ITEM 515 PRESTRESSED CONCRETE BRIDGE MEMBERS

515.01 Description. This work consists of preparing shop drawings and manufacturing, testing, fabricator performed quality control and documentation, and handling, transporting, storing, and erecting prestressed concrete bridge members.

515.02 Fabricator Approval Procedure. Select fabricators that are pre-qualified and evaluated by the Laboratory according to ODOT Supplement 1079 and listed by ODOT before the Contract letting Date.

515.03 Levels of Fabricator Qualification. There are three levels of fabricator qualification. The Laboratory will classify each fabricator at the highest level of fabrication it is qualified to perform.

Level	Description of Capabilities
1	Straight strand prestressed box beam members
2	Straight strand prestressed I-beam members
3	Draped strand prestressed I-beam members

515.04 General. Produce all members according to Item 511, except as otherwise specified herein.

515.05 Fabricator Documentation Responsibility. The fabricator shall keep and maintain records for each project bid line number concerning:

A. Fabricator plant approval.

B. Shop drawing approval.

C. Material test reports.

D. Welding qualifications.

E. Quality Control Plan (QCP) per ODOT Supplement 1079.

The fabricator shall provide access to the above records for audit, inspection, and copying. Provide a copy of the complete records at the completion and final shipment of the work. The Fabricator shall retain all documentation for at least 5 years from the date of final shipment from the fabrication shop.

The fabricator shall document all Quality Control (QC) activities to verify the fabrication conforms to the specification requirements. QC activities include material quality checks, dimensional checks, weld inspections, strand tensioning procedures, release procedures, post-pour inspections, concrete strengths at release of strand and final strength of concrete before shipment, cleaning operations, coating applications, final QC inspections, repairs and all other QC procedures required to provide a prestress concrete member conforming to the specifications.

ODOT Supplement 1079 defines the quality control plan evaluation process and quality control plan enhancement process

The City will perform a quality assurance (QA) evaluation of the fabricator's quality control performance using forms in ODOT Supplement 1079 and will include both validation of the fabricator's actual records of inspection and City inspection.

515.06 Shop Drawings. Provide shop drawings conforming to 501.04 and the following requirements.

Include all details, dimensions, dimensional tolerances, size of materials, lifting devices, inserts, reinforcing steel supports, fabricator incorporated reinforcing, piece mark diagrams for field connection and erection of any steel and all prestress members, and all other information necessary for the complete fabrication and erection of the prestressed members. Show all items that will be incorporated into each prestressed member.

Provide the detensioning procedure and pattern conforming to 515.16.

515.07 Pre-Fabrication Meeting. At least 7 days after the City receives shop drawings, conduct a pre-fabrication meeting at the fabricator's facilities, or another location agreed to by all parties.

As part of the pre-fabrication meeting request, provide a initial fabrication schedule for the prestressed beam project including:

A. Start date for fabrication of the project

B. Expected phasing of fabrication, if any

C. Number of workdays for the project and length of work day

D. Quality control final inspection date

The fabricator's production manager, quality control specialists (QCS) for the project, the City's inspector, and the Contractor, or its designated representative, shall attend the meeting. The meeting is to review fabrication issues, including information on shop drawings, previous QC/QA inspection issues, QC and Quality Assurance inspection hold points, unique and special fabrication items, and special processes. The QCS will

conduct the meeting and record and distribute meeting minutes that document all issues discusses. Begin fabrication when all meeting issues have been resolved.

The Engineer may waive the pre-fabrication meeting if accepted by the Fabricator and the Contractor. If Contractor submitted shop drawings do not comply with the requirements of 515.06, no pre-fabrication meeting can be scheduled or waived.

515.08 Materials. Furnish materials conforming to:

Reinforcing steel	509
Concrete	515.15
Portland cement	701.01 thru 701.09
Aggregate*	703.02
Air-entraining admixture	705.10
Chemical admixtures for concrete	705.12
Prestressing steel	711.27
Transverse tie rods	711.01

* For fine aggregate, use natural sand for members without a separate wearing course. Modify coarse aggregate as follows:

Do not allow more than 0.4 percent deleterious materials.

For gradation, use No. 57, 6, 67, 68, 7, 78, or 8 size coarse aggregate.

515.09 Materials Approval. The fabricator shall control, test, and validate material requirements for all materials either incorporated into the prestressed fabricated item or supplied under Item 515 as component parts to the fabricated items. The fabricator shall provide ODOT Supplement 1079 documentation to the inspector at the time of final inspection.

The City will not sample materials at the fabricator's shop for City approval. The City will randomly sample materials to verify the fabricator's performance.

515.10 Casting Beds. Use steel or concrete casting beds set above grade to ensure the beds remain above the accumulation of water resulting from production and curing operations. Design beds and abutments capable of safely resisting all forces applied to them without appreciable movement or deflection. These forces include compression and eccentric forces due to end-jacking operations, forces at hold down points when draped strands are used, and downward forces due to the dead weight of the members.

515.11 Weather Conditions During Production. Make temperature change adjustments to initial strand tensioning according to PCI Quality Control Manual 116.

A. Cold Weather. Conform to the requirements of this subsection if the ambient air temperature is below 50 °F (10 °C). Heat mixing water, aggregates, or both as necessary to produce a concrete temperatures from 50 to 70 °F (10 to 21 °C) when placed. Do not allow water heated above 150 °F (66 °C) to directly contact the cement. Do not place concrete against forms, reinforcing steel, prestressing strand, or other hardware materials with a temperatures below 32 °F (0 °C).

Do not place concrete when the ambient temperature with sustained wind chill factor at the point of concrete placement is below 0 °F (-18 °C).

B. Hot Weather. If the ambient temperature is above 90 °F (32 °C) cool the mixing water, aggregates, or both, as necessary to produce a concrete temperature from 70 to 90 °F (21 to 32 °C). Do not place concrete against forms, mild reinforcing steel,

prestressing strand, or other hardware materials with a temperature greater than 120 °F (49 °C).

Water fog spray forms, mild reinforcing steel and strand just prior to placing the concrete. Cover beams immediately after casting to prevent surface drying.

Do not place concrete when the ambient temperature at the point of concrete placement is above 100 °F (38 °C).

C. Inclement Weather. If a rainfall event begins after placement of concrete in the forms has begun, provide cover and complete only the beam that had concrete in it when the rain began. Provide immediate cover over previously poured concrete, not yet cured. Resumption of concrete placement is permitted after the rainfall stops.

515.12 Equipment. Provide hydraulic jacks of sufficient capacity and stroke to tension strands. Use either single or multiple strand tensioning. Provide tensioning jacks equipped with automatic cutoff valves and equipped with 6 inch (150 mm) minimum diameter gages that provide readings at 500-pound (2 kN) increments. Calibrate gages for the jacks with which they are to be used. Have a graph or table showing the calibration available for the inspector. Calibrate jacks according to a method acceptable to the Laboratory at least every 12 months or as required by the Engineer. Maintain calibration documentation as part of the project's QC inspection records.

Design the jacking system to ensure uniform stress in all strands. If simultaneously tensioning multiple strands, use approved types of dynamometers to equalize the initial stress on all strands before applying the full tensioning load with the master jack. Provide dynamometers with sufficient capacity to ensure that the desired readings are in the middle to upper range.

515.13 Inspection Facilities. The fabricator shall provide the inspector office accommodations conforming to the following requirements:

A. Minimum floor area of 120 square feet (11 m^2).

B. Minimum ceiling height of 7 feet (2.1 m).

C. Adequate working and storage facilities, work space, lighting, electrical outlets, lockable files or cabinets and ventilation.

D. Heat capable of maintaining a temperature of not less than 68 °F (20 °C).

E. Telephone with direct access to an outside trunk line for the inspector's exclusive use.

F. A set of keys for the lockable files or cabinets in the office.

515.14 Construction Methods. Use metal forms capable of producing members within the tolerances shown on the plans. Forms made of material other than metal may be used for bulkheads and voids. Ensure that the surfaces of the forms in contact with the concrete are smooth and the joints between panels are tight. The soffit form shall have a plane surface at right angles to the vertical axis of the members and have the two bottom edges beveled 3/4 inch (19 mm) with a triangular strip built into the forms. Increase the length of the forms for elastic shortening and normal concrete shrinkage, and design the forms to accommodate this movement.

Provide water-resistant formwork for box beam voids constructed of a material that resists breakage and deformation during placement of concrete. Provide form material that does not excessively increase the dead load of the beams.

Prevent the release agent from contacting the prestressing strands or reinforcing steel.

Install and assemble reinforcing steel according to the approved shop drawings. If authorized, weld reinforcing cages using welders qualified to AWS D1.4. Do not weld epoxy coated or galvanized reinforcing steel unless approved by the Engineer. Repair all coating areas damaged by welding according to the coating manufacturer's instructions. Reject reinforcing steel with a loss of cross-section of reinforcing caused by welding.

Provide a protective covering for the prestressed steel from the elements until the strand is pulled into the bed. Accurately place strands in the positions shown on the shop drawings. Do not use strands with kinks, bends, nicks, broken wires, scale, loose rust, or other defects. The fabricator may use slightly rusted reinforcing steel provided the rust is not sufficient to cause visible pits. Before placing the concrete, carefully clean the strands of all dirt, grease, oil, or other foreign matters. Do not splice strands within a member.

Tension strands uniformly to the stress indicated on the shop drawings. If multiple stands are stressed simultaneously, use dynamometers to equalize the initial stress on all strands before applying full tension load with master jack. Measure the required stress in the strands using the calibrated jacking equipment gages, and check the measured stress by the elongation of the strands. If the stress from the gages and the measured elongation are not within a 5 percent tolerance of the design, stop stressing the strands and determine the reason for the differences. The quality control specialist shall keep a record of the jacking forces and elongations of all strands. Secure the strands by suitable anchorage devices capable of developing at least 85 percent of the ultimate strength of the strands. The anchorage shall not allow the strand to slip after the tensioning operation.

If using draped strands, the loss of stress due to friction shall not exceed 5 percent. Tension the strands at both ends. The quality control specialist shall measure the loss due to friction by a procedure approved by the Engineer. Place hold-down points within 3 inches (90 mm) of the locations shown on shop drawings and within 12 inches (0.3 m) of the locations shown on the plans.

515.15 Concrete. The fabricator shall provide concrete mix designs to the Laboratory. The submittal will include:

A. Test data showing the mix achieves the required 28-day strength when cured by methods used for member fabrication. The strength of the concrete for the mix design approval and during production is determined using sets of two 6" x 12" cylinders or three – 4" x 8" cylinders.

B. Maximum w/c ratio

C. A design and maximum slump

D. Test data showing the mix design achieves 2000 coulombs or less at 90 days when tested per AASHTO T277. Use samples for the test that were mixed without corrosion inhibitors and that were cured with the same methods that will be used to

produce the prestressed concrete bridge members. Do not apply additional cure to samples that have reached the required design strength.

Changes in proportioning, cement, pozzolans or aggregate will require retesting and resubmittal. The Engineer may waive the retests. Provide the waiver request in writing and include all information for the new mix design and a comparison to the previously tested and approved mix design(s).

Deliver concrete according to Item 499, except that 499.03 and 499.04 does not apply. The plastic air content of the concrete before placement shall be 6 ± 2 percent. If the City questions the concrete's placed air content, obtain cores from the prestressed member and have hardened air testing performed by an independent testing lab acceptable to the City. Beams with hardened air contents below 4% will be rejected. Add an approved corrosion inhibiting admixture at the approved dosage and document the dosage that has been incorporated into each batch of concrete.

Maintain the mix design slump during production. Segregation of the mix is not acceptable. Do not exceed the maximum water-cement ratio during concrete production. When using admixtures to increase the slump, use Type F or G as described in 705.12. Do not use calcium chloride or admixtures containing calcium chloride.

For beams containing up to 20 yards of concrete each, make at least two cylinders from both the first and last loads placed on each casting bed, each day. If producing more than 200 feet (60 m) of beam on the same bed, make at least two additional cylinders for each additional interval of 100 feet (30 m) or part thereof. In general, produce the additional cylinders from a load placed in the middle of the additional member length. The QCS shall determine the exact location for these samples.

For beams containing between 20 and 35 yards of concrete, make at least one set of two cylinders per beam. For beams containing more than 35 yards of concrete, make at least two sets of two cylinders per beam.

Determine strength, for both strand release and final shipping, by testing a group of cylinders, which consists of one cylinder from every sample location. Each group of cylinders shall have an average strength of what is specified in the shop drawings, and no individual cylinder shall have less than 95 percent of the specified strength.

The inspector may require additional cylinders from locations were the concrete does not conform to mix design or placement requirements. Include these additional cylinders in the group of cylinders for determining release and final strength.

The fabricator may place concrete in the bottom flange of a box beam before placing the interior forms and reinforcement for the upper portion of the member, provided continuous concrete placement is not interrupted for more than 45 minutes.

Screed the top surfaces of non-composite members and finish the surface with a burlap drag or other means to provide a uniform surface with a gritty texture suitable for waterproofing.

Screed the top surface of composite members and finish the surface with a wire broom, in a transverse direction and penetrating the finished surface approximately 1/4 inch (6 mm) + 1/16 inch (1.5 mm) – 1/8 inch (3 mm).

Immediately after final concrete placement and surface finishing, protect the concrete surface with a suitable enclosure until application of live steam or radiant heat. Assure the enclosure's ambient temperature is at least 50 °F (10 °C). Assure the plastic concrete's temperature before initial set doesn't rise more than 10 °F (5 °C) per hour. Limit the total rise before initial set to less than 40 °F (22 °C) and the maximum temperature to 100 °F (38 °C). Record the times and concrete temperatures before initial set.

For curing with low-pressure steam, do not apply live steam directly onto the concrete forms if it causes localized high temperatures.

For accelerated curing with radiant heat, apply radiant heat using pipes circulating steam, hot oil, or hot water, or using electric heating elements. Minimize moisture loss by covering all exposed concrete surfaces with plastic sheeting, 705.06, or by applying a liquid membrane curing compound, 705.07, to all exposed concrete surfaces. Before bonding field-cast concrete or other materials in the finished structure, remove the curing compound from the shear faces of composite members and other surfaces.

Start initial application of the steam or heat 2 to 4 hours after final concrete placement. If using retarders, start applying the steam or heat 4 to 6 hours after final concrete placement. If determining the time of initial set according to ASTM C 403, these time limits do not apply. Record and report the actual time of concrete placement of the last load, placement of enclosure and initial set time.

Apply live steam or radiant heat so the ambient temperature within the curing enclosure does not gain more than 40 °F (22 °C) per hour until reaching the curing temperature. Do not exceed 160 °F (71 °C). Only use a maximum temperature of 180 °F (82 °C) if the fabricator documents to the City that delayed ettringite or alkali silica reaction is not at issue. Maintain the maximum curing temperature until the concrete has reached the required release strength. De-tension the strands immediately upon completing the accelerated curing. Keep a record of the time the application of heat began, and curing temperatures throughout the entire curing process.

Neatly fill cavities in the exposed surface of beams with nonshrink grout. Clean the concrete, and apply and cure the grout according to the manufacturer's published recommendations. Reject beams with honeycombing that impairs the member's performance.

515.16 Release of Prestressing Strands. Do not release prestressed strands until the concrete reaches a minimum strength of 4000 pounds per square inch (28.0 MPa), or plan defined release strength. Determine strength of concrete by testing cylinders produced according to AASHTO T 23 and cured in the same method as the member. Test cylinders in the fabricator's laboratory. Assure all tested cylinders obtain the required strength of 4000 pounds per square inch (28.0 MPa) or the plan defined release strength. Provide the City the ability to witness the cylinder testing by notifying the inspector before testing.

Before releasing prestressed strands, loosen or remove forms and hold-downs and all other attachments restricting either horizontal or vertical movement of prestressed members. Release the strands immediately upon completing accelerated curing. Heat release and burn the strands simultaneously between each beam and at all exposed points between anchorages, and follow an approved pre-determined pattern, to equalize

the forces being transferred to the various areas of the cross-section of the member. Submit any alternative strand release plans during the prefabrication meeting to Engineer for approval. For heat release, use a low-oxygen flame to uniformly heat at least a 4 inch (100 mm) long section of strand before completely cutting the strand.

515.17 Fabrication Tolerances. Construct all members to conform to the following tolerances.

BEAM DIMENSIONAL TOLERANCES		
Description	**Box Beam**	**I Beam**
Length of beam	±1/8” per 10 ft (1 mm/m) max ±3/4” (19 mm)	±1/8” per 10 ft (1 mm/m) max ±1” (25 mm)
Depth of beam	± 1/4” (6 mm)	+1/2”(13 mm) – 1/4”(6 mm)
Depth of I beam flange including fillets	N/A	± 1/4” (6 mm)
Flange Width	± 1/4” (6 mm)	+3/8”(10 mm) – 1/4”(6 mm)
Flange Thickness excluding fillets a) Top b) Bottom	 + 1/2" (13 mm) + 1/2" (13 mm) – 1/8” (3 mm)	 ± 1/4” (6 mm) ± 1/4” (6 mm)
Width Web	N/A	+3/8”(10 mm) – 1/4”(6 mm)
Width beam walls	+3/8” (10 mm) – 1/4”(6 mm)	N/A
Width of Void	± 1/2” (13 mm)	N/A
Height of Void	± 1/2” (13 mm)	N/A
Box Beam Diaphragm spacing	± 2” (50 mm)	N/A
Deviation from True Vertical	± 1/8” (3 mm)	1/8” per ft (8 mm per m)
Deviation from Skew Angle	± 1/2” (13 mm)	± 1/2” (13 mm)

BEAM ACCESSORY TOLERANCES		
Description	**Box Beam**	**I Beam**
Position of railing anchors	± 1/4" (6 mm)	N/A
Position of lifting Devices	± 6" (150 mm)	± 6" (150 mm)
Positions of anchor dowels and tie rods, inserts	± 1/2" (13 mm)	± 1/2" (13 mm)
Deviation from Skew Angle	± 1/2" (13 mm)	± 1/2" (13 mm)

BEAM STRAND TOLERANCES		
Description	**Box Beam**	**I Beam**
Strand tendon position	± 1/4" (6 mm)	± 1/4" (6 mm)
Strand CG position	± 1/4" (6 mm)	± 1/4" (6 mm)

REINFORCING STEEL TOLERANCES		
Description	**Box Beam**	**I Beam**
Clear cover	-0 + 1/4(6 mm)	-0 + 1/4(6 mm)
Splice lengths	- 1 1/2" (38 mm)	- 1 1/2" (38 mm)
Stirrup spacing In Anchorage Zone	± 1/4" (6 mm)	± 1/4" (6 mm)
Stirrup spacing outside Anchorage Zone	± 1" (25 mm)	± 1" (25 mm)
Stirrup extension above top flange	+1/4"(6 mm) – 1/2"(13 mm)	+1/4"(6 mm) – 3/4"(19 mm)

BEAM SWEEP AND CAMBER TOLERANCES		
Description	**Box Beam**	**I Beam**
Horizontal Sweep Max Gap between beam	±1/8" per 10 ft (1 mm/m) max ±3/4" (19 mm) 1" (25 mm)	±1/8" per 10 ft (1 mm/m) max ±1" (25 mm) N/A
Camber – Deviation from Design camber (DC)*	±1/8" per 10 ft (1 mm/m) max ±1/2" (13 mm)	For member lengths ≤ 80 ft: ± 1/8" per 10 ft (1 mm/m) max ± 1/2" (13 mm) For member lengths > 80 ft: ± 1/8" per 10 ft (1 mm/m) max ± 1" (25 mm)
Design plan camber at release (0 days)= Dcr Design plan camber at paving (30 days old) = Dcp Design plan long term camber (720 days old)= Dltc Formulas For DC [0 – 30 days] = [Dcp-Dcr]* [beam age/30] + Dcr For DC [> 30 days] = [Dltc –Dcp] * [(beam age -30)/690] + Dcp		
Variation in camber between beams in same span	max 1/2" (13 mm)	N/A

515.18 Prestressed Member Acceptance and Repair. Throughout the fabrication process reject all prestressed members not meeting specification requirements.

For all rejected members provide the City with a complete description of the rejection, and unless waived by the Engineer, an Ohio registered professional engineer's written evaluation of the criticalness of the rejection and the professional engineer's proposed repair method that will repair the rejected member to an acceptable condition. The City will determine the acceptability of the member and the repair procedure. If acceptable, the fabricator will only make repairs witnessed by the City's inspector unless waived by the Engineer.

Use the Precast/Prestress Concrete Institute's Manual for the evaluation and repair of Precast, Prestressed Concrete Bridge Products MNL-137-06 as a general guide.

515.19 Handling Storage, Transportation, and Erection.

Handle, store, transport, and erect the members in an upright position. The direction of support reactions during storage and transportation shall be the same as the member will experience in its in-service position. Do not ship prestressed members until the concrete obtains its 28-day design strength and the inspector's approval.

Provide at least 30 inches (762 mm) horizontally between each beam for inspection. Provide at least 8 inches (200 mm) of vertical clearance from the bottom. Use storage support locations as close as practical to the in-service support locations. During storage, provide unyielding horizontal supports and bracing capable of maintaining the members in a vertical position.

Transportation support locations shall be the sole responsibility of the fabricator with respect to member stresses and safe delivery to the job site. If it is necessary to transport the members in a position other than vertical, obtain the Engineer's written approval.

Provide lifting devices capable of withstanding the required loads to lift and erect the members. During erection, accurately place the prestressed beams on their bearings to ensure a uniform load on all bearings. When shifting a member, lift the member up completely off of its bearings. Temporarily brace the first I-beam erected to its substructure support units in the vertical position before releasing the beam from the crane. Tie each subsequent I- beam to the previously braced beam(s). Provide bracing after erection adequate to prevent sliding, tipping, or other movement that may result from high winds, creeping down the grade, or other causes, until placement of the diaphragms. Within any one day erect and brace at least 2 adjacent members in any one span before suspending operations for the day.

Place box beams to ensure a correct fit of the keyways and to ensure proper grouting of the keyways. After placing the beams and installing tie devices, fill the longitudinal keyways using non shrink keyway grouts, 705.22, approved by the Engineer. Mix, install, and cure the grout according to the manufacturer's published recommendations to obtain a design compressive strength of 5000 pounds per square inch (34.5 MPa).

Do not allow vehicular load on an individual prestressed concrete box beam until the grout in the keyway obtains the specified design strength of 5000 pounds per square inch (34.5 MPa).

If erection of prestressed members requires placing cranes or launching devices on previously erected spans, submit erection procedures for approval according to Item 501.

At the Engineer discretion, repair or replace members damaged by improper handling, storage, transportation, or erection.

515.20 Safety Requirements. Provide effective safety measures to prevent injuries to personnel due to breakage of strands or failure of anchorage devices during the tensioning operations. Provide adequate protection and assure the City inspector can perform inspection of beams and manufacturing processes. The City inspector will report any inadequate safety precautions to the plant QCS and to the Engineer if fabricator remedial action is not taken. City inspectors will follow safety rules established by the fabricator, at a minimum. Where fabricator safety rules interfere with the inspectors duties, the process should be altered to allow the inspections to be performed while maintaining the required level of safety.

515.21 Method of Measurement. The City will measure Prestressed Concrete Bridge Members by the number of members.

The City will measure the intermediate diaphragms by the number of each placed.

515.22 Basis of Payment. Payment for prestressed concrete beams include all inserts, sleeves, fittings, reinforcing steel fully or partially encased in the members, and all transverse tie rods necessary to complete this work.

The City will pay for concrete diaphragms, steel diaphragms, and bearing plates or pads, or other expansion materials, as separate items.

The City will not pay for repaired or replaced members damaged by improper handling, storing, transporting, or erecting.

The City will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
515	Each	Prestressed Concrete Non- Composite Box Beam Bridge Members, Level 1
515	Each	Prestressed Concrete Composite Box Beam Bridge Members, Level 1
515	Each	Straight Strand Prestressed Concrete Bridge I-Beam Members, Level 2
515	Each	Draped Strand Prestressed Concrete Bridge I-Beam Members, Level 3
515	Each	Intermediate Diaphragms