
Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use

AASHTO Designation: M 102M/M 102-22

Technically Revised: 2022

Technical Subcommittee: 4f, Metals

ASTM Designation: A668/A668M-20a



**American Association of State Highway and Transportation Officials
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1. SCOPE

- 1.1. This specification covers untreated and heat-treated carbon and alloy steel forgings for general industrial use. ASTM specifications for forgings are available for specific applications such as pressure vessels, railroad use, turbine generators, gearing, and others involving special temperature requirements.
- 1.2. Hot-rolled or cold-finished bars are not within the scope of this specification.
- 1.3. Six classes of carbon steel and seven classes of alloy steel forgings are listed (Section 7), which indicates their required heat treatments as well as mechanical properties.
- 1.4. Provision, with the suffix “H” for certification and marking, for the supply of forgings after hardness testing only.
- 1.5. Supplementary requirements, including those in ASTM A788, of an optional nature, are provided. These shall apply only when specified by the purchaser.
- 1.6. Appendix X1 lists the current classes corresponding to the various classes of ASTM A235, A237, and A243, which have been superseded by this specification.
- 1.7. The values stated in either SI units or inch-pound units are to be regarded separately as the standard; within the text and tables, the inch-pound units are shown in brackets. The values stated in each system are not exactly equivalent; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standard:*
 - T 244, Standard Method of Test for Mechanical Testing of Steel Products
- 2.2. *ASTM Standards:*
 - A275/A275M, Standard Practice for Magnetic Particle Examination of Steel Forgings
 - A388/A388M, Standard Practice for Ultrasonic Examination of Steel Forgings

3. TERMINOLOGY

- 3.1. The terminology section of ASTM A788 is applicable to this specification.
- 3.2. *Definition of Terms Specific to This Standard:*
- 3.2.1. *class*—a description of steel forgings based on heat treatment, mechanical properties, and composition.
- 3.2.2. *controlling cross section thickness (T_c)*—the diameter of the largest theoretical sphere which can be inscribed within the volume of the forging.
- 3.2.3. *T_p* —designates prolongations which have a size other than the controlling cross section thickness (T_c).

4. ORDERING INFORMATION

- 4.1. Material supplied to this specification shall conform to the requirements of ASTM A788, which outlines additional ordering information, manufacturing requirements, testing and retesting methods and procedures, marking, certification, product analysis variations, and additional supplementary requirements.
- 4.1.1. If the requirements of this specification are in conflict with the requirements of ASTM A788, the requirements of this specification shall prevail.
- 4.2. *When this specification is to be applied to an inquiry, contract, or order, the purchaser shall furnish the following information:*
- 4.2.1. The ordering information required by ASTM A788;
- 4.2.2. The class of forging desired as listed in Table 1;
- 4.2.3. Location(s) of areas of significant loading if test specimens are to be located in accordance with Section 7.1.4.5;
- 4.2.4. The options that may be selected as found in Sections 5.3.2, 6.1, and 7.3.
- 4.2.5. Any applicable supplementary requirements.

5. MATERIALS AND MANUFACTURE

- 5.1. *Discard*—Sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.
- 5.2. *Forging Process:*
- 5.2.1. The forging shall be brought as close as practical to finished shape and size by hot mechanical work.

- 5.2.2. Supplementary requirements S2, S14, and S15 may be specified by the purchaser to satisfy concerns about the utility of the proposed forging.
- 5.3. *Heat Treatment:*
- 5.3.1. All forgings, other than Class A, shall be heat treated. See Section 7.
- 5.3.2. Where options exist within a class, the choice of heat treatment shall be left to the discretion of the manufacturer, unless the purchaser specifies one of the available options.

6. CHEMICAL COMPOSITION

- 6.1. The steel shall conform to the requirements for chemical composition prescribed in Table 1.

Table 1—Chemical Requirements

Elements	Composition, Max, %	
	Classes A to F and AH to FH	Classes G to N and GH to NH
Manganese	1.35	—
Phosphorus	0.050	0.040
Sulfur	0.025	0.025

- 6.2. The choice of chemical composition is left to the discretion of the manufacturer, unless otherwise specified by the purchaser. See Appendix X2.
- 6.3. *Heat Analysis*—An analysis of each heat shall be made by the manufacturer.
- 6.4. *Product Analysis*—An analysis may be made by the purchaser according to the requirements of ASTM A788. If a standard grade has been used to manufacture the forging, the permissible variations in composition of ASTM A788 shall apply. If a nonstandard grade of steel has been used, and composition limits have not been supplied, the product analysis can be used only to confirm the type of steel supplied.

7. MECHANICAL PROPERTIES

- 7.1. *Tensile Requirements:*
- 7.1.1. The material shall conform to the tensile and hardness properties prescribed in Table 2. See T 244.
- 7.1.2. *All Forgings*—The dimensions of the controlling cross section thickness (T_c) of the forging at time of heat treatment determines the mechanical properties to be met within each class (See Table 2), except as noted in Section 7.1.4.2.

Table 2—Tensile Requirements

Class	Size, mm [in.]		Tensile Strength, Min	Yield Point, Yield Strength 0.2% Offset, Min	Elongation in 50 mm [2 in.], Min	Reduction of Area, Min	Brinell Hardness
	Over	Not Over	MPa [ksi]	MPa [ksi]	%	%	
Carbon Steel							
A (AH) (untreated)	—	500 [20]	325 [47] 415 [60]	—	—	—	183 max
B (BH) (Annealed or normalized, or normalized and tempered)	—	500 [20]	415 [60]	205 [30]	24	36	120–174
C (CH) (Annealed or normalized, or normalized and tempered)	— 300 [12]	300 [12] 500 [20]	455 [66] 455 [66]	230 [33] 230 [33]	23 22	36 34	137–183 137–183
D (DH) (Normalized, annealed, or normalized and tempered)	—	200 [8]	515 [75]	260 [37.5]	24	40	149–207
	200 [8]	300 [12]	515 [75]	260 [37.5]	22	35	149–207
	300 [12]	500 [20]	515 [75]	260 [37.5]	20	32	149–207
	500 [20]		515 [75]	260 [37.5]	19	30	149–207
E (EH) (Normalized and tempered or double normalized and tempered)	—	200 [8]	585 [85]	305 [44]	25	40	174–217
	200 [8]	300 [12]	570 [83]	295 [43]	23	37	174–217
	300 [12]	500 [20]	570 [83]	295 [43]	22	35	174–217
F (FH) (Quenched and tempered, or normalized, quenched, and tempered)	—	100 [4]	620 [90]	380 [55]	20	39	187–235
	100 [4]	175 [7]	585 [85]	345 [50]	20	39	174–217
	175 [7] 250 [10]	254 [10] 500 [20]	585 [85] 565 [82]	345 [50] 330 [48]	19 19	37 36	174–217 174–217
Alloy Steel							
G (GH) (Annealed or normalized, or normalized and tempered)	—	300 [12]	550 [80]	345 [50]	24	40	163–207
	300 [12]	500 [20]	550 [80]	345 [50]	22	38	163–207
H (HH) (Normalized and tempered)	—	175 [7]	620 [90]	415 [60]	22	44	187–235
	175 [7]	250 [10]	620 [90]	400 [58]	21	42	187–235
	250 [10]	500 [20]	620 [90]	400 [58]	18	40	187–235
J (JH) (Normalized and tempered or normalized, quenched, and tempered)	—	175 [7]	655 [95]	485 [70]	20	50	197–255
	175 [7]	250 [10]	620 [90]	450 [65]	20	50	187–235
	250 [10]	500 [20]	620 [90]	450 [65]	18	48	207–255
K (KH) (Normalized, quenched, and tempered)	—	175 [7]	725 [105]	550 [80]	20	50	212–269
	175 [7]	250 [10]	690 [100]	515 [75]	19	50	207–269
	250 [10]	500 [20]	690 [100]	515 [75]	18	48	207–269
L (LH) (Normalized, quenched, and tempered)	—	100 [4]	860 [125]	725 [105]	16	50	255–321
	100 [4]	175 [7]	795 [115]	655 [95]	16	45	235–302
	175 [7]	250 [10]	760 [110]	585 [85]	16	45	223–293
	250 [10]	500 [20]	760 [110]	585 [85]	14	40	223–293
M (MH) (Normalized, quenched, and tempered)	—	100 [4]	1000 [145]	825 [120]	15	45	293–352
	100 [4]	175 [7]	965 [140]	790 [115]	14	40	285–341
	175 [7]	250 [10]	930 [135]	758 [110]	13	40	269–331
	250 [10]	500 [20]	930 [135]	758 [110]	12	38	269–341
N (NH) (Normalized, quenched, and tempered)	—	100 [4]	1175 [170]	965 [140]	13	40	331–401
	100 [4]	175 [7]	1140 [165]	930 [135]	12	35	331–401
	175 [7]	250 [10]	1100 [160]	900 [130]	11	35	321–388
	250 [10]	500 [20]	1100 [160]	900 [130]	11	35	321–402

7.1.3. *Number of Tests*—Unless the purchaser specifies that forgings shall be furnished in accordance with the requirements of Section 7.3, the number of tension tests performed shall be as follows:

7.1.3.1. For all classes of heat-treated forgings with as-heat treated weights (excluding test prolongations) less than 2250 kg [5000 lb] each, one test shall be made from each controlling cross section thickness (T_c) represented in each heat and heat-treating charge. For untreated forgings (Class A) weighing less than 2250 kg [5000 lb] each, one test from each heat shall be made.

7.1.3.2. On all classes, for forgings with rough-machined masses of 2250 kg [5000 lb] or more, at least one test from each forging shall be made.

7.1.3.3. On all classes, for forgings with as-heat treated weights (excluding test prolongations) of 3200 kg [7000 lb] or more, two tests will be taken: on ring and disk forgings 180 degrees apart; on shafts and long hollow cylinders more than 2.0 m [80 in.] in length (excluding test material), one from