

PART 1 - GENERAL

- 1.1 Related Sections .1 Section 03 30 00 Cast-in-Place concrete
- .2 Section 03 41 00 Precast structural concrete.
- 1.2 Description .1 This section specifies the materials for forms, form ties and release agents as well as their fabrication, erection, removal and restoring.
- 1.3 Measurement Procedures .1 No measurement will be made under this section. Include costs in items of concrete work for which formwork is required.
- 1.4 References .1 Canadian Standards Association (CSA International)
- .1 CSA-A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
- .2 CAN/CSA-O86-09, Engineering Design in Wood.
- .3 CSA O121-08, Douglas Fir Plywood.
- .4 CSA O151-09, Canadian Softwood Plywood.
- .5 CSA O153-M1980(R2008), Poplar Plywood.
- .6 CSA S269.1-16, Falsework and Formwork.
- 1.5 Submittals .1 Submittals in accordance with Section 01 33 00 Submittal Procedures.
- .2 Submit shop drawings for formwork and falsework.
- .1 Submit drawings stamped and signed by professional engineer

- registered or licensed in the Province of New Brunswick.
- .2 Indicate method and schedule of construction, shoring, stripping and re-shoring procedures, materials, arrangement of joints, ties, liners, anchorages, and locations of temporary embedded parts. Comply with CSA S269.1, for falsework and formwork drawings.
 - .3 Indicate formwork design data: permissible rate of concrete placement, and temperature of concrete, in forms.
 - .4 Indicate sequence of erection and removal of formwork/falsework as directed by Departmental Representative.
- 1.6 Delivery, Storage and Handling .1 Store and manage hazardous materials in accordance with Section 01 74 21 Construction/Demolition, Waste Management and Disposal.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 Construction/Demolition, Waste Management and Disposal.
 - .2 Place materials defined as hazardous or toxic in designated containers.
 - .3 Divert wood materials from landfill to a recycling facility.
 - .4 Divert plastic materials from landfill to a recycling facility.
 - .5 Divert unused form release material from landfill to an official hazardous material collections site.

PART 2 - PRODUCTS

- 2.1 Materials
- .1 Formwork materials:
 - .1 Formwork materials to be to CAN/A23.1/A23.2.
 - .2 Wood and wood product formwork materials to be to CSA-0121, CSA-086 and CSA-0153.
 - .2 Form ties:
 - .1 Use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm dia. in concrete surface.
 - .3 Form release agent: non-toxic, biodegradable.
 - .4 Form stripping agent: colourless mineral oil, non-toxic, and biodegradable.
 - .5 Falsework materials: to CSA-S269.1.

PART 3 - EXECUTION

- 3.1 Fabrication and Erection
- .1 Verify lines, levels and centres before proceeding with formwork/falsework and ensure dimensions agree with drawings.
 - .2 Fabricate and erect falsework in accordance with CSA S269.1.
 - .3 Fabricate and erect formwork in accordance with CSA-S269.1 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA-A23.1/A23.2.
 - .4 Align form joints and make watertight.
 - .1 Keep form joints to minimum.

- .5 Build in anchors, sleeves, and other inserts required to accommodate work specified in other sections.
- .6 Clean formwork in accordance with CSA-A23.1/A23.2, before placing concrete.

3.2 Formwork Removal

- .1 Leave formwork in place for following minimum periods of time after placing concrete.

Remove formwork when concrete has reached 75% of its design strength or minimum period noted above, whichever comes later.

- .2 Re-use formwork and falsework subject to requirements of CSA-A23.1/A23.2.

END OF SECTION

PART 1 - GENERAL

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| <u>1.1 Related Sections</u> | .1 | Section 03 10 00 Concrete Forming and Accessories. |
| | .2 | Section 03 30 00 Cast-in-place concrete |
| | .3 | Section 03 41 00 Precast Structural Concrete. |
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| <u>1.2 Description</u> | .1 | This section specifies concrete reinforcing materials, their fabrication and placing. |
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| <u>1.3 Measurement Procedures</u> | .1 | No measurement will be made under this section. Include costs in items of concrete work for which reinforcement is required. |
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| <u>1.4 References</u> | .1 | American Society for Testing and Materials International (ASTM). |
| | .1 | ASTM A82/A82M-07, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement. |
| | .2 | Canadian Standards Association (CSA) |
| | .1 | CSA-A23.1-09, Concrete Materials and Methods of Concrete Construction/Methods and Standard Practices for Concrete. |
| | .2 | CSA-A23.3-04 (R2010), Design of Concrete Structures. |
| | .3 | CSA-G30.18-09, Carbon Steel Bars for Concrete Reinforcement. |
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| <u>1.5 Shop Drawings</u> | .1 | Submit shop drawings including placing of reinforcement in accordance with Section 01 33 00 Submittal Procedures. |
| | .2 | Indicate on shop drawings, bar bending details, lists, quantities of reinforcement, sizes, spacings, and |

locations of reinforcement with identifying code marks to permit correct placement without reference to structural drawings. Prepare reinforcement drawings in accordance with Reinforcing Steel Manual of Standard Practice - by Reinforcing Steel Institute of Canada.

- .3 Detail lap lengths and bar development lengths to CSA-A23.3, unless otherwise indicated. Provide Class B tension lap splices unless otherwise indicated.
- .4 Each shop drawing submitted to bear the stamp and signature of a qualified Professional Engineer registered in the Province of New Brunswick.

PART 2 - PRODUCTS

2.1 Materials

- .1 Substitute different size bars only if permitted in writing by Departmental Representative.
- .2 Reinforcing steel: carbon steel, having a yield stress of 400 MPa, deformed bars to CSA-G30.18, unless indicated otherwise.
- .3 Cold-drawn annealed steel wire ties: to ASTM A82/A82M.
- .4 Chairs, bolsters, bar supports, spacers: to CSA-A23.1.

2.2 Fabrication

- .1 Fabricate reinforcing steel in accordance with CSA-A23.1 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.
- .2 Obtain Departmental Representative's approval for locations of reinforcement splices other than those

shown on placing drawings.

- .3 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

2.3 Source Quality Control

- .1 Upon request, provide Departmental Representative with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis.

PART 3 - EXECUTION

3.1 Field Bending

- .1 Do not field bend or field weld reinforcement.

3.2 Placing Reinforcement

- .1 Place reinforcing steel as indicated on reviewed placing drawings and in accordance with CSA-A23.1.
- .2 Prior to placing concrete, obtain Departmental Representative's approval of reinforcing material and placement.
- .3 Ensure cover to reinforcement is maintained during concrete pour.

END OF SECTION

PART 1 - GENERAL

- 1.1 Related Sections
- .1 Section 03 10 00 Concrete Forming and Accessories.
 - .2 Section 03 20 00 Concrete Reinforcing.
 - .3 Section 05 50 00 Metal Fabrications.
- 1.2 Measurement Procedures
- .1 No measurement will be made under this section. Include costs in items of concrete in work for which concrete is required.
 - .2 Reinforcing steel will not be measured but considered incidental to the work.
 - .3 Formwork and falsework will not be measured but considered incidental to the work.
 - .4 No deductions will be made for volume of concrete displaced by reinforcing steel.
 - .5 Heating of water and aggregates and providing cold weather protection will not be measured but considered incidental to work.
 - .6 Cooling of concrete and providing hot weather protection will not be measured but considered incidental to work.
 - .7 Supply and installation of concrete additives as recommended by the concrete supplier will not be measured but considered incidental to work.

1.3 Reference
Standards

- .1 American Society for Testing and
Materials International (ASTM)
 - .1 ASTM C260/C260M-10a, Standard
Specification for Air-Entraining
Admixtures for Concrete.
 - .2 ASTM C309-11, Standard
Specification for Liquid
Membrane-Forming Compounds for
Curing Concrete.
 - .3 ASTM C494/C494M-17, Standard
Specification for Chemical
Admixtures for Concrete.
 - .4 ASTM C881/C881M-15, Standard
Specification for
Epoxy-Resin-Base Bonding Systems
for Concrete.
 - .5 ASTM D1751-18(2018), Standard
Specification for Preformed
Expansion Joint Filler for
Concrete Paving and Structural
Construction (Nonextruding and
Resilient Bituminous Types).
- .2 Canadian Standards Association (CSA)
 - .1 CSA-A23.1/A23.2-14, Concrete
Materials and Methods of Concrete
Construction/Test Methods and
Standard Practices for Concrete.
 - .2 CSA A283-06 (R2016),
Qualification Code for Concrete
Testing Laboratories.
 - .3 CSA-A3000-13, Cementitious

Materials Compendium.

- .4 CAN/CSA-G30.18-F09, Carbon Steel Bars for Concrete Reinforcement.

1.4 Abbreviations

- .1 Portland Cement: hydraulic cement, blended hydraulic cement (XXb - b denotes blended) and Portland-limestone cement types:
 - .1 GU, GUb and GUL - General use cement.
 - .2 MS and MSb - Moderate sulphate-resistant cement.
 - .3 MH, MHb and MHL - Moderate heat of hydration cement.
 - .4 HE, HEb and HEL - High early-strength cement.
 - .5 LH, LHb and LHL - Low heat of hydration cement.
 - .6 HS and HSb - High sulphate-resistant cement
- .2 Fly ash types:
 - .1 F - with CaO content maximum 8%.
 - .2 CI - with CaO content 15 to 20%.
 - .3 CH - with CaO minimum 20%.
- .3 GGBFS - Ground, granulated blast-furnace slag.

1.5 Action and
Informational
Submittals

- .1 Submit certificates in accordance with Section 01 33 00 Submittal Procedures.
- .2 Provide certification indicating the concrete supplier is certified in accordance with the Atlantic Provinces Ready Mix Concrete Association Program or equivalent.
 - .1 Only concrete supplied from such certified plants shall be acceptable to the Departmental Representative.
 - .2 Plant certification shall be maintained for the duration of the fabrication and erection until the warranty period expires.
- .3 Provide certification that plant, equipment, and materials to be used in concrete comply with requirements of CSA-A23.1.
- .4 Provide mix design in compliance with CSA-A23.1 to provide concrete of quality, yield and strength as specified under 2.2 Mix Design. Mix design to be prepared by and stamped by an engineer licensed to practice in the Province of New Brunswick.
- .5 Prior to starting concrete work, submit to Departmental Representative manufacturer's test data and certification by qualified independent inspection and testing laboratory that following materials will meet specified requirements:
 - .1 Portland cement.

.2 Blended hydraulic cement.

.3 Supplementary cementing
materials.

.4 Admixtures.

.5 Aggregates.

.6 Water.

1.6 Shop Drawings

.1 Submit required documents and samples
in accordance with Section 01 33 00
Submittal Procedures and in accordance
with CSA-A23.4.

.2 The drawings provided must indicate,
show or understand the following:

.1 Details of concrete elements,
reinforcement and joining
elements.

.2 A nomenclature of finishes.

.3 Handling and installation
methods.

.4 Anchorage system, including
supporting calculations stamped
by an engineer.

.3 Submit shop drawings bearing the seal
and signature of a qualified engineer
licensed or licensed to practice in the
province of New Brunswick, Canada.

1.7 Waste Management
and Disposal

.1 Designate a cleaning area for concrete
trucks off site, at a company owned site
for such a purpose meeting all federal

and provincial requirements.

- .2 Use trigger operated spray nozzles for water hoses.
- .3 Designate a cleaning area for tools to limit water use and runoff.
- .4 Carefully coordinate the specified concrete work with weather conditions.
- .5 Prevent plasticizers, water-reducing agents and air-entraining agents from entering drinking water supplies or waterways. Using appropriate safety precautions, collect liquid or solidify liquid with an inert, noncombustible material and remove for disposal.
- .6 Choose least harmful, appropriate cleaning method which will perform adequately.

1.8 Ambient
Conditions

- .1 Placing concrete during rain or weather events damaging to concrete is prohibited.
- .2 Protect newly placed concrete from rain or weather events in accordance with CSA A23.1/A23.2.
- .3 Cold weather protection:
 - .1 Maintain protection equipment, in readiness on Site.
 - .2 Use such equipment when ambient temperature below 5°C, or when temperature may fall below 5°C before concrete cured.
 - .3 Placing concrete upon or against surface at temperature below 5°C is prohibited.
- .4 Hot weather protection:
 - .1 Protect concrete from direct sunlight when ambient temperature above 27°C.
 - .2 Prevent forms of getting too hot before concrete placed. Apply accepted methods of cooling not to affect concrete adversely.
- .5 Protect from drying.

PART 2 - PRODUCTS

2.1 Materials

- .1 Blended hydraulic cement: Type GUB-F/SF to CSA-A3001.
- .2 Supplementary cementing materials: to CSA-A3001.
- .3 Water: to CSA-A23.1.
- .4 Aggregates: to CSA-A23.1/A23.2. Coarse aggregates to be normal density.
- .5 Air entraining admixture: to ASTM C260.
- .6 Chemical admixtures: to ASTM C494/C494M. Departmental Representative to approve accelerating or set retarding admixtures during cold and hot weather placing.
- .7 Concrete retarders: to ASTM C494/C494M water based, low VOC, solvent free. Do not allow moisture of any kind to come in contact with the retarder film.
- .8 Curing Compound:
 - .1 To CSA-A23.1, and ASTM C309
 - .2 Liquid Membrane-Forming Compounds, Water-based, clear, non-yellowing, acrylic emulsion cure and seal.
- .9 Pre-molded Joint Filler:
 - .1 Bituminous impregnated fiber board to ASTM D1751.
- .10 Joint Sealer for horizontal joints:

- .1 Gray - polyurethane-based, elastomeric sealant.
- .11 Joint Sealer for vertical joints:
 - .1 Multi-component and polyurethane-based, elastomeric sealant chemical cured material of a non-sag consistency.
- .12 Anchorage Adhesive (Above Water): to ASTM C881/C881M, Type IV, Grade 3, Class A, B, and C.
- .13 Anchorage Adhesive (Below Water): to be fast curing epoxy or approved alternate.
- .14 Acrylic-Tie Anchoring System by Simpson Strong-Tie. Can't use brand name
- .15 Alternate Materials: Approved by addendum in accordance with Instructions to Tenderers.
- .16 Formwork: to CSA-A23.4.
- .17 Refer to Section 05 50 00 for metal fabricated assemblies to be installed in concrete items
- .18 Steel reinforcing: conforms to Section 03 20 00 Concrete Reinforcing
- .19 Hydraulic Cement Compound: in accordance with CSA-A3000
- .20 Aggregates: in accordance with CSA-A23.1. Large aggregates must be of normal density.

- .21 Air entraining agents: ASTM C260 compliant.
- .22 Chemical admixtures: in accordance with ASTM C494 / C494M.
- .23 Hardware and Miscellaneous Equipment: Complies with CSA-A23.1

2.2 Mix Design

- .1 The contractor shall be responsible for the concrete mix design.
- .2 It shall be the responsibility of the Contractor to ensure that the mixture proportions shall be properly batched, mixed, placed and cured such that the concrete conforms to the specifications.
- .3 Proportion normal density concrete in accordance with CSA-A23.1, Alternative 1, to give following properties:
 - .1 Cement: GUb-F/SF.
 - .2 Minimum compressive strength at 28 days: 35 MPa.
 - .3 Minimum cement content: 400 kg/m³ of concrete.
 - .4 Class of exposure: C-1.
 - .5 Maximum silica fume content is 10% of all cementitious materials.
 - .6 Nominal size of coarse aggregate: 20 mm.
 - .7 Slump at time and point of

discharge: 50 to 100 mm.

.8 Maximum water/cement ratio: 0.40.

.9 Air content: 5 to 8 %

.10 Penetration of chloride ions:
less than 1500 coulombs in 91
days.

PART 3 - EXECUTION

3.1 Preparation

- .1 Inform Department Representative before placing concrete. Provide 24 hours' notice prior to placing of concrete.
- .2 Place concrete reinforcing in accordance with Section 03 20 00 - Concrete Reinforcing.
- .3 Ensure reinforcement and inserts are not disturbed during concrete placement.
- .4 Pumping of concrete is permitted only after review of equipment and mix.
- .5 Prior to placing of concrete advise Departmental Representative of proposed method for protection of concrete during placing and curing in adverse weather.
- .6 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.
- .7 In locations where new concrete dowelled to existing work, drill holes in existing concrete.

.1 Place steel dowels of deformed steel reinforcing bars and pack solidly with epoxy grout to anchor and hold dowels in positions as indicated.

.8 Do not place load upon new concrete until authorized by Departmental Representative.

3.2 Construction

.1 Do cast-in-place concrete work in accordance with CSA-A23.1.

.2 Provide locations of steel reinforcing bars to Departmental Representative (prior to formal As Built submission) to for anchor bolts for to install Navigational lights.

3.3 Curing

.1 Cover and wet cure the concrete slab for duration of 7 days commencing as soon as the cover or moisture can be applied without marking the surface.

.1 Use curing compounds compatible with applied finish on concrete surfaces free of bonding agents and to CSA A23.1/A23.2 only after 5 days of wet curing.

3.4 Finishing

.1 Only ACI American Concrete Institute certified or other pre-approved concrete finishers are to be utilized in finishing all concrete works.

.2 Finish concrete in accordance with CSA-A23.1.

.3 Float surfaces with wood or metal floats or power finishing machines and bring surfaces to true grade or dimensions.

- .4 All formed surfaces to be smooth form finish.

3.5 Site Tolerance

- .1 Concrete tolerance in accordance with CSA-A23.1.

3.6 Field Quality Control

- .1 Inspection and testing of concrete and concrete materials will be carried out by a Testing Laboratory designated by Departmental Representative in accordance with CSA-A23.1/A23.2 and Section 01 45 00 Testing and Quality Control.
- .2 Departmental Representative will take additional test cylinders during cold weather concreting. Cure cylinders on job site under same conditions as concrete which they represent.
- .3 Non-destructive Methods for Testing Concrete shall be in accordance with CSA-A23.2.

3.7 Cleaning

- .1 Remove all impurities from exposed surfaces of concrete panels and piles.
- .2 Before cleaning the soiled surfaces of precast concrete elements, review with the Departmental Representative, cleaning methods that are expected to be used.

PART 1 - GENERAL

- 1.1 Related Sections .1 Section 03 20 00 Concrete Reinforcing.
- .2 Section 05 50 00 Metal Fabrications.
- .3 Section 31 23 10 Excavating, Trenching and Backfilling
- 1.2 Measurement Procedures .1 **Precast concrete box culvert:** The precast concrete box culvert sections shall be measured as a lump sum of complete box culvert and end sections installed.
- .2 Reinforcing steel will not be measured but considered incidental to the work.
- .3 Excavation, trenching, cofferdams, backfilling, backfill materials and bedding material are incidental to the installation of the box culvert and must be performed in accordance with Section 31 23 10 - Excavation, Trenching and Backfilling.
- 1.3 Reference Standards .1 American Society for Testing and Materials International (ASTM)
- .1 ASTM A1064, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- .2 ASTM C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- .3 ASTM C136, Standard Test Method for Sieve Analysis of Fine and

Coarse Aggregates.

.4 ASTM C1433, Standard
Specification for Precast
Reinforced Concrete Monolithic
Box Sections for Culverts, Storm
Drains, and Sewers.

.2 Canadian Standards Association (CSA)

.1 CSA-A23.1/A23.2, Concrete
Materials and Methods of Concrete
Construction/Test Methods and
Standard Practices for Concrete.

.2 CSA A23.4, Precast concrete -
Materials and construction.

.3 CSA S6, Canadian highway bridge
design code.

.4 CSA 30.18, Carbon steel bars for
Concrete reinforcement

.3 New Brunswick Department of
Transportation and Infrastructure
Standard Specifications for Highway
Construction (January 2019 Edition)

1.4 Action and
Informational
Submittals

.1 Submit certificates in accordance with
Section 01 33 00 Submittal Procedures.

.2 Provide certification indicating the
concrete supplier is certified in
accordance with the Atlantic Provinces
Ready Mix Concrete Association Program
or equivalent.

.1 Only concrete supplied from such
certified plants shall be
acceptable to the Departmental
Representative.

- .2 Plant certification shall be maintained for the duration of the fabrication and erection until the warranty period expires.
- .3 Provide certification that plant, equipment, and materials to be used in concrete comply with requirements of CSA-A23.1.
- .4 Provide mix design in compliance with CSA-A23.1. Mix design to be prepared by and stamped by an engineer licensed to practice in the Province of New Brunswick.
 - .1 The proposed mix design shall be submitted to the Engineer for review at least 14 days before concrete production is due to start.
 - .1 The Contractor shall submit a production schedule to the Engineer.
 - .2 The Contractor shall submit to the Engineer the proposed method and sequence to be employed for the curing and protection of the precast concrete sections.
- .5 The Contractor shall submit, in advance of the commencement of the Work the manufacturer's certification that all the materials to be supplied for the fabrication meet the specified requirements.

1.5 Shop Drawings

- .1 Submit required documents and samples in accordance with Section 01 33 00 Submittal Procedures and in accordance

with CSA-A23.4.

- .2 The Contractor shall submit, in accordance with Section 01 33 00, shop drawings for each precast concrete box culvert, containing, but not limited to, the following information:
 - .1 Station of culvert, name of watercourse, Public Works Contract number and description.
 - .2 General layout showing all box culvert sections and appurtenances.
 - .3 Length and weight (mass) of individual sections.
 - .4 Joint details (including gap, gasket, connection plates and waterproofing).
 - .5 Proposed construction joints (if sections not cast monolithically).
 - .6 Location and type of inserts and lift devices (including location where rebar and/or mesh will be cut for lifting anchors).
 - .7 Location of reinforcing steel.
 - .8 Bar schedules for all reinforcing steel.
 - .9 Itemized supply list.
 - .10 Detail showing year of fabrication embedded in the end sections.
 - .11 Concrete design strength, age of test, form removal strength and

shipping strength.

- .12 Two sets of design calculations.
- .13 Location of manufacturing plant.
- .14 BOXCAR design input and output, including printouts of outputs for load cases as indicated on the Contract Documents.
- .3 Submit shop drawings bearing the seal and signature of a qualified engineer licensed or licensed to practice in the province of New Brunswick, Canada.

PART 2 - PRODUCTS

2.1 Materials

- .1 All materials shall be supplied by the Contractor.
- .2 Concrete shall meet the requirements of CSA A23.1 and CSA A23.2.
 - .1 Concrete shall be marine grade.
 - .2 Exposure class shall be C-XL.
 - .3 Air content shall be 5 to 8%.
 - .4 Concrete to have 56 day compressive strength of 50Mpa.
- .3 Interior water tight joint seal shall be Rub/r-Nek, size per joint seal manufacturer's written recommendations, or approved equivalent.
- .4 Exterior joint wrap shall be 300mm wide Conwrap, ConSeal CS-212 or approved equivalent, with primers recommended by manufacturer.
- .5 The calcium nitrite corrosion

inhibitor shall conform to the following:

- .1 The dosage rate shall be 25 L/m³.
- .2 The corrosion inhibiting calcium nitrite admixture shall contain between 30% to 36% calcium nitrite by weight of solution.
- .3 The calcium nitrite shall be added at the concrete ready mix plant and verification shall be provided to the Engineer for the quantity of the calcium nitrite added to each batch of concrete.
 - .1 Acceptable verification shall include, but is not necessarily limited to printouts from computerized batch plants or printouts from computerized admixture dispensing units.
 - .2 Verification shall be provided on the delivery slip.
- .6 Dowels for attachment of cut-off walls to box culverts shall be 25M deformed reinforcing steel bars.
- .7 Reinforcing steel shall be rebar conforming to NBDTI Standard Specifications (January 2019 Edition) Item 304.2 and/or welded deformed steel wire fabric conforming to ASTM A1064.
 - .1 Welding of reinforcing steel, including tack welding, is prohibited unless Departmental Representative gives written approval.

- .8 Weirs, baffles and headwalls shall be reinforced and secured to the culvert by a method approved by the Engineer and moist cured for a minimum of 72 hours:
 - .1 When drilled holes and dowels are used to attach weirs/baffles to the invert, and headwalls to boxes, the holes shall be drilled to a minimum depth of 100mm, and the dowels shall be secured with an epoxy or acrylic adhesive such as Epcon A7 or approved equivalent.
 - .2 Reinforcement shall be placed in both faces of weirs, baffles, headwalls and cut-off walls.
 - .1 The maximum spacing of reinforcing steel for weirs, baffles, headwalls and cut-off walls shall be 300mm.
- .9 The concrete for precast weirs, baffles, headwalls and cut-off walls shall have an air content of 5 to 8%.
- .10 Weirs, baffles, headwalls and cut-off walls shall be made with the same concrete requirements as the culvert.
- .11 Non-shrink grout shall conform to ASTM C1107.
- .12 Levelling sand shall be clean, non-plastic, free of deleterious materials and shall be a natural or manufactured crusher dust obtained from crushing bedrock.

- .1 Sand (including crusher dust) shall meet the following grading limits when tested in accordance with ASTM C136.

ASTM Sieve Size	Percent Passing
9.5mm	100
4.75mm	95 to 100
2.36mm	80 to 100
1.18mm	50 to 90
600um	25 to 26
300um	10 to 25
75um	2 to 10

- .13 Lifting anchorage devices shall be Dayton Superior Swift Lift Systems or equivalent, of sufficient capacity for handling and placing culvert sections.

- .14 Rigid sheets (boards, plywood, sheet metal or similar) for placing under joints shall be of sufficient durability so as to allow adjacent culvert sections to slide into place.

- .1 The supplied rigid sheets shall be of a length to extend beyond each side of the box culvert.

- .15 Reinforcing supports shall be made of plastic, stainless steel, or galvanized steel with a minimum of 25mm of cover.

- .16 Side form spacers shall be made entirely of plastic or entirely of stainless steel.

- .17 Backfill material to be Class "A" as per NBDTI Standard Specifications (January 2019 Edition) Item 167.2.

- .1 Backfill material shall be obtained from within the Work Site or as approved by the Departmental Representative.
- .2 If sufficient quantities of suitable backfill material are not available within the Work Site, as determined by the Departmental Representative, additional backfill shall be imported by the Contractor in accordance with NBDTI Standard Specifications (January 2019 Edition) Item 167, from a source approved by the Engineer.
- .18 Anchor straps to be stainless steel, Type 304.

PART 3 - EXECUTION

3.1 General

- .1 The Contractor shall carry out the Work in the Contract Documents and/or as specifically directed by the Engineer.
- .2 The Contractor shall work in the dry for box culvert installation. Cofferdam to be steel sheet piling of similar method resulting in small footprint of disturbance.
- .3 The Contractor shall pre-load site to finish conditions for a period of not less than 4 weeks prior to commencing box culvert installation.
- .4 The Contractor shall comply with the requirements of CSA A23.4 and ASTM 1433 with respect to fabrication, transportation, storage and delivery of the precast concrete box culvert

sections.

- .1 Reinforcing steel bars or wire mesh shall have a minimum concrete cover of 55mm \pm 5mm.
- .2 At joints, the minimum concrete cover shall be 13mm for all longitudinal steel from the end of the bell and spigot.
- .3 For circumferential steel, in the bell and spigot, the minimum concrete cover shall be 13mm and the maximum concrete cover shall be 50mm.
- .4 Two additional anchors shall be installed on the inside of each box at approximately one-third of the height of the inside wall, mid length and on opposite sides for jacking boxes to home the joints for a tight seal.
- .5 All aspects of precast concrete work shall comply with CSA A23.1 and CSA 23.4 and shall be to the satisfaction of the Engineer.
- .6 Manufacture of the box culvert sections shall not commence until the Shop Drawings have been reviewed by the Engineer.
 - .1 The Engineer's written notice of review of the Shop Drawings shall in no way relieve the manufacturer of the responsibility for correctness of dimensions, size of components and details of fabrication in accordance with Item 1.5.2.

- .7 The Contractor shall ensure that the manufacturer notifies the Engineer at least 5 days in advance of the commencement of any phase of the manufacture so that the Public Works or Departmental Representative assigned inspector can be scheduled.
- .1 The Engineer shall have the right to inspect the manufacture of the precast sections, and the authority to order the Work to stop if it does not conform to the Plans, Shop Drawings, or Specifications.
- .2 The manufacturer shall ensure that safe working conditions exist for the Engineer or Department Representative.
- .8 Shop Drawings may show a design with wall and slab thicknesses different from those on the Plans, but the inside dimensions (ID) of the span and rise shall not be less than those indicated on the Plans.
- .9 The cured culvert sections shall be fitted horizontally at the plant to a gasket-free gap of 10mm or less, and the joints so fitted shall be sequentially numbered on the outside of each unit, to ensure proper fit at the Work Site.
- .10 Waterproofing, if required, shall be carried out in accordance with NBDTI Standard Specifications (January 2019 Edition) Item 351.

3.2 Culvert Design

- .1 Box culvert design shall be in accordance with the latest edition of CSA S6.
- .2 The design live load is CL-625-ONT.
- .3 Box culvert design shall be carried out using the "CHBDC" design option contained within the latest edition of the BOXCAR software sponsored by the American Concrete Pipe Association.

3.3 Forms

- .1 Forms shall be of a configuration to ensure compliance with the allowable tolerances.
- .2 Forms shall be clean and free of mortar prior to application of form coating.
- .3 Forms shall be complete and inspected by the Engineer before placing of concrete shall be permitted.
- .4 Permanently exposed sharp edges shall be chamfered with triangular fillets, 19mm by 19mm, made of steel, plastic, or clear straight-grained wood placed on the side exposed to concrete.
- .5 The minimum cover over form snap-ties shall be 50mm and the voids shall be filled to their entire depth with an approved cement grout mix as per Item 3.6.

3.4 Material Testing

- .1 Sampling, test cylinders and air content tests shall be performed by the manufacturer on accordance with CSA A23.2.
 - .1 A strength test is defined as a minimum of 2 cylinders broken at

the specified age, with additional cylinders broken at earlier dates for production purposes.

- .2 For dry-cast precast concrete sections, air content shall be tested on every section and a strength test shall be taken on every second section.
- .3 For wet-cast precast concrete sections, air content and one strength test shall be taken on every section.
- .4 If superplasticizers are added, the air content test shall be performed after the addition of the superplasticizer.

3.5 Curing and
Protection of Concrete

- .1 Moist curing of the concrete sections shall be carried out in accordance with CSA A23.1, until the design strength is reached.
- .2 Artificially accelerated curing of the concrete sections shall be in accordance with CSA A23.4 and the following:
 - .1 The concrete sections shall be maintained on the casting bed in an approved enclosure that ensures full circulation of thoroughly saturated air and/or steam around the concrete sections with a minimum loss of moisture and heat.
 - .2 During the initial curing period (typically 4 to 5 hours after casting) the enclosure temperature shall be kept at

approximately 20 degrees Celsius.

.3 For the next stage of curing, the enclosure temperature shall be raised at a rate not to exceed 15 degrees Celsius per hour, to a temperature between 40 and 60 degrees Celsius.

.1 The temperature differential within the enclosure shall not exceed 5 degrees Celsius.

.3 Steam, radiant heat or forced air used for accelerated curing shall not be applied before the initial set, shall provide excess moisture for proper hydration of the cement, and shall not be applied directly to the concrete, forms, or cylinders.

.4 The exposed surfaces of the concrete shall have an excess of moisture during the entire curing period. Water applied for this purpose shall have a temperature that varies no more than 10 degrees Celsius from the concrete temperature, and in no case shall exceed 60 degrees Celsius.

.5 The Contractor/Manufacturer shall provide a continuous record of curing temperatures for the entire curing period by means of approved accurate automatic recording devices; one device per length of the curing enclosure to record the temperature.

.6 When a concrete section has reached its required strength, the enclosure temperature shall be lowered, at a rate of 15 degrees Celsius per out, to the ambient air temperature.

.7 Culvert section(s) shall not be exposed

to freezing temperatures until they have dried 48 hours in warm temperatures following curing, and cooled at not more than 5 degrees Celsius per hour to the outside air temperature.

3.6 Finishing of Concrete Surfaces

- .1 All surfaces of the precast concrete sections shall receive an "Ordinary Surface Finish" in accordance with the following:
 - .1 All surface voids larger than 12mm in diameter and cavities, or holes visible upon the removal of the formwork, shall be filled to their entire depth with an approved cement grout mix of cement and the fine sand from the same source as used in the concrete and incorporate a latex bonding agent.
 - .2 All objectionable fins, projections, offsets, streaks or other surface imperfections shall be totally removed to the Engineer's satisfaction.
 - .3 If the concrete surface does not adequately fulfill the requirements for Ordinary Surface Finish, the Contractor shall, as directed by the Engineer, entirely remove certain designated portions, or all of the concrete, and replace with new concrete.
- .2 Immediately after the removal of forms, any part of the Work which displays defects shall be clearly marked and the

Contractor shall notify the Engineer of the location and the extent of the defect.

.1 The Contractor shall submit a repair procedure for approval.

.1 Cement washes of any kind shall not be used.

.2 All defects shall be finished smooth, uniformly color matched and flush with the adjacent surface.

.3 All ridges occurring at junctions of form panels shall be ground smooth.

.4 Exposed ends of lifting devices that have been cut off shall be painted with an approved coating to prevent rusting.

3.7 Culvert Placement

.1 Excavation and backfilling are incidental to the installation, and shall be carried out in accordance with Section 31 23 10 - Excavating, Trenching and Backfilling.

.1 If over-excavation occurs, the Contractor shall, at his/her own expense, repair and fill the over-excavation with an approved backfill material, place in accordance with NBDTI Standard Specifications (January 2019 Edition) Item 936, and compacted to 95% of the maximum dry density.

.2 Following placement and backfilling of the cut-off wall, the top horizontal surface of the cut-off wall shall be "buttered" with a 25mm layer of non-shrink grout and the beveled end section shall be immediately set into

place on the cut-off wall.

- .3 With the end section in place, the Contractor shall core drill 30mm diameter holes through the end section and to a nominal depth of 150mm into the top of the cut-off wall.
- .4 The 25 M dowels shall be inserted and secured into place using an epoxy or acrylic adhesive such as Epson A7 or an approved equivalent.
- .5 The Contractor shall place a minimum thickness of 50mm of bed levelling sand, compacted and raked or screed to provide a uniform bedding surface, over the entire foundation area of the culvert.
- .6 A rigid sheet shall be installed flush with the bed levelling material surface and centered under each joint of the culvert sections, such that when sections are joined, sand and other materials are prevented from entering and contaminating the joint.
- .7 Precast concrete box culvert sections shall be erected in the sequence indicated on the manufacturer's shop drawings.
 - .1 Deviation from the manufacturer's shop drawings shall not be permitted without the written authorization of the Engineer.
- .8 Culvert sections shall be joined in a straight line using industry methods, with the bell end up grade. Each culvert section shall be set into place and positioned together as recommended by the manufacturer of the lifting device.

- .1 After final alignment of each box culvert section by overhead means, homing shall be performed by jacking or winching with "come-alongs" attached to the inner anchors while the box culvert section is still suspended.
- .2 Boxes that are subsequently moved after the gasket joint seal has been compressed, will require re-installation with a replacement gasket.
- .9 The maximum joint gap between any two box culvert sections shall be 20mm uniformly across the joint with the sections in straight alignment.
 - .1 Sections set to a joint gap greater than 20mm shall be removed and reset to the specified gap.
 - .2 Sections which cannot be reset as Item 3.7.8 will be rejected.
- .10 After satisfactory placement of the culvert sections, all anchor pockets shall be filled with non-shrink grout.
- .11 Joint seal and exterior wrap material and appurtenances shall be installed in accordance with the manufacturer's specifications.
 - .1 Joint seal shall be placed around the entire joint.
- .12 Backfill shall be carried out in accordance with NBDTI Standard Specifications (January 2019 Edition) Item 166.

- .13 No backfill shall be placed in the excavation until the excavation has been approved by the Engineer, including but not limited to the dimensions of excavation and the character of the foundation materials.
- .1 Material over 75mm in size shall not be placed within 300mm of the culvert.
- .2 Backfill shall be placed in lifts of not more than 200mm in thickness for vibratory plate or rammer-type compactors and not more than 300mm in thickness for vibratory rollers.
- .3 Backfill shall be compacted in accordance with NBDTI Standard Specifications (January 2019 Edition) Item 936, to a minimum of 95% of the maximum dry density.
- .14 Backfilling of box culverts shall proceed simultaneously and evenly on both sides of the box culvert and shall never exceed 600mm in differential elevation.
- .15 No traffic or equipment shall be allowed to cross over the installed box culvert until a minimum of 600mm of backfill material has been placed over the box culvert in the area of crossing.
- .16 Shoring, bracing, sheeting, pumps, temporary roads and/or bridges that are necessary for the Work to be employed, maintained, and removed by the Contractor.

- .17 Place two (2) stainless steel anchor straps on last 2 pipe joints on both ends of box culvert.
- .18 Contractor shall work in the dry for box culvert installation.

END OF SECTION
