

# Special Specification 4072

## Segmental Concrete Bridge Unit



### 1. DESCRIPTION

Construct cast-in-place segmental concrete box girder superstructure according to the plans, this specification, and approved submittals. All superstructure concrete, reinforcing steel, embedded items (with the exception of post-tensioning hardware), and appurtenant items (with the exception of bridge bearings) are included.

### 2. MATERIALS

Furnish materials in accordance with this Item, the details in the plans, and the following Items from the Standard Specifications:

- Item 421, "Hydraulic Cement Concrete,"
- Item 422, "Concrete Superstructures,"
- Item 426, "Post-Tensioning," and
- Item 440, "Reinforcement for Concrete."

### 3. CONSTRUCTION

Design and construct the segmental concrete bridge unit according to the requirements of this Item, the plan details and the following pertinent Items:

- Item 422, "Concrete Superstructures,"
- Item 426, "Post-Tensioning," and
- Item 440, "Reinforcement for Concrete."

The segmental plans and specifications for this project describe a cast-in-place concrete box girder, post-tensioned by 7-wire strands longitudinally and transversely, and erected by the balanced cantilever method, using a form traveler method of construction.

- 3.1. **Contractor Construction Alternates.** The Department will consider the following three contractor alternates, subject to the restrictions outlined in 3.1.4., "Restrictions on Contractor Alternates," and acceptance provisions of 3.1.5., "Acceptance of Contractor Alternates."
- 3.1.1. **Alternate Post-Tensioning Layouts.** Other post-tensioning layouts provided such layouts meet the requirements of this Item and Item 426, "Post-Tensioning."
- 3.1.2. **Alternate Segment Lengths.** Other segment lengths provided such lengths meet the requirements of this Item.
- 3.1.3. **Alternate Erection Methods.** Other erection methods, including precast segmental box girders, provided such methods meet the requirements of this Item.
- 3.1.4. **Restrictions on Contractor Alternates.** Satisfy the following requirements if incorporating an alternate:
- Do not encroach on the horizontal and vertical clearance envelope shown on the bridge layout.
  - Meet the design criteria noted on the plans or in the Specifications.
  - Conform to the contract time defined in the plans, regardless of additional effort to develop the alternate design, including preparation, submittal and approval of plans or calculations.

- Do not use unbonded tendons.
- Locate stressing blocks for an alternate or modified permanent prestressing system's anchorages within the slab, within the webs of the box girders, within reinforced stressing blocks or within full diaphragms at pier segments. Stressing blocks for any temporary prestressing system anchorages may be located within the slabs, in partial depth diaphragms within the box girder, in external systems temporarily anchored to the girders and removed after use, or a combination of any of the above methods. Remove all construction added outside the box girder for temporary prestressing, after it is no longer required.
- Perform design and plan preparation for any proposed alternate under the direct supervision of an Engineer thoroughly knowledgeable in the design of post-tensioned segmental concrete bridges. Plans and calculations must be prepared, signed and sealed by a Professional Engineer licensed in the State of Texas.

- 3.1.5. **Acceptance of Contractor Alternates.** Base project bid on the design and details shown on the plans. The Engineer will evaluate alternates against the quality of the structure detailed on the contract plans, after award of the contract. The Engineer may reject an alternate if, in the sole opinion of the Engineer, the alternate results in a structure of lesser quality than what is detailed in the contract plans.
- 3.2. **Construction Methods.** The plans show a basic schematic method for segment construction. Additional details and drawings are required to describe the fabrication and erection of the structure. Design, construction and operation of all erection equipment are the responsibility of the Contractor. Incorporate equipment consistent with the erection concept in the contract plans to assure compatibility with the overall design. Do not commence segment construction until the fabrication and erection details are submitted to the Engineer. Refer to Section 4.3 of this Special Specification.
- 3.2.1. **Construction Tolerances.** Do not exceed 1/8 in. maximum differential between outside faces of adjacent segments in the erected position. Do not exceed 0.001 ft. per foot deviation from the theoretical transverse slope difference between 2 successive segment joints. Do not exceed 0.003 ft. per foot deviation from the theoretical longitudinal slope difference between 2 successive segments. Compensate for any deviations within a single segment by adjusting dimensions of remaining segments so the overall dimensions of the completed structure conform to the dimensions shown on the plans.
- 3.2.2. **Horizontal and Vertical Alignment.** Carefully check elevations and alignments at each stage of construction and correct as necessary to avoid any possible accumulation of errors. Perform surveying activities at a time that minimizes temperature effects. Utilize surveying methods with an accuracy of  $\pm 0.125$  in. Construct expansion segments according to the final longitudinal alignment, grade and cross-slope. Construct final segments (end segments at transition bents and final free cantilever segments at midspan) such that the horizontal and vertical alignment is within 3/16 in. of that required by the approved construction plans. Correct any deviation from the required alignment based on a method submitted to the Engineer. Refer to Section 4.4 of this Special Specification.
- 3.2.3. **Casting Requirements.** Cast segments using the materials, details and procedures specified herein, as noted on the plans, or as directed by the Engineer. Do not begin casting segments without approval of the shop drawings, required computations, and the post-tensioning system.
- 3.2.3.1. **Forms.** The design and engineering of the forms, form travelers, and falsework, as well as their construction, is Contractor responsibility. Form all exposed surfaces of each superstructure element with similar material to produce similar concrete surface textures, color, and appearance. Conform to the formwork requirements in Section 422.4.2 unless noted otherwise below, and Section 427.4.3.4, "Off-the-Form Finish." Do not commence casting operations until forms have been inspected and approved by the Engineer.

Clean and treat faces of all forms, other than end headers, with form oil or other bond breaking coating prior to placing concrete. Use flax soap and talc, or other approved material, as a bond breaker between the end face of segment and end headers. Clean all forms thoroughly prior to each casting operation. Accurately survey forms on a monthly or more frequent basis to monitor settlements and distortion. Do not use forms that fail to meet the specified casting tolerances. Repair worn, damaged or otherwise unacceptable forms.

In addition, provide a forming system capable of:

- Producing the segments within tolerances.
- Accommodating blockouts, openings and protrusions.
- Adjusting to changes in segment geometry as shown on the plans, and correcting previous minor casting errors to prevent accumulation.
- Stripping without damage to the concrete.
- Providing a tight, leak proof joint to the previous segment.
- Positioning and connecting ducts in a manner to hold their position and prevent intrusion of grout.
- Where sections of forms are joined on exterior faces of the segment, do not exceed an offset of 1/16 in. for flat surfaces and 1/8 in. for corners and bends. Do not exceed an offset of 1/8 in. between adjacent matching faces of cast-in-place segments.

3.2.3.2. **Preparation for Casting.** Exercise care in the setup of each segment. Properly position and support all materials to be encased within the concrete of the segment. Make provisions for all projections, recesses, notches, openings, and blockouts shown in the plans. Exercise extreme care in positioning the next segment cast in relation to the previously cast segment. Clean and remove laitance and form release agents from the abutting surface of the previously cast segment before casting the next segment.

3.2.3.3. **Embedded Items.** Fabricate and place reinforcing steel in accordance with the plans, Item 440, "Reinforcement for Concrete," and this special specification. Do not remove reinforcing steel to obtain proper alignment of stressing ducts. If any reinforcing steel cannot be fabricated to clear the ducts, replace using additional bars with adequate lap lengths as approved by the Engineer.

Position embedded ducts for tendons in accordance with Item 426, "Post-Tensioning." Properly fabricate and identify ducts associated with a varying tendon alignment so proper positioning is assured and can be verified after casting. Indicate the method of identification and positioning ducts on the shop drawings.

Immediately prior to installation of the prestressing steel, demonstrate to the Engineer that all ducts are unobstructed and free of water and debris.

3.2.3.4. **Concrete.** Provide and place concrete in accordance with the plans, Item 422, "Concrete Superstructures," and this special specification. Do not include any construction joints within a segment, except as noted in the plans.

3.2.3.5. **Tolerances.** Meet the tolerances for casting of superstructure segments shown in Table 1. Make segment to segment dimensional adjustments as necessary to compensate for any deviations within a single segment so that the overall dimensions of the completed structure conform to the dimensions shown on the plans. Meet placement tolerances for reinforcing steel as shown in Item 440, "Reinforcement for Concrete."

Ensure superstructure conforms to required grade and alignment as shown in the plans after erection, final post-tensioning, and final corrections/adjustments, with due consideration of creep and superimposed dead load deflections.

**Table 1**  
**Casting Tolerances**

Dimension	Tolerance
Web Thickness	± ¼ in
Depth of Bottom Slab	± 3/16 in
Depth of Top Slab	± 3/16 in
Overall Depth of Segment	± 3/16 in
Overall Width of Segment	± ½ in
Length of Segment	± ½ in
Wingtip to Centerline	± 1/4 in
Diaphragm Dimensions	± 3/8 in
Tendon Hole Locations	± 1/4 in

- 3.2.3.6. **Form Removal.** Leave weight-supporting interior forms in-place until the concrete has attained a compressive strength of 3500 psi but no sooner than 48 hrs. after placement of concrete. Stress transverse and longitudinal post-tensioning after the concrete reaches the release strength specified on the contract plans. Do not remove remaining load-supporting forms until stressing operations are complete and at least 48 hrs. have elapsed since placement of concrete. Exercise care in removing the forms to prevent spalling and chipping of the concrete. Maturity methods may be used to assess early age compressive strength of concrete as outlined in Item 421, "Hydraulic Cement Concrete."
- 3.2.3.7. **Finishing and Curing.** Provide Off-the-Form Finish for all surfaces, except riding surfaces, as described in Item 427, "Surface Finishes for Concrete." Water cure the top surface of the top slab for 4 days, in accordance with Section 422.2.7 "Curing Materials", 422.4.7 "Finish and Interim Curing of Bridge Slabs", and 422.4.8, "Final Curing". Locate curing mats or blankets as necessary to avoid interference for placement and launching operations of the form traveler. Maintain curing in these areas of interference as much as possible.
- Do not use membrane curing for the segmental concrete bridge unit.
- Minor or nonstructural cracks or checks, other than those in the deck, on the surface of the member which, as determined by the Engineer, do not extend to the plane of the nearest reinforcing steel are acceptable unless they are numerous and extensive. Deck cracks, diagonal cracks due to torsion, longitudinal cracks that follow stressing tendons or any cracks which extend into the plane of the reinforcing steel and/or prestressed tendons are subject to a structural review prior to acceptance. If found acceptable, repair cracks by "veeing" out 1/4 in. deep and wide and sealing with epoxy, or by epoxy injection as directed.
- Repair minor breakage, spalling or honeycombing (not over 1 in. deep) in accordance with a repair procedure approved by the Engineer. Major breakage or honeycombing in excess of that specified is subject to structural review. If found to be satisfactory, repair these areas as directed by the Engineer. Repair breakage, spalling or honeycombing on any mating surface prior to casting the mating segment.
- 3.2.3.8. **Ride Quality.** Unless otherwise shown on the plans, measure ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces" and special provisions thereto.

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#### 4. SUBMITTALS

Submit complete details, information, and all applicable drawings of the method, materials, equipment, and procedures proposed to construct the segmental concrete bridge unit.

Submit all items in this Article electronically, unless otherwise noted, as documented in the "Guide to Electronic Shop Drawing Submittal" ([ftp://ftp.dot.state.tx.us/pub/txdot-info/library/pubs/bus/bridge/e\\_submit\\_guide.pdf](ftp://ftp.dot.state.tx.us/pub/txdot-info/library/pubs/bus/bridge/e_submit_guide.pdf)). Review period begins on the following business day if submittals are sent outside of regular business hours.

Show written or stamped indication of approval by the Contractor on all plans, shop drawings, calculations, procedures, and schedules. Refer to the "Guide" as stated above.

- 4.1. **Calculations and Plans for Contractor Construction Alternates.** For review and approval, provide electronic copies of design calculations on 8-1/2 x 11 in. sheets and amended plan sheets on 11 x 17 in. sheets, sealed and signed by a Professional Engineer licensed in the State of Texas. Allow 30 calendar days for review and approval by the Engineer.
- 4.1.1. **Confirmation of Substructure Adequacy.** Submit design calculations for Contractor alternate designs demonstrating conformance to the design criteria noted on the plans and verifying the adequacy of the piers, footings, and foundations. At a minimum, provide:
- Input of boundary conditions, material modulus (E), section area (A), and moment of inertia (I).
  - Magnitude and location of temporary and permanent loads.

- Force and deflection diagrams for axial, moment and shear, with values at critical sections and critical times during construction and service life, for pertinent load cases from the AASHTO LRFD Bridge Design Specification.

4.1.2. **Post Tensioning System.** Submit calculations to substantiate the proposed post-tensioning system in accordance with Section 426.4.2, "Required Submittals."

Conduct field mockup tests for post-tensioning operations. Conduct the field mockup tests in advance of production grouting. Provide the design engineer a written plan at least 4 weeks in advance of the mockup for approval. In the plan, include the following information: test setup, materials, ducts, inlets, outlets, anchorages, pre-stressing elements, grouting and dissection procedure.

4.1.3. **Temporary Works.** Submit design calculations for any falsework, erection equipment or other temporary construction. Include maximum loadings and stresses created in the completed segments due to equipment, forms, and concrete placement with indicated allowances for impact loading. Compute deflections of the forming system during concrete placement.

4.1.4. **Amended Plan Sheets.** Submit amended plan sheets for an alternate design, showing all changes in construction from that in the contract plans. Provide plans comparable to the extent, quality, and appearance of the contract plans.

4.2. **Shop Drawings.** For review and approval, provide electronic shop drawings with borders suitable for printing on 11 x 17 in. sheets.

- Provide a unique shop drawing for each segment and pier table of the bridge. For twin structure bridges, provide separate shop drawing submittals for each structure.
- Call out each variation that the shop drawings have from the requirements of the contract documents. All drawings containing variations must be sealed and signed by a Professional Engineer licensed in the State of Texas, unless amended plan sheets for Contractor Alternates are submitted.
- Provide fully and accurately dimensioned views showing the geometry of the segments including all projections, recesses, notches, openings, blockouts, and other pertinent details.
- Indicate segment reinforcing steel and post-tensioning on fully integrated fabrication plans. Call out any reinforcing steel and tendon conflicts to the attention of the Engineer. Clearly show details of mild steel reinforcing with respect to size, spacing, and location, including any anchorage reinforcing required by the post-tensioning system not shown on the contract plans.
- Call out reinforcing steel from cast-in-place pier that extends into the segmental superstructure.
- Show plan and elevation views of the duct layout for the entire width of structure.
- Show details and locations of all items to be embedded in the segments such as inserts, lifting devices, and post-tensioning hardware.
- Provide details of the post-tensioning system in accordance with Item 426, "Post-Tensioning." Include information for temporary, permanent, and future tendons. Provide details of the anchorages.
- Provide information for the grouting system in accordance with Item 426, "Post-Tensioning."

4.3. **Fabrication and Erection Details.** For review, provide electronic shop drawings with borders suitable for printing on 11 x 17 in. sheets.

4.3.1. **Form Traveler System.** Provide complete details of the fabrication system to be used, including the forms, form travelers and geometry controls. Include details for the following tasks: attaching and advancing the form traveler; adjusting the traveler and forms for calculated deflection; placing concrete; and fixing cantilever ends against changes in position or relative rotation during and following placement of concrete in the closure segment between cantilevers.

4.3.2. **Erection Details.** Submit proposed erection details showing the methods, equipment and construction loads affecting the various structural components. Indicate special erection equipment. Provide a step-by-step

detailed erection procedure. Submit, for review and approval, a structural analysis and any necessary redesign for any deviation from the allowable limits indicated in the plans to assure the structural adequacy of the bridge during construction.

- 4.4. **Geometry Control.** For review, provide electronic shop drawings with borders suitable for printing on 11 x 17 in. sheets.
- 4.4.1. **Geometry Control Method.** Submit a proposed method of geometry control for the casting operation. Provide the following information for the control procedure: a detailed narrative of the geometry control theory, detailed calculation forms, any computer program used to monitor or calculate adjustments, and a set of sample calculations. Include in this proposal all measuring equipment, procedures, and the location of the control points on each segment.
- 4.4.2. **Casting Curve.** Compute a theoretical casting curve based on the actual schedule and construction method. Provide sufficient accuracy to determine control point settings for accurately casting the segments. Consider all deviations from straight line and deformations due to the final required alignment, dead load, future superimposed dead load, erection loads, and post-tensioning stresses including secondary moments, creep and shrinkage
- 4.4.3. **Adjustments.** Produce new erection elevations or casting curves upon a change of construction sequence and schedule.
- 4.5. **Material Samples and Certifications.** Submit for review all material samples and certifications required by the contract documents. Provide specific indication the material satisfies the requirements of the contract documents and clearly identify the material, supplier, product code or number, and the intended use. Unless directed otherwise, submit documentation for materials electronically to the Engineer using the procedures outlined above.
- 4.6. **Contractor's Schedule.** Submit for review a bar graph schedule of segmental construction activities. Provide a bar graph with months as the abscissa and activities as the ordinate. As a minimum, provide the following activities in the schedule:
- Mobilization
  - Shop drawing review.
  - Form fabrication.
  - Erection equipment fabrication.
  - Form assembly.
  - Erection equipment assembly.
  - Foundation installation.
  - Pier construction.
  - Pier table construction.
  - Segment casting.
  - Finishing work (parapets, overlay, expansion joints, clean-up).

Provide the following milestone dates on the schedule:

- Set-up of staging area.
- Initial shop drawing submissions (all major items).
- Delivery of batch plant (each).
- Batch plant operational (each).
- Delivery of forms and erection equipment.
- Forms and erection equipment operational.
- Start of foundation construction.
- Start of pier construction.
- Start of pier table construction.

- Start of segment casting.
- Start of span closures.

Update the bar graph and CPM schedule on a monthly or more frequent basis to reflect job progress.

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**5. MEASUREMENT**

Bridge superstructure constructed under this Item will be measured by the cubic yard of Class "H" Concrete (Segmental)(HPC) using the nominal dimensions and configuration shown on the plans.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal unless modified by Article 9.2, "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

No additional measurement will be made for concrete, reinforcing steel, or post-tensioning tendons required by a Contractor Construction Alternate that are in excess of what is shown in the plans.

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**6. PAYMENT**

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Class H Concrete (Segmental)(HPC)". This price is full compensation for furnishing, hauling, and mixing concrete materials; furnishing, bending, fabricating, and placing reinforcing steel; placing, finishing, curing, and grooving concrete; furnishing all appurtenances; all forms (removable or permanent), erection equipment, and falsework; grinding of deck surface; and equipment, labor, tools, and incidentals.