



Designation: D 5649 – 9401

## Standard Test Method for Torque Strength of Adhesives Used on Threaded Fasteners<sup>1</sup>

This standard is issued under the fixed designation D 5649; 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 ( $\epsilon$ ) 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 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:*

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<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D-14 on Adhesives and is the direct responsibility of Subcommittee D14.80 on Metal Bonding Adhesives. Current edition approved ~~Dec. 15, 1994~~, March 10, 2001, Published ~~February 1995~~, May 2001. Originally published as D 5649 - 94. Last previous edition D 5649 - 94.

D 907 Terminology of Adhesives<sup>2</sup>

D 2651 Guide for Preparation of Metal Surfaces for Adhesive Bonding<sup>2</sup>

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods<sup>3</sup>

E 691 Practice for Conducting an Interlaboratory Test Program to Determine the Precision of a Test Method<sup>3</sup>

### 3. Terminology

3.1 *Definitions*—For technical terms pertaining to adhesives, see Terminology D 907.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *breakaway torque*—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*—the maximum torque required to screw the nut onto a preapplied adhesive-coated bolt.

3.2.3 *prevailing torque*—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  $\pm 5\%$ .

### 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 ~~shall be degreased~~ (refer to Guide D 2651), stored 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.

### 8. Assembly

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

8.1.1 ~~N Preassemble nuts and bolts shall be preassembled~~ prior to application of adhesive. Any Discard any pairs showing sticking due to burrs or damaged ~~threads shall be discarded.~~ 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 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.

8.1.5 ~~The accuracy of the results will depend on the conditions under which the bonding process is carried out. Unless otherwise agreed upon between the manufacturer and the purchaser, the bonding conditions shall be specified by the manufacturer of the~~

<sup>2</sup> Annual Book of ASTM Standards, Vol 15.06.

<sup>3</sup> Annual Book of ASTM Standards, Vol 14.02.

adhesive. In order to ensure that complete information is available to the individual conducting the tests, the manufacturer of the adhesive shall furnish numerical values and other specific information for each of the following variables:

8.1.5.1 Procedures for preparation of surfaces prior to application of adhesive, for cleaning and drying of metal surfaces, and for special surface treatments that are not specifically limited by the pertinent test method.

8.1.5.2 Directions for mixing the adhesive.

8.1.5.3 Instructions for preconditioning the test specimens or adhesive, including desired temperature, relative humidity, and length of time.

8.1.5.4 Procedure for conditioning before testing including the length of time, temperature, and relative humidity.

## 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,  $\frac{3}{8}$ -in. size, 16 threads per inch, Unified National Coarse thread series ( $\frac{3}{8} \times 16$  UNC), Grade 5 steel bolts with degreased, Grade 2 steel nuts. Adhesives E and G were tested using  $\frac{3}{8}$ -in. size, 24 threads per inch, Unified National Fine thread series ( $\frac{3}{8} \times 24$  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 E 691 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 E 177. The respective standard 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; threadlocking; torque

**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

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