# Bridge Construction Inspection Manual

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Alberta
Government

# BRIDGE CONSTRUCTION INSPECTION MANUAL

**Technical Standards Branch**

**Alberta Transportation**

**September 2015**

# PREFACE

The Bridge Construction Inspection Manual (Manual) is a documentation of Alberta Transportation's bridge construction inspection practices and policies and is intended to supplement the requirements of the Standard Specifications for Bridge Construction and the Engineering Consulting Guidelines for Highway, Bridge, and Water Projects.

The inspection of the Province's bridges is a significant activity, and the carrying out of consistent, thorough and properly documented bridge inspection is an important factor in achieving performance, durability, and an adequate level of safety.  It is intended that this document will help facilitate the achievement of this goal.

It is not the intent of this Manual to limit progress or overrule the exercise of proper engineering judgment in the carrying out of bridge inspections. Consultants should satisfy themselves that the requirements of both this Manual, the Standard Specifications for Bridge Construction, and the Engineering Consulting Guidelines for Highway, Bridge, and Water Projects are appropriate for a specific bridge project.

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# SECTION A

# INTRODUCTION

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## A.1 Introduction – General

Bridge construction inspection includes inspection of major bridge structures, bridge rehabilitation work, standard bridge structures, bridge-size culverts and related structures, such as earth retaining walls.

Successful bridge construction requires careful coordination between the designer, Project Manager, materials inspectors and the bridge construction inspector (Inspector), who are on the Consultant's team. The effectiveness of bridge construction inspection relates directly to the Inspector's capabilities, knowledge, experience, aptitude and competency of the project team. An effective Inspector can prevent the incidence of construction issues and conflict through proper planning, communication and technical knowledge.

It is the Inspector's responsibility to review, witness, assess, measure and otherwise determine the acceptability of the work. It is also the Inspector's responsibility to document, photograph and record the progress of the work and his communications with the Contractor.

"Informed inspection is the link between design and construction." This quotation summarizes the essence of the Inspector's job.

The purpose of this Manual is to:

- Describe the Department's expectations for bridge construction inspection relevant to each section of the *Standard Specifications for Bridge Construction*, with discussion about specific activities that need to be reviewed, witnessed, assessed, measured, documented and photographed.
- Describe the Inspector's role with respect to contract administration, coordination with others and technical interpretation.
- Provide consistency in inspection effort for the Department and their Consultants.
- Provide supplemental technical commentary and photographs to the *Standard Specifications for Bridge Construction.*
- Provide guidance and reference to the junior Inspector, and be a resource for the experienced Inspector.
- Provide comprehensive inspection checklist templates and activity photographs.

## A.2 Qualifications of the Inspector

Appendix J3 of the *Engineering Consulting Guidelines for Highway, Bridge, and Water Projects – Volume 1* provides qualification requirements for the Inspector. Inspectors lacking the necessary project experience requirements must work under the direct on-site supervision and guidance of an Inspector with extensive field experience. An effective and experienced Inspector:

- is certified in the field of civil engineering and maintains an ongoing program of relevant training, including periodic review of specifications and technical standards referenced in the *Standard Specifications for Bridge Construction*
- has excellent written and oral communication skills
- has a fundamental knowledge of bridge design
- understands and has extensive experience with all relevant bridge construction methods, equipment and practices
- understands and has experience in surveying and other common forms of dimensional and positional checks
- understands construction limitations, sequencing and duration of activities

- has specific technical knowledge in concrete, steel, earthworks and other products and materials, and has an understanding of bridge material fabrication and testing processes
- is knowledgeable about current environmental legislation and permitting
- understands the current Occupational Health and Safety Act and Regulations
- is skilled in the interpretation of contract documents, specifications and drawings
- thoroughly understands construction contract administration and contract law principles
- understands the roles and responsibilities of the Contractor, the Owner and other stakeholders
- understands the role of and relationship to the design engineer
- understands the role, responsibilities and protocol of his team, the Contractor and the Department with respect to decisions and actions
- can anticipate potential conflicts and problems, thereby promoting a proactive instead of a reactive solution.

The Inspector's aptitude is equally as important as the qualification requirements. An effective Inspector must possess the following characteristics:

- pragmatic and logical approach to the resolution of problems and issues
- ability to use direct, clear, incisive language
- confident, assertive and firm, not timid
- skilled at negotiation and diplomacy
- observant, insightful, vigilant and able to anticipate through familiarization with Contract documents
- pleasant in disposition and positive in attitude, slow to anger and staid, patient demeanor, skilled at maintaining a professional relationship with all parties
- meticulous and diligent in record keeping, energetic not indolent
- deliberate and circumspect when making determinations, not easily coerced or intimidated to make incautious or hasty decisions
- ability to repudiate work without hesitation when project requirements not met
- skilled at processing information and understanding the perspective of others, continuously demonstrating an attitude of 'partnering' through actions and words, able to consider the implication of decisions on all parties
- a sense of "the big picture" and a great deal of patience and perseverance

## A.3 Definitions

### A.3.1 Activities Related to Inspection

**Inspect**: To view, witness, investigate, study or examine closely and critically, formally or officially. Inspectors use observation, measurement, testing and judgment to evaluate conformity. **The Inspector is required to inspect the Work.**

**Review**: An evaluation of a document, procedure, construction activity or process for general conformance to contract documents. A review is an activity, and its purpose is to determine whether or not the document, procedure, construction activity or process being evaluated is adequate to meet requirements. The Inspector does not accept responsibility for accuracy or compliance to contract documents as the result of a review. **The Inspector is required to review the Work.**

**Audit**: A systematic, independent and documented process for obtaining records and other information and evaluating it objectively to determine the extent to which procedures and requirements are fulfilled. **The Inspector may be required to audit aspects of the Work.**

**Supervise**: To oversee a process during execution or performance, and to have oversight and direction of. **The Inspector does not supervise the Work.** It is the responsibility of the Contractor to supervise, and thereby take responsibility for the Work.

**Accept**: To acknowledge review without accepting responsibility for (in contract terminology). **The Inspector is required to provide initial acceptance but not final acceptance of the Contractor's Work. Conversely, the Inspector may reject the Contractor's Work.**

**Approve**: To confirm or sanction formally. **The Inspector does not approve the Contractor's drawings, procedures or Work; however, he may be authorized to approve changes to the scope of Work.**

**Certify**: To attest as certain, give reliable information of, to confirm, to testify or to guarantee. **The Inspector does not certify aspects of the Work.**

**Ensure**: To secure or guarantee, to make certain. As with the term "certify", **the Inspector does not ensure that aspects of the Work are adequate or acceptable.**

### A.3.2 Quality Roles Defined

**Quality Control (QC)**: The comparison of a product against the Contract documents, as in the case of an inspection. Persons responsible for QC must be fully conversant with project documents and be capable of evaluating the Work against the Contract documents. QC must be independent of production, be allocated sufficient time to perform its function, and have the authority to reject non-compliant work or to require changes to it prior to acceptance. It is reactive and can result in rejection of the work. **QC must be performed by the Contractor.**

**Quality Assurance (QA)**: This involves establishing, monitoring and modifying a process of production or construction so that the final product must comply with the Contract documents. Persons responsible for QA must be conversant with both the project requirements and the construction processes used to do the Work. QA is a product of management, but it is implemented by production personnel. In principle, perfect QA would eliminate the need for QC. **QA must be performed by the Contractor.**

**Inspector's Quality Role**: The terms QC and QA as defined above are consistent with ISO 9000 but are frequently misused, which can lead to confusion. Unless specifically identified in the *Standard Specifications for Bridge Construction*, it is best to avoid stating that the Inspector has either a QC or QA role. **The Inspector reviews or inspects the work at various stages of completion for the purpose of assessing compliance to Contract documents.** The Inspector may reject work if non-compliant. Rejection of work must result in a review by the Contractor of his QA process. Exceptions exist when the Inspector does QA backfill or concrete site testing; this testing is done at the Department's and Consultant's discretion for the purpose of verifying the accuracy of the Contractor's testing.

### A.3.3 Language Defining Accountability

**Shall**: An auxiliary verb, used in contract terminology when reference is made to the second and third person (you, they). Therefore, the verb "shall" is used when providing written instruction to the Contractor.

**Will**: An auxiliary verb, used in contract terminology when reference is made to the first person (I, We). Therefore, the verb "will" is used when making reference to the Owner or Consultant's actions in a written instruction.

## A.4 The Inspector's Tools

Certain equipment is required by the Inspector. All equipment should be in good working condition and be readily available throughout the Work.

### A.4.1 Basic Equipment

- *Project Journal*
- *Writing Instruments*: Pens, highlighters, felt markers, soapstone, paint markers, spray marking paint.
- *Tape Measure*: This includes a short steel pocket tape (minimum 5 m) and a long survey chain.
- *Camera*: Digital and video.
- *Thermometers*: Traditional, max/min and hand-held LASER to record surface temperatures.
- *25m String Line, Clamps, Plump Bob*: Used to check form alignments.
- *Chipping Hammer*: Used for sounding.
- *Lights*: Pocket flashlight and high-power light for inspecting deep forms and pile excavations.
- *Carpenter's Levels* (torpedo 1 m)
- *Straight Edges* (aluminum 3 m and polystyrene 3 m): Used for checking trueness of concrete surfaces.
- *Vest*: This is often also a safety vest and is required so that the Inspector's gear can accompany him while at the site.

### A.4.2 Survey Equipment

- *Survey Level*: Used to check structure elevations from a given benchmark elevation.
- *Automatic Theodolite* (Total Station): Used to check structure stations or coordinates from given control points.
- *Survey Flagging Tape, Lath, Hubs, Steel Pins*
- *Prism and Level Rod*

### A.4.3 Specialized Equipment

- *Optical Hand Level or Clinometer*: Used to estimate slope angles.
- *Dry Film Thickness Gauge*: Used to measure coating thickness.
- *Feeler Gauge and Crack Template*: Used to determine crack widths and deck finger joint tolerances.
- *Pachometer*: Used to determine reinforcing steel cover after concrete has been placed (as required).
- *Anemometer*: Sailing-type wind gauge, used to determine evaporation rate for Class HPC Concrete.
- *Humidity Meter*: Used to check RH in hoardings and to determine evaporation rate for Class HPC Concrete.
- *Plunger Gauge*: Used to measure waterproofing membrane thickness.
- *Mirror*: Used for inspecting pile excavations.
- *Watch and Stopwatch*: For counting 'Blows per 250 mm' and 'Blows per Minute' during pile driving.
- *Pocket Penetrometer*: Used to estimate soil densities.

- *Telescoping Measuring Rod or Laser Level*: Used for measuring rise and span of culvert barrels.
- *Torque Wrench*: Used to check bolt tightening for culverts and structural steel.

# SECTION B

# ADMINISTRATION

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## B.1 Administration – General

The Department requires written project field records, including forms, reports, photographs and journals. The Inspector must diligently and regularly prepare and maintain these records. Written records support the Department's position when quality and payment disagreements arise.

The Department maintains various documents that describe requirements and provide reference information to the Consultant and the Contractor. These include requirements for project administration, which must be followed to achieve consistency from project to project.

## B.2 Contract Terminology

### B.2.1 Project Team Definitions

**Consultant**: Retained by the Department to administer a construction contract between the Department and the Contractor. The Consultant is not a party to the Contract. The Inspector represents the Consultant at the project site. The Inspector reports directly to the Project Manager, who manages and administers the Contract on behalf of the Consultant.

**Department**: Her Majesty the Queen, in right of Alberta, as represented by a person authorized by the Minister and represented by Alberta Transportation. The Project Sponsor is appointed by the Department to act as a direct liaison between the Department and the Consultant.

**Contractor**: The corporation agreeing to perform the Work set out in the Contract documents.

### B.2.2 Contract Definitions

**Contract**: The written agreement describing the performance of the Work and furnishing the labour, equipment and materials necessary to complete the Work. The Contract is a legally binding agreement between the Department and a Contractor for the purpose of completing Work at specified rates of payment. Only documents specifically referenced in the Contract are binding.

**Work**: All of any part of the Work to be performed under Contract.

**Warranty**: A stipulation, explicit or implied, of some particular aspect of the Work. A statement of promise or a statement of formal assurance (i.e., an assurance that the Work will be performed as intended is an implied warranty).

**Guarantee**: A statement of promise or assurance that the Work is of a specified quality, or that it will perform satisfactorily for a given length of time; a pledge to take responsibility for performance.

**Procedure**: The sequence of actions or instructions to be followed by a Contractor in accomplishing a task, while maintaining compliance to Contract requirements. Procedures are prepared by the Contractor.

**Deficiencies**: Items that are non-compliant and were not corrected are considered deficiencies.

### B.2.3 Generic Document Definitions

**Manual**: A reference document that provides information or instructions.

**Regulation**: A principle, rule or law prescribed by authority, designed to control, regulate or govern conduct.

**Guideline**: A document of policy or procedure by which to determine a course of action.

**Shop Drawings**: A set of drawings produced by the Contractor, supplier, fabricator or manufacturer for construction of the Work. Shop drawings detail the construction, installation or erection of work items. Shop drawings must be compliant with and meet the intent of the Consultant's design drawings. The Consultant typically reviews shop drawings.

**Specification**: Describes an explicit set of requirements to be met by a material, product or process.

**Technical Standard**: A document referenced in a Specification that establishes uniform engineering or technical criteria, methods, processes and practices. An established norm or requirement.

**Bid Documents**: A set of documents produced for the process of bidding. Note that the contractual relationship between bidders and the Department is different than the contractual relationship formed between the successful bidder and the Department. Bid documents are not construction contract documents.

## B.3 Construction Contract Documents

**General Condition(s)**: Stipulates minimum performance requirements of the Contractor, and describes the rights, responsibilities and relationships of parties to the Contract.

**Special Provision(s)**: A clause or condition that modifies or qualifies a requirement of the Specifications. Special Provision requirements supersede Specification requirements in the hierarchy of construction contract documents.

**As-Constructed Plans**: A set of final drawings prepared by the Consultant and submitted to the Department. As-Constructed Plans are revised original plans that include changes known to the Consultant. These include dimensions, locations and quantities of the Work.

## B.4 Department Requirements of the Consultant

The Department's *Engineering Consultant Guidelines for Highway, Bridge and Water Projects, Volume 2 – Construction Contract Administration* Manual:

- outlines the Department's expectations for the provision of engineering services for the administration of provincial highway, bridge and water management construction projects where a Consultant is hired directly by the Department.
- outlines specific responsibilities and authorities of the Consultant when providing these services.
- ensures uniformity and consistency in the provision of these services to the Department.

The Department does not utilize Consultants for:

- tendering and award of construction contracts
- administration of holdback and contract security monies
- warranty inspections

## B.5 Department Construction Documents

The list of construction documents below is comprehensive and consists of all written materials needed to execute the Contract.

- **Department Construction Contracts**: These consist of a schedule of work items and prices, Standard Specifications, Specification Amendments, Supplemental Specifications, Special Provisions, typical drawings, Plans and permits.
- **Contract Specifications and Standards**: The Department Construction Contracts contain reference to specific elements or editions of one or more of the following Contract Specifications and Standards, which include:

  - *Standard Specifications for Highway Construction*
  - *Standard Specifications for Bridge Construction*
  - *General Specifications*
  - *Specification Amendments and Supplemental Specifications for Highway and Bridge Construction*
  - *Civil Works Master Specification for Construction of Provincial Water Management Projects*
  - *Bridge Standard Drawings and Highway Standard Plates CB6 Standards*
  - *Traffic Accommodation in Work Zones*

- **Construction Bulletins**: These are issued by the Department if an ambiguity is identified in the standard specification or manuals. The Bulletin will clarify the intent of the applicable clause until the ambiguity is addressed in a new edition of the Department's document.

### B.5.1 Standard Documents

The *Standard Specifications for Bridge Construction* is revised regularly to incorporate changes in construction materials and processes. These requirements have been developed through consultation with industry, academia, expert practitioners and other transportation departments. The text is written to be precise in meaning. The *Standard Specifications for Bridge Construction* also references additional Department documents, approved products lists, CSA and ASTM Standards, guidelines and other industry documents of practice.

The *General Specifications, Specification Amendments, and Supplemental Specifications for Highway and Bridge Construction* documents are used in conjunction with the *Standard Specifications for Bridge Construction*. The general specifications describe the contractual relationship between the Department and the Contractor, and the role of the Consultant in administering the Contract. The amendments serve the purpose of providing standardized specifications for project-specific issues that do not occur for all projects. The supplemental specifications are intended to address certain requirements that are not yet included in the *Standard Specifications for Bridge Construction*.

### B.5.2 Project Specific Documents

The schedule of work items, Special Provisions and the Plans are unique to a particular contract.

- **Project-specific Construction Plans** provide general layouts, site details, utility details, dimensions, quantities and information required to complete the Work.
- **Special Provisions** provide project-specific or unique requirements and details that may relate to technical, scope, schedule, quantity, environmental, safety or payment aspects of the Work.

Special Provisions may be used to modify or replace other specifications. They also identify which amendments and supplemental specifications apply.

- **Schedule of Work Items** include a unit or lump sum price schedule, estimated quantities and specification references.

## B.6 Hierarchy of Documents and Drawings

The Contract between the Department and the Contractor includes all provisions of the following documents:

1. Contract Forms
2. Tender Forms
3. Special Provisions
4. Specification Amendments
5. Supplemental Specifications
6. Plans and Permits
7. Addenda
8. Specification Amendments and Supplemental Specifications
9. Supplementary Specifications
10. Standard Specifications for Bridge Construction
11. Bridge Construction Drawings

## B.7 Extra Work

Extra Work is described in the General Specifications and in the *Construction Contract Administration Manual*. It includes work not specified or of a class not included in the Contract but is necessary for the completion of the Work.

An ‘Order for Extra Work’ will be prepared by the Project Manager. This document must be signed by the Contractor, reviewed by the Inspector and approved by the Department before any Extra Work may begin.

Sometimes the exact scope of Extra Work is not possible to define. It is sometimes necessary to approve the Extra Work in principle, then proceed with the Work and measure quantities at the time the Work is performed. In this case, it is necessary to agree on the method of measurement and payment before the Work starts.

### B.7.1 Supplemental Work

Supplemental Work includes work that is outside the scope or intent of the Contract. Supplemental Work may only be done with the Department`s consent. This may result in a Contract Scope Change or Contract Extension.

## B.8 Claims, Negotiations, Disputes

A claim arises when the Contractor believes that he has been required to perform Work that is beyond the scope of the Contract for which he has not been adequately compensated. A claim may also arise when the Inspector refuses to pay for Work that he considers non-compliant. Any disagreement of this nature is considered to be a claim.

Claims may be resolved at the Consultant–Contractor level. If the claim is not resolved, it is then escalated to the Department–Contractor levels. If the claim is still not resolved, it becomes a dispute.

A claim is a formal term as defined by the Public Works Act. In making a claim, the Contractor must submit a Notice of Claim to the Department. If a dispute arises, the Contractor must submit a Notice of Dispute as described in the *Dispute Resolution Process for Government of Alberta Construction Contracts*. The terms “claim” and “dispute” must not be misused by the Inspector in discussions and when preparing written correspondence. If the Contractor fails to provide formal notice within the period specified, he forfeits his right under the Contract to proceed with claim or dispute action.

- The Inspector must immediately notify the Project Manager of a discussed claim or claim circumstance.
- The defence of the Department’s position in a claim situation depends greatly on the accuracy, completeness and appropriateness of the Inspector’s records. The project journal and site photographs are by far the most valuable sources of information used to defend a claim.
- It is important that the Inspector give no assistance, advice or gratuitous information to the Contractor to help formulate the basis of a claim. The Contractor must not have access to the Inspector’s project journals or Departmental correspondence; however, information relating to progress estimates and quality assurance testing may be provided.
- If errors discovered by either the Contractor or Inspector are found to exist in the content of the Contract Documents, these errors must immediately be brought to the attention of the Project Manager.
- When a claim arises, the Inspector must act in the Department’s best interests. The Inspector must make genuine efforts to resolve the claim at the site level. The Inspector is not a mediator between the Contractor and the Department; rather, the Inspector represents the Department in all respects.
- The Inspector may not compensate the Contractor for a claimed amount by increasing the quantity of an unrelated item that is measured and paid on the basis of a unit-rate. This may seem to be a simple mechanism for deserved payment, but this action is fraudulent. All claims must be justified, properly processed and be paid on the basis of their merit alone. When claims are deemed payable, the supporting details must be well documented in the project record.

## B.9 Avoidance of Claims

The Inspector must, through planning and effective communication, try to anticipate where disagreements may arise. The source of the potential disagreement must be discussed in an effort to avert a claim.

When the Inspector suspects that the Contractor does not understand the project requirements, he must proactively discuss his concern with the Contractor. In this way, the Inspector can prevent re-work and the potential for claims due to a misunderstanding. It is essential that the Inspector be familiar with all aspects of the project requirements.

The Inspector must never require that the Contractor perform work that is not in the scope of the Contract. Extra Work must always be approved in advance by the Project Manager and the Department.

The Inspector must promptly measure and calculate all items for payment, and must not delay payment to the Contractor for Work performed.

The Inspector’s instructions to the Contractor must always be supported by project requirements and be documented.

The Inspector must never interfere with the Contractor's progress and may only delay the Work if it has been found to be non-compliant. The Inspector must be decisive and not delay the Contractor when accepting or rejecting Work. However, when the Inspector has grounds to suspect that the Work may be deficient, he must investigate in a timely fashion, even if this results in delay to the Contractor.

## B.10 Documentation Records and Forms

The task of keeping complete, current and accurate records is a key role of the Inspector. The *Construction Contract Administration Manual* contains various forms that are to be completed by the Inspector.

### B.10.1 Project Journals

It is very important that the Inspector maintain a project journal containing a comprehensive account of daily site activities and information. The journal is a legal document that will be submitted to the Department with final project details and must be treated as such. Its content consists of eyewitness observations that may be used to defend the Department against a claim or dispute.

During a claim or dispute, the journal will be submitted for review by others. The content will not be considered credible if the entries are inconsistent in their detail.

#### B.10.1.1 Instructions for Maintaining the Project Journal

- The journal should consist of a weather-resistant hard-cover book with printed page numbers. The pages must not be removable. The journal must be safeguarded against loss as it contains sensitive and valuable record. The journal must be regularly scanned and stored within the project directory to protect against loss.
- It is best to develop a template for journal entries so that the Inspector develops a routine in making his entries. A journal sample template is included at the end of this section. It is better to strike through a forced entry heading in the journal instead of being silent on a matter, since the former demonstrates that the matter had been considered and reported on.
- The Inspector's name, address and phone number or email address must be clearly written on the inside cover.
- Make all entries in indelible ink, not pencil. Do not erase, but instead cross out and rewrite if it is necessary to change an entry. Never remove pages from the journal.
- Use sketches if they clarify the entry.
- Write legibly, concisely and preferably in point format.
- Only record factual information. Do not include opinions or comments of a personal nature. Do not enter libelous remarks.
- Always be specific regarding location, distances, stations, quantities, etc.
- Make entries each day and as events occur. It is very difficult to recall specific details or conversations after time has passed.
- The journal is the source of information for all other Department progress forms. Do not use information from forms to prepare journal entries.
- The Inspector must sign each daily entry in the event that relief Inspectors use his journal.
- If electronic tablets are used to complete journals, similar considerations must be given in making the entries credible, unalterable and permanent.

### B.10.1.2 Minimum Daily Information to be Recorded in the Project Journal

- Weather conditions for each day.
- Identification of the period of time that the Inspector was physically at the site.
- Description of work activities underway, equipment on site whether in use or not, size and utilization of labour force.
- Equipment and manpower hours where hourly rate is the payment method.
- Record of any verbal instructions or agreements made with the Contractor, and identification of subsequent written documentation.
- Record of any verbal disagreements, disputes or requests that the Contractor makes regarding interpretation of Contract Documents.
- Information pertaining to the relocation of utilities and note of any delay to the Contractor.
- A record of visits and discussions held with the Project Sponsor and other government officials, and any resulting instructions and decisions.
- All changes from original plans and/or design quantities and an explanation of the reasons. Include record of discussions with Project Manager or designer. Details regarding errors in Contract Documents.
- All irregularities on any item during the stages of construction.
- Explanation of incompleteness of field records.
- Details of accounts that were not directly observed by the Inspector.
- Identification of the supervision, QC personnel, foremen or other Contractor personnel on site who were present during the activities.
- Explanations of non-conformance, including when and how they were remediated, with reference to pertinent photographs.
- General progress of the Work and an account of any difficulties encountered by the Contractor. Description of any problems or incidents that may affect the quality, schedule or cost of the Work.
- Special notations or items pertaining to Extra Work or possible Extra Work. Details on the validity of any claims or changed conditions.
- The Contractor’s claims, intention to claim, complaints, disputes, etc., including photographs as applicable.
- Any significant or unexpected event that may affect the Contractor’s schedule or cost.
- All discussions or dealings with property owners and other public personnel.
- All discussions or dealings with officials of municipalities.
- All discussions or dealings with safety officers pertaining to safety matters, information pertaining to work safety, tail gate meetings, etc., and subsequent action taken.
- Record of environmental issues and subsequent action taken.
- All discussions or dealings with emergency personnel or police.
- Record of all accidents within the Contract limits, a record of conditions at the time of the accident and relevant photographs, including description of all pertinent signing in place at the time.
- Discussions with the Contractor regarding work schedules and quality of work.
- Status of traffic accommodation, detours, construction signs and flag persons.
- Full description of construction photos or videos taken, with reference made to journal entries when possible.
- Signature and date.

## B.10.2 Weekly Progress Report

The Inspector’s weekly progress report is submitted on a standardized form with entries that must be completed daily. At the beginning of each week, the report is reviewed by the Contractor and subsequently submitted to the Project Manager and the Project Sponsor by the Inspector.

Daily entries must include a brief description of the activity for that day and the progress made for those activities during that day.

Daily entries must include a summary of the Contractor's hours worked for that day for each activity, as they relate to Site Occupancy and Lane Rental.

All information contained in the report must be taken from the Inspector`s journal. The form must not replace the journal.

The report must be signed by the Contractor's superintendent, which confirms that he is in agreement with the Site Occupancy and Lane Rental days charged.

### B.10.3 Field Memo

The Field Memo is issued to the Contractor at the project site to document instructions given. It should include a summary of the issue, instruction given, specification references, and the basis of payment if applicable. The Field Memo should be hand delivered and also submitted electronically. It must also be sent to the Project Manager and the Project Sponsor.

### B.10.4 Monthly Progress Estimate

The Monthly Progress Estimate must be submitted promptly to the Project Sponsor on the 25th of each month, identifying the appropriate pay quantity for each bid item.

For items paid by unit, the Inspector must measure and calculate the quantities of work items that the Contractor has acceptably constructed during the past month.

The Inspector must enter the appropriate quantities and submit the estimate to the Project Manager for processing.

Whenever Extra Work is progressed, an approved Extra Work Order must be submitted with the progress estimate.

### B.10.5 Survey Book

The Bridge Inspector must maintain a survey record book. Entries must include complete notes for:

- All level notes, kept in proper levelling note format. The notes and calculations must be explicit and clear. The calculations must be reproducible from the notes. The entries must be well explained and must include date and specific location of benchmarks.
- All measurements with sketches and calculations recorded to calculate quantities for payment.
- All sketches used to check quantities during inspection.
- All sketches used to track locations of concrete batches during concrete pours.
- Survey books must be submitted with the project's As-Constructed records.

## B.11 Deficiencies

The Inspector must keep an accurate record of all deficiencies and review them with the

Contractor as they occur.

## B.12 Final Acceptance

At the completion of the project, the Contractor is required to request an inspection for Final Acceptance of the completed Work. Prior to this final inspection, the Bridge Inspector must confirm that the Contractor has corrected all known deficiencies.

The inspection for Final Acceptance must include the Project Manager, the Inspector, the Project Sponsor, any other Department personnel requested by the Project Sponsor and the Contractor.

Additional deficiencies noted during a final inspection must be corrected by the Contractor prior to a request for re-inspection. All deficiencies must be corrected before Final Acceptance is given.

The Project Manager, after the Final Acceptance, will issue a Contract Completion Certificate (CCC) to the Contractor indicating that the project has been satisfactorily completed in accordance with the Contract requirements. The warranty period begins at Final Acceptance.

## B.13 "As-Constructed" Documents

The Inspector will be issued one full-size set of Plans designated as the "As-Constructed" set. This set of plans is only to be used for the purpose of recording the details of any changes to the actual construction, as it is done. These plans must be protected, and they usually remain in the site office. All information must first be recorded on a half-scale set of plans, which the Inspector carries with him at all times. The As-Constructed information is then transferred to the official full-size plans. All significant deviations from the plans must be noted, including, but not limited to:

- Exact footing elevations and dimensions.
- Pile penetrations shown as an average, maximum and minimum for each element.
- Any additional piles required, or defective piles.
- Any revision to pier or abutment geometry.
- Any variation in the placing of the reinforcing steel or additional reinforcing used.
- The actual dimensions of rock riprap or concrete slope protection.
- The elevation of the stream bed at each pier and at other critical locations, such as the toe of riprap.
- Drain trough lengths and locations.
- Additional concrete, tremie seals and blinding courses, even if these are not paid items.
- All quantities on each applicable drawing.
- Measurement of the gap in deck joints, including gap measurements between plates after installation, and the position of the expansion bearings, including the date and ambient air temperature when measured.
- The elevation for the wingwall "Bench Mark Tablet".
- Measurement of clearance boxes on railroad overpasses and grade separations.
- Exact location of the ends of ducts and conduit in approach fills.
- Misalignment of MSE walls.

As-Constructed drawings must be forwarded to the Project Manager together with the final estimates, including the final quantity calculations and all pertinent field notes.

## B.14 Final Reports

A Bridge Construction Completion Report, including appropriate BIM inspection report and BIS coding sheet, will be required at the end of the project. The report is a standard form and includes a list of deficiencies identified at the Final Acceptance inspection and confirmation that the deficiencies have been corrected. The report is submitted at Final Acceptance, and it signifies the beginning of the warranty period.

A Final Bridge Construction Report is also required. It provides a comprehensive summary of construction events.

### B.15 Sample Records and Forms

- Inspector's Project Journal
- Inspector's Meeting Record Journal
- Field Memo

## B.15 Sample Records and Forms

# INSPECTOR’S PROJECT JOURNAL

# INSPECTOR'S PROJECT JOURNAL — SAMPLE

BF 99999

Time Arriving at Site: 7:00 am

Time Leaving Site: 6:30 pm

Today's Date: AUGUST 1/15

Summary of Activities, Progress and Delays:

- CONCRETE POUR AT ABUT 1 BACKWALL
- CURING AT PIER 2 BEARING GROUT
- REBAR PLACEMENT AT EAST SLOPE PROTECTION, BOTTOM THIRD OF SLAB COMPLETED.
- STRUCTURAL BACKFILL PLACEMENT AT PIER 1 PILECAP, COMPLETED TO EL 620m
- DELAY TO SCHEDULED FORMWORK ERECTION AT ABUT 2 DUE TO HIGH WINDS.

Instructions, Agreements, Disputes:

- DUE TO FREEZING TEMPERATURES, INSTRUCTED SUPERINTENDENT TO IMPLEMENT COLD WEATHER PROCEDURES FOR BEARING GROUT. AGREED.

Construction Problems or Incidents:

- DUE TO SOFT CONDITIONS, OVER EXCAVATION NEEDED AT PIER 1, AS DETERMINED AFTER REVIEW WITH GEOTECHNICAL ENGINEER.

Equipment/Personnel Used:

- 12 LABOURERS - 8h
- 4 RODBUSTERS (SUBS) - 6h
- 1 26m CONCRETE PUMP - 6.5h
- 1 HYDRAULIC EXCAVATOR - 4h
- 2 TANDEM DUMP TRUCKS - 4h

Site Occupancy 36

Minimum Temperature Last Night -2°C

~~Lane Rental~~

Maximum Temperature Today +3°C

- [ ] Sunny
- [ ] Cloud
- [x] Rain
- [ ] Snow
- [x] Wind At 90km/h
- [ ] Clear

Notes:

· HAD DISCUSSION WITH SUPERINTENDENT ABOUT SIGNS BLOWN DOWN. IMMEDIATE ACTION WAS TAKEN BY CREW TO RECTIFY – MORE WEIGHT ADDED. FOLLOWED-UP WITH EMAIL WHICH IDENTIFIES THE ISSUE & CONSEQUENCES OF REPEATED OCCURENCE.

· IDENTIFIED SUBEXCAVATION LIMITS TO THE SUPERINTENDENT. CHECKED THE CONTRACTOR'S SURVEY AND AGREED TO AN ADDITIONAL QUANTITY OF 750 $m^3$. AFTER CONSULTATION WITH THE PM, CONFIRMED THAT THIS WORK WILL BE PAID FOR AT THE UNIT PRICE BID. PM WILL PREPARE A WRITTEN ORDER FOR EXTRA WORK, TO BE RETURNED TO THE CONTRACTOR PRIOR TO THE AUG 25 CUT-OFF FOR PROGRESS PAYMENT.

Traffic, Environmental, Safety Concerns:

· TEMPORARY SIGNS BLOWN OVER

· TEMPORARY RAILING AT ABUT 1 BACKWALL IN SERVICE BUT MISSING TOE BOARDS

Other Field Documentation: ___ Checklist ___ Field Memo ___ Other ______

| Daily Report Titled and Stored: | | Photos Titled and Stored:: | | Signature: |
|---|---|---|---|---|
| YES | NO | YES | NO | |
| ☐ | ☐ | ☑ | ☐ | ______ |

# INSPECTOR'S PROJECT JOURNAL — SAMPLE

Time Arriving at Site: 7:00 am

Time Leaving Site: 6:30 pm

Today's Date: AUGUST 1/15

- CONTINUED

Summary of Activities, Progress and Delays:

Instructions, Agreements, Disputes:

Construction Problems or Incidents:

- CONTRACTOR HAS EXPERIENCED A DELAY IN PIER 1 CAP FORMWORK ERECTION – THIS WAS PLANNED FOR TODAY BUT DELAYED UNTIL AUG 5 DUE TO WIND.

Equipment/Personnel Used:

- 2 PLATE TAMPERS
- 1 SMOOTH-DRUM ROLLER

Site Occupancy ______ Minimum Temperature Last Night ______

Lane Rental ______ Maximum Temperature Today ______

☐ Sunny ☐ Cloud ☐ Rain ☐ Snow ☐ Wind At ☐ Clear

Notes:

- SUBMITTED EMAIL TO SUPERINTENDENT, ADVISING THAT THE RAILING DOES NOT MEET OH&S REQUIREMENTS. CREW IMMEDIATELY ESTABLISHED SETBACK TO THE EDGE UNTIL RAILING IS REPAIRED.
- SUPERINTENDENT INFORMED THAT THE DELAY IN FORM-WORK ERECTION WILL LIKELY RESULT IN UNFINISHED WORK AT THE SPECIFIED COMPLETION DATE. ADVISED PM AND PROJECT SPONSOR.

Traffic, Environmental, Safety Concerns:

Other Field Documentation: ✓ Checklist ✓ Field Memo ✓ Other 2 EMAILS

BACKFILL, CONC. F.M. #1

Daily Report Titled and Stored: YES ☑ NO ☐

Photos Titled and Stored:: YES ☑ NO ☐

Signature: INSPECTOR

## B.15 Sample Records and Forms

# INSPECTOR'S MEETING RECORD JOURNAL

# INSPECTOR'S MEETING RECORD JOURNAL — SAMPLE

Today's Date: AUGUST 1/15

Time Started: 8:00 am

Time Finished: 9:30 am

Project No: BF 99999

Purpose of Meeting or Conversation:

PRECAST GIRDER ERECTION PREJOB MEETING.

Attendees / Participants:

CONTRACTOR'S PROJECT MANAGER
CONTRACTOR'S FIELD SUPERINTENDENT
SUBCONTRACTOR'S ERECTION FOREMAN
DEPARTMENT REPRESENTATIVE

Key Issues to be Discussed:

- ACCEPTANCE OF UNITS PRIOR TO SHIPPING FROM PLANT
- LAY-OUT OF SUBSTRUCTURE – POTENTIAL ERROR
- TEMPORARY ANCHORING SYSTEM – REVISION REQ'D
- CAPACITY OF SUBSTRUCTURE – RESULTS OUTSTANDING
- CRANE SWING RADIUS – CONFIRM NO CONFLICTS WITH TRAFFIC
- DETAILS OF LIFTING SYSTEM – REQUIRED REVISION
- P/T PROCEDURES – OUTSTANDING ITEMS
- GIRDER ADJUSTMENTS & SWEEP/CAMBER CHECK
- TRAFFIC ACCOMMODATION DURING ERECTION
- SAFETY CONSIDERATIONS DURING ERECTION
- FIELD BENDING OF REINFORCING STEEL – DISCUSSION

Notes:

RECORD OF DISCUSSED ACTION ITEMS:

- TWO UNITS ARE PRESENTLY NOT ACCEPTED SINCE REPAIRS ARE REQUIRED – INSPECTOR
  THESE WILL NOT BE TRANSPORTED – SUPERINTENDENT.

- DISCREPANCY IN LAY-OUT. – CHALK LINES AT ABUTMENT 1 NEED TO BE CHECKED – INSPECTOR
  AGREED – ERECTION FOREMAN

- PROPOSED TEMPORARY ANCHORING SYSTEM INCLUDES DRILLING INTO CONCRETE; REVISION TO PROCEDURE REQUIRED – INSPECTOR.
  TO BE SUBMITTED 2 WEEKS PRIOR TO ERECTION – SUPERINTENDENT.

- SUBSTRUCTURE TEST REPORTS OUTSTANDING; MUST BE SUBMITTED BEFORE ERECTION – INSPECTOR.

- SWING OF GIRDERS SHOWN TO BE VERY NEAR TRAFFIC. UNITS MAY NOT SWING OVER TRAFFIC, AND TRAFFIC MAY NOT BE STOPPED. – INSPECTOR
  TWO CRANES WILL BE USED FOR EACH LIFT, WITH CONFIRMATION OF CRANE POSITION MEASURED PRIOR TO ERECTION – ERECTION FOREMAN

- LIFTING SYSTEM FOR SHORT UNITS USING SINGLE CRANE WILL RESULT IN UNACCEPTABLY HIGH HORIZONTAL FORCES AT LIFTING HOOKS – INSPECTOR
  REVISION TO PROCEDURE INCLUDING SPREADER BAR WILL BE SUBMITTED 2 WEEKS PRIOR TO ERECTION – ERECTION FOREMAN.

Photos Titled and Stored:

YES ☐ NO ☐

Signature: ____________________

Notes:

- P/T PROCEDURES HAVE NOT BEEN SUBMITTED
  -INSPECTOR.

- ONE GIRDER HAS CAMBER VALUES NOT MATCHING THE OTHERS -INSPECTOR
  ADJUSTMENTS TO BEARING ELEVATION PROPOSED TO MINIMIZE DIFFERENTIAL CAMBER. TO BE DISCUSSED FURTHER FOLLOWING MEETING - SUPERINTENDENT.
  AGREED - INSPECTOR.

- TRAFFIC ACCOMMODATION PLAN HAS BEEN ACCEPTED. WATER-FILLED BARRIERS MUST BE FILLED PRIOR TO LANE CLOSURES. TRAFFIC ACCOMMODATION MEASURES TO BE JOINTLY REVIEWED BY INSPECTOR & SUPERINTENDENT 1hr PRIOR TO START OF ERECTION.
  AGREED - ALL

- SAFETY MEETING SCHEDULED FOR AFTERNOON ON DAY OF ERECTION. MANDATORY FOR ALL FIELD STAFF
  - SUPERINTENDENT

- THERE HAVE BEEN PREVIOUS INSTANCES OF REINFORCING STEEL FIELD BENDING, WHICH IS NOT PERMITTED. DURING ERECTION, CREWS MUST BE REMINDED THAT BENDING OF GIRDER PROJECTING BARS IS NOT PERMITTED - INSPECTOR.
  AGREED - SUPERINTENDENT

Photos Titled and Stored:

YES ☐ NO ☑

Signature: INSPECTOR

## B.15 Sample Records and Forms

### FIELD MEMO

# Field Memo – Sample

| | | | |
|---|---|---|---|
| Project: | BF 99999 | Date: | AUGUST 1/15 |
| Location: | BEDDING | Project No: | 1234 |
| Contractor: | XYZ CONSTRUCTION | Memo No: | 1 |
| Attention: | XYZ SUPERINTENDENT | | |

**Issue:**

CULVERT FOUNDATION CONDITIONS ARE CONSIDERED SOFT AND UNSTABLE.

**Instruction:**

THE CONTRACTOR SHALL FURTHER EXCAVATE TO AN ELEVATION OF 1.6m BELOW PIPE INVERT. THE EXCAVATION AND BACKFILL, AS MEASURED BY THE CONSULTANT, WILL BE PAID FOR AS 'EXTRA WORK' BETWEEN 0.6m AND 1.6m BELOW PIPE INVERT.

**Reference:**

- GENERAL SPECIFICATION 1.2.25.1 - EXTRA WORK
- SSBC 18.3.3 'CSP AND SPCSP STRUCTURES' - BEDDING
- SSBC 1.8.1 'EXCAVATION' - UNIT PRICE PER CUBIC METRE
- SSBC 2.4.1 'BACKFILL' - UNIT PRICE PER CUBIC METRE

**Basis of Payment (if applicable):**

PAYMENT WILL BE MADE FOR EXTRA WORK IN ACCORDANCE WITH SSBC 1.8.1 AND 2.4.1.

**Bridge Inspector:** INSPECTOR

HAND DELIVERED & SUBMITTED BY EMAIL

# SECTION C

# THE ROLE OF THE INSPECTOR

## TABLE OF CONTENTS

## C.1 The Role of the Inspector – General

It is the Contractor's responsibility to supply materials for construction that comply with all requirements of the Contract documents. It is the Inspector's role to reasonably confirm and document that the Contractor's Work is compliant with the Contract.

The Contractor is responsible for his own construction means, methods, techniques, sequences, procedures and adaptation of good construction practices. The Inspector is not responsible for the Contractor's acts and omissions, but it is the Inspector's duty to take appropriate action to bring the Contractor into compliance with the Contract.

The inspection is critical in nature but must be approached with a positive attitude since it benefits the project as a whole and contributes to the Contractor's successful completion of the project.

The Inspector must apply his own good judgment in making determinations as to whether project requirements have been met.

### C.1.1 Responsibilities of the Inspector

- It is the responsibility of the Inspector to review and understand the full content of the standard documents, their purpose and their intent. The Inspector must continuously review the Department's library of documents to be aware of changes and updates.
- It is the responsibility of the Inspector to review the full content of the project-specific documents. The Inspector must discuss any discrepancies, conflicts and omissions with the Project Manager as they are identified.
- Prior to the commencement of construction, the Inspector must review project details with the Contractor and become familiar with the Contractor's proposed work methods and procedures. Any anticipated inability to meet the project requirements must be discussed well in advance of the activity.
- The Inspector must calculate or confirm the accuracy of quantities prior to processing payment.
- The Inspector must review all project submittals that pertain to the Work.
- The Inspector must suspend Work under certain conditions.
- The Inspector must effectively and professionally communicate with the Contractor.
- The Inspector must diligently document and photograph the Contractor's Work.

### C.1.2 Duties of the Inspector

The Inspector must be present at the work site during all major phases of construction that require measurement, review or documentation.

- The Inspector must protect and safeguard the environment by understanding the relevant project requirements.
- The Inspector must review the effect that the Contractor's operations have on the travelling public and require that corrective action be taken if these are hazardous or will cause undue inconvenience.
- The Inspector needs to be able to anticipate issues through familiarity with project details and documents.

## C.2 Authority of the Inspector

The Inspector is the Department's representative at the project site. The Inspector therefore assumes many of the Consultant's responsibilities described in the General Specifications.

### C.2.1 Interpretation

The *General Specifications* describe the Authority of the Consultant, which includes the right to provide the initial interpretation of the Contract documents and the authority to be the initial judge for the acceptability of the Work.

- The Inspector and the Project Manager may not relax or waive the Contract requirements. The Inspector must use his own judgment and, when necessary, seek the advice of the Project Manager for interpretation.
- Final Acceptance of the Work may only be given by the Department at the time of final construction completion. The Inspector is the judge of initial acceptability and compliance; however, he is not authorized to give Final Acceptance of the Work.
- The Inspector must NOT complete or sign documents produced by the Contractor that indicate that the work has been certified, accepted, approved, witnessed or “signed-off” by the Department. Initial acceptability of a completed activity for the purpose of continuing work, or acceptability of preparations for an upcoming activity are often requested by the Contractor. The Contractor may request initial acceptance from the Inspector for driven pile capacities before piles are cut to elevation, and the Contractor may request that initial acceptance of formwork and reinforcing steel be given prior to concrete placement. It is not necessary for the Inspector to provide written documentation for initial acceptability; however, it is the duty of the Inspector to bring any items of non-compliant work to the Contractor’s attention.
- It is beneficial for the Inspector and the Contractor to discuss and agree to inspection schedules. It is not the Inspector’s duty to act as the Contractor’s superintendent, field engineer or Quality Control. An efficient and knowledgeable Inspector will schedule the inspections to be timely and efficient. The Inspector may advise the Contractor that, in his judgment, the Work thus far is deemed initially acceptable and may continue. The Inspector must promptly notify the Contractor of non-compliant work so that the Contractor may immediately rectify the deficiency prior to proceeding.
- The Inspector must report the lack of adequate Quality Control or supervision by the Contractor to the Project Manager. The Inspector must not allow the Contractor to become dependent on his services where his effort is lacking for work which the Contractor is responsible for.
- The Contract documents are precise in their meaning, and it is important that the documents are interpreted consistently with their intent. The Inspector must rely on his knowledge and judgment when interpreting the Contract documents. The Project Manager must consult with the Department to obtain further clarification and opinion if necessary and subsequently advise the Inspector.

### C.2.2 Defective and Unauthorized Work

The *General Specifications* describe Defective Work. The Inspector has the authority and duty to reject Work that, in his judgment, does not conform to the requirements of the Contract documents. The Inspector does not have a contractual relationship with the Contractor and has no duty to the Contractor to identify deficiencies or defects in the Work.

The *General Specifications* describe Unauthorized Work. The Inspector must identify Work done or material supplied that is beyond what is required by the Contract documents but is unauthorized by the Department or Consultant. Unauthorized Work must not be included in monthly payment quantities.

### C.2.3 Temporary Suspension of Work

The *General Specifications* describe Temporary Suspension of Work. The Inspector has the authority to suspend the Work, in whole or in part, for such a period as he deems necessary due to conditions that he considers unfavourable for the execution of the Work, or due to the failure of the Contractor to comply with any provision of the Contract documents.

The Suspension of Work is an action that negatively affects the Contractor, often significantly. The Contractor may suffer a loss in productivity, schedule and reputation. The Contractor may strongly oppose the suspension and elect to submit a claim for compensation for standby if he believes that the suspension was not the result of his performance. The Inspector must be certain that the suspension is necessary for compliance to the requirements, and that the Contractor has previously been advised of the exact cause of the suspension.

The Inspector must make reasonable efforts to rectify a situation before suspending Work. Clear and ongoing communication is essential to prevent a situation that results in a suspension. The Inspector's communication with the Contractor must be well documented. The Inspector must be sure that no miscommunication or misunderstanding has resulted in the escalation of an issue that inappropriately leads to a suspension.

The Inspector must prepare and serve the Contractor with a written notice of temporary suspension that includes details and conditions of the suspension.

It is the Contractor's responsibility to remove, replace or otherwise correct deficient Work, and he must be given the opportunity to efficiently do so. If the Contractor refuses to acknowledge the Inspector's instruction to correct deficient Work but instead chooses to build upon it, then a temporary suspension may be appropriate.

The Project Manager must be consulted before the Inspector suspends Work, except in situations where immediate action needs to be taken. The following are instances where the Inspector may need to suspend work immediately without first consulting with the Project Manager:

- Inadequate or non-compliant traffic accommodation measures that pose an immediate danger to workers or the public.
- Work that is deficient and will immediately and permanently be covered, obstructed or otherwise be inaccessible.
- Work that does not comply with the Occupational Health and Safety Act and Regulations and poses an immediate danger to workers or the public.

### C.3 Relations with the Contractor

The Contractor/Inspector relationship has the common objective of ensuring that the Work fully meets the requirements of the Contract.

The Inspector must maintain a productive, cooperative, and professional relationship with the Contractor at all times. An appropriate relationship exists when the Inspector:

- maintains the best interests of the Department while providing the Contractor with the opportunity to control the means, methods and procedures that are efficient and cost effective.
- maintains ongoing and open discussions with the Contractor for the purpose of scheduling activities and inspections, clarifying the intent of the specifications, identifying potential issues and preventative measures, reviewing quantities and responding to requests for information.
- is fair and impartial in his actions and makes reasonable decisions that are based on fact and not on speculation.
- performs inspections promptly and efficiently.

- is decisive and consistent in his instructions and actions throughout the project.
- does not hinder or delay the Contractor and is diligent in identifying non-compliant Work.
- does not impose requirements onto the Contractor that are not supported by the Contract.
- makes attempts to resolve disputes at the site level but, when necessary, escalates these promptly to the Project Manager.
- does not accept gratuities, favours or other personal benefits from the Contractor that may be intended to influence his judgment.
- maintains appropriate lines of communication for project discussions and, when warranted, recognizes and commends good workmanship.
- is cordial but firm in his discussions, does not show anger or resentment, does not use offensive or inappropriate language, does not make comments of a personal nature.
- is confident in his decisions and discussions and is unintimidated yet respectful when challenged.
- does not slander or criticize the Contractor's staff or organization, their work, methods, or failures, and is not vengeful.

## C.4 Communication with the Contractor

Effective communication with the Contractor is extremely important. At the pre-construction meeting, the lines of communication between the Contractor and the Inspector need to be clearly established. The Inspector must strictly follow the communication protocols and must encourage the Contractor to maintain them as well. Generally, the Inspector will establish the lines of communication with the Contractor's site superintendent, the foremen and the Quality Control personnel. The Contractor's relief or alternate personnel must be identified.

### C.4.1 Verbal Communications

- The Inspector must initiate discussions when beneficial. The Inspector must be thorough in his discussions yet not verbose. Discussing an upcoming task and identifying potential challenges is far more productive than discussing solutions to non-compliant Work.
- The Inspector must not provide direction to the Contractor, or instruct the Contractor with regard to means, methods, techniques, procedures or sequences.
- The Inspector must discuss the upcoming activities with the superintendent on a daily basis. The Inspector must have a clear understanding of what activities the Contractor is scheduling.
- The Inspector needs to coordinate inspection schedules with the superintendent or Quality Control personnel. Advance planning will avoid delays to the Contractor's schedule since the Inspector will be reviewing the Work at the appropriate time.
- The Inspector must not directly criticize the Contractor's actions, but instead identify circumstances that have the potential to result in non-compliant work.
- The Inspector must not provide any instructions to or reject the work of subcontractors without first providing this information to the Contractor.

### C.4.2 Written Communications

Written instructions must be factual, brief and respectful in tone. Instructions must not contain opinions but must instead be based upon observations, measurements and the requirements of the Contract.

Instructions that are deemed significant and requiring immediate action must be written. Before issuing written instructions, the Inspector must be confident that his determination is consistent with the Contract. The Project Manager must be notified of all written instructions.

An *Order for Extra Work*, *Accident-Motor Vehicle Traffic Collisions in Work Zones*, *Accident Notification* and *Utility Accident Report* must always be made in writing using Department standard forms.

### C.5 Relations with the Public

The Inspector's relationship with the public must be cordial and discreet, and should not discuss costs or Contractor's performance or progress. The Inspector is the sole representative of the Department at the project location and may be subject to public scrutiny, which should be referred to the Project Manager or Department for appropriate action, if required.

# SECTION D

# SAFETY

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## D.1 Safety – General

Safety incidents have occurred at bridge construction sites, including injury and death to construction personnel and to the travelling public. Safety procedures, policies, training and equipment are needed for every project to prevent incidents at the construction site.

In Alberta, construction safety is administered by the Occupational Health and Safety Act, Regulation and Code (OHS). These documents are published by the Province and must be accessible to the Inspector at the project site. They identify the minimum requirements for health and safety at the workplace.

- The Act identifies obligations of employers and workers, defines the Prime contractor, and identifies safety processes, obligations and rights.
- The Regulation identifies requirements and penalties for infractions to both corporations and individuals.
- The Code provides specific safe-work requirements by activity.

Work Safe Alberta is an initiative to reduce work-related injuries, illnesses and fatalities. This program provides safety awareness through education, development of industry resources, public awareness and statistics.

### D.1.1 Prime Contractor Designation

A Prime contractor is required when two or more employers are working at the site. The Prime contractor is generally the party that contracts directly with the Department (the Contractor). The Prime contractor is responsible for coordinating the health and safety program for all other subcontractors and all other agencies, organizations and visitors that require access to the site. This includes the Consultant and the Department.

The obligation of the Prime contractor is to establish and to implement reasonably practicable measures that comply with OHS legislation.

The Prime contractor must maintain a physical presence at the site at all times when Work is occurring and, for certain situations, formally delegating his responsibilities to other site personnel under his employ.

## D.2 Contractor's Health and Safety Program

Certificates of Recognition (COR) are awarded through the Partnerships in Injury Reduction program. They are provided to Contractors in recognition of the development of a health and safety program that meets OHS requirements. A valid COR is required for all Contractors working on Department bridge projects.

The General Specifications require that the Contractor identifies all work site hazards and keeps a copy of the safety policies, procedures and plans available at the site at all times. The Contractor's safety manual must contain these documents and also include the following:

- Safety Policy and Objectives
- Job Hazard Analysis: assigns safety priorities based on an evaluation of severity and probability.
- Safe Work Practices: general guidelines describing how to perform a task safely.
- Safe Job Procedures: step-by-step process describing how to complete a task.

- Project Hazard Assessment: used to identify all project hazards at the onset of the project.
- Field Level Risk Assessment / Job Hazard Assessment: used to identify changing hazards, or hazards for new activities.
- Site Evacuation Procedures and Muster Points
- Personal Protective Equipment
- Specialized Training Requirements
- First Aid Record
- Emergency Response
- Health and Safety Evaluation
- Company Rules
- Fire Protection
- Maintenance of Equipment Requirements

### D.2.1 Worksite Hazards and Responsibilities of the Inspector

The Prime contractor communicates his means for hazard assessment and control to the Inspector through his Project Hazard Assessments, Field Level Risk Assessment/Job Hazard Assessments, Worksite Inspection Reports and meetings. The Prime contractor's subcontractors may have their own unique procedures that the Prime contractor will adopt as his own.

The Inspector must follow all requirements of the Prime contractor's safety program in addition to his firm's own safety program. In the event that there exists conflicting or omitted conditions between these safety programs, the most stringent will apply.

In some instances where personnel at the site are working as sub-consultants to the Consultant and under the Inspector's direction, the Inspector must provide all necessary safety information, and confirm that the necessary orientation has been completed.

The Inspector must be aware of the typical hazards that exist at bridge construction sites including:

- Traffic on active roadways
- Mobile equipment
- Fall hazard from ladders, aerial lifts and falsework
- Impaling hazard from projecting reinforcing steel
- Trench or excavation cave-in
- Restricted and confined spaces
- Inadequate hoarding ventilation
- Drowning
- Inhalation of concrete or cement dust
- Contact with concrete and harmful substances
- Eye damage caused by welding arc, dust or flying debris
- Hearing damage caused by work near heavy or pile driving equipment
- Trips on uneven surfaces or reinforcing steel

### D.2.2 Safety Meetings

At the commencement of the project, the Project Manager must conduct a preconstruction meeting. In addition to the technical items, the meeting agenda must include the Contractor's health and safety plan, Traffic Accommodation Strategy (TAS) status, emergency contacts, work site inspection reports and requirements for standard Department forms.

The Contractor must require that all workers, subcontractors and others who enter the site, including the Inspector, are aware of general safety requirements. This is done through the Contractor's mandatory site orientation, which is conducted at the start of the project and is generally repeated annually for multi-year projects. The orientation is administered by the Contractor's superintendent or safety officer who is the safety representative for the Contractor. Any safety-related concerns must be raised by the Inspector to the Contractor's superintendent.

The safety requirements for specific activities are discussed by the superintendent at daily "toolbox" or "tailgate" meetings. These meetings are informal and are conducted at the site.

### D.2.3 Temporary Structures

The Inspector must frequently use temporary structures for construction access. These may include stair towers, ladders and scaffolds. The Contractor is required to engineer certain structures as required by OHS. The superintendent must verify that such structures are adequately constructed and inspected and must retain all drawings at the site.

### D.2.4 Personal Protective Equipment (PPE)

The minimum PPE generally required for the Inspector includes a hard hat, high visibility vest, safety glasses and steel-toed boots. The specific characteristics for these items is regulated by CSA Standards. Additional PPE may be required for certain activities, such as hearing protection for pile driving and bolt torqueing procedures.

## D.3 OHS and Inspector's Role

Regulators may conduct work site inspections that result in orders being issued to the Contractor. The Contractor must immediately submit these to the Inspector, who must then immediately submit them to the Department.

The Inspector may suspend work if:

- A situation of recognized imminent danger exists to workers or the public.
- The Contractor fails to comply with safety orders.
- The Contractor fails to rectify previously identified worksite hazards.

It is important that the Inspector takes action when a safety violation occurs. Indifference to an unsafe condition may contribute to an incident, and the Inspector may incur liability as a result.

## D.4 Department's Role

The Department's Regional staff includes a Safety Officer. The Safety Officer may visit the site to confirm that the Contractor and Consultant are following Department safety requirements. The Safety Officer is a resource to the Inspector. When requesting information from the Safety Officer, it is important that the Department's Project Sponsor also be advised of any changes to safety procedures or any instructions given to the Contractor.

### D.4.1 Reporting

#### D.4.1.1 Standard Department Forms

- **At Project Commencement:** The Project Manager will complete the Safety TAS OH&S Review form, which identifies Prime contractor status, minimum PPE requirements, the Inspector's authority in circumstances of imminent danger, accident reporting, TAS details and site-specific safety considerations. The Project Manager will also complete the Traffic Accommodation Strategy Component Checklist form, which confirms that the minimum traffic accommodation requirements have been met. The Inspector must understand the content of these documents.
- **During Project Activity:** The Monthly Health and Safety Summary is completed by the Contractor each month. It is signed by the Inspector and is submitted to the Department with the progress estimate. The form identifies the number of workers hired during the period and confirms that they have participated in a formal site safety orientation. It also identifies incidents and corrective actions taken.

The Project Completion Health and Safety Review is completed and signed by the Contractor at project completion. It is reviewed for completeness and accuracy and is then signed by the Inspector and submitted to the Department. The form identifies that the Contractor has performed his OHS-related obligations. The Inspector must review the content of the form on a monthly basis at the time that the Monthly Health and Safety Summary is prepared. Assessment of the Contractor's compliance is an ongoing activity, and the Inspector must not wait to evaluate performance only at project completion.

The Notification of Highway and Bridge Construction Operations is completed by the Project Manager and is distributed to the Department's Project Sponsor and Safety Officer.

Traffic incident reporting must be done as soon as practicable and submitted to the Department. The form Report of Motor Vehicle Collisions Occurring in Work Zones provides a summary of the collision details and identifies how the Contractor's operations have contributed to the event. If the Contractor or his subcontractors were involved in the incident, then an Accident Notification – Incident Report Involving Third Party or Contractor's Equipment must also be completed by the Inspector and submitted to the Department.

The Inspector must immediately notify the Contractor of any health and safety violations. Any orders issued to the Contractor by OHS must be immediately distributed by the Inspector to the Department's Project Sponsor and Safety Officer. Also, any written correspondence by the Inspector to the Contractor related to safety must be immediately distributed to the Department's Project Sponsor and Safety Officer.

## D.5 Specialized Training

OHS requires that specialized training be completed before certain activities are performed. The Inspector must be aware that:

- **Fall protection training** is required when working above a certain height, or when impaling hazards exist. Fall protection can be achieved by means of fall arrest devices, setbacks or railings.
- **Restricted or Confined space training** is required when working in restricted or confined spaces. These may include excavations, culverts, hoardings and inside trapezoidal girders.
- **Aerial lift training** is required to operate aerial work platforms/lifts.

## D.6 Utility Safety and Accident Reporting

Utility locations may or may not be identified, and if identified they may not be accurately located on the Plans. Locations of utilities must always be done by the Contractor before carrying out any sub-surface work. If a utility accident occurs, the Inspector must promptly complete the form Utility Accident Report and submit to the Department.

The Contractor is responsible for safeguarding all existing and relocated utility installations.

## D.7 Traffic Accommodation

Whenever construction activities are performed on or adjacent to a public highway, the Contractor must take appropriate precautions to safely accommodate the travelling public.

The Department's manual entitled *Traffic Accommodation in Work Zones* provides guidelines for accommodating traffic in a consistent, safe and effective manner. This document identifies the primary roles and responsibilities of each of the three parties (the Department, the Consultant and the Contractor) regarding public safety, outlines general considerations for developing an effective traffic accommodation strategy, and provides guidelines for the use of various Traffic Control Devices. Included are typical drawings identifying the minimum temporary signing requirements for Work Zones.

Traffic accommodation requirements are identified in the Special Provisions. These requirements must be implemented by the Contractor, in addition to the information contained in the *Traffic Accommodation in Work Zones* manual, to develop the site-specific Traffic Accommodation Strategy (TAS). The Inspector must confirm that the TAS has been accepted by the Project Manager and the Regional Safety Officer prior to any site work.

The Inspector is responsible for monitoring the traffic accommodation measures used by the Contractor and for confirming that these measures comply with the Contract to safely and effectively accommodate vehicular and pedestrian traffic through and around the work zone. Changes may be required after the effectiveness of the measures have been determined. If any apparent danger to the public is identified, the measures must immediately be modified by the Contractor.

The Contractor must have available a designate who is responsible for inspecting the traffic accommodation measures for conformity to requirements and for making changes as necessary.

## D.8 Sample – Contractor's Field Level Risk Assessment

*Field Level Risk Assessment Sample*

# Field Level Risk Assessment

**Date** ______________

**Project** ______________________________ **Site Representative** ______________________

**Task Location** ______________________________ **Project #** ______________________

***Review the following with the work crew at the work site and check the items which only apply to the job. List them on the other side and in the third column identify the plans to eliminate or control them.***

**Environmental Hazards**
- ☐ Work area clean
- ☐ Dust/Mist/Fume
- ☐ Working near water
- ☐ Noise in area
- ☐ Spill potential
- ☐ Waste containers needed
- ☐ Other workers in area
- ☐ Weather conditions
- ☐ Wildlife and Insects
- ☐ Vegetation Hazards
- ☐ Lighting Levels too Low
- ☐ Foreign Bodies in Eyes
- ☐ Burn/Heat Sources
- ☐ Hazardous Road Conditions
- ☐ Sediment control

**Ergonomic Hazards**
- ☐ Awkward body position
- ☐ Heavy Lifting Required
- ☐ Repetitive motion
- ☐ Working above your head

**Activity/Construction Hazards**
- ☐ Traffic Movement
- ☐ Overhead hazards
- ☐ Construction equipment
- ☐ Working around utilities
- ☐ Trenching
- ☐ Equipment/Tool Condition

**Electrical Hazards**
- ☐ GFI requirement
- ☐ Working on/near energized equipment
- ☐ Hot work or electrical permit required

**Access/Egress Hazards**
- ☐ Aerial lift/Man basket (inspected and trained)
- ☐ Scaffold (inspected and tagged)
- ☐ Ladders (tied off)
- ☐ Slips/Trips
- ☐ Hoisting (tools, equipment)
- ☐ Excavation (alarms, routes, phone #s)
- ☐ Confined space entry permit required
- ☐ Trenches, shoring, casing

- ☐ Hole coverings identified (secured)
- ☐ Harness/Lanyard inspected (trained)
- ☐ 100% Tie-off and Tie off points identified
- ☐ Falling items
- ☐ Guard rails/mid-rail, toe board
- ☐ Working on ice

**Personal Limitations/Hazards**
- ☐ Procedure not available for task
- ☐ Confusing instructions
- ☐ No training to task or tools to be used
- ☐ First time performing the task
- ☐ Micro Break (stretching/flexing)
- ☐ Fatigue awareness
- ☐ Distracted driver

**Personal Protective Equipment**
- ☐ Hard Hat
- ☐ Safety Glasses
- ☐ Traffic Vest
- ☐ CSA Boots
- ☐ Insect Repellent

- ☐ Hydrated
- ☐ Hearing Protection
- ☐ Barricades and signs in place
- ☐ Communication Device
- ☐ Gloves
- ☐ Sunscreen
- ☐ First Aid kit
- ☐ Traffic Signs and Barricades
- ☐ Clothing for Weather Conditions
- ☐ Fall protection
- ☐ Ground disturbance
- ☐ Confined space
- ☐ Emergency Stations Identified
- ☐ Muster Point/s
- ☐ Eye Wash Station
- ☐ Nearest Hospital
- ☐ Location of Work Zone Identified
- ☐ Fire Extinguisher
- ☐ Culvert entrance

Other: ______________________________________________

Additional Hazards/Training Requirements______________________________

______________________________________________

Is the worker alone? ☐ Yes ☐ No Have you completed a "Work Alone Safety Checklist"? ☐ Yes ☐ No

Will the worker have to enter a confined/restricted space? ☐ Yes ☐ No Have you completed a "Confined Space Entry Checklist"? ☐ Yes ☐ No

If Yes, explain ______________________________________________

It is important that all hazards have plans to eliminate them and the plans are put in place. Ensure that all associated permits are closed off at the end of the job.

**Remember: "Stop & Think" and See It Again For The First Time**

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MSDS Reviewed? ☐ Yes ☐ No Access consent form required? ☐ Yes ☐ No

Any injuries noted? ☐ Yes ☐ No If Yes, explain ______________________________

______________________________________________

Please print and sign (all members of the task group, prior to commencing work)

| Site Representative Name and Signature (below) | Site Representative Name and Signature (below) | Project Manager Name and Signature (below) |
|---|---|---|
| print name | print name | print name |
| signature | signature | signature |

# SECTION 1

# EXCAVATION

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## 1.1 Excavation – General

Excavation is necessary to construct foundations, substructures, retaining walls, culverts and other works at the elevations shown on the Plans. Further requirements for excavation are described in Sections 3, 9, 10, 18, 25 and 26 of this Manual. Excavation of all types of existing materials is required, including vegetation, soil, boulders, bedrock, refuse, rubble, wood, abandoned structures or utilities, ice and water.

### 1.1.1 Classification

Excavation is generally described to be either ‘Structural’ or ‘Channel’.

- **Structural Excavation** is required to construct bridge substructure foundations and culverts. The limits of this type of excavation are defined by the Plans. Often, this excavation is paid as a lump sum.

Structural excavation can include the removal of embankment material for abutment construction. Often, fills are built in advance of the bridge to enable the soils to consolidate. The process of consolidation and subsequent settlement may take months or years. Since the bridge fill material is engineered and consists of non-granular material, unexpected conditions are not typically encountered.

The construction of piers, whether for grade separations or watercourse crossings, often requires that cofferdams, berms or other retaining structures be used to separate water and soil from the base of the excavation.

- **Channel Excavation** is usually carried out within a watercourse channel and includes the construction of a new channel and improvements to the alignment of the existing channel. Channel excavation is also required to properly key-in rock riprap aprons and bank protection. Grubbing and stripping are often necessary to remove vegetation. Material types may consist of granular and silty channel alluvium and embankment clay. The limits of excavation are sometimes adjusted to suit actual field conditions. Dewatering is often required, and excavated materials may be saturated. Environmental permits limit the period in which channel excavation may occur.

### 1.1.2 Equipment

Excavation is normally done using tracked hydraulic excavators of varying size, which load the excavation spoil into haul trucks. The excavator’s function can be modified by tools attached to its boomstick:

- **Ripper:** This attachment can dislodge pieces of rock and break or separate softer rock into manageable pieces. Rippers may have one or multiple ripper teeth.
- **Breaker:** This attachment consists of a percussion hammer and is used for demolition of concrete, boulders and weathered bedrock.
- **Digging Bucket:** Buckets of varying size exist, but these are fitted with bucket teeth and are used for large-scale excavation of common materials and for dense materials like clay and rock.
- **Grading Bucket:** These buckets are also called ‘finishing’ or ‘clean-up’ or ‘ditching’ buckets. They are generally larger than digging buckets and have no teeth, but instead have a cutting edge. They are used for excavating gravels and sands, and for neatly trimming the base of excavations.

- **Tilting Bucket:** This attachment permits a grading bucket to also tilt. This is advantageous when trimming slopes.
- **Bucket with Thumb:** This attachment is useful when dealing with broken rock from an excavation and can be used with both a digging and grading bucket. It is also used to accurately place heavy rock riprap into a watercourse.

The installation of sheet-piled cofferdams requires specialized equipment, such as a crane and vibratory driving hammer.

### 1.2 Environmental Considerations

Permitting and approvals may exist from various agencies, including Fisheries and Oceans Canada (DFO), Transport Canada and Alberta Environment and Sustainable Resource Development (SRD). The permits and approvals are contained in the Special Provisions.

1. DFO administers the Fisheries Act and is responsible for protecting fish habitat. This agency issues formal Authorizations.
2. Transport Canada is responsible for maintaining navigable waterways.
3. SRD is responsible for environmental protection. Permits make references to Codes of Practice that must be followed and place restrictions on the time when in-stream work may be done. This period is called the Restricted Activity Period (RAP). During the RAP, the Contractor may not disturb the natural watercourse or the diverted watercourse. Fish spawn may exist on the bed substrate, and this spawn may be damaged if disturbed.

The Contractor is responsible to prepare an Environmental Construction Operation (ECO) Plan consistent with the Department's document entitled *Environmental Construction Operations (ECO) Plan Framework*. This Plan must be completed and accepted by the Consultant prior to the commencement of construction. This document needs to address:

1. Environmental sensitivities
2. Schedule and drawings
3. Potential impacts and controls
4. Waste management and hazardous materials
5. Emergency response

Silt curtains and booms are often used to isolate turbid water and prevent pluming downstream. These details will be described in the Contractor's ECO Plan.

When excavating within or adjacent to a watercourse, turbidity monitoring may be necessary. The Contractor's Environmental Specialist must collect turbidity baseline measurements and then compare those to measurements taken downstream of the bridge site. Turbidity monitoring is important during the Contractor's de-watering operations. If water removed from an excavation is too turbid, the Contractor must treat this water by settlement, filtration or other means before reintroducing it into the watercourse. He must obtain prior approval for his methods of pumping and treating or otherwise dewatering from the excavations. Natural drainage of surface water must be maintained.

Certain special limitations exist when excavating within and near wetlands. These conditions will be described in the Special Provisions.

Berms that exist within an active channel may cause local scour holes. As material scours from the channel bed, it is transported and deposited downstream of the construction site. The

Contractor and the Project Manager must immediately be advised if scour holes or deposition of bed materials is observed. Corrective measures may need to be made to the Contractor's berm. The recovery of materials deposited downstream may be necessary, and this is generally difficult due to access limitations.

When excavating a watercourse diversion, fish capture and salvage may be necessary. The Inspector must understand all requirements specified in the *Special Provisions and Supplemental Specification*, including the responsibilities of the Contractor's *Qualified Aquatic Environmental Specialist*, the requirement for a *Fish Research License* and the requirements of the ECO Plan.

If the Contractor's activities contravene the requirements of the environmental permits, the Inspector must instruct the Contractor to cease operations and advise the Project Manager.

## 1.3 Safety Considerations

Excavation faces may slump, cave-in or otherwise fail. The failure can occur rapidly and without prior warning. It is very important that excavated faces be constructed at the specified slope angle and benched where specified. Surface water must not be allowed to flow into the excavation from above or otherwise saturate the excavation faces. If any sloughing, tension cracks or other indications of instability exist, the trench must be abandoned until the Contractor can obtain geotechnical recommendations. Requirements for sloped excavation are provided in the Occupational Health and Safety (OHS) documents.

Slope stability structures are to be designed by the Contractor's engineer and inspected by the Contractor as they are constructed. These structures must be monitored for any movement and leakage.

It is the responsibility of the Contractor to locate and protect all utilities within the work area.

## 1.4 Competency of Soil Materials

The Plans often include soil logs, and the Special Provisions may provide direction regarding the excavation and stabilization of soils.

The presence of water and certain soil types affects the stability of an excavation. A high groundwater table or the presence of granular layers may increase the rate and volume of water entering the excavation. The ingress of water may de-stabilize the excavation slopes. Standing water may soften clay soil at the base of the excavation, lowering the bearing strength. The presence of standing water may also saturate fine grained soils composed of silts and clays, resulting in heaving if these saturated soils are exposed to frost. Clays with high plasticity may tend to swell and shrink with changes in moisture content.

Fine sand, silts and weak clays are easily disturbed during construction. They are sensitive to flows of groundwater when excavations are carried below the water table and are subject to erosion, frost heave and piping.

Some materials, including clay shale, are competent at the time of excavation but can weaken rapidly when exposed to the elements. The slope of a stable excavation may become shallower over time as the face of the excavation for these materials weathers.

When excavating into engineered fill, the excavated material is generally consistent in type and density. However when excavating into in-situ or non-engineered fill, the nature of the material is often unknown and variable, and the quality of the soil at the base of the excavation may be inadequate. An unsuitable base may consist of soft or saturated soils, lenses or seams of differing materials, or organic materials. When the base of the excavation appears unsuitable, the Project Manager must be consulted.

The competency of the base of an excavation depends on its bearing strength and consistency of the soil type. The acceptable quality of the base of an excavation depends upon the structural requirements of the bridge element. Often, an on-site geotechnical review is required. The Inspector must discuss the excavation schedule with the Project Manager and determine if a geotechnical review is needed. The review must be planned in advance since the geotechnical reviewer must be present immediately after excavation has been completed. The Inspector must also discuss with the Project Manager the need for test pits, test drilling, over-excavation or similar means to confirm that the minimum foundation requirements have been met.

The Inspector must understand any specific requirements for the bearing strength or competency of the excavation base in advance of the work. A firm foundation generally does not have seams of weaker dissimilar material, nor does it consist of loose and disturbed material, and it does not have standing water on the surface. An estimate of the density of the excavation base can be made using a field soil penetrometer.

For piled structures, poor soil quality at the base of the excavation will not cause the concrete element to settle; however, this may result in other problems. A soft excavation base may prevent the construction of a neat base for the concrete element. Where a soft base is encountered, a mud slab or a work slab is normally cast.

For bearing structures such as MSE walls and structures supported by spread footings, a poor quality of soil at the base of the excavation may cause increased settlement of the element.

For culverts, a poor quality bed may cause the culvert to sag more than expected at its midspan, resulting in a final camber that does not meet the geometric requirements.

## 1.5 Foundation Improvements

Variability of soil types, or saturated, soft and yielding soils at the base of the excavation will often require improvement. A geotechnical review is required to recommend measures for foundation improvement. The Inspector must discuss this need with the Project Manager in advance. Improvement measures may consider the following:

- When excavating soil that softens in the presence of water, placement of concrete may be required to immediately follow excavation.
- All loose material must be removed before erecting forms or placing reinforcing steel.
- Where a shallow layer of weak material exists, it may be practical to over-excavate the bed materials and replace them with a compacted granular material or concrete.
- Where excavations for foundation elements and culverts must be de-watered, drainage trenches, well points and sumps must be constructed beyond the work area. The excavation area must be sufficiently large enough to accommodate de-watering devices without over-steepening the cut slopes.

### 1.5.1 Temporary Slope Stability

Depending on the soil type and depth of excavation, temporary slope stability may be required. Slope stability is required when there is an insufficient work area to construct sufficiently shallow cut slopes to prevent their failure. Slope stability measures are temporary construction measures and are therefore not designed by the Consultant; instead, they are designed by the Contractor's engineer.

- Shoring is commonly used to stabilize slope faces and trenches. Shoring systems prevent failure of the cut slopes. They protect the structure and workers from collapse and sloughing of the cut slopes. Shoring should not be confused with shielding, which is the protection of workers from a collapse.
- *"Shotcrete" is a method of shoring that may prevent the surface of an excavation from eroding.*
- Soil nailing is a technique that may be used in conjunction with pile-and-timber shoring. Slopes are reinforced by the insertion of relatively slender steel reinforcing rods. The bars are usually installed into a pre-drilled hole and then grouted into place. The rods may then be tensioned to the face of the slope or wall.
- Shoring may also be used to stabilize tall formwork. Raking shores consist of angled members that are supported by the adjacent ground. They are usually fastened to a deadman weight or to driven stakes.

## 1.6 Water Management

Keeping water from flowing into an excavation is challenging and requires careful planning and engineering by the Contractor. Surface water and groundwater must both be managed. Generally, two types of water-management structures are used to prevent the ingress of water:

- **Cofferdams**: These are walled enclosures that are constructed at the perimeter of the excavation. Their purpose is to act as barriers for water that may seep through the cut faces of the excavation. Their secondary purpose is to steepen the excavation face where the work area is not sufficiently large enough to cut a stable excavation face. Cofferdams are often built by driving interlocking sheet piling into the ground to form an enclosed area. The soil within the enclosed area can then be excavated. Sheet piling can be driven through shale, sandstone or clay soils.

Water may seep into the excavation through the base of a cofferdam. This seepage from the base may be prevented by driving the sheets deeper or by placing a concrete mudslab, which provides a seal between the bed and the sheet piling. The mudslab concrete may need to be placed into water, in which case it must be placed by the tremie method, as described in Section 4 of this Manual. Mudslab construction must normally incorporate a sump from which any surface runoff or cofferdam leakage may be removed.

Cofferdams must be designed by the Contractor's engineer. The Contractor must continuously check the cofferdam and note lateral movements or increased leakage through the seams. Other types of cofferdams may consist of corrugated pipe or water-filled bladders.

- **Dikes and Berms**: These terms are often used interchangeably in the context of bridge excavation. A dike is constructed by excavating a ditch and placing the spoil material into a mound to direct water flow. A berm is a raised earthen embankment built for the purpose of isolating an excavation. 'Berm' is the more commonly used term for bridge excavation.

Berm construction requires special planning and design by the Contractor's engineer. Berms that constrict the watercourse will cause the local velocity to increase. Often, rock riprap will be prescribed to reduce the likelihood of scour, both at the berm and also the opposing bank. Surveys are done to determine the bathymetry of the watercourse, which is needed to determine the necessary depth and plan area of the berms.

Berms placed into the active watercourse channel need to follow a specific sequence and method of construction to comply with environmental approvals. Rock riprap and clay are generally placed simultaneously until the entire berm has been constructed.

Water leakage or seepage is managed by utilizing pumps or well point systems.

After the construction of the foundation element is complete and access is no longer required, removal of the cofferdam and berms is done in the reverse sequence to that followed for construction. It is essential that all fill materials be removed down to the original channel bed elevation. The bathometric survey is used to re-establish the original channel bed. The Contractor must accurately locate the channel bed and must not simply excavate by trial and error.

## 1.7 Material Disposal

Excavated material suitable for re-use is usually stored at the site. The Contractor must confirm that this stockpiled material is not placed on private property without prior permission, nor in a manner that will interrupt the flow of surface drainage, nor at a location that will interfere with subsequent construction operations. Unsuitable or surplus excavated materials must be disposed of by the Contractor in a location and manner approved by the Inspector. When disposing of waste material onto private property, the Contractor must provide the Inspector with a letter of permission from the landowner accepting the materials.

- Excavated materials must not be disposed in the vicinity of a watercourse where there is the risk that this material will erode into the watercourse.
- Some excavated materials like topsoil need to be stockpiled and salvaged instead of being disposed. These materials need to be excavated with care so as not to contaminate them with other excavated materials.
- The Inspector must be aware of any excavated materials that have been contaminated by fuel and oil spills, creosote oil, concrete washout or any other chemicals. These soils need to be disposed at an appropriate waste facility. The Inspector must confirm through the Contractor's documentation that these materials have been acceptably disposed.

## 1.8 Hauling of Waste Material

When hauling excavated material to a disposal area, material can be spilled onto the highway, creating a hazardous condition for the travelling public, especially during winter.

- The Contractor must have an approved traffic control plan in place for trucks entering and leaving the highway.
- The Contractor must clean the roadway as required.
- The Contractor may only be permitted to haul during certain hours.

Government of Alberta ■
Transportation

**Bridge Construction Inspection Manual 2015**
Section 1 – Excavation Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

---

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | | Have the specifications, Plans and borehole logs been reviewed? | ☐ | |
| 1.2 | | Have the arrangements for access routes and disposal area been reviewed? | ☐ | |
| 1.3 | | Has compliance with environmental permits been confirmed? | ☐ | |
| 1.4 | | Have soft or saturated bed materials been identified? | ☐ | |
| 1.5 | | Has the Project Manager been advised of any seepage during excavation? | ☐ | |
| 1.6 | | Have the excavation limits that extend beyond required depth been surveyed? | ☐ | |
| **2** | | **Preparation of Foundations for Footings** | | |
| 2.1 | 1.4 | Is all rock or other hard foundation material free of loose material, cleaned and cut to a firm surface as shown on the drawings? | ☐ | |
| 2.2 | 1.4 | Have all seams been cleaned out and filled with concrete, mortar or grout? | ☐ | |
| 2.3 | 1.4 | Is the bottom of the excavation of a non-rock surface confirmed to be prior to placing concrete? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.4 | 1.4 | In the case of spread footings placed against the ground without forms, has the lower part of the excavation for a depth corresponding to the height of the footings been made neatly to the plan dimensions of the footing? | ☐ | |
| 2.5 | 1.4 | Has seepage water been collected and drained or pumped away before it could enter the neat portion of the excavation? | ☐ | |
| **3** | | **Cofferdams, Dikes and Berms** | | |
| 3.1 | 1.5 | For substructure work, has the Contractor submitted drawings and associated work procedures of the proposed cofferdam, shored excavation, dike or berm construction? | ☐ | |
| 3.2 | 1.5 | Are the drawings and work procedures signed and sealed by a Professional Engineer registered in the Province of Alberta? | ☐ | |
| 3.3 | 1.5 | Have the Contractor’s submittals been reviewed by the Project Manager? | ☐ | |
| 3.4 | 1.5 | Has any timber or bracing been left in the cofferdams in such a way as to extend into the substructure concrete, without written permission of the Consultant? | ☐ | |
| 3.5 | 1.5 | Has pumping from the interior of any cofferdam been done in such a way as to cause the flow of water through any fresh concrete? | ☐ | |
| 3.6 | 1.5 | Has pumping to de-water a sealed cofferdam commenced before the seal has set sufficiently to withstand hydrostatic pressures? | ☐ | |
| 3.7 | 1.5 | In cases where turbid water is to be pumped from any excavation, has a suitable settling pond been provided so that only water free from suspended material enters the watercourse? | ☐ | |
| 3.8 | 1.5 | Have cofferdams, dikes and berms been removed after completion of the work for which they were installed? | ☐ | |
| 3.9 | 1.5 | Was all required backfill placed prior to removal of cofferdams, dikes or berms? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **4** | | **Inspection of Excavation** | | |
| 4.1 | 1.6 | Was the completed excavation consistent with that shown on the drawings? | ☐ | |
| 4.2 | 1.6 | Was the need for test pits, test drilling or further excavation assessed before any further work proceeded? | ☐ | |

**Details and Summary:**

Signature

Date

1.1 Pier excavation for pile cap. Piles cut off at elevation. Safe slopes and good access to excavation shown.

1.2 Channel excavation for culvert construction. Channel bed crowned and graded to shed water. Existing stream diverted with sheet piling and clay berm. Slopes cut at 1:1 for safety.

1.3 Pier excavation for pile cap. Piles cut off at elevation. H-piles and lagging for temporary retaining wall shown.

1.4 Sheet piling installed for pier piling cofferdam. H piles placed horizontally as bracing. Ladder access to excavation.

1.5 Installation of berm. Silt curtain downstream to control turbidity.

1.6 River berm construction. Perimeter placed first to isolate the work area. Riprap being placed for scour control.

1.7 River berm construction. Infill material and riprap being placed, pumping out water from work area.

1.8 Berm construction and infill work. Pumping water from work area. Equipment access from top of berm.

1.9 River berm construction complete. Sides armored with riprap and filter fabric.

1.10 Cast-in-place concrete bridge constructed on existing grade. Excavation of roadway beneath, after superstructure is cast.

1.11 Cofferdam excavation for pier foundation piles and pile cap. Piling rig installing foundation H-piles.

1.12 Steel H-beam frame set at perimeter of excavation.

1.13 Sheet piling and frame for pier offerdam. Vibratory hammer advancing sections of sheet piling.

# SECTION 2

# BACKFILL

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## 2.1 Backfill – General

Backfill is placed to fill excavations, construct embankments, divert water and raise grades. Backfill is also used as a structural material for culverts and MSE walls where it acts compositely with other materials. In-place backfill must generally have certain properties of strength, density, capacity, permeability and corrosivity. Backfill is compacted to reduce voids and consequent settlement.

## 2.2 Environmental Considerations

The requirements identified in Section 1, Excavation of this Manual are also relevant to this section.

Generally, the placement of backfill material directly into a watercourse is only permitted for the construction of cofferdams. The Special Provisions and environmental permits will contain specific requirements for material properties and placement techniques, which must be strictly followed.

## 2.3 Safety Considerations

Specific safety hazards may exist during backfill construction, including the inhalation of silica dust from crushed aggregate backfill and having to work in close proximity to earthmoving and compaction equipment.

## 2.4 Materials

Backfill material is categorized into 2 types:

- **Compacted Non-Granular Material**: This is a cohesive material consisting primarily of clays. This material may be imported, but it may also be excavated from a borrow source within the project limits. The performance of a material will be affected by the presence of silt, sand and organics. Material must be free of topsoil, vegetation or other organic material.

Material used for clay seals at culverts requires special properties. This material must be able to prevent water from flowing through the culvert's structural backfill. It needs to be highly plastic and free of voids and seams after placement.

- **Compacted Granular Material**: This material may consist of either gravel material or crushed aggregate material. These materials are graded with coarse aggregates to achieve strength and drainage properties, and are graded with fine aggregates to achieve compaction density requirements. They are identified by a Designation and a Class. The Designation "2" refers to base course aggregates, and the Designation "6" refers to gravel fill. The Class refers to the maximum size of coarse aggregate material.

    - 'Gravel Material' is commonly called pit-run gravel. This is gravel found in natural deposits and is not crushed. However, some processing may be needed to meet gradation requirements. Pit-run gravel has inferior properties and is less expensive than crushed aggregate material. Pit-run gravel is seldom used for backfilling of bridge elements; however, it is commonly used for the construction of embankments.

- ‘Crushed Aggregate Material’ is a manufactured product. It is highly processed by screening, sorting, crushing, washing and blending to produce material with a specific gradation. This material has superior properties and is often used as culvert backfill and MSE wall backfill. The designations for crushed aggregate used for backfilling of bridge structures are Des 2 Class 40 and Des 2 Class 25.

## 2.5 Quality Control Testing

Prior to any backfill placement, a sample must be taken from the source to a qualified testing firm. Tests are conducted on this sample to confirm that the proposed material meets the requirements for gradation, durability, plasticity and compacted density.

For granular material:

- A sieve analysis is performed in a lab. The material is deposited into successively finer sieves by a mechanical shaker, and the percent passing by volume is recorded. The particle size distribution (gradation) is plotted against the sieve size. If the material gradation does not fall within the limits specified, the material is not acceptable for use.
- The ‘percent of two-face fractures by weight’ test is performed in a lab, where a sample is visually assessed. This parameter is important to achieve strength and density.
- The ‘plasticity index’ is measured in a lab as the difference between the liquid and plastic limits for fine-grained soil components. This limit has a direct correlation to soil strength.
- The ‘L.A. abrasion loss percent maximum’ is a test measure of degradation of aggregates resulting from abrasion, attrition, impact and grinding in a steel drum filled with the granular sample and a specified number of steel spheres. The test measures aggregate durability.

For non-granular material:

- The source of the material needs to be approved prior to acceptance. If the quality and potential density of the proposed material falls into question, the soil type must be sampled and visually identified using ATT-29 or ASTM D2487 and the density determined using ATT-8 or ASTM D6938. For culverts, the minimum plasticity index for material used as culvert seals is specified.

For both granular and non-granular material:

- A Proctor test is performed on the sample. This test is used to determine the soil’s compaction properties. It determines the optimal water content at which the soil can reach its maximum dry density. The results of this test are used to determine acceptability of field density tests, where 95% of the maximum (lab-determined) Procter density is required for a test to pass.

## 2.6 Placement and Compaction

### 2.6.1 Equipment

Compaction of soil is the process by which a stress applied to the soil causes densification by the removal of air. There are several methods of achieving compaction. Some are unsuitable in certain circumstances where they may cause damage to structural components:

- **Static**: Stress is slowly applied to fill and then released.
- **Impact**: Stress is applied by dropping a mass onto fill.
- **Vibrating**: Stress is applied repeatedly and rapidly by a mechanical plate or roller.

- **Rolling**: Stress is applied by a heavy smooth cylinder.
- **Kneading**: Shear is applied by rolling action.

Typical compaction equipment consists of:

- **Self-powered mobile compaction equipment**: These are rollers that may operate in static or vibrating mode. The rollers may have smooth-drums that compact granular soils, or they may have sheeps-foot drums that compact non-granular soil by kneading.
- **Plate tampers**: These are vibratory walk-behind machines of different weights, typically used to compact granular materials in confined spaces including near MSE wall panels and near culverts.
- **Excavator-mounted plate tampers**: These are vibratory attachments to an excavator stick used to compact granular materials.
- **Pogo sticks**: These are narrow, hand-operated vibratory rammers used to compact backfill material at culvert haunches.
- **Vibratory rammers**: These are impact rammers that contact the soil through a small plate. They are used to compact non-granular soils in confined areas.

### 2.6.2 Compaction Density Testing

Two different methods are used to confirm that the specified compaction density has been achieved:

- For Crushed Aggregate Des 2 Class 25 and Non-Granular Material, moisture and density testing is done at the frequency specified. Acceptable density is specified as 95% of the maximum Proctor dry density at optimum moisture content achieved during the lab testing.
- For Crushed Aggregate Des 2 Class 40 and Gravel Material, density testing is done using the Control Strip Method. This method is described in ATT-58A and is used to determine the minimum number of passes of compaction equipment needed to achieve maximum density. The Contractor compacts an area of production backfill, keeping track of the number of passes used to achieve an apparent maximum density. Moisture and density testing is done at the prescribed frequency. The control strip is repeated if the Contractor changes equipment or materials.

A nuclear moisture-density gauge, sometimes called a nuclear densometer, is used to measure soil moisture and density by comparing field density to the lab Proctor maximum density. The device discharges gamma photons that can measure density. The gauge is set in the “Backscatter” mode to test the density of the top few centimeters of the backfill lift. The bottom surface of the gauge must be in a clean condition, and the soil surface to be tested must be flat with the gauge properly seated.

### 2.6.3 Special Considerations

The sequence of placing and compacting backfill can be an important construction consideration depending on the structural element being backfilled.

- Backfill must not be placed against concrete elements that have not yet achieved sufficient strength. Tall slender elements like wingwalls may crack or deflect under earth pressure loading if backfilled too soon after casting. The Inspector must receive direction from the Project Manager before permitting the Contractor to backfill recently cast concrete elements.
- The curing of concrete patches must be acceptably completed before backfilling against any concrete element.

- A weak plane may result at the base of the backfill. Steps or terraces must be excavated into slopes so that the backfill material can be mechanically “keyed” into the slope.
- Backfill must be in an unfrozen state prior to placement. The Inspector must closely examine material that is at near-freezing temperatures. Ice particles indicate that some of the water needed to achieve compaction is unavailable.
- Proper placement and compaction of culvert backfill material is important since backfill is a structural component.
- Proper placement and compaction of backfill at abutments is important to prevent approach settlement.

Government of Alberta ■

Transportation

**Bridge Construction Inspection Manual 2015**

Section 2 – Backfill Check Sheet

Project Name:

Date:

Time:

Project No.:

Bridge File No:

Inspector:

Stage of Activity:

Element:

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| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | | Have the specifications and drawings been reviewed? | ☐ | |
| 1.2 | | Was the Contractor compliant with the project environmental requirements? | ☐ | |
| 1.3 | | Has the Project Manager accepted the backfill material? | ☐ | |
| **2** | | **Material Testing** | | |
| 2.1 | 2.2.3 | Has the Contractor submitted, two (2) weeks before placing of the granular material, a sieve analysis representing the material to be used at the site? | ☐ | |
| 2.2 | 2.2.3 | Has the sampling and testing been done no more than 90 days prior to usage unless otherwise approved by the Consultant? | ☐ | |
| 2.3 | 2.2.3 | Do the test methods and minimum frequencies meet the requirements as shown in Table 2.2.3 Quality Control Testing Requirements? | ☐ | |
| **3** | | **Placing** | | |
| 3.1 | 2.3 | Were all excavated spaces not occupied by permanent work backfilled with compacted material up to the elevation indicated on the drawings? | ☐ | |
| 3.2 | 2.3 | Have all excavations been surveyed prior to the start of backfilling? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.3 | 2.3 | Were all backfill materials, regardless of type, placed in lifts not exceeding 150 mm in thickness of loose material, each lift mechanically tamped with pneumatic tampers or approved equivalent? | ☐ | |
| 3.4 | 2.3 | Is Crushed Aggregate (Des 2 Class 25) and Non Granular Material (Soil), compacted to a minimum of 95% Proctor density at optimum moisture content? | ☐ | |
| 3.5 | 2.3 | Is compaction of Gravel Material and Crushed Aggregate (Des 2 Class 40) acceptable as determined by the Control Strip Method? | ☐ | |
| 3.6 | 2.3 | Has backfill material been placed against any concrete abutment, wingwall or culvert without acceptance from the Consultant? | ☐ | |
| 3.7 | 2.3 | Has placement proceeded before the concrete has been in place at least seven (7) days or before the compressive strength of the concrete is 75% of the required 28 day strength? | ☐ | |
| 3.8 | 2.3 | Has backfill material around culverts and concrete elements been placed simultaneously on both sides at the same elevation to avoid unbalanced loading? | ☐ | |
| 3.9 | 2.3 | Have special precautions been taken to prevent wedging action against concrete and the slope bounding the excavation for abutments and wingwalls? | ☐ | |
| 3.10 | 2.3 | Have the slopes been stepped to prevent wedge action? | ☐ | |

**Details and Summary:**

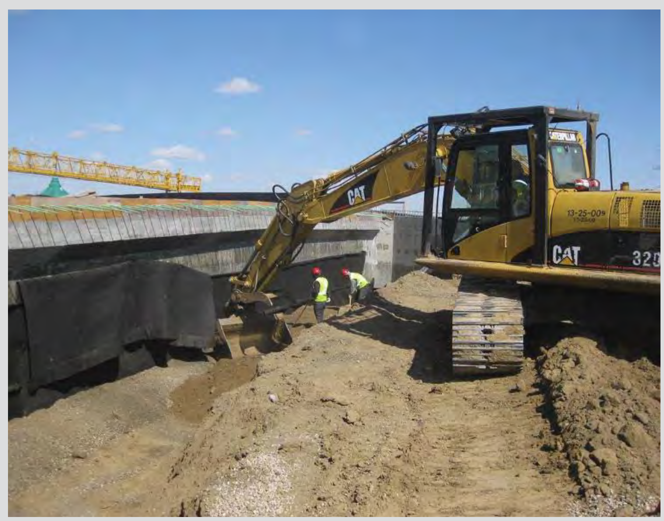
Signature

Date

2.1 Compaction of backfill between abutment pipe piles and grade beam H-piling.

2.2 Soft soil at base of excavation removed and replaced with competent granular back fill.

2.3 Compaction of granular backfill behind abutment diaphragm and wingwalls using walk behind remote controlled compaction equipment.




2.4 Hydraulic excavator placing granular backfill material against abutment backwall. Sheet drain placed against abutment seat.

2.5 Hand-operated plate tamper used for compacting granular material between H-piles and against MSE wall fascia panels. Smaller compaction equipment must be used near fascia panels.

2.6 Skid steer loader used to spread 150 mm granular fill for MSE wall fill.

2.7 Culvert foundation material in loose state, spread by dozer.

2.8 Smooth-drum roller compacting culvert bedding material. Geotextile and safe side slopes shown.

2.9 Compaction of bedding.

2.10 Backfill placed at culvert haunches.

2.11 Placing backfill evenly on both sides of culvert in 150 mm lifts.

# SECTION 3

# FOUNDATION PILES

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## 3.1 Foundation Piles – General

Foundations provide support for structures, transferring their loads to layers of rock or soil that have sufficient bearing capacity. Foundations are broadly categorized as being either shallow or deep. Shallow foundations include spread footings, and deep foundations include piles. Bridge substructure elements are most commonly supported on pile foundations.

Piles offer advantages over spread footings in the following ways:

- Piles can penetrate to deeper ground where greater strength and capacity exists. Piles are often driven to a layer of competent bedrock.
- Pile foundations can extend across slip planes beneath the structure, which may cause movement and failure with shallow foundations.
- Piles will resist failure caused by scour, which can undermine shallow foundations.
- Piled foundations do not require regular inspection, whereas elements on shallow footings do.

Piles have the following characteristics:

- Piles behave as slender columns; however, they are also laterally supported by the surrounding soil.
- When used as substructure foundations, piles are placed in groups. Often, the ends of wingwalls are also supported on piles.
- For some bridge piers, foundation piles are driven and extended to provide a laterally unsupported length above grade, which are the pier columns. The row of piles/columns in the transverse direction, connected with bracing and a pier cap, is often referred to as a 'pile bent'.

Piles achieve their performance capacity as follows:

- **Friction Piles**: Most of the pile capacity is developed by shear stresses caused by skin friction from direct contact with soil. Some capacity may also be developed by soil adhesion. These piles are used when hard soil or bedrock is too deep to use for a bearing surface. Friction piles often need to be long to develop their required capacity.
- **End-Bearing Piles**: Most of the capacity is developed at the toe of the pile, since the pile tip bears on a competent strata. To improve bearing capacity, the tips of driven pipe piles can be closed, and the tips of bored piles can be belled. The competency and cleanliness of the bearing surface for bored piles is important for end-bearing piles.

In practice, most piles provide capacity through both friction and end-bearing.

## 3.2 Environmental Considerations

The Inspector must be aware of the following environmental concerns:

- Damage to adjacent structures or foundations may occur during pile driving. Pre-condition inspections must be done if this risk exists.
- Noise bylaws exist for some municipalities, limiting the hours during which pile driving may occur.
- Diesel hammers generally discharge soot, oil and fuel. Special precautions are required when working near watercourses.

### 3.3 Safety Considerations

The Inspector must be aware of the following safety concerns:

- Noise from the hammer impact may contribute to long-term hearing damage.
- Hammer components — including the piston, helmet, bridle and winch cables — may fail during driving and fall from the leads. Working beneath pile sections and the hammer must never occur.
- Open holes may exist during pile drilling or pipe pile driving and must be marked and covered.
- Gas poisoning and suffocation from pile excavation collapse may occur. Entering excavations must never occur except under carefully planned circumstances and only with proper safety measures in place.
- Timber piles may split during driving.

### 3.4 Driven vs. Bored Foundation Piles

The choice of utilizing driven or bored piles depends on many factors, such as soil conditions, cost, water table elevation, headroom, size of foundation and substructure loading requirements.

**Driven Piles**: These are installed with a driving hammer. Driven piles may consist of either H-Pile shapes or pipes. Pipe piles may be driven with closed ends to provide end-bearing, as detailed in Standard Drawing S-1479. Precast concrete piles may also be driven, though their usage is very limited for bridge work.

**Bored Piles**: These are drilled to the design tip elevation and then immediately filled with cast-in-place concrete. Bored piles are typically used when geotechnical conditions warrant their usage.

**Specialty Piles**: Micropiles are arrays of small piles used to increase capacity for footings. They can be installed by jacking, driving or vibrating. Continuous Flight Augered (CFA) piles are bored piles where boring and concrete placement are done simultaneously to avoid excavation failure or water ingress.

### 3.5 Pile Lay-out

The lay-out of pile locations by the Contractor and the checks by the Inspector are very important. The bridge substructure elements must be accurately located to meet the design requirements. If concrete bridge elements are constructed onto incorrectly located piles, significant re-work, cost and project delays may result. The Inspector must make every effort to confirm the completeness and accuracy of the Contractor's pile lay-out.

For driven piles, the Contractor normally marks the theoretical centre of each pile location with a soil nail. Batter boards are often used at each end of the pile row so that the alignment and locations can be easily re-established, as required.

For bored piles, the Contractor normally locates the pile centre using offset soil nails. The offset marks must be established such that the theoretical pile centre can be quickly determined after the completion of concrete placement to confirm that the reinforcing steel cage is accurately positioned before the concrete reaches initial set.

## 3.6 Geotechnical Investigation and Soil Properties

The Plans contain a geotechnical information sheet which provides soil log information. The information provided by the soil logs is used to anticipate the degree of driving difficulty and the expected penetration of the piles.

Pile driving usually affects the properties of the soil through which the pile is being driven. When piles are driven in the ground, they displace soil. The soil can be pushed down, up or sideways or a combination of these.

For some over consolidated materials and saturated clays, soil displacement may cause heaving of the surrounding soil, which can lift previously driven piles or push them out of alignment.

## 3.7 Pile Driving Equipment

The pile driver consists of a crane, hammer, leads, frame, guides, and template. Hammers are generally classified as impact or vibratory hammers.

### 3.7.1 Impact Hammers

An impact hammer is the device that imparts the load into the pile. The hammer components consist of the weight or ‘ram’, an impact block or striker plate, and a hammer cushion.

It is important that the hammer does not damage the piles during driving. The pile helmet cushion transfers the impact from the hammer to the pile. Helmet or drive head components are positioned between the hammer and the pile. The helmet cools and dampens the impact from the hammer. The helmet may rest on a pile insert that neatly fits onto the pile top and helps to maintain alignment during driving. A second cushion is placed between the pile and the helmet assembly.

The pile hammer travels along guiderails within frame rails that are called “leads”. The leads are tracks along which the hammer moves, and these help to position and steady the pile during driving. The positioning of the leads is critical to achieving accurate pile alignment. It is important that the leads be rigidly attached, or “fixed”, to the crane boom. Fixed leads may be either underhung or extended, the latter being attached by a swivel boom adapter. “Fixed” vertical travel lead systems are connected to the crane boom with a sliding connection. Some “fixed” vertical travel lead systems are also connected to the crane with an adjustable hydraulic ram to maintain the pile location and alignment.

The crane is used to position the leads. The crane boom must have sufficient capacity and size to suspend leads for the full length of the pile section.

A ground template or driving frame is required to accurately locate and maintain alignment and location of piles during driving. Custom templates are fabricated by welding together sections of steel to create slots within which to place pile tips at the start of driving. Templates are usually secured in place with soldier piles. The Contractor is responsible for the accuracy of pile alignments and location.

#### 3.7.1.1 Drop Hammer

Drop or gravity hammers consist of a weight, guides or leads, a supporting framework and a means for raising and dropping the weight, such as a crane. The weight is raised along the leads to a desired height above the pile top, then released onto the pile. Gravity hammers are only permitted when the specified pile capacity is less than 350 kN. In hard soil formations, using a drop hammer may cause damage to the pile top.

#### 3.7.1.2 Diesel Hammer

A diesel hammer consists of a two-stroke diesel engine with the engine's piston acting as the hammer ram.

A diesel hammer can be a single or double acting hammer. The diesel hammer is a precision pile hammer and has a high-energy rating. It is efficient and compact since it carries its own fuel from which it generates its power internally. However, there can be unknown variability in the hammer's energy output due to uncertain performance characteristics of its components. The hammer may not reach its full energy output if it is not at operating temperature or if it is pre-igniting. The hammer will experience energy losses and inefficiency due to its helmet and cushioning, and these losses are often difficult to quantify.

Diesel hammers use rapid combustion of fuel to directly drive the pile down and the ram up. The unit contains a fuel-injection system, ram, anvil and vertical cylinder.

To start the hammer, a cable lifts the ram and a trip drops it. As it falls, it actuates a fuel pump that injects fuel between the ram and the anvil. The compression on impact ignites the fuel, and the resulting explosion drives the pile down and the ram up for the start of another blow cycle.

For double-acting diesel hammers, fuel is injected at the top of the ram travel and the resulting explosion also drives the ram downward, giving additional energy to the ram weight as it falls. A lighter ram weight is used, but more blows per minute are obtained.

#### 3.7.1.3 Hydraulic Hammer

Hydraulic hammers operate the ram by means of a hydraulic cylinder that lifts it from the bottom. They may be used in place of diesel hammers. Hydraulic hammers:

- generally require less headroom than diesel hammers
- may produce more consistent energy output as compared to diesel hammers
- are sometimes encased in the leads, and the hammer stroke is not measureable
- are generally equipped with calibrated metering that measures performance and energy
- must be properly adjusted so that the hydraulic cylinders that lift the ram are activated at the correct time to produce the rated energy.

### 3.7.2 Vibratory Hammer / Extractor

Vibratory pile hammers contain rotating eccentric weights that produce vibrations at a given frequency. A vibratory pile hammer drives a pile while rigidly connected to the pile, and it advances the pile through the soil by vibration. Vibratory pile drivers are effective for advancing piles in granular soil conditions and especially in sandy material.

The operation of vibratory pile drivers is more complex than other pile installation equipment.

Vibratory pile hammers are efficient for driving sheet piles at cofferdams.

Vibratory pile hammers can be used to extract piles.

Vibratory pile hammers are sometimes used to install the upper portions of long production piles that are initially driven at low resistance. It is difficult to maintain pile alignment using a vibratory hammer, and use of this equipment and its permitted range of driving must be approved by the Project Manager in advance.

### 3.7.3 Drill Rig

The pile drill rig is used to excavate drilled piles. It can drill through sandy, silty, clay or sandstone soils. The rig is mounted on a hydraulic crawler chassis. The mast utilizes an automatically adjusted telescopic drill pipe, or Kelly bar. The Kelly bar transfers torque and crowd force from the rotary drive to the drilling tool. Various drilling tools can be attached to the Kelly bar.

#### 3.7.3.1 Temporary Casing

The ingress of water or sloughing of the freshly drilled pile hole must be managed by use of temporary casing. Piles constructed in this way are often called “caissons”, with the casing itself acting as the caisson.

Small diameter and short casings are often pushed into the excavation and subsequently extracted using the rig’s Kelly bar.

Hydraulic casing oscillators are used to drive and extract large steel casings. The required hydraulic power is supplied by either the rig or by a separate power compressor and pump.

Casing must extend to a sufficient depth so as to intercept sloughing soil or seepage. The casing is removed during concrete placement.

#### 3.7.3.2 Drill Rig Tools

Various tools may be attached to the end of the Kelly bar:

- **Augers** of varying pitch are used to excavate softer soils. The cutting edge of the auger is fitted with maintainable blades. As the auger flights become filled with soil, the auger is retracted and the tailings are wasted.
- **Rock auger bits** are used to drill through harder soils.
- **Pilot bits** are used to drill smaller cores through hard materials.
- **Core barrels** are used to excavate rock.
- **Clean-out tools** are used to remove loose material from the base of the excavation.
- **Belling tools** are used to increase the diameter of the shaft at the base.

- **Submersible pumps** are used to remove standing water from the pile base, prior to placing concrete.

## 3.8 Criteria for Achieving Pile Capacity

The acceptability of the piles is assessed for each individual pile driven. The Inspector must be aware of important criteria that must be met to determine the acceptability of piles:

**Refusal Criteria**: This is a measure of the driving resistance encountered. If the refusal criteria has been met, the pile is considered to have adequate capacity. Its value is a measure of the number of hammer blows per distance of pile advancement, usually designated as 'Blows per 250 mm'. The number of hammer blows required to advance a 250 mm section of pile will depend on the particular hammer efficiency at the time of driving. The hammer efficiency will vary depending on the rate of blows and the physical components of the hammer itself.

**Pile Tip Elevation**: This is the design tip elevation, as indicated on the Plans. The tip elevation is theoretical, and the actual tip elevation will likely vary from theoretical. If the tip elevation is reached but the refusal criteria has not been met, then the pile is not acceptable and driving must continue. If a pile reaches refusal at a tip elevation higher than designed, the Inspector must consult with the Project Manager and geotechnical engineer. Often, structural considerations dictate an acceptable pile length and not only capacity. Piles often need a minimum length for proper bearing, scour protection and stability of the substructure element.

### 3.8.1 Challenges with Achieving Pile Capacity

Generally, driving effort becomes more difficult as the length of driven pile increases. However, sometimes a locally hard strata or the incidence of boulders can cause hard driving, which satisfies the refusal criteria at a higher elevation than design tip. If the refusal criteria is achieved at an elevation significantly higher than the design tip, the driving should continue so that it can be determined if a locally hard strata is encountered. Often, with continued driving, the pile will break through the hard strata and easier driving will again occur. The soil log information must be reviewed by the Inspector to determine if the problematic soil has been identified. Sometimes boulders can only be removed by excavation. The Inspector must consult with the Project Manager and his geotechnical engineer if clarification is needed.

The Inspector must be aware that when refusal has not yet been achieved and the pile flanges or pipe are seen to become damaged due to high driving forces, driving must stop until he consults with the Project Manager.

Pile deflection may occur when driving through soils containing cobbles, boulders or other inconsistent conditions. The Inspector must monitor pile alignment during driving. If piles deviate from the specified tolerances, the Inspector must require that driving operations stop. The Contractor must correct his methods, and the Inspector must seek the advice of the Project Manager.

Some soil types, such as clays and silts, offer relatively little resistance to the penetration of a pile as it is being driven, but then "tighten-up" to grip the pile at some time after driving has stopped. This is called pile "set-up". If a pile has been driven to the required tip elevation but the refusal criteria has not been met, the driving may be stopped and the pile allowed to set-up in anticipation that the refusal criteria will be met at a later date. Generally, many days are required after driving for set-up effects to be realised. The requirements to re-strike will be addressed in the Special Provisions.

Some foundation piles are driven through vertical Corrugated Steel Pipe (CSP) sleeves. This is typical for integral-abutment type substructures and for pilings placed through backfill materials at MSE walls.

Where piles are driven through fills that are expected to settle or consolidate in the future, the piles are coated with a bond-breaking material that will reduce or eliminate the soil’s adhesion to the pile.

## 3.9 Determination of Pile Capacity

### 3.9.1 Bearing Formulas

The bearing formulas provided in the *Standard Specifications for Bridge Construction* are generally used to determine pile capacities.

The bearing formulas are used to calculate the ‘Minimum Number of Blows per 250 mm’ of pile length, which is the pile refusal criteria or the point at which the design capacity is attained. These values are calculated for each corresponding energy output value of the hammer. This energy output and corresponding value of ‘Blows per Minute’ will vary during driving as the driving resistance changes, therefore the refusal criteria also changes with the hammer’s energy output.

The hammer parameters are provided by the manufacturer of the hammer.

### 3.9.2 Efficiency Factor

The efficiency factor must be confirmed by the Inspector by observing that the operational ‘Blows per Minute’ falls within the range of values provided by the manufacturer of the hammer.

Energy determination is important with diesel hammers. The number of blows the hammer produces per minute must be recorded so the hammer energy output can be determined. The accuracy of the bearing formulas depends on the condition and efficiency of the hammer and may be inaccurate compared to other test methods.

For some hammers, the operator can vary the fuel supply, which directly effects the energy output. Pre-ignition or other malfunctions may also result in lower efficiency.

Hammers may bounce, thereby reducing their delivered energy.

A cold hammer will not generally have the efficiency of a hammer that is at operating temperature.

The length of ram stroke varies with pile resistance, and as driving resistance increases, the ‘Blows per Minute’ is reduced.

The energy output of a specific hammer is provided in the hammer manufacturer’s data, supplied by the Contractor. When evaluating the performance of a specific hammer, it must be understood that the relationship between the number of ‘Blows per Minute’ and the efficiency of the hammer is not linear.

### 3.9.3 WEAP Analysis

As an alternative to the bearing formulas, a Wave Equation Analysis of Piles (WEAP) can be used to determine the refusal criteria. The WEAP analysis will provide a more accurate and sometimes less conservative refusal criteria than the bearing formulas.

A WEAP provides theoretical refusal criteria. The analysis is based on hammer data provided by the manufacturer and local soil conditions.

The WEAP provides a value of 'Blows per 250 mm' for the full range of possible 'Blows per Minute' from the hammer. The analysis requires specialized knowledge and is therefore performed by the Contractor's geotechnical engineer and reviewed for acceptance by the Project Manager. The Inspector must obtain the results from the Project Manager prior to the start of pile driving.

### 3.9.4 WEAP Analysis with PDA and Signal Matching Analysis

In addition to a WEAP, a Pile Driving Analysis (PDA) may be done to field-verify the results of the WEAP. PDA is a method for dynamic load testing of piles at the end of the initial driving stage. PDA also can evaluate the pile shaft integrity, driving stresses and hammer energy. The PDA system equipment consists of strain transducers that compute force and accelerometers that measure velocity caused by the mechanical wave as it travels down the shaft with each hammer blow. The soil resistance and its distribution can then be measured.

Sometimes a signal matching analysis is done, which helps to interpret the PDA data accurately and determines a capacity. This is normally done for test piles but may be done for production piles.

The PDA field results are compared to the theoretical WEAP to determine if the values match. If the values do not match, the WEAP parameters may be refined within permissible limits until the values match. In this way, the PDA results are used to confirm the WEAP.

This method is generally used on major bridges or on standard bridges that have multiple spans or more than 10 substructure piles. The analysis reduces the magnitude of the design safety factors and may result in a more economical pile configuration since it is more reliable when compared to the bearing formulas or WEAP with no PDA. When the cost of PDA is offset by a savings in piling materials, it becomes practical. PDA can be used on representative test piles during design to reduce pile lengths, pile size and the number of piles. If PDA is only used during construction on production piles, it may reduce the pile length since PDA is more accurate than the bearing formulas.

The use of PDA requires specialized knowledge and is therefore performed in the field by the Contractor's geotechnical technician, following the requirements of the technical standard referenced in the *Standard Specifications for Bridge Construction*.

## 3.10 Static Load Tests

Static load testing is a method to determine pile capacity that is more accurate than PDA. If required, it will be specified in the Special Provisions. These tests are normally not done on production piles. Rather, they are used on test piles for complex multi-bridge projects where value may be realized to the Department by refining the pile design to be more efficient. Static load testing is expensive, and the potential savings must offset this cost. The analysis reduces the magnitude of the design safety factors further and may result in a more economical pile configuration.

Static load testing requires specialized knowledge and is therefore performed in the field by the Contractor's geotechnical technician, following the requirements of the technical standard and frequency of testing referenced in the *Standard Specifications for Bridge Construction*.

### 3.10.1 Inspector's Records

#### 3.10.1.1 Field Documentation

Prior to driving, each pile is marked by the Contractor for its full length while the pile is on the ground. The pile is marked in 250 mm increments. The Inspector must request that the Contractor's marks be made neatly using a square and a brightly coloured paint stick. If the pile needs to be spliced, a new section is 'stacked' onto the driven section and again marked with numbers in continuing sequence.

Prior to the start of driving, the Contractor must establish elevation control for each pile since it is necessary to determine if the piles have reached the theoretical tip elevation. The Inspector must determine and confirm the actual pile tip elevation for each pile.

The *Engineering Consultant Guidelines for Highway, Bridge, and Water Projects – Construction Contract Administration* manual contains the Bridge Construction Administration Form titled 'Pile Data'. This form is completed by the Inspector for each pile.

#### 3.10.1.2 Using Bearing Formulas

During driving, the Inspector must monitor and record the number of hammer 'Blows per Minute' for each 250 mm of pile driven, so that he can confirm the depth at which the refusal criteria has been met. The criteria must be determined by the Inspector using the appropriate bearing formula given in the *Standard Specifications for Bridge Construction*. The calculated values must be confirmed through a discussion with the Project Manager in advance of the work.

#### 3.10.1.3 Using WEAP Analysis

The Inspector must confirm that the refusal criteria provided by the Contractor's geotechnical engineer has been accepted by the Project Manager.

The Inspector's records during piling are maintained on the 'Pile Data' form in the same way as is done for the bearing formulas.

WEAP is generally used to determine the refusal criteria in terms of 'Blows per 250 mm'. Since it is difficult to measure 'Blows per Minute' for hydraulic hammers, a calibrated gauge is often provided from which performance and energy can be determined. The Inspector needs to identify the hammer efficiency from the gauge and then determine the appropriate refusal criteria from pre-determined tabulated values.

#### 3.10.1.4 Using WEAP Analysis with PDA and Signal Matching Analysis

The Inspector must confirm that the refusal criteria provided by the Contractor's geotechnical engineer has been accepted by the Project Manager.

The Inspector must be aware of the required frequency and distribution of piles tested, and must further confirm that the required frequency of testing is properly performed by the Contractor.

The Inspector must advise the Project Manager when changes in hammer type, hardware or procedures occur.

The Inspector must confirm with the Project Manager that the Contractor's PDA equipment has been adequately calibrated.

The Inspector does not maintain records during piling on the ‘Pile Data’ form; however, a representative sample of piles may need to be logged in the same way as is done for the bearing formulas. The Inspector must discuss this requirement with the Project Manager in advance of the Work.

The Contractor’s geotechnical technician determines when refusal occurs for each pile. The Inspector must confirm with the geotechnical technician and Project Manager that the piles have met the design refusal criteria.

The Inspector must confirm with the Project Manager that the Daily Field Reports referenced in the *Standard Specification for Bridge Construction* and final test results are acceptable.

#### 3.10.1.5 Using Static Load Tests

The Inspector must confirm that the required frequency and representation of testing is accurately performed in accordance with the technical standard referenced in the *Standard Specifications for Bridge Construction*.

Due to the specialized nature of the work, the Consultant will typically have his geotechnical engineer review the Contractor’s work and take sample readings to verify the Contractor’s values. The Inspector must confirm with the Project Manager that all site deficiencies identified by the Consultant’s geotechnical engineer have been addressed before the testing is accepted.

## 3.11 Driven Pile Materials

Materials for driven piles generally consist of structural steel. Steel must be fabricated to the requirements specified in the *Standard Specifications for Bridge Construction*. The Inspector must confirm with the Project Manager that all piles delivered to the job site have been accepted on the basis of the mill certificates provided. The Inspector must confirm that the tags on the shipments match the identification numbers of the mill certificates.

Splicing must be done to the requirements of Standard Drawings S-1414 and S-1415. The Inspector must be knowledgeable of the requirements of the Standard Drawings. The Inspector must also review the requirements of Section 13 of the *Standard Specifications for Bridge Construction*, which provides field welding requirements for structural steel. The Inspector must confirm with the Project Manager that the welding procedures and welder qualifications have been received and accepted. The Inspector must confirm that the accepted weld procedures are followed, including requirements for pre-heat, warming of welding rod, and maintenance of temperature by hoarding. The Inspector must further confirm that non-destructive testing is comprehensive and that the results are acceptable before further driving is permitted.

Care must be taken when handling and driving galvanized piles to prevent coating damage. The Inspector must inspect all piles to confirm that coating damage, including scratches and blisters, has not occurred. If significant damage occurs, the Inspector must consult with the Project Manager to determine if the pile sections are repairable.

## 3.12 Types of Driven Piles and Installation

### 3.12.1 Timber Piles

Timber piles are infrequently used for foundations due to safety considerations and their potential short life expectancy.

### 3.12.2 Steel H-Piles

Steel H-piles are commonly rolled wide flange square sections varying from 250 mm to 360 mm in width. H-piles are strong and durable and can be driven into relatively hard ground. They have a small cross-section, and ground displacement and heaving are minimized.

The pile head must be cut squarely and a suitable helmet and cushion provided so that the driving force is transferred uniformly over the full cross-section of the pile.

Under difficult driving conditions, a pile “shoe” or end reinforcement may be required at the tip.

When splicing piles in cold weather, the welding area must be sheltered and the splice location pre-heated. The Contractor must use a bevelling machine to properly prepare the end of the pile prior to welding.

H-piles have both a strong and weak axis of orientation. Piles must only be placed in the orientation shown on the Plans.

### 3.12.3 Steel Pipe Piles

Steel pipe piles may be driven with open or closed ends. All steel pipe piles must be checked for roundness. It is essential that the pile cap on the helmet fits the pipe piles properly.

Steel pipe piles with closed bottom ends displace a relatively large amount of soil.

Care must be taken during driving to confirm that pipe piles are not damaged by buckling of the pipe walls. The interior of the pipe pile must be inspected by either lowering a light or using a mirror to visually confirm that the pile is not buckled or broken.

During hard driving, some local buckling of the pipe wall at the helmet may occur, requiring removal of the damaged portion.

When splicing in cold weather, the welding area must be sheltered and the splice location pre-heated. The Contractor must use a bevelling machine to properly prepare the end of the pile for welding and also use backup rings when making the weld.

The Inspector must discuss all special requirements with the Project Manager, such as cleaning out the pipe pile after driving, socketing the pile base, concreting and reinforcement.

Temporary covers must be installed onto finished pipe piles for safety up to the time that the concrete is cast.

## 3.13 Final Acceptance of Driven Piling

- The Inspector must be present at all times during driving, and must thoroughly understand the driving criteria before the start of driving.
- The Inspector must, before the start of driving, confirm that the piles are correctly oriented.
- Pile tops must be cut squarely to accommodate the helmet guide, which holds the pile in positive relative to the hammer.
- Throughout driving, the Contractor must confirm that the pile alignment is correct, as verified by the Inspector.
- When using a value of ‘Blows per 250 mm’ as a refusal criteria, the Inspector generally indicates verbally to the Contractor or his subcontractor that a pile has acceptably attained both the tip elevation and the required capacity.
- After all piles are driven to refusal and before the end of the day, the Inspector must carefully record the length of pile driven from tip to the theoretical cut-off elevation.
- Prior to the cut-off of any piles, the Inspector must calculate the length of each pile driven, to the nearest centimetre.

**Drilled Piles**

Drilled piles are commonly designed to be founded at a specific elevation. Their capacity is not generally determined during production, therefore care must be taken to construct drilled piles to their specified diameter and depth. All requirements for capacity testing are stated in the Special Provisions, and the Inspector must identify any inspection and reporting requirements with the Project Manager in advance. Pile capacity may be determined by PDA but this is uncommon for bored piles.

### 3.13.1 Soil Logs

It is necessary that the drilling contractor be experienced and knowledgeable. The Inspector must confirm with the Project Manager that the drilling contractor meets an acceptable level of competency.

The Inspector must thoroughly review the pile soil logs to identify the expected soil types, properties and water conditions. The Inspector must be able to visually identify the soil types. The Inspector must consult with the Project Manager or the Consultant’s geotechnical engineer in advance to identify critical aspects of the Work, including the potential for difficult drilling, condition requirements for the base and the identification of competent bearing soils.

### 3.13.2 Equipment

The Inspector must confirm that the Contractor has all necessary equipment and tools available before the start of drilling, including casing, specialty augers, bits, clean-out tools, pumps and bailing tools.

### 3.13.3 Casing

Drilled pile holes must be stabilized to prevent sloughing and ingress of water using temporary casing, as required.

The casing must be of sufficient length to protect the hole from sloughing and to intercept seepage water. Casing must be removed during or immediately after concrete placement. The Inspector must confirm that the base of the casing remains below the level of concrete at all times so that the ingress of soil or water is prevented.

### 3.13.4 Drilling

The Inspector must review the tailings from the auger to observe that the soil types match those identified in the soil logs. The Inspector must confirm the elevation at which the soil strata changes and the elevations where any seepages occur.

The Inspector must pay particular attention in recording the elevations where boulders or unexpectedly hard drilling has occurred. It is necessary to record any instance that has resulted in a delay or suspension to drilling operations.

The Inspector must confirm that the belling tool is able to excavate the base of the pile to the required dimensions. The tool must be tested at the surface to confirm that the cutting wings are adjustable to the required opening angle and diameter.

If battered piles are required, the batter angle must be checked by measuring the angle of the Kelly bar.

The Inspector must confirm that the pile hole depth meets the design tip elevation.

The Inspector must confirm that the pile hole base material consists of the material specified in the Plans. The use of a powerful flashlight or a mirror to reflect sunlight is required to properly view the base. A special clean-out tool attached to the Kelly bar is required to remove any loose material.

### 3.13.5 Reinforcing Steel Cage

The pile reinforcing steel is prefabricated into a cage and lowered into the pile hole. It may be necessary to install the cages in sections due to the depth of the pile. The Inspector must confirm that the cages are sufficiently tied to maintain their shape during placement and splicing.

The reinforcement cage must be adequately chaired so that the required cover is maintained. Typically, round ‘wagon wheel’ style chairs of appropriate diameter are placed onto cage ties. The Inspector must confirm that the appropriate size and number of chairs are properly secured to the cage.

The Inspector must determine if chairs or other approved devices are needed at the base of the vertical bars to prevent them from depressing into soft ground.

The cage must be installed at its precise location and checked by the Inspector prior to concrete placement. The cage must be adequately secured to prevent movement during concrete placement or casing extraction.

### 3.13.6 Placing Pile Concrete

Concrete must be placed immediately after the cage is acceptably installed and secured. Prior to concrete placement, it is necessary to confirm that the hole is dry and clean. The Inspector must view the base of the pile hole to confirm cleanliness and dryness.

The Contractor must make every effort to achieve a ‘dry’ hole prior to placing concrete. An acceptably dry hole may not in fact be completely dry but may contain a very shallow layer of water. This may be acceptable only if all precautions, including casing and pumping, have been performed and the amount of water is determined to be non-detrimental by the Project Manager.

Concrete must be placed through a drop tube to avoid segregation and contamination of reinforcing steel.

Casing removal may result in a void that will cause concrete to slump. The top section of the pile may require additional concrete and may need to be re-vibrated after casing removal. Care must be taken to prevent shifting of the reinforcing steel cage.

The Contractor must check the position and projection of the reinforcing steel cage immediately after completion of concrete placement.

If pile holes cannot be effectively dewatered, the pile concrete needs to be placed by tremie as described in Section 4 of this Manual. Crosshole Sonic Logging (CSL) must then be completed. It is important that advance planning be done to determine if a tremie will be required, since CSL requires that tubes be placed with the reinforcement cage. If tremie concrete is expected, the Contractor must submit his proposed methods. The Inspector must confirm that the Contractor’s methods have been accepted by the Project Manager before any concrete is placed by tremie.

#### 3.13.7 Crosshole Sonic Logging

CSL is described in Section 4 of the *Standard Specifications for Bridge Construction*. This method is used to determine the structural integrity of the tremied concrete.

Testing must be done by a qualified testing agency with a minimum of three (3) years of CSL testing experience. The Inspector must confirm that the Project Manager has accepted the qualifications of the testing firm and the personnel.

Results other than “G” are not acceptable, and the Contractor must submit a corrective proposal for review. No further construction for this element may be done until the Contractor’s proposal is deemed acceptable by the Project Manager.

Government of Alberta ■
Transportation

**Bridge Construction Inspection Manual 2015**
Section 3 – Foundation Piles Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No:
Inspector:
Stage of Activity:
Element:

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | | Have the specifications and plans been reviewed? | ☐ | |
| 1.2 | | Have the driving equipment and methods been accepted by the Project Manager? | ☐ | |
| 1.3 | | Is pre-boring permitted? | ☐ | |
| 1.4 | | Has refusal criteria been determined? | ☐ | |
| 1.5 | | Has the driving operation been reviewed and the results reported to the Project Manager? | ☐ | |
| **2** | | **Handling** | | |
| 2.1 | 3.3 | Has piling been handled, hauled and stored in a manner that prevents damage to the materials? | ☐ | |
| 2.2 | 3.3 | Has loading and unloading been done by crane, loader or other appropriate hoisting equipment? | ☐ | |
| 2.3 | 3.3 | Have fabric slings, wood blocking and other approved methods been used to support and separate galvanized piling when handling, hauling or storing? | ☐ | |
| 2.4 | 3.3 | Has any repair to damaged galvanizing been by metallizing in conformance with ASTM A780, Method A3 to a thickness of 180 µm? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.5 | 3.3 | Has the Contractor avoided breaking through the surface treatment of treated timber piles? | ☐ | |
| 2.6 | 3.3 | Have any cuts or breaks in the surface of treated timber piles been given three brush coats of preservative material of approved quality, and has preservative material been poured into all bolt holes? | ☐ | |
| **3** | | **Driven Piles** | | |
| 3.1 | 3.4.1 | Have all pile driving equipment, driving methods and procedures been reviewed and accepted by the Project Manager before pile driving commences? | ☐ | |
| 3.2 | 3.4.1 | Has driving of piles with driving extensions been performed only with acceptance by the Consultant? | ☐ | |
| 3.3 | 3.4.1 | When driving extensions were used, has one pile from each group of 10 been a long pile driven without extensions and used as a test pile to determine the average capacity of the group? | ☐ | |
| 3.4 | 3.4.1 | Has the Contractor painted markings on each pile at 0.25 m intervals with a label at each 1.0 m interval starting from the toe of the pile? | ☐ | |
| 3.5 | 3.4.1 | Has the Contractor taken proper measures to ensure in proper position and alignment by the use of driving frames and fixed leads? | ☐ | |
| 3.6 | 3.4.1 | Were any piles out of the horizontal position by more than 150 mm after driving? | ☐ | |
| 3.7 | 3.4.1 | Were any piles for fully integral abutments out of horizontal position by more than 50 mm? | ☐ | |
| 3.8 | 3.4.1 | Was the variation in position between the pile casing center and the pile centre more than 25 mm for fully integral abutments? | ☐ | |
| 3.9 | 3.4.1 | Were any piles driven with a variation of more than 20 mm per metre from the vertical or the batter as shown on the drawings? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.10 | 3.4.1 | Were any piles in exposed bents out of position by more than 50 mm at the ground line or 25 mm at the pier cap? | ☐ | |
| 3.11 | 3.4.2 | Were all required Pile Data forms completed? | ☐ | |
| 3.12 | 3.4.2 | Were all piles confirmed to be driven to capacity prior to cut off? | ☐ | |
| **4** | | **Steel Piles** | | |
| 4.1 | 3.4.3 | When pipe piles are to be driven closed-ended, has lower section been supplied with a welded pipe pile end plate in accordance with Standard Drawing S-1479 “Standard Closed Pipe Pile End Plate”? | ☐ | |
| 4.2 | 3.4.3 | Has all foreign material adhering to the inside walls of the pipe piles been removed? | ☐ | |
| 4.3 | 3.4.3 | Has the Contractor reinforced the driving end of the piling or provided other suitable equipment or procedures to prevent buckling at the driving end? | ☐ | |
| 4.4 | 3.4.3 | Were the piles cut-off level at the accepted elevation? | ☐ | |
| 4.5 | 3.4.3 | Has the Contractor supplied and secured temporary caps on all open pipe piles or drilled holes? | ☐ | |
| **5** | | **Steel Pile Splices** | | |
| 5.1 | 3.4.3.1 | Has all field-welding been done in accordance with Section 13.4.1? | ☐ | |
| 5.2 | 3.4.3.1 | Where the upper portions of piling are galvanized, has excess piling been removed from the ungalvanized portion of the piling to ensure that the galvanized portion extends to the elevation shown on the drawings? | ☐ | |
| 5.3 | 3.4.3.1 | Has all damaged galvanizing been metallized in accordance with ASTM A780, Method A3 to a thickness of 180 µm? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 5.4 | 3.4.3.2 | Has the Contractor performed ultrasonic testing for a minimum of 20% of all full penetration compression splice welds at all piles for each bridge component? | ☐ | |
| 5.5 | 3.4.3.2 | Has ultrasonic testing been completed for welds in which visual inspection indicates the presence of a potential defect? | ☐ | |
| 5.6 | 3.4.3.2 | Has the Contractor tested 100% of full penetration tension splice welds as identified on the drawings? | ☐ | |
| 5.7 | 3.4.3.2 | Has ultrasonic testing been done by a company certified to CAN/CSA W178.1? | ☐ | |
| 5.8 | 3.4.3.2 | Were ultrasonic testing technicians certified to Level II of Canadian General Standards Board (CGSB)? | ☐ | |
| **6** | | **Field Welding – Structural Members – Section 13** | | |
| 6.1 | 13.4.1 | Has all welding, cutting and preparation been done in accordance with the American Welding Society (AWS) – Bridge Welding Code D1.5? | ☐ | |
| 6.2 | 13.4.1 | Were the welders performing the weldments approved by the Canadian Welding Bureau in the particular category, and was their qualification current and available for examination? | ☐ | |
| 6.3 | 13.4.1 | Have the welding procedures been approved by the Canadian Welding Bureau and submitted for review prior to welding? | ☐ | |
| 6.4 | 13.4.1 | Were low hydrogen filler, fluxes and welding practices used in accordance with SSBC Section 6.2.5.1? | ☐ | |
| 6.5 | 13.4.1 | When the air temperature is below 10°C, has all material to be welded been preheated to 100°C for a distance of 80 mm beyond the weld and sheltered from the wind? | ☐ | |
| 6.6 | 13.4.1 | Has welding been permitted when the air temperature is below 0°C, other than with suitable hoarding and heating provided? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **7** | | **Drilled Cast-in-Place Concrete Piles** | | |
| 7.1 | 3.5.2 | Have all equipment, drilling methods and procedures been reviewed and accepted before drilling started? | ☐ | |
| 7.2 | 3.5.4 | Have drilled pile holes been stabilized and sealed by means of temporary casings or other methods to prevent the possible collapse of the pile holes or ingress of water? | ☐ | |
| 7.3 | 3.5.4 | Was temporary casing, if used in drilling operations, removed from the hole as pile concrete was placed? | ☐ | |
| 7.4 | 3.5.4 | Has the bottom of the casing been maintained below the top of the concrete during withdrawal and placing operations unless otherwise permitted? | ☐ | |
| 7.5 | 3.5.4 | Have the walls and bottoms of the pile holes been cleaned to remove all loose and extraneous material? | ☐ | |
| 7.6 | 3.5.4 | Has pile reinforcement and pile concrete been placed with acceptance of the Inspector? | ☐ | |
| 7.7 | 3.5.5 | Has the Contractor covered all open holes at the site until the time they are filled with concrete or otherwise properly backfilled? | ☐ | |
| 7.8 | 3.5.5 | Were the covers of adequate strength and securely fitted so that machinery and workmen were protected against cave-ins and so that surface water was prevented from entering the pile hole? | ☐ | |
| 7.9 | 3.5.6 | Has steel reinforcement been fabricated to the sizes and dimensions shown on the drawings and placed, centered and braced in the pile hole? | ☐ | |
| 7.10 | 3.5.6 | Has projecting reinforcing steel been located to a tolerance not exceeding 10 mm in any direction? | ☐ | |
| 7.11 | 3.5.6 | Have adequate "shoes" or spacers been firmly attached to the reinforcement cage to ensure that it is kept centered in the pile hole? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **8** | | **Concrete Placement for Drilled Piles – Section 4** | | |
| 8.1 | 4.15.1 | General – Has the Contractor made all attempts necessary to obtain a dry pile hole prior to placing pile concrete?<br>*Note: If, in the opinion of the Consultant and the Department, all attempts to achieve a dry pile hole have been taken and proven unsuccessful, placement of pile concrete by tremie will be required.* | ☐ | |
| 8.2 | 4.15.2 | Concrete Placed in the Dry – Was pile concrete placed by means of a hopper equipped with a centre pipe drop tube with concrete in the upper 3 m of the piles consolidated? | ☐ | |
| 8.3 | 4.15.3 | Concrete Placed Under Water – Was placement of pile concrete under water in accordance with Section 4.22 of the Standard Specifications for Bridge Construction? | ☐ | |
| 8.4 | 4.15.3 | Crosshole Sonic Logging (CSL) – Did the Contractor submit the proposed method for review two (2) weeks before beginning drilled pile work? | ☐ | |
| 8.5 | 4.15.3 | Did the Contractor supply and install four (4) 50 mm inside diameter tubes in each drilled pile with a diameter of 1.5 m or less and six (6) tubes in each pile with a diameter of greater than 1.5 m? | ☐ | |
| 8.6 | 4.15.3 | Did the Contractor install the tubes in a manner such that the CSL probes pass through the entire length of the tube without binding? | ☐ | |
| 8.7 | 4.15.3 | Did the Contractor fit the tubes with watertight shoes on the bottom and removable caps on the top, and did he ensure that the CSL tubes were not damaged during the installation of the reinforcement cage? | ☐ | |
| 8.8 | 4.15.3 | Did the Contractor make CSL measurements at depth intervals of 65 mm from the bottom of the tubes to the top of each pile, and upon completion of testing and acceptance of the pile concrete, were the tubes filled with an approved grout mix? | ☐ | |
| 8.9 | 4.15.3 | Qualification – Did the testing agency hired by the Contractor have a minimum of three (3) years' experience in CSL testing? | ☐ | |
| 8.10 | 4.15.3 | Did the Contractor provide written evidence of completion of all CSL tests by the testing agency? | ☐ | |
| 8.11 | 4.15.3 | Did the Contractor's submission include personnel qualifications and descriptions of testing equipment? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 8.12 | 4.15.3 | CSL Results – Did the Contractor submit two (2) original copies of the CSL report to the Consultant within five (5) working days of completion of CSL testing, signed and sealed by the CSL engineer, including test summaries, results, analyses and an opinion of the pile concrete's suitability for intended use? | ☐ | |
| 8.13 | 4.15.3 | Were the summaries in accordance with the criteria listed in Section 4.15.3 Concrete Condition Rating Criteria? *Note: Test results with ratings other than "G" will be considered unacceptable and will result in rejection of the pile.* | ☐ | |
| 8.14 | 4.15.3 | Were any piles considered unacceptable by the Consultant and the Department? | ☐ | |
| 8.15 | 4.15.3 | If remedial action is required, has the Contractor submitted a remedial action proposal with supporting calculations to the Department and the Consultant for review and acceptance? | ☐ | |
| **9** | | **4.20 – Concreting in Cold Weather** | | |
| 9.1 | 3.5.8 | If the ground against which pile concrete was placed was below -5°C, was the pile hole oversized by 100 mm? | ☐ | |
| 9.2 | 3.5.8 | Was the top exposed surface of the pile concrete protected with insulated tarps or other means to adequately cure the concrete for a period of seven (7) days? | ☐ | |
| 9.3 | 3.5.8 | If the pile extended above the ground, did the Contractor protect the concrete as per Section 4 "Concreting in Cold Weather" of the Standard Specifications for Bridge Construction? | ☐ | |
| 9.4 | 4.21 | Did the Contractor submit details of his proposed cold weather concreting plan to the Consultant for review and acceptance a minimum of two (2) weeks prior to any concrete placement? | ☐ | |
| 9.5 | 4.21 | Did the Contractor enclose the structure in such a way that the concrete and air within the enclosure was kept above 15°C for a period of 21 days after placing the concrete. | ☐ | |
| 9.6 | 4.21 | Was the enclosure constructed large enough to comfortably accommodate the men and equipment necessary to place, finish and cure the concrete? | ☐ | |
| 9.7 | 4.21 | Was the relative humidity within the enclosure maintained at not less than 85%? | ☐ | |

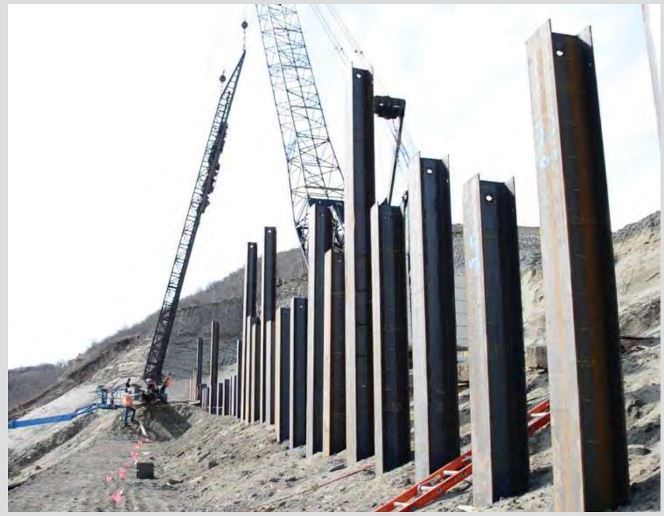
| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 9.8 | 4.21 | Were heaters kept well clear of the formwork housing and was adequate ventilation provided for combustion, and prevention of carbon dioxide accumulation?<br>*Note: The use of salamanders, coke stoves, oil or gas burners and similar spot heaters that have an open flame and intense local heat is prohibited without the Consultant's specific acceptance.* | ☐ | |
| 9.9 | 4.21 | Was adequate pre-heat provided to raise the temperature of formwork, reinforcing steel, previously-placed concrete and/or soil to between 10°C and 20°C before placing concrete? | ☐ | |
| 9.10 | 4.21 | Was fully insulated formwork used as an alternative to providing further heat during the curing period? | ☐ | |
| 9.11 | 4.21 | Was concrete curing in accordance with the requirements of Subsection 4.23 of the Standard Specifications for Bridge Construction? | ☐ | |
| 9.12 | 4.21 | Was the adequacy of protection monitored and recorded a minimum of every four (4) hours for the first 72 hours and every eight (8) hours for the remainder of the curing period, including measurement of internal and surface concrete temperatures? | ☐ | |
| 9.13 | 4.21 | Was protection and heating, where used, withdrawn in such a manner so as not to induce thermal shock stresses in the concrete, with the temperature of the concrete gradually reduced at a rate not exceeding 10°C per day to that of the surrounding air? | ☐ | |
| 9.14 | 4.21 | Did the Contractor measure the temperature of internal concrete, surface of the concrete and ambient air temperatures a minimum of every four (4) hours and make adjustments as necessary to keep the rate of cooling within the specified parameters? | ☐ | |
| 9.15 | 4.21 | Did the Contractor demonstrate to the satisfaction of the Consultant that the requirements of the cold weather concreting plan were met? | ☐ | |
| **10** | | **Pile Tolerance for Drilled Piles** | | |
| 10.1 | 3.5.9 | Were the piles within 50 mm of the horizontal position and within 20 mm of vertical or batter position as shown on the drawings? | ☐ | |
| 10.2 | 3.5.9 | Did the Contractor make immediate changes to his piling procedures and correct any piles where tolerances were not met? | ☐ | |

**Details and Summary:**

Signature

Date

3.1 Diesel hammer and crane showing “fixed” box leads.



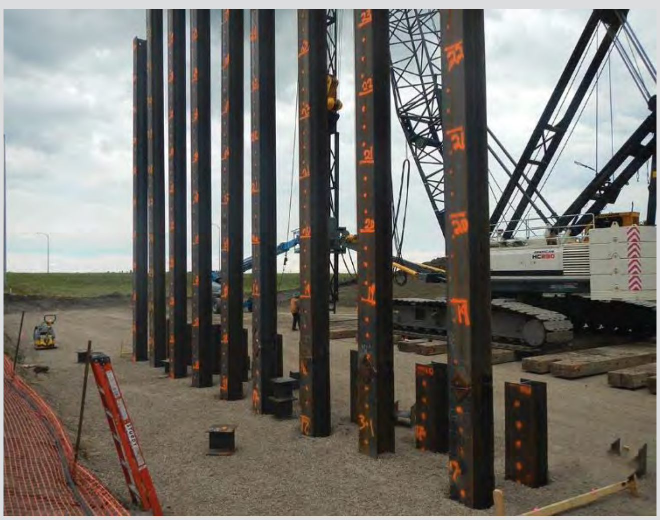
3.2 Diesel hammer and crane showing “hanging” leads.

3.3 Hydraulic pile driving hammer. Pile offset line marked with paint.

3.4 Pile driving frame used to position piles accurately at the start of driving. Frame is anchored by welding to soldier piles.

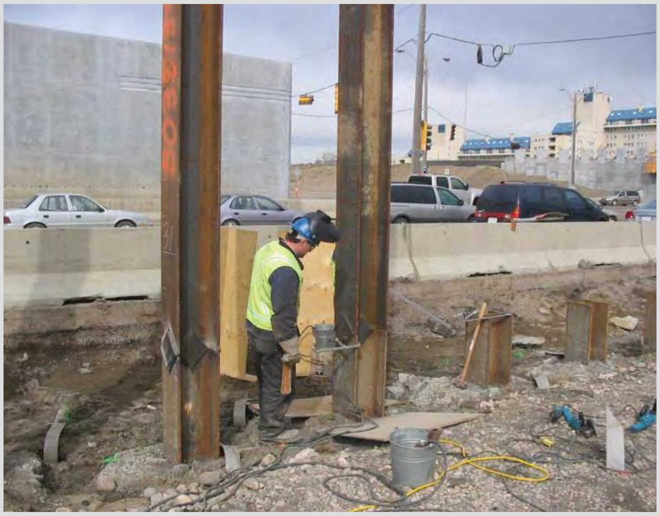
3.5 Diesel hammer piling rig shown. Centre of pile marked out by pins or flags. H-pile orientation painted on ground.

3.6 Batterboards and string line set up with 2x4s. String line offset to re-establish pile location.

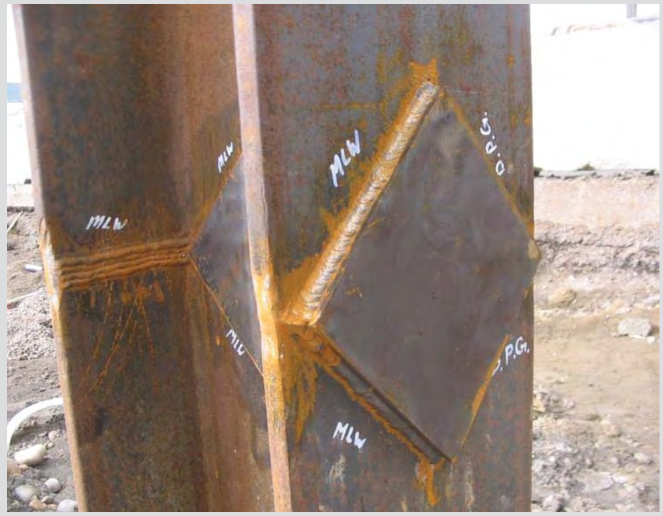


3.7 Pile driving at abutment seat location. Piles are marked at 250 mm intervals.

3.8 H-pile splice detail. Splice plates are welded to the pile extension, the pile is stacked on the previously driven pile, and the extension is then welded to the pile.

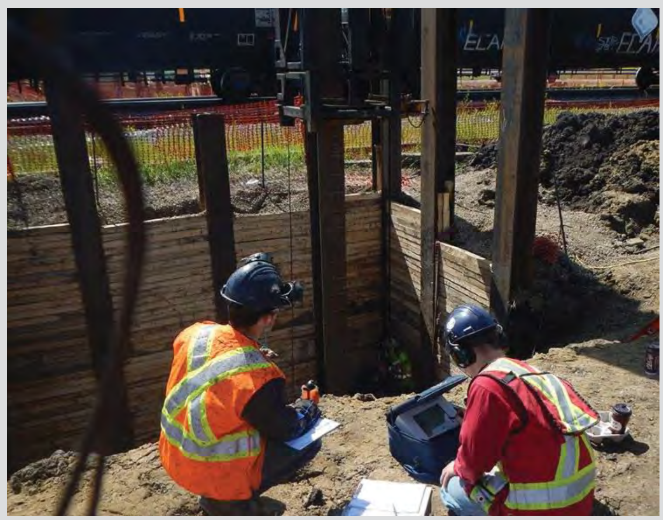


3.9 Tack welding of H-pile splices. 50% of final welds are completed before releasing H-pile from crane.



3.10 Completed H-pile splice welds.

3.11 PDA testing instrumentation consists of accelerometers that return driving force information for analysis.

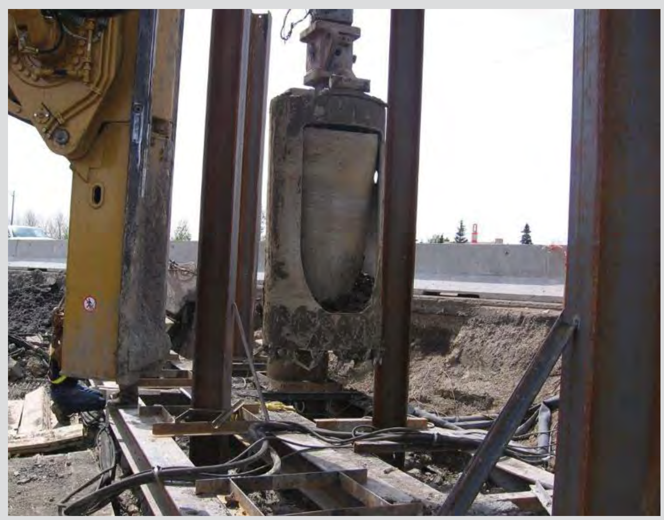


3.12 PDA testing technicians and instrumentation.

3.13 Piling rig with auger and soil tailings.

3.14 Slush bucket, coring barrel and augers shown.

3.15 Rock bit auger.



3.16 Break-up bucket attachment used to loosen hard soils and break up rocks and other obstructions.

3.17 Large muck or slush bucket, used to clean out the bottom of wet or muddy holes prior to cage placement.

3.18 Drilling auger and tailings. Offset measurement used to confirm pile location.

3.19 Belling tool, fully opened. Wings are opened at the tip elevation to create a belled pile.


3.20 Drilling frame used to achieve pile location accuracy.

3.21 Drilling pile holes with casing installed. Casing is used temporarily to keep the excavation from caving in, or to stop seepage. Casing is removed during concrete placement.

3.22 Vibratory hammer used to advance drilling casing. Worker checking if casing is plumb.

3.23 Drilling rig used to advance drilling casing. Kelly bar advances the casing into the excavation. For larger diameters, a vibratory hammer or an oscillator is used to advance the casing.

3.24 Splicing pipe pile. Bevelled edge with backing plate shown.

3.25 Splicing pipe pile shown after fit-up.

3.26 Splicing of galvanized and plain pipe piles. Galvanized pipe piles used above grade.

3.27 Hoarding for welding required during cold and windy conditions.

3.28 Vibratory hammer used to advance drilling casing.

3.29 Wire brush clean up bucket attachment.


3.30 Water pump may be required to maintain a dry hole.

3.31 Plastic spacer chairs attached to bottom of reinforcing steel cage to prevent the cage from punching through the base of the excavation.

3.32 Wheel spacers are used to maintain required cover for pile cages.

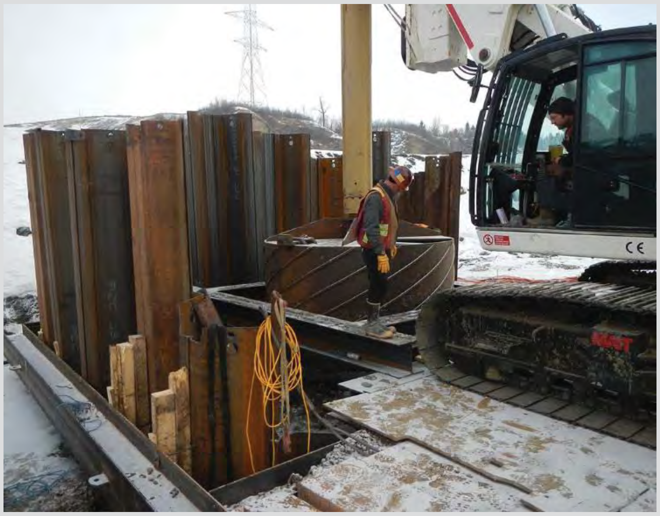

3.33 Concrete hopper for discharging concrete through pile cage.

3.34 Concrete pumped through tremmie pipe. Cross-hole Sonic Log (CSL) pipe attached to reinforcing steel (black pipes).

3.35 Vibrating top of pile. Efforts should be made to keep reinforcing steel free of paste.

3.36 H-pile set into centre of concrete pile. Steel frame used to set location and elevation.

3.37 Cross-hole Sonic Log (CSL) testing equipment.



3.38 Large 3.0 m diameter pile. Muck bucket attached.

3.39 Piling ongoing. Checking depth of pile and condition of base.

3.40 Large 3.0 m diameter pre-fabricated cage. Extra support / bracing used to retain shape and stability for lifting.

3.41 Double crane pick for reinforcing steel cage installation. Halo ring and extra reinforcement required to pick large cage.

3.42 Concrete discharge down centre of pile by pump. Pump hose centred so that concrete does not impact reinforcing steel.

3.43 Vibratory hammer used to remove temporary drilling casing.

3.44 Construction joint at pile top.

3.45 Galvanized pipe piles at exposed pier columns.

Alberta Transportation

# PILE DATA

Date: ____________

Project: ____________ Contract No: ____________ Bridge File No. ____________

Project Sponsor: ____________ Contractor: ____________

Consultant Inspector: ____________ Piling Sub: ____________

Ground/Ice Elevation: ____________ Location: Sta ____________ : ____________ m rt/ft Abut/Pier No: ____________

Pile No: ____________ Pile Type: ____________ Pile Length: ____________

Type of Hammer: ____________ Mass/Energy of Hammer: ____________ kg/kj

Efficiency Factor: ____________

Remarks: ____________

| Depth of Pile (m) | Number of Blows | Drop of Hammer (m) | Remarks | Depth of Pile (m) | Number of Blows | Drop of Hammer (m) | Remarks |
|---|---|---|---|---|---|---|---|
| 0.00 - 0.25 | | | | 8:00 - 8.25 | | | |
| 0.25 - 0.50 | | | | 8.25 - 8.50 | | | |
| 0.50 - 0.75 | | | | 8.50 - 8.75 | | | |
| 0.75 - 1.00 | | | | 8.75 - 9.00 | | | |
| 1.00 - 1.25 | | | | 9.00 - 9.25 | | | |
| 1.25 - 1.50 | | | | 9.25 - 9.50 | | | |
| 1.50 - 1.75 | | | | 9.50 - 9.75 | | | |
| 1.75 - 2.00 | | | | 9.75 - 10.00 | | | |
| 2.00 - 2.25 | | | | 10.00 - 10.25 | | | |
| 2.25 - 2.50 | | | | 10.25 - 10.50 | | | |
| 2.50 - 2.75 | | | | 10.50 - 10.75 | | | |
| 2.75 - 3.00 | | | | 10.75 - 11.00 | | | |
| 3.00 - 3.25 | | | | 11.00 - 11.25 | | | |
| 3.25 - 3.50 | | | | 11.25 - 11.50 | | | |
| 3.50 - 3.75 | | | | 11.50 - 11.75 | | | |
| 3.75 - 4.00 | | | | 11.75 - 12.00 | | | |
| 4.00 - 4.25 | | | | 12.00 - 12.25 | | | |
| 4.25 - 4.50 | | | | 12.25 - 12.50 | | | |
| 4.50 - 4.75 | | | | 12.50 - 12.75 | | | |
| 4.75 - 5.00 | | | | 12.75 - 13.00 | | | |
| 5.00 - 5.25 | | | | 13.00 - 13.25 | | | |
| 5.25 - 5.50 | | | | 13.25 - 13.50 | | | |
| 5.50 - 5.75 | | | | 13.50 - 13.75 | | | |
| 5.75 - 6.00 | | | | 13.75 - 14.00 | | | |
| 6.00 - 6.25 | | | | 14.00 - 14.25 | | | |
| 6.25 - 6.50 | | | | 14.25 - 14.50 | | | |
| 6.50 - 6.75 | | | | 14.50 - 14.75 | | | |
| 6.75 - 7.00 | | | | 14.75 - 15.00 | | | |
| 7.00 - 7.25 | | | | 15.00 - 15.25 | | | |
| 7.25 - 7.50 | | | | 15.25 - 15.50 | | | |
| 7.50 - 7.75 | | | | 15.50 - 15.75 | | | |
| 7.75 - 8.00 | | | | 15.75 - 16.00 | | | |

| Depth of Pile (m) | Number of Blows | Drop of Hammer (m) | Remarks | Depth of Pile (m) | Number of Blows | Drop of Hammer (m) | Remarks |
|---|---|---|---|---|---|---|---|
| 16.00 - 16.25 | | | | 22.00 - 22.25 | | | |
| 16.25 - 16.50 | | | | 22.25 - 22.50 | | | |
| 16.50 - 16.75 | | | | 22.50 - 22.75 | | | |
| 16.75 - 17.00 | | | | 22.75 - 23.00 | | | |
| 17.00 - 17.25 | | | | 23.00 - 23.25 | | | |
| 17.25 - 17.50 | | | | 23.25 - 23.50 | | | |
| 17.50 - 17.75 | | | | 23.50 - 23.75 | | | |
| 17.75 - 18.00 | | | | 23.75 - 24.00 | | | |
| 18.00 - 18.25 | | | | 24.00 - 24.25 | | | |
| 18.25 - 18.50 | | | | 24.25 - 24.50 | | | |
| 18.50 - 18.75 | | | | 24.50 - 24.75 | | | |
| 18.75 - 19.00 | | | | 24.75 - 25.00 | | | |
| 19.00 - 19.25 | | | | 25.00 - 25.25 | | | |
| 19.25 - 19.50 | | | | 25.25 - 25.50 | | | |
| 19.50 - 19.75 | | | | 25.50 - 25.75 | | | |
| 19.75 - 20.00 | | | | 25.75 - 26.00 | | | |
| 20.00 - 20.25 | | | | 26.00 - 26.25 | | | |
| 20.25 - 20.50 | | | | 26.25 - 26.50 | | | |
| 20.50 - 20.75 | | | | 26.50 - 26.75 | | | |
| 20.75 - 21.00 | | | | 26.75 - 27.00 | | | |
| 21.00 - 21.25 | | | | 27.00 - 27.25 | | | |
| 21.25 - 21.50 | | | | 27.25 - 27.50 | | | |
| 21.50 - 21.75 | | | | 27.50 - 27.75 | | | |
| 21.75 - 22.00 | | | | 27.75 - 28.00 | | | |

## *SKETCH OF PILE LOCATION*

**NOTE: SHOW NORTH ARROW**

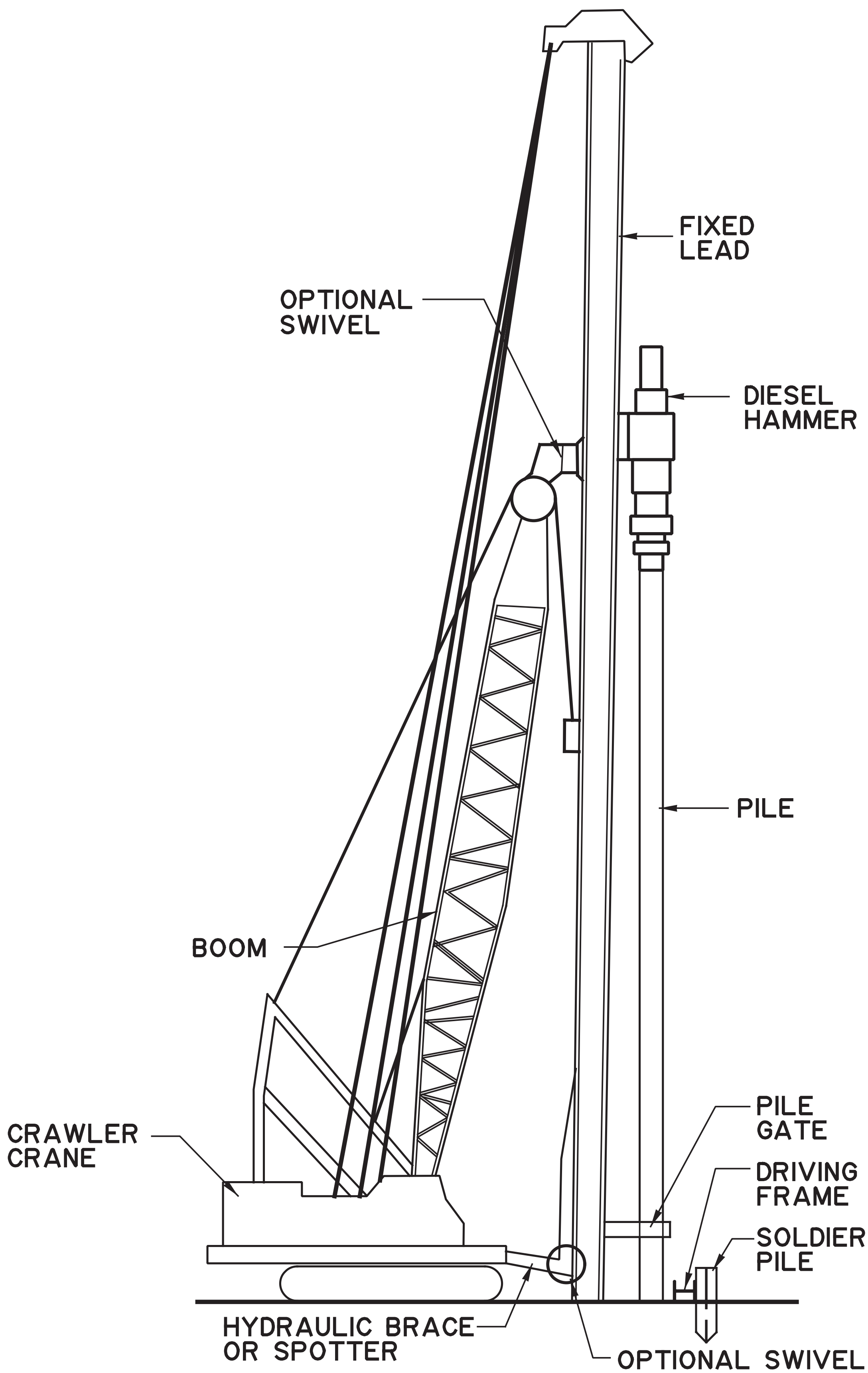



FIGURE 3-1 – TYPICAL DIESEL PILE DRIVING HAMMER AND FIXED LEAD

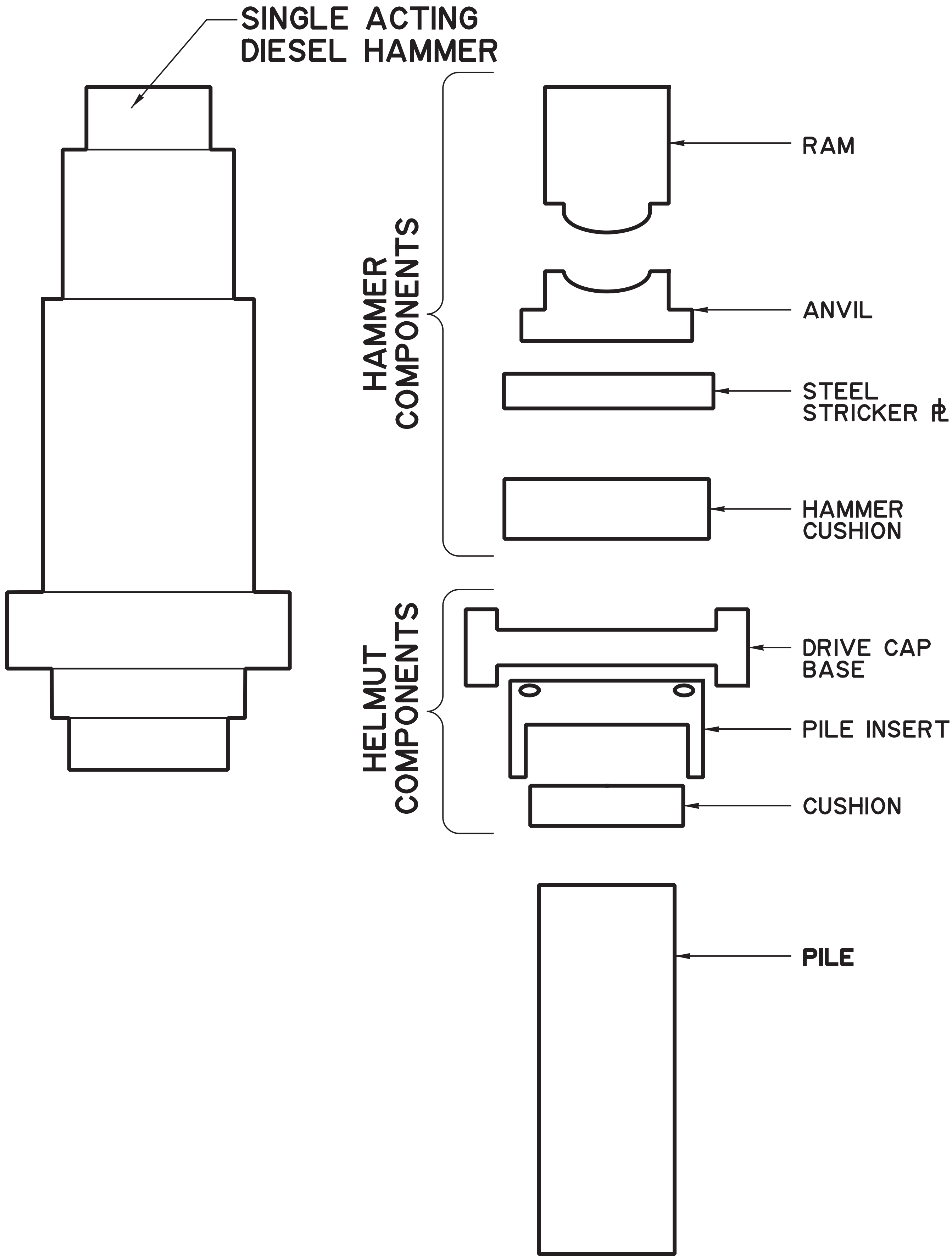



FIGURE 3-2 - TYPICAL COMPONENTS
OF A SINGLE ACTING DIESEL HAMMER

# SECTION 4

# CAST-IN-PLACE CONCRETE

## TABLE OF CONTENTS

**FIGURES**

## 4.1 Cast-In-Place Concrete – General

Cast-in-place concrete is commonly used to construct many bridge elements, including piles, substructures, wingwalls, decks, barriers, approach slabs and slope protection. Unlike most other bridge materials that are fabricated off-site and under controlled conditions, the quality of cast-in-place concrete depends primarily on the Contractor's construction practices. An acceptable quality of cast-in-place concrete requires attention to batching, transporting, sampling, testing, forming, placing, curing and finishing. It is important that the Inspector be knowledgeable about concrete materials and construction practices.

## 4.2 Environmental Considerations

The Contractor's Environmental Construction Operation (ECO) Plan must contain provisions for cast-in-place concreting activities that could potentially have an impact on the environment such as delivery, placement, wash-out and disposal.

Specific precautions must be taken to prevent concrete from entering a watercourse or water body. The constituents of concrete — especially hydraulic cement and Supplementary Cementitious Materials (SCMs) — are harmful to aquatic life. Wash-out water or diluted concrete is often highly alkaline and sufficiently caustic to harm the environment. Contaminated soil must be isolated and treated or removed from the job site.

In the event of a mixer truck upset or spill, significant environmental damage may occur. Prevention is achieved through proper planning. Adequate access and staging for concrete mixer trucks must be provided. Temporary access road grades and turn-around areas must be designed to accommodate the size of mixers expected. Access roads must have adequate surfacing, especially in wet conditions. Mixers must be directed through the site by the Contractor, and must be spotted when driving in reverse to the discharge location. The Contractor's site must be equipped with spill kits.

After mixers have discharged, the drum hopper and chutes must be cleaned before returning to the batch plant. The location and conditions for the wash-out site must be established prior to the pour, and this information must be communicated effectively by the Contractor to the concrete supplier. The contaminated cleaning water must be collected and properly disposed of.

Unusable concrete is often discarded at the job site. The source of this concrete may include material sampled for testing, initial concrete between the 0% and 10% point of mixer discharge that cannot be tested, concrete used to prime a pump, clean-out of pump lines, or other concrete that does not meet project requirements. The location for unusable concrete discharge must be established prior to placement. Precautions must be taken to prevent leachate from the disposal area.

Many chemicals used at the jobsite have the potential to enter the environment. Form release oil may leach from stripped and stockpiled forms after rain. Pre-bagged patching materials may spill.

Leaking forms or form failures may cause concrete contamination. All forming components must be in place and checked before the start of the placement. Deck forms must be caulked along girders to prevent paste leakage. Placement rates must be observed, especially for tall elements where allowable hydrostatic pressures may be exceeded if concrete near the bottom of the form has not yet started to set. Catastrophic failures may occur that have the potential to cause significant environmental damage. Forms and cofferdams must be properly designed and checked, especially for large elements with significant volume and weight of concrete.

## 4.3 Safety Considerations

Contact with plastic concrete can cause skin irritation, chemical burns and serious eye damage. Frequent exposure may be associated with irritant or allergic contact dermatitis. Gloves, glasses and other protective clothing must always be worn when working near concrete.

Contact with hardened concrete dust — as a result of grinding, cutting or drilling — and exposure to cement and SCMs can result in serious health issues. Inhalation of crystalline silica may cause silicosis, pneumoconiosis or other serious lung diseases. The effects of exposure are cumulative over time.

Concrete mixer trucks may pose a significant safety hazard. Deck placement is done at night, which increases the risk of collisions. Concrete mixer trucks often congest the jobsite during a pour. Drivers often need to back-up for long distances and may not see those approaching the truck. Discharge chutes are controlled hydraulically and may come into contact with those nearby, causing injury. Chutes are extended in sections and a pinching hazard exists during assembly and disassembly.

Trucks also frequently need to enter the jobsite from a public highway. This must be done while safely accommodating traffic. Trucks that need to decelerate or accelerate with traffic or merge into congested traffic can create a dangerous situation for motorists.

Concrete pumps have hydraulic lines, outriggers and other moving parts that are dangerous, and pump lines or couplers may rupture. It is best to maintain a safe distance from this equipment whenever possible. The discharge end of the pump line terminates with a section of flexible hose. This hose can whip and cause injury if not properly operated.

Concrete deck finishing machines have chains, gearwheels, tracks, rollers and other hidden moving parts that are dangerous. While the deck finisher is in operation, personnel must not be near the carriage augers or rollers. The deck finisher may move along the screed rails at unpredictable rates. Pinching at the screed or carriage rail locations is a significant hazard. Hands and feet must not be in contact with the finisher or the screed rails at any time during operation.

Impaling hazard due to protruding reinforcing steel often exists at locations such as barriers and abutment seats. Projecting reinforcing steel must be protected with high visibility “mushroom” type caps if there is an impaling hazard due to falling.

When walking on placed reinforcing steel, care must be taken to avoid tripping or falling through the reinforcing steel mat. Tie wires may detach under the weight of an individual, causing the bars to shift and creating further hazards.

During cold weather concreting, hoarding and heating is required. If improperly vented, poisonous gases may be generated by heating equipment. Proper ventilation of hoardings must be confirmed before entering.

In addition to the minimum Personal Protective Equipment (PPE) required by Occupational Health and Safety (OHS) and described in Section D, wrap-around safety glasses and gloves are necessary when working near concrete.

## 4.4 Concrete Basics

Concrete consists of paste and aggregates. The paste is comprised of hydraulic cement, supplementary cementitious materials, water and admixutures. Aggregates are classified as fine and coarse.

- Fine aggregates consist of natural or manufactured sand and are sometimes blended from different sources to achieve a more desirable gradation.
- Coarse aggregates consist of crushed gravels. Their size limits are prescribed in the specifications. Strength requirements, formwork and reinforcing steel congestion, mass concrete and shrinkage limitations are factors which affect the maximum desired size of coarse aggregate.
- Hydraulic Cement: The types of hydraulic cement currently used for bridge projects in Alberta include Type GU (general use), HS (high sulphate resistant) and HSb (high-sulphate resistant blended).
- Supplementary Cementitious Materials (SCMs): SCMs are commonly combined with hydraulic cements to enhance concrete properties and to increase the number of locally available aggregate sources for concrete production. Fly ash and silica fume are the most commonly used SCMs in Alberta. The finer particle size of these SCMs contribute most notably to lower permeability and higher compressive strengths.
- Admixtures are added to concrete before or during mixing to enhance durability, workability and to maintain the quality of concrete throughout construction processes. Common admixtures used in Department concrete mixes include air entrainers, water reducers, hydration stabilizers and anti-washout products.

    - Air entrainers introduce, distribute and stabilize microscopic air bubbles into concrete. The dosage and effectiveness of air entrainers can be affected by numerous factors. Interaction with superplasticizer may increase air content, SCMs may decrease air content, hot ambient or concrete temperatures and delays may decrease air content, and pumping may decrease air content. Specified test methods must be followed closely to confirm the accurate measurement of air content.

      Too much air content can be detrimental to concrete strength and durability. The downward adjustment of air is not permitted because methods such as turning the drum at mixing speed at the job site or addition of air detraining admixtures do not consistently or effectively reduce air content. If a concrete batch is determined to have too much air content, it must be rejected.

    - Normal range water reducers are used to minimize the quantity of water required to produce concrete of a given consistency. For ready mix concrete supply, these admixtures are added at the batch plant and not at the job site. Water-reducing admixtures are classified into several different types.

      Water-reducing admixtures that reduce the amount of mixing water by 12% or more are commonly referred to as high range water reducers or superplasticizers. Superplasticizers improve concrete workability and reduce the vibration effort required for consolidation. Thin elements or those with reinforcing steel congestion benefit significantly from the addition of superplasticizers. The effect of superplasticizer is short-lived, generally 30 to 60 minutes, after which the lubricating effect diminishes and a loss of slump and workability follows. Superplasticizer is therefore often added at the job site.

- o Hydration-stabilizing admixtures (HSAs) coat cementing material particles to delay hydration processes/set times. The HSA coating breaks down over time. The use of HSAs is permitted, but only under circumstances where there is a unique structural need to increase the time of haul, or where time of haul is significantly increased beyond the Contractor's control. HSAs are sometimes used in pile concrete to provide additional working time for cage adjustments and casing removal. Sometimes, HSAs are used in substructure elements as a precaution for the prevention of cold joints in the event of a delivery disruption. HSAs can adversely affect the workability and set times of concrete resulting in surface crusting, finishing challenges and the delayed application of wet cure systems. They must not be used in deck concrete unless necessary and only with the acceptance of the Department.

- o Anti-washout admixtures are typically used in tremie concrete mixes where flowing water is encountered, such as with cofferdams. For placement under very low flow conditions, an increase in cement content is often utilized in lieu of anti-washout admixtures. Anti-washout admixtures increase the cohesiveness of concrete and reduce the loss of cement and fines, but in high doses they may reduce compressive strength.

## 4.5 Concrete Construction Activities

### 4.5.1 Concrete Production

Batching is the process used to measure and combine materials for the production of concrete. Materials are batched by weight and/or volume according to mix design requirements. The accuracy of measurement and the sequence in which materials are combined is important to produce consistent, high-quality concrete.

For bridge projects, concrete is most commonly produced by ready-mix methods. Large volume suppliers typically produce concrete using highly efficient wet-batching processes, while smaller suppliers tend to use dry-batching processes. In wet-batching or central-mixed processes, all materials are mixed at a stationary plant prior to being discharged into a mixer truck for delivery. Dry-batching or transit-mixed processes charge all materials into the mixer truck prior to delivery. In both wet and dry batching processes, the only materials permitted for addition to the batch once it has left the plant are air-entraining and superplasticizing admixtures.

Concrete can be produced on site using portable batch plants or pre-bagged materials, which is called "site-batching". Site-batching is more commonly utilized in remote areas where concrete supply is not readily available or where large project concrete volumes render it cost effective. Successful site-batching requires experienced personnel and equipment in good working condition. Trial batches for all classes of concrete are encouraged when site-batching is considered.

### 4.5.2 Trial Batching

Trial batches are generally performed at the concrete plant. Trial batches are required for Class HPC concrete and for any class of concrete containing HSAs. The Inspector must attend trial batch testing. If any tested properties of the plastic or hardened concrete do not meet the specified requirements, the mix design must be adjusted and the trial batch repeated. Special attention must be given to slump retention and to set times for HSA mixes. This information must be used by the Contractor to plan his pour and schedule finishing operations.

If during the project mix proportions are modified or if sources of mix constituents change, a new trial batch is required.

### 4.5.3 Inspection and Testing

#### 4.5.3.1 Mix Confirmation

When concrete arrives at the job site, the Inspector must review the delivery ticket to confirm that the mix number and corresponding class of concrete is correct. The delivery ticket typically contains a machine-printed batch time, which the Inspector should use to determine the time of haul. The punched batch time indicates when the cement first came into contact with the mix water.

#### 4.5.3.2 On-Site Batch Testing

The Contractor is required to use certified testers to complete on-site batch testing. Air content, density, slump and temperature must be tested and recorded for each batch of plastic concrete delivered to site. The on-site testers may be employed either by the Contractor or by the concrete supplier. The test procedures must be conducted in strict accordance with specification requirements, and the Contractor is required to provide a proper work area for testers and their equipment.

The Contractor's test results become part of the project record. If the Contractor uses certified testers that are independent from the concrete supplier and the concrete supplier also performs testing, only one set of these tests may form the project record to be used for acceptance and payment. The identification of testers and verification of their certifications must be done prior to concrete placement. The Consultant/Inspector may perform his own testing that may be used to confirm acceptance of the concrete; however, these results do not form part of the project record.

When concrete arrives at the job site, slump and air testing is often done by the concrete supplier's QC technician. This is to establish a baseline for the site-addition of admixtures and to confirm that the batching process is producing consistent concrete. Generally, the concrete supplier will indicate to the Contractor that the delivered plastic concrete is ready for record testing and acceptance.

The specifications require that, when sampling from a mixer truck, the test sample be taken between the 10% and 90% points of discharge. A sample taken "off the top of the load" may not be as homogeneous as the concrete that is between the 10% and 90% points. As the first 10% of concrete from the mixer truck is not permitted for testing, this concrete is of unknown quality. If the Contractor initially lacks confidence in the concrete quality, he may elect to discard this portion of the load. Conversely, he may place it into the forms in anticipation that the testing will confirm its acceptance. The Contractor assumes all risk for any placed concrete that does not meet specification requirements. The Inspector must confirm that the Contractor is fully aware that placed concrete consequently deemed unacceptable needs to be removed, and that this may result in extensive rework and delay to the pour. The Contractor must be strongly cautioned against discharging an entire batch of concrete before test results have confirmed its acceptance.

When concrete is placed by pump, it is important to determine when a new batch is discharging through the pump hose. The initial 10% of the load is often not discarded due to practical delays in repositioning the pump's boom for each batch delivered. The Inspector must closely monitor that the Contractor accurately determines when a new batch is discharging through the pump so that proper sampling for testing may be done at the correct frequency. Familiarity with pump equipment and bore-stroke counts can assist in determination of volumes being transported through the lines. When concrete is pumped, sampling must be done at the point of discharge. Where lubricants have been used to prime pump lines, the initial concrete must not be incorporated into the Work until the lubricants have been flushed.

For large pours, it is common that more than one concrete mixer truck will discharge into a pump hopper at the same time. In this case, it is important that the Contractor understands that if tests are not acceptable for one batch then any blended concrete that has already been discharged from both batches will be deemed unacceptable.

The Inspector must have access to witness sampling and testing. If test results are highly variable or at the limits of the acceptance criteria, the Inspector may require re-tests or perform his own quality assurance testing. The Inspector may either accept or reject concrete based on test results and must communicate this clearly to the Contractor as each batch is tested.

#### 4.5.3.3 Storage of Cylinders

Care must be taken to protect freshly prepared cylinders and must follow the requirements of CSA A23.2-3C, Making and Curing Concrete Compression and Flexural Test Specimens. Cylinders must not be exposed to extreme temperatures or freezing conditions during storage or transport. Cylinders must not be exposed to damaging vibrations, such as those that exist in a site trailer. Cylinders on site must be stored in a temperature-controlled curing box in accordance with specification requirements.

Field-cured cylinders are generally used to determine when formwork and falsework may be removed. Field-cured cylinders must be exposed to the same environmental conditions as the element represented. If stored in a hoarding, field-cured cylinders must not be located near locally hot or cold areas.

Concrete cylinders must be properly labelled and coded for identification. Labels and identification must be in compliance with the template forms provided in the specifications.

### 4.5.4 Formwork

All concrete elements require formwork, except for piles that are poured into neatly drilled excavations. Formwork materials may consist of dimensional lumber, plywood, prefabricated steel or other materials.

- Deck interior bays are commonly formed using timber materials. Adjustable metal hangers support wooden or aluminum ledgers, which support joists and plywood. Deck overhangs are constructed using knee-braces, which bear on the exterior girder webs, which support joists and plywood.
- Pile caps, columns, abutment seats and pier caps may be formed from timber or pre-fabricated steel forms. The forming system used may depend on schedule since pre-fabricated forms may be erected and cycled more rapidly.
- Wingwalls are typically formed of timber due to their irregular shapes. Timber systems typically use a combination of studs, walers and strongbacks as main structural members, studs and strongbacks typically being vertical and walers being horizontal.
- Pier columns are typically formed using pre-fabricated steel forms due to their circular cross-sectional shape.
- Anchor bolt void forms are most suitably fabricated of polyvinyl chloride (PVC) with a weakened cross section to facilitate subsequent removal.

Falsework includes temporary structures used to support formwork during erection. Formwork is a temporary structure used to contain concrete until it has sufficient strength to support itself. Often, falsework and formwork are used together. The rigidity, geometry, form facing and joint details may greatly affect the final performance and appearance of the element. Falsework used during winter must take into consideration the effects of ground thawing or heaving. Settlement may occur during pre-heating of hoarding enclosures.

The Contractor is responsible for the design, construction, inspection and performance of formwork and falsework. Formwork must be designed to withstand concrete pressures without appreciable deflections and meet specification requirements. Falsework must be designed to adequately support or brace formwork without settlement.

Formwork and falsework drawings — including all hardware — must bear the seal of a Professional Engineer registered in the Province of Alberta. Often, the Contractor will have typical drawings for a type of forming system or detail. These generic drawings may form part of the drawing package, but the drawing package must be site-specific. The formwork designer has the responsibility to confirm that the work is completed in accordance with the drawings. A formwork and falsework inspection must be done by the Contractor prior to the pour. This is particularly important for large elements where a form failure would pose a safety hazard, result in discharge of concrete into a watercourse, or cause significant delay or damage.

The integrity of formwork for tall elements often limits the rate of concrete placement. Limitations are placed to allow the concrete in the lower portion of the forms to sufficiently set before the pour is complete. If the pour rate is exceeded, or if the concrete sets at a rate slower than anticipated, the form may fail or distort due to larger hydrostatic pressure. Special considerations must be given to concrete containing HSAs.

The condition of the formwork will directly affect the appearance of the finished concrete. This is of particular importance for elements that will receive a Class 2 or 3 finish. Elements with a specified Class 2 or 3 finish may only be formed with new sheets of plywood having a resin-impregnated paper overlay and factory treated chemically active release agent.

Plywood panels must be of the approved type and in acceptable condition. Joints must be neatly and properly aligned with care. Joints must be minimized by planning formwork construction so that full sheets of plywood are used wherever possible. Where discontinuities in smoothness occur at the edges of plywood forming sheets, these will be reflected onto the concrete surface. For highly visible elements, only minor grinding to correct these discontinuities is permitted by the specifications. Parging to correct deficiencies is never permitted. It is of the highest importance to correct formwork deficiencies before concrete placement because finishing operations cannot properly correct formwork deficiencies.

Care and attention must be given to positioning formwork against hardened concrete, particularly at the construction joints of highly visible elements such as the exterior faces of curbs/barriers and wingwalls. Pour strips must be used to create a neat construction joint at the exterior concrete surface. Formwork must be securely attached to hardened concrete. If formwork is not in intimate contact with the hardened concrete, paste may leak from the form resulting in hardened fins.

Care must be given in the positioning of chamfer strips, blockouts and fillets. Misalignment of these strips will be highly visible and unsightly.

#### 4.5.4.1 Deck Formwork

The Inspector must check that the Contractor has accommodated any required camber in the deck formwork and supporting rails for the deck finishing machine. Allowance for deflection of forms during concrete placement must be accounted for. Formwork hardware mechanisms must be installed to allow for adjustment. A description of the procedure for verifying the Contractor’s deck formwork installation and setting is provided in Figure 4.

Deck formwork must be adequately sealed to prevent paste leakage.

### 4.5.5 Reinforcing Steel Placement

Reinforcing steel must be cleaned of all deleterious materials including mud, oil, concrete, mortar and other substances that prevent the necessary bond between the concrete and reinforcing steel. Mud and fresh concrete can be removed readily with high-pressure washing or wire brushing.

Where practical, projecting reinforcing steel must be protected from mortar and paste accumulation by covering with tubing or polyethylene plastic sheeting. When placing concrete into deep forms with layers of bars, the discharge end of the pump hose must be as low as possible to prevent paste contamination of upper bars. Concrete must not be deposited on upper layers of reinforcing steel, even when upper bars are to be covered with concrete later during the same placement, since when it dries it may act as a bond-breaker.

When the Contractor applies form oil, he must ensure that no spray contaminates reinforcing steel. Oil-less air compressors must be used to prevent contamination. Oils can be removed by using a combination of solvent wiping and high-pressure washing.

### 4.5.6 Concrete Delivery

Concrete mixer trucks must be the revolving-drum type for the delivery of concrete to the site. Mixer trucks can mix concrete as required by the dry-batch process or agitate concrete in a wet-batch process to keep the mix homogeneous. Mixing or agitating action depends on the speed of drum revolution. The interior of the drum is fitted with a helical screw blade. When turned in one direction, the drum mixes or agitates the concrete. When turned in the other direction, concrete is discharged from the opening in the drum. Worn fins or overloading of the drum can affect the mixer’s performance. When truck mixing, it is important that the drum spins at charging speed for the required number of revolutions. It is also important that concrete is remixed after arrival and after the site addition of superplasticizer and air entrainer. The concrete must be adequately mixed before any samples are drawn for testing. Evidence of inadequate mixing or incorrect batch sequencing may include ineffectiveness of admixtures, clumping of cementitious materials and balling of fibres.

Mixer truck drums have varying rated maximum capacities depending on if it is used as a mixer or an agitator. Drums typically have capacities that range from 5 $m^3$ for tandem trucks to 8 $m^3$ for tridem trucks to 11 $m^3$ for trailers. Smaller trucks sometimes increase their capacity through the use of booster axles. Concrete mixer drums may be made of steel or fiberglass, the latter having greater capacity due to lower drum weight.

### 4.5.7 Concrete Discharge

#### 4.5.7.1 Chute Discharge

Concrete is most economically placed directly from a mixer truck chute, which may have a positive impact on quality as handling requirements are minimized. With chute placement, mixer trucks need additional time to accurately back into position and chutes may not be able to efficiently reach all areas of pour. If placing by chute causes unacceptable delays in placement or the chute is unable to deposit concrete to its final position, other methods will be required. Elements such as barriers, approach slabs and MSE wall foundation strips can typically be placed by chute if accessible.

When concrete is deposited by chute into an excavation that results in the freefall of concrete, a drop tube structure must be used. The purpose of a drop tube structure is to prevent the impact of concrete into reinforcing steel and other obstructions. Impact may segregate the concrete and contaminate reinforcing steel with paste. Pile concrete is typically placed using a drop tube structure.

#### 4.5.7.2 Mobile Boom Pump

Mobile boom pump units (pumps) are commonly used in bridge construction. These pumps have lines attached to articulating booms of varying length. Pumps can deposit concrete precisely at its final position.

Concrete properties may change as it is passed through pump lines. Typically, air-entrained content is lowered, especially if sections of the lines are configured, in the vertical position where concrete may experience freefall. Mixes must be specifically designed for pumping and must flow steadily from the discharge hose without air pockets. The pump hopper must remain continuously full of concrete to avoid air from becoming trapped within the lines. Pumps frequently experience mechanical problems; it is important that backup pumps are available. Set up of a pump is time-consuming, so the secondary pump should be readily accessible. When depositing concrete, the discharge hose end must be lowered into position as closely to the discharge point as possible; concrete must not freefall or be discharged onto reinforcing steel and other obstructions.

Mobile line pumps are similar to boom pumps except that their lines are placed horizontally along the ground to a designated outlet location. They are typically used for large deck placements where access is not available for mobile boom pumps.

#### 4.5.7.3 Crane and Bucket

Concrete may be placed by crane and bucket. This system is commonly used in precast facilities and where concrete must be delivered to high elevations in building construction. It is generally inefficient and not frequently utilized in bridge construction.

#### 4.5.7.4 Tremie Method

When standing water exists within a form or excavation and this water cannot be removed prior to placing, concrete is placed by tremie. The tremie method utilizes a tube fitted with a hopper into which concrete is discharged. The lower end of the tube is equipped with a valve or seal such as a ball bladder that will prevent the entry of water. This tube is placed into the water with the outlet at the bottom of the form or excavation. As concrete is discharged, the water above is displaced. The low end of the tube remains below the concrete surface at all times during placement.

Tremie methods are typically used for piles and mudslabs of cofferdams. A small portion of the concrete at the top of the pour typically consists of a water-weakened concrete or laitance, which must be removed. Concrete placed by tremie is not vibrated.

### 4.5.8 Placing

#### 4.5.8.1 Workability

Workability is an important property of freshly mixed concrete. It is related to the amount of effort required to place concrete using a specific method of discharge. A concrete is said to be workable if it is easily transported, placed, consolidated and finished without segregation or loss of homogeneity. Workability is most affected by consistency (ability to flow) and cohesiveness (ability to resist segregation).

Workability is not a fundamental property of concrete, and workability requirements may differ from element to element and Contractor to Contractor. A less workable concrete may be acceptable for a pile or mass pour, but not for a wall or deck which has thinner sections and more reinforcing steel congestion. Concrete with reduced workability may result in surface air pockets or bugholes, honeycombing or other defects.

#### 4.5.8.2 Consistency

Consistency of freshly mixed concrete describes the ease with which it flows. The slump test is used to measure consistency of different batches of concrete made from the same mix proportions.

Slump loss is the reduction in slump from the time of batching to the time when concrete is placed into its final position. Concrete slump decreases with time as a result of hydraulic cement hydration and evaporation. The rate of slump loss should be predictable and demonstrated through trial batching when required.

Slump is not an accurate measure of water content where superplasticizers are added at the batch plant. In some cases, superplasticizer is added both at the plant and at the site. The supplier may elect to transport the concrete to the site at a slump that is less than that specified, and then add superplasticizer at the site to raise the slump. This is done to minimize the slump loss during discharge and placing. The actual value of the slump of concrete arriving at the site is not necessarily of great significance. What is important is that all batches arrive at the job site with slumps that are consistent. If slumps differ significantly between batches, an undesirable inconsistency exists that needs to be identified and addressed.

#### 4.5.8.3 Consolidation

Consolidation is the means by which concrete is compacted to remove entrapped air. Consolidation is most often achieved through mechanical vibration. Internal vibrators, either electric or gas, are most commonly used to achieve concrete consolidation by transmitting pulses through specialized heads. Vibrator heads come in different configurations that are designed for the application. It is also important that vibrators have a sufficient length to reach the required location. External vibrators can be attached to forms, but these may only be used if accepted by the Consultant.

Proper vibration technique includes placing the vibrator into the concrete at a vertical orientation, as deeply as necessary to consolidate the entire lift and into the lift below as applicable. The vibrator is slowly withdrawn and will demonstrate a radius of effect. Within this radius, entrapped air will be released from the surface and paste will begin to rise. The size of this radius is determined both by the characteristics of the vibrator and by the consistency of the concrete. The head must remain embedded in the concrete until the entrapped air is no longer visibly released and before appreciable paste accumulates at the surface.

Vibration must be done systematically following a grid pattern. Without adopting a systematic method of vibration, regions of concrete may be neglected and not properly consolidated. The spacing of the grid pattern must be determined by trial and error to determine the radius of action. When the head is moved to the next position, the radius of action must overlap the radius of action from the previous position. In this way, no area of concrete will be left unconsolidated.

Special attention must be given to areas with congested reinforcing steel and slender sections since entrapped air may be difficult to remove. Similarly, special attention needs to be given when vibrating near form faces. The form face dampens the energy of the vibrator pulses, thereby rendering vibration less effective. As a result, honeycombing, bug holes and rock pockets tend to occur at form faces.

The vibrator must not be dragged or pulled through concrete. It must not be used to transport concrete within the form, since segregation may result. Excessive or prolonged vibration may potentially reduce the volume or distribution of entrained air.

Operation of a vibrator is demanding work, and the operator must follow the pace of concrete placement. It is often necessary to have many vibrator operators and spare vibrators at a pour, both to keep up with the pace of work and for operator relief when fatigued.

#### 4.5.8.3.1 Pour Lines

As horizontal lifts of concrete are placed, some slight segregation occurs after vibration. A thin but distinct layer of paste rises to the surface of the lift. As a successive lift is placed on top, it will similarly segregate slightly, with the coarse aggregate tending towards the bottom of the lift. If the vibrator extends completely through the current lift and into the underlying lift, then the two successive lifts will be mixed at their interface through vibrator action. If, on the other hand, the vibrator does not penetrate both lifts, an interface between lifts will exist where the smooth paste surface layer contacts the lift above, and this can often be seen as a visible “pour line”. Deterioration can occur along this line more readily than other locations within the element.

### 4.5.8.4 Segregation

Segregation typically occurs when coarse aggregate settles out of the matrix, paste separates from coarse aggregate, or water rises to the surface through a process known as bleeding.

#### 4.5.8.4.1 Bleeding

Bleeding is a form of segregation where some of the water in concrete rises to the surface. It occurs due to the inability of the solid components to fully react with all mixing water. The free water rises to the surface as it has the lowest specific gravity of all materials. Bleeding generally continues until the cement paste has stiffened sufficiently to stop the diffusion processes.

Bleeding may be caused by poorly graded or an improperly proportioned concrete. The presence of an adequate proportion of fine aggregate and SCMs will reduce bleeding. Over-vibration can increase the amount of bleeding.

Finishing operations must be performed immediately after screeding. If bleed water is worked into the concrete surface, a weak surface layer will form, which can result in scaling.

#### 4.5.8.4.2 Settlement

Placement techniques such as excessive vibration, freefall of concrete and the impact of concrete into formwork or reinforcing steel during placement can contribute to settlement. Some mixes with low amounts of SCMs and higher slumps may be more prone to segregation. Settlement can produce microscopic fissures between the paste and the aggregate, thereby reducing strength and increasing permeability.

### 4.5.8.5 Initial Set and Final Set

In a laboratory setting, the length of time after which the paste can withstand a defined amount of pressure signifies initial and final set times. In practice, initial set is defined quite differently. The initial set of a concrete batch on site represents the point in time at which it can no longer be adequately placed, mixed, consolidated and finished without detrimental effect. Final set represents the start of rapid strength development. Initial and final set times are highly dependent on the environmental conditions during placing, finishing and curing.

The specifications require that concrete be discharged into its final position within 90 minutes of batching, with the exception of Class HPC that must be discharged within 70 minutes. These time limits are prescribed so that concrete is placed before initial set begins. It is important to realize that high ambient or concrete temperature will accelerate the time of initial set, and that set may begin within the time of haul. If during consolidation the vibrator head encounters increasing resistance to penetration, initial set may already have occurred. Set may occur differentially throughout the element due to temperature differences between the top and bottom of the element. Initial set must not be confused with slump loss, since lower slump makes full consolidation more difficult. Slump loss results in less flowable concrete, while initial set causes resistance to vibrator penetration.

### 4.5.8.6 Pile Caps, Abutment Seats and Pier Caps

Deep and long elements such as pile caps, abutment seats and pier caps are generally poured in horizontal lifts. Concrete must be placed as closely as possible to its final position and must not be discharged at one end of the form and made to flow into position across the length of the form. It must be poured in uniform lifts and consolidated by inserting the internal vibrator head through the current lift and previous lift below.

If conditions for early initial set are encountered, lift thicknesses should be reduced in an effort to place lifts more quickly. Lifts must not be placed in a serpentine pattern; rather all lifts must be placed in the same direction along the form so that the oldest concrete placed is topped-up first. If it is confirmed that initial set has occurred on a concrete surface and the pour is not completed, the pour must be stopped and the surface prepared as a cold joint. Cold joints can be prevented through proper pour planning, and they should only occur as a result of unforeseeable disruptions.

#### 4.5.8.7 Decks and Barriers

Concrete for decks is placed in transverse pour strips. It is important to locate and map the final position of each batch of concrete for decks and barriers. In the event of failed compressive tests, the area where the issue exists may then be easily identified. During the deck placement, the deck area must be delineated with reference to girder 10th points and girder lines. This makes mapping of the approximate width and limit of strips a simple matter.

#### 4.5.8.8 Construction Joints

Construction joints must be placed only where indicated on the Plans in accordance with Standard Drawing, and otherwise only in the event of an unexpected pour disruption.

A cold joint requires bonding new to hardened concrete. The hardened concrete substrate must be adequately prepared and brought to a Saturated Surface Dry (SSD) condition prior to concrete placement. SSD is necessary to achieve an acceptable bond and minimize the potential for cracking of the freshly placed concrete. To achieve SSD, the surface must be kept continuously wet for hours prior to the pour. Before concrete placement, the hardened concrete surface must be given sufficient time to dry so that no free standing water exists, and the surface starts to change from a dark, wet colour to a light, dry colour. The time between wetting and drying times is variable and depends primarily on temperature and wind. Compressed air must be used to remove any standing water on the hardened concrete since it must not be wet and shiny. Water must not be added to a surface immediately before new concrete is placed.

### 4.5.9 Finishing Plastic Concrete

Finishing is the operation that creates a surface of desired texture and gradient. The finishing operation consists of consolidation, screeding and floating.

**Screeding:** The concrete is raked or shovelled into its final position as necessary. The surface is then screeded to the desired elevation, crossfall and gradient. For substructure elements and tops of walls, a screed board must be pre-cut to length and run along the top of chamfer strips. Free-hand screeding is not acceptable since it can result in local depressions and inadequate drainage. Concrete finishing machines are used to screed decks, but gutters and approach slabs are screeded with straight edges. It is important that the deck finishing machine has sufficient screed rail length to “run-off” the deck so as to eliminate the need for hand screeding.

**Floating:** As soon as screeding is complete and before bleeding occurs, the concrete may be floated. The float is typically a magnesium tool used to close voids left by screeding to further smooth the surface and to embed the coarse aggregate below the paste surface. A hand float is typically used for finishing the top surfaces of substructure elements. A larger bull float is used on decks with the operator being positioned on a work bridge that spans the deck. Areas near the gutters are floated with a darby. It is important that the floating operation makes the surface smooth without sealing or densifying the concrete. Floating must be completed in one or two passes, since over-floating may seal the surface. Over-floating may also bring excess fines and water to the surface, which can result in scaling of the surface. Bleeding will occur after floating. Bleed water must be allowed to evaporate after floating. Trowelling must not be done for most concrete surfaces since this densifies the concrete surfaces, causing delamination.

**Texturing:** Texturing is completed prior to curing as the concrete begins to set. If completed too soon, the intended texture profile can be lost and coarse aggregate plucked and exposed.

#### 4.5.9.1 Evaporation Reducer on Decks

For Class HPC concrete, it is very important to reduce the surface evaporation potential of the concrete after it has been placed. HPC concrete must not be placed when the evaporation rates exceed 0.5 kg/m2/hr as calculated using the nomograph found in CSA A23.1, Figure D1. Wind speed, ambient temperatures, concrete temperatures and humidity contribute to evaporation.

Screeding of deck concrete must follow closely behind placement. Concrete placed too far ahead of screeding operations increases the time available for mix water to evaporate. If a delay between placing and screeding is unavoidable due to an unforeseen disruption, placing white polyethylene sheets over the concrete may help to retain moisture.

Immediately after bull floating, a monomolecular film-forming evaporation reducer must be applied to the exposed concrete surfaces. The evaporation reducer must not be applied before bull floating and used as a finishing aid.

Weakness or scaling of the deck surface paste layer may result if bleed water or evaporation reducer is worked into the surface during finishing operations, or if curing water is applied before the paste has stiffened sufficiently to prevent wash-out. This is of particular importance for decks or high performance concrete overlays that will have no ACP wearing surface.

### 4.5.10 Curing

Effective curing is essential to produce durable concrete. Curing is the process in which concrete is protected from loss of moisture and kept within a certain temperature range for a given period of time following placement for the purpose of improving its properties. The curing process provides conditions for continued hydration. This produces concrete with increased strength and decreased permeability. Curing also reduces the instance of certain types of cracks which can otherwise greatly reduce durability.

Temperature control during curing is important. In warm weather, Class HPC concrete is placed at night when conditions are typically more favourable. In cold weather, effective hoarding and heating is necessary to maintain the minimum curing temperatures. Curing methods are intended to protect concrete from temperature extremes and differentials, moisture loss and water damage. Many methods of curing exist in concrete practice, but only certain methods are permitted for bridge projects.

#### 4.5.10.1 Wet Curing

Wet curing is the most effective of all curing methods. Wet cure is always required for Class HPC concrete. The Contractor must follow a curing procedure that has been accepted by the Consultant. The procedure needs to clearly identify the equipment and methods that will be used for curing. The Contractor must not deviate from the procedure unless it has been proven ineffective. The Contractor must continuously monitor the effectiveness of the curing.

Bridge decks require special consideration due to their large surface area. Filter fabric is usually secured by weighting with dunnage. It is challenging to prevent filter fabric from drying, especially in warm and windy conditions. Often the dunnage needs to be removed before the filter fabric can be lifted and some sections of fabric may be wet while others are dry. Locations receiving direct sunlight and locations higher on the grade or crown may tend to dry sooner. Polyethylene sheeting (poly) is effective at retaining moisture, but may adversely affect the concrete by raising surface temperatures due to a greenhouse effect. Poly must be clear and perforated by the manufacturer and not on site by the Contractor. Filter fabric covered by poly is more difficult to monitor since the fabric cannot be checked without removing the poly and dunnage. In checking filter fabric for wetness, it is important to expose the deck concrete since the filter fabric may feel or appear to be wet, while in fact the deck surface itself is dry.

#### 4.5.10.2 Form Curing

Form curing is acceptable for Class C and D concrete. Top surfaces that are not formed must be wet cured. Curing must be in place for a minimum 72 hours starting from the time of final concrete placement. Where forms are removed before 72 hours has elapsed, wet curing must begin immediately. During form curing, formwork surfaces must remain in intimate contact with the concrete. Forming hardware may be removed so long as forms are not “cracked”. Forming materials must not be absorbent since this will wick water out of the concrete surfaces.

Curing in the form for thin elements of Class HPC is not desirable. Class HPC demands additional water during curing and providing protection only from a loss of moisture that is already present may be inadequate to prevent surface damage. For barriers, forms must be stripped as soon as practically possible and the form cure changed to wet cure so additional water may be introduced. If the form has cured for the entire period, surface crazing cracks may result at barrier surfaces.

#### 4.5.10.3 Curing Compounds

Curing compounds may be used for certain elements, including slope protection, culvert collars and deck joint block-outs for rehabilitation projects. These are membrane-forming compounds that cover a surface and prevent moisture loss. Compounds may be clear, clear with dye, and white pigmented. Only white pigmented compound is acceptable for bridge projects. It is important that the manufacturer’s coverage requirements be strictly followed. Compound must cover the surface entirely with no visible concrete exposed. Curing compound must be applied after any bleed water has dissipated.

#### 4.5.10.4 Maintaining Temperature Differentials During Curing

During the hydration/setting of concrete, heat is generated that may cause the core of the element to reach a higher temperature than the surface. Temperature differentials must be maintained within the specified limit of 20˚C to eliminate the possibility of thermal cracking. In addition to maintaining appropriate temperature differentials, the concrete at any location must be maintained to be within 10˚C to 60˚C. Thermocouples are placed just below the surface and at the core of the element to obtain temperature measurements.

For thin elements such as bridge decks, the temperature differential may be unintentionally increased if heating occurs from only one side. It is important for the Contractor to monitor concrete temperatures at the frequency specified and to take immediate action if required. Temperatures can change suddenly, and adequate planning is required to achieve the desired temperatures.

Pier caps and abutment seats may be considered “mass concrete” depending on their dimensions. These large concrete elements will generate a higher core temperature during the hydration processes, and planning must be taken in advance to maintain acceptable temperature differentials. Special mix designs, including increased amounts of fly-ash and coarse aggregate, can slow the rate of hydration and minimize the heat generated. In some cases, it is necessary to increase an element’s surface temperature to maintain an acceptable temperature differential, which may include the application of insulating materials. As the core cools, action may also be required to reduce the element's surface temperature.

#### 4.5.10.5 Concrete Cracks Resulting from Inadequate Curing

Plastic shrinkage cracks may develop if the evaporation rate of a concrete surface exceeds the bleed rate. Class HPC concrete with SCMs have very low bleed rates, making them much more susceptible to plastic shrinkage cracking. Surface evaporation rates can be effectively controlled by reducing concrete delivery temperatures and placing concrete during cool and calm conditions. Artificial windbreaks and/or sunshades used to lower evaporation rates are generally impractical and of unknown effectiveness.

As hydration processes occur, concrete experiences a loss in volume known as drying shrinkage. While this process is a function of the mix itself, the amount of drying shrinkage can be reduced through proper curing. Drying shrinkage most commonly appears on bridge decks because the concrete is significantly restrained by reinforcing steel, girder flanges and a large surface area of formwork.

All cracks in cast-in-place elements must be identified, measured in width and mapped. Cracks that are 0.2 mm or greater in width are required to be epoxy injected. Special attention must be given to cracks in bridge decks because they can have a significant impact on long term durability. Bridge decks must have cracks mapped before and after shotblasting. Deck cracks greater than 0.2 mm must be repaired by application of a gravity flow crack filler prior to waterproofing operations. At all identified deck crack locations — regardless of width — reinforcing fabric material must be placed within the asphaltic membrane to improve the membrane's crack bridging performance.

### 4.5.11 Removal of Forms

Concrete supports must be allowed to remain undisturbed until the concrete can safely bear its own weight including any construction live loads. Supports and forms must only be removed in conformance with the specifications.

- At normal temperatures, vertical forms can typically be removed 24 hours after concrete is placed.
- Forms directly supporting the weight of the concrete must be left in place for a longer period, depending on such factors as the type and size of the member, the final set period of the concrete, temperatures and the expected loads.
- Supports must be removed in such a manner as to permit the concrete to take its share of the load gradually and uniformly.
- Early removal of forms is desirable for finishing in that surface repairs and treatments bond better to "green" concrete and wet curing conditions can be applied to any required repairs and finishing.
- In warm dry weather, it is preferable to remove formwork and implement the specified curing requirements at the earliest possible time after concrete is placed.
- Concrete strength test results from field-cured specimens will provide an indication as to when forms may be removed.
- Horizontal spanning elements such as beams and slabs must remain supported for as long as practicable in order to increase the maturity of the concrete at the time of loading.

#### 4.5.12 Concrete Surface Finishing

- Where practical, finishing must be done immediately following the removal of forms. Finishing products need to be applied and cured appropriately.
- Repair areas and voids from formwork hardware must be filled with a patching material that is approved by the Department. Patching materials are approved for particular classes of application. Grouting materials may not be substituted for approved patching materials. Proper curing and protection is essential for long term durability.
- The application rate for silane sealers (Type 1C) must be closely followed and monitored. Type 1C sealer must not be applied to any concrete surface receiving a Class 3 Surface finish.
- Concrete faces must be checked for trueness. Discontinuities caused by formwork misalignment that exceed specified tolerances must require that the element be removed and recast.
- Finishing must be done at an early stage of concrete maturity to assure bonding of applied materials to the concrete. The concrete surfaces must be saturated before and after treatment to ensure sufficient moisture for complete curing.

## 4.6 Special Considerations

### 4.6.1 Placing Pile Concrete by Tremie Method

Pile concrete placed in water must use a tremie method. It is important that voids, soil contamination and water contamination is prevented when placing pile concrete by tremie. To confirm that pile concrete is acceptable, all pile concrete placed by tremie must be tested by Crosshole Sonic Logging (CSL).

The Contractor must submit a methodology for CSL. To facilitate CSL probes, a number of tubes must be installed by securing them to the pile reinforcing steel cages prior to cage installation. These tubes must be clean, dry, capped and installed uniformly and equidistantly.

### 4.6.2 Cold Weather Concrete

Bridge construction during winter months is common. Special precautions are required when concreting in cold weather to prevent damage to freshly placed “green” concrete.

Forms, reinforcing steel and substrates, must be pre-heated. This is especially important for thin sections like walls and for slabs on grade since the materials that come into contact with concrete may act as a heat sink and result in cooling or freezing of the concrete.

Similar to temperature monitoring required for mass concrete, it is important to monitor the differential temperatures of an element inside a heated enclosure. The maximum differential between the core of the element and the surfaces must be maintained as with mass concrete, but the maximum differential between the surfaces and the ambient air temperature must also be maintained. This means that following the curing period the forms cannot be suddenly removed to “shock” the surfaces by exposing them to a larger-than-permitted differential. Instead, the hoarding air temperature must be gradually reduced until the concrete surfaces are similar in temperature to the outside ambient temperature. Sometimes, the Contractor will temporarily remove portions of the hoarding structure during the curing period so that formwork can be stripped. This must not be permitted until discussed and accepted by the Inspector. It must be considered only if the permissible temperature differentials will not be exceeded.

Hoardings are susceptible to damage by wind and snow, and their condition must be closely monitored. Heaters must not create local hot spots. Fans or other methods should be used to distribute warm air. Leaks and drafts need to be sealed to prevent cold spots.

Heaters must contain breathers and exhaust ducting to the exterior of the hoarding. Exhaust must not be directed into the hoarding, both for safety and to prevent carbonation of concrete surfaces.

Often humidity in hoardings is far lower than required. It is much more difficult to control humidity than to control temperature. The Contractor may need to install humidifiers inside the hoarding or else keep all exposed concrete surfaces continuously wet by covering with filter fabric.

Insulated formwork can be proposed in lieu of hoarding enclosures if it is demonstrated that placing and curing temperature requirements can be met. The adequacy of insulated formwork is the Contractor's responsibility, and he needs to regularly monitor concrete temperatures and make immediate changes if required.

### 4.6.3 Hot Weather Concrete

Hot weather issues typically concern Class HPC concrete, more specifically decks. Problems encountered during hot weather may include premature setting, drying by evaporation and finishing difficulty due to crusting.

In hot weather, concrete pours must be scheduled during the night when calm winds and lower ambient temperatures exist. The mix must be cooled by inclusion of ice or other acceptable means, and wet curing must commence as soon as possible after floating.

### 4.6.4 Protection of Weathering Steel Girders

Steel girders are fabricated of weathering steel, which is a low carbon alloy steel that forms a surface rust that is initially lightly coloured, fine grained and loose. As further oxidation occurs, a tightly-adhering stable oxide film or patina forms that is rough, dark brown in colour and adheres tightly to the surface, preventing further oxidation. It is essential that this uniformity of rust formation is not impeded as a result of contamination.

Paste leakage onto girders must be prevented. This is both a durability and an aesthetic requirement. Paste will prevent the formation of the protective patina, and the Contractor must take whatever precautions necessary to prevent mortar and concrete residue from being spilled or spattered onto weathering steel components.

If the face of the exterior girder is stained or marked by the Contractor, the entire exterior face of the girder must be lightly sandblasted and "weathered" to achieve uniformity of colour. "Weathering" is achieved by repeatedly fogging the exterior faces with clean water while allowing them to dry between cycles. Fogging should leave the girders wet, but not "running wet", and must be repeated only when the girders are completely dry. In the event that weathering is necessary, all sandblasting dust and grit must be completely removed, with precautions taken to prevent the grit from settling into the moving parts of bearings, deck joints or into watercourses.

### 4.6.5 Protection of Concrete Work from Staining

The Contractor must protect all concrete work and bridge components from staining during construction activities. If staining occurs, it must be removed and the required surface finish completed.

## 4.7 Concrete Slope Protection

Concrete slope protection is typically constructed at the headslopes of grade separations. It provides a protective surface that is resistant to erosive forces, directs runoff to the roadway drainage below and is aesthetically pleasing.

Slope protection is cast after the abutments have been constructed and the headslopes have been trimmed. Generally, slope protection is cast after the bridge superstructure has been constructed.

Slope protection is typically installed only under the shadow of the bridge where grasses will not thrive. The edges of the slope protection that run in the longitudinal direction terminate at a swale. The swale is positioned to capture drip water from the exterior fascia.

Slope protection is less frequently constructed as a river training work. Concrete is often difficult to place near a watercourse, and the risk of a concrete spill requires environmental protection measures. Concrete slope protection generally does not offer the same level of scour protection as does heavy rock riprap since the backfill layer can be washed-out. Heavy rock riprap can generally be installed and maintained more easily as river training.

#### 4.7.1.1 Lay-out

The Inspector must confirm that the Contractor’s survey lay-out of the slope protection is correct. For grade separations, the General Layout Plan provides the station and elevation for each corner of the concrete slope protection. The toe edge of the concrete slope protection will be parallel to the abutment seat face. The transverse grade of the slope protection will be constant. The top-of-concrete elevation line must be marked onto the face of the abutment seat, and the top-of-concrete elevations at the toe cut-off wall must be established on the bulkhead formwork.

It is important that the constant transverse grade of the slope protection closely matches the transverse roadway geometry so that the roadway gutter at the toe transfers water away from the slope protection. Water must never pond at the base of the slope protection.

#### 4.7.1.2 Installation

Concrete slope protection must resist sliding and buckling, and must accommodate a certain degree of settlement. The performance of the concrete slope protection depends on careful attention to the construction details.

- The Contractor must trim the slope to within 150 mm of the required elevations as measured in the direction perpendicular to the slope surface. If the depth of backfill varies significantly, differential settlement will occur that may cause distress to the slab.
- The vertical face of the toe cut-off wall is formed. The remainder is excavated neatly to the dimensions shown. If the interior face of the excavation is soft or unstable at the specified 1:1 slope, it must be flattened.
- Placement of granular backfill for concrete slope protection requires special consideration. It may be necessary for the Contractor to use a mobile conveyor or other unique equipment. Backfill placement and compaction typically starts at the toe of the slope and progresses upwards in horizontal strips.
- Compaction of granular backfill is difficult to achieve on the slope. Plate tampers are generally impractical and dangerous to operate on sloped ground. A vibratory compactor that is mounted to the stick of a tracked hydraulic excavator is generally effective.

- The Contractor's Layout and Forming Plan must identify his proposed equipment, backfill, concrete delivery methods, panel dimensions, chairing system and pour sequence. The panel dimensions must be nearest to 1200 mm in height and 1800 mm in width.
- Formwork on the slope usually consists of dimensional timber, which must be separated mid-height to accommodate Welded Wire Mesh (WWM) reinforcement. The WWM must be continuous across the entire slope and must be lapped between adjacent courses. Panels are of sufficient size to require appropriate chairing of the WWM between forms.
- It is important that the forms do not vary in grade between courses. Uniformity of grade between all concrete courses must be checked by string line. The horizontal form alignment must be checked to confirm that the forms are perpendicular to the abutment face, are straight over their entire length, are in the same plane and that the formed course width does not vary.
- Due to irregularities in the compacted backfill surface, gaps may exist between the underside of the form and the subgrade surface. These gaps must be sealed to prevent excessive concrete leakage.
- Concrete placement is typically completed by a concrete pump. Planning and control of concrete consistency is very important when placing concrete slope protection. It is best that the Contractor use a pump to allow rapid placement of concrete and that quality measures are implemented to achieve consistent delivery slumps that are at the targeted value.
- After formwork for the first pour has been stripped and cured for a minimum of 12 hours, the adjoining infill courses may be placed. It is very important that tooling of the joint between courses be done as soon as practical after screeding.
- Slope protection concrete is screeded and floated as normal; however, it is also trowelled and broom textured. Edging must be done concurrently with trowelling, and brooming should immediately follow trowelling.
- Abutment drains normally project from the face of the concrete slope protection. The drains must be accurately located and care must be taken to prevent concrete from entering the drains. After concrete placement, the projecting drains are normally trimmed flush with the face of concrete, and protective screens are installed.
- Following concrete placement and formwork removal, the exposed edges must be adequately backfilled to prevent entry of runoff, which can cause scouring and undermining of the slab or softening of the granular subgrade.

#### 4.7.1.3 Curing

Curing for concrete slope protection consists of the application of two coats of an approved membrane-forming curing compound. It is important to apply curing compound at the time and application rate specified.

Concrete slope protection is typically cast when weather conditions are favourable as the required hoarding and heating is cost prohibitive.

## 4.8 Rejection and Payment

If concrete fails to meet the specified requirements, it must be rejected with a clear explanation given to the Contractor. The Inspector must be confident of the requirements that have not been met. If a batch appears questionable, the Contractor must stop placing it until slump and air tests are completed to determine whether or not the concrete is acceptable.

If the 7-day strength results indicate the possibility of low strength at 28 days, the Contractor must be notified immediately since he has certain avenues of recourse.

## 4.9 Inspector’s Role

### 4.9.1 Inspector’s Role Prior to Concrete Placement

- Confirm that a concrete mix design is in place and accepted for each class of concrete.
- Attend trial batches when specified to confirm that the proposed mix has acceptable properties for placing.
- Review the Contractor’s pour plan — including access, equipment, discharge method and pour rate — and discuss any concerns prior to the pour day.
- Discuss target slump with the Contractor considering the geometry and congestion of the reinforcing steel.
- Calculate the concrete volume of the element and discuss production and delivery considerations with the Contractor to avoid foreseeable disruptions that may result in cold joints.
- Attend the Contractor’s pre-activity safety meeting and understand all safety requirements.
- Confirm that the Contractor’s environmental protection measures are in place.
- Inspect formwork materials and construction for compliance to design; check dimensions, connections, elevations, plywood joint alignment, plywood damage, water-tightness, cleanliness and trueness of surfaces.
- Check reinforcing steel cleanliness, spacing and cover.
- Confirm that CSL tubes for crosshole sonic logging are installed correctly when required.
- Where formwork is secured to hardened concrete, make sure that forms are in close contact with concrete to prevent the formation of paste fins caused by leakage.
- Confirm that protection measures are in place to prevent paste contamination of girders and substructure elements.
- Review the Contractor’s lay-out and agree on proposed panel geometry for concrete slope protection.
- Confirm the adequacy of the Contractor’s headslope excavation and preparation by performing string line and survey checks at concrete slope protection.
- Confirm that final shaping and backfilling has been acceptably completed for concrete slope protection.
- Discuss, monitor and confirm acceptance of the Contractor’s backfill and compaction methods at concrete slope protection.
- Confirm that the work associated with abutment drain termination and protective end screens are acceptable at concrete slope protection.

### 4.9.2 Inspector’s Role During Concrete Placement

- Review concrete delivery tickets for each batch, confirming that the mix number, project and type of constituents are correct.
- Record time of batching for each load and monitor age of load during placement.
- Record and map locations of concrete batch placement.
- Confirm that precautions are taken to minimize the risk of cold joints.
- Inspect the concrete mix at the point of discharge to confirm homogeneity of batches.
- Monitor slump loss over time as tests are performed to confirm that it is consistent with trial batch results.
- During consolidation, monitor the ease of penetration of the vibrator to confirm that the concrete has not started to set. Monitor the frequency and effectiveness of vibration.
- Identify any instances of excessive bleeding and discuss potential causes with the Contractor.

- Confirm that certification of the Contractor's designated testing personnel is compliant with specification requirements and that an adequate work area has been established for on-site testing.
- Witness the testing process and review plastic batch test results to confirm acceptability.
- Confirm proper storage and handling of test cylinders.

### 4.9.3 Inspector's Role After Concrete Placement

- Monitor finishing operations to confirm that they are performed correctly and at the proper time.
- Confirm that precautions have been taken to minimize evaporation potential for deck concrete.
- During the curing period, monitor to confirm that wet cure systems are adequate to maintain moist surfaces and that forms for form-cured elements are non-absorbent and have not been cracked or opened.
- During the curing period, monitor the Contractor's reporting of temperature readings and require that action be taken when non-compliant.
- Map all cracks identified after the curing period and discuss findings with the Contractor.
- Confirm that concrete age and field cure test samples demonstrate that forms may be stripped.
- Record as-built details on appropriate Plans.

Government of Alberta ■
Transportation

**Bridge Construction Inspection Manual 2015**
Section 4 – Cast-In-Place Concrete Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

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| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | | Have the aggregate gradations and mix designs been accepted by the Project Manager. | ☐ | |
| 1.2 | | Have the locations of each concrete test batch been recorded? | ☐ | |
| 1.3 | | Have low strength quantities and penalties been identified to the Project Manager? | ☐ | |
| **2** | | **Delivery** | | |
| 2.1 | 4.7 | Does the concrete supplier have sufficient plant capacity and satisfactory transporting equipment for continuous delivery at the rate required? | ☐ | |
| **3** | | **Placement Schedules** | | |
| 3.1 | 4.8 | Did the Contractor inform the Consultant of the proposed placement schedule? | ☐ | |
| 3.2 | 4.8 | Is the volume of pour greater than can be placed with the methods proposed? | ☐ | |
| 3.3 | 4.8 | Is the Contractor’s crew size adequate? | ☐ | |
| 3.4 | 4.8 | Does the Contractor have adequate lighting to facilitate proper placing, finishing and inspection? | ☐ | |
| **4** | | **Inspection and Testing** | | |
| 4.1 | 4.9 | Has the Consultant been afforded full facilities for random quality assurance inspection and testing? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 4.2 | 4.9 | Are all site cast concrete cylinders compliant to the relevant specifications? | ☐ | |
| 4.3 | 4.9 | Is the Contractor utilizing ACI or CSA certified testers with extensive related experience to test at site, and were the results of all tests provided to the Consultant? | ☐ | |
| 4.4 | 4.9 | Were additional tests performed if the results were borderline or widely variable? | ☐ | |
| 4.5 | 4.9 | Did the certified testers personally cast the test cylinders, as specified in Section 4.9.3 “Test Cylinders”? | ☐ | |
| 4.6 | 4.9 | Did the certified testers utilize the “Concrete Test Results” form contained at the end of Section 4 of the SSBC with the completed forms accompanying the concrete test cylinders to the testing laboratory? | ☐ | |
| 4.7 | 4.9 | Is the certification of the testers current and available for examination by the Consultant? | ☐ | |
| 4.8 | 4.9.1 | Did the "Strength Test" consist of the compression tests of four (4) standard test specimens sampled, made, cured and tested in accordance with CSA Standard Specifications? | ☐ | |
| 4.9 | 4.9.1 | Were additional cylinders cast at the discretion of the Consultant or Contractor? | ☐ | |
| 4.10 | 4.9.1 | Did the Contractor take a strength test to represent each approximate 20 m3 portion of the concrete pour, at a minimum of one strength test for every two (2) batches of concrete for Class HPC and Class HPC with steel fibres? | ☐ | |
| 4.11 | 4.9.1 | Were these tests taken from representative batches as determined by the Inspector? | ☐ | |
| 4.12 | 4.9.2 | Was sampling of concrete carried out in accordance with CSA Standard A23.2-1C? | ☐ | |
| 4.13 | 4.9.3 | Was the making and curing of concrete test cylinders carried out in accordance with CSA Standard A23.2-3C, with the exception that the time for cylinders to reach the testing laboratory was between 20 and 48 hours? | ☐ | |
| 4.14 | 4.9.2 | Were test cylinders cast by the Contractor in standard CSA approved heavy duty steel or plastic moulds? | ☐ | |
| 4.15 | 4.9.3 | Did the Contractor provide use designed temperature-controlled storage boxes and further protect cylinders from adverse weather until removed from the site? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 4.16 | 4.9.3 | Was a max-min thermometer provided for each storage box and were site curing temperatures recorded for all test cylinders? | ☐ | |
| 4.17 | 4.9.3 | Was the storage facility provided, installed and accepted by the Inspector before any concrete was placed? | ☐ | |
| 4.18 | 4.9.3 | Did the Contractor deliver, handle and transport the test cylinders to an independent CSA-certified testing laboratory in accordance with CSA Standard A23.2-3C? | ☐ | |
| 4.19 | 4.9.3 | Was a copy of the test results forwarded to the Consultant and concrete producer within two (2) days of the break date? | ☐ | |
| 4.20 | 4.9.3 | Did any test cylinders exhibit frost etchings, were they stored at temperatures below 10°C or above 25°C, or were they otherwise mishandled? | ☐ | |
| 4.21 | 4.9.3 | Has the Contractor provided written reports of the concrete test results to the Consultant? | ☐ | |
| 4.22 | 4.9.4 | Were slump tests conducted in accordance with CSA Standard A23.2-5C? | ☐ | |
| 4.23 | 4.9.5 | Were air content and density tests conducted in accordance with CSA Standard A23.2-4C and A23.2-6C, respectively? | ☐ | |
| 4.24 | 4.9.6 | Were cylinders tested in accordance with CSA Standard A23.2-9C by an independent CSA certified engineering laboratory? | ☐ | |
| 4.25 | 4.9.7 | In the event that slump and/or air content were outside the specified tolerance range, were adjustments made within the maximum time allowed as specified in Section 4.6.3 “Time of Hauling”? | ☐ | |
| **5** | | **Falsework and Formwork** | | |
| 5.1 | 4.10.1 | General – Were detailed falsework and formwork drawings supplied to the Consultant for review and examination?<br>Did the formwork Engineer confirm that the design was followed, prior to concrete placement? | ☐ | |
| 5.2 | 4.10.1 | Was all falsework and formwork fabricated in accordance with the drawings? | ☐ | |
| 5.3 | 4.10.1 | Did the Contractor secure formwork against hardened concrete at construction joints within the tolerances for formwork misalignments outlined in Section 4.25.8 of the SSBC? | ☐ | |
| 5.4 | 4.10.2 | Design – Were all forms designed and built mortar-tight and of sufficient rigidity to prevent distortion? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 5.5 | 4.10.2 | Was falsework that could not be founded on a satisfactory footing instead supported on piling spaced, driven and removed in a manner acceptable to the Consultant? | ☐ | |
| 5.6 | 4.10.2 | Did the drawings for timber formwork specify the type and grade of lumber and show the size and spacing of all members and the type, size and spacing of all ties or other hardware, and the type, size and spacing of all bracing? | ☐ | |
| 5.7 | 4.10.2 | In the opinion of the Inspector, do forms appear to be satisfactory? | ☐ | |
| 5.8 | 4.10.2 | Are removable panels provided at the bottom of narrow wall and column forms? | ☐ | |
| 5.9 | 4.10.3 | Are forms for exposed surfaces requiring a Class 1 “Ordinary Surface Finish” made of good quality plywood, or an acceptable equivalent? | ☐ | |
| 5.10 | 4.10.3 | Are forms for exposed surfaces requiring a Class 2 “Rubbed Surface Finish” or Class 3 “Bonded Concrete Surface Finish” all new material made of “Coated Formply”, consisting of Douglas Fir substrate with resin-impregnated paper overlay and factory treated chemically active release agent? | ☐ | |
| 5.11 | 4.10.3 | Are re-used forms acceptable to the Inspector? | ☐ | |
| 5.12 | 4.10.3 | Are all forms for exposed surfaces mortar-tight, filleted at all corners, and given a bevel or draft in the case of projections? | ☐ | |
| 5.13 | 4.10.3 | Are chamfer strips used at the top edges of exposed surfaces? | ☐ | |
| 5.14 | 4.10.5 | Did the Contractor use the standard details shown on Standard Drawings S-1411 “Standard Concrete Joints”, S-1412 “Standard Construction Joints” and S-1443 “Deck Waterproofing”? | ☐ | |
| 5.15 | 4.10.6 | Are formwork hangers or ties for exposed surfaces of decks, including underside surfaces, removable threaded type, and were all cavities resulting from threaded rod removal along the underside of deck overhangs adequately prepared and filled with an approved concrete patching material? | ☐ | |
| 5.16 | 4.10.6 | Are deck overhang patches true to adjacent surfaces and similar in colour? | ☐ | |
| 5.17 | 4.10.6 | Are cavities resulting from threaded rod removal for interior bays filled with Sikaflex 15LM or an approved equivalent placed true to adjacent surfaces and be similar in colour? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 5.18 | 4.10.6 | Is the formwork for decks, curbs, sidewalks and parapets fabricated so that the lines and grades shown on the drawings were achieved? | ☐ | |
| 5.19 | 4.10.6 | Has the Contractor calculated the girder haunch dimensions required to achieve the specified gradeline? | ☐ | |
| 5.20 | 4.10.6 | Has this information been provided to the Consultant for review and acceptance prior to commencing any deck formwork? | ☐ | |
| 5.21 | 4.10.6 | If the actual girder camber values vary significantly from the estimated values indicated on the drawings, has the Contractor raised or lowered the gradeline accordingly? | ☐ | |
| **6** | | **Protection of "Weathering" Steel Girders** | | |
| 6.1 | 4.11 | Has the Contractor exercised utmost care and provided the necessary protection to prevent marking or staining of the girders? | ☐ | |
| 6.2 | 4.11 | Are all joints between deck formwork and steel members (including interior girders, and diaphragms) sealed to prevent leakage of cement paste or concrete? | ☐ | |
| 6.3 | 4.11 | Did the Contractor clean off, wash and sandblast any contaminated areas to the satisfaction of the Inspector, and in the case of an exterior girder becoming stained, did the Contractor lightly sandblast and "weather" the entire exterior face of the girder line so that uniformity of girder colour was achieved? | ☐ | |
| **7** | | **Protection of Concrete Work and Bridge Components from Staining** | | |
| 7.1 | 4.12 | Did the Contractor take precautions to protect all bridge components from staining? | ☐ | |
| 7.2 | 4.12 | Was any staining that occurred removed to the full satisfaction of the Inspector? | ☐ | |
| **8** | | **Removal of Falsework, Forms and Housing** | | |
| 8.1 | 4.13 | Were forms and supports removed prior to acceptance by the Inspector? | ☐ | |
| 8.2 | 4.13 | Was the guide for removal of forms for temperatures above 15°C followed? | ☐ | |
| 8.3 | 4.13 | Did the Contractor furnish evidence satisfactory to the Department and Consultant that the strength of the concrete had attained the noted percentage of the specified 28-day strength prior to the removal of forms? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 8.4 | 4.13 | Was all formwork removed from the completed structure? | ☐ | |
| **9** | | **Handling and Placing Concrete** | | |
| 9.1 | 4.14.1 | General – Did the Contractor give the Consultant a minimum of two (2) days advance notice of a concrete placement date or a change to a pour date? | ☐ | |
| 9.2 | 4.14.1 | Has all equipment proposed for use in mixing, conveying, placing and compacting the concrete been reviewed and accepted by the Inspector prior to its use? | ☐ | |
| 9.3 | 4.14.1 | Has all the necessary equipment for any particular placement been proven to be in working condition before the placement commenced, with backup equipment on site? | ☐ | |
| 9.4 | 4.14.1 | Has all extraneous matter like sawdust, wood chips and other construction debris been removed from the interior of forms in preparation for placing concrete? | ☐ | |
| 9.5 | 4.14.1 | Are temporary struts, spreaders, stays and braces in correct shape and alignment, and removed when the concrete placement reached an elevation rendering their service unnecessary? | ☐ | |
| 9.6 | 4.14.1 | Is concrete placed so as to avoid segregation of the materials and the displacement of the reinforcement? | ☐ | |
| 9.7 | 4.14.1 | Is concrete deposited by concrete pump, metal or plastic chute or other means acceptable to the Inspector when operations required free dropping concrete more than one (1) metre? | ☐ | |
| 9.8 | 4.14.1 | Is concrete deposited in the forms in the order indicated on the drawings? | ☐ | |
| 9.9 | 4.14.1 | Is each portion placed between construction joints placed in one continuous operation? | ☐ | |
| 9.10 | 4.14.1 | Is concrete placement working off or transporting directly over concrete previously placed? | ☐ | |
| 9.11 | 4.14.2 | Is the concrete consolidation done internally by mechanical vibration? | ☐ | |
| 9.12 | 4.14.2 | Are vibrators of a type and design acceptable to the Inspector? | ☐ | |
| 9.13 | 4.14.2 | Did the Contractor provide a sufficient number of vibrators to properly compact each batch, immediately after placing? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 9.14 | 4.14.2 | Are vibrators manipulated so as to thoroughly work the concrete around the reinforcement and embedded fixtures and into the corners and angles of the forms applying vibration at the point of deposit and in the area of freshly deposited concrete? | ☐ | |
| 9.15 | 4.14.2 | Are the vibrators inserted vertically and withdrawn out of the concrete slowly with application of vibrators at points uniformly spaced and not farther apart than the radius over which the vibration was visibly effective? | ☐ | |
| 9.16 | 4.14.2 | Is vibration applied directly or through the reinforcement of sections or layers of concrete that have hardened to the degree that the concrete ceases to be plastic? | ☐ | |
| 9.17 | 4.14.2 | Is vibration applied in a manner which prevents concrete flow in the forms causing segregation? | ☐ | |
| 9.18 | 4.14.2 | Is vibration supplemented by spading as necessary to ensure smooth and dense concrete along form surfaces and in corners? | ☐ | |
| 9.19 | 4.14.2 | Did the Contractor avoid disturbing concrete after vibration? | ☐ | |
| 9.20 | 4.14.3 | Is all accumulation of mortar splashed on the reinforcing steel and form surfaces removed? | ☐ | |
| 9.21 | 4.14.3 | Is concrete placed while fresh and before it had taken its initial set? | ☐ | |
| 9.22 | 4.14.3 | Were forms jarred or strain placed on ends of projecting reinforcing steel following initial set of the concrete? | ☐ | |
| 9.23 | 4.14.3 | Did the Contractor take the necessary steps to prevent free water build-up in the event of unexpected rainfall or similar occurrences for the first 24 hours? | ☐ | |
| 9.24 | 4.14.3 | Was water used to keep equipment clean during the pour, or to clean equipment at the end of the pour, discharged clear of the structure and water crossing? | ☐ | |
| 9.25 | 4.14.4 | Does the pump produce a continuous flow of concrete without air pockets? | ☐ | |
| **10** | | **Placing Pile Concrete** | | |
| 10.1 | 4.15.1 | Has the Contractor made all attempts necessary to obtain a dry pile hole prior to placing pile concrete?<br>*Note: If in the opinion of the Consultant and the Department all attempts to achieve a dry pile hole have been taken and proven unsuccessful, placement of pile concrete by tremie will be required.* | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 10.2 | 4.15.2 | Concrete Placed in the Dry – Is pile concrete placed by means of a hopper equipped with a centre pipe drop tube with concrete in the upper 3 m of the piles consolidated by the use of an acceptable concrete vibrator? | ☐ | |
| 10.3 | 4.15.3 | Concrete Placed under Water – Is placement of pile concrete under water in accordance with Section 4.22 of the Standard Specifications for Bridge Construction? | ☐ | |
| 10.4 | 4.15.3 | Crosshole Sonic Logging (CSL) – Did the Contractor submit the proposed method for the Consultant's review two (2) weeks before beginning drilled pile work and supply and install four (4) 50 mm inside diameter tubes in each drilled pile with a diameter of 1.5 m or less and six (6) tubes in each pile with a diameter of greater than 1.5 m? | ☐ | |
| 10.5 | 4.15.3 | Are tubes installed by the Contractor in a manner such that the CSL probes pass through the entire length of the tube without binding? | ☐ | |
| 10.6 | 4.15.3 | Did the Contractor fit the tubes with watertight shoes on the bottom and removable caps on the tops, and ensure that the CSL tubes were not damaged during the installation of the reinforcement cage? | ☐ | |
| 10.7 | 4.15.3 | Did the Contractor make CSL measurements at depth intervals of 65 mm from the bottom of the tubes to the top of each pile, and upon completion of testing and acceptance of the pile concrete, were the tubes filled with an approved grout mix? | ☐ | |
| 10.8 | 4.15.3 | Did the testing agency hired by the Contractor have a minimum of three (3) years' experience in CSL testing? | ☐ | |
| 10.9 | 4.15.3 | Did the Contractor provide written evidence of completion of all CSL tests by the testing agency? | ☐ | |
| 10.10 | 4.15.3 | Did the Contractor's submission include personnel qualifications and descriptions of testing equipment? | ☐ | |
| 10.11 | 4.15.3 | Did the Contractor submit two (2) original copies of the CSL report to the Consultant within five (5) working days of completion of CSL testing signed and sealed by the CSL engineer, including test summaries, results, analyses and an opinion of the pile concrete's suitability for intended use? | ☐ | |
| 10.12 | 4.15.3 | Were the summaries in accordance with the criteria listed in Section 4.15.3 Concrete Condition Rating Criteria?<br>*Note: Test results with ratings other than "G" will be considered unacceptable and will result in rejection of the pile.* | ☐ | |
| 10.13 | 4.15.3 | Were any piles considered unacceptable by the Consultant and the Department? | ☐ | |
| 10.14 | 4.15.3 | If remedial action is required, has the Contractor submitted a remedial action proposal with supporting calculations to the Department and the Consultant for review and acceptance? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **11** | | **Placing HPC Concrete and HPC Concrete with Steel Fibres** | | |
| 11.1 | 4.16.1 | General – Did concrete placing occur when the air temperature was below 5°C or above 25°C, or in the event of rain or excessive wind or dust, or when there were other conditions judged by the Consultant to be harmful to the concrete? | ☐ | |
| 11.2 | 4.16.1 | Was HPC concrete and HPC concrete with steel fibres placed between the hours of 6:00 pm and 10:00 am of the following day, unless reviewed and accepted by the Department and Consultant? | ☐ | |
| 11.3 | 4.16.1 | Was HPC concrete and HPC concrete with steel fibres placed when the evaporation rate exceeds 0.5 kg/m$^2$/hr as determined using Figure D.1 of CSA A23.1 – Annex D? | ☐ | |
| 11.4 | 4.16.1 | Was the rate of evaporation recorded as concrete placing operations progressed, with the Contractor making all necessary adjustments to ensure the evaporation rate did not exceed the specified limit | ☐ | |
| 11.5 | 4.16.1 | Was acceptable lighting provided for night pours? | ☐ | |
| 11.6 | 4.16.1 | Was the temperature of the concrete during discharge between 10°C and 20°C? | ☐ | |
| 11.7 | 4.16.1 | Were substrate surfaces brought to a saturated surface dry condition with clean water meeting the requirements of Section 4.2 of the SSBC, and were substrate surfaces free of standing water? | ☐ | |
| 11.8 | 4.16.1 | Did the Contractor's Project Manager and field superintendent attend a pre-construction meeting at a location determined by the Consultant, prior to commencement of any site work? | ☐ | |
| 11.9 | 4.16.1 | Was all deck concrete and deck overlay concrete consolidated in accordance with Section 4.14.2 of the SSBC? | ☐ | |
| 11.10 | 4.16.1 | Was screeding for all deck concrete and deck overlay concrete done using placing/finishing machines as follows (or acceptable equivalents)?<br>• Bidwell Models RF200, 364, 2450, 3600 and 4800<br>• Gomaco Models C450 and C750 | ☐ | |
| 11.11 | 4.16.1 | Did the Contractor provide two (2) work bridges, separate from the placing/finishing machine and of adequate length to completely span the width of the pour? | ☐ | |
| 11.12 | 4.16.2 | Were acceptable steel screed guide rails installed to suit the profile of the required surface and to ensure a smooth and continuous surface from end to end of the bridge, located outside of the finished surface of the pour for overlay and deck concrete and extending beyond the end of the bridge to accommodate finishing of the entire concrete surface with the deck finishing machine? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 11.13 | 4.16.3 | Was the finishing machine set up to match the skew angle of the bridge, and were the finishing machine and guide rails adjusted so that the height of the screed finished the concrete to the design gradeline and crown? | ☐ | |
| 11.14 | 4.16.3 | Was the screed dry-run prior to the pour to confirm the adjustment of the machine and guiderails, and were clearance measurements taken at each of the girder points corresponding to the camber diagram and provided to the Consultant for review and acceptance? | ☐ | |
| 11.15 | 4.16.3 | Was re-setting of the machine and/or screed rails done as necessary to obtain an acceptable dry-run? | ☐ | |
| 11.16 | 4.16.3 | Did the Contractor pre-load a test section of a cantilevered formwork on each side of the bridge to determine deflections that might occur during concrete placement? Was the formwork, machine and/or screed rails adjusted to compensate for the expected formwork deflection? | ☐ | |
| 11.17 | 4.16.4 | Was concrete placed as close as practical ahead of the finishing machine and at no time more than 6 m in front of the trailing end of the finishing machine's roller? | ☐ | |
| 11.18 | 4.16.4 | Did the screed move slowly and at a uniform rate maintaining a roll of concrete along the entire front of the screed to ensure the filling and consolidation of the concrete surface? | ☐ | |
| 11.19 | 4.16.4 | Did the Contractor ensure that the required concrete thickness was being placed by continually probing the concrete behind the finishing machine? | ☐ | |
| 11.20 | 4.16.4 | Were no more than two (2) passes of the screed needed for completion, and finishing done from work bridges? | ☐ | |
| 11.21 | 4.16.5 | Was bull floating and surface texturing done as close as practically possible behind the screed?<br>*Note: Evaporation reducer or water shall not be finished into the concrete at any time during finishing operations.* | ☐ | |
| 11.22 | 4.16.5 | Did the Contractor check the concrete surface with a 3 m long extended polystylene straight edge immediately after final bull floating and before texturing and application of evaporation reducer? | ☐ | |
| 11.23 | 4.16.5 | Was the surface such that, when checked with a 3 m long straight edge placed anywhere in any direction on the surface (except across the crown), there were no gaps greater than 3 mm between the bottom of the straight edge and the surface of the deck concrete? Did the Contractor make corrections to any concrete surfaces that did not meet the surface tolerances described in Section 4.16.6 while the concrete was still plastic and before curing procedures were implemented? | ☐ | |
| 11.24 | 4.16.6 | Did the finished surface of the concrete conform to the design gradeline profiles as indicated on the drawings and/or as determined on site? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 11.25 | 4.16.6 | Was the surface free from open texturing, plucked aggregate and local projections? | ☐ | |
| 11.26 | 4.16.6 | Were any areas higher than 3 mm but lower than 10 mm ground down to the correct surface? | ☐ | |
| 11.27 | 4.16.6 | Were any areas lower than 3 mm but not lower than 10 mm below the correct surface by grinding down the adjacent high areas? | ☐ | |
| 11.28 | 4.16.6 | Where deviation exceeded 10 mm, was the deck removed and replaced in accordance with Section 20.3.2 Partial Depth Repair of the SSBC with the perimeter joint waterproofed in accordance with the details on S-1443? | ☐ | |
| 11.29 | 4.16.6 | Did the Contractor submit a proposal for review and acceptance by the Department and Consultant for all corrective work prior to commencement? | ☐ | |
| **12** | | **Placing Approach Slab and Roof Slab Concrete** | | |
| 12.1 | 4.17 | Was concrete placed in a manner such that the newly deposited concrete was continually placed against fresh concrete across the entire face of the pour and the formation of cold joints avoided? | ☐ | |
| 12.2 | 4.17 | Was the concrete surface manually bull floated as necessary to ensure that the surface was free from open texturing, plucked aggregates and local projections or depressions? | ☐ | |
| **13** | | **Concreting Shear Keys and Diaphragms** | | |
| 13.1 | 4.18 | Was form work for shear keys and diaphragms designed to accommodate variations in girder dimensions, positioning, alignment, camber and sweep? | ☐ | |
| 13.2 | 4.18 | Were girder keyways and diaphragms brought to a saturated surface dry condition prior to concrete placement with saturation not less than 30 minutes prior to blowing free of standing water? | ☐ | |
| 13.3 | 4.18 | Was concrete placed in the keyways adequately consolidated and finished smooth and level with the top surfaces of the girders? | ☐ | |
| 13.4 | 4.18 | Immediately after finishing, were two layers of clean Nilex 4504 white coloured filter fabric or an approved equivalent placed on the shear keys and kept continuously wet for 72 hours? | ☐ | |
| **14** | | **Construction Joints** | | |
| 14.1 | 4.20.1 | General – Were construction joint locations, other than where indicated on the drawings or shown in the pouring schedule, reviewed and accepted by the Project Manager? | ☐ | |
| 14.2 | 4.20.1 | Were construction joints where, not detailed on the drawings or in the case of emergency, installed in accordance with Standard Drawings S1412 or as determined by the Project Manager? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 14.3 | 4.20.1 | Were construction joints located to allow a minimum of 50 mm concrete cover on reinforcing steel running parallel to the joint? | ☐ | |
| 14.4 | 4.20.2 | Were the forms retightened and the surface of the hardened concrete thoroughly cleaned and saturated with water, with all free standing water removed, before depositing new concrete? | ☐ | |
| 14.5 | 4.20.2 | Was the placing of concrete carried out continuously from joint to joint and the face edges of all exposed joints carefully finished true to line and elevation? | ☐ | |
| **15** | | **Concreting in Cold Weather** | | |
| 15.1 | 4.21 | Did the Contractor submit details of his proposed cold weather concreting plan to the Consultant for review and acceptance a minimum of two (2) weeks prior to any concrete placement? | ☐ | |
| 15.2 | 4.21 | Was all aggregate and mixing water heated to a temperature of at least 20°C but not more than 65°C with aggregates heated by either dry heat or steam?<br>*Note: In the latter case, the quantity of mixing water may need to be reduced.* | ☐ | |
| 15.3 | 4.21 | Was the temperature of the concrete in accordance with Section 4.4.3 of the SSBC at the time of placing in the forms, or, in the case of mass pours, did the Contractor follow the Consultant's temperature requirements? | ☐ | |
| 15.4 | 4.21 | For the HPC and HPC with fibres did the Contractor enclose the structure in such a way that the concrete and air within the enclosure can be kept above 15°C for a protection period of 21 days after placing the concrete? | ☐ | |
| 15.5 | 4.21 | Was the enclosure large enough to comfortably accommodate the men and equipment necessary to place, finish and cure the concrete? | ☐ | |
| 15.6 | 4.21 | Was the underside of the deck suitably protected? | ☐ | |
| 15.7 | 4.21 | Was the relative humidity within the enclosure maintained at not less than 85%? | ☐ | |
| 15.8 | 4.21 | Were heaters kept well clear of the formwork housing, and was adequate ventilation provided for combustion and prevention of carbon dioxide accumulation?<br>*Note: The use of salamanders, coke stoves, oil or gas burners and similar spot heaters that have an open flame and intense local heat is prohibited without the Consultant's specific acceptance.* | ☐ | |
| 15.9 | 4.21 | Was adequate pre-heat provided to raise the temperature of formwork, reinforcing steel, previously-placed concrete and/or soil to between 10°C and 20°C before placing concrete? | ☐ | |
| 15.10 | 4.21 | Was concrete curing in accordance with the requirements of Subsection 4.23 of the SSBC? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 15.11 | 4.21 | Was the adequacy of protection monitored and recorded as outlined in Section 4.21.6 of the SSBC? | ☐ | |
| 15.12 | 4.21 | Was protection and heating, where used, withdrawn so as not to induce thermal shock stresses in the concrete as outlined in Section 4.21.7 of the SSBC? | ☐ | |
| 15.13 | 4.21 | Did the Contractor measure the temperature of internal concrete, surface of the concrete and ambient air temperatures a minimum of every four (4) hours, and make adjustments as necessary to keep the rate of cooling within the specified parameters? | ☐ | |
| **16** | | **Depositing Concrete Under Water** | | |
| 16.1 | 4.22 | Was concrete deposited under water with the acceptance of the Inspector? | ☐ | |
| 16.2 | 4.22 | Was concrete that was deposited in water of the specified class, with the mix design modified to provide 170 mm ± 30 mm slump, and a 15% increase in cementing materials? | ☐ | |
| 16.3 | 4.22 | Were anti-washout admixtures incorporating viscosity modifiers used in the mix design, and was the modified concrete mix design submitted by the Contractor for review and acceptance by the Project Manager in accordance with Section 4.4.4 of the SSBC? | ☐ | |
| 16.4 | 4.22 | Was the concrete temperature at discharge between 10°C and 25°C? | ☐ | |
| 16.5 | 4.22 | Was a concrete pump used to place concrete carefully in a compact mass to prevent segregation? | ☐ | |
| 16.6 | 4.22 | Was a properly designed and operated tremie used only when specifically reviewed and accepted by the Project Manager? | ☐ | |
| 16.7 | 4.22 | Was the discharge end of the concrete pump line lowered to the bottom of the form or hole, with the end of the discharge line being continually buried no less than 500 mm below the surface of fresh concrete, until the form or hole was completely filled with fresh uncontaminated concrete? | ☐ | |
| 16.8 | 4.22 | Was water temperature above 4°C? | ☐ | |
| 16.9 | 4.22 | Was the surface of the concrete kept as nearly horizontal as practical at all times? | ☐ | |
| 16.10 | 4.22 | Did the Contractor remove all laitance or other unsatisfactory material from the exposed concrete surfaces, as determined by the Inspector? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **17** | | **Curing Concrete** | | |
| 17.1 | 4.23.1 | Was freshly deposited concrete protected from freezing, abnormally high temperatures or temperature differentials, premature drying, water damage and moisture loss during the curing period? | ☐ | |
| 17.2 | 4.23.3 | Curing Requirements for Class HPC and Class HPC with Steel Fibres – Did the Contractor prepare and submit details for his proposed curing procedures to the Project Manager for review and acceptance a minimum of two (2) weeks prior to the scheduled pour date, including a description of equipment, materials and work methods/techniques employed to carry out the work? | ☐ | |
| 17.3 | 4.23.3 | Did the Contractor provide protection to ensure that the temperature of the centre of the in-situ concrete did not fall below 10°C or exceed 60°C and the temperature difference between the centre and the surface did not exceed 20°C, as per the requirements of Table 21 of CSA A23.1? | ☐ | |
| 17.4 | 4.23.3 | Did the Contractor supply and install two thermocouples, one in the centre and one at the surface of the concrete, for every 100 $m^2$ of deck? | ☐ | |
| 17.5 | 4.23.3 | Did the Contractor monitor and record the temperatures every four (4) hours for the first 72 hours after concrete placement and every eight (8) hours thereafter for the remainder of the specified cure period? | ☐ | |
| 17.6 | 4.23.3 | Were daily temperature records forwarded to the Project Manager? | ☐ | |
| 17.7 | 4.23.3 | Immediately after final bull floating and/or surface texturing, was an evaporation reducer applied by a hand sprayer with a misting nozzle at the manufacturer's recommended concentration and application rate? | ☐ | |
| 17.8 | 4.23.3 | Were two (2) layers of Nilex 4504 white filter fabric or an approved equivalent placed on the concrete surface as soon as the surface would not be marred by its installation, and was the fabric pre-wet or a fine spray of clean water immediately applied once placed? | ☐ | |
| 17.9 | 4.23.3 | Was the filter fabric in a continuously wet condition throughout the curing period by means of soaker hoses or other means reviewed and accepted by the Inspector? | ☐ | |
| 17.10 | 4.23.3 | Was curing with filter fabric and water maintained for a minimum of seven (7) days for rehabilitation projects and 14 days for new bridge construction? | ☐ | |
| 17.11 | 4.23.3 | In cold weather, was curing with filter fabric and water maintained for a minimum of 14 days, followed by seven (7) days of air drying for both rehabilitation and new bridge construction projects? | ☐ | |
| 17.12 | 4.23.3 | Was wet curing of deck joint blockout concrete for rehabilitation projects reduced to three (3) days, followed by the application of a Type 2 curing compound meeting the requirements of ASTM C309 or ASTM C1315? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 17.13 | 4.23.3 | For locations where formwork was removed prior to the completion of this specified curing period, were the resulting exposed concrete surfaces wet cured for the remaining days? | ☐ | |
| 17.14 | 4.23.3 | Was any of the curing unacceptable or any portion of the surface dry during the curing period?<br>*Note: The Consultant will have cause to reject the concrete*. | ☐ | |
| **18** | | **Concrete Finishing Under Bearings** | | |
| 18.1 | 4.24 | Was concrete on which bearing plates, pads or shims are placed finished or ground to a smooth and even surface? | ☐ | |
| 18.2 | 4.24 | Were air voids created by forming grout-pad recesses filled with an approved patching material a minimum of seven (7) days in advance of girder erection, and in cold weather conditions, was this work completed while the substrate concrete was warm from hydration processes?<br>If the filling of air voids did not occur while the substrate concrete was still warm, was it carried out in accordance with Section 4.21 of the SSBC? | ☐ | |
| **19** | | **Concrete Surface Finish** | | |
| 19.1 | 4.25.1 | General – Were surface finishes on exposed concrete surfaces 600 mm below grade or, in the case of river piers, 600 mm below lowest water level, as outlined in Section 4.25.1 of the SSBC? | ☐ | |
| 19.2 | 4.25.1 | Were wood or magnesium tools of a type and quality acceptable to the Inspector used for finishing concrete? | ☐ | |
| 19.3 | 4.25.2 | Class 1 Ordinary Surface Finish<br>Unformed Surfaces – Was concrete screeded to conform to the required surface elevations, then trowelled to ensure that the surface was free from open texturing, plucked aggregate and local projections or depressions? | ☐ | |
| 19.4 | 4.25.2 | Class 1 Ordinary Surface Finish<br>Formed Surfaces – Were all fins and irregular projections removed from all surfaces immediately following the removal of forms, and were cavities produced by form ties, all other holes, honeycomb areas, broken corners or edges and other defects, thoroughly chipped out, cleaned and filled with a Department-approved patching product acceptable to the Consultant and placed in accordance with the manufacturer's recommendations? | ☐ | |
| 19.5 | 4.25.2 | Were all repairs wet cured for a minimum of 72 hours? | ☐ | |
| 19.6 | 4.25. | Class 2 Rubbed Surface Finish – Immediately following the removal of forms, were all concrete fins and irregular projections removed, and were surfaces that did not meet tolerance requirements corrected by grinding or partial depth repair as outlined in Section 20 of the SSBC? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 19.7 | 4.25. | Were surface voids greater than 19 mm diameter but less than 0.05 $m^2$ in area or 30 mm deep filled with a Department approved patching material? | ☐ | |
| 19.8 | 4.25.3 | Were surface voids less than 19 mm in diameter and 30 mm deep filled with a pre-bagged sack rub material? | ☐ | |
| 19.9 | 4.25. | Were sack rub materials placed over the entire prepared surface in accordance with the manufacturer's recommendations and wet cured for a minimum of 72 hours? | ☐ | |
| 19.10 | 4.25.3 | When the patching and sack rub materials had adequately cured, was a carborundum stone or approved equivalent method used to finish the surface to a smooth, uniform and closed texture? | ☐ | |
| 19.11 | 4.25.3 | Were all prepared surfaces, including all patching and sack rubbing, uniform in colour and texture, and did the Contractor apply sealer as specified in Section 4.26 of the SSBC Type 1c Sealer? | ☐ | |
| 19.12 | 4.25.4 | Class 3 Bonded Concrete Surface Finish – Was surface preparation done as specified for Class 2 Rubbed Surface Finish except that uniformity in colour was not required? | ☐ | |
| 19.13 | 4.25.4 | Was the surface pressure washed to remove all dust, dirt, laitance and all other bond breaking materials? | ☐ | |
| 19.14 | 4.25.4 | Did the concrete surface dry for a minimum of 24 hours? | ☐ | |
| 19.15 | 4.25.4 | After the surface dried, did the Contractor apply an approved pigmented concrete sealer meeting the requirements for a Type 3 sealer of the Material Testing Specifications for Concrete Sealers – B388 and in accordance with the manufacturer's specifications? | ☐ | |
| 19.16 | 4.25.4 | Were a minimum of two (2) coats of sealer applied, and was the colour acceptable to the Department and Project Manager before application of the coating? | ☐ | |
| 19.17 | 4.25.4 | When spray application was used, was the surface back rolled and is no colour variation visible and does color match the previously painted adjoining surfaces? | ☐ | |
| 19.18 | 4.25.5 | Class 4 Floated Surface Finish – Unless otherwise noted on the drawings, were concrete surfaces receiving a waterproofing membrane and a final wearing surface manually bull floated as necessary to provide a smooth surface? | ☐ | |
| 19.19 | 4.25.6 | Class 5 Floated Surface Finish, Broomed Texture – Was the concrete surface floated as necessary to produce a smooth surface with no more than a 3 mm variance, under a 3 m long straightedge? | ☐ | |
| 19.20 | 4.25.6 | After the concrete had set sufficiently, was the surface given a transversely broomed finish using a coarse broom to produce regular corrugations to a maximum depth of 2 mm? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 19.21 | 4.25.6 | Was an edging tool used at all edges and expansion joints, and where indicated on the drawings, were sidewalk surfaces laid out in blocks using an acceptable grooving tool? | ☐ | |
| 19.22 | 4.25.7 | Class 6 Floated Surface Finish, Surface Textured – After bull floating, was the concrete given a suitable texture with a "flat wire" texture broom having a single row of tines, and was the textured surface uniform and consistent? | ☐ | |
| 19.23 | 4.25.7 | Following texturing, was a 300 mm width adjacent to the curb, barrier or median finished smooth? | ☐ | |
| 19.24 | 4.25.8 | Repairing Concrete Defects – Were honeycomb, cavities, cracking and other casting defects immediately reported to the Project Manager, and did the Contractor submit a repair procedure for review and acceptance by the Department and Project Manager prior to the commencement of the repairs? | ☐ | |
| 19.25 | 4.25.8 | Did the Contractor's repair procedure include removing and replacing the defective concrete with the originally specified class of concrete by saw cutting 25 mm deep and removing defective concrete to 35 mm below reinforcing steel? | ☐ | |
| 19.26 | 4.25.8 | Was exposed reinforcing steel cleaned and repaired to original condition? | ☐ | |
| 19.27 | 4.25.8 | Were repair areas saturated with water for 24 hours and free of standing water prior to concrete placement? Was the concrete cured in accordance with the requirements for the class of concrete? | ☐ | |
| 19.28 | 4.25.8 | Were concrete elements with formwork misalignments exceeding the allowable tolerances removed and recast? | ☐ | |
| 19.29 | 4.25.8 | Did the Contractor and Inspector jointly inspect and identify all cracks for class HPC and HPC with steel fibres after the curing period and before opening to traffic? | ☐ | |
| 19.30 | 4.25.8 | Did the Inspector plot the width in millimeters and length in linear metres of cracks and report the findings to the Department? | ☐ | |
| 19.31 | 4.25.8 | Did the Contractor repair cracks with widths greater than or equal to 0.2 mm by cleaning and drying cracks with oil-free compressed air? | ☐ | |
| 19.32 | 4.25.8 | After cleaning, did the Contractor seal cracks with an approved gravity flow concrete crack filler, having a viscosity less than 105 centipoises (cP) and placed in accordance with the manufacturer's recommendations? | ☐ | |
| 19.33 | 4.25.8 | Was epoxy injection used for full depth cracks? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 19.34 | 4.25.8 | Did the epoxy resin meet the requirements of ASTM C881 Type IV, Grade 1, Class B or C, having a viscosity less than 500 cP, and did the Contractor submit an injection procedure to the Project Manager for review and acceptance? | ☐ | |
| **20** | | **Type 1c Sealer** | | |
| 20.1 | 4.26 | Was an approved Type 1c sealer applied to all concrete surfaces that received a Class 2, Class 5 and Class 6 surface finish, including all concrete surfaces to 600 mm below grade or in the case of river piers 600 mm below lowest water level? Were surfaces receiving a waterproofing membrane, the underside of bridge decks or on concrete diaphragms in the interior bay areas, not treated with sealer? | ☐ | |
| 20.2 | 4.26 | Did the Type 1c sealers meet the current Material Testing Specifications for Concrete Sealers – B388, and was sealer applied in accordance with the manufacturer's recommendations, except for a 30% application rate increased from that indicated on the approved Product List? | ☐ | |
| 20.3 | 4.26 | Before applying the sealer, had the concrete cured for at least 28 days, and was the surface dry, air blasted to remove all dust and accepted by the Inspector prior to applying sealer? | ☐ | |
| 20.4 | 4.26 | Did the Contractor apply measured volumes of sealing compound to appropriately dimensioned areas of concrete surface, using a minimum of two (2) coats in order to insure a uniform and sufficient coverage? | ☐ | |
| 20.5 | 4.26 | Were asphalt concrete pavement surfaces adequately protected from overspray and runoff during sealer application? | ☐ | |
| **21** | | **Concrete Strength Requirements** | | |
| 21.1 | 4.27.1 | Did all classes of concrete meet the specified strength requirements? | ☐ | |
| 21.2 | 4.27.2 | Was the concrete cured in accordance with Section 4.23 of the Standard Specifications for Bridge Construction and had it attained the minimum compression strength of 70% of the design strength prior to opening to traffic? | ☐ | |
| 21.3 | 4.27.3 | Was coring necessary to confirm or contest low concrete strength test results? | ☐ | |
| 21.4 | 4.27.3 | Did the Contractor employ an independent, certified testing laboratory to take and test cores within seven (7) days of the testing of the 28-day cylinders representing the concrete in question, and was the Project Manager’s representative present? | ☐ | |
| 21.5 | 4.27.3 | Were cores tested by an independent CSA certified laboratory and in accordance with the requirements of CSA Standard A23.2-14C? | ☐ | |
| 21.6 | 4.27.3 | Was the average strength of each set of three cores equal to or greater than the 28-day specified strength? | ☐ | |

**Details and Summary:**

Signature

Date

4.1 Abutment seat partial formwork and reinforcing steel.

4.2 Pile cap partial formwork and reinforcing steel. Formwork braced from excavation walls.

4.3 Pier shaft formwork being erected.

4.4 Pier cap formwork being erected.

4.5 Partial wingwall formwork.

4.6 Mudslab shown at pier columns.

4.7 Partial wingwall and backwall formwork.

4.8 Formwork bracing for wingwall. Waler form construction used. Forms braced using deadman lock-block anchors.

4.9 Formwork and bracing for wingwall. Full sheets of plywood used to reduce form lines.

4.10 Abutment diaphragm formwork and reinforcing steel. Asthetic enhancement motif cast into exterior face of diaphragm.

4.11 Pier diaphragm formwork and reinforcing steel.

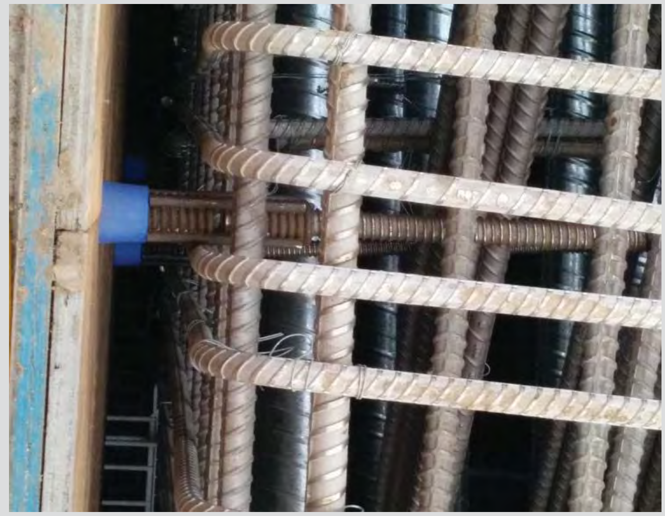
4.12 Elevated construction. Shoring towers used to construct abutment seat.

4.13 Pier strut shoring towers and scaffolding. Pre-fabricated reinforcing steel cage installed by crane.

4.14 Pier strut with plain steel reinforcement.

4.15 Pier cap shoring towers and scaffolding.

4.16 Wingwall formwork and plain steel reinforcement. Asthetic enhancement motif cast into exterior face of wingwall.



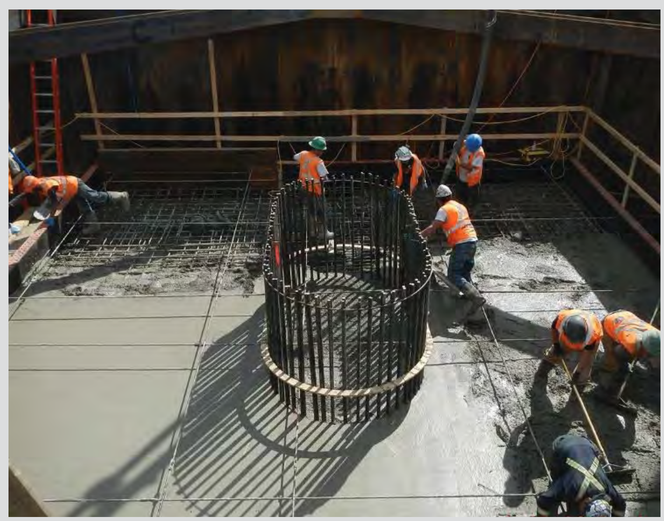
4.17 Internal form ties with recessed rod inserts. Insert is removed and void patched.

4.18 Substructure concrete placement. Long vibrator used to consolidate concrete for deep elements.

4.19 Concrete pump used for pile cap pour. Forms braced against precast concrete deadmen.

4.21 Plastic supports or chairs used to maintain required cover to edge of formwork.

4.20 Pile cap ready for concrete placement.

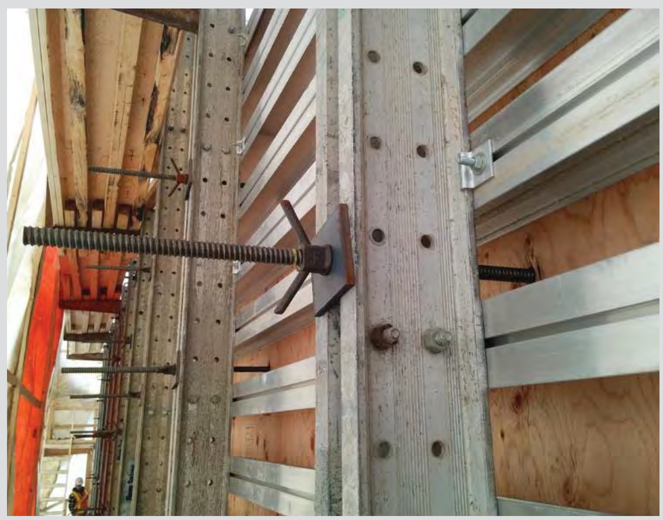


4.22 Crews performing strike off at finished elevation.

4.23 Concrete placement using crane and bucket. Freefall of concrete minimized.

4.24 Scaffolding and shoring towers for straddlebent pier beam. Heating and hoarding for cold weather concreting in place.

4.25 Scaffolding and shoring towers for straddlebent pier beam.

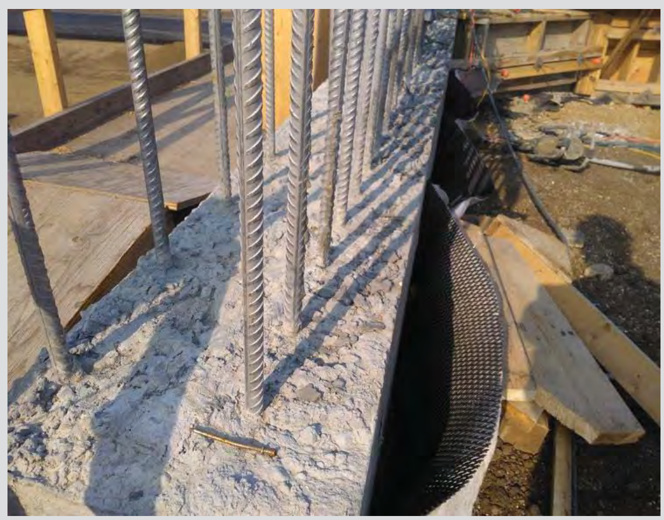


4.26 Aluminum beam whalers and strong backs.

4.27 External vibrator attached to form. Due to congestion of reinforcing steel and post-tensioning ducts, internal vibration difficult.

4.28 Cold weather concreting. Hoarding for pier columns consists of insulated tarps and heaters.


4.29 Cold weather concreting. Hoarding for pier cap pour.



4.30 Construction joint preparation at wingwall barrier.

4.31 Backwall corbel formwork.

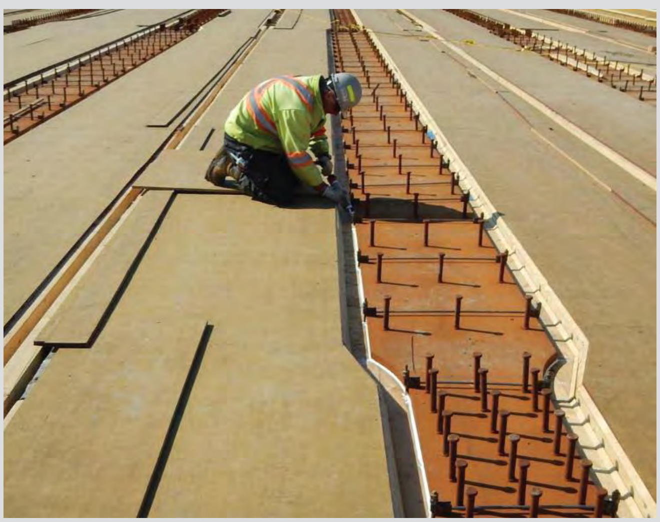
4.32 Cold weather concreting. Hoarding for pier cap pour. Room for workers and equipment to work within the enclosure. Roof tarps open to allow for concrete pump access.

4.33 A false deck is typically constructed at the lower flanges to provide a working surface.

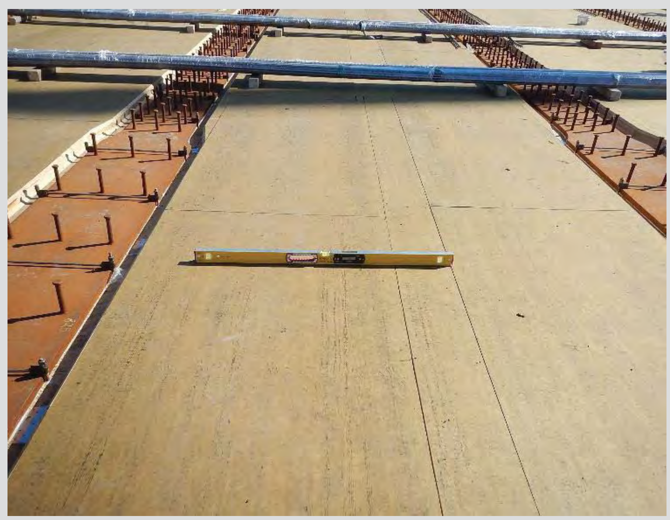
4.34 Timber deck formwork is typically hung from coil bolt hangers supported on girder top flanges. False deck working surface shown.

4.35 Timber ledger beams are typically hung from hanger rods.

4.36 Joists and plywood are placed onto ledgers. Neat chamfers must separate the haunch and interior bay formwork. Holes through plywood to accommodate coil bolts must be properly sealed.

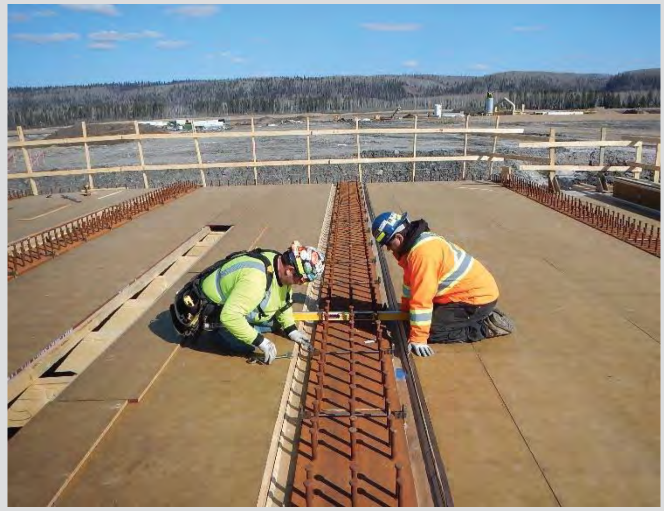


4.37 All girder-to-form joints must be caulked prior to the placement of reinforcing steel to prevent paste leakage during concrete placement, which cause girder staining.



4.38 Prior to installation of reinforcing steel, it is important to check form cross-fall to confirm form position accuracy.

4.39 Prior to installation of reinforcing steel, it is important to check actual haunch values at all girder 10th points to confirm form position accuracy.



4.40 If necessary, formwork position must be adjusted before placement of reinforcing steel begins.

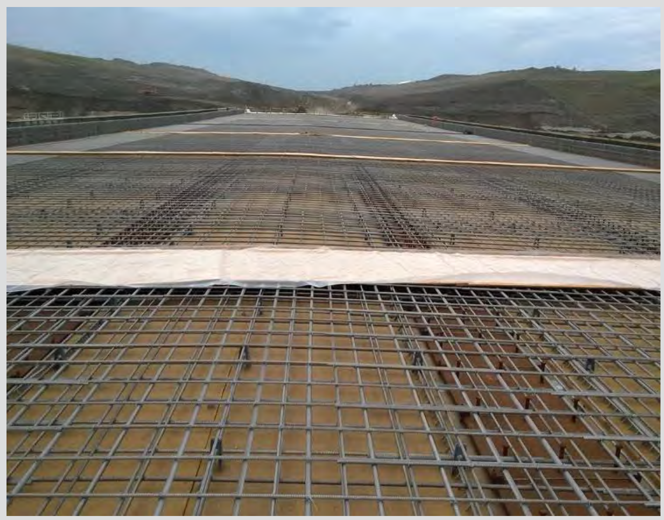
4.41 Cantilevered formwork at deck overhangs must be pre-load tested to determine anticipated deflections during concrete placement.

4.42 Typical deck overhang formwork, also showing hanger rods.

4.43 Adjustable deck overhang brackets.

4.44 Softener wrapped around bracket end to prevent girder web damage.

4.45 Deck formwork in place on concrete girders.



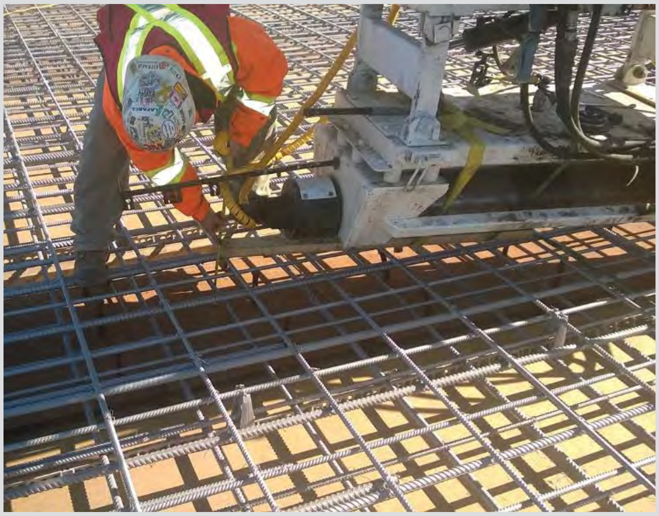
4.46 Deck reinforcing steel installed, tied, and chaired. Bulkheads constructed at planned termination of deck placement sections.

4.47 Finishing machine screed rail cups are installed and rail is set by instrument to the design gradeline.

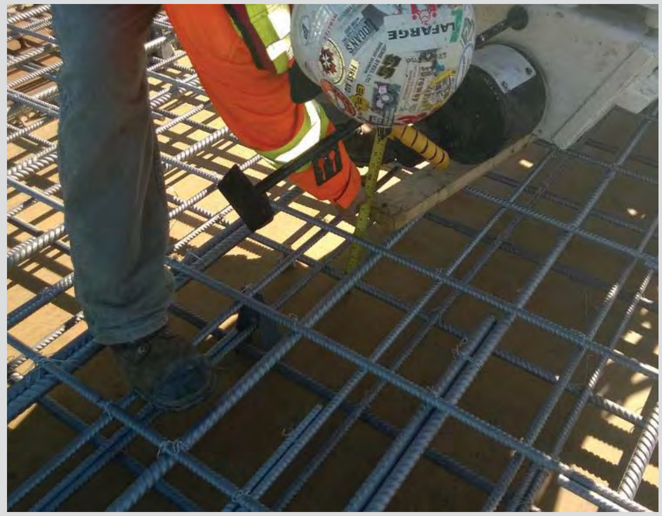
4.48 Finishing machine rail and chain system for carriage shown.

4.49 Carriage rails must be adjusted for cross-fall and crown location.

4.50 Carriage rails checked for cross-fall after adjustment.



4.51 Finishing machine dry run consists of directly measuring theoretical haunch values at each girder 10th point.



4.52 During dry run, the constant theoretical depth of concrete at interior bays is also confirmed.

4.53 Deck finishing machine run-off rails.

4.54 Start of deck pour. Plywood walkway on deck reinforcing steel for safety and protection of reinforcing steel. Pressure sprayer for cleaning and wetting deck.

4.55 Bridge deck pour. Screeding closely following placement. Workers avoiding walking on screeded concrete.

4.56 Deck concrete placement is placed in transverse strips so that it can be screeded as soon as practical after placement and vibration.

4.57 Deck concrete must be floated as soon as practical after screeding.

4.58 Concrete testing station set up on deck.

4.59 Full enclosure type heating and hoarding for cold weather deck pour.

4.60 Concrete finishers bull floating concrete deck immediately after screeding. Finishing done from work bridges.

4.61 It is important that concrete be screeded and raked before consolidation. Workers must not walk through or place additional concrete at locations where vibration has already taken place.

4.62 It is important that paste be removed from barrier reinforcing steel prior to initial set.

4.63 Straight edge checks must be done in both the transverse and longitudinal directions along the gutter as hand floating is done.

4.64 Line pump used to place deck concrete.

4.65 Line pump with adjustable swivel arm for accurate concrete placement.

4.66 Placement of curing fabric from work bridges.

4.67 Crews applying pre-soaked curing fabric.

4.68 Once the concrete will not be marred, crews apply pre-soaked curing fabric.

4.69 Placement of second layer of filter fabric after initial set.

4.70 Dunnage is used to secure filter fabric.

4.71 Soaker hoses are used at the crown to maintain wet filter fabric throughout the curing period.

4.72 Curing material placed. Dunnage used to hold wet cure in place.

4.73 Approach slab reinforcing steel. Plastic chairs used to separate reinforcing mats. Reinforcing steel placed on skew with deck.

4.74 Placing approach slab concrete.

4.75 Heating and hoarding during winter curing.

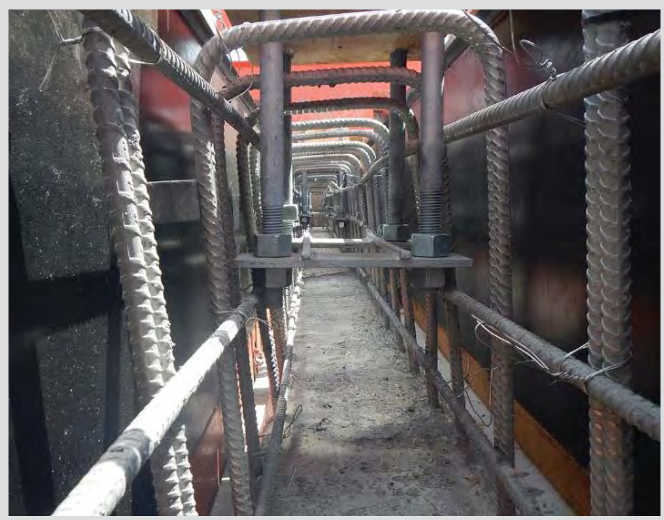
4.76 Barrier reinforcing steel and formwork. Bridge rail anchor bolt assembly secured to reinforcing steel.

4.77 Typical gap at barrier reinforcing steel at control joint.

4.78 Typical construction joint at outside face of barrier. Note pour strip detail.

4.79 Typical rough vibrator-finish at barrier construction joint. Note that concrete surface at construction joint slopes towards deck and away from outside face of barrier.

4.80 Barrier formwork showing anchor bolt assemblies, chamfer strip, and control joint crack initiator.



4.81 Barrier anchor bolt assembly.

4.83 Typical formwork and pour strip at outside face of barrier. Note that forms are tight to the hardened concrete to prevent paste leakage.

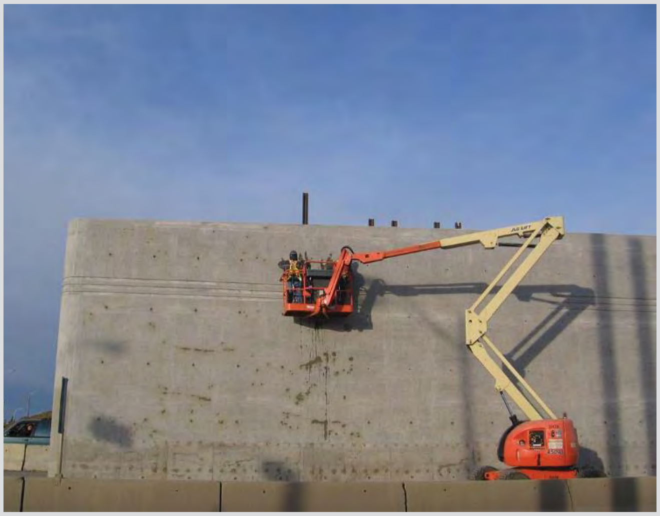
4.82 Wooden forms for barrier and curb formwork. Form attachment to deck concrete must be avoided.

4.84 Completed transition barrier.

4.85 Median pour. Wooden strike off board built to maintain desired profile.


4.86 Re-usable steel forms for barriers.

4.87 Crews tooling joints at 3.0 m spacing. Broom finish to be applied.



4.88 Concrete surface finishing. Form tie voids filled with approved patching material. Proper patching techniques must be followed in order to have a durable and lasting patch.

4.89 Concrete surface finishing at exterior faces of barriers. Workers using aerial work platform to access work. Class 2 rubbed surface finish followed by two applications of pigmented sealer.

4.90 Concrete surface finishing of exterior faces of barriers. Workers using aerial lift truck to access work.

4.91 Wing wall after form stripping. Form tie holes to be patched.

4.92 Outside face of wingwall showing patching of form tie holes.

4.93 Applying pigmented sealer to MSE wall fascia panels and barriers by spraying.

4.94 Applying pigmented sealer to MSE wall fascia panels below grade.

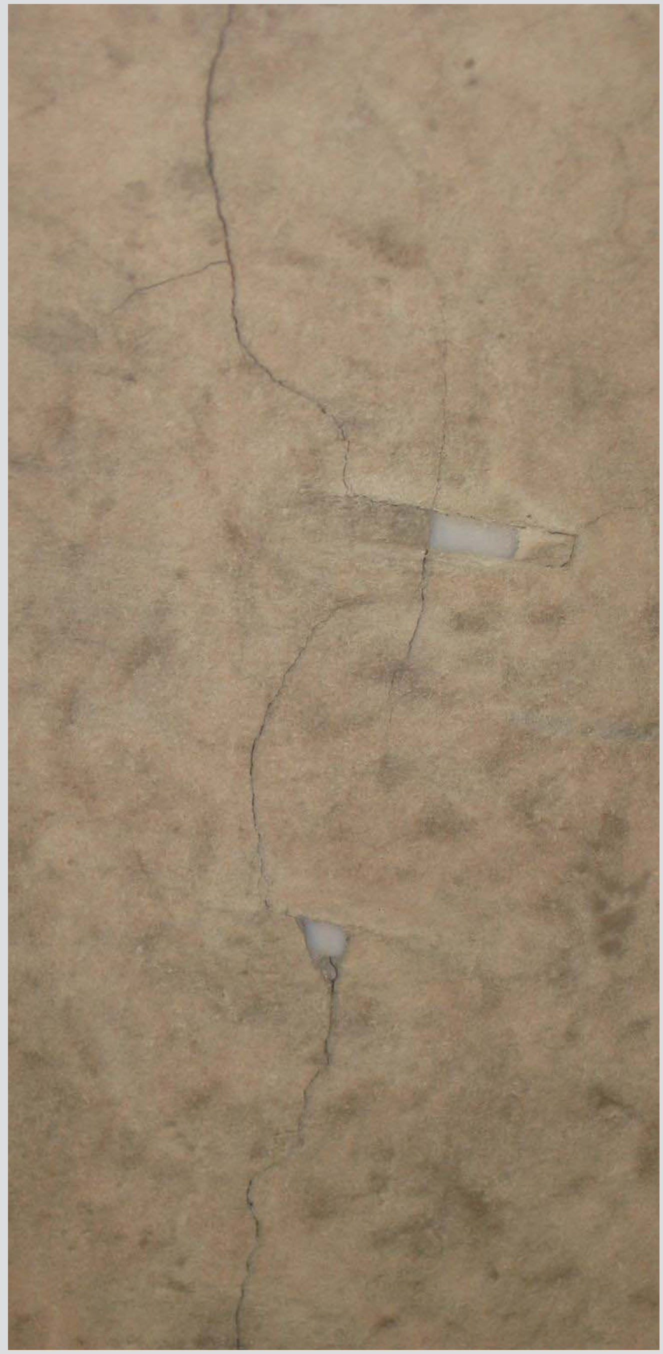
4.95 Honeycomb defect.

4.96 Transverse-direction deck slab drying shrinkage crack.


4.97 Crack comparator gauge used to measure crack width.

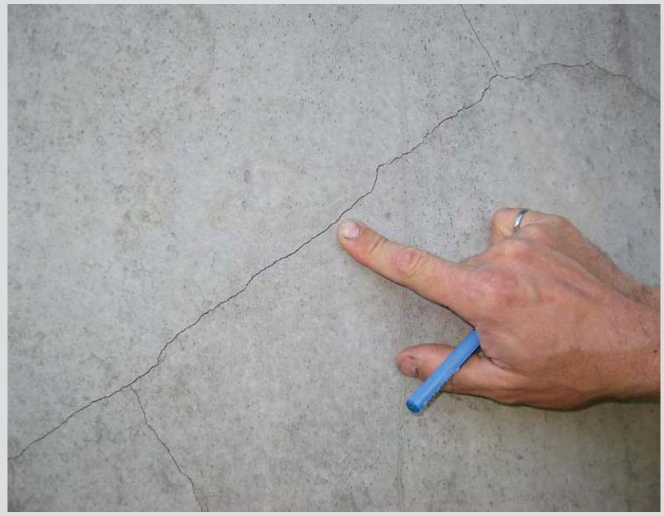
4.98 Plastic shrinkage cracks on deck slab surfaces.

4.99 Deck slab soffit drying shrinkage crack.



4.100 Drying shrinkage crack along crack inducer such as reinforcing steel chairs.

4.101 Crazing -type cracking seen on formed surfaces.



4.102 Drying shrinkage cracks on vertical substructure surface.

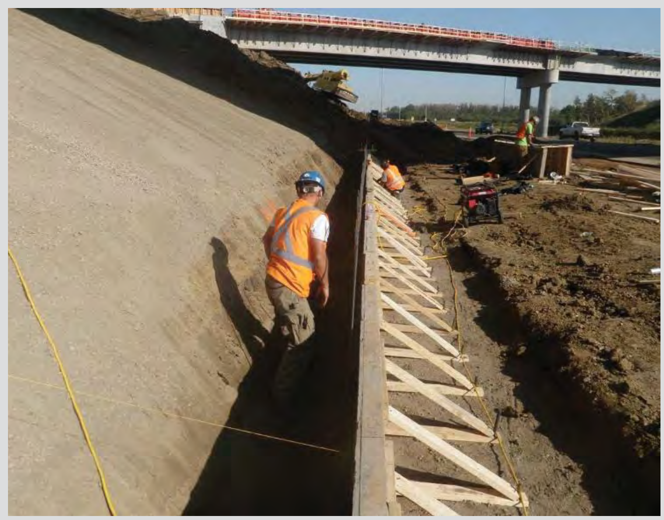
4.103 Drying shrinkage cracks on substructure.

4.104 Concrete washout bin.

4.105 Typical trailer-type concrete mixer and concrete pump.

4.106 Preparation of headslope with telescoping boom excavator.

4.107 Headslope compaction with hydraulic excavator.

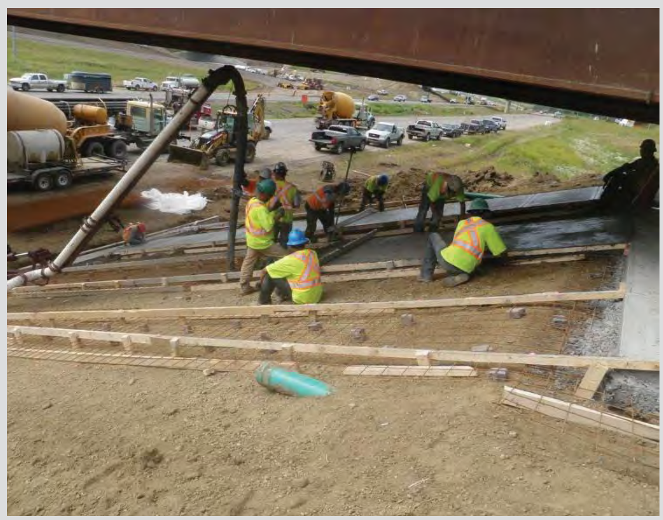


4.108 Toe cut-off wall formwork at base of concrete slope protection.

4.109 Excavation for toe cut-off wall

4.110 Forming of vertical concrete slope protection courses.

4.111 Forming vertical courses. Reinforcing mesh chaired using masonry bricks.



4.112 Pouring vertical courses in alternating sections. Care is required to avoid crushing chairs as pour progresses.

4.113 Alternate vertical courses placed.

4.114 Checking cover and alignment.

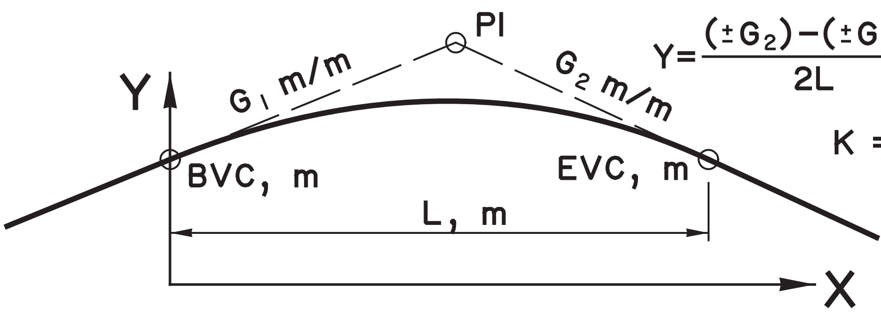
4.115 Pouring fill-in courses.

# FIGURE 4.1 – DECK GEOMETRY CHECK PROCEDURE

## GENERAL NOTES:

Using the Control Line:

1. The control line is presented as the completed deck surface and often coincides with the crown line. It is shown on the General Layout, whereas the roadway surface profile is shown on the Information Sheet.
2. The control line may include sections of constant gradient and sections of vertical curve. Vertical curves may be sag or crest, and are parabolic.
3. Where vertical curves exist, the vertical curve formula is used to calculate the theoretical elevation of any point on the structure. For any known station along the control line (X) a corresponding elevation (Y) may be determined.
4. The vertical grade information is calculated and plotted on the Camber Diagram. The Camber Diagram provides vertical grade information at 10th or 20th points along the control line.

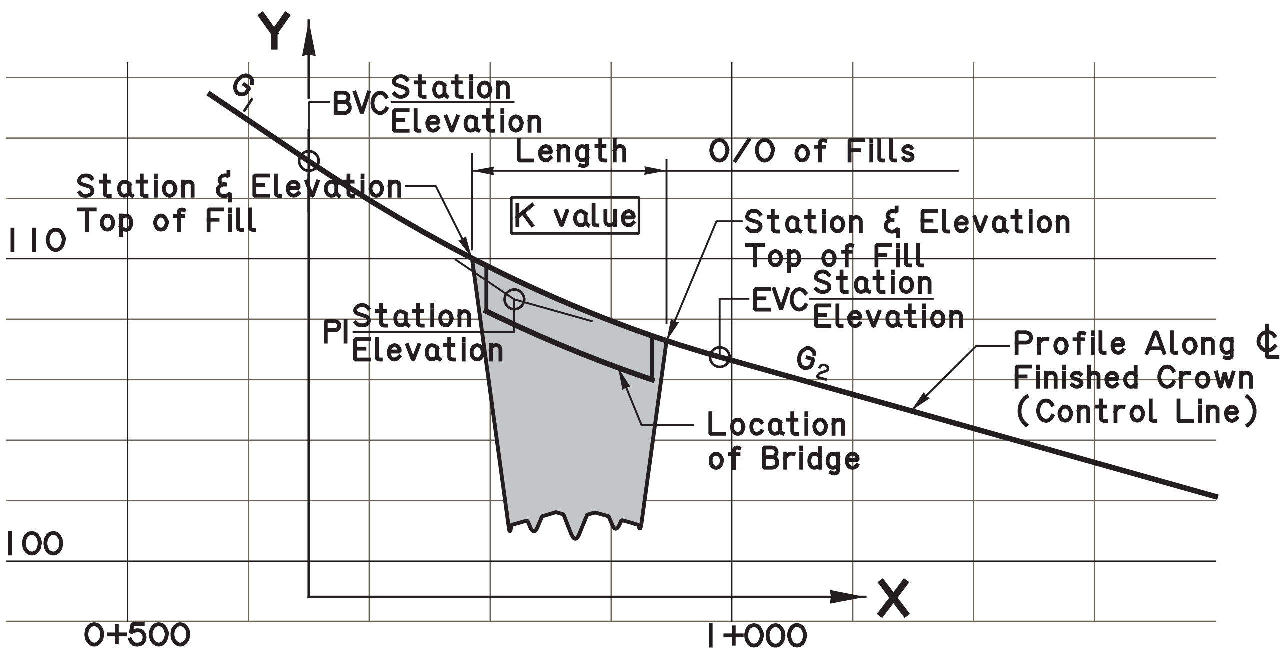



$$Y = \frac{(\pm G_2) - (\pm G_1)}{2L} X^2 + (\pm G_1)X + \text{Elev BVC}$$

$$K = \frac{L}{A} = \frac{\text{Horizontal Distance}}{\text{Magnitude of Grade Change}}$$

**ROADWAY VERTICAL CURVE FORMULA**

(CREST CURVE SHOWN
SAG CURVE SIMILAR)




**TYPICAL ROAD PROFILE WITH VERTICAL SAG CURVE**

## FIGURE 4.1

GENERAL NOTES CONTINUED:

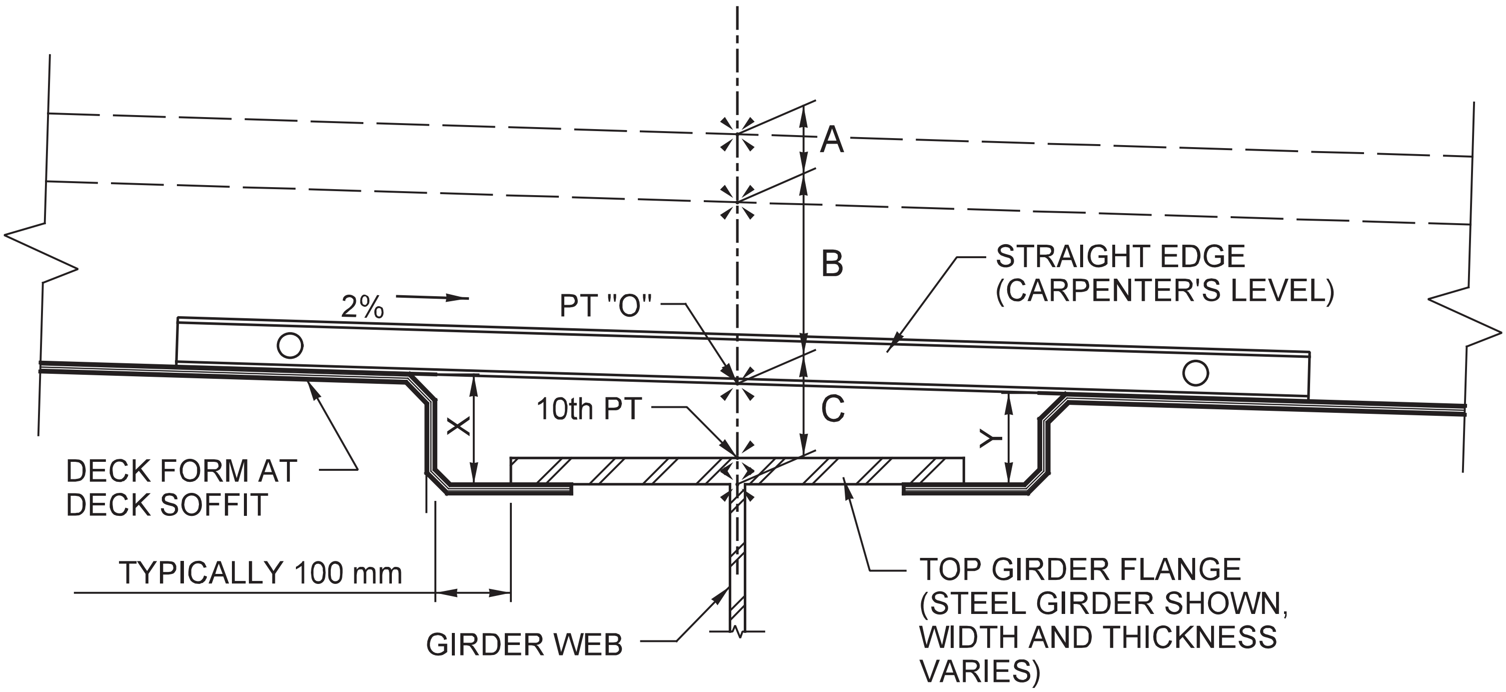
Checking the Girder Elevations after Erection:

1. Each girder top flange is divided into 10 equal sections along its length ("10$^{th}$ points"), measured along the centreline of web. The bearing locations correspond to points "0" and "10", with point "0" coinciding with Abutment 1. For long girders, each span is normally divided into 20 equal sections. The required number of points will be shown on the Camber Diagram.
2. The top of girder elevations at all bearing locations must be checked by survey instrument after girder erection is complete. The theoretical elevations are compared to the surveyed elevations to determine if any girder elevation adjustments need to be made. The nominal haunch dimension provided in the Plans, is used to calculate the theoretical top of girder elevations.
3. Girder elevation adjustments are made by modifying the height of the shim stacks under the bearing base plates. If the resulting grout pad thickness is not as detailed, the Project Manager must be consulted.

Checking the "10$^{th}$ Point" Girder Elevations:

1. The top of girder elevations at all other 10$^{th}$ points must be checked by survey instrument after the girder elevation adjustments at the bearing points have been made and accepted by the Inspector.
2. The Inspector must compare his check survey with the Contractor's survey to identify and resolve any discrepancies.
3. Starting at the control line and using geometry provided in the Plans, the theoretical top of girder elevations at each 10$^{th}$ point may be calculated. The vertical grade, deck cross-fall, bridge skew, structure element thicknesses, top flange thickness for steel girders, and haunch depth are used in the calculations. The nominal haunch value is only applied at the bearing location 10$^{th}$ points ("0", "10", "20", etc.). At all other 10$^{th}$ points, the nominal haunch value must be adjusted for consideration of future superimposed dead load (SDL). The values of SDL are provided on Camber Diagram for each 10$^{th}$ point on the control line. The Camber Diagram normally provides values for the future dead load of concrete, as well as values for other future SDL including ACP, barriers and concrete shrinkage. The nominal haunch value is not adjusted for the dead load of girders since these are in place at the time of the 10$^{th}$ point elevation survey.
4. The haunch depth at the bearings will be the exact value shown on the Plans, but the haunch depth dimension is nominal and will vary between the bearing points. The variation is due to consideration of future SDL, and variation in girder camber. Precast prestressed girders, in particular, may increase their camber, over time.

# FIGURE 4.2
# DECK FORMWORK POSITION CHECK PROCEDURE
# (PERFORMED PRIOR TO PLACEMENT OF REINFORCING STEEL)




GENERAL NOTES:

Checking the Deck Formwork Cross-Fall:

1. A straight edge, such as a carpenter's level, is placed onto formwork at the deck soffit formwork bays in the transverse direction so that the haunch is bridged by the straight-edge, as shown. The underside of the straight-edge must be in full contact with the deck soffit formwork to confirm that the adjacent forms are in the same geometric plane. The slope of the straight-edge is measured to confirm that the formwork cross-fall is correct.

2. A string line is placed transversely from the crown to the deck overhang, to confirm that all deck soffit forms are in the same plane.

Checking the Deck Formwork Elevation:

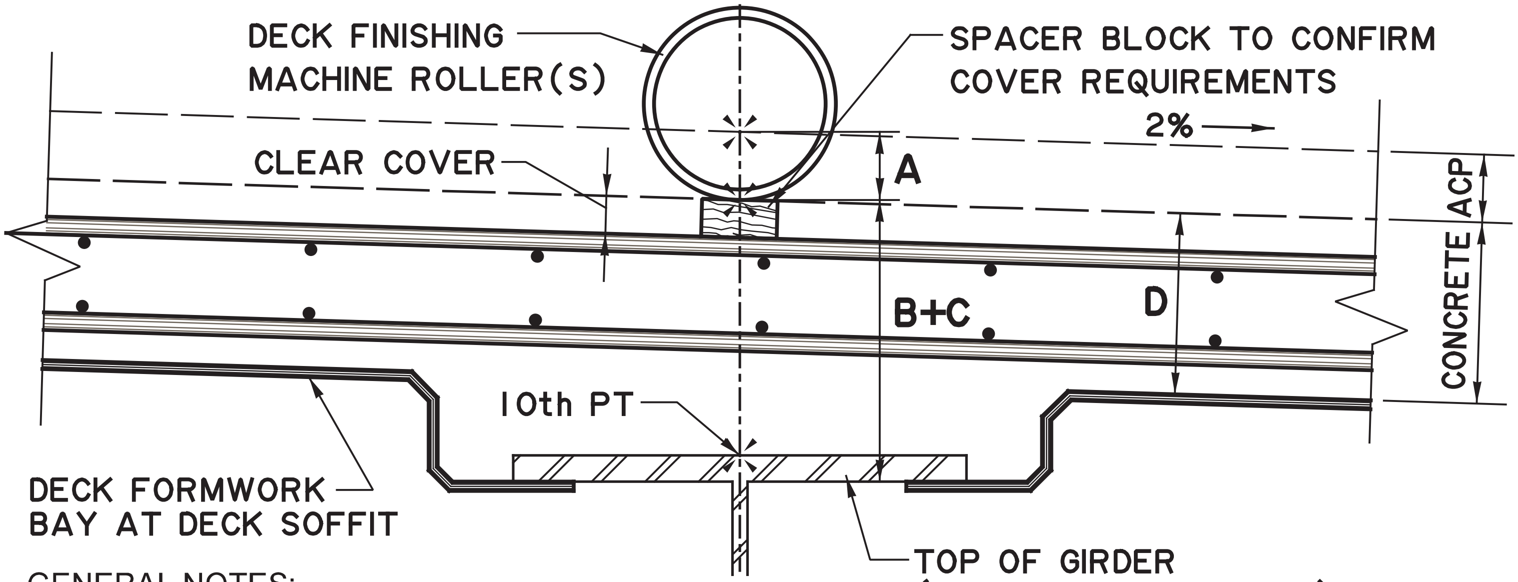
1. The dimension "C" is the theoretical haunch depth that was calculated as described in Figure 4.1. Note that for steel girders, the top flange extends into the haunch and this thickness must be deducted from "C" when making haunch measurements. The measurement is made directly from the underside of the straight-edge to the top of the girder flange.

2. The Contractor may calculate values for "X" and "Y" instead of "C", since "X" and "Y" are useful in setting formwork hangers at the flange tips.

3. If the deck formwork cross-fall is not correct, then a measurement of "C" cannot be made using a straight-edge. Instead, the theoretical values of "X" and "Y" should be calculated and measured to identify the form that is incorrectly positioned.

4. Reinforcing steel may only be placed once the Inspector has confirmed that all formwork cross-fall and elevation positioning is correct.

# FIGURE 4.3
# PRE-POUR DRY RUN DECK CHECK PROCEDURE OF REINFORCING STEEL COVER, CONCRETE THICKNESS, GRADELINE AND CROSS-FALL




GENERAL NOTES:

Set-up of the Concrete Finishing Machine:

1. The screed rails must follow the design roadway gradeline profile, taking into account the corrections for future SDL. The screed rails are checked by the Inspector by surveying the top of rails at the 10$^{th}$ points to confirm that all screed rail points are at a constant elevation above the design gradeline. Prior to surveying the rails, the finishing machine should make sufficient travel passes to properly seat the rail.
2. The finishing machine carriage rails must follow the design roadway cross-fall. The carriage rails are checked by the Inspector to confirm that the crown is correctly located. The carriage rails on either side of the crown must be straight and free of local irregularities. The straightness of the carriage rails is checked using a string line and clamps. The carriage must be moved to the crown position before checking straightness.

Dry Run Process:

1. The dry run process consists of taking actual measurements at each 10$^{th}$ point haunch and deck soffit formwork bay to confirm the reinforcing steel cover, concrete thickness, gradeline and cross-fall. The finishing machine is moved along the screed rails and positioned at a 10$^{th}$ point line. The finishing machine carriage is then moved along the 10$^{th}$ point line to obtain measurements at each girder haunch and at each formwork bay.
2. The dry run process should include the entire deck and not just the portion of the deck to be poured.
3. Two measurements are taken at each girder haunch point and at each formwork bay point: (1) the cover between the finishing machine roller and the top of the reinforcing steel is measured with the assistance of a jig, such as a wooden block, and (2) the distance between the finishing machine roller and the underside of the haunch (B+C) or the distance between the finishing machine roller and the form (D). Note that the finishing machine may have one or two rollers, but the measurements may be taken from either roller. However, the trailing edge of the roller(s) is lower than the leading edge; all measurements must be taken from the lowest (trailing) point on the roller. After all points along each 10$^{th}$ point line are measured, the results are plotted.

Confirmation of Dry Run:

1. The dry run is an iterative process. After the initial dry run, corrections to the screed rails, carriage rails or finishing machine elevation may be required. The need for adjustments is determined by review of the 10$^{th}$ point survey plot. If the cross-fall or grade is consistently incorrect, adjustments to the finisher legs or carriage may be needed to modify the elevations. If local discrepancies exist, adjustment to a portion of the screed rail may be required. The concrete formwork tolerances specified in CSA A23.1 do not apply to the dry run procedure. The dry run is repeated until there is no longer a measurable error.
2. The dry run procedure confirms that the minimum cover to reinforcing steel is maintained. However, cover to the deck soffit should also be checked. If excessive cover exists, this must also be corrected through adequate chairing. It is also important that the heads of shear studs on steel girders and the tails of projecting web reinforcing steel for precast girders be located between the top and bottom mats of deck reinforcing steel.
3. After the dry run has been accepted by the Inspector, no subsequent adjustments to the screed rail or finishing machine may be made.
4. Payment for haunch concrete is made on the basis of the haunch values calculated. The volume of haunch concrete may be determined using the average end areas calculated at each 10$^{th}$ point.

# SECTION 5

## REINFORCING STEEL

### TABLE OF CONTENTS

## 5.1 Reinforcing Steel – General

The required reinforcing steel is detailed on the Plans. The Plans also contain bar list charts, which provide a bar mark reference number, bar size, shape type, number of each shape type, total length and dimensions of each bar leg.

## 5.2 Safety Considerations

The Inspector must be aware of similar safety considerations identified in Section 4 of this Manual.

## 5.3 Material Types

Plain reinforcing steel is commonly used in Class C, D, S or Pile concrete where chloride exposure is low. Plain reinforcing steel is often called “black” bar.

Corrosion Resistant Reinforcing (CRR) steel consists of either low carbon/chromium steel or stainless steel reinforcing. This material is used in Class HPC concrete or where chloride exposure is high.

Epoxy-coated reinforcing steel is not used in new construction except for MSE wall panels. However, it may be used in concrete rehabilitation work. This application is discussed in Section 20 of this Manual.

## 5.4 Material Production and Testing

Plain reinforcing steel is Grade 400 and must meet the requirements of CSA Standard G30.18M. This Standard provides requirements for carbon steel bars as concrete reinforcement. The manufacturer must test the material in accordance with the Standard and must provide mill test certificates to the Consultant that demonstrates the material meets the project requirements. In particular, the mill test report must include the CSA designation, grade, size, heat numbers, chemical composition, yield strength, tensile strength, elongation at failure, bend test results and carbon equivalent.

Low carbon/chromium CRR is Grade 100 and must meet the requirements of ASTM A1035. Stainless steel CRR must meet the requirements of ASTM A276 and A955M, with additional testing required to confirm compliance to ASTM A262 and A923. CRR bars must be roller-marked to identify the mill source, size, type and minimum yield designation.

Stainless CRR is pickled to remove surface oxidation, mill scale and other impurities. The pickling process involves placing stainless CRR into a bath of pickle liquor, which contains strong acids. Occasionally, the pickling process is not successful or causes damage to stainless CRR that can be seen in the form of excessive discolouration or staining. Details of the pickling process must be submitted to the Consultant by the Contractor. Stained or discoloured bars must not be accepted by the Inspector, and their occurrence must be brought to the attention of the Project Manager.

The Inspector must:

- Confirm with the Project Manager that the submitted material test reports represent all expected reinforcing steel materials and that the content of the reports is acceptable. The Inspector must have access to the reviewed and accepted mill test reports.

- Confirm with the Project Manager that the pickling process for stainless CRR has been accepted.

## 5.5 Fabrication

The Concrete Reinforcing Steel Institute (CRSI) provides requirements for fabrication. The bar leg dimensions provided on the bar list of the Plans are measured out-to-out and are projected to the out-to-out tangent point of the bend radius. Fabrication tolerances are provided in the *Reinforcing Steel Institute of Canada Manual of Standard Practice*. Generally, bars are bent at a constant radius and not at kink points.

- Straight bars must not exhibit gradual bends or sweeps.
- Bar deformations (ribs) must not show loss of depth or other mechanical damage.
- Bars must not exhibit burrs or laminations.
- Stainless CRR must be free of iron contamination as specified. Iron contamination is caused when steel particles become embedded into stainless bars through the fabrication process. These particles are small, and contamination generally occurs on the surface of the bar deformations since these are handling contact points during straightening and bending operations.

The Inspector must review the *Reinforcing Steel Institute of Canada Manual of Standard Practice* and, prior to reinforcing steel delivery, be aware of the fabrication tolerances.

## 5.6 Shipping, Handling, Initial Inspection and Storage

Shipments arriving at site must be protected from the elements and be tagged. The information on the tag typically includes the fabricator's name, customer's name, job number, mark, number, size, quantity, grade, type, length, bend class, run number, number of bundles and other information.

The Inspector's role includes the following:

- Confirm that each shipment of reinforcing steel has been protected during transport. Bars that have not been protected may be contaminated by road salt and sand, which is detrimental to bond and can consequently reduce the life expectancy of the concrete. Bundles are usually protected with tarps or shrink-wrap, but may also be protected by transporting in enclosed trailers. If tarps are used, confirm that they are secure with no breaches.
- Confirm that reinforcing steel is not placed if there will be a planned disruption to the Work, such as a winter shut-down.
- Confirm that spreader bars are used to prevent sagging, which results in bar-to-bar abrasion with long bundles. Bundles or bars must not be dragged to avoid contamination and damage. Bundles must be stored on platforms to prevent contamination.
- Confirm that the heat numbers on the shipment tag match the heat numbers on the reviewed and accepted mill test reports. Confirm that the marks rolled into CRR bars match the information provided on the mill certificates and testing reports. If the heat numbers or bar markings do not match the documentation, then the reinforcing steel material properties have not been accepted. Such reinforcing steel must not be incorporated into the Work.
- With the Contractor's cooperation and assistance, remove one or more sample bars from a bundle for each bar type to confirm dimensions. For straight bars, confirm that the bars are the correct diameter and length. Measure all legs for bent bars, confirming that the out-to-out dimensions match those of the bar list from the Plans. To measure out-to-out dimensions for bent bars, it will be necessary to use a projecting straight-edge to locate the curve tangent

point. After dimensions have been verified, confirm that protection to the bundle is reinstated. It is important to check reinforcing steel dimensions as soon as the materials arrive on site and well before placement.

- Confirm that only one type of CRR is supplied to the project (either carbon/chromium or stainless).

## 5.7 Placing and Fastening

The Inspector's role during this stage is critical. Improperly placed or fastened reinforcing steel may significantly affect the intended performance and durability of the structure.

### 5.7.1 Bar Condition

Reinforcing steel must be free of all foreign materials before being placed. Bond strength can be greatly compromised by contaminants.

Plain reinforcing steel will seldom appear 'black' or metallic in appearance. After fabrication, transportation and storage, it is natural for plain reinforcement to exhibit a surface oxide that is light orange-brown in colour. This oxide is easily removable by hand or brush and has the appearance of a fine dust. Generally, a light rust covering is not detrimental to bond, and bars exhibiting this type of oxide may be accepted. If in doubt, the Inspector must discuss the nature of rust with the Project Manager.

Plain reinforcing steel may exhibit loose, flaking rust, which is dark brown in colour and is dissimilar to the surface oxide described above. Often, loose rust results in pitting and section loss to the bar. Such bars may have been exposed to the elements for a considerable length of time. <u>These bars must not be accepted</u>.

Oil and paint will reduce bond and must be removed. Form release oil may inadvertently be sprayed onto bars. Forms must always be oiled prior to the placement of reinforcing steel.

Mud is a typical contaminant commonly tracked onto in-place reinforcing steel by workers. Temporary wooden platforms, wash stations or other means must be employed to keep reinforcing steel surfaces clean of mud. <u>Prevention is much more effective than cleaning</u>.

The Inspector must:

- Thoroughly inspect reinforcing steel for any contamination before it is placed and prior to concrete placement. It is very difficult to clean bars and to inspect the cleanliness of bars once they are in place.
- Inspect placed bars for straightness and correct positioning/location.
- Inspect bars for laminations, burrs and damage to deformations.
- Inspect stainless CRR for discolouration, staining and iron impregnation.

### 5.7.2 Bar Placement

Often, reinforcing steel needs to be carried by hand from the storage area to the element being constructed. It is important that the reinforcing steel not be dragged along the ground.

The work of placing and tying reinforcing steel is specialized. The Contractor typically subcontracts this work to placers, called "rodbusters", for reasons of efficiency.

#### 5.7.2.1 Bar Tying

The performance of the structure depends upon accurate reinforcing steel placement. Reinforcing steel cages may either be assembled by tying them in place or by pre-assembly. Piles, columns, abutment seats and pier caps are commonly pre-fabricated. Wingwalls, backwalls and decks are usually tied in place.

Pre-assembly is almost always done at the site, and it allows the Contractor to construct cages without the access restrictions caused by formwork. Pre-assembly also permits the use of jigs, which results in more accurate placement. It also allows formwork to be constructed concurrently with cage pre-assembly, which can improve scheduling. After fabrication is complete, the cage is “flown-in” using a crane. Prior to placing the cage, it is very important that the bar count, bar spacing and overall cage dimensions have been carefully checked. It is very difficult to correct the cage after it is installed into the form.

Bars that are tied in place are usually laid out, spaced and then tied. The bar count and bar spacing must be thoroughly checked for accuracy before tying. It is important to confirm the accuracy of lower layers or “mats” before installing reinforcing steel for the upper mat.

#### 5.7.2.2 Bar Support

Cover is maintained by use of bar supports or spacers, typically called “chairs”. <u>It is extremely important that reinforcing steel be spaced from the forms to obtain the minimum clear cover specified.</u> The most common direct cause of concrete rehabilitation for existing structures is the lack of reinforcing steel cover. The Plans identify the minimum cover; it is not permissible to apply a tolerance to this value. There is no practical way to re-establish cover after concrete has been cast. Surface treatments or toppings do not provide a durable alternative to the provision of proper cover.

Chairs are used both to provide cover to forms and to separate bar mats. Chairs are typically made of high-impact and chemically-resistant polypropylene; however, precast block chairs are required for exposed faces of curbs, barriers and medians. The CRSI maintains and publishes standards relating to strength of chairs, to which manufacturers must comply. Two important considerations need to be made by the Contractor when selecting the chairing system: 1) the ability of the chairs to support or secure the reinforcing steel in position, and 2) the workability and consolidation needed for concrete to come into complete contact with the chair’s surfaces.

- **Polypropylene chairs** are typically used to support deck mats and lighter cages. They are available in standard heights and each support only a single bar, but some chairs may support a single bar for both a top and bottom reinforcing steel mat. Chairs must be placed in a regular pattern consistent with manufacturer’s requirements. Many different types of plastic chairs are available to contractors. Chairs vary in strength and in detail.
- **Polypropylene slab bolsters** are a type of continuous chair that supports multiple bars in the same mat. An advantage of bolsters is their ease of installation and reduction in the overall number of chairs. These chairs are typically used for large areas, such as decks. However, without proper care and attention, bolsters can be placed more haphazardly and less systematically than single chairs. Due to their length, bolsters may create an obstruction to concrete movement, and honeycombs and voids can result if concrete is not sufficiently workable to fill the voids beneath the bolster line. Bolsters vary in type and only certain types are permitted by the Department.
- **Precast block chairs** are used at exposed concrete surfaces where durability is critical. Precast blocks are also used to chair heavy cages, like abutment seats and pier caps. Precast

chairs must strictly meet all strength and durability properties of the class of concrete being placed. Chairs for barriers, curbs and median faces must be pre-fabricated by an approved supplier. It is very important that the exposed face of these chairs be carefully aligned with the form face, otherwise a weak concrete paste layer will exist at the finished face.

- **Circular chairs or "wagon wheel" spacers** are used primarily for piles, columns or other pre-assembled cages that are "flown-in" to the formwork. Circular chairs rotate as they move along a form or an excavation, maintaining cover during cage installation.
- **Support bars or "carry bars"** are typically heavy bars, not required by design but proposed by contractors to support other bars efficiently and with minimal chairing. Support bars must be of the same type and must maintain all cover and clearance requirements. They are only permitted if approved by the Project Manager. No additional payment is made for these additional bars.

#### 5.7.2.3 Field Bending and Cutting

Bars must be bent and sheared only at the fabrication facility.

Bars may not be field bent. Certain bar materials, such as carbon/chromium CRR, have high strengths that make them sensitive to micro-cracking. Bars projecting from concrete that are field-bent are susceptible to cracking or embrittlement. Bars that are bent abruptly at the location where they project from concrete may no longer meet their minimum design radius. If bars are field-bent, it is extremely difficult to visually detect cracks and Non-Destructive Testing (NDT) methods are needed to determine if damage exists.

Bars may not be flame cut. Special shearing and sawing equipment is required to cut reinforcing steel.

#### 5.7.2.4 Inspector's Role

Reinforcing steel inspection is required at delivery, placement and during concrete placement. The Inspector must:

- Check reinforcing steel position immediately after the first bars of an element are placed and tied. It is undesirable to wait until reinforcing steel for an entire element is placed before checking it. Bottom mats become very difficult to correct after top mats have been placed.
- Confirm that lap splicing is only done where shown on the Plans. Any additional splicing must be approved by the Project Manager.
- Check chairing before reinforcing steel placement to confirm correct cover and spacing. Chairs must acceptably support the weight of the reinforcing steel and be sufficiently strong to resist movement as a result of worker activity or concrete placement.
- Confirm that ties are securely made, at the frequency specified, and using the correct type of wire.
- Be aware that bar substitutions require the Project Manager's approval.
- Be aware that at congested areas, bars must be spaced so that they may be adequately covered by concrete at all surfaces. It is important that the coarse aggregate in the concrete is able to flow between and encapsulate all bars.
- Perform a pre-pour inspection of the completed reinforcing steel installation. Bars may have shifted, become contaminated or otherwise become noncompliant due to worker activity. The Contractor must not be permitted to begin placing concrete until the Inspector's pre-pour inspection is complete and any identified non-conforming Work has been rectified. The Contractor must not be permitted to begin placing concrete if reinforcing steel placement and

tying is still occurring at the element. All Work must be inspected and deemed acceptable by the Inspector before concrete placement may begin.

- Conduct the pre-pour inspection systematically. It is very difficult to track checked bar without the aid of a Plan drawing that is “checked-off” as the Work is inspected. Bar numbers, sizes, positions and cover must be recorded accurately during checks.

## 5.8 Acceptance Criteria of Stainless CRR

Stainless CRR that exhibits staining, discolouration or iron impregnation in excess of that permitted by the specifications must not be incorporated into the Work. Acceptance must be deferred to the Project Manager. Stainless CRR exhibiting mechanical damage such as crushed deformations is not acceptable.

Government of Alberta ■ Transportation

**Bridge Construction Inspection Manual 2015**

Section 5 – Reinforcing Steel Check Sheet

Project Name:

Date:

Time:

Project No.:

Bridge File No:

Inspector:

Stage of Activity:

Element:

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | | Have the specifications and drawings been reviewed? | ☐ | |
| 1.2 | | Were lap lengths adequate? | ☐ | |
| 1.3 | | Was the mass of reinforcement recorded for unit price payment? | ☐ | |
| **2** | | **Delivery Inspection** | | |
| 2.1 | 5.3 | Did all reinforcing steel bundles have tags and markings that matched the accepted mill test certificates? | ☐ | |
| 2.2 | 5.5 | Were bundles acceptably protected during transport? | ☐ | |
| 2.3 | 5.4 | Did bars meet the dimensional requirements on the Plans and were they within acceptable fabricating tolerances? | ☐ | |
| 2.4 | 5.5 | Were stored bundles adequately protected? | ☐ | |
| 2.5 | 5.5 | Were bundles unloaded so as to prevent bar-to-bar abrasion? | ☐ | |
| 2.6 | 5.4 | Did bars exhibit damage to deformations during fabrication or handling? | ☐ | |
| 2.7 | 5.6 | Did bars exhibit staining, discolouration, corrosion, iron contamination or any other foreign contamination? | ☐ | |
| **3** | | **Placing Inspection** | | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.1 | 5.6 | Were any bars field cut or bent? | ☐ | |
| 3.2 | 5.6 | Were bars placed accurately? | ☐ | |
| 3.3 | 5.6 | Were bars tied securely at the specific spacing and with the appropriate tie wire? | ☐ | |
| 3.4 | 5.6 | Were support chairs of adequate strength, frequency and correct type? | ☐ | |
| 3.5 | 5.6 | Was cover adequate? | ☐ | |
| 3.6 | 5.6 | Were support chairs seated firmly against forms? | ☐ | |
| 3.7 | 5.7 | Did lapped splice lengths comply with drawings? | ☐ | |
| 3.8 | 5.6 | Did bar counts comply with drawings? | ☐ | |
| 3.9 | 5.6 | Did bar sizes and lengths comply with drawings? | ☐ | |
| 3.10 | 5.9 | Did bars exhibit site contamination? | ☐ | |
| 3.11 | 5.6 | Were all non-compliant conditions rectified prior to concrete placement? | ☐ | |
| 3.12 | 5.10 | Was the mass of all reinforcing steel placed recorded for payment? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **4** | | **Post-pour Inspection** | | |
| 4.1 | 5.6 | Did any locations exist where cover was inadequate? | ☐ | |
| 4.2 | 5.4 | Were any bars field-bent without approval? | ☐ | |
| 4.3 | 5.6 | Were any bars contaminated with concrete paste? | ☐ | |
| 4.4 | 5.7 | Did any bars lack necessary projection? | ☐ | |

**Details and Summary:**

Signature

Date

5.1 Proper storage of plain reinforcing steel on timber dunnage in dry location.

5.2 Abutment seat formwork and plain reinforcing steel.

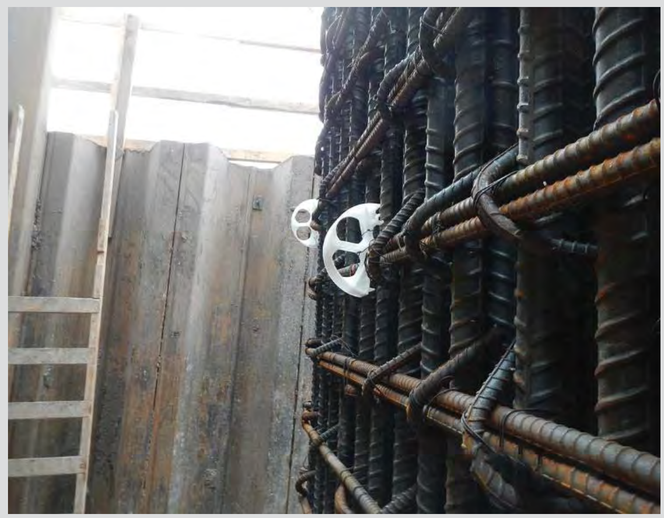
5.3 Pier pile cap formwork and plain reinforcing steel.

5.4 Pier strut consisting of plain reinforcing steel.

5.5 Wingwall reinforcing steel. CRR projecting for barriers.

5.6 Pier column plain reinforcing steel.

5.7 Pier shaft plain reinforcing steel. 50 mm wagon wheel chairs attached at open face.



5.8 Pier shaft plain reinforcing steel. Wagon wheel chairs attached.

5.9 Crews tying and placing first mat of deck reinforcing steel.

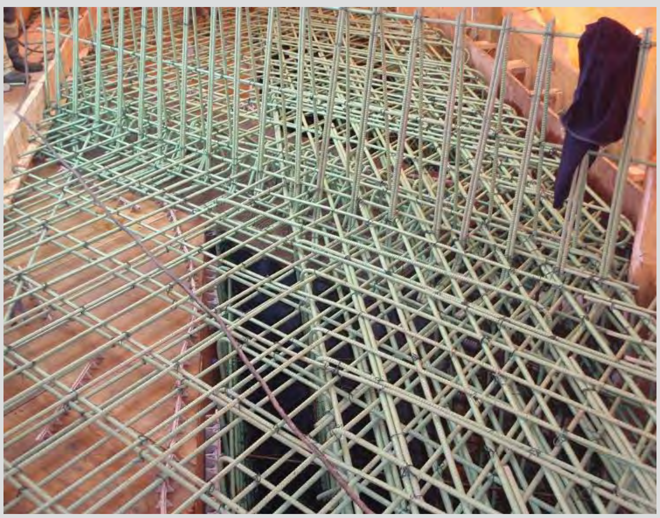
5.10 Deck and barrier CRR placed on precast concrete deck panels.

5.11 Crews tying barrier CRR.

5.12 Improper chair placement and broken or crushed chairs. Chairs may impede consolidation and may cause honeycomb.

5.13 Improper chair placement or inadequate consolidation does not allow concrete to flow and may cause honeycombing.

5.14 CRR showing iron contamination. Contamination is caused during fabrication but corrosion may begin at the project site.



5.15 Reinforcement detail at abutment diaphragm section. Bars are heavily congested in these areas. Special attention is required during concrete placement and vibration.

# SECTION 6

# STRUCTURAL STEEL

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## 6.1 Structural Steel – Erection General

Erection of structural steel includes bridge girders, diaphragms and bracing, deck joint assemblies, and other structural steel components. The work also includes accommodation of traffic if required, and the protection of the environment.

Steel girder erection is an activity that requires a highly experienced and knowledgeable Contractor. Damage to girder units can be caused by improper handling and erection. The Inspector must confirm that proper methods and techniques are being implemented.

Various methods are used to erect steel girder units. Most commonly, girders are erected by mobile or crawler type cranes. Cranes often require the closure of roadway travel lanes or the construction of berms within a watercourse. Where crane capacities are exceeded by longer spans or where cranes cannot be used, girders can be installed using a launching system.

## 6.2 Environmental Considerations

The Inspector must be aware of the following environmental considerations:

- All berm work, temporary pilings, shoring towers and falsework must be acceptably removed within the time frames specified.
- The Contractor must leave the bridge site, roads, watercourse channel and adjacent property in an acceptable condition.

## 6.3 Safety Considerations

It is important to conduct a pre-girder erection meeting with the Contractor to discuss all traffic and safety issues. The Inspector must be aware of the following constraints:

- Girders may tip from steering dollies during transport, creating a hazard to the public. Access must be safe and a site inspection must be done prior to delivery.
- Girders may tip if not properly stored on timber blocking.
- Many hazardous situations exist with cranes, including tipping, collision, falling loads and contact with overhead power lines.
- Access to the Work may involve ladders, scaffold and aerial platforms. Lifelines and fall protection equipment will be required. Proper training is needed for these activities.
- Trip hazards exist when walking on or near steel girder shear studs.
- Erection work is often done during nighttime when darkness creates traffic and tripping hazards.
- Load swings over traffic create an unacceptable risk and are not acceptable. Traffic stoppage at night increases the risk of vehicle incidents.
- Catastrophic failure of girders due to inadequate temporary bracing creates a dangerous situation for workers and the travelling public.
- Cylindrical erection pins may fall from connections and impact traffic below.

## 6.4 Pre-Erection

### 6.4.1 Delivery

The Inspector must be aware of the delivery schedule of girders and confirm with the Project Manager that the girder units have been accepted for shipment. As the girders arrive at the site, the Inspector must confirm that the girders are acceptable for erection.

The girders must be free of contaminants, such as road salt and other staining. It is very difficult to clean girders at the site, especially during freezing conditions. The Contractor must be encouraged to protect the girders during transport, as is practical. Girders exhibiting staining or evidence of road salt and other contaminants will require high pressure washing or sandblasting.

The Contractor must demonstrate, through field-cured concrete test specimens if necessary, that the substructure concrete has achieved sufficient strength to place girders.

Girders are sometimes unloaded and temporarily stored on site before they are erected into position. Girders must be supported on timber blocking at the bearing points and never directly onto the ground or onto concrete or steel blocks. The timber blocking must be sufficient to support the weight of the girders, and the ground must be level and unyielding. The girders must be supported so that the bottom flange does not twist, and the girder web must be plumb at all times.

After unloading, the Inspector must confirm that the girders are free of scratches and nicks. A thorough inspection is required since even small defects can result in subsequent cracks.

After girders are properly blocked or erected, the Inspector must confirm that the girder sweep tolerance is not exceeded.

If girders are not transported and stockpiled in the upright position, the Inspector must confirm that the Contractor’s submission for alternate delivery, handling or storage has been accepted.

Heat-straightening of distorted girders requires special procedures and may not be done at the site without approval from the Project Manager.

### 6.4.2 Erection Procedure

Girders are commonly erected using mobile or crawler type cranes. Short girders and light sections such as bracing are typically erected using a single crane. A spreader bar is used to lift the girder at each end using one crane. The erection crew assists with positioning the girder by using taglines. Longer girders and heavier sections are typically erected using two cranes.

Erection of heavy or deep girders may require large cranes. Certain sites are not conducive to erection by crane due to traffic, swing radius or watercourse limitations. Alternatively, girders may be erected by launching. Launching systems may include launching girders or trusses and a restraining system that are specially designed for the site.

Full bolting of girder splices is completed after erection. Cylindrical erection pins are used to align holes. Shoring towers or other temporary falsework is required to temporarily support a girder end until the splice is completed.

The Contractor must prepare and submit an erection procedure to the Consultant for review. Prior to the start of erection, the Inspector must confirm with the Project Manager that the Contractor’s procedure has been accepted. The Inspector must thoroughly review and understand the details of the procedure. The Inspector must promptly notify the Project Manager if the Contractor deviates from the accepted procedure. Important aspects of the procedure that the Inspector must review include:

- **Traffic Accommodation**: Girder erection often requires complex traffic accommodation, including lane closures and cross-over detours. Girder erection is often done during off-peak nighttime hours when lighting and flashers are required. The Inspector must check that all traffic control devices are installed, according to the Contractor's Traffic Accommodation Strategy (TAS). The Inspector must monitor the effectiveness of the traffic control devices and require changes if danger to workers or the public is observed. Protection measures are required to prevent vehicles from entering the closed work area, including barricades and typically water-filled barriers. The Inspector must confirm that the swing radius of the crane does not result in loads being over traffic. Generally, it is not permitted to stop traffic at any time, but short stoppages are sometimes permitted if stated in the Special Provisions. The Inspector must confirm that all flagging and signage is in place to effectively warn motorists of the stoppage. The Inspector must record details of traffic disruptions and queues, and must promptly report all traffic incidents to the Department.

- **Survey Layout**: Prior to girder erection, the Contractor must lay out the actual centre points of all bearings and confirm the distance between adjacent bearings. The as-built survey information must be examined to confirm that the bearings are correctly located with respect to the stationing of the control line. The Contractor must also survey the actual elevations of all bearing recesses and determine shim and grout pad thickness requirements. The Inspector must check all survey work of the Contractor.
- **Crane Position**: The cranes must be set up as shown in the erection procedure to ensure that the intended swing radius and lifting capacity are maintained. Reference measurements must be taken by the Contractor to confirm that crane locations are accurate. The Inspector must also check the crane positioning. Crane outriggers must bear on adequate foundations and, if soft soils exist, may require the use of timber mats to distribute loads. Protection to existing roadway surfacing is required before setting outriggers. Cranes are sometimes set-up on river ice, which requires special precautions and testing requirements that must be described in the Contractor's erection procedure.
- **Lifting**: It is important that girders are lifted only at their designated lift points. Girders must not be modified upon arrival at the site by drilling or field welding to accommodate lifting devices. Only non-marring lifting tongs may be used. Girders must be kept in the vertical position at all times to prevent damage.
- **Shoring Towers**: Temporary shoring towers and ground improvements must be constructed as described in the girder erection procedure. Towers may not be removed until the girder splice locations have been confirmed to be at their design elevations.
- **Temporary Bracing**: It is necessary to temporarily secure girders to the substructure elements. This is especially important prior to the installation of diaphragms and braces, and when the bridge is on a grade. The girders are normally secured with temporary angle braces that bolt to the substructure. The Inspector must confirm that the temporary bracing is installed and removed as detailed in the Contractor's erection procedure.

## 6.5 Assembly

Assembly of the structural steel members must be done accurately as shown on the Plans, and in a manner that will prevent bending or damage to the steel. During erection, the diaphragms, braces and splices are pinned and bolted to a snug-tight condition so that all components are secured. Prior to bolt tightening, the Inspector must confirm the following:

- All components must be assembled in accordance with the match marks established at the shop. Misfits encountered in the field must be reported to the Project Manager for further review. Before installing and securing splice plates, the faying surfaces must meet the conditions of cleanliness required by the specifications and must be free of all dirt, oil, loose scale, burrs, pits, paint or lacquer.
- After the steel girders are erected and the splice locations loosely pinned and bolted, all shims, wedges or jacks used to support the steel on the falsework must be removed or lowered such that the steel girders are carrying their own weight.

- The Contractor must perform a survey of the erected girders to check the top of the girder elevations at all bearing locations and at all splice locations. Adjustments to the bearing shim stack heights and rotation of the splice locations may be necessary to achieve the design elevations. The Contractor must make corrections to the girder locations and elevations until the elevations are correct.
- After all adjustments have been made, the Inspector must record the actual bearing grout pad depths at each bearing location. If the pad heights are out of tolerance, a proposal for corrective action from the Contractor with acceptance from the Project Manager is needed.
- The Contractor may begin bolt tightening only when the Inspector confirms that all of the girder elevations and locations at the bearing and splice locations are correct.

## 6.6 High Strength Bolted Connections

High tensile strength bolts are used in bolted connections and tightened to a very high tension, which clamps the joined plates between the head and the nut of the bolt. This clamping action enables the load to be transferred from one plate to the other by friction with no slip, thus producing a rigid joint. The frictional resistance is transferred over a relatively large area, reducing local stresses at the holes. In addition, the high initial tension prevents the nuts from loosening over their service life.

Frictional resistance depends on the amount of initial tension in the bolt, therefore it is essential that proper tightening be done to develop adequate clamping forces. Special attention must be given to installing and tightening high strength bolts. The Inspector must consider the following:

- The Contractor must tighten the bolts to produce the minimum tensions required. Tightening must always be done by the “turn-of- nut” method.
- The Contractor must use a Skidmore Tension Calibrator or other approved device capable of measuring bolt tension to verify that the specified bolt tension has been achieved by the “turn-of-nut” method. The torque wrench must be calibrated to this device for each bolt lot or at minimum on a daily basis. The Contractor must check torque for at least 10% of all bolts.
- The Inspector must visually check all bolts at splice locations to confirm that the bolts are the same size, grade and condition as those used in the torque wrench calibration device. The Inspector must confirm that all bolts have been tightened to the specified values.
- For sloped surfaces, bevelled washers must be used. The bevelled washers must be designed to produce a bearing surface normal to the bolt axis.
- At splice locations, bolts are to be tightened at the centre first, working progressively outwards. Each bolt must be tightened to a tension of at least 5% but not more than 10% greater than the specified minimum tension. All bolts must be tightened in the sequence specified.
- Bolts may be tightened by turning either the nut or the head of the bolt, provided that a washer is used at the tightening end.

### 6.6.1 Tightening by the “Turn-of-Nut” Method

The “turn-of-nut” method of tightening assures proper tension by imposing a set amount of strain (lengthening) in the bolt. The bolts are first tightened snugly to ensure full contact of jointed parts, and the nut (or bolt head) is then turned a further specified amount. The nut moving along the pitch of the thread forces the bolt to stretch, thus developing the required tension in the bolt. The amount of rotation required depends on the length of the bolt.

In using the “Turn-of-Nut” method, the Contractor must snug-tighten enough bolts to ensure that the parts of the joint are brought into full contact.

All bolts must be tightened to the minimum bolt tension by rotating the nut or bolt head through the required portion of a turn, working systematically from the most rigid part of the joint to its free edges.

During tightening, there should be no rotation (“wheeling”) of the bolt head or nut.

The Inspector must confirm that the joints are being properly snugged, and that the required rotations are being achieved. The Inspector must also visually confirm that 10% of all bolts have been checked for tightness with a torque wrench. This must be done continuously as the work proceeds. The Contractor’s rotation marks must be neatly applied, and must be made using indelible paint.

## 6.7 Deck Joints

Deck joints are required for major bridges with non-integral abutments. Deck joints are installed across the openings between the bridge deck and abutment, and can also be located over piers. They accommodate thermal, creep and live load movements.

Deck joints have a deck and abutment side and are shipped as assembled units. The deck joint assemblies must remain joined together, wrapped and adequately supported on timber until they are installed.

Deck joints are installed into blocked-out sections of the deck and abutment. They must be installed with care to avoid damage to the galvanized coating, where applicable.

### 6.7.1 Types of Deck Joints

**Finger plated deck joints** are common on longer spans. Details for fabrication and installation are shown on Standard Drawings S-1638, S-1639 and S-1640. These deck joints consist of a finger support plate attached to the girders that engages finger plates on both the deck and abutment sides. Finger plate deck joints allow water to pass through the joint, requiring a drainage system below the joint. This typically consists of a stainless steel trough that directs water away from the substructure. Proper fabrication and installation of these joints is critical for the joint to function as intended.

**Type 1 strip seal deck joints** consist of two extruded metal flanges with keyways that are designed to accommodate a replaceable, flexible gland. Stop-movement bars prevent the joint from closing beyond a minimum gap. Details for fabrication and installation are shown on Standard Drawings S-1810, S-1811 and S-1812. The extrusions are cast into the concrete on both deck and abutment sides using studs for anchorage.

**Cover plated strip seal deck joints** are similar to Type 1 joints, but they utilize a steel plate above the strip seal to protect it from punctures. Details for fabrication and installation are shown on Standard Drawings S-1800, S-1801 and S-1802.

### 6.7.2 Installation of Deck Joints

The Inspector must consider the following for proper deck joint installation:

- Deck and backwall reinforcing steel must be carefully adjusted to accommodate deck joint anchor studs.

- It is important that the deck joints be properly aligned, set to required elevation and gapped prior to concrete placement.
- Where applicable, field welding at the specified splice location must be done in accordance with Section 13 of the *Standard Specifications for Bridge Construction*. Damaged galvanizing is to be repaired to the requirements of ASTM A380.
- The girder temperature must be measured at the bottom flanges to determine the appropriate gap from the gap setting table shown on the Plans. The gap is normally measured on the square of the joint for skewed bridges.
- Placement of Class HPC concrete for deck joint block-outs requires careful attention to concrete quality control.
- Placement of block-out concrete requires that concrete completely fills the space beneath the extrusions. Care must be taken to precisely follow the requirements specified on the Standard Drawings.
- Concrete at block-outs must be finished slightly proud of the extrusions so that the extrusions are recessed 6 mm, to avoid future damage by snowplows.
- Special finishing and curing requirements exist for block-out concrete.
- It is important that the deck joint to erection angle bolts be loosened after the concrete is placed so that joint movement can occur before the concrete sets.
- Care must be taken to accurately install the strip seal into position, especially at skewed bridges. The Inspector must confirm that the strip seal is not torn and that it is turned-up at the ends. The Inspector must witness the flood test performed by the Contractor.

Government of Alberta
Transportation

**Bridge Construction Inspection Manual 2015**
Section 6 – Structural Steel Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

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| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | | Have the specifications and drawings been reviewed? | ☐ | |
| 1.2 | | Were the substructure elements surveyed prior to girder erection? Were all discrepancies of the Contractor's layout reported to the Project Manager? | ☐ | |
| 1.3 | | Were the erection procedure and the falsework details approved by the Project Manager? | ☐ | |
| **2** | | **Structural Steel Erection** | | |
| 2.1 | 6.3.1 | Transportation, Handling and Storing Materials – If girders and beams were not transported in the vertical position, did the Contractor submit calculations and associated sketches, signed and sealed by the engineer who performed the analysis to the Project Manager for review two (2) weeks prior to shipping? | ☐ | |
| 2.2 | 6.3.1 | Did the Contractor, in the presence of the Inspector, check the elements prior to erection, and was an adequate flat storage area provided for the inspection? | ☐ | |
| 2.3 | 6.3.1 | Did the Contractor immediately report and provide an engineering assessment report, prepared by a professional engineer experienced in evaluation and inspection of damaged steel members, for any structural steel member damaged during transportation?<br>Did the Inspector arrange for an independent inspection and assessment of the damaged member? | ☐ | |
| 2.4 | 6.3.1 | Was material stored on timber blocking, kept clean and stored in a properly drained area? | ☐ | |
| 2.5 | 6.3.1 | Were girders and beams placed upright and adequately shored? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.6 | 6.3.1 | Were long members, such as deck joint assemblies, buffer angles, columns and chords, supported on timber blocking to prevent damage from deflection? | ☐ | |
| 2.7 | 6.3.1 | Was galvanized material handled and stored as per Section 12.2.8 of the SSBC? | ☐ | |
| **3** | | **Bridge Girders** | | |
| 3.1 | 6.3.2.1 | Did the Contractor prepare and submit drawings for the Project Manager's review for temporary supporting structures and berms, where applicable? | ☐ | |
| 3.2 | 6.3.2.1 | Were all temporary supporting structures and/or berms removed from the stream channel prior to spring break-up or runoff periods? | ☐ | |
| 3.3 | 6.3.2.1 | Did the Contractor repair any damage to property resulting from the existence of berms? | ☐ | |
| 3.4 | 6.3.2.2 | Was a detailed erection procedure submitted to the Project Manager? | ☐ | |
| 3.5 | 6.3.2.2 | Does the erection procedure bear the Seal of a Professional Engineer registered in Alberta? | ☐ | |
| 3.6 | 6.3.2.2 | Did the Project Manager schedule a pre-job meeting with the Contractor's project manager and field superintendent prior to commencement of any field work? | ☐ | |
| 3.7 | 6.3.2.2 | Did the Contractor 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 reviewed layout plan? | ☐ | |
| 3.8 | 6.3.2.3 | Did the Contractor provide 100% fall protection and a safe work procedure for girder erection and deck formwork? | ☐ | |
| 3.9 | 6.3.2.4 | Did the Contractor submit a detailed procedure for the straightening of plates, angles or other shapes to the Department and Project Manager prior to any straightening being done? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.10 | 6.3.2.4 | Following the accepted straightening of a bend or buckled material, was the surface of the metal carefully inspected for evidence of fractures, including any non-destructive testing deemed necessary? | ☐ | |
| 3.11 | 6.3.2.5 | Were the parts accurately assembled and with all match-marks followed? | ☐ | |
| 3.12 | 6.3.2.5 | Was the material carefully handled to avoid damage?<br>Note: Hammering, which will damage or distort the members, is not permitted. | ☐ | |
| 3.13 | 6.3.2.5 | Were bearing and faying surfaces cleaned before the members were assembled? | ☐ | |
| 3.14 | 6.3.2.5 | Did splices and field connections have 1/2 of the holes filled with bolts and cylindrical erection pins before bolting? | ☐ | |
| 3.15 | 6.3.2.6 | Did bolted parts fit solidly together when assembled? | ☐ | |
| 3.16 | 6.3.2.6 | Were contact surfaces, including those adjacent to the washers, de-scaled, and were contact surfaces free of dirt, grease, burrs, pits and other defects? | ☐ | |
| 3.17 | 6.3.2.6 | Were bolts in exterior girders installed with the heads on the outside face of the girder web and on the bottom faces of lower flanges? | ☐ | |
| 3.18 | 6.3.2.6 | For bolts that were partially embedded in concrete, were the nuts located on the side of the member that was encased in concrete? | ☐ | |
| 3.19 | 6.3.2.6 | Were connections assembled with a hardened washer under the bolt head or nut (whichever is the element turned in tightening)? Were surfaces of bolted parts in contact with the bolt head and nut parallel? | ☐ | |
| 3.20 | 6.3.2.6 | Were bevelled washers used for sloped surfaces, and were all bolts of new quality stored in weatherproof containers to prevent loss of lubrication or accumulation of dirt? | ☐ | |
| 3.21 | 6.3.2.6 | Were all girder elevations and alignments checked by the Inspector prior to any bolt tightening? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.22 | 6.3.2.6 | Were bolts tightened to at least the minimum bolt tension as shown in Section 6.3.2.6 Table 1 – Bolt Tension of th SSBCe? | ☐ | |
| 3.23 | 6.3.2.6 | Were enough bolts brought to a "snug tight" condition to ensure that the parts of the joint were brought into full contact with each other? | ☐ | |
| 3.24 | 6.3.2.6 | Was additional tightening done based on the specified nut rotation:<br>• 1/3 turn where bolt is 4 bolt diameters or less<br>• 1/2 turn where bolt is over 4 bolt diameters but not 8<br>• 2/3 turn where bolt is over 8 diameters long<br>and using a tolerance of 1/6 turn (60 deg) over, nothing under?<br>*Note: Bolt length is measured from underside of head.* | ☐ | |
| 3.25 | 6.3.2.6 | Were high strength bolts tensioned only once and not reused? | ☐ | |
| 3.26 | 6.3.2.7 | Were any corrections of minor misfits involving any reaming, cold cutting and chipping for secondary members required? | ☐ | |
| 3.27 | 6.3.2.7 | If reaming was required, was it immediately reported to the Department and the Inspector, and did the Contractor submit a repair procedure to the Project Manager for review? | ☐ | |
| 3.28 | 6.3.2.7 | If accepted, were repairs made in the Inspector's presence? | ☐ | |
| 3.29 | 6.3.2.8 | Did the Contractor ensure that the structural steel was maintained in the correct alignment at all times during construction? | ☐ | |
| 3.30 | 6.3.2.9 | Before final acceptance, did the Contractor remove all fill material or temporary supporting structures placed in the watercourse or elsewhere during construction? | ☐ | |
| 3.31 | 6.3.2.9 | Did the Contractor 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 the work? | ☐ | |
| 3.32] | 6.3.2.9 | Was disposal of surplus materials done in a manner and location satisfactory to the Inspector? | ☐ | |
| 3.33 | 6.3.2.9 | Did the Contractor leave the bridge site, roadway and adjacent property in a neatly restored and presentable condition, satisfactory to the Inspector, and when required, provide written evidence that affected property owners or regulatory agencies were satisfied? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.34 | 6.3.2.9 | Was all steel left clean and free of oil, grease, mud, dust, road spray or other foreign matter? | ☐ | |

**Details and Summary:**

Signature

Date

6.1 Steel girder delivery and erection. Spreader bar used for unloading and erecting girders when using a single crane.

6.2 Girders stored at bridge site. Storage of girders is on timber dunnage and free-draining ground.

6.3 Girder erection. Scaffolding shoring towers used at splice connection between girder segments.

6.4 Girder erection. H-pile shoring towers used to support girders at splice connection between girder segments.

6.5 Erecting girder between piers. Spreader bar used to erect girder.

6.6 Temporary bracing, tie downs secured to pier and girder. Diaphragm installation completed prior to release.

6.7 Steel diaphragm bracing installation with crane.

6.8 Splice plate detail. All bolts tightened by turn-of-nut method.

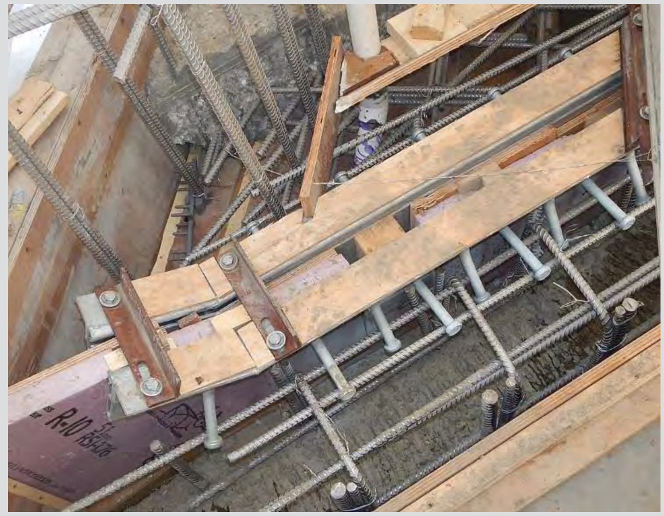
6.9 Bolting of diaphragms. Bolts presently in snug tight position. Tightening of bolts to be done by turn-of-nut method. Bolt markings shown prior to tightening.

6.10 Girder and rocker bearing. Centre line of bearing marked on rocker, base plate and pier cap. Bottom of rocker plate machine-finished.

6.11 Deck joints stored on site and on timber dunnage to prevent damage.

6.12 Deck joint installation. Deck joint gap set in accordance with the “Expansion Gap Setting Table” found in the design drawings.

6.13 Deck joint installation. Deck joint gap set in accordance with the “Expansion Gap Setting Table” found in the design drawings. Erection angles left in place to maintain the required gap.



6.14 Deck joint installation. Deck joint gap set in accordance with the “Expansion Gap Setting Table”. Wood spacer block is to maintain gap.

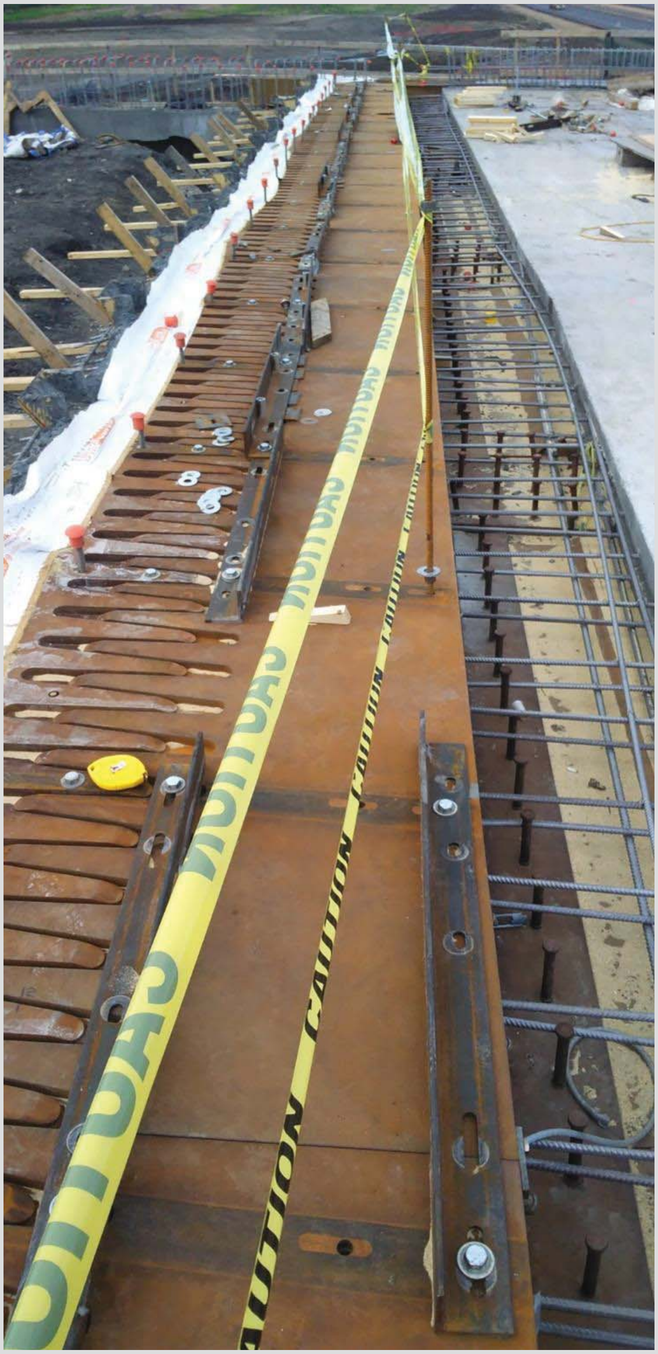
6.15 Checking joint alignment with stringlines and instrument.

6.16 Strip seal type joint temporarily supported.

6.18 Casting abutment side of strip seal deck joint.

6.17 Abutment side coil rod supports shown.

6.19 Finger type joint showing erection angles.



6.20 Finger type joint showing deck-side block-out.

6.21 Galvanized nose plate for river pier protection.

6.22 Damage to galvanized coating during transportation and/or installation. Metallizing repairs completed.

6.23 Steel girder delivery. Girder covered in plastic wrap to protect from road salt and contamination during transportation.

6.24 Fall protection system consisting of uprights and cables used during girder erection and deck overhang bracket installation.

6.25 Steel girders are sometimes erected in pairs and stabilized with steel diaphragms.

6.26 Setting elastomeric bearing. Wood wedges used to adjust and secure the bearing until girder is in place.

6.27 Pancake jack for final adjustment of bearing for temperature and elevation.

6.28 H-pile shoring towers for splicing steel girders. Bearing plate and jack adjust girders to required elevation.

# SECTION 7

## PRECAST CONCRETE UNITS

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## 7.1 Erection of Precast Concrete Units – General

Erection of precast concrete units includes bridge girders, MSE fascia panels, bridge deck panels and miscellaneous precast components. This work also includes traffic accommodation and protection of the environment. Erection for MSE fascia panels is discussed in Section 25, and the erection for bridge deck panels is discussed in the Special Provisions. This section does not include RCP and PCB structures. Standard Drawings exist for girder Types NU, SL, SLW and SLC. Post-tensioning of NU girders is included in this section.

Precast concrete girder erection is an activity that requires a highly experienced and knowledgeable Contractor. Damage to girder units can be caused by improper handling and erection, resulting in girders that may be damaged beyond repair.

## 7.2 Environmental Considerations

The Inspector must be aware of the following environmental considerations:

- All berm work, temporary pilings, shoring towers and falsework must be acceptably removed within the specified time frames.
- The Contractor must leave the bridge site, roads, watercourse channel and adjacent property in an acceptable condition.

## 7.3 Safety Considerations

It is necessary to conduct a pre-girder erection meeting with the Contractor to discuss all traffic and safety issues. The Inspector must be aware of the following safety considerations:

- Girders may tip from steering dollies during transport, creating a hazard to the public. Access should be safe and a site inspection should be done prior to delivery.
- Girders may tip if not properly stored on timber blocking.
- Many hazardous situations exist with cranes, including upset, collision, falling loads and contact with overhead power lines.
- Access to the Work may involve ladders, scaffold and aerial platforms. Fall protection equipment is required. Proper training is needed for these activities.
- Trip hazards exist with projecting reinforcing steel.
- Erection work is often done during nighttime when darkness creates traffic and tripping hazards.
- Load swings over traffic creates an unacceptable risk. Traffic stoppage at night increases the risk of vehicle incidents.
- Catastrophic failure of girders due to inadequate temporary bracing creates a dangerous situation for workers and the travelling public.
- As a post-tensioning strand is pulled or pushed into the duct, it may exit the duct at high speed. Never stand in front of or look into a duct that is receiving strand.
- During stressing of tendons, failure of anchors or strand may occur. Never stand behind the jack during stressing operations.

## 7.4 Pre-Erection

### 7.4.1 Delivery

The Inspector must be aware of the delivery schedule of girders and confirm with the Project Manager that the girder units have been accepted for shipment. The Contractor's post-tensioning procedure including grout mix design, stressing calculations and equipment calibration data must be accepted by the Consultant before post-tensioning work may begin. As the girders arrive at the site, the Inspector must confirm that the girders are acceptable for erection.

The girders must be free of contaminants such as road salt and other staining. It is very difficult to clean girders at the site, especially during freezing conditions. The Contractor must be encouraged to protect the girders during transport, as it is practical. Girders exhibiting staining or evidence of road salt or other contaminants will require high pressure washing.

The Contractor must demonstrate, through field-cured concrete test specimens if necessary, that the substructure concrete has achieved sufficient strength.

Girders are sometimes unloaded and temporarily stored on-site before they are erected into position. Girders must be supported on timber blocking at the bearing points and never placed directly onto the ground or on steel or concrete blocks. The timber blocking must be sufficient to support the weight of the girder, and the ground must be level and unyielding. The girders must be supported so that the girder web is plumb.

After unloading, the Inspector must confirm that the girders are free of cracks, chips, scrapes and spalls. If pigmented sealer has been applied to the girders at the fabrication facility, any damage to the sealer must be repaired by an approved method.

After girders are properly blocked or erected, the Inspector must confirm that the girder sweep tolerance has not been exceeded. Precast girders may sweep due to improper fabrication, transportation or storage. Excessive girder sweep may be corrected by the Contractor; however, corrective measures must be approved.

The Inspector must survey the girders for camber immediately prior to erection and compare the theoretical camber for the girder age with the measured camber. If the camber is out of tolerance, the Inspector must notify the Project Manager.

The Inspector must inspect the girder ends for cracks that may have occurred since they were inspected at the fabrication facility. Cracks that do not met tolerance requirements must be reported to the Contractor and the Project Manager.

### 7.4.2 Erection Procedure

Girders are commonly erected using mobile or crawler type cranes. Short box girders may be erected using a single crane. A spreader bar is used to lift the girder at each end when using a single crane. The erection crew assists with positioning the girder using taglines. Longer girders are typically erected with two cranes.

Erection of long, heavy and deep girders may require large cranes. Certain sites are not conducive to erection by crane due to traffic, swing radius or watercourse limitations. Alternatively, girders may be erected by using a combination of cranes and a launching or erection truss.

Girder diaphragms are either prefabricated of steel and bolted on at the site, or cast-in-place after erection. Sometimes shoring towers are required to temporarily support girders before diaphragms are installed.

The Contractor must prepare and submit an erection procedure to the Consultant for review. Prior to the start of erection, the Inspector must confirm with the Project Manager that the Contractor's procedure has been accepted. The Inspector must thoroughly review and understand the details of the procedure. The Inspector must promptly notify the Project Manager if the Contractor deviates from the accepted procedure. Important aspects of the procedure that the Inspector must review include:

- **Traffic Accommodation**: Girder erection often requires complex traffic accommodation, including lane closures and cross-over detours. Girder erection is often done during off-peak nighttime hours when lighting and flashers are required. The Inspector must check that all traffic control devices are installed according to the Contractor’s Traffic Accommodation Strategy (TAS). The Inspector must monitor the effectiveness of the traffic control devices and require changes if danger to workers or the public is observed. Protection measures are required to prevent vehicles from entering the closed work area, including barricades and water-filled barriers. The Inspector must confirm that the swing radius of the crane does not result in loads being positioned over traffic. It is generally not permitted to stop traffic; however, short stoppages are sometimes permitted if stated in the Special Provisions. The Inspector must confirm that all flagging and signage is in place to effectively warn motorists of the stoppage. The Inspector must record details of traffic disruptions and queues and must promptly report all traffic incidents to the Department.
- **Survey Layout**: Prior to girder erection, the Contractor must lay out the actual centre points of all bearings and must confirm the distance between adjacent bearings. The as-built survey information must be examined to confirm that the bearings are correctly located with respect to the stationing of the control line. The Contractor must also survey the actual elevations of all bearing recesses and determine shim and grout pad thickness requirements. The Inspector must check all survey work of the Contractor.
- **Crane Position**: The cranes must be set up as shown in the erection procedure to ensure that the intended swing radius and lifting capacity are maintained. Reference measurements must be taken by the Contractor to confirm that crane locations are accurate. The Inspector must also check the crane positioning. Crane outriggers must bear on adequate foundations and, if soft soils exist, may require the use of timber mats to distribute loads. Protection to existing roadway surfacing is required before setting outriggers. Cranes are sometimes set up on river ice, which requires special precautions and testing requirements that must be described in the Contractor’s erection procedure.
- **Lifting**: It is important that girders are lifted only at locations where the designated lifting hardware has been cast into the units. Girders must be kept vertical at all times to prevent damage.
- **Temporary Bracing**: It is necessary to temporarily secure the girders to the substructure element. Precast NU type girders may tip if not properly secured. This is especially important prior to the installation of diaphragms and braces, and if the bridge is on a grade. The girders are normally secured with temporary angle braces that bolt to the substructure, and blocks are typically used between the girder ends and backwall at the low end of the bridge. Bearings are often temporarily secured using wooden wedges or blocks, details of which must be submitted by the Contractor for review by the Consultant. The Inspector must confirm that the temporary bracing is installed and removed as detailed in the Contractor’s procedure.

### 7.4.3 Assembly

The Inspector must confirm the following:

- Installation of bolted girder diaphragms is done after girders are erected. Diaphragms must be bolted to the girder webs through inserts that are cast into the webs during fabrication. The diaphragm bolts are tightened to the fabricator’s specifications. After all diaphragms are installed, the Contractor must confirm that final girder sweep is within allowable tolerances.

- The Contractor must perform a survey to check the top of the girder elevations at all bearing locations and at midspan, to determine camber values. Adjustments to the bearing shim stack heights may be necessary to achieve the design elevations. The Contractor must make corrections to the girder locations and elevations until all requirements are met.
- After all adjustments have been made, the Inspector must record the actual bearing grout pad depths at each bearing location. If the pad heights are out of tolerance, a proposal for corrective action from the Contractor, with acceptance from the Project Manager, is needed.
- The Inspector must review the girder surfaces to identify any damage that may have occurred during erection.
- Lifting hardware must be cut off and lifting pockets and holes filled with an approved patching material.
- Projecting stirrup reinforcing steel may not be bent in the field since field bending may cause embrittlement failure.

## 7.5 Post-Tensioning

Post-tensioning is a method of reinforcing concrete using high strength tendons. Post-tensioning includes the fabrication, installation, protection and stressing of tendons, and grouting of ducts. Post-tensioning is normally done for Type NU girders; however, post-tensioning may also be done for pier caps. All post-tensioning is “bonded”, meaning that the tendon is protected by grout that is pumped into the duct under pressure after stressing has been completed.

Post-tensioning requires that the Contractor have specialized knowledge and expertise. The Contractor should utilize site superintendents that possess current Level 2 certification from the Post-Tensioning Institute (PTI), with the minimum required experience in the areas of stressing and grouting. The Inspector must confirm that the Project Manager has accepted the Contractor’s qualifications before the Work begins.

Post-tensioning ducts are cast into girder webs during girder fabrication. The thickened end section of the girder web contains a block-out for the post-tensioning anchor recess. The end of the ducts terminate at a steel anchor plate and trumpet, which guide the tendons and protect the girder web from the high forces experienced during stressing operations. A girder may contain more than one duct. Ducts are placed at a specified parabolic vertical curve within the girder webs.

The Contractor must submit a post-tensioning procedure that includes jack and gauge calibration data, strand data and theoretical tendon elongations. The Inspector must confirm that the Contractor’s submission has been accepted before starting work.

### 7.5.1 Assembly and Installation of Tendons

The term “tendon”, if strictly used, describes the complete system, including the anchorages, pre-stressing strand, duct and grout. The common term “tendon” used in the *Standard Specifications for Bridge Construction* describes the assemblage of individual pre-stressing strands. Tendons are normally assembled on site by drawing strand from a strand dispenser pack and then welding the ends together so that the individual strands can be pulled into the duct simultaneously. A pull cord is normally installed into the duct using compressed air. The tendon is winched into the duct using the pull cord. Alternatively, the strands can be individually pulled or pushed into the duct by attaching a guide cap to the tip of each strand. The Inspector must consider the following during tendon assembly:

- Strand must not be dragged or winched over ground or otherwise be allowed to become contaminated.
- The elongation of the tendon depends on the "E" values of the individual strand. To achieve the design elongation, the Inspector must confirm that the tags on the strand match the "E" value used in the Contractor's elongation calculations.
- Ducts must be clean and dry before tendons are installed. The Contractor's procedure must be accepted prior to the start of work. The Contractor must demonstrate that the ducts are free of obstructions and contamination.

### 7.5.2 Stressing of Tendons

For multi-span continuous bridges, post-tensioning ducts will need to be extended from girder ends at the intermediate diaphragms so that the ducts are continuous. The Inspector must confirm that duct extensions match the geometry shown on the shop drawings. The duct extensions must be secured so that they do not shift or separate during concrete placement. Intermediate diaphragms must be cast before post-tensioning work is done.

Tendons may be stressed from one end of the bridge, or they may be stressed from both ends (called two-stage stressing). Two-stage stressing is normally done when losses due to friction do not result in sufficiently stressed tendons at the non-stressed end. For two-stage stressing, the Contractor provides theoretical elongation values for both the 1st and 2nd stage.

The Inspector must consider the following during tendon stressing:

- Jacks are positioned using a crane or hoist. The Inspector must confirm that the jack and gauge identification numbers match those submitted with the Contractor's calibration data.
- Tendons must be stressed as an assembly and not as individual strands. The Inspector must witness the stressing operation to confirm that the specified jacking pressure has been reached on the gauge. Following this, the actual elongation is measured and recorded. The Inspector must compare the actual values of elongation with the theoretical values provided by the Contractor. If the values differ by more than the allowable tolerance, the Inspector must consult with the Project Manager.
- If the values of elongation are acceptable, the Contractor may proceed to pump grout into the duct. The Inspector must confirm that all strand wedges have gripped the strand and are seated properly into the anchor plate. The strands must project by the length specified, and the strand tails may not be cut off until the successful completion of grouting.
- If stressed tendons are not grouted within 20 days of completion of stressing, strand corrosion inhibitor is required. If ducts will not be grouted for a significant period beyond 20 days, the Project Manager must be consulted. The Inspector must confirm the Contractor's stressing and grouting schedule before tendon assembly. If cold weather suddenly occurs after stressing, it may not be possible to place grout. In some cases where tendons cannot be grouted within a reasonable time period and there is a risk of strand corrosion, it may be necessary to de-stress the tendon to remove it.
- After stressing has been completed, the stressing records must be reviewed and accepted by the Consultant.

### 7.5.3 Grouting of Ducts

The grouting procedure is designed to displace all air from within the duct. It is important that the Contractor's approved grouting procedure be followed precisely. The procedure should include measures that will be taken in the event of grout equipment failure. Grout stiffens quickly, and decisive action must be taken if a breakdown occurs. The Inspector must consider the following during duct grouting:

- The grout mixer and pump must meet the requirements specified, and a back-up pump must be set up to be immediately operational in the event that the primary pump fails.
- The inlet and outlet tubes must have adequate valves or caps capable of withstanding the grouting pressure. The sequence of venting and bleeding grout from the outlets shown on the Contractor's procedure must be strictly followed to prevent air from becoming trapped within the duct. If an outlet tube ruptures after it has been vented and air is introduced into the duct, the Project Manager must be immediately notified for direction. It is important that the Contractor follows the approved grouting procedure in the event of a pressure loss.
- The Inspector must confirm that the Contractor performs grout testing using a qualified and experienced technician and that the frequency of testing is as specified.
- After grouting has been acceptably completed, the strand tails may be cut off and the protective end caps installed.

**Checklist**

**Photographs**

**Government of Alberta ■**
Transportation

**Bridge Construction Inspection Manual 2015**
Section 7 – Precast Concrete Units Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

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| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | | Was the girder erection and post-tensioning procedure reviewed? | ☐ | |
| 1.2 | | Were all bearings and bearing surfaces of girders clean before erection? | ☐ | |
| 1.3 | | Was the security and stability of girders checked as erection progressed? | ☐ | |
| 1.4 | | Were lifting hooks cut off, and all holes and pockets painted? | ☐ | |
| 1.5 | | Was cleanup satisfactorily done and, if private property was involved, was the owner satisfied? | ☐ | |
| **2** | | **Erection of Precast Concrete Girders** | | |
| 2.1 | 7.3.1 | Did the Contractor remove any temporary construction and do all work required to complete the erection in accordance with the drawings and specifications? | ☐ | |
| 2.2 | 7.3.1 | Did the substructure concrete cure for a minimum of three (3) days and achieve 80% of the 28 day specified concrete strength prior to erection of precast girders? | ☐ | |
| 2.3 | 7.3.2 | Were the precast concrete units stored upright, shored on timber blocking, and kept clean? Was the storage area properly drained? | ☐ | |
| 2.4 | 7.3.3 | Did the Contractor prepare and submit drawings for temporary supporting structures and berms and for traffic control and accommodation, to the Project Manager? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.5 | 7.3.3 | If temporary supporting structures and/or berms remained in any watercourse during spring break-up or run-off periods, were all necessary approvals obtained by the Contractor? | ☐ | |
| 2.6 | 7.3.4 | Did the Contractor submit a detailed girder erection procedure to the Project Manager for review? | ☐ | |
| 2.7 | 7.3.4 | Did the drawings contain all the information listed under Section 7.3.4 of the SSBC? | ☐ | |
| 2.8 | 7.3.4 | Did the girder erection procedure bear the Seal of a Professional Engineer registered in Alberta, and was it compliant with the Occupational Health and Safety Act and Regulations? | ☐ | |
| 2.9 | 7.3.4 | Did the Contractor attend a pre-job meeting prior to the commencement of any field work? | ☐ | |
| 2.10 | 7.3.4 | Did the Contractor 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, before erection began? | ☐ | |
| 2.11 | 7.3.5 | Did the Contractor adjust girder position, bearing location and bearing elevation in order to achieve as closely as possible the lines and grades shown on the drawings? | ☐ | |
| 2.12 | 7.3.5 | Did the Contractor minimize any differential camber (girder to girder) and the sweep of the girders, and did he provide the necessary temporary attachments to hold the girders in position? | ☐ | |
| 2.13 | 7.3.6 | After the erection of the girders, were all lifting holes on exterior girders filled with an approved patching material? | ☐ | |
| 2.14 | 7.3.6 | Were all lifting hooks cut off 50 mm below surface and all lifting hook pockets filled with an accepted grout? | ☐ | |
| **3** | | **Post-Tensioning System** | | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.1 | 7.3.7.2 | Were applicable requirements of the current edition of the following standards followed?<br>• CSA A23.1/23.2 – Concrete Materials and Method of Concrete Construction<br>• CSA A23.4 – Precast Concrete Materials and Construction<br>• Section 4 of the Standard Specifications for Bridge Construction<br>• Guide Specification Acceptance Standards for Post-Tensioning Systems – PTI<br>• Specifications for Grouting of Post-Tensioned Structures – PTI<br>• AASHTO LRFD Bridge Construction Specifications | ☐ | |
| 3.2 | 7.3.7.3 | Did the Contractor or the subcontractor have extensive experience in this work and utilize only fully trained, competent and experienced operators? | ☐ | |
| 3.3 | 7.3.7.3 | Was the site supervisor responsible for the tensioning and grouting operations at the site while these operations were being carried out? | ☐ | |
| 3.4 | 7.3.7.4 | Did the Contractor submit post-tensioning drawing and calculations to the Project Manager prior to commencement of post-tensioning work? | ☐ | |
| 3.5 | 7.3.7.4 | Did the Contractor provide information for mill reports and stress strain curves for the stressing strand at least five (5) days prior to stressing? | ☐ | |
| 3.6 | 7.3.7.5 | Did the stressing strand conform to the requirements of Sections 7.2.4.9 and 7.2.5.3 of the SSBC? | ☐ | |
| 3.7 | 7.3.7.5 | Was water-soluble corrosion inhibitor if the stressing and grouting operations were not completed within 20 calendar days of the installation of the stressing steel? | ☐ | |
| 3.8 | 7.3.7.5 | Was stressing steel secured at the ends by means of permanent anchoring devices and compliant to CSA S6-06 Clause 8.4.4.1 accepted by the Inspector? | ☐ | |
| 3.9 | 7.3.7.5 | Did the Contractor provide mortar tight inlets and outlets in all ducts at the following locations?<br>• The anchorage area<br>• All high points of the duct, when the vertical distance between the highest and lowest point is more than 0.5 m<br>• Place an inlet at or near the lowest point<br>• Place free-draining outlet at all low points of duct | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.10 | 7.3.7.5 | Did the Contractor provide inlets and outlets with valves, caps or other devices capable of withstanding the grouting pressure, and were the ducts and vents securely fastened in place to prevent movement? | ☐ | |
| 3.11 | 7.3.7.5 | Did the Contractor provide details of inlets and outlets on the shop drawings? | ☐ | |
| 3.12 | 7.3.7.5 | Was concrete supplied in accordance with Section 7.2.4, with the maximum size of coarse aggregate being 10 mm and 28 day minimum compressive strength of 50 MPa unless otherwise specified? | ☐ | |
| 3.13 | 7.3.7.5 | Was grout 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? | ☐ | |
| 3.14 | 7.3.7.5 | Was a test for wet density performed in accordance with the ”Standard Test Method for Density” ASTM C138? | ☐ | |
| 3.15 | 7.3.7.5 | Was pre-bagged grout packaged in plastic lined bags or coated containers stamped with the date of manufacture, lot number and mixing instructions, and were copies of the quality control data for each lot number and shipment sent to the job site and provided to the Inspector? | ☐ | |
| 3.16 | 7.3.7.5 | Were materials with a total time from manufacture to usage in excess of six (6) months retested and certified by the supplier before use? | ☐ | |
| 3.17 | 7.3.7.5 | Was the average minimum compressive strength of three (3) cubes at 28 days, 50 MPa as per CSA A23.2-1B? | ☐ | |
| 3.18 | 7.3.7.5 | Did the results for bleed test and fluidity test meet the requirements noted in Table 10.9.3-2 of the AASHTO LRFD Bridge Construction Specifications? | ☐ | |
| 3.19 | 7.3.7.5 | Was grout testing in the field completed by a qualified and experienced technician as outlined in Section 7.3.7.5 of the SSBC? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.20 | 7.3.7.6 | Equipment –<br>a) Stressing<br>• Were hydraulic jacks and pumps of sufficient capacity for tensioning of strands?<br>• Was the force induced in the stressing strand measured using calibrated jacking gauges, load cells or a calibrated dynamometer?<br>• Did the pressure gauge have an accurate reading dial at least 150 mm in diameter?<br>• Were the forces to be measured within 25% and 75% of the total graduated capacity of the gauge, unless calibration data clearly established consistent accuracy over a wider range?<br>• Were the measuring devices calibrated at least once every six (6) months? Was the jack and the gauge calibrated as a unit? Was a certified calibration chart kept with each gauge? | ☐ | |
| 3.21 | 7.3.7.6 | Equipment –<br>b) Grouting<br>• Was a high speed shear mixer capable of continuous mechanical mixing and of producing grout that is free of lumps and undispersed cement used? Was the water supply to the mixer measured by an accurate gauge?<br>• Was the holding tank capable of keeping the mixed grout in continuous motion until it is used? Did the outlet to the pump have a screen with 3 mm maximum clear opening?<br>• Was a positive displacement type pump used capable of producing an outlet pressure of at least 1.0 MPa, with a pressure gauge having a full-scale reading of no greater than 2 MPa, placed at some point in the grout line between the pump outlet and the duct inlet? Was there a spare, fully functional pump also on site?<br>• Was standby flushing equipment with water supply available at the site prior to commencing grouting?<br>• Was the grouting equipment of sufficient capacity so that grouting of the longest duct was completed within 30 minutes after mixing?<br>• Were grout hoses and their rated pressure capacity compatible with the pump output and the maximum grout pressure? Were all connections from the grout pump to the duct airtight so that air did not draw into the duct? | ☐ | |
| 3.22 | 7.3.7.7 | Construction – Did the Contractor demonstrate to the satisfaction of the Inspector that all ducts were unobstructed prior to placing post-tensioning steel? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.23 | 7.3.7.7 | Where the ends of strands welded together to form a tendon to pull the strand through the ducts. Was a length of the strands used as an electrical "ground" or 1 m, whichever is greater, cut off prior to stressing? | ☐ | |
| 3.24 | 7.3.7.7 | Was post-tensioning carried out as per reviewed drawings and stressing calculations. Was the stressing and release of tendons done in the sequence specified on the drawings? | ☐ | |
| 3.25 | 7.3.7.7 | Were all strands in each tendon stressed simultaneously with a multi-strand jack? | ☐ | |
| 3.26 | 7.3.7.7 | Was the force in the tendons measured by means of a pressure gauge and verified by means of tendon elongation? | ☐ | |
| 3.27 | 7.3.7.7 | Were tendons tensioned to a preliminary force to eliminate any slack, between 15% and 25% of the final jacking force, before elongation readings were started? | ☐ | |
| 3.28 | 7.3.7.7 | Were stressing tails of post-tensioned tendons kept intact until the record of gauge pressures and tendon elongations were provided by the Contractor to the Project Manager for review and acceptance? | ☐ | |
| 3.29 | 7.3.7.7 | Was a record of the following post-tensioning operations kept for each tendon installed:<br>• Project Name and File Number<br>• Contractor/Subcontractor<br>• Tendon location and size<br>• Date tendon installed<br>• Tendon pack/heat number<br>• Modulus of elasticity (E)<br>• Date stressed<br>• Jack and gauge identifier<br>• Required jacking force and gauge pressures<br>• Elongation (anticipated and actual)<br>• Anchor set (anticipated and actual)<br>• Stressing sequence<br>• Witnesses to stressing operation<br>• Grout information (brand name)<br>• Time for grouting each tendon<br>• Date grouted | ☐ | |
| 3.30 | 7.3.7.7 | Were anchorage recesses concreted after tensioning but before grouting of tendons? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.31 | 7.3.7.7 | Were the concrete surface of the anchorage recesses abrasive blasted, thoroughly wetted and covered with a thin cement scrub coat immediately before placing fresh concrete? | ☐ | |
| 3.32 | 7.3.7.7 | Were ducts or openings clean and free of all deleterious matter that would impair bonding of the grout to the ducts and stressing steel, and were ducts thoroughly flushed out with water and blown out with compressed oil free air? | ☐ | |
| 3.33 | 7.3.7.7 | Were inlets and outlets checked for their capacity to accept injection of grout by blowing compressed oil free air through the system? | ☐ | |
| 3.34 | 7.3.7.7 | Were all grout vents opened prior to commencement of grouting? | ☐ | |
| 3.35 | 7.3.7.7 | Was the duct completely filled by continuously injecting grout from the lowest end of the tendon in an uphill direction until no visible signs of water or air were ejected at the outlet? | ☐ | |
| 3.36 | 7.3.7.7 | Was a continuous, one-way flow of grout maintained at a rate of 5 to 15 lineal metres of duct per minute and completed within 30 minutes of mixing? | ☐ | |
| 3.37 | 7.3.7.7 | Was normal pumping pressure between 0.1 to 0.4 MPa, measured at the inlet, with pumping pressure at the injection vent not exceeding 1 MPa? | ☐ | |
| 3.38 | 7.3.7.7 | Was the air temperature acceptable at the time of grouting?<br>*Note: Grouting not permitted below 5°C or above 25°C* | ☐ | |
| 3.39 | 7.3.7.7 | Did the Contractor provide 50 mm deep grout tube termination recesses formed around the tubes projecting from top of the deck? | ☐ | |
| 3.40 | 7.3.7.7 | After grouting, were tubes cut flush with the bottom of the recesses, and the recesses then grouted flush with the top of the deck? | ☐ | |
| 3.41 | 7.3.7.8 | Did the Contractor give adequate notice so that the Inspector could be present for the stressing and grouting operations? | ☐ | |
| 3.42 | 7.3.8 | Did the Contractor remove all earth material or temporary supporting structures placed in the stream channel or elsewhere during construction? | ☐ | |
| 3.43 | 7.3.8 | Was piling, excavated or surplus materials, rubbish and temporary buildings removed? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.44 | 7.3.8 | Were any damaged fences replaced or renewed? | ☐ | |
| 3.45 | 7.3.8 | Was all property damaged during the execution of the work restored in an acceptable manner? | ☐ | |
| 3.46 | 7.3.8 | Was disposal of surplus materials done in a manner and location satisfactory to the Inspector? | ☐ | |
| 3.47 | 7.3.8 | Did the Contractor leave the bridge site, roadway and adjacent property in a neatly restored and presentable condition, satisfactory to the Inspector, and if required, provide written evidence that affected property owners or regulatory agencies have been satisfied? | ☐ | |

**Details and Summary:**

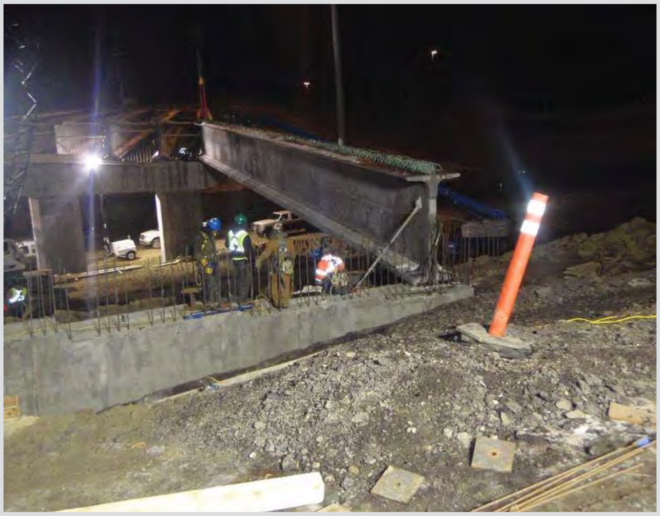
Signature

Date

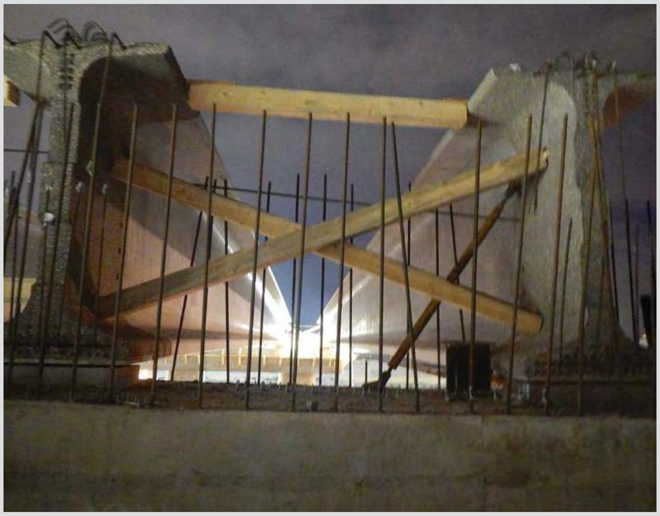
7.1 Precast concrete NU girder delivered to site.

7.2 Lifting precast concrete girder into position with two cranes.

7.3 First girders erected and stabilized with temporary shoring and bracing. Short H-pile section bolted to the abutment to provide additional lateral stability at the bearing.



7.4 First girder erected, stabilized with temporary shoring and braced to the abutment seat.



7.5 Subsequent girders erected, stabilized with temporary bracing prior to installation of steel diaphragms. H-piles at bearings for lateral stability until erection is completed and all diaphragms are in and bolted.

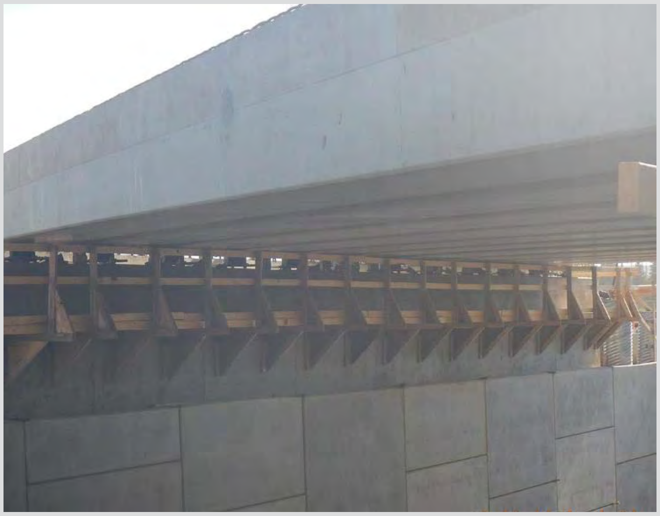
7.6 Subsequent girders erected, stabilized with temporary bracing until installation of steel diaphragms is completed.

7.7 Erecting concrete box girders from approach fill, using a spreader bar to achieve vertical forces at lifting points.

7.8 Setting elastomeric bearing with wooden wedges.

7.9 Concrete box girder on bearing.

7.10 Concrete box girder on pot bearing.

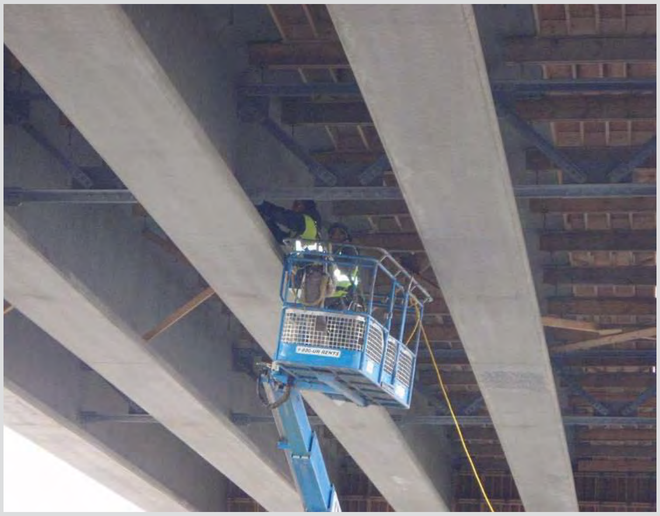


7.11 Completed erection of concrete box girders.

7.12 Erecting concrete box girders from approach fill.

7.13 Setting NU girder onto bearing. Survey layout/control visibly marked on abutment seat.

7.14 Installing deck overhangs and galvanized cross bracing. Fall protection system is in place.



7.15 Installing galvanized diaphragm cross bracing. Bolt tightening done from aerial work platform.

7.16 Galvanized diaphragm cross bracing installed. False deck used as a work platform.

7.17 Cast-in-place girders with post tensioning ducts. U-bars set at 1.0 m spacing to secure duct elevations.

7.18 Post tensioning ducts within NU girders at fabrication shop.


7.19 Post tensioning ducting in pier cap. Congested reinforcing steel exists at pier cap ends.

7.20 Post tensioning tendons in pier cap. Survey at every 1.0 m to confirm proper tendon profile.

7.21 Post tensioning duct anchors in straddlebent. Congested reinforcing steel at pier cap ends.

7.22 Post tensioning ducts at pier cap. Smooth profile throughout length of tendon.

7.23 Post tensioning ducts cast into pier cap. Tendons to be installed, stressed and grouted.

7.24 Strand pack dispenser for tendon assembly.

7.25 Tendons pulled through post-tensioning ducts.

7.26 Winch used to pull strands through post tensioning ducts.

7.27 Jack used for post-tensioning. Tendon strand protruding beyond jack end.

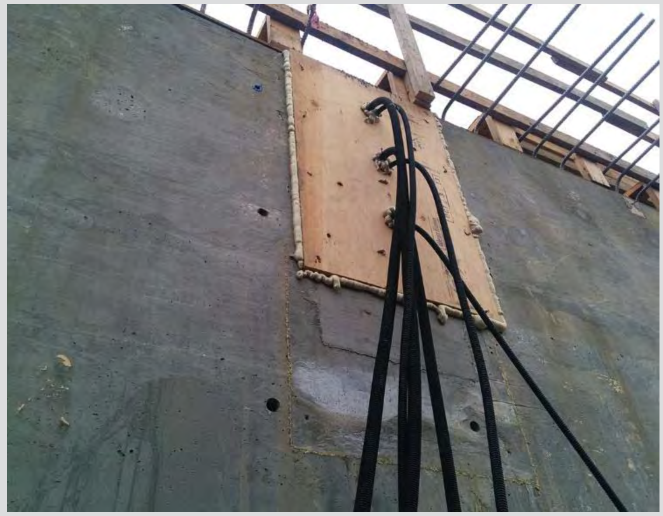

7.28 Tendon elongation measurement taken from wedge plate.

7.29 Tendons cut and capped, ready for grouting. Grout flow tubes protruding from cap.


7.30 Portable grout mixer.


7.31 Grouting operation.

7.32 Workers open and close bleed tubes as instructed by the post-tensioning supervisor.



7.33 Diaphragm end ready for grout. Blockout formwork is sealed to prevent grout leakage.

7.34 Grout pump pressure gauge.

7.35 Once grout flow is confirmed at all vents, caps are closed.

7.36 Grout sampled for testing.

7.37 Grout testing equipment. Efflux test performed with flow cone, modified bleed test with graduated cylinder and mud balance used to determine density. Grout cubes cast for compressive strength.

7.38 Modified bleed test with graduated cylinder on left. Grout cubes for compressive strength testing cast in brass mould.


7.39 Approved grout product stored on site. Expiration dates need to be labelled on package.

7.40 Severe honeycombing on pier cap due to congestion at post tensioning tendon heads.

# SECTION 8

# BRIDGE BEARINGS

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## 8.1 Bridge Bearings – General

Bridge bearings must transfer loads from the superstructure to the substructure, including superstructure dead loads and live loads, such as traffic and wind. Bearings must be able to withstand a number of forces caused by vibrations, deflections, girder sliding and rotation, braking impact, backwall pressure, ice forces and thermal girder movements.

Bridge bearings are vulnerable to deterioration if exposed to chlorides and roadway contaminants. Deck joint seal failure causes bearings to be exposed to these damaging conditions.

Bearing replacement is a costly maintenance activity that often requires traffic disruption. Bearing replacement requires jacking of the superstructure and grout pad removal. It is critical that new bearing assemblies be installed correctly to maximize their performance.

## 8.2 Safety Considerations

Bearing installation can involve working from heights. Fall protection is required.

Ladders and scaffolds may be used to gain access to abutment seat tops and pier caps that must be secured or tagged. Aerial platforms may also be used. Fall protection and a certified operator are required for these.

Bearings may easily slide off shims, causing injury.

Welding creates hot surfaces, and heating of galvanized surfaces produces harmful gases.

## 8.3 Bridge Bearing Types

For all bearing types other than elastomeric sheet bearings, the bearing components are contained within two plates.

- The **base plate** (also called the masonry plate) separates the bearing components from the bridge substructure and grout pad. This plate forms the base of the bearing assembly and is supplied by the bearing manufacturer. The underside of the plate must be treated with a base plate corrosion protection paint. Anchor rods and grout pads provide fixity of the base plate to the substructure.
- The **sole plate** (also called the top plate) separates the bearing components from the bridge girders. This plate forms the top of the bearing assembly and is also supplied by the bearing manufacturer. The sole plate is usually tapered to compensate for the camber of the girder and the longitudinal grade of the bridge. The sole plate is generally designed to be level in both the longitudinal and transverse directions. The plate is either welded or bolted to the bottom flange of a steel girder. If the sole plate is galvanized, the plate must be isolated from the steel girder flange by an epoxy mastic separator. Field-welding for a galvanized sole plate requires that the zinc coating be removed at the weld location prior to welding.

Acceptable bearing types for bridges include rocker bearings, pot bearings, elastomeric bearings and elastomeric sheet bearings.

- **Rocker Bearings:** Rocker bearings are comprised of steel, and they accommodate unidirectional rotations and displacements around their pins. They require precision fabrication and are susceptible to loss of performance due to “freezing” or “seizing” caused by contamination and corrosion. Tall expansion rockers require routine resetting. Rocker bearings are not suited for wide or highly skewed bridges.

- **Pot Bearings:** Pot bearings are used when large vertical loads exist. They consist of an elastomeric disc confined within the “pot”. The elastomer is confined by the pot’s smooth piston walls and is protected by rings. Pot bearings can accommodate rotations about any axis and are therefore classified as either unidirectional or multidirectional. They can also accommodate horizontal displacements when they contain a stainless steel slider plate. Pot bearings may bind if their components become contaminated.
- **Elastomeric Bearings:** Elastomeric bearings are the most common type of bearings. Elastomers include natural rubber or synthetic rubber (usually neoprene). Elastomers have differing properties of hardness and thermal characteristics. The grade of elastomer required for bearings generally requires that they are comprised of natural rubber. Tall elastomer pads are often reinforced with steel shims or plates to limit their lateral displacement under load. Elastomeric bearings may or may not be designed to slide at the interface with the sole plate. Sliding bearings contain a PTFE sheet adhered to the top of the elastomer pad and a stainless steel mirror-finished plate welded to the bottom of the sole plate.
- **Continuous Plain Elastomeric Sheets:** Elastomeric sheet bearings consist of continuous strips of elastomer, usually neoprene. These strips of elastomer are used as bearings for Standard Bridge girders, including types SL, SLW and SLC. They may also be used on all girder types where girder bearings are encased within the end diaphragms for integral abutments. The elastomeric sheet is placed directly on top of the concrete or steel substructure.

## 8.4 Bridge Bearing Fabrication

Bearings are designed by the fabricator. The fabricator must produce shop drawings, mill certificates, weld procedures and test reports. Prior to accepting bridge bearings at the site, the Inspector must inspect the bearings and confirm that all submittals have been received and accepted by the Project Manager.

## 8.5 Construction

The Contractor must provide a bearing installation procedure prior to the start of bearing installation. The Inspector must confirm that the procedure has been submitted and accepted by the Project Manager.

### 8.5.1 Delivery

Bearings are typically delivered as assembled units containing the sole plate, bearing components and base plate. The bearings must not be disassembled at the site because bearing components include highly machined and polished surfaces that may be easily damaged by handling. However, in some cases elastomeric bearings may be delivered without a sole plate. If the sole plate is removed, a risk of damage to the sliding surfaces exists. If the sliding surfaces of either the elastomer or the sole plate become contaminated, they must be acceptably cleaned in accordance with the manufacturer’s requirements.

When bearings arrive at the site, the Inspector must confirm that the bearings are transported on pallets and wrapped or otherwise securely protected from road spray and other contaminants. Bearings must remain protected at the site until they are installed.

### 8.5.2 Installation of Bearings with Sole and Base Plates

Bearings are normally installed by the girder erection crew. The bearings must be installed by experienced and competent personnel. The Contractor must survey the substructures to determine the theoretical locations and alignment of all bearings. Chalk lines are marked on the top surfaces of the substructure elements from which the bearing locations can be accurately set.

Prior to the installation of bearings, the Inspector must confirm that the abutment seat and pier caps have been properly constructed:

- The top surfaces must be sloped so that water will not pond at the bearing locations.
- The bearing pad recesses must be accurately positioned relative to the centre of bearing and bearing alignment. The recess must be of adequate area to produce a 1(H):1(V) slope at the grout pad face.
- The bearing pad recess must be constructed to the correct elevation to achieve the design thickness of grout. Grout pads that are too low are difficult to construct and may result in trapped air pockets. Grout pads that are too high may have performance issues or may crack due to heat of hydration. Recesses must be level in both the longitudinal and transverse directions.
- The bearing pad recess surfaces must be properly prepared. Bearing pad recesses are formed by casting plywood into the substructure. After the plywood is removed, small air voids typically exist that are filled with an approved concrete patching product so that the surface is smooth. Bearing pad recesses must not be sawcut and chipped into the substructure element after concrete placement.

Bearings are positioned onto galvanized shim stacks, which support and maintain the final elevation of the bearing assembly until the base plate is grouted. For some bearing assemblies, the shim stacks are placed underneath the self-rocking pintles, which are welded to the underside of the base plates. The purpose of the pintles is to allow the bearing to rotate in the longitudinal direction after the girder is erected. The tapered sole plate will remain level as it rotates around the pintle axis. For bearing assemblies that do not contain pintels, the shim stacks are placed directly in contact with the underside of the base plate.

After steel plate girders are erected, the sole plate may need to be field welded to the bottom flange. The requirements of Section 13 of the *Standard Specifications for Bridge Construction* for Field Welding of Structural Members must be followed. Special precautions for pre-heat and hoarding need to be taken into consideration during cold weather. Additionally, special requirements exist when welding a galvanized sole plate to the girder. All zinc coating needs to be removed at the weld location and the damaged coating needs to be repaired in compliance with ASTM A780 Method A1 or A3 (the method depends on the area of damage).

### 8.5.3 Installation of Continuous Plain Elastomeric Sheets

Bearing sheets or strips must be in intimate contact with both the substructure element and the underside of girder. Where the elastomer bears on concrete, the concrete needs to be finished to provide a continuously smooth bearing surface with no local high or low areas. If gaps exist between the substructure concrete and the elastomer or between the girder and the elastomer, modifications to the substructure element are required. Voids may not be filled with lead shims.

### 8.5.4 Function and Setting of Bearings

Bridge bearings are classified as either “fixed” or “expansion” type. Fixed bearings do not permit longitudinal or transverse movement. Expansion bearings allow controlled movement and rotation. Rocker bearings may accommodate deflections by rotation in the longitudinal direction. Pot bearings may accommodate deflections, longitudinal and transverse movements if they are unidirectional or multidirectional. Elastomeric expansion bearings may permit longitudinal thermal movements by sliding of the PTFE sheet and the polished sole plate.

Setting of elastomeric expansion bearings for thermal girder movement is required in the field. The sole plates of elastomeric expansion bearings contain slotted holes that receive anchor rods projecting from anchor rod void forms. The range of thermal expansion motion is limited by the slotted holes. After the bearings are installed and positioned, the anchor rods must be positioned at the correct location within the slot to match the girder temperature.

At expansion bearings, the rods must be positioned accurately within the slotted sole plate holes. Normally the rod is centered at 5°C. The Plans include a bearing setting table that indicates the offset from the centre of the slot for different temperatures. This temperature is not the ambient temperature, rather it is the temperature of the bottom girder flange. The Inspector must measure the temperature of the bottom flanges at various locations for all girders, and then determine a reasonable average for each girder to be consistently used when reading the table. The bearings must be set on a cloudy day, during the early morning or at night when the girders will have a more consistent temperature.

Once the average girder temperature is determined, the Inspector must increment the slots to determine the offset distance from the centre of the slot to the determined setting temperature. The anchor rods must be moved to the required position so that it can be confirmed that the distance of at least one anchor rod diameter of grout remains between the rod and the side of the anchor rod void. The grout must fully encapsulate the rod.

The Inspector must carefully check the Contractor’s installation of the anchor rods for each bearing.

The Inspector must record all bearing settings for inclusion on the Record Plans.

### 8.5.5 Grouting

**Anchor Rod Grouting:** After the girders have been erected and the locations and elevations approved by the Inspector, the anchor rods must be grouted into place as soon as it is practical so that thermal movements do not cause the girders to move out of position. The anchor rods at the fixed bearings are generally grouted into position first, followed by the expansion bearings. The proper process for grouting anchor rods is as follows:

- Anchor rod voids are formed at the base of the bearing recess. The forms must be removed and the concrete surfaces roughened.
- Prior to placing grout within the voids, it must be confirmed that the voids are clean and that no standing water exists. It may be difficult to visually check the condition of the voids since the access is obstructed by the bearing base plate.
- Prior to grouting, the Inspector must confirm that the Contractor has set the anchor rods so that they are plumb and their projection is in accordance with the design requirements.

**Base Plate Recess Grouting:** The recesses are grouted prior to the start of deck concrete placement. The proper process for grouting recesses is as follows:

- The substructure concrete must be clean and in a saturated surface dry condition prior to grouting.
- Grout must be batched to the correct proportions and must be used within the time period specified by the manufacturer. Grout must be tested by certified personnel.
- Normally, the perimeter above the recess is formed with wood. Grout is poured into the recess, and all entrapped air is systematically removed by rodding. The grout is generally poured slightly above the level of the underside of the base plate so that air is not introduced under the plate.
- After the grout has set sufficiently, the perimeter forms are removed and the sides of the grout are trimmed to the angle specified. The angle extends upward from the edge of the recess to the lower corner of the base plate.
- The grout is then cured in accordance with the manufacturer's requirements.

It is important that the galvanized coatings of the bearing assemblies are not damaged during grouting procedures.

The Inspector must witness the entire grouting procedure.

#### 8.5.5.1 Grouting in Cold Weather

Grouting in cold weather should be avoided. Abutments and pier caps are large heat sinks, and adequate hoarding and pre-heating must be done for the entire substructure element and not just locally around the bearing recess. The relatively small volume of grout is highly susceptible to freezing if the preheat is inadequate.

The Inspector must regularly monitor the curing of the grout. Access to bearings must be maintained by the Contractor during the curing period.

Government of Alberta ■
Transportation

**Bridge Construction Inspection Manual 2015**
Section 8 – Bridge Bearings Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

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| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | 8.4.1 | Did the Contractor submit a bearing installation procedure at least four (4) weeks in advance of scheduled start of installation? | ☐ | |
| 1.2 | 8.4.2 | Were bridge seat bearing areas properly finished and not deformed or irregular? | ☐ | |
| 1.3 | 8.4.2 | Were bearings set level in their exact position? | ☐ | |
| 1.4 | 8.4.2 | Was anchor rod forming material removed? | ☐ | |
| 1.5 | 8.4.2 | Were the concrete surfaces cleaned? | ☐ | |
| 1.6 | 8.4.2 | Did the location of the anchor rods in slotted holes correspond to the setting temperature? | ☐ | |
| 1.7 | 8.4.2 | Were the nuts on the anchor rods at expansion bearings adjusted to allow for free movement of the spans? | ☐ | |
| 1.8 | 8.4.2 | Did shim stacks have 75 mm of cover from the edge of grout pads? | ☐ | |
| 1.9 | 8.4.2 | Were tops of bearing sole plates within a tolerance of +/- 3 mm of design elevation prior to girder erection? | ☐ | |
| 1.10 | 8.4.2 | If sole plates were welded to flanges, were they welded in the longitudinal direction only? | ☐ | |
| 1.11 | 8.4.2 | Was any damaged galvanizing metalized as per ASTM A780 Method 3? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 1.12 | 8.4.3 | Was grout mixed, placed and cured as per manufacturer's recommendations? | ☐ | |
| 1.13 | 8.4.3 | Were testers certified to ACI or CSA utilized by the Contractor to test the compressive strength of the grout? | ☐ | |
| 1.14 | 8.4.4 | Was "Grouting in Cold Weather" implemented when daily minimum air temperatures were at or below 5°C during the placing and curing period of the grout? | ☐ | |
| **2** | | **Concrete Finishing Under Bearings** | | |
| 2.1 | 4.24 | Was concrete finished or ground to a smooth and even surface where bearing plates, pads or shims were installed? | ☐ | |
| 2.2 | 4.24 | Were air voids, created by forming grout-pad recesses, filled with an approved patching material a minimum of seven (7) days in advance of girder erection? | ☐ | |
| 2.3 | 4.24 | In cold weather conditions, was this work completed while the substrate concrete was warm from hydration processes? | ☐ | |
| 2.4 | 4.24 | If the filling of air voids did not occur while the substrate concrete was still warm, was it carried out in accordance with Section 4.21 of the SSBC? | ☐ | |

**Details and Summary:**

Signature

Date

8.1 Placing bearings at pier cap.

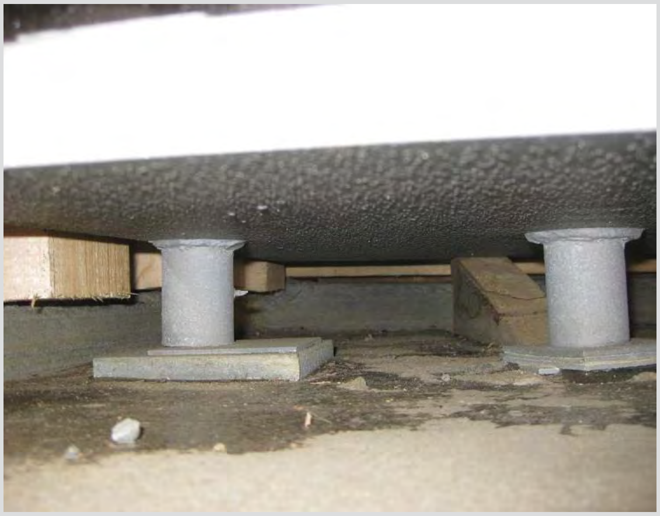
8.2 Longitudinal pot bearing on abutment seat. Erection hardware still in place to hold the bearing components together during transportation and installation.

8.3 Rocker bearing. Centre line of bearing marked on masonry plate, rocker plate and top of pier. Grout pad recess smooth and providing an even bearing on the shim stacks.

8.4 Reinforced elastomeric bearing pad. Wooden wedges and pintles to set masonry plate level.

8.5 Bearing assembly centred and blocked in position.

8.6 Block out for grout pad formed and ready for grout.



8.7 Bearing elevation set using shim stacks placed under pintles. Pintles allow bearing to rotate. Underside of plate is coated to prevent direct contact between zinc and grout.

8.8 Bearing set to elevation.

8.9 Clean-out prior to grouting.

8.10 Placing grout.

8.11 Rodding grout with thin metal strap to remove entrapped air from beneath masonry plate.

8.12 Trimming grout after form removal. Note that top of grout pad elevation is not higher than the underside of masonry plate elevation.

8.13 Bearing plinths for girders cast into pier diaphragm.

8.14 Bearing plinths for girders cast into pier diaphragm. 20 mm neoprene pad is between the girder and plinth.

8.15 Pot bearing assembly. Once the girder is set in place, the wooden wedges are no longer needed.

8.16 Improperly set bearing resulting in bent anchor rods and failed grout pad.

8.17 Concrete plinths on pier cap. Girder to be set on the plinths and cast with the diaphragm.

8.18 Damage to grout pad due to improperly set bearing.

8.19 Grout pad constructed at 45 degree slope from abutment seat to bottom of base plate.

8.20 Grout pad constructed at 45 degree slope from abutment seat to bottom of base plate.

8.21 Bearing pad form work for grouting.

8.22 Setting bearing offset to “X” value in accordance with bearing temperature chart, just prior to grouting.

# SECTION 9

# DRAIN TROUGH TERMINAL PROTECTION

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## 9.1 Drain Trough Terminal Protection – General

Drain trough terminal protection is normally located at the toe of concrete drain troughs. The purpose of drain trough terminal protection is to dissipate the energy of the surface drain water and to provide scour protection to the soil at the base of the drain troughs.

## 9.2 Environmental Considerations

The following environmental considerations must be considered by the Contractor:

- Prevent deleterious material from washing into any nearby water channel.
- Transit mix trucks must be cleaned in a suitable area away from any nearby water channel.
- Clean up oil leaks and spills.
- Disturbed areas are to be acceptably restored.
- Excess material must be properly disposed of in a location and manner approved by the Inspector.

## 9.3 Safety Considerations

Drain trough terminal protection is generally at the base of a steep embankment slope. Use care when walking up and down slopes.

Concrete materials are corrosive and can cause burns. Use care when handling bags to prevent leakage and contact with skin or eyes.

## 9.4 Material

### 9.4.1 Bags Filled with Concrete

Drain trough terminal protection is normally constructed with burlap or reinforced polyethylene bags filled approximately two-thirds with Class S Concrete. Bags are placed on a shaped and prepared foundation.

The requirements for Class S Concrete used to fill bags is specified in Section 4 “Cast-In-Place Concrete” of the *Standard Specifications for Bridge Construction*. A mix design submission is not required.

### 9.4.2 Rock Riprap Alternate

Class 1M rock riprap may be approved in lieu of bags filled with concrete at the discretion of the Consultant. Class 1M rock riprap must conform to Section 10 “Heavy Rock Riprap” of the *Standard Specifications for Bridge Construction*.

### 9.4.3 Preparation and Placing

Care must be taken during the construction of the excavation. The Inspector must confirm that all final grading has been completed and that the subgrade elevations are correct. It is important that the centre of the terminal protection be located accurately by survey so that the end of the concrete trough is centred onto the depression and that the trough extends into the terminal at the proper grade and projection.

The Contractor must neatly excavate the subgrade into a dish shape. The sides of the dish must gently slope towards the centre, and the edges of the dish must not be overly steep.

The base of the dish must be free of loose material and must be compacted so that no soft areas remain.

## 9.5 Bags Filled with Concrete

As bags are placed, they must be rammed and packed into place so that the contact area between adjacent bags is maximized. No soil can be exposed at any locations. The bags must also be in intimate contact with the ground.

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

## 9.6 Rock Riprap Alternate

The diameter for a rock riprap terminal protection is the same as for bagged concrete; however, the depth to the top of riprap at the centre point is 320 mm rather than 450 mm.

Filter fabric is required underneath the rock riprap, and it is important to key this material into the subgrade.

The outer edge of the riprap terminal protection must be level.

Government of Alberta ■
Transportation

**Bridge Construction Inspection Manual 2015**
Section 9 – Drain Trough Terminal Protection Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **Materials** | | |
| 1.1 | 9.2 | Were the bags approximately 400 mm x 700 mm in size? | ☐ | |
| 1.2 | 9.2 | Did the concrete meet the requirements of Section 4 of the SSBC? | ☐ | |
| 1.3 | 9.2 | Did the rock riprap meet the requirements of Section 10 of the SSBC? | ☐ | |
| **2** | | **Preparation and Placing** | | |
| 2.1 | 9.3 | Was a depression formed at the toe of the drain trough as shown on Standard Drawing S-1410? | ☐ | |
| 2.2 | 9.3 | Was the depression compacted in the shape of a dish approximately 450 mm deep and 3 m in diameter? | ☐ | |
| 2.3 | 9.3 | Were the bags filled two-thirds with Class S concrete? | ☐ | |
| 2.4 | 9.3 | Were bags sewed, stapled or folded to form a straight-edge closure, and were they immediately placed in the work? | ☐ | |
| 2.5 | 9.3 | Was the first bag placed in the centre (bottom) of the dish, with subsequent bags placed in a circular direction around the first bag? | ☐ | |
| 2.6 | 9.3 | Did each bag overlap the closed end of the bag previously placed, and also the bag beside it, so that a shingled effect was produced? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.7 | 9.3 | Was the folded part of the bag on the underside when in place? | ☐ | |
| 2.8 | 9.3 | Were the bags rammed and packed against each other so as to obtain a closed and uniform surface? | ☐ | |
| 2.9 | 9.3 | Were the bags in intimate contact with the ground and each other? | ☐ | |
| 2.10 | 9.3 | Did the placed drain trough terminal protection have an average thickness of 130 mm? | ☐ | |
| 2.11 | 9.3 | Was the outer edge of the concrete-filled burlap bags level? | ☐ | |
| 2.12 | 9.1 | Were all the requirements of Standard Drawing S-1410 met? | ☐ | |
| **3** | | **Rock Riprap Alternate** | | |
| 3.1 | 9.4 | Was Class 1M rock riprap placed to a minimum depth of 350 mm? | ☐ | |
| 3.2 | 9.4 | Was the size of the terminal dish the same as for bagged concrete terminal protection? | ☐ | |
| 3.3 | 9.4 | Was the bed shaped to the extent that the dimension from the level surface to the top of rock riprap is 320 ± 100 mm? | ☐ | |
| 3.4 | 9.4 | Was the dish formed in the subgrade covered with Terrafix 270R or approved equivalent filter fabric? | ☐ | |
| 3.5 | 9.4 | Was the filter fabric keyed 300 mm into the subgrade at the perimeter of the dish in order to anchor the fabric? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.6 | 9.4 | Was the rock riprap placed so that the filter fabric was fully covered? | ☐ | |

**Details and Summary:**

Signature

Date

9.1 Riprap drain trough terminal protection.

9.2 Riprap drain trough.

9.3 Drain trough with riprap terminal protection.

9.4 Drain trough with riprap terminal protection.

# SECTION 10

## HEAVY ROCK RIPRAP

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## 10.1 Heavy Rock Riprap – General

Heavy rock riprap is highly durable, has a history of superior performance and is readily available throughout most of Alberta. Headslopes and guidebanks constructed of rock riprap are flexible, do not easily fail as a result of settlement and can be constructed and repaired using simple techniques and equipment.

Rock riprap is used at culvert aprons, berms and for watercourse crossings as protection from scour and erosion. Scour is a common cause of bridge foundation failure and occurs as the stream velocity increases locally around bridge structures. Erosion describes the more global process for natural degradation of the stream channel.

Rock riprap resists scour and erosion through a combination of stone size, density, angularity, resistance to weathering, gradation and thickness of the riprap mat. The interlocking nature of angular stones and their weight provides resistance to movement.

## 10.2 Environmental Considerations

Riprap may not be cleaned or washed after it has been placed. Runoff water from cleaning must be properly contained and not be permitted to enter the watercourse.

Riprap must only be placed at the locations shown on the Plans.

Restricted Activity Periods (RAP) exist for most watercourses within which no in-stream work is permitted. In-stream work includes any activity within the active flow channel.

Precautions must be taken when using heavy equipment near a watercourse, including refuelling, fuel storage, cleaning and spill management.

## 10.3 Safety Considerations

Tripping and crushing hazards exist when walking over placed riprap. Pieces may settle or roll after they have been placed.

Pieces of rock may easily be dropped or rolled during placement. No personnel must be near the excavator during placement.

## 10.4 Manufacture

Rock riprap may either consist of screened field stone or blast rock. Class 1M and Class 1 riprap are typically fieldstone, Class 2 may be either fieldstone or blast rock, and Class 3 is commonly blast rock. The Contractor may need to import suitable riprap over long distances. If different classes of riprap are required for the project, the Contractor may need to import riprap from different sources.

Fieldstone is commonly manufactured at a gravel pit and is typically a by-product of aggregate production. Oversized rock materials are screened-out for riprap. The riprap is dumped onto a rock separator, which grades the rock into size ranges. The separator has fixed or adjustable “grizzly” bars that act like sieves. After separating, rocks of certain size ranges are re-combined into the correct proportions to comply with the riprap gradation requirements.

Rock riprap may be quarried by blasting or ripping. It is then graded using a separator and re-combined in a similar fashion to fieldstone.

## 10.5 Performance Records and Testing

Rock riprap must be sufficiently durable to perform over the entire life of the bridge structure. For Class 1M and Class 1 riprap, angular fieldstone is considered durable and no further testing is required. If riprap for Class 2 and Class 3 are not fieldstone, then the quality of the material must be tested by the Contractor. The performance of the riprap is critical to the protection of both the bridge foundation elements and the watercourse environment.

### 10.5.1 Sandstone and Other Weak Rock

Proper identification of different rock types is often difficult, and some types of sedimentary rock may not be sufficiently durable when used as riprap.

Concrete rubble or other recycled materials may not be used as riprap.

### 10.5.2 Performance Records and Testing

For all Class 2 and Class 3 rock, the Contractor must either produce reliable performance records or else test the proposed materials for durability and absorption. The durability test exposes the stone pieces to abrasion with other pieces while in water, and the absorption test assesses rock porosity.

The reliability of performance records, if available, must be evaluated by the Project Manager. The records must comprehensively evaluate the performance of the proposed rock from the same source in similar applications. The records must also confirm that the properties of the source material have not changed.

### 10.5.3 Shape

The individual stone pieces must be angular and the smallest dimension must be larger than one-third of the largest dimension. Angularity is a qualitative parameter that is assessed by visual inspection as there is no standard test to evaluate angularity.

Pieces of angular stone must have flat faces and defined edges and corners. They must be block-like and not have a tendency to roll at the placement angle specified.

Fieldstone has been worn by the process of abrasion or glaciation and typically has rounded corners. Fieldstone that has defined and flattened faces is considered acceptable since it is sub-angular. Round fieldstone is not acceptable.

Angularity is an important property of riprap as it permits the stone pieces to interlock and form a stable mat. Riprap placed with greater angularity will have a steeper angle of repose. Consequently, angular pieces will be less likely to roll or be displaced if the riprapped slope settles or steepens.

## 10.6 Installation

### 10.6.1 Excavation

The top surface of placed riprap must match the channel or bank elevation. Riprap for aprons must be placed into a neatly constructed excavation of constant depth and at the specified surface elevations.

### 10.6.2 Geotextile

Stream banks are often composed of non-cohesive sand and gravel that require a filter layer to prevent erosion. Where filter fabric is specified, the excavation must be uniform and free of sharp objects so that the fabric does not tear or span across depressions.

It is important that the fabric be lapped and pinned as specified by the manufacturer. To prevent shifting, it is also important that the fabric be keyed into the ground at the edges by trenching beyond the perimeter of the excavation, inserting the edge of the fabric, then backfilling.

### 10.6.3 Inspection of Gradation

The Class of riprap selected is designed to resist the design velocity of the watercourse. Any deviations from the required gradation or a substitution with a lower Class of material will render the riprap ineffective.

Sampling for visual inspection of gradation is required for all classes of riprap. The weight of all sample pieces must be marked. The Inspector can then determine the average size for each weight category for the required gradation.

It is important that each load of riprap delivered to the site meets the specified gradation. Additional material may be added at the site to conform to the specified gradation, prior to the riprap being placed into its final position. It is important that the gradation is uniform throughout with no segregation.

The rock must arrive at site clean and free of debris and other contamination.

The Inspector must require the Contractor to schedule the gradation sampling immediately following the initial delivery of the material to be sampled. The Inspector must be present during the riprap placement to confirm conformance to all requirements.

### 10.6.4 Placement

Riprap placement must start at the base of the slope and proceed upwards.

Generally, riprap is dumped near the worksite and placed by hydraulic excavator using a specialized bucket to permit accurate rock placement.

Riprap must be placed at a uniform thickness and to the specified elevation. The specified thickness for slopes is typically the nominal diameter of the largest specified stone size, and for aprons is twice the largest specified stone size.

It is important that no geotextile filter fabric be exposed after placement to the required thickness. The finished surface must be reasonably uniform without large cavities and without individual stones projecting above the nominal surface.

Government of Alberta ■
Transportation

**Bridge Construction Inspection Manual 2015**
Section 10 – Heavy Rock Riprap Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

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| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | | Was the rock riprap measured and the quantities calculated for payment? | ☐ | |
| **2** | | **Permits** | | |
| 2.1 | 10.2 | Did the Contractor obtain all the necessary permits, agreements and authorizations prior to loading riprap? | ☐ | |
| 2.2 | 10.2 | Did the Contractor advise the Inspector of any special provisions required under such permits and provide satisfactory evidence that the requirements of the permits were fully complied with? | ☐ | |
| **3** | | **Materials** | | |
| 3.1 | 10.3 | Was the supplied rock hard, durable and angular in shape, resistant to weathering and water action, free from overburden, spoil, shale or shale seams and organic material, and did it meet the gradation requirements for the class specified? | ☐ | |
| 3.2 | 10.3 | Was the minimum dimension of any single rock not less than one third of its maximum dimension for the class specified? | ☐ | |
| 3.3 | 10.3 | Was the minimum acceptable unit weight of the rock 2.5 $t/m^3$? | ☐ | |
| 3.4 | 10.3 | Did the Contractor provide evidence of the acceptability of the rock riprap material? | ☐ | |
| 3.5 | 10.3 | Did the Contractor submit samples of Class 2 and Class 3 rock riprap for which no performance records are available? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.6 | 10.3 | Was the proposed material sent to an independent certified testing laboratory, and was a written report of the test results provided, stamped by a Professional Engineer? | ☐ | |
| 3.7 | 10.4 | Was the slope receiving rock rip-rap graded to provide a smooth, uniform surface free of stumps, large rocks, brush or other debris, and were holes and depressions filled prior to placing filter fabric? | ☐ | |
| 3.8 | 10.4 | Was loose or unstable soil replaced prior to placing rock riprap? | ☐ | |
| 3.9 | 10.4 | Did the non-woven geotextile filter fabric meet the specifications and physical properties as outlined in the chart under 10.4 of the Standard Specifications for Bridge Construction? | ☐ | |
| 3.10 | 10.4 | Was the filter fabric laid parallel to the slope with the top edge anchored 300 mm? | ☐ | |
| 3.11 | 10.4 | Was the rock riprap placed on the filter fabric within sufficient time so as to avoid ultraviolet damage? | ☐ | |
| 3.12 | 10.5 | Was the rock riprap finished surface reasonably uniform? | ☐ | |
| 3.13 | 10.6 | Did the Contractor provide a minimum of two samples of rock of the minimum sample size specified? | ☐ | |
| 3.14 | 10.6 | Did the samples conform to the required gradation? | ☐ | |

**Details and Summary:**

Signature

Date

10.1 Load cell used to weigh heavy rock riprap at site.

10.2 Heavy rock riprap sample with weights painted on each piece.

10.3 Crews placing filter fabric material prior to heavy rock riprap placement. Filter fabric keyed into top of slope.

10.4 Riprap placed at the end of culvert bevel.

10.5 Heavy rock riprap at culvert bevel.

10.6 Filter fabric placed around end of RCP.

10.7 Riprap apron placed at RCP end.


10.8 Riprap placement in creek bed by excavator with a bucket thumb.

10.9 Completed installation of heavy rock riprap as channel armouring.


10.10 Placement of heavy rock riprap, starting from base and working upwards.

# SECTION 11

## DUCTS AND VOIDS

TABLE OF CONTENTS

## 11.1 Ducts and Voids – General

Ducts and rigid conduit described in this section include only those service ducts used for utility containment and do not include the following:

- Post-tensioning ducts used in precast girders
- Displacement voids that are placed into precast box girders to reduce their weight

Often utilities, such as telecommunication lines, must be accommodated in the bridge structure. In some cases, the utility is needed to provide service to the bridge itself, as with Real Weather Information System (RWIS) and electrical service for bridge lighting.

## 11.2 Materials

Utility ducts, conduits and voids may only be made of PVC pipe. The Inspector must make sure that the Contractor's Electrician is aware of all specified requirements and referenced standards. The Inspector must be knowledgeable regarding the content of the reference standards as they pertain to materials, bending, fittings, expansion sleeves and pull cords.

## 11.3 Installation

The Inspector must confirm that attention to duct, conduit and void placement and securement has taken place. This inspection must be done prior to concrete placement.

Ducts and voids contain air and will become positively buoyant when surrounded by concrete. Vibration of concrete will cause the ducts and voids to float unless they are restrained. Ducts and voids must be tied adequately to prevent this. The ties must be placed at sufficient intervals to prevent the ducts and voids from bowing between tie points.

Ducts and voids must not rest directly on hardened concrete. Instead, they must be raised and secured above the surface of the construction joint. This will allow concrete to completely encase the duct. The presence of a duct at a construction joint location will also result in a poorly constructed joint since it may reduce the contact area between the hardened and fresh concrete. A well performing joint depends on a good interface between the hardened and new concrete surface.

Any concrete paste leaking into a duct joint can plug the conduit and plug its opening. Air leaking from a duct joint during concrete placement can result in entrapped air voids within the concrete above the duct joint.

Ducts placed across deck joints must precisely follow the deck grade and not be skewed to the direction of expansion since a misaligned joint may break. Some joints may also require accommodation for rotation.

Ducts installed into column forms must be well secured at the base of the column to withstand concrete placement operations.

Electrical conduits and junction boxes may be detailed on electrical Plans. The Inspector must reference these Plans prior to the start of work.

Prior to installation of the pull cord, the Contractor's electrician must demonstrate that no blockages exist by pulling an object through the duct. The ductwork must be completed prior to this test, and the Inspector must witness the test. This test must be done twice: first before concrete placement, and again after concrete placement. If a blockage is encountered after concrete placement, the Contractor must provide a repair procedure acceptable to the Consultant.

Duct expansion assemblies must not interfere with the deck joint blockouts and deck joint turn-up ends. These potential areas of conflict must be investigated by the Inspector and identified to the Contractor in advance of placing ducts.

Ducts must not interfere with other appurtenances, such as anchor bolts for bridge rail posts. These potential areas of conflict must be investigated by the Inspector and identified to the Contractor in advance of placing ducts.

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Transportation

**Bridge Construction Inspection Manual 2015**
Section 11 – Ducts and Voids Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

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| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | | Was the electrical conduit bent with a standard conduit bender? | ☐ | |
| 1.2 | | Were expansion joints provided, and was the conduit continuous? | ☐ | |
| **2** | | **Installation** | | |
| 2.1 | 11.3 | Were ducts, conduits and voids firmly secured to prevent floating during of concrete placement? | ☐ | |
| 2.2 | 11.3 | Were continuous pull wires installed in all service ducts and conduits unless specified otherwise? | ☐ | |
| 2.3 | 11.3 | Were the pull wires 12-gauge galvanized steel, unspliced, extending with a tight fit through the duct end caps and terminating one metre beyond in 300 mm loops? | ☐ | |
| 2.4 | 11.3 | If the duct was over 75 mm diameter, was 8 mm mono-poly rope or equivalent used, and if so, was the rope unspliced with the extra length of 300 mm each end coiled up inside the duct and the duct end caps secured in place? | ☐ | |
| 2.5 | 11.3 | When specified, were lamp standards properly bedded, securely bolted and painted with two field coats? | ☐ | |
| 2.6 | 11.3 | Was the installation of any electrical equipment carried out to completion by a fully qualified electrician, tested and left in good working order? | ☐ | |

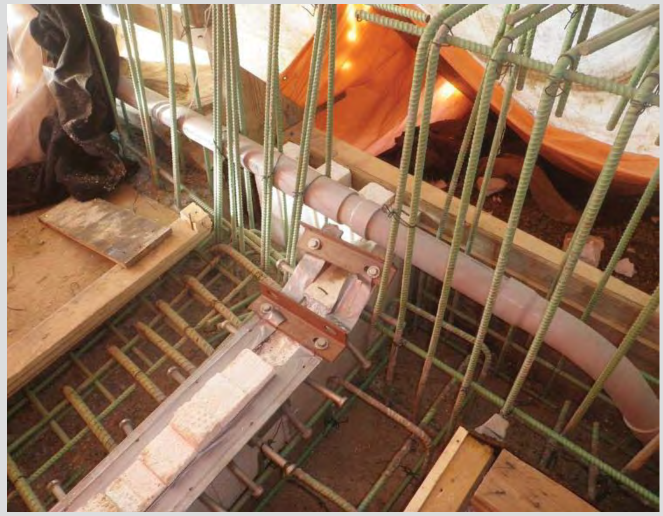
| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.7 | 11.3 | Were all runs of conduit or duct proven in the presence of the Inspector to be clear by passing a round object, no less than 75% of the conduit area, through the entire length? | ☐ | |

**Details and Summary:**

Signature

Date

11.1 Duct for electrical conduit in barrier.



11.2 Properly installed expansion joint at duct. Care must be taken to properly align the joint.

11.3 Electrical conduit exiting barrier.

11.4 Ducts in barrier for overhead lighting.

11.5 Electrical ducts exiting bottom of wingwall below grade.

11.6 RWIS junction box cast on outside face of barrier. Box must be sealed to prevent contamination with concrete paste.

11.7 Improper connection at expansion joint using expanding foam.

11.8 Poorly aligned connection at expansion joint.

# SECTION 12

# BRIDGERAIL

## TABLE OF CONTENTS

## 12.1 Bridgerail – General

Bridgerail is a critical safety element at all bridge structures. The function of the bridgerail is to provide protection for traffic and pedestrians at the bridge overhangs. In performing this function, the railing must have the capacity to withstand a vehicular impact and have the appropriate geometric configuration to safely redirect the vehicle without causing crushing or overturning. Bridgerail systems have been crash tested and therefore must be designed, fabricated and installed in strict conformance.

The type of bridgerail system to be used depends on many factors, including traffic volume, design speed, bridge geometry and the number of heavy trucks. Various test levels were established from NCHRP Report 350 and the current Performance Levels from CSA-S6. The following Performance Levels are applicable:

- PL-1 is used for most local roads when no salt application is expected.
- PL-2 is used for the majority of applications on high-speed provincial highways and freeways with a mixture of trucks and heavy vehicles.
- PL-3 is used for bridges with high-speed, high volume and truck traffic.

## 12.2 Material Handling and Storage

The Contractor must deliver, handle and store bridgerail materials suitably to avoid damage. Nylon straps or slings must be used for loading and unloading. Bridgerail materials must be stored in such a manner as to prevent the formation of wet storage stains and white rusting. This is done by utilizing wooden blocks, platforms or skids that keep the material off the ground.

## 12.3 Installation

Bridgerail installation includes casting the anchor bolt assemblies into the deck concrete, erecting/aligning of the rail and grouting under the post baseplates. The Inspector must be familiar with the shop and erection drawings. The posts must be installed vertically, unless noted on the shop drawings. It is the Contractor’s responsibility to accurately locate the bridgerail anchor bolts. The Inspector must check the location and height of the anchor bolts prior to casting. The proper projection of anchor bolts must be sufficient to accommodate the grout pad, thickness of the base plate and full thickness of top anchor nut plus a minimum of two threads. In order to accurately locate the anchor bolt assemblies, the reinforcing steel must be installed concurrently in order to avoid potential conflicts.

The bridgerail must be erected and aligned true to the required lines. The Inspector must check the alignment and the profile prior to grouting of baseplates. Expansion joints in the bridgerail must be installed as detailed on the Plans.

Grouting under baseplates must be carried out using an approved flowable grout. Full contact with the underside of the post baseplate must be achieved. The grout must be wet cured for a period of 72 hours. Type 1c sealer must be applied to the exposed grout surfaces after at least 28 days of curing.

When the temperature falls below 5ºC, cold weather grouting procedures must be followed.

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Transportation

**Bridge Construction Inspection Manual 2015**
Section 12 – Bridgerail Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

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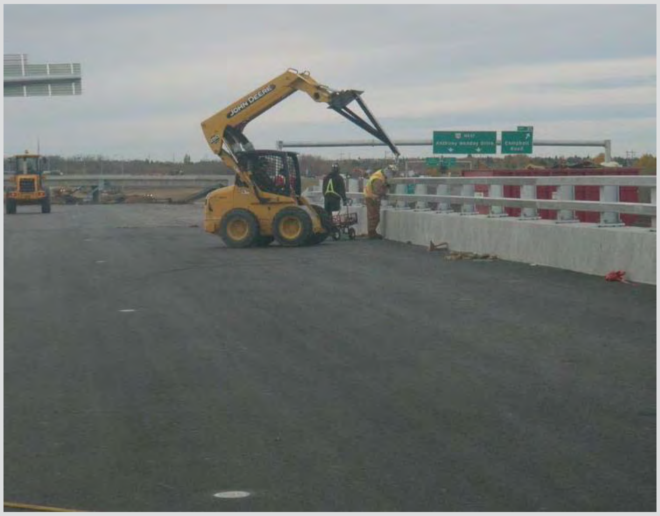
| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | | Was grout for bridgerail anchor bolt pads, mixed in required proportions? | ☐ | |
| 1.2 | | Was any damage to a galvanized surface repaired by metallizing? | ☐ | |
| **2** | | **Documentation** | | |
| 2.1 | | Did the Contractor supply approved shop and erection drawings, as well as a method of forming and pouring grout? | ☐ | |
| **3** | | **Material Handling and Storage** | | |
| 3.1 | 12.2.7.4 | Did the Contractor notify the Fabrication Inspector 48 hours prior to shipment to facilitate final inspection of the materials? | ☐ | |
| 3.2 | 12.2.7.4 | Were all holes (round and slotted) de-burred and accurately located? | ☐ | |
| 3.3 | 12.2.7.4 | Were galvanized surfaces smooth, free of scratches, handling damage, wet stains and uncoated? | ☐ | |
| 3.4 | 12.2.7.4 | Were underside of post base plates coated with barrier coating? | ☐ | |
| **4** | | **Erection** | | |
| 4.1 | 12.3 | Were anchor bolts checked for type, location and elevation, minimum anchor bolt projection of full thickness of a nut plus two threads, overall alignment and adequate attachment to form? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 4.2 | 12.3 | Were all structural bolts tightened by the turn-of-nut method? | ☐ | |
| 4.3 | 12.3 | Was the bridgerail checked for secure attachment, and alignment both horizontally and vertically, location, and gap of expansion joints? | ☐ | |
| 4.4 | 12.3 | Was a method of forming and pouring the grout submitted to the Inspector for review and acceptance? | ☐ | |
| 4.5 | 12.3 | Was Sika 212 flowable grout or an approved grouting material mixed in required proportions as per manufacture's specifications? | ☐ | |
| 4.6 | 12.3 | Was grout poured only to the bottom of base plate and wet cured for a period of 72 hours prior to applying Type 1c sealer, as per Clause 4.26 of the SSBC? | ☐ | |
| 4.7 | 12.3.1 | If the air temperature fell below 5°C, was an adequate preheat provided to raise the temperature of the adjacent areas to at least 10°C? | ☐ | |
| 4.8 | 12.3.1 | Was the temperature of the grout during placing between 10°C and 25°C? | ☐ | |
| 4.9 | 12.3.1 | Was the grout pad enclosed and kept at 10°C to 25°C for at least five (5) days using a system of heating, designed to prevent excessive drying-out of the grout? | ☐ | |
| 4.10 | 12.3.2 | Was the supply and installation of the approach rail transition included and installed in accordance with Section 14 Guardrail of the SSBC | ☐ | |

**Details and Summary:**

Signature

Date



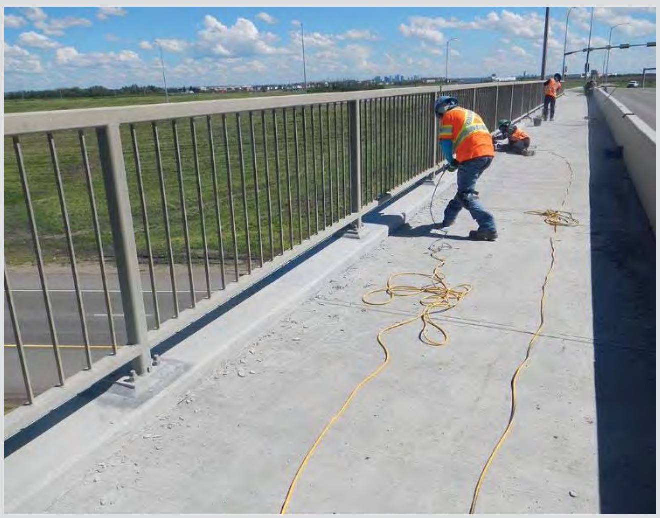
12.1 Installation of bridgerail. Bolting railing to posts.

12.2 Bridgerail alignment and elevation adjusted prior to grouting. Alignment and elevation to required lines is important for overall functionality and appearance of the bridgerail.

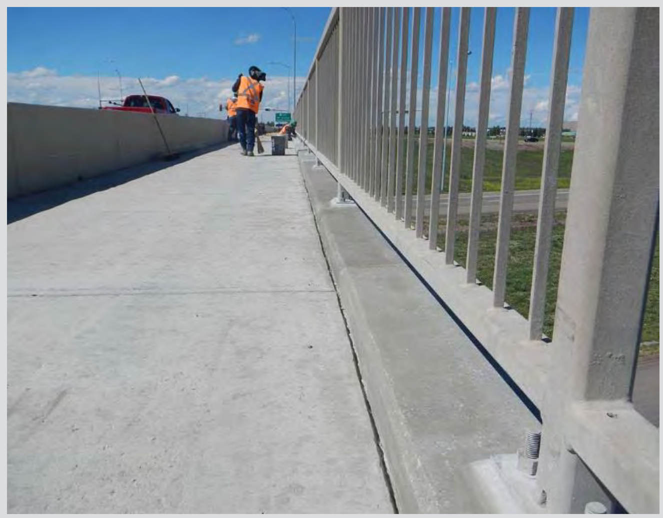
12.3 Expansion joint sleeves between rail sections.

12.4 Completed bridgerail grout pad. Acceptable projection of bolts shown.

12.5 Bridgerail to guardrail transition.



12.6 Sidewalk pedestrian rail. Horizontal and vertical alignment is important for the overall appearance.



12.7 Sidewalk pedestrian rail must be installed at correct alignment and elevation.

12.8 Completed pedestrian rail grout pad.

12.9 Completed PL-2 bridgerail.

12.10 Anchor bolt assembly cast into barriers. Wooden blockouts form grout recesses. Bolt projection to be protected to prevent contamination from concrete during barrier placement.

# SECTION 13

# MISCELLANEOUS IRON

## TABLE OF CONTENTS

## 13.1 Miscellaneous Iron – General

The term “miscellaneous iron” includes metal bridge components that are generally non-structural in nature. These may include steel drain troughs, pier drip sheets, deck buffer angles, dowels, connector angles, anchor bolt sleeves, bridge plaques and benchmark tablets. Miscellaneous iron items that are included in the Work will be listed in the Special Provisions.

The Inspector must be knowledgeable regarding the content of all applicable Standard Drawings that provide fabrication and installation details.

The Inspector must review the list of miscellaneous iron items with the Contractor early in the project to confirm that no items are overlooked.

## 13.2 Installation

Items of miscellaneous iron that are often embedded into concrete require that:

- The Inspector confirm that all such items and their anchorage devices are positioned at the correct location and alignment.

- Where the embedded item is required at the edge or face of a concrete surface, it must be secured tightly against the formwork so that the surfaces are true and free of paste after concrete placement.

## 13.3 Handling Galvanized Steel

Many items of miscellaneous iron are hot dip galvanized. Storage stains may occur if items are not properly stored. These are caused by trapped water that may occur if no air spaces exist between stockpiled items, or when water ponds at a surface. The formation of a white powdery deposit may result, which will affect the durability of the coating.

The Inspector must review all items after they are separated from shipment bundles at the site. Items which exhibit staining, marring, scratches, blisters or other coating damage must be rejected until they are acceptably repaired.

## 13.4 Field Welding

Field welding requirements for all bridge items are specified in Section 13 of the *Standard Specifications for Bridge Construction*. The differentiation between ‘Structural Members’ and ‘Non-Structural Members’ is made with respect to field welding, and the requirements differ for each. The Inspector must assume that a field-welded item is a ‘Structural Member’ unless the Project Manager advises that the item is a ‘Non-Structural Member’. Prior to any field welding, the Inspector must confirm that the Contractor is aware of those items that are ‘Structural Members’.

Prior to being delivered to the job site, all miscellaneous iron material is to be inspected by the Consultant’s Level II certified visual welding inspector. The Inspector must confirm with the Project Manager that the visual welding inspector’s report has been received, and that the fabricated materials are compliant to the requirements with no outstanding quality issues.

### 13.4.1 Structural Member Field Welding

Structural Member field welding is only done when necessary. Many factors can adversely affect the quality of the welds. Shop welding in controlled conditions is preferred so as to provide a consistent level of quality.

The Inspector must confirm that the Project Manager has received welder qualifications in the correct category, and has received and accepted the welding procedures. Prior to the start of welding, the Inspector must check that only those welders for whom qualifications have been accepted are performing the welds.

The Inspector must confirm with the welders that they are using the correct weld process as described in Section 6 of the *Standard Specifications for Bridge Construction*.

Ambient temperature limits and material pre-heating limits are more stringent for Structural Members than for Non-Structural Members.

Structural Member field welding is commonly done at the following elements:

- **Foundation Pile Splices**: Piles requiring splicing are normally sheltered to retain pre-heat during cool conditions by use of local hoardings. It is generally impractical to hoard the entire length of the pile. The local hoarding may consist of an insulated box that surrounds the splice location. The effectiveness of the hoarding is the Contractor’s responsibility.
- **Bearing Components**: The welding of galvanized plates is often required. Prior to welding, all zinc coating must be removed. Safety hazards exist when welding over galvanized coating. After welding, the coating must be repaired as described in the referenced specifications and documents.
- **Steel Substructures**: The welding of pile caps to substructures is generally done inside fully hoarded enclosures.

### 13.4.2 Non-Structural Member Field Welding

Non-Structural Member field welding is normally done only on culverts and deck joint splices.

The Inspector must confirm that the Project Manager has received and accepted welding procedures. Prior to the start of welding, the Inspector must check that the welders are qualified to perform weldments.

The Inspector must confirm with the welders that they are using the correct weld process as described in Section 6 of the *Standard Specifications for Bridge Construction*.

Government of Alberta ■ Transportation

**Bridge Construction Inspection Manual 2015**

Section 13 – Miscellaneous Iron Check Sheet

Project Name:

Date:

Time:

Project No.:

Bridge File No: Inspector:

Stage of Activity:

Element:

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| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **Materials** | | |
| 1.1 | 13.3 | Was all lifting and handling for galvanize steel done using devices that did not mark, mar, damage or distort the galvanized members and assemblies in any way? | ☐ | |
| 1.2 | 13.3 | Was galvanized material stacked or bundled and stored to prevent wet storage stain, as per the American Hot Dip Galvanizers Association (AHDGA) publication "Wet Storage Stain"?<br>*Note: Delivery of a damaged product will be cause for rejection.* | ☐ | |
| **2** | | **Field Welding – Structural Members** | | |
| 2.1 | 13.4.1 | Was all welding, cutting and preparation done in accordance with the American Welding Society (AWS) Bridge Welding Code D1.5? | ☐ | |
| 2.2 | 13.4.1 | Were the welders performing the weldments approved by the Canadian Welding Bureau in the particular category, and was their qualification current and available for examination? | ☐ | |
| 2.3 | 13.4.1 | Were the welding procedures approved by the Canadian Welding Bureau and submitted for review prior to welding? | ☐ | |
| 2.4 | 13.4.1 | Were low hydrogen filler, fluxes and welding practices used in accordance with Section 6.2.5.1 of the SSBC? | ☐ | |
| 2.5 | 13.4.1 | When the air temperature was below 10°C, was all material to be welded preheated to 100°C for a distance of 80 mm beyond the weld and sheltered from the wind? | ☐ | |
| 2.6 | 13.4.1 | Was welding permitted when the air temperature was below 0°C, other than with suitable hoarding and heating provided, as accepted by the Inspector? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **3** | | **Field Welding – Non Structural Members** | | |
| 3.1 | 13.4.2 | Were journeyman welders with Class B tickets performing the weldments and was their qualification current and available for examination? | ☐ | |
| 3.2 | 13.4.2 | Were the welding procedures prepared and stamped by a Professional Engineer, and were they submitted for review prior to welding? | ☐ | |
| 3.3 | 13.4.2 | Were low hydrogen filler, fluxes and welding practices used in accordance with Section 6.2.5.1 of the Standard Specifications for Bridge Construction? | ☐ | |
| 3.4 | 13.4.2 | When the air temperature was below 10°C, was all material to be welded preheated to 100°C for a distance of 80 mm beyond the weld and sheltered from the wind? | ☐ | |
| 3.5 | 13.4.2 | Was welding permitted when the air temperature was below 0°C, other than with suitable hoarding and heating provided, as accepted by the Inspector? | ☐ | |

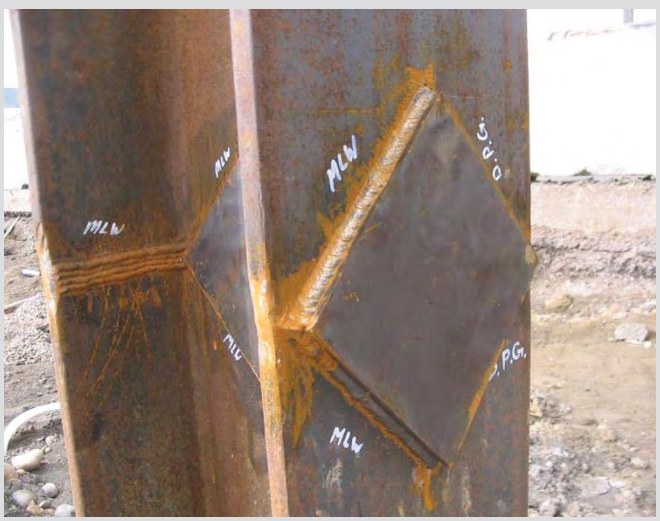
**Details and Summary:**

Signature

Date

13.1 Polyurethane coated and galvanized deck drain.

13.2 Cast-in-place bridge plaque. Bridge plaques must be set true to wingwall and barrier lines.




13.3 Completed H-pile splice plate detail.

13.4 Splicing pipe pile. Bevelled edge with backup ring.

13.5 Pipe pile splice ready for field welding.

13.6 Hoarding setup for welding in windy or cold conditions.

# SECTION 14

# GUARDRAIL

## TABLE OF CONTENTS

## 14.1 Guardrail – General

Guardrail is designed to protect motorists when a vehicle leaves the roadway surface. Guardrail may protect the vehicle occupants by:

- Preventing a vehicle that has left the roadway from striking other objects or vehicles, which would result in a more severe crash.
- Deflecting the vehicle back onto the roadway surface.
- Reducing the speed of or stopping a moving, uncontrolled vehicle.

Guardrail end terminals are special treatments installed at the terminus of the system. They are designed to prevent a blunt vehicular impact or an overturning impact at the end of the guardrail. Special end terminal treatments include turn-downs and cushions.

Flexbeam guardrails will deflect under crash impact, while bridgerail systems are rigid. The transition from guardrail to bridgerail is important to ensure that the system prevents a blunt vehicular impact collision at the end of the bridge barrier or parapet.

## 14.2 Guardrail – Details

Guardrail is normally installed at all four corners of bridge approaches. The guardrail details depend on the type of bridgerail barrier system in use. The length of guardrail varies depending on the design volume and speed of the roadway, as well as on site-specific conditions. Guardrail is installed after all roadway work has been done, and after bridgerail installation has been done for PL-1, 2 and 3 systems. For thrie-beam systems, guardrail is often installed at the same time that the bridgerail is installed.

Guardrail may also be installed on roadway shoulders or in medians to protect bridge piers.

Guardrail systems are crash-tested to assess their performance, and even slight modifications to the specified details can significantly and adversely affect their performance:

- Guardrail may itself be a hazard, and must only be installed at the locations specified.
- Guardrail must be installed at the correct height.
- Guardrail post spacing and location must be precise.
- End terminals must be constructed exactly as specified, or they may present an unnecessary hazard.

The Inspector must carefully measure or otherwise check the location of the guardrail components. The safety of the travelling public may be compromised if the guardrail system is not properly constructed as specified.

## 14.3 Temporary Guardrail

During bridge construction activities, it is sometimes necessary to remove existing guardrail. If traffic is to be maintained on the roadway, it is necessary to replace this guardrail with a temporary system that provides similar protection, often in conjunction with reduced speed. The Inspector must confirm that the Contractor has adequately installed all temporary replacement guardrail as required before traffic is permitted to travel on the affected roadway.

## 14.4 Material

The *Standard Specifications for Bridge Construction* provide references to various other specifications and standard. These documents provide the material fabrication requirements for rails, steel posts, wooden posts, special hardware and bolts.

Prior to any materials being incorporated into the Work, the Inspector must confirm with the Project Manager that a copy of the producer's certificate — which confirms compliance to the required material and chemical tests — has been received and accepted.

Prior to any materials being incorporated into the Work, the Inspector must confirm by on-site measurement and visual inspection that:

- All holes punched after galvanizing have any damaged coating repaired by ASTM A780 Method A1 'Repair using Zinc-Based Alloy', including requirements for adhesion testing and minimum thickness of 180 um.
- The curvature of rail sections is correct. The curved sections, if fabricated by crimping, do not have damage to the galvanized coating.
- The sheet thickness is correct.
- Wooden posts are marked with a No. 1 NLGA grade and are date stamped.
- Wooden posts are not excessively waned and not warped.
- Wooden posts are pressure preservative treated after cutting and drilling. If penetration testing is required, the Inspector must drill a test hole into the side of a sample post at an above-ground location. The core shavings must indicate that the preservative has penetrated a minimum of 75 mm into the post. The drilled hole must be plugged with a disinfectant-treated countersunk dowel and silicone caulk.

## 14.5 Installation

The Inspector must confirm that the Contractor has taken precautions to accurately install all guardrail posts.

Locations must be surveyed and marked in advance by the Contractor, and checked by the Inspector. The location of existing or future curb and gutter or drain troughs must be considered since these may conflict with guardrail post locations. The location of utility ducts that may be buried beyond the ends of wingwalls must also be avoided when installing guardrail posts.

The Contractor must inspect the materials once they arrive at the site, including size, thickness and coating. The Inspector must confirm with the Contractor that the actual measurements of supplied materials meet acceptable tolerances.

The Contractor must take care when augering holes to ensure that they are accurate in location and plumb. The Inspector must confirm that there is sufficient space on all sides of posts so that proper placement of backfill can be done. Posts must not be in contact with the sides of the hole.

The Inspector must check the material at the base of the holes for suitability. Bases must consist of firm, dry soil. Unsuitable or loose materials must be removed by over-excavating and then placing approximately 150 mm of granular backfill.

If the excavated material consists of highly plastic clay, wet clay, silt or organic material, it is unsuitable for use as backfill and must be replaced with imported granular backfill.

It is very important that the guardrail laps be consistently placed in the direction of traffic so that vehicles that come into contact with the guardrail do not impact the exposed edge of a rail section and separate the rail sections at the lap, creating a dangerous condition.

The Contractor must take care not to damage the galvanized coating during installation or bolting. Guardrail sections must be properly stored until they are erected. Guardrail must not be erected using equipment that may scratch the coating.

Bolts must be tightened to a torque of 100 Nm. Threaded holes in the embedment mounting plate in the transition barrier must be kept clean at all times.

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Transportation

**Bridge Construction Inspection Manual 2015**
Section 14 – Guardrail Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

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| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **Inspection of Materials** | | |
| 1.1 | 14.3.1 | Was the size and thickness of 2.67 mm nominal base metal thickness rails and terminal elements within the tolerance specified:<br>• Base metal thickness: 2.67 mm<br>• Galvanized finished thickness: 2.82 mm<br>• Tolerance: 0.23 mm | ☐ | |
| 1.2 | | Was the size and thickness of 3.5 mm nominal base metal thickness rails and terminal elements within the tolerance specified:<br>• Base metal thickness: 3.43 mm<br>• Galvanized finished thickness: 3.58 mm<br>• Tolerance: 0.23 mm | ☐ | |
| 1.3 | 14.3.2 | For timber guardrail posts, was testing of the penetration of the preservative carried out?<br>*Note: Warped wood posts will be rejected.* | ☐ | |
| **2** | | **Installation** | | |
| 2.1 | 14.4 | Was the permissible tolerance for plumb and grade of posts (20 mm maximum) achieved? | ☐ | |
| 2.2 | 14.4 | Was any unsuitable material at the bottom of the holes excavated and replaced with granular material directed by the Inspector at the Contractor's expense? | ☐ | |
| 2.3 | 14.4 | Did the Contractor thoroughly compact the bottom of the hole? | ☐ | |
| 2.4 | 14.4 | Did the guardrail posts rest directly and solidly on the bottom of the hole at the time of installation? | ☐ | |
| 2.5 | 14.4 | Was the backfill thoroughly compacted using pneumatic tampers in layers not exceeding 150 mm for the full depth of the excavation? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.6 | 14.4 | For posts installed on paved surfaces, was the top 150 mm of backfill completed using ACP in accordance with Section 17 of the SSBC? | ☐ | |
| 2.7 | 14.4 | Was any guardrail material requiring field modification reported before work was carried out?<br>*Note: Modification by flame cutting method is prohibited. Modification by cold cutting method is allowed.* | ☐ | |
| 2.8 | 14.4 | Were guardrail laps in the direction of traffic flow? | ☐ | |
| 2.9 | 14.4 | Were bolts tightened to a torque of 100 Nm? | ☐ | |
| 2.10 | 14.4 | Were metal reflectors (Scotchlite or equivalent) supplied and attached to the top of every third guardrail post with two 50 mm ring nails? | ☐ | |
| 2.11 | 14.4 | Did the Contractor take all necessary precautions to eliminate damage to galvanizing? | ☐ | |
| 2.12 | 14.4 | Were minor abrasions and exposed steel areas resulting from cold cutting repaired in accordance with ASTM A780 Method A2 Repair Using Paints Containing Zinc Dust? | ☐ | |
| 2.13 | 14.4 | Were major abrasions repaired by regalvanizing? | ☐ | |
| 2.14 | 14.4 | Was the guardrail connected to bridgerail, parapets or existing guardrail as shown on the drawings? | ☐ | |

**Details and Summary:**

________________________ Signature

________________________ Date

14.1 Guardrail to bridgerail transition.

14.2 Guardrail to bridgerail transition.

14.3 Guardrail transition posts.

14.4 Guardrail transition post holes in concrete drain trough take off.

14.5 Guardrail and posts with end treatment.

14.6 Guardrail and posts with end treatment.

14.7 Guardrail and posts with end treatment.

14.8 Installing guardrail to posts.

14.9 Post installation drilling.

# SECTION 15

## NON-SKID POLYMER WEARING SURFACE

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## 15.1 Non-skid Polymer Wearing Surface – General

Resurfacing concrete bridge decks with a non-skid polymer wearing surface consists of repairs to the bridge deck and the application of a thin, flexible, multi-layered polymer bound aggregate surface. The purpose of this repair is to waterproof the deck, restore skid resistance and reinstate a smooth riding surface.

- The Inspector must confirm that proper traffic control is in place prior to the start of the Work.
- The prepared surface must be clean, dry and free of foreign materials.
- Multiple layers of polymer are applied to seal the concrete deck.
- A broom and seed method of application is used to achieve the polymer-aggregate composite.
- A fine aggregate is seeded onto the polymer to reduce the potential for shear failure caused by differences in thermal expansion between the polymer and the concrete deck. This also provides skid resistance, protects the membrane from UV damage and provides durability.
- Application conditions are important due to the sensitivity of the products.
- Prior to and during polymer application, no strong winds may exist.
- There must be adequate manpower to successfully complete a pour section without interruption. Larger structures may require several pour sections.

## 15.2 Environmental Considerations

Be aware of the following environmental considerations:

- Concrete chipped from partial and full depth repairs must not be allowed to fall into the watercourse or roadway surface.
- Sandblasting operations must meet all environmental requirements.
- Excess seed aggregate and debris must not be blown into the water channel or the roadway below.
- Before acceptance of the surface preparation and final payment, the Contractor must remove and dispose of all waste material.

## 15.3 Safety Considerations

The Contractor must supply, install and maintain all necessary signing, flagging, flashing arrow boards, traffic control lights, barricades, temporary medians and other warning or traffic control devices as may be required for the safety of the public, inspection staff and Contractor's personnel.

- The traffic control plan must be submitted to the Consultant for review and comment two weeks prior to the pre-construction meeting.
- The Inspector must confirm that proper traffic control is in place prior to work commencement.
- The traffic control plan must be adjusted as necessary to accommodate the traffic conditions.
- The Contractor is responsible for monitoring and maintaining the traffic control devices at all times while traffic restrictions are in effect.

## 15.4 Preliminary Work

The Contractor must submit a proposed schedule and work plan to the Consultant, which must address the following:

- Crew size and number of working hours.

- Deck layout diagram, including dimensions, batch sizes and calculations.
- Traffic accommodation plan, when required.
- Equipment and material being used.

## 15.5 Surface Preparation

Proper surface preparation is important for adequate bond strength between the polymer surface and deck concrete. Acceptability of the surface preparation must be determined by the vertical axis pull test. This test consists of bonding a 64 mm diameter sandblasted steel disk to the prepared substrate by using a fast-setting epoxy, then pulling it from the substrate by applying a vertical pulling force. Substrate preparation will not be approved unless at least 75% of the bonded steel disk surface has retained substrate concrete.

The deck surface must be prepared by shot blasting to remove all bond inhibitors, such as concrete laitance, and to expose the coarse aggregate in the substrate concrete.

Those areas inaccessible to shot blasting, such as the vertical face of the concrete curb, must be prepared by sandblasting.

The prepared areas must be re-blasted in the event of rain.

The deck is accepted as adequately dry when there is no evidence of moisture, as determined by the “Plastic Window Test”. This is a condensation test that consists of sealing a sheet of clear poly to the concrete with duct tape and checking to see if condensation occurs after a period of hours.

### 15.5.1 Crack Repairs and Deck Patching

The limits of deck concrete removal must be determined by the Inspector and may vary from simply sealing a crack to total removal and replacement of an area of deteriorated concrete.

Chain dragging and hammer sounding are used by the Inspector to determine the limits of deteriorated concrete.

Concrete must be removed completely around any exposed reinforcing steel.

Exposed reinforcing steel must be sandblasted to a white metal finish.

All areas to be repaired must be clean and an approved bonding compound applied to the concrete surface immediately prior to concrete placement.

Replacement concrete must be properly consolidated.

Sealer may require up to six hours of drying time before the first layer of polymer overlay may be applied.

Surface patching must be done with polymer mortar for depressions in excess of 6 mm deep. The surface of the concrete must be shotblasted prior to patching. Aggregate must be placed to produce a rough surface.

Full and partial depth repairs must be carried out in accordance with Section 20 of the *Standard Specifications for Bridge Construction*.

## 15.6 Batching and Mixing of Polymer

The Contractor's batching operation must be calibrated each day prior to any production. Batching may be done either by static mixer or by premeasuring each polymer component in calibrated pails.

### 15.6.1 Static Mixer

When calibrating by static mixing heads, the polymer components may be deposited into two separate measuring containers, each equipped with marks for a given volume.

One of the material components is drawn from a disconnected feed upstream of the static-mixing head while the other is drawn downstream of the pump.

The calibration is only approved if the quantities of each component drawn correspond to that of the manufacturer's recommendation.

The calibration must be repeated if the change in temperature of the polymer component exceeds 50°C.

### 15.6.2 Pre-measured Containers

Calibration may also be achieved by measuring each polymer component using marked pails.

- Water is used to calibrate the measuring pails.
- The calibration required on the pails is marked with four screws.

The following points must be noted when batching the polymer for deck overlay:

- Fill polymer components to the permanent mark in the respective container.
- Pour polymer components into the first mixing pail and mix thoroughly according to the manufacturer's specified time.
- Transfer mixed polymer into second mixing pail for further mixing.
- Mixing time must not be less than three (3) minutes.
- Each component must be measured to an accuracy of +/- 3% and mixed batches must not exceed 20 litres.

### 15.6.3 Application of Polymer Resin

The polymer must be applied in accordance with the manufacturer's instructions, otherwise failures such as improper gelling of the polymer, poor bond or thermal incompatibility may occur. It should also be noted that a change of deck temperature may cause out-gassing and in-gassing, which results in undesirable “pinholes”.

- To avoid out-gassing and in-gassing, application of the first layer must be done during dropping deck temperatures.
- The polymer must be spread uniformly over the pre-measured areas using a squeegee and obtaining the required depth. The use of spiked footwear will only be permitted prior to gelling of the polymer.
- Spreading and levelling of fresh polymer must be completed within seven minutes of batching.
- All cold joints must be offset 100 mm from cold joints of the previous layers.
- The first layer must extend up the concrete curb or parapet face as specified.

- The longitudinal joint must be overlapped 150 mm between the first half and the second half of the overlay for each layer.
- Aggregate must be seeded uniformly into fresh polymer before gelling.
- All deficiencies must be satisfactorily repaired.
- After curing each seeded layer, the excess aggregate must be swept and collected into old bagging for calculating of sufficient quantity of aggregate seeded.
- Application of each layer of the polymer must be done in accordance with the manufacturer's specification.
- Anchoring of overlay edges may be required for polymer wearing surfaces.
- Rough spots exceeding 3 mm in height must be ground to provide a smooth transition.

## 15.7 Weather

Polymer overlay work must be done in suitable weather conditions. Mixing and placing of polymer must be done at ambient air temperatures between 5°C and 27°C.

## 15.8 Sealing of Concrete Gutters (Polymer Membrane Only)

Sealing of the concrete gutter is required where a paving lip is present. An approved epoxy sealer must be applied to the concrete gutter in two applications.

- The concrete surface must be lightly sandblasted, cleaned and dried prior to sealing.
- The rate of the first application is 0.38 L/$m^2$, while the second application is 0.16 L/$m^2$.

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**Bridge Construction Inspection Manual 2015**
Section 15 – Non-Skid Polymer Wearing Surface Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | | Was chain drag and hammer sound testing done to locate and mark delaminated areas? | ☐ | |
| 1.2 | | Were areas surveyed for payment? | ☐ | |
| 1.3 | | Was the deck surface dry prior to repair? | ☐ | |
| 1.4 | | Were air, deck and polymer temperatures acceptable? | ☐ | |
| 1.5 | | Was moisture of deck present? | ☐ | |
| 1.6 | | Were cube specimens for compressive strength testing made? | ☐ | |
| 1.7 | | Was a pull test for bond strength performed? | ☐ | |
| **2** | | **Installation** | | |
| 2.1 | 15.4 | Were all patches consisting of Type NH patching materials cured for 14 days and tested for moisture in accordance with Section 15.7.3 of the SSBC prior to the application of polymer overlay? | ☐ | |
| **3** | | **Crack Repair** | | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.1 | 15.5 | Were all deck cracks more than 2 metres in length and greater than 0.3 mm wide treated with a Type 1c sealer meeting the current Material Testing Specifications for Concrete Sealers (B388)? | ☐ | |
| **4** | | **Bridge Deck Repair** | | |
| 4.1 | 15.6 | Were surface voids and depressions in excess of 6 mm patched by the Contractor? | ☐ | |
| 4.2 | 15.6 | Did the Contractor make the necessary repairs? | ☐ | |
| 4.3 | 15.6.1 | Was the surface shotblasted and/or sandblasted in accordance with Clause 15.7.1 of the SSBC prior to placement of the polymer mortar? | ☐ | |
| 4.4 | 15.6.1 | Were the areas to be patched primed with a 75 mm wide band of liquid polymer along their perimeter while the liquid polymer primer was liquid or tacky and to the original gradeline? | ☐ | |
| 4.5 | 15.6.2 | Was all concrete cured for 28 days and tested for moisture in accordance with Clause 15.7.3 of the SSBC prior to the application of polymer overlay? | ☐ | |
| 4.6 | 15.6.3 | Were all patches and levelling areas accepted by the Inspector prior to commencing the overlay? | ☐ | |
| **5** | | **Polymer Construction** | | |
| 5.1 | 15.7 | Did the Contractor obtain the Project Manager’s acceptance prior to increasing the minimum polymer coverage requirements? | ☐ | |
| 5.2 | 15.7.1 | Did the Contractor properly prepare the surface prior to placement of overlay? | ☐ | |
| 5.3 | 15.7.1 | Did any areas require re-blasting due to rain, delay in applying overlay or leakage of contaminants onto the deck? | ☐ | |
| 5.4 | 15.7.2 | Did the Contractor submit a sketch to the Project Manager showing the deck surface divided into segments to be covered by each polymer batch? | ☐ | |
| 5.5 | 15.7.2 | Did the Contractor apply masking tape to the boundaries of the work areas, as shown on the submitted sketches? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 5.6 | 15.7.3 | Were weather conditions and temperatures suitable for mixing, placing and curing of polymer overlay, and was the concrete substrate completely dry? | ☐ | |
| 5.7 | 15.7.4 | Were the batching and mixing of the polymer done in accordance with the manufacturer's instructions? | ☐ | |
| 5.8 | 15.7.4 | Was the deck and adjacent areas protected from spillage of polymer, solvents and other materials by the Contractor? | ☐ | |
| 5.9 | 15.7.5 | Was the polymer applied in accordance with the manufacturer's instructions and only after acceptance by the Inspector of the prepared deck surface and completion of layout? | ☐ | |
| 5.10 | 15.7.5 | Did the Contractor 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? | ☐ | |
| 5.11 | 15.7.6 | Did the Contractor seed the first and second layer of polymer for Class A and B wearing surfaces and the first layer for Class C wearing surfaces? | ☐ | |
| 5.12 | 15.7.6 | Did the Contractor seed the basecoat layer when a Degussa Degadur System (MMA) was used? | ☐ | |
| 5.13 | 15.7.6 | After acceptance by the Inspector of the previously placed cured overlay, did the Contractor remove all excess aggregate prior to placing a subsequent layer of polymer? | ☐ | |
| 5.14 | 15.7.6 | Did the Contractor do vertical pull out tests to confirm the adequacy of the material when any layer of polymer material was subjected to rain or any other form of damage? | ☐ | |
| 5.15 | 15.7.6 | Did the Contractor repair all bond test locations? | ☐ | |
| 5.16 | 15.7.7 | Did any areas of the bridge deck contain larger smoothness defects? | ☐ | |
| 5.17 | 15.7.8 | Did the Contractor, two (2) weeks prior to commencement of work, conduct 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 tests, and did he provide the results to the Project Manager? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 5.18 | 15.7.8 | During placement of the polymer, were samples of the mixed polymer material randomly selected by the Inspector for compressive strength testing in accordance with test method ASTM C-109? | ☐ | |
| 5.19 | 15.7.8 | Did the Inspector determine the test location of each test, and did the Contractor cast a set of three (3) cubes to the frequency of test listed in the table in Section 15.7.8 of the SSBC? | ☐ | |
| 5.20 | 15.7.9 | Did the polymer overlay reach a minimum of 60% of the seven-day compressive strength or 3.0 MPa of tensile strength achieved, based on the last batch of the day, prior to opening to traffic? | ☐ | |

**Details and Summary:**

Signature

Date

# SECTION 16

## BRIDGE DECK WATERPROOFING

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## 16.1 Bridge Deck Waterproofing – General

A hot-applied rubberized membrane waterproofing system is applied to deck concrete prior to the installation of the Asphalt Concrete Pavement (ACP) wearing surface. The waterproofing system is used to prevent the ingress of chlorides into the deck concrete. If chlorides permeate to the deck reinforcing steel, corrosion may occur, which can result in concrete delamination. Significant rehabilitation and reduced deck life can result once the concrete has become contaminated.

## 16.2 Environmental Considerations

The Inspector must be aware of the environmental considerations:

- Environmental conditions must be dry to prevent rain from washing waterproofing materials into a watercourse.
- Deck shotblast or sandblast spoil must not be allowed to enter into the stream or surroundings.

## 16.3 Safety Considerations

The bridge deck waterproofing procedures requires the use of “hot” material and proper protective equipment, including eye protection, must be worn. A fire extinguisher must be at the melting/mixing kettle.

## 16.4 Surface Preparation

It is essential that the deck surface be adequately prepared prior to applying the waterproofing system. Often, deck finishing and curing operations result in a surface that exhibits “dusting”. Dusting is a chalky powder at the deck surface called ‘laitance’. The laitance is a weak paste layer that breaks down easily. This condition is typically caused by finishing operations that segregate the mix, resulting in bleeding and consequent weakening of the surface. If the concrete surface is damaged by excessive quantities of water, then this weak surface can be 5 mm or more in depth.

All laitance must be removed by sandblasting or shotblasting the concrete surfaces to be waterproofed. The extent of blasting must be closely monitored by the Contractor and the Inspector. Too light of a blast will result in the incomplete removal of the laitance layer, while too heavy of a blast will remove the entire paste layer and expose the aggregate in the concrete. It is important that the paste layer not be entirely removed since an exposed aggregate texture is more permeable and more prone to future contamination.

It is very important that all sand and debris be removed from the blasted surface before the application of the tack coating. The Contractor must schedule the blasting and tack coating operations so that there are no delays between these operations and consequently minimal likelihood of contamination before tacking.

It is also important that the concrete substrate be dry before blasting and tacking. Concrete and concrete patches must be allowed to cure and dry to prevent free water from becoming trapped under the waterproofing membrane. Often, the concrete will appear to be dry, but it still may contain a large volume of free water due to its early age or due to rainfall.

To determine if the concrete is off-gassing water vapour, the Inspector may perform a condensation test (“Plastic Window Test”) that consists of sealing a sheet of clear poly to the concrete with duct tape and checking to see if condensation occurs after a period of hours. The

Inspector must approve the surface preparation prior to the application of the tack coat by the Contractor.

## 16.5 Application of Waterproofing Membrane

The Inspector must review in detail the Standard Drawing S-1443 for the criteria and requirements necessary for applying the waterproofing system.

### 16.5.1 Tack Coating Deck Surface and Curbs

The Inspector must carefully monitor the application of the tack coat.

The Inspector must confirm that the material supplied is compatible with the proposed waterproofing membrane material, as confirmed by the manufacturer's recommendations.

The tack coat material must be properly diluted. The Inspector must confirm that the Contractor has properly measured the volume of the tack coat material and the thinner.

The tack coat material must be applied at the specified rate. The Inspector must confirm that the Contractor's methods allow the volume per area to be accurately measured. The Inspector must pay particular attention to the application rate at the start of the operation.

The Inspector must confirm that no equipment or materials may travel or be stored on the tacked surface until it is fully cured. Curing guidelines can be obtained from the manufacturer. A cured surface is not tacky and typically has changed in colour from a dull black to a dull brown.

The tack coat must be applied to all locations that receive hot applied membrane, including the vertical curb face for the full height of the ACP.

The tack coat may be applied by either brushing or spraying, but brush application is advisable for the curb face to avoid overspray.

All areas, other than where tack coat is to be applied, must be protected from overspray or brushing operations.

### 16.5.2 Application of Reinforcing Fabric Material

It is necessary to install reinforcing fabric at all locations where construction joints, cracks, patches, lift hook pockets and post-tensioning grout tubes exist.

The Inspector must identify all locations that require reinforcing fabric. This must be done before the tack coat is applied. Of particular importance is the location of cracks. Cracks typically occur in the transverse direction, at regular intervals. Cracks may be difficult to detect visually. The Inspector must inspect the deck for cracks immediately after the curing filter fabric is removed. As the deck surface dries, the cracks will become more visible. The crack locations must be mapped and sketched, and reference marks made at the adjacent barriers. The cracks must be marked so that they can be located after the tack coat is applied.

The Inspector must confirm that the material supplied meets the specified requirements.

### 16.5.3 Application of Rubber Membrane

At the faces of curbs, barriers and medians, a rubber membrane is placed at the gutter. The membrane provides additional protection at this vulnerable location where construction joints exist. The material is supplied in rolls.

The Inspector must confirm that the supplied material meets the referenced standards.

The specification requires that the rubber membrane be lapped when multiple strips are used. The rubber membrane strip is embedded in the hot asphalt membrane such that it extends 50 mm up on the vertical face and 100 mm on the deck surface.

### 16.5.4 Application of Waterproofing Membrane

The membrane materials are supplied as solid cakes or bricks. A heating and mixing kettle is used to prepare the material. The material resides in the kettle until it is drawn for immediate use. The kettle must properly agitate the material and maintain its temperature. The Inspector must confirm that the Contractor’s equipment meets the specified requirements through the entire duration of the operation.

The Inspector must confirm that the material supplied meets the referenced standards.

The waterproofing membrane must be placed after the tack coat has cured. The Contractor must plan to do the waterproofing membrane application continuously and complete it in a single operation with no cold laps.

Waterproofing membrane material is also used to secure the reinforcing fabric material and rubber membrane, at the locations described above. The installation of the reinforcing fabric material and the rubber membrane is done for the entire deck surface concurrently with the application of the waterproofing membrane and protection board placement.

Waterproofing membrane material is transported in pails from the kettle to the deck surface and is spread using a rubber-tipped floor squeegee. The working time for the waterproofing membrane material is limited, and it is important that the Contractor checks the thickness of the material immediately after it is placed and before the protection boards are placed. The Inspector must continuously and systematically check the waterproofing membrane thickness using a device such as a tire tread thickness gauge or a calibrated probe.

The Inspector must confirm that wick drain pipes are flush with the deck and that the wick drains have been installed along the full lengths of the gutters when the asphalt membrane is still hot and tacky.

### 16.5.5 Installation of Protection Board

The protection board serves the following functions:

- It protects the waterproofing membrane from the heat of the ACP as it is being placed.
- It protects the waterproofing membrane from the abrasive action of the course aggregate in the ACP, both during placement and in service.
- It protects the waterproofing membrane from equipment used during ACP placement.
- Through proper lapping, it prevents water from coming into direct contact with the waterproofing membrane.

The Inspector must carefully and continuously monitor the installation of the protection board as follows:

- The Inspector must confirm that the material supplied meets the referenced standards.
- The boards must be placed onto the waterproofing membrane before it loses its initial tackiness, with the length of the board running transversely to the deck.
- Subsequent rows of protection boards must be placed with the longitudinal joints staggered and all joints lapped according to specifications, starting at the low end of the bridge. The direction of laps must produce a shingling effect. This will prevent water from becoming trapped under or against the edges of the board, which can result in the premature deterioration of ACP surfacing.
- The boards must be cut to fit within 6 mm of the curb and wick drains, and boards must overlap by 25 mm. Excessive laps may result in boards curling or becoming damaged prior to the placement of ACP surfacing. The Inspector must use a measuring jig to easily and rapidly check lap dimensions.
- For decks with medians, it is necessary to place waterproofing membrane under the median concrete.
- It is important to schedule ACP placement immediately after waterproofing to avoid potential deterioration of the protection board.

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**Bridge Construction Inspection Manual 2015**

Section 16 – Bridge Deck Waterproofing Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **Pre-Activity Inspection: Materials and Equipment** | | |
| 1.1 | | Was the Contractor's submittal documentation for materials reviewed? | ☐ | |
| 1.2 | | Were the products supplied identifiable and identical to those reviewed? | ☐ | |
| 1.3 | 16.2 | Did tack coat primer meet the requirements of CGSB-37-GP-9MA? | ☐ | |
| 1.4 | 16.2 | Were asphalt membrane cakes supplied in sealed packages labelled by the manufacturer? | ☐ | |
| 1.5 | 16.2 | Did asphalt membrane materials meet the requirements of MTO Specification OPSS 1213? | ☐ | |
| 1.6 | 16.2 | Did rubber membrane consist of either butyl rubber or EPDM rubber that met the requirements of CGSB-37.52M and had a thickness of 1.2 mm? | ☐ | |
| 1.7 | 16.2 | Was asphalt membrane reinforcing fabric supplied in widths of 300 mm? | ☐ | |
| 1.8 | 16.2 | Did the material consist of a spun bonded sheet structure composed of 100% continuous filament polyester fibres bonded together at their crossover points? | ☐ | |
| 1.9\ | 16.2 | Did wick drains have dimensions of 3.6 mm total thickness and 100 mm width? | ☐ | |
| 1.10 | 16.2 | Was puncture strength of wick drain material 45 N in accordance with ASTM D4833? | ☐ | |
| 1.11 | 16.2 | Did waterproofing protection board meet MTO Specification OPSS 1215? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 1.12 | 16.3 | Was the kettle a double boiler oil-transfer type with a built-in agitator and built-in dial thermometer? | ☐ | |
| 1.13 | 16.3 | Was a separate and calibrated thermometer with an accuracy of +/- 2°C provided by the Contractor to verify the kettle thermometer accuracy? | ☐ | |
| 1.14 | 16.4 | Did the Contractor provide a weighted linoleum or lawn type roller for use during placement of protection board? | ☐ | |
| 1.15 | 16.2, 16.4 | Were the supplied protection boards durable and free of distortion, warping or other damage? | ☐ | |
| **2** | | **Pre-Activity Inspection: Deck Condition** | | |
| 2.1 | 16.4 | Was the air and concrete deck surface temperature 5°C or higher? | ☐ | |
| 2.2 | 16.4 | Were P/T grout tubes cut flush with the deck surface? | ☐ | |
| 2.3 | 16.4 | For a new surface, was the concrete cured for at least 14 days and exposed to drying conditions for three (3) additional days? | ☐ | |
| 2.4 | 16.4 | Was the concrete 'dry' immediately prior to application of tack coat, as confirmed by condensation test? | ☐ | |
| 2.5 | 16.4 | Was a localized heat source that may be damaging used for drying? | ☐ | |
| 2.6 | 16.4 | For a new surface, did sandblasting or shotblasting result in a uniformly sound, laitance and dust-free surface? | ☐ | |
| 2.7 | 16.4 | At the start of the operation, was the intensity of blasting demonstrated effective without exposing concrete aggregate? | ☐ | |
| 2.8 | 16.4 | Was all sand, dust, dirt and other debris effectively removed by vacuuming, air blasting, pressure washing or other means? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.9 | 16.4 | Immediately prior to the application of tack coat primer, was the entire surface air blasted using oil and water-free compressed air? | ☐ | |
| 2.10 | 16.4 | Did the surface preparation also meet the tack coat primer manufacturer's recommendations? | ☐ | |
| 2.11 | 16.4 | For a rehabilitated surface, was the concrete cured for at least seven (7) days and exposed to drying conditions for three (3) additional days? | ☐ | |
| 2.12 | 16.4 | For a rehabilitated surface, did grinding, scabbling or bush hammering result in a surface texture profile with a 3 mm amplitude? | ☐ | |
| **3** | | **Placement Inspection** | | |
| 3.1 | 16.4 | Did the Contractor provide 48 hours advance notice to the Project Manager or Inspector prior to commencing operations? | ☐ | |
| 3.2 | 16.4 | Was the tack coat primer cut back with an equal volume of gasoline or an alternative product? If an alternative product, was it accepted by the Project Manager? | ☐ | |
| 3.3 | 16.4 | Was the tack coat primer consistently applied at a rate of approximately 0.25 L/m sq, as measured by the Contractor? | ☐ | |
| 3.4 | 16.4 | Was the tack coat primer absorbed into the concrete, as evidenced by a dull black appearance, or was it over-applied, resulting in a shiny appearance? | ☐ | |
| 3.5 | 16.4 | Did the Contractor protect the work by preventing equipment and materials from being placed onto the tacked surface until it was fully cured and tack free as defined by the manufacturer's recommendations? | ☐ | |
| 3.6 | 16.4 | Was a separate and calibrated thermometer with an accuracy of +/- 2°C provided by the Contractor to verify the kettle thermometer accuracy? | ☐ | |
| 3.7 | 16.4 | Was asphalt membrane prepared in the heating and mixing kettle to a temperature not exceeding that recommended by the asphalt membrane manufacturer? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.8 | 16.4 | Was the tack coat primer fully cured prior to placing asphalt membrane as determined by the manufacturer's recommendations? | ☐ | |
| 3.9 | 16.4 | Was the asphalt membrane within the range of temperature recommended by the manufacturer at the time of placement? | ☐ | |
| 3.10 | 16.4 | Was it free flowing and free of clumps? | ☐ | |
| 3.11 | 16.4 | Was the final in-place thickness of the asphalt membrane within 4 mm to 6 mm, except at those locations where membrane reinforcing fabric or rubber membrane were placed? | ☐ | |
| 3.12 | 16.4 | Was the asphalt membrane placed in a continuous manner, and where cold joints were unavoidable, was hot membrane lapped over cold membrane by a minimum width of 150 mm and a thickness of 2 mm to 3 mm? | ☐ | |
| 3.13 | 16.4 | Did the Contractor identify and mark all cracks that exceeded 0.2 mm in width, all construction joints, all P/T grout tubes, all lift hook pockets and all patches? | ☐ | |
| 3.14 | 16.4 | Was asphalt membrane placed to a thickness of 3 mm to 4 mm and 200 mm beyond these discontinuities? | ☐ | |
| 3.15 | 16.4 | Were strips of membrane reinforcing fabric placed onto hot and tacky membrane for 150 mm beyond these discontinuities? | ☐ | |
| 3.16 | 16.4 | Was membrane reinforcing fabric lapped for a minimum of 100 mm? | ☐ | |
| 3.17 | 16.4 | Was the membrane reinforcing fabric covered by a thickness of 2 mm to 3 mm of asphalt membrane? | ☐ | |
| 3.18 | 16.4 | Was asphalt membrane placed vertically to the thickness of ACP and by 150 mm beyond the vertical face, for a depth of 3 mm to 4 mm along all curbs, barrier walls and deck drains? | ☐ | |
| 3.19 | 16.4 | Was a rubber membrane placed onto hot and tacky membrane for 50 mm at the vertical face and by 100 mm beyond the vertical face? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.20 | 16.4 | Was a rubber membrane lapped for a minimum of 100 mm? | ☐ | |
| 3.21 | 16.4 | Was a rubber membrane covered by a thickness of 2 mm to 3 mm of asphalt membrane? | ☐ | |
| 3.22 | 16.4 | Did the application of the continuous asphalt membrane extend over all areas, including locations where membrane reinforcing fabric or rubber membrane were placed? | ☐ | |
| 3.23 | 16.4 | Were wick drains installed along the full length of gutters onto hot and tacky asphalt membrane? | ☐ | |
| 3.24 | 16.4 | Were deck drains and wick drain tubes free of obstruction from asphalt membrane or protection board? | ☐ | |
| 3.25 | 16.4 | Were protection boards placed onto hot and tacky asphalt membrane? | ☐ | |
| 3.26 | 16.4 | Were protection boards placed with the length of the boards in the transverse direction? | ☐ | |
| 3.27 | 16.4 | Were protection board lapped between 12 mm and 25 mm? | ☐ | |
| 3.28 | 16.4 | Were laps shingled in both the longitudinal and transverse directions? | ☐ | |
| 3.29 | 16.4 | Were longitudinal joints staggered by 150 mm minimum? | ☐ | |
| 3.30 | 16.4 | Were protection boards placed 5 mm shy of all wick drains, vertical faces of expansion joints and vertical faces of drains? | ☐ | |
| 3.31 | 16.4 | Were protection boards secured using a weighted roller? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.32 | 16.4 | Were all boards secured to the asphalt membrane? | ☐ | |
| 3.33 | 16.4 | Where protection board edges had curled, were these areas adequately cemented into position using additional asphalt membrane? | ☐ | |
| 3.34 | 16.4 | When rain occurred after protection board placement but before ACP placement, were measures taken to prevent water from ponding on the protection boards at the bridge ends? | ☐ | |

**Details and Summary:**

Signature

Date

16.1 Deck surface preparation by shot-blasting.

16.2 Deck surface preparation by shot-blasting.

16.3 Surface preparation by shot-blasting.

16.4 Waterproofing equipment and materials. Heating and mixing kettle on site. Workers unloading protection board.

16.5 Tack coat on deck surface. Tack has changed from a dull black to a dull brown, indicating the tack coat has cured and is ready for the next stage.


16.6 Asphalt membrane heating in kettle.

16.7 Wick drain placement along edges of barriers. Wick drains are installed over the asphalt membrane while it is still tacky. Protection boards are not placed over wick drains.

16.8 Membrane reinforcing fabric placed along construction joint.

16.9 Asphalt membrane is poured from a pail and spread with a rubber squeegee.

16.10 Protection board placed immediately after asphalt membrane has been placed.

16.11 Protection board is rolled with a water-filled garden roller before membrane cools.

16.12 Waterproofing complete. Clean up of sand and debris from protection board required before tack coat for ACP. Joints and laps in protection boards shown.

# SECTION 17

# ASPHALT CONCRETE PAVEMENT

## TABLE OF CONTENTS

## 17.1 Asphalt Concrete Pavement – General

Asphalt Concrete Pavement (ACP) is placed as a wearing surface onto bridge decks, roof and approach slabs, and roadway transitions. Special requirements exist for ACP placement that are unique to bridge construction and may not be followed in normal road paving practice. When properly designed, mixed, placed and compacted, ACP provides a durable and smooth bridge surfacing.

ACP for bridges is hot mix asphalt concrete produced by heating the asphalt binder to decrease its viscosity and drying the aggregate to remove moisture prior to mixing.

Mixing is done at high temperature, and the placing and compaction must be done while the mix is still hot. The time from mixing to placement, as well as environmental factors such as wind and cool weather, will affect the ability to properly compact ACP.

ACP is normally placed in two courses (mats or lifts). The lower course is purposely compacted at a cooler temperature so that the waterproofing membrane is not damaged. When the pavement has reached the end of its service life, only the top lift is milled and replaced while the bottom lift remains in place.

## 17.2 Environmental Considerations

The Inspector must be aware of the following environmental considerations:

- Before final acceptance of the ACP on a bridge, the Contractor is required to remove all excess material, clean up and restore the site to its original state.
- All oversprayed tack coat must be satisfactory removed and cleaned.
- Asphalt materials must not be wasted into stream or adjacent embankments.

## 17.3 Safety Considerations

The following safety considerations exist during paving operations:

- ACP is hot when placed and protective clothing, including gloves and eye protection, needs to be worn when working near ACP.
- Heavy equipment, including trucks and rollers, is dangerous due to its speed and congestion on the deck. Take care when working around heavy equipment, especially when equipment is being operated in reverse direction.

## 17.4 Materials

The material requirements for the supply of asphalt cement, aggregates and tack coat are specified in the *Standard Specifications for Highway Construction*. This specification contains references to other internal Department documents, such as test methods, procedures and the products list. This specification also references AASHTO requirements. These referenced documents include requirements for recycled ACP, asphalt grades and mix design.

Two different asphalt mix types exist for bridges. Type H2 is specified for bridges with a higher volume of traffic, while Type M1 is specified for lower volume highways and local roads. The asphalt cement grade for Type H2 is superior to that of Type M1. Prior to any placement, the Inspector must confirm with the Project Manager that the Contractor’s material submissions are complete and are acceptable.

## 17.5 Quality Control Testing

Quality control testing is required for projects that exceed a specified volume of production. Quality control and testing is done by the Contractor. It is necessary that testing be performed only by a qualified supplier's laboratory or a qualified independent laboratory licensed to practice in Alberta.

Since performance grades of asphalt are used in ACP, the Contractor is required to submit a Quality Control Plan for bridge ACP that is jointly prepared with his supplier. Prior to any hot mix production, the Inspector must confirm with the Project Manager that the Contractor's Quality Control Plan is complete and acceptable. The Inspector must also confirm with the Project Manager that the supplier's initial compliance testing results are acceptable prior to any ACP placement.

The asphalt plant must be properly calibrated to produce a uniform mixture in accordance with the job mix formula. Prior to any ACP production, the Inspector must confirm with the Project Manager that the supplier's certification of calibration has been received.

Certain tests are required from the Contractor at the Consultant's discretion. Some tests are required at the time of construction, and the need is determined by the Inspector and the Project Manager. These include cores for density, pavement segregation and pavement smoothness. The Inspector must be aware of the situations that will result in the need for additional testing, and must be knowledgeable in the test methods. The ATT test methods specified are available on the Department's website.

Normally, the Consultant will use Quality Assurance (QA) testing to determine the asphalt content and the aggregate gradation for conformance requirements. The Inspector must discuss this requirement with the Project Manager and collect the necessary samples during the ACP placement.

## 17.6 Equipment

The equipment and methods used by the Contractor are subject to the acceptance of the Consultant. If the Inspector has concerns regarding the suitability of equipment or methods prior to the start of placement, he must discuss these with the Project Manager.

The Inspector must also be aware of equipment limitations during placement, including:

- Insufficient compaction equipment to match placing rate.
- Dirty or leaky truck boxes, and truck boxes without tarps.
- Inadequate compaction effort, especially for smaller self-powered rollers and walk-behind tampers used to compact the ACP at gutters and paving lips.

## 17.7 Spreading and Compaction

The Inspector must be present at all times during the spreading, placement and compaction operations. The lower lift of ACP, if defective, is very difficult to remove and replace due to the existence of the waterproofing membrane and protection board. It is essential that the Contractor and his supplier be knowledgeable of the specified requirements. The Inspector must conduct a pre-activity meeting with the Contractor and his supplier to discuss the following:

- Understanding of project specifications, especially those requirements for ACP that are unique to bridges.
- Suitability of proposed equipment, particularly the number of haul trucks, pavers and compaction equipment.
- Concerns due to weather, especially related to compaction in cooler temperatures.
- Location of longitudinal joints.
- Final acceptance criteria and consequences for not meeting this criteria, especially with regard to smoothness and segregation.

During the spreading and compaction operations, the Inspector must consider the following requirements:

- Paving of the bridge deck must commence within seven days of waterproofing completion, or in the event of inclement weather as determined by the Inspector.
- Tack coat must not be applied during conditions that are cooler than specified, or when moisture exists under the waterproofing protection boards. The corners of protection boards can be lifted to check for moisture because condensation and rainwater can frequently become trapped under the laps of the board. These areas must be dried before tacking may begin. The Inspector must confirm that the correct tack coat product is used, and that the surfaces to be tacked are clean, dry and of adequate temperature. Paving must begin as soon as practical after tacking, and damage to the freshly tacked surface must be prevented.
- Care must be taken to prevent tacking over wick drains. Care must also be taken in protecting curb faces from overspray of tack. Drains and curb faces are commonly protected with tape and sheets of polyethelene.
- ACP delivery trucks must be able to supply materials at an acceptable rate. Delays or disruptions to delivery may cause delays in placement and compaction, which may result in cooling of the mix below the specified limits.
- ACP delivery trucks must be cleaned of foreign materials and hardened asphalt mixture. Boxes and tools must not be cleaned or lubricated with diesel fuel or detergent since this may damage the ACP mix. The Inspector must inspect truck boxes as the ACP is being discharged.
- The self-propelled, rubber-tired paving machine screed needs to be capable of placing a constant lift of ACP of adequate width to minimize the number of longitudinal joints. The paving machine must have an automatic screed or strike-off system to produce the designed cross-section and profile. The contractor must continuously probe the depth of the mix as it leaves the screed.
- Compaction needs to follow closely behind placement with no unnecessary delays since delays will allow the mix to cool, and consequently compaction will become more difficult to achieve. The main areas of the deck are compacted by self-propelled rollers. The areas adjacent to the gutters and paving lips are normally compacted using smaller self-propelled rollers or heavy hand-operated vibratory plate tampers. The Inspector must confirm that the Contractor supplies self-propelled rollers that are capable of compacting the ACP immediately adjacent to curbs and barriers; many rollers have drums that cannot compact against vertical objects because their frame or roller yoke projects beyond the edge of the roller itself. Deterioration of the ACP at gutters and paving lips is common because water tends to pond at gutters and there is a transition from ACP to concrete at paving lips. It is very important that proper compaction of ACP is done at the paving lip transition and over the gutter wick drain. The Inspector must pay particular attention to these locations. The Contractor will need multiple self-propelled rollers and plate tampers to efficiently compact the mix at all locations.
- A control strip must be established to monitor the compaction process. One control strip is required for each lift of ACP. The Inspector must confirm that the roller(s) have been ballasted to their maximum weight capacity, which is a minimum of 10 tonnes. The Inspector must be

diligent in confirming that the density for the first strip of the bottom lift has been achieved. If density requirements are not achieved, the Inspector must require corrections to the Contractor's methods or equipment.

- The bottom lift of ACP must be carefully placed to avoid damage to the waterproofing membrane or protection board. The paver and trucks must travel only in the direction of the protection board laps and must avoid turning while travelling. No dumping of material ahead of the paver is permitted; material may only be dumped directly into the paver hopper. The Inspector must carefully monitor the protection board for signs of movement and must require changes to the Contractor's methods if distress to the waterproofing system is observed.
- The proper temperature of the mix is critical to achieve the specified density and texture. The bottom lift is compacted at a cooler temperature so as to protect the waterproofing membrane, and consequently the required density of the bottom lift is lower than the top lift. It is important that delivery trucks are staged so that the time between mixing and dumping is minimized. To maintain the required temperature of the mix, the truck boxes must keep their tarps in place while parked at site until they are required to discharge. The Inspector must check the temperature of the mix of each load as it is being discharged into the hopper. Care must be taken to record the internal temperature of the load and not the outer surfaces, which may provide an inaccurate cooler reading. The temperature of the mix must also be checked and recorded at the screed and during compaction.
- The Inspector must calculate the distance from the curb to the wheel paths in advance of paving so that he can quickly verify at the time of paving that the longitudinal joints will not coincide with the wheel paths. The exact location of joints must be determined before paving begins. All longitudinal joints must be carefully sealed. The Inspector must pay particular attention to this detail for the top mat because pavement deterioration is common at poorly constructed joints.
- The top lift is normally placed on the same day as the lower lift and as soon as the lower lift has sufficiently cooled. The tack coat on the first lift of ACP must be applied and cured prior to placement of the top lift. Placement of the top lift must be delayed by the Inspector after consultation with the Project Manager if the Contractor's equipment or methods have proven to be ineffective and not immediately correctable.
- Following the placement of the first strip of the bottom lift, the Inspector must carefully examine the surface for open texturing and segregation. If these exist, the Inspector must immediately discuss with the Contractor his plans for improvement. The Contractor's successful completion of the first lift will demonstrate his ability to achieve a final product that meets the specified requirements. Following the placement of the top lift, the Contractor must perform smoothness testing, which is monitored by the Inspector.
- All ACP must be protected from damage due to solvents. Paving tools and truck boxes must not be washed with diesel or other solvents while on the freshly placed ACP. Curbs and barriers must be finished and silaned prior to paving, or else the pavement must be adequately protected from overspray from silane application. Silane must not be allowed to drip down the face of curb or barrier onto the pavement.

### 17.8 Defects

The Contractor must perform straight-edge testing checks on the finished product. The Inspector must also perform spot checks using a straight-edge similar to the Contractor's. The smoothness of the bottom lift will provide an indication of the potential smoothness achievable by the Contractor for the upper lift. The Inspector must check the bottom lift and advise the Contractor of any necessary corrections to the paving process. The compaction effort must continue until no further tire or roller marks are visible.

Segregation is defined as an area greater than 0.1 $m^2$ where the texture differs visibly from the texture of the surrounding pavement. Areas smaller than 0.1 $m^2$ are called defects. Segregation is classified into degrees of severity and described by the Department's Paving Guidelines and Segregation manual. Classifications can be slight, moderate and severe. The Inspector must make sure that the Contractor understands the definition of segregation and its consequences.

If the compaction effort for the top lift of ACP is not achieving the specified densities, the compaction effort must continue unless the mix has cooled to a temperature where further densification is unachievable. In this instance, coring may be required to determine the in-place densities. The Inspector must discuss the circumstances with the Project Manager and advise the Contractor of the locations and frequency of coring.

Government of Alberta ■
Transportation

**Bridge Construction Inspection Manual 2015**
Section 17 – Asphalt Concrete Pavement Check Sheets

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

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| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | | Was the equipment and manpower of the Contractor recorded? | ☐ | |
| 1.2 | | Were asphalt temperatures and samples taken during paving operations? | ☐ | |
| 1.3 | | Was the longitudinal smoothness of the surface checked? | ☐ | |
| 1.4 | | Was the surface texture (e.g., segregation, roughness and porous areas) monitored? | ☐ | |
| 1.5 | | Was cross fall for drainage checked? | ☐ | |
| 1.6 | | Was the ACP volume and tonnage that was placed calculated and recorded? | ☐ | |
| 1.7 | | Was the longitudinal sawcut and excess removal of ACP, where required, inspected? | ☐ | |
| 1.8 | | For projects where transition ACP was required, did the Contractor cold-mill to achieve a 40 mm minimum thickness of ACP? | ☐ | |
| 1.9 | | Was the joint between the existing ACP and the new transition ACP sawcut a minimum of 40 mm across the full width of roadway? | ☐ | |
| **2** | | **Materials** | | |
| 2.1 | 17.2 | Was the asphalt cement and aggregate supplied in accordance with Sections 3.50.2.1 and 3.50.2.2 of the Standard Specifications for Highway Construction? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.2 | 17.2 | Was the liquid asphalt applied as a tack coat to ensure a bond between the surface being paved and the subsequent course? | ☐ | |
| 2.3 | 17.2 | Did the tack coat consist of SS-1 or RC 30/70? | ☐ | |
| 2.4 | 17.2 | If SS-1 was used, was it diluted with an equal volume of water? | ☐ | |
| 2.5 | 17.2 | Did the tack coat materials conform to the Specifications listed in Tables ASPH6 and ASPH7 of Specification 5.7 of the Standard Specifications for Highway Construction? | ☐ | |
| 2.6 | 17.3 | Did the Contractor prepare and submit asphalt mix designs in accordance with Section 3.50.3 Asphalt Mix Design and Job Mix Formula of the Standard Specifications for Highway Construction? | ☐ | |
| 2.7 | 17.4 | Was QA testing completed on two (2) 6 kg samples per lift to determine the uncorrected asphalt content and aggregate gradation, using the Contractor's measured correction factor to establish the actual asphalt content? | ☐ | |
| 2.8 | 17.4 | Was the actual asphalt content determined by test method ATT-12 or ATT-74 and did it include the correction factor for asphalt binder lost due to absorption by the aggregate or aggregate loss? | ☐ | |
| 2.9 | 17.5 | Was QA testing done on projects with 50 tonnes of ACP or more? | ☐ | |
| 2.10 | 17.5 | Were the results received within seven (7) days of test completion? | ☐ | |
| 2.11 | 17.5 | Did the Contractor 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 of the Standard Specifications for Highway Construction? | ☐ | |
| 2.12 | 17.5 | Were test methods and minimum frequencies of testing in accordance with requirements shown in Table 17.5 Quality Control Testing Requirements? | ☐ | |
| **3** | | **Equipment and Methods** | | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.1 | 17.6.1 | Was the equipment and methods used adequate to place and compact the material as specified, and was it acceptable? | ☐ | |
| 3.2 | 17.6.2 | Did the asphalt mixing plant used by the Contractor conform to the requirements of Section 3.50.5.1.2 of the Standard Specifications for Highway Construction? | ☐ | |
| 3.3 | 17.6.2 | Did the Contractor provide a certificate of calibration certifying that the plant had been calibrated to produce a uniform mixture in accordance with the Job Mix Formula? | ☐ | |
| 3.4 | 17.6.3 | Was the mixture transported to the worksite in trucks with smooth metal boxes in good and leak proof condition, previously cleaned of all foreign materials or hardened asphalt concrete mixture? | ☐ | |
| 3.5 | 17.6.3 | Was prevention taken so that truck box lubricants, such as detergent or lime solutions, did not contaminate the mix? | ☐ | |
| 3.6 | 17.6.4 | Did pavers maintain required levels, cross-falls and joint matching? | ☐ | |
| 3.7 | 17.6.5 | Was there sufficient self-propelled equipment to obtain the required degree of compaction of the asphalt concrete mixture? | ☐ | |
| 3.8 | 17.6.5 | Was the compaction equipment operating such that uniform and complete compaction was obtained throughout the entire width, depth and length of the pavement being constructed? | ☐ | |
| 3.9 | 17.6.5 | Were rollers configured to ensure uniform and complete compaction up to the face of barriers, curbs and medians, and did they leave a smooth, properly finished surface, true to grade and cross-section without ruts or other irregularities? | ☐ | |
| 3.10 | 17.6.5 | Was a minimum of one (1) rubber tired roller and one (1) smooth steel drum type roller provided? | ☐ | |
| **4** | | **Construction** | | |
| 4.1 | 17.7.1 | Was the asphalt temperature maintained within ± 10°C of that specified? | ☐ | |
| 4.2 | 17.7.2 | Was the asphalt mixture produced in accordance with Section 3.50.5.1.3 Mix Production of the Standard Specifications for Highway Construction? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 4.3 | 17.7.3 | Were all bridge components protected to prevent splatter or staining from asphaltic materials? | ☐ | |
| 4.4 | 17.7.4 | Was asphalt tack coat applied at the locations and to the dimensions designated by the Inspector? | ☐ | |
| 4.5 | 17.7.4 | Were surfaces to be tacked dry and free of loose or deleterious material when the tack was applied? | ☐ | |
| 4.6 | 17.7.4 | Was the asphalt tack coat applied in a uniform manner at an application rate of 0.5 ℓ/m2 and at the asphalt temperature designated by the Inspector? | ☐ | |
| 4.7 | 17.7.4 | Was the ambient air temperature at the time of application 5°C or higher? | ☐ | |
| 4.8 | 17.7.4 | Where traffic accommodation was required, was the surface tacked in two operations? | ☐ | |
| 4.9 | 17.7.4 | Did the Contractor retack all areas on which the tack was damaged by traffic? | ☐ | |
| 4.10 | 17.7.5.2 | Was the mix temperature during spreading, sufficient for the specified compaction and finishing at the final placement area? | ☐ | |
| 4.11 | 17.7.5.2 | Were the longitudinal and transverse edges of each lane straight in alignment, uniform and of the same thickness as the adjoining pavement layer? | ☐ | |
| 4.12 | 17.7.5.2 | Was each layer 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? | ☐ | |
| 4.13 | 17.7.5.2 | Was longitudinal joints in the successive lifts not less than 0.30 m? | ☐ | |
| 4.14 | 17.7.5.2 | Was the longitudinal joint of the final lift of asphalt concrete pavement not located within the wheel path areas? | ☐ | |
| 4.15 | 17.7.5.2 | Was any evidence of surface segregation exhibited? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 4.16 | 17.7.5.2 | Was the compaction monitored using a Control Strip Method? | ☐ | |
| 4.17 | 17.7.5.2 | Following the initial pass of the breakdown roller, were moisture and density measurements for determining the Control Density taken at five (5) locations within the Control Strip area and continued following repeated passes of the compaction equipment until the apparent maximum density was attained by the Contractor using nuclear testing equipment? | ☐ | |
| 4.18 | 17.7.5.2 | Was compaction of the pavement to a minimum average density of 97% of Marshall density with no individual density less than 95%? | ☐ | |
| 4.19 | 17.7.5.2 | After compaction was achieved, were cores of the top lift taken for testing? | ☐ | |
| 4.20 | 17.7.5.2 | Were the results provided to the Project Manager? | ☐ | |
| 4.21 | 17.7.5.2 | Were core holes completely de-watered and dried? | ☐ | |
| 4.22 | 17.7.5.2 | Was a generous application of liquid asphalt applied to the bottom and sides of the core hole and allowed to cure? | ☐ | |
| 4.23 | 17.7.5.2 | Was asphalt mix tamped in lifts into the core hole until flush with the surface of the surrounding pavement? | ☐ | |
| 4.24 | 17.7.5.4 | Was the ACP wearing surface for Hot-Applied Rubberized Asphalt Waterproofing Membrane System Paving placed and compacted in two nominal 40 mm lifts? | ☐ | |
| 4.25 | 17.7.5.4 | Was the first lift of ACP spread by the asphalt paver in the direction of the protection board laps (downhill)? | ☐ | |
| 4.26 | 17.7.5.4 | If not carried out in the direction of the protection board laps, did the Contractor submit a procedure for review identifying measures that were taken to ensure that the protection board and waterproofing membrane was not damaged during paving? | ☐ | |
| 4.27 | 17.7.5.4 | Was the allowable temperature range for compaction of ACP lifts on the hot-rubberized asphalt waterproofing membrane system as per the Table in Section 17.7.5.4 of the SSBC? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 4.28 | 17.7.5.4 | Was the minimum average Marshall density of the first lift 95%, with no individual test less than 93%? | ☐ | |
| 4.29 | 17.7.5.4 | Was the minimum average Marshall density of the second lift 97%, with no individual density less than 95%? | ☐ | |
| 4.30 | 17.7.5.5 | Was the ACP wearing surface placed in one lift of 50 mm nominal thickness on top of a polymer waterproofing membrane? *Note: Dumping of the asphalt mixture onto the polymer waterproofing membrane ahead of the paver will not be permitted.* | ☐ | |
| 4.31 | 17.7.5.5 | Was the temperature of the asphalt mixture between 123°C and 138°C at the start of compaction? | ☐ | |
| 4.32 | 17.7.5.6 | Was ACP placed on transition or approach roads, as shown on the drawings and in lifts not exceeding 70 mm? | ☐ | |
| 4.33 | 17.7.5.6 | Was the temperature of the asphalt mixture between 123°C and 138°C at the start of compaction? | ☐ | |
| 4.34 | 17.7.6.1 | Was the surface checked for smoothness using a 3 m long straightedge, resulting in no gaps greater than 3 mm, done by the Contractor immediately after the final rolling? | ☐ | |
| 4.35 | 17.7.6.1 | Were any final lift pavement surfaces not meeting the smoothness requirements repaired by the Contractor? | ☐ | |
| 4.36 | 17.7.6.2 | Did the Contractor make every effort to achieve a finished surface that has a uniform closed texture and free of segregated areas? | ☐ | |
| 4.37 | 17.7.6.2 | If segregation was present, did the Contractor take immediate corrective action to the paving process to prevent any further occurrence of segregation? | ☐ | |
| 4.38 | 17.7.6.2 | Did the Contractor repair segregated areas of all severities following the procedure outlined in Section 17.7.6.2 of the SSBC? | ☐ | |
| 4.39 | 17.7.6.3 | Did the Contactor repair any obvious defects promptly and in an acceptable manner? | ☐ | |
| 4.40 | 17.7.6.4 | Was the average asphalt content in the top lift material not greater than ± 0.50% from the accepted mix design asphalt content? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 4.41 | 17.7.6.4 | Was the average asphalt content in the bottom lift material not greater than ± 0.65% from the accepted mix design asphalt content? | ☐ | |
| 4.42 | 17.7.6.5 | Was a check done to make sure that the difference between the average gradation and the Job Mix Formula gradation did not exceed the amounts shown in Table 17.6 Aggregate Gradation Variation of the SSBC? | ☐ | |

**Details and Summary:**

Signature

Date

17.1 Protection of deck drain and barriers prior to tack coat and ACP placement.

17.2 Application of tack coat by hand sprayer.

17.3 Application of tack coat by spray truck.

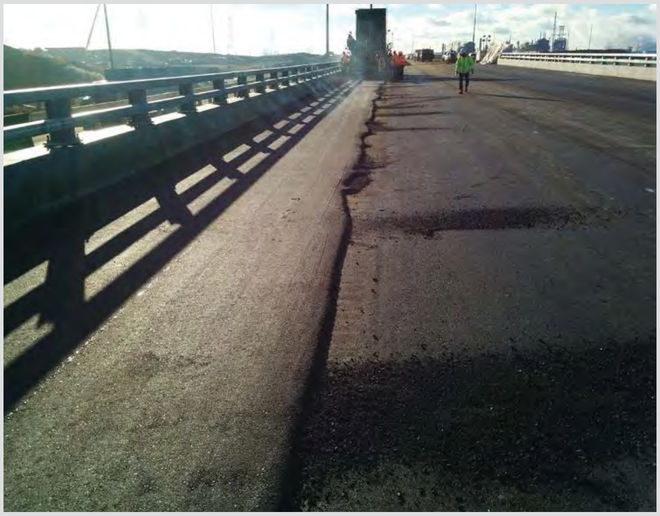
17.4 Wick drain and barriers protected from tack spray. Plastic strip placed over wick drain, and barriers covered with poly during spraying of tack coat.

17.5 Placing first lift of ACP. Small smooth drum roller following as soon as practical.

17.6 Large smooth drum and rubber tired rollers used to compact ACP.

17.7 Control strip method used to determine maximum density. Location for nuclear densometer marked for consistent testing.

17.8 Longitudinal joint shown. Compaction equipment must be capable of travelling immediately adjacent to curbs, barriers and median as required.



17.9 Unacceptable, uneven longitudinal joint.

17.10 Unacceptable segregation near barrier face.

17.11 Cracking at approach slab transition.

17.12 Unacceptable segregation in travel lanes.

# SECTION 18

# CSP AND SPCSP STRUCTURES

## TABLE OF CONTENTS

## 18.1 Construction of CSP and SPCSP Structures – General

Flexible metal culverts are commonly used as drainage structures and bridge crossing structures. The actual culvert structure consists of both the flexible metal culvert and the surrounding granular backfill material. Flexible metal culvert structures develop their strength through a complex composite soil-steel interaction.

The Department differentiates between roadway drainage and watercourse culverts on the basis of opening area. All culverts that are 1500 mm or greater in diameter are considered 'Standard Bridge Sized'. All culverts that are 4500 mm or greater in diameter are considered 'Major Bridge Sized'. For culverts with a non-round section, these are considered 'Bridge Sized' if their equivalent end-area is greater than a 1500 mm diameter culvert. This Section deals only with 'Bridge Sized' culverts. Standard Drawing S-1418 normally applies to all culverts with diameters between 1500 mm and 3000 mm.

At any particular location of cross-section within the culvert, the following terms are used:

- The 'span' of the culvert is the maximum horizontal opening as measured from inside the culvert from crest to crest of the corrugations. The 'springline' is the elevation of maximum span.
- The 'rise' of the culvert is the maximum vertical opening as measured from inside the culvert from interior crest to crest of the corrugations.
- The 'invert' is the lowest point of the culvert as measured on the corrugation crest and not streambed.
- The 'crown' or 'obvert' is the highest interior point or soffit of the culvert at the corrugation crest.

The Corrugated Steel Pipe Institute (CSPI) is the association of CSP manufacturers in Canada. This association publishes the *Handbook of Steel Drainage & Highway Construction Products* as well as other technical bulletins and technical resources.

## 18.2 Environmental Considerations

The Inspector must be aware of the environmental considerations identified in Sections 1 and 2 of this Manual.

## 18.3 Safety Considerations

The Inspector must be aware of the following safety considerations, including those from Sections 1 and 2 of this Manual:

- Trenching operations must follow the applicable regulations for sloping and stability. The Inspector must be aware of the hazards associated with working in the trench and must be able to identify deficiencies with the excavation.
- Working inside of a culvert structure may lead to tripping over protruding bolts and slips from ice or water within the culvert.
- Working at heights from ladders or scaffolding within culverts may present a falling hazard. Appropriate protection measures must be taken.
- Working within a confined trench may result in hazards from overhead equipment and equipment working within the excavation. High visibility and awareness are required.
- Smaller diameter and longer culverts may be defined as 'restricted' or 'confined' spaces. The Inspector must knowledgeable regarding the regulated access requirements.

- The location of utilities must be determined prior to the start of any excavation work.

## 18.4 Materials

Two main types of flexible metal culverts are commonly used: corrugated steel pipe and structural plate corrugated steel pipe.

### 18.4.1 Corrugated Steel Pipe (CSP)

CSP culverts are manufactured from rolls of steel coil. The steel coil is normally pre-coated. The coil is processed by first corrugating it and then rolling it into a helix or spiral, thereby forming a pipe. The edges of the coiled corrugated pipe sheet are crimped to each other to form lockseams.

CSP is most commonly manufactured in round sections, but many other shapes are produced, including horizontal and vertical ellipses, high profile arches, low profile arches and boxes. Arches and boxes may be open-bottomed.

CSP culverts are manufactured in varying corrugation profiles. The corrugation profile is a measure of the distance from crest-to-crest (pitch) and the depth from crest-to-valley. The values are given as "pitch x depth" (152 x 25). Corrugation profiles are standardized, though various corrugation profiles are available, from low profile spiral rib to large profiles for boxes and arches. Larger corrugations are generally used where greater culvert strength is required.

CSP culverts are supplied to the job site as complete pipe 'barrel' sections of specific length. The sections are connected by means of mechanical couplers. Because the corrugations of the CSP are helical, the ends of the barrel sections are re-corrugated to make the corrugations square to the edge of the barrel. Mechanical couplers are bolted connectors that secure two adjacent barrel sections by friction. The couplers have corrugations that 'nest' neatly into the barrel corrugations. Annular 'corrugated band' type couplers are the only type of couplers permitted. Dimpled, semi-corrugated or flat band type couplers are not permitted.

### 18.4.2 Structural Plate Corrugated Steel Pipe (SPCSP)

SPCSP culverts are manufactured from steel plate. The plate thickness is normally heavier than that of CSP culverts.

The corrugation profile for SPCSP is larger than that of CSP. Since SPCSP is made from plate and not from coil, the corrugations for SPCSP are square to the length of the plate and are not helical. This orientation of corrugation makes the culvert section stronger as well. Corrugation profiles for SPCSP are standardized.

SPCSP culverts are typically round in section, but also come in various shapes, similar to CSP. SPCSP culverts are generally used for structures that require a larger cross-sectional opening, or are subjected to higher loadings.

SPCSP is commonly known by its proprietary names.

SPCSP is supplied to the job site in plates, which are assembled by bolting in-place. SPCSP does not have barrel sections or couplers; rather, it is assembled in a specific sequence with consideration given to lap and seam locations. Plates join at 'circumferential' and 'longitudinal' locations, and reference in shop drawings is made to circumferential seams and longitudinal seams.

SPCSP plate width is designated 'N', where 'N' is the distance between two adjacent circumferential bolt holes, or one circumferential bolt hole space.

### 18.4.3 Durability

The performance of the CSP or SPCSP depends primarily on the thickness of the steel and the type of coating. Aside from structural considerations, the designed steel coil or plate thickness is determined by the corrosivity of the soil and water at the site. To achieve an acceptable design life, the culvert thickness is increased when aggressive soils or water are present. CSP and SPCSP are coated to further resist corrosion, which may typically include hot dip galvanizing, laminated or powder coated polymer, or hot dip aluminized. The life expectancy of a CSP or SPCSP is reached when the culvert becomes excessively perforated or deformed.

## 18.5 Supply, Fabrication and Delivery

Supply and Fabrication of CSP and SPCSP must be in accordance with CSA Standard G401 with additions and exceptions described in Section 18 of the *Standard Specifications for Bridge Construction*. This Standard provides material, fabrication and quality control requirements, for which the Contractor is responsible.

### 18.5.1 CSP Supply and Fabrication

The *Engineering Consultant Guidelines for Highway, Bridge, and Water Projects – Construction Contract Administration Manual* contains the Bridge Construction Administration Form titled 'CSP Inspection Report'. This form is completed by the Consultant's Level 1 certified visual welding inspector. Prior to releasing the CSP materials from the fabrication facility, the Inspector must confirm that the Project Manager has received the Level 1 inspector's report and that no outstanding deficiencies exist. The report confirms that the CSP dimensions, shape, lockseams and coating are acceptable. The Contractor is required to provide 72 hours of notice to the Consultant prior to shipping materials.

After the materials have arrived at the site and before they are installed, the Inspector must be aware of the following requirements:

- All pipe arriving at site must be marked by the supplier as required by the specifications. The Inspector must confirm that all properties match those required by the specifications.
- If any aspects of the pipe are found to be visually defective, the Inspector must confirm that all necessary repairs have been performed in accordance with the specifications and CSA Standard G401. Notably, the bevels must be cut to the correct dimensions as shown on the tables contained in the specifications. The lockseams must be welded at the cut ends for larger pipes, and any coating damage must be repaired.
- The Inspector must measure the rise and span at each end of all barrel sections after they are unloaded to confirm that they have not been damaged during transit. Barrel sections are often relatively light and therefore must be properly unloaded to prevent damage.

### 18.5.2 SPCSP Supply and Fabrication

The *Engineering Consultant Guidelines for Highway, Bridge, and Water Projects – Construction Contract Administration Manual* contains the Bridge Construction Administration Form titled 'SPCSP Inspection Report'. This form is completed by the Consultant's Level 1 certified visual welding inspector. Prior to releasing the SPCSP materials from the fabrication facility, the Inspector must confirm that the Project Manager has received the Level 1 inspector's report and that no outstanding deficiencies exist. The report confirms that the SPCSP plate dimensions, bolt holes, stacking and coating are acceptable. The Contractor is required to provide 72 hours of notice to the Consultant prior to shipping materials.

After the materials have arrived at the site and before they are installed, the Inspector must be aware of the following requirements:

- Since plates arrive in nested bundles, it is not possible for the Inspector to review the plates immediately upon delivery. However, the Inspector must review the storage conditions and the condition of the individual plates at the time they are separated for installation.
- Storage stains take the form of a white residue that can damage the coating and require repair. Storing plate materials in the concave-down orientation will prevent the formation of stains.

## 18.6 Installation

The installation of CSP and SPCSP includes excavation, bed preparation, pipe assembly, backfill and additional culvert enhancements.

The culvert performance depends greatly on its position relative to the watercourse channel. For most watercourses, the culvert invert will be placed lower than the natural streambed elevation by one-quarter of the culvert diameter. The elevation of the invert relative to the streambed is important to prevent scour and to maintain natural velocities for fish passage. It is very important that the culvert be installed at the elevations specified.

The culvert performance depends greatly on the alignment relative to the watercourse channel. The channel transitions have been designed with the purpose of maintaining velocities and other flow characteristics without causing scour. The Inspector must discuss any field-fitting of the channel realignment beyond the culvert ends with the Project Manager. It is very important that the culvert be installed on the alignment specified, therefore the channel realignment must match that shown on the Plans.

### 18.6.1 Coating Repair

The requirements for coating repair are provided in CSA Standard G401. The Inspector must be knowledgeable regarding the content of this Standard. The Inspector must carefully examine the pipe materials before and during assembly and backfilling since damage may occur during these operations.

Small, localized areas of damage such as scratches, storage stains or welding burns are repairable by cleaning and subsequent application of a repair product. Areas where the entire coating has been scratched to bare steel may also be repaired by cleaning and subsequent application of a repair product if the defect does not exceed 3 mm in width and 50 mm in length. Cut ends for CSPs are exempt from this requirement. If scratches to bare metal exceed these dimensions or if an excessive number of scratches exists, the Inspector must consult with the Project Manager to determine if the affected sections need to be removed from the Work and repaired by hot dipping, or if they can be repaired in place by zinc-metallizing.

Damage to metallic coatings, including galvanized and aluminized coatings, is repaired with zinc-rich paint if the conditions for paint repair have been met. The paint must contain a minimum concentration of zinc particulate and must be applied to a minimum thickness. Paint is normally applied by brushing on two coats, but it is permissible to spray under certain conditions with permission from the Department and adherence to G401. If sprayed, coatings must be thinned and must be applied in a single continuous wet film. Prior to painting, the surfaces must be prepared by power-disc or sanding to a bright metal finish. The Inspector must confirm that the repair paint material and application methods meet the requirements of CSA Standard CGSB-1.181. Commercially available products with unknown properties must not be used.

Damage to polymer coating is repaired in accordance with the manufacturer's recommendations. Normally, the defective areas or scratched areas are repaired with a special adhesive tape. These areas must be adequately prepared, and the tape must extend sufficiently beyond the defect. Repairs may also be done by application of a brush-on cold repair product. The Inspector must confirm that the Project Manager has accepted the Contractor's proposed repair procedure. It should be noted that polymer coated pipes are usually also galvanized, therefore damage may have occurred not only to the polymer but also to the galvanizing.

### 18.6.2 Excavation

Refer to Section 1 of this Manual for more excavation information. Culvert excavation may include 'Structural Excavation' for when a trench needs to be dug at an existing roadway embankment. For culverts on a new grade, 'Structural Excavation' may not be necessary. Culvert excavation may include 'Channel Excavation' if the channel beyond the ends of the new culvert requires realignment or other modification. Standard Drawing S-1418 provides details for 'Structural Excavation'.

#### 18.6.2.1 Preparation

The ends of the culvert are located by the Contractor, using the Consultant's control points and benchmark. The Inspector must check the Contractor's layout.

The watercourse is diverted around the site using pumps or a temporary diversion channel. The Inspector must confirm that the Contractor has followed all environmental permitting requirements for Restricted Activity Periods (RAP), turbidity monitoring and fish salvage. The Inspector must also confirm that the Contractor has properly constructed and lined the diversion channel, or alternatively that the necessary pumping equipment is in place. The tie-in points for diversion channels are important and these must not be constructed too close to the excavation site since the diversion channel may limit the ability to construct drainage sumps beyond the culvert end on the bed, or may limit the ability to cut back trench slopes if necessary.

The site is excavated to an elevation 600 mm below the invert. The Inspector must confirm that the base at this elevation is firm with no wet or soft areas, no abrupt change in soil type and no large rocks or boulders. At sites where a bridge has previously been removed, the Inspector must confirm that wooden piles have been adequately removed from the location within the excavation because piles below this level may heave and damage the culvert.

If the quality of the soil at the excavated surface is questionable, the Inspector must obtain the advice of the Project Manager. The use of geosynthetic materials or further excavation may be required. The Inspector must notify the Project Manager of the excavation schedule. To protect the excavated surface from deterioration, the Contractor should begin placing bedding materials immediately following excavation. The Project Manager must be available to immediately consult with his geotechnical engineer as the condition of the excavation base becomes known.

The Inspector must confirm that the profile and elevations are correct at the base of the excavation.

#### 18.6.2.2 Limits of Excavation

The Contractor must carefully plan the width and length of his excavation trench before beginning the work. Any slope cuts higher than 6 m must be designed by the Contractor's engineer. For lower slopes, the Contractor must plan his cutslope and benching requirements based on the stability of the natural soil. It is the Contractor's responsibility to provide a safe and stable slope.

The width and length of the excavation will also need to accommodate placing and backfilling equipment. The Inspector must confirm with the Contractor his planned use of equipment. If excavators are located above the cut, the slopes need to be constructed to be safe under this load. If the placing equipment will directly deposit materials into the excavation at the level of backfill placement, then an access road and sufficiently wide trench needs to be constructed to safely accommodate both workers and equipment.

The length of the trench needs to be sufficient to accommodate not just the culvert structure itself, but also the full riprap apron and new channel construction. Sufficient area for drainage sumps needs to be accommodated if they are needed at the low end of the excavation beyond the end of the pipe.

If sub-excavation is required lower than 600 mm below the invert, the excavation slopes will need to be cut back further to maintain a safe angle. This work is paid for as specified in the Special Provisions.

#### 18.6.2.3 Stability of Excavation

A stabilized trench may require slopes shallower than those shown on S-1418. Slopes that are seeping or those that have sand lenses may slough during excavation. Dry, silty or sandy clays may be stable at a steeper slope.

The exposure time of the excavation faces must be reduced by backfilling as soon as practical.

The top of the slope must be unloaded by removing spoil piles, construction materials, etc.

Subsurface water may seep into the trench. The Contractor must construct the trench of sufficient width so that drainage ditches or perforated drain pipe can be constructed at the bed elevation beyond the width of the granular backfill zone, and the trench must be of sufficient length so that a sump and pumps are located at the low end of the culvert beyond the riprap apron. The Contractor must also intercept or otherwise prevent surface runoff from entering the trench.

Under special circumstances and approval from the Project Manager, it may be necessary to excavate and place bedding in short sections to prevent deterioration of the excavation due to the ingress of water.

Under special circumstances and approval from the Project Manager, it may be necessary to undertake excavation during freezing conditions.

### 18.6.3 Bedding

The bedding material consists of the granular backfill material that is below the pipe invert and may also include a portion of the haunch if pre-shaping of the bed is required.

A minimum depth of 600 mm of granular backfill is placed below the invert. This material serves to provide a consistent bearing surface, utilizing the Class of granular material shown on the Plans.

The 200 mm of granular material immediately below the pipe invert is placed in an uncompacted state. It is necessary for this material to completely fill all of the corrugations at the invert. This strip of uncompacted fill is placed for the full length of the granular backfill and at a width that is one-half of the span. The uncompacted section can be constructed either by first compacting the entire surface up to the invert elevation and then ripping the strip to de-compact it, or else the adjacent surfaces may be placed and compacted, with the strip of loosened material placed afterwards.

The bed must be shaped in the longitudinal direction to match the profile shown on the Plans. After the bed has been constructed and before the pipe is placed, the Inspector must check by survey the elevations at all culvert 10th points. A crest-cambered profile is usually required. The culvert will typically experience greater loading and settlement under the roadway, where the fill is the deepest. Therefore, the culvert profile may flatten after the roadway embankment is placed. It is very important that the culvert be installed at the profile specified.

### 18.6.4 Haunch Area

For any section along a round pipe, the haunch area is located between the top of bedding and the underside of pipe. For pipe arches, the haunch area is located beneath the location that has the smallest radius of curvature. Over time and under high loads, pipes may distort in shape and ultimately fail at their haunch location. It is critical that particular attention be given to the proper placement and compaction of backfill at the haunch.

For larger pipes or non-round pipes, pre-shaping of the bed is specified. The 200 mm deep uncompacted zone is constructed as normal, but the uncompacted zone is extended above the invert elevation and partially into the haunch zone. The limits of the pre-shaping are provided in the specifications or Special Provisions. The pre-shaping activity is normally done by over-constructing the elevation of the loosely-placed bedding material and then preparing its final shape using a template. Pre-shaping is important to prevent the pipe from twisting or rolling during backfilling operations.

### 18.6.5 CSP Culvert Assembly

After placement of barrel sections, the Inspector must confirm through close-up visual observation that the uncompacted bedding is in intimate contact with the pipe invert and that all corrugations are completely filled.

CSP barrel sections must be positioned for assembly with the ends true in alignment and a constant gap maintained as shown on the shop drawings. The pipe sections must be placed sequentially, starting at the upstream end and working towards the downstream end. Annular couplers must be well fitted and evenly tightened all around the pipe. The corrugations of the coupler and the corrugations of the re-corrugated barrel ends must neatly ‘nest’ together so that there is direct contact between the coupler and the barrel at every corrugation. Where a gap exists between the coupler and the barrel corrugations, the gaps must be sealed by using materials recommended by the manufacturer, or else an internal coupler may be added. These procedures must be submitted by the Contractor for the Project Manager’s acceptance.

### 18.6.6 SPCSP Culvert Assembly

After placement of each plate assembly, the Inspector must confirm through close-up visual observation that the uncompacted bedding is in intimate contact with the pipe invert and that all corrugations are completely filled.

The Inspector must thoroughly review and be knowledgeable regarding the details contained in the shop drawings. The shop drawings provide details regarding the assembly sequence, location of laps, location of circumferential and longitudinal seams, and stagger of longitudinal seams.

When the plates have been assembled to form complete rings or shapes, the Contractor must check the rise and span and other chord dimensions as necessary to confirm that the shape of the culvert has been maintained within 2% of the design dimensions. Both the rise and span measurements must also be within 2%. If the pipe shape is not within tolerance, the Contractor must mechanically secure the pipe using restraining devices, scaffolding or shoring towers. The Inspector must calculate shape dimensions as follows:

- (Actual Rise +/– Design Rise) / (Design Rise) = % Magnitude of Sag or Peaking
- (Actual Span +/- Design Span) / (Design Span) = % Magnitude of Sidewall Deflection

SPCSP bolts are tightened to the specified torque and not by the turn-of-nut method. The Inspector must confirm that the Contractor is checking bolt torque for all bolts, and that over-torqued bolts are removed and discarded. The Inspector must physically check, with a calibrated torque wrench, a representative number of randomly located bolts to confirm that the torque applied meets the specified requirements.

Bolts in the valley of each longitudinal seam must be nearer to the visible edge of the plate than the bolts in the crest. This requirement is noted on the shop drawings, and the Inspector must carefully observe that the practice is followed in the field as the work proceeds. It is more difficult to correct this condition after the pipe has been fully assembled. If bolts are incorrectly placed nearer to the visible edge of the crest, future cracking of the plate across the bolt hole may occur.

### 18.6.7 Backfill

Refer to Section 2 of this Manual for more backfill information. Backfill consists of granular backfill material except at the ends of the pipe when clay seepage cutoffs are specified within a structural fill envelope. Material beyond the structural fill envelope is considered embankment fill.

Structural issues arising in culverts during construction are often the result of unsuitable backfill properties, including unacceptable gradation, plasticity, moisture content, poor compaction or the use of frozen material. Granular backfill material has the following favourable characteristics as compared to other soils:

- Compaction is easier to control since it is not too sensitive to moisture content and temperatures.
- Higher shear strength and bearing capacity can be obtained and is not significantly affected by moisture content.
- Low potential for frost action exists due to free-draining characteristics and large void ratio.
- Material can be placed and compacted at 0°C, allowing more flexibility for installation.
- Material is generally non-corrosive compared to clay material.
- Material exhibits negligible compressibility under high loads when saturated.
- Material has good workability.

The *Engineering Consultant Guidelines for Highway, Bridge, and Water Projects – Construction Contract Administration Manual* contains the Bridge Construction Administration Form titled 'Culvert Barrel Measurements'. This form is completed by the Inspector and is used for both CSP and SPCSP. The completed form is submitted to the Department by the Inspector. The form confirms that the final culvert dimensions conform to the design dimensions within the allowable tolerance. The Inspector must measure the span and rise at each coupler or at each circumferential ring, and repeat these measurements for different stages of backfill, including up to the midpoint, crown and 300 mm overtop. The Inspector must closely monitor the pipe shape as backfill proceeds, and advise the Contractor of any out of tolerance measurements. It is worth noting that thinner culverts sometimes 'peak' temporarily as they are backfilled to the springline. The culvert will normally return to its design shape as backfill is placed over the crown. The Inspector must obtain advice from the Project Manager if the pipe dimensions are out of tolerance by 4% or more.

The Inspector must confirm that the culvert has maintained its proper alignment by use of plumb bobs. The use of extendable measuring rods or a laser level will result in more accurate measurements for rise and span.

#### 18.6.7.1 Compaction

All backfill materials are compacted to:

- Increase the soil strength and bearing capacity.
- Decrease the compressibility of the soil, thereby reducing settlement.
- Decrease the void ratio, which reduces inter-granular movement.
- Increase the passive resistance of the fill and reduce horizontal deflections.
- Provide uniform support along the pipe, thus enhancing the soil-steel interaction.

The compaction of backfill material in the haunch area is critical to the performance of the structure. Backfill must be carefully placed in thin layers and compacted using manually operated air driven compactors, vibrating pogos, shovels and poles. It is important that all corrugations are completely filled and compacted.

Backfilling of the non-granular seals is critical, since 'piping' seepage pathways through the granular backfill may develop if the seals are not impermeable. The Contractor must mark the limits of non-granular material onto the pipe. Seals must be placed and compacted simultaneously with the granular backfill.

The Contractor must mark the culvert barrel to identify the heights of lift placement targets. The Inspector must carefully monitor the Contractor's lift placement to confirm that the lifts are not too thick. The placement of fill must not be excessively unbalanced from one side of the culvert to the other so that the barrel does not distort or roll.

Special backfill requirements may typically exist for culverts with diameters larger than 3000 mm, and again for diameters larger than 4500 mm.

## 18.7 Final Reporting

The *Engineering Consultant Guidelines for Highway, Bridge, and Water Projects – Construction Contract Administration Manual* contains the Bridge Construction Administration Form titled 'Culvert Installation Inspection Record'. This form is completed by the Inspector and is used for both CSP and SPCSP. The form is a final construction checklist that confirms the final parameters for the structure, including excavation, bedding, assembly, backfill, end treatments and riprap.

The Inspector must complete and submit this form to the Department upon the completion of the Work.

## 18.8 Details of Culvert Enhancements

The following structural enhancements are specially designed additions or special features added to culverts to increase the limits of their structural performance and their scope of application.

**End Treatment** provides a smooth transition, decreasing entrance and exit losses while increasing flow capacity. Standard end treatment consists of cut-off walls that prevent scouring and undermining at the ends of the culvert, and also consists of shoulders and a collar over the crown of the pipe to provide stiffening and counteraction of buoyant hydraulic uplift at the bevel ends. Standard Drawings S-1444 and S-1445 provide Standard End Treatment details.

**Concrete Headwalls** are used for aesthetics or to retain fill at the upper portion of the culvert. Headwalls reduce the culvert length and eliminate bevel ends.

**Substrate Holders** consist of metal, precast concrete or rock riprap. They are used to facilitate the passage of fish. These types of baffles provide several benefits. In addition to providing resting areas for fish, they increase the invert roughness, which locally reduces velocities and promotes natural sedimentation within the culvert.

**Reinforcement Ribs** are commonly used in large elliptical culverts to provide additional capacity for the top arch to withstand dead loads from high cover.

**Thrust Blocks** are continuous longitudinal structural stiffeners attached to the culvert where the side and top arcs meet. These provide additional stiffness and facilitate easy backfill placement.

**Attached Concrete** slabs consist of a reinforced concrete slabs cast onto the top arc portion of low profile horizontal ellipses and open arch culverts. The slabs act compositely with the culvert.

When the depth of cover does not meet the minimum requirements, **Unattached Concrete Slabs** can be used to transfer some live loads to the backfill at the sides of the pipe.

**Releasable Joints** are used on large horizontal ellipse or arch pipes to promote positive arching and/or permit relative vertical movement of the top and bottom arcs. The joint between two arcs can be left loose to enable their relative movements, and these can eventually be tightened.

Government of Alberta ■
Transportation

**Bridge Construction Inspection Manual 2015**
Section 18 – CSP and SPCSP Structures Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No:
Inspector:
Stage of Activity:
Element:

---

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | | Were arrangements of access routes and disposal areas reviewed? | ☐ | |
| 1.2 | | Was the behaviour of excavation and in-situ material that was exposed to weather and water observed? | ☐ | |
| 1.3 | | Were elevations and dimensions at the bottom of excavation confirmed? | ☐ | |
| 1.4 | | Was any excavation extending beyond the required depth recorded? | ☐ | |
| **2** | | **Materials** | | |
| 2.1 | 18.2 | Were the culvert materials new? | ☐ | |
| 2.2 | 18.2 | Were material in accordance with CSA G401? | ☐ | |
| 2.3 | 18.2 | Were shop drawings submitted and reviewed for SPCSP, bevels and for non-standard items like elbows, arches, ellipses, etc.? | ☐ | |
| 2.4 | 18.2 | Were materials stockpiled neatly and in such a manner as to facilitate inspection and inventory prior to assembly? | ☐ | |
| 2.5 | 18.2 | Were 5-bolt annular couplers supplied for CSP culverts? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.6 | 18.2 | Were SPCSP plates stockpiled in the concave-down position to prevent storage stains? | ☐ | |
| 2.7 | 18.2 | Were materials handled carefully to prevent damage to the coating? | ☐ | |
| 2.8 | 18.2 | Where damage to the coating existed, were the affected plates or sections set aside by the Contractor for further inspection? | ☐ | |
| 2.9 | 18.2 | Did the Contractor make adequate provisions for the care of water, in accordance with Special Provisions, permits and other direction from resource agencies? | ☐ | |
| **3** | | **Installation Inspection – Assembly** | | |
| 3.1 | 18.3 | Was the excavation done to the neat lines shown on the Drawings? Were the excavation walls competent, and did they meet requirements for safety? | ☐ | |
| 3.2 | 18.3 | Were foundation conditions determined to be soft or unstable? Was woven geotextile placed, and did it meet the specified physical properties? | ☐ | |
| 3.3 | 18.3 | Was the bottom of the excavation 600 mm or lower than the pipe invert? | ☐ | |
| 3.4 | 18.3 | Was this material compacted to 95% SPD at the 600 mm level and above, as measured at 150 mm lifts? | ☐ | |
| 3.5 | 18.3 | Was the culvert bed preshaped as required? | ☐ | |
| 3.6 | 18.3 | Did the top of bedding have a gradual crest curve profile? | ☐ | |
| 3.7 | 18.3 | Was pre-shaping of bed material done where specified? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.8 | 18.3 | Was the top 150 mm of bedding placed in a loose uncompacted state? | ☐ | |
| 3.9 | 18.3 | Were CSP barrel sections placed so that the ends were in close contact and couplers were well nested? | ☐ | |
| 3.10 | 18.3 | Where gaps of 5 mm or more existed between the barrel and coupler, were these joints sealed using materials approved by the Project Manager? | ☐ | |
| 3.11 | 18.3 | Were SPCSP bolted seams properly lapped with adjacent plates in full contact for the full width and length of the lap? | ☐ | |
| 3.12 | 18.3 | Was the SPCSP assembled in the approved sequence, with invert plates being first bolted on the bed, followed by loose bolting assembly of the side and top arc plates into complete rings starting from the upstream end? | ☐ | |
| 3.13 | 18.3 | For SPCSP, were all bolts in corrugation valleys at longitudinal seams located nearest to the visible edge and not to the corrugation crest? | ☐ | |
| 3.14 | 18.3 | After loose bolting of two (2) SPCSP rings, were the vertical dimensions checked, and were consequent adjustments using mechanical means made where necessary? | ☐ | |
| 3.15 | 18.3 | Was this continued for the remainder of loosely bolted rings? | ☐ | |
| 3.16 | 18.3 | Was local plate distortion observed? | ☐ | |
| 3.17 | 18.3 | Were the longitudinal seams of the SPCSP straight, and was the vertical axis upright? | ☐ | |
| 3.18 | 18.3 | Were all SPCSP bolts torqued between 200 Nm and 340 Nm? | ☐ | |
| 3.19 | 18.3 | Was a representative number of bolts checked by the Inspector using a torque wrench? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.20 | 18.3 | Did distortion exist due to over-torquing, and if so, were additional holes properly drilled? | ☐ | |
| 3.21 | 18.3 | Was the final rise and span dimensions of the torqued and un-backfilled SPCSP within 2% of design dimensions? | ☐ | |
| **4** | | **Installation Inspection – Backfill** | | |
| 4.1 | | General – See also Section 2, Backfill Check Sheet. | ☐ | |
| 4.2 | 18.3 | Was the specified type and gradation of backfill materials used? | ☐ | |
| 4.3 | 18.3 | Was backfilling completed in accordance with S-1418? | ☐ | |
| 4.4 | 18.3 | Was backfilling done only when the air temperature was above 0°C? | ☐ | |
| 4.5 | 18.3 | Were all backfilling materials in an unfrozen state at the time of placement? | ☐ | |
| 4.6 | 18.3 | Was backfill material placed on unfrozen substrate? | ☐ | |
| 4.7 | 18.3 | Did backfill completely fill all the corrugations at the haunches? | ☐ | |
| 4.8 | 18.3 | Was the backfill material placed so that the level between sides did not exceed 300 mm? | ☐ | |
| 4.9 | 18.3 | Was appropriate compaction equipment used, and were proper techniques used? | ☐ | |
| 4.10 | 18.3 | Did non-granular backfill meet the specified material properties for type and plasticity? | ☐ | |
| **5** | | **Installation Inspection – Backfill** | | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 5.1 | | General – See also Section 4, Cast-in-Place Concrete Check Sheet and Section 5, Reinforcing Steel Check Sheet. | ☐ | |
| 5.2 | 18.4 | Were submittals made for all collars for culverts exceeding 3000 mm in diameter? | ☐ | |
| **6** | | **Installation Inspection – Rock Riprap** | | |
| 6.1 | | General – See also Section 10, Heavy Rock Riprap Check Sheet. | ☐ | |
| 6.2 | 18.6 | Was all rock riprap placed at the location shown on the Drawings, including provisions for geotextile, gradation, thickness and depth of key-into banks? | ☐ | |

**Details and Summary:**

Signature

Date

18.1 Culvert bed excavation completed and filter fabric placed.

18.2 Compacting of culvert bedding material.

18.3 Assembling SPCSP culvert. Plates lifted into position with crane.

18.4 Assembling SPCSP culvert.

18.5 Assembling SPCSP culvert.

18.6 Compacting haunch area using air tampers (pogo sticks).

18.7 SPCSP showing that bolts in the valley of each longitudinal seam are nearer to the visible edge of the plate than the bolts in the crest.

18.8 Compacting haunch area with pogo stick. Shovels and small equipment are also used to fill all corrugations.


18.9 Backfilling of SPCSP. Small equipment only permitted to work within 1.0 m of pipe. Backfill progressing evenly on both sides of the pipe.

18.10 On site storage of round CSP on timber dunnage.

18.11 CSP bevel ends cut by fabricator. Coating repaired using zinc-rich paint

18.12 Storage of CSP couplers in concave down position to prevent storage staining.

18.13 Temporary watercourse diversion.

18.14 Temporary diversion for watercourse. Silt fence and filter fabric lining the temporary streambed.

18.15 Excavation for culvert bed. Excavation crowned and sides trenched to control water.

18.16 Backfilling of culvert bed.

18.17 Backfill being placed at haunches.

18.18 Removal of existing bridge structure.

18.19 Removal of existing bridge structure. Abutment piles removed to specified depth below streambed.

18.20 Formwork for cast-in-place collar cut-off wall.


18.21 Formwork and reinforcing steel for cast-in-place cut-off wall.

18.22 Concrete placement for collar.

18.23 Compaction of granular backfill material.

18.24 Completed culvert outlet.

18.25 Completed collar and heavy rock riprap.

18.26 Soft conditions at culvert bed elevation.

18.27 Backfilling at culvert bed.

18.28 Installation of CSP structure at pre-shaped bed.

18.29 Installation of CSP structure. Backfilling and compaction at haunches.

18.30 Pre-shaping and compacting bed material for second CSP structure.

18.31 Installing CSP couplers.

18.32 Backfilling and compacting haunch area.


18.33 Small equipment spreading granular backfill material between culverts.


18.34 Completing backfill placement at crown of culverts.

18.35 Completed culvert outlet.

18.36 Damage to polymer coated CSP structure. Special adhesive tape or approved brush on coating is required.

Alberta Transportation

# CULVERT INSTALLATION

## *Inspection Record*

Project: ______________________ Contract #: ______________ Bridge File ______________

Contractor: ____________________________________________

Project Sponsor: ______________________ Consultant Inspector: ______________________

| STRUCTURAL FILL | DESIGNATION REQUIRED | SOURCE | TESTED BY | APPROVED BY |
|---|---|---|---|---|
| Granular Fill | Des 2 - Class 20 or | | | |
| Crush | Des 2 - Class 40 | | | |
| Pit run | Des 6 - Class 80 | | | |
| Clay Fill | | | | |

| INSTALLATION | INSPECTED BY | DATE | COMMENTS |
|---|---|---|---|
| Culvert Settings | | | |
| Excavation | | | |
| Bedding | | | |
| Assembly | | | |
| Backfill | | | |
| Haunch Area | | | |
| Sidewall Area | | | |

**COMPACTION EQUIPMENT** ____________________________________________

____________________________________________

____________________________________________

Lift Thickness ______________ mm Passes per Lift ______________

| CONCRETE END TREATMENT | INSPECTED BY | DATE | COMMENTS |
|---|---|---|---|
| Rebar and Formwork | | | |
| Finished Work | | | |
| Concrete Compressive Strength | | | |
| Riprap | | | |
| Special Features | | | |
| Final Trimming/Cleanup | | | |

*Please return form to Project Sponsor*

# SECTION 19

## PAINTED ROADWAY MARKINGS

### TABLE OF CONTENTS

## 19.1 Painted Roadway Markings – General

Painted roadway markings on bridge decks and approach roadways consist of lane lines, edge lines and directional arrows or dividing lines.

## 19.2 Environmental Considerations

The Inspector must be aware of the following considerations:

- Prevent soil and water contamination from paint, oil and chemical leaks or spills.
- Immediately clean up any accidental spills and report hazardous material spills.

## 19.3 Safety Considerations

The Contractor is responsible to accommodate traffic safely through the work zone.

## 19.4 Material

All materials are supplied by the Contractor. The materials must be 'approved' products currently on the *Alberta Transportation Products List*. The suppliers and their paint formulations must meet all specified requirements in the List's referenced specifications, which include 'TPC-05: Specification for White and Yellow Traffic Paint' and 'GB-05: Specification for Glass Beads for Pavement Markings'. Included in these specifications are requirements for low VOC formulations and field sampling and testing requirements.

The Special Provisions may include additional requirements to those referenced in the *Standard Specifications for Highway Construction* or the *Highway Maintenance Specifications*.

The Inspector must review the referenced specifications and manufacturer's literature and be knowledgeable of all requirements for field sampling and testing. The Inspector must confirm that the Project Manager has received and accepted the written confirmation from the Contractor stating that all supplied materials meet the specified requirements.

## 19.5 Application

For bridge sites with high volumes of traffic and lane closure requirements, a Traffic Accommodation Strategy (TAS) must be developed by the Contractor and accepted by the Project Manager. The Inspector must carefully monitor traffic activity and report to the Project Manager if changes are needed.

Before the Work begins, the Inspector must be knowledgeable regarding the specified mixing procedures, application rates for paint, application rate for glass bead, marking locations and marking dimensions.

The Inspector must assess the existing pavement conditions prior to the Work to confirm that the surfaces are sufficiently clean and dry, with no loose materials or existing paint. Premature paint failure is most commonly caused by the application of paint onto pavement that is in poor surface condition.

Construction and public traffic are not permitted to travel on the painted markings until after the paint has sufficiently cured. The Inspector must be aware of the cure time of the paint used.

The Inspector must confirm that all paint markings are uniform in thickness with no spatter, excessive overspray or other defects.

Government of Alberta ■
Transportation

**Bridge Construction Inspection Manual 2015**
Section 19 – Painted Roadway Markings Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

---

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **Materials** | | |
| 1.1 | | 19.2 – Did the Contractor advise the Consultant of any change in paint formulation?<br>*Note: No paint formulation can be diluted or mixed with a different formulation or with any other material without the specific acceptance of the Department.* | ☐ | |
| 1.2 | 19.2 | Did the Contractor take all necessary steps to prevent contamination of the materials? | ☐ | |
| 1.3 | 19.2 | Was the paint protected from freezing? | ☐ | |
| 1.4 | 19.3 | Did the Contractor take due precautions against damaging or disfiguring any portion of the structure, guarding against spatters, overspray, splashes or smirches of paint or associated paint materials, and damages caused by fuel or lubricants used with his equipment? | ☐ | |
| **2** | | **Application** | | |
| 2.1 | 10.3 | Did the Contractor paint lines or directional arrows on the roadway and bridge deck, either restoring what existed prior to the construction work or as shown on the Drawings, or as specified? | ☐ | |
| 2.2 | 19.4 | Were centrelines and shoulder lines 100 mm wide?<br>Were broken centrelines 3 m in length followed by a 6 m space?<br>Did the Contractor ensure that painted lines matched the existing lines exactly? | ☐ | |
| 2.3 | 19.4 | Was the substrate surface clean, dry and at least 10°C in temperature during the paint application? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.4 | 19.4 | Were painted messages and lines applied at the rate of 0.4 ℓ/m$^2$ of actual painted area, and were glass beads applied immediately following the paint application at a uniform application rate of 600 g/ℓ of paint? | ☐ | |
| 2.5 | 19.4 | Were all painted markings uniform in thickness with no spatter, excessive overspray or other defects? | ☐ | |
| 2.6 | 19.4 | Was construction or public traffic permitted to travel on the painted markings before the paint had sufficiently cured? | ☐ | |

**Details and Summary:**

Signature

Date

19.1 Protecting paint with cones during curing period.

19.2 Shoulder and centreline paint lines.

19.3 Shoulder and centreline paint lines.

# SECTION 20

# DECK OVERLAY AND CONCRETE REHABILITATION

## TABLE OF CONTENTS

## 20.1 Deck Overlay and Concrete Rehabilitation – General

Rehabilitation work may include localized repair to the concrete deck or substructure elements, as well as milling of the entire deck surface and overlaying with either concrete or Asphalt Concrete Pavement (ACP). Concrete decks deteriorate due to chlorides contained in de-icing agents. Significant performance issues, including cracking and delamination, generally begin as the chlorides penetrate to the reinforcing steel.

## 20.2 Environmental Considerations

Refer to the requirements of Section 4 of this Manual for more information.

The Contractor’s Environmental Construction Operation (ECO) Plan must contain provisions for concrete delivery, discharge, spills and emergency procedures.

Specific precautions must be taken for all phases of construction to prevent concrete or construction debris from entering a watercourse or water body. Contaminated soil must be isolated and treated or else removed from the job site.

## 20.3 Safety Considerations

Refer to the requirements of Section 4 of this Manual for more information.

Precautions must be taken to prevent falling debris. Work areas may require cordoning off to keep workers and the public out.

Contact with plastic concrete or cement mixtures can cause skin irritation, severe chemical burns and serious eye damage. Gloves, glasses and other protective clothing must always be worn when working with concrete.

## 20.4 Traffic Accommodation

Bridge rehabilitation is usually performed on active highways where it is necessary to stage the work to accommodate traffic. Rehabilitation is generally completed for one direction of travel before beginning work for the other direction.

The Inspector must confirm that the Contractor follows all requirements for traffic accommodation, including lane restrictions, closures, hours of operation, lighting and signage. These requirements must be addressed in the Contactor’s Traffic Accommodation Strategy (TAS).

Where applicable, the traffic accommodation must include provision for the collection of debris during demolition.

## 20.5 Deck Concrete Overlay Process

The process for concrete overlay includes:

- Surface removal of deteriorated concrete or existing ACP, generally done by cold-milling.
- Cleaning and sandblasting the milled surface.
- Inspection of the deck for unsound concrete. Unsound concrete is removed and replaced through partial depth repair or full depth repair methods.
- Producing gradeline profiles and “dry-running” the deck finishing machine.

- Applying slurry grout to the deck substrate and placing, texturing, curing and seaing HPC concrete.

## 20.6 Surface Removal and Disposal

It is important that the removal of the existing wearing surface be completed to the limits specified. Before removal, the Inspector must carefully review the Contractor’s removal procedure.

The removal equipment must be capable of milling close to curbs and barriers with minimal removal by chipping.

The milling depth must be carefully monitored by the Contractor as the Work progresses, and adjustments may need to be made as the Work proceeds. The Inspector must check the milling depth to confirm the Contractor’s measurements.

Care must be taken when milling existing ACP as the thickness may vary; however, a minimal thickness of deck concrete needs to be removed. Existing concrete paving lips also need to be removed using light chipping hammers. The Inspector must confirm that existing deck reinforcing steel is not damaged as a result of milling procedures.

## 20.7 Identification of Concrete Repairs

It is the Inspector’s role to identify all locations that require concrete removal for partial or full depth concrete replacement. The Inspector’s judgment is required to determine the exact limits of concrete removal.

Deck concrete will generally be tested in advance to estimate the extent of concrete deterioration. Plots of the test results may be used to assist in identifying areas with deteriorated concrete. The precise location of deteriorated concrete is determined at the site by the Inspector.

Delamination of concrete occurs when chlorides cause corrosion of the reinforcing steel. As the reinforcing steel corrodes, it expands, causing cracking and ultimately delamination, which can be seen as concrete cracks. If not visible, delaminations can be identified using sounding methods.

The Inspector must use visual observation, hammer sounding and chain dragging methods to identify the limits of concrete removal. In the chain dragging method, a heavy chain is dragged in a systematic pattern along the entire surface area, and where concrete is delaminated, the chain will produce a hollow sound. Once the chain drag has been completed, the precise boundary of the delaminated concrete must be determined by sounding using repetitive taps with a light hammer. The limits of the deteriorated concrete must then be marked onto the deck surface.

The Inspector must visually inspect the deck soffit to identify locations where leakage may occur. These areas are often identified by the presence of a white leachate or efflorescence. The Inspector must determine if these areas coincide with visible deterioration noted at the deck surface, and if such defects extend full-depth through the deck.

### 20.7.1 Removal of Existing Concrete

Concrete must be removed in such a manner as to prevent damage to adjacent concrete, to other components and to utilities that are to remain in the structure. Care must be taken to prevent damage to reinforcing steel, pre-stressing tendons, shear connectors, structural steel and deck joints.

- Concrete removal is not permitted where injurious vibrations may damage freshly placed concrete.
- Areas marked for removal must have well-defined edge prepared by saw-cutting to a depth of 25 mm around the perimeter.
- Only small chipping hammers may be used for removal of concrete near or around reinforcing steel.
- Chipping hammers must not contact reinforcing steel in a manner that will cause de-bonding at the adjacent concrete areas.
- All surfaces of exposed reinforcing steel, except for epoxy coated reinforcing steel, must be sandblasted. The entire bar area must be sandblasted, including the undersides.
- Reinforcing steel that has suffered more than 20% section loss will require additional bars to be installed. The Inspector must be aware of the requirements for splicing and anchoring additional bars.
- Existing epoxy coated reinforcing steel must either be repaired using an approved brush-on patch product or through the installation of galvanic anodes. The requirements are detailed in the Special Provisions and the Plans. The Department has no standard specifications for galvanic anode protection. The exact placement of anodes depends on the density of reinforcing steel and will be site-specific.

### 20.7.2 Partial Depth Repair on Deck Surface

Partial depth repair procedures are performed when the deteriorated concrete does not extend through the full thickness of the deck.

Partial depth repairs at the deck surface are poured monolithically with the overlay concrete.

Concrete for partial depth repair areas must meet the same requirements as HPC for deck overlay concrete, as specified in Section 4 of the *Standard Specifications for Bridge Construction*.

Normally, concrete removal extends to a depth of 25 mm below any exposed reinforcing steel. After concrete around the reinforcing steel has been acceptably removed, the Inspector must check to confirm that sound concrete exists at the sides and base of all prepared areas.

### 20.7.3 Full Depth Repair for Deck

Full depth repair procedures are used when the deteriorated concrete extends the full thickness of the deck. The deck soffit requires forming on the deck underside.

Full depth repairs at the deck are generally poured monolithically with the overlay concrete; however, large areas are often repaired prior to casting the overlay concrete. The Inspector must discuss the pour sequence with the Project Manager in advance.

Concrete for full depth repair areas must meet the same requirements as HPC for deck overlay concrete, as specified in Section 4 of the Standard Specifications for Bridge Construction.

After the concrete around the reinforcing steel has been acceptably removed, the Inspector must check to confirm that sound concrete exists at the sides of all prepared areas. The underside of the deck must be formed to neatly restore the original lines of the concrete. Formwork must be adequately secured and sealed to prevent paste leakage and form lines.

### 20.7.4 Partial or Full Depth Repair at Non-Deck Surfaces

Concrete repair areas may occur at curbs, barriers and substructure elements. Full depth repairs typically occur at curbs and barriers, and partial depth repairs typically occur at piers, abutment, seats and wingwalls.

Partial depth repairs are completed using an approved concrete patching material, as identified in the *Alberta Transportation Products List*. Approved concrete patching materials are classified into five types according to performance requirements. These types are:

- High Early Horizontal (HEH)
- Low Temperature Horizontal (LTH)
- Normal Horizontal (NH)
- Overhead or Vertical (OH-V)
- Form and Pour (FP)

The *Alberta Transportation Products List* provides details for the applications of each type. The Inspector must be aware of the following details:

- Approved concrete patching material for partial depth repair areas must be extended with aggregates.
- Full depth repair areas must be re-cast using Class C or Class HPC concrete, depending on location.
- Surface removals and preparation are similar to those required for partial and full depth repairs for deck concrete.

Beyond a specified volume, patches for partial depth repair areas must be repaired using Class C or Class HPC concrete. Concrete patches must be placed and cured in accordance with the requirements of Section 4 of the *Standard Specifications for Bridge Construction* and the manufacturer's recommendations.

When concrete is used as a patching material and is not poured monolithically with the deck overlay concrete, reduced payment rates for low-strength concrete are specified in Section 20 of the *Standard Specifications for Bridge Construction*.

Placing of patching materials requires specific attention to detail. Curing of patches is important to their performance. It is difficult to effectively cure vertical and overhead patches. The Inspector must carefully monitor the entire patching and curing process to confirm that requirements are precisely followed.

## 20.8 Deck Surface Preparation for Overlay Concrete

The deck surface and all other vertical surfaces that will be in contact with the deck overlay concrete must be adequately sandblasted. The Inspector must confirm that:

- Adequate shielding is in place to protect any epoxy coated reinforcing steel or galvanic anodes.
- The sandblasted surfaces must uniformly expose the fine aggregate in the concrete substrate.
- The final surfaces are adequately cleaned of all sand and other contaminants.

## 20.9 Dry Run Criteria

The Inspector must survey the prepared deck surface to determine the existing elevations at specified locations. The Inspector must then determine the required thickness of the concrete overlay in order to provide the desired gradeline. In determining the desired gradeline, the Inspector must take into account the anticipated deadload deflection from the overlay, drainage requirements and rideability.

The screed rails for the deck finishing machine are set by the Contractor to meet the profile provided by the Inspector. The Inspector must confirm through the dry-run that the finishing roller(s) is set to achieve the desired gradeline and that the minimum thickness of overlay concrete specified.

Payment for the overlay concrete is based on the dry-run values. The Inspector and Contractor must be in agreement of the measurement for payment before any overlay concrete is placed.

The location of all construction joints must be determined and agreed to by the Inspector before the start of concrete placement.

## 20.10 Concrete Production

Site batching with pre-bagged materials may be done at remote locations when there is no availability of ready-mix concrete. The Inspector must confirm that the batching and mixing requirements are strictly followed. The Inspector must review Section 4 of this Manual, which describes the process for truck-mixing.

## 20.11 Concrete Placement

The Inspector must confirm that the specified slurry grout is mixed to the correct proportions and that it is applied immediately in advance of concrete placement. The slurry grout acts as a bonding agent; however, if it dries, it becomes ineffective and may instead inhibit the bond between the overlay concrete and the deck concrete.

The concrete overlay is usually the final riding and wearing surface and care must be taken to achieve the desired profile and texturing. The Inspector must confirm that the Contractor performs the following tasks:

- Straight-edge checks to demonstrate that there are no local depressions, and the crossfall and crown are preserved.
- Bull floating achieves a smooth and closed surface, before texturing.
- Texturing must not cause plucking of aggregate or tearing of the surface.

## 20.12 Surface Defects and Tolerances

Areas of the overlay concrete that do not meet the required surface tolerance must be clearly identified by the Inspector and removed or replaced at the Contractor’s expense.

If the surface is damaged by construction operations, or if the concrete overlay shows signs of distress or scaling prior to final completion, it must be removed and replaced.

**Government of Alberta ■**
Transportation

**Bridge Construction Inspection Manual 2015**
Section 20 – Deck Overlay and Concrete Rehabilitation Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No:
Inspector:
Stage of Activity:
Element:

---

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | | Have traffic control devices been properly implemented to provide safety to the public? | ☐ | |
| 1.2 | | Was depth of milling checked to prevent over milling? | ☐ | |
| 1.3 | | Were unsound concrete areas marked for removal? | ☐ | |
| 1.4 | | Was the deck profile and minimum thickness of overlay (normally 50 mm) set? | ☐ | |
| 1.5 | | Was the Inspector present at the “Dry Run”? | ☐ | |
| **2** | | **Surface Preparation for Concrete Overlay** | | |
| 2.1 | 20.3.1 | General – Were jack hammers less than nominal 14 kg class and chipping hammers less than nominal 7 kg class used for concrete removal? | ☐ | |
| 2.2 | 20.3.2 | Did the Contractor submit details of his proposed surface removal methods to the Consultant for review and acceptance? | ☐ | |
| 2.3 | 20.3.2 | Was surface removal carried out in stages to the depth(s) shown on the Drawings or as described in the special provisions? | ☐ | |
| 2.4 | 20.3.2 | Was surface removal carried out as close as possible to all curbs, medians, barriers, drains, deck joints and other bridge components without causing damage? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.5 | 20.3.2 | Were concrete curbs, deck joints and paving lips within the limits of the surface removal area removed, including the reinforcing steel projecting into these components? | ☐ | |
| 2.6 | 20.3.2 | On bridges with no formal deck joints, did the Contractor sawcut through the full depth and width of the wearing surface at both ends of the bridge or at the transition paving limits prior to commencing removal operations? | ☐ | |
| 2.7 | 20.3.2 | Did the Contractor use small milling machines having a maximum removal width of 1.2 m in areas where the specified removal depth includes more than 5 mm of concrete removal? | ☐ | |
| 2.8 | 20.3.2 | Did the Contractor remove milling debris from behind the cold-milling machine and clean the milled surface on a continuous basis? | ☐ | |
| 2.9 | 20.3.2 | Was any reinforcing steel that was damaged as a result of the Contractor’s surface removal operations repaired or replaced? | ☐ | |
| 2.10 | 20.3.2 | Was the completed surface of removal operations inspected to identify unsound concrete to be repaired? | ☐ | |
| 2.11 | 20.3.2 | Were repairs carried out in accordance with Subsection 20.4, Concrete Repair of the SSBC? | ☐ | |
| 2.12 | 20.3.3 | Did the Contractor sandblast the entire deck surface and the vertical faces of the curb, median and parapet up to a height equal to the overlay thickness prior to deck overlay concrete placement? | ☐ | |
| 2.13 | 20.3.3 | Did the Contractor clean the sandblasted area to the satisfaction of the Inspector and dispose of debris at an approved location? | ☐ | |
| 2.14 | 20.3.3 | Did the Contractor maintain the cleaned deck in satisfactory condition until placement of deck overlay concrete? | ☐ | |
| **3** | | **Concrete Repair** | | |
| 3.1 | 20.4.1 | General – Were the limits of concrete removal determined? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.2 | 20.4.1 | General – Were the perimeters of repair areas sawcut with neat, perpendicular, 25 mm deep cuts? | ☐ | |
| 3.3 | 20.4.1 | General – Did the Contractor address the areas of unsound concrete by chipping, scabbling or other means approved by the Inspector, resulting in a sound surface suitable for bonding to the deck overlay concrete or repair material? | ☐ | |
| 3.4 | 20.4.1 | General – Did the Contractor contain all debris resulting from concrete removal operations and dispose of it at an approved location? | ☐ | |
| 3.5 | 20.4.2 | Partial Depth Repair – Was partially exposed reinforcing steel entirely exposed by removal of the concrete to a depth of 25 mm below the bars? | ☐ | |
| 3.6 | 20.4.2 | Partial Depth Repair – Was reinforcing steel sandblasted to a white metal finish? | ☐ | |
| 3.7 | 20.4.2 | Partial Depth Repair – Was epoxy coated reinforcing steel sandblasted clean, and was the exposed reinforcing steel protected by installing discrete galvanic anodes? | ☐ | |
| 3.8 | 20.4.2 | Partial Depth Repair – Was the epoxy coating repaired in accordance with the requirements of Section 5, Reinforcing Steel of the SSBC? | ☐ | |
| 3.9 | 20.4.2 | Partial Depth Repair – Was additional reinforcing steel of the same type installed at locations where the existing reinforcing steel suffered sectional loss greater than 20%? | ☐ | |
| 3.10 | 20.4.2 | Partial Depth Repair – Did the Contractor follow splicing and/or development requirements? | ☐ | |
| 3.11 | 20.4.2 | Partial Depth Repair – Was the repair area acceptable for placement of repair material? | ☐ | |
| 3.12 | 20.4.2 | Partial Depth Repair – Did the Contractor saturate the approved area with clean water for 30 minutes? | ☐ | |
| 3.13 | 20.4.2 | Partial Depth Repair – Were the repairs finished smooth, levelled flush to adjacent surfaces and given the appropriate concrete surface finish? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.14 | 20.4.2 | Partial Depth Repair – Did the Contractor re-establish the original design concrete cover at each repair location? | ☐ | |
| 3.15 | 20.4.2 | Partial Depth Repair – Were all partial depth repair areas located on the deck surface poured monolithically with placement of deck overlay concrete? | ☐ | |
| 3.16 | 20.4.2 | Partial Depth Repair – Were other partial depth repair areas formed and recast with an appropriate Alberta Transportation approved concrete patching product? | ☐ | |
| 3.17 | 20.4.2 | Partial Depth Repair – Was a rubber paddled mortar mixer of adequate size used for mixing where the volume of patching product required exceeded the volume produced by three (3) 25 kg bags?<br>*Note: The use of free fall mixers are not permitted.* | ☐ | |
| 3.18 | 20.4.3 | Full Depth Repair – Did areas where concrete deterioration extended completely through the deck, curbs or other elements, as determined by the Consultant, have all unsound concrete removed and replaced with new concrete? | ☐ | |
| 3.19 | 20.4.3 | Full Depth Repair – Was exposed reinforcing steel sandblasted and the area blown clean with oil-free compressed air? | ☐ | |
| 3.20 | 20.4.3 | Full Depth Repair – Was reinforcing steel sandblasted to a white metal finish? | ☐ | |
| 3.21 | 20.4.3 | Full Depth Repair – Was epoxy coated reinforcing sandblasted clean, and was the exposed reinforcing steel protected by installing discrete galvanic anodes? | ☐ | |
| 3.22 | 20.4.3 | Full Depth Repair – Was the epoxy coating repaired in accordance with the requirements of Section 5, Reinforcing Steel? | ☐ | |
| 3.23 | 20.4.3 | Full Depth Repair – Was additional reinforcing steel of the same type installed at locations where the existing reinforcing steel suffered sectional loss greater than 20%? | ☐ | |
| 3.24 | 20.4.3 | Full Depth Repair – Did the Inspector determine splicing and/or development requirements? | ☐ | |
| 3.25 | 20.4.3 | Full Depth Repair – Was the underside of the deck, curbs and other areas requiring full depth repair formed to neatly restore the original lines of the concrete? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.26 | 20.4.3 | Full Depth Repair – Did the Contractor saturate the approved area with clean water for 30 minutes? | ☐ | |
| 3.27 | 20.4.3 | Full Depth Repair – Was the concrete for the repair areas vibrated, trowelled smooth, levelled flush to adjacent surfaces, and given the appropriate concrete finish? | ☐ | |
| 3.28 | 20.4.3 | Full Depth Repair – Did the concrete cure in accordance with Subsection 4.23 of Section 4, Cast-In-Place Concrete? | ☐ | |
| 3.29 | 20.4.3 | Full Depth Repair – Were full depth repairs located on the deck surface recast monolithically with placement of deck overlay concrete? | ☐ | |
| 3.30 | 20.4.3 | Full Depth Repair – When conditions did not permit a monolithic pour with the deck overlay concrete, was concrete placed to a depth such that, once the subsequent overlay concrete was placed, the specified design overlay thickness was achieved? | ☐ | |
| **4** | | **Deck Overlay** | | |
| 4.1 | 20.5.1 | General – Was deck overlay concrete placed as shown on the Drawings in accordance with the requirements of this specification and Section 4, Cast-in-place Concrete of the SSBC? | ☐ | |
| 4.2 | 20.5.3 | Were two parallel profile lines the entire length of the bridge for each construction stage provided by the Consultant +as follows:<br>• Line No. 1 located 1.0 m from curb face<br>• Line No. 2 located 0.3 m in from the opposite edge of proposed pour | ☐ | |
| 4.3 | 20.5.3 | Were the stations of Line No. 1 and Line No. 2 square to each other? | ☐ | |
| 4.4 | 20.5.3 | Were additional profile lines produced when determined by the Inspector? | ☐ | |
| 4.5 | 20.5.3 | Were stations established at 3.0 m intervals at the edges of existing deck joints to be retained and/or at new deck joint locations? | ☐ | |
| 4.6 | 20.5.3 | Did profiles include 30 m of approach at each end of the bridge at 3.0 m intervals? | ☐ | |
| 4.7 | 20.5.3 | Was fluorescent paint used to mark profile locations on the existing deck surface, curbs and approaches? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 4.8 | 20.5.3 | Did the Contractor remove all exposed markings remaining after the deck overlay work was complete? | ☐ | |
| 4.9 | 20.5.3 | Were screed rails properly set to match the gradeline provided by the Consultant? | ☐ | |
| 4.10 | 20.5.3 | Were screed guide rails placed with enough rails for the entire contemplated placement? | ☐ | |
| 4.11 | 20.5.3 | Did the screed "dry-run" confirm proper adjustment of the machine and guide rails? | ☐ | |
| 4.12 | 20.5.3 | Were proposed longitudinal overlay construction joint locations accepted by the Inspector prior to commencement of overlay construction? | ☐ | |
| 4.13 | 20.5.4 | Prior to the commencement of concrete placement operations, was a cement/silica fume slurry grout applied to all surfaces to be overlaid? | ☐ | |
| 4.14 | 20.5.4 | Was the slurry grout mixed and applied as outlined in Section 20.5.4 of the SSBC? | ☐ | |
| 4.15 | 20.5.6 | Did the Contractor employ adequate equipment in order to mix concrete and provide a suitable, dedicated water source for the purpose of batching concrete? | ☐ | |
| 4.16 | 20.5.6 | Were the mixers maintained in good condition at all times while the work was being carried out? | ☐ | |
| 4.17 | 20.5.6 | Did the Contractor ensure that mixers were not loaded with more than 3 $m^3$ of concrete or in excess of 85% of its rated capacity, whichever was less, and only operated at the speeds recommended by the manufacturer? | ☐ | |
| 4.18 | 20.5.6 | Did the Contractor test the air content, slump and temperature of each batch at the mixing site? | ☐ | |
| 4.19 | 20.5.6 | Was concrete discharged within 70 minutes after initial introduction of water. | ☐ | |
| **5** | | **Concrete Placement** | | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 5.1 | 20.5.7.1 | Was adequate lighting provided for night pours? | ☐ | |
| 5.2 | 20.5.7.1 | Was concrete placed in such a manner that segregation of materials did not occur? | ☐ | |
| 5.3 | 20.5.7.2 | Did the deck overlay concrete receive a Class 6 or a Class 4 finish as specified? | ☐ | |
| 5.4 | 20.5.7.3 | Where an overlay did not terminate at a deck joint, such as on roof slabs, was the overlay extended for a distance of 150 mm beyond the required end of the overlay to a bulkhead? | ☐ | |
| 5.5 | 20.5.7.4 | Did the Contractor construct acceptable bulkheads at each Longitudinal or Transverse construction joint location? | ☐ | |
| 5.6 | 20.5.7.5 | Was curing of overlay concrete in accordance with Subsection 4.23.3 of Section 4, Cast-In-Place Concrete of the SSBC? | ☐ | |
| 5.7 | 20.5.7.6 | After the concrete has cured for a minimum of 14 days, did the Contractor apply a Type 1c sealer to all areas where a Class 6 surface finish had been applied and along trowelled gutter areas? | ☐ | |
| 5.8 | 20.5.7.6 | Was sealer applied in accordance with Subsection 4.26 of Section 4, Cast-In-Place Concrete of the SSBC? | ☐ | |
| 5.9 | 20.5.7.7 | Opening to Traffic – Did the concrete reach a minimum strength of 35 MPa before being opened to traffic? | ☐ | |

**Details and Summary:**

Signature

Date

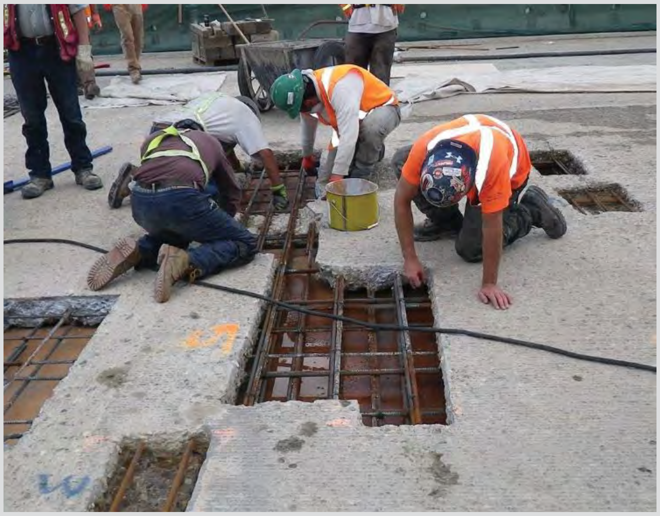
20.1 ACP milling operation.

20.2 ACP removed and locations requiring full or partial depth repair are identified and marked out with paint by the inspector.

20.3 Partial or full depth repair areas prepared.

20.4 Full depth repair area prepared.

20.5 Full and partial depth repair areas prepared.



20.6 Crew preparing repair areas.

20.7 Bonding agent applied to full depth repair area.

20.8 Full depth repairs are marked onto the deck soffit as well.

20.9 Concrete being placed into repair area.

20.10 Concrete being placed into repair area.

20.11 Workers routing cracks in preparation for epoxy.

20.12 Cracks prepared for epoxy repair.

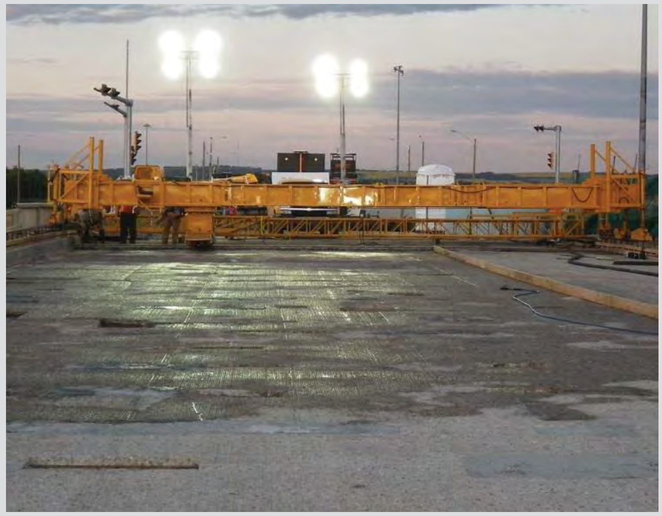
20.13 Cracks being filled with gravity flow epoxy.

20.14 Existing deck joint removal using pneumatic hammer.

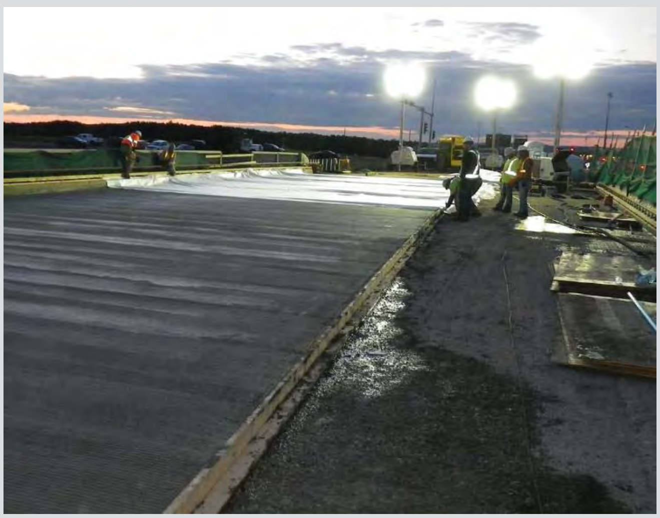
20.15 Deck joint set into position using erection angles.

20.16 Checking deck joint elevation.

20.17 Type I strip seal deck joint ready for concrete placement.



20.18 Deck finishing machine for concrete overlay pour.



20.19 Overlay concrete placed and curing fabric being installed.

# SECTION 21

## REMOVAL AND SALVAGE OF BRIDGE STRUCTURES

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## 21.1 Removal and Salvage of Bridge Structures – General

Materials that are typically salvaged during bridge demolition include:

- CSP barrel sections, SPCSP plates, RCP and PBC sections
- Precast concrete girders
- Treated timber stringers and other members
- Structural steel girders and other members

All materials that are to be salvaged for Department usage will be listed in the Special Provisions. All other bridge materials to be demolished become the responsibility of the Contractor and must be disposed of accordingly.

The Contractor must provide a Demolition Plan that identifies the equipment used, protection to the public, noise attenuation, protection to the roadway surface or watercourse, capture of debris and protection of salvageable components.

The Inspector must discuss the list of items to be salvaged with the Contractor and must be confident that the Contractor clearly understands the quantities and limits of the items to be salvaged.

The Inspector must perform a pre-inspection of each component that is listed for salvage. Photographs and sketches must be collected and reviewed with the Contractor before the work begins. These records must be sufficiently detailed to confirm the pre-existing condition of the salvageable components.

The Contractor is responsible to ensure that all utilities attached to or in the vicinity of the bridge are accurately located, protected or relocated.

## 21.2 Environmental Considerations

The following environmental considerations may exist:

- Restricted Activity Periods (RAP) may exist for watercourse crossings. The Inspector must review all requirements of the Special Provisions. Underslung tarps or netting may be required to prevent debris from entering the watercourse.

- Prior to final acceptance of the Work, the Contractor is required to tidy the site and restore disturbed areas to the specified requirements or the original condition.

## 21.3 Safety Considerations

The following safety considerations may exist:

- The Contractor’s Demolition Plan must specifically identify and locate the mobile equipment and must consider the safe lifting capacity of such equipment.

- Since concrete removal operations may produce flying and falling debris, it is important to confirm that this area is isolated from the public.

## 21.4 Workmanship and Handling of Materials

The methods of removal and salvage employed by the Contractor are his responsibility. The Inspector must not advise the Contractor regarding demolition or salvage methods. However, the Inspector must advise the Contractor that he is responsible for any damage caused to salvageable items by his work methods.

The Inspector must be present at all times during demolition and salvage.

A variety of equipment is generally used to demolish and salvage bridge structure components, such as hand-operated or excavator-mounted pneumatic hammers, cutting saws, torches, wrecking balls, excavator-mounted hydraulic breakers, cranes, loaders and trucks.

The Inspector must review the Contractor’s methods of removal, handling, transporting and stockpiling of materials. If the Inspector has concerns that the Contractor’s methods may cause damage to salvageable items or damage to other infrastructure, the Inspector must discuss these concerns with the Project Manager before any work commences.

The Inspector must confirm with the Project Manager that all traffic accommodation submissions have been received and accepted prior to the start of the Work. The Inspector must be knowledgeable of all traffic accommodation requirements and must confirm that all devices and measures are in place prior to the start of the Work.

After the Work begins, if work methods are determined to unnecessarily cause damage to salvageable components, the Inspector must instruct the Contractor to change his methods before proceeding further.

The Inspector must be aware of any limiting physical condition or frailty of the components that are listed for salvage. The Inspector must use fair judgment when determining if any damage to components during salvage was caused by the Contractor’s equipment or carelessness, or rather by the inherent weakness of the component. The Inspector must use judgment to differentiate between major damage caused by careless handling from the slight damage caused from normal wear-and-tear of a properly executed salvage.

Where public access or traffic must be maintained, the Inspector must confirm that proper protection measures are in place. This may include underslung tarps, netting or screening.

Where falling debris may potentially cause damage to the roadway structure below, the Inspector must confirm that cushioning materials or other protection measures are in place.

## 21.5 Removal

Materials listed for salvage must be dismantled one piece at a time by removing all connecting hardware and grout. Removal of multiple components from the structure at one time is not permitted.

SPCSP plates must not be bent, and bolts must be removed in a manner that does not damage the plate or the coating. After removal, the sections of plate must be properly stacked and nested with separators so that there is no plate-to-plate contact. During excavation, care must be taken to prevent gouges, dents or coating damage.

CSP barrel sections must not become distorted due to excavation, lifting or loading. During excavation, care must be taken to prevent gouges, dents or coating damage.

RCP and PBC sections must be carefully winched apart so that no spalling occurs at the joints.

Precast concrete girders must be individually dismantled using the following requirements:

- Grout must be carefully chipped-out in shear keys and connector pockets, taking care not to damage reinforcing
- Connector bolts must be removed
- Precast concrete girders must be carefully jacked away from adjoining girders
- Drift pins and other hardware must be removed prior to girder removal

Precast concrete girders must be lifted only at the designed lifting points with the top of each unit in the up position at all times, and they must be supported only on their designed bearing points. If the original lifting hardware has been removed, slings or other lifting methods must be proposed by the Contractor and accepted by the Project Manager.

Government of Alberta ■
Transportation

**Bridge Construction Inspection Manual 2015**

Section 21 – Removal and Salvage of Bridge Structures Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

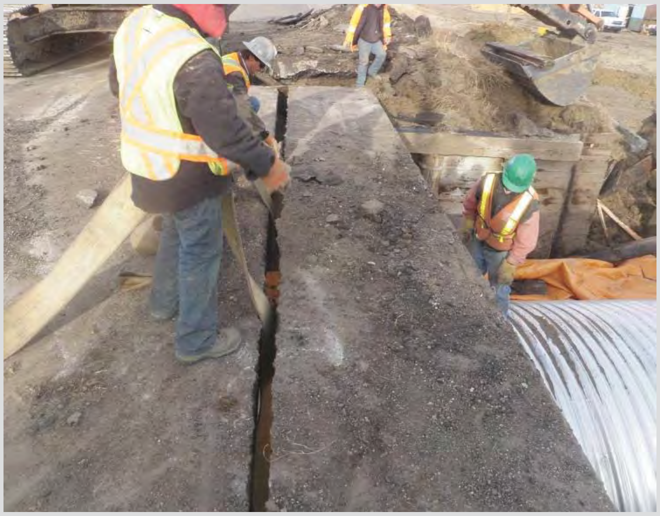
| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | | Were the conditions of bridge materials to be salvaged reviewed and documented with photographs? | ☐ | |
| 1.2 | | Did the Contractor tidy up the site and restore all disturbed areas to their original state or to the specified requirements? | ☐ | |
| 1.3 | 21.1 | Prior to removal of bridge structures, did the Contractor obtain a list of materials to be salvaged and permission to proceed, from the Consultant?<br>*Note: Treated timber, structural steel, corrugated steel pipes and precast concrete units may be considered for salvage and when required will be specified in the special provisions of the contract.* | ☐ | |
| **2** | | **Workmanship and Handling of Materials** | | |
| 2.1 | 21.2 | Did the Contractor perform the work in a manner that prevented damage to or loss of materials listed for salvage? | ☐ | |
| **3** | | **Excavation** | | |
| 3.1 | 21.3 | Did the excavation conform to Section 1, Excavation of the SSBC? | ☐ | |
| 3.2 | 21.3 | Did the culvert excavation extend to the invert elevation, and was the width at this level the culvert width plus 3.0 m? | ☐ | |
| 3.3 | 21.3 | Did the bridge abutment excavation extend to the ground level at the front of the abutment, and were the sides excavated at one horizontal to one vertical or as required for stability? | ☐ | |
| **4** | | **Removal** | | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 4.1 | 21.4.1 | Were all the salvaged materials listed by the Consultant removed and stockpiled, either at the site or at the Contractor's storage area, and was the work area left in a tidy and safe condition? | ☐ | |
| 4.2 | 21.4.2 | Were the materials listed by the Consultant for salvage dismantled piece by piece removing all nails, bolts, drift pins and other hardware?<br>*Note: Torch cutting to remove hardware or to dismantle these materials is not permitted.* | ☐ | |
| 4.3 | 21.4.2 | Were SPCSPs dismantled to yield lengths not exceeding eight (8) metres? | ☐ | |
| 4.4 | 21.4.2 | Were CSPs dismantled by removing the couplers to achieve the original fabricated lengths? | ☐ | |
| 4.5 | 21.4.2 | Were precast concrete units 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? | ☐ | |
| 4.6 | 21.4.3 | Were materials in bridge structures not listed for salvage disposed of in a manner and location acceptable to the Consultant? | ☐ | |
| 4.7 | 21.4.3 | Did the Contractor provide written acceptance from the owners of the disposal site(s) and evidence of their acceptance of the disposal site cleanup? | ☐ | |
| 4.8 | 21.4.3 | Was the portion of bridge abutments and piers located above natural ground level completely removed, and the portion 1 m below the natural ground level left in place? | ☐ | |

**Details and Summary:**

Signature

Date



21.1 Concrete box girders salvaged. Girders lifted at their bearing points.

21.2 Concrete box girders salvaged. Girders lifted at their bearing points.

21.3 Concrete box girder salvage.

21.4 Demolition of substructure. Piles are removed or cut to specified elevation below streambed.

21.5 Girder removal.

21.6 Girder removal.

# SECTION 22

# PAINTING

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## 22.1 Painting – General

Cleaning and painting a bridge structure has become an expensive operation. There is growing emphasis on environmental, health and safety related issues. Consequently, it is more important now than ever to obtain the longest possible life from bridge coatings. Like all quality products, bridge coatings require adequate specifications, high quality materials, proper usage, maintenance of equipment and effective inspection.

Most of the premature coating failures are caused by either deficient surface preparation or coating application. This makes it clear that the Inspector is a vital part of the bridge painting process. The Inspector diligently carrying out duties can help assure that the painting project that is inspected will perform throughout its expected service life.

## 22.2 Environmental Considerations

The following emission levels will be specified in the Special Provisions and detailed in the SSPC-Guide 6:

- Minimum percentage (%) of blasting spoil that must be recovered.
- Class of containment required.
- Method to monitor the quantity of emissions escaping the enclosure.

The Inspector must be aware of the environmental considerations governing the project and confirm that paint being removed and materials used to accomplish the removal are contained and properly and safely disposed of in accordance with the applicable laws and regulations.

The Contractor must comply with all Federal, Provincial and Municipal air, soil and water pollution control regulations, as well as any requirements included with the environmental permits issued for the project. At a minimum, the Contractor must:

- Identify background contamination levels.
- Prevent noise, air, soil and water pollution/contamination.
- Contain and clean up any paint, fuel, oil or chemical leaks or spills.

The Contractor must ensure that no deleterious material enters waters during his painting operations. Some of the basic requirements to achieve this include:

- Detergent used to wash bridge structures must be biodegradable and not harmful to fish.
- Paint debris and other solids washed from the bridge structure require filtering out.
- De-icing salts washed from the bridge structure must be allowed to settle.
- Siltation of water must be avoided.

The Contractor must obtain approval from Alberta Environment before withdrawing water from any stream or waterbody.

The Contractor must take all necessary precautions to fully protect the environment, the workers, traffic, parked vehicles, adjacent property and other portions of the bridge structure from damage caused by cleaning debris, blast cleaning materials, dirt, dust equipment oils, solvent, acids, burning matter and paint drifts, drops, spray or spatter.

If the Contractor's activities contravene the environmental permit conditions, the Inspector must require the Contractor to stop work and the Inspector must immediately contact the Project Manager.

### 22.3 Safety Considerations

Refer to the current edition of *Alberta's Occupational Health and Safety Act, Regulation and Code* for specific approved safety requirements for a typical paint project, including but not limited to:

- Health and Safety Plan
- Hazard Assessment, Elimination and Control
- Specifications and Certifications
- Chemical Hazards, Biological Hazards and Harmful Substances
- Confined Spaces
- Cranes and Hoists
- Emergency Preparedness and Response
- Entrances, Walkways, Stairways and Ladders
- Fall Protection
- Fire and Explosion Hazards
- First Aid
- General Safety Precautions
- Joint Work Site Health and Safety Committee
- Lifting and Handling Loads
- Noise Exposure
- Overhead Power Lines
- Personal Protective Equipment
- Powered Mobile Equipment
- Rigging
- Safeguards
- Scaffolds and Temporary Work Platforms
- Toilets and Washing Facilities
- Ventilation Systems
- Violence
- Workplace Hazardous Materials Information System (WHMIS)

The Contractor is responsible for meeting all public and occupational health and safety requirements and must:

- Develop an appropriate traffic accommodation strategy through the work zone.
- Develop and implement a Lead Health and Safety Program (LHASP) for any project involving lead paint removal.

The Inspector is responsible for identifying to the Contractor any safety violations that he discovers and to take necessary action where there is non-compliance.

### 22.4 Bridge Inspector's Record

The Inspector must keep an accurate record of the following information:

- Environmental conditions

  - Ambient air temperature
  - Steel surface temperature
  - Relative humidity
  - Dew point
  - Wind speed and direction

- Record of quality control test results from Contractor and any independent quality assurance testing pertaining to:

  - Abrasive blasting media sieve analysis, petrographic/contaminant analysis, etc.
  - Product Material Data sheets and Material Safety Data Sheets
  - Colour, gloss, and formulation testing for each paint batch
  - Toxic Characteristic Leachate Procedure (TCLP) tests
  - Background contamination levels of air, soil and water
  - Chloride, soluble ferrous ion and sulphate levels after wash cleaning
  - Surface profile (replica tape) after blast cleaning
  - Blotter tests for compressed air dryness
  - Blast spoil recovery calculations
  - Areas of bridge painted each day
  - Batch numbers for paint applied to each bridge area
  - Thinners used, and in what quantities
  - Record location of each Wet Film Thickness (WFT) taken, rejected or accepted
  - Record location of *each Dry Film Thickness (DFT) taken, rejected or accepted*

- Agreements between the Contractor and private landowners, and designated hazardous waste disposal sites pertaining to disposal areas for hazardous and non-hazardous materials.
- Traffic disruptions, queuing of the traffic or minor traffic mishaps through the work zone.

## 22.5 Bridge Inspector’s Role

As with any assignment, the first step is to become familiar with the scope of the project by reviewing the Plans, specifications and any Special Provisions for the project. In addition, the Inspector must become familiar with the project site, including the areas noted that may be difficult for equipment access as well as sensitive areas such as homes, schools, playgrounds and other areas of public activities. Painting operations generate dust, solvent fumes and noise. Every effort must be made to minimize the impact of these activities on the surrounding community. This can best be accomplished through the cooperative effort between the Contractor and the community itself. The Contractor’s schedule must be reviewed, noting when weather conditions that could negatively impact the proposed work. Concerns and questions must be brought to the attention of the Project Manager. Some issues may need to be referred to the Department’s Project Sponsor.

### 22.5.1 Existing Bridge Structure

The Inspector must inspect the bridge structure to be painted to identify the existing coating type, thickness, adhesion, localized rust and presence of mill scale. Areas that will be hard to coat — such as confined areas, or areas with weld spatter, weld flux, skip welds, rough welds, sharp corners or laminations — must be identified and discussed with the paint contractor. These areas may require special treatment, such as grinding all burrs and sharp edges prior to painting or painting by mitt in difficult to access locations.

Localized rust areas are shown to be prone to premature coating failure. Extra effort must be made by the paint contractor to ensure that proper surface preparation and coating thickness are achieved. The presence of mill scale under the existing paint indicates a potential need for additional surface preparation.

### 22.5.2 Inspector's Equipment

The Inspector must inventory, inspect and calibrate inspection equipment to make sure these are in good working order. It is good practice to calibrate equipment, such as Dry Film Thickness (DFT) meters, in coordination with the Contractor to prevent disputes. Backup equipment and batteries must be readily available.

### 22.5.3 Contractor's Proposed Schedule and Methodology

In reviewing the Contractor's schedule and methodology, the Inspector must verify that the Contractor understands the magnitude of the Work to be performed and is prepared to do the Work in a satisfactory manner.

Further to the OH&S safety requirements, the Contractor must have a Health and Safety Plan for all projects involving paint removal. The Inspector must discuss the following with the Contractor:

- Monitoring and sampling requirements.
- The manner in which the Contractor is planning to protect his workers and the environment from contamination, including shower/washing facilities, work clothing, debris containment and handling of emergencies.
- Proper location of the Contractor's recycling dust collection and storage equipment to ensure that they are out of the way of potential vehicle collisions. The Contractor should be aware that lead-contaminated waste cannot be stored on site for more than 90 days.
- Any concerns with the work schedule and mitigating measures if required.

### 22.5.4 Inspector's Safety and Proper Access

The Contractor must provide safe and proper access for the Inspector at all times. Inspection staff must not be expected to risk their safety at any time on the job site.

### 22.5.5 Inspection and Measurements

The Inspector must discuss the inspection and measurement procedures, especially those related to payment with the Contractor.

The Inspector must:

- Inform the Contractor of the inspection control points that must be inspected and approved before he is allowed to proceed. The control points are usually:
    - after a water blast and SP-1 cleaning
    - after the completion of the surface preparation
    - after each individual paint coating application, prior to overcoating
- Identify potential inaccessible areas and discuss a method of acceptable treatment with the Contractor.

### 22.5.6 Product Information

The Contractor must provide copies of the Product Material Data Sheets and Material Safety Data Sheets for the paint system and any solvents or cleaning materials that will be used during the project. These sheets contain the information on the materials to be used and are necessary to complete the material inspection.

### 22.5.7 Visual Standard for Surface Preparation

SSPC publishes reference photographs (SSPC-VIS 1) for steel surfaces prepared by dry abrasive blast cleaning, which can be used as the reference standard. A good practice is to have the Contractor blast a section of the bridge or a separate steel plate and seal with clear coat. This can be used as an on-site reference for the rest of the project.

### 22.5.8 Documentation

The Inspector must document all discussions and instructions given at the pre-construction meeting and especially any agreements that were reached that may modify the Contract proposal or specifications requirements.

## 22.6 Inspection of the Painting Procedures

### 22.6.1 Inspecting the Enclosure

A containment system, or enclosure, is needed to prevent the debris generated during surface preparation from entering the environment and to facilitate its gathering and disposal. Enclosures are generally made up of combinations of cover panels, scaffolds, supports, screens and tarps. The containment system requirements will be specified in the Special Provisions and described in SSPC-Guide 6. The complexity of any given enclosure will vary depending on the amount and type of paint being removed, the method of paint removal being employed and the degree of surface preparation that is specified. For simple scraping operation, ground-covering tarps may be sufficient, while for a blasting operation, the enclosure must be a designed structure often including a negative pressure ventilation system.

The Inspector must check the adequacy of the containment system to confirm that:

- The work area be clearly distinguishable from the surroundings.
- Tarps are overlapped with seams fastened, are in good condition and are free of holes.
- During blasting operations with negative pressure, the tarps have a concave inward appearance.
- The containment is tightly sealed to prevent any dust from escaping. Check the ground around the containment.
- Dust collectors are operated at the rated capacity or at a capacity consistent with the ventilation design of the containment system.
- The containment is able to support workers, construction loads, spent abrasive loads and wind loads without placing undue stress on the bridge structure. Confirm that the containment is constructed in accordance with an approved plan stamped by a professional engineer.

### 22.6.2 Assessment of Containment Design and Function in the Field

Containment for abrasive blast and other paint removal operations are designed to protect the surrounding environment and the public from debris and potentially hazardous material during paint removal. These containment structures are intended to help contain and collect the lead-containing debris for proper treatment and disposal.

- The standard features of containment systems are described in detail in the SSPC Guide 6.
- The purpose of the containment is so that a conscientious and diligent job of containing and collecting debris is done. While 100% containment is often not practical nor necessary, close to 100% containment can be achieved with appropriate specifications, designs and implementation.
- Containment of abrasive blast involving lead is mandatory and is required by law.
- Fugitive emissions of abrasive blast dust must be limited to 3% (for example, 15 minutes over an 8-hour work shift). These emissions can be controlled by properly designing and maintaining the containment and ventilation system.
- If high or ultra-high pressure water jetting is used, the Contractor is responsible for performing all work and disposing of all waste water and debris properly. This may include filtering the waste water and folding the cloth filters so as to contain all debris prior to disposal. These requirements will be stipulated in the Special Provisions.

### 22.6.3 Components of a Containment System

**Support Structure**: Containment can be a scaffold from the ground or rigged to hang from the bridge structure. The key issues to consider are structural integrity under wind load, abrasive waste load and dynamic loads on the bridge. Access, air movement and visibility must also be considered.

**Ventilation**: Proper ventilation is necessary to facilitate workers and inspectors within the containment structure. Ventilation also reduces the concentration of lead dust in the work environment and makes clean-up operations easier prior to painting.

**Lighting**: Proper lighting is required to address safety concerns and facilitate proper surface preparation and painting procedures.

**Debris Handling**: The manner in which spent debris is collected is a key element to the quality and timeliness of the job. It is critical to clear debris and dust prior to paint application. Acceptable or suitable debris handling is a major part of a bridge painting project.

**Air Movement**: Air movement is necessary for work inside an enclosure to avoid a build-up of dust. High dust concentrations impair visibility and increase hazardous exposure levels to workers. Air movement is dependent upon the capacity of dust collectors, the volume of air input by makeup fans and blast nozzles, and interference to airflow caused by the bridge structure itself.

**Debris Storage**: Spent shot blasting waste resulting from the removal of paint from steel surfaces is classified as a hazardous material unless it can be shown to contain less than 5 ppm of lead. It is subject to strict disposal requirements and can only be temporarily contained and stored at the site when the Environmental Permit states that this is acceptable.

### 22.6.4 Bridge Washing

Prior to any surface preparation procedures, the Contractor must hand-clean all surfaces to be coated, including removing all organic materials such as bird droppings and other non-structural items attached to the bridge. Oil, grease and road tar must be removed manually by solvent cleaning in accordance with SSPC-SP1. Any remaining areas contaminated with residual oil or grease must be cleaned with an approved environmentally friendly, biodegradable detergent. The entire area to be coated must be washed clean of road spatter, salts and other surface contaminants using water of sufficient pressure and volume.

The Contractor must determine the level of cleanliness achieved after washing by testing for chloride levels, ferrous ion levels and sulphate levels on the cleaned steel and runoff water at the lower extremities of the steel being cleaned.

Chloride contamination of the cleaned surface will be determined by using either the Quantab Method or by Kitagawa Tube testing. The results must be less than 7 $\mu g/cm^2$.

Ferrous ion levels will be determined using ferrous ion test strips, and the results must be less than 10 $\mu g/cm^2$.

Sulphate contaminants will be determined by use of a barium chloride optical comparator, or another method approved by the Consultant, with a maximum level of 17 $\mu g/cm^2$.

### 22.6.5 Surface Preparation

Surface preparation is typically accomplished by abrasive blasting; however, it can also be achieved in some circumstances by water jetting methods. The Society for Protective Coatings (SSPC) has developed a nomenclature for the different types of surface preparation methods:

- SP-1 denotes "solvent" cleaning and can refer to solvent wiping, water washing or steam cleaning. The surface is cleaned to remove oil, grease, etc.
    - Lint-free clean rags and solvent must be used to assess the acceptability of the surface.
- SP-2 denotes hand tool cleaning in small areas. Hand tools are used to remove loose mill scale, loose rust, loose or otherwise defective paint, weld flux, slag and spatter. This is done either by brushing, sanding, chipping or scraping the surface. Tightly adhering rust, mill scale and paint are allowed to remain.
    - A dull putty knife must be used to assess the acceptability of the surface.
- SP-3 denotes power tool cleaning. This is similar to SP-2 except power tools are used to clean larger areas.
    - A dull putty knife must be used to assess the acceptability of the surface.
- SP-7 denotes abrasive brush off blast cleaning. The resulting surface must be free of oil, grease, dirt, loose mill scale, loose rust and loose coatings.
- SP-6 denotes abrasive commercial blast cleaning. The resulting surface must be free of oil, grease, dirt, all rust, mill scale, paint and foreign matter except for slight shadows, streaks or discoloration caused by rust stains, mill scale stains and tight residue of previous coatings.
- SP-10 denotes abrasive near-white blast cleaning. The resulting surface must be free of oil, grease, dirt, all rust, mill scale, paint and foreign matter, leaving only slight stains from rust and mill scale.

- SP-5 denotes abrasive white metal blast cleaning. The resulting surface must be free of oil, grease, dirt, all rust, mill scale, paint and foreign matter, leaving only a uniform gray-white color.
- SP-12 denotes high and ultra-high pressure water jetting. There are four levels of visual surface cleanliness identified in this standard:

  - WJ-1: Surface free of all previously existing visible rust, coatings, mill scale and foreign matter and have a matte metal finish.
  - WJ-2: Surface cleaned to a matte finish, with 5% of area containing only randomly dispersed stains of rust, coatings and foreign matter.
  - WJ-2: Surface cleaned to a matte finish, with at least 2/3 of the surface free of all visible residues (except mil scale) and allows 1/3 of the area to contain only randomly dispersed stains of rust, coatings and foreign matter.
  - WJ-4: Surface free of all loose rust, loose mill scale and loose coatings.

Prior to blast cleaning, the Contractor must demonstrate that the compressed air is dry, typically by blowing air on blotter paper.

Visual and written standards can often be interpreted differently by contractors and inspectors. It is therefore important to clarify the standards to be used for the project.

The anchor pattern needs to be checked to ensure that proper paint adhesion will occur. Profile inspection requires the use of a surface profile gauge or a micrometer and replica impression tape. Comparison coupons can also be used for a qualitative visual comparison of the profile. It is particularly important to verify that the required surface profile has been achieved if water jetting has been used for the surface preparation as this preparation method does not impart any additional surface profile to the underlying steel surface.

Pack rust between mated steel surfaces must be cleaned and all connections treated with sealant and caulk to provide a watertight seal along the top edge.

The Contractor must only prepare as much surface area as can be coated with primer the same day. If unprimed surfaces must be left overnight due to unusual circumstances, the Contractor is required to re-clean the steel using a light blast cleaning.

### 22.6.6 Material/Pre-Painting

Shelf life is considered as the length of time from date of manufacture that paint will remain usable when stored in its container. The date printed on the can must be checked to make sure the shelf life of paint has not expired. Consequences of exceeding the shelf life include:

- Gelling
- Odour
- Changes in viscosity
- Formation of lumps
- Pigment settling
- Colour separation
- Liquid separation

Paint must be stored and secured in a climate-controlled environment that keeps its temperature between 10°C and 25°C. If more stringent storage requirements are indicated on the manufacturer's Material Product Data Sheets, they must be adhered to. The Contractor's paint storage site must be equipped with a high/low thermometer for monitoring the required temperature range for proper paint storage.

Paint storage exceeding the acceptable temperature range can cause changes in viscosity and shelf life. Water-based paint will spoil when stored below freezing temperatures. Solvent-based paint will gel or become flammable or explosive when stored at high temperatures.

'Pot life' is considered as the length of time that paint is useful after opening its original package for single component systems, and the length of time after it has been mixed for multi-component systems. Pot life is dependent on temperature, and can be affected by humidity and multi-component reaction times. Exceeding the pot life can result in a variety of application and performance problems. The Contractor must never mix more paint than can be applied within the specified pot life.

The Inspector must witness and document the mixing operation:

- All paint must be thoroughly mixed in a clean container in correct proportions.
- The bottom of the original containers must be checked for evidence of unmixed pigment.
- Unused paint must not be left in buckets or spray pots; instead, it must be placed in a clean container and re-mixed prior to use.
- Zinc rich coatings require that the spray pot has adequate agitation at all times.

Thinner may be added to paint to achieve optimum viscosity for proper paint application. The Product Material Data Sheets will indicate the specific type and maximum amount of thinner to be used.

The Inspector must witness and document any addition of thinner. Adding too much thinner can prevent proper application thickness, cause runs and sags, and may extend the cure time of the paint. Addition of thinners may also result in the mixture exceeding acceptable limits for Volatile Organic Compounds (VOC). Wet film thickness measurements during paint application will vary with the amount of thinner added.

Drying time of paint refers to the length of time a coating is sensitive to local damage. The Drying Schedule on the Product Material Data Sheet indicates how long the paint is:

- Dry to touch – the paint will not collect dust.
- Dry to tack free – the paint does not feel sticky and can be handled without damage.
- Dry to re-coat – time the paint needs to dry until applying the next coat of paint.
- Paint drying time varies significantly with temperature.

Curing time of paint refers to the length of time required to reach full integrity and be ready for service. Re-coating before enough time has passed can seriously affect the curing and integrity of both the layer being over-coated and the layer being applied. Some paint has a maximum time to re-coat. Exceeding the maximum time limit can jeopardize adherence of the topcoat.

## 22.7 Paint Application

Once the level of surface preparation has been achieved and approved and the quality of the coating system has been verified, the Contractor can proceed to paint. If painting proceeds before approval has been given, any applied coatings must be blasted off.

To prevent “rust-back” or “flash-rust” of the cleaned surface, the first coat of paint must be applied as soon as possible after blast cleaning and on the same day that the steel was cleaned. Painting must begin at a practical time to avoid weather changes that could cause significant adverse changes to the surface condition of the steel.

Stripe painting must be applied along all sharp changes in steel surfaces either prior to or after the primer coat has been applied.

Faying surfaces may require special treatment, coatings or no coatings. The Inspector needs to be aware of these areas and what treatments are required.

### 22.7.1 Environmental Conditions

The Inspector must record ambient conditions every four hours to confirm that the paint is applied and allowed to dry and cure under reasonable environmental conditions. Excessively high or low temperatures or the presence of surface moisture, including frost, can have a detrimental effect on the performance of the paint.

- The ambient temperature range to ensure proper curing will be specified in the Product Material Data Sheet for each paint material; however, the paint must not be applied if the ambient temperature is at or below 4°C, or if it is possible that the air temperature may drop below 0°C before the paint has dried.
- The acceptable surface temperature range for the paint products will also be specified in the Product Material Data Sheets; however, the paint must not be applied if the surface temperature is above 50°C. The minimum surface temperature is usually given in the Product Material Data Sheets as a certain amount of degrees above the dew point temperature, but it must be at least greater than 5°C with the ambient temperature rising. This dew point spread is used to ensure that there is no moisture present on the steel prior to paint application.
- Maximum or minimum permissible relative humidity is given in the Product Material Data Sheets. A dew point meter or a sling psychrometer is used to determine the relative humidity.
- Heavy winds can cause airborne overspray to be carried onto adjacent properties and result in premature drying of the paint. If heavy winds are present, it may be prudent to delay the painting operation or restrict spray application.

### 22.7.2 Application

The following are spray application good practices:

- The spray pot must have two pressure regulators: one for pot pressure and one for atomization pressure. The pot pressure must be sufficiently high enough to provide enough material at the spray gun. The atomization pressure regulator must be set just high enough to atomize the material. Too high a setting will result in the paint drying before it hits the surface. Too low a setting will cause the paint to clump and could clog the gun.
- The spray gun must be held perpendicular to the work surface. The ideal distance between spray nozzle and surface can vary depending on the equipment used; however, it must be kept uniform, and the common habit of supplementing the painter’s reach by increasing the spraying distance is unacceptable.
- Angling the gun or holding it too far away could result in the paint drying before it hits the surface. The spray pattern must overlap the previous pass by approximately 50%. A good paint applicator will make a pass of the spray gun by moving his arm and body rather than rotating his wrist to "fan" the gun. The technique of the operator and the adjustment of the gun

must be observed by the Inspector for any deficiencies that would result in non-uniform thicknesses.

- Surfaces that are hard to reach by spray applications must be brushed or swabbed with coating.

### 22.7.3 Brush, Roller and Mitt Application

The material used in brushes or rollers must be tested with the paint to confirm that they are chemically compatible with the paint being used. In general, natural bristled brushes are recommended for solvent-based paints, while synthetic bristles work better for waterborne paints. The nap of the roller must be as recommended by the coating manufacturer for the desired finish.

Brushing must be done as neatly as possible to ensure a uniform coating thickness. Rolling must be done in a "W" pattern and finished by rolling in one direction. Rolling the coating out over too large of an area must be avoided as this can cause thin spots or holidays.

The Inspector must:

- Confirm that all areas with runs, drips, pinholes, fisheyes, blisters, blushing, wrinkling or overspray are repaired immediately.
- Confirm that the Wet Film Thickness (WFT) is periodically checked, due to variances to the spray pressure, the "load" of paint on the brush or roller, and the orientation of the surface being painted.

It is important to check the Dry Film Thickness (DFT) after the application of each coat as this is the most direct measure of the Contractor's work. The thickness must be checked at five locations for every 10 $m^2$ of coated area. Three separate gauge measurements must be taken and averaged to determine the paint thickness reading at each location. Individual gauge measurements that are unusually high or low that cannot be repeated can be discarded. The paint thickness at any location must be reported as the average of the three individual gauge measurements. Each paint thickness reading must be not less than 80% of the specific thickness nor greater than 150% of the specified thickness (SSPC-PA2 Level 4 Restriction Level).

It is important to monitor thickness for areas too thin or too thick, as it is not necessarily true that "thicker is better". Excessively thick applications can cause the coating to sag or fail to achieve a full cure.

### 22.7.4 Common Paint Problems

**Runs**

When this defect occurs, the wet paint film runs in rivulets. It is caused by over thinning, extra slow thinners, improperly cleaned surface or the surface being too cold. Holding the spray gun too close to the surface and depositing too much paint on the surface can also cause runs.

**Remedy**: The affected area must be sanded or washed off and refinished, and then the surface must be thoroughly cleaned. Thinning must be carried out as recommended using specified solvents.

**Sags**

Sags consist of a heavy thickness of paint that has slipped and formed curtains on the surface. This is caused by insufficient thinner, insufficient drying time between coats, low air pressure causing insufficient atomization, spray gun too close to work or out of adjustment.

**Remedy**: The affected area must be sanded or washed off and refinished. Reduce viscosity as recommended, use proper thinning solvent, adjust the air pressure and spray gun for correct atomization and keep the spray gun at correct distance from work.

**Blistering**

There are many causes of blistering. Some of them are:

- Failure of the topcoat to stick to the primer.
- Painting over oil or moisture on the surface that prevents proper bonding of paint to the surface.
- Applying too much paint at one time so that the solvents in the coating cannot escape before the top of the coating has dried.
- Coating has been cleaned by steam and the steam has penetrated it and caused debonding.
- Finger prints on metal.
- Trapped air when very thick coatings are being applied.

**Remedy**: The blistered area must be sanded down and refinished.

**Blushing**

Blushing occurs when the surface of the coating turns milky. This is almost always a reaction of the coating with surface moisture or excessive moisture in the air. Using fast or unbalanced thinners in high humidity is the primary cause of blushing.

Most epoxies, regardless of the curing system, can be made to blush because of moisture if the curing agent is not properly mixed in and allowed to set a while before application.

**Remedy**: Blushing may be overcome by the addition of a "retarder", which is a high boiling, slow evaporating solvent. However, in high humidity, this might fail and then painting must stop.

**Fisheyeing**

This is the separation of the coating over slick surfaces or over oil or greasy surfaces. Silicone contamination from lubricants, greases, etc., can also cause this to happen, but this is rare. Fisheyes allow corrosion to start because of insufficient paint coverage.

**Remedy**: The affected area of wet paint must be washed off, and the surface must be cleaned properly. The source of silicone must be removed. Silicone contamination on the surface must be removed by washing off with solvent. A fisheye preventer must be used in paint sprayed over old film containing silicone.

### Pinholing (Bubbling, Solvent Pops)

These defects are quite common to coating application. Pinholing often is the result of water contamination in the air line or of a solvent imbalance (a solvent that is drying too quickly). If the solvent is too “fast”, the coating will not have enough time to flow out before it becomes a solid and little holes are left in the coating. In addition, trapped solvents, settling of pigments and insufficient atomization of the material may cause pinholing.

Bubbling and pinholing are quite common with inorganic zinc coatings. These coatings are quite porous, and when a topcoat is applied over them, the pressure of the coating filling the voids in the zinc film forces air to the surface.

**Remedy**: Often, the best remedy is to use a tie coat of primer thinned considerably, or to thin the topcoat 25% to 50%. If allowed to dry, this will seal the porous surface of the zinc-rich primer and allow the final topcoat to be applied without problem. If the use of a tie coat is not acceptable, a mist coat of the topcoat over the surface before following it with a full wet coat may prevent the problem. This acts very much like a tie coat. In extremely severe cases of pinholing, it may be necessary to sand down to a smooth surface and refinish.

**Prevention**: The drain valve of the air line extractor must be opened daily to allow drainage of collected moisture. The internal cleaning section of older type extractors must be removed and cleaned at regular intervals. Paint needs to be applied in uniform, normal coats to allow proper evaporation of solvents. Using recommended thinners and increasing air pressure for proper atomization should prevent pinholing.

### Wrinkling

This may occur either in cold weather when the thickened paint is improperly applied, or in hot weather when the topcoat dries quickly but the paint underneath is still wet. The resulting stresses cause the paint to wrinkle.

**Remedy**: Paint must be applied within prescribed weather requirements.

## 22.7.5 Inspector’s Responsibilities

- Review specifications, drawings and special provisions.
- Become familiar with the project site, including the surrounding area.
- Inspect the bridge structure for existing coating type, thickness, adhesion and presence of mill scale.
- Inventory and calibrate inspection equipment.
- Attend pre-construction meeting.
- Ensure that the Paint Contractor provides all relevant Product Material Data Sheets and Material Safety Data Sheets and be familiar with the information they contain.
- Ensure ladders and scaffolding are in good condition and that they provide safe access to all necessary areas. Any required alternations must be immediately brought to the Contractor’s attention.
- Locate areas that will be difficult to coat.
- During blasting operations, check that no dust leaks are visible outside the enclosure. If working inside the enclosure, ensure appropriate breathing apparatus has been provided.
- During blasting operations, ensure that no blast debris is present on the ground or in any waterways.

- Ensure hazardous waste is stored away from public access and in an area where it is not vulnerable to being struck by traffic or wind drift.
- Check that the anchor pattern is as specified.
- Check that the surface preparation is as specified.
- Check that all dust has been removed from the surface to be painted.
- Check that coatings are as specified.
- Check that coatings are correctly mixed/thinned.
- Check that coatings do not exceed pot life.
- Check that stripe coating has been completed.
- Check that correct WFT is being done.
- Check that correct DFT has been achieved.
- Check that there are no flaws.
- Check that the weld treatments have been acceptably done.
- Record weather conditions.
- Ensure Contractor's work schedule and work procedure conforms to the contractual requirements.
- Ensure Contractor complies with Environmental Permit conditions and Occupational Health and Safety requirements.
- Review containment system and methods of spoil collection and acceptability of disposal areas.
- Communicate any concerns or questions to the Project Manager as required and refer issues to the Department's Project Sponsor.

### 22.7.6 Project Manager's Responsibilities

The Consultant will address the following issues in the pre-construction meeting:

- The nature of the work and its effects on the surroundings, including possible mitigation measures.
- Contractor's method of operation, including equipment and personnel.
- Contractor's schedule – discuss weather related concerns.
- Contractor's Traffic Accommodation Strategy.
- Contractor's Lead Health and Safety Program if lead paint is present.
- Proper storage of material and equipment, including lay down area.
- Location of recycling, dust collection and storage of equipment.
- Inspector safety, including provision of safe access and lead contamination monitoring in accordance with OHS requirements.
- Inspection and measurement procedures, including control points.
- Areas to be coated/not coated.
- Treatment of faying surfaces.
- Identification and treatment of inaccessible areas.
- Product Material Data Sheets and Material Safety Data Sheets for all relevant materials.
- Visual or other standards to be met – Discuss Contractor's preparation of field reference sections.

Government of Alberta
Transportation

**Bridge Construction Inspection Manual 2015**
Section 22 – Painting Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

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| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | | Have the specifications, drawings and special provisions been reviewed? | ☐ | |
| 1.2 | | Was the inspection equipment inventoried and calibrated? | ☐ | |
| 1.3 | | Were all relevant Material Safety Data Sheets obtained and reviewed? | ☐ | |
| 1.4 | | Were weather conditions recorded? | ☐ | |
| 1.5 | | Were containment systems, methods of spoil collection and acceptability of disposal areas reviewed? | ☐ | |
| **2** | | **Contractor Qualifications** | | |
| 2.1 | 22.3 | Did the Contractor conform to one of the following four competency levels as specified in the Special Provisions of the Contract?<br>• **CQ1:** The Contractor or painting subcontractor must have certification in good standing with the Society for Protective Coatings (SSPC) under SSPC-QP2.<br>• **CQ2:** The Contractor or painting subcontractor must have certification in good standing with the Society for Protective Coatings (SSPC) under SSPC-QP1.<br>• **CQ3:** The Contractor or painting subcontractor acceptance will be based on submission of documented experience, which should include but not be limited to: the names of owners, projects and dates of previous bridge painting projects where containment and disposal of blasting spoil was practiced, copies of any relevant environmental permits and any citations for failure to comply. A list of qualified personnel responsible for the actual paint removal and application will be required. Once accepted, no personnel changes shall be made without the | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| | | Consultant's written acceptance. Permission for the Consultant to interview the owners, environmental departments and personnel listed above. Falsifying information in the submission will be grounds for disqualification of the bid.<br>• **CQ4:** No specific pre-qualification requirements. | | |
| **3** | | **Environmental Considerations** | | |
| 3.1 | 22.5.1 | Was the percentage of blasting spoil, specified in the contract Special Provisions and detailed in the SSPC-Guide 6, recovered? | ☐ | |
| 3.2 | 22.5.2 | Did the Contractor ensure that existing paint to be removed and any abrasive material used to accomplish the removal was contained and properly and safely disposed of in accordance with the applicable laws and regulations? | ☐ | |
| 3.3 | 22.5.2 | Did the Contractor 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 and performed additional work to modify containment or disposal procedures to ensure compliance with all applicable laws and regulations? | ☐ | |
| 3.4 | 22.5.3 | Did the Contractor conform to the requirements of the Alberta Transportation Fish Habitat Manual? | ☐ | |
| 3.5 | 22.5.4 | Was the containment system for the blast cleaning and painting installed such that the minimum specified percentage of the blast spoil and paint removed, as listed in the Special Provisions, was contained? | ☐ | |
| 3.6 | 22.5.5 | Did the Contractor 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 during cleaning and painting procedures? | ☐ | |
| 3.7 | 22.5.6 | Was an Environmental Auditor 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? | ☐ | |
| 3.8 | 22.5.7 | Did the Contractor identify locations in which to establish background soil, water/snow and air contamination levels in his work proposal? | ☐ | |
| 3.9 | 22.5.7 | After the Contractor's work proposal was reviewed and accepted by the Consultant and prior to commencement of the work, did the Contractor collect — in the presence of the Consultant and at locations most likely affected by the work, such as at the dust collector, recycling unit, key points along the spoil material transfer | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| | | lines and spoil material storage areas — soil, water/snow and air samples from the project site for analysis?<br>Was a minimum of three (3) samples collected at each location and sent to an accredited laboratory approved by the Consultant for analysis, and was analysis consistent with regulatory reporting requirements and results submitted to the Consultant? | | |
| 3.10 | 22.5.7 | Were any additional soil, water/snow and air samples requested where contamination is suspected?<br>Were results received within a week? | ☐ | |
| 3.11 | 22.5.7 | Did the Contractor collect a minimum of two (2) post-construction composition test samples at all established background locations, after painting was done and equipment removed, and was analysis performed at the approved laboratory using the same test methods used for initial background analysis?<br>Did analysis show any adverse effect on the environment requiring remediation be carried out to the full satisfaction of the Department and the Consultant? | ☐ | |
| **4** | | **Permits, Licences and Approvals** | | |
| 4.1 | 22.6 | Did the Contractor 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? | ☐ | |
| 4.2 | 22.6 | Did the Contractor comply with all regulations, such as but not limited to, environmental permits, the Worker's Compensation Act, the Occupational Health and Safety Act, Regulation and Code that control the exposure of workers to chemical hazards? | ☐ | |
| **5** | | **Work Proposal** | | |
| 5.1 | 22.7 | Did the Contractor submit a work proposal to the Consultant for review and acceptance a minimum of two (2) weeks prior to the pre-construction meeting, and did it include:<br>• Schedule<br>• Sequence of operations<br>• Traffic accommodation strategy<br>• Site lay down plan, including placement of equipment<br>• Proposed sampling locations for establishment of background contamination levels<br>• Bridge washing strategy<br>• Storage, handling and disposal of new and contaminated blasting material<br>• Methods of weighing blasting material on and off the project<br>• Method of separating hazardous and non- hazardous blasting spoil<br>• Sample documentation for tracking the disposal of hazardous waste<br>• Final destination of hazardous waste | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| | | • Chosen coating system from the Alberta Transportation Product List – Approved Products "Bridge Coating Systems (Paint)"<br>• Bridge load evaluation report | | |
| 5.2 | 22.7 | Did the Contractor submit drawings signed and sealed by a Professional Engineer registered in the Province of Alberta detailing his containment structure, scaffolding, platforms, swing stages and attachments for the Consultant's review? | ☐ | |
| **6** | | **Work Site Health and Safety** | | |
| 6.1 | 22.8 | Did the Contractor develop and implement a Lead Health and Safety Program (LHASP) that met all the requirements of the Occupational Health and Safety Act and Regulations (Attention is drawn to OH&S Bulletin MSB-06 and in particular the chemical requirements) and all other Municipal, Provincial and Federal Regulations that may apply when working in a hazardous environment? | ☐ | |
| 6.2 | 22.8 | Did the Contractor provide shower and change facilities for all personnel associated with the Contract, in accordance with governing regulations and ordinances? | ☐ | |
| 6.3 | 22.8 | Were respirators furnished by the Contractor and used when such equipment was necessary to protect the health of employees? Were extra protective clothing and clean respirators available for use by visitors to the work site? | ☐ | |
| 6.4 | 22.8 | Did the Contractor designate a Health and Safety officer to act as the primary on-site monitor of the program and to ensure that the LHASP was implemented on a daily basis and that all work on the site was in compliance with the LHASP? | ☐ | |
| **7** | | **Protection of Surfaces** | | |
| 7.1 | 22.10 | Did the Contractor protect and maintain the painted surfaces until acceptance of the entire project? | ☐ | |
| **8** | | **Areas Not To Be Painted** | | |
| 8.1 | 22.10 | Unless noted in the Special Provisions, were any surfaces, such as surfaces that will be cast into concrete (ie. 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? | ☐ | |
| **9** | | **Work Execution** | | |
| 9.1 | 22.12.1 | Temporary Attachments – Were all clamps or other devices attached to the structure, padded or designed such that they did not mark or damage the surface? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 9.2 | 22.12.2 | Containment System – Did the containment system and its operation meet or exceed the class of containment specified in the Special Provisions? | ☐ | |
| 9.3 | 22.12.3 | Containment System Monitoring<br>**(1) Abrasive Blasting**<br>Did the Contractor 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? | ☐ | |
| 9.4 | 22.12.3 | Did the Contractor take whatever measures were necessary to prevent the release of dust or spent material from ground tarpaulins and other components of the containment enclosure during moving or removal? | ☐ | |
| 9.5 | 22.12.3 | Was debris collected on temporary work platforms, ground cloths or walls of the containment structure removed each workday with a vacuum system equipped with High Efficiency Particulate Air (HEPA) filters adequately sized to collect all spent material? | ☐ | |
| 9.6 | 22.12.3 | Did the Contractor provide a temporary platform located directly underneath the area enclosed for surface preparation cleaning, power tool cleaning or blast cleaning and paint application? | ☐ | |
| 9.7 | 22.12.3 | Did the containment system fail to function properly at any time? | ☐ | |
| 9.8 | 22.12.3 | **(2) Water Blasting**<br>Was the filtration or collection and treatment of water used in the cleaning as specified in the Special Provisions?<br>Was the wastewater filtered through a cloth system of specified porosity, and when the cleaning was completed, were the cloth filters carefully folded to contain the debris collected and disposed of as outlined in Section 22.16 of the SSBC? | ☐ | |
| 9.9 | 22.12.4 | Was the ventilation system used as specified in the Special Provisions and described in the SSPC-Guide 6? | ☐ | |
| 9.10 | 22.12.5 | Did the Contractor have monitoring equipment to ensure that the containment was performing to the required level as specified in the Special Provisions and as described in the SSPC-Guide 6? | ☐ | |
| **10** | | **Surface Cleaning** | | |
| 10.1 | 22.13 | Did the Contractor carry out surface cleaning on all steel designated to receive a coating system and adjacent surfaces that could contaminate surfaces prior to commencement? | ☐ | |
| 10.2 | 22.13 | Was oil, grease and road tar removed manually by solvent cleaning in accordance with SSPC Specification SP1? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 10.3 | 22.13 | Was residual oil or grease cleaned with an approved biodegradable detergent?<br>Did the Contractor supply copies of the Material Safety Data Sheets (MSDS) sheets of the proposed cleaning products for review and acceptance? | ☐ | |
| 10.4 | 22.13 | Were all areas to be coated washed clean of road spatter, chlorides and other contaminates using water of sufficient pressure and volume to flush the contaminants from the structure? | ☐ | |
| 10.5 | 22.13 | Were areas of cleaned steel tested for chloride contaminants, soluble ferrous ions and sulphate contaminants? | ☐ | |
| 10.6 | 22.13 | Did the Contractor submit the test results to the Consultant for review and acceptance prior to commencing surface preparation operations? | ☐ | |
| 10.7 | 22.13 | Was wash water captured, filtered and disposed of in compliance with all applicable laws and regulations? | ☐ | |
| **11** | | **Surface Preparation** | | |
| 11.1 | 22.14.1 | Abrasive Blast Cleaning – Prior to abrasive blast cleaning, did the Contractor demonstrate to the Inspector that the air was moisture free and that air driven power tools that were properly lubricated in accordance with the respective manufacturer's instructions, did not deposit lubrication onto the surface being prepared? | ☐ | |
| 11.2 | 22.14.1 | Was blast cleaning of steel surfaces in preparation for painting in accordance with the SSPC Surface Preparation Standards specified in the Special Provisions? | ☐ | |
| 11.3 | 22.14.1 | Did the Contractor grind all burrs and sharp edges to the satisfaction of the Consultant? | ☐ | |
| 11.4 | 22.14.1 | Did the Contractor prepare only as much surface as can be coated with primer the same day? | ☐ | |
| 11.5 | 22.14.1 | Did any areas require compressed air cleaning before the application of any coat of paint? | ☐ | |
| **12** | | **Pack Rust** | | |
| 12.1 | 22.15 | Were pack rust areas cleaned and treated with an approved penetrant and caulked to form a water tight seal along the top edge and the two sides of plates involved? | ☐ | |
| 12.2 | 22.15 | Was the type of penetrant and caulking used compatible with the paint system used, applied according to the manufacturer's instructions, and was it accepted by the Consultant? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 12.3 | 22.15 | Were all connection plates, regardless of whether pack rust was evident or not, treated with an approved penetrant and caulked? | ☐ | |
| **13** | | **Disposal of Blasting Spoil** | | |
| 13.1 | 22.16 | Was the collection, storage and disposal of blasting residue carried out in compliance with Federal, Provincial and Municipal laws? | ☐ | |
| 13.2 | 22.16 | Was all waste residue collected during the surface preparation process stored at the site in containers acceptable to the Inspector in an acceptable area and protected at all times with waterproof covers? | ☐ | |
| 13.3 | 22.16 | Were collected and stored waste residues sampled and tested by the Contractor in accordance with the Toxic Characteristic Leachate Procedure (TCLP) test, and were test results for each batch provided to both the Consultant and the Department before disposal of waste was undertaken? | ☐ | |
| 13.4 | 22.16 | Did the Contractor provide documentation to the Consultant that all hazardous waste was disposed of, in conformance with all applicable regulations governing the disposal of such materials, consisting of a certificate of disposal that provided 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? | ☐ | |
| **14** | | **Priming and Painting** | | |
| 14.1 | 22.17.1 | Did the Contractor apply stripe paint along all sharp changes in steel surfaces, including but not limited to edges of flanges, stiffeners, bracing, plates, bolts, nuts, washers, rivets, plates and sections with sharp profile?<br>Was stripe coat applied over the primer or intermediate coat tinted to contrast the underlying coat? | ☐ | |
| 14.2 | 22.17.2 | Was paint applied in accordance with the manufacturer's instructions, and when required, was the coating manufacturer's representative available at the site to provide guidance and solve problems? | ☐ | |
| 14.3 | 22.17.2 | (Was paint applied when the air and/or steel temperatures were above 4°C and 50°C? | ☐ | |
| 14.4 | 22.17.2 | Was paint applied to dry, frost-free surfaces when there was no risk of dew and the dry bulb temperature exceeded the wet bulb temperature by more than 5°C and the ambient temperature was rising? | ☐ | |
| 14.5 | 22.17.2 | Was only the anticipated quantity of paint required for one day's work opened on that day?<br>*Note: Leftover paint must not be left exposed to air, and any paint that becomes oxidized, thickened, ropy, lumpy or dirty must be discarded.* | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 14.6 | 22.17.2 | Was the paint mixed in a manner that ensured breaking up of all lumps, complete dispersion of settled pigment and a uniform composition, and was it agitated often enough during application to keep the pigment in suspension? | ☐ | |
| 14.7 | 22.17.2 | Was any paint left in spray pots, painter's buckets, etc., overnight? | ☐ | |
| 14.8 | 22.17.2 | Did the Contractor store paint safely in a location that kept its temperature between 10°C to 25°C? | ☐ | |
| 14.9 | 22.17.1 | Was paint applied by spraying, brushing, rolling or a combination of these methods?<br>Where surfaces were inaccessible, were sheepskin mitts, specifically manufactured for this purpose, used? | ☐ | |
| 14.10 | 22.17.2 | Was touched-up primer dry before finish coat paint was applied? | ☐ | |
| 14.11 | 22.17.2 | Were all portions of the paint system within the range of film thicknesses in which it was originally approved? | ☐ | |
| 14.12 | 22.17.2 | Was the wet film thickness checked at the time the paint was applied to ensure that the proper dry film thickness was obtained? Was dry film thickness verified with a Type 2 constant pressure probe magnetic gauge, calibrated in accordance with SSPC-PA 2, as defined by SSPC-PA 2? | ☐ | |
| **15** | | **Quality Control** | | |
| 15.1 | 22.18 | Did the Contractor have an experienced quality control person solely dedicated to actively monitoring and correcting the work of his employees whenever cleaning, surface preparation and coating application was taking place? | ☐ | |
| 15.2 | 22.18 | Did the Consultant provide a NACE certified quality assurance inspector to monitor and accept the work, and did the Contractor provide safe and free access to all areas of the work in all stages of completion? | ☐ | |
| 15.3 | 22.18 | Was all cleaning and surface preparation inspected and accepted before painting?<br>Was each coat thoroughly dry and mil thickness accepted by the Consultant prior to applying an additional coat? | ☐ | |
| **16** | | **Acceptance** | | |
| 16.1 | 22.20 | Were any painted surfaces showing defects, listed below, that resulted in rejection?<br>(1) Runs, sags, holidays or shadowing. | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| | | (2) Evidence of poor coverage at bolts, plate edges, lap joints, crevices, pockets, corners and re-entrant angles.<br>(3) Surfaces that were struck, scraped, spotted by rain or otherwise damaged.<br>(4) Surfaces that exhibited an objectionable texture, such as orange peel, mud cracking, fish eyes, etc.<br>(5) Surfaces damaged by overspray. | | |
| **17** | | **Repair** | | |
| 17.1 | 22.21 | Did the Contractor carry out all repairs to the satisfaction of the Inspector by cleaning all damaged paint and re-applying the system using all coats typical to the original paint system? | ☐ | |
| 17.2 | 22.21 | Were support points for work platforms or containment structures painted with the accepted paint system, or did the Contractor submit a proposed alternate paint system and application procedure for the painting of touch points? | ☐ | |
| **18** | | **Site Clean-Up** | | |
| 18.1 | 22.22 | Did the Contractor 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? | ☐ | |

**Details and Summary:**

Signature

Date

22.1 Environmental containment system.

22.2 Environmental containment system

22.3 Chloride test.

22.4 Washing steel.

22.5 Salt test.

22.6 Girder after sandblasting.

22.7 Primer applied to girder.

22.8 Applying finish coat of paint.

22.9 Typical paint setup.

# SECTION 23

## STRUCTURAL LUMBER AND PILING

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## 23.1 Structural Lumber and Piling – General

The Contractor must supply all dimensional structural lumber and round timber piling, including the independent inspections required by the referenced standards and material specifications.

The Inspector must review and accept the quality of materials at the work site prior to any materials being incorporated into the Work.

## 23.2 Material

The Inspector must be familiar with the following material specifications:

- **Planking (Strip Deck)**: Species Group HEM-FIR conforming to stress grade “No. 1 Structural Joists and Planks”, 20% conforming to stress grade No. 2 of each size length supplied.
- **Sheeting, Retainers, Nailers and S 1 S 1 E (Sanded 1 Side 1 Edge) Subdeck**: Coast Douglas Fir or Pacific Coast Hemlock species conforming to stress grade “No. 1 Structural Joists and Planks”, 15% conforming to stress grade No. 2.
- **Rough Caps**: Coast Douglas Fir species conforming to stress grade “Structural Posts and Timbers”.
- **Framed Subcaps**: Coast Douglas Fir species conforming to stress grade “Structural Posts and Timbers”.
- **Wheel Guards**: Coast Douglas Fir or Pacific Coast Hemlock species conforming to stress grade “No. 1 Structural Beams and Stringers”, 15% of BM conforming to stress grade No. 2.
- **Rough Stringers**: Coast Douglas Fir species conforming to stress grade “Selected Structural Beams and Stringers”.
- **Struts and Handrails Posts**: Coast Douglas Fir or Pacific Coast Hemlock species conforming to stress grade “No. 1 Structural Posts and Timbers”.
- **S 1 S 1 E Cleats**: Coast Douglas Fir or Pacific Coast Hemlock species conforming to stress grade “No. 2 Structural Joists and Planks”.
- **Railings**: Coast Douglas Fir or Pacific Coast Hemlock species conforming to stress grade “No. 1 Structural Joists and Planks”.

Pilings are to be cut from sound trees of Douglas Fir or Pine.

- Piling lengths are normally 6.1 m, 12.2 m and 18.3 m.
- Corresponding tip diameters are approximately 230 mm, 205 mm and 180 mm +/- 12 mm.
- Corresponding butt diameters are approximately 305 mm, 305 mm and 330 mm +/- 12 mm.
- Sapwood (the part of the section where the sap flows, towards the outer edge of the circumference) thickness is to be 12 mm but not less than 10 mm.
- Knots that are loose, show signs of decay or clustered are defects and cause for rejection.
- Pile straightness is checked with a stringline. A line drawn from the centre of the butt and to the centre of the tip must lie within the body of the pile.
- Pitch streaks that extend through the length of pile is cause for rejection.
- Material may be kiln dried or seasoned, provided that moisture content is no greater than 19%.
- Material is to be incised and pressure treated with 100% creosote, unless it is planking material, in which case it must be treated with Chromate Copper Arsenate.
- Wood must be stored properly, be free of dirt and not allow water to pond. Conditions that allow rapid drying must be avoided.
- Wood must be given three coats of creosote to repair all cuts.

## 23.3 Inspection by the Contractor

The supplier is responsible for the inspection of the material by an independent inspector who is qualified and has a minimum of 10 years of experience. All material must be inspected prior to and after the treatment. All material must be stamped by the inspector identifying the inspection date and that the material meets or exceeds the required specifications. The stamp must be placed at the end of each member at a location that is clearly visible, even when the material is in stockpile.

## 23.4 Acceptance

- All material is subject to inspection by the Inspector prior to usage.
- Where S 1 S 1 E or S4S (sanded 4 sides) size is specified, the material must be not more than 6 mm scant per side.
- When 15% “No. 1” or 15% “No. 2” grade is allowed, this means that 85% must be the specified grade and not more than 5% of the 15% below “No. 1” or 15% “No. 2” grade or there will exist the need for re-inspection.

23.1 Treated strip decking properly stacked on timber dunnage.

23.2 Strip deck partially removed.

23.3 Strip deck replacement ongoing.

23.4 Strip deck replacement ongoing, boards staggered.

23.5 Completed strip deck.

23.6 Treated timber pier cap replacement.

23.7 Treated timber pier cap with splice bearing on treated timber subcap.

# SECTION 24

## SIGN STRUCTURES AND PANELS

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## 24.1 Sign Structures and Panels – General

Sign structures may contain sign panels and, less commonly, permanent electronic message boards. Sign structures are generally of two types: overhead bridge or cantilevered. Cantilevered sign structures have only one foundation pile, whereas overhead bridge sign structures have two foundation piles. Overhead bridge sign structures are used when the length limitation for cantilevered signs has been reached. Sign structure supports consist of tubular columns. Sign structure cantilever arms consist of tubular sections. Overhead bridge sign superstructures are either tubular sections or trusses, often with an access platform.

Sign panels are made of extruded aluminum and are bolted to the sign structure after erection using stainless steel hardware.

Sign structures are founded on drilled cast-in-place concrete pile bases, secured by an anchor rod system.

Sign structures may include illumination.

## 24.2 Safety Considerations

The following safety considerations may exist:

- Sign structure erection involves the use of cranes and other heavy equipment.
- Inspection at heights is required from aerial lifts or platforms.
- Open excavations exist with drilled piles.
- Temporary stabilizing measures must be deemed adequate before traffic is permitted under sign structures with non-tightened anchor rod nuts.

## 24.3 Materials and Fabrication

Sign structures are considered ‘major’ steel components and are inspected during fabrication by the Consultant’s Level III visual welding inspector. Sign structure components are also Non-Destructive Tested (NDT) and are pre-assembled prior to galvanizing and delivery. Prior to accepting sign structure components delivered to site, the Inspector must confirm that the material and testing reports have been accepted by the Project Manager.

Each sign structure must have a unique identification plaque. The Inspector must confirm that the plaque is fabricated and located as shown on Standard Drawing S-1682.

The Inspector must confirm that the materials delivered to the site meet the specified requirements, including:

- Bolting hardware to ASTM A325
- Reinforcing steel to CSAG30.18 Grade 400
- Concrete Class C Type HS or HSb
- Sika 212 grout or equivalent

The Inspector must thoroughly inspect all components for damage to coating or base plate protection that may have occurred during transport, handling and installation. Any damage to the galvanized coating must be metallized.

## 24.4 Construction

### 24.4.1 Foundation

The Inspector must review the requirements of Sections 1, 2, 3, 4, 5 and 6 of the *Standard Specifications for Bridge Construction* and this Manual for related requirements.

The Inspector must confirm that the concrete mix design has been accepted.

The foundation piles must be accurately located by the Contractor’s survey, which is checked by the Inspector. It is important that the location of the piles be located as shown on the Plans. The distance between piles for bridge sign structures must be precise so that the anchor rod assemblies are centred within the piles. The location of the piles relative to the roadway must be accurate to maintain the required distance to the travel lanes, specified as the Clear Zone distance.

Prior to the start of any drilling for foundation piles, the Inspector must confirm that the Contractor has accurately located and managed any utilities in the vicinity of the Work.

The foundation piles are designed by the Contractor. The Inspector must confirm that the pile dimensions and bearing soils are consistent with those shown on the shop drawings.

If the pile hole is extended deeper than shown on the shop drawings, the reinforcing steel cage must be revised accordingly. The pile diameter must be large enough to compensate for any construction tolerances. The reinforcing steel cage must be chaired securely so that it is in the precise location specified.

The pile hole must be dry at the time of concrete placement. The top of the concrete pile foundations must project between 700 mm and 850 mm above the finished grade on the traffic side. The Inspector must determine the final ground height at the pile location and confirm the projection requirements.

Anchor rods are assembled into a single unit for installation. The assemblies are positioned by survey to the locations specified. For bridge sign structures, the actual distance between the column base plates is measured to determine the required positioning of the anchor rod assemblies. Plywood templates may be used to accurately position and secure the assemblies before they are cast into the pile. The Inspector must confirm that the assemblies are correctly located.

Anchor rod projection must be checked by the Inspector. Anchor rod projection must take the grout pad depth into account.

### 24.4.2 Assembly and Erection

No field welding is permitted at any location on the sign structure.

The sign structure is often assembled at the site and erected as a completed unit; however, some large sign structures are assembled in place. It is important that the sections be handled in a manner that prevent bending and twisting of the component sections. The Inspector must confirm that the Contractor’s assembly staging area, lifting slings and equipment are suitable. Sign structures must be erected as soon as they are delivered to site. If they are not erected immediately, they must be stored on dunnage and protected so that they do not suffer damage to the coating or distress to the components.

After the sign structure is erected and prior to panel installation, temporary measures must be employed to maintain the structure's stability until the anchor rod nuts are acceptably tightened. The Inspector must confirm that the Contractor's temporary measures have been accepted by the Project Manager. The Inspector must monitor the use of temporary stabilization measures to confirm that the structure does not pose a risk to public safety.

The proper placement of the grout pad is important to the performance and protection of the structure. The Inspector must review the Contractor's grout placement procedure. The procedure must contain requirements for placement, temperature, extending grout with aggregate and curing. It is important that the Inspector witness the entire grouting operation, and that he confirms that the grout is placed so that it is fully in contact with the underside of the base plate with no air pockets.

Anchor rod nuts are tightened by using the turn of nut method after the grout has achieved the design strength. The Inspector must confirm that all nuts meet the tightening requirements.

### 24.4.3 Sign Panels

The Inspector must review the shop drawings to confirm the location of the sign panels. The Inspector must confirm that the panels meet the specified requirements. Panels are normally installed after the sign structure has been erected. Following panel installation, the Inspector must confirm that all hardware has been acceptably installed and the clearance requirements have been met. The signs must be positioned accurately over the travel lanes and angled towards traffic.

## 24.5 Bridge Inspector's Role

The Inspector must check with the Project Manager to confirm that the following items have been submitted and accepted or confirmed:

- Shop drawings
- Material mill certificates
- Repair procedures for damaged galvanizing
- NDT and visual inspection reports
- Traffic accommodation strategy
- Grouting procedure

The Inspector must confirm the following:

- Bolts and hardware markings meet the specified grades.
- Utilities have been located.
- Accurate lay-out survey has been completed.
- Lighting conduit has been properly installed.
- Identification plaque has been installed.
- Pile concrete placed into a 'dry' hole. Depth of pile is as designed.
- Pile concrete has correct projection and has attained sufficient strength prior to erection of structural components.
- Accurate placement and alignment of anchor rod assembly, including projection and plumbness.
- Base plate corrosion protection has been applied.
- Structure has been set on galvanized shims with 75 mm cover to the edge of the grout.

- Components are stored and handled appropriately. Fabric slings are used.
- Bolts and hardware meet the grades specified.
- Turn of nut method was used to check bolt tightening.
- Grouting was compliant with procedure.
- Panels are at the correct location, orientation and clearance. Correct connection hardware has been used.
- Coating damage has been repaired acceptably.
- Protective traffic measure, if required, were installed correctly.

Government of Alberta ■
Transportation

**Bridge Construction Inspection Manual 2015**
Section 24 – Sign Structure and Panels Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

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| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **General** | | |
| 1.1 | 24.1 | Did the Contractor, prior to design and construction, confirm underground and overhead utility conflicts with the sign bases and support structure and immediately inform the Consultant of any conflicts? | ☐ | |
| **2** | | **Erection** | | |
| 2.1 | 24.2.3 | Was any part of the sign structure damaged in shipping or during erection? | ☐ | |
| 2.2 | 24.2.3 | Was the substructure concrete cured a minimum of three (3) days, and did it achieve 80% of the 28 day specified concrete strength? | ☐ | |
| 2.3 | 24.2.3 | Were all components handled with care, and were any additional supports required to maintain stability until the anchor rod nuts were fully tightened? | ☐ | |
| 2.4 | 24.2.3 | Was the structure set accurately on galvanized shims on top of the concrete foundation, and did shim stacks have 75 mm of cover from the edge of grout pads? | ☐ | |
| 2.5 | 24.2.3 | Were base plates grouted with Sika 212 flowable grout or equivalent with top of the finished grout elevation not higher than the underside of the column base plate?<br>*Note: Dry pack methods of constructing grout pads will not be accepted.* | ☐ | |
| 2.6 | 24.2.3 | Were hand hole bolts coated with anti-seize lubricant? | ☐ | |
| 2.7 | 24.2.3 | Did bolted parts fit solidly together when assembled? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.8 | 24.2.3 | Were contact surfaces free of dirt, grease, burrs, pits and other defects preventing solid seating of the parts? | ☐ | |
| 2.9 | 24.2.3 | Were connections assembled with a hardened washer under the bolt head or nut, whichever is the element turned in tightening and surfaces of bolted parts in contact with the bolt head and nut parallel? | ☐ | |
| 2.10 | 24.2.3 | Were bolts tightened to at least the minimum bolt tension as shown in Section 24.2.3, Table 1, Bolt Tension of the SSBC? | ☐ | |
| 2.11 | 24.2.3 | Were all structural bolts tightened by using turn-of-nut method as outlined in Table 1, Bolt Tension of the SSBC? | ☐ | |
| 2.12 | 24.2.3 | Were enough bolts brought to a “snug tight” condition to ensure that the parts of the joint were brought into full contact with each other? | ☐ | |
| 2.13 | 24.2.3 | Were remainder of bolts placed in holes and brought to snug tight? | ☐ | |
| 2.14 | 24.2.3 | Was additional tightening done based on the specified nut rotation and using a tolerance of 1/6 turn (60 deg) over, nothing under? | ☐ | |
| **3** | | **Foundation** | | |
| | | General – Section 3, Bearing Piles; Section 4, Cast-In-Place Concrete; and Section 5, Reinforcing Steel shall apply. | | |
| 3.1 | 24.2.4 | Did all reinforcing steel conform to CSA G30.18-M92 Grade 400? | ☐ | |
| 3.2 | 24.2.4 | Were anchor rods installed true and plumb in one complete assembly and accurately positioned and secured to prevent movement or displacement during concreting procedures? *Note: No welding of any component is allowed.* | ☐ | |
| 3.3 | 24.2.4 | Where necessary, did top anchor nuts have bevelled washers to ensure full contact with the top of the column base plate? | ☐ | |
| 3.4 | 24.2.4 | After grout attained sufficient strength, were the anchor rod nuts tightened an additional 1/3 turn, past the snug-tight condition? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 3.5 | 24.2.4 | Were all voids, including the slots and annular space around anchor rods in the base plate, filled with an approved corrosion inhibiting paste? | ☐ | |
| 3.6 | 24.2.4 | Were the grout pockets filled and grout pads constructed using Sika 212 flowable grout or approved equivalent? | ☐ | |
| 3.7 | 24.2.4 | Was the grout pocket 25 mm deep and the total grout thickness not less than 75 mm? | ☐ | |
| 3.8 | 24.2.4 | Was the grout packaged in waterproof containers with the production date and shelf life shown, and mixed, placed and cured in strict accordance with the manufacturer's recommendations? | ☐ | |
| 3.9 | 24.2.4 | Was the sign structure erected in a manner that addressed all safety issues, including the interim period between erection grouting and final tightening of anchor rod nuts? | ☐ | |
| 3.10 | 24.2.4 | After erection, did the Contractor place grout pockets and pads and tighten anchor rod nuts as soon as possible after grout achieved sufficient strength? | ☐ | |
| 3.11 | 24.2.4 | Was adequate safe traffic accommodation provided until tightening and grouting was complete? | ☐ | |
| 3.12 | 24.2.4 | When minimum air temperature or substrate concrete in the immediate area of grouting was expected to be below 5°C, did the Contractor employ provisions for grouting in cold weather? | ☐ | |
| **4** | | **Sign Panels** | | |
| 4.1 | 24.3.3 | Did the Contractor erect the sign panels onto the sign structures as shown on the Plans, ensuring that the signs were located correctly over the indicated lanes and that the correct vertical clearance was maintained? | ☐ | |
| 4.2 | 24.3.3 | Did the Contractor provide the T-stiffeners, J-clips, bolts, flat washers, nylon insert lock nuts, slip arresting bolts and all of the necessary hardware to securely assemble the sign and connect the sign panels to the sign structure, as detailed on Alberta Transportation drawing TCS-A4-335A and shown on the accepted shop drawings? | ☐ | |
| 4.3 | 24.3.3 | Was the face of the sign panels cleaned prior to acceptance? | ☐ | |

**Details and Summary:**

Signature

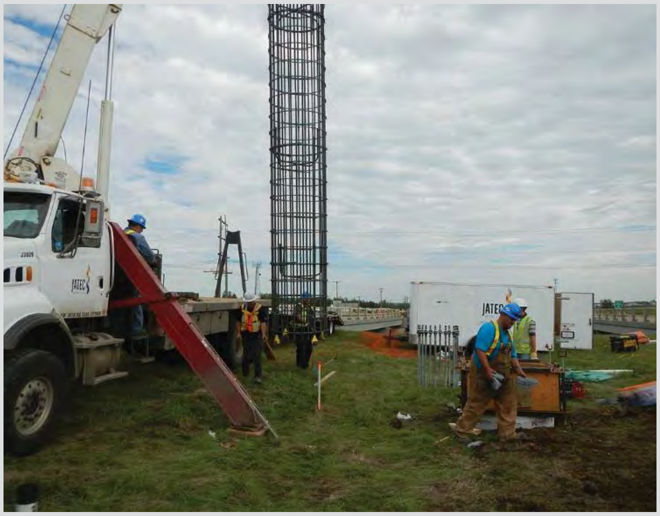
Date

24.1 Drilling foundation pile.


24.2 Checking depth of pile.


24.3 Post tensioned anchor rod assembly. Threaded ends wrapped in poly to maintain cleanliness, and tubes sealed to protect from concrete paste.

24.4 Plastic chairs used to maintain bottom cover and prevent cage form punching into ground at base.



24.5 Installation of plain reinforcing steel cage.

24.6 Anchor rod assembly installed. Angle iron on formwork to hold anchor rod assembly at correct elevation.

24.7 Sign structure base prior to grouting.

24.8 Sign structure erection. Workers tightening bolts to connect horizontal and vertical columns using aerial lifts.

# SECTION 25

# MECHANICALLY STABILIZED EARTH WALLS

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## FIGURES

## 25.1 Mechanically Stabilized Earth Walls – General

Mechanically Stabilized Earth (MSE) walls are gravity-type earth retaining walls. They are commonly used at bridge abutments where headslopes are otherwise constructed. Gravity walls depend on their mass to resist earth pressure. The MSE wall structure consists of compacted lifts of reinforced engineered fill that act together to form a single mass. The fill material is composed of granular backfill that has special properties of strength, drainage and corrosiveness. The soil reinforcement consists of either galvanized steel or geosynthetic material that is placed between lifts of the engineered fill material. The walls typically incorporate a fascia surface that does not resist earth pressure but protects the wall face. This fascia consists of precast concrete panels that are mechanically connected to the soil reinforcement. MSE walls are constructed with a slightly battered near-vertical face.

## 25.2 Safety Considerations

Specific safety hazards that may exist during MSE wall construction include:

- Inhalation of silica dust from crushed aggregate backfill.
- Working in close proximity to earthmoving and compaction equipment.
- Working at heights at wall face.
- Crushing from precast concrete elements.

## 25.3 Special Considerations

MSE type retaining walls are unique. The basic structural components are standardized by the specification, but their details are proprietary. Suppliers of MSE wall components produce wall designs based on the Consultant’s project-specific design parameters and specifications.

MSE walls are:

- Durable and able to achieve a design life of 100 years.
- Generally tolerant of some differential settlements.
- Sensitive to changes in backfill moisture content, requiring adequate drainage systems to prevent hydrostatic pressures from acting on the fascia panels.
- Usually built as single-stage walls where the fascia panels are installed at the same time as backfill and are in direct contact with backfill — these are generally used where long-term settlement is not an issue.
- Occasionally built as two-stage walls where a temporary face is constructed with geosynthetic or wire wrap, and fascia panels are installed after backfilling and after long-term settlement has occurred.

## 25.4 Components

Following is a detailed description of the typical components of the MSE wall, as illustrated in Figure 25-1 and 25-2.

**Engineered Foundation**: The Special Provisions will often require ground improvement measures to the soil beneath the wall. This may include compaction of soils at the bottom of wall elevation, de-watering and drying, or it may include excavation and backfill of native soil below the wall. Foundation improvements must strictly follow the project requirements since these are intended to reduce wall settlement.

**Crushed Aggregate Backfill Material**: This material is specially designed to meet the structural requirements for strength, durability and drainage. This material is placed and compacted in lifts of specific depth since adequate compaction is required to achieve the specified density and strength. Electrochemical properties (pH, resistivity, limits of sulphates, chlorides, organics) are specified to control the corrosiveness of the backfill material so that the soil reinforcement is not prematurely corroded. Backfill material that has higher permeability may be specified for placement immediately behind the fascia panels. This drainage layer usually extends 2 m from the wall face, in plan view as shown in Figure 25-1. The drainage layer material must not have more than 5% of material passing the 80 um sieve size.

**Common Backfill Material**: This is fill material that is placed into the excavation beyond the crushed aggregate backfill material. The common backfill is placed in lifts simultaneously with the crushed aggregate backfill.

**Soil Reinforcement**: Reinforcement is placed horizontally throughout the crushed aggregate backfill. The reinforcement material is placed directly onto a lift of compacted backfill. The length and spacing of reinforcement is specified by the proprietary wall designer. The reinforcement material acts compositely with the backfill, resulting in a wall structure that acts as a gravity unit. The reinforcement may consist of galvanized steel strips or mesh, or geosynthetic polymer grid. The reinforcement is mechanically connected to the precast concrete fascia panels by means of a proprietary system of bolting, clipping or lapping.

**Concrete Levelling Pad**: The levelling pad is not reinforced and is cast onto the prepared excavated surface. It does not act as a bearing footing; rather, it provides a neat surface at design grade from which to set the bottom course of fascia panels. The top surface of the pad is marked with a chalk line before panel erection to maintain horizontal alignment. The panels are placed so that they are centred on the pad.

**Precast Concrete Fascia Panels**: Panels may be produced in a variety of size and shape configurations. Panel faces may be cast with either a smooth form finish or a textured motif finish. Panel edges have a ship-lap detail that provides a gap at the joints yet prevents the exposure of backfill. Joints between the panels are important since they accommodate differential settlements. Mechanical anchorages are cast into the panels, which connect to the soil reinforcement.

**Filter Fabric**: Non-woven geotextile material strips are placed on the backside of panel joints before backfilling. They are attached with a construction adhesive. These strips prevent backfill from spilling out from the face at the joints.

**Inspection Components**: Access ports are located at certain fascia panels. These ports access sacrificial wires that are inspected periodically for corrosion. The load carrying members of an MSE wall are the soil reinforcements, which cannot be inspected once backfilled. The inspection wires are made of the same material and coating as the soil reinforcement. Also, it is necessary to provide an access walkway at the top of the wall to facilitate future bridge inspections.

**Bearing Pads, Spacer Bars, Wedges, Braces, Clamps**: Commonly, fascia panels are placed onto elastomeric pads that separate them from the lower course of panels. Bars and other spacers maintain the panel-to-panel alignment during the panel placement and backfilling operations. Temporary wooden wedges are often used to level panels before they are backfilled. Wooden braces and clamps are also used to maintain the panel-to-panel alignment before they are backfilled.

**Swale and Geomembrane**: It is important that surface water be directed away from the crushed granular backfill area since pressure on the fascia panels will increase as the backfill becomes saturated. Additionally, contaminated water may affect performance of the soil reinforcement. The final grade of the inspection walkway must not direct surface drainage towards the abutment seat. Instead, the walkway must be graded to allow drainage to flow into the swale that is constructed immediately behind the wall coping cap. This swale must direct flow away from the site, and water must not pond at the swale. The wall is protected from the infiltration of surface water by a geomembrane that is placed onto the completed backfill. It is important that the surface onto which the geomembrane is placed is properly graded and that the joints in the geomembrane material are properly lapped, shingled and welded.

**Coping Cap**: The top course of panels is fitted with a cast-in-place concrete coping that serves to direct rainfall away from the top panels. The coping also provides an aesthetic finish. It must be properly detailed with correctly spaced joints and separation from the panels.

**Safety Railings**: The coping is normally fitted with a pedestrian safety rail over its length.

## 25.5 Materials – General

Shop drawings must be submitted by the Contractor and reviewed for acceptability by the Consultant. The shop drawings include a great deal of information that is required during inspection, such as material lists, backfill properties, lay-out plans complete with elevations, dimensions, typical cross-sections, component details, connection details and drainage details. The Inspector must carefully review and understand the content of the shop drawings.

### 25.5.1 Precast Concrete Fascia Panels – Transport and Handling

The panels are fabricated at an off-site facility and generally arrive at site in flat vertical stacks. Large panels are normally transported on edge in horizontal stacks. Panels are separated by dunnage and plastic dimple spacers. Prior to being released by the precast fabrication facility, the Consultant’s fabrication inspector will have accepted the panels for use. Damage to panels may occur during transit and unloading. The Inspector’s responsibilities for panels include:

- Identify the shipments of panels as they arrive and confirm that the Consultant’s fabrication inspector has accepted the panels prior to shipment. Panels are indelibly marked with identification numbers.
- Confirm that panel shipments are immediately stored in an acceptable manner. Panels must be separated from each other by suitable dunnage. If wooden dunnage is in direct contact with panel faces, this may result in permanent staining. Panels must be covered to protect the faces from contamination and staining from the elements. Panel stacks must be placed on level ground supported by timber blocking.
- As panels are separated for installation, visually inspect each unit for physical damage, including cracks, broken corners, broken edges, scrapes or other damage to the face, an excess of surface cavities, contamination by road spray or form release oil, dunnage marks or staining, damage to embedded hardware and any other damage that has occurred during transport and handling.

### 25.5.2 Soil Reinforcement

Reinforcement is fabricated at an off-site facility and generally arrives at site in wrapped bundles or rolls. Prior to being released by the precast fabrication facility, the Consultant’s fabrication inspector will have accepted the reinforcement for use. Damage may have occurred during transit and unloading. The Inspector's responsibilities for reinforcement include the following:

- Steel reinforcement fabrication and coating requirements are identified in ASTM Standards, referenced by the specifications. The Inspector must identify the shipments by their documentation and tags, and confirm that the Consultant's fabrication inspector has accepted the materials prior to shipment. The Inspector must track the type, length, gauge and other identification of the shipment upon its arrival.
- Geosynthetic reinforcing must meet the material test methods specified and must contain ultraviolet exposure mitigants. The Inspector must identify the shipments by their documentation and tags, and confirm that the Consultant's fabrication inspector has accepted the materials prior to shipment. The Inspector must track the type, length and other identification of the shipment upon its arrival.
- All reinforcement must be stored above ground and must be adequately covered to protect it from the elements.
- As reinforcement is separated for installation, visually inspect each unit for physical damage including kinks, bends, tears, breaks, broken welds, coating loss, road spray, or other damage that may have occurred during transport and handling.

### 25.5.3 Crushed Aggregate Backfill

Crushed aggregate backfill material must meet the specified requirements for gradation. For some wall designs, there may exist two soil zones. The drainage layer soil zone adjacent to the panels must specifically not contain an excess of fines. Before the commencement of any backfilling, the Inspector must:

- Review the Contractor's submitted sieve analysis to confirm that the testing is current and that the gradation requirements are met for all granular backfill types.
- Confirm that the Contractor has retained the services of a qualified and licensed testing firm.
- Confirm that the Contractor's methods of stockpiling and handling include precautions that will minimize material segregation.

Crushed aggregate backfill material must also strictly meet the specified electrochemical parameter limits. These include resistivity, pH, limits of chlorides, sulphates, organics and site temperature. Before the commencement of any backfilling, the Inspector must:

- Confirm that the electrochemical tests were performed by a qualified and licensed testing firm.
- Confirm that the electrochemical parameters meet the specified requirements.

## 25.6 Construction – General

The Contractor must utilize a construction crew that is knowledgeable and experienced in MSE construction. Well in advance of wall construction, the Inspector must request that the Contractor produce details of related project experience for his superintendent and crew.

Before the start of construction, the Inspector must confirm that no conflicts exist between the Plans and the shop drawings.

### 25.6.1 Ground Improvements

Requirements for site preparation are generally specified in the Special Provisions. The Inspector must confirm that the Contractor:

- Locates and identifies all underground utilities and structures in the vicinity of the construction site before starting excavation. These locations must be identified throughout the duration of construction.
- Excavate the site to the plan elevation and proof roll the subgrade to identify soft, yielding, unstable, loose, wet or otherwise unsuitable foundation conditions. The Inspector must contact the Project Manager to discuss the observed conditions, who will then advise regarding additional measures of sub-excavation and backfill or contact the project geotechnical engineer if required.

### 25.6.2 Levelling Pad

Once the ground has been prepared, the pad is cast with Class C concrete and cured for 72 hours. The pad is not a structural component of the wall; however, it is important because it sets the horizontal and vertical alignment of the wall.

### 25.6.3 Fascia Panel Installation and Wall Erection

Following are typical construction sequences and details:

- Panel joints are generally staggered between horizontal courses. However, in some cases, a continuous vertical joint (often called a slip joint) is constructed full-height. Generally, corner panels have a continuous vertical joint over the full height of the wall.
- Panels are placed in horizontal courses, with backfill placed against the lower course before the subsequent course is placed. The first course of panels is placed onto the levelling pad. Shimming is done as necessary until the panels are level along the longitudinal direction of the levelling pad. The first course is secured by external braces or struts, which are anchored to the ground at the front face of the panel.
- Construction adhesive is applied to the panels to secure filter fabric at the joints between panels.
- Drainage structures are placed, as specified, with ends of drains temporarily plugged or otherwise protected.
- Backfill is placed and compacted in 150 mm lifts of loose material to the level of the first row of reinforcement connections at the first course of panels. The compacted backfill is not placed directly against the first course of panels because the panels are not yet connected to any soil reinforcement and backfilling against the panels would force them off of the levelling pad. Instead, a temporary void is left between the backfill and the panels.
- Soil reinforcement is placed onto the compacted fill and mechanically secured to the first row of fascia panels. Further backfill lifts and reinforcement are placed until the panels are backfilled and reinforced up to the level of their top reinforcement anchors. Since the bottom layer of reinforcement is now backfilled and panels are secured, the void between the panel and previously placed backfill can now be filled. At this juncture, the Inspector must confirm that the design batter of the lower course of panels is correct.
- A second course of panels is then placed. These upper-course panels are temporarily clamped to the lower-course panels at the panel corners so that the adjacent panel faces do not become offset.
- The above process is repeated, and with the completion of backfill for each course, the wooden alignment wedges are removed. The Inspector must confirm that the design batter, joint width, adjacent panel offset and levelness of panels in the longitudinal direction are acceptable. The Inspector must also confirm that no panels were cracked, spalled, scraped or otherwise damaged during construction. Panels deemed unacceptable must be replaced.

- Prior to casting the coping, the Inspector must again review the entire wall alignment, panel offset, panel joints and panel condition to confirm that the project requirements have been met.

### 25.6.4 Placement and Testing of Crushed Aggregate Backfill

Proper backfilling procedures are important to the performance and aesthetics of the wall. Most problems encountered in MSE wall construction relate to improper backfilling procedures. The Inspector must confirm that:

- Backfill is placed neatly to the level of the panel connection anchors. No depressions or loose material may exist on the prepared surface. Reinforcing steel must bear evenly onto compacted backfill for its entire length.
- Lift thicknesses are carefully monitored so that they do not exceed 150 mm after compaction.
- Backfill materials are not segregated. After each lift is compacted, the Inspector must review the surface and identify any areas where rock pockets or other segregation exists. The Contractor must remove and replace segregated backfill.
- Backfill material stockpiles are protected from freezing and not placed onto a frozen subgrade. The Inspector must regularly monitor the temperature of stockpiles and compacted backfill surfaces using a calibrated laser thermometer. Care must be taken to obtain accurate readings within the stockpiles and not just at the surface of stockpiles.
- Water that is added to backfill to achieve the desired moisture content for compaction must be clean, potable and may not contain contaminants like chlorides or sulphates.
- Backfill density testing is done using the Alberta Transportation Test Method ATT-58A “Density Test-Control Strip Method”. Section 2, Backfill of this Manual provides guidance in using this method. The Contractor must remove and replace any material found to be noncompliant.
- Backfill testing for electrochemical properties must be done by a certified tester at the frequency specified. The Inspector must be aware of the required testing frequency and monitor the volume of material placed to confirm that the required testing frequency is performed.
- Backfill compaction equipment must not operate directly over soil reinforcement and must only travel in the direction parallel to the wall panels. It is important that backfill equipment be restricted to hand-operated tampers when within 1 m of the panels.
- At the end of each day of production, the backfill must be left in a compacted state and be backsloped slightly so that any rainwater is directed away from the panels. The site must be graded so that surface water is not introduced into the backfill area.

### 25.6.5 Placement of Soil Reinforcement

Steel soil reinforcement must be carefully separated from shipment bundles.

Prior to installation of reinforcement for each backfill lift, the Inspector must confirm that the reinforcement length, type, gauge, etc., match the requirements of the shop drawings.

Reinforcement around obstructions, such as foundation piles, may only be skewed from the normal orientation if accepted by the Project Manager.

Soil reinforcement must be engaged with the panels prior to backfilling in accordance with the manufacturer’s design. Polymer reinforcement must be tensioned before placing backfill overtop.

#### 25.6.6 Drainage

Subsurface drains and their locations are important to wall performance and must not be crushed or blocked during construction.

Wall drain outlet locations must be suitably marked.

#### 25.6.7 Geomembrane

It is important that the geomembrane is not breached, that all laps and splices be properly constructed and that drainage is away from the wall.

## 25.7 Construction Records

### 25.7.1 Final Shop Drawings

At the completion of construction, the Contractor must submit to the Consultant a final set of shop drawings that incorporate all as-built conditions. As-built changes that need to be identified on the final shop-drawings include, but are not limited to:

- Revised location of adjacent utilities.
- Change to ground improvement procedures based on geotechnical recommendations.
- Changes to any wall elevations or locations.
- Identification of all fascia panels that have been damaged, including cracks, broken edges or corners and other mechanical damage. Identification of repair procedure used.
- Identification of any fascia panels that are measured to be out of tolerance, including flatness, overall vertical alignment, adjacent panel offset and joint width.

### 25.7.2 Supplier's Construction Inspection Records

#### 25.7.2.1 Qualifications and Duties of On-Site Personnel

The MSE wall supplier must provide a full-time representative during all construction activities. The representative must be sufficiently qualified to advise the Contractor in all aspects related to the construction and must have a thorough understanding of the ground improvement requirements, material inventories, shop drawing details, hardware assembly details and material quality requirements. The representative must report directly to the Contractor's MSE wall supervisor. The Contractor's MSE wall supervisor must be experienced in constructing MSE walls.

The Inspector must maintain appropriate lines of communication with both the Contractor's supervisor and the supplier's representative.

The supplier's representative must provide the Inspector with a weekly summary report detailing the construction activities and confirming their compliance. The report must be sufficiently detailed to show the exact components that were constructed during the past week, which components are presently noncompliant, and where re-work, repair or other remedial action was necessary to achieve compliance. The Inspector must, on a weekly basis, review the supplier's report and obtain clarification where needed. The Inspector must notify the Contractor immediately if it is determined that the supplier's representative does not adequately understand aspects of the construction, is not sufficiently present or if he otherwise fails to perform his duties.

#### 25.7.2.2 Hold Points and Engineering Documentation

The Contractor must provide an engineered report at the completion of specific construction phases or hold-points. The Contractor may not proceed with subsequent phases of the work until the reports have been received and accepted by the Project Manager or the Inspector. These hold points include:

- **Foundation base preparation**: This report confirms that the foundation has been inspected by a qualified Engineer and that the conditions meet the designer's requirements. Casting of the levelling pad may not proceed until this report is accepted by the Project Manager.
- **On-site delivery of components**: This report confirms that all materials delivered to site meet all requirements. Materials not referenced in the report are not to be incorporated into the Work.
- **Alignment of precast wall panels**: After final completion of the wall, the Contractor must perform a final check at the face of the wall to confirm that all fascia parameters meet the specified tolerances. These results are provided in a report and will also be used to complete the Contractor's as-built shop drawings. Casting of the coping cap may not proceed until this report is accepted.
- **Backfill requirements**: This includes specifications for backfill materials and a summary of density and electrochemical test results. This is a weekly reporting process by the supplier's representative.

### 25.7.3 Identification of Corrective Action

Corrective action, when required, must be identified at regular intervals during construction. It is not acceptable for the Contractor to delay inspection and reporting. If the identification of noncompliant conditions is identified at a late stage, significant removal and reconstruction may be required. This may create project delays due to re-work and re-ordering of materials. The Inspector must review the Contractor's reports and measure the Work on an ongoing and continuous basis.

## 25.8 Inspector's Tools

It is important that the Inspector possess and maintain the tools necessary to carry out his work. These include:

- 3 m aluminum straight-edge used for checking wall alignment
- 1 m carpenter's level used for checking panel-to-panel offset and levelness of panel tops
- Gap gauge or jig to measure joint width

**Government of Alberta ■**
Transportation

**Bridge Construction Inspection Manual 2015**
Section 25 – Mechanically Stabilized Earth Walls Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No:

Inspector:

Stage of Activity:
Element:

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| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **Material Delivery and Storage** | | |
| 1.1 | 25.3.5 | Did the backfill material conform to the requirements listed in Section 25.3.5 of the SSBC for gradation and according to reinforcement type used? | ☐ | |
| 1.2 | 25.5.10 | Was material stored safely and uniformly? | ☐ | |
| 1.3 | 25.5.10 | Was soil reinforcement stored above ground? | ☐ | |
| 1.4 | 25.5.10 | Were panels stored in a manner to prevent avoid staining of the panel face? | ☐ | |
| **2** | | **Wall Construction** | | |
| | | Did the Contractor employ qualified personnel experienced in constructing MSE walls to supervise and perform the work? Did the Contractor require the MSE wall supplier to provide a full time representative on site during construction? | ☐ | |
| 2.1 | 25.5.3 | Was the MSE wall area excavated (if required) to the proper elevation as shown on design and shop drawings? | ☐ | |
| 2.2 | 25.5.3 | Was the area proof rolled after excavation and backfill to locate weak soils? | ☐ | |
| 2.3 | 25.5.3 | Was all soft or unsuitable material compacted or removed and replaced? | ☐ | |
| 2.4 | 25.5.4 | Were the levelling pad elevations set by instrument? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.5 | 25.2.4 | Did the levelling pad project 75 mm minimum beyond either side of the precast concrete fascia panels? | ☐ | |
| 2.6 | 25.5.5 | Was wall backfill compaction performed in such a manner that equipment ran parallel to the wall panels, moving away from the precast fascia panels to the end of the soil reinforcement? | ☐ | |
| 2.7 | 25.5.5 | Was only hand operated compaction equipment used within 1000 mm of the fascia panels? | ☐ | |
| 2.8 | 25.5.5 | Was proper compaction testing of the backfill material done (1 test per lift or every 45 m of wall)? | ☐ | |
| 2.9 | 25.5.5 | Was the back fill material placed and compacted in 150 mm loose lifts? | ☐ | |
| 2.10 | 25.5.5 | Was equipment kept off the soil reinforcement until a minimum of 150 mm of soil was placed? | ☐ | |
| 2.11 | 25.2.4 | Was the soil reinforcement in the proper alignment (not exceeding 20° splay angle)? | ☐ | |
| 2.12 | 25.5.5 | Were panel vertical and horizontal alignments checked periodically and adjusted as needed? | ☐ | |
| 2.13 | 25.2.4 | Was the 300 mm wide filter fabric adhered to the back side of panels on both vertical and horizontal joints? | ☐ | |
| 2.14 | 25.2.4 | Was the wall battered at 50:1? | ☐ | |
| 2.15 | 25.2.5 | Were inspection wires installed at the locations shown on the drawings? | ☐ | |
| 2.16 | 25.2.5 | Were inspection access holes in the panels patched with the appropriate product? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.17 | 25.2.5 | Was a survey target anchored into the patching material flush with the wall? | ☐ | |
| 2.18 | 25.5.7 | Was closed cell foam used to isolate concrete coping from other concrete components? | ☐ | |

**Details and Summary:**

Signature

Date

25.1 Ground improvement excavation. Soil was removed since it was not competent.

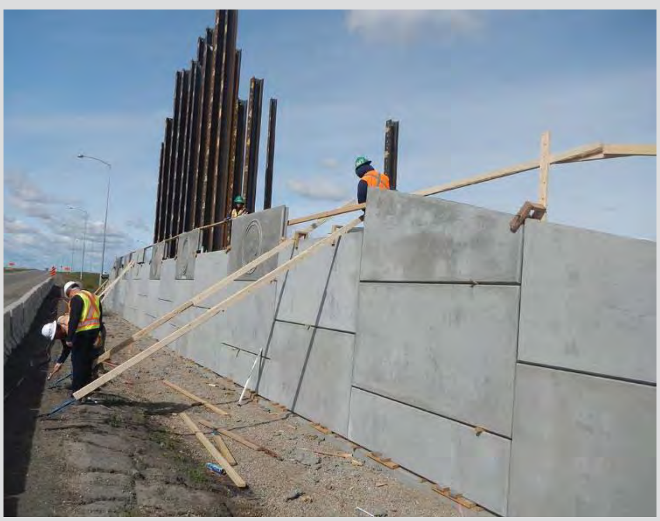
25.2 Ground improvement excavation. Soil was removed since it was not competent.

25.3 Levelling pad poured.

25.4 Installation of first row of precast panels on the levelling pad.

25.5 Installation of first course of panels.

25.6 Installation of soil reinforcement.



25.7 Panels set at batter. Turnbuckle on bracing used to set batter. Panels clamped together at edges to maintain alignment.

25.8 Hydraulic excavator pushing backfill material over soil reinforcement.


25.9 Hydraulic excavator pushing backfill material over soil reinforcement.

25.10 Wooden wedges used to engage panels. Filter fabric placed over panel joints to prevent loss of material through gaps.

25.11 Two types of backfill material placed. Drainage layer backfill material placed within 1.5m of back face of wall.

25.12 Adjustment of wall batter using turnbuckles.

25.13 Two stage wall construction.

25.14 Two stage wall construction. Backfilling against wire wall. Fascia panels not in contact with fill.

25.15 Checking wall batter and panel alignment with digital level and 3.0 m straight edge.

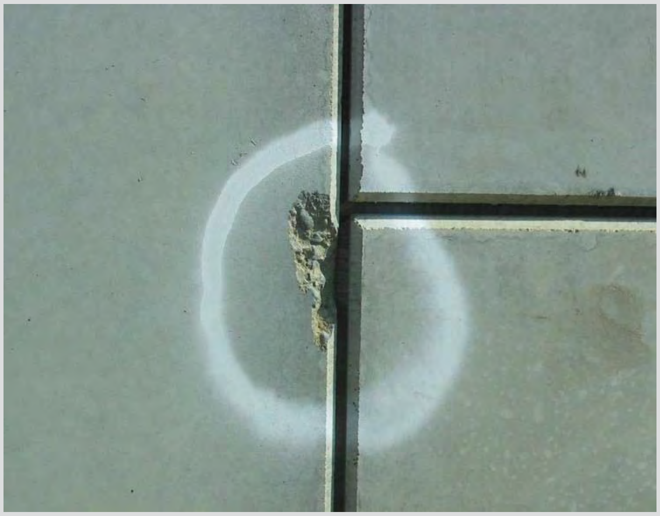
25.16 Completed backfilling and panel installation. Panels require cleaning prior to application of pigmented sealer.

25.17 Pigmented sealer application.

25.18 Cast-in-place coping cap.

25.19 Panel damaged during erection.

25.20 Panel damaged during erection.



25.21 Panel damaged during erection.

25.22 Poor handling of soil reinforcement. Fabric slings and spreader bar should be used.

25.23 Damaged soil reinforcement.


25.24 Correct handling using spreader bar.

25.25 Storage of fascia panels onsite. Panels should be stacked neatly with blocking between panels.

25.26 Soil reinforcement stored on timber blocks. Colour system used to identify reinforcement gauge.

25.27 Wire wall completed at two stage wall.

25.28 Installation of 2nd stage panels after settlement has occurred at Stage 1.

25.29 Installation of 2nd stage panels.

25.30 Space between 1st and 2nd stage. Panel anchorages shown.

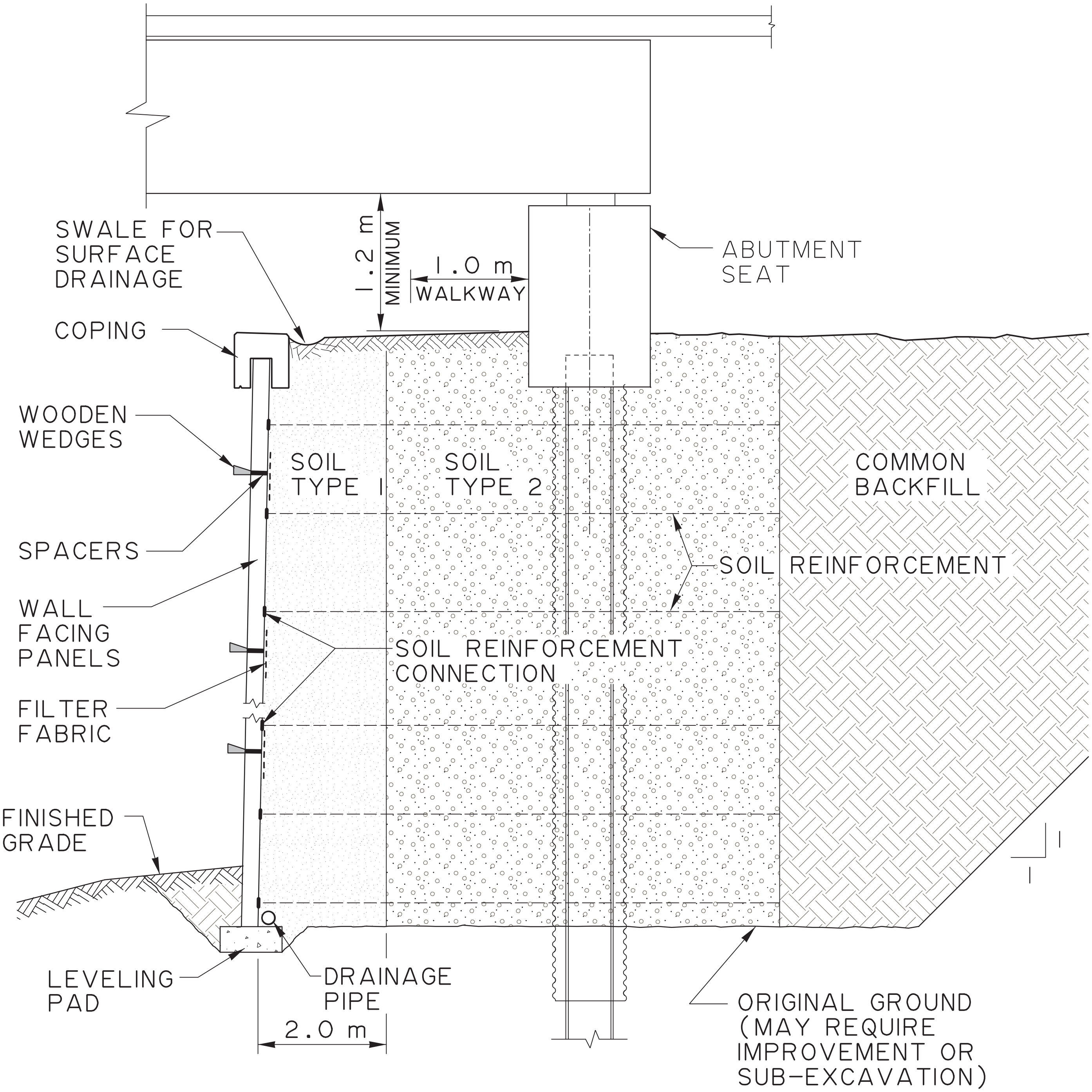



FIGURE 25-1

SOIL TYPE 1 – GENERALLY DES 2 CLASS 25 WITH < 5% PASSING THE 80µm SIEVE SIZE

SOIL TYPE 2 – GENERALLY DES 2 CLASS 25 OR DES 2 CLASS 40

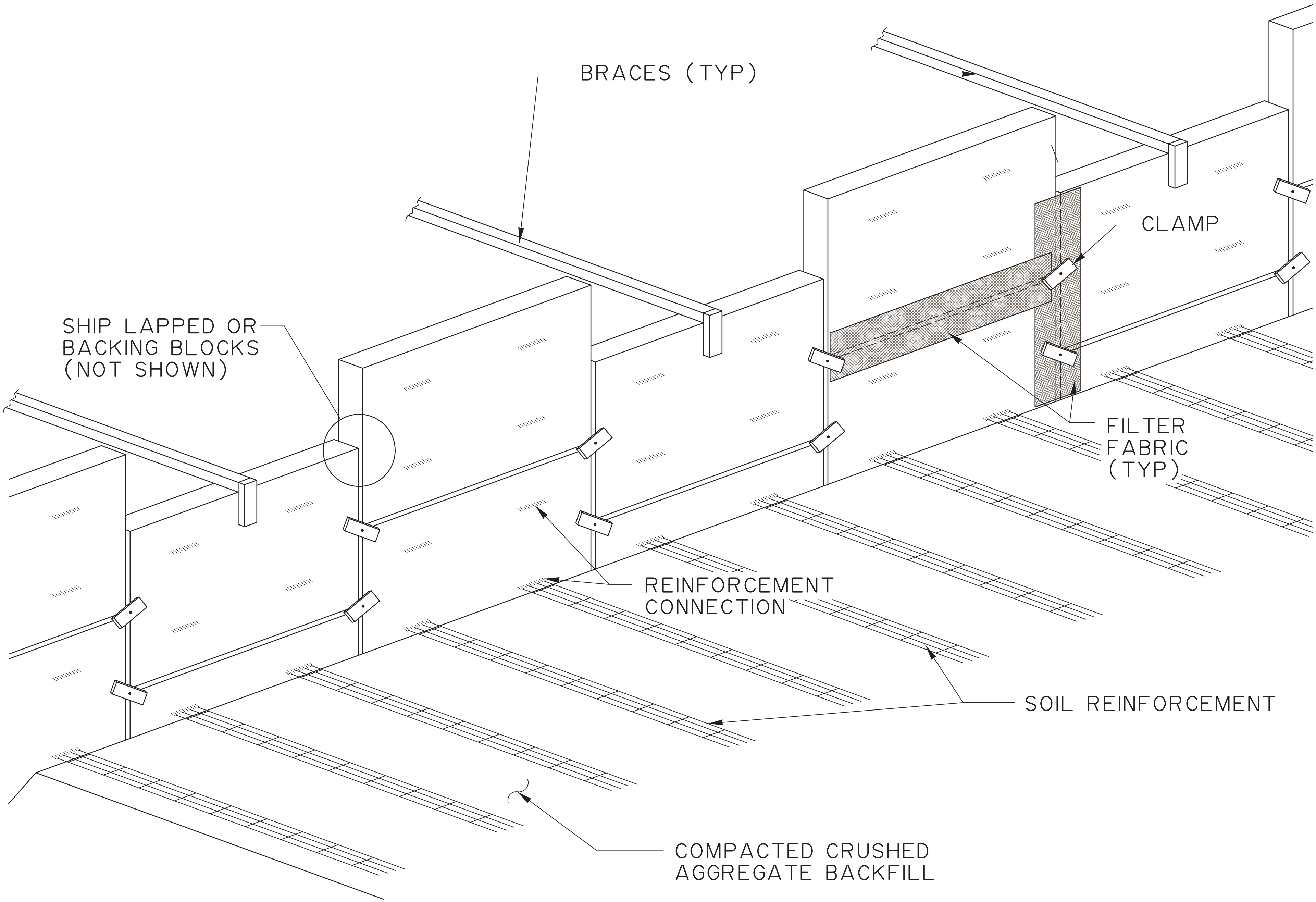

BRACES (TYP)
CLAMP
SHIP LAPPED OR BACKING BLOCKS (NOT SHOWN)
FILTER FABRIC (TYP)
REINFORCEMENT CONNECTION
SOIL REINFORCEMENT
COMPACTED CRUSHED AGGREGATE BACKFILL

FIGURE 25-2

# SECTION 26

## RCP AND PBC STRUCTURES

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## 26.1 RCP and PBC Structures – General

Reinforced Concrete Pipe (RCP) and Precast Box Culverts (PBC) can be used as bridge culverts instead of CSP and SPCSP structures. RCP and PBC normally are used where the typical life expectancy of 50 years for CSP and SPCSP needs to be increased, where quality granular backfill materials are not as readily available, or where geotechnical site conditions warrant their usage. The manufacturing, transportation and installation costs for RCP and PCB may be higher than for CSP and SPCSP.

Precast RCP and PBC units are considered ‘rigid’ in that they are less dependent on the backfill properties as compared to ‘flexible’ metal CSP and SPCSP pipes. Like CSP and SPCSP pipes, RCP and PBC also depend on soil-pipe interaction, but the majority of their soil-pipe structure is contained within the pipe itself.

RCP and PBC units are joined to provide water-tightness and soil-tightness with the ability to accommodate some lateral and longitudinal movements. The connection joint for RCP between adjacent mating units consists of a bell at one end and a spigot on the other, whereas PBC units utilize rubber gaskets or coil sealants. Several possible details for joint sealants and gaskets exist.

## 26.2 Environmental Considerations

The environmental considerations are identical to those identified in Sections 1, 2 and 18.

## 26.3 Safety Considerations

In addition to the requirements stated in Sections 1, 2 and 18, the following must be considered:

- Precast units may roll and crush if adequate precautions are not taken to mitigate this hazard.
- Heavy equipment, including cranes, earthmoving equipment and compaction equipment, creates a hazard in the confined area of the trench.

## 26.4 Supply and Manufacture

RCP and PBC units are produced in standard cross-sectional shapes and for standard loading classifications. Culverts may be installed into open-cut excavations and subsequently backfilled, or they may be jacked into place by trenchless methods. Individual units are typically precast by either of the following methods:

- batched using a dry mix zero-slump concrete, which is vibrated and then the forms are immediately removed
- batched using self-consolidating concrete, which is not vibrated and the unit is left in the forms until stripping strength is attained

The *Standard Specifications for Bridge Construction* reference various technical specifications and standards that must be followed in the design and manufacture of units:

- Prior to the start of production, the Consultant’s fabrication inspector must confirm with the Project Manager that the Contractor’s supplier is certified under the Ontario Concrete Pipe Association prequalification program. This is a third-party certification program that audits the production process.

- Prior to the start of production, the Consultant's fabrication inspector must confirm with the Project Manager that all shop drawings and design reports for concrete, reinforcing steel and gaskets have been submitted and acceptably reviewed.

### 26.4.1 Shop Inspection and Site Inspection

Upon receipt of 72 hours' notice, the Consultant's fabrication inspector must conduct quality inspections of the units. Prior to the transport of units from the fabrication facility, the Consultant's fabrication inspector will confirm with the Project Manager that no outstanding deficiencies exist.

Upon delivery to the site, the Inspector must perform a thorough review of all units for the purpose of identifying cracks. All cracks 0.2 mm in width or less should have been previously identified at the shop; however, any additional cracks of this width need to be documented at the site. The Inspector must also identify all cracks that are greater than 0.2 mm. No units may be installed that have cracks 0.2 mm in width or greater until the appropriate actions have been determined by the Project Manager and implemented by the Contractor.

During transport and handling, the bell and spigot ends of units are susceptible to chips and spalls. The Inspector must monitor unloading and stockpiling to confirm that the Contractor handles the units in a manner that will not result in damage. If damage does occur, the Inspector must review the referenced Standards and the Special Provisions and obtain the advice of the Project Manager.

The Inspector must perform a thorough check of the ends of each unit. It is imperative that the bell and spigot ends for RCP units make a satisfactory joint. Roughness, honeycomb, form bleeding voids, chips, formline fins and cracks all may impede the performance of a joint.

## 26.5 Installation

The referenced CAN/CSA S6 Bridge Design Code requires that the Inspector be experienced in the work of soil installations for buried concrete structures. Inspection records must include details of foundation conditions, bedding installation, soil identification and control, and compaction.

### 26.5.1 Excavation

The excavation requirements are similar to those for CSP and SPCSP culverts. The requirements of Section 1 and Section 18 of this Manual must be reviewed by the Inspector.

### 26.5.2 Bed preparation

The provision of a competent bed is very important for RCP and PCB culverts. The undisturbed in-situ soil beneath the bedding layer must provide uniform support, consisting of moderately firm to hard soil or stabilized soil. No rock or hard-points may exist immediately below the bed material. Rigid RCP and PCB culverts are sensitive to local variations in the capacity of the bed and consequent stresses must be taken up in the joints. These stresses may cause breaking of the bell or spigot, joint leaking or joint faulting between adjacent units. These deficiencies are very difficult to correct after the culvert has been backfilled and is in service.

The installation of RPC and PCB must be done in accordance with CAN/CSA S6 Bridge Design Code and other technical Standards referenced in the *Standard Specifications for Bridge Construction*. The Inspector must be knowledgeable of the content of the referenced documents in advance of the Work.

The Inspector must be knowledgeable of the specific requirements for foundation preparation and acceptance. The Inspector must notify the Project Manager of the schedule for the completion of excavation so that the Project Manager and his geotechnical engineer can be available for consultation when required.

The installation of bedding material must follow the requirements shown in the *Standard Specification for Bridge Construction* Figure 3 'Standard Trench Installations' and Figure 7.11 'Standard Installations for Concrete Box Sections in Trenches' for RCP and PCB, respectively. These figures supersede the dimensions and details of Standard Drawing S-1418, but otherwise the requirements of S-1418 apply, including the need to pre-shape the bed and to construct clay seals.

### 26.5.3 Placement of Units

The Inspector must not permit the placement of units until the excavation, foundation condition preparation and bedding suitability has been inspected and accepted.

Prior to the start of installation of the units, the Inspector must confirm with the Project Manager that the manufacturer's recommended installation methods have been received and accepted.

The Contractor must carefully control the line and grade during the installation of all units.

The construction of 'bell holes' beneath each RCP connection is required when installing a pipe with expanded bells, as described in the Standards and CAN/CSA S6 Code referenced in the *Standard Specification for Bridge Construction*. It is important that the pipe is supported by the barrel and not the bells. The Inspector must be knowledgeable of the specific requirements in the referenced Standards and Special Provisions that apply to the Work.

The Inspector must carefully monitor the installation of each unit. If a unit is out of alignment, it must be completely disconnected, the alignment corrected by adjustment to the bedding and then re-installed. The Inspector must immediately identify units that are out-of-alignment as the work progresses and not after the problem is compounded when a further number of units have been installed. The use of external force must never be permitted during the installation of units.

The Inspector must confirm that the Contractor is only using lifting hardware, clutches and slings that are approved by the manufacturer. These details must be confirmed in advance of any scheduled installation.

The Inspector must confirm that the Contractor is using gasket materials and installation procedures that are approved by the manufacturer and that meet the requirements of the referenced technical Standards. Gasket materials are sensitive to heat, moisture, light and contamination. It is important to properly install gaskets so that the units are adequately sealed at their joints.

### 26.5.4 Backfilling – General

Backfilling requirements are similar to those for CSP and SPCSP culverts. The requirements of Section 2 and Section 18 of this Manual and Standard Drawing S-1418 must be reviewed by the Inspector and discussed with the Contractor prior to the start of Work.

The Inspector must confirm that a qualified tester employed by the Contractor is performing density tests during the backfilling operation.

During backfilling operations, the measurement of rise and span is not necessary; however, the invert profile needs to be carefully surveyed by the Contractor and checked by the Inspector. Any misaligned or faulted joints must be identified and corrected before any backfilling takes place.

Trench width must be sufficient to permit proper compaction and temporary drainage systems.

Construction loads imposed on the installed structure must not exceed the design loads of the structure. The Inspector must obtain the advice of the Project Manager if he suspects that the structure may be exposed to damaging loads during construction.

#### 26.5.4.1 RCP

Backfill materials do not follow the gradations shown in Section 2 of the *Standard Specification for Bridge Construction*. Instead, backfill criteria is specified on the Plans and Special Provisions. Backfill criteria and required density are specified as Installation Type 1, 2, 3 or 4. Figure 3 'Standard Trench Installations' in Section 26 of the Standard Specifications for Bridge Construction illustrates dimensional requirements.

The backfill material properties are classified into Category I, II, III or IV.

The Inspector must confirm with the Project Manager that the proposed backfill material for each Category to be used has been accepted and the Contractor's sampling and testing results have been submitted and accepted.

#### 26.5.4.2 PBC

Backfill materials do not follow the gradations shown in Section 2 of the *Standard Specification for Bridge Construction*. Instead, backfill criteria is specified on the Plans and Special Provisions. Backfill dimensions and required density are specified as Installation Type B1 or B2. Figure 7.11 'Standard Installations for Concrete Box Sections in Trenches' in section 26 of the Standard Specifications for Bridge Construction illustrates dimensional requirements.

The backfill material properties are classified into Soil Group I, II or III.

The Inspector must confirm with the Project Manager that the proposed material source for each Soil Group to be used has been accepted and that the Contractor's sampling and testing results have been submitted and accepted.

#### 26.5.4.3 Post-Backfill Inspection

The Inspector must conduct a post-backfill inspection of the interior of the culvert after all backfill has been placed and before flow is diverted into the culvert. The Inspector must confirm that all seals are functional and that the joints are not faulted. The culvert profile must be surveyed to confirm that it matches the design profile. The Inspector must visually inspect all interior surfaces for cracks that may have developed during installation and backfilling, particularly at the crown and invert.

Government of Alberta ■
Transportation

**Bridge Construction Inspection Manual 2015**
Section 26 – RCP and PBC Structures Check Sheet

Project Name:

Date:
Time:
Project No.:

Bridge File No: Inspector:
Stage of Activity:
Element:

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| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| **1** | | **Identification** | | |
| 1.1 | 26.2.5.1 | Pipe – Were all pipes supplied marked in accordance with ASTM 1417M standards:<br>• Was the pipe designation indicated as follows: Di, T, H, where<br>  o Di = designated pipe nominal inside diameter, mm<br>  o T = type<br>  o H = minimum-maximum fill height, m<br>• The date of manufacture<br>• The manufacture's name or trademark<br>• The plant identification<br>*Note: For pipe with elliptical reinforcement or otherwise requiring special placement, appropriate marking to indicate the correct installed orientation.* | ☐ | |
| 1.2 | 26.2.5.2 | Box Sections – Were all boxes supplied marked in accordance with ASTM 1433M standards:<br>• The box designation was indicated as follows: S, R, H, where<br>  o S = designated box section span, mm<br>  o R = designated section rise, mm<br>  o H = minimum-maximum fill height, m<br>• The date of manufacture<br>• The manufacture's name or trademark<br>• The plant identification (Box Id)<br>*Note: One end of each box section designed to be installed with the top slab up must be legibly marked during the process of manufacturing or immediately thereafter on the inside and outside of the top slab, or must have the top identified by the location of one or more lift holes or devices.* | ☐ | |
| 1.3 | 26.2.6.3 | Crack Identification/Repairs – Were any cracks equal to or less than 0.2 mm in width, considered minor, documented on the inspection report? | ☐ | |
| 1.4 | 26.2.6.3 | Were any cracks greater than 0.2 mm and less 0.3 mm in width assessed by the manufacturer, and was a repair or replacement strategy developed and submitted to the Department and Consultant | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| | | for review and acceptance prior to the commencement of the repair or replacement work? | | |
| 1.5 | 26.2.6.3 | Were any sections with cracks 0.3 mm in width or greater identified for rejection? | ☐ | |
| 1.6 | 26.2.7 | Did stockpiled materials meet the specified requirements at the time they were to be used? | ☐ | |
| 1.7 | 26.2.7 | Was RCP stockpiled at ground height? | ☐ | |
| 1.8 | 26.2.8 | Were all RCP and PBC material handled carefully to prevent damage, and were rubber gaskets kept at room temperature prior to installation? | ☐ | |
| **2** | | **Installation** | | |
| 2.1 | 26.3 | Did the Contractor submit documentation of lifting procedures for the Consultant's review two (2) weeks prior to installation of RCP or PBC? | ☐ | |
| 2.2 | 26.3.1 | Was excavation done to the lines and grades as shown on the drawings or as determined by the Consultant, and in accordance with the appropriate sections of Section 1, Excavation of the Standard Specifications for Bridge Construction? | ☐ | |
| 2.3 | 26.3.2.1 | Reinforced Concrete Pipe – Did the excavation and backfill requirements follow Section 26.3.2.1, Figure 3, standard trench installations in the SSBC? | | |
| 2.4 | 26.3.2.1 | Did the bedding and haunch criteria for reinforced concrete pipe follow one of the bedding types, based on the Consultant's design and as shown in the chart in Section 26.3.2.1 of the SSBC? | ☐ | |
| 2.5 | 26.3.2.1 | Did the categories of soil for haunch and bedding material follow the Table shown in Section 26.3.2.1 of the SSBC? | ☐ | |
| 2.6 | 26.3.2.1 | Was the fill material below the bottom of the pipe invert compacted by the Contractor to a minimum of 95% of Standard Proctor Density at optimum moisture content up to the bedding material? | ☐ | |
| 2.7 | 26.3.2.1 | Was the bedding material placed in a loose, uncompacted state under the middle third of the pipe? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.8 | 26.3.2.1 | Did the haunch material extend only to the 'springline' of the pipe? | ☐ | |
| 2.9 | 26.3.2.1 | Was the material in the overflow zone, from the springline of the pipe to the road surface, clean and void of rocks and sharp objects? | ☐ | |
| 2.10 | 26.3.2.2 | Precast Box Culvert – Did the excavation and backfill requirements follow Section 26.3.2.2, Figure 7.11, Standard Installations for Concrete Box Sections in Trenches in the SSBC? | ☐ | |
| 2.11 | 26.3.2.2 | Did the bedding and haunch criteria conform to the installation types as shown in Section 26.3.2.2, Table 7.11 in the SSBC? | ☐ | |
| 2.12 | 26.3.2.2 | Did the soil group categories for bedding conform to Table 7.11 in Section 26.3.2.2 of the SSBC? | ☐ | |
| 2.13 | 26.3.2.2 | Was the fill material below the bottom of the pipe culvert compacted by the Contractor to a minimum of 95% of Standard Proctor Density at optimum moisture content? | ☐ | |
| 2.14 | 26.3.2.2 | Was the thickness of the bedding material under the middle 1/3 of the culvert placed in a loose, uncompacted state? | ☐ | |
| 2.15 | 26.3.3.1 | Installation – Reinforced Concrete Pipe (RCP) – Was excavation, foundation and bottom bedding material accepted by the Inspector? | ☐ | |
| 2.16 | 26.3.3.1 | Was the Contractor's installation method in conformance to the manufacturer's recommendations, and did the rubber gasket at each joint conform to CSA 257.3, and were joint gaps less than 13 mm? | ☐ | |
| 2.17 | 26.3.3.1 | Did the Contractor install the RCP from the lowest elevation to the highest elevation with the bell end upstream? | ☐ | |
| 2.18 | 26.3.3.1 | Did the Contractor clean the inside of the bell end and outside of the spigot end prior to installation? | ☐ | |
| 2.19 | 26.3.3.1 | Were rubber gaskets kept at room temperature, out of direct sunlight, free of dirt, oil and grease? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.20 | 26.3.3.1 | Where pipe sections were supplied with a protruding bell, did the Contractor excavate at each bell section, ensuring uniform support underneath the pipe as per Section 26.3.3.1, Figure 4 of the SSBC? | ☐ | |
| 2.21 | 26.3.3.2 | Precast Box Culvert (PBC) – Was excavation, foundation and bottom bedding material and shape accepted by the Inspector? | ☐ | |
| 2.22 | 26.3.3.2 | Did installation include a rubber gasket and/or coil sealants, such as Kent Seal or Con Seal, at each joint conforming to CSA 257.3? | ☐ | |
| 2.23 | 26.3.3.2 | Did the Contractor install and join sections in conformance to the manufacturer's recommendations? | ☐ | |
| 2.24 | 26.3.3.2 | Did the Contractor install the PCB from the lowest elevation to the highest elevation? | ☐ | |
| 2.25 | 26.3.3.2 | Did the Contractor clean the inside of both ends prior to joint installation? | ☐ | |
| 2.26 | 26.3.3.2 | Were rubber gaskets kept at room temperature, out of direct sunlight, free of dirt, oil and grease? | ☐ | |
| 2.27 | 26.3.3.2 | Did the Contractor use lifting clutches in conjunction with the embedded lifting pins (anchors)? | ☐ | |
| 2.28 | 26.3.3.2 | If a section was installed on an unacceptable grade, did the Contractor completely unjoin the sections, correct the grade and rejoin the box sections? | ☐ | |
| 2.29 | 26.3.4 | Backfilling – After installation was accepted by the Consultant, was backfilling done with materials as per the drawings and Section 26.3.2 of the SSBC and in accordance with the current version of the standard drawing S-1418 Installation of Large Steel Pipes? | ☐ | |
| 2.30 | 26.3.4 | Was the ambient air temperature below 0°C?<br>*Note: No backfilling is allowed unless otherwise accepted by the Department and the Consultant.* | ☐ | |
| 2.31 | 26.3.4 | Where acceptance to backfill was granted, was all backfill material in a thawed state when placed, compacted, and was substrate in a thawed condition? | ☐ | |

| | SSBC Section | Reference | Compliance | Observations and Comments |
|---|---|---|---|---|
| 2.32 | 26.3.4 | Was backfilling under the haunches compacted to achieve density as per Section 26.3.2, Bedding/Backfill of the SSBC? | ☐ | |
| 2.33 | 26.3.4 | Was backfilling free of voids, providing uniform support to the structure and such that the level of fill on one side did not exceed the level of fill on the other side of the structure by more than 300 mm, at any time? | ☐ | |
| 2.34 | 26.3.4 | Was vibratory equipment, if required, moving parallel to the structure with simultaneous handwork along the structure? | ☐ | |
| 2.35 | 26.3.4 | Was clean material void of rocks and sharp objects used from the springline of the structure to the road surface? | ☐ | |
| 2.36 | 26.3.4 | If in-situ material was used in place of granular material, did the Inspector confirm the in-situ material conforms to the type and compaction level as specified on the drawings? | ☐ | |
| 2.37 | 26.3.4 | Did the Contractor supply suitable material for the compacted non-granular backfill, and was it accepted by the Inspector before commencement of this stage of construction? | ☐ | |
| **3** | | **Fish Passage Infrastructure** | | |
| 3.1 | 26.4 | Was fish passage infrastructure constructed as shown on the drawings and fabricated in accordance with the applicable specifications? | ☐ | |
| **4** | | **Rock Riprap** | | |
| 4.1 | 26.5 | Was rock riprap placed as shown on the drawings and conforming to Section 10, Heavy Rock Riprap of the Standard Specifications for Bridge Construction? | ☐ | |

**Details and Summary:**

Signature

Date

26.1 Excavation for bedding complete. Placing filter fabric prior to bedding material.

26.2 Bedding material placed and compacted.

26.3 Rig mats placed to allow for ease of access to work.

26.4 Crews unloading RCP. RCP lifted with slings from truck bed. Small swale dug at unloading area.

26.5 Placing first section of RCP.

26.6 Gasket placed at spigot end of pipe.

26.7 Placing gasket adhesive.

26.8 Pipe section joint.


26.9 Loader loosening bedding material at bell.

26.10 Joining RCP sections. Typically done with chucks or winches. Rubber softeners and 2x6 blocks used here to lift and push pipe.

26.11 Compacting haunch area with a rammer.

26.12 Both sides of pipe simultaneously backfilled. Skid steer and remote controlled walk behind packer used to compact material.


26.13 Clay seal compacted at end of pipe. Filter fabric material in place.

26.14 Completed placement of heavy rock riprap.


26.15 Installation of PCB units onto prepared bed, using string for alignment control.


26.16 Erection of PCB unit.

26.17 PCB unit partial gasket shown.


26.18 Positioning of PCB unit. Hydraulic excavator bucket is positioning unit will timber cushion.

26.19 PCB culvert backfilling operation.