



## Standard Specification for Grade 80 Alloy Steel Chain<sup>1</sup>

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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

### 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 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:

A 29/A 29M Specification for Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-Finished, General Requirements for<sup>2</sup>

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products<sup>3</sup>

E 30 Test Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron<sup>4</sup>

E 44 Definitions of Terms Relating to Heat Treatment of Metals<sup>5</sup>

E 350 Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron<sup>4</sup>

E 415 Test Method for Optical Emission Vacuum Spectrometric Analysis of Carbon and Low-Alloy Steel<sup>6</sup>

### 3. Terminology

#### 3.1 Definitions of Terms Specific to This Standard:

3.1.1 *breaking force, minimum*—the minimum force in pounds or newtons at which the chain, in the condition it leaves the producer's plant, has been found by representative testing

to break when a constantly increasing force was applied in direct tension to a straight length of chain on a standard testing machine. Breaking force values are a statistical attribute test and are not a guarantee that all chain segments per lot will endure these loads. Breaking force loads shall not be used as criteria for service or design purposes.

3.1.2 *lot*—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.

3.1.3 *proof test*—a quality control tensile test applied to chain for the purpose of verifying weld and material quality. 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.

3.1.4 *working load limit (WLL)*—the 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.

5.3 *Heat Treatment*—After welding, alloy steel chain shall be heat treated before applying the proof test. Heat treatment

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 01.05.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 01.03.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 03.05.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 01.02.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 03.06.

TABLE 1 Grade 80 Alloy Chain Mechanical and Dimensional Requirements

Nominal Chain Size		Material Diameter		Working Load Limit, max		Proof Test, <sup>A</sup> min		Minimum Breaking Force <sup>A</sup>		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	0.693	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	0.900	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	1.010	25.6	0.410 to 0.472	10.41 to 12.00
3/8	10.0	0.394	10.0	7 100	3 200	14 200	63.0	28 400	126.0	1.260	32.0	0.512 to 0.591	13.00 to 15.00
1/2	13.0	0.512	13.0	12 000	5 400	24 000	107.0	48 000	214.0	1.640	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	2.020	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	2.520	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	136 500	610.0	2.770	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	3.280	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	4.030	102.4	1.580 to 1.890	40.00 to 48.00

<sup>A</sup> The proof test and minimum breaking force loads shall not be used as criteria for service or design purposes. (See Section 3.)

shall include quenching and tempering as defined by Definitions E 44.

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/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 E 30, E 350, or E 415 shall be used for referee purposes.

7. 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.

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 The test specimen shall be subjected to testing head speed in accordance with Test Methods and Definitions A 370.

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

7.3 Elongation:

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

7.3.2 Elongation is to be determined as follows:

7.3.2.1 Test samples are to consist of at least the number of links in Table 2 that constitutes the gage length. Two additional links will be required to engage the jaws of the testing machine unless this is done by half links or another method.

7.3.2.2 Place the test sample in the testing machine and load to a maximum of 10 % of the proof test force. Measure the gage length (L), which does not include the links engaged in the jaws of the testing machine (see Fig. 1).

7.3.2.3 The load is then gradually and smoothly increased until fracture occurs, and the maximum load applied is recorded as the breaking force. The elongation may be determined by an autographic recorder, side scale, or alternatively by measuring the broken lengths on either side of the broken link as shown in Fig. 2.

7.3.3 Calculation of Elongation:

7.3.3.1 The mean pitch (p') after seating of the links at some load not exceeding 10 % of the manufacturing test force is calculated as follows:

$$p' = (L - 2d)/n \tag{1}$$

where n is the actual number of links in gage length L.

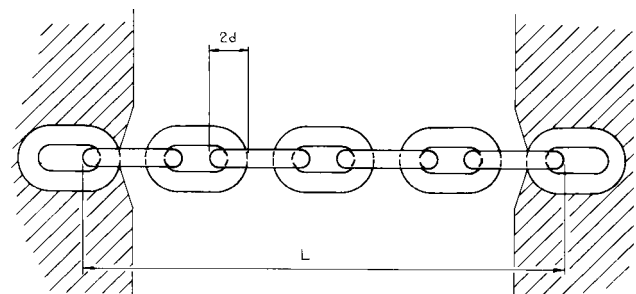


FIG. 1 Gage Length

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