



Designation: A 964/A 964M – 96

Standard Specification for Corrugated Steel Box Culverts¹

This standard is issued under the fixed designation A 964/A 964M; 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 steel box culverts manufactured from corrugated plate or sheet, with or without attached stiffeners, for field assembly. Appropriate fasteners and optional materials such as steel invert plates and headwalls are also described. Applications for steel 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, Customary U.S. Units (LRFD Bridge Design Specifications, SI Units).

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 manufacturers' suggested design properties for the box culvert types described in this specification, and for the spacing classes and material thicknesses typically available.

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 6/A 6M Specification for General Requirements for

Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling²

A 36/A 36M Specification for Carbon Structural Steel²

A 123 Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products³

A 761/A 761M Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches³

A 796 Practice for Structural Design of Corrugated Steel Pipe, Pipe-Arches, and Arches for Storm and Sanitary Sewers and Other Buried Applications³

A 902 Terminology Relating to Metallic Coated Steel Products³

2.2 AASHTO Standard:

LRFD Bridge Design Specifications, Customary U.S. Units (LRFD Bridge Design Specifications, SI Units)⁴

2.3 FHWA Standard:

HDS No. 5, Hydraulic Design of Highway Culverts, Report No. FHWA-IP-85-15⁵

3. Terminology

3.1 Definitions:

3.1.1 For definitions of general terms related to metallic coated steel products refer to Terminology A 902.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *box culvert, n*—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 or without stiffeners, footing plates, or invert plates.

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

3.2.3 *haunch, n*—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).

3.2.4 *shell, n*—the continuous, structural enclosure of the box culvert consisting of modular, field assembled and bolted,

² Annual Book of ASTM Standards, Vol 01.04.

³ Annual Book of ASTM Standards, Vol 01.06.

⁴ Available from American Association of State Highway and Transportation Officials, 444 N. Capitol St. N.W., Suite 225, Washington, DC 20001.

⁵ Available from the National Technical Information Service, Springfield, VA 22161.

¹ This specification is under the jurisdiction of ASTM Committee A-5 on Metallic Coated Iron and Steel Products and is the direct responsibility of Subcommittee A05.17 on Corrugated Steel Pipe Specifications.

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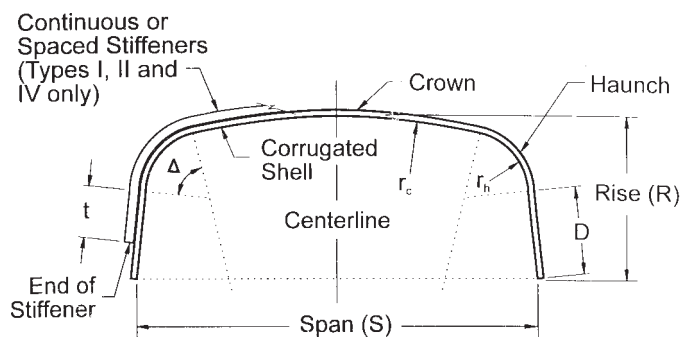


FIG. 1 Box Culvert Geometry

corrugated plate members forming the crown, haunch and side segments (see Fig. 1).

3.2.5 *stiffeners, n*—spaced, hot rolled or cold formed 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).

3.2.6 *rise, n*—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).

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

3.2.8 *unit weight, n*—the force resulting from gravitational attraction on a mass having a unit volume.

4. Classification

4.1 Steel box culverts are furnished in four types. Each type represents an alternate means of providing the required structural strength. The shell thickness and, where applicable, the stiffener thickness 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). Furthermore, while the box culvert structure shall be supplied in a consistent type throughout its length, the shell thickness and, where applicable, the stiffener thickness and spacing class also may be varied along the length, in accordance with cover and loading requirements, as agreed upon between the purchaser and the fabricator.

4.1.1 *Type I Box Culvert*, consisting of a corrugated plate shell having 6 by 2 in. [152 by 51 mm] corrugations in combination with spaced, cold formed, corrugated plate stiffeners as detailed in Fig. 2. Stiffener spacing classes shall be as defined below and as illustrated in Fig. 3.

4.1.1.1 *Type I, Class A Spacing*, consisting of external stiffeners spaced at 24 in. [610 mm] center-to-center.

4.1.1.2 *Type I, Class B Spacing*, consisting of external stiffeners spaced at 12 in. [305 mm] center-to-center.

4.1.1.3 *Type I, Class C Spacing*, consisting of both external and internal stiffener groups, each spaced at 24 in. [610 mm] center-to-center, with the outer group offset 9 in. [229 mm] from the inner group.

4.1.2 *Type II Box Culvert*, consisting of a corrugated plate shell having 6 by 2 in. [152 by 51 mm] corrugations in combination with spaced, hot rolled, angle stiffeners as detailed in Fig. 4. Stiffener spacing classes shall be as defined below and as illustrated in Fig. 4.

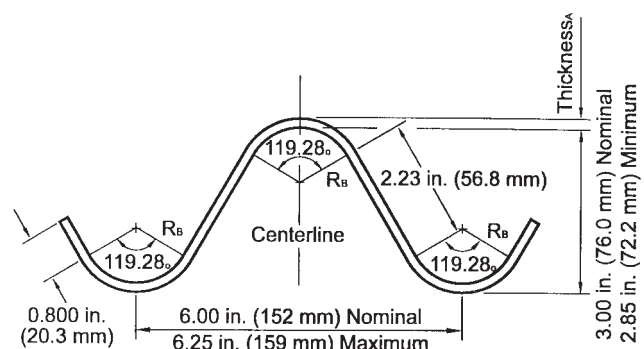
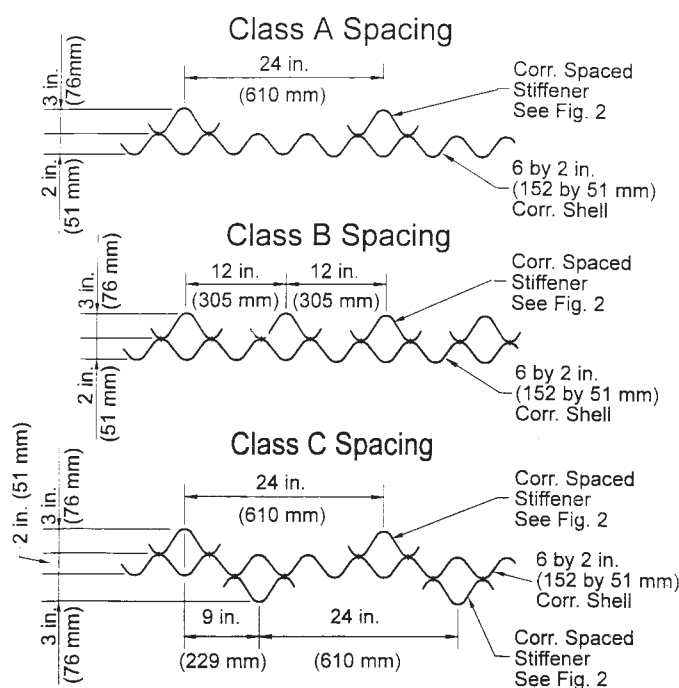


FIG. 2 Type I Rib Stiffener Geometry

^a Rib Stiffener Thickness:
For thickness tolerances,
see ASTM A 761/A 761M.

^b Inside Radius:
1.00 in. (25.4 mm) nominal,
0.938 in. (23.8 mm) minimum.



NOTE—All dimensions are nominal.

FIG. 3 Type I Rib Spacing Classes

4.1.2.1 *Type II, Class A Spacing*, consisting of external stiffeners spaced at 30 in. [762 mm] center-to-center.

4.1.2.2 *Type II, Class B Spacing*, consisting of external stiffeners spaced at 24 in. [610 mm] center-to-center.

4.1.2.3 *Type II, Class C Spacing*, consisting of external stiffeners spaced at 18 in. [457 mm] center-to-center.

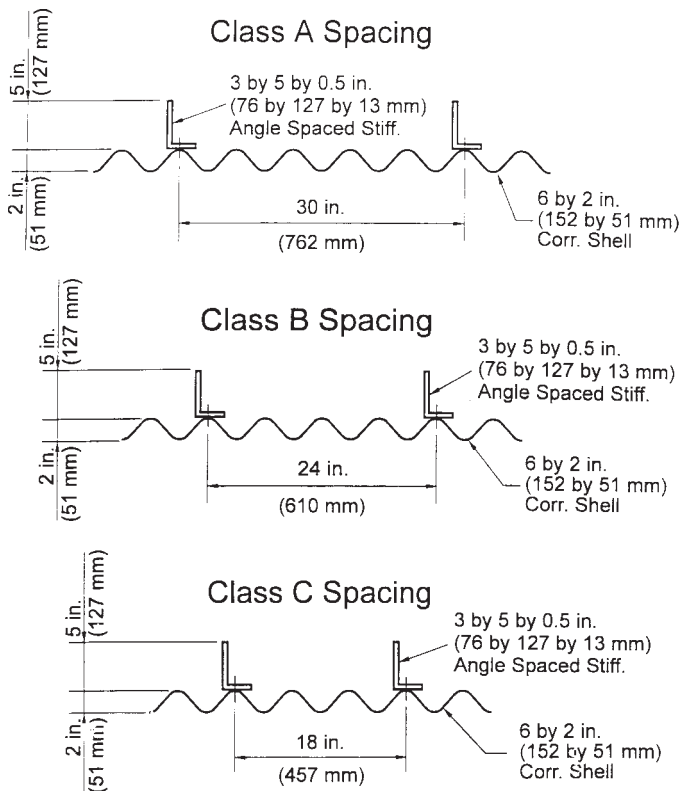
4.1.3 *Type III Box Culvert*, consisting of a 15 by 5.5 in. [381 by 140 mm] corrugated plate shell without stiffeners.

4.1.4 *Type IV Box Culvert*, consisting of a corrugated plate shell having 6 by 2 in. [152 by 51 mm] corrugations in combination with continuous corrugated plate stiffeners. The stiffener placement and cross section shall be as detailed in Fig. 5.

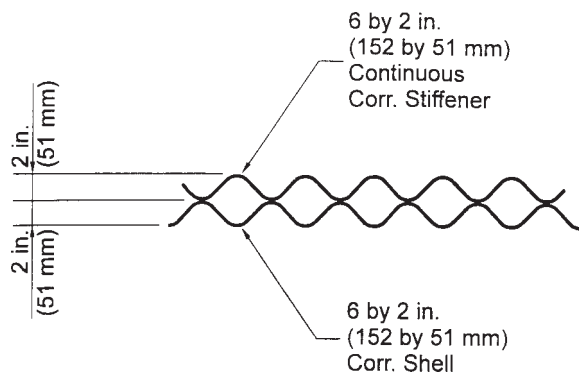
5. Ordering Information

5.1 Orders for products specified herein shall include the

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NOTE—All dimensions are nominal.
FIG. 4 Type II Rib Spacing Classes



NOTE—All dimensions are nominal.
FIG. 5 Type IV Stiffener

following information required as necessary to adequately describe the desired product characteristics:

- 5.1.1 Name of product (corrugated steel box culvert),
- 5.1.2 ASTM designation and year of issue, as A 964- for inch-pound units or A 964M- 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 the unobstructed cross sectional area required,

NOTE 1—The nominal length increment is 2 ft [0.61 m] for Types I, II and IV box culverts and 2.5 ft [0.76 m] for Type III box culverts. Also, structure types with internal stiffeners reduce the available cross sectional area below nominal values. Therefore, the unobstructed cross sectional area required by the hydraulic design may be important in some cases.

5.1.5 The design ground surface profile documenting the location and magnitude of the 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 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 the ground surface profile to the nearest 0.1 ft [30 mm].

5.1.6 Dead load unit weight, if different than 120 lb/ft³ [18.9 kN/m³],

5.1.7 Structure live load vehicle configuration, if different than AASHTO HS 20-44 (see AASHTO LRFD Bridge Design Specifications, Customary U.S. Units [LRFD Bridge Design Specifications, SI Units]),

5.1.8 Base channel, 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/ft² (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 A 796. Also, specific design criteria for similar applications are available in the AASHTO LRFD Bridge Design Specifications, Customary U.S. Units [LRFD Bridge Design Specifications, SI Units].

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

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

5.1.10 Optionally, structure type (if not included in the order, structure type shall be the option of the fabricator),

NOTE 5—Some of the structure types specified herein may be proprietary and available from only one fabricator. Also, some fabricators may furnish more than one type. The most competitive alternative will generally be obtained by leaving type selection to the option of the fabricator.

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

5.1.12 Material certification, if required (see 13.1).

NOTE 6—Typical ordering information may be described as: one corrugated steel box culvert, in accordance with ASTM A 964-, 7 ft, 3 in. rise by 20 ft, 8 in. span by 120 ft long, having a 1.4 ft minimum cover and a 3.0 ft maximum cover, with base channels for concrete footings; or two corrugated steel box culverts, in accordance with ASTM A 964M-, each being 1.88 m rise by 4.65 m span by 18.3 m long, each having 0.43 m minimum and maximum covers, assuming a dead load unit weight of 21.3 kN/m³, having full invert plates and having ends slope adjusted for 2-percent grade, including certification.

6. Design Properties

6.1 The required design properties shall be determined for the crown and haunch segments of the box culvert in accordance with the ordering information and the AASHTO LRFD Bridge Design Specifications, Customary U.S. Units [LRFD Bridge Design Specifications, SI Units] (see 13.1).