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Standard Specification for Grade 100 Alloy Steel Chain[1]

This standard is issued under the fixed designation A973/A973M; 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 100 heat-treated alloy steel chain for such applications as slings, lifting assemblies, and load binding. For overhead lifting applications, only alloy chain should be used.

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

1.2 This specification is a performance standard for Grade 100 chain used between ~~−20~~−20 °F and ~~400°F [−29~~400 °F [−29 °C and ~~205°C].~~205 °C]. The chain manufacturer should be contacted for use at temperatures outside this range.

1.3 The ~~Grade designation~~chain grade is ~~1/10 of the minimum breaking strength in newtons divided~~based on the nominal stress in the link at the design breaking force strength. It is calculated by taking the minimum breaking force load and dividing by two times the nominal cross-sectional area of the ~~chain in square millimetres.~~ link.

1.4 The values stated in either SI units or in other units ~~shall~~ are to be regarded separately as standard. The values stated in each system ~~may~~are not ~~be~~necessarily exact equivalents; therefore, to ensure conformance with the standard, each system ~~must~~shall be used independently of the other, ~~without combining values in any way.~~and values from the two systems shall not be combined.

1.4.1 *Metric Units*—Grade = 1/10 of the minimum breaking force in kilonewtons divided by two times the nominal cross-sectional area in square millimeters.
= (MBF)/(0.005)(π)(d)2

1.4.2 *English Units*—Grade = 0.000689 of the minimum breaking force in pounds divided by two times the nominal cross-sectional area in square inches.
= (0.000689)(MBF)/(0.5)(π)(d)2

1.4.3 MBF = minimum breaking force (lb or kN); d = chain diameter (in. or mm).

NOTE 2—The above formulas are for round diameter links only. If different cross sections are used, the actual cross section of the link would need to be calculated and used.

1.5 *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.*

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A29/A29M Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought

A751 Test Methods and Practices for Chemical Analysis of Steel Products

A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

2.2 *SAE Standard:*

SAE J422 Microscopic Determination of Inclusions in Steels[3]

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~~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 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 include, but are not limited to, the following:

4.1.1 Product to conform to Specification A973/A973M and date of issue,

4.1.2 Nominal size of chain (in. or mm),

4.1.3 Quantity of chain (ft or 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,

4.1.7 Acceptance of inspection by purchaser, if required, and

[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~~standard's Document Summary page on the ASTM website.

[3] Available from ~~Society of Automotive Engineers,~~ SAE International (SAE), 400 Commonwealth ~~Drive,~~Dr., Warrendale, PA ~~15096.~~15096, http://www.sae.org.

4.1.8 Supplementary requirements, if required.

5. Manufacturing

5.1 *Melting Process*—The alloy steel shall be fully killed and have an austenitic grain size of five or finer.

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 shall include quenching and tempering as defined by Terminology A941.

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. The following elements must all be present in alloying amounts, nickel (0.40% min), chromium (0.40% min), and molybdenum (0.15% min). The steel shall have oxide and silicate inclusions of 4 or less as determined by SAE J422.

6.2 *Product Analysis*—The steel used may be analyzed by the purchaser and shall conform to the requirements of ~~6.1~~6.1 subject to the product analysis tolerances specified in Specification A29/A29M. 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 A751 shall be used for referee purposes.

7. Mechanical Requirements

7.1 *Proof Test*—~~All~~ Every link of 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~~3). 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 3—"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 results shall meet or exceed the minimum breaking force values given in Table 1 for the appropriate size chain.

7.3 *Elongation:*

TABLE 1 Grade 100 Alloy Chain Mechanical and Dimensional Requirements

Nominal Chain Size		Material Diameter		Working Load Limit (max)		Proof Test (min)		Minimum Breaking Force		Inside Length (max)		Inside Width Range	
in.	mm	in.	mm	lb	kg	lb	kN	lb	kN	in.	mm	in.	mm
7/32	5.5	0.217	5.5	2700	1220	5400	23.8	10 800	47.6	0.69	17.6	0.281 to 0.325	7.14 to 8.25
9/32	7	0.276	7.0	4300	1950	8600	38.5	17 200	77	0.90	22.9	0.375 to 0.430	9.53 to 10.92
5/16	8	0.315	8.0	5700	2600	11 400	51	22 800	102	1.04	26.4	0.430 to 0.500	10.92 to 12.70
3/8	10	0.394	10.0	8800	4000	17 600	79	35 200	158	1.26	32.0	0.512 to 0.600	13.00 to 15.20
1/2	13	0.512	13.0	15 000	6800	30 000	134	60 000	268	1.64	41.6	0.688 to 0.768	17.48 to 19.50
5/8	16	0.630	16.0	22 600	10 300	45 200	201	90 400	402	2.02	51.2	0.812 to 0.945	20.63 to 24.00
3/4	20	0.787	20.0	35 300	16 000	70 600	315	141 200	630	2.52	64.0	0.984 to 1.18	25.0 to 30.0
7/8	22	0.866	22.0	42 700	19 400	85 400	381	170 800	762	2.77	70.4	1.08 to 1.30	27.5 to 33.0
1	26	1.020	26.0	59 700	27 080	119 400	531	238 800	1060	3.28	83.2	1.28 to 1.54	32.5 to 39.00

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

7.3.1 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~~gauge 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~~gauge 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:~~*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).~~

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

9.2 The stated breaking forces in Table 1 are only for chains in the raw uncoated or quenched and tempered surface condition. With other surface conditions, the values of the breaking forces are reduced due to different friction coefficients on the contact areas of the chain links. Actual minimum breaking forces may be up to 7 % below values listed in Table 1 if the chain is tested with a coated surface condition.

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.