SPECIAL PROVISION

PROJECT # XXXXX
PIN # XXXXX

SECTION 02645S

PRECAST CONCRETE BOX CULVERT AND THREE-SIDED STRUCTURES

Delete Section 02645 in its entirety and replace with the following:

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Single-cell precast concrete box culverts and multi-cell precast concrete box culverts, with waterproofing membrane.

B. Precast concrete three-sided structures with waterproofing membrane and precast, or cast-in-place, elements required along the barrel of the structure.

C. Precast concrete secondary elements associated with the structure.

1.2 RELATED SECTIONS

A. Section 02056: Embankment, Borrow, and Backfill

B. Section 02317: Structural Excavation and Backfill

C. Section 03055: Portland Cement Concrete

D. Section 03152: Concrete Joint Control

E. Section 03211: Reinforcing Steel and Welded Wire

F. Section 03310: Structural Concrete

G. Section 03390: Concrete Curing

H. Section 03575: Flowable Fill

I. Section 03924: Structural Concrete Repair

J. Section 07105: Waterproofing Membrane

1.3 REFERENCES

A. AASHTO M 111: Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

B. AASHTO M 270: Structural Steel for Bridges

C. AASHTO LRFD Bridge Design Specifications

D. AASHTO Manual for Bridge Evaluation

E. ASTM C 877: External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections

F. ASTM C 1107: Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

G. ASTM C 1504: Manufacture of Precast Reinforced Concrete Three-Sided Structures for Culverts and Storm Drains

H. ASTM C 1577: Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD

I. ASTM C 1619: Elastomeric Seals for Joining Concrete Structures

J. ASTM C 1786: Segmental Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD

K. Precast/Prestressed Concrete Institute (PCI) Design Handbook

L. UDOT Bridge Management Manual (BMM)

M. UDOT Quality Management Plan (QMP) 505: Precast/Prestressed, and Drycast Concrete Structures

N. UDOT Structures Design and Detailing Manual (SDDM)

1.4 DEFINITIONS

A. Butt Joint – A joint where the surface to be connected is flat and uniform.

B. Box Puller – Hydraulic winches and post tensioning rods, or other mechanical mechanism that pulls uniformly on the box culvert segments to achieve correct fit up of joints and correct compression of joint material.

C. Precast Secondary Elements – Precast elements attaching to the box culvert or three-sided structure system outside of the main barrel such as cutoff walls, aprons, headwalls, wingwalls, return walls and footings.

D. Profile Joint – A step joint in which a raised area on the edge of one segment fits into a corresponding groove in the edge of the other segment to produce a flush surface. Commonly referred to as “tongue and groove” or “bell and spigot” joint.

1.5 SUBMITTALS

A. Shop drawings for review
   1. Fabrication and Installation
      a. Detail all phases of fabrication and construction including layout, joint details, lifting devices, casting methods, and construction placement.
         1) Show that the “bell” or “groove” end of the section faces the upstream direction.
      b. Include details for cast-in-place elements that are included in this item of work and are not detailed in the plans.
      c. Include excavation, bedding, and backfill requirements.
      d. Include joint tolerances.
      e. Note proposed transportation methods.
   2. Include inventory and operating load ratings in a table on the first sheet of the drawings for structures meeting the definition of a bridge.
      a. Provide load rating package according to the UDOT BMM, UDOT SDDM, and the AASHTO Manual for Bridge Evaluation.
      b. The design must result in load ratings for Legal and Utah permit load ratings equal to or greater than 1.05.
   3. Provide the seal of a Professional Engineer (PE) or Professional Structural Engineer (SE) licensed in the State of Utah on the drawings and supporting engineering calculations for the following:
      a. Special designs of precast concrete monolithic box culverts
      b. Precast concrete segmental box (clamshell) culverts
      c. Precast concrete three-sided structures
      d. Foundations for precast concrete three-sided structures
      e. Floor slabs of precast concrete three-sided structures
      f. Lifting devices
      g. Secondary elements

h. Connections between precast and cast-in-place, and precast to precast, members and secondary members
i. Load ratings
j. Other means and methods that require an engineer's design

B. Certificate of compliance for dry cast concrete for information

C. Manufacturer's product data sheets and recommended installation instructions for review for the following products:
1. Non-shrink grout
2. Joint sealant
3. Flexible watertight gaskets
4. Joint wrap

PART 2 PRODUCTS

2.1 MATERIALS

A. Concrete
1. Wet Cast Concrete
a. Class AAA(AE) according to Section 03055.
1) Provide 28-day minimum compressive strength of 5,000 psi.
2. Dry Cast Concrete
a. Provide 28 day minimum compressive strength of 5,000 psi or as shown in the shop drawings and associated calculations.

B. Reinforcing Steel and Welded Wire
1. Coated – Refer to Section 03211.

C. Bedding
1. Granular backfill borrow according to Section 02056
a. Limit soil gradation to 100 percent passing the ¾ inch sieve.
2. Free draining granular backfill when shown according to Section 02056
a. Limit soil gradation to 100 percent passing the ¾ inch sieve.

D. Leveling Course
1. Use gravel or chip limited to 100 percent passing the 3/8 inch sieve.

E. Flowable Fill
1. Refer to Section 03575.

F. Embankment
    1. Refer to Section 02056.

G. Structural Steel
    1. Use AASHTO M 270, Grade 36 steel unless shown otherwise.
    2. Galvanize structural steel items permanently cast into concrete or that are necessary to the performance of the structure.
        a. Galvanize according to AASHTO M 111 after fabrication.

H. Miscellaneous Steel Items
    1. Galvanize or coat steel items permanently cast into concrete.

2.2 JOINT SEALS

A. Use one of the following:
    1. Hydrophilic waterstop strips
        a. Use hydrophilic waterstop strips on segmental box (clamshell) culverts and three-sided structures.
        b. Provide product meeting the following requirements:
            1) Expands or swells to at least 400 percent of its original size in the presence of water
            2. Preformed strip with dry dimension of at least $^{3}/_{4}$ inch by $^{3}/_{8}$ inch
    2. Flexible watertight gaskets
        a. Use flexible watertight gaskets on monolithic box culverts.
        b. Provide product meeting the following requirements:
            1) ASTM C 1619, Class C
            2) Pre-lubricated by the manufacturer

B. Joint seals are furnished by the precaster.

2.3 JOINT WRAP

A. Meet the requirements of ASTM C 877, Type III.
    1. Provide joint wrap at least 12 inch wide.

2.4 WATERPROOFING MEMBRANE

A. Refer to Section 07105.

2.5 JOINT SEALER (STRUCTURES)

A. Refer to Section 03152.

2.6 NON-SHRINK GROUT

A. Provide non-shrink grout suitable for vertical or overhead applications.

B. Refer to ASTM C 1107.

2.7 LIFTING DEVICES

A. Use lifting devices that can support the required vertical and horizontal forces with the applicable safety factors as specified in the Component Handling and Erection Bracing requirements of the PCI Design Handbook.

B. Galvanize according to AASHTO M 111.

2.8 GROUTED SPLICE COUPLERS

A. Refer to Section 03211.

2.9 BOX CULVERTS AND THREE-SIDED STRUCTURES

A. General
   1. Manufacture precast segments in at least 4 ft lay lengths.
   2. Do not locate horizontal and vertical changes in alignment greater than 10 degrees at a joint between precast segments of a precast concrete box culvert.

B. Joint Shape
   1. Provide Profile Joints between precast element segments.
      a. Size tongue and groove to provide at least 6 inch of overlap between adjacent segments.
      b. Do not slope horizontal Profile Joints by more than 5 degrees.
      c. Provide a radius of at least 6 inch at corners when flexible watertight gaskets are used.
      d. Steel “H” section connections are permitted for horizontal joints in segmental box (clamshell) culverts.
   2. Provide Butt Joints where precast element segments join cast-in-place concrete as shown.
      a. Project the reinforcing steel at least 12 inch out of the precast sections or as shown.

C. Precast Concrete Monolithic Box Culverts
   1. Refer to ASTM C 1577.
      a. Select a design earth cover from ASTM C 1577 based on an equivalent weight of material over the culvert, including the additional load for design pavement section and future wearing surface described in the SDDM.
         1) ASTM C 1577 assumes that the soil column over the box is 120 pcf material.
   2. Provide special designs for sizes and loads other than those shown in Table 1 of ASTM C 1577 if the design is not provided.
      a. Prepare special designs according to the SDDM and the AASHTO LRFD Bridge Design Specifications, Section 12.
      b. Provide at least 1 inch concrete cover to reinforcing steel.
      c. Provide at least 2 inch concrete cover to reinforcing steel in the top of the top slab when covered by less than 2 ft of fill.

D. Precast Concrete Segmental Box (Clamshell) Culverts
   1. Refer to ASTM C 1786 with the following exceptions:
      a. Design the structure according to the SDDM and the AASHTO LRFD Bridge Design Specifications, Section 12.
      b. Design for HL-93 live loading.
   2. Provide longitudinal wire spacing of no more than 8 inch for welded wire.
   3. Provide a circumferential wire spacing not greater than 4 inch or less than 2 inch.
   4. Provide at least 2 inch concrete cover to reinforcing steel in the top of the top slab when covered by less than 2 ft of fill.
   5. Provide Profile Joint or sealed steel “H” section connection between lower and upper box sections.
      a. Profile Joints require that the lower portion of the joint be on the outside face of the box culvert.
      b. Steel “H” section connections with joint sealer.
         1) Size steel “H” sections so that gaps between the steel and precast sections are ½ inch wide or less.
         2) Provide Joint Sealer (Structures) along the four vertical interfaces between the steel and the concrete box.

E. Precast Concrete Three-Sided Structures
   1. Refer to ASTM C 1504 for precast concrete three-sided structures with the following exceptions:
      a. Design the structure according to the SDDM and the AASHTO LRFD Bridge Design Specifications, Section 12.
   2. Provide longitudinal wire spacing of no more than 8 inch for welded wire.

3. Provide a circumferential wire spacing not greater than 4 inch or less than 2 inch.
4. Provide at least 2 inch concrete cover to reinforcing steel in the top of the top slab when covered by less than 2 ft of fill.
5. Mechanical connections for three-sided structures
    a. Mechanically connect the exterior sections of precast three-sided structures at top joints which are within 12 ft from end of the structure.
        1) Use at least four mechanical connections per joint with a maximum spacing of 10 ft.
        2) Use galvanized plates, shapes, and hardware.
    b. Connect precast three-sided structures to the footing, pedestal, or slab 2 ft from the outermost exterior edge of the structure at the four corners of the structure
        1) Use a galvanized rigid mechanical connection.
        2) Locate the connection on the interior face of the segment to allow for future inspection.

F. Precast Secondary Elements
1. Design secondary elements and connections according to AASHTO LRFD Bridge Design Specifications and the SDDM.

G. Lifting Devices
1. Provide the number and type of lifting devices required to support the vertical and horizontal forces with the applicable safety factors as specified in the Component Handling and Erection Bracing requirements of the PCI Design Handbook.
    a. Limit diameter of holes for lifting devices to 3 inch when used.
    b. Locate holes to avoid interference with the reinforcing steel.

2.10 FABRICATION

A. General
1. Use a Department prequalified supplier of precast concrete products.
2. Fabricate according to the authorized shop drawings.
3. Permanently mark each precast segment with date of casting and supplier identification.
4. Cast the Department structure number into the top and exposed faces of the headwall at each end of the structure as shown.
5. Provide ¾ inch chamfer on all edges of precast elements.
    a. Do not provide chamfers on Profile Joints or Butt Joints.

6. Form segment ends so that the segments can be laid together to make a continuous line of box segments compatible with the permissible construction tolerances
    a. Fit adjacent precast segments to provide a uniform joint that does not exceed a width of ¾ inch.

B. Concrete Curing – Refer to Section 03390.

C. Quality Control
1. Prevent cracking or damage of precast elements during shipping, handling, and storage.
2. Replace defects and breakage of precast elements.
    a. Members that sustain damage or surface defects during fabrication, handling, storage, hauling, or erection are subject to review or rejection.
    b. Obtain authorization before performing repairs.
    c. Repair work must reestablish the elements' structural integrity, durability, and aesthetics to the satisfaction of the Engineer.
    d. Determine the cause when damage occurs and take corrective action.
    e. Failure to take corrective action, leading to similar repetitive damage, can be cause for rejection of the damaged element.
    f. Cracks that extend to the nearest reinforcement plane and fine surface cracks that do not extend to the nearest reinforcement plane but are numerous or extensive are subject to review and rejection.
    g. Spalls greater than 1 ft in any direction or cracking greater than half the element thickness are cause for rejection.
3. The Engineer may reject box sections when the installation tolerance cannot be met due to casting variations.

PART 3 EXECUTION

3.1 EXCAVATING, TRENCHING, BEDDING, AND BACKFILL

A. Refer to Section 02317.

B. Use a trench width adequate to place and compact bedding material.
1. Outside width of trench is the outside width of structure plus at least two feet on each side.

C. Excavate to at least 12 inch below the bottom of the precast structure unless shown otherwise.

D. Scarify, moisture condition, and compact the top 8 inch of the excavated ground surface to at least 90 percent of the maximum dry density.

E. Place a bedding of at least 10 inch unless shown otherwise.
   1. Level and compact bedding material to provide uniform support of the structure along its entire supported width and length.

F. Place a leveling course of at least 2 inch on top of the bedding.

G. Backfill as shown.

H. Fill the gap between multiple adjacent single cell culverts with flowable fill as shown.

3.2 INSTALLATION

A. General
   1. Inspect precast elements for defects before lowering into trench.
      a. Repair or replace defective, damaged, or unsound precast elements.
      b. Replace damaged gaskets.
   2. Follow the authorized shop drawings
   3. Follow any best practices or requirements from precast manufacture on handling and installation.
   4. Establish working points, working lines, and benchmark elevations before placing elements.
   5. Place precast segments with the bell end of the box facing the upstream direction.
      a. Begin placement from the downstream end when feasible.
      b. Do not place precast elements when water is in the trench.
   6. Prevent soil from being forced into the joint as the box sections are placed.
      a. Remove dirt and foreign material from joints to allow for snug and uniform joint fit.
      b. Do not lubricate gaskets.
   7. Use a box puller to draw the box segment into uniform contact with a maximum of joint gap of ¾ inch.
      a. Disassemble joint, check position of joint sealant, repair alignment, and re-install when adjoining elements cannot be pulled together to meet joint requirements.

B. Apply joint seal to precast elements.
   1. Joint sealant
      a. Apply joint sealant on the inside of the groove (bell) of the box last placed and on the outside of the tongue (spigot) of the box to be set.
      b. Apply joint sealant about 1 inch from the leading edge of the groove and tongue.
      c. Maintain the joint sealant at 70 degrees F or greater during placement.
   2. Flexible watertight gasket
      a. Coordinate with the precaster to reattach gasket if gasket detaches during shipping and handling.

C. Install precast secondary elements
   1. Clean bonding surfaces between elements of debris, dust, and rust before connecting elements.
   2. Place cut-off wall and apron elements as shown.
      a. Adjust the final location of the cut-off wall or apron elements if actual joint gaps cause the final location to vary.
      b. Adjust the height of each apron element by means of leveling devices or shims.
   3. Adjust vertical leveling devices before full release of the apron from the crane to reduce the amount of torque required to turn the bolts in the leveling devices.
   4. Place or pump flowable fill into voids and pockets.
   5. Connect secondary elements to precast concrete box culvert or three-sided structure as shown in the shop drawings.

D. Apply joint wrap to the top slab and side walls at segment joints of box culverts and three-sided structures, and on the back face of secondary elements at joints between elements.
   1. Clean top and sides of concrete surface at segment joints before placing joint wrap.
   2. Apply joint wrap at least 12 inch wide and centered on the joint

3.3 FINISHING RECESSES FROM LIFTING HOLES AND DEVICES

A. Plug lifting holes and lifting device recesses with non-shrink grout.
   1. Finish flush with adjacent concrete surfaces.

3.4 CAST-IN-PLACE CONCRETE

A. Place and finish concrete according to Section 03310.

B. Cure concrete according to Section 03390.

3.5 WATERPROOFING MEMBRANE

A. Apply a waterproofing membrane to the full length of the top slab and side walls.

3.6 REPAIR

A. Repair minor damage to precast elements according to Section 03924 and QMP 505.

END OF SECTION