CONSTRUCTION SPECIFICATION FOR PRECAST CONCRETE BRIDGE ELEMENTS

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916.01 SCOPE

This specification covers the construction requirements for precast concrete bridge elements.

916.02 REFERENCES

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

Ontario Provincial Standard Specifications, Construction

OPSS 910 Stressing Systems for Post Tensioning

Ontario Provincial Standard Specifications, Materials

OPSS 1355 Precast Concrete - Materials and Production

Ontario Ministry of Transportation Publications:

Structural Manual

MTO Forms:
PH-CC-701 Request to Proceed
PH-CC-702 Notice to Proceed

Canadian Standards Association (CSA)

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

National Cooperative Highway Research Program

Project 12-98, Appx. C Proposed Guidelines for Prefabricated Bridge Elements and Systems Tolerances

Precast/Prestressed Concrete Institute

MNL-135-00 Tolerance Manual for Precast and Prestressed Concrete Construction

916.03 DEFINITIONS

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

Assembly Plan means a package of plans, specifications and calculations developed by the Contractor that describes the process for the assembly of the prefabricated bridge elements and systems.

Bridge Elements means a category of Prefabricated Bridge Elements and Systems (PBES) that consists of precast concrete sections of a bridge. For the purposes of this specification, bridge elements do not include precast girders but may include precast bridge deck components, including full and partial depth deck panels, abutments, approach slabs, footings, columns, shafts, ballast walls, wingwalls, and pier caps. “Bridge element” is used interchangeably with “precast bridge element” and “precast concrete bridge element”.

Element means an individual precast concrete bridge unit. “Element” is used interchangeably with “precast element”.

Element Type means an element defined by function and cross-sectional shape.

Erection Drawings means those drawings which show the relationship of the precast bridge elements and their connections in the erected structure, and which provide such information as is necessary to properly erect and connect the various elements.

Erection Tolerances means the total allowable deviation from a theoretically exact dimension locating a precast bridge element relative to a work line, work point, or grid coordinates after they are erected.

Grid Coordinates means a survey coordinate system.

Interfacing Tolerances means those allowable variations in dimensions associated with other materials or systems in contact with or in close proximity to precast concrete. These could include, but are not limited to, tolerances of cast-in-place concrete footings, structural steel or cast-in-place concrete frames, and subsystems such as electrical and ATMS ducts.

Post-Tensioning means a method of prestressing in which tendons are tensioned after the concrete has reached a predetermined strength.

Prefabricated Bridge Elements and Systems (PBES) means structural components of a bridge that are built offsite or near the site.

Prefabricated Bridge System means a category of PBES that consists of an entire superstructure, an entire superstructure and substructure, or a total bridge that is procured in a modular manner such that traffic operations can be allowed to resume after placement. A prefabricated system is rolled, launched, slid, lifted, or otherwise transported into place.

Prestressed Element means a precast element in which internal stresses have been initially introduced so that subsequent stresses resulting from dead load and superimposed loads are counteracted to a desired degree. This may be accomplished by pretensioning or post-tensioning.

Work Lines means dimensional control lines based on a common datum which are mathematically tied to the vertical or horizontal geometry of the structure.

Work Points means dimensional control points based on a common datum which are mathematically tied to the bridge coordinate system.

916.04 DESIGN AND SUBMISSION REQUIREMENTS

916.04.01 Design Requirements

916.04.01.01 Precast Concrete Bridge Elements

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

916.04.02 Submission Requirements

916.04.02.01 Working Drawings

916.04.02.01.01 General

One electronic copy of all Working Drawings, including supporting documentation, shall be submitted to the Contract Administrator at least 14 Days prior to the commencement of fabrication of any precast elements, for information purposes only. Prior to submitting, the design Engineer and the design-checking Engineer shall affix their seals and signatures on the Working Drawings and supporting documentation verifying that the drawings and documentation are consistent with the Contract Documents.

When other authorities are involved in the approval of the design and/or construction of a highway structure, the Working Drawings submission shall be made at least 5 weeks prior to the commencement of work and one additional copy of the submission shall be provided for each authority. The requirements of each authority and the requirements of the Owner as specified in the Contract Documents shall be satisfied prior to the commencement of the work.

916.04.02.01.02 Assembly Plan

The assembly plan Working Drawings shall be developed and coordinated with the shop drawings to ensure details are consistent.

The assembly plan Working Drawings shall include, but not be limited to:

a) Assembly sequence and construction methods detailing:

   i. Overall construction process;
   ii. Installation sequence taking into account the actual loading on the structure, previously installed elements, attachments, sealing and tolerances;

iii. Any formwork, including but not limited to temporary supports, falsework, scaffolding for field cast joints, including methods for attachment to the adjacent elements;
iv. Methods and materials to be used for attachment, such as casting and curing of field cast joints;
v. Equipment that will be employed for assembly of the bridge;
vi. Equipment that will be used to lift elements including, but not limited to cranes, excavators, lifting slings, sling hooks, and jacks;
vii. All affected utilities, drainage and protective measures that will be employed throughout construction;
viii. Methods of adjusting, stabilizing and securing elements after placement until final completion;
ix. Methods for controlling erection tolerances for both horizontal and vertical directions including any surveying requirements;
x. Removals and disposals of any temporary and excessive materials after completion.

b) Identification marking of each element for erection;

c) Erection drawings including a site plan showing crane locations and operation radii. If multiple crane set-ups are required, a separate plan shall be included for each crane set-up. The site plan shall show the layout of multi-crane lifts if required. The plan shall also depict all affected utilities, drainage and protective measures that will be employed;

d) Shipping and handling; and

e) Geometry control plan including details of the layout process used for checking the location and elevation of each element prior to releasing the element from the erection equipment.

The supporting documents shall include the following information:

a) Calculations:

i. Bridge temporary works;
ii. Analysis of elements and calculation of forces for shipping, handling and lifting; maintenance of stability of elements; and modification of lifting and handling methods and/or the addition of supplemental reinforcement to resist shipping and handling forces if they cannot be resisted by the as-designed element;
iii. Lifting calculations for all crane lifts. The centre of gravity shall be determined for all elements. Special care shall be used for elements that are not symmetrical and may require special lifting hardware to allow for installation to the proper grades specified in the Contract Documents.
iv. Required strength of poured material that can produce connections capable of resisting forces during construction.

b) Material specifications including estimated timeframe of strength gain for field cast joint materials.

c) Scheduling:

i. Related to the construction schedule;
ii. Weather limitations for the assembly work, including but not limited to temperature and wind; and
iii. Contingency plan for schedule adjustment in the event of a major equipment breakdown or other major delays.

906.04.02.01.03 Precast Concrete Bridge Elements

The precast concrete bridge elements Working Drawings shall include shop drawings, erection drawings, and drawings for handling and installation of the elements.

The Working Drawings shall include the following information:

a) Element details including all projections, recesses, notches, openings, blockouts, and other pertinent details;

b) Steel reinforcement schedules;

c) Size, dimensional fabrication tolerances and markings of individual elements;

d) For prestressed elements include:

   i. Prestressing reinforcing steel size, grade, location.
   ii. Jacking force as required by the design.
   iii. Strand release sequence.

e) When post-tensioning is required, the post-tensioning details shall be included according to OPSS 910;

f) Stripping strength for formwork removal;

g) Installation details including:

   i. Lifting point details and locations;
   ii. Temporary shoring;
   iii. Supports and guys; and
   iv. Sequence for installation and removal of temporary and permanent works.

h) Details and location of all temporary supports;

i) Layout details which includes:

   i. All information required to identify and install precast elements and shall be based on work lines, work points or grid coordinates.
   ii. Markings of individual elements;
   iii. Special installation methods;
   iv. Sequence of installation where this is critical; and
   v. Layout dimensions for each element. In the layout, centre-to-centre spacing dimension shall not be used.

j) Erection tolerances;

k) Interfacing tolerances;

l) Details of bracing installed to provide adequate support and stability to the element during construction; and

m) All other applicable details.

The supporting documents shall include the following information:

a) Handling and installation procedures including calculations and lifting point locations.

b) Fabrication schedule of all precast elements.

916.05 MATERIALS

916.05.01 Precast Concrete Bridge Elements

Precast concrete bridge elements shall be according to OPSS 1355.

916.07 CONSTRUCTION

916.07.01 Inspection of Bridge Elements Prior to Installation

Prior to commencing installation, the Contractor shall inspect all the bridge elements on site for any defects or deficiencies. The Contract Administrator shall be notified immediately in writing if any of the 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 bridge 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 bridge 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 bridge elements shall not proceed until a MTO form PH-CC-702, Notice to Proceed has been received from the Contract Administrator.

916.07.02 Installation of Bridge Elements

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 the Working Drawings, assembly plan, and as specified in the Contract Documents. A copy of the Working Drawings shall be kept on the site during installation of the elements.

The work shall consist of installation and stabilization of the elements. Elements shall be lifted and placed in a manner to ensure they are not damaged, overstressed, unstable, or unsafe at any time.

Elements shall not be stacked temporarily on other elements during installation unless allowance has been made for this in the design of the elements and the connections.

Any error that prevents the proper assembly and fitting of parts shall be reported and the proposed method of correction shall be submitted to the Contract Administrator. Corrective measures shall not commence until the submitted proposal is accepted.

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

916.07.03 Installation Tolerances

Elements shall meet the installation tolerances specified in Table 1 and the Contract Documents. Installation tolerances are a combination of the fabrication tolerances, erection tolerances and interfacing tolerances. Unless specified otherwise, the installation tolerances shall be according to NCHRP Project 12-98 Appendix C, CSA A23.4, or MNL-135-00.

916.07.04 Inspection after the Installation of the Elements

A MTO form PH-CC-701, Request to Proceed shall be submitted to the Contract Administrator after the installation of each element type for each structure within a construction stage and prior to the cutting or removal of any temporary lifting, setting or levelling devices, or casting of concrete or grouted joints.

The next operation shall not proceed until a MTO form PH-CC-702, Notice to Proceed has been received from the Contract Administrator.

916.07.05 Field Cast Joints

Field cast joints for bridge elements shall be as specified in the Contract Documents.

916.07.06 Management of Excess Material

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

916.08 QUALITY ASSURANCE

916.08.01 General

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

916.08.02 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 of the installed bridge elements to confirm the installation tolerances which include fabrication, erection and interfacing tolerances meet the requirements of Table 1 and the Contract Documents.

If an element fails to meet the tolerances specified in the Contract Documents, the Contractor shall submit a proposal for remediation. The proposal may include but not be limited to rejection of the element, adjusting the element, modification of erection activities, grinding, or acceptance of out of tolerance elements.

Acceptance of the proposal for remediation is at the sole discretion of the Owner. Acceptance of out of tolerance elements may be considered if:

a) The structural integrity is not affected by exceeding the tolerance; or

b) The erection of the overall structure can be performed by satisfactory means such as minor adjustments to layout of connecting elements.

916.08.02.03 Field Inspection

The Contract Administrator will inspect the installed elements 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.

916.10 BASIS OF PAYMENT

916.10.01 Precast Concrete Bridge Elements, 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.

Rejected elements shall be removed and replaced at no additional cost to the Owner.

Bridge elements that requires no further fabrication and that are 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.

916.10.02 Precast Concrete Bridge Elements, Delivery - Item
Precast Concrete Bridge Elements, 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.

TABLE 1
Installation Tolerances for Precast Concrete Bridge Elements

Item	Footing	Column	Pier Cap	Wall Element	Full Depth Deck Panel	Partial Depth Deck Panel
Bearing length in span direction					±13 mm	±13 mm
Differential elevation between adjacent panels					3 mm (may be achieved with grinding)	19 mm
Joint taper				13 mm over length of panel and 9 mm over 3 m length		±6 mm
Joint width				±9 mm	±10 mm	±10 mm
Maximum jog in alignment of matching edges (straight line measurement taken horizontally from adjacent elements)		13 mm or 7 mm for architectural features	7 mm	7 mm		15 mm
Maximum plumb variation in any 3 m		7 mm	7 mm	7 mm		
Maximum plumb variation over height of element		1H:200V up to a maximum of 25 mm				
Plan location from structure datum (straight-line measurement taken horizontally from the plan datum)	±13 mm	±13 mm or ±9 mm for architectural features	±13 mm	±13 mm or ±9 mm for architectural features	±7 mm	±25 mm
Top surface elevation from nominal top surface elevation (straight-line measurement taken vertically from the elevation datum)	13 mm max low 7 mm max high	13 mm max low 7 mm max high	13 mm max low 7 mm max high	13 mm max low 7 mm max high		