Designation: A 938 – 07

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:* [2]

E 6 Terminology Relating to Methods of Mechanical Testing

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,
L_x = new length, and

[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 A01.03 on Steel Rod and Wire.

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[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 Document Summary page on the ASTM website.

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

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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.

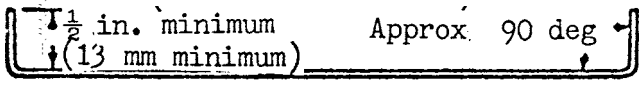

FIG. 1 Sketch Showing 90° Bends at Ends of Wire Twist Test Specimen

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,

8.1.2 Wire diameter,

8.1.3 Test length, 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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TABLE 1 Applied Load for Torsion Testing

Diameter of Wire		Applied Load[A]			
		Pounds Force (lbf)		Newtons (N)	
Inches	mm	Minimum	Maximum	Minimum	Maximum
Up to 0.010	Up to 0.25	0.50	2.0	2.2	8.9
Over 0.010 to 0.015	Over 0.25 to 0.41	1.0	4.0	4.4	18
Over 0.015 to 0.020	Over 0.41 to 0.51	1.5	6.0	6.7	27
Over 0.020 to 0.030	Over 0.51 to 0.76	2.0	8.0	8.9	36
Over 0.030 to 0.040	Over 0.76 to 1.02	3.0	12	13	53
Over 0.040 to 0.050	Over 1.02 to 1.28	4.0	16	18	71
Over 0.050 to 0.060	Over 1.28 to 1.53	5.0	20	22	89
Over 0.060 to 0.070	Over 1.53 to 1.79	6.0	24	27	107
Over 0.070 to 0.080	Over 1.79 to 2.04	7.0	28	31	125
Over 0.080 to 0.090	Over 2.04 to 2.30	8.0	32	36	142
Over 0.090 to 0.100	Over 2.30 to 2.55	9.0	36	40	160
Over 0.100 to 0.110	Over 2.55 to 2.80	10	40	44	178
Over 0.110 to 0.120	Over 2.80 to 3.06	11	44	49	196
Over 0.120 to 0.130	Over 3.06 to 3.31	12	48	53	214
Over 0.130 to 0.140	Over 3.31 to 3.57	13	52	58	231
Over 0.140 to 0.150	Over 3.57 to 3.82	14	56	62	249
Over 0.150 to 0.160	Over 3.82 to 4.07	15	60	67	267
Over 0.160 to 0.170	Over 4.07 to 4.33	16	64	71	285
Over 0.170 to 0.180	Over 4.33 to 4.58	17	68	76	302
Over 0.180 to 0.190	Over 4.58 to 4.84	18	72	80	320
Over 0.190 to 0.200	Over 4.84 to 5.09	19	76	85	338
Over 0.200 to 0.210	Over 5.09 to 5.34	20	80	89	356
Over 0.210 to 0.220	Over 5.34 to 5.60	21	84	93	374
Over 0.220 to 0.230	Over 5.60 to 5.85	22	88	98	391
Over 0.230 to 0.240	Over 5.85 to 6.10	23	92	102	409
Over 0.240 to 0.250	Over 6.10 to 6.35	24	96	107	427

[A] For sizes larger than 0.250 in. (6.35mm), the tensile force of 1 % of the nominal maximum load of the wire is recommended.

TABLE 2 Recommended Maximum Twisting Speeds

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

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue, A 938 – 04, that may impact the use of this standard. (Approved Sept. 1, 2007.)

(*1*) Revised Table 1 to show minimum and maximum load values and wire sizes larger than 0.160 inches (4.06mm) in. diameter.

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