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Standard Test Method for Torsion Testing of Wire[1]

This standard is issued under the fixed designation A 938; 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 test method describes the torsion (or twist) testing of metallic wire.

1.2 The values stated in U.S. customary units are to be regarded as the standard. The SI equivalents of U.S. customary units may be approximate.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 6 Terminology Relating to Methods of Mechanical Testing[2]

3. Terminology

3.1 *Definitions*—The definitions related to torsion testing appearing in Terminology E 6 shall be considered as applying to the terms used in this test method.

4. Significance and Use

4.1 The complex stress and strain conditions that occur in the sample during the torsion test are sensitive to minor variations in materials, making the torsion test a useful tool in assessing wire ductility under torsional loading.

5. Apparatus

5.1 *Clamping Heads*:

5.1.1 The torsion test apparatus must have clamping heads that will remain coaxial (within 10°) during the test.

5.1.2 One clamping head shall be easily displaceable in the direction of the wire axis. This longitudinally displaceable clamping head shall be equipped with a device capable of applying the necessary tensile load.

5.1.3 The clamping heads shall clamp the wire firmly, but should not damage it to the extent that fracture occurs at the clamping point during twisting. The distance between the clamps is the test length. The wire shall be twisted only along the test length, and not at the point of clamping. These requirements can be satisfied by bending a short section at each end of the specimen to an angle of about 90° to the wire axis, as described in 6.3.

5.2 *Revolution Counter*—A mechanism to count the number of twists shall be provided.

5.3 *Protective Shield*—A protective shield shall be provided to protect the operator from flying fragments in cases when the wire breaks into more than two pieces.

6. Specimen Preparation

6.1 *Straightening*—The test piece, consisting of a length of wire, should be straight before being tested. If straightening is necessary, it shall, unless otherwise specified, be done by hand. Other straightening techniques are permitted provided surface damage is avoided. Since the shear stress is maximum at the surface of the wire during testing, even slight surface damage such as pits or scratches can cause early fracture, and the results may not be indicative of the full capability of the wire.

NOTE 1—During straightening, it is important that the properties and cross section remain unchanged as far as possible. In particular, the specimen shall not be subjected to any twisting.

6.2 *Test Length* :

6.2.1 Recommended test length is 8 in. (203 mm) (distance between the clamping heads). Sufficient material must also be provided to allow for gripping.

6.2.2 Other test lengths may be used as agreed upon between the producer and purchaser or as specified in the appropriate product specification.

6.2.3 When a test length other than 8 in. (203 mm) is used, the minimum torsions shall be revised in direct proportion to the change in the jaw spacing, or as determined by the following formula:

$$T_x = \frac{(T_L)\,(L_x)}{(L_L)} \quad (1)$$

where:

T_x = minimum torsions for new length,

T_L = minimum torsions for 8 in. (203 mm) length,

[1] This test method is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of A1.03 on Steel Rod and Wire.

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[2] *Annual Book of ASTM Standards*, Vol 03.01.

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L_x = new length, and
L_L = 8 in. (203 mm).

6.3 *End Preparation*—To prevent the gripped ends from slipping tangentially in the clamps, a minimum of ½ in. (12.7 mm) of each end of the wire is often bent approximately 90° to the axis of the test sample. The end sections need not be exactly parallel to each other. See Fig. 1.

7. Procedure

7.1 *Tensile Force*—Clamp the specimen in the clamps of the test apparatus with its longitudinal axis coaxial with the clamping heads and in such a manner that the specimen remains as straight as possible during testing (see 5.1.1). Unless specified otherwise, this can be accomplished by applying a small tensile force to the specimen. This force should be just sufficient to prevent the specimen from deflecting away from the axis of rotation during twisting. Recommended tensile forces are shown in Table 1.

7.2 *Speed of Twisting*—The speed of testing should be such that the wire is not heated appreciably during the test since excessive speed results in a lowering of torsion values. Recommended maximum speeds are shown in Table 2.

7.3 *Number of Turns*:

7.3.1 After placing the test specimen in the machine, rotate one clamp at a reasonably constant speed until the test specimen fractures, defined as a complete separation of the broken ends.

7.3.2 If the number of turns is satisfactory, the test specimen is considered as having passed the test, regardless of the position of fracture, defined as complete separation of the broken ends. If the number of turns does not satisfy the requirements of the specification, and the initial fracture, defined as complete separation of the broken ends, location is within two times the wire diameter from the clamps, the test is considered invalid and shall be repeated.

NOTE 2—Specimens often break into more than two pieces, subsequent fractures resulting from the rapid untwisting of the wire following the initial fracture. In many cases, the initial fracture will have a smooth surface perpendicular to the wire axis. The above validity test applies only to the location of this initial break.

8. Report

8.1 The following information shall be included in the test report:

8.1.1 Specimen identification,

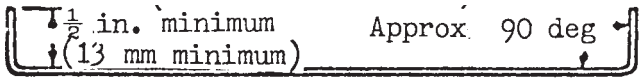

FIG. 1 Sketch Showing 90° Bends at Ends of Wire Twist Test Specimen

TABLE 1 Recommended Tensile Forces to be Applied to Wire During Torsion Testing

Wire Size Nominal Diameter		Applied Tensile Force[A]	
in.	mm	lb.	N
0.011 to 0.016	0.28 to 0.42	1	4
0.017 to 0.020	0.43 to 0.52	2	9
0.021 to 0.030	0.53 to 0.77	4	18
0.031 to 0.040	0.78 to 1.02	6	27
0.041 to 0.050	1.03 to 1.28	8	36
0.051 to 0.060	1.29 to 1.53	9	40
0.061 to 0.070	1.54 to 1.79	11	49
0.071 to 0.080	1.80 to 2.04	12	58
0.081 to 0.090	2.05 to 2.30	16	71
0.091 to 0.100	2.31 to 2.55	19	85
0.101 to 0.110	2.56 to 2.80	21	93
0.111 to 0.120	2.81 to 3.06	23	102
0.121 to 0.160	3.07 to 4.06	25	111

[A] For sizes larger than 0.160 in., the tensile force of 1% of the nominal maximum load of the wire is recommended.

TABLE 2 Recommended Maximum Twisting Speeds per 100 Wire Diameters of Gage Length

Wire Diameter, in. (mm)	Twisting Speed (Rpm)
< 0.040 (1.02)	90
0.040 to < 0.142 (1.02 to < 3.61)	60
0.142 and larger (3.61 and larger)	30

8.1.2 Wire diameter,

8.1.3 Test length, including fractional turns when applicable, and

8.1.4 Total turns to fracture.

NOTE 3—If a minimum number of turns is specified and this number is exceeded, the test need not be continued to fracture. It is then sufficient to record that no fracture occurred.

9. Precision and Bias

9.1 *Precision*—Sufficient multilaboratory tests have not been compared to establish the reproducibility of this test method. Test variables that affect precision include: (*1*) initial length and straightness of the wire, (*2*) the amount of tensile stress, (*3*) the speed of testing, and (*4*) location of the fracture.

9.2 *Bias*—Determination of the bias of a test method requires reference standard values for one or more materials based on many measurements. Such standard reference values are not available for this test method. Therefore, the bias of the method is not known.

10. Keywords

10.1 coaxial clamping; fracture; revolution counter; test length; torsion; torsion testing; twisting rates; wire; wire axis; wire ductility

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