AISI S904-17

American Iron and Steel Institute

AISI STANDARD

Test Standard for Determining the Tensile and Shear Strengths of Steel Screws

2017 Edition

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Approved by

the AISI Committee on Specifications for the Design of

Cold-Formed Steel Structural Members

The material contained herein has been developed by the American Iron and Steel Institute (AISI) Committee on Specifications for the Design of Cold-Formed Steel Structural Members. The organization and the Committee have made a diligent effort to present accurate, reliable, and useful information on testing of cold-formed steel members, components or structures. The Committee acknowledges and is grateful for the contributions of the numerous researchers, engineers, and others who have contributed to the body of knowledge on the subject. With anticipated improvements in understanding of the behavior of cold-formed steel and the continuing development of new technology, this material will become dated. It is anticipated that future editions of this test procedure will update this material as new information becomes available, but this cannot be guaranteed.

The materials set forth herein are for general information only. They are not a substitute for competent professional advice. Application of this information to a specific project should be reviewed by a registered professional engineer. Indeed, in most jurisdictions, such review is required by law. Anyone making use of the information set forth herein does so at their own risk and assumes any and all resulting liability arising therefrom.

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PREFACE

The American Iron and Steel Institute Committee on Specifications developed this Standard to provide test methods for conducting tests to determine the tensile and shear strength of steel screws.

The Committee acknowledges and is grateful for the contribution of the numerous engineers, researchers, producers and others who have contributed to the body of knowledge on this subject.

User Notes are non-mandatory and copyrightable portions of this Standard.

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AISI S904-17
TEST STANDARD FOR DETERMINING THE TENSILE AND SHEAR STRENGTHS OF STEEL SCREWS

1. Scope

1.1 This Standard establishes procedures for conducting tests to determine the tensile and shear strength of steel screws. The screws may be carbon, stainless or *bi-metal* thread-forming or thread-cutting *screws*, with or without a self-drilling point, and with or without washers. The intended application for these screws is to connect cold-formed sheet steel material.

1.2 Two test methods are included in this Standard:

Tensile Test. This test is intended to determine the ability of a screw to withstand a load when applied along the axis of the screw.

Single Shear Test. This test is intended to determine the ability of a screw to withstand a load applied transversely to the axis of the screw.

1.3 This Standard does not intend to address all of the safety concerns, if any, associated with their use. It is the responsibility of the user of these methods to establish appropriate safety and health practices, and to determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

The following documents or portions thereof are referenced within this Standard and shall be considered as part of the requirements of this document.

a. American Iron and Steel Institute (AISI), Washington, DC:

S100-16, *North American Specification for the Design of Cold-Formed Steel Structural Members*

b. ASTM International (ASTM), West Conshohocken, PA:

A370-16, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

E6-15, *Standard Terminology Relating to Methods of Mechanical Testing*

F606/F606M-16, *Standard Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets*

IEEE/ASTM SI10-10, *American National Standard for Metric Practice*

3. Terminology

Terms not defined in Section 3 of this Standard, AISI S100 or ASTM E6 shall have the ordinary accepted meaning for the context for which they are intended.

Bi-metal Screw. A screw that is manufactured from two different metals that are joined together at the manufacturing facility, such as a screw with a stainless steel body fused to a hardened carbon steel drilling tip.

4. Symbols

d = Screw diameter
w = Test specimen width
e = Distance from center of the hole to the end of the specimen

p = Spacing of bolt holes

5. Units of Symbols and Terms

Any compatible system of measurement units is permitted to be used in this Standard, except where explicitly stated otherwise. The unit systems considered in this Standard shall include U.S. customary units (force in kips and length in inches) and SI units (force in Newtons and length in millimeters) in accordance with IEEE/ASTM SI10.

6. Measurement Precision

6.1 Loads shall be recorded to a precision of ±1 percent of the full range of the measuring device.

User Note:
The capacity (range) of the load-measuring device should be appropriate to the expected maximum tested load. The use of a measuring device with a calibrated capacity greatly exceeding the anticipated load is inappropriate. A target ratio of the load-measuring device capacity to specimen strength of no greater than three is recommended.

The tests should be conducted on a testing machine that complies with the requirements of ASTM E4-16, *Standard Practices for Force Verification of Testing Machines*.

7. Test Procedure

A test series shall be conducted for each screw material grade, head type, thread series and nominal diameter.

7.1 Tensile Test

7.1.1 The screw shall be tested in a holder with the load axially applied between the head and a suitable fixture, which shall have sufficient thread engagement to develop the full strength of the screw. See Figure 1 for a standard tensile test setup.

User Note:
Threads may be clamped directly by jaws of the testing machine if screw shank is not crushed.

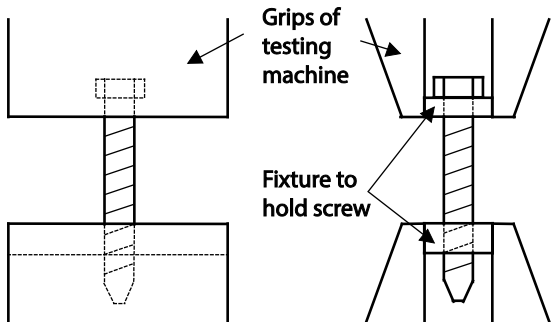

Figure 1 – Standard Tensile Test

7.1.2 The speed of testing, as determined by the rate of separation of the testing machine heads, shall be limited to the greater of 0.1 in. (2.5 mm) per minute or the separation rate caused by a loading rate of 500 pounds (2 kN) per minute.

7.1.3 The maximum load applied to the specimen, coincident with or prior to screw failure, shall be recorded as the tensile strength of the screw.

7.2 Single Shear Test

7.2.1 The specimen shall be tested using steel plates or shapes of sufficient thickness to preclude bearing failure and ensure failure through the fully threaded section. The shear plates or shapes shall create a single-lap joint connected with one or two fasteners. If two fasteners are used, the total shear strength of the connection shall be divided by two to determine the shear strength for one screw. Geometrical proportions of the test specimen shall be as suggested in Table 1, with reference to Figure 2. The test fixture shall provide for central loading across the lap joint. When the machine grips are adjustable, or when the thickness of either plate is less than 1/16 in. (2 mm), packing shims shall not be required for central loading.

Table 1 - Geometrical Proportions of Specimen

Screw Diameter, d in. (mm)	w in. (mm)	e in. (mm)	p in. (mm)
≤ 0.250 (6.5)	2 (50)	1 (25)	2 (50)
> 0.250 (6.5)	8d	3d > 1 (25)	3d > 2 (50)

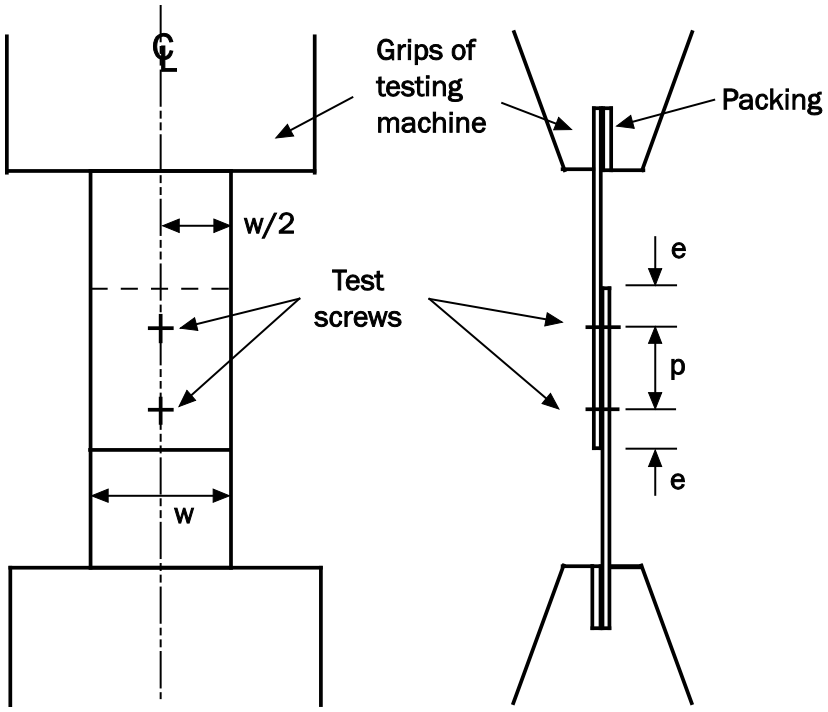

Figure 2

User Note:
In addition to precluding a bearing failure, the thickness or shape of the steel plates must also restrain the rotation of the screw during loading to minimize any tension being added to the screw. To facilitate this behavior, the length of the specimen should be as short as practical.

7.2.2 The test specimen shall be permitted to be assembled in a shear fixture or threaded into two flat sheets. The test specimen shall be mounted in a tensile-testing machine capable of applying load at a controllable rate. The grips shall be self-aligning and care shall be taken when mounting the specimen to ensure that the load will be transmitted in a straight line transversely through the test screw(s). Load shall be applied and continued until failure of the screw(s). Speed of testing, as determined by the rate of separation of the testing machine heads, shall be limited to the greater of 0.1 in. (2.5 mm) per minute or the separation rate caused by a loading rate of 500 pounds (2 kN) per minute.

7.2.3 The maximum load applied to the specimen, coincident with or prior to screw failure, shall be recorded as the shear strength of the screw.

8. Test Report

8.1 The objectives and purposes of the test series shall be stated at the outset of the report so that the necessary test results, such as the maximum load per fastener and the mode of failure, are identified.

8.2 The types of tests, the testing organization, the supervising engineer, and the dates on which the tests were conducted shall be included in the documentation.

8.3 The test specimen shall be fully documented, including:

(a) The measured dimensions and identification data of each specimen:

- Thread O.D.
- Thread I.D.
- Threads per unit length
- Head dimensions
- Screw length
- Manufacturer
- Designation or type
- Unthreaded length or imperfect threads below head
- Grade of material
- Drill-point diameter and length of flutes for self-drilling screws
- Any other distinguishing characteristics

(b) The details of fastener installation including pre-drilling, diameter of the pilot drill if used, tightening torque, and any unique tools used in the installation, and

(c) Identification of the washers or washer-head data, including diameter, thickness, material, and data on the sealant if present.

8.4 The test setup shall be fully described, including the type of testing machine, the specimen end grips or supports.

8.5 The test procedure shall be fully documented, including the rate of loading.

8.6 In accordance with the test objectives stated by the responsible engineer, the report shall include a complete documentation of all applicable test results for each specimen such as the maximum load and the mode of failure. The report shall also include the necessary calculations for the screw design strength [factored resistance] and safety factors/resistance factors based on the requirements specified in Section K2 of AISI S100.

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