Designation: D8054/D8054M − 22

Standard Test Methods for Tensile Testing of Para-Aramid Flat Yarns[1]

This standard is issued under the fixed designation D8054/D8054M; 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 the tensile testing of para-aramid flat yarns. The methods include testing procedure only and include no specifications or tolerances.

1.2 This standard includes the following test methods:

	Section
Linear Density	10
Force at Specified Elongation (FASE)	11
Modulus	11

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D76 Specification for Tensile Testing Machines for Textiles
D123 Terminology Relating to Textiles
D1776/D1776M Practice for Conditioning and Testing Textiles
D1907/D1907M Test Method for Linear Density of Yarn (Yarn Number) by the Skein Method
D2258 Practice for Sampling Yarn for Testing
D3800 Test Method for Density of High-Modulus Fibers
D4848 Terminology Related to Force, Deformation and Related Properties of Textiles
D6477 Terminology Relating to Tire Cord, Bead Wire, Hose Reinforcing Wire, and Fabrics
D6587 Test Method for Yarn Number Using Automatic Tester
D7269 Test Methods for Tensile Testing of Aramid Yarns
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

3. Terminology

3.1 The following terms are relevant to this standard: elongation, flat yarn, force at specified elongation (FASE), force-elongation curve, modulus.

3.2 For definitions of terms related to industrial fibers and metallic reinforcements, see Terminology D6477.

3.3 For definitions of terms related to force and deformation in textiles, refer to Terminology D4848.

3.4 For definitions of other terms related to textiles, refer to Terminology D123.

4. Summary of Test Methods

4.1 Using various test methods and protocols identified in the procedures, this standard determines the tensile strength, force at specified elonation (FASE), linear density and modulus of para-aramid flat yarns.

5. Significance and Use

5.1 For application areas such as optical fiber and cable reinforcements, aramid is usually used in a linear – not twisted – form. For designing constructions like this, it is essential to use data based on a specimen without twist applied.

5.1.1 The modulus and FASE of twisted yarns demonstrate reduced values when compared to p-aramid flat yarns.

5.1.2 Use Test Method D7269 for testing of twisted p-aramid yarns.

5.2 The levels of tensile properties obtained when testing aramid yarns are dependent on the age and history of the

[1] These test methods are under the jurisdiction of ASTM Committee D13 on Textiles and are the direct responsibility of Subcommittee D13.19 on Industrial Fibers and Metallic Reinforcements.

Current edition approved Nov. 1, 2022. Published November 2022. DOI: 10.1520/D8054_D8054M-22.

[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.

specimen and on the specific conditions used during the test. Among these conditions are rate of stretching, type of clamps, gauge length of specimen, temperature and humidity of the atmosphere, rate of airflow across the specimen, and temperature and moisture content of the specimen. Testing conditions accordingly are specified precisely to obtain reproducible test results on a specific sample.

5.3 FASE (Force At Specified Elongation) describes the absolute resistance of the p-aramid flat yarn to an imposed elongation.

5.4 Modulus is a measure of resistance of yarn or cord to extension as a force is applied. It is useful for estimating the response of a textile reinforced structure to the application of varying forces and rates of stretching. Although modulus may be determined at any specified force, initial modulus is the value most commonly used.

5.5 Shape, size, and internal construction of the end-product can have appreciable effect on product performance. It is not possible, therefore, to evaluate the performance of end product in terms of the reinforcing material alone.

5.6 If there are differences of 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, test samples should be used that are as homogeneous as possible, that are drawn from the material from which the disparate test results were obtained, and that are randomly assigned 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.

6. Apparatus

6.1 *Tensile Testing Machine*—A single-strand tensile testing machine of the constant rate of extension (CRE) type. The tensile testing equipment can be either manually operated or can be an automated device. The specifications and methods of calibration and verification of these machines shall conform to Specification . The tester shall be equipped with an electronic data acquisition and data evaluation system.

6.2 Bollard type clamps, in which the specimen is gripped between plane-faced jaws and then makes a partial turn (wrap angle) around a curved extension (or other type of snubbing device) of one jaw face before passing to the other similar clamp (see Appendix X1; Fig. X1.1). Clamps with a minimum wrap angle of 180° are required for yarns with a linear density up to 3500 decitex [3000 denier]. For linear densities above 3500 decitex [3000 denier], clamps with a minimum wrap angle of 270° are recommended to prevent slippage. See Note 1.

6.3 Clamps shall grip the test specimen without spurious slippage or damage to the test specimen which can result in jaw breaks. The clamps shall maintain constant gripping conditions during the test by means of pneumatic or hydraulic clamps. The surface of the jaws in contact with the specimen shall be of a material and configuration that minimizes slippage or specimen failure, or both, in the clamping zone.

6.4 *Gauge Length*—The gauge length shall be the total length of yarn measured between the clamping point A of the first clamp and the point B of the second clamp in the starting position (see Appendix X1; Fig. X1.1).

NOTE 1—The selected testing equipment (tester, clamp, gauge length) is known to have an influence on the properties measured. A method for eliminating the influences introduced by the selected testing equipment is given in Test Methods D7269, Appendix X1.

7. Sampling

7.1 *Yarn*—For acceptance testing, sample each lot as directed in Practice D2258. Take the number of specimens for testing specified for the specific property measurement to be made.

7.1.1 *Number of Samples and Specimens*—The recommended number of specimens is included in the appropriate sections of specific test methods covered in this standard. Where such is not specified, the number of specimens is as agreed upon between buyer and supplier. Take samples at random from each of a number of cones, tubes, bobbins, or spools within a lot to be as representative as possible within practical limitations. Make only one observation on an individual package for each physical property determination. Take the number of samples, therefore, that will be sufficient to cover the total number of specimens required for the determination of all physical properties of the yarn.

7.1.2 *Preparation of Samples*—Remove and discard a minimum of 25 m [27 yd] from the outside of the package before taking the sample or any specimens. Use care in handling the sample. Special care should be used to prevent over handling and disruption of the filament alignment in the yarn bundle. Discard any sample subjected to any change of twist, kinking, or making any bend with a diameter less than 10 times the yarn thickness (or diameter).

8. Conditioning

8.1 Without pre-drying, bring the bobbin with yarn to equilibrium in the atmosphere for testing as directed in Practice D1776/D1776M for aramid.

9. Sample Preparation

9.1 *Sample Preparation*—Take test specimens directly from the original package. Rewound and skein specimen will likely result in lower values. Remove the surface layer and discard.

9.2 *Specimen Preparation*—Mount the sample onto a frame using the "Rolling take off" method. Examples of suitable frames are shown in Fig. 1. Take off test specimen tangentially from the bobbin directly without touching any of the measured part of the yarn and without applying any twist.

9.3 Holding the yarn firmly at the free end and using the "rolling take off" method, remove about 1 m for the specimen. Do not use yarn within 50 mm of either end of the sample ball. Do not let test specimen sag or loop.

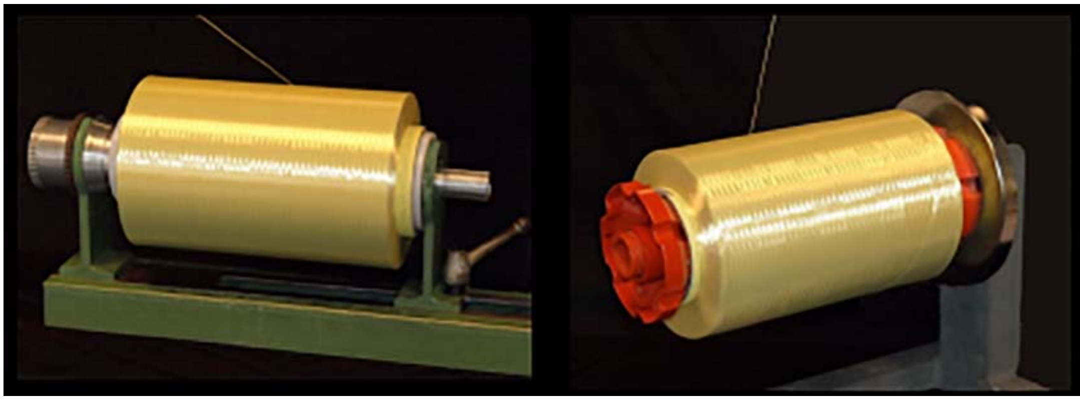

FIG. 1 Examples of Frames/Holders for "Rolling Take Off" Sampling

9.4 Clamp the specimen in the clamps ensuring that when clamped the tension does not exceed 20 mN/tex.

9.5 During testing, monitor the sample for slippage and splayed yarn due to excessive catenary.

9.6 If slippage is monitored, reject by deletion, clean clamps and repeat.

NOTE 2—Test specimen should be taken off freely with no great drag on the specimen which would increase tension, but still with enough tension applied by hand to remove and keep removed any catenary present. This is particularly important when the specimen is made up of more than one threadline as it requires more tension by hand to ensure that the catenary is all removed. As long as the mounted specimen does not give a reading greater than 20 mN/tex, the test will be valid.

10. Linear Density

10.1 This test method is used to determine the linear density of flat yarn for use in the calculation of tensile properties such as modulus.

10.1.1 Determine linear density as directed in Option 1 of Test Method D1907/D1907M or use an Automated Tester as directed in Test Method D6587. For both test methods, condition the yarn as specified in Section 8.

10.1.2 If scoured oven-dried linear density is needed, use Test Method D1907/D1907M, Option 5.

10.2 Report the average linear density of the sample and the method used.

11. Determination of the Modulus of FASE Values of Aramid Flat Yarn

This test method describes two options for the determination of the modulus and FASE values of aramid flat yarn:

Option 1: Measurement of the FASE and modulus of flat yarns (see 11.1).

Option 2: Compute the flat yarn FASE and modulus from twisted yarn test-results (see 11.2).

11.1 *Option 1: Tensile Testing of Flat Yarns:*

11.1.1 *General:*

11.1.1.1 The velocity of conditioned air flowing across a specimen while determining tensile properties can have a measurable effect on the breaking force and elongation at break because of the Gough-Joule effect. The magnitude of this effect depends on the type of fiber, air velocity, and sample history. Interlaboratory testing of nylon, polyester, and rayon cords indicates that air velocities of less than 250 mm/s [50 ft/min] across the specimen will not significantly bias the comparison of cord properties between laboratories.[3]

11.1.1.2 *Tensile Tester*—Select a load cell and the settings of the tensile tester such that the estimated breaking force of the specimen will fall in the range from 10 % to 90 % of the full-scale force effective at the time of the specimen break. This selection of the full scale force may be done manually by the operator before the start of the test or by electronic means or computer control during the test by automatically adjusting the amplification of the load cell amplifier.

11.1.1.3 *Gauge Length*—Adjust the distance between the clamps on the testing machine so that the nominal gauge length of the specimen, measured between the jaw faces of the clamps, is 500 mm ± 2 mm [20.00 in. ± 0.01 in.]. For bollard type clamps with a wrap angle of 270° or higher a gauge length of 635 mm ± 2 mm [25.0 in. ± 0.1 in.] is recommended. Make all tests on the conditioned yarns in the atmosphere for aramid yarn. Remove the specimen from the sample and handle it to prevent any change in configuration prior to closing the jaws of the clamps on the specimen. Avoid any damage to the yarn.

11.1.1.4 *Test Speed*—Use a crosshead travel rate of 250 mm/min ± 1 mm/min [10.00 in./min ± 0.05 in./min]. This is 50 % of the nominal gauge length of the specimen.

11.1.1.5 *Slack Start*—Thread one end of the specimen between the jaws of one of the clamps and close it. Place the other end of the specimen through the jaws of the second clamp and keep the specimen just slack (zero tension) and close the clamp, taking care that the thread is positioned in the centerline of the jaws of the clamp. Operate the testing machine at the rate as specified in 11.1.1.4 and stretch the specimen until it ruptures. If the clamps are of the air-actuated type, adjust the air pressure to prevent specimens slipping in the jaws, but keep the air pressure below the level that will cause specimens to break at the edge of the jaws. The gauge length is defined as the length at a pretension level of 20 mN/tex. The slack start procedure has the effect that the nominal gauge length of the specimen is not exactly 500 mm [20 in.] as specified in 11.1.1.3, but always will be slightly increased due to slack in the specimen after closing the clamps.

11.1.2 *Tenacity:*

[3] Jones, R. E., and Desson, M. J., "Adiabatic Effects on Tensile Testing," *Journal of the I.R.I.*, June 1967.

11.1.2.1 This test method is used to determine the tenacity of yarns after conditioning in the atmosphere for testing aramid at any force level. The calculation of tenacity is required to determine the modulus (11.1.4).

11.1.2.2 *Tenacity*—Tenacity is defined by dividing the load (force) by the linear density using Eq 1.

$$T_F = \frac{F}{LD} \quad (1)$$

where:

F = force, N [gf],
LD = linear density, tex [den], and
T_F = tenacity, N/tex [gf/den].

11.1.2.3 *Reporting*—This parameter is used for determining the modulus and is not reported.

11.1.3 *Elongation of Flat Yarns:*

11.1.3.1 This test method is used to determine the elongation of yarns after conditioning in the atmosphere for testing aramid at any forced level. The calculation of elongation from clamp displacement is required in order to determine Modulus and FASE.

11.1.3.2 *Pretension*—The pretension for aramid yarns corresponds with 20 mN/tex ± 1 mN/tex [0.20 gf/den ± 0.01 gf/den].

11.1.3.3 *Slack Start*—Calculate the specimen length (L_0) including the slack using Eq 2:

$$L_0 = L_S + DP \quad (2)$$

where:

L_0 = gauge length of the specimen, under specified pretension, measured from nip-to-nip of the holding clamlps, mm [in.],
L_s = length after clamping specimens (absolute distance nip-to-nip before movement of crosshead), mm [in.], and
DP = displacement of crosshead to reach the specified pretension of the specimen (see Fig. 2).

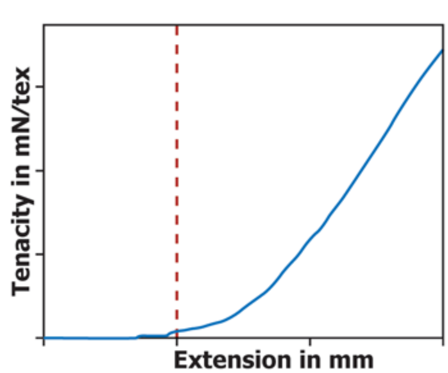

FIG. 2 Force-Extension Curve

11.1.3.4 *Elongation*—The general equation for elongation is given in Eq 3:

$$E_F = \frac{l_f}{L_0} \cdot 100\% \quad (3)$$

where:

E_F = elongation at force F, %,
l_F = extension of specimen at force F, mm [in.],
L_0 = length of the specimen, under specified pretension, measured from nip-to-nip of the holding clamps, mm [in.].

11.1.3.5 *Reporting*—This parameter is used for determining the modulus and FASE and is not reported.

11.1.4 *Modulus of Yarns:*

11.1.4.1 This test method is used to determine the modulus of yarns after conditioning in the atmosphere for testing aramid.

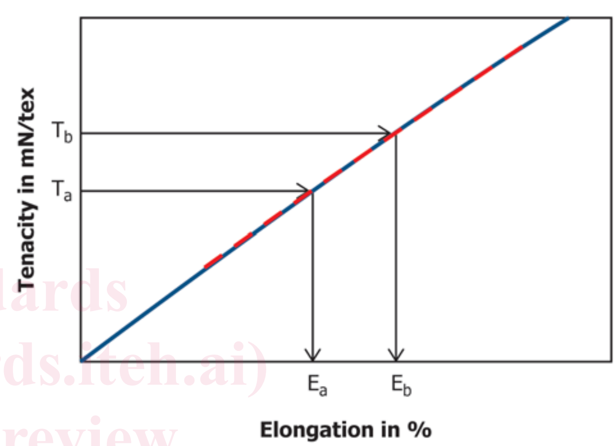

FIG. 3 Tenacity-Elongation Curve for the Determination of Modulus

where:

T_a = tenacity Lower Limit as specified in Table 1
T_b = tenacity Upper Limit as specified in Table 1
E_a = elongation point corresponding to Upper Limit Force in Table 1
E_b = elongation point corresponding to Upper Limit Force in Table 1

11.1.4.2 *Procedure: Modulus Yarns*—Determine the modulus of each conditioned specimen from the tenacity-elongation curve (see Fig. 3). Determine the modulus between the points as specified in Fig. 3 and Table 1. Locate the points E_{a1} and E_{b1} on the ordinate at the forces F_{a1} and F_{b1} equivalent to the lower and the upper tenacity limit in N/tex [gf/den] as given in Table 1. Draw from each of these two points respectively a line perpendicular to the ordinate to the intersection with the

TABLE 1 Lower and Upper Limit of the Modulus Intervals

Type of Fiber	Lower Limit, Ta		Upper Limit, Tb	
	N/tex	[gf/den]	N/tex	[gf/den]
aramid	0.30	[3.4]	0.40	[4.5]

force-elongation curve. From these intersection points determine the related elongation values by drawing perpendicular lines to the abscissa.

11.1.4.3 Calculate the modulus *CM* of a specimen using Eq 4:

$$CM = 100 \cdot \frac{T_b - T_a}{E_b - E_a} \quad (4)$$

where:

CM = modulus, N/tex [gf/den],
T_b = upper limit in N/tex [gf/den],
T_a = lower limit in N/tex [gf/den],
E_b = elongaton corresponding to T_b, %, and
E_a = elongation corresponding to T_a, %.

The modulus can also be reported per cross-sectional area:

$$CMA = CM \cdot \frac{Rho}{1000} \quad (5)$$

where:

CMA = modulus, GPa, and
Rho = density in kg/m^3.

The density is either:

(1) Determined according to Test Method D3800; Procedure A—Buoyancy (Archimedes) Method; test temperature as in Section 8.

(2) The value determined by the supplier (Test Method D3800; Procedure A—Buoyancy (Archimedes) Method; test temperature as in Section 8.).

(3) The nominal value of 1440 kg/m^3 for p-aramids.

The density must be reported.

11.1.4.4 Calculate the average and standard deviation of the modulus and specific modulus.

11.1.4.5 Report results as stated in Section 12.

11.1.4.6 *Precision and Bias*—See Section 13.

11.1.5 *Force at Specified Elongation (FASE) of Conditioned Yarns:*

11.1.5.1 This test method is used to determine the force at specified elongation (FASE) of yarns conditioning in the atmosphere for aramid.

11.1.5.2 *Procedure*—Determine the force at specified elongation (FASE) of each conditioned specimen from the force-elongation curve (see Fig. 4) or by electronic means or with an on-line computer at the specified value of elongation listed in Table 2.

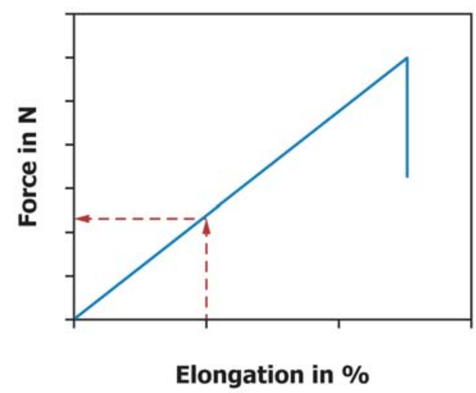

FIG. 4 Force-Elongation Curve

TABLE 2 Elongation Values for Determination of FASE

Type of Fiber	Elongation in %
aramid Flat Yarn	0.3
	0.5
	1.0

NOTE 3—The preferred term to use is FASE (Force at Specified Elongation), however the use of LASE (Load at Specified Elongation) is also permitted.

11.1.5.3 Calculate the average and standard deviation of the FASE values.

11.1.5.4 Report results as stated in Section 12.

11.1.5.5 *Precision and Bias*—See Section 13.

11.2 *Option 2: Computed Flat Yarn FASE and Modulus from Twisted Yarn Test-Results:*

11.2.1 *General:*

11.2.1.1 With the procedure for determination of properties for quality control and test reports (Test Methods D7269) it is required to twist the yarn prior to testing. Option 2 describes a method for computing the modulus and FASE from these data.

11.2.1.2 *Physical Background*—See Appendix X2 for the physical background of the procedure.

11.2.2 *Modulus:*

11.2.2.1 This test method is used to determine the modulus of yarns after conditioning in the atmosphere for testing aramid.

11.2.2.2 *Modulus*—The equation for calculating the modulus from twisted data is given by Eq 6:

$$M_S = \frac{1}{\frac{1}{M_{\text{twisted, standard}}} - c_M} \tag{6}$$

where:

$M_{\text{twisted, standard}}$ = modulus of the twisted yarn, GPa (See Test Methods D7269; conversion to GPa using Eq 5),

c_M = experimentally determined constant, GPa^{-1}. This constant has to be determined for every clamp type and yarn type (yarn + finish), and

M_S = modulus of the flat yarn, GPa.

11.2.2.3 *Constant*—The constant is experimentally determined by measuring the modulus of twisted and flat yarns from a representative selection of samples. This is done by:

(a) Per sample, measure the modulus of twisted material using Test Methods D7269.

(b) Per sample, measure the modulus using the method described in 11.1.

(c) Calculate the constant using Eq 7:

$$C_M = \frac{1}{M_{\text{twisted, standard}}} - \frac{1}{M_S} \tag{7}$$

(d) Calculate the average constant.

NOTE 4—The number of samples to be selected: the validation procedure will be discussed and defined with ASTM-ILS.

11.2.3 *FASE:*

11.2.3.1 *Scope*—This test method is used to determine the FASE of yarns after conditioning in the atmosphere for testing aramid.

11.2.3.2 *FASE*—The equation for calculating the FASE of flat yarn from twisted data is given in Eq 8:

$$FASE_S = \frac{1}{\frac{1}{FASE_{\text{twisted, standard}}} - \frac{c_F}{LD}} \tag{8}$$

where:

$FASE_{\text{twisted, standard}}$ = FASE of the twisted yarn, *N* (see Test Methods D7269),

c_F = experimentally determined constant, tex/N. This constant has to be determined for every yarn type (yarn + finish) and FASE level,

$FASE_S$ = FASE of the flat yarn, *N*, and

LD = linear density, tex.

11.2.3.3 *Constant*—The constant is experimentally determined by measuring the FASE of twisted and flat yarns from a representative selection of samples. This is done by:

(a) Per sample, measure the FASE of twisted material using Test Methods D7269.

(b) Per sample, measure the FASE of flat yarn using the method described in 11.1.

(c) Calculate per FASE level the constant using Eq 9:

$$C_F = \frac{LD}{FASE_{\text{twisted, standard}}} - \frac{LD}{FASE_S} \tag{9}$$

(d) Calculate the average constant.

NOTE 5—The number of samples to be selected: the validation procedure will be discussed and defined with ASTM-ILS.

NOTE 6—The preferred term to use is FASE (Force at Specified Elongation), however the use of LASE (Load at Specified Elongation) is also permitted.

12. Reports, General

12.1 State that all specimens were tensile tested as directed in Test Method D8054, Section 11. Describe the material or product sampled and the methods of sampling used.

12.2 Report the following information:

12.2.1 Test procedure used (pretension or slack start, gauge length and wrap angle),

12.2.2 Laboratory conditions,

12.2.3 Type of clamp used,

12.2.4 Number of specimens tested per sample, and

12.2.5 The value of each property measured or calculated.

13. Precision and Bias of Certain Yarn Tests

13.1 *Precision and Bias*—The precision of this test method is based on an intralaboratory study of ASTM WK45529 – New Test Methods for Determination of Modulus and Force at Specified Elongation of Flat Aramid Yarns, conducted in 2015. A single laboratory participated in this study, testing two different types of yarns. Every "test result" represents an individual determination. The laboratory was asked to report ten replicate test results for each yarn type. Except for the use of only one laboratory, Practice E691 was followed for the design and analysis of the data; the details are given in an ASTM Research Report.[4]

13.1.1 *Repeatability (r)*—The difference between repetitive results obtained by the same operator in a given laboratory applying the same test method with the same apparatus under constant operating conditions on identical test material within short intervals of time would in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D13-1143. Contact ASTM Customer Service at service@astm.org.

13.1.1.1 Repeatability can be interpreted as maximum difference between two results, obtained under repeatability conditions, that is accepted as plausible due to random causes under normal and correct operation of the test method.

13.1.1.2 Repeatability limits are listed in Tables 3 and 4.

TABLE 3 A-3140 dtex

	Average $\bar{x}$	Repeatability Standard Deviation S_r	Repeatability Limit r
CM (N per tex)	85.65	0.30	0.85
FASE 0.3 (N)	75.39	0.80	2.25
FASE 0.5 (N)	129.22	0.92	2.59
FASE 1.0 (N)	260.11	1.23	3.47
FASE 2.0 (N)	–	–	–

TABLE 4 B-1610 dtex (N)

	Average $\bar{x}$	Repeatability Standard Deviation S_r	Repeatability Limit r
CM (N per tex)	86.59	0.20	0.57
FASE 0.3 (N)	41.79	0.32	0.90
FASE 0.5 (N)	69.66	0.33	0.92
FASE 1.0 (N)	138.13	0.36	0.99
FASE 2.0 (N)	281.31	0.62	1.74

13.1.2 *Reproducibility (R)*—The difference between two single and independent results obtained by different operators applying the same test method in different laboratories using different apparatus on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

13.1.2.1 Reproducibility can be interpreted as maximum difference between two results, obtained under reproducibility conditions, that is accepted as plausible due to random causes under normal and correct operation of the test method.

13.1.2.2 Reproducibility limits cannot be calculated from a single laboratory's results.

13.1.3 The above terms (repeatability limit and reproducibility limit) are used as specified in Practice E177.

13.1.4 Any judgment in accordance with 10.1.1 would normally have an approximate 95 % probability of being correct, however the precision statistics obtained in this ILS must not be treated as exact mathematical quantities which are applicable to all circumstances and uses. The limited number of laboratories reporting replicate results essentially guarantees that there will be times when differences greater than predicted by the ILS results will arise, sometimes with considerably greater or smaller frequency than the 95 % probability limit would imply. Consider the repeatability limit as a general guide, and the associated probability of 95 % as only a rough indicator of what can be expected.

13.2 *Bias*—At the time of this study, there was no accepted reference material suitable for determining the bias for this test method, therefore no statement on bias is being made.

13.3 The precision statement was determined through statistical examination of 90 test results, from a single laboratory.

14. Keywords

14.1 aramid; flat yarn; linear density; tensile properties/tests

APPENDIXES

(Nonmandatory Information)

X1. SUGGESTED GUIDELINE FOR CLAMPING IN TENSILE TESTING

X1.1 Clamp suitability in mechanical testing is a balance of sufficient grip to limit test variation yet no impose damage to the fiber. A determinant of slip in the clamps is the variation observed during testing. This guideline is intended to minimize yarn slippage in the clamps during tensile testing. An indicator of slip in the clamps is the ultimate elongation of the fiber. If variation or significantly higher value is observed in the ultimate elongation, slippage is most likely occurring in the clamps. Pneumatic yarn bollard shaped grips stainless steel faces have been evaluated and found to grip the yarn without noticeable slippage. both a linear and non-linear yarn lay-up are allowed (see Fig. X1.1).