



7805 - SPECIFICATION FOR THE FABRICATION OF PRECAST PRESTRESSED CONCRETE GIRDERS

7805 - 1 DESCRIPTION

- 1.01 The work shall consist of the fabrication and delivery of precast prestressed concrete bridge girders in accordance with this specification, the attached plans of the Saskatchewan Highways and Transportation, and the special provisions.

7805 - 2 MATERIALS

General

- 2.01 All materials required for the fabrication of these girders shall be supplied by the Fabricator.

Cement

- 2.02 Portland cements used shall meet the requirements of the latest edition of CSA Standard CAN/CSA-A5-M. The total alkali content expressed as sodium oxide (Na_2O) equivalent shall be 0.60% or less.

Silica Fume

- 2.03 When the use of silica fume is identified on the plans, silica fume shall be added to the concrete mix at a minimum rate of 20 kg per cubic metre. The silica fume shall meet the requirements of CSA Standard CAN/CSA-A23.5, Type U.

Aggregates

- 2.04 Fine Aggregate

Fine aggregates shall satisfy the provisions of CSA Standard CAN/CSA-A23.1-M.

- 2.05 Coarse Aggregate

Coarse aggregates shall have a maximum nominal size of 20 mm and shall satisfy the provisions of CSA Standard CAN/CSA A23.1-M.

- 2.06 In addition to the preceding requirements, aggregates shall not contain more than 0.5 percent, by weight, particles which will float on a liquid having a relative density of 2.0.

Prestressing Steel

- 2.07 Prestressing steel shall be seven-wire stress-relieved strand with low relaxation property conforming to the requirements of CSA Standard G279-M, Grade 1860.
- 2.08 A copy of the manufacturer's stress-strain curve for each lot of prestressing steel used and the location of each lot used shall be supplied to the Department.

Reinforcing Steel

- 2.09 Reinforcing steel shall be fabricated from deformed bars conforming to the requirements of CSA Standard CAN/CSA-G30.18-M.

- 2.10 For Grade R bars, the minimum elongation at rupture in a 200 mm gauge length shall be 12 percent for No. 25 bars and smaller, and 10 percent for No. 30 bars and larger.
- 2.11 The pin diameter for the 180 degree bent test shall be:
- (a) 4 bar diameters for No. 25 bars and smaller;
 - (b) 6 bar diameters for No. 30 and No. 35 bars;
 - (c) 8 bar diameters for No. 45 and No. 55 bars.

Admixtures

- 2.12 Air entraining admixtures shall conform to the requirements of CSA Standard CAN3-A266.1-M. Water-reducing admixtures shall conform to the requirements of CSA Standard CAN3-A266.2-M. Superplasticizer admixtures shall conform to the requirements of CSA Standard CAN3-A266.6-M. Other chemical admixtures may only be used if approved by the Department.

7805 - 3 CONSTRUCTION

Shop Drawings

- 3.01 The Fabricator shall supply detailed shop drawings of girder construction and prestressing methods for approval of the Department. The Fabricator shall be responsible for the correctness of all his drawings, irrespective of any approval of the Department.

Concrete

General

- 3.02 In order to obtain finished concrete members of high quality, the procedures as outlined in "Guide for Measuring, Mixing, Transporting and Placing Concrete (AC1 304R)" shall be followed.

Air Entrainment

- 3.03 All concrete shall contain $6\% \pm 1\%$ entrained air.

Mix Temperature

- 3.04 The temperature of the concrete, when placed, shall be not less than 10°C nor more than 30°C.

Formwork

- 3.05 The faces of the forms shall be smooth so as to impart a good finish to the concrete. Care shall be taken to ensure rigidity of the forms so that the dimensional tolerances noted herein are met.
- 3.06 The faces of the forms shall be treated with a release agent to ensure that stripping of the forms may be carried out without damage to the concrete. Care shall be taken to maintain all embedded material free of the release agent.
- 3.07 Forms shall be so constructed as to allow for the re-distribution of the loading and the movement which will take place upon application of the prestressing force.
- 3.08 Forms shall be provided with temporary openings, as necessary, to facilitate the removal of all foreign substances prior to placing the concrete.
- 3.09 Recesses at ends of girders to facilitate positioning of prestressing strands will not be allowed.

Placing

- 3.10 The Fabricator shall ensure that the mixer has a coating of mortar and sand before any of the components for the first concrete batch are introduced into the mixer.
- 3.11 Concrete shall be conveyed from the mixer to the place of final deposit by methods which will prevent the separation or loss of materials and shall be deposited as close as practicable to its final position so as to avoid segregation due to rehandling or flowing.
- 3.12 Low slump, high cement content mixes shall be placed in the shortest possible time after mixing so as to prevent loss of workability.
- 3.13 Concreting shall be carried on at such a rate that the concrete is at all times plastic and flows readily into the spaces between the bars or strands. Concrete that has partially hardened or been contaminated by foreign material shall not be deposited in the structure, nor shall re-tempered concrete be used. When concreting is once started, it shall be carried on as a continuous operation during the girder fabrication.

Vibration

- 3.14 All concrete shall be thoroughly consolidated by suitable means of vibration during placement, and shall be thoroughly worked around the reinforcement and embedded fixtures and into the corners of the forms. Over-vibration shall be avoided.
- 3.15 Vibrators shall not be used to move concrete longitudinally in the form.
- 3.16 When internal vibration is used, vibrator heads shall be smaller than the minimum distance between the forms and the reinforcement. Care shall be exercised to avoid damage or misalignment of forms and reinforcing steel.

Curing

- 3.17 If moist curing only is to be used, the exposed concrete surfaces shall be moist cured for a minimum of three days from time of casting.
- 3.18 Accelerated curing may be done by means of low pressure steam or radiant heat applied under a suitable enclosure. The start of accelerated curing shall be delayed for a period of four hours after the final placement of the concrete.
- 3.19 During the waiting period, the temperature within the curing enclosure shall not be less than 10°C.
- 3.20 Live steam or radiant heat may be used to maintain the curing enclosure at the proper minimum temperature, but shall not be used if the temperature within the curing enclosure exceeds 30°C.
- 3.21 During the initial application of live steam or of radiant heat, the ambient temperature within the curing enclosure shall increase at an average rate not exceeding 20°C per hour until the curing temperature is reached. The curing temperature within the enclosure shall not exceed 70°C. The maximum temperature shall be held until the concrete has reached the strength specified for the application of the prestress force. Detensioning shall be completed within 2 hours after the accelerated curing has been discontinued.
- 3.22 Application of live steam shall not be directed on the concrete or forms so as to cause localized high temperatures.

- 3.23 During radiant heat curing, moisture loss shall be minimized by covering all exposed concrete surfaces with a plastic sheeting.
- 3.24 The units shall not be subjected to freezing temperatures until the design strength has been attained as determined by breaking standard concrete test cylinders cured under the same conditions as the units. For purposes of this specification, freezing temperatures shall be defined as a period of six hours during which the air temperature in the vicinity of the units is continuously below 0°C.
- 3.25 When exposure to freezing temperatures is considered a possibility, the units shall either be stored inside the fabrication plant, or immediately placed inside a heated temporary enclosure, until the design strength has been attained. This enclosure shall be reasonably tight and safe for wind and snow loading, and shall be arranged to permit heated air to freely circulate to all surfaces of the units. The air temperature within the enclosure shall be a minimum of 10°C. Heating shall be by means of dry heat.
- 3.26 Should units be subjected to freezing temperatures prior to the concrete attaining its design strength, the Fabricator shall return the units to a heated enclosure until the design strength has been attained.

Surface Finishing

3.27 Formed girder surfaces shall be finished as follows:

- (a) All fins and irregular projections shall be removed from all concrete surfaces.
- (b) Honeycomb spots, holes, broken corners and edges, and other concrete spalls shall be repaired by thoroughly cleaning the area, applying an approved bonding agent, if required, and carefully filling with an approved preblended commercial patching material. The member temperature shall be a minimum of 10° C. Patches shall be properly cured.

Prestressing Steel

General

3.28 Prestressing steel shall be kept clean, dry, and free of excessive rust, oil, dirt, scale and pitting. A light oxide is permissible.

Placing

3.29 The maximum permissible tolerance for location of the prestressing steel shall be ± 5 mm of the location shown on the plans. The position of deflection points for deflected strand shall be within ± 150 mm of the location shown on the plans.

Measurement of Prestressing Force

3.30 The prestressing force shall be determined by measuring elongation and checking the jack pressure on a calibrated gauge. When there is a difference of over 5 percent between the steel stress determined from elongation and from the gauge reading, the cause of the discrepancy shall be ascertained and corrected. If several wires or strands are stretched simultaneously, provisions must be made to induce the same initial load in each.

Transfer of Prestressing Force

3.31 If the force in the wires or strands is transferred individually, the sequence of release shall be such as to avoid subjecting the member to unanticipated stresses and cracking. The sequence of release shall be subject to the approval of the Department. The compressive strength of bed-cured concrete cylinders shall be as designated on the plans before the transfer of prestressing force.

Protection

- 3.32 Exposed ends of prestressing steel shall be ground smooth with the member, and protected by coating with a minimum 3 mm thickness of waterproofing material. The waterproofing material shall be approved by the Department and shall be installed in accordance with the recommendations of the manufacturer.

Debonding

- 3.33 Debonding of strands shall be achieved by the use of plastic sheathing, either solid or split. When split sheathing is used, it shall have a minimum thickness of 0.6 mm, and shall be thoroughly sealed with tape prior to placing the concrete. The ends of solid sheathing shall be taped to prevent migration of concrete mortar along the strand.

Reinforcing Steel

- 3.34 Reinforcing steel shall be cold bent to the shapes shown on the plans, and unless otherwise provided on the plans or by authorization, bends shall be made in accordance with the requirements of CSA Standard CAN/CSA-S6-M.
- 3.35 All reinforcing steel shall be accurately placed in the positions shown on the plans, and shall be retained in such positions by means of bar accessories and wires so that the bars shall not be moved out of alignment during or after the depositing of concrete. When placed in the work, reinforcing steel shall be free from mud, oil, or other coatings that adversely affect bonding capacity. Reinforcing steel with rust, mill scale, or a combination of both shall be considered as satisfactory provided the minimum dimensions, including height of deformations, and weight of a hand wire brushed test specimen meet the requirements of CSA Standard CAN/CSA G30.18M.
- 3.36 Welding will not be allowed as a means of fastening the bars together unless so detailed on the plans or authorized by the Department in writing.
- 3.37 Distances from the forms shall be maintained by means of approved supports. Spacing of these supports shall be as recommended by the manufacturer. Metal chairs which are in contact with the exterior surface of the concrete shall be galvanized. The use of concrete blocks, pebbles, pieces of broken stone or brick, metal pipe and wooden blocks shall not be permitted.
- 3.38 The maximum permissible tolerance for location of the reinforcing steel shall be ± 12 mm of the location shown on the plans.

Concrete Quality Control

- 3.39 The concrete quality will be monitored by certain standard tests carried out by the Department's inspector. In the main, these will be tests on aggregates, slump tests, tests for percentage of entrained air, and tests of concrete cylinders for compressive strengths. Compression tests of cylinders will, in general, be made at the rate of at least one test for each two girders, with not less than two tests for each day's pouring. A test shall be defined as an average of the results from two concrete test cylinders made from the same batch of concrete. In addition, results of tests made by the Fabricator's inspector shall be supplied to the Department.

- 3.40 All test cylinders made for acceptance purposes shall initially be cured under conditions similar to the curing of the actual units they represent. Test cylinders taken from a batch made within 30 minutes of the end of a pour will be used to determine the strength of girders prior to application of the prestress force, unless required otherwise by the Department's inspector. Test cylinders cured under lab conditions for the balance of the curing period will be used to determine the 28 day compressive strength (f'_c) of the units. The making and method of testing of compression cylinders shall be done in accordance with CSA Standard CAN/CSA-A23.2-M. The results of compression tests performed on the 28 day cylinders shall meet the following requirements:
- (a) Not more than ten percent of the compression tests shall fall below the specified value of f'_c shown on the plans.
 - (b) The average of any three consecutive compression tests shall not be less than the specified value of f'_c .
 - (c) An individual compression test shall not be more than 3.5 MPa below the specified value of f'_c .
- 3.41 Should compression test results fail to meet the above requirements, the Fabricator shall thoroughly check the girders in question by non-destructive tests, such as the impact hammer, to determine if in fact the girders actually contain low strength concrete. If further investigations are deemed necessary, the Fabricator may be required to have cores drilled from the areas in question and tested in accordance with ASTM Standard C42, Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete. When required, cores shall be drilled within the 14 day period immediately following the standard 28 day test date. A minimum of three cores will be taken. Concrete in the areas represented by the core tests will be considered to be structurally adequate if the average of the three cores is equal to at least 85 percent of f'_c and if no single core is less than 75 percent of f'_c . Costs for core tests will be the responsibility of the Fabricator.
- 3.42 If the Fabricator does not have quality control experience for the mix to be used, then the following limitations shall be placed on the mix design.
- (a) For $f'_c = 35$ MPa
 - the water-cement ratio shall not exceed 0.35.
 - the amount of cement per cubic metre of concrete shall not be less than 460 kg.
- 3.43 At least ten consecutive compression tests shall be made for each mix design and meet the previously stated three requirements before the Fabricator shall be considered to have quality control experience for the particular mix to be used.

Tolerances

- 3.44 Forms for construction shall be true to shape, lines and dimensions shown on the plans and shall be constructed and protected from warping so that the finished product will be within the following limits.
- (a) Overall length of member shall not vary from those shown on the drawings by more than 5 mm, measured after stress transfer.
 - (b) Overall cross-sectional dimensions shall not vary from those shown on the drawings by more than 3 mm.

- (c) Maximum lateral deviation from the face of the section to a chord joining any 2 points on the face of the section shall not be more than 1 mm per 3 m of chord length.
- (d) Maximum deviation from the specified camber 24 hours after transfer of prestressing force shall be limited to 3 mm per 3 m of span.

Inspection

- 3.45 The Fabricator shall furnish facilities for the inspection of material and workmanship in the plant, and the Saskatchewan Highways and Transportation's inspectors shall be allowed free access to all parts of the work.
- 3.46 All units shall be inspected and accepted by the Department at least 24 hours prior to shipping.
- 3.47 The Inspector shall have the authority to reject any material or work which does not meet specified requirements. In case of dispute, the Fabricator may appeal to the Minister of Highways and Transportation whose decision shall be final.

Handling and Shipping

- 3.48 The lifting devices shown on the plans are minimum requirements. The Fabricator shall satisfy himself as to the adequacy of the devices. The girders shall be picked up only by lifting devices.
- 3.49 The girders shall not be hauled to the site until the concrete design strength has been reached.
- 3.50 The Fabricator shall ensure that the girders are not damaged during the handling, storing and shipping operations. The girders shall be handled in an upright position. During storage and shipping the support points shall be located outside of the lift point locations.

Rejection

- 3.51 Failure to meet the requirements of these specifications shall be due cause for the rejection of a girder.
- 3.52 Major irregularities or damage to the girders shall be inspected by the Department to determine whether or not the member will be rejected. If the member can be used, the method of repair shall be approved by the Department, and the Department's Inspector shall witness the repair.
- 3.53 Minor surface cavities or irregularities which are satisfactorily repaired will not constitute cause for rejection.

7805 - 4 MEASUREMENT

7805 - 5 PAYMENT

- 5.01 Payment for FABRICATION OF PRECAST PRESTRESSED CONCRETE GIRDERS will be at the contract lump sum price. The lump sum price will be full compensation for the supply of materials, fabrication and delivery f.o.b. destination.