Designation: A 913/A 913M – 07

Standard Specification for High-Strength Low-Alloy Steel Shapes of Structural Quality, Produced by Quenching and Self-Tempering Process (QST)[1]

This standard is issued under the fixed designation A 913/A 913M; 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 high-strength low-alloy structural steel shapes in Grades 50 [345], 60 [415], 65 [450] and 70 [485], produced by the quenching and self-tempering process (QST).[2] The shapes are intended for riveted, bolted or welded construction of bridges, buildings and other structures.

1.2 The QST process consists of in line heat treatment and cooling rate controls which result in mechanical properties in the finished condition that are equivalent to those attained using heat treating processes which entail reheating after rolling. A description of the QST process is given in Appendix X1.

1.3 Due to the inherent characteristics of the QST process, the shapes shall not be formed and post weld heat treated at temperatures exceeding 1100°F [600°C].

1.4 When the steel is to be welded, it is presupposed that a welding procedure suitable for the grade of steel and intended use or service will be utilized. See Appendix X3 of Specification A 6/A 6M for information on weldability.

1.5 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with this specification.

2. Referenced Documents

2.1 *ASTM Standards:* [3]

A 6/A 6M Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

A 673/A 673M Specification for Sampling Procedure for Impact Testing of Structural Steel

A 898/A 898M Specification for Straight Beam Ultrasonic Examination of Rolled Steel Structural Shapes

3. General Requirements for Delivery

3.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification A 6/A 6M.

4. Materials and Manufacture

4.1 The shapes shall be produced by the quenching and self-tempering process (QST). Self-tempering temperature shall be a minimum of 1100°F [600°C] and the self-tempering temperature for the material represented shall be reported on the mill test report. See Appendix X1 for Process Description.

4.2 For grades 60 [415], 65 [450], and 70 [485], the requirements for fine austenitic grain size in Specification A 6/A 6M shall be met.

5. Chemical Composition

5.1 The chemical analysis of the heat shall conform to the requirements prescribed in Table 1.

5.2 The steel shall conform on product analysis to the requirements prescribed in Table 1 subject to the product analysis tolerances in Specification A 6/A 6M.

[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 A01.02 on Structural Steel for Bridges, Buildings, Rolling Stock and Ships.

Current edition approved Nov. 1, 2007. Published November 2007. Originally approved in 1993. Last previous edition approved in 2004 as A 913/A 913M–04.

[2] The quenching and self-tempering process (QST) and the used apparatus are covered by patents held by the Centre de Recherches Métallurgiques (CRM)—Rue Ernest Solvay, 11, B 4000, Liège (Belgium). Interested parties are invited to submit information regarding the identification of acceptable alternatives to these patented items to the Committee on Standards, ASTM Headquarters, 100 Barr Harbor Drive, West Conshohocken, PA 19428–2959. Comments will receive careful consideration at the meeting of the responsible technical committee, which any interested party may attend.

[3] 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.**

Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States.

Copyright ASTM International
Provided by IHS under license with ASTM
No reproduction or networking permitted without license from IHS
Not for Resale

TABLE 1 Chemical Requirements (Heat Analysis)

Element	Maximum content in %			
	Grade 50 [345]	Grade 60 [415]	Grade 65 [450]	Grade 70 [485]
Carbon	0.12	0.14	0.16	0.16
Manganese	1.60	1.60	1.60	1.60
Phosphorus	0.040	0.030	0.030	0.040
Sulfur	0.030	0.030	0.030	0.030
Silicon	0.40	0.40	0.40	0.40
Copper	0.45	0.35	0.35	0.45
Nickel	0.25	0.25	0.25	0.25
Chromium	0.25	0.25	0.25	0.25
Molybdenum	0.07	0.07	0.07	0.07
Columbium	0.05	0.04	0.05	0.05
Vanadium	0.06	0.06	0.06	0.09

6. Mechanical Properties

6.1 *Tensile Properties*—The material as represented by the test specimens shall conform to the tensile properties given in Table 2.

6.2 Charpy V-notch tests shall be made in accordance with Specification A 673/A 673M, Frequency H:

6.2.1 The test results of full-size specimens shall meet an average value of 40 ft-lbf [54 J] at 70°F [21°C].

6.2.1.1 Test reports for every heat supplied are required.

6.2.2 Charpy V-notch test requirements exceeding the value specified in 6.2.1 or lower test temperatures are subject to agreement between the purchaser and the producer.

TABLE 2 Tensile Requirements

Grade		Yield Point, min.		Tensile Strength, min.		Elongation, min	
		ksi	[MPa]	ksi	[MPa]	8 in. [200 mm], %	2 in. [50 mm], %
50	[345]	50	[345]	65	[450]	18	21
60	[415]	60	[415]	75	[520]	16	18
65	[450]	65	[450]	80	[550]	15	17
70	[485]	70	[485]	90	[620]	14	16

7. Maximum Carbon Equivalent Requirement

7.1 The carbon equivalent on heat analysis shall not exceed the limits listed in this section. The chemical analysis (heat analysis) of the elements that appear in the carbon equivalent formula and the actual carbon equivalent shall be reported.

Carbon equivalent limits
Grade 50 [345]: 0.38 %
Grade 60 [415]: 0.40 %
Grade 65 [450]: 0.43 %
Grade 70 [485]: 0.45 %

7.2 Calculate the carbon equivalent using the following equation:

$$CE = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15$$

8. Keywords

8.1 high-strength low-alloy steel; QST; quenching and self-tempering process; steel shapes; structural shapes; structural steel

SUPPLEMENTARY REQUIREMENTS

Supplementary requirements shall not apply unless specified in the purchase order or contract. Standardized supplementary requirements for use at the option of the purchaser are listed in Specification A 6/A 6M. Those that are considered suitable for use with this specification are listed by title:

S1. Vacuum Treatment.
S2. Product Analysis.
S3. Simulated Post-Weld Heat Treatment of Mechanical Test Coupons.
S5. Charpy V-Notch Impact Test.
S18. Maximum Tensile Strength.
S30. Charpy V-Notch Impact Test for Structural Shapes: Alternate Core Location.

ADDITIONAL SUPPLEMENTARY REQUIREMENTS

In addition, the following special supplementary requirements are also suitable for use with this specification:

S4. *Additional Tension Test:*

S4.1 One tension test shall be made per ingot or per bloom. The results obtained and the actual self-tempering temperature for the ingot or bloom represented shall be reported on the mill test report when such tests are required by the order.

S8. *Ultrasonic Examination:*

S8.1 Ultrasonic Examination in accordance with Specification A 898/A 898M.

S32. *Single Heat Bundles:*

S32.1 Bundles containing shapes or bars shall be from a single heat of steel.

S75. *Maximum Yield Point to Tensile Strength Ratio—Grade 50 [345]:*

S75.1 The maximum yield point shall be 65 ksi. [450].

S75.2 The maximum yield to tensile strength ratio shall be 0.85.

Copyright ASTM International
Provided by IHS under license with ASTM
No reproduction or networking permitted without license from IHS
Not for Resale

S77. *Reduced Sulfur—Grade 65 [450]:*

S77.1 The Grade 65 [450] shall be furnished with a maximum sulfur of 0.010 %. This may be desirable in material subjected to high through-thickness stresses.

APPENDIX

(Nonmandatory Information)

X1. QUENCHING AND SELF-TEMPERING PROCESS (QST)

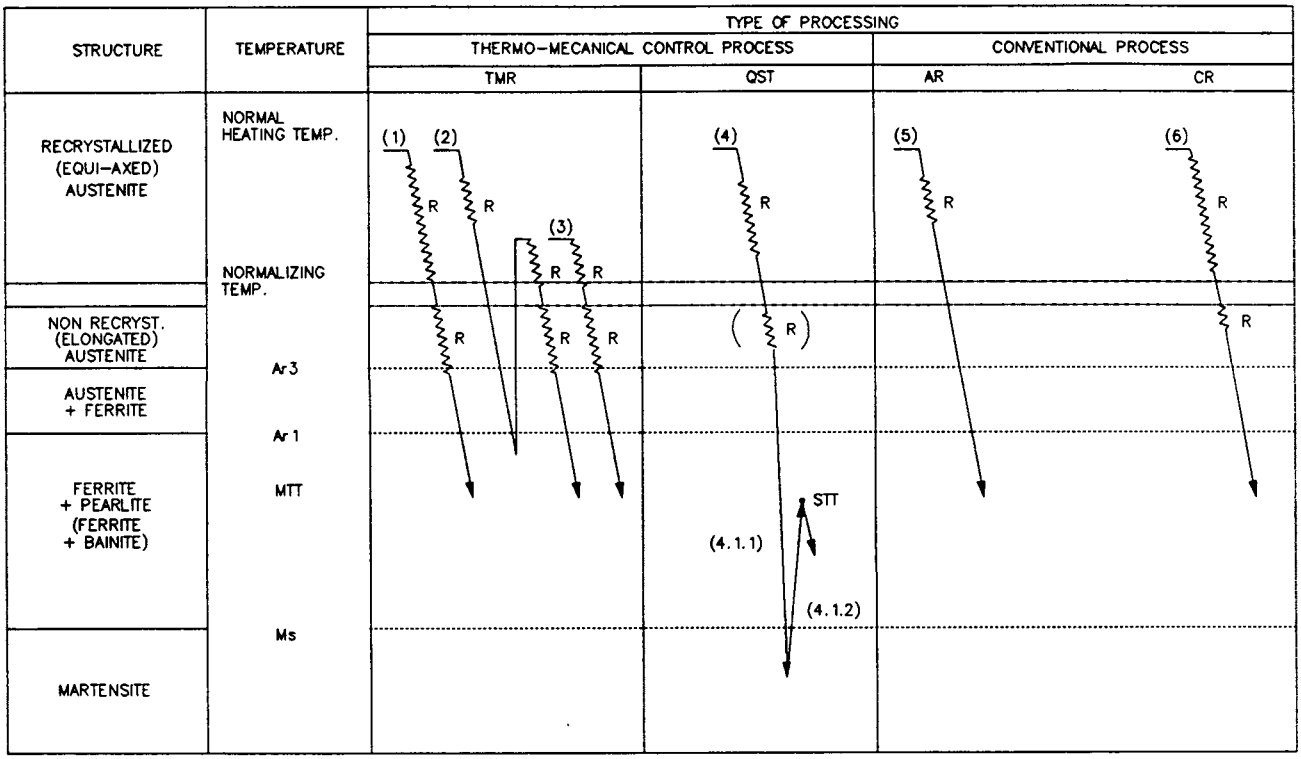
X1.1 *Introduction*—The quenching and self-tempering process, commonly referred to as "QST," has evolved from the "thermo-mechanical control processes" (TMCP) that have been known and used for a number of years. QST, which is a variation of TMCP, produces fine-grained steel by a combination of chemical composition and integrated controls of manufacturing processes from ingot or bloom reheating to in-line interrupted quenching and self-tempering, thereby achieving the specified mechanical properties in the required product thicknesses.

X1.2 *Outline of QST*—Given in Fig. X1.1.

X1.2.1 Quenching and self-tempering (QST)-steels of fine grain size are manufactured by producing tempered martensite and varying the pearlite or bainite, or both, volume fraction through time quenching (interrupted quenching in which the duration of holding in the quenching medium (water) is controlled) in the temperature region above Ar3 (the temperature at which austenite begins to transform to ferrite during cooling) to a minimum self-tempering temperature (STT, that is, the maximum surface temperature after quenching) of 1100°F [600°C] in order to meet the specified requirements. Time quenching can be performed after conventional rolling processes (AR) and (CR) or after thermomechanical controlled rolling (TMCR).

X1.2.2 The selection of the rolling process to be used is made by the producer depending upon the chemical composition, the product thickness, and the required properties.

Copyright ASTM International
Provided by IHS under license with ASTM
No reproduction or networking permitted without license from IHS
Not for Resale



NOTE TMR: THERMO-MECHANICAL ROLLING
AR: AS ROLLED
MTT: MARTENSITE TEMPERING TEMPERATURE
STT: SELF TEMPERING TEMPERATURE
QST: QUENCHING AND SELF-TEMPERING*
CR: CONTROLLED ROLLING
R: REDUCTION

* EXPLANATION OF TEMPERATURE CURVES
(4.1.1): SURFACE TEMPERATURE DURING QUENCHING
(4.1.2): SURFACE TEMPERATURE DURING SELF-TEMPERING

FIG. X1.1 Schematic Diagrams of Thermo-Mechanical Control and Conventional Process

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A 913/A 913M–04) that may impact the use of this standard.

(*1*) Added 6.2.1.1.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).

Copyright ASTM International
Provided by IHS under license with ASTM
No reproduction or networking permitted without license from IHS
Not for Resale