Designation: B864/B864M – 13

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.

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:*

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).

[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**

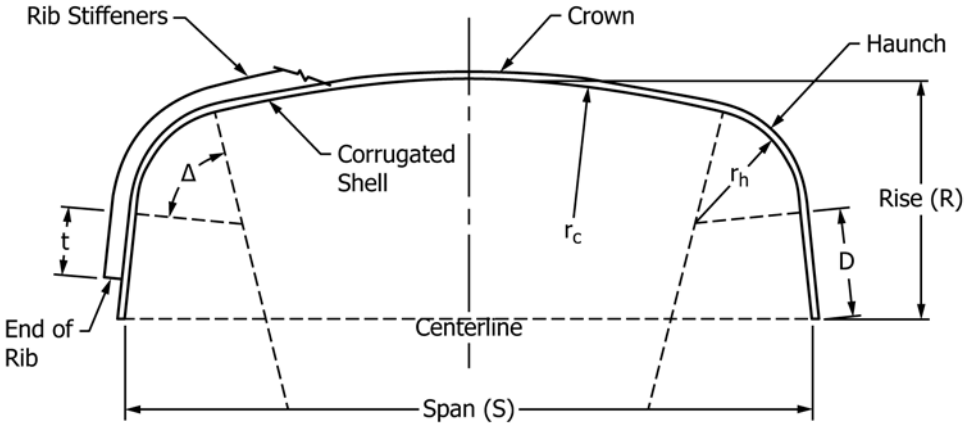


FIG. 1 Box Culvert Geometry

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,

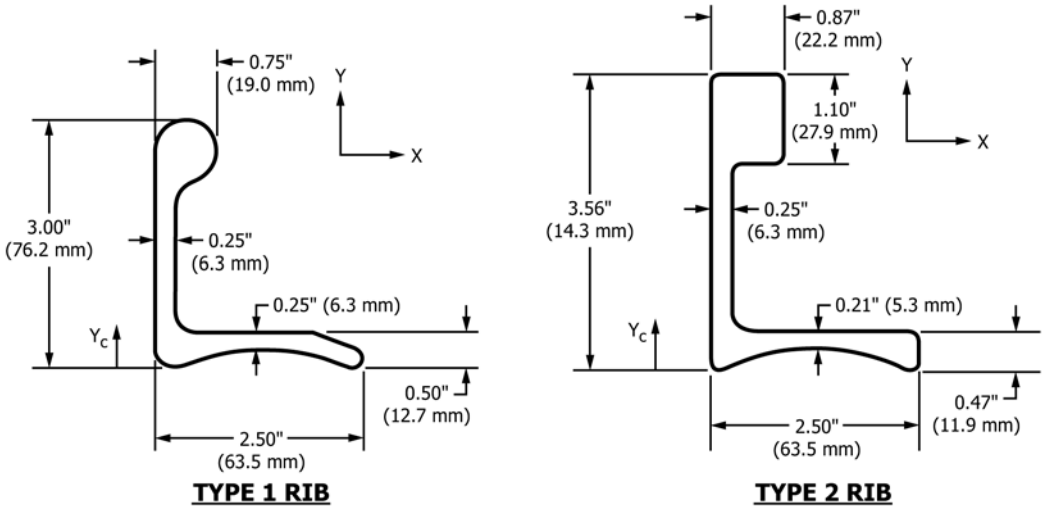
NOTE 1—The nominal length increment is 2.25 ft [0.68 m]. Special lengths can be provided.

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 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].

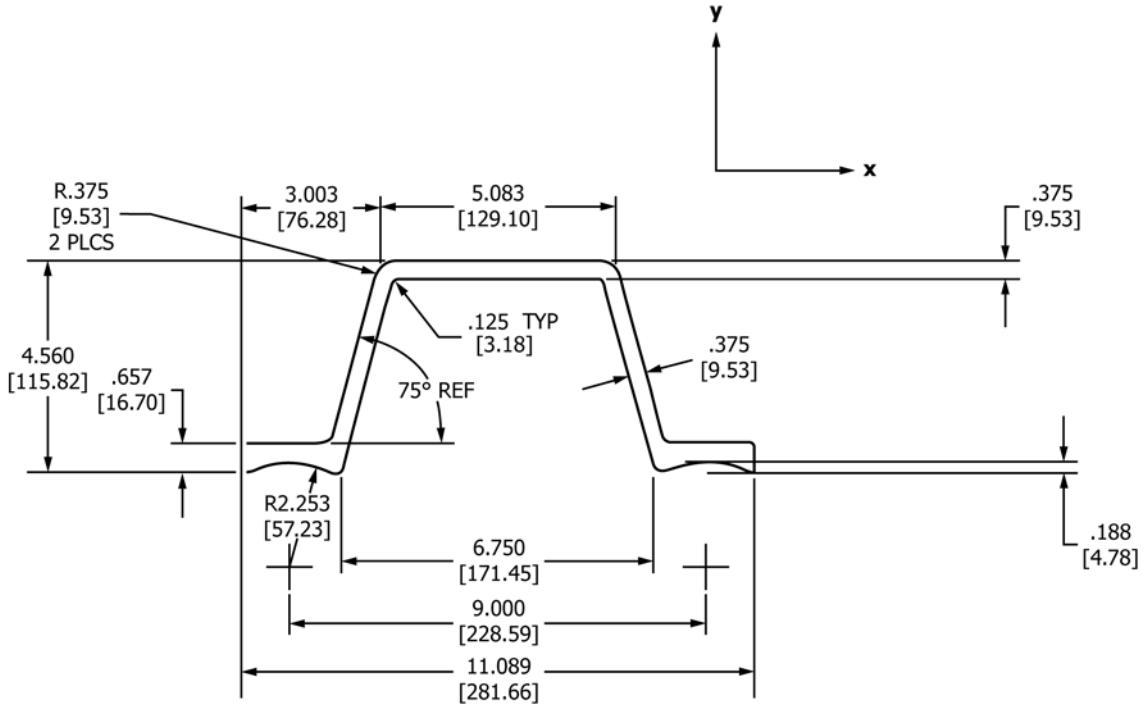
5.1.6 Dead load unit weight, if different than 120 lb/ft^3 [1920 kg/m^3],

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



	Type 1	Type 2
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

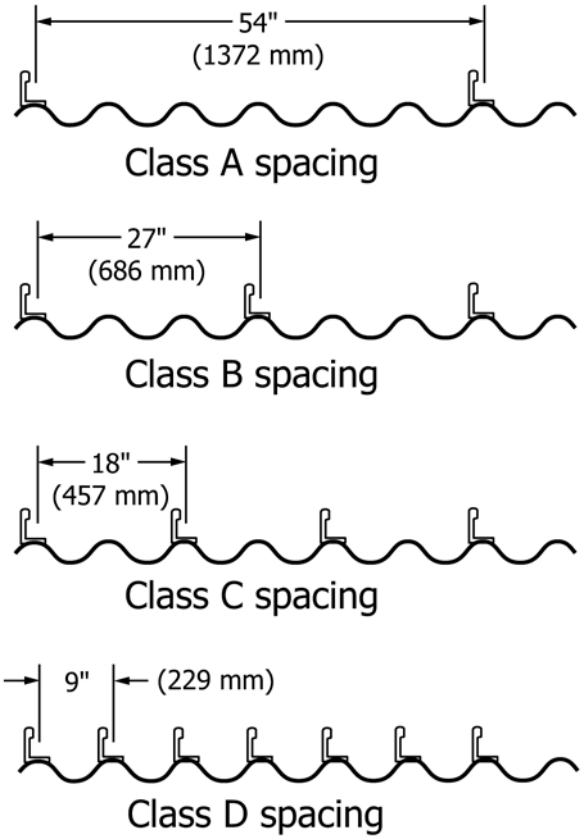


FIG. 4 Rib Stiffener Spacing Classes for Type 1 and Type 2 Ribs

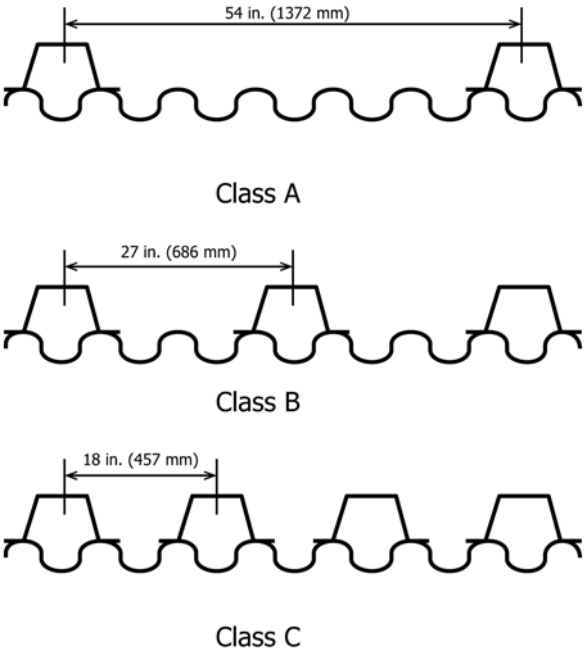


FIG. 5 Rib Stiffener Spacing Classes for Type 10 Ribs

5.1.8 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 Table 1 and Table 2. When agreed upon by the purchaser and the fabricator, box culvert geometries outside the limits given in Table 1 and Table 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 chemical, mechanical, thickness and shape requirements of Specification B746/B746M. Section properties for the corrugated plate are provided in Practice B790/B790M.

7.2 Rib stiffeners shall be extruded shapes conforming to the chemical and mechanical requirements of Specification B221 for 6061-T6. Their dimensions and the required, nominal section properties developed are shown in Fig. 2 and Fig. 3.

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..

TABLE 2 Geometric Limits of Box Culverts with Spans from 25 ft 6 in. to 36 ft 0 in. [7.75 to 10.97 m]

Elements[A]	Minimum	Maximum
Span (S)	25.50 ft [7.75 m]	36.0 ft [10.97 m]
Rise (R)	5.58 ft [1.70 m]	14.00 ft [4.27 m]
Radius of crown (r_c)	...	26.33 ft [8.03 m]
Radius of haunch (r_h)	3.64 ft [1.11 m]	...
Haunch angle (Δ)	48°	68°
Length of leg (D)	0.40 ft [0.125 m]	5.92 ft [1.80 m]
Length of rib on leg (t)	[B]	...

[A] See Fig. 1 for illustration of geometric elements.
[B] Minimum 28 in. [483mm] or length of leg (D) minus 3 in. [76 mm], whichever is less, or within 3 in. [76 mm] top of footing.

7.3 Corrugated aluminum footing and invert members, when specified, shall conform to the same material requirements as 7.1. Thickness shall be as required by the design (see Note 3) and shall not be less than 0.100 in. [2.5 mm].

7.4 Corrugated aluminum headwalls, when specified, shall conform to the same material requirements as 7.1. Aluminum walers, tie-back rods, deadman anchors, and other aluminum structural members shall conform to the mechanical and chemical requirements of 7.2. Any steel tie-back rods, deadman anchors, or other steel structural member shall meet the requirements of Specification A36/A36M. Where they are installed in contact with aluminum members steel members shall be hot-dip galvanized after fabrication in accordance with the coating requirements of Specification A123/A123M. The thickness, shape, and dimensions of headwall and incidental members shall be as required by the design (see Note 4).

7.5 Aluminum cut-off walls, when specified, shall conform to the same material requirements as 7.1 and provide a nominal thickness of 0.10 in. [2.5 mm].

7.6 Bolts and nuts required to join corrugated plates together, or to join corrugated plates to the stiffeners or other structural members, shall conform to the requirements of Specification B746/B746M. Bolts and nuts for joining structural and other items that are not corrugated shall conform to the requirements of Specification B746/B746M or alternatively meet or exceed the requirements of Specification A307, Grade A and Specifications A563 and A563M. Steel bolts and nuts shall be hot-dip galvanized in accordance with Specification A153/A153M, Class C.

8. Fabrication

8.1 The corrugated aluminum shell of the box culvert shall conform to the geometric dimensional limits specified in Table 1 and shall be subject to the manufacturing tolerances in 9.1 – 9.3.

8.2 Corrugated aluminum shell plates shall be fabricated in accordance with Specification B746/B746M.

8.3 Extruded aluminum rib stiffeners shall consist of annular rings conforming to the shape and dimensions of the structural plate shell. The bolt holes shall be punched so that all members having like dimensions and curvature are interchangeable. Sufficient bolt holes shall be provided in the corrugated shell to match the arrangement, number, and spacing of bolt holes in the stiffeners. The layout of the stiffeners relative to the corrugated shell shall be in accordance with 4.2 for the stiffener type and spacing class required by the design.

8.4 Rib stiffeners that are designed to be continuous around the periphery of the crown and haunch, but that are not fabricated in one piece, shall be provided with splice connections at the intermediate ends. The design of the splice shall be adequate to develop the bending and axial loads carried by the rib stiffener at the location of the splice.

8.5 Rib stiffeners shall be provided with adequate bolted connectors to resist the beam shear that develops between the stiffener and the shell due to the moment requirements described in 6.1.

8.6 Corrugated footing and invert plates shall be fabricated in accordance with Specification B746/B746M.

8.7 Special members for headwalls, cut-off walls, etc. and special plates forming skewed ends, beveled ends, or curved alignment, when required, shall be accurately cut to fit the requirements of the ordering information. Cut edges of members shall not contain excessive notches, gouges, or burrs, and shall present a workmanlike finish.

9. Dimensions and Permissible Variations

9.1 Furnished box culvert dimensions shall not vary from the ordered sizes by more than the permissible amounts given in Table 3, except as noted in 9.2 and 9.3.

9.2 When agreed upon between the purchaser and the fabricator, the span dimension furnished may exceed the limits given in Table 3. However, the cross-sectional area furnished shall not be less than that ordered. Also, the actual span shall be used in lieu of the ordered span for structural design (see 1.2 and 6.1).

9.3 When agreed upon between the purchaser and the fabricator, the variation in the rise dimension furnished may exceed Table 3. However, the resulting shape and height of cover shall meet the structural and hydraulic design requirements for box culverts (see 1.2, 1.3 and 6.1).

10. Workmanship

10.1 Plates, rib stiffeners, accessories, and fasteners shall be of uniform quality consistent with good manufacturing, fabrication, and inspection practices.

TABLE 3 Tolerances on Dimensions

Rise[A]	Span[A]	Length	Area[B]
+ 2 in. [50 mm] or 1 % of span, whichever is greater to a maximum of 3 in. [75 mm]	±2 % to a maximum of 4 in. [100 mm]	±1.5 ft [±0.46 m]	−2 %
−2 % of span to a maximum of 3 in. [75 mm]	...	...	...

[A] In no case shall permitted variations in rise and span result in a combination of cover height and loading requirements that fall outside the limits specified by the design (see 6.1).
[B] Positive tolerance on area is not applicable.

11. Sampling and Testing

11.1 Sampling and testing of corrugated plate and miscellaneous flat plate materials for chemical composition and mechanical properties shall be in accordance with Specification B746/B746M.

11.2 Sampling and testing of rib stiffeners and miscellaneous aluminum structural shapes for chemical composition and mechanical properties shall be in accordance with Specification B221.

11.3 Sampling and testing of structural steel members for chemical composition and mechanical properties shall be in accordance with Specification A36/A36M. Testing for galvanizing coating weight shall be in accordance with Specification A123/A123M.

12. Rejection and Rehearing

12.1 Material that fails to conform to the minimum requirements of this specification may be rejected. Rejection should be reported to the fabricator promptly and in writing. In case of dissatisfaction with the results of the test, the fabricator may make claim for a rehearing.

13. Material Certification

13.1 When specified in the purchase order or contract, the purchaser shall be furnished a material certification that samples representing each lot have been either tested or inspected as directed in this specification and that the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

14. Product Marking

14.1 Each corrugated plate shall be identified in accordance with the requirements of Specification B746/B746M.

15. Assembly Drawings

15.1 The purchaser shall be furnished with assembly drawings showing the layout and location of all corrugated plates, stiffener ribs, and other structural members supplied in accordance with the ordering information. Legible identification shall be placed on each special member to designate its proper position in the finished structure and shall be referenced on the assembly drawings.

16. Keywords

16.1 bridge; box culvert; corrugated aluminum structural plate; culvert; grade separation; low cover structure; low profile structure; storm sewer

APPENDIXES

(Nonmandatory Information)

X1. DIMENSION AND HYDRAULIC INFORMATION

TABLE X1.1 Dimension and Hydraulic Information

Structure Number	Span, ft-in. [m]	Rise, ft-in. [m]	Area[A], ft² [m²]	R[B], ft [m]	WP[C], ft [m]	AR^2/3[D]	AD^1/2[E]
1	8 ft–9 in. [2.67]	2 ft–6 in. [0.76]	18.4 [1.71]	0.92 [0.28]	20.11 [6.13]	17.40	29.10
2	9 ft–2 in. [2.79]	3 ft–3 in. [0.99]	25.4 [2.36]	1.15 [0.35]	22.14 [6.75]	27.88	45.79
3	9 ft–7 in. [2.92]	4 ft–1 in. [1.24]	32.6 [3.03]	1.35 [0.41]	24.17 [7.37]	39.82	65.88
4	10 ft–0 in. [3.05]	4 ft–10 in. [1.47]	40.2 [3.73]	1.54 [0.47]	26.20 [7.99]	53.61	88.38
5	10 ft–6 in. [3.20]	5 ft–7 in. [1.70]	48.1 [4.47]	1.71 [0.52]	28.22 [8.60]	68.78	113.66
6	10 ft–11 in. [3.33]	6 ft–4 in. [1.93]	56.4 [5.24]	1.86 [0.57]	30.25 [9.22]	85.30	141.94
7	11 ft–4 in. [3.45]	7 ft–2 in. [2.18]	65.0 [6.04]	2.01 [0.61]	32.28 [9.84]	103.52	174.01
8	10 ft–2 in. [3.10]	2 ft–8 in. [0.81]	23.0 [2.14]	1.00 [0.30]	23.14 [7.05]	23.00	37.56
9	10 ft–7 in. [3.23]	3 ft–5 in. [1.04]	31.1 [2.89]	1.24 [0.38]	25.11 [7.65]	35.90	57.49
10	10 ft–11 in. [3.33]	4 ft–3 in. [1.30]	39.5 [3.67]	1.46 [0.45]	27.09 [8.26]	50.84	81.43
11	11 ft–4 in. [3.45]	5 ft–0 in. [1.52]	48.2 [4.48]	1.66 [0.51]	29.07 [8.86]	67.57	107.76
12	11 ft–8 in. [3.56]	5 ft–9 in. [1.75]	57.2 [5.31]	1.84 [0.56]	31.05 [9.46]	85.89	137.16
13	12 ft–1 in. [3.68]	6 ft–7 in. [2.01]	66.4 [6.17]	2.01 [0.61]	33.03 [10.07]	105.75	170.37
14	12 ft–5 in. [3.78]	7 ft–4 in. [2.24]	76.0 [7.06]	2.17 [0.66]	35.01 [10.67]	127.39	205.81
15	11 ft–7 in. [3.53]	2 ft–10 in. [0.86]	28.1 [2.61]	1.08 [0.33]	26.15 [7.97]	29.58	47.30
16	11 ft–11 in. [3.63]	3 ft–7 in. [1.09]	37.4 [3.47]	1.33 [0.41]	28.08 [8.56]	45.23	70.80
17	12 ft–3 in. [3.73]	4 ft–5 in. [1.35]	46.9 [4.36]	1.56 [0.48]	30.01 [9.15]	63.08	98.56
18	12 ft–7 in. [3.84]	5 ft–2 in. [1.57]	56.6 [5.26]	1.77 [0.54]	31.94 [9.74]	82.82	128.65
19	12 ft–11 in. [3.94]	6 ft–0 in. [1.83]	66.6 [6.19]	1.97 [0.60]	33.87 [10.32]	104.66	163.14
20	13 ft–3 in. [4.04]	6 ft–9 in. [2.06]	76.9 [7.14]	2.15 [0.66]	35.80 [10.91]	128.10	199.79
21	13 ft–0 in. [3.96]	3 ft–0 in. [0.91]	33.8 [3.14]	1.16 [0.35]	29.16 [8.89]	37.32	58.54
22	13 ft–4 in. [4.06]	3 ft–10 in. [1.17]	44.2 [4.11]	1.42 [0.43]	31.04 [9.46]	55.84	86.54
23	13 ft–7 in. [4.14]	4 ft–7 in. [1.40]	54.8 [5.09]	1.66 [0.51]	32.91 [10.03]	76.83	117.32
24	13 ft–10 in. [4.22]	5 ft–5 in. [1.65]	65.6 [6.09]	1.89 [0.58]	34.79 [10.60]	100.28	152.68
25	14 ft–1 in. [4.29]	6 ft–2 in. [1.88]	76.6 [7.12]	2.09 [0.64]	36.67 [11.18]	125.22	190.22
26	14 ft–5 in. [4.39]	3 ft–3 in. [0.99]	40.0 [3.72]	1.24 [0.38]	32.15 [9.80]	46.17	72.11
27	14 ft–8 in. [4.47]	4 ft–1 in. [1.24]	51.5 [4.78]	1.52 [0.46]	33.98 [10.36]	68.08	104.07
28	14 ft–10 in. [4.52]	4 ft–10 in. [1.47]	63.2 [5.87]	1.77 [0.54]	35.80 [10.91]	92.48	138.94

TABLE X1.1 *Continued*

Structure Number	Span, ft-in. [m]	Rise, ft-in. [m]	Area[A], ft² [m²]	R[B], ft [m]	WP[C], ft [m]	AR^2/3D	AD^1/2E
29	15 ft–1 in. [4.60]	5 ft–8 in. [1.73]	75.1 [6.98]	2.00 [0.61]	37.63 [11.47]	119.21	178.77
30	15 ft–4 in. [4.67]	6 ft–5 in. [1.96]	87.2 [8.10]	2.21 [0.67]	39.46 [12.03]	147.95	220.89
31	15 ft–6 in. [4.72]	7 ft–3 in. [2.21]	99.4 [9.23]	2.41 [0.73]	41.28 [12.58]	178.68	267.64
32	15 ft–9 in. [4.80]	8 ft–0 in. [2.44]	111.8 [10.39]	2.59 [0.79]	43.11 [13.14]	210.85	316.22
33	15 ft–10 in. [4.83]	3 ft–6 in. [1.07]	46.8 [4.35]	1.33 [0.41]	35.13 [10.71]	56.60	87.55
34	16 ft–0 in. [4.88]	4 ft–3 in. [1.30]	59.5 [5.53]	1.61 [0.49]	36.90 [11.25]	81.73	122.66
35	16 ft–2 in. [4.93]	5 ft–1 in. [1.55]	72.3 [6.72]	1.87 [0.57]	38.68 [11.79]	109.74	163.01
36	16 ft–4 in. [4.98]	5 ft–11 in. [1.80]	85.2 [7.92]	2.11 [0.64]	40.45 [12.33]	140.16	207.24
37	16 ft–6 in. [5.03]	6 ft–8 in. [2.03]	98.3 [9.13]	2.33 [0.71]	42.23 [12.87]	172.77	253.81
38	16 ft–8 in. [5.08]	7 ft–6 in. [2.29]	111.5 [10.36]	2.53 [0.77]	44.00 [13.41]	207.02	305.36
39	16 ft–10 in. [5.13]	8 ft–3 in. [2.51]	124.8 [11.59]	2.73 [0.83]	45.78 [13.95]	243.78	358.46
40	17 ft–9 in. [5.41]	3 ft–10 in. [1.17]	54.4 [5.05]	1.41 [0.43]	38.71 [11.80]	68.40	106.51
41	18 ft–2 in. [5.54]	4 ft–7 in. [1.40]	68.3 [6.35]	1.68 [0.51]	40.72 [12.41]	96.52	146.22
42	18 ft–7 in. [5.66]	5 ft–4 in. [1.63]	82.5 [7.66]	1.93 [0.59]	42.74 [13.03]	127.89	190.53
43	19 ft–0 in. [5.79]	6 ft–1 in. [1.85]	97.1 [9.02]	2.17 [0.66]	44.75 [13.64]	162.75	239.49
44	19 ft–5 in. [5.92]	6 ft–11 in. [2.11]	111.9 [10.40]	2.39 [0.73]	46.77 [14.26]	200.03	294.29
45	19 ft–10 in. [6.05]	7 ft–8 in. [2.34]	127.1 [11.81]	2.61 [0.80]	48.79 [14.87]	240.94	351.92
46	20 ft–3 in. [6.17]	8 ft–5 in. [2.57]	142.6 [13.25]	2.81 [0.86]	50.80 [15.48]	283.96	413.70
47	19 ft–1 in. [5.82]	4 ft–2 in. [1.27]	63.3 [5.88]	1.52 [0.46]	41.60 [12.68]	83.68	129.21
48	19 ft–5 in. [5.92]	4 ft–11 in. [1.50]	78.3 [7.27]	1.80 [0.55]	43.56 [13.26]	115.86	173.62
49	19 ft–9 in. [6.02]	5 ft–8 in. [1.73]	93.6 [8.70]	2.06 [0.63]	45.52 [13.87]	151.54	222.81
50	20 ft–1 in. [6.12]	6 ft–8 in. [1.98]	109.2 [10.15]	2.30 [0.70]	47.48 [14.47]	190.27	278.41
51	20 ft–6 in. [6.25]	7 ft–3 in. [2.21]	125.0 [11.61]	2.53 [0.77]	49.44 [15.07]	232.09	336.57
52	20 ft–10 in. [6.35]	8 ft–1 in. [2.46]	141.2 [13.12]	2.75 [0.84]	51.39 [15.66]	277.16	401.45
53	21 ft–2 in. [6.45]	8 ft–10 in. [2.69]	157.6 [14.64]	2.95 [0.90]	53.35 [16.26]	324.17	468.40
54	20 ft–4 in. [6.20]	4 ft–6 in. [1.37]	73.1 [6.79]	1.64 [0.50]	44.48 [13.56]	101.66	155.07
55	20 ft–7 in. [6.27]	5 ft–3 in. [1.60]	89.2 [8.29]	1.92 [0.59]	46.38 [14.14]	137.79	204.38
56	20 ft–11 in. [6.38]	6 ft–1 in. [1.85]	105.5 [9.80]	2.19 [0.67]	48.28 [14.72]	177.92	260.21
57	21 ft–3 in. [6.48]	6 ft–10 in. [2.08]	122.1 [11.34]	2.43 [0.74]	50.18 [15.29]	220.69	319.18
58	21 ft–6 in. [6.55]	7 ft–8 in. [2.34]	139.0 [12.91]	2.67 [0.81]	52.08 [15.87]	267.52	384.87
59	21 ft–10 in. [6.65]	8 ft–5 in. [2.57]	156.0 [14.49]	2.89 [0.88]	53.98 [16.45]	316.51	452.58
60	22 ft–1 in. [6.73]	9 ft–3 in. [2.82]	173.3 [16.10]	3.10 [0.94]	55.88 [17.03]	368.45	527.07
61	21 ft–7 in. [6.58]	4 ft–11 in. [1.50]	83.8 [7.79]	1.77 [0.54]	47.32 [14.42]	122.62	185.81
62	21 ft–10 in. [6.65]	5 ft–8 in. [1.73]	101.0 [9.38]	2.05 [0.62]	49.16 [14.98]	162.99	240.43
63	22 ft–1 in. [6.73]	6 ft–6 in. [1.98]	118.4 [11.00]	2.32 [0.71]	51.00 [15.54]	207.50	301.86
64	22 ft–3 in. [6.78]	7 ft–3 in. [2.21]	135.9 [12.63]	2.57 [0.78]	52.84 [16.11]	254.98	365.92
65	22 ft–6 in. [6.86]	8 ft–1 in. [2.46]	153.7 [14.28]	2.81 [0.86]	54.69 [16.67]	308.06	436.99
66	22 ft–9 in. [6.93]	8 ft–10 in. [2.69]	171.6 [15.94]	3.04 [0.93]	53.53 [16.32]	360.11	510.01
67	23 ft–0 in. [7.01]	9 ft–8 in. [2.95]	189.8 [17.63]	3.25 [0.99]	58.37 [17.79]	416.44	590.11
68	22 ft–9 in. [6.93]	5 ft–4 in. [1.63]	95.5 [8.87]	1.91 [0.58]	50.14 [15.28]	147.01	220.55
69	23 ft–0 in. [7.01]	6 ft–1 in. [1.85]	113.7 [10.56]	2.19 [0.67]	51.92 [15.83]	191.74	280.43
70	23 ft–2 in. [7.06]	6 ft–11 in. [2.11]	132.1 [12.27]	2.46 [0.75]	53.70 [16.37]	240.73	347.42
71	23 ft–4 in. [7.11]	7 ft–8 in. [2.34]	150.6 [13.99]	2.71 [0.83]	55.48 [16.91]	292.73	416.99
72	23 ft–6 in. [7.16]	8 ft–6 in. [2.59]	169.3 [15.73]	2.96 [0.90]	57.27 [17.46]	349.02	493.59
73	23 ft–8 in. [7.21]	9 ft–3 in. [2.82]	188.1 [17.48]	3.18 [0.97]	59.05 [18.00]	406.76	572.08
74	23 ft–10 in. [7.26]	10 ft–1 in. [3.07]	207.0 [19.23]	3.40 [1.04]	60.83 [18.54]	468.05	657.31
75	24 ft–0 in. [7.32]	5 ft–9 in. [1.75]	108.2 [10.05]	2.05 [0.62]	52.92 [16.13]	174.61	259.45
76	24 ft–1 in. [7.34]	6 ft–6 in. [1.98]	127.5 [11.85]	2.33 [0.71]	54.64 [16.65]	224.09	325.06
77	24 ft–3 in. [7.39]	7 ft–4 in. [2.24]	146.8 [13.64]	2.60 [0.79]	56.37 [17.18]	277.57	397.54
78	24 ft–4 in. [7.42]	8 ft–2 in. [2.49]	166.2 [15.44]	2.86 [0.87]	58.09 [17.71]	334.87	474.96
79	24 ft–5 in. [7.44]	8 ft–11 in. [2.72]	185.7 [17.25]	3.10 [0.94]	59.81 [18.23]	394.81	554.51
80	24 ft–7 in. [7.49]	9 ft–9 in. [2.97]	205.3 [19.07]	3.34 [1.02]	61.54 [18.76]	458.73	641.05
81	24 ft–8 in. [7.52]	10 ft–6 in. [3.20]	225.0 [20.90]	3.56 [1.09]	63.26 [19.28]	524.58	729.08
82	25 ft–2 in. [7.67]	6 ft–2 in. [1.88]	122.0 [11.33]	2.19 [0.67]	55.67 [16.97]	205.74	302.96
83	25 ft–2 in. [7.67]	7 ft–0 in. [2.13]	142.2 [13.21]	2.48 [0.76]	57.33 [17.47]	260.54	376.23
84	25 ft–3 in. [7.70]	7 ft–9 in. [2.36]	162.4 [15.09]	2.75 [0.84]	59.00 [17.98]	318.77	452.10
85	25 ft–4 in. [7.72]	8 ft–7 in. [2.62]	182.6 [16.96]	3.01 [0.92]	60.66 [18.49]	380.67	534.97
86	25 ft–4 in. [7.72]	9 ft–5 in. [2.87]	202.9 [18.85]	3.26 [0.99]	62.33 [19.00]	446.09	622.63
87	25 ft–5 in. [7.75]	10 ft–2 in. [3.10]	223.3 [20.75]	3.49 [1.06]	63.99 [19.50]	513.77	712.00

[A] Inside area of box culvert cross section.
[B] Hydraulic radius of box culvert section.
[C] Wetted perimeter of box culvert cross section.
[D] Uniform flow section factor.
[E] Inlet control section factor.

X2. MANUFACTURER'S SUGGESTED DESIGN PROPERTIES

X2.1 The plastic moment capacities tabulated in Table X2.1 are based on test results adjusted for minimum mechanical properties.

TABLE X2.1 Plastic Moment Capacity in k-ft/ft [kN-m/m]

Rib Type	Spacing Class	Plate and Rib Composite Section Properties					
		Metal Thickness, in. [mm]					
		0.125 [3.18]	0.150 [3.81]	0.175 [4.45]	0.200 [5.08]	0.225 [5.72]	0.250 [6.35]
		Plastic Moment Capacity					
Type 1	A	4.62 [20.55]	5.46 [24.28]	6.04 [26.86]	6.61 [29.40]	7.17 [31.89]	7.74 [34.42]
Type 1	B	6.18 [27.49]	7.25 [32.25]	7.94 [35.31]	8.60 [38.25]	9.25 [41.14]	9.87 [43.90]
Type 1	C	7.41 [32.96]	8.66 [38.52]	9.48 [42.16]	10.26 [45.63]	11.00 [48.93]	11.71 [50.75]
Type 1	D	10.63 [47.28]	12.13 [53.95]	13.08 [58.18]	14.05 [62.48]	15.03 [66.85]	16.02 [71.26]
Type 2	A	5.87 [26.11]	6.82 [30.33]	7.43 [33.05]	8.04 [35.76]	8.63 [38.30]	9.21 [40.96]
Type 2	B	8.32 [37.00]	9.59 [42.65]	10.39 [46.21]	11.14 [49.55]	11.85 [52.71]	12.55 [55.82]
Type 2	C	10.42 [46.35]	11.90 [52.93]	12.84 [57.11]	13.72 [61.02]	14.57 [64.81]	15.39 [68.45]
Type 2	D	16.45 [73.17]	18.46 [82.11]	19.41 [86.39]	20.38 [90.65]	21.37 [95.05]	22.37 [99.50]
Type 10	A	13.13 [58.40]	14.37 [63.93]	15.43 [68.63]	16.64 [74.00]	17.68 [78.63]	18.68 [83.09]
Type 10	B	22.22 [98.85]	23.91 [106.37]	25.14 [111.84]	26.33 [117.12]	27.46 [122.39]	28.65 [127.46]
Type 10	C	30.79 [136.95]	32.20 [143.22]	33.52 [149.11]	34.81 [154.85]	36.11 [160.63]	37.38 [166.29]

SUMMARY OF CHANGES

Committee B07 has identified the location of selected changes to this standard since the last issue (B864/B864M – 08) that may impact the use of this standard. (Approved May 1, 2013.)

(1) Updated references to AASHTO Specifications for Highway Bridges and FHWA Hydraulic Design of Highway Culverts in 2.2 and 2.3.
(2) Updated live load reference to reflect the AASHTO LRFD Design Specification in 5.1.7.
(3) Updated geometric limits of box culverts to reflect current limitations in AASHTO LRFD Design Specifications and other recognized standards in Table 2.
(4) Updated tolerances on dimensions to suit larger box culverts in Table 3.