Designation: D5649 – 15

# Standard Test Method for Torque Strength of Adhesives Used on Threaded Fasteners[1]

This standard is issued under the fixed designation D5649; 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 used to make comparative assessments of the securing or locking effect of adhesives used in threaded assemblies.

1.2 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this 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]

D907 Terminology of Adhesives

D2651 Guide for Preparation of Metal Surfaces for Adhesive Bonding

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

## 3. Terminology

3.1 *Definitions*—For technical terms pertaining to adhesives, see Terminology D907.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *breakaway torque, n*—the initial torque required to break the bond measured at the first movement between the nut and the bolt when unscrewing an unseated assembly.

3.2.2 *on torque, n*—the maximum torque required to screw the nut onto a preapplied adhesive-coated bolt.

3.2.3 *prevailing torque, n*—the torque measured after the initial breakage of the bond measured at 180° rotation of the nut.

## 4. Summary of Test Method

4.1 This test method consists of determining the torque required to unscrew a bonded nut and bolt assembly. Breakaway torque and prevailing torque are determined.

## 5. Significance and Use

5.1 This test method provides reasonably accurate information with regard to the determination of the securing or locking effect of adhesives used in threaded fasteners. This test method may also be used to determine the degree of cure and the effect of environment on torque strength.

5.2 The accuracy of the test results depends to a large degree on the thread clearance of the test fasteners and the inclusion of air bubbles in the bond line. Data generated by this test method should be safety-factored accordingly if used as quality assurance acceptance or rejection.

## 6. Apparatus

6.1 *Electronic Recording*—Test machine consisting of a clamping device to secure the bolt head, and a device for turning the nut with simultaneous measurement and registration of the torque as a function of the angle of turning by direct analog or digital means.

6.2 *Direct Reading*—A clamping device to secure the head of the bolt, and a torque wrench accurate to ±5 %.

## 7. Test Specimens

7.1 Any size and substrate fasteners may be used upon agreement between the supplier and the user of adhesives.

7.2 Unless otherwise agreed upon between the user and the adhesive manufacturer, degrease all non-plated nuts and bolts (refer to Guide D2651), store in an atmosphere of low humidity, and keep them clean.

7.3 Where desired, and if agreed upon between the user and the adhesive manufacturer, non-plated nuts and bolts may be used as received, reoiled, or after other special treatments.

7.4 Plated nuts and bolts do not normally require any special cleaning prior to assembly.

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[1] This test method is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.60 on Adhesive Material Classification System.

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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.

## 8. Assembly

8.1 Assemble not less than five specimens for each test as follows:

8.1.1 Preassemble nuts and bolts prior to application of adhesive. Discard any pairs showing sticking due to burrs or damaged threads. Disassemble the parts.

8.1.2 For liquid adhesives, apply sufficient adhesive to the bolt to completely cover an area equal to the height of the nut plus three threads. Also, apply adhesive to the threads of the nut. Follow the adhesives manufacturer's instructions for application of preapplied adhesives.

8.1.3 Remove, flip and re-screw the nut onto the bolt by hand, allowing three threads to protrude. For preapplied adhesives, screw the nut onto the coated bolt using the apparatus in 6.1 or 6.2 and record the on torque. Allow three adhesive-coated threads to protrude.

8.1.4 Cure the adhesive in accordance with the manufacturer's instructions with the test specimen standing vertically on the bolt head.

8.1.4.1 When specified or recommended, for primed or activated surfaces, use the manufacturer's primer. Apply the primer and adhesive in accordance with the manufacturer's instructions. Assemble and cure the specimens for a time and temperature in accordance with the manufacturer's recommendations.

## 9. Procedure

9.1 After allowing for cure and any planned environmental conditioning, determine the torque strengths as follows:

9.1.1 Secure the bolt head in the clamping device and unscrew the nut at a speed of <10 r/min.

9.1.2 Record the breakaway torque and the prevailing torque as measured on the electronic recording equipment, or from a direct reading if a torque wrench is used.

NOTE 1—If electronic recording equipment is used, breakaway torque is measured at the initial point of deviation from linearity on the curve which corresponds to the first movement of the nut.

## 10. Report

10.1 Report the following information:

10.1.1 Complete identification of the adhesive used, including type, source, date manufactured, manufacturer's code number, and form,

10.1.2 Specimen size and substrate used,

10.1.3 Method of cleaning and surface preparation prior to bonding,

10.1.4 Application and bonding conditions used in preparing the specimens,

10.1.5 Conditioning procedure used for specimens prior to testing.

10.1.6 Number of specimens tested,

10.1.7 Testing speed,

10.1.8 Test equipment, and

10.1.9 Average value for torque strengths determined.

## 11. Precision and Bias

11.1 *Precision*—An interlaboratory study of the torque strength of anaerobic adhesives was run in 1992. Each of eight laboratories tested ten test specimens for breakaway torque and ten test specimens for prevailing torque from each of eight adhesives ranging in viscosity from 10 to 10 000 cP. Adhesives A, B, C, D, F, and H were tested using degreased, ⅜-in. size, 16 threads per inch, Unified National Coarse thread series (⅜ × 16 UNC), Grade 5 steel bolts with degreased, Grade 2 steel nuts. Adhesives E and G were tested using ⅜-in. size, 24 threads per inch, Unified National Fine thread series (⅜ × 24 UNF), Grade 2 steel bolts with degreased, Grade 2 steel nuts. Relative humidity was controlled between 40 and 60 % at 70 to 77°F, and all samples were cured for 24 h. Practice E691 was followed for the design and analysis of the data. The repeatability and reproducibility limits in Table 1 were obtained for each of the eight materials as a result of the interlaboratory study.

11.1.1 The terms repeatability and reproducibility limit are used as specified in Practice E177. The respective standard

**TABLE 1 Interlaboratory Study of the Torque Strength of Anaerobic Adhesives**

| Adhesive | Breakaway Torque, lbf/in. | 95 %, limit, lbf/in. | |
|---|---|---|---|
| | | Repeatability | Reproducibility |
| G | 39 | 16 | 44 |
| D | 78 | 79 | 201 |
| E | 95 | 79 | 242 |
| A | 98 | 28 | 77 |
| F | 137 | 74 | 118 |
| H | 192 | 64 | 180 |
| B | 240 | 65 | 134 |
| C | 294 | 89 | 170 |
| Adhesive | Prevailing Torque, lbf/in. | 95 % limit, lbf/in. | |
| | | Repeatability | Reproducibility |
| G | 33 | 17 | 68 |
| A | 43 | 21 | 79 |
| F | 87 | 55 | 120 |
| H | 167 | 115 | 204 |
| B | 262 | 109 | 246 |
| D | 264 | 159 | 254 |
| C | 276 | 132 | 293 |
| E | 283 | 174 | 185 |

deviations among test results may be obtained by dividing Columns 3 and 4 in Table 1 by 2.8.

11.2 *Bias*—Since there is no accepted reference material, method, or laboratory suitable for determining the bias for the procedure in this test method for measuring torque strength of adhesives, no statement on bias exists.

## 12. Keywords

12.1 adhesive; breakaway torque; prevailing torque; thread-locking; torque