Designation: D 1423 – 99

Standard Test Method for Twist in Yarns by Direct-Counting[1]

This standard is issued under the fixed designation D 1423; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method covers the determination of the amount and direction of twist at the completion of any stage of twisting in single (spun or filament), plied, cabled, or novelty (exclusive of long-term repeat patterns) yarns. The procedures are designed primarily for yarns in packages, but, with special precautions, they are applicable to yarns taken from fabrics. The procedure for spun yarn in 9.2 is also applicable to rovings. For tire yarns/cords and industrial yarns/cords use conditions as specified in Methods D 885 and D 885M.

1.2 For plied yarns, this test method covers the determination of the twist of the plied yarns and the twist of the single yarn before plying. For cabled yarns, the test method covers the determination of the cable or hawser twist; the twist of the plied yarn after plying, but prior to the last twisting operation; and the twist of the single yarn before plying. Procedures are also included for the determination of the twists of the single and plied yarn components as they lie in the final structure.

1.3 This test method is not intended for yarns that extend more than 5.0 % when tension is increased from 2.5 to 7.5 mN/tex (0.25 to 0.75 gf/tex). Following the procedures of this test method for such yarns would be independent of the bias and precision determined for this test method. The report from such testing should include the tension used for this testing.

1.4 The values stated in either inch-pound or SI units are to be regarded separately as standard. Within the text, the SI units are shown in parentheses. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance within this test method.

NOTE 1—For a more rapid but less accurate method of determining twist in single spun yarns, refer to Test Method D 1422.

NOTE 2—This test method has been evaluated for use in determining twist in open end yarns and is not recommended.

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:*

D 123 Terminology Relating to Textiles[2]

D 1059 Test Method for Yarn Number Based on Short-Length Specimens[2]

D 1422 Test Method for Twist in Single Spun Yarns by the Untwist-Retwist Method[2]

D 1425 Test Method for Unevenness of Textile Strands Using Capacitance Testing Equipment[2]

D 1776 Practice for Conditioning Textiles for Testing[2]

D 1907 Test Method for Yarn Number by the Skein Method[2]

D 2258 Practice for Sampling Yarn for Testing[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *cable twist, n*—the construction of cabled yarn, cord, or rope in which each successive twist is in the opposite direction to the preceding twist, an S/Z/S or Z/S/Z construction.

3.1.2 *direction of twist, n*—the right or left direction of the helix formed in a twisted strand as indicated by superimposition of the capital letter "S" or "Z."

3.1.2.1 *Discussion*—Yarn has **S** twist if, when the yarn is held in a vertical position, the visible spirals or helices around its central axis conform in direction of slope to the central portion of the letter" S," and **Z** twist if the visible spirals or helices conform in direction of slope to the central portion of the letter "Z." When two or more yarns, either single or plied, are twisted together, the letters "S" and "Z" are used in a similar manner to indicate the direction of the last twist inserted.

3.1.3 *final twist, n*—the number of turns per unit length in a single yarn component of a plied yarn or the plied yarn component of a cabled yarn as the component lies in the more complex structure. (*Syn.* "as-is" twist)

3.1.4 *hawser twist, n*—the construction of cabled yarn, cord, or rope in which the single and first-ply twist are in the same direction and the second-ply twist is in the opposite direction, an S/S/Z or Z/Z/S construction.

[1] This test method is under the jurisdiction of ASTM Committee D-13 on Textiles, and is the direct responsibility of Subcommittee D13.58 on Yarn Test Methods, General.

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

3.1.5 *original twist*, *n*—the twist in a single or plied yarn component of a plied or cabled yarn as the component was before incorporation into the more complex structure.

3.1.6 *single yarn*, *n*—the simplest strand of textile material suitable for operations such as weaving, knitting, etc.

3.1.6.1 *Discussion*—A single yarn may be formed from fibers with more or less twist; from filaments with or without twist; from narrow strips of material such as paper, cellophane, or metal foil; or from monofilaments. A yarn which is either twistless or can be rendered twistless in a single untwisting operation. When twist is present, it is usually all in the same direction.

3.1.7 *spun yarn*, *n—in a staple system*, a continuous strand of fibers held together by some binding mechanism.

3.1.7.1 *Discussion*—The binding mechanism most commonly used in spun yarns is twist. Other mechanisms used are chemical additives, wrapping, entanglement, or some combination of these.

3.1.8 *twist*, *n—in textile strands*, the helical or spiral configuration induced by turning a strand about its longitudinal axis.

3.1.8.1 *Discussion*—Twist is usually expressed as the number of turns about the axis that are observed in a specified length, either turns per metre (tpm) or turns per inch (tpi).

3.1.9 *twist factor, TF*, *n*—the product obtained when the twist expressed in turns per centimetre is multiplied by the square root of the yarn number expressed in tex.

$$\text{Twist factor } (TF) = \text{tpcm} \times \sqrt{T} \quad (1)$$

where:

T = yarn number expressed in tex.

3.1.9.1 *Discussion*—Twist multiplier and twist factor are a measure of the "twist hardness" of yarn because they are approximately proportional to the tangent of the angle between fibers on the outer yarn surface and the axis of the yarn; the larger this angle, the harder the twist. Furthermore, this angle is a function of both the twist content (turns per unit length) and the number of fibers per yarn cross section (yarn number). Hence, twist content alone cannot provide a measure of the twist hardness of a yarn. Twist multiplier and twist factor are proportional to each other and differ only in the units used. The two are related by Eq 2 and Eq 3:

$$TF = k \times TM \quad (2)$$

$$k = 277.29/\sqrt{L} \quad (3)$$

where:

L = length in yards of the hank used to define the indirect yarn number of the type,

N = hanks/lb. In particular for cotton system,

k = 9.567 and Eq 2 becomes Eq 4:

$$TF = 9.567 \times TM \quad (4)$$

3.1.10 *twist multiplier, TM*, *n*—the quotient of the twist expressed in turns per inch and the square root of the yarn number in an indirect system.

$$\text{Twist multiplier } (TM) = \text{tpi}/\sqrt{N} \quad (5)$$

where:

N = yarn number in an indirect system, the cotton system unless otherwise specified.

3.1.11 *twist take-up*, *n*—the change in length of a yarn or other textile strand caused by twisting, expressed as a percent of the original untwisted length.

3.1.12 *yarn*, *n*—a generic term for a continuous strand of textile fibers, filaments, or material in a form suitable for knitting, weaving, or otherwise intertwining to form a textile fabric.

3.2 For definitions of other terms used in this test method, refer to Terminology D 123.

4. Summary of Test Method

4.1 A specified length of specimen is mounted in a twist device. One end is rotated until all the elements are free of twist. The number of turns is counted and the turns per unit length are calculated.

4.2 The amount of twist in the component elements of a plied or cabled yarn is determined by either of two options.

4.2.1 In the procedure for determining original twist, one end of the yarn is fixed while the other end is rotated until the structural components are parallel. Any one or all of these components may then be used as test specimens.

4.2.2 In the procedure for determining final twist in components, both ends of one component of the yarn are held fixed while all the other components are removed and discarded. The twist is then determined in the remaining component.

5. Significance and Use

5.1 Test Method D 1423 for testing for twist in yarns by the direct-counting method is considered satisfactory for acceptance testing of commercial shipments because current estimates of between-laboratory precision are acceptable and the method has been used extensively in the trade for acceptance testing.

5.1.1 If there are differences or practical significance between reported test results for two laboratories (or more), comparative tests should be performed to determine if there is a statistical bias between them, using competent statistical assistance. As a minimum, the test samples should be used that are as homogeneous as possible, that are drawn from the material from which the disparate test results are obtained, and that are assigned randomly in equal numbers to each laboratory for testing. Other materials with established test values may be used for this purpose. The test results from the two laboratories should be compared using a statistical test for unpaired data, at a probability level chosen prior to the testing series. If a bias is found, either its cause must be found and corrected, or future test results must be adjusted in consideration of the known bias.

5.2 The determination of twist in a straight section of a yarn is not the simple straightforward operation it appears to be, for the test results may be greatly influenced by variations in test procedures and techniques. In all manipulations, extreme care is necessary to prevent specimen rotation altering the twist level before testing begins.

5.3 The twist in a yarn before it is packaged may be different from that of the yarn after it has been withdrawn from the package because of changes in tension and the effect of the

method of withdrawal. If the yarn is withdrawn over-end, a slight increase or decrease in twist will take place, depending upon the direction of the twist in the yarn, the direction of winding on the package, and the length of the wrap on the package.

5.4 When a yarn is incorporated into or removed from a more complex structure, alterations may occur as a result of the plying, untwisting, or raveling operation. For example, when determining the twist in plied yarn by the procedure for determining original twist, as the plied yarn is untwisted, a comparable amount of twist is reinserted in, or removed from, the single-yarn components. As a consequence, the single yarns have approximately the original twist prior to the plying operation but not the twist they have when they are functioning as components of the plied yarn. The latter or final twist may be estimated by adding the ply twist to (or subtracting it from) the single-yarn twist depending on the directions of the ply and singles twist. For a more precise determination, the test procedure must be modified. There are thus two different procedures for preparing specimens of the component elements of a plied or cabled yarn for twist determination. The procedure for the original twist measures the twist in a component of a complex strand after the components have been untwisted. The procedure for final twist measures the twist in a component as it lies in the complex strand. Although the original twist procedure is most often used, selection of a particular procedure will depend on the type of information needed.

NOTE 3—The difference in twist between unwinding from the side and over-end is $1/\pi d$, where d is the diameter of the package.[3] Thus, for a 25-mm (1-in.) diameter package, the difference would be about 13 tpm or about ⅓ tpi.

5.5 When a yarn is taken from a more complex yarn structure or from a fabric, the resultant twist should be considered only an approximation of the original value because of alterations that may have occurred as a result of the effects of unwinding, handling, and mechanical strains met in processing.

5.6 The optimum amount of twist depends upon the use for which the yarn is intended. The amount of twist affects both the strength and elongation properties of the yarn with increased twist being associated with increased elongation. The relationship between twist and strength is more complex.

5.6.1 In filament yarns, some twist up to 280 tpm (7 tpi) or a suitable sizing is required to facilitate textile operations. A small increase in twist results in a slight increase in strength, but a further increase results in a loss in strength. However, higher twist in such yarns may be used to subdue luster or increase elongation, or to secure other special effects, as in crepe fabrics.

5.6.2 In conventional ring spun yarns a certain minimum amount of twist is necessary to bind or hold the individual fibers together to produce a useful yarn. A limited increase in twist will result in an increase in strength until the critical twist level for the particular yarn involved has been reached, but further increase in twist results in a loss in strength.

5.7 The same amount of twist in yarns of different sizes (diameter) will produce yarns with different degrees of compactness, twist character, and twist angles. The twist multiplier or twist factor is approximately proportional to the tangent of the angle that the surface fibers make with the axis of the yarn. Therefore, the greater the angle, the greater the twist multiplier. A constant twist multiplier indicates comparable compactness and degree of liveliness in yarns of different sizes and conversely a difference in twist multiplier indicates a difference in compactness in yarns of the same size. Yarns intended for different uses are frequently made with different twist multipliers, for example, warp yarns and filling yarns.

6. Apparatus

6.1 *Twist Tester*, consisting of a pair of clamps, one of which is rotatable in either direction and positively connected to a revolution counter. The tester may be hand- or power-driven. The position of one clamp (or both clamps) shall be adjustable to accommodate specimens of the lengths specified in 9.2 and 9.3 and to permit measuring the change in length during untwisting. Means shall be provided for applying the specified tensions to the specimen and for determining the specimen length with an accuracy of ±0.5 mm (0.02 in.). The movable but nonrotatable clamp shall be capable of being traversed with substantially no friction to permit determining the untwisted length of the specimen under the specified tension. The counting device shall be resettable to zero count and shall indicate the total number of turns to the nearest 0.1 turn.

6.2 *Dissecting Needle or Stylus*.

6.3 *Gage or Calipers*.

6.4 *Magnifying Glass with Stand*.

6.5 *Equipment for Reeling Laboratory Sample Skeins*, optional.

7. Sampling and Test Specimens

7.1 *Lot Sample*—Select one or more shipping units taken at random to represent an acceptance sampling lot and used as a source of laboratory samples.

7.2 *Laboratory Sampling Unit*—From each primary sampling unit, take a laboratory sample as specified in 7.2.1 and 7.2.2

7.2.1 For packaged yarns, take a minimum of five packages.

7.2.2 For rolls, take a full width of sufficient length that will provide the 25 yarn specimens described in 7.3 and 7.4.

7.3 *Test Specimens*:

7.3.1 *Spun Yarn Singles*—Take 25 specimens from each laboratory sampling unit of spun yarn singles.

7.3.2 *Filament Yarn Singles*—Take eight specimens from each laboratory sampling unit of filament yarn singles containing 100 tpm or 2.5 tpi or less, and five specimens per laboratory sampling unit of filament yarn singles containing more than 100 tpm or 2.5 tpi.

7.3.3 *Plied and Cabled Yarns*——Take five specimens per laboratory sampling unit of plied and cabled yarns for each component to be tested.

7.4 *Selection of Specimens*:

7.4.1 Take an approximate equal number of specimens from each package or unit of the laboratory sample. Take the specimens from each package in a random manner to minimize

[3] Woods, H. J., "The Kinematics of Twist, I, The Definition of Twist," *Journal of Textile Science*, Vol 4, 1931, pp 33–36.