CONSTRUCTION SPECIFICATION FOR PRECAST CONCRETE CULVERTS WITH SPANS GREATER THAN 3.0 M

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912.01 SCOPE

This specification covers the construction requirements of single and adjacent side-by-side (multi-cell) precast concrete box culverts with spans greater than 3.0 m, and associated concrete appurtenances, in open cut, for both new culverts and replacement of existing culverts.

912.02 REFERENCES

This specification refers to the following specifications, standards, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading
OPSS 209 Embankments Over Swamps
OPSS 404 Support Systems
OPSS 501 Compacting
OPSS 517 Dewatering
OPSS 539 Temporary Protection Systems
OPSS 902 Excavating and Backfilling - Structures
OPSS 904 Concrete Structures
OPSS 905 Steel Reinforcement for Concrete

Ontario Provincial Standards Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1004	Aggregates - Miscellaneous
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1205	Clay Seal
OPSS 1301	Cementing Material
OPSS 1302	Water
OPSS 1303	Admixtures for Concrete
OPSS 1350	Concrete - Materials and Production
OPSS 1355	Precast Concrete - Materials and Production
OPSS 1860	Geotextiles

MTO Publications

Structural Manual

MTO Laboratory Testing Manual:

LS-706	Moisture - Density Relationship of Soils Using 2.5 kg Rammer and a 305 mm Drop

MTO Forms:

PH-CC-701	Request to Proceed
PH-CC-702	Notice to Proceed

CSA Standards

A23.4-16 (R2021)	Precast Concrete Materials and Construction
S6:25	Canadian Highway Bridge Design Code

ASTM International

C990/C990M-24	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
D6938-23	Standard Test Methods for In-Place Density and Water Content of Soil and Aggregate by Nuclear Methods (Shallow Depth)

912.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Backfill means rock, or granular material used as fill within the excavation placed beyond the limits of bedding and cover below the subgrade elevation, including frost tapers.

Bedding means the material used to cushion and evenly distribute the soil reaction at the bottom of the structure.

Culvert means a structure constructed of precast concrete box units with a span greater than 3.0 m that is typically embedded in fill, and is used to convey water, pedestrians, vehicles, cyclists, or animals.

Competent Native Material means rock, or soil with a density of compact or greater, or a consistency of firm or greater, or otherwise determined by the Contract Administrator to be suitable as a foundation material.

Concrete Appurtenances means head walls, cut-off walls, aprons, collars and any other concrete fixtures associated with the culvert, and excludes concrete bedding or concrete structures covered elsewhere in the Contract Documents.

Distribution Slab means a reinforced concrete slab placed directly on top of the culvert when the earth cover is less than 600 mm to improve load distribution on a culvert.

Element means an individual precast concrete culvert unit.

Granular Cover means the material placed as a protective layer above the culvert to prevent damage to the culvert.

Native Material means the soil that is naturally occurring, formed by normal geologic and biological processes.

Protection Layer means the material placed around the culvert to provide protection from damage.

Protection Slab means a concrete slab placed on the top of the culvert in an area exposed to chlorides.

Rock means as defined in OPSS 206.

Soil means as defined in OPSS 902.

Span means the horizontal distance measured perpendicular to the inside faces of the walls of the culvert.

912.04 DESIGN AND SUBMISSION REQUIREMENTS

912.04.01 Design Requirements

912.04.01.01 Culvert

The design shall be according to CSA S6, the Structural Manual Division 1, and as specified in the Contract Documents.

912.04.02 Submission Requirements

912.04.02.01 Working Drawings

One electronic copy in PDF format of the Working Drawings, including supporting documentation, shall be submitted to the Contract Administrator at least 7 Days prior to the commencement of fabrication of the elements, for information purposes only. All Working Drawings shall bear the seal and signature of an Engineer certifying they are as specified in the Contract Documents.

When other authorities are involved in the approval of the design or construction of the culvert, the submission of Working Drawings shall be made at least 35 Days prior to commencement of fabrication of the elements and one additional copy of the submission shall be provided for each authority. The requirements of each authority and the requirements of the Owner specified in the Contract Documents shall be satisfied prior to commencement of the Work.

The Working Drawings shall include as a minimum the following information:

a) Element details.

b) Steel reinforcement details.

c) Lifting point locations.

d) Details and location of any temporary supports.

e) Stripping strength for formwork removal and requirements for handling of components immediately after stripping.

f) Design calculations, of any components not specified on, or altered from, the Contract Documents.

g) Connection details.

h) Details for invert, obvert, depth of embedment, and substrate materials.

i) Details for inlet and outlet control structures, and any associated retaining structures.

j) Details of any openings required in the walls or slabs for connection of storm drainage.

k) Details of any features required to facilitate fish passage, up-welling or any other environmental requirements.

l) Any other applicable details.

The supporting documents shall include, as a minimum, the following information:

a) Handling and installation procedures including calculations.

b) Details of any bracing required to provide stability to the elements during transportation and construction.

912.04.02.02 Preformed Joint Seal

The manufacturer's recommended installation procedures for the preformed joint seal shall be submitted to the Contract Administrator, a minimum of 5 Days prior to the installation.

912.05 MATERIALS

912.05.01 Backfill

912.05.01.01 Backfill to Structure

Backfill to the structure shall be as specified in the Contract Documents.

When Granular A is specified in the Contract Documents, the Granular A shall be according to OPSS 1010.

When Granular B is specified in the Contract Documents, the Granular B shall be Type I or II, with 100% passing the 26.5 mm sieve, according to OPSS 1010.

When rock backfill is specified in the Contract Documents, it shall be according to the Rock Backfill to Structure subsection of OPSS 206.

The 19.0 mm clear stone for wall drains shall be according to OPSS 1004.

Protection layer shall be as specified in the Contract Documents.

912.05.01.02 Backfill Beyond Structure

Backfill beyond the structure shall as specified in the Contract Documents.

When Granular A is specified in the Contract Documents, the Granular A shall be according to OPSS 1010.

When Granular B is specified in the Contract Documents, the Granular B shall be Type I or II, with 100% passing the 26.5 mm sieve, according to OPSS 1010.

When rock backfill is specified in the Contract Documents, it shall be according to the Rock Backfill to Structure subsection of OPSS 206.

When native material is specified in the Contract Documents, the native material shall be as specified in the Native Material subsection.

912.05.02 Bedding

Bedding shall be as specified in the Contract Documents. The nominal maximum aggregate size for bedding shall not exceed 26.5 mm in diameter, unless the bedding layer has a thickness of 150 mm or greater, in which case the nominal maximum aggregate size shall not exceed 37.5 mm in diameter.

Granular aggregate materials shall be according to OPSS 1010.

912.05.03 Clay Seal

Clay seal shall be according to OPSS 1205.

912.05.04 Concrete

912.05.04.01 General

Concrete appurtenances shall be precast or cast-in-place, as specified in the Contract Documents.

912.05.04.02 Cast-in-Place Concrete

Cast-in-place concrete shall be according to OPSS 1350.

912.05.04.03 Precast Concrete Culverts and Appurtenances

Precast concrete shall be according to OPSS 1355.

912.05.05 Geotextile

Geotextiles shall be non-woven according to OPSS 1860 and shall be of the type, class and filtration opening size (FOS) specified in the Contract Documents. The minimum width of the geotextile roll shall be 900 mm. Geotextile shall be free of folds, tears, holes and wrinkles.

912.05.06 Granular Cover

Granular cover shall be as specified in the Contract Documents.

When Granular A is specified in the Contract Documents, the Granular A shall be according to OPSS 1010.

When Granular B is specified in the Contract Documents, the Granular B shall be Type I or II, with 100% passing the 26.5 mm sieve, according to OPSS 1010.

912.05.07 Grout

Grout shall be non-shrink.

Cementing materials for grout shall be according to OPSS 1301. Sand for grout shall be a mortar sand according to OPSS 1004. Water for grout shall be according to OPSS 1302. Admixtures for grout shall be according to OPSS 1303.

The workability of the grout mix shall be suitable for the application.

912.05.08 Levelling Course

Fine aggregate for levelling courses shall be according to OPSS 1002.

912.05.09 Native Material

Native material shall be acceptable to the Contract Administrator prior to use in the work. All material shall be free from frozen lumps, cinders, ashes, refuse, vegetable or organic matter, rocks and boulders over 150 mm in any dimension, and other deleterious material.

912.05.10 Preformed Joint Seal

Preformed joint seals, for sealing between elements, shall be butyl rubber according to ASTM C990. The primer for the preformed joint seal, shall be as recommended by the preformed joint seal manufacturer.

912.05.11 Proprietary Patching Materials

Proprietary patching materials shall be from the Owner's List of Acceptable Concrete Patching Materials. The list of proprietary patching materials shall be obtained from the Contract Administrator. Water used for proprietary patching materials shall be according to OPSS 1302.

912.07 CONSTRUCTION

912.07.01 Foundation

912.07.01.01 General

The culvert shall be placed on the leveling course and bedding, or as specified in the Contract Documents.

When unsuitable material is encountered during excavation for the culvert foundation, the unsuitable material shall be removed to competent stratum and replaced to the foundation grade with compacted Granular A, to according to OPSS 1010 , as specified in the Contract Documents.

The elevation of the top of the levelling course shall be as specified in the Contract Documents, unless otherwise stated, in writing, by the Owner.

912.07.01.02 Support Systems

Support systems shall be according to OPSS 404.

912.07.01.03 Temporary Protection Systems

Temporary protection systems shall be according to OPSS 539.

912.07.01.04 Excavation

The excavation for the installation of the culvert shall be according to OPSS 902, including frost tapers and culvert end treatments.

Swamp excavation shall be according to OPSS 209.

912.07.01.05 Dewatering

Dewatering shall be according to OPSS 517.

912.07.01.06 Bedding

Bedding shall not be placed on frozen material.

Bedding shall be placed as specified in the Contract Documents,

Bedding shall be placed in uncompacted, uniform layers not exceeding 200 mm in thickness, and each layer shall be compacted according to OPSS 501.

Bedding shall ensure uniform support under the full width and length of the culvert. The length of the culvert shall be the distance measured between the ends of the assembled elements, measured along the longitudinal axis

Bedding and subgrade material shall be protected from disturbance during construction.

912.07.01.07 Levelling Course

The levelling course shall consist of a 75 mm minimum thickness of fine aggregate.

912.07.02 Placement of Geotextile at Joints Prior to Installation of Elements

Prior to installation of the elements, geotextile shall be placed under the location of the bottom slab of the culvert elements, centered at the joints, as specified in the Contract Document. A sufficient length of geotextile shall be placed such that the entire culvert joint can be wrapped. The geotextile shall be protected from damage prior to final installation.

For side-by-side culverts, geotextile shall wrap both culverts together and omit covering the portion of the joints between the two culverts that is filled with grout.

912.07.03 Inspection of Elements Prior to Installation

Prior to commencing installation, the Contractor shall inspect all the elements on site for any defects or deficiencies. The Contract Administrator shall be notified immediately in writing if any of the culvert elements contain defects or deficiencies.

A MTO form PH-CC-701, Request to Proceed shall be submitted to the Contract Administrator prior to installation. The culvert elements shall be inspected on site by the Contract Administrator for any defects and deficiencies prior to installation. The Contract Administrator will notify the Contractor immediately in writing if any of the culvert elements contain defects or deficiencies.

Any defects or deficiencies identified shall be addressed prior to installation according to the Defects and Deficiencies subsection of OPSS 1355, as applicable.

Installation of elements shall not proceed until a MTO form PH-CC-702, Notice to Proceed has been received from the Contract Administrator.

912.07.04 Installation of Elements

912.07.04.01 General

The Contract Administrator shall be notified in writing of the installation date a minimum of 3 Business Days prior to the commencement of installation.

Installation shall be according to CSA A23.4, Working Drawings and as specified in the Contract Documents. A copy of the Working Drawings shall be kept on the site during the installation of the culvert elements.

Elements shall be lifted and placed in a manner to ensure they are not overstressed, unstable, or unsafe at any time.

Box units shall not be installed on bedding containing frozen material.

Installation of the elements shall commence at the outlet end and proceed in the upstream direction with the bell ends of the culvert elements facing up grade. The elements shall be placed with the base of each box unit in uniform contact with the prepared bedding throughout its full length. The ends of the box units shall be joined so there is no unevenness along the inside. The box units and joint surfaces shall be kept clean as work progresses. Water shall not be allowed to flow through the box units during installation. The excavation shall be kept dry and the box units shall not be installed in water.

The position of the inner and outer top edges of elements shall be set true to the elevations and alignment according to the Working Drawings and as specified in the Contract Documents. Culverts shall be constructed to the specified geometry, plumbness, and alignment and shall not exceed the tolerances specified in Table 1.

The ends of each culvert element when laid together shall make a continuous culvert with a smooth interior, free of irregularities in the flow line.

After the installation, the Contractor shall inspect the elements for any defects or deficiencies and for geometery, plumbness, and alignment, to ensure that the culvert is as specified in the Contract Documents. The Contract Administrator shall be notified, in writing, of any requirements that are not met.

Repairs to erected elements, according to OPSS 1355, shall only be carried out after the Contract Administrator has accepted the repair proposal.

912.07.04.02 Joints Between Elements

Joint treatment shall be as specified in the Contract Documents.

All joints between elements of the culvert shall be constructed to prevent leakage and infiltration.

All elements shall be provided with bell and spigot ends.

Preformed joint seals shall be used for sealing the joint between elements. Preformed joint seals shall be placed according to the preformed joint seal manufacturer's recommendations and the following:

a) The concrete surface to receive the preformed joint seal shall be cleaned with a stiff bristle brush immediately prior to placing the preformed joint seal. All dirt and debris shall be removed from the concrete surface prior to placing the preformed joint seal.

b) The concrete surface shall be dry prior to placing the preformed joint seal.

c) If recommended by the preformed joint seal manufacturer, primer shall be applied to the concrete surface to receive the preformed joint seal, according to the manufacturer’s recommendations. The primer shall be allowed to dry prior to placement of the preformed joint seal.

d) Preformed joint seal shall be clean and free of dirt and debris when placed.

e) Preformed joint seal shall be placed at the locations specified in the Contract Documents. Preformed joint seal shall be placed around the entire circumference of the culvert and shall be pressed into place. The preformed joint seal shall be placed such that the end of the length of the seal is located on the top portion of the element. The preformed joint sealant shall not be stretched.

f) Treatment at the ends of the preformed joint seal shall be as recommended by the manufacturer. There shall be no gap between the ends of the length of the preformed joint seal.

g) After placement, remove any protective backing paper from the preformed joint seal, if present. The placed preformed joint seal shall be protected from dirt and debris prior to installation of the next culvert element.

h) The preformed joint seal shall be compressed to the degree recommended by the manufacturer.

The gap at the joints shall not exceed the maximum value specified in Table 1.

912.07.04.03 Additional Requirements for Side-By-Side Culverts

For culverts placed in parallel, side-by-side, the gap between the adjacent culverts shall be 60 mm, within the tolerance specified in Table 1.

The 60 mm gap shall be filled with grout. The vertical surfaces to receive the grout shall not be waterproofed on the inside vertical face between the two culvert.

912.07.05 Filling of Holes for Lifting Devices

After installation of the elements, a proprietary patching material shall be used to fill holes for lifting devices. The proprietary patching material shall be comparable to the surrounding concrete in terms of strength and permeability. The patching material shall be mixed, handled, and cured according to the manufacturer's instructions. Immediately prior to filling, the inside surface of each lifting device hole shall be cleaned with nylon brushing and all free water shall be removed. The patch shall be finished flush with the surface of the surrounding concrete. All excess material shall be removed from the surface of the concrete. When filling lifting device holes, the proprietary patching material shall be cured with curing compound according to OPSS 904, or shall be cured as recommended by the manufacturer of the proprietary patching material.

912.07.06 Inspection After the Installation of the Culvert and Prior to Waterproofing

After installation of all elements of a culvert within a construction stage, and prior to placement of a protection slab or distribution slab and prior to waterproofing, a MTO form PH-CC-701, Request to Proceed shall be submitted to the Contract Administrator. The next operation shall not proceed until a MTO form PH-CC-702, Notice to Proceed has been received from the Contract Administrator.

912.07.07 Cast-in-Place Concrete Appurtenances, Protection Slabs and Distribution Slabs

Cast-in-place concrete appurtenances, protection slabs and distribution slabs shall be according to OPSS 904.

When a protection slab or distribution slab is required, it shall be as specified in the Contract Documents. The protection slab or distribution slab shall be placed without any damage to or movement of the culvert.

912.07.08 Waterproofing of the Culvert

Waterproofing of the culvert shall be as specified in the Contract Documents.

912.07.09 Inspection After the Waterproofing of the Culvert and Prior to Backfilling

After waterproofing of all elements of a culvert within a construction stage, and prior to backfilling, a MTO form PH-CC-701, Request to Proceed shall be submitted to the Contract Administrator. The next operation shall not proceed until a MTO form PH-CC-702, Notice to Proceed has been received from the Contract Administrator.

912.07.10 Placement of Geotextile at Joints After Waterproofing

After completion of waterproofing, including placement of protection board, the joints shall be covered with geotextile. The geotextile shall be placed to form a continuous barrier centered on the exterior of all buried joints, including on top of areas of the joint that are waterproofed.

The geotextile shall be joined so that the geotextile laps a minimum of 500 mm, and shall be pinned together. When the lap is on the vertical face of the culvert, the geotextile from the top surface shall overlap the geotextile from the bottom of the culverts.

912.07.11 Backfilling

Backfilling shall be according to OPSS 902 with the addition that the maximum uncompacted lift thickness shall be 300 mm. Backfill shall be placed without any damage to or movement of the elements.

912.07.12 Granular Cover

Cover shall be placed in layers not exceeding uncompacted thickness of 200 mm, and each layer shall be compacted according to OPSS 501. The cover material shall be placed without causing any damage to or movement of the culvert.

912.07.13 Clay Seals

When a clay seal is specified in the Contract Documents, the clay seal shall be placed to the dimensions specified in the Contract Documents and compacted to a minimum of 95% of the maximum dry density (MDD). The MDD shall be determined according to LS-706, and carried out on a single representative sample, selected by the Contract Administrator. Field density and field moisture determinations shall be made according to ASTM D6938.

912.07.14 Access for Quality Assurance

Unhindered access for inspection and testing of all the work shall be provided to the Contract Administrator or the Owner’s representative.

Any debris and obstructions shall be removed to allow access for the purposes of covermeter and dimensional measurements or inspection. The Contract Administrator shall be notified in writing when the culvert is ready for the verification measurements and inspection.

912.07.15 Management of Excess Materials

Management of excess material shall be as specified in the Contract Documents.

912.08 QUALITY ASSURANCE

912.08.01 General

The acceptance of culverts shall be as specified in this specification and the Contract Documents, including satisfactory completion of any repairs.

912.08.02 Acceptance of Installation Tolerances

The Contract Administrator shall be notified in writing when the bridge elements are ready for the verification measurements.

The Contract Administrator will carry out measurements on the installed culvert prior to any waterproofing or backfilling operations, to confirm the installation tolerances meet the requirements specified in Table 1 and the Contract Documents. Culverts that do not meet the installation tolerances specified in Table 1 shall be deemed rejectable.

912.08.03 Dowels

When dowels are specified in the Contract Documents, they shall be according to the visual acceptance criteria and pull testing criteria requirements specified in the Contract Documents.

912.08.04 Field Inspection

The Contract Administrator will inspect the installed culverts to determine if the completed work contains any defects and deficiencies.

For precast concrete, any defects and deficiencies identified shall be addressed according to the Defects and Deficiencies subsection of OPSS 1355, as applicable.

912.09 MEASUREMENT FOR PAYMENT

912.09.01 Actual Measurement

912.09.01.01 Precast Concrete Box Culvert, Fabrication
Precast Concrete Box Culvert, Delivery
Precast Concrete Box Culvert, Installation

Measurement for the fabrication, and the delivery and installation, of precast concrete culverts shall be by the horizontal length in metres along the centerline of the invert of the culvert.

Each side-by-side culvert shall be measured separately.

912.09.01.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

912.10 BASIS OF PAYMENT

912.10.01 Precast Concrete Box Culvert, Fabrication (Span ≥ 3.0 to < 4.0 m) - Item
Precast Concrete Box Culvert, Fabrication (Span ≥ 4.0 to < 5.0 m) - Item
Precast Concrete Box Culvert, Fabrication (Span ≥ 5.0 to ≤ 6.1 m) - Item
Precast Concrete Appurtances, Fabrication - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work, subject to payment adjustments according to OPSS 1355.

For side-by-side culverts, the work includes supply and placement of grout between the culverts, as specified in the Contract Documents.

Elements deemed rejectable shall be replaced at no additional cost to the Owner.

Culvert elements that requires no further fabrication and that is stored at the fabricator's premises in Ontario or some other location in Ontario away from the Working Area shall be eligible to be paid for when the Contractor obtains a lease from the property owner that names the Owner as the tenant. The Owner shall provide the form of lease for this purpose that specifies payment of $1.00 for the term of the lease. The Contractor shall retain full responsibility for the Work.

912.10.02 **Precast Concrete Box Culvert, Delivery (Span ≥ 3.0 to < 4.0 m) - Item**
Precast Concrete Box Culvert, Delivery (Span ≥ 4.0 to < 5.0 m) - Item
Precast Concrete Box Culvert, Delivery (Span ≥ 5.0 to ≤ 6.1 m) - Item
Precast Concrete Appurtances, Delivery - Item
Precast Concrete Box Culvert, Installation (Span ≥ 3.0 to < 4.0 m) - Item
Precast Concrete Box Culvert, Installation (Span ≥ 4.0 to < 5.0 m) - Item
Precast Concrete Box Culvert, Installation (Span ≥ 5.0 to ≤ 6.1 m) - Item
Precast Concrete Appurtances, Installation - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Payment for removal of unsuitable material encountered below the predetermined elevations shall be administered as a Change in the Work. The replacement to competent stratum to the foundation grade with compacted granular material shall be administered as a Change in the Work.

912.10.03 **Excavation for Culverts**

Payment for earth and rock excavation shall be at the Contract price for the tender items “Earth Excavation for Structure” and “Rock Excavation for Structure”, according to OPSS 902.

912.10.04 **Swamp Excavation**

Payment for swamp excavation shall be at the Contract price for the tender item Earth Excavation, Grading, according to OPSS 206.

Payment shall not be made for the removal of materials that slide or slough inside the excavation limits.

912.10.05 **Granular**

Granular material used for bedding, backfill, cover, and frost tapers shall be paid for under the appropriate granular items specified in the Contract Documents.

Payment will not be made for granular used to fill any area excavated beyond the lines specified in the Contract Documents.

912.10.06 **Concrete in Cast-in-Place Appurtenances, Protection Slabs and Distribution Slabs**

Payment shall be at the Contract price for the tender item “Concrete in Culverts”, according to OPSS 904.

912.10.07 **Steel Reinforcement in Cast-in-Place Concrete Appurtenances, Protection Slabs and Distribution Slabs**

Payment shall be at the Contract price for the tender items " "Carbon Steel Reinforcing Bar, Grade 500W", "Stainless Steel Reinforcing Bar", "Carbon Steel Mechanical Connectors" and "Stainless Steel Mechanical Connectors" according to OPSS 905.

912.10.08 Clay Seal - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Installation Tolerances

Item	Tolerances
Alignment of elements	± 10 mm
Plumbness	1 in 300 maximum
Joint Gap	20 mm maximum
Gap between adjacent side-by-side culverts (multi-cell culverts)	± 10 mm