PRECAST CONCRETE BOX CULVERT AND THREE-SIDED STRUCTURE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Material and procedures for fabricating and installing single cell precast concrete box culverts, multi-cell precast concrete box culverts, precast conventionally reinforced concrete three-sided culvert structures, and ancillary appurtenances such as cutoff walls, aprons, footings, floor slabs, headwalls and wing walls.

1.2 REFERENCES

A. AASHTO LRFD Bridge Design Specifications

B. ASTM C 150: Standard Specification for Portland Cement

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

D. ASTM C 990: Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

E. ASTM C 920: Standard Specification for Elastomeric Joint Sealants

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

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

H. ASCE 26-97: Standard Practice for Direct Design of Buried Precast Concrete Box Sections

I. OSHA

1.3 SUBMITTALS

A. Detailed plans including culvert sizes and wall widths, line layout, joint details and lifting devices.

B. Structural calculations for the precast element. ASTM C 1577 steel areas may be used for box culverts without providing supporting calculations. For special designs, or for sizes and loads other than those shown in Table 1 of ASTM C 1577, engineering calculations shall be required. Engineering calculations shall be performed using software approved by the American Concrete Pipe Association (currently the ACPA approved software is “ET Culvert”; “Boxcar” is no longer being updated and is not approved for use by ACPA). Engineering calculations shall address the following:

1. Box culverts shall be designed as rigid frame sections with a minimum of two (2) separate continuous cages (inner and outer cages) of steel reinforcement. All other specification requirements such as laps, welds, and tolerances of placement in the wall of the box section shall conform to ASTM C 1577.
2. Load combinations shall be designed in compliance with ASCE 26-97, Section 11
3. Design load criteria shall be designed in compliance with ASTM C 1577, including all notes, commentary, and appendices contained within the specification
4. Crack control shall be designed for a Class 2 Exposure in compliance with AASHTO LRFD Bridge Design Specifications, Sections 5 and 12

C. For Three Sided Structures, design the structure in compliance with AASHTO LRFD Bridge Design Specifications, Section 12. Computer aided design calculations may be submitted. Design for HL-93 live loading.

D. Provide the seal of a Professional Engineer (PE) licensed in the State of Utah on drawings and supporting engineering calculations.

E. Allow the Engineer up to seven calendar days to review and approve working drawings and supporting engineering calculations.

F. Foundation material gradation (for over excavation replacement), bedding material gradation or leveling course gradation will be submitted for the Engineers approval.

PART 2 PRODUCTS

2.1 CONCRETE

A. Provide strength and size of the culvert or structure.
B. Use ASTM C 150 or ASTM C 1157 cement unless otherwise specified.
C. Meet the concrete performance requirements per the appropriate manufacturing specification, either ASTM C 1577 or ASTM C 1504.

2.2 REINFORCING

A. Use steel bars or steel welded wire.

2.3 JOINTS

A. Use tongue and groove joints with a bituminous mastic joint sealant that meets the requirements of ASTM C 990.
B. Use a mastic joint sealant with a minimum cross-sectional area of 1 to 1½ square inches.
C. Joint wrap is not required. Use ASTM C 877 if joint wrap is specified.
D. Mortar grout is not required.
E. Joints using mastic joint sealant alone are typically not considered water-tight or pressure rated joints. If an application requires water-tight joints, other methods or materials should be specified.

2.4 LIFTING DEVICES

Provide the number and type of lifting devices required to support the vertical and horizontal forces

A. Use at least four lifting devices for box culvert and three sided structures.
B. Use a minimum safety factor of 4:1 for lifting inserts used in handling and erection of precast concrete box culverts and three-sided structures.
C. Attach to lifting inserts according to manufactures recommendations.
D. Use a maximum diameter of three (3) inches when lifting holes are used. Locate holes to avoid interference with the reinforcing steel.

2.5 MANUFACTURE

A. Precast Concrete Box Culverts:
    1. Meet the requirements in ASTM C 1577.
    2. Special designs for sizes and loads other than those shown in Table 1 of ASTM C 1577 require approval by the Engineer.
    3. Prepare special designs according to AASHTO LRFD Bridge Design Specifications, Section 12.

B. Precast Concrete Three-Sided Structures:
   1. Meet the requirements in ASTM C 1504 with the following exceptions:
      a. Design the structure in compliance with AASHTO LRFD Bridge Design Specifications, Section 12.
      b. Design for HL-93 live loading.

2.6 QUALITY ASSURANCE

A. Manufacture of pre-cast concrete box and three-sided culvert section must be completed in a plant where the quality assurance program has been certified by either the American Concrete Pipe Association (for box culverts) or the National Precast Concrete Association (for three-sided structures).

B. Permanently mark each precast unit with date of casting and supplier identification.

C. Prevent cracking or damage during shipping, handling and storage of precast units.

D. Replace or repair, cracked or damaged precast units at no additional cost to the Owner.

E. Manufacturer shall dry fit box sections in the plant to verify that joints are consistent through the manufacturing process and that the different mating surfaces (i.e. tongue and groove) do not bind during the dry fit test. Dry fitting is defined as placing two box sections together, either vertically or horizontally, without any type of joint sealant in the joints. Dry fitting shall be performed as follows:

   1. Wet cast sections: each section shall be tested
   2. Dry cast sections: a minimum of one test shall be performed per size of box per day of production, or twenty percent (20%) of one day's production, rounded up to the nearest whole number, whichever is greater.
   3. Dry fit tests shall be documented and kept in the manufacturing plant. Documentation shall be made available upon request of the owner.
   4. If the dry fit test shows that the joints are not consistent or the mating surfaces bind, the manufacturer will make the necessary repairs to the products or adjust the manufacturing process necessary to correct the issue.

PART 3 EXECUTION

Meet all applicable local, state, and federal statutes, regulations, codes, etc., including applicable OSHA standards, in the construction of box culverts, three-sided structures and ancillary appurtenances.

3.1 BEDDING AND BACKFILL

A. Over-excavate the material under the box location in compliance with the project specifications to a minimum depth of six (6) inches.
   1. Where unstable material is encountered below the plan foundation, it should be removed to the depth and width directed by the Engineer and replaced.
   2. Rock/boulders encountered at the bedding level (within six inches from the bottom of the box) must be removed and replaced.
   3. Replace over-excavated material with granular backfill borrow or free draining granular material.
   4. Provide a minimum bedding of six (6) inches of granular backfill borrow or free draining granular material.
   5. Limit soil gradations for bedding material to a ¾-inch maximum particle size.

B. Provide a two-inch leveling course in addition to the bedding material.
   1. Excavate the area to the appropriate depth to accommodate the backfill and leveling course.
   2. The leveling course will have a maximum particle size of 3/8-inch.
   3. If the bedding material has voids after compaction, then a filter fabric will be required to separate the leveling course from the bedding material.

C. Level and compact bedding material to provide uniform support of the structure along its entire supported width and length. Verify alignment and grade requirement with a laser instrument set on a solid surface outside of the box. Check alignment of each section that is set. Check final grade of bedding to meet the grade required in the plans. The grade will be checked every two feet along the longitudinal alignment of the box culvert, in two foot increments to either side of the center line extending one foot wider than the outside wall of the box culvert (i.e., a two-foot square grid over the entire bedding). Use a large landscaping rake or board to check the grade in between the survey points.

D. Backfill structure as shown in the plans. Backfill in uniform lifts on each side of the structure. Do not disturb the alignment of the boxes.

E. Refer to project plans for excavation, bedding, and backfill requirements where a three-sided culvert structure is placed on a footing.

F. Backfill the gap between multiple single-cell culverts with the material specified on the plans.

3.2 INSTALLATION

A. Inspect precast elements for defects before lowering into trench.

B. Repair or replace any defective, damaged or unsound precast elements.

C. Use a trench width adequate to place and compact bedding material.

D. Adjust the lifting cables so that the box hangs to meet the specific slope of the channel where longitudinal slope is encountered.

E. Lay precast elements starting at the downstream end and working upstream. Place the bell (groove) of the box upstream.

F. Carefully lower precast elements into the trench with suitable equipment to prevent damage.

G. Remove all dirt and foreign material from joints. Prevent dirt and material from re-entering joints. Joint walls must be clean, dry, frost-free, and free of oil and grease and any other contaminants.

H. For box culverts, a small transverse trench (shovel width wide by at least three inches deep by the width of the box culvert) should be formed at the end of the last installed box culvert section to allow material to fall into when the next box section is pulled into place.

I. Apply joint sealant furnished by manufacturer.
   1. Place the joint material on the bottom of the groove (bell) of the box last placed. Place this material against the shoulder of the groove (bell).
   2. Place the balance of the joint material on top of the tongue (spigot) and down the sides of the tongue (spigot) of the box to be set. Place the joint material about one inch from the leading edge of the tongue (spigot).
   3. Place the joint material so that there are no voids and so that the joint material from the bell overlaps the joint material on the spigot. This overlap shall be at least ½-inch but no more than one inch.
   4. Use a winter grade joint material when constructing in temperatures less than 50 degrees.

J. Do not attempt to force box culverts to grade.

K. Disassemble joint, check position of joint sealant, reapply new joint sealant if necessary, repair alignment, and re-install when adjoining elements cannot be pulled together to meet minimum joint requirements.

L. Pull sections home to ½-inch joint gap spacing (measured face to face of adjoining concrete surfaces). In cases where it is necessary to adjust the total length or alignment of a run of box culvert, the Engineer can approve up to a one (1) inch joint gap spacing.

M. Check the lay length of each section where necessary to make sure that cut-off walls, head walls, special precast sections, etc. are properly placed. Different joint gaps than the project line lay out can cause the project length to increase/decrease.

N. Two pulling inserts are installed in each box culvert section. Use the pulling inserts to attach chains and come-along devices from the previously set box culvert to the next box culvert. Use chains and come along devices to pull the box culvert home evenly to the tolerances shown above.

O. Do not disturb previously completed joints during laying operation. After the initial two box culvert sections are set, the come-along device, must remain in place over three box culvert sections or span at least three box culvert sections while progressing along the alignment. Recheck previously completed sections to make sure they are not pulled apart after they have been set.

P. Keep the majority of the box weight on the lifting devices and gradually pull the box home until it meets joint gap spacing. Gradually, let the box down on the bedding. If the joint gap is not within the specification, the box should be lifted slightly and pulled again.

Q. Construction equipment such as backhoes, front end loaders, etc., must not be used to push the box culvert home.

R. Alternatives for pulling box culvert sections together must be approved by the Engineer.

S. Do not lay precast elements when water is in the trench.

3.3 CONNECTION TO CAST-IN-PLACE CONCRETE

A. Project the reinforcing steel at least twelve (12) inches out of the precast box section and square off the concrete face where precast box sections join cast-in-place concrete.

END OF SECTION