Designation: A769/A769M – 17 (Reapproved 2023)

Standard Specification for Carbon and High-Strength Electric Resistance Forge-Welded Steel Structural Shapes[1]

This standard is issued under the fixed designation A769/A769M; 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 carbon and high-strength steel shapes of structural quality manufactured by the electric-resistance forge-welding process from coils.

1.2 The size range covered is described in nominal dimensions for columns, beams, and tees.

	Size Range, in. (mm)
Web thickness	0.060 to 0.500 [1.5 to 12.7]
Flange thickness	0.060 to 0.500 [1.5 to 12.7]
Overall depth	2.00 to 24.00 [50 to 600]
Flange width	0.50 to 12.00 [12.7 to 300]

1.3 These shapes are intended for two classes of application:

1.3.1 *Class 1*—General structural use where static loading predominates.

1.3.2 *Class 2*—Structural use where fatigue loading occurs and is a principal design consideration.

NOTE 1—**Caution**—Because of the absence of smooth, integral, large radius fillets at the junctions of the webs and the flanges (see Fig. 1), fatigue limits of resistance forge-welded shapes in torsion, lateral loading, and flexure are usually lower than those for hot-rolled shapes of similar size and material. Users should consult shape manufacturers for recommended values of fatigue limits for each specific use, material, and size in cases where dynamic loading is a principal design consideration.

1.4 When the steel is to be welded, it is presupposed that a welding procedure suitable for the grade of steel and intended use or service will be utilized. See Appendix X3 of Specification A6/A6M for information on weldability.

1.5 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.

1.6 The following safety hazards caveat pertains only to the test methods portion, Section 10, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *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]

A6/A6M Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A568/A568M Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for

A635/A635M Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for

A700 Guide for Packaging, Marking, and Loading Methods for Steel Products for Shipment

2.2 *American Welding Society Standard:*

AWS Specification D 1.1 Structural Welding Code[3]

3. Ordering Information

3.1 Orders for material under this specification should include the following, as required, to describe the desired material adequately:

3.1.1 Quantity (total number of feet (metres) or lengths),

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.02 on Structural Steel for Bridges, Buildings, Rolling Stock and Ships.

Current edition approved May 1, 2023. Published June 2023. Originally approved in 1979. Last previous edition approved in 2017 as A769/A769M – 17. DOI: 10.1520/A0769_A0769M-17R23.

[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 Welding Society (AWS), 8669 NW 36 St., #130, Miami, FL 33166-6672, http://www.aws.org.

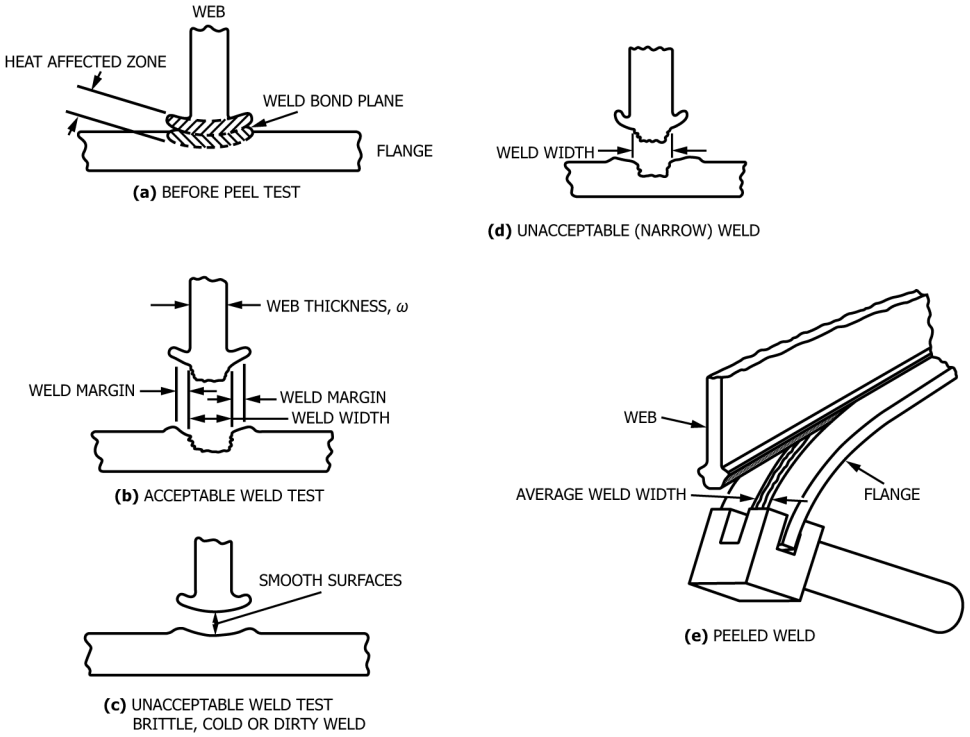

FIG. 1 Appearance of Peel Test Criteria

3.2 ASTM designation and year of issue, grade, and class,

3.3 Shape and size,

3.4 Length of each piece,

3.5 Information on intended application,

3.6 Other special requirements, and

3.7 Required certification and test reports.

4. Materials and Manufacture

4.1 The shapes shall be manufactured from coils by the electric-resistance forge-welding process. All components of a shape shall be furnished to the same grade unless otherwise specified.

4.2 For Class 1 shapes the average width of weld at the joint to the flange shall be more than 110 % of the nominal web thickness (see Fig. 1(*b*)). The acceptability of coil-splice welds in webs and flanges shall be subject to negotiation between the purchaser and the manufacturer.

4.3 For Class 2 shapes the average width of weld at the joint to the flange shall be more than 130 % of the nominal web thickness (see Fig. 1(*b*)). Coil-splice welds shall not be permitted.

4.4 Flash caused by welding will not be removed unless indicated on the purchase order.

NOTE 2—Flash is considered to be non-structural.

5. Chemical Composition

5.1 A chemical analysis of each heat of steel shall be made by the steel manufacturer. The chemical composition thus determined shall conform to the requirements of Table 1. The steel manufacturer shall provide a test report of the heat analysis to the shape manufacturer. Heat analysis reports shall be furnished by the shape manufacturer to the shape purchaser.

TABLE 1 Chemical Requirements[A]

	General Limitations, %
Carbon	0.26 max
Manganese	0.30 min to 1.65 max
Phosphorus	0.03 max
Sulfur	0.035 max
Silicon	0.60 max

[A] The choice and use of alloying elements (combined with carbon, manganese, phosphorus, and sulfur within the limits prescribed) to provide the specified mechanical properties, or to enhance the atmospheric corrosion resistance, or both, may vary with manufacturer and thickness of material. The heat analysis, including the alloying elements intentionally added, shall be reported to the purchaser. Permitted variations in product analysis shall be within the limits established in Table A of Specification A6/A6M for plate steel coils or Specification A568/A568M for sheet steel coils.

5.2 The steel manufacturer, shape manufacturer, and the shape purchaser shall establish a chemical composition, which will assure the purchaser of the desired properties while providing the shape manufacturer with material that is weldable by the electric-resistance welding process.

6. Tension Test

6.1 The material as represented by the test specimen shall conform to the requirements of tensile properties prescribed in Table 2.

6.2 The shape manufacturer shall furnish test reports of tensile properties determined in accordance with Sections 8, 9, and 10.

TABLE 2 Mechanical Properties

Grade	36	45	45W[A]	50	50W[A]	60	80
Tensile strength, min, psi [MPa]	53 000 [365]	60 000 [415]	65 000 [450]	65 000 [450]	70 000 [485]	75 000 [520]	90 000 [620]
Yield point, min, psi [MPa]	36 000 [250]	45 000 [310]	45 000 [310]	50 000 [345]	50 000 [345]	60 000 [415]	80 000 [550]
Elongation, min, %							
in 2 in. [50 mm]	22	19	19	17	17	17	17
in 8 in. [200 mm][B]	15	14	14	12	12	12	12

[A] The suffix "W" indicates steel grades having atmospheric corrosion resistance approximately two times that of carbon structural steel with copper.
[B] See elongation requirement adjustments under the Tension Tests section of Specification A6/A6M. See specimen orientation in the Tension Tests section of Specification A6/A6M.

TABLE 3 Common Sizes of Electric Resistance Forge-Welded Sections

Designation			Area		Weight		Depth		Web Thickness		Flange Width		Flange Thickness	
Depth	×	lb/ft	in.^{2}	mm^2	lb/ft	kg/m	in.	mm	in.	mm	in.	mm	in.	mm
3.50	×	3.57	1.028	663	3.57	5.31	3.50	89	0.105	2.7	3.25	83	0.105	2.7
3.63	×	5.54	1.599	1032	5.54	8.24	3.625	92	0.155	3.9	3.50	89	0.155	3.9
3.63	×	7.59	2.200	1419	7.59	11.30	3.625	92	0.155	3.9	3.50	89	0.245	6.2
3.63	×	10.28	2.973	1918	10.28	15.30	3.625	92	0.245	6.2	4.500	114	0.245	6.2
4.00	×	3.75	1.080	697	3.75	5.58	4.00	102	0.105	2.7	3.25	83	0.105	2.7
4.00	×	5.61	1.627	1050	5.61	8.35	4.00	102	1.105	2.7	4.00	102	0.155	3.9
4.00	×	8.62	2.504	1615	8.62	12.83	4.00	102	1.155	3.9	4.00	102	0.245	6.2
5.25	×	3.63	1.051	687	3.64	5.42	5.25	133	0.090	2.3	2.50	64	0.120	3.0
5.50	×	4.28	1.238	799	4.28	6.37	5.50	140	0.105	2.7	3.25	83	0.105	2.7
5.50	×	9.42	2.737	1766	9.42	14.02	5.50	140	0.155	3.9	4.00	102	0.245	6.2
6.00	×	4.46	1.290	832	4.46	6.64	6.00	152	0.105	2.7	3.25	83	0.105	2.7
6.00	×	6.80	1.967	1269	6.80	10.12	6.00	152	0.155	3.9	3.50	89	0.155	3.9
6.00	×	7.75	2.253	1454	7.75	11.53	6.00	152	0.120	3.0	4.50	114	0.175	4.4
6.00	×	9.68	2.814	1815	9.68	14.41	6.00	152	0.155	3.9	4.00	102	0.245	6.2
6.00	×	10.48	3.047	1966	10.48	15.60	6.00	152	0.175	4.4	4.25	108	0.245	6.2
6.00	×	12.41	3.610	2329	12.41	18.47	6.00	152	0.210	5.3	5.00	127	0.245	6.2
6.00	×	14.76	4.290	2768	14.76	21.97	6.00	152	0.245	6.2	6.00	152	0.245	6.2
6.50	×	4.02	1.181	762	4.02	5.98	6.50	165	0.090	2.3	2.50	64	0.120	3.0
8.00	×	6.38	1.853	1195	6.39	9.51	8.00	203	0.120	3.0	3.00	76	0.155	3.9
8.00	×	11.34	3.290	2123	11.34	16.88	8.00	203	0.210	5.3	3.50	89	0.245	6.2
8.00	×	21.52	6.276	4049	21.52	32.03	8.00	203	0.245	6.2	6.00	152	0.375	9.5
8.25	×	5.65	1.662	1072	5.65	8.41	8.25	210	0.090	2.3	3.00	76	0.155	3.9
10.00	×	7.59	2.208	1425	7.59	11.30	10.00	254	0.120	3.0	3.00	76	0.175	4.4
10.00	×	11.62	3.380	2181	11.62	17.29	10.00	254	0.175	4.4	3.50	89	0.245	6.2
10.25	×	7.69	2.238	1444	7.70	11.46	10.25	260	0.120	3.0	3.50	89	0.175	4.4
10.25	×	7.60	2.235	1442	7.60	11.31	10.25	260	0.100	2.5	3.50	89	0.175	4.4
10.25	×	8.28	2.437	1572	8.28	12.33	10.25	260	0.120	3.0	3.50	89	0.175	4.4
12.00	×	10.62	3.120	2013	10.62	15.80	12.00	305	0.120	3.0	3.50	89	0.245	6.2
12.25	×	9.90	2.911	1878	9.90	14.73	12.25	311	0.100	2.5	3.50	89	0.245	6.2
12.25	×	9.91	2.890	1865	9.91	14.75	12.25	311	0.120	3.0	3.50	89	0.210	5.3
12.25	×	10.71	3.150	2032	10.71	15.94	12.25	311	0.120	3.0	3.50	89	0.245	6.2
12.25	×	10.74	3.136	2023	10.74	15.98	12.25	311	0.100	2.5	4.00	102	0.245	6.2
12.25	×	11.54	3.371	2175	11.55	17.19	12.25	311	0.120	3.0	4.00	102	0.245	6.2
13.00	×	21.86	6.376	4114	21.86	32.53	13.00	330	0.245	6.2	4.50	114	0.375	9.5
13.00	×	24.41	7.1126	4597	24.41	36.33	13.00	330	0.245	6.2	5.50	140	0.375	9.5
14.00	×	11.43	3.336	2152	11.43	17.01	14.00	356	0.120	3.0	3.50	89	0.245	6.2
14.00	×	13.10	3.826	2468	13.10	19.50	14.00	356	0.120	3.0	4.50	114	0.245	6.2
16.00	×	14.11	4.150	2677	14.11	21.00	16.00	406	0.155	3.9	3.50	89	0.245	6.2

7. Permissible Variations in Dimensions

7.1 Unless otherwise agreed upon by the shape manufacturer and the purchaser, dimensional variations shall conform to Specification A6/A6M (12.3 and Tables 16 to Tables 24 inclusive) for shapes of similar dimensions. Thicknesses of the shape components shall be based on nominal thicknesses conforming to Specification A6/A6M (Table 1, plate) or Specification A568/A568M (Tables 4 and Tables 5) for material thickness between 0.031 in. to 0.230 in. inclusive or Specification A635/A635M (Tables 2 and Tables 3) for material thickness between 0.230 in. to 1.000 in. inclusive. Nominal thickness shall be defined as the minimum thickness specified plus one half the allowable thickness tolerance as shown in the tables. The nominal weight per foot of the shape shall be calculated based on the nominal thickness and allowable variations in weight shall be equivalent to allowable variations in thickness.

8. Number of Tests

8.1 *Tension Tests:*

8.1.1 For steel ordered from the steel manufacturer as coiled sheet or plate to minimum mechanical properties (ASTM or equivalent), the shape manufacturer may certify his product based on the steel manufacturer's test reports of mechanical properties.

8.1.1.1 In addition, the shape manufacturer shall make one tension test using a specimen which is representative of the approximate middle of the original coil length.

8.1.2 For all steel not made to minimum mechanical properties, regardless of thickness, the shape manufacturer shall make the tests for each coil per the requirements of Specification A6/A6M, sections 11.4.2, 11.4.3, or 11.4.4 (Tables B and C shall be followed) as applicable. Specimens taken for testing from the middle of the original coil length shall, in addition, be taken from the approximate quarter point of the original coil width.

8.2 *Peel Tests:*

8.2.1 One peel test, 10.2, is required on both sides of each butt weld on the flanges and web. A short (2 ft to 5 ft) sample shall be cut from the section and a peel test shall be performed on both ends of the section, on both welds.

8.3 *Tee Tension Tests*—One tee tension test, 10.3, is required of each weld for each lot.

8.3.1 A lot consists of not more than 1 h of welding of material of unchanged dimensions and heat number. A new lot will be started in the event of a dimension change or start of a new heat of steel for any component of the shape.

9. Retests

9.1 If one tension test fails, run two more tension tests from an adjacent location of the same parent coil. Both retests shall conform to the requirements prescribed in this specification; otherwise, the product of all coils represented by those tests shall stand rejected.

9.2 If the results of the peel tests and tee tension tests representing any lot do not meet a requirement as specified in Section 10, make two retests, one on each side of and adjacent to the original test, from the same lot. Each retest shall meet the requirements specified, or the lot represented by the retests shall be rejected.

10. Test Methods

10.1 *Tension Test:*

10.1.1 The tension specimens required by this specification shall conform to those described in the latest issue of Test Methods A370.

10.1.2 Take all tension test specimens longitudinally. Remove all burrs from the specimens and ensure that there are no surface imperfections that would interfere with proper determination of the tensile properties of the metal.

10.1.3 Determine the mechanical properties, Table 2, in accordance with one of the methods described in Test Methods A370.

10.2 *Peel Test*—The peel test is conducted to determine weld width and ductility. In this test it is necessary to separate the flange from the web and the flange from the stem of tee sections mechanically for a length of approximately 2 in. (50 mm) by any method that places the weld bond plane in progressive, peeling tension. A slotted bending hook, Fig. 2(*a*), is preferred. Fracture may be initiated on the bond plane by a notch pressed or sawed into the end of the specimen along the weld bond plane (Fig. 2(*c*)). Striking of the inner surface of the flange on alternate sides of the weld with a hammer may be used to perform the peel test, if necessary, in cases where a bending hook is not appropriate. Appearance and width of the fracture are the bases for evaluating weld quality.

10.2.1 *Flange Pullout*—The usual mode of fracture causes a pullout of the surface of the flange under the weld. This is evidence of an acceptable metallurgical bond. The average width of the pullout material (Fig. 1(*b*)) expressed as a percentage of the nominal web thickness shall be: for Class 1 shapes, more than 110 %; and for Class 2 shapes, more than 130 %. Typically, the appearance of pulled out material is rough, often having a woody texture. A general nonoriented roughness or granular appearance is acceptable. Measure the weld width using an appropriate steel scale or caliper. Some variation of width is to be expected. Fracture that results in a relatively smooth surface shall be taken as an indication of a brittle or poorly bonded weld, and is unacceptable. Regions of this appearance that lie adjacent to pulled-out flange material are not to be included in estimating width of pulled-out material (see Weld Margin in Fig. 1(*b*)).

10.2.2 *Web Fracture*—Fracture will ordinarily not occur in the web or stem unless (*1*) that member is made of significantly weaker steel than the flange, or (*2*) the weld width is over 150 % of web thickness for similar materials. For (*1*) the test is

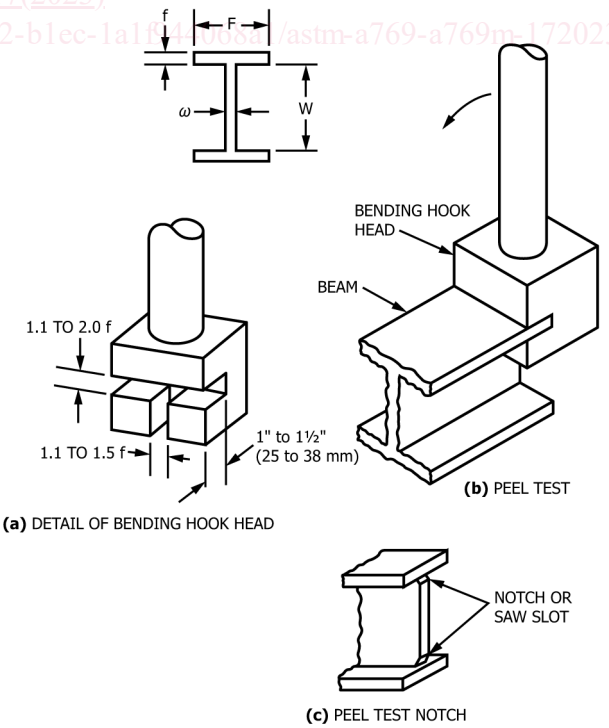

FIG. 2 Details of Peel Test