Designation: A 391/A 391M – 07

Standard Specification for Grade 80 Alloy Steel Chain[1]

This standard is issued under the fixed designation A 391/A 391M; 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 Grade 80 heat-treated alloy steel chain for such applications as slings, lifting assemblies, and load binding.

NOTE 1—This specification does not cover alloy steel chain for pocket wheel applications.

1.2 The Grade designation is 1/10 of the minimum breaking strength in newtons divided by two times the nominal cross-sectional area of the chain in square millimetres.

1.3 The values stated in either SI units or in other units shall be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system must be used independently of the other, without combining values in any way.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 29/A 29M Specification for Steel Bars, Carbon and Alloy, Hot-Wrought, General Requirements for

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *breaking force, minimum*, *n*—minimum force in pounds or newtons at which the chain, during manufacture, has been found by testing to break when a constantly increasing force is applied in direct tension.

3.1.1.1 *Discussion*—This test is a manufacturer's attribute acceptance test and shall not be used as criteria for service.

3.1.2 *date code*, *n*—series of letters, numbers, or both, embossed on the chain which enables its manufacturing history to be traced.

3.1.3 *lot*, *n*—for the purpose of acceptance testing, a lot shall consist of 3000 ft [1000 m], or fraction thereof, of the same grade and size chain. If a continuous length of chain exceeds 3000 ft [1000 m], it shall also be considered a lot.

3.1.4 *proof test*, *n*—quality control tensile test applied to chain for the purpose of verifying weld and material quality.

3.1.4.1 *Discussion*—It is the minimum force in pounds or newtons which the chain has withstood at the time it left the producer, under a test in which a constantly increasing force has been applied in direct tension to a straight length of chain. Proof test loads are a manufacturing integrity test and shall not be used as criteria for service or design purposes.

3.1.5 *traceability code*, *n*—series of letters, numbers, or both, embossed on the chain which enables its manufacturing history, including the identity of the steel heat, to be traced.

3.1.6 *working load limit (WLL)*, *n*—maximum combined static and dynamic load in pounds or kilograms that shall be applied in direct tension to an undamaged straight length of chain.

4. Ordering Information

4.1 It shall be the responsibility of the purchaser to specify all requirements that are necessary for material ordered under this specification. Such requirements to be considered include, but are not limited to, the following:

4.1.1 Product to conform to Specification A 391 or A 391M and year of issue,

4.1.2 Nominal size of chain in in. [mm],

4.1.3 Quantity of chain in ft [m],

4.1.4 Length of each piece, if required,

4.1.5 Finish, if required,

4.1.6 Certification of test(s), if required, and

4.1.7 Acceptance of inspection by purchaser, if required.

5. Manufacturing

5.1 *Melting Process*—The alloy steel shall be made to a fully-killed fine austenitic grain process.

5.2 *Welding Process*—Alloy steel chain may be made by the electric welding or gas welding process.

[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 A01.27 on Steel Chain.

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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.

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

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5.3 *Heat Treatment*—After welding, alloy steel chain shall be heat treated before applying the proof test. Heat treatment shall include quenching and tempering as defined by Terminology A 941.

6. Material Requirements

6.1 *Heat Analysis*—The selection and amounts of the alloying elements in the steel are left to the judgment of the individual chain manufacturer provided the steel meets the following criteria: Carbon: 0.35 % max.; Phosphorous: 0.025 % max.; Sulfur: 0.025 % max. Nickel must be present in an alloying amount (0.40 % min); and at least one of the following elements must be present in an alloying amount: Chromium (0.40 % min) or Molybdenum (0.15 % min).

6.2 *Product Analysis*—The steel used may be analyzed by the purchaser and shall conform to the requirements of 6.1 subject to the product analysis tolerances specified in Specification A 29/A 29M. Test samples may be taken from rods, bars, or finished chain. Samples for analysis shall be so taken as to represent the full cross section of the specimen.

6.3 Test Methods, Practices, and Terminology A 751 shall be used for referee purposes.

7. *Mechanical Requirements* Mechanical Requirements

7.1 *Proof Test*—All chain shall be tested to at least the proof load prescribed in Table 1 for the appropriate size chain. When so tested it shall withstand these loads without loss of chain integrity. Links or chain segments not withstanding the proof test load shall be removed from the chain.

7.2 *Breaking Force*—The breaking force test specimen shall consist of a length from the lot containing at least the number of links in Table 2. All chain shall be in the quenched and tempered condition before the breaking force is measured.

7.2.1 Fixtures for securing chain in a testing machine shall be properly designed to support securely the shoulder of the link (see Note 2). The opening in the fixture shall not be more than 125 % of the stock diameter being tested. Links engaged in the testing fixture shall not be considered part of the test specimen.

NOTE 2—"U" bolts of the same or larger diameter and the same or greater strength may be used to secure the chain to the jaws of the testing machine.

7.2.2 Test specimens shall meet or exceed the minimum breaking force values given in Table 1 for the appropriate size chain.

TABLE 2 Mechanical Test Sample Length Requirements

Size of Chain	Minimum Number of Links in Test Specimen
7/32 in. [5.5 mm]	9
Larger than 7/32 in. [5.5 mm] but less than 3/4 in. [20.0 mm]	7
3/4 in. [20.0 mm] and larger	3

7.3 *Elongation*:

7.3.1 All chain must be in the quenched and tempered condition before the elongation is measured.

7.3.2 The elongation test specimen shall consist of a length from the lot containing at least the number of links in Table 2.

7.3.3 A positive load not exceeding 10 % of the proof test shall be applied for determining the original gage length ($L\{0\}$).

7.3.4 The elongation shall be based on the total extension at fracture. This is expressed as a percentage of the change in length (ΔL) divided by the original gage length ($L\{0\}$). The elongation may be determined by the equation below or by autographic recorder or side scale.

$$\text{Elongation } (\%) = \{\Delta L / L\{0\}\} \times 100$$

where:

ΔL = test specimen final length at fracture – test specimen original gage length ($L\{0\}$), and

$L\{0\}$ = original gage length (sum or the inside lengths of the test chain links, not counting the fixture links, or as determined in 7.3.3).

7.3.5 The elongation shall be a minimum of 20 %.

7.4 One test for breaking strength and elongation shall be made from each lot. The elongation and breaking force tests may be performed at the same time on the same test specimen.

8. Dimensional Requirements

8.1 The chain shall conform to the dimensional requirements specified in Table 1 for the appropriate size chain.

8.2 *Diameter*—The diameter of the material from which the chain is manufactured shall not be smaller than the material diameter listed in Table 1 within the following tolerance: –3 %. Oversized material may be used for all applications.

9. Finish

9.1 The manufacturer may apply a surface treatment or finish of their own choice for identification or corrosion

TABLE 1 Grade 80 Alloy Chain Mechanical and Dimensional Requirements

Nominal Chain Size		Material Diameter		Working Load Limit, max		Proof Test,[A] min		Minimum Breaking Force[A]		Inside Length, max		Inside Width, min to max	
in.	mm	in.	mm	lb	kg	lb	kN	lb	kN	in.	mm	in.	mm
7/32	5.5	0.217	5.5	2 100	970	4 200	19.0	8 400	38.0	0.69	17.6	0.281 to 0.325	7.14 to 8.25
9/32	7.0	0.276	7.0	3 500	1 570	7 000	30.8	14 000	61.6	0.90	22.9	0.375 to 0.430	9.53 to 10.92
5/16	8.0	0.315	8.0	4 500	2 000	9 000	40.3	18 000	80.6	1.04	26.4	0.430 to 0.500	10.92 to 12.70
3/8	10.0	0.394	10.0	7 100	3 200	14 200	63.0	28 400	126.0	1.26	32.0	0.512 to 0.600	13.00 to 15.20
1/2	13.0	0.512	13.0	12 000	5 400	24 000	107.0	48 000	214.0	1.64	41.6	0.688 to 0.768	17.43 to 19.50
5/8	16.0	0.630	16.0	18 100	8 200	36 200	161.0	72 400	322.0	2.02	51.2	0.812 to 0.945	20.63 to 24.00
3/4	20.0	0.787	20.0	28 300	12 800	56 600	252.0	113 200	504.0	2.52	64.0	0.984 to 1.180	25.00 to 30.00
7/8	22.0	0.866	22.0	34 200	15 500	68 400	305.0	136 800	608.0	2.77	70.4	1.080 to 1.300	27.50 to 33.00
1	26.0	1.024	26.0	47 700	21 600	95 400	425.0	190 800	850.0	3.28	83.2	1.280 to 1.540	32.50 to 39.00
1 1/4	32.0	1.260	32.0	72 300	32 800	144 600	644.0	289 200	1288.0	4.03	102.4	1.580 to 1.890	40.00 to 48.00

[A] The proof test and minimum breaking force loads *shall not* be used as criteria for service or design purposes. (See Section 3.)

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resistance unless the customer specifies otherwise. The surface treatment or finish shall not alter the chain properties in a manner that would cause the chain to not meet the other provisions of this standard.

10. Retests

10.1 If the original test specimen fails to conform to the requirements in 7.2.2, two additional test specimens from the same lot may be tested, each of which shall conform to the requirements in 7.2.2. If both additional tests are satisfactory, the chain will be considered acceptable.

11. Rework and Retreatment

11.1 Materials that fail to conform to the requirements for dimensions and mechanical tests may be resubmitted after being reworked.

12. Inspection

12.1 When requested on the purchase order or contract, the chain shall be free of paint or other coatings which could mask surface discontinuities at the time of inspection.

12.2 The manufacturer shall afford the purchaser's inspector all reasonable facilities necessary to verify that the chain produced is being furnished in accordance with this specification. Inspection by the purchaser shall not interfere unnecessarily with the manufacturer's operations. All tests and inspection shall be made at the place of manufacture, unless otherwise agreed upon.

12.3 The purchaser may make the tests to govern acceptance or rejection of the chain at their own laboratory or elsewhere. Tests and acceptance criteria shall conform to the requirements contained in this specification unless otherwise stated in the purchase order. Tests at the purchaser's laboratory or elsewhere shall be made at the expense of the purchaser.

13. Rejection and Rehearing

13.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection shall be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of any test, the producer or supplier may make claim for a rehearing.

13.2 In the case of dissatisfaction with the results of the test in 12.3, the manufacturer may make claim for a rehearing.

14. Certification

14.1 A manufacturer's certification that the chain conforms to Specification A 391/A 391M of the date of issue specified shall be furnished when requested on the purchase contract or order.

14.2 When requested on the purchase contract or order, the manufacturer shall furnish a certificate of proof test to the purchaser or his representative.

15. Product Marking

15.1 Body chain links shall not be marked with indented characters.

15.2 Body chain links shall be marked for identification purposes at intervals no greater than 3 ft [0.9 m].

15.3 The marking shall consist of at least the grade indicator, the manufacturer's mark or symbol, and the traceability code or date code.

15.4 The grade indicator marking for Grade 80 shall include 8, 80, or 800.

16. Keywords

16.1 alloy steel chain; chain; Grade 80; steel chain

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A 391/A 391M – 01) that may impact the use of this standard. (Approved Nov. 1, 2007.)

(*1*) Added 1.2.
(*2*) Revised Section 2.
(*3*) Added new terms to Section 3.
(*4*) Added new referenced standards to 5.3 and 6.3.
(*5*) Revised Section 9.
(*6*) Revised Section 15.
(*7*) Revised inside width range values in Table 1 for 5⁄16 and 3⁄8 in.

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