”. Delivery of a damaged product will be a cause for rejection.

12.3 Erection

Anchor bolt assemblies shall be accurately positioned with anchor bolt projections as shown and specified.

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.

Anchor bolts that project less than the full thickness of the nuts, by more than 2 threads, shall be extended. The proposed repair will require the acceptance of the Department and Consultant in writing and the repair shall be done at no cost to the Department. However, if the repair work described above is due to deficiency in the work of others, it will be paid for as “Extra Work”.

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.

All structural bolts shall be tightened by using turn of nut method as specified in 6.3.2.7.

Sealer shall be applied to the exposed grout pad surfaces in accordance with Section 4.25 “Type 1c Sealer”.

12.3.1 Grouting in Cold Weather

When the daily minimum air temperature, or the temperature of the bridgerail, the bridge substructure or superstructure in the immediate area of the grouting falls below 5°C, the following provisions for cold weather grouting shall be put into place:

(a) Before grouting, adequate preheat shall be provided to raise the temperature of the adjacent areas of the bridgerail, the bridge substructure and superstructure to at least 10°C.

(b) Temperature of the grout during placing shall be between 10°C and 25°C.

(c) The grout pad shall be enclosed and kept at 10°C to 25°C for at least 5 days. The system of heating shall be designed to prevent excessive drying-out of the grout.

12.3.2 Approach Rail Transition

The supply and 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 included as Bridgerail. These materials shall be supplied and installed in accordance with Section 14 “Guardrail”, of the Specifications.

12.4 Payment

Payment for **Bridgerail** will be made on the basis of the lump sum price bid for Bridgerail acceptably completed. The price bid shall include full compensation for the cost of furnishing all labour, materials, equipment, tools, and incidentals necessary to supply, fabricate, and erect the bridgerail, including the approach rail transition and guardrail connection and wing end sections where specified. Payment for **Bridgerail** will be made at 80% of the lump sum price bid upon receipt and acceptance of the material at the site. The remaining payment will be made after the bridgerail is suitably installed and accepted by the Consultant.

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 13

MISCELLANEOUS IRON

TABLE OF CONTENTS

REFERENCE DRAWINGS Drawing No.

13.1 General

Items included as Miscellaneous Iron will be listed in the Special Provisions, and typically include the following:

- steel drain troughs
- pier drip sheets
- deck buffer angles
- dowels
- connector angles
- anchor bolt sleeves
- bridge plaques
- bench mark tablets

13.2 Fabrication and Installation

Miscellaneous Iron shall be supplied, fabricated, placed and erected by the Contractor as shown on the drawings or as specified in the Special Provisions and applicable portions of Section 6 “Structural Steel”.

Bridge plaques shall be fabricated and installed in accordance with the construction drawings and the following standard drawings:

- S-1424-87 “Standard Irrigation Canal Bridge and Small Bridge Plaques”
- S-1477 “Standard Large Bridge Plaque Installation Details”
- S-1617 “Cast Aluminum Bridge Foundry Casting Details”

Bench mark tablets shall be supplied and installed by the Contractor in accordance with the construction drawings and the following standard drawing:

- S-1478 “Standard Bridge Bench Mark Tablet Installation”

The standard drawings are attached to these Specifications.

13.3 Handling Galvanized Steel

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 American Hot Dip Galvanizers Association (AHDGA) publication “Wet Storage Stain”. Delivery of a damaged product will be a cause for rejection.

13.4 Field Welding of Miscellaneous Iron

13.4.1 Field Welding of Structural Members

Where the installation of Miscellaneous Iron includes field welding of structural members, the following requirements shall be met:

(a) All welding, cutting and preparation shall be in accordance with the American Welding Society (AWS) - Bridge Welding Code, D1.5.

(b) Only welders approved by the Canadian Welding Bureau in the particular category shall be permitted to perform weldments. Their qualification shall be current and available for examination by the Consultant.

(c) Welding procedures approved by the Canadian Welding Bureau shall be submitted for review by the Department prior to welding.

(d) Low hydrogen filler, fluxes and welding practices shall be used in accordance with 6.2.5.1.

(e) When the 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.

(f) When the air temperature is below 0°C, welding shall not be permitted unless suitable hoarding and heating, accepted by the Consultant, is provided.

13.4.2 Field Welding of Non-Structural Members

Where the installation of Miscellaneous Iron includes field welding of non-structural members, the following requirements shall be met:

(a) Journeyman welders with Class B tickets shall be permitted to perform weldments. Their qualification shall be current and available for examination by the Consultant.

(b) Welding procedures prepared and stamped by a Professional Engineer shall be submitted for review by the Department prior to welding.

(c) Low hydrogen filler, fluxes and welding practice shall be used in accordance with 6.2.5.1.

(d) When the air temperature is below 5°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.

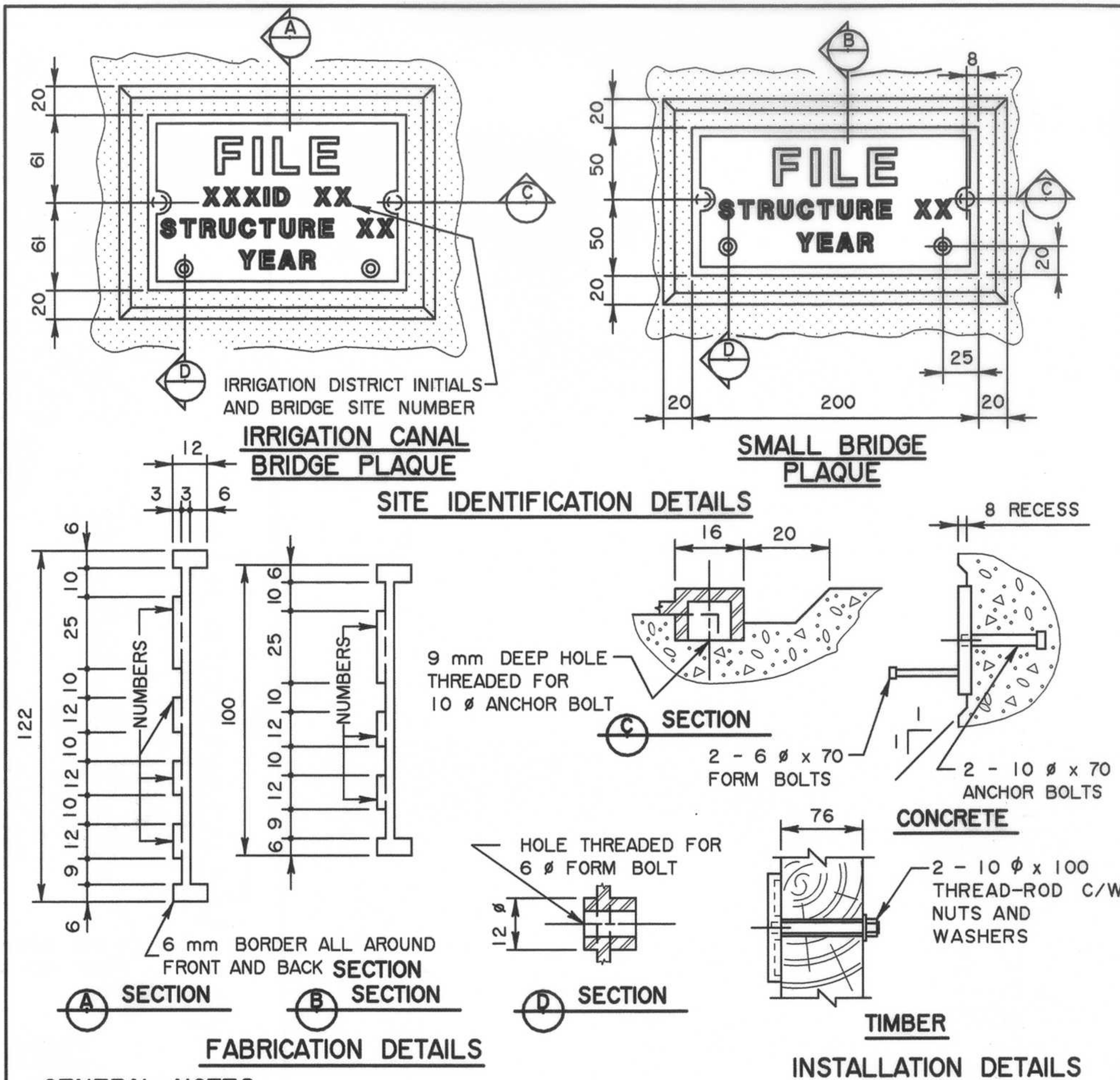
(e) When the air temperature is below 0°C, welding shall not be permitted unless suitable hoarding and heating, is provided.

Unless otherwise determined by the Consultant, the following are examples of non-structural field welding.

- Type 1 deck joint splices
- Culvert struts
- Stitch welding of steel caps/corbels
- Field welding of the end bulkhead on culvert liner

13.5 Payment

Payment for **Miscellaneous Iron** will be made on the basis of the lump sum price bid for Miscellaneous Iron acceptably placed and remaining in the completed work, which price shall include full compensation for the cost of furnishing all materials, labour, equipment, tools and incidentals necessary to complete the work.



GENERAL NOTES

- DIMENSIONS ARE GIVEN IN mm. DETAILS ARE NOT TO SCALE. DIMENSIONS ARE TYPICAL UNLESS SHOWN OTHERWISE.
- THE "FILE NUMBER" AND "YEAR" OF CONSTRUCTION WILL BE SHOWN ON THE CONTRACT DRAWINGS. IRRIGATION "DISTRICT" INITIALS AND "SITE NUMBER" WILL BE INCLUDED WHERE APPLICABLE.
- THE "STRUCTURE NUMBER" IS TO BE OBTAINED FROM TECHNICAL STANDARDS BRANCH, BRIDGE ENGINEERING SECTION.
- PLAQUES SHALL BE CAST ALUMINUM. ALL SURFACES SHALL BE COVERED WITH BLACK BAKED ENAMEL
- LOCATION OF PLAQUES TO BE ON RIGHT HAND SIDE OF THE FIRST ABUTMENT ENCOUNTERED IN DIRECTION OF TRAVEL.

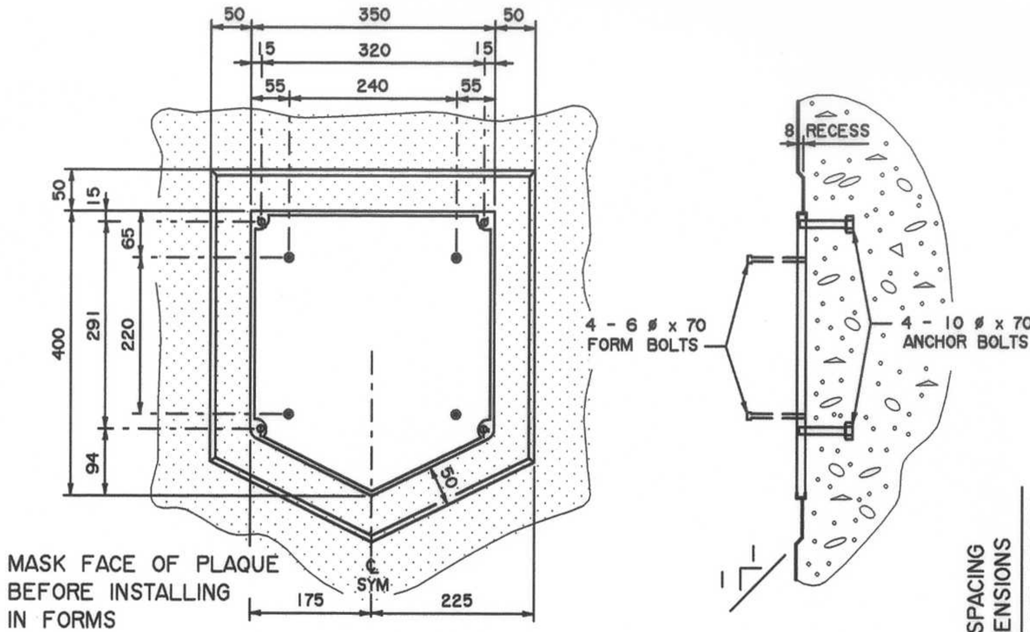
NO	DATE	REVISIONS	BY
4			
3			
2			
1	2004-05-21	REDRAWN FROM S-1424-87 REV 5	WS

Alberta TRANSPORTATION
TECHNICAL STANDARDS BRANCH

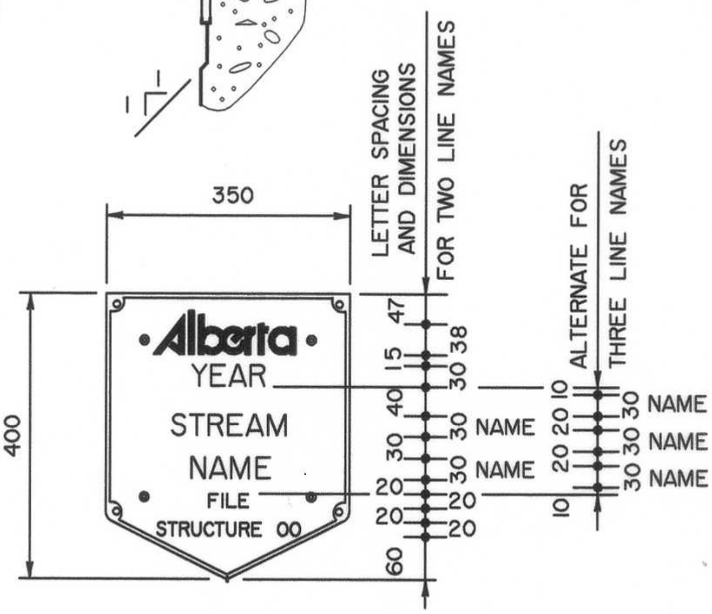
STANDARD
IRRIGATION CANAL BRIDGE AND
SMALL BRIDGE PLAQUES

DESIGNED	DRAWN	DATE	APPROVED	SIGNATURE	DATE	DRAWING
DHQ	WS	2004-05-21	EXECUTIVE DIRECTOR	Allan Kwan	May 26, 2004	S-1424-04

PLOTTED MAY 21, 2004 S1424x04.DGN



INSTALLATION DETAILS



SITE IDENTIFICATION DETAILS

GENERAL NOTES

- DIMENSIONS ARE GIVEN IN mm. DETAILS ARE NOT TO SCALE.
- SEE DWG S-1617-04 FOR FOUNDRY CASTING DETAILS.
- THE "YEAR" OF COMPLETION, THE "STREAM OR STRUCTURE NAME", THE "FILE NUMBER" AND "STRUCTURE NUMBER" SPECIFIC TO THE BRIDGE SITE, AND THE LOCATION FOR INSTALLATION, WILL BE SHOWN ON THE CONTRACT DRAWINGS.
- LOCATION OF PLAQUES TO BE ON RIGHT HAND SIDE OF THE FIRST ABUTMENT ENCOUNTERED IN DIRECTION OF TRAVEL.

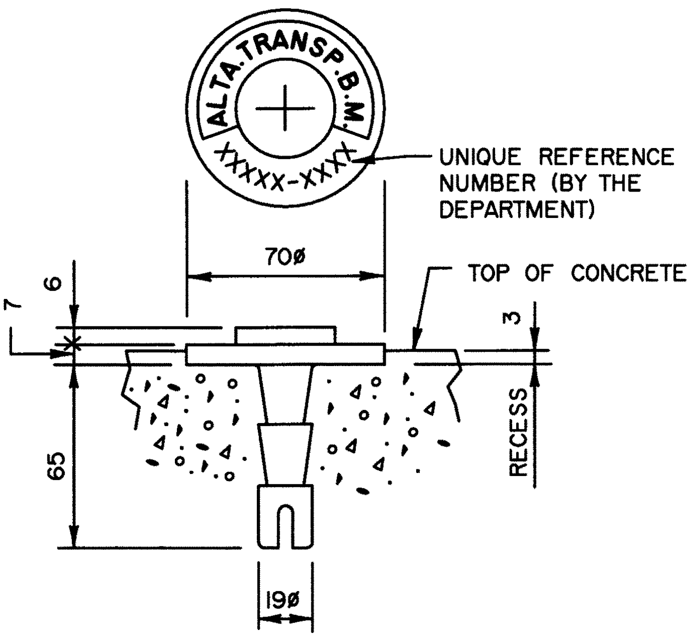
NO	DATE	REVISIONS	BY
4			
3			
2			
1	2004-05-21	REDRAWN FROM S-1477 REV 3	WS

Alberta TRANSPORTATION
TECHNICAL STANDARDS BRANCH

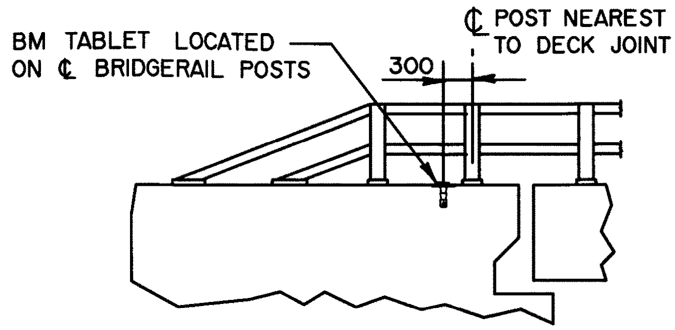
STANDARD
LARGE BRIDGE PLAQUE
INSTALLATION DETAILS

DESIGNED	DRAWN	DATE	APPROVED	SIGNATURE	DATE	DRAWING
DHQ	WS	2004-05-21	EXECUTIVE DIRECTOR	Allan Kwan	May 26, 2004	S-1477-04

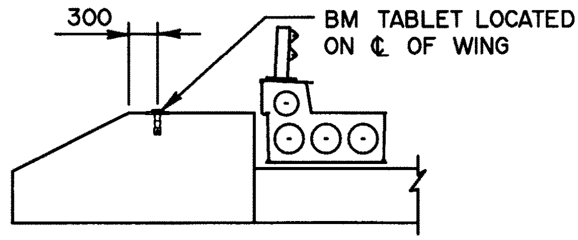
PLOTTED MAY 21, 2004 S1477-04.DGN



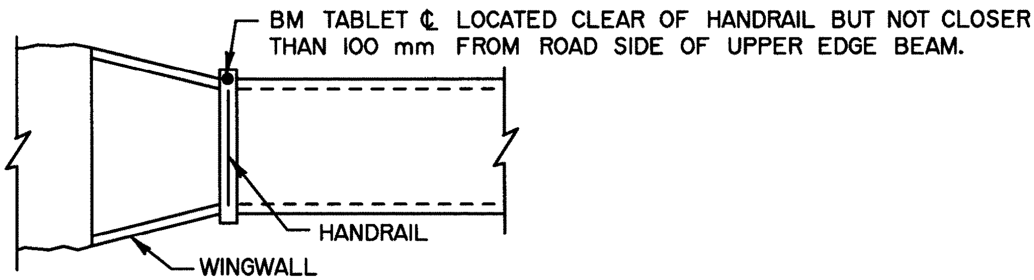
BENCH MARK TABLET



WINGWALLS PARALLEL TO ROAD



WINGWALLS PARALLEL TO STREAM



CONCRETE ARCH AND BOX CULVERTS

GENERAL NOTES

- DIMENSIONS ARE GIVEN IN mm. DETAILS ARE NOT TO SCALE.
- 3 ONE BRONZE BM TABLET WILL BE SUPPLIED AND INSTALLED BY THE CONTRACTOR FOR EACH STRUCTURE AS PER SECTION 13 "MISCELLANEOUS IRON" OF THE BRIDGE CONSTRUCTION SPECIFICATIONS.
- BM TABLET SHALL GENERALLY BE PLACED ON THE NW CORNER OF THE BRIDGE AS PRESCRIBED ON THE BRIDGE DRAWINGS.
- BM TABLET SHALL BE PLACED ONLY IN SUBSTRUCTURE ELEMENTS NOT SUBJECT TO SETTLEMENT ie ABUTMENTS SUPPORTED ON PILES OR FIRM BEDROCK.
- 3 THE DEPARTMENT WILL ASSIGN A UNIQUE REFERENCE NUMBER FOR EACH BENCHMARK TABLET. THE NUMBER IS ISSUED BY THE SURVEY/IMAGERY COORDINATOR IN TECHNICAL STANDARDS BRANCH.
- 3 FINAL BM ELEVATION (TO NEAREST 0.001 m) SHALL BE DETERMINED BY THE CONSULTANT AFTER INSTALLATION AND SHALL BE SHOWN ON THE "AS CONSTRUCTED" GENERAL LAYOUT DRAWING. THE FINAL ELEVATION, AS WELL AS WHICH GEODETIC BASED BENCHMARK IT WAS TIED TO, SHALL BE REPORTED TO THE SURVEY/IMAGERY COORDINATOR IN TECHNICAL STANDARDS BRANCH.

5

1 DRAFTING STANDARDS PAGE: 3.5

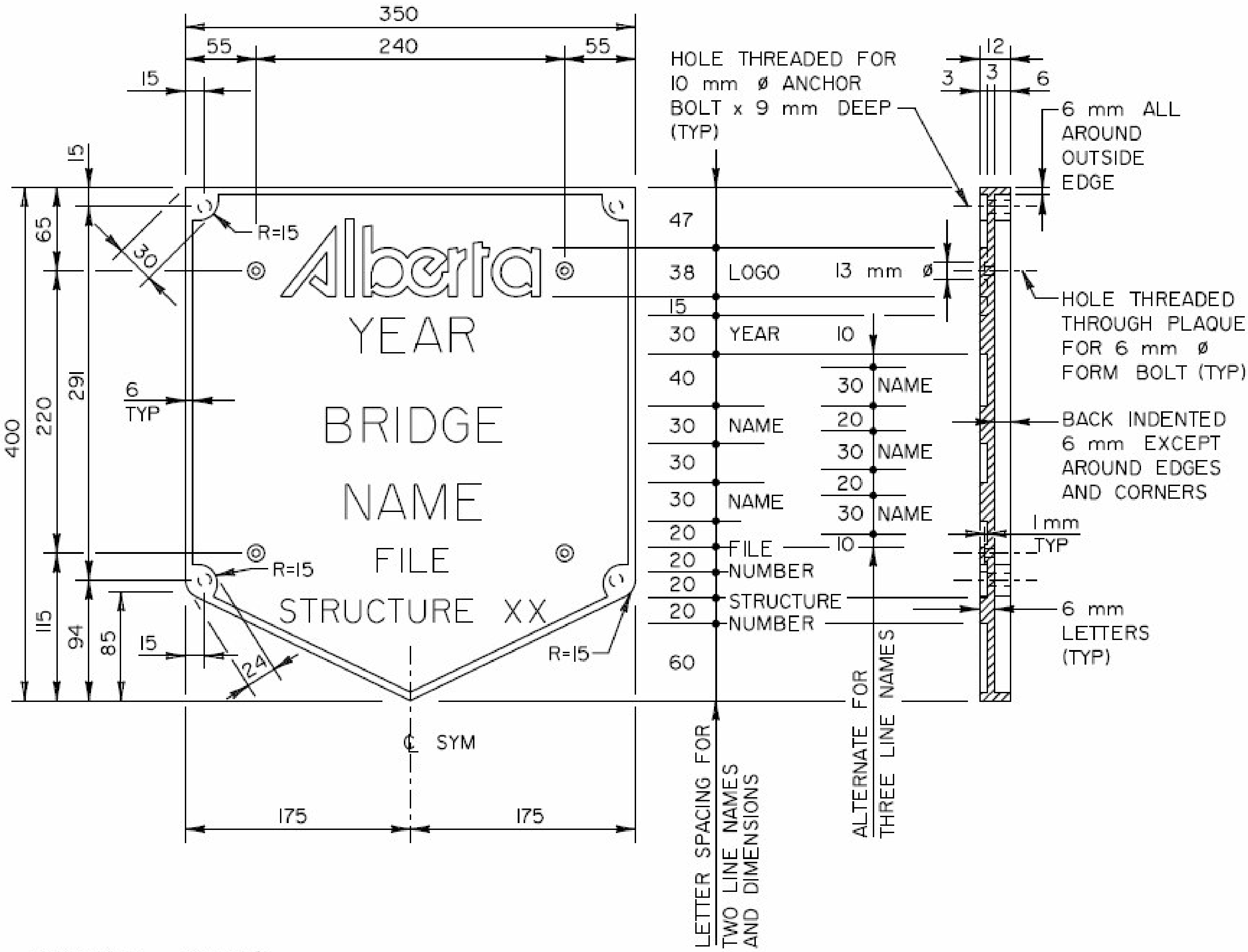
NO	DATE	REVISIONS	BY
4	99-03-29	BEB CHANGED TO TSB	RY
3	98-04-20	TABLET SUPPLIER AND REPORTING NOTES	CTC
2	94-11-30	SMALL CONTRACTS PAGE NO	RJR
1	90-03-01	DRAFTING STANDARDS PAGE NO	VGB

Alberta TRANSPORTATION AND UTILITIES
TECHNICAL STANDARDS BRANCH

STANDARD
BRIDGE BENCH MARK TABLET
INSTALLATION

DESIGNED	DRAWN	DATE	APPROVED	SIGNATURE	DATE	PAGE 2	DRAWING
DHQ	WS	87-09-02	EXECUTIVE DIRECTOR	[signature]	May 8/87	13.9	S-1478

PLOTTED MARCH 29 1999 S1478X87 RV3



GENERAL NOTES

- DIMENSIONS ARE GIVEN IN mm. DETAILS ARE NOT TO SCALE.
- PLAQUE TO BE FABRICATED TO DIMENSIONS SHOWN.
- THE ALBERTA LOGO IS TO FOLLOW IN ABSOLUTE DETAIL, DEVIATIONS REQUIRED FOR CASTING PURPOSES MUST BE APPROVED BY THE ENGINEER.
- ALL LETTERS AND NUMBERS CAST ON THE PLAQUE, EXCEPT FOR THE ALBERTA LOGO, SHALL BE UPPER CASE UNIVERS 65. DEVIATIONS MUST BE APPROVED BY THE ENGINEER.
- THE "YEAR" IS THAT OF THE PROJECT'S COMPLETION.
- THE "BRIDGE NAME" IS THE 'STREAM NAME' OR 'STRUCTURE NAME' AND IS PLACED ON 2 OR 3 LINES.
- THE "NAME", "FILE NUMBER" AND "STRUCTURE NUMBER" ARE SPECIFIC TO EVERY BRIDGE SITE AND ARE SHOWN ON THE CONTRACT DRAWINGS.
- THE "STRUCTURE NUMBER" IS TO BE OBTAINED FROM TECHNICAL STANDARDS BRANCH, BRIDGE ENGINEERING SECTION.
- PLAQUE SHALL BE SUPPLIED WITH BLACK BAKED ENAMEL EVERYWHERE, EXCEPT FOR FULL BORDERS AND ALL NUMERALS AND LETTERS, WHICH SHALL BE EXPOSED ALUMINUM.
- 2 PLAQUE SHALL BE CAST ALUMINUM.

NO	DATE	REVISIONS	BY
4			
3			
2	2009-07-07	GENERAL NOTE ADDED	WS
1	2004-05-21	REDRAWN FROM S-1617 REV 2	WS

Alberta TRANSPORTATION
TECHNICAL STANDARDS BRANCH

STANDARD LARGE BRIDGE PLAQUE CASTINGS DETAILS

DESIGNED	DRAWN	DATE	APPROVED	SIGNATURE	DATE	DRAWING
LEA	WS	2004-05-21	EXECUTIVE DIRECTOR	ALLAN KWAN	2004-05-26	S-1617-04

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 14

GUARDRAIL

TABLE OF CONTENTS

14.1 General

This specification is for the supply and installation of Modified Thrie Beam Guardrail, Strong Post W-beam Guardrail, Weak Post W-beam Guardrail, Transitions, W-beam Turn-Down End Terminals, and other approved crash-worthy end treatments. Work shall include all guardrail components, connections, treated timber posts, steel posts, wing and buried end sections, connections to other barriers and end terminals.

Drawings shall include TEB Standard Drawings for approach guardrails, Bridge Engineering Standard Drawings for bridgerails and bridgerail/approach guardrail transitions, drawings in the ASSHTO-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 TEB 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 section 12.2.6.7 of the Specifications.

Curved W-beam rails shall be formed to the radius specified in accordance with drawing TEB 3.54.

The rails and terminal elements shall be manufactured according to the following standards:

14.2.1.1 Metal Properties

Properties of the base metal for the rails shall conform to the following requirements:

Minimum Yield Point	345 MPa
Minimum Tensile Strength	483 MPa
Minimum Elongation	Minimum 12% in 50 mm length

14.2.1.2 Sheet Thickness

The rails and terminal elements thickness shall be manufactured according to Table 2 (Class A, Type II) of AASHTO Standard M180 with nominal base metal thickness of 2.67 mm (2.44 mm minimum).

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 hot dip galvanized after fabrication conforming to the current edition of ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

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 upon request.

14.2.2 Bolts, Nuts and Washers

All bolts, nuts and washers shall conform to ASTM A307, unless noted otherwise on the drawings, and shall be hot dip galvanized conforming to the current edition of ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

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 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 the following width:

Above ground (including blocks)	25 mm
Below ground	60 mm

Posts and 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 CSA Standard G40.21 Grade 350W or ASTM Standard A36 and shall be hot dip galvanized after fabrication conforming to ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

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 size and thickness of 2.67 mm nominal base metal thickness rails and terminal elements shall be within the tolerance specified below:

Base metal thickness	-	2.67 mm
Galvanized finished thickness	-	2.82 mm
Tolerance	-	0.23 mm

The size and thickness of 3.5 mm nominal base metal thickness rails and terminal elements shall be within the tolerance specified below:

Base metal thickness	-	3.43 mm
Galvanized finished thickness	-	3.58 mm
Tolerance	-	0.23 mm

14.3.2 Timber Material

Testing of the penetration of the preservative may be carried out by the Consultant. Warped wood posts will be rejected.

14.4 Installation

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 directed by the Consultant. Permissible tolerance for plumb and grade of posts shall be 6 mm maximum.

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.

Unsuitable material at the bottom of the holes excavated shall be replaced with granular material at the Contractor's expense, as directed 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 meeting the requirements of section 2.2.2 (Designation 2 Class 25). 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.

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 to be carried out. Modification by flame cutting method is prohibited. Modification by cold cutting method with a suitable drill press is allowed. Field guardrail modification is considered incidental to the work. Adequate edge distances of guardrail material shall be maintained during the modification process. All exposed steel areas shall be patched with two coats of zinc rich paint.

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 30 mm ring nails.

The Contractor shall take all necessary precautions to eliminate damage to galvanizing. Minor abrasions shall be repaired by painting with two coats of zinc rich paint. Major abrasions shall be repaired by regalvanizing. The method to be used for repair of any damage shall be accepted by the Consultant before such work is commenced. The Contractor shall repair or replace components to the satisfaction of the Consultant.

The guardrail shall be connected to bridgerail, parapets or existing guardrail as shown on the drawings.

Surplus excavated material and debris shall be removed from the site.

14.5 Payment

Payment for **Guardrail** will be made on the basis of the lump sum price bid for guardrail acceptably placed and remaining in the completed work, which price shall include full compensation for the cost of furnishing all labour, materials, equipment, tools, and incidentals necessary to supply the guardrail and all associated hardware.

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 15

NON-SKID POLYMER OVERLAY

TABLE OF CONTENTS

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

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 noted below.

PROPERTIES OF DEGADUR RESINS					
Property	**Units**	**Primer**	**Basecoat**	**Sealer**	**Test Method**
Density	g/cm^3	1.05	1.01	0.98	- -
Viscosity*	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

* at time of mixing

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 noted below.

PROPERTIES OF DEGADUR BASECOAT			
Property	**Units**	**Required Value**	**Test Method**
Compressive Strength*	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

* 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 shall conform to the following sieve analyses:

GRADATION OF BASECOAT FILLER AGGREGATES (MMA) **0.045 mm Ground Silica Flour** A minimum of 90% shall pass the 0.045 mm sieve. **Basaltic Sand**						
Sieve, mm	4.750	2.360	1.000	0.600	0.300	0.150
% Passing	99-100	92-100	61-70	45-65	10-20	0-10

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 Clause 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 the table below.

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 section 15.7.3 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.

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” of the Specifications for Bridge Construction.

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 Clause 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 Clause 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 Clause 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, Clauses 20.3.2 “Partial Depth Repairs” and 20.3.3 “Full Depth Repairs” shall apply.

All concrete shall be cured for 28 days and tested for moisture in accordance with Clause 15.7.3 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 Clause 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 below 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.

MINIMUM POLYMER COVERAGE REQUIREMENTS (ℓ/m^2)			
WEARING SURFACE CLASS	**1st Layer**	**2nd Layer**	**3rd Layer**
A	1.33	2.00	0.30
B	1.33	2.00	N/A
C	1.33	0.30	N/A

MINIMUM MMA POLYMER COVERAGE REQUIREMENTS FOR DEGUSSA DEGADUR SYSTEM (MMA) (ℓ/m^2)			
WEARING SURFACE	**Primer Layer**	**Premixed Basecoat Layer**	**Sealer Layer**
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℃ and 27℃.

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 ml poly, 1000 mm x 500 mm located in moisture prone areas. The test windows shall be heated at a temperature of 55℃ 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℃. 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℃ and 27℃. 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 Clause 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 Clause 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 2½ 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 the following tables.

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

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 below.

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

Payment for **Polymer Wearing Surface** will be made at the unit price bid per square metre of deck resurfaced, 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. The areas of the curb, median, deck joint or parapet vertical faces will be considered incidental and will not be included in the area of polymer wearing surface to be paid.

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 16

BRIDGE DECK WATERPROOFING

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16.1 General

This specification shall include the supply and installation of an approved waterproof asphaltic membrane. The area to be covered by the waterproofing shall be as shown on the site specific construction drawings. The work shall be completed in accordance with standard drawing S-1443 Deck Waterproofing System with 80 mm Two-Course Hot-Mix Asphalt Concrete Pavement.

16.2 Materials

All materials for this application shall be reviewed and accepted by the Consultant.

Tack Coat
The tack coat used in conjunction with the asphalt membrane shall be primer, cut back with an equal volume of gasoline type solvent, or an acceptable alternative cut-back asphalt product and be compatible with the asphalt membrane.

Asphalt Membrane
Asphalt membrane shall be hot applied rubberized asphalt and meet all requirements of the Ontario Ministry of Transportation's OPSS 1213 Specification. The asphalt membrane shall be supplied in cakes ready for melting and application.

Rubber Membrane
The rubber membrane shall be 1.2 mm thick butyl rubber.

Membrane Reinforcing Fabric
Membrane reinforcing fabric shall be 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. The performance of the material shall be unaffected by the heat generated by the waterproofing processes.

Wick Drain
Wick drain shall be composite polypropylene with a total thickness of 3.6 mm and supplied in 100 mm widths. The puncture strength shall be a minimum of 45 N measured in accordance with ASTM D4833. The performance of the material shall be unaffected by the heat generated by the waterproofing processes.

Waterproofing Protection Board
The protection board shall be a durable panel of 3 mm thickness specifically designed to provide a protective cushion between the hot mix asphaltic concrete pavement and the asphalt waterproofing membrane. It shall have a water absorption property of 5% or less and shall meet the Ontario Ministry of Transportation Specification OPSS 1215 for Protection Board.

16.3 Equipment

An approved heating and mixing kettle shall be used to heat the hot-applied rubberized asphalt membrane. The kettle shall be of the double boiler oil transfer type with a built-in agitator and equipped with permanently installed dial type thermometers to measure the temperature of the melted compound and the oil.

16.4 Installation

16.4.1 Traffic Restrictions

Traffic restrictions apply to all traffic other than the construction equipment directly associated with the waterproofing operations and the paving operations that follow.

After sandblasting operations have commenced, construction traffic will not be allowed on the sandblasted area until the ACP has been placed and cooled to ambient temperature.

16.4.2 Procedure

The Contractor shall perform all of the operations involved in waterproofing in sequential order, such that there are no delays between individual operations except those necessary to meet the requirements of these specifications.

16.4.3 Notice of Commencement of Waterproofing Operations

The Contractor shall give the Consultant 48 hours notice prior to commencing any waterproofing operations.

16.4.4 Surface Preparation

The deck concrete, including curbs, sidewalks and medians must be completely dry and cured at least 14 days before application of tack or membrane can proceed.

The existing surface of the concrete shall be completely sandblasted or shotblasted to expose sound, laitance-free concrete. All dirt and debris shall be removed and disposed of, leaving a prepared surface satisfactory for tack coating. Tack coating and waterproofing shall not commence until the Consultant has accepted all preparation work.

Immediately prior to the application of the tack coat, the concrete surface shall be air blasted to remove all dust and any other foreign material. The tack coat shall be cut back 50% with gasoline solvent. The application rate shall be such that the tack material will be absorbed into the concrete, resulting in a surface that is dull and black in appearance. The application of an excessive amount of tack as indicated by a shiny black surface shall be avoided. Tack coat material shall be applied with approved equipment which will provide uniform application at the required rate. The tack coat shall be applied only when the concrete is dry and clean, and when the air and concrete surface temperatures are above 5°C. Waterproofing equipment or material shall not be permitted on the tack coat until it has fully cured and is completely tack-free.

16.4.5 Waterproofing of Joints and Cracks

Special attention shall be paid to waterproofing over all construction joints, lift hook pockets, patches, and cracks.

Prior to the application of the hot asphalt membrane to the deck, a coat of hot asphalt membrane at least 4 mm thick and wide enough to extend 200 mm on either side of the joint or crack shall be applied in accordance with section 16.4.6, to the tack-coated concrete surface. A strip of membrane reinforcing fabric material wide enough to extend 150 mm on either side of the construction joint, lift hook pocket, patch or crack shall be applied while the asphalt membrane is still hot and tacky. Membrane reinforcing fabric shall be overlapped 100 mm when multiple strips are used.

Along all curbs, barrier walls, and deck drains the hot asphalt membrane shall be applied to the height of the top of the hot mix ACP surface course, and 150 mm onto the deck. The butyl rubber membrane shall extend 50 mm up the vertical face, 100 mm onto the deck surface, and overlapped 100 mm when multiple strips are used. The rubber membrane shall be applied while the asphalt membrane is still hot and tacky.

16.4.6 Application of Asphalt Membrane

Cakes of asphalt membrane shall be melted in the mechanically agitated heating and mixing unit specified. This unit shall keep the contents continuously agitated until the material can be drawn free flowing and lump-free from the mixing unit at a temperature not exceeding that recommended by the Manufacturer.

Membrane shall not be applied until the tack coat has cured completely. The asphalt membrane shall be applied within the temperature range recommended by the Manufacturer, to the clean, tack-coated concrete deck, to form a uniform film having a minimum thickness of 4 mm and a maximum thickness of 6 mm. The laying operation shall be such that discontinuities in the membrane are avoided and any joints lapped 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 hot mix surface course. Deck drains and drainage tubes shall not be plugged.

16.4.7 Installation of Wick Drain

Wick drains shall be placed along the full length of gutters and 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. Wick drain details shall be in conformance with standard drawing S-1443.

16.4.8 Application of Protection Board

The Contractor shall check and ensure that the asphalt membrane thickness conforms to the specified requirement, 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 minimum 12 mm to maximum of 25 mm both longitudinally and transversely. The protection board edge shall be within 5 mm of all curbs, drain verticals, and deck joint verticals.

Protection boards shall be placed such that the longitudinal (direction of traffic flow) joints are staggered at least 150 mm. It shall be rolled by means of a linoleum or lawn type roller while the membrane is still warm, in order 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. In instances where edges of the protection board curl up, the 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, by manufacture, storage, handling or exposure to weather, shall be rejected.

16.5 Sampling and Testing

The Consultant may require that sufficient quantities of the asphalt membrane, rubber membrane, membrane reinforcing fabric and protection board be supplied from the materials being used on the project for immediate analysis, flow tests, water absorption, or for other future testing purposes.

16.6 List of Approved Materials

16.6.1 Hot Applied Rubberized Asphalt Membrane

- “Bakor” 790-11
- “Beamalastic 1213 BDM”
- “Ultraseal 3750”

16.6.2 Rubber Membrane

- “Elastosheet 6147"
- “BP47 Elastometric Reinforcement”
- ”Bakor 990-25"

16.6.3 Membrane Reinforcement

- “Remay 2016”
- “Bakor Polyester Fabric”

16.6.4 Wick Drain

- "Nilex MD/7407"
- “Amerdrain 407”

16.6.5 Waterproofing Protection Board

Test results and samples of proposed protection board shall be submitted to the Consultant for review. The Consultant may carry out additional testing to confirm test data provided.

Acceptable products of Protection Board shall consist of spun glass fibres and not cellulose reinforcing fibres. Products which currently meet the 5% or less water absorption requirement are:

- “Vibraflex MTO Protection Board”
- “Bakor Asphalt Protection Board”
- “IKO Protectboard”

16.7 Measurement and Payment

Payment for **Deck Waterproofing** will be made at the unit price bid per square metre of deck waterproofed, which price shall be full compensation for the cost of all labour, equipment and materials required for the preparation of the concrete deck surface including sandblasting, supply and application of the tack coat, asphalt membrane, rubber membrane and protection board, handling and controlling of traffic, and for all other items of work necessary for the satisfactory completion of the work.

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 17

ASPHALT CONCRETE PAVEMENT

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17.1 General

Asphalt Concrete Pavement shall consist of crushed aggregates with reclaimed asphalt pavement (RAP), blend sand and filler material as required, and asphalt cement, combined in a hot mix plant as hereinafter specified, placed and compacted on bridge decks and approaches in conformity with the lines, grades, dimensions and cross-section as provided and as shown on the drawings.

This specification is for the following applications:

- ACP Wearing Surface applied over hot applied rubberized asphalt membrane waterproofing complete with protection board.

- ACP Wearing Surface applied on polymer membrane waterproofing.

- Asphalt Concrete Pavement transition and approach road paving.

For projects where transition ACP is required, the Contractor shall cold mill to achieve a 40 mm minimum thickness of ACP. The joint between the existing ACP and the new transition ACP shall be sawcut a minimum of 40 mm across the full width of roadway. Milling shall be considered as part of Asphalt Concrete Pavement and no separate or additional payment will be made.

This specification shall be used in conjunction with the current version of the Standard Specifications for Highway Construction which is referred to below as “Standard Specifications”. In areas of conflict between this specification and the “Standard Specifications”, this specification shall govern.

17.2 Materials

The Contractor shall supply Asphalt Cement and Aggregate in accordance with sections 3.50.2.1 and 3.50.2.2 of the Standard Specifications for Highway Construction.

The liquid asphalt shall be applied as a tack coat to ensure a bond between the surface being paved and the subsequent course, and shall consist of SS-1 or RC 30/70. When SS-1 is used it shall be diluted with an equal volume of water. In all cases where weather conditions permit, SS-1 shall be used in preference to RC 30/70. The 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.

17.3 Asphalt Mix Design

The Contractor shall prepare and submit asphalt mix designs in accordance with section 3.50.3 Asphalt Mix Design and Job Mix Formula of the Standard Specifications that are representative of materials to be used. For asphalt mix designs which were completed in excess of six months prior to anticipated production, additional analysis of more recent sampling shall be provided, as required to confirm that the mix ingredients continue to meet requirements.

The Type of Asphalt Mix to be used shall be as specified. Generally on primary highways (Highway 1 - 216) a Type H2 Asphalt Mix using a 150-200A asphalt cement grade will be specified, and on secondary highways (Highway 500 - 986) and local roads a Type M1 Asphalt Mix using a 200-300A asphalt cement grade will be specified.

When accepted by the Consultant the Contractor will be permitted to supply a Type H2 Asphalt Mix where a Type M1 Asphalt Mix has been specified.

17.4 Sampling and Testing

Unless otherwise specified sampling and testing procedures used to determine material characteristics shall be as outlined in the Standard Specifications for Highway Construction section 3.50.4 Sampling and Testing.

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 layers or other structures to the satisfaction of the Consultant at the positions where samples have been taken. Compensation for providing assistance with sampling and for reinstatement where samples are taken shall be included in the unit price bid for the various items of Work tested and no separate payment will be made.

Sampling of the asphalt mixture by the Consultant shall be done at a minimum frequency of two samples for each lift of placement. Sample size shall be 6 kg.

Quality Assurance (QA) testing done by the Consultant on each sample shall consist of an uncorrected asphalt content determination and aggregate gradation.

The Consultant shall use the Contractors correction factor determination as a guide to approximate the actual asphalt content. The actual asphalt content is the amount of asphalt binder in the mix as determined by ATT-12 or ATT-74, and includes a correction factor for the asphalt binder lost due to absorption by the aggregate or aggregate loss.

In-place density testing may be carried out on an as required basis at locations as determined by the Consultant.

Inspections during construction for pavement segregation shall be as outlined in section 3.50.4.7 of the Standard Specifications. Contrary to section 3.50.4.7.4 “Repairing Pavement Segregation”, areas identified as either moderate or severe segregation, shall be removed and replaced. Areas identified as slight segregation shall be repaired using a slurry patch.

The Consultant’s 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.

Generally, sampling and testing will only be carried out on projects consisting of 50 tonnes or more of ACP.

17.5 Quality Control Testing

The Contractor shall produce crushed aggregates in accordance with Specification 3.2, Aggregate Production and Stockpiling for Designation 1 aggregate and requirements listed in section 3.50.3.2 Design Requirements. The Contractor shall be totally responsible for production of aggregate that meets all the specified requirements.

The Contractor shall be responsible for all costs associated with quality control testing. Results of all quality control tests shall be submitted to the Consultant as they become available.

Unless otherwise specified, the latest edition of the following standard Alberta Transportation test methods (ATT) will be used to determine material characteristics.

Test methods and minimum frequencies of testing are shown in Table 17.5 Quality Control Testing Requirements.

Table 17.5
Quality Control Testing Requirements

TEST	STANDARD	MINIMUM FREQUENCY
AGGREGATE PRODUCTION		
SIEVE ANALYSIS 1. Sieve Analysis Crushed Aggregate	ATT- 26	Minimum of one test for each aggregate component.
PERCENT FRACTURE 1. Percent Fracture Crushed Aggregate	ATT- 50	Minimum of one test for each crushed aggregate component.
ASPHALT MIX PLANT 1. Calibration 2. Inspection	ATT-17 ATT-16	Once per project or as required Minimum of one per lift.
SAMPLES		
1. Asphalt Cement	ATT-42	If requested by the Consultant
2. Tack, Prime and Fog Materials	ATT-42	If requested by the Consultant
3. Cold Feed Aggregate	ATT-38	-3
4. Mix	ATT-37	Minimum of one per lift
5. QA Cores - Stratified Random Test Sites Chosen By The Consultant (Coring done by Contractor)	ATT-56 ATT-5	As requested by the Consultant

TEST	STANDARD	MINIMUM FREQUENCY
OTHER SPECIFIED TESTS		
1. Mix Asphalt Content	AASHTO T-164, T287 or ATT-12 or ATT-74	Minimum of one per lift.
2. Correction Factors	ATT-12, Part III or ATT-74, Part II	Once for each mix design.
3. Mix Moisture Content	ATT-15	Minimum of one per lift.
4. Aggregate Sieve Analysis	ATT-26	-3
5. Pavement Segregation	Paving Guidelines and Segregation Rating Manual	Daily Inspection
ADDITIONAL TESTING REQUIREMENTS		
1. Field Formed Marshall Briquettes	ATT-13	-1
2. Density Immersion Method, Saturated Surface Dry	ATT-7	-2
3. Void Calculations, Formed Specimens	ATT-36	-1
4. Temperatures	ATT-30	-1
5. Percent Compaction, Nuclear Density	ATT-67, ATT-5 or ATT-11	-2

Notes: (1) Minimum frequency not specified.
(2) Nuclear Density Testing is required on all projects. The Consultant may require the Contractor to obtain pavement cores (top lift only) for QC testing.
(3) One sieve analysis of the combined aggregate (any combination of cold feed, extraction or ignition) are required per lift.

17.6 Equipment and Methods

17.6.1 General

Equipment and methods used on this work shall be adequate to produce and place the material as specified herein, and shall be subject to the acceptance of the Consultant. The Department reserves the right to order changes or the discontinuance of use of any equipment or method which, in the opinion of the Consultant, fails to produce satisfactory results.

17.6.2 Asphalt Mixing Plant Requirements

All asphalt mixing plants used by the Contractor for the preparation of asphalt concrete material shall conform to the requirements of section 3.50.5.1.2 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.

17.6.3 Equipment for Transportation of Mixture

The mixture shall be transported from the asphalt plant to the worksite in trucks with smooth metal boxes in good and leakproof condition, previously cleaned of all foreign materials or hardened asphalt concrete mixture. Each vehicle shall be equipped with a tarpaulin of suitable material and of sufficient size to overhang the vehicle box when fully loaded. Tarpaulins shall be on the haul unit at all times and shall be used to cover the mixture completely unless otherwise determined by the Consultant. Tarpaulins shall be securely fastened on all sides of the box.

Truck boxes shall be clean, free from accumulations of asphalt mix and foreign material. Excess truck box lubricants such as detergent or lime solutions shall not be allowed to contaminate the mix, and shall be disposed of in an environmentally acceptable manner. Petroleum based truck box lubricants shall not be used

17.6.4 Paver

Pavers shall be acceptable to the Consultant and be self-propelled and operated to maintain required levels, cross-falls and joint matching.

17.6.5 Compaction Equipment

The Contractor shall provide sufficient self propelled equipment to obtain the required degree of compaction of the asphalt concrete mixture. The compaction capability of the equipment used shall equal or exceed the placing rate of the spreading operations and shall be capable of obtaining the required compaction before the temperature of the mat falls below specified levels. 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 does not occur. Specialized equipment may be required to achieve adequate compaction and smoothness in tight corners, such as adjacent to expansion assemblies and deck joints.

The Contractor is advised that a minimum of two pieces of compaction equipment shall be provided. They shall be rollers of at least 10 tonnes mass, one rubber tired and one smooth steel drum type. Vibrators on vibratory rollers shall not be activated.

The compaction equipment shall be in proper mechanical condition and shall be operated such that uniform and complete compaction is obtained throughout the entire width, depth and length of the pavement being constructed. Rollers provided 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 the asphalt mixture.

17.7 Construction

17.7.1 Asphalt Temperatures

The asphalt tank supplying the plant mixer shall be equipped with heating apparatus capable of producing asphalt temperatures up to but not greater than 160°C uniformly throughout the entire contents of the tank. The Contractor shall maintain the asphalt temperature within plus or minus 10°C of the specified mixing temperature.

17.7.2 Mix Production

The Contractor shall produce an asphalt mixture in accordance with section 3.50.5.1.3 Mix Production of the Standard Specifications for Highway Construction.

17.7.3 Protection of Adjacent Bridge Components

The Contractor must protect curbs, deck joints, and expansion assemblies to prevent splatter or spillage of asphaltic materials.

17.7.4 Tack Coat

Asphalt tack coat shall be applied to the existing protection board, polymer membrane waterproofing, granular base course, or existing asphalt concrete substrate and between lifts of asphalt concrete pavement, at the locations and to the dimensions designated by the Consultant.

The surface to be tacked shall be dry and free of loose or deleterious material when the tack is applied.

The asphalt tack coat shall be applied in a uniform manner at an application rate of 0.5 ℓ/m^2 and asphalt temperature designated by the Consultant. Air temperature in the shade at the time of application shall be 5°C or higher.

On areas where the Contractor is required to accommodate traffic, he shall tack the surface in two operations. In the first operation one half of the width shall be tacked with the remaining half being tacked after the first half has cured.

The tack coat shall be protected from traffic or other damage. Areas on which the tack has been damaged by traffic shall be retacked at the Contractor's expense.

17.7.5 Spreading and Compaction

17.7.5.1 General

The mixture shall be placed only upon a dry, frost free substrate on which the tack coat has cured and under weather and temperature conditions acceptable to the Consultant. Prior to the delivery of the mixture on the work, the base shall be cleaned of all loose or foreign material. The mixture shall be spread and compacted during daylight hours only, unless artificial light satisfactory to the Consultant is provided.

During spreading and compaction operations, care shall be taken at all times to ensure that:

- Asphalt mixture is not wasted over the side or onto the adjacent surface mat.
- Damage is not done to the waterproofing membrane, curbs, manholes, drains or medians.
- Damage is not done to guide posts, guardrails, signs, power conduits or any other roadside installations.

The Contractor shall make immediate and adequate repair of any damage resulting from his operations at his own expense.

17.7.5.2 Spreading

The mix shall be spread at a temperature sufficient for specified compaction and finishing at the final placement area.

The manner of placing shall be as acceptable to the Consultant to ensure safe accommodation of traffic, quality control and drainage. The longitudinal and transverse edges of each lane shall be straight in alignment, uniform, and of the same thickness as the adjoining pavement layer. Adequate measures for the protection of the exposed edges shall be maintained throughout the work.

Each layer shall be placed, finished and compacted for the full width, and then allowed to cool down to 50°C or colder prior to commencing the subsequent layer.

In the placing of successive layers, the individual mixture spreads shall be aligned in a manner such that the longitudinal joints in successive layers do not coincide. Unless otherwise directed, the lateral distance between the longitudinal joints in the successive layers shall be not less than 0.30 m. The longitudinal joint of the final lift of asphalt concrete pavement shall not be located within the wheel path areas.

The surface of all lifts shall not exhibit evidence of segregation, such as pockets of fine and coarse material.

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.

17.7.5.3 Compaction

The Contractor shall monitor the compaction process using a Control Strip Method. Control Strips are generally established on each mat placed.

The Control Strip lift shall be compacted using at least the following equipment:

(a) One steel roller weighing not less than 10 t; and

(b) One self-propelled pneumatic rollers, ballasted to its maximum capacity, weighing not less than 10 t.

Once the mix has been spread by the paver and the initial pass of the breakdown roller has been done, moisture and density measurements for determining the Control Density will commence at five locations within the Control Strip area, and will continue following repeated passes of the compaction equipment until the apparent maximum density is attained. These measurements will be taken by the Contractor using nuclear testing equipment.

The Contractor shall compact the pavement to a minimum average density of 97% of Marshall Density, with no individual density less than 95%.

When the compaction methods and procedures, in the opinion of the Consultant are not achieving the desired compaction specifications, the Consultant may require the Contractor, at any time to obtain cores of the top lift pavement. The number of cores will be determined by the Consultant. The cores will be tested by the Contractor and the results provided to the Consultant as they become available.

Percent compaction will be expressed in percent of Marshall Standard Density. The Marshall Standard Density used for determining pavement compaction shall be as follows:

(a) Marshall Densities determined on field sampled mix, or if not available then;

(b) Marshall Design Density as reported in the accepted mix design.

Coring shall be done using methods which will not damage the rubberized asphalt membrane or protection board. Core holes shall be completely de-watered and dried. A generous application of liquid asphalt shall be applied to the bottom and sides of the core hole and allowed to cure. Asphalt mix shall then be tamped in lifts into the core hole until flush with the surface of the surrounding pavement.

The Contractor shall not undertake any coring unless acceptance by the Department and the Consultant.

The Contractor shall be reimbursed for obtaining, preparing and testing cores at the rate of $100 per core location.

In order to maintain the crown of the bridge deck and approaches, the contractor shall avoid operating the compaction equipment on or across the crown. Compaction procedures and equipment shall be such that displacement of the mixture does not occur. Roller wheels shall be kept slightly moistened by water or oil to prevent picking up the mixture, but an excess of either water or oil will not be permitted.

In cases where the asphaltic mixture is placed under weather and temperature conditions which may be considered less than ideal, the Contractor shall modify normal operations and provide special attention to these situations such that specified compaction results are achieved.

17.7.5.4 Hot-Applied Rubberized Membrane Waterproofing

The first layer of the ACP Wearing Surface shall be spread by the asphalt paver moving with the laps in the protection board.

With the possibility of damage to the waterproofing membrane, the paver must not push the delivery trucks and all equipment must perform all turning movements off the bridge deck. Dumping of the asphalt mixture onto the protection board ahead of the paver will not be permitted.

The prepared material shall be placed and compacted in two nominal 40 mm layers.

To avoid displacement of the mixture the first lift shall be compacted only after the spread asphalt mixture has cooled to 105°C. The second lift shall be compacted when the spread asphalt mixture is within the following temperature ranges:

	COMPACTION TEMPERATURE RANGE	
ASPHALT GRADE	**FIRST LIFT**	**SECOND LIFT**
150 - 200 (A)	MAX. 105°C	128°C - 138°C
200 - 300 (A)	MAX. 105°C	123°C - 133°C

Due to the cooler compaction temperature (105°C) of the first lift, it may not be possible to achieve the 97% average density.

17.7.5.5 Polymer Membrane Waterproofing

The ACP Wearing Surface shall be placed in one lift of 50 mm nominal thickness. Dumping of the asphalt mixture onto the waterproofing membrane ahead of the paver will not be permitted.

The temperature of the asphalt mixture shall be between 123°C and 138°C at the start of compaction.

17.7.5.6 Transition and Approach Road Paving

The asphalt concrete pavement shall be placed as shown on the drawings and determined by the Consultant. Lifts of ACP shall not exceed 70 mm. Coarse aggregates shall be raked out of “feathered” edges of the asphalt concrete mat, to provide a smooth transition to the existing pavement.

The temperature of the asphalt mixture shall be between 123°C and 138°C at the start of compaction.

17.7.6 Surface Defects and Material Tolerances

The completed pavement and all intermediate lifts shall be smooth, true to established cross-section and grade, thoroughly compacted and free from ruts, humps, depressions, or other irregularities. Any ridges, indentations or other objectionable marks left in the surface of the asphalt concrete pavement shall be eliminated by rolling or by other means. The Contractor shall be responsible for all costs including materials associated with the repair of Surface Defects.

17.7.6.1 Smoothness

Except across the crown, the surface 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 deck anywhere below the straight edge. The surface shall be checked by the Contractor, as described above, immediately after the final rolling.

Any final lift pavement surface which does not meet the smoothness requirements given above shall be repaired by the Contractor to meet the requirements using methods acceptable to the Consultant.

Material removed by cold milling shall be hauled and disposed of by the Contractor, at his expense.

17.7.6.2 Segregated Areas

Segregated areas identified by the Consultant shall be repaired by the Contractor. Methods of repair for segregation shall be as reviewed and accepted by the Department and Consultant. All repairs carried out by the Contractor shall be at his own expense.

17.7.6.3 Obvious Defects

The finished surface of any lift shall have a uniform close texture and be free of visible signs of poor workmanship. Any obvious defects as determined by the Consultant such as, but not limited to the following, shall be promptly repaired in a manner acceptable to the Consultant.

(a) Areas of excess or insufficient asphalt
(b) improper matching of longitudinal and transverse joints
(c) roller or tire marks
(d) cracking or tearing
(e) sampling locations not properly reinstated
(f) improperly constructed patches

17.7.6.4 Asphalt Content

For top lift material the average asphalt content shall not be greater than ± 0.50% from the accepted mix design asphalt content.

For bottom lift material the average asphalt content shall not be greater than ± 0.65% from the accepted mix design asphalt content.

17.7.6.5 Aggregate Gradation

For each lift of placement the difference between the average gradation and the Job Mix Formula gradation shall not exceed the amounts shown in the following table:

Aggregate Gradation Variation

Sieve Designation	Maximum Permissible Variation* Percent by Weight Passing
5000	±6
1250	±4
630	±3
315	±3
160	±2.5
80	±2.0
*In any case the Average Gradation must meet the gradation requirements of Specification 3.2 Aggregate Production and Stockpiling	

17.8 Measurement and Payment

17.8.1 By Lump Sum Price Bid

Payment for **Asphalt Concrete Pavement** will be made on the basis of the lump sum price bid for the Asphalt Concrete Pavement acceptably placed on the bridge deck, approach slabs and approach roadways (as specified) and remaining in the completed work, which price shall include full compensation for the cost of furnishing all labour, equipment, tools, materials, milling, hauling and placing the mix, quality control testing and incidentals necessary to complete the work.

17.8.2 By Unit Price Bid

Payment for **Asphalt Concrete Pavement** will be made on the basis of the unit price bid per tonne for the Asphalt Concrete Pavement acceptably placed on the bridge deck, approach slabs and approach roadways (as specified) and remaining in the completed work, which price shall include full compensation for the cost of furnishing all labour, equipment, tools, materials, milling, hauling and placing the mix, quality control testing and incidentals necessary to complete the work. The number of tonnes to be paid for will be calculated based on the field measurement. The conversion factor for Asphalt Concrete Pavement from cubic metre to tonne shall be 2.3.

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 18

SUPPLY AND CONSTRUCTION OF CSP AND SPCSP STRUCTURES

TABLE OF CONTENTS

REFERENCE TABLES | Table No.

18.1 General

This section describes the supply, fabrication, delivery and installation of Corrugated Steel Pipe and Structural Plate Corrugated Steel Pipe with an equivalent diameter of 1500 mm or greater.

Abbreviations for the various types of metal pipe are as follows:

CSP	Corrugated Steel Pipe
CSP Arch	Corrugated Steel Pipe Arch
SPCSP	Structural plate Corrugated Steel Pipe
SPCSP Arch	Structural plate Corrugated Steel Pipe Arch

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 CSA Standard G401 with additions and exceptions as described in this specification.

18.2.2 Engineering Data

18.2.2.1 Shop Drawings

Five copies of the shop drawings for SPCSP structures and any non-standard materials (e.g. elbows, bottomless arch details, horizontal ellipses, etc.) as well as bevel end details shall be submitted to the Consultant for review prior to fabrication.

18.2.2.2 Plate Arrangement

The arrangement of the plates for SPCSP structures shall be shown on the shop drawings. The drawings shall also indicate that the bolts in the valley of each longitudinal seam are nearer to the visible edge of the plate than the bolts in the crest. With the exception of “change of radii” locations, all longitudinal seams shall be staggered a minimum of 2N.

The Contractor shall use the shop drawings at the site to facilitate the assembly of the pipe.

18.2.3 Materials

Previously installed pipe shall not be used. All pipe supplied shall be clearly marked with the following information at intervals of not more than 3 m.

- Manufacturer's Name or Trade Mark
- Nominal Thickness and Type of Metal
- Plate/Metal Coating (for non standard coating)
- Specification Designation
- Plant Designation Code
- Date of Manufacture

18.2.4 Fabrication

18.2.4.1 Fabrication of CSP

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.

Termination of Lockseams
On pipes 1000 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.

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.

Recorrugated Ends
All corrugated steel pipes shall have ends recorrugated to provide annular corrugations for couplers.

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 per coupler.

18.2.4.2 Fabrication of SPCSP

Sloped Ends
Sloped end sections are required for each culvert unless otherwise noted on the drawing or the order. When 2:1 sloped end sections are specified by the order the attached Table C will apply unless stated otherwise.

18.2.5 Shop Inspection

18.2.5.1 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 with acceptable material by the Contractor at the Contractor's expense.

Reinspection required due to faulty work shall be paid by the Contractor.

18.2.5.2 Notification

The Contractor shall contact the Consultant at least 72 hours prior to contemplate shipment. This is to facilitate inspection of the materials at the plant.

18.2.5.3 Failure to Notify for Inspection

Material that has not been inspected in the plant by the Consultant will not be passed for payment until such material has been inspected. The Contractor may be charged with all expenses incurred for the material to be inspected at the site.

18.2.6 Storage of Material

18.2.6.1 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.

18.2.6.2 Storage Stains

In addition to CSA G401, when noted on the order, SPCSP material is to be stored concave down. This requirement is to reduce the occurrence of storage stain damage on plates that are not going to be assembled immediately.

18.2.7 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.

18.3 Installation

Metal pipes are flexible, and their resistance to deformation depends on careful bedding and backfilling. As they deflect under vertical load they must build up wide support and therefore, to obtain maximum load bearing capacity, it is essential that the material under and beside the pipe be of good quality, carefully placed and properly shaped and compacted as specified on the drawings. It is essential that the structure be kept dewatered to the bottom of the excavation until all backfilling is complete.

18.3.1 Care of Water

The Contractor shall be responsible to make adequate provisions for handling water in and around the construction site. Care of water will be considered incidental to the work and no separate or additional payment will be made.

18.3.2 Excavation

Excavation shall be done to the lines and grades shown on the drawings, or as determined by the Department and Consultant, and in accordance with the appropriate sections of Section 1 “Excavation” of the Bridge Construction Specifications, to permit placing of the bedding material.

18.3.3 Bedding

Where the bottom of the excavation lies at 600 mm or less below the pipe invert the fill material shall be compact 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 when compacted. The Contractor shall use whatever materials, labour, equipment and incidentals necessary to achieve a stable bed.

When in the opinion of the Department and Consultant foundation conditions are considered soft and unstable, the Contractor shall supply and place woven geotextile filter fabric at the base of the excavation between the clay seals as shown on standard drawing S-1418-03. The woven geotextile filter fabric shall be in accordance with the following table:

Woven Geotextile Filter Fabric	
Specifications and Physical Properties	
Grab Strength	1275N
Elongation (Failure)	15%
Puncture Strength	275 N
Burst Strength	3.6 MPa
Trapezoidal Tear	475 N
Minimum Fabric Lap to be 1000 mm	

The granular 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 established by the Consultant. 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.

18.3.4 Assembly

Placing and assembly of the pipe may proceed only after the excavation, foundation and bottom bedding material and shape have been inspected and accepted by the Consultant.

<u>Assembly of CSP</u>
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. Where required joints shall be sealed using materials supplied by the Contractor.

<u>Assembly of SPCSP</u>
SPCSP shall be assembled as shown on the drawings which will be provided by the pipe supplier and as outlined below:

(a) The pipe shall be assembled on the invert bed as detailed on the drawings and reviewed by the Consultant.

(b) 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.

(c) Assembly and loose bolting of the side arc and top arc plates may then proceed to starting from the upstream end of the structure and progressing towards the downstream end.

(d) 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.

(e) 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.

(f) The vertical axis shall be upright and the longitudinal seams shall be straight. Rotation of the pipe and/or spiralling of the longitudinal seams shall not be permitted.

(g) 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.

(h) Bolts shall be torqued to not less than 200 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.

(i) Distortion of bolt holes caused by over-torquing, or poor assembly methods will not be permitted. Where additional holes are required they shall be drilled. Torch cutting of holes or welding on the pipe will not be permitted.

(j) The shape of the pipe shall be maintained within two percent of design dimensions. This includes the rise, the span, and any chords or chord offsets identified by the Consultant. Where required, the Contractor shall supply and install devices and/or use methods to maintain the shape of the structure. These devices shall not cause local distortions of the pipe or other signs of distress. Horizontal strutting shall not be used unless the Contractor obtains written acceptance from the Consultant. Restraining devices shall be left in place until the structural fill reaches the top of the sidewall or as determined by the Consultant. When determined by the Consultant, the Contractor shall supply and install devices to monitor the shape of the pipe.

18.3.5 Backfilling

When the assembly of the structure has been accepted by the Consultant, backfilling with Granular and or Non-Granular materials as specified on the drawings may proceed. Backfilling shall be in accordance with the current version of standard drawing S1418-03 and Section 2 “Backfill” of the Bridge Construction Specifications. In addition, the following requirements shall be met.

When the air temperature is below 0°C, no backfilling is allowed unless otherwise accepted by the Department and Consultant. When acceptance is granted, 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. Generally the material shall consist of clay or till materials. Highly plastic clay material or material with high silt content will not be permitted. The quality of the material, and the methods of placing and compacting, shall be accepted by the Consultant before commencement of this stage of construction.

18.3.6 Strutting for Composite Concrete/SPCSP Structure

For composite concrete/SPCSP structures strutting and scaffolding shall be supplied and installed as shown on the drawing.

18.4 Concrete Work

Where detailed and specified, the concrete work shall be constructed as shown on the drawings and in accordance with the Specifications for Bridge Construction:

Section 4 - Cast-In-Place Concrete

Section 5 - Reinforcing Steel

18.5 Fish Baffles

Fish baffles shall be constructed as shown on the drawings and be fabricated in accordance with the applicable Specifications for Bridge Construction section.

18.6 Rock Riprap

Rock riprap shall be placed as shown on the drawings and shall conform to the Specifications for Bridge Construction: Section 10 “Heavy Rock Riprap”.

18.7 Measurement and Payment

Unless otherwise specified on the drawings or in the “Special Provisions” payment for the following items:

- Detour Road - Construct and Maintain
- Salvage or Disposal of Existing Structure
- Excavation
- SPCSP - Supply
- CSP with couplers - Supply
- Pitrun Granular Backfill - Des 6 Class 80
- Crushed Granular Backfill - Des 2 Class 40
- Non-Granular Backfill
- SPCSP Assembly
- CSP Assembly
- Concrete End Treatment
- Fish Baffles
- Miscellaneous Iron
- Guardrail
- Roadway Work

will be on the basis of the unit price or lump sum prices bid for each of these items of work, acceptably completed. The prices bid shall include full compensation for the cost of furnishing all labour, materials, equipment, tools and incidentals necessary to complete the work.

When specified, payment for the supply and assembly of SPCSP or CSP with couplers can be made on the basis of the unit price bid per metre in place. The price bid shall be full compensation of the cost of furnishing all labour, materials, equipment, tools and incidentals necessary to complete the work.

When materials are delivered to the worksite, payments for: **“SPCSP – Supply” and “CSP with Couplers – Supply”** will be made to a maximum of 90% of the cost of the materials based upon the applicable supplier’s invoices. Payments will not be initiated until the Contractor submits the invoices to the Consultant upon receipt and acceptance of the material at the site. The remaining payment will be made after the structure is backfilled and accepted by the Consultant.

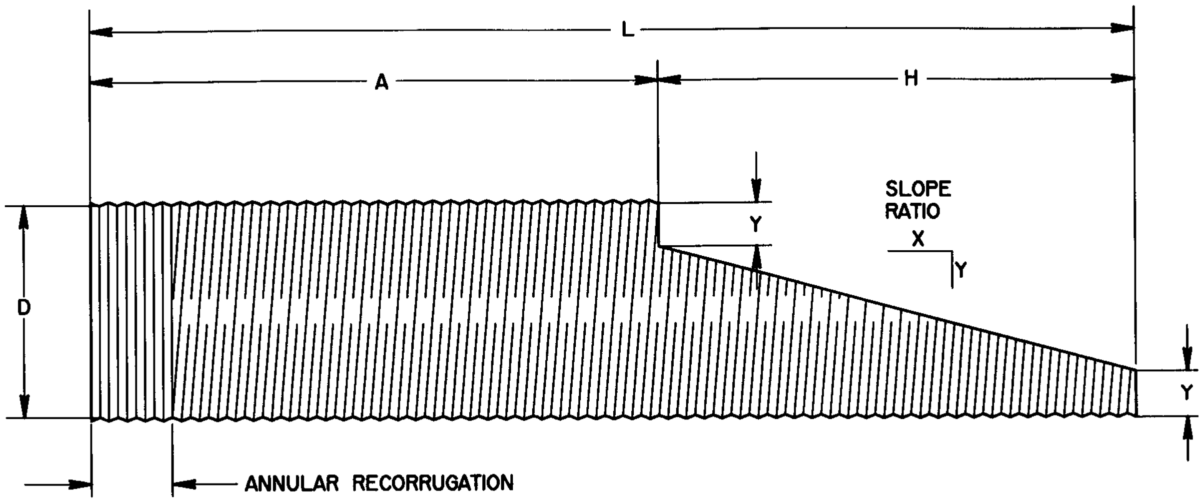
When woven geotextile filter fabric is specified, the supply, placing, equipment and tools necessary to acceptably complete this work will be considered incidental and no separate or additional payment for this incidental work will be made.

When woven geotextile filter fabric is not specified but deemed necessary as determined by the Consultant due to unsuitable foundation conditions, the supply, placing and the related work will be paid for by a negotiated lump sum price or in accordance with 1.2.25 “Extra Work” of the General Specification as determined by the Consultant.

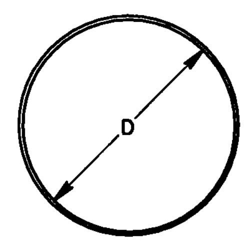
Payment for Concrete, Reinforcing Steel and Rock Riprap will be made on the basis of the unit price bids or lump sum bid for these items of work. These prices shall include full compensation for the cost of supplying all labour, materials, equipment, tools and incidentals necessary to complete the work.

The quantity to be paid for will be the actual number of units of materials and work satisfactorily completed and remaining in the structure.

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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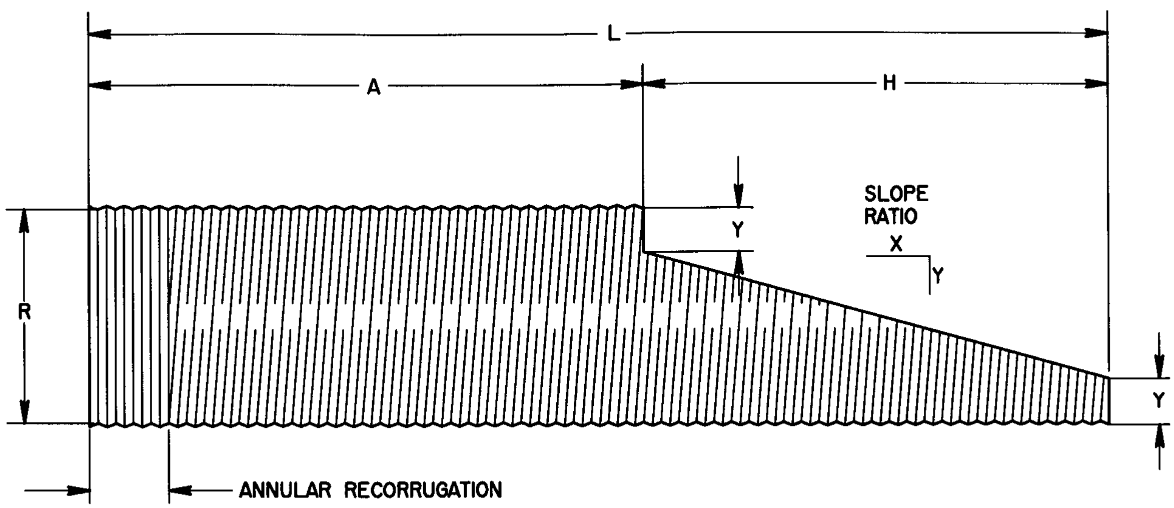
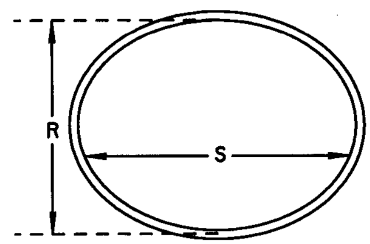
TABLE B
DETAILS OF STANDARD 2:1 SLOPED END SECTIONS FOR CSP ARCH CULVERTS





SECTION

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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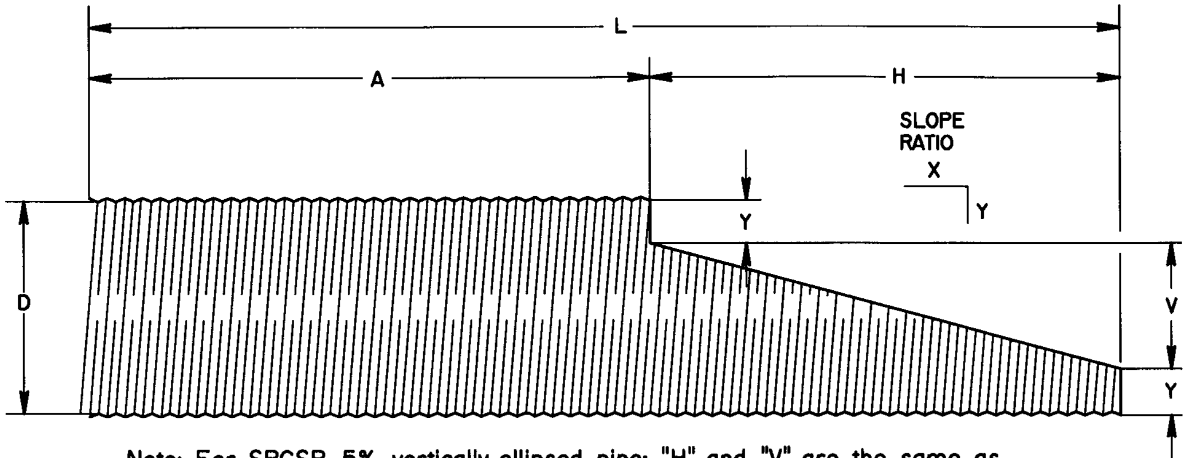
TABLE C
DETAILS OF STANDARD 2:1 SLOPED END SECTIONS FOR SPCSP ROUND CULVERTS



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
6160	2:1	1250	7.320
6470	2:1	1405	7.320
6780	2:1	1560	7.320
7090	2:1	1715	7.320
7400	2:1	1870	7.320
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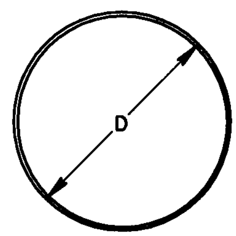

SECTION

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SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 19

PAINTED ROADWAY MARKINGS

TABLE OF CONTENTS

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

Paint and Glass Beads
The Contractor shall supply paint and glass bead materials from the current edition of the approved products listed in Specification Amendments (AMC-S139). 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
- Paint formulation

The Contractor shall advise the Consultant of any change in paint formulation. No paint formulation shall 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. He 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 during the paint application. All painted messages and lines shall be applied at the rate of 0.4 ℓ/m^2 of actual painted area. Glass beads shall be applied immediately following the paint application at a uniform application rate of 600 g/ℓ 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 sufficiently cured.

19.5 Payment

Unless otherwise specified, Painted Roadway Markings including the cost of furnishing all labour, materials, equipment and tools necessary to acceptably complete the work, will be considered incidental and no separate or additional payment for this incidental work will be made.

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

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SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 20

DECK OVERLAY AND CONCRETE REHABILITATION

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20.1 General

Deck Overlay Construction is bridge deck repair and resurfacing with Class HPC or Class HPC with Steel Fibres. This work involves traffic accommodation, bridge deck preparation, partial or full depth repair and deck overlay construction. Usually this work will be done on one half of the bridge deck at a time, while traffic is maintained on the other half. This section describes the requirements of quality control that constitute good and acceptable construction practice in the placement of these specialized types of overlay concrete.

20.2 Traffic Accommodation

Requirements for traffic accommodation shall conform to Appendix A – "Traffic Accommodation and Temporary Signing" of the Specifications for Bridge Construction.

20.3 Preparation Work

Bridge deck preparation includes but is not limited to all work necessary on the bridge deck prior to overlay concrete placement. This work includes the following:

- Removal and disposal of asphaltic concrete pavement and 5 mm depth of underlying concrete
- Removal and disposal of existing concrete paving lips
- Partial depth repair
- Full depth repair
- Sandblasting of the deck surface
- Removal and reinstallation of bridgerail, if required, to accommodate screedrail.

All unsound concrete will be located and marked out by the Consultant after the Contractor has completed Surface Removal, thoroughly cleaned the deck surface of debris and water, and removed all equipment.

"Jack Hammers" heavier than nominal 14 kg class and "Chipping Hammers" heavier than nominal 7 kg shall not be used.

20.3.1 Surface Removal

All ACP, tack coat and 5 mm of the underlying concrete shall be removed by cold milling or other acceptable methods. Curb and deck joint paving lips shall be removed, including the reinforcing steel projecting into these components. On bridges not having deck joints at the abutments, the Contractor shall saw cut through the full depth and width of the asphaltic concrete at both ends of the bridge prior to cold milling.

The Contractor is advised to exercise care during cold-milling to avoid damaging existing reinforcing steel or stressing strands.

Cold-milling shall be carried out as close as possible to all curbs, medians, parapets, drains, and deck joints without causing damage; chipping equipment will be required for use in these areas. Thickness of the ACP will vary, and the Contractor shall take care to remove not more than 5 mm in depth of the concrete surface. In the event he mills off more than 5 mm of concrete, without being so directed by the Consultant, the Contractor shall be responsible for the cost of the additional quantity of overlay concrete required to replace the overmilled concrete and repairing damaged reinforcing steel or strands.

For rehabilitation projects consisting of either concrete or ACP overlay, a minimum of one undisturbed travel lane shall be available for traffic at all times during construction, unless otherwise approved by the Consultant. Cold milling shall be carried out in stages and all costs associated with Mobilization/Remobilization shall be included in the unit price bid for “Surface Removal”.

The Contractor shall dispose of all debris in an area and in a manner suitable to the Consultant. Written acceptance from the owner of the disposal site shall be submitted, and evidence of his acceptance of the disposal site cleanup will be required before holdback will be released.

Payment for **Surface Removal** will be made on the basis of the unit price per square metre bid for this work, which price shall include full compensation for the cost of furnishing all labour, materials, equipment, tools and incidentals necessary to complete the work, including disposal of the debris.

20.3.2 Partial Depth Repair

All unsound concrete on the deck, curbs, parapets and medians will be located and marked out by the Consultant, and removed by the Contractor by chipping, scabbling or other acceptable means to provide a sound surface on which to bond the new concrete. Partially exposed rebar shall be entirely exposed by removal of the concrete to a depth of 25 mm below the bars. Additional rebar will be required when the existing rebar has a sectional loss of 20% or greater. The additional rebar shall be of the same bar size as that of the original. Splicing requirements shall be in accordance with 5.6 of the specifications. The supply and installation of the rebar will be considered incidental and no separate or additional payment will be made. For repair areas other than the deck substrate, the limits of the concrete removal shall be outlined by 25 mm deep sawcuts. The Contractor shall bend exposed rebar back to provide minimum 25 mm cover when accepted by the Consultant. All exposed rebar surfaces shall be sandblasted to a white-metal finish immediately prior to casting of concrete. The repair areas shall be formed and recast with 45 MPa Class HPC, using the procedures detailed in section 20.3.3 “Full Depth Repair”. For other deteriorated areas, the preparation work shall be the same as above except that appropriate Alberta Transportation approved patching material can be used in lieu of the silica fume concrete. Removed deck concrete shall be replaced monolithically with the Deck Overlay Concrete. All debris shall be disposed of in an area suitable to the Consultant.

Payment for **Partial Depth Repair** will be made on the basis of the unit price bid per square metre of concrete repaired. This will include the cost of removal of unsound concrete, sandblasting, disposal of debris, and the supply and placing of rebar (if required), replacement concrete and incidentals necessary to complete the work.

20.3.3 Full Depth Repair

Where concrete deterioration extends completely through the deck or at the curbs, as determined by the Consultant, all unsound concrete shall be removed and replaced with Class HPC. All exposed rebar and bond surfaces are to be sandblasted and blown clean prior to casting. Additional rebar will be required when the existing rebar has a sectional loss of 20% or greater. The additional rebar shall be of the same bar size as that of the original. Splicing requirements shall be in accordance with section 5.7 of the specifications. The supply and installation of the rebar will be considered incidental and no separate or additional payment will be made. The underside of the deck and curbs shall be formed so as to neatly restore the original lines of the concrete. Forms shall not be hung or suspended from existing deck reinforcing steel.

Before placing the concrete patch, the surfaces of adjoining concrete shall be saturated with water for a period not less than 30 minutes, and coated with an approved bonding agent immediately ahead of placing the fresh concrete. The concrete must be adequately vibrated and trowelled smooth and flush to the existing concrete. Concrete shall be cured in accordance with section 4.22 of the Specifications. When the conditions do not permit a monolithic pour, full depth repair concrete shall be cured at least 3 days and shall develop sufficient strength before placing the overlay so that it is not adversely affected by the overlay operation.

Payment for **Full Depth Repair** will be made on the basis of the unit price bid per square metre of concrete repaired. This will include the cost of removal of unsound concrete to full depth, sandblasting, provision and removal of all forming, scaffolding, falsework, disposal of debris, the supply and placing of rebar (if required), the replacement concrete and incidentals necessary to complete the work.

Fully acceptable Class HPC patching shall have a 28-day minimum compressive strength of 45 MPa based on the results of the strength tests as specified in section 4.9.1. The Department reserves the right to reject any concrete whatsoever which fails to meet these specifications.

In the event that the strength of any particular batch indicates concrete failing to meet fully the specifications above, the Department and Consultant may, at his sole discretion, accept that batch at reduced payment rates according to the following schedule:

28 Day Minimum Compressive Strength	Amount of Payment
45 MPa and over	Full bid price
42 - 45 MPa	Bid price less $25.00 per square metre
40 - 42 MPa	Bid price less $50.00 per square metre
37 - 40 MPa	Bid price less $100.00 per square metre

All concrete below 37 MPa will be rejected.

20.3.4 Deck Surface Sandblasting

The entire deck surface, the vertical faces of the curb, median and parapet up to the height of the thickness of the overlay, and partial and full depth repair areas shall be sandblasted just prior to placing Deck Overlay Concrete to avoid rusting of the exposed sandblasted reinforcing steel. The Contractor shall provide adequate shielding to protect any exposed epoxy-coated reinforcing steel. Sandblasting should be sufficient to uniformly expose the fine aggregate, and clean the deck surface so that it is free of all sand, dust and other contaminants.

Sandblasting and all other surface preparation shall be done to the acceptance of the Consultant. If, in the opinion of the Consultant, rusting of the sandblasted reinforcing steel has occurred or the sandblasted deck has in any way become contaminated, the Contractor shall repeat the sandblasting at his expense.

Payment for **Sandblasting** will be made on the basis of the unit price bid per square metre of bridge deck surface for this work, which price shall include full compensation for the cost of furnishing all labour, materials, equipment, tools and incidentals necessary to complete the work.

Sandblasting at the vertical faces of the curb, median and parapet up to the height of the thickness of the overlay is considered to be incidental and no extra payment will be made.

20.4 Construction

20.4.1 General

The Deck Overlay Concrete shall consist of Class HPC or Class HPC with steel fibres as described in Section 4 “Cast-in-place Concrete”, of which sections 4.2 to 4.9, 4.14, 4.16, 4.20 and 4.22 shall apply. Additional requirements are included in this section.

20.4.2 Gradeline Profiles/Dry Run

Design gradeline profiles for the finished overlay and transition ACP shall provide a smooth riding surface. Where no asphaltic concrete pavement exists on the bridge deck, the design gradeline profiles will be nominally 70 mm above the concrete surface. For projects with existing ACP, the Consultant, with the assistance of the Contractor, will profile the bridge deck and approaches prior to and after cold milling. When developing the gradeline profiles, the Consultant will consider such items as rideability, concrete thickness/quantity, dead load deflection and deck drainage. Emphasis should be on producing a high standard of overall rideability with a “reasonable” quantity of overlay concrete.

Typically the design gradeline will be determined on 3 m intervals on two to four profile lines for the entire length of each half of the bridge deck, to determine the overlay thickness and the height of the screed above the existing concrete, at each of these controlled points. The gradeline will be designed by the Consultant and be provided to the Contractor for his use in setting up his screed. The following are guidelines that shall be used to produce the gradeline profiles:

- provide two complete parallel profile lines for each construction stage
  Line No. 1: 1.0 m from curb face.
  Line No. 2: 0.3 m in from other edge of proposed pour.
  Stations of Line No. 1 and Line No. 2 shall be square to each other.

- establish station intervals at 3 m and at edges of existing joints that are to be retained or at new joint locations.

- profiles shall include 30 m (at 3 m intervals) of approaches at each end.

- fluorescent paint shall be used to mark profile points on the existing deck surface, curbs and approaches. The marks shall be approximately 40 mm in diameter. The Contractor shall be responsible for removing these profile points after the deck overlay is completed.

- provide profile plots on metric graph paper to a scale of:
  Horizontal - 10 mm = 1000 mm
  Vertical - 1 mm = 1 mm (normal) or 1 mm = 5 mm (minimum)

- proposed design gradeline shall be a smooth line achieving a nominal overlay thickness of 70 mm or as shown on the drawings.

The Consultant will provide the summary of proposed overlay thickness to the nearest mm at each controlled point prior to the Contractor setting screed guide rails.

The location of the longitudinal overlay construction joint will require the acceptance of the Consultant. Typically, the joint 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 will be offset by a minimum 300 mm. A longitudinal bulkhead shall be provided at the location of the overlay construction joint.

The Contractor is responsible for properly setting the screed rails to match the gradeline provided by the Consultant with emphasis on providing positive longitudinal and transverse drainage from the bridge deck. Depressions in the concrete surface, resulting from deficient finishing procedures and creating ponded water, shall be repaired by the Contractor at his cost.

Sufficient screed guide rails for the entire contemplated pour shall be set out, adjusted for height, and accepted by the Consultant.

Screed guide rails upon which the finishing machine travels on shall be placed outside the area to be concreted. 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. To confirm the adjustment of the machine and guide rails, the screed shall be “dry-run” prior to the pour and clearance measurements taken at each controlled point and provided to the Consultant for review and acceptance. Re-setting of the machine and/or guide rails shall be done as necessary, to obtain an acceptable dry-run. Adjustments to the machine or the rails will not be permitted after an acceptable dry-run has been made.

20.4.3 Cement/Silica Fume Slurry Grout

After all deck preparation is complete, the wet cure water supply system specified in section 4.22 shall be used to continuously soak the entire deck for a minimum of 3 hours with clean water conforming to concrete mixing water. Just before concrete placing commences the deck shall be blown free of all excess water. A thin coating of cement slurry grout shall be scrubbed onto the prepared surface.

The grout for bonding the new concrete overlay to the existing concrete shall be mixed in a mechanical mixer, and shall consist of equivalent parts by weight of 4% silica fume, 46% Type GU hydraulic cement and 50% sand of maximum 2.5 mm aggregate size, mixed with sufficient water to form a slurry. The consistency of the slurry shall be such that it can be applied with a stiff brush or broom to the existing concrete surface in a thin, even coating that will not run or puddle in low spots.

Care shall be exercised to ensure that the surface receives a thorough, even coating, and that no grout is permitted to pond. The rate of progress in applying grout shall be limited so that the grout is placed immediately prior to placing the new concrete, and in no case shall the grout be permitted to dry before placing of the concrete.

Mixed grout, not yet deposited, shall be re-agitated at frequent intervals to prevent segregation. Any grout that has not been placed within 45 minutes will be rejected. The Contractor shall have at least two grout mixers on site during placing of the overlay.

20.4.4 Conveyance of Concrete on Deck

Vehicles and equipment shall not be permitted directly on the prepared surface. The Contractor may, however back his truck mixers onto the deck, and discharge concrete directly ahead of the finishing machine provided the deck is continuously protected. The sandblasted surface shall not become contaminated with water, oil, spilled concrete, or other substances. The protection shall remain in place until it has to be removed to allow air blasting and grouting.

20.4.5 Mixing Overlay Concrete

The Deck Overlay Concrete shall be mixed at a qualified concrete batch plant or at the bridge site in truck mixers. Concrete produced at a qualified batch plant will only be acceptable when the anticipated delivery and discharge time is in conformance with section 4.6 “Mixing Concrete” of the Specifications. In the event of site batching, additional requirements are included in this section.

Pre-bagging for Site Batching

The fine and coarse aggregates, cement, fibres if applicable and silica fume shall be measured and pre-mixed together in the approved proportions before being packaged in suitable bags. Each bag shall be in good condition, free of holes or tears, with all seams fully sealed. The bags must be constructed of moisture proof material and securely closed after filling. The bags shall have adequate lifting hooks or straps attached to the top and shall be designed to suitably discharge the material from the bottom of the bag through a discharge opening of at least 460 mm diameter. Each bag shall have at least a nominal 1100 kg capacity. Partially filled bags will not be permitted 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, 1100 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 particular care to protect the bagged pre-mix from the elements during hauling and storage at the site.

Truck Mixers and Water Supply for Site Batching

The Deck Overlay Concrete shall be mixed at the bridge site in truck mixers. The Contractor shall provide all labour, materials, and equipment necessary to do the work.

The Contractor shall employ adequate equipment in order to mix concrete at a rate sufficient to ensure continuous concrete placement. A minimum of three truck mixers shall be brought to the site prior to each overlay pour and utilized in the mixing operation. Truck mixers 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 mass. All materials for the concrete shall be charged into the drum at the bridge site.

The Contractor shall supply a suitable water source or tank, solely for the purpose of batching concrete, and having sufficient mixing water for each pour. The water supply shall be equipped with an accurate water measuring device, having 0.1 ℓ increments.

Mixing of Deck Overlay Concrete for Site Batching

Initially, approximately two-thirds of the required mixing water shall be released into the drum, after which the air entraining agent, superplasticizer and other admixtures shall be added. The remaining required water shall continue to flow into the drum as the solid materials are being charged into the mixer. Mixing shall continue until all concrete is uniform in appearance, with all ingredients uniformly distributed.

The water supply pipe shall be adequate to ensure 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 quickly mix with the entire batch.

The Contractor shall take whatever steps are necessary to ensure that the full content of each pre-mix bag enters the mixer in an even and uniformly proportioned stream. Segregation, spillage, and 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 must be accurately proportioned; increases in water-cement ratio will not be permitted.

The Contractor shall in no case load the mixer with more than 3 cubic metres of concrete, or above 85% of its rated capacity. The Contractor shall maintain the mixer in good condition while it is being employed on Department work. Inner surfaces of the mixer shall be kept free of hardened concrete and mortar, and 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 fault charging shall be taken out of service until repaired or improved. 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 concrete shall be discharged within 70 minutes after the introduction of the water to the pre-mixed material.

Discharge chutes shall be kept clean and free from hardened concrete and shall be wetted down prior to use. After each batch is discharged, the drum shall be thoroughly cleaned and any excess water removed, before additional batches are mixed.

The truck mixer shall be backed onto the bridge deck protected with plywood or heavy tarps, and the concrete discharged directly in front of the finishing machine.

The Contractor shall test and record, at the mixing site, the bag production dates/numbers, the air content, slump, and temperature of each batch; results of all such tests shall be provided to the Consultant. In case of an unacceptable result, the Contractor will be allowed to adjust only the quantities of superplasticizer and air entraining agent. Addition of 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 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 this batch which may have already been placed in the structure.

20.5 Concrete Placement

In addition to the requirements of section 4.16, “Placing Deck, Curb and Deck Overlay Concrete”, the following shall apply.

The Contractor shall take every precaution necessary to secure a smooth-riding bridge deck, within the tolerances indicated in section 4.16.6.

Concrete placing shall normally be between the hours of 6:00 pm and 10:00 am except with specific acceptance of the Department and Consultant. Night pours shall require proper lighting as acceptable to the Consultant. Adequate lighting will be required both in front and behind the finishing machine. Additionally, four-bulb halogen tower lights will be required at each end of the bridge and at the sampling and testing site.

Discharge chutes shall be kept clean and free from hardened concrete and shall be wetted down prior to use. After each batch is discharged, the drum shall be thoroughly cleaned and any excess water removed, before additional batches are mixed.

Concrete shall be placed so as to avoid segregation of materials. The concrete finishing machine shall conform to section 4.16 of the specifications.

Placement of the concrete shall be a continuous operation for the duration of the pour. No more than 5 minutes shall elapse between truck mixer discharges. In the event that due to equipment breakdown, concrete placement is stopped or delayed for a period of 60 minutes or more, further placement shall be discontinued and may resume only after a period of not less than 12 hours. This restriction does not prohibit continuation of placement provided a gap is left in the lane or strip; the gap shall be sufficient in length for the finishing machine to clear the previously placed concrete. The fill-in section shall be placed after a period of not less than 12 hours. The edge of any discontinued overlay shall be saw-cut before placing further overlay material.

The width of the initial overlay section placed shall extend to the approved construction joint location. The subsequent overlay course shall match the adjacent previously placed course, and shall not be placed until the course initially placed is at least 72 hours old.

20.5.1 Surface Texture

Surface texture shall be in accordance with section 4.24 of the specifications.

The Contractor is advised that achieving a satisfactory texture on concrete overlay is difficult. It is essential that a worker competent in this work be employed. Several types of wire brooms, rakes and combs should be available at site so that the one giving the best result can be selected. In the event that a satisfactory texture, in the opinion of the Consultant, is not achieved, the Contractor will be required to sawcut transverse grooves of the dimensions described in the specifications. This work shall be done at the Contractor’s cost, and no additional payment for this work will be made.

Following the surface texturing, a strip of the overlay along the curb shall be trowelled smooth and the surface left closed so that a gutter is formed. The gutter shall have a width of 400 mm measured from the curb face.

20.5.2 End of Overlay

The overlay shall be placed to match the deck joints however where the overlay does not terminate at a deck joint, such as on roof slabs, the overlay shall be continued to and bulkheaded off 150 mm beyond the required end of the overlay. After adequate curing, the 150 mm over-pour shall be sawcut and disposed.

20.5.3 Longitudinal and Transverse Overlay Construction Joints

The Contractor shall construct an approved bulkhead at the construction joint location which will maintain horizontal and vertical alignments during concrete placing and finishing. The resulting vertical face of concrete shall be sandblasted in conformance to section 20.3.4 of the specifications. The sandblasting at the vertical face is considered to be incidental to the work and no extra payment will be made.

For longitudinal and transverse construction joints, the top edge of the overlay concrete at faces of curbs, barriers, medians, previously placed overlay concrete or existing concrete shall be tooled to a depth of 12 mm and a width of 6 mm. The tooled groove shall be filled with a gravity flow epoxy listed in the following Alberta Transportation website path: Alberta Transportation Product List/Crack Treatment/Concrete Crack Filler/Proven. Prior to installation, the contact concrete surfaces shall be blown clean to remove all deleterious materials and prepared in accordance with the manufacturer's recommendations. The tooled groove shall be full of epoxy material upon completion of the work and may require subsequent applications for maximum penetration. The creation of the tooled groove and the application of the gravity flow epoxy is considered incidental to the work and no extra payment will be made.

20.5.4 Curing Concrete

Curing concrete shall be in accordance with section 4.22 "Curing Concrete" of the specifications.

In the event that the wet curing is unacceptable, and any portion of the overlay becomes surface dry during the curing period, the Consultant will have cause to reject the overlay.

20.5.5 Opening to Traffic

In addition to the curing requirements, the concrete overlay shall not be opened to traffic until the requirements of section 4.26.2 of the specifications have been met.

20.6 Measurement and Payment

Payment for **Deck Overlay Concrete** will be made on the basis of the unit price bid per cubic metre for acceptable overlay concrete remaining in the completed work. The number of cubic metres to be paid for will be calculated by the Consultant from the final "dry-run" values, and the area overlayed. No separate or additional payment will be made for the supply of concrete overpour.

Payment for **Placement Deck Overlay Concrete** will be made on the basis of the unit price bid per square metre, which price shall include full compensation for the cost of all labour, tools, and equipment to satisfactorily place, finish, cure, and sawcut the overlay. It shall include all costs to remove and dispose concrete overpour and debris. The number of square metres to be paid for will be calculated by the Consultant from the actual area overlayed and remaining in the completed structure.

20.6.1 Failure to Meet Strength Requirements

Fully acceptable concrete shall have a 28 day minimum compressive strength of 45 MPa based on the results of the strength tests. The Department reserves the right to reject any concrete whatsoever which fails to meet these specifications, and to require its removal from the deck.

In the event that the strength test of any particular 10 m^3 portion of the concrete pour indicates concrete failing to meet fully the specifications above, the Department may accept that 10 m^3 portion at reduced payment rates according to Section 4 "Cast-in-place Concrete", of which section 4.26 shall apply only to the unit bid per cubic metre of overlay concrete. All concrete below 37.0 MPa will be rejected.

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 21

REMOVAL AND SALVAGE OF BRIDGE STRUCTURES

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21.1 General

This specification covers materials and related works for the removal of bridge structures and bridge culverts. This includes salvage and disposal of materials from these bridge structures.

Work shall be completed in accordance with this specification or as determined by the Department and Consultant.

All materials in bridge structures are the property of the Department. Prior to removal of bridge structures the Contractor shall obtain, from the Consultant, a list of materials to be salvaged and permission to proceed. In general, treated timber, structural steel, corrugated steel pipes and precast concrete units will be listed for salvage.

21.2 Workmanship and Handling of Materials

The Contractor shall perform his work in a manner that prevents damage to or loss of materials listed for salvage. Where the Contractor causes damage to or loss of materials listed for salvage, the Contractor shall repair or replace these materials at his expense and to the acceptance of the Consultant.

21.3 Excavation for Removal

The excavation shall conform to Section 1 - Excavation.

For culverts, the excavation shall extend to the invert elevation and the width at this level shall be the culvert width plus 3.0 m. For bridge abutments, the excavation shall extend to the ground level at the stream side of the abutment. The sides of all excavations shall be excavated at one horizontal to one vertical or as required for stability.

21.4 Removal

21.4.1 General

Removal shall mean removing bridge structures, salvaging the materials listed by the Consultant, stockpiling the salvaged materials at the bridge site or the Contractor's storage area, disposing of the remainder of the bridge structure and leaving all work areas in a tidy and safe condition.

The Contractor shall provide the Consultant with a list of all materials salvaged.

21.4.2 Salvage

Materials listed by the Consultant for salvage shall be dismantled piece by piece removing all nails, bolts, drift pins and other hardware. Torch cutting to remove hardware or to dismantle these materials will not be permitted.

Structural Plate Corrugated Steel Pipes shall be dismantled to yield lengths not exceeding eight metres. Corrugated Steel Pipes shall be dismantled by removing the couplers to yield 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, and by removing 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.

21.4.3 Disposal

Materials in bridge structures not listed for salvage shall be disposed of in a manner and location acceptable to the Consultant. The Contractor shall provide written acceptance from the owners of the disposal site(s) and evidence of their acceptance of the disposal site clean up, prior to receiving full payment.

In general, the portion of bridge abutments and piers located above natural ground level shall be completely removed, and the portion below the natural ground level may remain in place.

21.5 Haul of Bridge Material

When determined by the Consultant, the Contractor shall haul salvaged materials. The haul of salvaged materials shall include loading, unloading, stockpiling and all associated handling of the materials.

21.6 Measurement and Payment

Payment for **Removal of Bridge Structures** will be made at the lump sum bid for the particular bridge structure removed. This payment will be full compensation for completing the work as described in section 21.4 including excavation and for the use of all equipment, tools, labour and incidentals necessary to complete the work.

21.6.1 Haul of Bridge Material

Haul of Bridge Material will be made only where the Consultant directs the Contractor to undertake the haul of salvaged material to a point outside the limits of the contract and only when the Consultant accepts the condition of the salvaged material at the final location. The haul of salvaged material to the Contractor's storage area, and haul of material to a disposal site will not be paid for separately but will be considered incidental to the removal of the bridge structures.

Where applicable, payment for the **Haul of Bridge Material** outside the limits of the contract will be at the lump sum price bid which price shall include full compensation for loading, hauling, unloading, stockpiling and for providing all labour, equipment, tools and incidentals necessary to complete the Work.

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 22

PAINTING

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22.1 General

This specification is for the field painting of structural steel bridges and for the 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 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.
- Society for Protective Coatings (SSPC) “Standard Procedure for Evaluating the Qualifications of Painting Contractors to Remove Hazardous Paint” SSPC-QP2
- Society for Protective Coatings (SSPC) Guide 6-Guide for Containing Debris Generated During Paint Removal Operations.
- Society for Protective Coatings (SSPC) SP 1 Solvent Cleaning.
- Society for Protective Coatings (SSPC) SP 6 Commercial Blast Cleaning.
- Society for Protective Coatings (SSPC) SP 7 Brush-Off Blast Cleaning.
- Society for Protective Coatings (SSPC) SP 10 Near-White Blast Cleaning.
- Society for Protective Coatings (SSPC) SP 12 Surface Preparation and Cleaning of Steel and Other Hard Materials by High- and Ultrahigh-Pressure Water Jetting Prior to Re-coating.
- Alberta Transportation “Fish Habitat Manual”
- Alberta Transportation “Approved Paint Systems”

SSPC specifications are available from:

The Society of Protective Coatings Telephone: (412) 281-2331
40 - 24th Street, 6th Floor Website: http://www.sspc.org
Pittsburgh, PA 15222-4656
USA

Alberta Transportation APPROVED PRODUCTS – Bridge Coating Systems (Paint) are available on the internet at:

http://www.transportation.alberta.ca/Content/docType253/Production/paintlist.pdf

22.3 Contractor Qualifications

One of four levels of Contractor competency will be specified in the Special Provisions of the Contract. The levels of competency are as follows:

CQ1 The Contractor and any subcontractors must have certification in good standing with the Society for Protective Coatings (SSPC) under SSPC-QP2.

CQ2 The Contractor and any subcontractors must have certification in good standing with the Society for Protective Coatings (SSPC) under SSPC-QP1.

CQ3 Contractor acceptance 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 practised, copies of any relevant environmental permits and any citations for failure to comply. A list of qualified personnel will be responsible for the actual paint removal and application. Once accepted no personnel changes shall be made without the Consultant's 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 closing tenders will be considered acceptable.

22.4 Materials

22.4.1 Supply

The painting Contractor 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.

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 acceptable to the Department and Consultant prior to closing of the tender.

22.4.3 Paint

The contractor shall use only the paint systems listed in the Alberta Transportation “Approved Paint Systems” specified in the Special Provisions of the applicable painting contract. The material data sheets and material safety data sheets of the chosen paint system shall be submitted with the contractors work procedure. Only one paint system shall be used throughout the project unless specified otherwise. The contractor shall not change to another approved system once the initial paint system has been applied to any portion of the structure.

For each batch, the Contractor shall carry out the necessary testing prior to usage, to ensure the paint being supplied meets Alberta Transportation requirements for:

- colour
- gloss
- solids content
- IR (Infra red analysis for comparison with the original approval testing)
- EDXA (Energy dissipating x-ray analysis for comparison with the original approval testing)

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.

Each batch of paint or coating will be sampled and tested by the Department and Consultant. Four (one litre) samples of paint will be removed and retained from a pail or barrel chosen at random by the Consultant. The samples will be tested to assure the paint complies with the original approval testing.

22.5 Examination of the Work

Before submitting a bid the Contractor is required to thoroughly examine the bridge structure, to become aware of the existing condition of the surfaces to be painted. He is to be completely familiar with every detail and intent of both this specification and the scope of the work to be performed, as detailed in the contract Special Provisions. Each bidder is to examine the site and the surrounding area and become familiar with any restrictions or possible restrictions, public traffic, and the property of others.

Bidders may conduct their own site testing to verify the blasting required and the lead content that may be expected in the blasting spoil. Any site testing must be pre-acceptable to Alberta Transportation/Consultant.

22.6 Environmental Issues

22.6.1 Emission Levels

The percentage of blasting spoil that must be recovered and the Class of containment required shall be as specified in the contract Special Provisions and detailed in the SSPC-Guide 6.

Monitoring and acceptance criteria described in section 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.

22.6.2 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 law.

The Contractor shall comply with all Federal, Provincial, and Municipal, air, soil and water pollution 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 or to otherwise modify containment or disposal procedures to ensure compliance with all applicable laws and regulations.

22.6.3 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

22.6.4 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, is contained.

22.6.5 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.

22.6.6 Compliance

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.

22.6.7 Background Contamination Levels

Pollution of the environment shall be minimized at all times during the cleaning and painting of the bridge. The Contractor's work may be monitored by other agencies. The Contractor is advised to consider collection of background levels of possible previous air, water and soil contamination prior to commencing work at the site.

22.7 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, Workplace Safety and Insurance Act and the Occupational Health and Safety Act, Regulation and Code which control the exposure of workers to chemical hazards.

22.8 Work Proposal

The contractor shall submit his proposed work methods to the Consultant, for review two weeks prior to commencement of work. These methods shall include but not be limited to:

- Schedule
- Sequence of operations
- Traffic accommodation strategy
- Placement of equipment
- 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 non hazardous blasting spoil
- Sample documentation for tracking the disposal of hazardous waste
- The final destination of hazardous waste

Plans sealed by a Professional Engineer registered in Alberta, detailing the Contractor's containment structure, scaffolding, platforms, or swing stages to be employed, shall be submitted to the Consultant for review.

These drawings shall clearly indicate where and how the spent blasting media is collected, recovered, weighed and removed from the project. All scaffolding, platforms, swing stages and material collection equipment shall be designed and operated in accordance with the authority having jurisdiction.

22.9 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 or 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 clean respirators shall be kept on the job for use by visitors wishing to access the work site. No visitors shall be allowed without adequate protection.

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.

Extra protective clothing shall be available for use by visitors to the work site.

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.

22.10 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: 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:

- 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.
- 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, any clamps or other devises attached to the structure shall be padded or designed such that they do not mark the steel 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. 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 or a paint removal tool.

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 not 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 engage a Professional Engineer, licence to practice in Alberta, who shall identify any loadings imposed on the bridge during the Work including but not limited to any containment system, scaffolding, platforms or swing stages, personnel, equipment and wind loads. The Contractor's Engineer shall determine where to transfer the loads to the bridge, and shall evaluate the ability of the bridge to accommodate the loads.

The Contractor shall submit a report, stamped by the Contractor's Engineer, which clearly identifies the loads, where the loads will be transferred to the bridge, and the Engineer's assessment of the ability of the bridge to accommodate these loads. The report shall be submitted to the Consultant as part of the Contractor's Work Proposal.

All costs associated with the preparation of the report, including wind loading analysis, will be considered incidental to the Work and no separate or additional payment will be made.

The Contractor shall supply auxiliary lighting to improve visibility where necessary within the enclosure.

22.12.3 Abrasive Blasting Spoil Recovery Monitoring

(1) Conventional Abrasive Blasting
Blasting debris containment must provide a minimum percentage of recovery and emission control effectiveness as specified in the Special Provisions. The Contractor shall monitor the blasting spoil recovery by weighing the blasting material delivered to the job and the blasting spoil removed from the job. An enclosure which does not meet the specified criteria must be modified at the contractor's expense. No blasting shall be performed using an unmodified containment that does not recover the required percentage of the blasting spoil. 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.

The recovery efficiency is to be calculated as follows:

(a) Determine the dry weight of abrasive (Wa) used to blast clean the entire structure or monitored portions thereof.

(b) Determine the weight of paint debris (Wp) for the same area.

(c) Determine the weight of abrasive and paint debris removed (Wd) after blast cleaning the designated area, or the whole structure.

(d) Calculate the recovery efficiency (RE) as follows: $\mathrm{RE} = \frac{\mathrm{Wd}}{\mathrm{Wa} + \mathrm{Wp}} \times 100\%$

(e) Recovery efficiency reports shall be submitted to the Consultant on a weekly basis and for the entire project at the end of the project.

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 or ground cloths shall be removed each workday with a vacuum system equipped with high efficiency particulate air (HEPA) filters adequately sized to collect all spent material.

Where the bridge extends over the waterway, 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.

(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. 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 section 22.16 of this specification. 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 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, 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 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 Bridge Washing

Before any blast cleaning operations commence, the Contractor shall carry out surface cleaning operations on all steel designated to receive a coating system. All organic materials such as bird droppings, nests and any other non-structural items or pollutants attached to the steel are to be removed by hand cleaning operations.

All oil, grease and road tar shall be removed manually with solvent cleaning as per SSPC Specification SP1. Any area contaminated with oil or grease shall be cleaned with an approved biodegradable detergent. The detergent is to be environmentally friendly and non toxic to fish. The Contractor shall supply copies of the applicable MSDS sheets to the Consultant prior to using the material.

The entire area to be coated shall be washed clean of road spatter, chlorides and other surface contaminates using water of sufficient pressure and volume to flush the chlorides free of the structure.

Cleaning will be inspected by testing for the chloride levels on the cleaned steel and by testing the run off water at the lower extremities of the steel being cleaned. Chloride contamination of the cleaned surface shall be less than that specified in the Special Provision prior to blast cleaning.

Wash water shall be filtered through a suitable fabric, to remove any coarse paint particles which may have been loosened and washed from the structure. Wash water may be filtered through a woven screen material containing not more than 15% voids with a mesh opening not exceeding 20 mils (500 microns). No restriction will be imposed on disposal of water passing through a woven screen meeting the above requirements.

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.

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 non blasted 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 $\frac{1}{32}$” (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 unprimed 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 6.0 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 Manufacturers instructions. No penetrant or caulking shall be used which has not been accepted by the Consultant. When caulking joints where only one plate edge is exposed, a fillet of caulking shall be formed which is not less than 3 mm or the width of the pack rust gap. 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 extra layer of paint is applied to all sharp edges of the structure being painted. When stripe painting is specified in the Special Provisions, the edges of plates and rolled sections with a sharp profile and all bolt heads shall be striped with a coat applied to increase the mil thickness of the coating around the sharp edge. It may be applied prior to the prime coat or after the prime coat to aid in preservation of the blast cleaned surface. All drying time and recoat conditions must be complied with as with other coats of paint. Paint systems using an intermediate coat shall also be stripe painted after each intermediate but not after the top coat. Stripe coats when applied over the primer or intermediate coat shall be tinted to contrast with the underlying coat.

22.17.2 Paint Application

(1) 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.

(2) 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.

(3) 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.

(4) 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.

(5) 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.

(6) 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.

(7) Paint shall be safely stored by the Contractor, in a location which keeps its temperature in the range of 10°C to 25°C.

(8) 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.

(9) Finish coat paint shall not be applied over touched up primer which is not dry.

(10) No portion of the paint shall be less than the specified film thickness(es). The film thickness(es) shall not be so great that either the appearance or service life of the paint will be detrimentally affected. Bolts, rivets, edges of members and other changes in surface contour shall also receive the specified film thickness(es).

(11) 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.

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 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 may result in the Consultant suspending the work until the infraction has been corrected. There will be no alteration to the completion date, lane charge dates and site occupancy as applicable due to this suspension of work.

22.20 Acceptance

Any newly painted surfaces will be considered to lack uniformity, continuity and soundness, and will be rejected, if any of the following defects are apparent.

(1) Runs, sags, holidays or shadowing caused by inefficient application methods.

(2) Evidence of poor coverage at bolts, plate edges, lap joints, crevices, pockets, corners and re-entrant angles.

(3) Surfaces which have been struck, scraped, spotted by rain or otherwise damaged.

(4) Surfaces which exhibit an objectionable texture such as orange peel, mud cracking, fish eyes, etc.

(5) Surfaces damaged by over spray.

22.21 Repair

Repair areas, as determined by the Consultant, 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 at no additional cost to the Department.

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 an acceptable manner.

22.23 Estimated Areas

The estimate of painted areas contained in the Special Provisions is presented as a convenience to the Contractor bidding the work. The areas shown will be used in pro-rating the value of work completed to date, during the course of the project. While it is believed that the areas are a good representation of the actual painted area of the structure, the Consultant makes no claim as to the accuracy of the values and in no way can be held responsible for the use of these values for any purpose whatsoever.

22.24 Payment

22.24.1 Surface Preparation and Painting

Payment for **Surface Preparation and Painting** will be made on the basis of the lump sum price bid, which shall include full compensation for the cost of furnishing all labour, materials, equipment, tools and incidentals necessary to complete the work.

Progress payments will be made on a monthly basis and will be based on the percentage of the total estimated area satisfactorily cleaned and coated as determined by the Consultant. Payment will not be made for areas which do not have the specified number of coats for the paint system used nor for areas which are complete but have designated repairs outstanding.

22.24.2 Protection of the Environment

Payment for **Protection of the Environment** will be made on the basis of the lump sum price bid, which shall include full compensation for the cost of furnishing all labour, materials, equipment, tools and incidentals necessary to complete the work.

The lump sum payment for protection of the environment will be made in stages. An initial payment of 25% of the lump sum price bid will be made at the time all containment structures and equipment are acceptably erected on the bridge and the Contractor is prepared to commence surface preparation and painting operations. An additional 50% of the lump sum price bid will be paid, on a pro-rated basis, as portions of the bridge are acceptably painted. The final 25% of the lump sum price bid will be paid when the work is acceptably completed; all blasting spoil material has been accounted for, removed from the bridge site and a disposal site owner's acceptance has been received by the Consultant.

22.25 Joint Warranty

(1) When required in the Special Provisions of the contract, the Coating Manufacturer, the General Contractor and the Painting Contractor shall jointly warrant the coating and its application 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 completed painting contract.

(2) The Contractor and the Manufacturer shall jointly execute the form entitled, “Agreement to Provide a 5 Year Bridge Painting Warranty”. The completed form shall be provided, prior to award of contract.

(3) During the warranty period the Consultant or Alberta Transportation will inspect the coating system, at least sixty days prior to warranty expiration, and will advise the Contractors, the Manufacturer, and the Surety in writing of any defects or repairs that are required. Intermediate inspections may be made and warranty repairs claimed and completed by the Contractor each year of the five year warranty period.

(4) 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.

(5) Repair under warranty includes the cost to supply material, labour, and equipment necessary to restore the coating to acceptable condition as judged by the Department.

(6) Warranty repairs shall be completed within 45 days of notification, or if this would place the repair work in winter weather conditions, by May 30 of the following year.

AGREEMENT TO PROVIDE 5 YEAR BRIDGE PAINTING WARRANTY

____
(Name of Paint Manufacturer)

manufacturer of

____
(Paint System Name)

and____
(Contractor/Applicator's Company Name)

who is an approved paint Applicator of the paint system, hereby certify that in the event that the Contractor is awarded the painting contract for

____
(Contract Number)

____
(Bridge File Number and Name)

the undersigned parties jointly agree to provide a 5 year warranty for the work. Warranty period will commence at the completion of the work. The Warranty shall include all repair costs needed within the 5 year period.

MANUFACTURER:

______________________	____________________	________________________
(Name of Company Officer)	(Corporate Position)	(Signature of Company Officer)
______________________	_____________________	___________________
(Name of Witness)	(Signature of Witness)	(Date)

CONTRACTOR/APPLICATOR:

_______________________	____________________	______________________
(Name of Company Officer)	(Corporate Position)	(Signature of Company Officer)
_______________________	______________________	__________________
(Name of Witness)	(Signature of Witness)	(Date)

22.26 Shop Coating of Structural Steel for Bridges

22.26.1 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.

22.26.2 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.

22.26.3 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.

22.26.4 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.

22.26.5 Masking

All no paint areas shall be masked prior to painting the work and portions of members which are to be field welded for a distance of 100 mm from the weld location shall not be painted. 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.

22.26.6 Paint

Unless otherwise noted on the drawings shop primer shall be Zinga, organic zinc rich primer.

22.26.7 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.

22.26.8 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.

22.26.9 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. Zinga primer may be recoated with itself after 2 hours, with other top coats after 48 hours. If a Zinga primed surface is left for more than 14 days without top coating, it must be water washed to remove zinc salts which will have formed on the surface.

22.26.10 Shipping Inspection

No product is to be shipped until the Consultant has inspected and accepted the coating. Section 22.20 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 Fabricator.

22.26.11 Shipping

The coating shall be protected from damage during shipping.

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 23

DIMENSIONAL 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) -1999 Standard Grading Rules for Canadian Lumber and CAN/CSA O141-91 - Softwood Lumber.

The round wood piles shall be as per CAN3-056-M79.

The treatment shall conform to CSA-080-97 Wood Preservation, CSA-080.2-97 Preservative Treatment of Lumber, Bridge Ties, and Mine Ties by Pressure Process; CSA-080.3-97 Preservative Treatment of Piles by Pressure Process 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 Special Provisions.

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.

(a) Dimensions
Unless otherwise specified, the minimum diameter after the outer and inner bark has been removed and after seasoning, will be as follows:

SIZES OF TIMBER PILES

Length (m)	**Tip Diameter (mm)**	**Butt Diameter (mm)**
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:

Diameter (mm)	**Circumference (mm)**
180 (7")	535 (21")
205 (8")	610 (24")
230 (9")	685 (27")
305 (12")	940 (37")
330 (13")	1015 (40")

The maximum butt diameter shall not exceed 405 mm (16").

(b) 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.

(c) 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.

(d) 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 per cent of the length of the bend, or 65 mm (2½").

(e) 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

(1) The material seasoned and incised as per Clauses 4.0 or 5.0 and 6.0 shall be pressure treated using 100% creosote treatment.

(2) 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

(1) When noted in the Special Provisions the planking material (strip deck) and guardrail posts seasoned and incised as per Clauses 4.0 or 5.0 and 6.0 shall be pressure treated using a waterborne preservative Chromate Copper Arsenate (CCA).

(2) 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.

(3) 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 (green house 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 and Owner.

23.11 Acceptance

(1) All materials shall be subject to inspection by the Consultant/Owner prior to usage.

(2) Where S1S1E or S4S Size is specified the material shall be not more than 6 mm (¼") scant per side.

(3) 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 reinspection.

SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 24

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 overhead and cantilevered sign structures and panels.

The underground utilities located on the drawings are approximate and are to be confirmed by the Contractor in the field.

Prior to design and construction, the Contractor shall confirm underground and overhead utility conflicts with the sign bases and support structure and immediately inform the Consultant of these conflicts. Any costs associated with addressing these underground utility conflicts shall be included in the bid price of the foundation.

24.2 Sign Structures

24.2.1 Design

24.2.1.1 Design Standards

The design shall be carried out by the Contractor. The Contractor's design engineer shall be a Professional Engineer registered to practice in the Province of Alberta under the APEGGA Act.

The design shall be in accordance with the requirements of AASHTO “Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals”, latest Edition and Interims, unless noted otherwise in these special provisions.

AASHTO equation 3-1, Clause 3.8.1, shall be modified as follows:

$$Pz = 2.7\ q\ Kz\ Cd$$

where q shall be taken from CAN/CSA S6-06, Table A3.1.7 for a return period of 50 years.

The design ice thickness for ice accretion shall be the value given in CAN/CSA S6-06 Figure A3.1.4.

For the design of all cantilevered sign structures, the Fatigue Importance Factors in Table 11-1 shall be based on Fatigue Category I. The deflection for cantilevered sign structures, as specified in Clause 11.8, shall not exceed 200 mm.

Anchor bolts shall be post-tensioned to 0.70 Fpu. Stresses for anchor bolts shall be limited to 0.50 Fpu applied to the root tensile stress area for Group Load Combination I, II & III. Stress range for Group IV shall be in accordance with Section 11. The design shall allow for the failure of one anchor at any one location for each pile foundation. After such failure, the remaining anchors shall still be capable of meeting the above design requirements.

Design sign panel area shall be taken as the largest of:

(a) Actual sign panels shown on the drawings.

(b) Future sign panels shown on the drawings.

(c) Area of 3.5 m x 60% of horizontal span length, placed in any position along the span.

The structures shall have a permanent vertical camber of at least L/200.

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 clearance below the sign panels shall be 6.0 metres.

24.2.1.2 Design Notes and Drawings

All design notes and shop drawings, shall be stamped, signed, and sealed by the Contractor's design engineer.

Two copies of the design notes and five copies of the shop drawings shall be submitted to the Consultant for review and acceptance at least three weeks in advance of scheduled fabrication.

The Contractor shall incorporate as-built conditions and re-submit all design notes and shop drawings, at the completion of construction.

(1) Design Notes
Design notes shall be presented in a legible and logical format and shall be sufficiently detailed to allow a technical review of the design concepts and assumptions used in the design. The design notes shall include, as a minimum, calculations for the following:

(a) Design moment, shear and axial force envelopes for serviceability, ultimate and fatigue limit states.

(b) Columns

(c) Horizontal arm or truss

(d) Column or arm flange bolted connections

(e) All welded connections, stiffeners, etc.

(f) Anchor bolts

(g) Foundation

(2) Shop Drawings
The shop drawings shall be legible and of adequate quality to be reproduced and microfilmed. All drawings shall be done on standard 11 x 17 or 22 x 34 sheet sizes.

The shop drawings shall include the following:

(a) Alberta Transportation Bridge File numbers, A-Ident numbers and project title, as provided by the Consultant, shall be shown on all the shop drawings.

(b) Design criteria meeting the requirements of section 24.2.1.1, for each individual 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
- Design temperature range
- Foundation soils parameters
- Critical anchor bolt forces

(c) Each individual shop fabricated section or assembly shall be shown separately with complete and clearly identified welded or bolted details.

(d) Weld procedure identification shall be shown on the shop drawings in the tail of the weld symbols.

(e) All material splice locations shall be shown on the drawings.

(f) Complete material list.

(g) Erection procedure including tensioning procedure for anchor bolts.

24.2.1.3 Consultant Review

The design notes and drawings will be reviewed by the Consultant solely to ascertain conformance with codes and specifications. Responsibility of the final design remains solely with the Contractor. The Consultant's acceptance of the shop drawings shall not be construed as relieving the Contractor from his responsibility for errors or omissions in the calculations and drawings or for proper completion of the work in accordance with the contract.

After the Consultant review, the Contractor shall revise the drawings and calculations as required to the satisfaction of the Consultant without any additional cost to the Department.

Prior to commencing fabrication, all shop drawings shall be clearly signed by the Department’s Consultant as verification that the Consultant has completed his review and accepted the Shop Drawings. The Consultant's review and acceptance of the Shop Drawings will apply to general arrangements and details of design but not to figured dimensions or details of fabrication, and will be subject to the requirements of specifications and to such corrections as may be marked here on.

24.2.2 Supply and Fabrication

24.2.2.1 Standards

Fabrication of sign structures shall conform to "The American Association of State Highway and Transport Officials (AASHTO), Standard Specifications for Highway Bridges" and the American Welding Society (AWS) - Bridge Welding Code, D1.5.

Where imperial/metric conversions are necessary, The National Standard of Canada, CAN 3-Z234.1-79 shall be used as the basis of conversion.

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

(1) Certification
The Fabricator shall operate a recognized steel fabricating shop accepted by the Consultant.

The Fabricator shall be fully approved by the Canadian Welding Bureau (CWB) as per CSA Standard W47.1 in Divisions 1 or 2.

The Contractor shall notify the Department and 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 CWB approval and right of access shall apply to the subcontractor.

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.

(2) Contractor's Quality System
The Contractor shall maintain acceptable quality management system throughout the contract. The purpose of the quality management system is to ensure that the product meets the quality requirements of the contract and is delivered on time. The Contractor's quality management system shall apply to all stages of the design, procurement, manufacturing, testing and delivery of the product.

24.2.2.3 Engineering Data

(1) Welding Procedures
Welding procedures shall be submitted for each type of weld used in the structure. The procedures shall bear the approval of the Canadian Welding Bureau and shall also be reviewed by the Department prior to use on the structure.

(2) Proposed Fabrication Sequence
Prior to commencement of fabrication, the Contractor shall present for review and acceptance an outline of the fabrication sequence that clearly describes the order of make-up and assembly of all the component parts, as well as shop assembly, inspection stations.

(3) Mill Certificates
Mill certificates shall be provided for all material before fabrication commences.

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

24.2.2.4 Materials

(a) All materials shall be new

(b) The use of aluminum and aluminum alloy are not acceptable, unless specifically stated otherwise by the Consultant

(c) Structural steel plate material shall conform to CSA G40.21M 300W*

*Silicon content shall be less than 0.04% for the shafts, whereas for flanges and base plates the silicon content shall be either less than 0.04% or between 0.15 to 0.25%

(d) All bolts, nuts and washers shall conform to ASTM Standard A325 or shall meet property class 8.8 of the Industrial Fasteners Institute for metric high strength structural bolts, nuts and washers. Certified mill test reports for the fastener material shall be provided

(e) Anchor bolts shall be fabricated from DYWIDAG thread bars conforming to the requirements of CSA Standard G279

(f) All steel materials including all hardware and anchor bolts shall be hot-dip galvanized

24.2.2.5 Welding

(1) Filler Metals
Low hydrogen filler, fluxes and low hydrogen 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 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. However metal core welding process utilizing low hydrogen electrodes with AWS designation of H4 will be allowed. The 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.

(2) Cleaning Prior to Welding
Weld areas must be clean, free of mill scale, dirt, grease, and other contaminants prior to welding.

(3) Longitudinal Seams
All longitudinal seams shall be made by an approved semi or fully automatic submerged arc or metal core welding processes.

(4) Weld Penetration
The full penetration welds shall be completed using properly fitted backing bars or backgouged to sound metal. The longitudinal seams shall have a minimum 60% penetration; however if backing bar is used for longitudinal seam, the weld penetration shall be 90%. The following welds shall have 100% penetration:

(a) Column to base plate

(b) Member to flange plate

(c) Flange plate to gusset plate

(d) 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.

(e) Backing bar splices

The backing bar for full penetration weld shall be properly fitted and the member prepared to a sharp edged 45° chamfer. The groove weld shall be placed in a minimum of two passes by using 100°C of preheat (unless higher preheat is required as per AWS) and maintain 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.

(5) 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 welding over.

(6) Run-off Tabs
Run-off tabs shall be used at the ends of all welds that terminate at the edge of a member. The tabs 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.

(7) Methods of Weldment Repair
Repair procedures for unsatisfactory weldments shall be submitted for review and acceptance by the Department and Consultant prior to repair work commencing.

(8) Arc Strikes
Arc strikes will not be permitted. In the event of accidental arc strikes, the Contractor shall submit to the Department and Consultant for review and acceptance a proposed repair procedure. The repair procedure shall include the complete grinding out of the crater produced by the arc strike. These areas will be examined by the Consultant to ensure complete removal of the metal in the affected area.

(9) Plug and Slot Welds
Plug welds or slot welds shall not be permitted.

24.2.2.6 Fabrication

Fabrication shall be performed in a fully enclosed area which is adequately heated. The shop temperature shall be at least 10°C. Field welding will not be allowed.

(1) Pre-job Meeting
A pre-fabrication meeting is required prior to commencement of fabrication of sign structures. 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 Department/Consultant will conduct this meeting after the shop drawings have been approved and welding procedures have been reviewed. The Contractor shall provide two weeks notice to the Department/Consultant prior to the meeting.

(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.

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

(4) Additional Requirements
(a) Each column, arm, extension, clamp and bracket shall be fabricated from one piece of sheet steel unless accepted otherwise.

(b) Intermediate circumferential butt welds will not be allowed however horizontal members greater than 12 m span may have a bolted splice.

(c) 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.

(d) All plate edges shall be free of notches and gouges.

(e) 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.

(f) The diameter of bolt holes in base plates shall be 10 mm larger than the bolt diameter.

(g) 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.

(h) Hand holes with cover plates on top and bottom of columns are to be provided for illuminated sign structures or when required as per special provisions.

(i) Hand hole (when required) 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.

(j) Only low stress stamps shall be used for identification marks. The stamps and specific location shall be shown on the shop drawings and accepted by the Consultant.

(k) Stiffeners are not allowed on column to base plate and member to flange plate connections.

(5) Dimensional Tolerances
All fabrication shall meet the tolerances described below:

(a) Straightness
The straightness of any item shall not exceed the overall length divided by 300 from the surface at any point. This shall be measured with a straight line joining the surface at both ends. The difference between the straight line and the surface shall then be measured to determine the straightness.

(b) Twisting
The twist in the overall length of any column, arm, or extension shall not exceed 7°.

(c) 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 unloaded condition. The tolerance for height shall be - 0 to +60 mm.

(d) Across the Flat Dimensions
The average of all across the flats 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 flats dimensions shall be less than or equal to 1.05.

(e) Tolerance for Flatness of 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.

(f) Arm Rise
Arm rises apply to unloaded structure in the standing position.

(6) Pre-Assembly
After welding and fabrication, but prior to galvanizing, the Contractor shall pre assemble all structures complete with welded sign clamps to check the fit and geometry. Pre assembled structures shall be inspected by the Consultant.

Following inspection by the Consultant, the structures shall be disassembled for galvanizing.

(7) Galvanizing
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 A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware with additions and exceptions as described in this specification. The Fabricator shall provide a smooth finish on all edges and surfaces, and remove all weld spatter and all welding flux residue from the steel components prior to galvanizing. Lumps, globules or heavy deposits of zinc will not be permitted. All threaded holes or threaded couplings shall be retapped after galvanizing.

Repair of galvanizing shall only be done if bare areas are infrequent, small, and suitable for repair. A detailed repair procedure shall be submitted and accepted prior to its use. It should be noted that repairs may require complete removal of the galvanized coating and regalvanizing. Repair shall be in compliance with ASTM A780, Method A3 Metallizing. The thickness of the metallizing 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.

(8) Base Plate Corrosion Protection
The bottom face 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 grout. 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 (a maximum allowable flaking of 5%).

24.2.2.7 Testing and Inspection

(1) Access
The Contractor shall provide full facilities for the inspection of material and workmanship. Free access shall be allowed to the Consultant to all parts of the works. When required by the Consultant, the Contractor shall provide needed manpower for assistance in checking layout and performing inspection duties.

(2) Testing by the Contractor
The Contractor shall provide quality control throughout the course of fabrication. All test records made by the fabricating shop in the course of normal quality control shall be open to the Consultant for inspection. Testing and inspection made necessary by the repair of faulty work shall be paid for by the Contractor.

The Contractor shall arrange to have all full penetration welds inspected either by ultrasonic testing or radiographic inspection methods. Partial penetration seam welds shall be inspected by ultrasonic testing. The frequency of partial penetration weld inspections shall be three random locations per weld and the length of weld for ultrasonic inspection at each location shall be 200 mm. Calibration blocks for each thickness shall be prepared for ultrasonic testing to establish sensitivity levels and acceptance criteria. The NDT shall be done by a company certified to CAN/CSA W178.1. Ultrasonic and radiographic testing technicians shall be certified to Level II of CGSB. Ultrasonic testing procedure shall be submitted to the Consultant for review and acceptance prior to commencement of fabrication. A copy of test results shall be provided to the Consultant indicating the percentage of penetration. The Contractor shall not proceed to the next stage of fabrication until all the seam welds have passed the Quality Control and the results have been reviewed by the Consultant.

All costs associated with non-destructive inspection of partial and full penetration welds, preparation of calibration blocks, establishing sensitivity levels and acceptance criteria shall be the responsibility of the Contractor.

The Contractor shall be responsible for all travel, boarding and lodging costs for a Department's representative to attend the prejob meeting and two additional trips during the course of fabrication when the sign structures are being fabricated outside the Province of Alberta.

(3) Testing by the Consultant
The Consultant will perform visual inspection. Any additional NDT; such as radiographic, ultrasonic, magnetic particle and any other inspection that may be specified or required will be performed by the Consultant or by his testing agencies at the Consultant's expense.

(4) Inspection Station
To insure that each stage of inspection is performed in an orderly manner, during the fabrication, Inspection Stations will be set up at specific points. Certain items of the work will then be checked, and deficiencies shall be corrected, prior to the work being sent to the next stage of fabrication. These check points are to be agreed to by the Department and Consultant and the Fabricator prior to commencement of fabrication. The Department and Consultant reserve the right to stop detrimental fabrication between check points if deemed necessary.

(5) Non-destructive Methods of Examination
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

(6) Inspection Schedule
All welds will be visually inspected.
Ultrasonic or radiographic inspection will be performed on full penetration welds.

24.2.2.8 Identification Tag

The Contractor shall supply and install an identification tag on one column of each structure at 2.4 m above base plate. The column shall be drilled and tapped for 2 - 10 mm diameter attachment bolts. The Identification Tag shall be fabricated as per the attached drawing S-1682-03.

24.2.3 Erection

Any product damaged in shipping shall be replaced at no extra cost to the Department.

The Contractor shall not erect the structural steel until the substructure 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 to the satisfaction of the Consultant.

The structure shall be set accurately on galvanized shim plates. The shim plates must be located so that a minimum of 75 mm of distance is provided from shims to grout edge. 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.

Hand hole bolts shall be coated with anti seize lubricant.

The Contractor shall erect the sign structure in a manner that addresses all safety issues including the interim period between erection, grouting and post-tensioning.

(1) 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.

(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 the following table for the size of bolt used:

Table 1 Bolt Tension

Specified Bolt Size (A325M Bolts)	Minimum Bolt Tension		Commonly Supplied Equivalent Imperial Size (A325 Bolts)	Minimum Bolt Tension	
	Kilonewtons	pounds-force		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

All structural bolts shall be tightened by using turn of nut method to provide bolt tension specified in Table 1. There shall first be enough 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. 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

Notes
- tolerance 1/6 turn (60°) over, nothing under
- length of bolt measured from underside of head

24.2.4 Foundation

The following sections of Alberta Transportation 'Specifications for Bridge Construction' shall apply:

Section 3 'Bearing Piles'
Section 4 'Cast-In-Place Concrete'
Section 5 'Reinforcing Steel'

(1) General
The Contractor is to undertake geotechnical work at his own cost where necessary to ensure proper performance of the sign structure.

Any adjustments to the locations of sign structures will be subject to the acceptance of the Consultant.

The Contractor shall co-ordinate placement of the street light cable and conduit around the sign support foundation to avoid any conflicts.

Foundations shall be designed to allow for local frost conditions.

(2) Material
(a) All reinforcing steel shall conform to CSA G30.18-M92 Grade 400.
(b) All concrete shall be Class C - 35 MPa, with Type HS sulphate resistance cement.

(3) Anchor Bolt Installation
Anchor bolts shall be supplied and installed in one complete assembly and consist of, but not limited to: anchor bolts complete with plate washers, full length sleeves filled with accepted corrosion inhibiting paste, top temporary templates, bottom anchor plates, bottom anchor nuts, thin clamping nuts and all necessary hardware for post-tensioning and future de-tensioning. No welding of any component is allowed. Anchor bolts shall be true and plumb. Anchor bolts shall be post-tensioned to 70% of the ultimate strength after the grout pads have attained design strength. The top anchor nuts shall have plastic caps, and all voids including annular space in the base plate shall be filled with corrosion inhibiting paste. Sufficient anchor bolt projection shall remain for future work. All Post-tensioning work and materials shall meet the requirements of Chapter 3 - Specifications of the PTI Post-tensioning Manual.

(4) Grout Pockets and Grout Pads
The Contractor shall fill the grout pockets and construct the grout pads using Sika 212 flowable grout or approved equivalent. Filling of grout pockets and construction of grout pads shall be done by workers competent in this work. The grout pocket shall be 25 mm deep and the total grout thickness shall not be less than 75 mm.

Grout shall be packaged in waterproof containers with the production date and shelf life of the material shown. It shall be mixed, placed, and cured in strict accordance with the Manufacturer's recommendations.

The method of forming and pouring the grout shall be submitted to the Consultant for acceptance. Dry pack methods of constructing grout pads will not be accepted.

(5) Protection of Sign Structures
The Contractor shall erect the sign structure in a manner that addresses all safety issues including the interim period between erection, grouting and post-tensioning.

After erection of sign structures, the Contractor shall place grout pockets and pads and post tension anchor bolts as soon as possible. However the Contractor shall provide adequate safe traffic accommodation until post tensioning and grouting is complete.

(6) 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, falls below 5°C, the following provisions for cold weather grouting shall be effected:

(a) Before grouting, adequate preheat shall be provided to raise the temperature of the substructure concrete to at least 10°C.

(b) Temperature of the grout during placing shall be between 10°C and 25°C.

(c) The grout pads shall be enclosed and kept at 10°C to 25°C for at least five days. The system of heating shall be designed to prevent excessive drying out of the grout.

(7) Clean-Up
All steel shall be left clean and free of oil, grease, mud, dust, road spray or other foreign matter.

24.3 Sign Panels

The Contractor shall supply and install overhead sign panels as shown on the plans and in accordance with the requirements specified herein.

24.3.1 Shop Drawings

The Contractor shall provide the Consultant with three copies of the shop drawings showing the number, spacing and locations of the aluminum T-section required for each sign panel(s), assembly and mounting details. These drawings shall also detail the required method of attaching the sign panels to the sign support arms.

The Consultant's review of the shop drawings shall not be construed as relieving the Contractor from his responsibility for errors or omissions in the calculations and drawings or for proper completion of the work in accordance with the Contract.

After the Consultant review, the Contractor shall revise the drawings and calculations as required to the satisfaction of the Consultant without any additional cost to the Department.

Fabrication shall not commence prior to the review of the shop drawings.

24.3.2 Materials

Extruded aluminum panels shall be manufactured in accordance with Specification 5.18, Supply of Permanent Highway Signs, Posts and Bases of the Standard Specifications for Highway Construction, except as noted herein.

24.3.2.1 Sheeting Materials

Reflective sheeting materials used on all overhead sign and cantilever sign structures shall be in accordance with Specification 5.18.2.8.2 of the 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 metres. 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 around the edges of each extruded aluminum section except for the sections that are on the top and bottom edges of the sign panel. The outer edges of the sign panel are to be neatly trimmed flush with the edge of the aluminum 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 sign structures as shown on the Plans 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, and all of the necessary hardware to securely assemble the sign and connect the sign panels to the sign structure as shown on the accepted shop drawings.

Individual extruded aluminum sign panels shall be fastened together using stainless steel 10 mm diameter x 25 mm long bolts, nuts, and with a single lock washer on the nut side of the bolt. 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 and a 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.

All joiner bolts and J-clip nuts must be tightened to a torque to 26.5 Nm within a tolerance of ± 0.5 Nm.

The face of the sign panels shall be cleaned prior to acceptance.

24.4 Measurement and Payment

24.4.1 Sign Structure

Payment for Supply and Install Sign Structures will be made at the lump sum price bid for the specified structure. Such payment will be considered full compensation for the design and construction of the foundation and sign structure, fabrication, erection and the furnishing of all materials, labour, equipment, tools, and incidentals necessary to complete the Work to the satisfaction of the Consultant.

24.4.2 Sign Panels

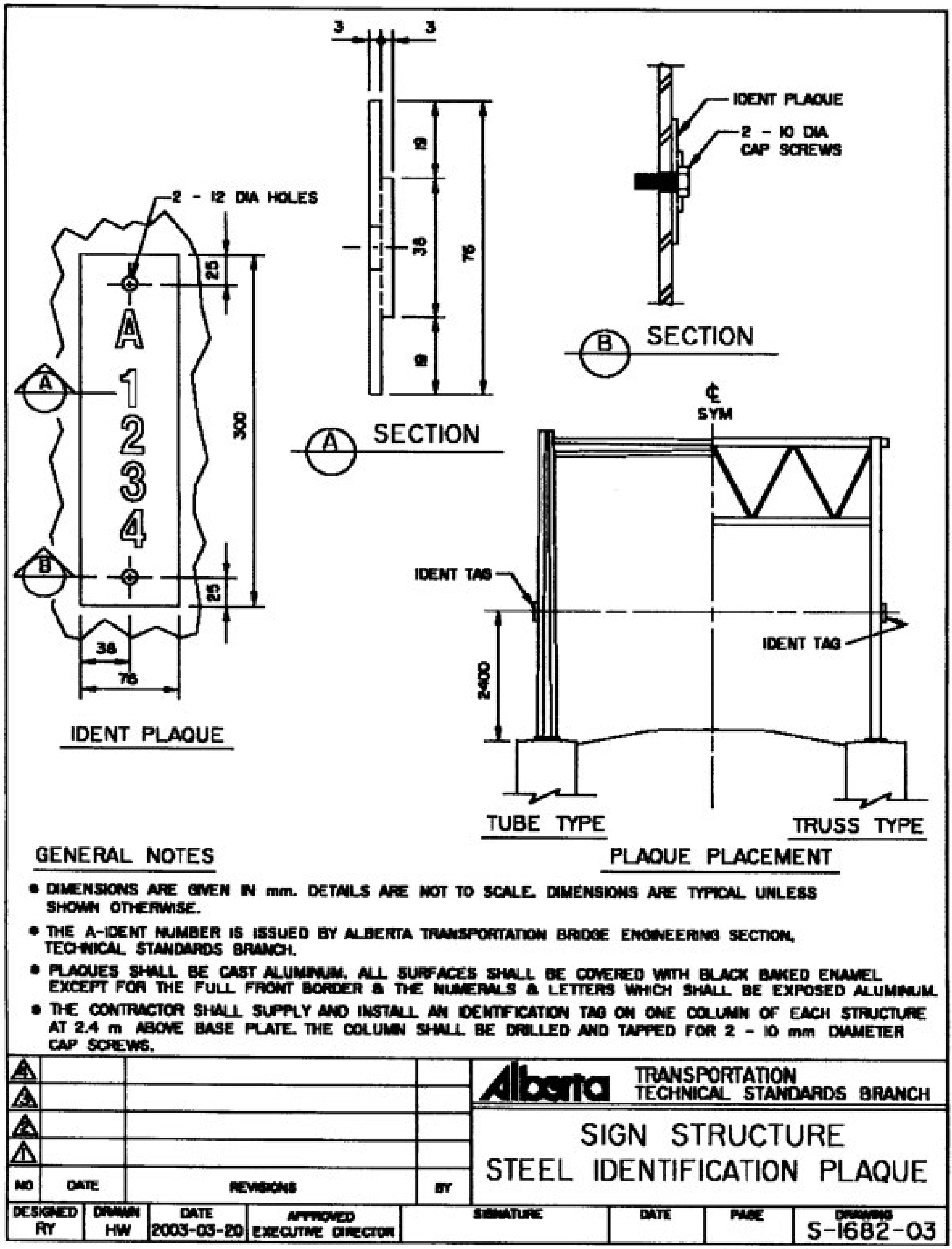
Sign panels for overhead sign structures will be measured in square metres based on surface area for the extruded aluminum sign panels acceptably supplied and installed.

Payment for Supply and Install Sign Panels - Extruded Aluminum will be made at the unit price bid per square metre. Such payment will be full compensation for all materials, labour, equipment, tools, and incidentals necessary to complete the Work to the satisfaction of the Consultant.

24.5 Warranty

The Contractor shall warrant that sign structures and panels are free from defect (material and workmanship) for a two year period in accordance with Specification 1.2.54 of the General Specifications.

24.6 Drawing S-1682-03 - Identification Plaque



ISPECIFICATIONS 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 mechanically stabilized earth (MSE) retaining walls with precast concrete facing panels. MSE retaining walls shall include, but not be limited to, excavation for the wall, concrete leveling pads, precast concrete panels, compacted granular backfill, soil reinforcement, perforated drain pipe complete with filter fabric sock, surface drains, cast-in-place concrete wall coping, traffic barrier, pedestrian railing, permanent safety railing or fence, hardware and all associated materials.

MSE retaining walls shall be designed and constructed in accordance with the provisions contained herein and as determined by the Department and the Consultant.

The Contractor shall supply all necessary materials. All components of the MSE wall system shall be supplied from one MSE supplier.

25.2 Design

25.2.1 Design Requirements

Location, layout, geometry control, global stability and allowable bearing capacity requirements shall be as specified in the contract documents. The Contractor's design responsibility shall include internal stability and all elements for a complete MSE wall system.

The most stringent requirements of the current version of the following standards shall be met:

- CAN/CSA S6 – Canadian Highway Bridge Design Code
- AASHTO LRFD Bridge Design Specifications
- Alberta Transportation Bridge Structures Design Criteria
- Alberta Transportation Roadside Design Guide Section H7.6

The design life for all MSE wall components shall be 100 years.

Highway and bridge surface drainage shall be controlled and channeled away from the back of the MSE walls and mechanically stabilized earth mass.

Weeping drains consisting of perforated 150 mm diameter pipe complete with filter sock shall be provided near the front and the back bottom corner of the mechanically stabilized earth mass. The weeping drains shall be day lighted or connected for positive drainage. A water level within the mechanically stabilized earth mass shall be assumed to be at the invert level of the weeping drains.

MSE walls with traffic running parallel to the top of the wall shall have rigid bridge barriers meeting the requirements of CHBDC Section 12. Such bridge barriers shall be located on top of the MSE walls and supported on the moment slab to resist sliding and overturning. Flexible guardrail systems shall not be used. All obstacles, such as sign supports and lighting posts, mounted on top of the barriers shall meet set-back and clearance requirements specified in the Roadside Design Guide. The MSE wall design shall account for all load effects from such accessories.

Water carrying appurtenances, such as catch basins, drainage inlets/outlets, culverts etc., shall preferably be placed away from, or close to the end of the soil reinforcement zone, and provisions shall be made to mitigate the detrimental effects of potential leakage.

Obstructions such as foundation piles and associated casings, or casings for future pile installations in the soil reinforcement zone, shall be accommodated with appropriate arrangement of soil reinforcing around such obstructions. For those MSE wall systems that lend themselves to splaying of the soil reinforcement, the splay angle shall not exceed 20° from the perpendicular of the facing panel. For other MSE wall systems, coverage ratios of soil reinforcement shall be specifically developed for each project.

Pedestrian railing and permanent safety railing or fence may be mounted on top of MSE wall coping.

Minimum precast concrete panel thickness shall be 140 mm, excluding any additional thickness required for aesthetic surface treatment. Minimum cover to reinforcing steel shall be 50 mm on both the front and back faces.

Precast concrete panels shall be designed to accommodate a differential settlement of 100 mm in 10 metres of length along the wall. The spacing between adjacent panels shall be designed to be 20 mm nominal.

Joints between panels should have a lip and recess (ship lap) configuration so that joint material is protected and overall aesthetics is enhanced. Butt joints may also be used if the Contractor can provide a backing board with sufficient strength and durability to meet 100 years life expectancy requirement.

Acute corners less than 70° inside panels shall not be allowed.

Special corner units shall be used when interior angle between adjacent panels is 130° or less.

The top of the cast-in-place concrete wall coping shall be smooth and have no steps or abrupt changes in height.

MSE wall panels shall be fully supported by compacted backfill without voids on the non-exposed side.

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 1500 mm.

Where staged construction is required and large differential settlement is expected between stages, appropriately located full height vertical slip joints shall be provided.

25.2.2 Submissions and Consultant Review

Design notes and shop drawings shall be stamped, signed and sealed by a professional engineer, registered to practice in the Province of Alberta.

Design notes shall be presented in a legible and logical format, and shall be sufficiently detailed to allow a technical review of design concepts and assumptions used in the design. Where necessary, the design package shall be accompanied by properties of materials used together with the appropriate test certificates.

Shop drawings shall be legible and of adequate quality to be reproduced and microfilmed. Each drawing shall have sufficient blank space for the Consultant's acceptance stamp.

As a minimum, shop drawings shall contain:

- Alberta Transportation bridge file number and project name on each drawing.
- Design criteria and materials lists.
- Wall layout plan and elevation complete with dimensions and elevations, and typical wall cross-sections.
- All component and connection details.
- Site drainage and drainage details.

Two copies of the design notes and five copies of the shop drawings shall be submitted to the Consultant for review and acceptance at least three weeks in advance of scheduled fabrication.

The design notes and shop drawings will be reviewed by the Consultant solely to ascertain conformance with codes and specifications. Responsibility of the final design remains solely with the Contractor. The Consultant's acceptance of the shop drawings shall not be construed as relieving the Contractor from his responsibility for errors or omissions in the calculations and drawings or for the proper completion of the work in accordance with the Contract.

After the Consultant's review, the Contractor shall revise the drawings and calculations as required to the satisfaction of the Consultant without any additional cost to the Department.

Prior to commencing fabrication, all shop drawings shall be clearly signed by the Department's Consultant as verification that the Consultant has completed his review and accepted the Shop Drawings.

The Contractor shall incorporate as-built conditions and re-submit the revised design notes and shop drawings for records at the completion of construction.

25.3 Materials

25.3.1 Concrete Materials

The fabrication of precast concrete panels shall conform to the requirements of Section 7 “Precast Concrete Units” of the Specifications for Bridge Construction. Any panel with crack exceeding 0.15 mm in width or 0.1 mm/m^2 (of panel area) in length shall be rejected. The concrete for the panels shall be Class HPC, conforming to the requirements of Section 4.4 “Class and Composition of Concrete” of the Specifications for Bridge Construction, with the exception that maximum aggregate size shall be 14 mm. The concrete leveling pads and the MSE wall coping shall conform to the requirements of Section 4 “Cast-In-Place Concrete” of the Specifications for Bridge Construction. The concrete for the leveling pads shall be Class B and the concrete for the wall coping shall be Class HPC. Chamfered edges shall be created around the periphery of all precast facing panels. The exposed faces of the precast panels and the cast-in-place wall coping shall have a Class 2 finish.

25.3.2 Concrete Reinforcing Materials

Reinforcing steel is to be in accordance with Section 5 “Reinforcing Steel” of the Specifications for Bridge Construction.

Reinforcing steel shall conform to CAN/CSA G30.18 Grade 400 deformed billet steel bars and be epoxy coated.

25.3.3 Soil Reinforcing Materials

Steel reinforcement shall be galvanized in accordance with the current edition of ASTM Standard A123/A123M. Geosynthetic reinforcing 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. Results of product specific durability studies carried out to determine the product-specific long term strength reduction factor (RF) shall be submitted for the Consultant’s review and approval. 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:

- GG 1-87 “Standard Test Method for Geogrid Rib Tensile Strength”
- GG 2-87 “Standard Test Method for Geogrid Rib Junction Strength”
- GG 3-90 “Standard Test Method for Tensile Creep Testing of Geogrids”
- GG 4-05 “Standard Practice for Determination of the Long Term Creep Design Strengths of Geogrids”

Geosynthetic reinforcing materials shall contain stabilizers or inhibitors to prevent degradation of properties due to ultraviolet light exposure.

25.3.4 Safety Rail Materials

Safety rail shall be fabricated in accordance with Section 12 “Bridgerail” of the Specifications for Bridge Construction.

25.3.5 Backfill Materials

The structural backfill shall be “Crushed Aggregate Material” meeting the requirements of the following table:

Designation/Class

Metric Sieve Size (CGSB 8-GP-2M)	**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**
125 000			
80 000			
50 000			
40 000			100
25 000		100	70 - 94
20 000	100	82 - 97	
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
L.A. Abrasion Loss Percent Maximum		50	50

*Note: For MSE wall systems consisting of geosynthetic soil reinforcement, the backfill designation/class should be chosen by the designer based on expected performance of the geosynthetic reinforcement.

The physical properties of the structural granular backfill material selected by the Contractor shall be used by the MSE wall supplier in the design of the MSE walls. The selected structural granular backfill material shall also meet the following electrochemical parameters:

REQUIREMENTS FOR STEEL REINFORCING

Select Backfill Requirements		Test Method (ASTM)	Test Method (AASHTO)
Resistivity	≥ 3000 ohm-cm	G57	T 288-91 I
pH	5 - 10	G51	T 289-91 I
Chlorides	≤ 100 ppm	G512	T 291-91 I
Sulphates	≤ 200 ppm	G516	T 290-91 I
Organic Content	≤ 0.1%	D2974	N/A

REQUIREMENTS FOR GEOSYNTHETIC REINFORCING

Select Backfill Requirements		Test Method (ASTM)	Test Method (AASHTO)
pH	3 - 12	G51	T 289-91 I
Organic Content	≤ 0.1%	D2974	N/A
Design Temperature at the Wall Site	≤ 30°C	N/A	N/A

In no case shall any backfill material placed within 2.0 m of the face panels have more than 5% passing the 0.75 mm sieve size.

25.3.6 Sealer Materials

Sealer shall be applied to the exposed concrete surfaces of the precast concrete panels and the cast-in-place wall coping in accordance with Section 4.25 “Type 1c Sealer” of the Specifications for Bridge Construction.

25.3.7 Geotextile Filter Fabric

Non-Woven geotextile filter fabric shall be in accordance with the following table of minimum average roll value properties:

Non-Woven Geotextile Filter Fabric	
Specifications and Physical Properties	
Grab Strength	650 N
Elongation (Failure)	50%
Puncture Strength	275 N
Burst Strength	2.1 MPa
Trapezoidal Tear	250 N
Minimum Fabric Lap to be 300 mm	

25.4 Construction

The Contractor shall employ qualified personnel experienced in constructing MSE walls to complete this work. The MSE wall shall be installed in accordance with the supplier's recommendation. The supplier of the MSE wall system shall provide a qualified representative on site to advise the erection crew regarding construction procedures. The representative shall be present for a minimum of 25% of the time throughout the construction of all phases of MSE wall as determined by the wall supplier.

The construction of the MSE wall system shall conform to the details on the approved shop drawings.

25.4.1 Conformance Criteria

The Contractor shall provide formalized documentation, sealed and signed by the engineer, who is responsible for each of the following construction phases and prior to commencement of each subsequent construction activity:

- Foundation base preparation
- On-site delivery of all components
- Alignment of precast wall panels as per contract requirements
- Backfill material gradations and compaction requirements

25.4.2 Excavation

Excavation for the wall shall be carried out in conformance with Section 1 “Excavation” of the Specifications for Bridge Construction. Excavation shall be done to establish grades to within reasonably close conformity to the design grades and limits shown on the drawings and shop drawings. The foundation subgrade shall be proof rolled to identify any soft spots. Soft material shall be removed and replaced with compacted granular material to the satisfaction of the geotechnical consultant. Temporary excavation support as required shall be the responsibility of the Contractor. In addition, the Contractor shall establish the locations and extents of all 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. All damages to existing services resulting from the Contractor’s operations shall be repaired at the Contractor’s expense.

25.4.3 Backfill

Backfill shall be in accordance with Section 2 “Backfill” of the Specifications for Bridge Construction and shall include the supply, placing and compaction required for construction of the MSE walls. Backfill placement shall closely follow erection of each course of panels. Backfill shall be placed in such a manner as to avoid any damage or disturbances of the wall materials or misalignment of the face panels. All wall materials that are damaged during backfill placement shall be removed and replaced at the Contractor’s expense. Any misalignment or distortion of the face panels due to placement of backfill shall be corrected by the Contractor at his expense.

A minimum 300 mm wide strip of filter fabric shall be installed behind all face panel joints. An adhesive shall be used to hold the fabric securely against the panels.

No equipment shall be allowed to run directly on the soil reinforcement. Backfill compaction shall be performed in such a manner that the compactor shall move in a direction parallel to the wall panels and work toward the end of the soil reinforcement away from the wall facing. Only hand operated power tampers and vibrators shall be used for compaction within 1000 mm of the wall panels. The Contractor shall slope the last level of backfill material away from the wall panels, at the completion of each day’s work to direct potential run-off away from the wall face. In addition, the Contractor shall not permit any surface runoff from adjacent areas to enter the wall construction site.

25.4.4 Precast Panel Tolerance

Precast concrete panel manufacturing tolerances shall be as described in CSA A23.4. The tolerance after installation shall be:

1. The flatness tolerance of wall surfaces measured in any direction shall not exceed 10 mm/m
2. The offset of adjacent panel edges at joints shall not exceed 10 mm
3. The variation for minimal joint gap shall not exceed 1.5 mm/m
4. The overall vertical tolerance of the completed wall (top and bottom) shall not exceed 13 mm/3 m of wall height.

Should any panels be out of tolerance, the backfill shall be removed and the panels reset to the proper tolerance.

To facilitate construction of the cast-in-place concrete coping, nominal-sized, pre-formed holes in the precast panel are permitted providing the holes are located a minimum of 100 mm above the coping soffit.

25.4.5 Material Storage

The Contractor's lay-down area shall be level graded to ensure the panels are safely and uniformly supported on timber bearing blocks. Precast concrete panels shall be stacked on timber planks or pallets and separated by timber blocks as required by the precast design engineer. Soil reinforcing material and connectors shall be stored clear of the ground. All materials shall be covered and protected from rain, snow, dirt and ultraviolet light. The precast panels shall be stored such that the uniform color of the panels is maintained and protected from staining or discoloration.

25.5 Payment

Measurement for payment for the design and construction of mechanically stabilized earth wall will be by square metre of installed precast panel wall face measured in place.

Payment will be made at the unit price bid for "**Mechanically Stabilized Earth Wall**", and will be full compensation for design and construction including, but not limited to such items as all excavation, backfill and compaction below the MSE walls where required; all excavation, leveling pad construction, backfill and compaction within and beyond the MSE wall zone necessary for construction of the MSE wall; the supply and installation of precast concrete panels complete with epoxy coated reinforcing steel; cast-in-place concrete coping complete with epoxy coated reinforcing steel; soil reinforcement; sealer; drains; traffic barriers; the supply and installation of galvanized steel safety railing including anchor bolts and concrete swale at the top of the MSE wall; and all labour, material, equipment, tools and incidentals necessary to complete the Work.

All costs associated with the design of the MSE wall will be considered incidental to the Work, and no separate or additional payment will be made.

APPENDIX A

Section 7 Specification 7.1

Traffic Accommodation and Temporary Signing

TABLE OF CONTENTS

7.1 TRAFFIC ACCOMMODATION AND TEMPORARY SIGNING

7.1.1 GENERAL

This specification details the requirements for traffic accommodation including the preparation of the Traffic Accommodation Strategy and the supply, installation, maintenance and removal of temporary construction signing and traffic control devices which are specifically related to construction, repair or emergency situations and which are generally removed when the Work is completed or the situation returns to normal.

Permanent signing requirements for normal use of the roadway are detailed in Specification 7.7, Permanent Highway Signing.

7.1.2 TRAFFIC ACCOMMODATION STRATEGY

The Contractor shall prepare a Traffic Accommodation Strategy detailing his proposed methods for accommodating traffic throughout the Work Zone. The minimum requirements are specified in the Department manual entitled "Traffic Accommodation in Work Zones 2008 (1st Edition). Any project specific requirements, in excess of the minimum requirements, will be identified in the Special Provisions.

The Traffic Accommodation Strategy shall consist of drawings detailing the configuration of temporary construction signs and other traffic control devices in the work area(s) and, written confirmation of the methods or procedures being used by the Contractor to address specific traffic safety related issues or situations at the work zone.

When localized detours are required, the Contractor’s Traffic Accommodation Strategy shall include detailed drawings of proposed traffic accommodation measures, signed and stamped by a Professional Engineer registered in the Province of Alberta. The detour plans shall be drawn to scale and shall include the proposed vertical and horizontal alignments. Detours shall meet or exceed the requirements of the following Department manuals:

- Traffic Accommodation in Work Zones 2008 (1st Edition), and;
- Section B7 of the Highway Geometric Design Guide, 1999.

Unless otherwise specified, the Contractor shall submit the Traffic Accommodation Strategy to the Consultant a minimum of 14 days prior to the pre-construction meeting for the project. The Consultant will review the Traffic Accommodation Strategy and communicate any concerns to the Contractor within 7 days of the pre-construction meeting. Any issues or concerns regarding the Contractor's proposed Traffic Accommodation Strategy shall be addressed to the mutual satisfaction of the Contractor and the Consultant prior to the commencement of the Work.

The Contractor shall have no claim against the Department resulting from the Consultant’s failure to accept the Contractor’s Traffic Accommodation Strategy submission, nor any costs incurred by the Contractor to address concerns raised by either the Consultant or the Department during the review of the Contractor’s Traffic Accommodation Strategy submission.

7.1.2.1 **Requirements for Traffic Accommodation and Temporary Signing**

Unless otherwise specified, the Contractor shall accommodate Public traffic through the Work Zone on a 24-hour per day basis using any means at the Contractor's discretion, subject to the minimum requirements of the Traffic Accommodation in Work Zones manual and the following:

The Contractor shall:

- Make suitable provisions, including the use of detours, to accommodate all vehicular and pedestrian traffic safely and with a minimum of inconvenience through or around the Work.
- Provide, install, maintain and protect traffic control devices such as signs, barriers, fences and lights at his own expense and in accordance with Section 7.1.4, Temporary Construction Signing.
- Install, maintain and protect at his expense, any additional traffic control devices that the Department chooses to provide.
- Provide the required number of flag persons, during all periods of active equipment operations which may affect normal traffic operations.
- Control his operations to ensure normal school bus operations are not interfered with.
- Ensure uninterrupted access to developments along the project.
- Obtain approval from the Consultant prior to changing or disrupting existing accesses and road crossings.
- Carry out construction operations in one continuous operation at road crossings, intersections and entrances for each phase of the Work.
- When working in large cut or fill areas, stage construction as shown on Standard Drawing CB6-2.3M30, and as approved by the Consultant.
- Provide and use such other methods or equipment necessary to accommodate traffic safely through the work site.
- Include provision in his Traffic Accommodation Strategy for Standard Drawing "TCS-B-8.1 for Double Fines when Passing Workers in the active work area". The Contractor is advised that the signing sequence shown on this drawing is provided as general guidance only. The Contractor shall adjust his Traffic Accommodation Strategy and construction zone signing as required based on site conditions.

  If the Contractor's operations are such that the active work area exceeds 5 km in length, the Contractor shall install interim "speed limit" and "ID-503" signs at the approximate mid-point of the active work area.

  If the Contractor maintains separate active work areas where the cumulative length of the active work area plus any gaps exceeds 5 km, the Contractor shall sign each active work area separately in general accordance with Standard Drawing "TCS-B-8.1".

The Contractor shall promptly make any modifications to the traffic accommodation operations deemed necessary by the Consultant. Where, in the opinion of Consultant, the Contractor fails to adequately provide for the safety of the public, for recurring safety issues and/ or when the Contractor fails to comply with orders issued by the Consultant regarding traffic accommodation operations, the Consultant may suspend Work in accordance with Subsection 1.2.17.1, Authority to Suspend Work, of Specification 1.2, General.

The Contractor shall remove or cover all traffic control devices when not essential for the safe accommodation of traffic, in order to eliminate unnecessary inconvenience to the traffic.

The Contractor shall coordinate his traffic accommodation measures with those of other forces that may be working at or adjacent to the Work, as required, to accommodate traffic safely and conveniently. This shall not relieve the Contractor of his responsibility for the safe accommodation of traffic over the whole of the Work.

7.1.3 TYPICAL DRAWINGS

Drawings detailing minimum requirements for temporary signing and other traffic control devices for typical rural and urban highway situations are contained in Sections II and III, respectively, of the Department manual entitled Traffic Accommodation in Work Zones 2008 (1st Edition).

Any drawings necessary to address non-typical rural or urban highway situations shall be developed by the Contractor and included in the Traffic Accommodation Strategy.

7.1.4 TEMPORARY CONSTRUCTION SIGNING

7.1.4.1 **Materials**

The Contractor shall supply all signing materials including sign posts, weighted stands, brackets and any required mounting hardware and miscellaneous materials required for the erection of temporary construction signs.

All signs, barricades and other traffic control devices shall conform to the requirements for shape, colour and size specified in Section V of the Traffic Accommodation in Work Zones manual. The orange portion of all signs, barricades and other traffic control devices shall be fully reflectorized using high brightness, retro-reflective, non-metallized, prismatic sheeting material which incorporates durable, transparent, flourescent pigment and meets the brightness requirements as specified in ASTM D4956 for Type VIII sheeting. Unless otherwise approved by the Consultant, the orange coloured reflective sheeting supplied by the Contractor shall be one of the Proven Products for “Temporary Orange Work Zone/Construction Signs” shown on the Alberta Transportation Products List.

All other colours of sheeting material shall be Type III or Type IV high intensity retro-reflective sheeting meeting or exceeding the minimum requirements as specified in ASTM-D4956.

Larger construction signs or oversized signs may be used where conditions require greater visibility in order to be effective. They shall be used in special circumstances where more than average attention value is required from the sign.

7.1.4.2 **Equipment**

The Contractor shall supply all equipment required to complete the Work.

7.1.4.3 **Erection of Signs**

Work on the project shall not commence until all necessary temporary construction signs and all other traffic control devices as proposed in the traffic accommodation strategy are in place.

When signs require frequent moves, portable type signs, mounted on weighted stands, may be used. Portable signs shall be placed on the shoulder of the road such that the face of the sign is fully visible to oncoming traffic and the bottom of the sign is not less than 0.3 m above the road surface. The stands shall be securely weighted and erected to ensure against being blown over by prevailing winds or gusts from passing vehicles.

Non-portable signs shall be conspicuously posted, and erected at right angles to the roadway, with the bottom of the sign at a height of 1.5 m above the roadway surface, and not less than 2.0 m nor more than 6.0 m from the nearest traffic lane.

Traffic signs and devices shall be moved and kept as close to the Work Area as practical as construction progresses.

Objects within or immediately adjacent to the roadway which constitute a hazard to traffic shall be marked with alternating black and orange stripes attached directly to the object or erected immediately in front of it.

The use of signs shall be held to a minimum to prevent confusion.

"STOP" signs shall be installed on all subsidiary roads (local, district, municipal, service or approach) intersecting a primary highway detour route.

Speed zones, where required, shall be posted as indicated on the applicable drawing contained in the Traffic Accommodation in Work Zones manual or as shown in the Special Provisions.

7.1.4.4 **Maintenance and Removal of Signs**

Poorly maintained, defaced, damaged and/or dirty construction signs shall be replaced, repaired or cleaned without delay. Special care shall be taken to ensure that construction materials and dust are not allowed to obscure the face of a sign.

Signs not in effect shall be covered or removed; and all construction signs shall be removed after the project has been completed.

7.1.4.5 **Modifications to Temporary Construction Signing**

The Contractor shall be responsible for the supply and proper placement of temporary construction signs. However, in the case of potential danger to the travelling public or other circumstances where the Consultant determines that signing is inadequate, the Consultant may direct that changes to the Contractor's operations be implemented to remedy the situation. These changes may involve the use of different types and/or sizes of signs, modifying the number or locations of signs, and/or any other modifications or additions required to protect the safety of the travelling public.

7.1.4.6 **Daily Recording of Temporary Construction Signing**

Each day and as the work area changes, the Contractor shall record the location of all temporary construction signs and any other traffic control devices used at the work areas. The Contractor shall record this information on a form suitable to the Consultant and shall submit it to the Consultant on a weekly basis or when requested.

7.1.5 REMOVAL OF EXISTING SIGNS AND GUIDEPOSTS

Unless otherwise specified, all existing signs which must be removed in the prosecution of the Work shall be carefully salvaged by the Contractor. Guideposts which must be removed shall be disposed of. Critical signs necessary for the protection of traffic such as railroad crossing signs or stop signs shall be maintained.

Payment for the removal and salvage of existing signs will be made at the applicable unit prices bid in accordance with Specification 7.7, Permanent Highway Signing. All costs associated with the maintenance of existing signs and the removal and disposal of guideposts will be considered incidental to the Work, and no separate or additional payment will be made.

7.1.6 SEQUENTIAL ARROWBOARDS AND VARIABLE MESSAGE BOARDS

7.1.6.1 General

When specified in the Special Provisions, the Specifications, or as directed by the Consultant, the Contractor shall use sequential arrowboards for the accommodation of traffic. The Contractor shall have the option of supplying either stationary arrowboards or truck-mounted mobile arrowboards.

When specified in the Special Provisions, the Specifications, or as directed by the Consultant, the Contractor shall supply and operate an electronic variable message board in advance of the sequential arrowboard.

7.1.6.2 Stationary Arrowboards

Stationary arrowboards shall meet the following requirements:

- (i) Minimum size of 1.22 m x 2.44 m (4 ft x 8 ft),
- (ii) Minimum of 25 lamps that are legible at a minimum distance of 1 200 m,
- (iii) Fully adjustable light intensity on all arrowboard lights,
- (iv) Operating modes which include:
    - (a) sequential left arrow or chevron
    - (b) sequential right arrow or chevron
    - (c) sequential double arrow or chevron
    - (d) horizontal bar
    - (e) all four lamps in the extreme corners of the panel shall be flashing

7.1.6.3 Truck-Mounted Mobile Arrowboards

Truck-mounted mobile arrowboards shall meet the following requirements:

- (i) Minimum size of 0.75 m x 1.52 m (2.5 ft x 5 ft),
- (ii) Minimum of 25 lamps are legible at a minimum distance of 1 200 m,
- (iii) Fully adjustable light intensity on all arrowboard lights,
- (iv) Operating modes which include:
    - (a) sequential left arrow or chevron
    - (b) sequential right arrow or chevron
    - (c) sequential double arrow or chevron
    - (d) horizontal bar
    - (e) all four lamps in the extreme corners of the panel shall be flashing

7.1.7 FLAGPERSONS

7.1.7.1 General

When construction operations or Work Zone conditions cause interruption, delay or hazard to the traveling public or anyone on the worksite, and necessitates the use of flag persons; the

Contractor shall provide and equip responsible flag persons for the direction and control of traffic. The Contractor shall ensure that flag persons are instructed in and use proper traffic control procedures appropriate for the prevailing conditions.

Flag persons shall have proof of certification from a recognized training program on traffic control procedures through construction zones. The Department will recognize traffic control programs administered by the Alberta Construction Safety Association, however the Department reserves the right to accept or reject certification from any other institute.

7.1.7.2 **Safety Apparel**

7.1.7.2.1 Coveralls

Flag persons shall be dressed in coveralls which meet the Class 3 Level 2 requirements of CSA Z96-02, High Visibility Safety Apparel. Each pair of coveralls shall have a permanent label affixed certifying compliance with Class 3 Level 2 of CSA Z96-02.

The colour of the coveralls shall be fluorescent yellow-green with silver retro-reflective striping. The retro-reflective striping shall be a minimum of 50 mm wide, and shall be sewn onto a 100 mm wide fluorescent red-orange background material. Flag person safety apparel shall be kept clean and in good condition at all times. Faded, torn and/or dirty coveralls, or coveralls without CSA certification labels will not be acceptable and shall be replaced by the Contractor.

7.1.7.2.2 Headgear

Prior to commencement of the Work, the Contractor shall identify and assess existing and potential hazards at the project site. Where there is a foreseeable risk of injury to a worker's head, flag person's shall wear fluorescent orange protective hardhats meeting the requirements of CSA Standard Z94.1-92.

Where no foreseeable risk of head injury exists, flag persons will be permitted to wear any type of fluorescent orange headgear.

7.1.7.3 **Night Time Operations**

During hours of darkness, flag persons shall be equipped with hand held red traffic signal wands of sufficient brightness to be clearly visible to approaching traffic. In addition, flagging stations shall be illuminated by overhead lighting; and signs indicating hazardous conditions and/or signs requiring increased attention shall be marked with flashers.

7.1.8 DETOURS

Unless otherwise indicated in the Special Provisions or shown on the Drawings, the Contractor shall have the option of constructing temporary localized detours, or utilizing local roads for the accommodation of public traffic around major phases of the Work.

7.1.8.1 **Localized Detour within or adjacent to the Right-of-Way**

Subject to review by the Consultant, localized detours within or adjacent to the right-of-way may be utilized by the Contractor to carry traffic around the Work.

If the Consultant directs the construction of a localized detour; the Consultant will obtain any required Environmental Authorizations and/or right-of-way easements; and will arrange for the temporary relocation of utilities.

When the Consultant directs that a localized detour be constructed, payment for the construction and removal of the detour, including gravel surfacing, will be made at the applicable unit prices bid for the types of work incorporated.

If the Contractor elects to accommodate traffic using localized detours, the Contractor shall be responsible for the design, construction and removal of the localized detour. In addition, the Contractor shall be responsible for obtaining any required Environmental Authorizations and/or right-of-way easements, the temporary relocation of any utilities, and the reclamation of disturbed areas to a condition similar to that which existed prior to the disturbance. Prior to the commencement of any construction, the Contractor shall provide a copy of the Authorizations and easement agreements to the Consultant for review.

When the Contractor elects to construct a localized detour, all associated costs including, but not limited to, design, construction, maintenance, and removal of the detour will be considered incidental to the Work, and no separate or additional payment will be made.

7.1.8.2 **Local Road Detour**

When traffic is diverted entirely off the right-of-way via local roads, the Contractor shall establish and maintain local road detour signing, complete with signs at every intersection, in accordance with the Plans and Specifications.

The Contractor shall initially condition, maintain and restore roads used as local road detours to the satisfaction of the agency having jurisdiction, and in the case of provincially owned or controlled roads, to the satisfaction of the Consultant. The Contractor shall maintain the local roads, including dust abatement as required, and, following completion of construction operations, restore the roads to a condition comparable to that which existed prior to the commencement of the Work.

If the Contractor elects to use local roads to accommodate Public traffic, the Contractor shall be solely responsible for obtaining authority to utilize the local road detour from the Agency having jurisdiction. In situations where the Consultant directs the use of a local road detour, the Consultant will obtain the necessary approvals from the local road authority.

Unless otherwise stated in the Special Provisions, all costs associated with local road detours including, but not limited to, local road signing, initial road conditioning, maintenance, dust abatement, gravel surfacing, and local road restoration, will be considered the incidental to the Work, and no separate or additional payment will be made.

7.1.9 ROADWAY MAINTENANCE AND GRAVEL SURFACING

When the Work requires disturbance of the surface of an existing roadway that is carrying public traffic, the Contractor shall, at his own expense keep the disturbed areas of the travelled lanes well graded, free of potholes and of sufficient width for the required number of travel lanes.

When, in the opinion of the Consultant, surfacing gravel is required for traffic accommodation on areas disturbed by the Contractor prior to the completion of the Work on these areas, the Contractor shall supply and place surfacing gravel to the satisfaction of the Consultant.

For detours, payment for the supply and placement of surfacing gravel will be made in accordance with Subsections 7.1.8.1, Localized Detour within or adjacent to the Right-of-Way, and/or 7.1.8.2, Local Road Detours, as applicable.

For haul roads from gravel pits, payment for the supply and placement of surfacing gravel will be in accordance with Specification 4.5, Hauling.

For roads other than detours and haul roads from gravel pits, the supply and placement of surfacing gravel shall be at the Contractor's expense, except that the Department will pay for the truck haul of the gravel at the rate specified in Subsection 3.2.4.2, Interim Crushing, Hauling and Stockpiling, of Specification 3.2, Aggregate Production and Stockpiling. If the Contract contains a Department source option for the supply of aggregate, the Contractor may obtain the pit-run material necessary for gravel surfacing from the Department source at no cost.

If the Contractor fails to promptly carry out maintenance and/or the application of surfacing gravel when directed by the Consultant, the Department may make other arrangements to have the Work done and deduct the cost thereof from any money owing to the Contractor.

The Contractor will not be responsible for maintenance of those areas of an existing roadway which are to be constructed or reconstructed, but which have not yet been disturbed by the Contractor's construction or hauling activities.

7.1.10 PROLONGED SHUT-DOWN

Prior to any prolonged shut-down of construction, the Contractor shall ensure that any disturbed roadway surface is restored to a condition suitable for traffic operations and acceptable to the Consultant. The Contractor will not be responsible for normal winter snow and ice control for traffic accommodation during the prolonged shut-down.

Prior to commencing any prolonged shut-down of the Work, the Contractor shall host a meeting between the Contractor, the Consultant, the Project Sponsor, and the Regional Maintenance Contractor. The purpose of the meeting shall be to develop a “Shutdown Plan” based on the specific needs and requirements of the project. The “Shutdown Plan” shall outline the Contractor’s methods and procedures for monitoring and maintaining the project during the winter shutdown period, and will outline any responsibilities of the other parties.

Notwithstanding the above, no component of the shut-down plan will negate the Contractor’s responsibilities for the project, except for snow and ice control.

7.1.11 DUST ABATEMENT

The Contractor shall maintain detours and disturbed roadways that carry traffic within the project limits free of excessive dust. In this case, "disturbed roadways" shall mean sections of roadway under construction and/or sections of roadway being used by the contractor for hauling of equipment or materials. The Contractor shall supply and apply all dust abatement materials at his expense.

If the Contractor fails to promptly undertake dust abatement measures, the Department may make other arrangements to have the Work done, and deduct the cost thereof from any money owing to the Contractor.

Dust abatement requirements for haul roads are detailed in Specification 4.5, Hauling.

7.1.12 TRAFFIC ACCOMMODATION FOR BRIDGE CONSTRUCTION

In addition to the requirements stated herein, the following requirements are required for work involving bridges and/or bridge culverts.

Detailed traffic control plans taking into account site specific conditions that may impact the Work shall be provided for each bridge site.

Traffic control shall be in place only during the time it is applicable to the Work on the bridge site.

Traffic control signals, if required, shall be adjusted to the traffic demands encountered.

The Contractor shall minimize inconvenience to traffic as much as possible, and shall provide the widest traffic roadway width practicable. The minimum traffic roadway width, as shown or specified, shall be maintained and be available to public traffic at all times.

The Contractor shall anticipate and as practical accommodate wide load vehicles that may enter the Work Zone.

On stand-alone bridge projects, the tender documents may contain a bid item for “Traffic Accommodation for Bridge Construction”. Generally, this bid item will be included only on projects where traffic accommodation is required by localized detour or staged construction and the tender documents do not include separate bid items for the detour construction Work; or when other specialized requirements are detailed in the Special Provisions.

When a lump sum bid item for “Traffic Accommodation for Bridge Construction” is included, payment will be considered full compensation for all costs associated with the accommodation of public traffic through the site by the use of a localized detour, staged construction, the implementation of other measures described in the Special Provisions, or any combination thereof; including the supply, installation, monitoring, maintenance and removal of all required temporary traffic control measures, barriers, signs and devices; and all labour, materials, equipment, tools and incidentals necessary to carry out the Work to the satisfaction of the Consultant.

Payment will be made as follows:

- When the Contractor accommodates traffic using a localized detour, 60% of the lump sum price bid will be paid once the detour is in-place and fully operational. The remaining 40% of the lump sum price bid will be paid once the detour and all temporary traffic control measures have been removed; the site is opened to the unrestricted flow of public traffic; all associated clean-up has been completed and the area has been restored to a condition satisfactory to the Consultant.
- When the Contractor accommodates traffic using staged construction, 40% of the lump sum price bid will be paid once the initial stage is in-place and fully operational. The second 40% of the lump sum price bid will be paid once the traffic is switched to the second stage. The remaining 20% of the lump sum price bid will be paid once all temporary traffic control measures have been removed; the site is opened to the unrestricted flow of public traffic; and all associated clean-up has been completed to the satisfaction of the Consultant.
- When the Contractor accommodates traffic through the implementation of methods described in the Special Provisions other than the use of a localized detour or staged construction, 60% of the lump sum price bid will be paid upon acceptance of the initial installation of temporary traffic accommodation measures. The remaining 40% of the lump sum price bid will be paid when construction has been completed; all temporary traffic control measures have been removed; the site is opened to the unrestricted flow of public traffic; and all associated clean-up has been completed to the satisfaction of the Consultant.

7.1.13 MONITORING TRAFFIC ACCOMMODATION AT THE WORK ZONE

To ensure the traffic accommodation strategy is performing as intended, the Contractor shall monitor and maintain traffic accommodation at the work zone on a regular basis. The Contractor shall designate a specific individual or individuals to perform this function to ensure any issues arising are addressed in a consistent and timely manner.

Designated personnel shall be qualified, trained and experienced in traffic control and shall be knowledgeable in the operation of the traffic control devices and other related equipment. These workers shall be provided vehicles equipped with revolving warning lights and suitable communication devices to contact others for assistance if and when required. The Contractor shall identify those workers who will be responsible for monitoring and maintaining the traffic control devices at the pre-construction meeting.

The Contractor shall monitor all traffic control devices, temporary signing and roadway conditions during periods of inactivity. The frequency of inspection shall be commensurate with the traffic volumes on the highway. For all localized detours on roadway and bridge projects, and for staged construction on bridge projects, under no circumstances shall consecutive inspections be more than six hours apart, unless otherwise agreed by the Consultant. All site inspections shall be documented by the Contractor and available for the Consultant's review upon request.

The Contractor’s traffic accommodation measures will be monitored by the Department and the Consultant. If, in the opinion of the Consultant, traffic is being unduly hindered, the Contractor may be required to modify his traffic accommodation measures.

7.1.14 COMPLIANCE

In cases where the Contractor is not in compliance with the specifications and, in the opinion of the Consultant there is imminent danger to the travelling public, the Consultant has the authority to order the immediate suspension of work. Such orders will be made in writing.

In other cases where the Contractor is not in compliance with the specifications but, in the opinion of the Consultant, the infraction is not causing imminent danger to the travelling public, the Consultant will use the following escalating process to address the situation:

- (i) Issue verbal instructions requiring the Contractor to correct the infraction.
- (ii) Issue a written warning instructing the Contractor to correct the infraction.
- (iii) Issue a written order instructing the Contractor to suspend work until the infraction is corrected to the satisfaction of the Consultant.

7.1.15 PAYMENT

7.1.15.1 General

Traffic accommodation and temporary construction signing is the sole responsibility of the Contractor. Unless otherwise stated, all costs including, but not limited to, the preparation and implementation of the Traffic Accommodation Strategy; the supply installation, maintenance and removal of all traffic control devices and temporary construction signing; the daily recording of temporary construction signing; the provision of flag persons; gravel surfacing; detour design, construction, dust abatement, maintenance, and removal; local road detour preparation, maintenance and restoration, dust abatement; and all labour, materials, equipment, tools, and incidentals necessary to complete the Work to the satisfaction of the Consultant will be considered incidental to the Work and no separate or additional payment will be made.

7.1.15.2 **Bonus and Penalty Assessment**

The Contractor will be assessed a $250.00 penalty for each written warning to correct an infraction issued by the Consultant. (Stage 2 of escalation process)

The Contractor will be assessed a $1,000.00 penalty for each written order to suspend Work issued by the Consultant. (Stage 3 of escalation process or in cases of immediate suspension of Work due to imminent danger)

If neither of the following has occurred prior to the issuance of the Construction Completion Certificate:

- Written orders to suspend Work or written warnings issued by the Consultant .
- Written orders to suspend Work issued by the Department.

the Contractor will receive a lump sum $2,000.00 payment.

Bonus and penalty assessments and written orders will not be administered separately for separate and distinct projects within the Contract or for distinct work phases on any given project within the Contract, but will be administered as a single process for the entire Work regardless of the number of separate and distinct projects or the number of distinct work phases on any given project.