

## **SECTION 426**

### **DESIGN, SUPPLY, AND INSTALLATION OF LONG SPAN STRUCTURAL PLATE STRUCTURES**

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**426.01 SCOPE**

The work of this Section covers the design, supply, fabrication, delivery, assembly, and backfilling of a structure fabricated from corrugated metal structural plate with spans greater than or equal to 3.0 metres.

The Contractor shall be responsible for all quality control for the design, supply and installation of the Long Span Structural Plate Installation.

The provision of footings for open bottom structures is covered under Section 450.

Should headwalls be required, then they shall be covered separately under Section 451.

**426.02 DESIGN**

The Contractor shall be responsible for the design of the long span structural plate structure. The long span structure shall be of the stated length, span and rise, although minor variations from the stated span and rise will be considered.

The design shall be carried out in accordance with the latest version of the Canadian Highway Bridge Design Code (CHBDC) CAN/CSA-S6. Design live load shall be CL-625, as per CHBDC, or as stipulated in the contract documents.

The entire structure shall have a design service life of 75 years.

The design shall be completed by a duly qualified Registered Professional Engineer licensed to practice in the Province of Newfoundland and Labrador.

Authentication of all drawings, specifications and submittals must follow PEGNL's, "Guideline for Authenticating Professional Documents".

The structure and the materials comprising the structure shall also be proportioned to carry all the stresses induced by manufacturing, handling, transportation, erection, construction and associated temporary loads in addition to those stipulated by the design code.

Design height of cover varies depending on the shape, design, and loading as specified for the project on the contract documents.

Unfactored reactions for footing design and allowable settlement of the foundation to be provided to the Department by the soil-metal structure designer.

For steel structures, the design shall include a calculated 75 year durability allowance that considers water, soil and atmosphere as identified in the Corrugated Steel Pipe Institute (CSPI) Technical Bulletin Thirteen. Soil conditions to be considered in the design shall be as published in Table 4 for AASHTO limits. Water conditions to be considered in the design shall be as detailed in Table 7 for Aggressive corrosivity classification. All structures must be designed as hot dipped galvanized with a minimum total mass both sides zinc coverage as outlined in CSA G401. Although not considered in the design, if specified, a thermoplastic copolymer coating shall be applied to the plates and base channel as specified in the latest version of CSA G401.

To confirm an accurate durability classification for this site, the Contractor shall carry-out water testing to determine the following water properties listed below:

pH Levels

Concentration of chloride ions (ppm)

Concentration of soluble sulfates (ppm)

Concentration of calcium carbonate/hardness (ppm)

Resistivity (ohm-cm)

In determining these levels a minimum of four samples are to be taken; two readings at the inlet, and two at the outlet. The final result shall be taken as the average of all sample values. A copy of the test results shall be provided to the Department prior to approval of shop drawings.

Where the structure is intended as an underpass, provision shall be made to prevent water from the fill seeping through joints in the plates, and then leaking on to the road below. A membrane shall be installed to prevent the ingress of water to the structure/engineered backfill zone and shall have a design life of 75 years. The waterproofing membrane system design shall be completed by the Contractor's Engineer and be considered incidental to this item. The waterproofing system design shall comply with CSPI Technical Bulletin 31.

For open bottom structures, the footing design shall be as shown on the project drawings. There shall be no modification to the geometry or configuration of the reinforced concrete footings without written approval from the Engineer of Record responsible for the

substructure design. The review and acceptance of the structural plate structure shop drawings shall not be misconstrued as acceptance of any substructure modifications. Acceptance of any changes to the substructure proposed by the soil-metal structure designer shall be at the sole discretion of the Engineer of Record for the substructure.

## **426.03 SUBMITTALS**

### **426.03.01 General Requirements**

The Contractor shall submit in a timely fashion all shop drawings, water testing results and design calculations. Drawings shall clearly show the dimensions of all components, materials, thicknesses, and special details. Drawings shall also detail the backfill specifications, gradation, extents and backfilling procedures to be followed. Following acceptance of these submittals by the Department, the issued for construction drawing set and design calculations shall bear the stamp of a Professional Engineer licensed to practice in the Province of Newfoundland and Labrador. Calculation submittals shall meet the requirements stipulated in Section 927.

The Department requires a minimum of 2 weeks to review submitted documents. The Department's review period shall not commence until the shop drawings, design calculations and water testing results have been submitted to the Department. All issued for construction submittals shall be received 2 weeks prior to the start of construction.

Any changes, deletions, omissions etc. to the Department's specifications shall be highlighted with each submission, with each instance specifically stated and explained for consideration by the Owner's Representative.

The Contractor is reminded of General Condition 41.3 and their responsibility to review, stamp, date and all submittals. Prior to the submission of shop drawings, calculations and other submittals, all documents must be reviewed by both the Contractor and the Contractor's Engineer to ensure that the Department receives a compliant submission.

The above submittals for the structure shall be received, reviewed and accepted by the Department prior to fabrication of the structure.

Once submittals are accepted by the Department then no changes can be made by the Contractor or the Contractor's Engineer without the submission of such changes and written approval from the Owner's Representative acknowledging acceptance of such changes.

All drawings and technical specifications shall be in accordance with PEGNL's "Guideline for preparation of Engineering and Geoscience Drawings and Technical Specifications".

The manufacturer shall provide a copy of the certificate of compliance for Corrugated Steel Structures. The manufacturer's certificate of compliance shall be issued by an independent 3rd party certification agency who are accredited by the Standards Council of Canada, confirming that the manufacturer produces certified corrugated steel pipe products in accordance with CSA G401. The steel structure shall have two identifier plates attached to the upper ends of the structure or individual plates containing the Certifying Agency's logo, CSA logo, manufacturer name, serial / project number and supply year.

Mill certificates for the material, as well as other Quality Assurance documentation related to the design and fabrication of the structure shall be available upon request.

Following the installation of the long span structural plate structure, including all backfilling, the manufacturer/designer shall provide a letter of conformance indicating that the structure has been installed in accordance with all specifications. The manufacturer/designer shall perform site inspections during construction as required by their quality management system to verify the installation. The Letter of certification shall be stamped by a Professional Engineer licenced to practice in Newfoundland and Labrador.

#### **426.03.02 Quality Control Plan**

The Contractor shall submit to the Department a Quality Control Plan which ensures compliance with the requirements stipulated by the manufacturer, designer, CAN/CSA S6, CSA G401 and the Contract Documents.

The Department requires a minimum of 2 weeks to review submitted documents. The Contractor's finalized Quality Control Plan must be submitted minimum of 2 weeks prior to construction.

At a minimum the Contractor's Quality Control Plan shall include the following:

##### **426.03.02.01 Bolt Torque Testing**

The Contractor shall include in their Quality Control plan a procedure that ensures that assembly and erection is in accordance with latest version of CAN/CSA S6, with the following exception:

#### **426.03.02.01.01 Initial Assembly**

The torque on all bolts prior to backfilling shall be in accordance with ASTM A807/807M for steel structures and ASTM B789/789M for aluminum structures. A minimum of 10% of all bolts shall be tested after assembly. The tested bolts shall be randomly selected and the bolted assembly shall be accepted if at least 90% of the randomly selected bolts tested above satisfy the torque requirement.

Should the tested bolts not meet the 90% threshold stated above, then the Contractor shall randomly select 50% of the remaining bolts for additional testing. The bolted assembly shall be accepted if at least 90% of the additional bolts tested satisfy the torque requirement. Otherwise, the Contractor shall re-torque all bolts.

#### **426.03.02.01.02 During Backfill Operations**

Additionally, a minimum of 5% of the bolts shall be randomly selected for testing as backfilling operations are underway. Testing shall be carried out as backfilling progresses and shall include the bolts which are exposed (above the current level of backfill at the time of testing). The tested bolts shall be randomly selected and the bolted assembly shall be accepted when at least 90% of the bolts tested satisfy the torque requirement.

Should the tested bolts not meet the 90% threshold stated above, then the Contractor shall randomly select 15% of the remaining bolts for additional testing. The bolted assembly shall be accepted if at least 90% of the additional bolts tested satisfy the torque requirement. Otherwise, the Contractor shall re-torque all bolts, or as directed by the Owner's Representative.

#### **426.03.02.01.03 Bolt Testing Results**

Bolt testing results shall be provided to the Owner's Representative as they become available. Bolt testing from initial assembly must be accepted by the Owner's Representative prior to commencing backfilling operations.

Bolt torque results must be signed by the Contractor's Representative and include: date, time, location and height of backfill.

#### **426.03.02.02 Shape Monitoring**

The Contractor must detail in the Quality Control Plan their procedure for monitoring shape throughout construction. Deflections from the specified dimensions shall be within the tolerances permitted by the soil-metal structure designer. Acceptable shape monitoring tolerances for the specific structure must be clearly shown in the Quality Control Plan and Shop Drawings.

All surveying shall be non-destructive in nature. No permanent alterations shall be made to the structure as part of this quality control activity.

#### **426.03.02.03 Backfill Testing and Compaction**

The Contractor's material testing, backfilling and inspection plan must be detailed in their Quality Control Plan. Select Backfill quality control procedures shall be compliant with Section 411.

All material testing requirements, testing methods, and frequency of testing for the select backfill material shall be clearly identified.

All equipment being used in backfilling operations should be listed. Maximum backfill lift thickness must be identified.

All details are to be provided on construction loading; including minimum heights of cover during construction and the use of any specific equipment and weights being utilized.

The backfilling and inspection plan shall indicate which third party geotechnical engineering consultant has been engaged to certify select backfill compaction. The plan shall also include the method and frequency by which the compaction is being tested.

#### **426.03.02.04 Manufacturer's Installation and Best Practices Manual**

The Manufacturer's Installation/Best Practices Guide shall form part of the Contractor's Quality Control Plan.

#### **426.03.02.05 Handling, Shipping and Storage**

As part of the Quality Control Plan the Contractor must detail the transportation, handling and storage methods for the structure. The methodology must be shown to be in compliance with the manufacturer's recommendations.

#### **426.03.02.06 Letter(s) of Compliance**

The Contractor's Quality Control Plan shall list all letters of compliance which are required to be submitted to the Department. These include, but are not limited to:

- Manufacturer's Certificate of Compliance
- Contractor's Geotechnical Engineer's Letter of Conformance (Materials Testing)
- Contractor's LSSPS Designer's Letter of Certification (Material Testing)
- Contractor's Geotechnical Engineer's Letter of Conformance (Compaction)

- Contractor's LSSPS Designer's Letter of Certification (LSSPS Structure Installation)

#### **426.03.02.07 Material on Site**

The Contractor's Quality Control Plan must include details to demonstrate compliance with Section 426.06 of this Specification.

As part of this procedure the Contractor must ensure that structure materials are made available and fully visible to the Owner's Representative for inspection and initial acceptance. The Contractor is advised that final acceptance of the structure material will only be given once the structure is completely installed and backfilled.

#### **426.03.03 Quality Control Reporting**

All quality control documentation shall be provided to the Department as the project progresses. Documentation shall include, but is not limited to: structure alignment/shape monitoring, bolt torque testing, material testing, and compaction testing. Failure to provide this information shall result in the issuance of a stop work order. Delays resulting from the failure to submit quality control documentation shall not form the basis of any claim.

Quality control reporting shall be provided as the installation progresses. Failure to submit quality control reporting in a timely manner shall result in a 10% holdback on the Long Span Structural Plate Structure, until such time that the required reports have been submitted to, and accepted by, the Owner's Representative.

#### **426.04 ENVIRONMENTAL PERMITS AND AUTHORIZATIONS**

Authorization from the Department of Fisheries and Oceans Canada's Fish and Fish Habitat Protection Program is required for work in or near any watercourse or water body deemed to be viable fish habitat.

Work is to be carried out in accordance with all requirements stipulated by regulatory agencies whose approval is required. This includes, but is not limited to, the Department of Fisheries and Oceans Canada, Transport Canada's Navigation Protection Program and the Water Resources Division of the Department of Environment, Climate Change and Municipalities.

Unless otherwise specified in the contract documents, where unwatering is required, the Contractor shall carry out this work in accordance with Section 180 "Unwatering Incidental to Work".



The Contractor shall be aware of the requirements of Division 8.

## **426.05 MATERIALS**

### **426.05.01 Fabrication**

Structural components shall be carefully formed to the corrugation profile and curved to the required radius along the inner crest, in the manufacturer's plant.

Fabrication of all steel components must meet the requirements of CAN/CSA G401 or ASTM A761, as applicable.

### **426.05.02 Materials for Steel Structures**

Steel plate to conform to the latest version of CSA G401.

Corrugated steel structural plate shall meet the general requirements as specified in CSA G401.

For galvanized structures, a zinc coating shall be applied after fabrication. The coating must provide a minimum coating weight of 915 grams per square metre total on both sides of the corrugated steel plates and base channels in accordance with CSA G401.

For thermoplastic copolymer coated structures, a thermoplastic copolymer coating shall be applied to both sides of the corrugated steel plates and base channels in accordance with CSA G401.

Bolts and nuts for the structural plate connections shall be heavy hex, meeting the requirements of CSA G401. Anchor bolts shall meet CSA G401. All fasteners and anchor bolts shall be zinc coated in accordance with CSA G401.

For thermoplastic copolymer coated structures all fasteners shall be in accordance with the latest version of CSPI Technical Bulletin Issue Twenty-Three.

Steel for base channels, if required, to conform to CSA G401.

Backfill requirements shall be in accordance with Section 411.

### **426.05.03 Materials for Aluminum Structures**

Aluminum plates to conform to the latest version of ASTM B746.

The aluminum structural plate shall meet the general requirements as specified in ASTM B746. Bolt holes shall be 25 millimetres in diameter using 19 millimetre diameter (M20) bolts.

Bolts and nuts for the structural plate connections shall be heavy hex.

Steel bolts shall meet the requirements of CSA G401. Anchor bolts shall meet CSA G401.

All fasteners and anchor bolts shall be coated in accordance with CSA G401.

Aluminum bolts shall meet the requirements of ASTM F468, made from Alloy 6061-T6.

Aluminum nuts shall meet the requirements of ASTM F467, made from alloy 6061-T6.

Backfill requirements shall be in accordance with Section 411.

#### **426.06 HANDLING, SHIPPING AND STORAGE**

The Contractor shall be responsible for the acceptance, unloading, handling, and storage of all material delivered to the project site. All components shall be handled, stored and shipped in such a manner as to eliminate the potential for damage as detailed in the manufacturer's installation guide. All damaged components shall be rejected by the Department and replaced at the Contractor's expense. Any loss or damage to material after acceptance shall be replaced by the Contractor at their own expense. Damaged components shall include, but is not limited to, any structural plates which exhibit permanent deformation or strain.

Stockpile lay down areas shall be specified by the Contractor prior to the start of construction, and will be subject to the approval of the Owner's Representative. Stockpile locations shall be at or near the project site.

The stockpile lay down areas shall not impact the operation and/or access to utilities, including but not limited to power lines, waterlines, and underground utilities. The Contractor shall acquire any required approvals, clearances, or permits for stockpile lay down areas prior to the start of construction. Work is to be carried out in accordance with all requirements stipulated by regulatory or utility agencies whose approval is required. This includes, but is not limited to, the Department of Fisheries and Oceans Canada and the Water Resources Division of the Department of Environment, Climate Change. The Contractor shall be aware of the requirements of Division 8.

Stockpile lay down areas shall be cleaned of any debris and objectionable material by the Contractor prior to placing the material. This cleaning shall be considered incidental to the work. Stockpile lay down areas shall have a uniform smooth surface and be graded to ensure positive drainage away from the stockpile materials.

For any stockpile lay down areas on private property, the Contractor shall obtain a signed agreement with the property owner prior to the start of construction. This agreement shall be submitted to the Owner's Representative for review and approval at minimum ten (10) working days prior to the start of construction.

Structural plate and any other fabricated material shall be stored at least 150 mm above ground level, in an organized fashion, and be supported to prevent any permanent deformation, in a manner acceptable to the Owner's Representative. Stockpiled material shall also be protected from environmental damage and corrosion, in a manner acceptable to the Owner's Representative. The Contractor shall adhere to any additional storage requirements specified by the manufacturer or as directed by the Owner's Representative.

The Contractor shall be responsible for providing any and all required security to prevent loss or damage to stockpiled materials. Any lost or damaged stockpiled material shall be replaced by the Contractor at their own expense.

## **426.07 ASSEMBLY AND BACKFILLING**

### **426.07.01 Assembly**

For open bottom structures, the Contractor shall construct footings for the structure on suitable foundation soils as approved by the Owner's Geotechnical Engineer. The footings must be accurately located as shown on the drawings. If base channels are required, the channel shall be attached to the footing as detailed on the manufacturer's shop drawings.

The Contractor shall allow the concrete footings to cure for at least three days before commencing the assembly of the structural plate and the bolting of the plates to the base channel embedded in the footing.

The Contractor shall be responsible for the provision and use of survey equipment required to complete and verify footing layout.

The cutting of plates or the drilling of holes in new structural plates in the field is not permitted without the Owner's written approval. On a case-by-case basis the Contractor shall submit to the Department a detailed request to modify any structural plate, which

includes but is not limited to: drilling, cutting etc. Requests of this nature must also be accompanied by a manufacturer/designer approved repair procedure.

Any defective plates must be reported to the supplier and corrective action taken by the supplier or manufacturer.

Plates shall be bolted at longitudinal and circumferential seams such that no more than 3 plates overlap at any bolt hole.

Any damage to metallic coatings shall be repaired in accordance with the latest version of CSA G401. With the following exception; an individual structural plate shall be rejected for either of the following:

- If an individual uncoated/damaged area exceeds 300mm in any one dimension.
- If an individual uncoated/damaged area exceeds 50mm in both dimensions.
- If the total combined uncoated/damaged surface area measures more than 1% of the total surface area.

In any of the above cases the Contractor may propose an engineered repair plan for consideration by the Department. If the Department elects not to accept the engineered repair plan, the structural plate shall be replaced with new material, or be re-dipped in accordance with CSA G401. The acceptance of the repair procedure shall be at the sole discretion of the Department.

Any damage to polymer coatings shall be promptly repaired in accordance with CSA G401 and CSPI Technical Bulletin Number Two. With the following exception; an individual structural plate shall be rejected for either of the following:

- If an individual uncoated/damaged area exceeds 300mm in any one dimension.
- If an individual uncoated/damaged area exceeds 50mm in both dimensions.
- If the total combined uncoated/damaged surface area measures more than 1% of the total surface area.

In any of the above cases the Contractor may propose an engineered repair plan for consideration by the Department. If the Department elects not to accept the engineered repair plan, the structural plate shall be replaced with new material, or be re-coated in accordance with CSA G401. The acceptance of the repair procedure shall be at the sole discretion of the Department.

All costs associated with preparation of repair procedures and repairing or replacing the damaged structural plate structure components shall be borne entirely by the Contractor.

Assembly and installation of the culvert shall be monitored by a qualified representative of the steel culvert industry, hereafter referred to as the industry representative. The industry representative will be responsible for providing site assistance to the Contractor during assembly and for giving an overview of the installation manual and educating the Contractor on proper assembly and backfilling methods. The industry representative shall monitor the structure assembly and backfilling operations, generally ensuring that the structure is installed in accordance with the requirements of the soil-steel structure designer and the soil-metal structure manufacturer. Any issues with the installation shall be immediately brought to the Owner's Representative.

The Contractor shall assemble and install the structure in accordance with the accepted issued for construction shop drawings, the manufacturer's installation guide and as directed by the Industry Representative.

The Contractor is responsible for quality control for the Long Span Structural Plate Structure installation.

Backfilling shall not commence until footings and any concrete headwalls and wing walls have cured to at least 70% of the specified design strength at 28 days or cured for seven days, whichever comes first. This requirement may be increased by Engineer of Record for the reinforced concrete components.

Backfill shall be carefully placed and compacted so that the correct shape of the structure is maintained. The Contractor shall monitor the shape of the structure during backfilling operations. Any deflection from the specified dimensions shall be within the tolerances noted on the manufacturer's shop drawings. If deflections exceed the permitted tolerances, then backfilling operations shall be ceased until a suitable procedure is developed and approved by the LSSPS manufacturer/designer or the structural components are replaced at the Contractor's expense. The manufacturer and Owner's Representative shall be notified in writing immediately of any deflections that are in excess of the permitted tolerances.

All structural plates which exhibit permanent deformation or strain for any reason shall be reject by the Department and replaced at the Contractor's expense.

#### **426.07.02 Backfilling**

Backfilling shall be carried-out in accordance with Section 411.

#### **426.08 PROTECTION FROM TRAFFIC**

Prior to allowing the movement of construction equipment or any vehicular traffic over the structure, the depth of cover over the structure shall not be less than the manufacturer's recommended minimum cover for the particular loading condition as stated on the manufacturer's Issued for Construction Shop Drawings. Any construction equipment exceeding CL-625 loading conditions shall not be permitted over the structure.

#### **426.09 MEASUREMENT FOR PAYMENT**

Measurement for payment for the design, supply and installation of the long span structural plate structure shall be the actual length of the installed plate structure, as shown on the shop drawings. The measurement shall be computed in metres, rounded to one decimal place.

#### **426.10 BASIS OF PAYMENT**

Payment at the contract price for the design, supply, and installation of the long span structural plate structure shall be compensation in full for all materials, labour, and use of equipment to: complete water testing, design, supply, transport, assemble, and install the structure, provide any required unwatering, supply, place, compact and test the backfill in accordance with Section 411 together with the provision of supervision by a qualified representative from the long span structural plate structure industry and professional engineering geotechnical consultant.

Included in the materials which shall be supplied by the Contractor are all plates, base channels, nuts, bolts, and washers, together with any thrust beams, distribution slabs, ribs and gaskets, select backfill and such other items which may be included in the design.

If the structure is intended as an underpass, then the supply and installation of a waterproof membrane, as specified by the Contractor's Engineer, shall be included and considered incidental to this item.

Should the water test results yield conditions more aggressive than that listed in Table 7 of the CSPI Technical Bulletin 13 for aggressive corrosivity classification, at the discretion of the Department, the structure shall receive a thermoplastic copolymer coating, payment for the coating shall be at the invoice cost from the supplier +10%. An original invoice from the supplier shall be provided to the Department prior to payment.

Payment for the long span structural plate structure, including materials, will only be made once the structure is installed, backfilled and all letters of conformance have been received and accepted by the Department. No interim payments will be considered.