Designation: D7737/D7737M – 15

Standard Test Method for Individual Geogrid Junction Strength[1]

This standard is issued under the fixed designation D7737/D7737M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method is an index test which provides a procedure for determining the strength of an individual geogrid junction, also called a node. The test is configured such that a single rib is pulled from its junction with a rib(s) transverse to the test direction to obtain the maximum force, or strength of the junction. The procedure allows for the use of two different clamps with the appropriate clamp selected to minimize the influence of the clamping mechanism on the specific type of geogrid to be tested.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D4354 Practice for Sampling of Geosynthetics and Rolled Erosion Control Products(RECPs) for Testing

D4439 Terminology for Geosynthetics

D5262 Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics

3. Terminology

3.1 *Definitions:* Definitions of other terms applying to this test method appear in Terminology D4439.

3.1.1 *atmosphere for testing geosynthetics, n*—air maintained at a relative humidity of 50 to 70 % and a temperature of 21 ± 2°C [70 ± 4°F].

3.1.2 *breaking force, (F), n*—the force at failure.

3.1.3 *geogrid, n*—a geosynthetic formed by a regular network of integrally connected elements with apertures greater than 6.35 mm [0.25 in.] to allow interlocking with surrounding soil, rock, earth, and other surrounding materials to primarily function as reinforcement. **D5262**

3.1.4 *index test, n*—a test procedure which may contain known bias, but which may be used to establish an order for a set of specimens with respect to the property of interest.

3.1.5 *integral, adj*—in geosynthetics, forming a necessary part of the whole; a constituent.

3.1.6 *junction, n*—the point where geogrid ribs are interconnected to provide structure and dimensional stability.

3.1.7 *rib, n*—for geogrids, the continuous elements of a geogrid which are either in the machine or cross-machine direction as manufactured.

3.1.8 *rupture, n*—for geogrids, the breaking or tearing apart of ribs.

4. Summary of Test Method

4.1 This standard proposes a test method for performing tension tests on geogrid junctions. The procedure provides two clamping techniques for the junction to be tested including: Method A in which the clamps firmly grip the ribs transverse to the test direction on each side of the junction; and, Method B in which the ribs transverse to the test direction are constrained in a slot, constraining rotation of the junction, while the rib in the test direction passes through the slot without the junction clamp applying confinement to the junction. The junction clamping technique is selected for the specific type of geogrid in order to minimize rotation and corresponding peal of the junction during the test. The rib in the test direction going through the junction is then clamped at a distance from the junction and the system tensioned until junction (or rib) failure occurs. This forces a tension or shear force to occur within the junction in the direction of the applied load. The junction has no normal pressure on it, that is, it is horizontally unconfined.

[1] This test method is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.01 on Mechanical Properties.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

5. Significance and Use

5.1 This index test method is to be used to determine the strength of an individual junction in a geogrid product. The test is performed in isolation, while in service the junction is typically confined. Thus the results from this test method are not anticipated to be related to design performance.

5.2 The value of junction strength can be used for manufacturing quality control, development of new products, or a general understanding of the in-isolation behavior of a particular geogrid's junction (for example, in relation to handling during shipment and placement of the geogrid).

5.3 This test method is applicable to geogrid products with essentially symmetrical orthogonal or non-orthogonal ribs, yarns or straps, that is, geogrids which are composed of ribs, yarns or straps that are entangled through weaving or knitting, welded, bonded or formed through drawing.

6. Apparatus

6.1 The test apparatus for this method consists of three parts; the tensile testing machine, the junction clamp and the rib clamp.

6.2 *Tensile Testing Machine*—The testing machine should operate under a constant rate of extension. It should have the capabilities of measuring the tensile force, typically with a load cell having an adequate load capacity to cover the full range of products to be tested. The test recorder must be able to adequately record the complete force-elongation curve during the test.

6.3 *Method A: Junction Clamp (Rotation is Unconstrained)*—The clamp assembly which holds the geogrid junction shall be of the same design or equivalent to that shown in Fig. 1. The clamp must only confine the horizontal or adjacent rib(s) transverse to the junction on each side of the

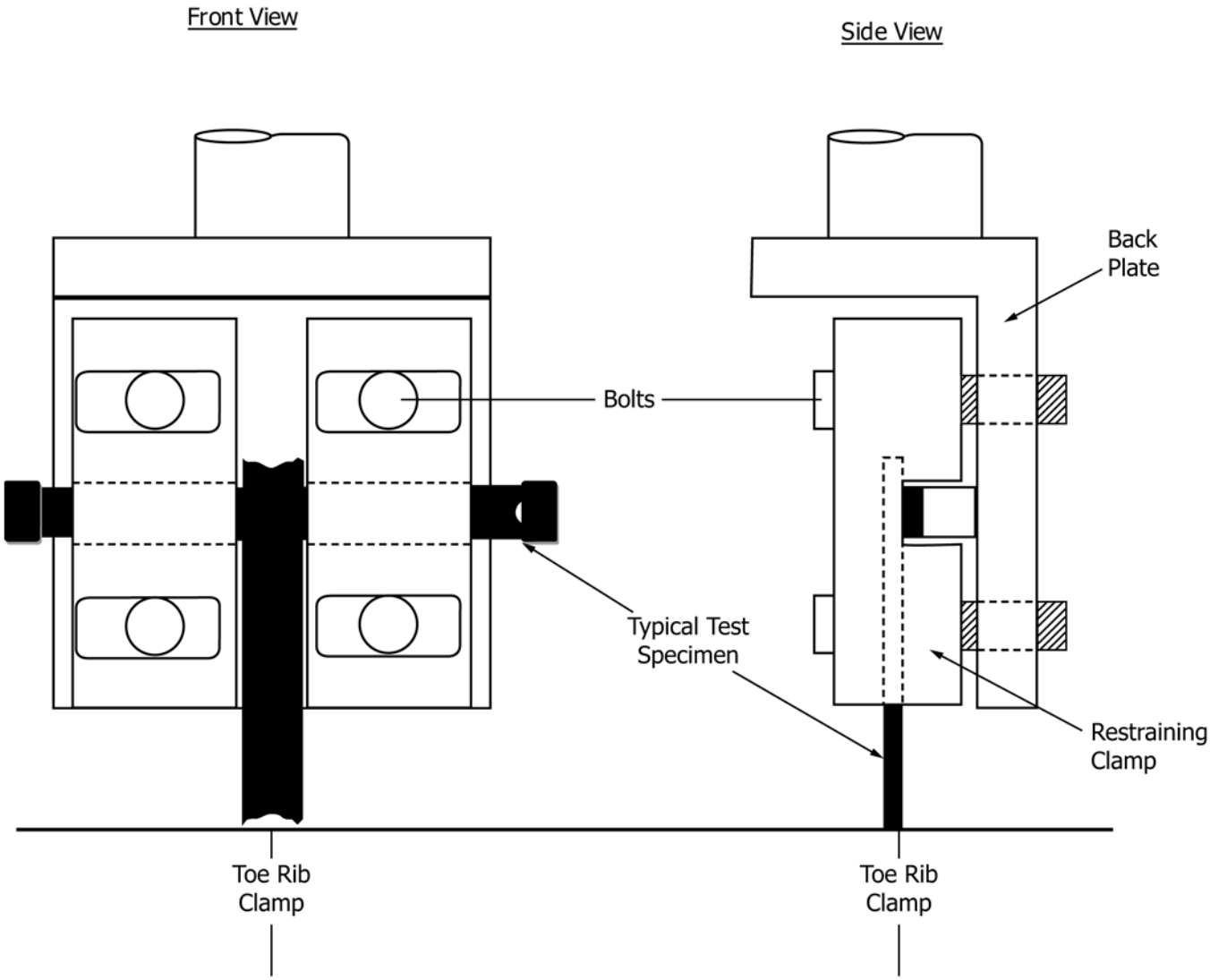

FIG. 1 Typical Junction Strength Test Specimen Test Setup [Rotation is not Constrained per 6.3]

junction and not the junction itself. The ribs transverse to the test direction should be placed horizontally level such that torsion is not applied to the junction. The clamp cannot hinder or influence the junction. The two movable parts of the restraining clamp should be adjustable to allow the bearing surfaces to fit snugly without touching the junction of the geogrid product being tested. The clamp assembly should provide the appropriate clamping power to prevent slipping or crushing (damage) of the horizontal rib. The entire clamp assembly is to be placed in the upper portion of the testing machine.

NOTE 1—These clamps are particularly well suited for homogeneous extruded and woven geogrids with either essentially symmetrical orthogonal or non-orthogonal ribs and longitudinal ribs concentric with transverse ribs.

6.4 *Method B: Junction Clamp (Rotation is Constrained)*—The clamps according to Fig. 2 must only confine the horizontal or adjacent rib(s) transverse to the test direction on each side of the junction and not the junction itself. The clamps should continuously support the transverse rib to the test direction such that torsion is not applied. The clamp cannot hinder or influence the junction. The insert clamp shall fit snugly into the opening of the restraining clamp. Fig. 2a is for geogrids with two straps welded together in one junction, Fig. 2b is for geogrids with two horizontal straps welded to one vertical strap. The screws in Fig. 2a and Fig. 2b are not needed if the insert clamp fits snugly into the opening of the restraining clamp. The entire clamp assembly is to be placed in the upper portion of the testing machine. The dimensions of the insert clamp as stated in Fig. 2a and Fig. 2b should be as follows:

a - average width of vertical strap [mm] (readability 0.1 mm) + 0.6 mm

b - 5 to 10 mm

c - average thickness of junction [mm] (readability 0.1 mm) + 0.2 mm

d - average thickness of vertical strap [mm] (readability 0.1 mm) + 0.2 mm

The assembled configuration of these clamps is shown in Fig. 3.

NOTE 2—These clamps are particularly well suited for welded or strap geogrids with longitudinal ribs not concentric with transverse ribs. They are also better suited than the unconstrained clamps for various woven and knit geogrids with transverse elements (that is, ribs or nodes) that tend to rotate when tension is applied.

6.5 *Rib Clamp*—The lower portion of the vertical rib passing through the clamp assembly is placed in a separate clamp at the base of the testing machine. This is typically the longitudinal rib of the geogrid test specimen. The clamp must be sufficiently wide to grip the entire rib and must have the appropriate clamping power to prevent slipping or crushing (damage). The suggested style of clamp is a wedge action type as used for a rib tensile strength test.

NOTE 3—It is also possible to reverse the positioning of the test assembly from that described in 6.3 and 6.4. In such a case, the junction clamp would be in the base of the testing machine and the rib clamp in the crosshead adjacent to the load cell.

7. Test Specimens

7.1 The test specimen shape is unique to the particular geogrid being tested. It generally involves specimens to be cut in the shape of a "T" with at least one junction remaining on each side of the junction being tested. The direction of the test shall be defined as a nominal angle (skew to the machine direction), according to Fig. 4, where machine direction (MD) is defined as 0° and cross machine direction (CMD) as 90°. See Fig. 5 for illustrations of some geogrid test specimens. For woven and knitted geogrids where nodes may unravel when cut, adjacent ribs can be cut away from the node as shown in Fig. 5d to minimize the effect of cutting on the structure of the product. Fig. 5e shows the testing arrangement for symmetrical, non-orthogonal ribs. The specimens should be cut to allow for the maximum amount of transverse rib on each side of the junction to be tested. The center rib shall be long enough (typically a minimum of three bars or nodes), so as to allow for enough clamping action within the rib clamp. The test specimens should be brought to standard test conditions of temperatures 21° ± 2°C [70° ± 4°F] and tested under the same conditions. Relative humidity is not an issue for this test method.

7.2 *Number of Test Specimens:*

7.2.1 *Reliable Estimate of v*—When there is a reliable estimate of v based upon extensive past records for similar materials tested in the user's laboratory as directed in the method, calculate the required number of specimens using Eq 1, as follows:

$$n = (tv/A)^2 \quad (1)$$

where:

n = number of test specimens (rounded upward to a whole number),

v = reliable estimate of the coefficient of variation of individual observations on similar materials in the user's laboratory under conditions of single-operator precision, %

t = the value of Student's t for one-sided limits, a 95 % probability level, and the degrees of freedom associated with the estimate of v, and;

A = 5.0 % of the average, the value of allowable variation.

7.2.2 *No Reliable Estimate of v*—When there is no reliable estimate of v for the user's laboratory, Eq 1 should not be used directly. Instead, there should be ten (10) replicate specimens tested in the direction of concern. This number of specimens is somewhat larger than usually found using a reliable estimate of v. When a reliable estimate of v for the user's laboratory becomes available, Eq 1 will usually require fewer than the fixed number of specimens.

8. Procedure

8.1 Calibrate and balance the testing system.

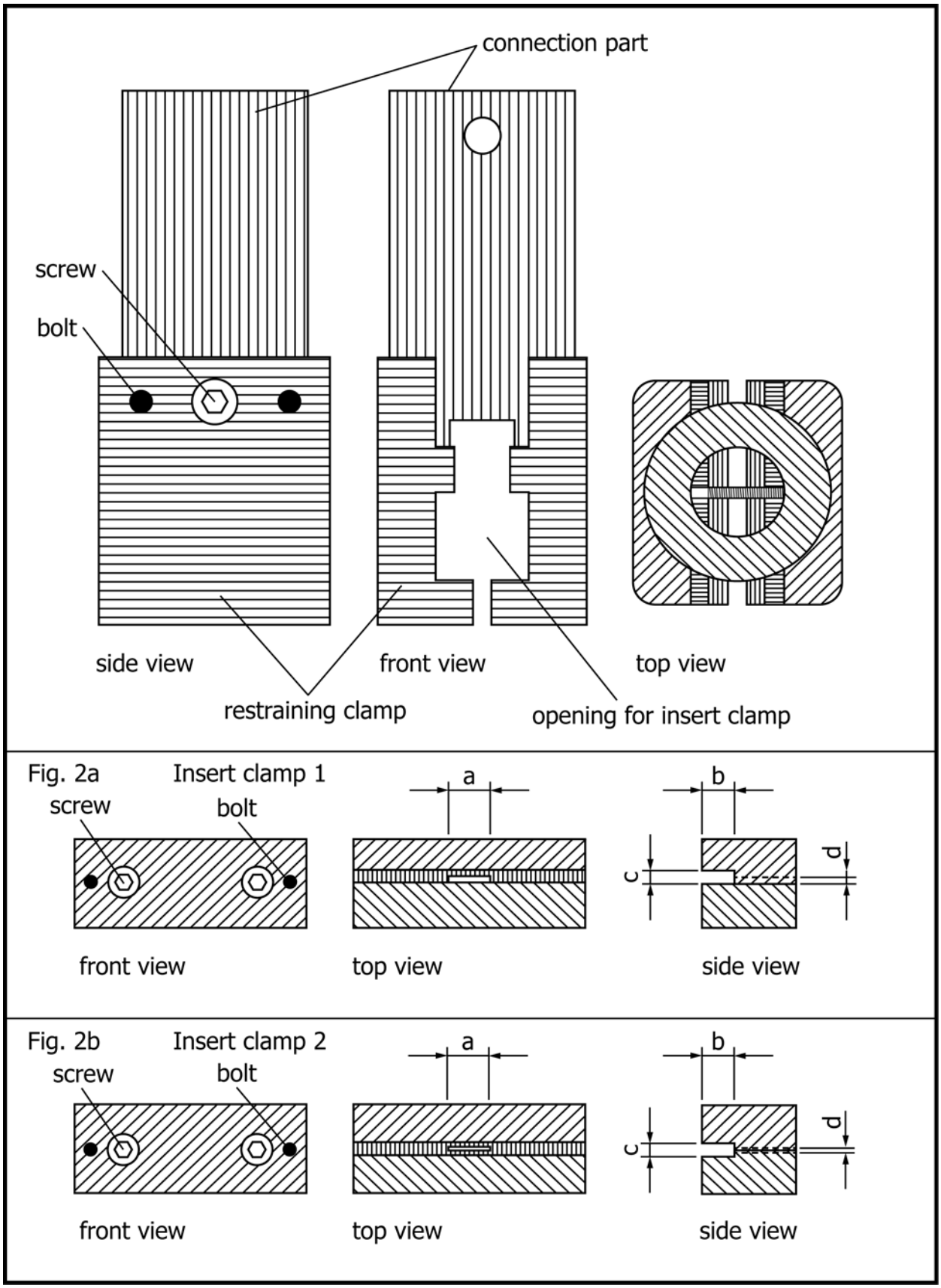

FIG. 2 Alternative Clamp for Constraining Rotation of the Geogrid Junction per 6.4

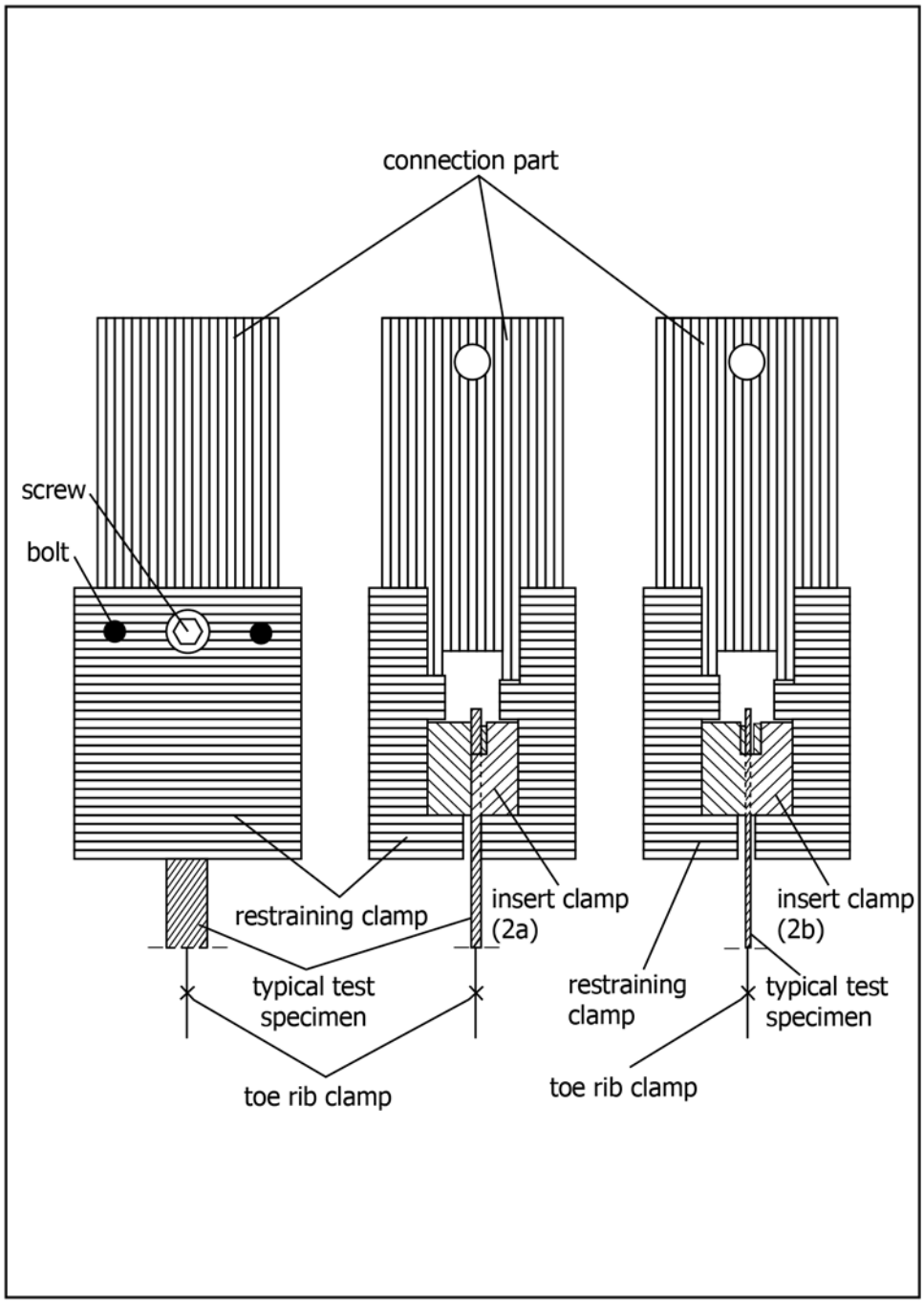

FIG. 3 Entire Assembly for Constrained Rotation of the Geogrid Junction per 6.4

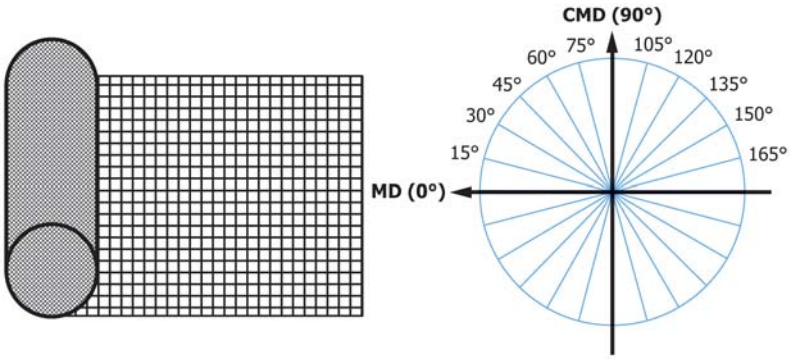

FIG. 4 Specimen Orientation and Test Direction

8.2 Install testing clamps; the junction clamp is typically the upper fixture and the rib clamp is then the lower fixture.

8.3 Adjust the movable parts of the junction clamp to fit as closely to the vertical center rib as possible, without touching it or influencing it (that is, within 1 mm of the edge of the junction).

8.4 Mount the specimen carefully in the upper clamps, tighten it with sufficient force to prevent slipping or damage of the specimen and see that its alignment is proper to mate with the lower rib clamp.

8.5 Mount the rib in the lower clamp so that bending or torsion is avoided and the rib is positioned so as to be uniaxially tensioned with respect to the upper assembly.

NOTE 4—If Note 3 is followed, 8.4 and 8.5 would be reversed.

8.6 Set the constant rate of extension of the test machine to be 50 mm/min [2 in./min].

8.7 Rebalance the test system and initiate the test by starting the testing machine and continue until rupture occurs. Record and report the maximum force obtained to cause failure.

8.8 Repeat the above procedure for ten (10) representative test specimens. Calculate the average junction strength per rib as described in the following section.

9. Calculations

9.1 From the resulting test data, the average junction strength per rib "J_{avg}" is calculated;

$$J_{ave} = \sum_{i=1}^{n} J_i/n \quad (2)$$

where:

J_{ave} = average junction strength per rib in kN [lb]
J_i = test strength for each junction evaluated in kN [lb]
n = number of specimens tested

9.2 Using J_{avg}, the average junction strength per unit width "Xj_{avg}" expressed in N/m [lbf/in.] is calculated;

$$Xj_{ave} = J_{avg}N_t \quad (3)$$

where:

Xj_{ave} = average junction strength per unit width in N/m [lbf/in.]
N_t = number of tensile elements in the testing direction per unit width, equal to N_c divided by b in the direction transverse to the rib being tested (see Note 5).

NOTE 5—N_t is determined by taking the average of three measurements from samples that are 95 % of the manufactured product roll width and same equivalent length. The b value is determined by measuring the distance from the central point of the starting aperture (center line to center line aperture dimension divided by 2) to the center point of the aperture a distance equal to 95 % of the manufactured product roll width away from the starting aperture. As such, this measurement will result in a fractional value. The number of tensile elements, N_c, within this distance, b, are counted and N_t is determined by dividing the N_c value by the b value. For multiple layer geogrids, "b" should be measured using the single layer. The number of tensile elements, N_c, within this distance, "b", are counted and multiplied by the number of layers found in the test specimen

NOTE 6—When testing a geogrid with ribs oriented in more than one direction, the nominal rib direction of the junction test specimens used to calculate Xj_{ave} should be clearly noted in terms of the nominal angle per Fig. 4 (with MD as defined by manufacturer).

10. Report

10.1 Report the following information:

10.1.1 Identification and description of geogrid sample(s),

10.1.2 The direction of testing should be clearly noted in terms of the nominal angle per Fig. 4 (with MD as defined by manufacturer),

10.1.3 Any deviation of the specified test procedure,

10.1.4 The type of junction clamp (that is, Method A or Method B),

10.1.5 The number of tests performed, and

10.1.6 The average and standard deviation for the junction strength per width of geogrid (Xj_{ave}), recorded during the testing program for each type of geogrid and direction of concern.

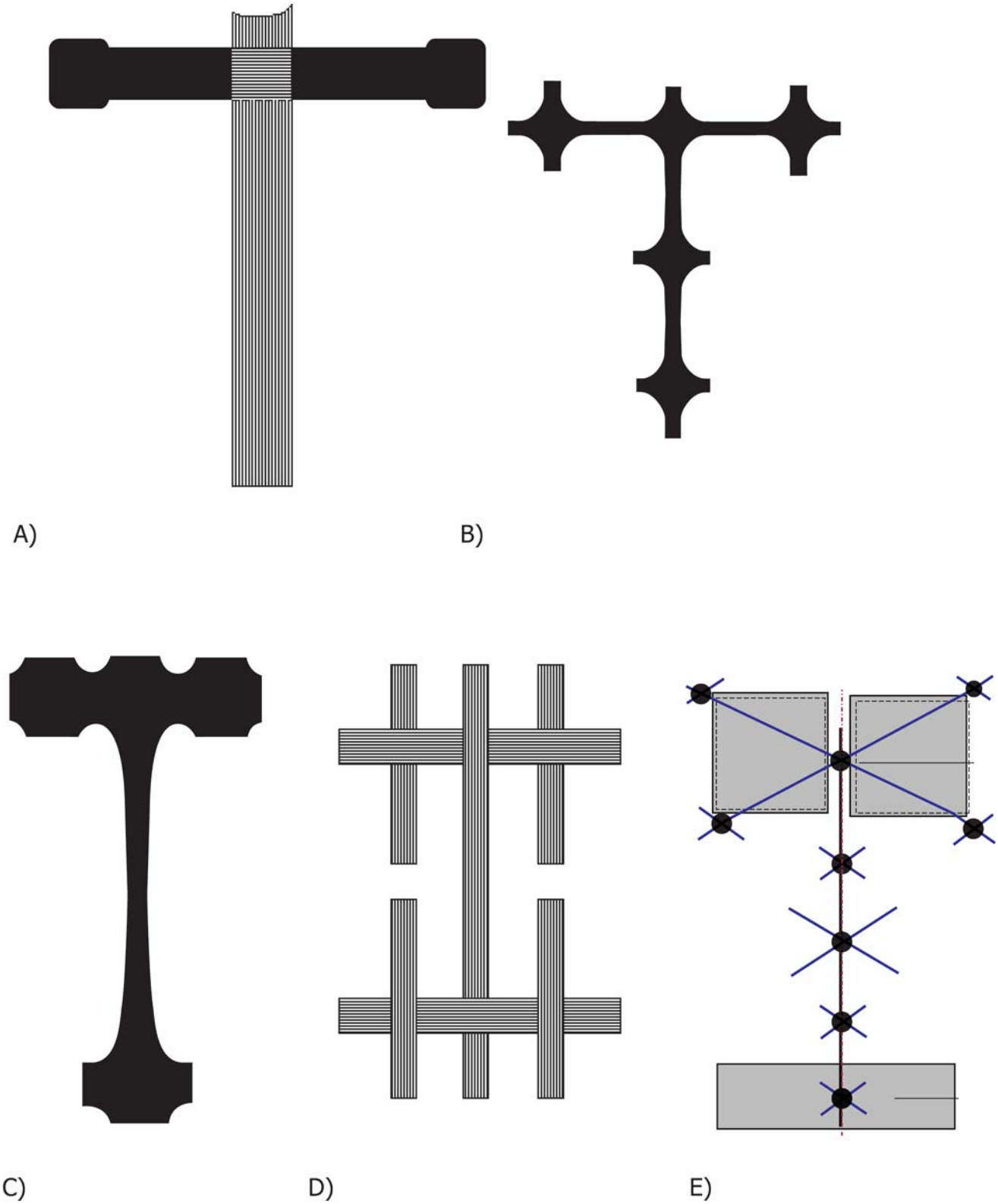

FIG. 5 Typical Junction Strength Specimens for Various Geogrid Products

10.1.7 If requested, a description of the way the sample was prepared and the force-elongation curves for each test (with a description of the type of failure that occurred) should also be included.

10.1.8 The rib spacing used in the calculation of junction strength.

11. Precision and Bias

11.1 *Precision*—No precision and bias has been established for this test standard.

12. Keywords

12.1 geogrid; geogrid junction; geogrid rib; geosynthetic; geotextile; index test; tensile test