



Designation: A 761/A 761M – 03

American Association State Highway and Transportation
Officials Standard
AASHTO No. M 167/M 167 M

Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field- Bolted Pipe, Pipe-Arches, and Arches¹

This standard is issued under the fixed designation A 761/A 761M; 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.

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

1. Scope*

1.1 This specification covers corrugated steel structural plate, zinc-coated, used in the construction of pipe, pipe-arches, arches, underpasses, and special shapes for field assembly. Appropriate fasteners and accessory materials are also described. The pipe, arches, and other shapes are generally used for drainage purposes, pedestrian and vehicular underpasses, and utility tunnels.

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, manufacture in the plant, and care in the installation. The purchaser must correlate the preceding factors and also the corrosion and abrasion requirements of the field installation with the plate thickness. The structural design of corrugated steel structural plate pipe and the proper installation procedures are described in Practices A 796/A 796M and A 807/A 807M.

1.3 This specification is applicable to orders in either inch-pound units (as A 761) or SI units (as A 761M). Inch-pound units and SI units are not necessarily equivalent. SI units are shown in brackets in the text, but they are the applicable values when the material is ordered to A 761M.

1.4 This specification references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of this specification.

2. Referenced Documents

2.1 ASTM Standards:

- A 36/A 36M Specification for Carbon Structural Steel²
- A 90/A 90M Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings³

- A 123/A 123M Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products³
- A 153/A 153M Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware³
- A 307 Specification for Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength⁴
- A 370 Test Methods and Definitions for Mechanical Testing of Steel Products⁵
- A 449 Specification for Quenched and Tempered Steel Bolts and Studs⁴
- A 563 Specification for Carbon and Alloy Steel Nuts⁴
- A 563M Specification for Carbon and Alloy Steel Nuts [Metric]⁴
- A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products⁵
- A 754 Test Method for Coating Thickness by X-ray Fluorescence³
- A 780 Practice for Repair of Damaged Hot-Dip Galvanized Coatings³
- A 796/A 796M Practice for Structural Design of Corrugated Steel Pipe, Pipe-Arches, and Arches for Storm and Sanitary Sewers and Other Buried Applications³
- A 807/A 807M Practice for Installing Corrugated Steel Structural Plate Pipe for Sewers and Other Applications³
- A 902 Terminology Relating to Metallic Coated Steel Products³
- B 6 Specification for Zinc (Slab Zinc)⁶
- B 695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel⁷
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁸
- E 376 Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Test Methods⁹
- F 568 Specification for Carbon and Alloy Steel Externally

¹ This specification is under the jurisdiction of ASTM Committee A05 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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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 01.03.

⁶ Annual Book of ASTM Standards, Vol 02.04.

⁷ Annual Book of ASTM Standards, Vol 02.05.

⁸ Annual Book of ASTM Standards, Vol 14.02.

⁹ Annual Book of ASTM Standards, Vol 03.03.

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



Threaded Metric Fasteners⁴

2.2 ANSI Standards:¹⁰

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

2.3 AASHTO Standard:¹¹

Standard Specifications for Highway Bridges, Division I

3. Terminology

3.1 *Definitions*—See Terminology A 902 for definitions of general terminology relating to metallic-coated steel products.

3.2 Definitions of Terms Specific to This Standard:

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

3.2.2 *box culvert, n*—a rectangular box with a long-radius crown and short radius corners, and having either a full invert or footings.

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

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

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

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

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

3.2.8 *pipe, horizontal ellipse, n*—an elliptically shaped pipe with the horizontal diameter approximately 25 % greater than the nominal diameter.

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

3.2.10 *purchaser, n*—the person or agency that purchases the finished pipe structure.

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

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

3.2.13 *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 (corrugated steel 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

A 761— ____ for inch-pound units or A 761M – ____ for SI units.

4.1.5 Dimensions of structure (diameter or span and rise, and length, and so forth) (see 8.2 and Note 7),

4.1.6 Thickness of plate (see 8.1),

4.1.7 Description of corrugations (see 6.2),

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 Seam bolt size and number per corrugation, if different than the minimums specified (see 6.3 and Table 1 and Table 2),

4.1.10 Special requirements (including reinforcement locations, shapes, and thicknesses), if required, and

4.1.11 Certification, if required (see 12.1).

NOTE 1—Typical ordering descriptions are as follows: (1) Structural plates and fasteners for two corrugated steel structural plate pipes, in accordance with ASTM A 761 – ____, 180-in. diameter, 0.168-in. plate thickness, 6 by 2-in. corrugations, each 140-ft nominal centerline length with end treatment as shown on plans; (2) Structural plates and fasteners for one corrugated steel structural plate pipe-arch, in accordance with ASTM A 761M – ____, 3860-mm span by 2460-mm rise, 5.54-mm plate thickness, 150 by 50-mm corrugations, 27.0-m nominal centerline length with square ends, longitudinal seams with four M20 bolts per corrugation.

5. Materials

5.1 Flat Plate:

5.1.1 *Manufacture*—The base steel shall be made by any of the following processes: open-hearth, basic-oxygen, or electric-furnace.

5.1.2 *Chemical Composition*—The base metal heat analysis shall conform to the chemical requirements of Table 3. The requirements of this specification shall be met in continuous

TABLE 1 Bolt and Nut Requirements

	Bolts ^A	Nuts
	<i>A 761 (in.)</i>	
General dimensions ^B	ANSI B18.2.1 Heavy Hex	ANSI B18.2.2 Heavy Hex
Seam bolts and nuts ^C	A 449	A 563 Grade C
Anchorage bolts and nuts	A 307	A 563 Grade A
Zinc coating	A 153 or B 695, Class 55	A 153 or B 695, Class 55
Nominal diameter, min, in. ^D	3/4	3/4
	<i>A 761M [mm]</i>	
General dimensions ^B	ANSI B18.2.3.4M Heavy Hex	ANSI B18.2.4.6M Heavy Hex
Seam bolts and nuts ^C	F 568 Class 8.8	A 563M Class 12
Anchorage bolts and nuts	F 568 Class 4.6	A 563M Class 5
Zinc coating	A 153 or B 695, Class 55	A 153 or B 695, Class 55
Nominal diameter, min, metric size ^D	M20	M20

^ABolts with a special hemispherical base under the head are only available in inch sizes. They are also intended for use with metric plate.

^BSee 5.4.1 for requirements for bolt and nut bearing surfaces.

^CBolts and nuts also used for connecting arch plates to bearings and structural reinforcement to structural plates.

^DBolt size of 7/8 in. or 1 in. [M22, M24, or M27] shall be furnished when specified in the order (see 5.4 and Note 4).

¹⁰ Available from American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.

¹¹ Available from American Association of State Highway and Transportation Officials, 444 N. Capitol St., NW, Suite 249, Washington, DC 20001.

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TABLE 2 Bolt Hole Patterns in Structural Plate^A

Corrugation Size, in. [mm]	6 by 2 [150 by 50]	15 by 5½ [380 by 140]	16 by 6 [400 by 150]
<i>Longitudinal seams:</i>			
Number of rows	2	3	3
Holes per corrugation, each row, min:			
plates less than 0.310 [7.87] thick	1 ^B	2 ^C	2 ^C
plates 0.310 [7.87] and thicker	2	2 ^C	2 ^C
Spacing between rows, min, in. [mm]	2 [50]	3 [75]	4 [100]
<i>Circumferential seams:</i>			
Number of rows	1	1	1
Spacing in rows, max, in. [mm]	10 [250]	16 [400]	16.75 [425]
<i>Arch anchorage seams:</i>			
Number of rows	1	1	1
Spacing in rows, nominal max, in. [mm]	24 [600]	15 [380]	16 [400]

^AAll bolt holes shall be located 1.75 bolt diameters, minimum, center of hole to edge of sheet.

^BFor minimum of one hole per corrugation, holes shall be staggered with holes in one row in valleys and holes in the other row in crests of corrugations.

^COne hole each crest and valley of all corrugations for each row.

TABLE 3 Chemical Composition By Heat Analysis

Corrugation Size in. [mm]		Composition, %	Tolerance Over the Maximum Limit by Product Analysis, %
6 by 2 [150 by 50]	Sulfur, max	0.05	+0.01
	Sum of carbon, manganese, phosphorus, silicon, and sulfur, max	0.75	+0.04
15 by 5½ [380 by 140] and 16 by 6 [400 by 150]	Sulfur, max	0.04	+0.01
	Sum of carbon, manganese, phosphorus, silicon, and sulfur, max	1.86	+0.13

mass production during which the manufacturer has made analysis of individual heats so as to ensure that material is controlled within the specified limits.

5.1.3 Mechanical Requirements—The mechanical properties of the flat plate material prior to corrugating shall conform to the requirements in Table 4.

NOTE 2—The properties given in Table 4 for the flat plate normally provide the minimum yield strength of 33 ksi [230 MPa] (used in structural design for pipe with 6 by 2-in. [150 by 50-mm] corrugations), or 44 ksi [300 MPa] (used in structural design for pipe with 15 by 5½ -in. [380 by 140-mm] and 16 by 6-in. [400 by 150-mm] corrugations), after the plate is corrugated.

5.2 Bearings for Arches—When specified, metal bearings for arches shall be cold-formed channels made from flat plate material conforming to 5.1, and not less than 0.188 in. [4.78 mm] in specified thickness.

5.3 Members for Structural Reinforcement—Steel members for circumferential or longitudinal stiffeners, or secondary structural components, shall be fabricated from rolled shapes

conforming to Specification A 36/A 36M, or from flat plate material conforming to 5.1.

NOTE 3—When used, steel transverse structural reinforcing members are part of long span or box corrugated steel structural plate structures. Members of these types of structures can be designed using Practice A 796. The structural design of long-span structures is given in AASHTO Standard Specifications for Highway Bridges, Division I, Section 12.6. The structural design of beams is under development by AASHTO.

5.4 Assembly Fasteners—Except as provided in 5.4.1, bolts and nuts shall conform to the requirements specified in Table 1 (Note 4). Bolts shall have sufficient length to provide at least “full nut” engagement when tightened in place. The number of bolts furnished shall be 2 % in excess of the theoretical number required to erect the structure or structures.

5.4.1 Bolts and nuts for use with 6 by 2-in. [150 by 50-mm] and 16 by 6-in. [400 by 150-mm] corrugations shall have the bearing surface of both bolt and nut shaped to a 1-in. [25-mm] radius spherical surface, or shall be standard-type bolts and

TABLE 4 Mechanical Requirements for Flat Plate^A

Corrugation Size in. [mm]	Yield Strength ^B , min, ksi [MPa]	Tensile Strength ^B , min, ksi [MPa]	Elongation in 2 in. [50 mm], ^C min, %
6 by 2 [150 by 50]	28.0 [190]	42.0 [290]	25
15 by 5½ [380 by 140] and 16 by 6 [400 by 150]	40.0 [275]	55.0 [380]	25

^ATo determine conformance with this specification, round each value for tensile strength and for yield strength to the nearest 0.1 ksi [1 MPa] and each value for elongation to the nearest 1 %, both in accordance with the rounding method of Practice E 29.

^BYield strength and tensile strength are based on thickness of the base metal. If tests are made after coating, determine the base metal thickness after stripping the coating from the ends of the specimen contacting the grips of the tension testing machine.

^CElongation requirement does not apply to material tested after corrugating.