Designation: B 864/B 864M – 00

Standard Specification for Corrugated Aluminum Box Culverts[1]

This standard is issued under the fixed designation B 864/B 864M; 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 Standard Specifications for Highway Bridges.

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 inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

2. Referenced Documents

2.1 *ASTM Standards:*

A 36/A 36M Specification for Carbon Structural Steel[2]

A 123/A 123M Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products[3]

A 153/A 153M Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware[3]

A 307 Specification for Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength[4]

A 563 Specification for Carbon and Alloy Steel Nuts[4]

A 563M Specification for Carbon and Alloy Steel Nuts [Metric][3]

B 221/B 221M Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes[5]

B 746/B 746M Specification for Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches[5]

B 790/B 790M Practice for Structural Design of Corrugated Aluminum Pipe, Pipe-Arches, and Arches for Culverts, Storm Sewers, and Other Buried Conduits[5]

2.2 *AASHTO Standard:*

Standard Specifications for Highway Bridges[6]

2.3 *FHWA Standard:*

HDS No. 5, Hydraulic Design of Highway Culverts, Report No. FHWA-IP-85-15[7]

3. Terminology

3.1 *Definitions of Terms Specific to 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

[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 Aluminum Culvert.

Current edition approved May 10, 2000. Published August 2000. Originally published as B 864/B 864M-95. Last previous edition B 864/B 864M-95.

[2] *Annual Book of ASTM Standards*, Vol 01.04.

[3] *Annual Book of ASTM Standards*, Vol 01.06.

[4] *Annual Book of ASTM Standards*, Vol 15.08.

[5] *Annual Book of ASTM Standards*, Vol 02.02.

[6] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 225, Washington, DC.

[7] Available from the National Technical Information Service, Springfield, VA 22161.

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

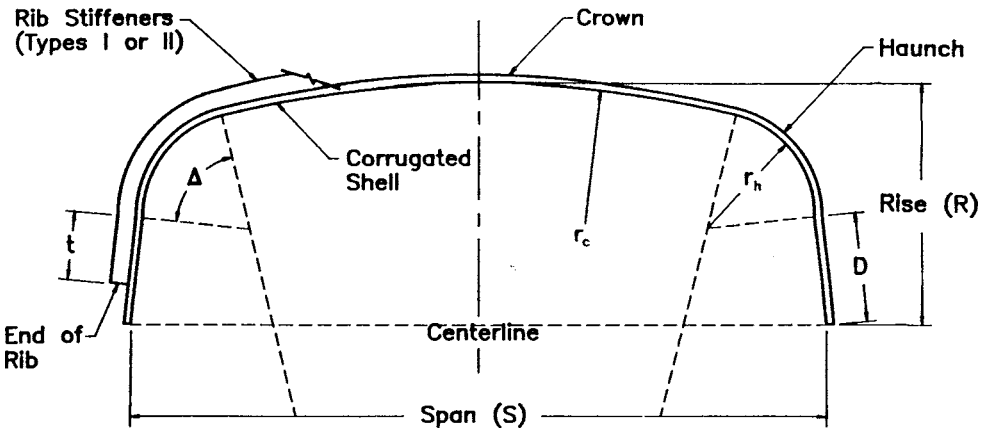


FIG. 1 Box Culvert Geometry

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).

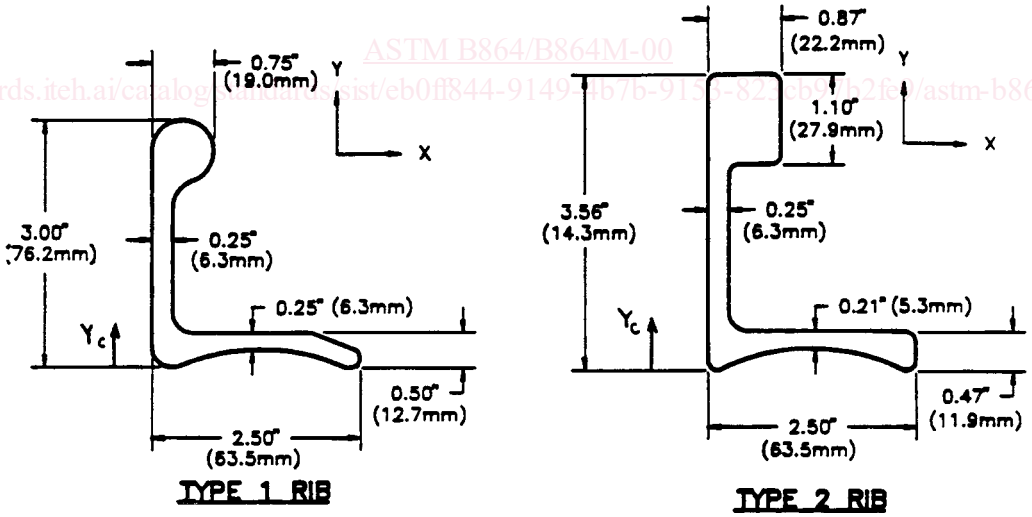
3.1.6 *shell*—the continuous, structural enclosure of the box culvert consisting of modular, field-assembled, and bolted corrugated aluminum plate members forming the crown, haunch, and side segments (see Fig. 1).

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*:



	Type 1	Type 2
Alloy	6061-T6	6061-T6
Yield Strength	35 ksi [241.3 MPa]	35 ksi [241.3 MPa
Tensile Strength	38 ksi [262.0 MPa]	38 ksi [262.0 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$^{k\text{-}ft}$ [6.72 kN-m]	Mp = 7.81$^{k\text{-}ft}$ [10.60 kN-m]

FIG. 2 Extruded Aluminum Rib Stiffeners Geometry and Nominal Properties for Design

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

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

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

4.2.4 *Class C Spacing*, consisting of either Type 1 or Type 2 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:

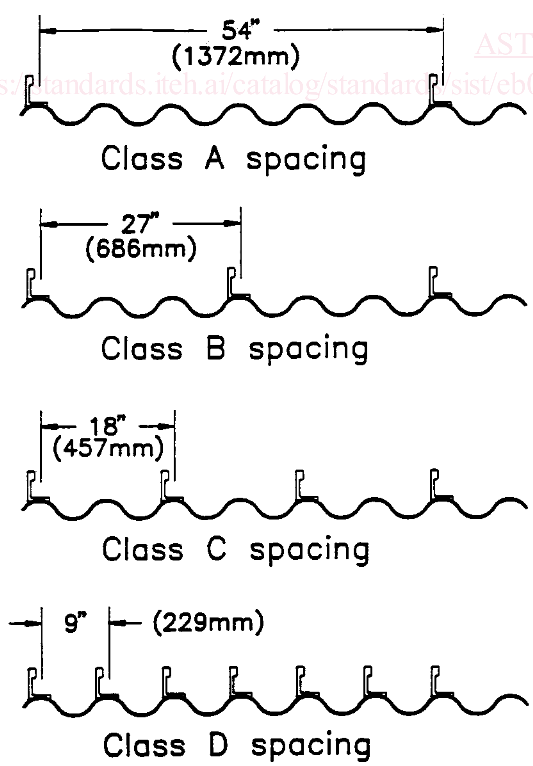
5.1.1 Name of product (corrugated aluminum box culvert),

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.



Ribs are either Type 1 or Type 2.

FIG. 3 Rib Stiffener Spacing Classes

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 ft and 5.0 ft [0.43 m 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],

5.1.7 Structure live load vehicle configuration, if different than AASHTO HS 20-44 (see AASHTO Standard Specifications for Highway Bridges),

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 B 790/B 790M. Also, specific design criteria for similar applications are available in the AASHTO Standard Specifications for Highway Bridges.

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 Standard Specifications for Highway Bridges. The AASHTO specification is applicable for the range of geometric limits given in Fig. 1 and Table 1.

7. Materials

7.1 The corrugated plate material utilized for the shell shall be fabricated from aluminum sheet or plate conforming to the chemical, mechanical, thickness and shape requirements of Specification B 746/B 746M. Section properties for the corrugated plate are provided in Practice B 790/B 790M.