Document Name: ASTM D4268: Standard Test Method for Testing Fiber Ropes

CFR Section(s): 33 CFR 164.74(a)(3)(i)

Standards Body: American Society for Testing and Materials

ASTM Logo Removed

Designation: D 4268 – 93

Standard Test Methods for Testing Fiber Ropes[1]

This standard is issued under the fixed designation D 4268; 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 specify procedures to determine diameter and circumference (Section 8), linear density (Section 14), breaking force (Section 21), and elongation (Sections 28 and 36)) of fiber ropes except those ropes incorporating steel wire. (See MIL-STD-191)

1.2 The values stated in SI units are to be regarded as standard. The values provided in parentheses are provided for information purposes only.

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.* Additional precautions for these test methods are given in Section 5.

2. Referenced Documents

2.1 *ASTM Standards:*

D 76 Specification for Tensile Testing Machines for Textiles[2]

D 123 Terminology Relating to Textiles[2]

E 4 Practices for Force Verification of Test Machines[3]

E 74 Practice for Calibration of Force Measuring Instruments for Verifying the Load Indication of Testing Machines[3]

2.2 *Military Standard*[4]*:*

MIL-STD-191

3. Terminology

3.1 *Definitions:*

3.1.1 *braided rope, n*—a cylindrically produced rope made by intertwining, maypole fashion, several to many strands according to a definite pattern with adjacent strands normally containing yarns of the opposite twist.

3.1.2 *cycle length n—in braided rope*, the distance, parallel to the rope axis, of the strand to make one revolution around the rope.

3.1.2.1 *Discussion*—pick count is reported in picks per metre, picks per foot, picks per inch, etc.

3.1.3 *pick count n—in braided rope*, the number of strands rotating in one direction in one cycle length.

3.1.4 *elongation, n*—the ratio of the change in length of a rope during application of tension to the original length of the rope when new.

3.1.4.1 *non-elastic elongation (NE) n—of rope*, elongation after cyclic tensioning the rope to a specified force for a specified number of cycles.

3.1.4.2 *recoverable elongation (CE) n—of rope*, elongation which may be reclaimed following a period of rope relaxation after the rope was cyclic tensioned.

3.1.4.3 *residual elongation (RE) n—of rope*, elongation after cyclic tensioning the rope to a specified force for a specified number of cycles and allowing the rope to relax for a specified period of time.

3.1.4.4 *working elongation (WE) n—of rope*, elongation which is immediately recoverable when tension is removed from the rope.

3.1.4.5 *total elongation (TE) n—of rope*, the entire elongation at any given applied force.

3.1.5 *extension, n*—the ratio of the change in length of a rope during application of tension to the length of the rope immediately before application of that load.

3.1.6 *fiber rope, n*—a rope produced primarily from textile fibers.

3.1.7 *fid, n*—a wooden or hard plastic tapered tool used as an aid in rope splicing.

3.1.7 *hockle, n—in rope*, a strand kink in a rope causing yarn displacement in the strand resulting in rope deformation and damage.

3.1.8 *kink, n—in rope*, an abrupt bend or loop in the rope which is the result of an unbalanced twist relationship in the rope structure.

3.1.9 *plaited rope, n*—rope made from eight strands arranged in four pairs in which one strand is placed adjacent to the second in each pair and in which each strand in each pair has been twisted in one direction while each strand in each alternate pair has been twisted in the opposite direction and the four pairs of strands are intertwined maypole fashion in a manner such that each pair of strands passes over and under adjacent pair of strands (syn. eight strand rope)

3.1.10 *tuck, n—in rope*, a free strand of the rope placed between rope strands during rope splicing.

3.1.11 *reference tension, n*—a low tensile force, generally about 1 % of the rope breaking strength, calculated in accordance with 11.2, and used for initial rope tension determinations.

3.1.12 *rope, n*—a compact and flexible, generally torsionally balanced continuous structure, greater than 4 mm (5⁄32″) diameter capable of applying or transmitting tension between two points.

3.1.13 *strand, n—in fiber rope*, an ordered assemblage of

---

[1] These test methods are under the jurisdiction of ASTM Committee D-13 on Textiles and are the direct responsibility of Subcommittee D13.16 on Ropes and Cordage.

Current edition approved July 15, 1993. Published September 1993. Originally published as D 4268 – 83. Last previous edition D 4268 – 93.

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

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

[4] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

textile yarns used to make fiber rope.

3.1.14 *twisted or laid rope, n*—rope made from three or more strands which are twisted or laid together in a twist direction opposite to the twist in the strands.

3.1.15 For definitions of other textile terms used in these test methods, refer to Terminology D 123.

4. Significance and Use

4.1 Test Methods D 4268 for the determination of size, linear density, breaking force, and elongation may be used for acceptance testing of commercial shipments of fiber ropes, but caution is advised since information on between-laboratories precision is not complete.

4.1.1 In case of dispute arising from differences in reported results when using Test Methods D 4268 for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum the 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 should then be randomly assigned in equal numbers to each laboratory for testing. The average test results from the two laboratories should be compared using Student's T-Test for unpaired data with an acceptable probability level chosen by the two parties before the testing is begun. If a bias is estimated, either its cause must be found and corrected, or the purchaser and supplier may agree to interpret further results in relation to the observed differences between the average test results.

4.1.2 The final decision to use a specified method for acceptance testing of commercial shipments must be made by the purchaser and the supplier and will depend on considerations other than the precision of the method, including the cost of sampling and testing and the value of the lot of material being tested. For very large ropes, where the cost for testing such ropes may be prohibitive, an extrapolation method for determining the rope characteristics may be a viable alternative when such methods are agreed upon by the purchaser and the supplier.

5. Hazards

5.1 Rope testing for breaking force and elongation can be dangerous and even lethal. It is important that persons witnessing such rope testing, including the testing machine operator, be made aware of the dangers involved and the precautions necessary to avoid injury. The test machine containing the rope specimen should be remote from observers or should be enclosed with an anchored cover or net that will contain the rope after it breaks. Persons witnessing the tests and the machine operator must be either far enough away from the testing machine or be behind barriers that will protect them if the broken rope should snap back and whiplash out of the test machine.

5.2 One can not expect a fiber rope that breaks at a specific force as determined using this test procedure to break at that same force if the rope is subjected to a sudden force such as while arresting a falling mass or if the rope is distorted by a knot, a kink or other such distortion. A knot, kink or other such distortion of the rope structure may reduce the breaking force as much as 60 %.

6. Sampling

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

NOTE 1—An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between shipping units and between specimens from a single shipping unit so as to provide a sampling plan which, at the specified level of the property of interest, has a meaningful producer's risk, acceptable quality level and limiting quality level.

6.2 *Test Specimens*—Rope specimens for laboratory testing shall be taken from the lot sample units in lengths directed in the sections on procedure for individual properties.

6.2.1 To remove a specimen for testing from a spool or reel, insert a pipe or solid round bar through the center holes of the spool or reel and support the pipe or bar ends so that the spool or reel can rotate as the specimen is pulled off the spool or reel. Do not remove the rope specimen over the spool or reel flange as this will distort the rope construction by adding or removing twist from the rope. If the shipping unit is a coil, remove each rope specimen according to the manufacturer's instructions.

6.2.2 Using a crayon or other suitable marking device, mark a line parallel to the rope axis along the rope specimen surface. The mark can be placed on the rope surface while the rope is on the spool or reel or the marking can be done as the rope is removed from the spool or reel. If the rope is in a coil, the marking should be done as the rope is removed from the coil.

7. Conditioning

7.1 Unless specified, standard conditioning of the rope specimen is not required.

DIAMETER AND CIRCUMFERENCE

8. Scope

8.1 This test method determines the diameter and circumference of fiber rope.

9. Significance and Use

9.1 Rope specifications indicate nominal diameter or nominal circumference or both. The nominal diameter must be known to calculate the Reference Tension to apply to the rope for test purposes. The actual diameter should be determined when the end use of the rope requires that the rope be threaded through sized holes or other sized hardware.

10. Apparatus

10.1 *Tensioning Device*, for applying the reference tension. Use calibrated masses or a calibrated force mechanism.

10.2 *Measuring Material*, for circumference determination shall have zero or very low stretch while under slight tension, such as manila or sisal fibers or 2 mm ($^1/_{16}$ in.) wide strip of kraft paper or bonded paper.

10.3 *Measuring Devices.*

10.3.1 For circumference determination.

10.3.1.1 A narrow flexible tape having zero to very low stretch, calibrated in 1 m (1/32 in.) increments.

10.3.2 For diameter determination.

10.3.2.1 *A narrow flexible Pi tape*, having zero to very low stretch, calibrated to measure diameter directly when wrapped around a cylinder. The Pi tape should indicate diameter in millimetres (0.01 in.). This tape is called a Pi tape because of its scaling.

10.3.2.2 *Calipers*, calibrated to measure diameter directly in 1 m (0.01 in.) increments. The caliper pressing feet should cover the width of two strands.

11. Procedure

11.1 If the nominal diameter is known, use it to calculate the initial rope tension for determination of linear density and elongation. If the diameter is not known, measure it with calipers or diameter tape while the rope is under zero tension. If circumference is measured, divide the measurement by 3.14 (Pi). Use this result for the nominal diameter and calculate the initial rope tension.

11.2 Calculate the Reference Tensions using eqs 1 & 2:

$$\text{SI Units: Reference Tension} = N = 1.38\ D^2 \quad (1)$$

$$\text{Inch-Pound Units: Reference Tension} = P = 200\ d^2 \quad (2)$$

where:

N = reference tension in newtons,
P = reference tension in pounds,
D = diameter in millimetres, and
d = diameter in inches.

11.3 From the laboratory sample, prepare a test specimen at least 1800 mm (6 ft) long between grips, knots or ends of splices. (See 6.21.)

11.4 Place the rope in the tensioning device with the marked line on the rope (see 6.2.2) parallel with the rope axis.

11.5 Apply the reference tension (see 11.2) to the specimen.

11.6 While the rope is under this tension, measure the diameter or circumference directly using one of the measuring devices specified in 10.3.

11.7 Repeat the measurement as described in 11.3.4 at two more points along the specimen of rope with no two points closer than 300 mm (1 ft) from each other or from the grips, knots or ends of the splice. Average the three determinations.

11.7.1 If calipers are used, the caliper feet should span and contact at least two strand crowns and a moderate compression applied. Secure the caliper feet, remove the caliper and read and record the dimension obtained.

11.7.2 If the flexible tape is used, wrap it around the rope, apply a moderate tension, read the circumference directly and record the result.

11.7.3 If a low stretch measuring material is used, wrap it around the rope and apply a moderate tension, cut or mark the measuring material at a point of overlap, measure the resulting length of the material and record the result as the circumference.

11.7.4 If a direct diameter measuring tape is used, wrap it around the rope and apply a moderate tension. Read the diameter directly from the tape and record the result.

12. Report

12.1 State that the specimens were tested as directed in Test Method D 4268 for Measuring Diameter and Circumference. Identify the rope specimen, the type of measuring devices used and method of sampling used.

12.2 Report the following information:

12.2.1 The average diameter and/or circumference in millimetres or inches, as required by the purchase order or contract.

12.2.2 The purchase order or contract number.

12.2.3 When required the ambient temperature and relative humidity prevalent during the test.

13. Precision and Bias

13.1 *Precision*—The precision of the procedure in Test Methods D 4268 for determining diameter and circumference is being determined and it is anticipated that the interlaboratory testing and statistical analysis will be completed by 1994.

13.2 *Bias*—The value of the diameter or circumference of rope can only be defined in terms of a specified test method. Within this limitation, the procedure in Test Method D 4268 for determining rope diameter and circumference has no known bias.

LINEAR DENSITY

14. Scope

14.1 This test method determines the linear density of fiber rope.

15. Significance and Use

15.1 Fiber ropes are usually specified and evaluated on a linear density and strength basis.

16. Apparatus

16.1 *Tensioning Device*—See 10.1.

16.2 *Weighing Device*—Balance or scale to measure the specimen mass to an accuracy of 0.25 % of its total mass.

16.3 *Measuring Device*—A graduated tape which will measure the required length of rope specimen to the nearest 1 mm (1/32 in.).

17. Procedure

17.1 The test specimen shall be at least 1800 mm (6 ft) between the holding clamps or other means used to terminate the rope, with the rope line parallel to the rope axis (see 6.2.2). Then the specimen shall be tensioned to the Reference Tension of 11.2.

17.2 Measure a minimum of 1500 mm (5 ft) of undisturbed rope in the specimen and mark the length on the rope carefully while the specimen is under the Reference Tension.

17.3 Remove the tension from the rope specimen, wrap adhesive tape tightly around the rope adjacent to the marks to prevent the specimen from unravelling when cut, and then cut the test length at the marks and perpendicular to the rope axis. Remove the tapes used to secure the specimen.

17.4 Weigh the rope specimen on the weighing device.

18. Calculation

18.1 Calculate the linear density of the specimen to the nearest 1 % of its specification linear density in kg/100 m (lb/100 ft) using equation 3 or 4:

$$\text{SI Units: } A = K/M \times 100 \quad (3)$$

$$\text{Inch-Pound Units: } B = P/F \times 100 \quad (4)$$

where:
A = linear density in kilograms per 100 metres,
B = linear density in pounds per 100 feet,
K = mass in kilograms,
P = mass in pounds,
M = length in metres, and
F = length in feet.

19. Report

19.1 State that the specimens were tested as directed in ASTM Test Method D 4268 for Determination of Rope Linear Density. Describe the rope tested and the method of sampling used.

19.2 Report the following information:

19.2.1 The linear density in kilograms per 100 metres or pounds per 100 ft as required by the purchase order or contract.

19.2.2 The purchase order or contract number.

19.2.3 When required the ambient temperature and relative humidity prevalent during the test.

20. Precision and Bias

20.1 *Precision*—The precision of the procedure in Test Methods D 4268 for determining linear density of fiber rope is being determined and it is anticipated that the interlaboratory testing and statistical analysis will be completed by 1995.

20.2 *Bias*—The value of linear density of fiber rope can only be defined in terms of a specified test method. Within this limitation, the procedure in Test Method D 4268 for determining rope diameter and circumference has no known bias.

BREAKING FORCE

21. Scope

21.1 This test method determines the breaking force of a fiber rope.

22. Significance and Use

22.1 The breaking force of a rope is a major property to gage its serviceability. When comparing the breaking forces of two or more ropes having the same construction or different constructions, it is important to know their comparative linear densities; for although ropes may appear the same size in diameter or circumference, their linear densities may be different enough to affect their breaking force.

22.2 Published specifications of fiber rope properties usually cover new and unused ropes. Used ropes may be tested using these methods, but test results may be different than published specifications depending on how the rope was used and how long it was used. Most used ropes do suffer a strength loss due to damage from abrasion, cuts, misuse due to mishandling, improper storage or over tensioning. It can be expected that strength loss will occur depending on the severity of the rope use. The degree of rope deterioration may be significant enough to warrant replacing the rope. When in doubt, consult with the manufacturer.

23. Apparatus

23.1 *Tensile Testing Machine* meeting the following requirements:

23.1.1 The rate of travel of the pulling cross head during the breaking force test shall be such that, after precycling the rope as described in 25.4, the rope is loaded to 20 % of its estimated breaking force in not less than 20 sec nor more than 200 sec. The rate of travel of the pulling head may be adjusted during the precycling to achieve this rate.

23.1.2 The stroke and bed length of the testing machine shall be long enough to extend the rope specimen to rupture in one continuous pull without interruption. With prior agreement of the purchaser and supplier, the splice procedure and splice eye size may be modified, if this will allow the test machine to accommodate the prescribed length of rope between splices.

23.1.3 The holding and pulling ends of the testing machine shall have pins or posts whose diameters are no less than one and one half times the diameter of the rope being tested when using eye splice terminations.

23.1.4 The stroke of the testing machine (the total distance the cross head will move) must be long enough to extend the rope specimen to rupture in one continuous pull.

23.1.5 The testing machine shall be equipped with a force indicating device such as a dial, digital read-out, or digital recorder, so that the maximum force required to rupture the specimen will remain on the indicator.

23.1.6 The testing machine shall be calibrated at least once a year. The method of verification and pertinent data should be in accordance with Specification E 4 with force measuring instruments certified in accordance with Practice E 74 and is directly traceable to the National Institute of Standards and Technology.

23.2 *Fids*, of appropriate design and size to aid in eye splicing of the rope specimen.

24. Precautions

24.1 See 1.3, 5.1, and 5.2.

25. Procedure

25.1 The length of undisturbed rope between the splices or other terminations shall be a minimum of 1500 mm (5 ft) for ropes up to 125 mm (5 in.) circumference and a minimum of at least 12 times the rope circumference for larger ropes.

25.1.1 For splicable ropes, the test specimens shall be terminated with splices. For three-strand laid ropes, the minimum number of tucks for each splice shall of four full tucks, one ⅔ tuck and one ⅓ tuck. For eight-strand plaited ropes, the minimum number of tucks for each splice shall consist of two double and two single tucks. For braided ropes and any special rope constructions, consult with the rope manufacturer or the Cordage Institute for the necessary splicing instructions.

NOTE 4—Poor splicing can result in poor test results which do not reflect the actual breaking force of the rope. It is essential that the person or persons preparing the specimen for test be trained properly and be experienced in the art of splicing rope so that the splicing is done properly and with good workmanship.

25.1.2 The inside length of each eye splice, measured with the insides of the eyes in contact, shall be at least twice the pin diameter around which the eye will be placed on the test machine. The results of a rope break which occurs in the tucked portion of the rope specimen may be disregarded and another rope tested.

25.1.3 If agreed to in advance by the purchaser and supplier, blocks, clamps, grips, or any other suitable means may be used in the above procedure instead of eye splices and pins to hold the test specimen while subjecting the rope to the test break. If a dispute arises concerning the test results using blocks, grips or any other holding mechanism, make the test with eye spliced rope.

25.4 Cycle the rope ten times from the Reference Tension of 11.2 to 20 % of the estimated breaking force. During this precycling, the rate of travel of the testing machine moving cross head may be adjusted to achieve the required rate of travel prescribed in 23.1.1.

25.5 At the beginning of cycling, during the tenth cycle, after the tenth cycle, and after the 30 minute waiting period, carry out the measurements prescribed in Parts 36 through 40.

25.6 Increase the force in the rope from the reference force calculated in 11.2 until it breaks, at the rate of moving cross head travel prescribed in 23.1.1. Record the force at which the rope breaks and the maximum force applied to the rope, if higher than this breaking force.

25.7 Carry out the calculations called for in Section 41.

26. Report

26.1 State that the break test was made as directed in Test Methods D 4268. Describe the rope tested and the method of sampling used.

26.2 Report the following information:

26.2.1 The specific method used for holding the specimen in the testing machine, the type of straining mechanism used and the rate of travel of the cross head.

26.2.2 The purchase order or contract number.

26.2.3 The number of cycles, applied load, elongations and extension called for in Part 42.

26.2.4 The breaking force of the specimen in kilonewtons or pounds force.

26.2.5 The ambient temperature and per cent relative humidity prevalent during testing when required by 7.1.

27. Precision and Bias

27.1 *Precision*—The precision of the procedure in Test Methods D 4268 for determining breaking force is being determined and it is anticipated that the interlaboratory testing and statistical analysis will be completed by 1995.

27.2 *Bias*—The value of the breaking force of fiber rope can only be defined in terms of a specified test method. Within this limitation, the procedure in Test Method D 4268 for determining breaking force is a function of the rate of the force application, condition and size of the holding mechanisms, splicing quality and technique, and other factors.

ELONGATION OF NEW ROPE, INITIAL TENSION APPLICATION

28. Scope

28.1 This method determines the elongation of new fiber rope during the initial application of force.

29. Significance and Use

29.1 Some end uses of fiber rope require information concerning the increase in rope length when initial forces are applied and other end users require information on the potential energy absorption ability of the fiber rope when used the first time. Both requirements can be calculated from a force-extension curve which can be created from information that can be obtained using this test method.

30. Apparatus

30.1 *Tensile Test Machine*—see 23.1.

30.2 *Fids*—see 23.3.

30.3 *Measuring Scale*, accurate to at least 1.0 mm ($^{1}/_{32}$ in.).

30.4 *Marking Device*—a pen or soft lead pencil that can clearly mark the rope surface.

31. Precaution

31.1 See 1.3, 5.1 and 5.2.

32. Procedure

32.1 Prepare the rope specimen as directed in 25.1.

32.2 If the breaking strength of the rope is not known, for safety sake, a specimen should be tested for breaking force before the elongation measurement is made.

32.3 Place the rope specimen in the testing machine and apply the Reference Tension determined in 11.2.

32.4 While the specimen is under Reference Tension, measure and clearly make two marks around the circumference of the rope beyond the effect of the splices such that the length of rope between the marks is a minimum of 1500 mm (5 ft) for ropes up to 125 mm (5 in.) circumference and a minimum of at least 12 times the rope circumference for larger ropes. This is distance A.

32.5 Apply 75 % of the breaking strength of the rope and remeasure the distance between the marks on the specimen. This is distance B.

33. Calculations

33.1 Calculate the elongation to the nearest 0.1 % using eq 5:

$$\text{Elongation} = 100\,(B - A)/A \qquad (5)$$

where:

A = original distance measured at reference tension, and

B = distance measured at tension equal to 75 % breaking strength.

33.2 If the percentage elongation at the breaking strength or any other lesser applied force is required, measure distance at several applied force levels up to 75 % breaking strength. Plot a force extensive curve accordingly, and then extrapolate the curve to the rope's breaking strength.

NOTE 5—There are other ways of measuring the specimen's elongation during continuous tensioning of the rope and right up to rope rupture using mechanical or electronic devices, such methods are safer and are acceptable as long as all other requirements of this test method are met. When such other methods are used, they must be described fully and be acceptable to both purchaser and supplier.

34. Report

34.1 Identify the rope specimen, method of sampling used, lot number from which rope was sampled, and purchase or contract number.

34.2 Report the percent elongation at 75 % breaking strength to the nearest 0.1 %, and at other applied forces specified and agreed upon between the purchaser and seller. State that the specimen was tested as directed in ASTM Test Method D 4268 for determining elongation of new rope during its initial tension application.

35. Precision and Bias

35.1 *Precision*—The precision of the procedure in Test Methods D 4268 for determining percentage elongation of a new rope specimen during its initial exposure to tensioning is being established. It is anticipated that the interlaboratory testing and statistical analysis will be completed by 1994.

35.2 *Bias*—The value of elongation of new rope during its initial exposure to tension can only be defined in terms of a specified test method. Within this limitation, the procedure in Test Method D 4268 for determining this type of elongation has no known bias.

ELONGATION AND EXTENSION AFTER CYCLIC TENSIONING TO A SPECIFIED APPLIED FORCE

36. Scope

36.1 This test method determines elongation and extension after cycling fiber rope to any specific applied force.

37. Significance and Use

37.1 This test method provides elongation and extension information which can be used to predict the suitability and serviceability of a fiber rope in an operation requiring the fiber rope to support repeated applied forces on a continuous or intermittent basis.

38. Apparatus

38.1 *Tensile Test Machine*—described in 23.1, except that for the purposes of conducting long cyclic load testing the moving cross head rate of travel may be increased to a rate agreed to by the purchaser and shipper.

38.2 *Fids*—described in 23.2.

38.3 *Measuring Scale*—described in 30.3.

38.4 *Marking Device*—described in 30.4.

39. Precaution

39.1 See 1.3, 5.1 and 5.2.

40. Procedure

40.1 Prepare the specimen as directed in 25.1.

40.2 Place the specimen in the testing machine and apply the Reference Tension determined in 11.2.

40.3 While the specimen is under Reference Tension, make two marks around the circumference of the rope beyond the effect of splices such that the length of rope between the marks is a minimum of 1500 mm (5 ft) for ropes up to 125 mm (5 in.) circumference and a minimum of at least 12 times the rope circumference for larger ropes. This is distance *A*.

40.4 Cycle tension the specimen for the prescribed number of cycles to the prescribed applied force. When conducting this test in conjunction with Breaking Force Testing, that prescribed number of cycles is ten and that prescribed applied force is 20 % of the estimated breaking force. For other testing, the prescribed number of cycles and the applied force shall be as agreed upon by the purchaser and seller. Apply the prescribed number of tensioning cycles continuously.

40.5 Before the last of the prescribed number of cycles, with the rope at the Reference Tension, measure the distance between marks at the prescribed applied force. This is Distance *C*.

40.5 On the last of the prescribed number of cycles, measure the distance between marks at the prescribed applied force. This is Distance *D*.

40.6 When the last prescribed cycle has decreased to the Reference Force, again measure the distance between marks at this Reference Force. This is Distance *E*.

40.7 Immediately after distance E is determined, reduce tension to 0 and leave the rope in a relaxed state (0 tension condition) for 30 plus or minus min. After the relaxation time, reapply the Reference Force and remeasure the distance between the marks. This is distance *F*.

41. Calculation

41.1 Using Equation 6, calculate the non-elastic elongation to the nearest 0.1 %.

$$NE = 100\ (E - A)/A \tag{6}$$

where: NE = nonelastic elongation.

41.2 Using Equation 7, calculate the residual elongation to the nearest 0.1 %.

$$RE = 100 - (F - A)/A \tag{7}$$

where: RE = residual elongation.

41.3 Using equation 8 calculate the recoverable elongation to the nearest 0.1 %.

$$CE = NE - RE \tag{8}$$

where: CE = recoverable elongation.

41.4 Using Equation 9, calculate the total elongation to the nearest 0.1 %.

$$TE = 100\ (D - A)/A \tag{9}$$

where: TE = total elongation.

41.5 Using equation 10 calculate the working elongation to the nearest 0.1 %.

$$WE = TE - WE$$

where: WE = working elongation.

41.6 Using Equation 11 calculate the Extension to the nearest 0.1 %.

$$EX = 100\ (D - C)/C.$$

where: EX = extension.

42. Report

42.1 State that the tests for Elongations and Extension after cyclic tensioning were made as directed in Test Methods D 4268.

42.2 Describe the rope specimen tested and method of sampling used.

42.3 Report the number of cycles and the applied force.

42.4 Report the elongations and the extensions after cyclic tensioning of the rope specimen.

42.5 The purchase order or contract number.

42.5 When required the ambient temperature and relative humidity prevalent during the testing.

43. Precision and Bias

43.1 *Precision*—The precision of the procedure in Test Methods D 4268 for determining elongation and extension after cyclic tensioning of the rope specimen to any specified applied force is being established and it is anticipated that the interlaboratory testing and statistical analysis will be completed by 1994.

43.2 *Bias*—The values of the elongations and extension after cyclic tensioning of the rope specimen to any specified applied force can only be defined in terms of a specified test method. Within this limitation, the procedures in Test Methods D 4268 for determining elongation after cyclic tensioning of the rope specimen at a given applied force has no known bias.

44. Keywords

44.1 breaking force; cyclic tensioning; elongation; extension; fiber rope; linear density; rope