EXCERPT

Structural Plate Design Guide
5th Edition

MULTI-PLATE®
Aluminum Structural Plate
Aluminum Box Culvert
SUPER-SPAN™
SUPER-PLATE®
BridgeCor®
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**Steel and Aluminum Structural Plate design guide.**

This design guide is provided to assist designers with most applications and design aspects of Contech Engineered Solutions' MULTI-PLATE, Aluminum Structural Plate, Aluminum Box Culverts, SUPER-SPAN/SUPER-PLATE and BridgeCor. In addition to this written guide, standard CAD details which can be used by any designer to aid with plan preparation are available. Hydraulic nomographs or FHWA HY-8 support is available from your local Contech representative.

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Aluminum Box Culverts

The Solution for Small Bridge Replacement: Aluminum Box Culverts

Contech Aluminum Box Culverts are a practical and cost-efficient solution for small bridge replacement. They have a lower installed cost because they are faster and easier to install than cast-in-place concrete structures. There are no forms to set and remove, no delays due to curing time, large installation crews are unnecessary and no special equipment is needed. Also, no heavy cranes are required as with precast concrete structures.

These wide-span, low-rise structures are available in a large range of standard sizes (from 8’-9” span x 2’-6” rise to 35’-3” span x 13’-7” rise) that permit a minimum cover of only 17 inches for all spans, handling HS-20 or HS-25 live loads.

Faster Installation Means Lower Installed Cost

Closing roads for bridge replacement causes extensive traffic detours, so minimizing installation time is critical. Aluminum Box Culverts may be quickly erected in place and are usually ready to be backfilled in a matter of hours. For faster installation, Aluminum Box Culverts can be completely assembled nearby while the site is being prepared. Light equipment can then be used to set them in place.

National Specifications

Contech Aluminum Box Culvert design and installation is covered by AASHTO Standard Specifications for Highway Bridges (Sec 12.8). The material is covered by AASHTO M 219 and ASTM B864.
1. Structure 1 is a one-plate shell. Structures 2-26 are two plate shells. Structures 27-143 are three-plate shells.

2. In Shell Fill Height Table 48 & 49, the HG\CG designation indicates thickness or gage of haunch (HG) and crown (CG) plates as follows: 2=.125", 3=.150", 4=.175", 5=.200", 6=.225", 7=.250". Example: 3\6=.150" haunch and .225" crown plate thickness. The HRS/CRS designation indicates the rib spacing on the haunch (HRS) and crown (CRS) plates. Example: 27/9=27" o.c. haunch and 9" o.c. crown.

3. Allowable cover (minimum and maximum) is measured from the outside valley of crown plate to bottom of flexible pavement or from the outside valley of crown plate to top of rigid pavement. Minimum cover is measured at the lowest fill area subjected to possible wheel loads (typically at the roadway shoulder). The roadway surface must be maintained to ensure minimum cover to prevent high-impact loads being imparted to the structure. Maximum cover is measured at highest fill and/or pavement elevation.

4. Select the structure with the lowest alphabetical sub-designation and cover range that will include the actual minimum and maximum cover. Example: Structure 51-A6 is more economical than 51-B6 if the cover is between 3.0 and 4.5 feet.

5. Shell Wt./Ft. shown is maximum handling weight and is based on heaviest component makeup for a specific span and rise combination. Weight per foot of shell includes plates, reinforcing ribs, rib splices, bolts, and nuts.

6. Total structure length can be any dimension, but whenever possible, it is recommended to work with a multiple of 4.5’ (net plate width). This practice usually results in lower total structure cost. Example: 50’ proposed structure + 4.5’=54.5’, nearest whole number is 55, therefore use 55 x 4.5’= 247.5’ for total structure length. When ordering a structure with headwalls on each end, total structure length must be a multiple of 9 inches.

7. Shell data in Table 48A is designed for standard highway HS-20 wheel loads, Table 48B for HS-25 loads and Tables 49A/49B for HL-93 load design information. Call a Contech representative for design information on other loadings.

8. Standard structure designs use Type VI ribs for most economical plate and rib combination. Plate and rib combinations using Type II and Type IV ribs are available for special designs.

9. The maximum cover for Aluminum Box Culverts with full inverts and footing pads should not exceed 4 feet. Special full invert and footing pad designs or slotted concrete footings can accommodate maximum covers to the limits shown in Tables 48A and 48B.
<table>
<thead>
<tr>
<th>Structure</th>
<th>Span &quot;A&quot; (Ft.-In.)</th>
<th>Rise &quot;B&quot; (Ft.-In.)</th>
<th>Area (Sq. Ft.)</th>
<th>HGCS (Gage)</th>
<th>HRSC/Ribs (Gage/Inches)</th>
<th>Min.</th>
<th>Max.</th>
<th>Max. Shell &quot;O&quot; (In.)</th>
<th>Dimension &quot;N&quot;</th>
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Box Culvert Shell-Plate and Rib Data (H-20, HS-20)

PLATE AND RIB COMBINATIONS WITH ALLOWABLE HEIGHT OF COVER

**STRUCTURES 1 THROUGH 26 HAVE TYPE II HAUNCH AND TYPE V CROWN RIBS**

**STRUCTURES 27 THROUGH 39 HAVE TYPE I HAUNCH AND TYPE VI CROWN RIBS**

**STRUCTURES 40 THROUGH 57 USE ALL TYPE VI RIBS**

**See Notes page** 65

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### Box Culvert Shell-Plate and Rib Data (H-25, HS-25)

#### Table 3C: Plate and Rib Combinations with Allowable Height of Cover

<table>
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<tr>
<th>Structure Number</th>
<th>Area (Sq. Ft.)</th>
<th>Min. HG/CG (Ft.-In.)</th>
<th>Max. HG/CG (Ft.-In.)</th>
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#### Structures 1 Through 20 Have Type II Haunch and Type IV Crown Ribs

- H-25, HS-25 Loading
- (Feet)
- (Inches)
- (Gage)
- (Inches)
- (Lbs.)

#### Structures 40 Through 77 Use All Type VI Ribs

- (Feet)
- (Inches)
- (Gage)
- (Inches)
- (Lbs.)

See Notes page 65
### Box Culvert Shell-Plate and Rib Data (HL-93)

**PLATE AND RIB COMBINATIONS WITH ALLOWABLE HEIGHT OF COVER**

**STRUCTURES 1 THROUGH 20 HAVE TYPE II HAUNCH AND TYPE IV CROWN RIBS**

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**STRUCTURES 21 THROUGH 39 HAVE TYPE II HAUNCH AND TYPE V CROWN RIBS**

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**STRUCTURES 40 THROUGH 87 USE ALL TYPE VI RIBS**

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3. The maximum cover for Aluminum Box Culverts with full inverts and footing pads should not exceed 4 feet. Special full invert and footing pad designs or slotted concrete footings can accommodate maximum covers to the limits shown in Tables 49A and 49B.

<table>
<thead>
<tr>
<th>Structure Number</th>
<th>Span (Ft.-In.)</th>
<th>Rise (Ft.-In.)</th>
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Notes:
1. The cover height is measured from the outside valley crown plate corrugation to the bottom of a flexible pavement, or to the top of a rigid pavement.
3. The maximum cover for Aluminum Box Culverts with full inverts and footing pads should not exceed 4 feet. Special full invert and footing pad designs or slotted concrete footings can accommodate maximum covers to the limits shown in Tables 49A and 49B.
4. Check with your Contech representative to see if additional options are available.
Headwall and Wingwall Details

-铝制冷藏箱

1. 全部面板均为铝制结构板，按照ASTM B746标准制造。
2. 头墙在表50B中列出的高度允许约24"的开挖深度在槽底以下。所有翼墙和头墙端面板必须开挖至现有地貌。
3. 水平旋转应不超过90°。
4. 头墙的顶面和翼墙的顶面总是水平的，除非需要斜切翼墙。
5. 标准头墙仅适用于垂直定位。
6. 如果侧坡比小于2:1，需要双排土钉。双排土钉每个土钉都应保持36"的最小距离。
7. 详情参见单排和双排土钉的参考页。
8. 结构的混凝土地脚墩需要在现有地脚墩周围进行现场修改。
9. 仅在方角结构上使用铝制头墙。
10. 结构长度必须是9英寸的增量，如果这些头墙用于两端。
### TABLE 50A

<table>
<thead>
<tr>
<th>Wall Height</th>
<th>Center Panel Thickness</th>
<th>End Panel Thickness</th>
<th>Wale Beam - Distance from top of HW</th>
<th>Single Anchor</th>
<th>Deadman Size</th>
<th>3/4&quot; dia Rod Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>6’2&quot; to 8’7&quot;</td>
<td>0.125&quot;</td>
<td>0.150&quot;</td>
<td>N/A</td>
<td>0.125&quot;</td>
<td>3’0&quot;</td>
<td>2’6&quot;</td>
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<tr>
<td>9’4&quot; to 11’9&quot;</td>
<td>0.125&quot;</td>
<td>0.150&quot;</td>
<td>N/A</td>
<td>0.150&quot;</td>
<td>3’6&quot;</td>
<td>3’0&quot;</td>
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<tr>
<td>12’7” to 14’2”</td>
<td>0.125&quot;</td>
<td>0.150&quot;</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>3’6&quot;</td>
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</tbody>
</table>

**ANYTHING GREATER THAN 14’2’': INQUIRE**

### SINGLE ANCHOR DESIGN

**HEADWALL ATTACHMENT TO CROWN**

**Section A-A (see page 71)**

**DUAL ANCHOR DESIGN**

**HEADWALL PLATE**

**DEADMAN ANCHOR ALUMINUM STRUCTURAL PLATE 0.150’’ (1’’ X 3’ X 3’’) (TYP.) REINFORCING RB**

**FIELD DRILL HOLES FOR ATTACHMENT OF THE HEADWALL PLATE TO THE END STIFFENER RB**

**CORRUGATED HEADWALL**

**2” x 24” ANCHOR ROD**

**FIELD DRILL HOLE FOR ATTACHMENT PLATE**

**ANCHOR ROD AND BOLT**

**DEOTEXTILE**

**ALUMINUM BRACING ASSEMBLY**

**HEADWALL CAP**

**5’10” (END) / 2’10” (CENTER) THICK PLATE**

**CORRUGATED HEADWALL REINFORCING RB**

**FIELD DRILL HOLES FOR ATTACHMENT OF THE HEADWALL PLATE TO THE END STIFFENER RB**

**END OF STRUCTURE**

**WHEN HEADWALLS ARE ORDERED FOR BOTH ENDS, THE LENGTH OF STRUCTURE MUST BE A MULTIPLE OF 3’**
### TABLE 50B. HEADWALL Dimensions for H-20, HS-20, H-25, HS-25 Loading

<table>
<thead>
<tr>
<th>No.</th>
<th>Width</th>
<th>Height</th>
<th>No. of Anchor Rods</th>
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</table>
Aluminum Full Invert Option (2,3,5,6)

Notes: Flat sheet toewalls are available only for structures having a full corrugated aluminum invert.

Notes:
1. \( N = 9.625" \) or \( 9 \frac{5}{8}". Use \( N \) as a conversion factor. For example, for Structure No. 1, Width \( "F" \) is \( 13 \times N \) or 125.13".
2. Minimum allowable soil-bearing pressure is 4,000 Lbs./Sq. Ft. for structures and details shown in this catalog. This applies specifically for width \( "G" \) below the receiving channel. Other conditions can be accommodated. Contact a Contech Representative for more information.
3. The maximum cover for Aluminum Box Culverts with full inverts and footing pads should not exceed 4 feet. Special full invert and footing pad designs or slotted concrete footings can accommodate maximum covers to the limits shown in Table 48 or Table 49.
4. Weight per foot of full invert includes receiving channels, scallop plates, nuts, bolts and all plates.
5. Full invert plates thickness are as shown. When reactions to the invert require additional thickness, supplemental plates of the thickness and width listed in Table 51 are furnished to bolt between the full invert and the receiving channel.
6. Invert widths 21N and greater are two-pieces.
7. Invert plates must not be overlapped on adjacent structures unless appropriate design modifications are incorporated.
<table>
<thead>
<tr>
<th>Structure Number</th>
<th>&quot;F&quot; (N)</th>
<th>&quot;G&quot; (N)</th>
<th>Supplemental Plate Thickness (inches)</th>
<th>Weight/Ft. (Lbs.)</th>
<th>Bolts/Ft. (Each)</th>
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1) For structures 1-87, invert plates are 0.100" thick.
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Notes:
1. N=9.625₉ or 9 ⁵/₈". Use N as a conversion factor. For example, for Structure No. 1, Width "G" is 2 x N, or 19.25".
2. Minimum allowable soil-bearing pressure is 4,000 Lbs./Sq. Ft. for structures and details shown in this catalog. This applies specifically for width "G" below the footing pad. Other conditions can be accommodated. Contact a Contech representative for more information.
3. The maximum cover for Aluminum Box Culverts with full inverts and footing pads should not exceed 4 feet. Special full invert and footing pad designs or slooted concrete footings can accommodate maximum covers to the limits shown in Tables 48A-48B and 49A-49B.
4. Weight per foot of footing pads includes receiving channels, nuts, bolts, and plates.
5. When the thickness listed is greater than .250", the footing pads will be two or more pieces equaling the composite thickness required.
6. Footing pads must not be overlapped on adjacent structures unless appropriate design modifications are incorporated.
Scour Discussion

In most cases, using a full aluminum invert with toe plate extensions at the inlet and outlet ends will eliminate the potential for scour through the structure. If, however, it is desirable to span the stream crossing, scour should be investigated. The most efficient counter measure, as listed below, should be chosen based on site specific conditions. The chosen alternative should be designed by a competent professional experienced in the chosen field.

These counter measures include:
- Rip rap protection
- Concrete paving
- Lower footings below anticipated scour depth
- Bearing foundation on competent rock
- Undercut erodible soils and replace with non-erodible material
- Construction of guide banks including sheet piling
- Implementation of permanent erosion control mats where vegetation can be established, such as Pyramat®,
- Implementation of hard armor interlocking blocks where vegetation cannot be established, such as ArmorFlex® or A-Jacks®

Please contact your Contech representative for more details and design guidance.
Notes:

1. If W is less than the required width, a concrete grout material may be required as backfill.
2. Backfill to be well graded granular, A-1, A-3, A-2-4, or A-2-5, per AASHTO M 145, placed in six- to eight-inch lifts symmetrically on each side compacted to minimum 90% density per AASHTO T 180. D4 dozer or smaller to operate near and above structure during backfilling to finish grade. Refer to AASHTO Sec. 26 installation specification.
3. Fill in these zones, must be placed in 8" maximum lifts and compacted to minimum 90% density per AASHTO T 180.
4. Minimum cover may need to be increased to handle temporary construction vehicle loads (larger than D4) but not to exceed maximum allowable cover for the specific box culvert design.
5. When using a full invert or footing pads, the foundation shall have a minimum of 4,000 psf bearing capacity and include a 6" stable well graded granular bed. Lower bearing capacities can be accommodated through special design or the use of concrete footings.
6. Standard headwalls shown are for vertical orientation only. Any design, other than vertical orientation, must be reviewed by the design engineer.
7. The type and extent of end treatment on the box culvert should be chosen and designed so as to prevent the loss of backfill due to high flow conditions.

8. Bolt torque requirements - plate lap must be properly mated in a tangent fashion using proper alignment techniques and adequate bolt torque to seat the corrugation. The recommended installation bolt torque for aluminum box culverts is 90 –115 ft-lbs for full inverts and 115 –135 ft-lbs for all other components. When seam sealant tape is used, bolts shall be installed and retightened to these torque levels after 24 hours. Torque levels are for installation, not residual, in-service requirements.
9. For assembly information, see the manufacturer’s detailed assembly drawings and instructions.
Aluminum Box Culvert Specification

**Scope**

This specification covers the manufacture and installation of the aluminum box culvert structure detailed in the plans.

**Material**

The aluminum box culvert shall consist of plates, ribs, and appurtenant items as shown on the plans and shall conform to the requirements of ASTM B864 and AASHTO M 219. Plate thicknesses, rib spacings, end treatment, and type of invert and foundation shall be as indicated on the plans.

Bolts and nuts shall conform to the requirements of ASTM A307 or ASTM A449 and shall be galvanized in accordance with ASTM A153.

**Assembly**

The box culvert shall be assembled in accordance with the shop drawings provided by the manufacturer and per the manufacturer’s recommendations. Bolts shall be tightened using an applied torque of between 90 and 135 ft-lbs.

**Installation**

The box culvert shall be installed in accordance with the plans and specifications, the manufacturer’s recommendations and the AASHTO Standard Specification for Highway Bridges, Section 26 (Division II).

**Bedding**

The bedding should be constructed to a uniform line and grade using material outlined in the backfill section. The foundation must be capable of providing a bearing capacity of at least two tons per square foot.

**Backfill**

The structure shall be backfilled using clean, well graded granular material that meets the requirements of AASHTO M 145 for soil classifications A-1, A-3, A-2-4, or A-2-5. Backfill must be placed symmetrically on each side of the structure in 8-inch uncompacted lifts. Each lift shall be compacted to a minimum of 90 percent density per AASHTO T 180.