Designation: B864/B864M – 13 (Reapproved 2018)

Standard Specification for Corrugated Aluminum Box Culverts[1]

This standard is issued under the fixed designation B864/B864M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers material, geometric, and wall section properties of aluminum box culverts manufactured from corrugated plate or sheet, with attached rib stiffeners, for field assembly. Appropriate fasteners and optional materials, such as aluminum invert plates and headwalls, are also described. Applications for aluminum box culverts include conduits for gravity flow drainage of surface water, such as culverts and storm drains, as well as for small bridges and grade separation structures such as pedestrian or vehicular underpasses, and utility tunnels.

1.2 This specification does not include requirements for foundations, backfill, or the relationship between earth cover or live loads and strength requirements. These important design considerations are described in the AASHTO LRFD Bridge Design Specifications and the LRFD Bridge Construction Specifications.

1.3 This specification does not include requirements for the hydraulic design of these structures. Hydraulic design, placement of footings or inverts, and end treatments to resist scour are described in FHWA HDS No. 5.

1.4 Appendix X1 lists nominal dimensions of box culvert sizes commonly available. Also listed are cross-sectional area and hydraulic design parameters for these sizes.

1.5 Appendix X2 lists manufacturer's suggested design properties for the rib stiffener types, spacing classes, and material thicknesses described in this specification.

1.6 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A36/A36M Specification for Carbon Structural Steel
A123/A123M Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A153/A153M Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A307 Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
A563 Specification for Carbon and Alloy Steel Nuts
A563M Specification for Carbon and Alloy Steel Nuts (Metric)
B221 Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
B746/B746M Specification for Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches
B790/B790M Practice for Structural Design of Corrugated Aluminum Pipe, Pipe-Arches, and Arches for Culverts, Storm Sewers, and Other Buried Conduits

2.2 *AASHTO Standard:*

LRFD Bridge Design Specifications[3]
LRFD Bridge Construction Specifications

2.3 *FHWA Standard:*

HDS No. 5, Hydraulic Design of Highway Culverts, Third Edition. FHWA publication number HIF–12–02 (2012).[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

[1] This specification is under the jurisdiction of ASTM Committee B07 on Light Metals and Alloys and is under the direct responsibility of B07.08 on Corrugated Aluminum Pipe and Corrugated Aluminum Structural Plate.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.

[4] Available from National Technical Information Service (NTIS), 5285 Port Royal Rd., Springfield, VA 22161, http://www.ntis.gov.

***A Summary of Changes section appears at the end of this standard**

3.1.1 *box culvert*—a generally rectangular conduit having a cross section symmetric about a vertical axis, with a long radius crown segment, short radius haunch segments, and straight side segments, with rib stiffeners (see Fig. 1).

3.1.2 *crown*—the long radius top arc segment of a box culvert cross section (see Fig. 1).

3.1.3 *haunch*—the short radius segments at the upper corners of a box culvert cross section, making the transition between the long radius crown segment and the straight side segments (see Fig. 1).

3.1.4 *rib stiffeners*—spaced extruded aluminum structural members, curved to the shape of the transverse cross section of box culverts and attached by field-bolting to the corrugated plate shell (see Fig. 1).

3.1.5 *rise*—the clear inside vertical dimension from the bottom of the straight side segments of a box culvert to the crown, measured at the axis of symmetry (see Fig. 1).

3.1.6 *shell*—the continuous, structural enclosure of the box culvert consisting of modular, field-assembled, and bolted corrugated aluminum plate members forming the crown, haunch, and side segments (see Fig. 1).

3.1.7 *span*—the clear inside horizontal dimension of a box culvert, measured at the bottom of the straight side segments (see Fig. 1).

4. Classification

4.1 Aluminum box culverts consist of a 9 by 2½ in. [229 by 64 mm] corrugated aluminum plate shell in combination with extruded aluminum stiffening ribs. The plate thickness, stiffener type, and spacing class at the crown and haunch of the box culvert may differ, provided they satisfy the ordering information and the design properties (see 5.1 and 6.1). The plate thickness and stiffener type and spacing class may be varied along the length of the box culvert in accordance with cover and loading requirements, as agreed upon between the purchaser and the fabricator.

4.2 *Rib Stiffener Type and Spacing Class:*

4.2.1 Rib stiffeners shall consist of Type 1, Type 2, or Type 10 at the option of the fabricator. Geometry, section, and mechanical properties must conform to the requirements of Fig. 2 or Fig. 3. Rib stiffener spacing classes shall be as defined in 4.2.2 – 4.2.5 and illustrated in Fig. 4 or Fig. 5.

4.2.2 *Class A Spacing,* consisting of either Type 1, Type 2, or Type 10 external rib stiffeners spaced at 54 in. [1372 mm] center-to-center.

4.2.3 *Class B Spacing,* consisting of either Type 1, Type 2, or Type 10 external rib stiffeners spaced at 27 in. [686 mm] center-to-center.

4.2.4 *Class C Spacing,* consisting of either Type 1, Type 2, or Type 10 external rib stiffeners spaced at 18 in. [457 mm] center-to-center.

4.2.5 *Class D Spacing,* consisting of either Type 1 or Type 2 external rib stiffeners spaced at 9 in. [229 mm] center-to-center.

5. Ordering Information

5.1 Orders for products specified herein shall include the following information required as necessary to adequately describe the desired product characteristics:

5.1.1 Name of product (corrugated aluminum box culvert),

5.1.2 ASTM designation and year of issue, as B XXX-____ for inch-pound units or B XXXM-____ for SI units,

5.1.3 Number of structures,

5.1.4 Nominal dimensions of each structure including the rise, span, length (measured along the bottom centerline), and cross sectional area required,

NOTE 1—The nominal length increment is 2.25 ft [0.68 m]. Special lengths can be provided.

5.1.5 Minimum and maximum cover height over structure top centerline (measured from the inside crest of the corrugated plate to the finished surface of the traveled way),

NOTE 2—The minimum and maximum cover height is assumed to apply to the entire length of the structure unless the purchaser specifies otherwise. The design specifications limit cover height to a range of between 1.4 and 5.0 ft [0.43 and 1.52 m]. Small deviations in the height of cover can make a significant difference in the design. It is recommended that the purchaser specify minimum and maximum cover heights to the nearest 0.1 ft [30 mm].

5.1.6 Dead load unit weight, if different than 120 lb/ft^3 [1920 kg/m^3],

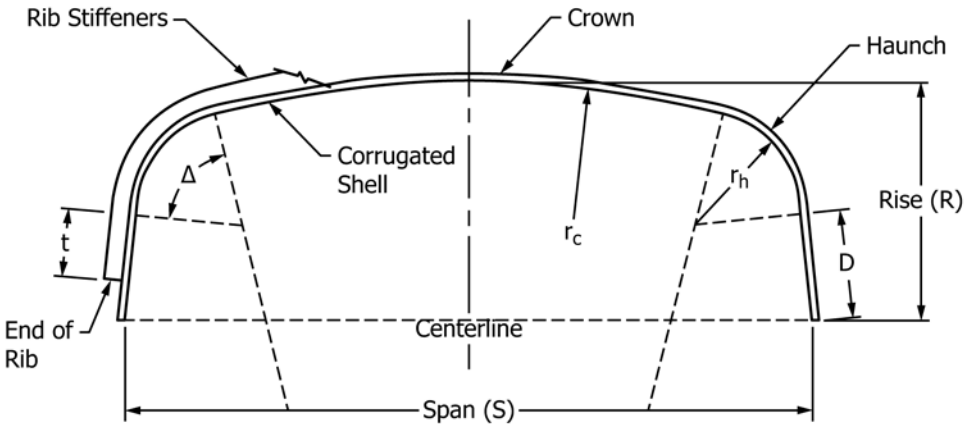
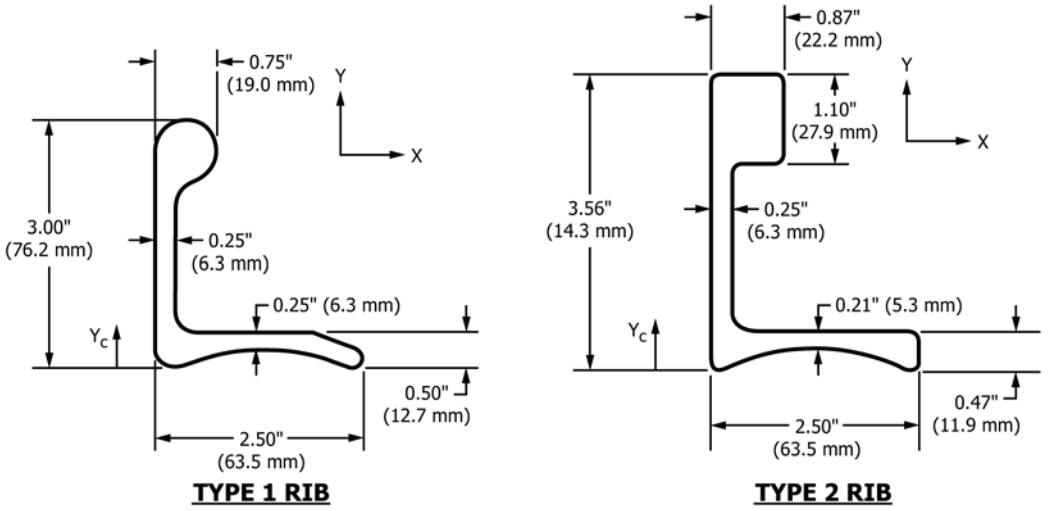
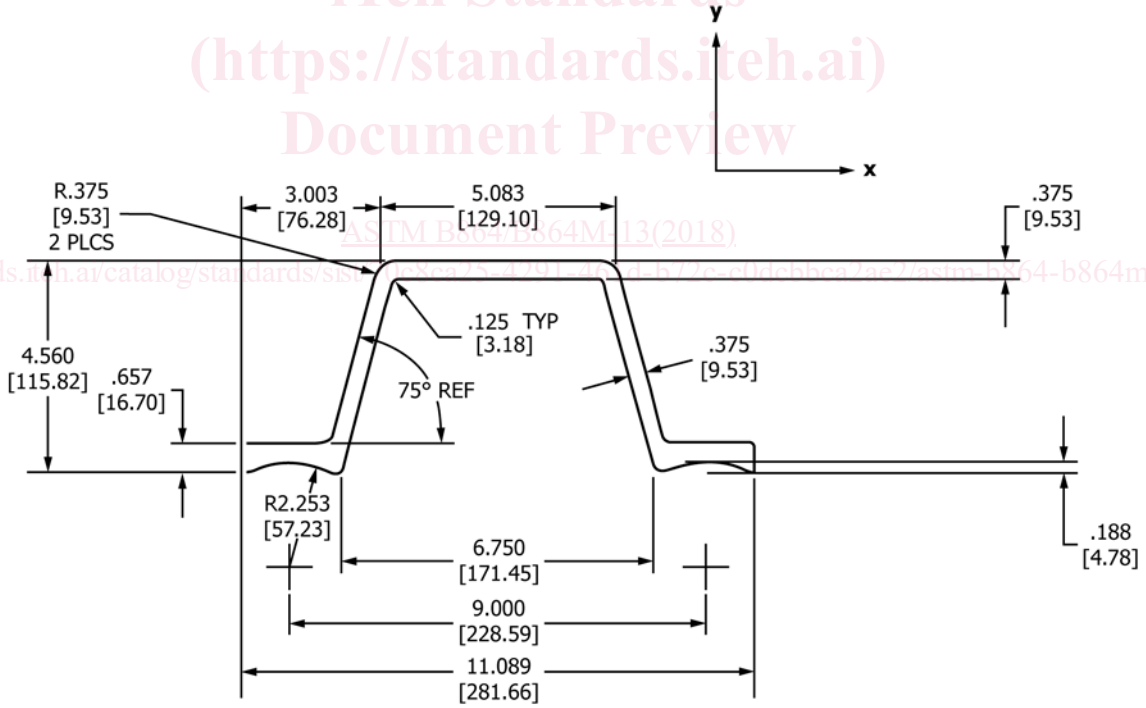


FIG. 1 Box Culvert Geometry



	Type 1 Rib	Type 2 Rib
Alloy	6061-T6	6061-T6
Yield Strength	35 ksi [240 MPa]	35 ksi [240 MPa]
Tensile Strength	38 ksi [260 MPa]	38 ksi [260 MPa]
Area	1.71 $in.^2$ [1103 mm^2]	2.27 $in.^2$ [1465 mm^2]
Center of Area	Yc = 1.02 in. [26.0 mm]	Yc = 1.76 in. [44.8 mm]
Plastic Modulus	1.70 $in.^3$ [27 858 mm^3	2.68 $in.^3$ [43 917 mm^3]
Plastic Moment	Mp = 4.97 k-ft [6.72 kN-m]	Mp = 7.81 k-ft [10.60 kN-m]

FIG. 2 Geometry and Nominal Design Properties for Types 1 and 2 Ribs



	Type 10 Rib
Alloy	6061-T6
Yield Strength	35 ksi [240 MPa]
Tensile Strength	38 ksi [260 MPa]
Area	7.166 $in.^2$ [4623 mm^2]
Center of Area	Yc = 2.228 in. [56.6 mm]
Plastic Modulus	11.074 $in.^3$ = [181 465 mm^3]
Plastic Moment	Mp = 32.23 k-ft [43.7 kN-m]

FIG. 3 Geometry and Nominal Design Properties for Type 10 Ribs

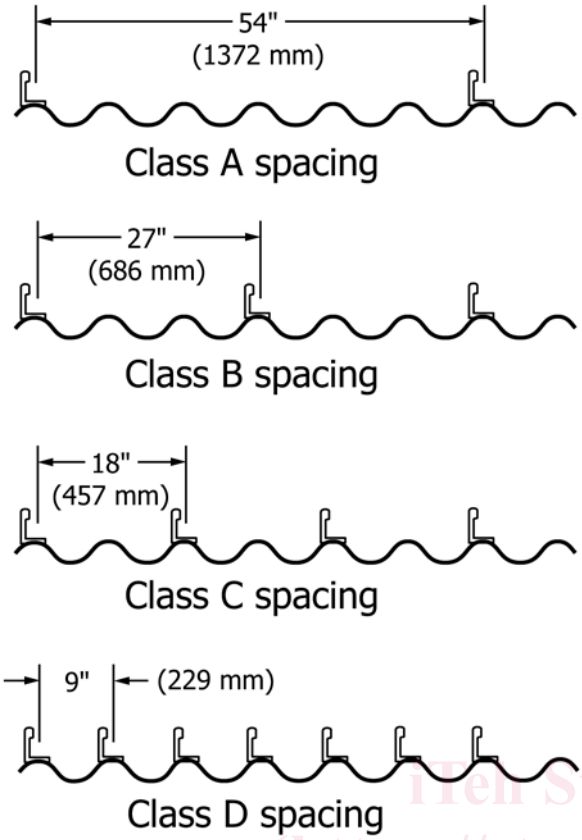


FIG. 4 Rib Stiffener Spacing Classes for Type 1 and Type 2 Ribs

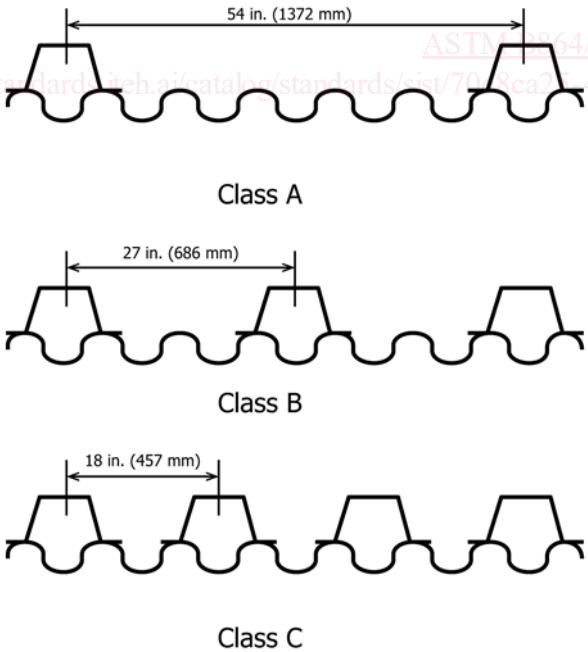


FIG. 5 Rib Stiffener Spacing Classes for Type 10 Ribs

5.1.7 Structure live load vehicle configuration, if different than AASHTO HL-93 (see AASHTO LRFD Bridge Design Specification),

5.1.8 Corrugated footing pads or full invert plates, if required. For box culverts not supported on concrete footings, allowable foundation bearing capacity, if different than 2 tons/ft^2 [192 kPa],

NOTE 3—Design procedures for corrugated footing pads or full invert plates are beyond the scope of this specification. However, general considerations for design of structural plate arch footings are given in Practice B790/B790M. Also, specific design criteria for similar applications are available in AASHTO LRFD Bridge Design Specifications.

5.1.9 End treatment (bevel, skew, grade or slope corrections, corrugated aluminum headwalls, cut-off walls, or other special provision), if required,

NOTE 4—End conditions involving beveled or skewed cut ends may require a structural support wall or collar. The design procedures for these end treatments as well as for vertical headwalls are beyond the scope of this specification.

5.1.10 Other special requirements such as stubs, tap-ins, saddles, elbows, etc., if required, and

5.1.11 Material certification, if required (see 13.1).

NOTE 5—Typical ordering information may be described as: (*1*) One corrugated aluminum box culvert, in accordance with ASTM B XXX-___, 7 ft, 3 in. rise by 20 ft, 6 in. span by 45 ft long, having a 1.4 ft minimum cover and a 3.0 ft maximum cover, with full invert plates; or (*2*) Two corrugated aluminum box culverts, in accordance with ASTM B XXXM-____, each being 1.96 m rise by 4.67 m span by 18.3 m long, each having 0.43 m minimum and maximum covers, assuming a dead load unit weight of 2162 kg/m^3, having full invert plates and having ends slope adjusted for 2 % grade, including certification.

6. Design Properties

6.1 The required plastic moment capacities shall be determined for the crown and haunch segments of the box culvert in accordance with the ordering information and AASHTO LRFD Bridge Design Specifications. The AASHTO LRFD Bridge Design Specifications are applicable for the range of geometric limits given in Fig. 1 and Tables 1 and 2. When agreed upon by the purchaser and the fabricator, box culvert geometries outside the limits given in Tables 1 and 2 may be designed using other recognized Design Specifications.

7. Materials

7.1 The corrugated plate material utilized for the shell shall be fabricated from aluminum sheet or plate conforming to the

TABLE 1 Geometric Limits of Box Culverts 8 ft 9 in. to 25 ft 5 in. [2.67 to 7.75 m]

Elements[A]	Minimum	Maximum
Span *(S)*	8.75 ft [2.67 m]	25.42 ft [7.75 m]
Rise *(R)*	2.50 ft [0.76 m]	10.50 ft [3.20 m]
Radius of crown (r_c)	. . .	24.79 ft [7.56 m]
Radius of haunch (r_h)	2.50 ft [0.76 m]	. . .
Haunch angle (Δ)	50°	70°
Length of leg *(D)*	0.50 ft [0.15 m]	5.2 ft [1.59 m]
Length of rib on leg *(t)*	[B]	. . .

[A] See Fig. 1 for illustration of geometric elements.
[B] Minimum 19 in. [483 mm] or length of leg *(D)* minus 3 in. [76 mm], whichever is less, or within 3 in. (76 mm) top of footing.