AMERICAN ASSOCIATION STATE
HIGHWAY OFFICIALS STANDARD
A.A.S.H.O. NO.: M102

Standard Specification for

CARBON STEEL FORGINGS FOR GENERAL INDUSTRIAL USE[1]

ASTM Designation: A 235 – 55

ADOPTED, 1954; REVISED, 1955.[2]

This Standard of the American Society for Testing Materials is issued under the fixed designation A 235; the final number indicates the year of original adoption as standard or, in the case of revision, the year of last revision.

It is recommended, when semi-finished steel is desired to process these forgings, that the latest issue of the Tentative Specification for Carbon-Steel Blooms, Billets, and Slabs for Forgings (A.S.T.M. Designation: A 273)[3] be used. This will enable the forger to select semi-finished material of such chemistry as he desires.

Scope

1. (*a*) This specification covers untreated and heat treated carbon steel forgings for general industrial use.

(*b*) The classes of forgings are as follows, the choice depending on design and stress or service to be imposed:

Class A, untreated, soft steel forgings.

Classes C, C1 and E, annealed, normalized, or normalized and tempered, mild steel forgings.

Class F, normalized and tempered forgings.

Class F1, double normalized and tempered forgings.

Class G, quenched and tempered, or normalized, quenched and tempered forgings.

(*c*) Supplementary requirements (Paragraphs S1 to S6) of an optional nature are provided. These shall apply only when specified by the purchaser.

Basis of Purchase

2. The purchaser shall specify in the inquiry, contract, and order, the class of steel desired; and any exceptions, modifications, or agreements with regard to the provisions of this specification.

[1] Under the standardization procedure of the Society, this specification is under the jurisdiction of the A.S.T.M. Committee A-1 on Steel.

[2] Prior to its present adoption as standard, this specification was published as tentative from 1940 to 1942, being revised in 1942. It was published as standard from 1942 to 1949, being revised in 1946. In 1949 it was revised and reverted to tentative, and published as tentative until 1954, being revised in 1952.

This specification is in effect a revision of, and replaces the former Tentative Specifications for Carbon-Steel Forgings (A 18 – 39 T) and the requirements for carbon-steel forgings in the Standard Specifications for Carbon-Steel and Alloy-Steel Forgings (A 18 – 30), which were accordingly discontinued in 1940.

[3] Appears in this publication, see Contents in numeric sequence of ASTM Designations at front of book.

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Process

3. The steel shall be made by either or both of the following processes: open-hearth or electric-furnace.

Discard

4. A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

Prolongations for Tests

5. Subject to Sections 12 and 13, approximately 20 per cent of the forgings shall have prolongations for testing unless otherwise specified. The manufacturer may elect to submit an extra forging to represent each test lot in lieu of prolongations; or, by agreement, test specimens can be taken from the forgings themselves with a hollow drill.

Boring

6. (*a*) Unless otherwise agreed upon by the manufacturer and the purchaser, no solid forging over 10 in. in diameter, and no bored forging over 10 in. in wall thickness shall be liquid quenched. For bored forgings with wall thicknesses over 5 in., the proportions of the forging must be such as to permit effective quenching.

(*b*) In bored forgings, the diameter of the hole shall be a matter of agreement between the manufacturer and the purchaser.

Heat Treatment

7. (*a*) *Cooling Prior to Heat Treatment.*—After forging and before reheating for heat treatment, the forgings shall be allowed to cool in a manner to prevent injury and to accomplish transformation.

(*b*) *Annealing.*—The forgings shall be reheated to and held at the proper temperature for a sufficient time to effect the desired transformation and then be allowed to cool slowly. A furnace charge thus treated is termed an annealing charge.

(*c*) *Normalising.*—The forgings shall be reheated to and held at the proper temperature for a sufficient time to effect the desired transformation and then withdrawn from the furnace and allowed to cool in air. A furnace charge thus treated is termed a normalizing charge.

(*d*) *Quenching.*—The forgings shall be reheated to and held at the proper temperature for a sufficient time to effect the desired transformation and then quenched in a suitable medium. A group thus treated is termed a quenching charge.

(*e*) *Tempering.*—The forgings shall be reheated to and held at the proper temperature, which will be below the transformation range, and then cooled under suitable conditions. A furnace charge thus treated is termed a tempering charge.

Chemical Composition

8. The steel shall conform to the requirements for chemical composition prescribed in Table I.

TABLE I.—CHEMICAL REQUIREMENTS.

Manganese, max., per cent	0.90
Phosphorus, max., per cent	0.050
Sulfur, max., per cent	0.050

TABLE II.—PERMISSIBLE VARIATIONS IN CHECK ANALYSIS.

Elements	Permissible Variations Over the Maximum Limit, per cent		
	200 sq. in. and under	Over 200 to 400 sq. in., incl.	Over 400 to 800 sq. in., incl.
Manganese	0.04	0.05	0.06
Phosphorus	0.010	0.010	0.010
Sulfur	0.010	0.010	0.010

Ladle Analysis

9. An analysis of each heat of steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus, sulfur and silicon. This analysis shall be made from a test ingot taken during the pouring of

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the heat. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements prescribed in Table I.

Check Analysis

10. An analysis may be made by the purchaser from a forging representing each heat. Drillings for analysis may be taken from the forging or from a full-size prolongation, at any point midway between the center and surface when solid, or between the inner and outer surfaces of the wall when bored; or turnings may be taken from the test specimen. The chemical composition thus determined shall not vary from the requirements prescribed in Table I by more than the amounts prescribed in Table II.

Tensile Properties

11. (*a*) The material shall conform to the requirements for tensile properties prescribed in Table III, when tested in accordance with the latest issue of the Methods and Definitions for Mechanical Testing of Steel Products (ASTM Designation: A370).[3]

(*b*) The nominal or specified rough machined diameter or thickness of solid forgings, disregarding large ends, collars, and flanges; or the nominal rough machined wall thickness of bored forgings shall determine the size classification.

(*c*) The nominal or specified outside rough machined diameter or thickness of the forgings, disregarding large ends, collars, and flanges, shall determine the size of the prolongations for test specimens.

(*d*) If the yield point is determined by total extension under load, such extension shall be 0.005 in. per inch of gage length (0.5 per cent).

TABLE III.—TENSILE REQUIREMENTS.

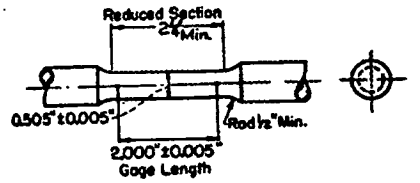
Class	Size				Tensile Strength, min., psi.	Yield Point or Yield Strength, min., psi.	Elongation in 2 in., min., per cent	Reduction of Area, min., per cent
	Solid Diameter or Thickness, in.		Bored Wall Thickness, in.[a]					
	Over	Not Over	Over	Not Over				
A (Untreated)[b]	..	20	..	..	47 000 to 60 000	....	..	..
C (Annealed, normalized, or normalized and tempered)[c]	..	12	..	..	60 000	30 000[d]	25	38
	12	..	..	..	60 000	30 000[d]	24	36
C1 (Annealed, normalized, or normalized and tempered)[c]	..	12	..	..	66 000	33 000[d]	23	36
	12	20	..	..	66 000	33 000[d]	22	34
E (Annealed, normalized, or normalized and tempered)[c]	..	8	..	..	75 000	37 500[d]	24	40
	8	12	..	..	75 000	37 500[d]	22	35
	12	20	..	..	75 000	37 500[d]	20	32
	20	..	..	..	75 000	37 500[d]	19	30
F (Normalized and tempered)	..	8	..	..	80 000	40 000[d]	22	35
	8	12	..	..	80 000	40 000[d]	21	33
	12	20	..	..	80 000	40 000[d]	20	31
F1 (Double normalized and tempered)	..	8	..	..	85 000	44 000[d]	25	40
	8	12	..	..	83 000	43 000[d]	23	37
	12	20	..	..	83 000	43 000[d]	22	35
G (Quenched and tempered or normalized, quenched and tempered)[c]	..	4	..	2	90 000	55 000[e]	20	39
	4	7	2	3½	85 000	50 000[e]	20	39
	7	10	3½	5	85 000	50 000[e]	19	37
	..	..	5	10	82 500	48 000[e]	19	36

[a] Where no figures are shown in the bored wall thickness column it is understood that the size classification is determined by the outside diameter, whether the forging is bored or not.
[b] Normalizing or annealing may be applied in accordance with Section 14 (*b*).
[c] Alternate treatments listed are optional with the manufacturer.
[d] Yield point, See Section 11 (*d*).
[e] Yield strength, see Section 11 (*e*).

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(*e*) The yield strength shall be determined at 0.2 per cent offset or by a total extension under load of 0.005 in. per inch of gage length.

(*f*) The yield point or yield strength shall be determined at a rate of separation of the crossheads under load not to exceed $\frac{1}{16}$ in. per minute per inch of gage length. The tensile strength shall be determined at a rate of separation of the crossheads under load not to exceed $\frac{1}{2}$ in. per minute per inch of gage length.



NOTE 1.—The gage length and fillets shall be as shown, but the ends may be of any shape to fit the holders of the testing machine in such a way that the load shall be axial.
NOTE 2.—The reduced section shall have a gradual taper from the ends toward the center, with the ends not more than 0.005 in. larger in diameter than the center.

FIG. 1.—Standard Round Tension Test Specimen with 2-in. Gage Length.

(*g*) Tests for acceptance shall be made after final heat treatment of the forgings.

Test Specimens

12. (*a*) Tension test specimens shall be taken from the test prolongations or the forgings as provided in Section 5.

(*b*) Unless otherwise specified, the axis of the specimen shall be located at any point midway between the center and the surface of solid forgings and at any point midway between the inner and outer surfaces of the wall of bored forgings, and shall be parallel to the axis of the forging in the direction in which the metal is most drawn out.

(*c*) The specimens shall be machined to the form and dimensions shown in Fig. 1.

Number of Tests

13. (*a*) Unless otherwise specified by the purchaser, tension tests shall be made as follows:

(*1*) For all classes of forgings weighing 5000 lb. or more each, at least one test from each forging.

(*2*) For all classes of forgings weighing more than 7000 lb. each, one test from each end of each forging.

(*3*) For untreated forgings (class A) weighing less than 5000 lb. each, one test from each heat.

(*4*) For heat treated forgings weighing less than 5000 lb. each, one test shall be made from each size classification represented in each heat in each annealing or normalizing charge; or from each size classification in each heat in each normalizing or quenching charge represented in each tempering charge.

(*b*) If any test specimen fails because of mechanical reasons such as testing equipment failure or improper specimen preparation, it may be discarded and another specimen taken.

Retests

14. (*a*) If, when heat treated forgings are specified, the results of the mechanical tests of any test lot do not conform to the requirements specified, the manufacturer may re-treat such a lot, but not more than three additional times, and retests shall be made in accordance with Section 13.

(*b*) If, when untreated forgings (class A) are specified, the results of the mechanical tests of any test lot do not conform to the requirements specified, the manufacturer may anneal, normalize, or normalize and temper, one or more times but not more than three times; and retests shall be made in accordance with Section 13. The tensile properties shall conform to the requirements for the class of forgings ordered.

(*c*) If the percentage of elongation of any tension test specimen is less than that prescribed in Table III and any part of the fracture is outside of the

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middle half of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

(*d*) If the results of the mechanical tests of any test lot do not conform to the requirements specified because a flaw develops in the test specimen during testing, a retest shall be allowed if the defect is not caused by ruptures, cracks, or flakes in the steel.

Workmanship

15. The forgings shall conform to the sizes and shapes specified by the purchaser. When centered, standard 60-deg. centers with clearance for lathe center points shall be bored.

Finish

16. The forgings shall be free from injurious defects and shall have a workmanlike finish.

Marking

17. Identification marks shall be legibly stamped on each forging and on each test specimen. The purchaser may indicate the location of such identification marks.

Inspection

18. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests (except check analysis) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection

19. (*a*) Unless otherwise specified, any rejection based on tests made in accordance with Section 10 shall be reported to the manufacturer within five working days from the receipt of samples by the purchaser.

(*b*) Material that shows injurious defects subsequent to its acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

Rehearing

20. Samples tested in accordance with Section 10 that represent rejected material shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

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SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements shall apply only when specified by the purchaser in the inquiry, contract, and order. Details of these supplementary requirements shall be agreed upon by the manufacturer and the purchaser.

Rough Turning and Boring

S1. The position of the rough turning and boring in the sequence of manufacturing operations may be a matter of agreement between the manufacturer and the purchaser.

Radial or Tangential Tests

S2. If radial or tangential tests are required, the location and mechanical properties shall be a matter of agreement between the manufacturer and the purchaser.

Magnetic Particle Test

S3. When magnetic particle testing of forgings is required, reference shall be made to the latest issue of the Standard Methods of Magnetic Particle Testing and Inspection of Heavy Steel Forgings (A.S.T.M. Designation: A 275).[3]

Macroetch Test

S4. When macroetch testing of forgings is required, reference shall be made to the latest issue of the Standard Method of Macroetch Testing and Inspection of Steel Forgings (A.S.T.M Designation: A 317).[3]

Carbon Content for Welding

S5. For forgings intended for welding, the carbon content may be limited to 0.35 maximum per cent for classes A, C, and C1.

Additional Tests

S6. Any testing in addition to that prescribed in Section 12 (*a*) shall be a matter of agreement between the manufacturer and the purchaser.

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