



Designation: **B746/B746M—16 B746/B746M – 22**

Standard Specification for Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches¹

This standard is issued under the fixed designation B746/B746M; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This specification covers corrugated aluminum alloy structural plate used in the construction of pipe, pipe-arches, arches, underpasses, box culverts, and special shapes for field assembly. Appropriate fasteners are also described. The pipe, arches, and other shapes are generally used for drainage purposes, pedestrian and vehicular underpasses, and utility tunnels. Aluminum box culvert shapes are covered in Specification [B864/B864M](#).

1.2 This specification does not include requirements for bedding, backfill, or the relationship between earth cover load and plate thickness of the pipe. Experience has shown that the successful performance of this product depends upon the proper selection of plate thickness, type of bedding and backfill, controlled manufacture in the plant, and care in the installation. The purchaser must correlate the above factors and also the corrosion and abrasion requirements of the field installation with the plate thickness. The structural design of corrugated aluminum structural plate pipe and the proper installation procedures are given in Practices [B790/B790M](#) and [B789/B789M](#), respectively. A procedure for using life-cycle cost analysis techniques to evaluate alternate drainage system designs using corrugated metal pipe is given in Practice [A930](#).

1.3 The values stated in either inch-pound units or SI units are to be regarded separately as standard. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other.

1.4 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

[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

[A449](#) Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use

[A563](#) Specification for Carbon and Alloy Steel Nuts (Metric) [A0563_A0563M](#)

¹ This specification is under the jurisdiction of ASTM Committee [B07](#) on Light Metals and Alloys and is the direct responsibility of Subcommittee [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.



- A563M Specification for Carbon and Alloy Steel Nuts (Metric) (Withdrawn 2021)³
- A930 Practice for Life-Cycle Cost Analysis of Corrugated Metal Pipe Used for Culverts, Storm Sewers, and Other Buried Conduits
- B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) B0209_B0209M
- B209M Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) (Withdrawn 2021)³
- B221 Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
- B221M Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
- B666/B666M Practice for Identification Marking of Aluminum and Magnesium Products
- B695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
- B789/B789M Practice for Installing Corrugated Aluminum Structural Plate Pipe for Culverts and Sewers
- B790/B790M Practice for Structural Design of Corrugated Aluminum Pipe, Pipe-Arches, and Arches for Culverts, Storm Sewers, and Other Buried Conduits
- B864/B864M Specification for Corrugated Aluminum Box Culverts
- E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- F467 Specification for Nonferrous Nuts for General Use
- F467M Specification for Nonferrous Nuts for General Use (Metric)
- F468 Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use
- F468M Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use (Metric)
- F568M Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners (Metric) (Withdrawn 2012)³
- F593 Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
- F594 Specification for Stainless Steel Nuts
- F738M Specification for Stainless Steel Metric Bolts, Screws, and Studs (Withdrawn 2014)³
- F836M Specification for Style 1 Stainless Steel Metric Nuts (Metric)

2.2 American National Standards:⁴

- B18.2.1 Square and Hex Bolts and Screws, Inch Series
- B18.2.2 Square and Hex Nuts
- B18.2.3.6M Bolts, Metric, Heavy Hex
- B18.2.4.6M Hex Nuts, Heavy, Metric

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *arch*, *n*—a part circle shape spanning an open invert between the footings on which it rests.

<https://standards.iteh.ai/catalog/standards/sist/5b30d66a-d892-42f7-8259-52195ee067b2/astm-b746-b746m-22>

3.1.2 *box culvert*, *n*—a rectangular box with short-radius in upper corners and a long-radius crown. It can be with full invert or with footing pads.

3.1.3 *fabricator*, *n*—the producer of the components for the finished product.

3.1.4 *flat plate*, *n*—sheet or plate used to fabricate structural plate.

3.1.5 *manufacturer*, *n*—the producer of the flat plate and accessories.

3.1.6 *pipe*, *n*—a conduit having full circular shape; also, in a general context, all structure shapes covered by this specification.

3.1.7 *pipe-arch*, *n*—an arch shape with an approximate semicircular crown, small-radius corners, and large-radius invert.

3.1.8 *pipe, horizontal ellipse*, *n*—an elliptically shaped pipe with the horizontal diameter approximately 20 % greater than the nominal diameter.

3.1.9 *pipe, vertically elongated*, *n*—an elliptically shaped pipe with the vertical diameter up to 10 % greater than the nominal diameter.

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.



3.1.10 *purchaser, n*—the purchaser of the finished product.

3.1.11 *special shape, n*—a shape, other than described elsewhere in this section, suitable for fabrication with structural plate.

3.1.12 *structural plate, n*—a corrugated and curved plate which is field assembled with other structural plates to form the required structure.

3.1.13 *supplier, n*—the seller of the finished product when other than the fabricator.

3.1.14 *vehicular underpass, n*—a high arch shape with an approximate semicircular crown, large-radius sides, small-radius corners between sides and invert, and large-radius invert.

4. Ordering Information

4.1 Orders for material under this specification shall include the following information as necessary to adequately describe the desired product:

4.1.1 Name of material (aluminum alloy structural plate and accessories),

4.1.2 Description of structure (see Section 3),

4.1.3 Number of structures,

4.1.4 ASTM designation and year of issue, as B746—___ for inch-pound units or B746M—___ for SI units,

4.1.5 Dimensions of structure (diameter or span and rise, and length, and so forth) (see 7.2),

4.1.6 Thickness of plate (see 7.1),

4.1.7 Type of bolts; whether aluminum, stainless steel, or steel bolts are required or permitted. If not specified, steel bolts and nuts shall be furnished (see 5.3 and Note 2),

4.1.8 End treatment (bevel, skew, grade or slope corrections, or other special provision if required by the project plans or specifications),

4.1.9 Special requirements (including extrusion reinforcement locations and shapes), if required, and

4.1.10 Certification, if required.

NOTE 1—Typical ordering descriptions are as follows: (1) Structural plates and fasteners for two aluminum alloy structural plate pipes, in accordance with ASTM B746—___, 180-in. dia., 0.100-in. plate thickness, each 140-ft nominal centerline length with end treatment as shown on plans. (2) Structural plates and fasteners for one aluminum alloy structural plate pipe arch, in accordance with ASTM B746—___, 3860 mm span by 2460 mm rise, 3.81 mm plate thickness, 27.0 m nominal centerline length with square ends.

5. Materials

5.1 *Flat Plate*—Insofar as applicable, flat plate shall conform to the requirements of Specification B209 or B209M. The plates shall be fabricated from alloy 5052-H141. The mechanical properties for alloy 5052-H141 shall conform to the requirements of Table 1.

5.2 *Extrusions*—The extrusions for circumferential or longitudinal stiffeners, or secondary structural components, shall be fabricated from aluminum alloys 6061-T6 or 6063-T6 conforming to Specification B221 or B221M.

5.3 *Assembly Fasteners*—Except as provided elsewhere in this section, bolts and nuts shall conform to the requirements specified in Tables 2 and 3. The bearing surface of both bolts and nuts shall be shaped to a 1-in. (25-mm) (25 mm) radius spherical surface, or to a uniform taper of approximately 22° to form a conical surface. In instead of bolts and nuts with the special bearing surface,



TABLE 1 Mechanical Properties of Aluminum Structural Plate, Alloy 5052-H141^A

Specified Thickness		Tensile Strength, min		Yield Strength (0.2 % offset), min		Elongation, % min in 2 in. or 50 mm
		ksi	MPa	ksi	MPa	
in.	mm					
0.100–0.150	2.54–3.81	35.5	245	24.0	165	6
0.175–0.250	4.44–6.35	34.0	235	24.0	165	8

^A To determine conformance with this specification, each value for tensile strength and for yield strength shall be rounded to the nearest 0.1 ksi (1 MPa) and each value for elongation to the nearest 0.5%, both in accordance with the rounding method of Practice E29.

TABLE 2 (B746) Bolt and Nut Requirements

	Bolts	Nuts
General Dimensions	ANSI B18.2.1 Heavy Hex	ANSI B18.2.2 Heavy Hex
Steel Bolts and Nuts	A307 ^A	A563 Grade A
Zinc Coating	A153/A153M or B695 Class 50	A153/A153M or B695 Class 50
Stainless Steel Bolts and Nuts	F593 Alloy Group 1, 2, or 3	F594 Alloy Group 1, 2, or 3
Aluminum Bolts and Nuts	F468 Alloy 6061-T6	F467 Alloy 6061-T6
Nominal Diameter, in.	3/4	3/4

^A Bolts conforming to Specification A449 with suitable nuts may be substituted.

TABLE 3 (B746M) Bolt and Nut Requirements

	Bolts	Nuts
General Dimensions	ANSI B18.2.3.6M Heavy Hex	ANSI B18.2.4.6M Heavy Hex
Steel Bolts and Nuts	F568M Class 4.6 ^A	A563M Class 5
Zinc Coating	A153/A153M or B695 Class 50	A153/A153M or B695 Class 50
Stainless Steel Bolts and Nuts	F738M Alloy Group A1, A2, or A4	F836M Alloy Group A1, A2, or A4
Aluminum Bolts and Nuts	F468M Alloy 6061-T6	F467M Alloy 6061-T6
Nominal Diameter, metric size	M 20	M 20

^A Bolts through Class 8.8 with suitable nuts may be substituted.

standard type bolts and nuts with special washers may be used. The number of nuts and bolts of each size and length furnished shall be 2 % in excess of the theoretical number required to field erect the structure or structures. Bolt lengths shall be such as to result in at least “full nut” engagement when tightened in place.

NOTE 2—Aluminum bolts and nuts, due to lower strength properties than steel bolts, have lower allowable design seam strengths in pipe with all plate thicknesses, but especially so for plate thicknesses greater than 0.175 in. (4.44 mm). The purchaser should indicate which bolts and nuts are acceptable or required based on his design calculations. Corrosion should be considered in selecting bolt types for use in corrosive environments.

6. Fabrication

6.1 Structural plates shall be fabricated from flat sheets or plates, corrugated in accordance with 6.2, punched for bolted lap seams in accordance with 6.3 and curved to the required radius.

6.2 *Corrugations*—Corrugations shall form smooth continuous curves and tangents. Corrugations shall form annular rings (complete or partial) about the axis of the structure. The dimensions of the corrugations shall be in accordance with Table 4.

6.3 *Bolt Holes*—The bolt holes shall be punched so that all plates having like dimensions, curvature, and same number of bolts per foot of seam shall be interchangeable. Longitudinal—As a minimum, longitudinal seams shall have holes for four bolts per

TABLE 4 Corrugation Requirements

Nominal Size	Maximum Pitch ^A	Minimum Depth ^B	Inside Radius	
			Nominal	Minimum
B746—All values in in.				
9 by 2½	9 ¾	2¾	2¼	2.0
B746M—All values in mm				
230 by 64	238	60	57	51

^A Pitch is measured from crest to crest of corrugations, at 90° to the direction of the corrugations.

^B Depth is measured as the vertical distance from a straightedge resting on the corrugation crests parallel to the axis of the pipe, to the bottom of the intervening valley.



corrugation, with two holes in each valley and two holes in each crest, with the holes placed $1\frac{3}{4}$ in. $\pm \frac{1}{8}$ in. (45 mm ± 3 mm) apart. Circumferential seams in the finished product shall provide for a bolt spacing of not more than 10 in. (250 mm). The diameter of the bolt holes in the longitudinal seams shall not exceed the bolt diameter by more than $\frac{1}{8}$ in. (3 mm) except those in the plate corners. Bolt holes in circumferential seams, including plate corners, may be slotted with a width equal to the bolt diameter plus $\frac{1}{4}$ in. (6 mm) and a length equal to the bolt diameter plus $\frac{3}{8}$ in. (10 mm). The minimum distance from the center of a hole to the edge of a plate shall be $1\frac{3}{4}$ times the diameter of the bolt. Holes shall be provided as required for connecting headwall anchors, bearings, and miscellaneous attachments.

6.4 *Special Plates*—Plates for forming skewed ends, beveled ends, or curved alignment shall be accurately cut to fit the order plans. Cut edges of plates shall be free of notches, gouges, or burrs and shall present a workmanlike finish. Legible identification shall be placed on each special plate to designate its proper position in the finished structure and referenced to the approved erection drawings.

6.5 *Extrusions*—Extrusions for longitudinal or circumferential structural reinforcing, if required, shall be as sized and located on the order plans, and fabricated from aluminum alloy 6061-T6. Extrusions for receiving angles or receiving channels on arches or other less critical structural members, if required, shall be as sized and located on the order plans, and shall be fabricated from aluminum alloy 6061-T6 or 6063-T6.

NOTE 3—Refer to Specification **B864/B864M** for circumferential stiffening rib profiles, properties, and capacities.

7. Dimensions

7.1 *Plate Thickness*—Plate thickness shall be as specified by the purchaser from the specified plate thickness listed in **Table 5** (**Note 4**). For corrugated plate, the thickness shall be measured on the tangents of the corrugations.

NOTE 4—The purchaser should determine the required thickness according to the design criteria in Practice **B790/B790M**.

7.2 *Cross-Section Dimensions*—Cross-section dimensions, such as diameter, span and rise, and radius of curvature, shall be measured to the inside crest of corrugations. The average diameter of circular pipe, based on two measurements at 90° to each other, shall not vary more than $\pm 2\%$ from the calculated inside diameter shown in **Table 6**. The span and rise of pipe arch, arch, underpass, and other noncircular structures shall be as specified within $\pm 2\%$.

NOTE 5—The purchaser should consult the fabricator to determine the standard dimensions for the various types of structures, other than circular structure.

8. Workmanship

8.1 Plates, fasteners, and accessories shall be of uniform quality consistent with good manufacturing and inspection practices.

9. Sampling and Testing

9.1 Sampling and testing of plate shall be according to Specification **B209** or **B209M**. Sampling and testing of other materials shall be according to the specification referenced. The manufacturer shall make adequate tests and measurements to ensure that the material produced complies with this specification.

TABLE 5 Plate Thickness^A

Specified Thickness		Minimum Thickness	
in.	mm	in.	mm
0.100	2.54	0.093	2.36
0.125	3.18	0.118	3.00
0.150	3.81	0.138	3.51
0.175	4.44	0.161	4.09
0.200	5.08	0.186	4.72
0.225	5.72	0.209	5.31
0.250	6.35	0.232	5.89

^A Thickness is measured at any point on the plate not less than $\frac{3}{8}$ in. or 10 mm from an edge, and if corrugated, on the tangents of corrugations.