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Precast Concrete Products
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SPECIFICATION FOR MANUFACTURE AND INSTALLATION OF PRECAST / PRESTRESSED REINFORCED CONCRETE THREE SIDED CROWN-SPAN CULVERT STRUCTURE

1. DESCRIPTION

1.1. This work shall consist of constructing a precast/prestressed reinforced concrete 3-sided rectilinear culvert structure (Crown-Span) in accordance with these specifications and in conformity with the lines, grades, design and dimensions shown on the plans or as established by the Engineer.

2. TYPES

2.1. Precast reinforced concrete ACrown-Span culverts are to be manufactured in accordance with this specification and shall by designated by span, rise, and depth of fill.

3. MATERIAL-CONCRETE

3.1. The concrete for the culverts shall be composed of Portland cement, fine and coarse aggregates, admixtures and water.

3.1.1. Cement - Portland cement shall conform to the requirements of ASTM standard C150-type I, Type II or III cement.

3.1.2. Aggregates - Aggregates shall conform to ASTM Specification C 33, except that the requirements for gradation shall not apply.

3.1.3. Water Reducing Admixture - The manufacturer may use water-reducing admixture for the purpose of increasing workability and reducing water requirement on the concrete.

4. MATERIALS - STEEL REINFORCEMENT AND PRESTRESSING STRANDS

4.1. Reinforcing steel for the culverts shall be fabricated and placed in accordance with the detailed shop drawings submitted by the manufacturer.

4.1.1. Steel Reinforcement - Reinforcement shall consist of welded wire fabric conforming to ASTM specification A185 or A497, or deformed billet steel bar reinforcing to ASTM specification A615, Grade 60.

4.1.2. Prestressing Strands - Stress-relieved steel strands for prestressed concrete shall conform to ASTM Specification A416. All prestressing strands shall be sized as indicated on plans and shop drawings and shall be 7 wire stressed relieved Grade 270.

5. MANUFACTURE

5.1. Mixture - The aggregate, cement and water shall be proportioned and mixed in a batch mixer to produce a homogeneous concrete meeting the strength requirements of this specification.

5.2. Curing - The precast concrete culvert unit shall be cured for a sufficient length of time so that the concrete will develop the specified compressive strength in 28 days or less. Any one of the following methods of curing or combinations thereof shall be used.

5.2.1. Steam Curing - The culverts may be steam cured by a system that will maintain a moist atmosphere.

5.2.2 Water Curing - The culverts may be water cured by any method that will keep the sections moist.

5.2.3. Membrane Curing - A sealing membrane conforming to the requirements of ASTM Specification C309 may be applied and shall be left intact until the required concrete compressive strength is attained. The concrete temperature at the time of application shall be within ∀ 10 degrees F of the atmospheric temperature. All Surfaces shall be kept moist prior to the application of the compound and shall be damp when the compound is applied.

5.2.4. Forms - The forms used in manufacture shall be sufficiently rigid and accurate to maintain the culvert dimensions within the permissible variations given in these specifications. All casting surfaces shall be of smooth material.

5.2.5. Handling - Handling devices or holes shall be permitted in each culvert for the purpose of handling and setting.

5.2.6. Storage - the culverts shall be stored in such a manner as to prevent damage.

6. DESIGN

6.1. The culvert dimensions and reinforcement detail shall be as prescribed in the plans and shop drawings provided by the manufacturer subject to the provisions of this specification. The minimum concrete compressive strength shall be 5,000 psi. The minimum steel yield strength shall be 60,000 psi.

6.2. Placement of Reinforcement - The cover of concrete over the outside circumferential reinforcement shall be 1-inch minimum. The cover of concrete over the inside circumferential reinforcement shall be 1-inch minimum. The clear distance of the end circumferential wire shall not be less than one inch nor more than two inches from the end of the culvert. Reinforcement shall be assembled utilizing single or multiple layers of welded wire fabric, or utilizing a single layer of deformed billet-steel bars.

6.3. Laps, welds, and Spacing - Tension splices in the circumferential reinforcement shall be made by lapping. For smooth welded wire fabric, the overlap shall meet the requirements of ACI 12.9 and 12.20. For deformed welded wire fabric, the overlap shall meet the requirements of ACI 12.8 and 12.19. For deformed billet-steel bars, the overlap shall meet the requirements of ACI 12.2. For splices other than tension splices, the overlap shall be a minimum of 12 inches. For welded wire fabric and deformed billet-steel bars, the spacing center to center of the circumferential wires in a wire fabric sheet shall not be less than two inches nor more than four inches.

6.4. Placement of Prestressing Strands - The centerline of the prestressing strands shall be located 3 inches from the bottom of the top slab.

6.5. For multiple cell installation see paragraph titled AMultiple Cell Installation in section 15.

7. PERMISSIBLE VARIATIONS

7.1. Internal Dimensions - The internal dimensions shall not vary more that 1% of design dimension. The haunch dimension shall not vary more than : inch from the design dimension.

7.2. Slab and Wall thickness - The slab and wall thickness shall not be less than that shown in the design by more than 5%. A thickness more than that required in the design shall not be cause for rejection.

7.3. Length for Opposite Surfaces - Variations in laying length of two opposite surfaces of the culvert shall not be more than : inch in any culvert section, except where beveled ends for laying of curves are specified by the purchaser.

7.4. Length of Section - The under run in length of a section shall not be more than 2 inch in any culvert.

7.5. Position of Reinforcement - The maximum variation in position of the reinforcement shall be $\forall$ 2 inch. In no case shall the cover over the reinforcement be less than ε inch for the outside circumferential steel or be less than ε inch for the inside circumferential steel as measured to the external or internal surface of the culvert. These tolerances and cover requirements do not apply to mating surfaces of the joints.

7.6. Area of Reinforcement - The areas of steel reinforcement shall be the designated steel areas as shown in the manufacturer's shop drawing. Steel areas greater than those required shall not be cause for rejection. Permissible variation in diameter of reinforcement shall conform to the tolerance prescribed in the ASTM specification for that type for reinforcement.

7.7. Position of Prestressing Strand - The maximum variation and position of the prestressing stand shall be $\forall$ 2 inch in the vertical and horizontal dimension, and in no case shall the strand be less than 2-2 inches from the bottom of the top slab.

7.8. During stress relief, the prestressing strand shall be cut at a point not less than 3 inch from the

face of the unit walls. The void created by this stress relief shall be sealed to protect the prestressing strand by the manufacturer in a manner such that the unit will meet all the test requirements of this specification.

8. TESTING AND INSPECTION

8.1.1. Type of Test Specimen - Concrete compressive strengths shall be determined from compressive tests made on cylinders. A minimum of six cylinders shall be made during each production run. There will be two cylinders for release testing and four for design testing. A production run shall be considered continuous if not interrupted by more that 3 consecutive days.

8.2. Compressive Testing - Cylinders shall be made and tested as prescribed by the ASTM C39 specification.

8.3. Acceptability of Cylinder Tests - Not more than 10% of the cylinders tested shall fall below the design strength. In no case shall any cylinder tested fall below 80% of the design strength. If the cylinder test fails to meet the acceptability requirements as outlined above, the manufacturer shall have the option of performing a core test. For core testing, one core shall be cut from a culvert section selected at random from the production run.

8.4. Acceptability of Core Tests - When the compressive strength of the core is less than the design concrete strength, the culvert from which the core was taken shall be rejected. Two culverts from the remainder of the group shall be selected at random and one core shall be taken from each. If the compressive strength of both cores is equal to or greater than the design concrete strength, the compressive strength of the remainder of the group of culverts is acceptable. If the compressive strength of either of the two cores tested is less than the design concrete strength, the remainder of the group of culverts shall be rejected or at the option of the manufacturer each culvert of the remainder of the group shall be cored and accepted individually, and any of these culverts that have cores with less than the designed concrete strength shall be rejected.

8.5. Plugging Core Holes - The core hole shall be plugged and sealed by the manufacturer in a manner such that the culvert will meet all of the test requirements for this specification. Culverts so sealed shall be considered satisfactory for use.

9. JOINTS

9.1. The precast reinforced concrete bridge sections may be produced with grout filled keyways or square ends. The ends of the bridge sections shall be of such design and so formed that, when they are laid together, they will make a continuous line of bridge sections with a smoother interior free of appreciable irregularities, all compatible with the permissible variations in Section 8.

9.2. Non-shrinking grout shall be placed in the keyways. For the grout, the cement, sand and water shall be mixed first after which the admixture shall be added. Batch size shall be

limited so placement can be completed within 30 minutes. Water shall not be added to increase flow ability, which has been decreased by delayed use of the mortar.

10. WORKMANSHIP AND FINISH

10.1. The culverts shall be substantially free of fractures. The ends of the culverts shall be normal to the wall and centerline of the culvert section within the limits of the variation given in this specification, except for bevel ends where specified. The surface of the culverts shall be provided by a smooth steel form or troweled surface. Trapped air pockets causing surface defects shall be considered as part of the smooth steel form finish.

11. REPAIRS

11.1. Culverts may be repaired if necessary because of imperfections in manufacturing or handling damage and will be acceptable if the repairs are sound, properly finished and cured, and the repaired section conforms to the requirements of this specification.

12. INSPECTION

12.1. The quality of material, the process of manufacturing, and the finished culvert shall be subject to inspection by the purchaser.

13. REJECTION

13.1. Culverts shall be subject to rejection if they fail to meet any of the specification requirements. Individual culverts may be rejected because of any of the following:

13.1.1. Fractures or cracks passing through the wall.

13.1.2. Honeycombed or opened texture.

13.1.3. The exposure of the ends of longitudinal, stirrups, or spacers that have been used to position the cages during the placement of the concrete is not cause for rejection.

14. MARKING

14.1. Each culvert shall be clearly marked by water proof paint or scoring into the concrete. The following shall be shown on the inside of the vertical leg of the culvert section:

14.1.1. Culvert Section Span x Culvert Rise x Height of Fill
14.1.2. Date Manufactured
14.1.3. Name of Trademark of Manufacturer

15. CONSTRUCTION REQUIREMENTS

15.1. Footings - The culvert shall be installed on precast or cast-in-place concrete footings. The Engineer shall determine the design size and elevation of the footing. The footings shall be given a smooth float finish and shall reach a compressive strength of not less that 3,000 psi before placing the culvert section. The completed footing surface shall be constructed in accordance with the grade shown on the plans. When tested with a 10 foot straight edge, the surface shall not vary more that 3 inch in 10 feet.

15.2. Placement of Culverts - The culverts shall be placed as shown on the Engineer=s plan and drawings. Special care shall be taken in setting the culvert to the true line and grade. Culverts shall be set on plastic or steel shims, located at support points as recommended by the manufacturer. A minimum of 2" gap shall be provided between the footing and the bottom of the culvert vertical legs. The gap shall be overfilled with 3,000-psi (minimum) cement grout prior to the placing of the culverts, and the culverts shall be placed in the wet grout to allow uniform bearing.

15.3. Multiple Cell Installations - The designs given herein are for single cell precast ACrown-Span≅ units. The units may be used in parallel for multicell installation if means of positive lateral bearing by continuous contact between the sides of adjacent units are provided. Compacted earth fill, granular backfill, or grouting between the units are considered means of providing such positive bearing.

15.4. External Protection of Joints - Joints between sections may be butt or grouted keyway as shown on the plans. Butt joints shall be covered with filter fabric or a seal. The cover shall be a minimum of twelve (12) inches wide and shall be cemented to the bridge sections. Care shall be exercised so as not to clog the filter over the joint. Filter fabric shall be used where soil particle size is 0.149 mm or larger and where there is no vehicular or pedestrian traffic under the structure. In cases where particle size is smaller than 0.149 mm or there is a vehicular or pedestrian traffic under the structure, the joint shall be covered with a seal. Filter fabric shall be woven, such as Mirafi 700X or equal. During the backfill operation, care shall be taken to keep the joint wrap in its proper location over the joint.

15.5. The joint wrap shall be cut in two lengths to allow an overlap of 4 to 6 inches at the top of the unit. After the ACrown-Span≅ unit has been set, the joint wrap shall be positioned directly over the butt joint of the adjoining ACrown-Span≅ unit. Beginning at the bottom of two adjoining units, stretch one end of the gasket tightly and press firmly against the wall of the unit. Stretch the other end up tightly and overlap near the center of the top of the unit. The gasket should be stretched at least 10% if using the ACadillac≅ gasket. Using the hammer, pound in at least three of the clips provided for the purpose of securing the overlap. Backfill completely around the joint.

15.6. If AMacWrap≅ joint sealant is used, the same procedure as outlined above shall be used, with the exception of stretching the sealant. AMacWrap≅ is furnished with a protective paper. The protective paper, which is against the mastic, shall be removed when the gasket is applied to the joint unstretched. A lap of 6 inches is recommended.

15.7. During the backfilling operation care shall be taken to keep the joint wrap in its proper location over the joint.

15.8. Backfill - Backfill shall be considered as all replaced excavation and new embankment adjacent
to the structure and wingwalls. The project construction and material specifications, which include the specifications for excavation for structures and roadway excavation and embankment, shall apply. This includes Section 125-8.2 of the FDOT Standard Specifications for Road and Bridge Construction, 1991. No backfill shall be placed against any structural elements until the Engineer has approved them. Backfill against a waterproofed surface shall be placed carefully to avoid damage to the waterproofing material. Mechanical tampers or approved compacting equipment shall be used to compact all backfill and embankment immediately adjacent to each side of the structure. The backfill within four (4) feet of each side of the structure shall be placed in lifts of eight (8) inches or less (loose depth). Heavy compaction equipment shall not be operated in this area. As a precaution against introducing unbalanced stresses in the structure and wingwalls, the backfill shall be placed and compacted to the same elevation on both sides of the structure and wingwalls before proceeding to the next layer. Backfill in front of wingwalls shall be carried to ground lines shown in the plans.

Crown - Span™
Fact Sheet

What is "Crown-Span"?
A three sided reinforced concrete
Structure
Spans: 16ft. to 40ft.
Rises: 2ft. to 10ft.

What is its uses?
Bridge replacements
New Bridges
Drainage structures
- Culverts
- Use instead of multiple boxes
- Drainage channels

Why "Crown-Span"?
Superior hydraulics
Structural integrity
Unobstructed flow
Confirms to Local, State, & National Standards
Ease of construction
Speed of construction
Quality control during manufacture
Economy

Design
Rigid frame design
Prestressed top slab/Reinforced legs & top
Incorporates all AASHTO Bridge Design Standards
Computer Design Analysis – Analyzes the complete unit; moment, sheer, & thrust at points throughout the unit

Input Data
Span X Rises (feet)
Depth of cover to the top of unit (feet)
Number of sections
Number of lanes (highway/street)
Support configuration – pinned or roller
Unit Geometry
- Top slab thickness (inches)
- Sidewall thickness (inches)
- Haunches, length (inches)
- Concrete cover over reinforcing steel

Material Properties
- Main reinforcing yield stress (ksi)
- Distribution reinforcing yield stress (ksi)
- Main reinforcing type
- Number of layers
- Design concrete strength (ksi)
- Concrete Density (pcf)

Load Factors
- Dead load (Shear & Moment)
- Dead Load (Thrust)
- Live Load (Shear & Moment)
- Live load (Thrust)

Soil Load Data
- Soil Density (pcf)
- Minimum lateral pressure coefficient
- Maximum lateral pressure coefficient
- Soil structure interaction factor

Live Load Data
- AAS|HTO HS-Series load condition
- Series magnitude (tons)
- Direction of the load
  - Parallel to culvert flow
  - Transverse to culvert flow

Surcharge Loads
- Uniform vertical load
- Varying lateral load

Fluid Loads
Prestress Design
Handling Data

Design Analysis
Echo Input Data
Displacement Matrix
End Forces
Service Forces of each Load Condition
- Moments
- Shears
- Thrusts

Service Load Forces
- Moments
- Shears
- Thrusts

Ultimate Load Forces
Handling Forces
Prestress Design
Flexure Design Table
Shear Design Table

Design Analysis
Installation Data
Loading Data
Material Properties
Geometry of Unit
Reinforcing Steel Data
Prestress Data
Footing Data