Designation: D 6320 – ~~99~~02

Standard Test Methods for Single Filament Hose Reinforcing Wire Made from Steel[1]

This standard is issued under the fixed designation D 6320; 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 These test methods cover testing of single filament steel wires that are used to reinforce hose products. By agreement, these test methods may be applied to similar filaments used for reinforcing other rubber products.

1.2 These test methods describe test procedures only and do not establish specifications or tolerances.

1.3 These test methods cover the determinations of the mechanical properties listed below:

Property	Section
Breaking force (strength)	7-13
Yield strength	7-13
Elongation	7-13
Knot strength	14-20
Torsion resistance	21-27
Reverse bend	28-34
Wrap	35-41
Diameter	42-48

1.4 These test methods are written in SI units; the inch-pound units which are provided are not necessarily exact equivalents of the SI units. Either system of units may be used in these test methods. In the case of referee decisions, the SI units will prevail.

1.5 *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:*

[1] These test methods are under the jurisdiction of ASTM Committee D-13 on Textiles and are the direct responsibility of Subcommittee D13.19 on Tire Cord and Fabrics.
Current edition approved ~~March~~ Sept. 10, ~~1999.~~ 2002. Published ~~June 1999.~~ November 2002. Originally published as D6320–98. Last previous edition D6320–9~~8~~9.

D 76 Specification for Tensile Testing Machines for Textiles[2]
D 123 Terminology Relating to Textiles[2]
D 2969 Methods for Testing Filaments, Strands, Cords, and Fabrics Made from Steel[2]
D 6477 Terminology Relating to Tire Cord, Bead Wire, Hose Reinforcing Wire and Fabrics[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *breaking force*, *n*—the maximum force applied to a material carried to rupture.

3.1.2 *elongation*, *n*—the ratio

3.1.1 For definitions of the extension of a material terms relating to the length of the material prior to stretching.

3.1.2.1 *Discussion*—Elongation may be measured at any specified force or at rupture and is usually expressed in percent.

3.1.3 *hose wire*, *n*—a monofilament steel wire with a metallic coating, usually brass, used in a reinforced tire cord, bead wire, hose product.

3.1.4 *torsion resistance*, *n*—in hose reinforcing wire, the number of turns of twist in a specified length of wire that causes rupture.

3.1.5 *yield strength*, *n*—the force at which a material exhibits a specific limiting deviation from the proportionality of stress to strain.

3.1.5.1 *Discussion*—It is customary in this instance to express the deviation in terms of strain and tire cord fabrics, refer to determine yield strength by the offset method, where a strain of 0.2 % is specified (see 11.11.1).

3.1.6 For Terminology D 6477.

3.1.2 For definitions of other textile terms, terms related to textiles, refer to Terminology D 123.

4. Summary of Test Method

4.1 A summary of the directions prescribed for determination of specific properties of hose reinforcing wire is stated in the appropriate sections of the specific test methods that follow.

5. Significance and Use

5.1 The procedures for the determination of properties of single-filament hose reinforcing wire made from steel are considered satisfactory for acceptance testing of commercial shipments of this product because the procedures are the best available and have been used extensively in the trade.

5.1.1 In the case of a dispute arising from differences in reported test results when using these test methods for acceptance testing of commercial shipments, the purchaser and supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for investigation of bias. As a minimum, two parties should take a group of test specimens which are as homogeneous as possible and which are from a lot of material of the type in question. The test specimens then should be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared by using an appropriate statistical test and an acceptable probability level chosen by the two parties before testing is begun. If a bias is found, either its cause must be determined and corrected or the purchaser and supplier must agree to interpret future test results with consideration to the known bias.

6. Sampling

6.1 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of reels, coils, spools, or other shipping units of wire directed in an applicable material specification or other agreement between purchaser and supplier. Consider reels, coils, spools, or other shipping units of wire to be the primary sampling units.

NOTE 1—A realistic specification or other agreement between the purchaser and the supplier requires taking into account the variability between and within primary sampling units, to provide a sampling plan which at the specified level of the property of interest has a meaningful producer's risk and acceptable quality level.

6.2 *Laboratory Sample*—Use the primary sampling units in the lot sample as a laboratory sample.

6.3 *Test Specimens*— For each test procedure, take the number of lengths of hose reinforcing wire of the specified lengths from each laboratory sample as directed in the test procedure.

BREAKING FORCE, YIELD STRENGTH, AND ELONGATION

7. Scope

7.1 This test method covers the measurement of breaking force, yield strength, and elongation of single filament steel reinforcing wire in a tensile test.

[2] *Annual Book of ASTM Standards*, Vol 07.01.
[3] *Annual Book of ASTM Standards*, Vol 07.02.

8. Summary of Test Method

8.1 The specimen is clamped in a tensile testing machine and increasing forces applied until the specimen breaks. The change in force is measured versus the increase in separation of the specimen clamps to form a force-extension curve. Breaking force is read directly from the curve and is expressed in newtons (pounds - force). Elongation at break is the extension at break divided by the original specimen length times 100. Yield strength the intersection of the force-extension curve with a line at 0.2 % offset, is read from the force-extension curve and is expressed in newtons (pounds - force). Current tensile test machines may have the capability for calculating elongation and yield strength using a programmed computer.

9. Significance and Use

9.1 The load bearing ability of a reinforced rubber product such as a steel reinforced hydraulic hose is related to the strength of the single-filament wire used as the reinforcing material. The breaking force and yield strength are used in engineering calculations when designing this type of reinforced product.

9.2 Elongation of hose reinforcing wire is taken into consideration in the design and engineering of hoses because of its effect on uniformity and dimensional stability during service.

10. Apparatus

10.1 *Tensile Testing Machine*, constant rate of extension (CRE) type tensile testing machine of such capacity that the maximum force required to fracture the wire shall not exceed 90 % nor be less than 10 % of the selected force measurement range. The specifications and methods of calibration and verification shall conform to Specification D 76.

10.2 In some laboratories, the output of CRE type of tensile testing machine is connected with electronic recording and computing equipment that may be programmed to calculate and print the results for each of the force - extension properties, optional.

10.3 Extensometer, any device that can be attached to the specimen and that permits recording of the specimen extension during loading, optional.

10.4 Grips, of such design that failure of the specimen does not occur at the gripping point, and slippage of the specimen within the jaws (grips) is prevented.

11. Procedure

11.1 Select a proper force-scale range on the tensile testing machine based on the estimated breaking force of the specimen being tested.

11.2 If specified, tensile testing may be carried out after aging for 1 h ± 5 min at 150 ± 5°C (300 ± 9°F).

11.3 Set the crosshead speed at 25 mm/min. (1.0 in./min.) and recorder chart speed at 250 mm/min. (10 in./min.)

11.4 Adjust the distance between the grips of the tensile machine, nip to nip, to a gage length of 250 mm (10 in.), ± 0.5 %.

11.5 Secure the specimen in the upper grip sufficiently to prevent slippage during testing. While keeping the specimen straight and taut, place and secure the other end in the lower grip.

11.6 Apply a force of no greater than 1 *N* (0.2 lbf) on the clamped specimen to take out any residual slack before initiating the test. This will be considered the zero-reference point for elongation calculations.

11.7 Start the testing machine and record the force-extension curve generated.

11.7.1 If the specimen fractures at, or within, 5 mm (0.2 in.) of the gripping point, discard the result and test another specimen. If such jaw breaks continue to occur, insert a jaw liner, such as an abrasive cloth, between the gripping surface and the specimen in a manner that the liner extends beyond the grip edge where it comes in contact with the specimen.

11.8 Conduct this test procedure on two specimens from each laboratory sampling unit.

11.9 *Breaking Force*— Read the maximum force from the force-extension curve.

11.10 *Elongation*—Determine the elongation from the force-extension curve.

11.11 *Yield Strength*— Determine the yield strength by the 0.2 % offset method.

11.11.1 On the force-extension curve (see Fig. 1) that has been generated (see 11.7), lay off Om equal to the specified value of the offset (0.2 % elongation): draw mn parallel to OA and locate *r*. This intersection of mn with the force-extension curve corresponds to force *R*, that is the yield strength. Should the force-extension curve exhibit an initial nonlinear portion, extrapolate from the straight line portion to the base line. This intersection is point 0 used in this section.

12. Calculation

12.1 *Break Strength*— Calculate the average breaking force for each laboratory sampling unit to the nearest 1 *N* (0.2 lbf), and record this value as breaking strength.

12.2 *Elongation at Break*:

12.2.1 Calculate the elongation at break for each specimen from the force-extension curve to the nearest 0.1 %. Should the force-extension curve exhibit an initial nonlinear portion, extrapolate from the straight line portion of the curve to the base line. This intersection is the point of origin for the elongation determination. The extension from this point to the force at the point of rupture is the total elongation.

12.2.2 Calculate the average elongation at break for each laboratory sampling unit.

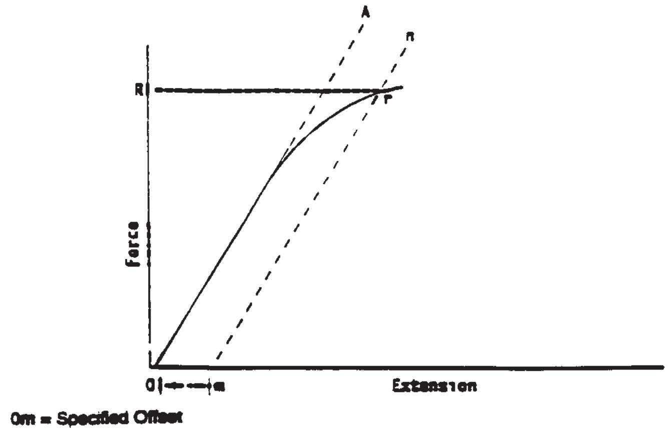


FIG. 1 Force-Extension Curve for Determination of Yield Strength by the Offset Method

12.3 *Yield Strength*— Calculate the average yield strength from each laboratory sampling unit as directed in Section 11.11.1 to the nearest 1 *N* (0.2 lbf).

13. Report

13.1 State that the tests were performed as directed in these test methods (D 6320) for breaking strength, elongation at break and yield strength. Describe the material or product tested.

13.2 Report the following information:

13.2.1 The test results of each specimen and the laboratory sample average. Calculate and report any other data agreed to between the purchaser and the supplier,

13.2.2 Type of tensile test machine, machine number (if applicable), and rate of extension,

13.2.3 Whether specimens were heat aged or not,

13.2.4 Any deviation from the standard test procedure, and

13.2.5 Date of test and operator.

14. Precision and Bias

14.1 *Precision*—0.30 mm HT (high tensile: 2750 MN/m^2 to 3050 MN/m^2) brass plated hose wire was tested. The single operator repeatability standard deviation for breaking force has been determined to be 8.24*N*. The single operator repeatability standard deviation for yield strength has been determined to be 5.24 *N*. The single operator repeatability standard deviation for elongation has been determined to be 0.14 %. The reproducibility of this test method is being determined and will be available before 2005.

14.2 *Bias*—The tensile property procedures of these test methods have no bias, because these properties can be defined only in terms of a test method.

KNOT STRENGTH

15. Scope

15.1 This section describes the test procedure to determine the knot test characteristic of hydraulic hose wire with a diameter less than or equal to 0.82 mm (0.032 in.). In practice, the knot test is most suitable for wires less than 0.50 mm (0.020 in.).

16. Significance and Use

16.1 Complex stress and strain conditions sensitive to variation in materials occur in wire specimens during knot strength testing. The knot strength test is a useful tool in assessing wire ductility as defective wire lowers knot strength.

17. Apparatus

17.1 *Tensile Test Machine*, CRE-type and grips as described in Section 10. Electronic recording and computing equipment is optional.

18. Procedure

18.1 Select a proper force-scale range on the tensile testing machine based upon the estimated breaking force of the specimen being tested.

18.2 If specified, the knot strength test may be carried out after aging for 1 h ± 5 min at 150 ± 5°C (300 ± 9°F).

18.3 Adjust the distance between the grips of the tensile testing machine, nip to nip, to a gage length of 250 mm (10 in.) ± 0.5 %.

18.4 Form a simple loop (overhand) knot in the middle zone of the test piece as shown in Fig. 2.

18.5 Center the knot between the grips. Secure one end of the specimen in the upper grip sufficiently to prevent slippage during testing. While keeping the specimen taut, place and secure the other end in the lower grip.

18.6 After setting the crosshead speed at 25 mm/min (1 in./min) and the recorder chart at 25 mm/min. (1 in./min), start the testing machine and record the force-extension curve generated.

18.7 When the knotted diameter reaches about 5 mm (0.2 in.), change the crosshead speed to 10 mm/min. and load to fracture.

18.8 If the specimen fractures at or within 5 mm (0.2 in.) of the gripping point, discard the result and test another specimen. If such jaw breaks continue to occur, see 11.7.1 for techniques to minimize the occurrence of such failures.

18.9 Conduct this test procedure on two specimens from each laboratory sampling unit.

18.10 Determine the breaking strength sample average of the wire (F_m) as in Section 12.

19. Calculation

19.1 *Knot Breaking Strength*—Read the maximum force (F_{kn}) for each knotted wire from the force-extension charts to the nearest 1 *N* (0.2 lbf).

19.2 *Knot Strength Ratio*—Calculate the knot strength ratio for each specimen using Eq 1.

$$Kn = 100\, F_{kn}/F_m \quad (1)$$

where:

Kn = knot strength ratio, %

F_{kn} = knot breaking strength, *N* (lbf), and

F_m = breaking strength of the wire, *N* (lbf).

20. Report

20.1 State that the tests were performed as directed in this test methods (D 6320). Describe the material or product tested and report the following:

20.1.1 The individual knot strength ratio values are reported for each specimen. Calculate and report any other data agreed to between the purchaser and the supplier,

20.1.2 Date of test and operator,

20.1.3 Type of tensile test machine, machine number (if applicable), and rate of extension, and

20.1.4 Any deviation from the standard test procedure.

21. Precision and Bias

21.1 *Precision*—0.30 mm HT (high tensile: 2750 MN/m ^{2} to 3050 MN/m^2) brass plated hose wire was tested. The single operator repeatability standard deviation for knot strength has been determined to be 3.85*N*. The reproducibility of this test method is being determined and will be available before 2005.

21.2 *Bias*—The procedure of the test method has no bias, since this property can be defined only in terms of a test method.

TORSION RESISTANCE

22. Scope

22.1 This test method covers the determination of wire ductility by twisting a wire to failure.

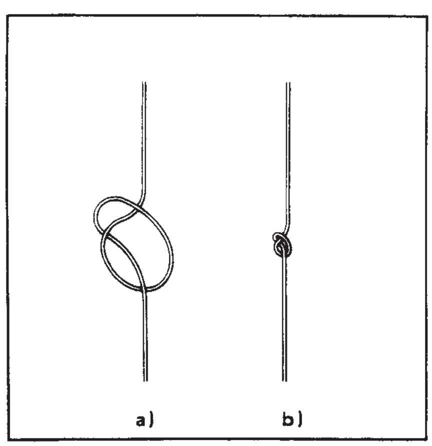


FIG. 2 Overhand Knot, (a) As Tied and (b) As Tightened During the Test

23. Summary of Test Method

23.1 Single filament of wire is tested in torsion by holding one end of the wire fixed while rotating the other.

24. Significance and Use

24.1 Complex stress and strain conditions sensitive to variation in materials occur in wire specimens during torsion testing. The torsion test is a useful tool in assessing wire ductility under torsional loading. Defective wire lowers torsion resistance.

25. Apparatus

25.1 *Torsion Test Machine*, with automatic drive, that allows a single filament of wire under light tension to be tested in torsion, with a counter which is provided which registers the number of wire revolutions to wire fracture.

26. Procedure

26.1 Cut the test specimens to the appropriate lengths to obtain the proper gage length between chuck or edges.

26.2 If specified, the torsion resistance test may be carried out after aging for 1 h ± 5 min at 150 ± 5°C (300± 9°F).

26.3 Place the specimen in the clamping fixtures and tighten the jaws while keeping the wire in a straight alignment. Apply a pretension of approximately 2 % of the wire breaking force to the specimen in the longitudinal direction to aid in keeping the wire straight during testing.

26.4 Set the rotation counter to zero.

26.5 Start the equipment and run until the specimen ruptures. For sizes below 1.40 mm (0.055 in.), use a rotational speed of 60 ± 15 rpm. Speeds in excess of these can cause excessive specimen heating and can cause inaccurate results.

26.6 If the specimen fails within 1 mm (0.04 in.) from the jaw edge, it is considered to be a jaw break. Discard the result and test another specimen.

26.7 Conduct this test procedure on two specimens from each laboratory sampling unit.

27. Calculation

27.1 Record the number of full rotational turns of the wire to fracture as torsion resistance.

27.2 Calculate the average torsion resistance for each laboratory sampling unit.

28. Report

28.1 State that the tests were performed as directed in these test methods (D 6320). Describe the material or product tested, and report the following:

28.1.1 The results of each specimen and the laboratory sample average,

28.1.2 Type of torsion tester and rate of rotation,

28.1.3 Any deviation from the standard test procedure, and

28.1.4 Date of test and operator.

29. Precision and Bias

29.1 *Precision*—0.30 mm HT (high tensile: 2750 MN/m ^{2} to 3050 MN/m^2) brass plated hose wire was tested. The single operator repeatability standard deviation for torsion resistance has been determined to be 2.83 turns. The reproducibility of this test method is being determined and will be available before 2005.

29.2 *Bias*—The procedure in this test method has no bias, since this property can be defined only in terms of a test method.

REVERSE BEND

30. Scope

30.1 This test method covers the determination of high stress fatigue performance and ductility by reverse bending wire to failure.

31. Summary of Test Method

31.1 The test consists of repeated bending of a specimen through 90° in opposite directions, in one plane. The test specimen is gripped at one end and a bend is made over a cylindrical surface of specified radius.

32. Significance and Use

32.1 The bending of a piece of wire around a known diameter in alternating direction applies alternating tensile and compressive loading on the outer surface of the wire. This test, therefore, may be related to the fatigue performance and particularly, the surface quality of the wire, because transverse surface cracks pre-existing in the wire will be rapidly propagated into a fracture if it coincides with the bending area. It is clearly important to recognize that only the wire being bent around the former is under test so that an intermittent surface condition may not necessarily be detected. The bending test also provides a means of evaluating the ductility of wire. Defective wire lowers the number of bends to failure.

33. Apparatus

33.1 *Bending Apparatus*—An automated-drive apparatus that allows a single filament of wire to be tested in bending is available. Counters are provided that register the number of bends to wire fracture. Two types of test machine are used. These are:

33.1.1 *Machine A*, constructed to conform with the principles indicated in Fig. 3. The essential dimensions are given in Table 1. With this machine, the specimen is clamped in the lower fixed position and the wire is free to move in the bending arm.

33.1.2 *Machine B*, constructed to conform with the principles indicated in Fig. 4, and the essential dimensions are given in Table 1. With this machine, the specimen is clamped in the upper bending arm and the wire is essentially free to move in the lower fixed guide.

34. Procedure

34.1 *Preparation of Test Specimens*:

34.1.1 Test two specimens from each laboratory sampling unit. Use a specimen length that is as straight as possible, but it may exhibit slight curvature in the plane in which it will be bent during testing. If straightening is necessary, do this by hand. During straightening, the surface of the wire must not be damaged and the test piece must not be subjected to any twisting.

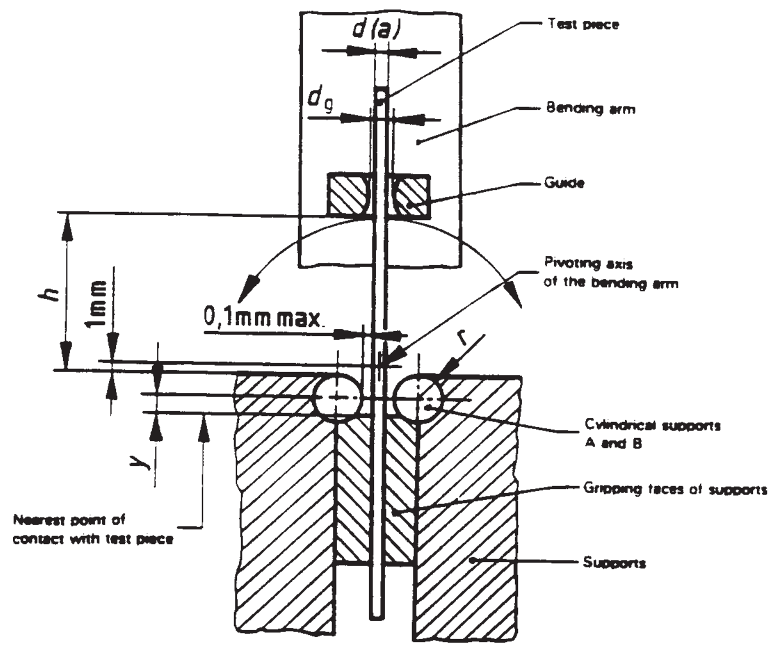
34.1.2 If specified, the reverse bend test may be carried out after aging for 1 h ± 5 min at 150 ± 5°C (300 ± 9°F).

34.2 *Counting of Bends*:

34.2.1 Counting of bends should be agreed upon between purchaser and supplier. For this test method, one bend is counted as a 90° bend plus a 90° return to the starting position.

34.3 *Wire Testing—Machine A*:

34.3.1 Use the machine set-up parameters for the wire diameter to be tested as shown in Table 1.



Symbol	Designation	Unit
d	Diameter of round wire	mm
a	Minimum thickness of wire of non-circular section capable of being held between parallel grips (see figure 2)	mm
r	Radius of cylindrical supports	mm
h	Distance from the top tangential plane of cylindrical supports to the bottom face of guide	mm
d_g	Diameter of guide hole	mm
y	Distance from a plane, defined by the axes of the cylindrical supports, to the nearest point of contact with the test piece	mm
N_b	Number of reverse bends	–

FIG. 3 Reverse Bending Machine A

TABLE 1 Essential Dimensions to Reverse Bend Testing

Nominal Wire Diameter *d* (mm)	Radius of Cylindrical Support *r* (mm)		Distance *h* (mm)		Diameter of Guide Hole d_g (mm)	
	Machine A	Machine B	Machine A	Machine B	Machine A	Machine B
0.3 < *d* < 0.5		1.25 ± 0.05	15	8	2.0	[A]
0.5 < *d* < 0.7	2.5 ± 0.1	1.75 ± 0.05	15	8	2.0	[A]
0.7 < *d*< 1.0		2.5 ± 0.1	15	8	2.0	[A]

[A]Select the appropriate color coded wire guide by choosing the nearest size above the wire size being tested – yellow = 0.368 mm, blue = 0.508 mm, red = 0.635 mm, grey = 0.787 mm.

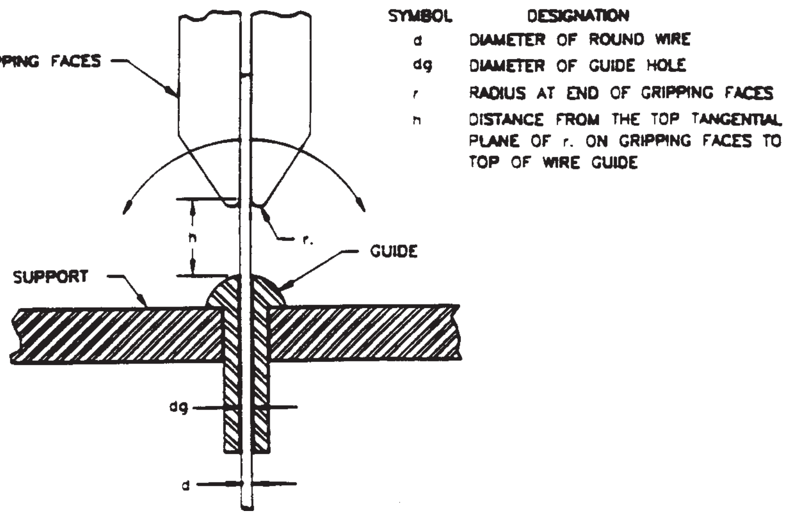


FIG. 4 Reverse Bending Machine B

34.3.2 Insert the specimen with the bending arm vertical through one of the holes in the guide as shown in Fig. 3. Hold the lower end of the specimen between the grips so that the test piece is perpendicular to the axes of the cylindrical supports.

34.3.3 Bend the test specimen first through 90°, then 180° alternately in opposite directions. Do not interrupt the testing between successive bends.

34.3.3.1 Bend the specimen at a uniform rate without shock, not exceeding one bend per second. Typically 40 bends per minute are used. In industry practice the rate of bending is limited to insure the heat generated does not affect the result of the test.

34.3.4 To ensure continuous contact between the test piece and the cylindrical supports during the test, some form of constraint may be applied. This may be in the form of a tensile stress not greater than 2 % of the value of the nominal tensile strength.

34.3.5 Continue the test until rupture of the test specimen occurs.

34.3.6 Do not include the bend during which the failure of the test specimen occurred in the count of the number of bends, N_b, to failure.

34.4 *Wire Testing—Machine B*:

34.4.1 Follow the machine set-up parameters for the wire diameter to be tested as shown in Table 1.

34.4.2 Select the appropriate counts per cycle.

34.4.3 With the bending arm vertical (Fig. 4), place the specimen through the wire guide permitting approximately 20 to 30 mm to protrude from the bottom. Machine B includes an electrical cutoff circuit to automatically stop the test when the test specimen fractures. Ensure the specimen is not in contact with the angle bracket or any other metal part of the equipment as this will alter the electrical circuit.

34.4.4 Clamp the specimen in the radiused jaws allowing 20 to 30 mm to protrude from the top and bend this by 90°. If this bent specimen rotates during the test, discard the test result because the specimen was not properly clamped.

34.4.5 Attach the electrical cutout circuit clip to the specimen end hanging down from the angle bracket completing the cutout circuit.

34.4.6 Adjust the counter meter to zero before starting the test.

34.4.7 Initiate the test by pressing the start button.

34.4.8 Bend the test specimen through 90° alternately in opposite directions. Do not interrupt the testing between successive bends.

34.4.9 Bend the specimen at a uniform rate without shock, not exceeding one bend per second. Typically 40 bends per minute are used. In industry practice, the rate of bending is limited to ensure the heat generated does not affect the result of the test.

34.4.10 Continue the test until rupture of the test specimen occurs.

34.4.11 Do not include the bend during which the failure of the test specimen occurred in the count of the number of bends, N_b, to failure.

35. Calculation

35.1 Calculate the average number of bends, N_b, to failure for each laboratory sampling unit.

36. Report

36.1 State that the tests were performed as directed in these Test Methods (D 6320). Describe the material or product tested and report the following:

36.1.1 The nominal diameter of the material,

36.1.2 Details regarding the preparation of the test specimen (i.e., straightening, heat treatment),

36.1.3 Test conditions (bend radius, application of tensile stress bends per minute),

36.1.4 Test result for each specimen and laboratory sample average in accordance with 35.1 and

36.1.5 Date of test and operator.

37. Precision and Bias

37.1 *Precision*—0.30 mm HT (high tensile: 2750 MN/m ^{2} to 3050 MN/m^2) brass plated hose wire was tested. The single operator repeatability standard deviation for reverse bend using Machine A has been determined to be 11.2 bends. The single operator repeatability standard deviation for reverse bend using Machine B has been determined to be 18.5 bends. The reproducibility of this test method is being determined and will be available before 2005.

37.2 *Bias*—The procedure in this test method has no bias, since this property can be defined only in terms of a test method.

WRAP

38. Scope

38.1 This test method covers determination of propensity of a wire to develop or propagate, or both, surface cracks from being wound. This test is also known as the wrap-around bend test.

39. Summary of Test Method

39.1 A specimen is wound a specified number of turns around a core of specified diameter. The specimen should neither fracture during testing nor exhibit cracks along the surface.

40. Significance and Use

40.1 This test may be used to determine the ductility of certain kinds of wire. The bending of wire around a specified diameter subjects the outer wire surface to tensile stresses.

40.2 This test may be related to high stress fatigue or more directly to the surface quality of the wire, because transverse surface cracks pre-existing in the wire will be rapidly propagated into a fracture if they coincide with the bending area. It is important to recognize that only the wire being bent is under test so that an intermittent surface condition may not necessarily be detected. Also, if a surface imperfection is present but is part of the surface placed in compression, it may not be detected.

41. Apparatus

41.1 Winding device, manual or power driven, that will coil the wire closely about a mandrel of the specified diameter for a required number of turns without damage to the wire surface. The diameter of the mandrel used in the test shall be agreed upon between the purchaser and the supplier. Typically, for wires less than 0.76 mm (0.030 in.) in diameter, a mandrel diameter of four times the wire diameter is used. For wires greater than 0.76 mm (0.030 in.) in diameter, a mandrel diameter of three times the wire diameter is used.

42. Procedure

42.1 Test one specimen from each laboratory sampling unit.

42.2 Wrap the specimen around the mandrel at a constant speed, not exceeding one turn per second, but in any case sufficiently slow to prevent any rise in temperature likely to affect the result of the test. Make five closely spaced wraps.

42.2.1 To ensure close coiling, a tensile stress not to exceed 2 % of the nominal tensile strength of the wire may be applied during wrapping.

42.3 At the end of the test, the test specimen is examined.

42.4 Consider the specimen to have failed if any cracks occur in the wire after the first complete turn.

42.4.1 If a crack occurs in the first turn, repeat the test because the specimen may have been bent locally to a radius less than that specified.

43. Report

43.1 State that the tests were performed as directed in these Test Methods D 6320. Describe the material or product tested and report the following:

43.1.1 The mandrel diameter used,

43.1.2 The number of wraps produced,

43.1.3 If the test was conducted by hand or in a test machine,

43.1.4 Report the test results as satisfactory or unsatisfactory,

43.1.5 Any deviation from the standard test procedure, and

43.1.6 Date of test and operator.

44. Precision and Bias

44.1 No information is presented about either the precision bias of test method D 6320 for measuring the propensity of wire to develop or propagate, or both, cracks from being wound since the test result is non-quantitative.

44.2 *Bias*—The procedure in this test method has no bias, since this property can be defined only in terms of a test method.

DIAMETER

45. Scope

45.1 This test method covers the measurement of the diameter and roundness of single filament wire using a micrometer.

46. Significance and Use

46.1 Diameter is one of the basic mechanical properties of single-filament wire. Tensile properties are dependent on the wire diameter.

47. Apparatus

47.1 *Micrometer*, precision type with a vernier capable of measuring to the nearest 0.001 mm (0.00004 in.) and with circular-shaped, flat anvil faces that are parallel within 0.002 mm (0.00008 in.).

47.1.1 Non-contact optical measuring systems are available, allowing for greater precision and ease of measurement, and may be used as an optional method for diameter determination.

48. Procedure

48.1 Verify that the measuring instrument reads 0.000 mm when the anvils are closed. Determine the maximum and minimum diameter by measurements to the nearest 0.005 mm (0.0002 in.) in approximately the middle of one specimen from each laboratory sampling unit.

48.2 Test one specimen from each laboratory sampling unit.

48.3 Hold the specimen between the anvils of the micrometer. Close the anvils gradually and gently until contact is made with the specimen by both anvils. Read the diameter directly from the micrometer scale and record the value to the nearest 0.005 mm (0.0002 in.).

48.4 Open the anvils, rotate the specimen through a small angle, and take another reading at the same location along the specimen. Do this three or four times to obtain a maximum and a minimum reading.

49. Calculation

49.1 Calculate the diameter (gage) for each laboratory sampling unit as the average of the minimum and maximum values.

49.2 Calculate the out-of-roundness for each laboratory sampling unit as the difference between the maximum and minimum diameter for that specimen.

50. Report

50.1 State that the test specimens were tested as directed in these test methods (D 6320). Describe the material or product tested and report the following:

50.1.1 The laboratory sample diameter to the nearest 0.005 mm (0.0002 in.) as determined in 49.1,

50.1.2 The out-of-roundness for each laboratory sample as determined in 49.2, and

50.1.3 Date of test and operator.

51. Precision and Bias

51.1 *Precision*—0.30 mm HT (high tensile: 2750 MN/m^2 to 3050 MN/m^2) brass plated hose wire was tested. The single operator repeatability standard deviation for diameter has been determined to be 0.004 mm. The reproducibility of this test method is being determined and will be available before 2005.

51.2 *Bias*—The procedure in this test method has no bias, since this property can be defined only in terms of a test method.

52. Keywords

52.1 diameter; elongation; reverse bend; strength, breaking; strength, knot; torsion; wire, hose reinforcing; wrap