



Designation: C 557 – 03

# Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing<sup>1</sup>

This standard is issued under the fixed designation C 557; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

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

## 1. Scope\*

1.1 This specification includes properties and covers minimum performance standards for adhesives intended to bond the back surface paper of gypsum wallboard to wood framing members.

1.2 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

1.3 This specification also covers test requirements and test methods for the adhesive used for the application of all thicknesses of gypsum wallboard.

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

## 2. Referenced Documents

### 2.1 ASTM Standards:

C 1396 Specification for Gypsum Board<sup>2</sup>

D 905 Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading<sup>3</sup>

D 907 Terminology of Adhesives<sup>3</sup>

E 4 Practices for Force Verification of Testing Machines<sup>4</sup>

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods<sup>5</sup>

## 3. Terminology

3.1 *Definitions*—Many terms in this specification are defined in Terminology D 907.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.70 on Construction Adhesives.

Current edition approved Aug. 10, 2003. Published September 2003. Originally approved in 1965. Last previous edition approved in 1999 as C 557 – 99.

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 04.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 15.06.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 03.01

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 14.02.

## 4. Significance and Use

4.1 The specification applies to adhesives for bonding the back surface paper of gypsum wallboard of any thickness to wood-framing members.

4.2 This specification provides a basis for ensuring the quality of the adhesives.

4.3 Although the bonds rendered by these adhesives shall have enough strength by themselves to maintain the bond between adherends, they are not intended as a substitute for the common practice of using mechanical fasteners to maximize integrity of drywall-wood-framing structures.

4.4 The tests are suitable for products performance certification and quality control programs and can be useful to the general public, adhesive manufacturers, distributors, specifiers, architects, contractors, testing laboratories and other businesses and professionals

4.5 The results do not include all possible conditions, which may occur during final assembly, but indicate a set of performance characteristics for laboratory controlled bonding variables.

## 5. Adhesive Physical Property Requirements

5.1 *Adhesives*—The adhesives shall be uniform, homogeneous mixtures of elastomeric polymers or viscoelastic resins, or both, free of lumps or foreign matter.

5.1.1 *Workability*—When applied to the framing member with a caulking gun or notched trowel, or both, in accordance with the manufacturer's instructions, the adhesive shall exhibit a consistency capable of ensuring non-sagging properties.

5.1.2 *Open Time*—The adhesive shall have an open assembly time of between 10 to 20 min to give the user sufficient time to apply and, if necessary, reposition the gypsum wallboard at ambient temperatures, ranging from 40 to 100°F (4 to 38°C).

\*A Summary of Changes section appears at the end of this standard.

5.1.3 *Storage Life*—The adhesive shall remain serviceable and meet all the requirements of this specification for not less than six months after delivery, when stored in original unopened containers at temperatures ranging from 40 to 85°F (4 to 30°C).

## 6. Adhesive Performance Property Requirements

6.1 The adhesives shall conform to the requirements summarized in Table 1.

## 7. Sampling

7.1 The test adhesive sample size of 1 qt (approximately 1 L) is a minimum amount to complete one full series of testing. The sample is to be handled and stored according to the manufacturers recommendations. For qualification testing, the sample is to be representative of the final product for which recognition is sought.

## 8. Materials and Apparatus for Conducting Tests

8.1 *Gypsum Wallboard*— $\frac{1}{2}$ -in. (12.7 mm) thick, complying with Specification C 1396; the dimensions are specified in each test.

8.2 *Plywood*— $\frac{5}{8}$ -in. (15.9 mm) or  $\frac{1}{32}$ -in. (15.1 mm) U.S. Product Standard PS-1-95 grade marked stamped commercial plywood, Group 1 Species, exterior glue, or sanded exterior grade plywood, underlayment type, with A grade face ply for the adhesion surface.

8.3 *Douglas-fir Dimension Lumber*—Nominal 2 by 4,  $1\frac{1}{2}$  by  $1\frac{1}{2}$  by  $3\frac{1}{2}$ -in. (38.0 by 38.0 by 89.0 mm); No. 1, straight-grained, and knot-free; the dimensions are specified in each test.

8.4 *Polyvinyl Acetate Adhesive*—Any commercially available product.

8.5 *Spacers*—No. 20 gage (American Standard or B&S) bronze or brass wire  $\frac{1}{32}$ -in. (0.8-mm) diameter.

8.6 *Trowels*—Plastic or metal with  $\frac{3}{16}$ -in. (4.76 mm) deep V-notches.

8.7 *Compression Shear Test Fixture*—A compression-shear apparatus that is similar to, but of a larger scale than the fixture recommended in Test Method D 905. A similar fixture is shown in Fig. 1.

8.8 *Tensile Test Fixture*—An assembly of one 5 by 5 by  $\frac{1}{2}$ -in. (127 by 127 by 6.35 mm) thick steel plate and two  $1\frac{1}{2}$  by  $1\frac{1}{2}$ -in. by  $\frac{1}{4}$ -in. thick by 6 in. long (38.1 by 38.1 by 6.4 mm thick by 152 mm long) steel angle sections. See Fig. 2.

8.9 *Scaffold Nails*—6d, common, double-head, smooth shaft, 0.113-in. (2.87 mm) diameter, 2 in. (51 mm) long.

8.10 *Testing Machine*—Any suitable testing machine that is capable of operation at a constant rate of motion of the moveable head and has a force measurement accuracy of  $\pm 1\%$  when calibrated in accordance with Practices E 4.

8.11 *Wood Screw with Eyelet*—#6 by  $1\frac{1}{2}$ -in. (38.1 mm) long, with a  $\frac{3}{8}$ -in. (9.5 mm) inside diameter eyelet.

8.12 *Plywood Shim*— $\frac{5}{8}$ -in. (15.9 mm) or  $\frac{1}{32}$ -in. (15.1 mm) thick plywood with dimensions of 4 by  $3\frac{1}{2}$  in. (101.6 by 88.9 mm) for shear test specimens and 4 by 4 in. (101.6 by 101.6 mm) for tensile test specimens.

## 9. Conditioning of Materials and Specimens (Standard Conditions)

9.1 Condition the gypsum wallboard, plywood, and Douglas-fir, lumber to a constant weight at  $73 \pm 2^\circ\text{F}$  ( $23 \pm 1^\circ\text{C}$ ) and  $50 \pm 5\%$  relative humidity, unless specified otherwise.

9.2 Subject all test adhesives and test specimens to standard conditioning for time period indicated at  $73 \pm 2^\circ\text{F}$  ( $23 \pm 1^\circ\text{C}$ ) and  $50 \pm 5\%$  relative humidity unless specified otherwise.

## 10. Test Methods

10.1 *Shear Strength (Rate-of-Shear Strength Development)*:

**TABLE 1 Adhesive Properties and Performance Requirements**

Test Method	Reference Number	Property	Condition	Requirements
Rate of shear strength development	10.1.4	shear strength	24 h at Std. Cond.	10 psi (69 kPa) min
	10.1.5	shear strength	14 days at Std. Cond.	40 psi (276 kPa) min
	10.1.6	shear strength	14 days at Std. Cond., + cyclic lab exposure, + 2 days at Std. Cond.	32 psi (220 kPa) min
	10.1.7	shear strength	(a) 178 N (40 lbf) for 24 h at Std. Cond. (b) 89 N (20 lbf) for 24 h at 100°F	no bond separation no bond separation
Rate of tensile strength development	10.2.3	tensile strength	24 h at Std. Cond.	15 psi (103 kPa) min
	10.2.4	tensile strength	14 days at Std. Cond.	25 psi (172 kPa) min
Adhesive open-time determination	10.3	open-time	24 h at Std. Cond.	75 % paper transfer, min
Substrate wet-out by adhesive				
1. Plywood	10.4.1	wet-out	spatula applied	good wetting property
2. Wallboard	10.4.2	wet-out	spatula applied	good wetting property
Bridging	10.5	gap filling	48 h at Std. Cond.	adhesive bond line is maintained - report paper failure %
Accelerated adhesive aging	10.6	accelerated aging	500 h at 70°C (158°F) 3 cycles of:	no fracture into separate pieces
Freeze-thaw stability	10.7	low-temperature storage	24 h at -17°C (0°F) + 24 h at Std. Cond.	no change in workability; 10 psi (69 kPa) shear strength, min
Suitability as a laminating adhesive for vinyl-covered wallboard	10.8.1	compatibility	24 h at 38°C (100°F)	no blistering, vinyl-film discoloration, or bond failure
	10.8.2	staining	1 h at Std. Cond.	no swelling or discoloration

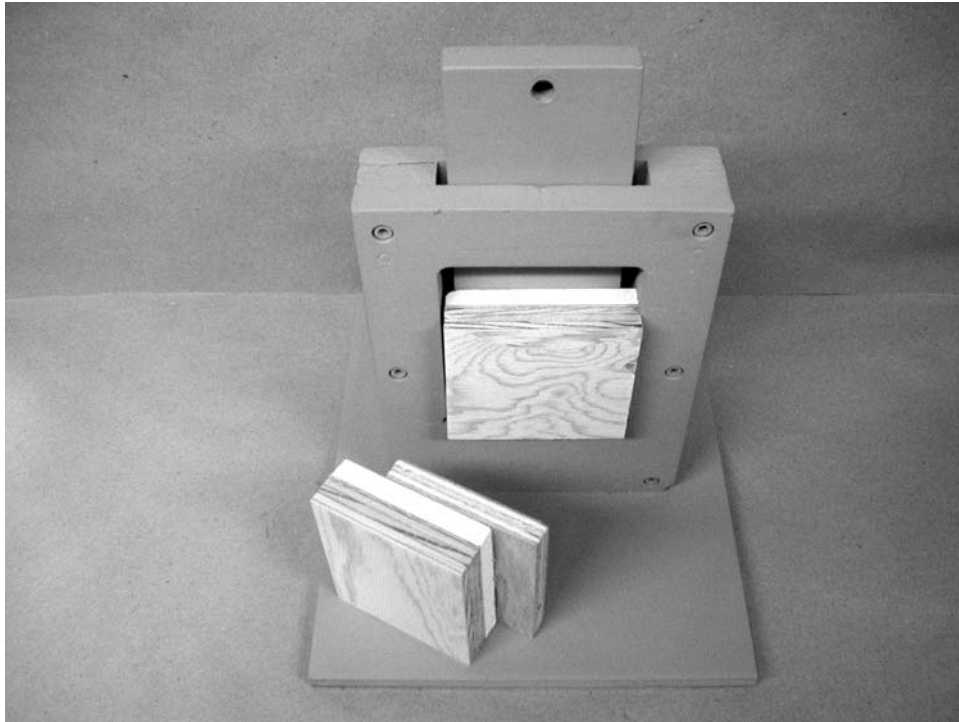


FIG. 1 Shear Strength Test Specimen in Text Fixture

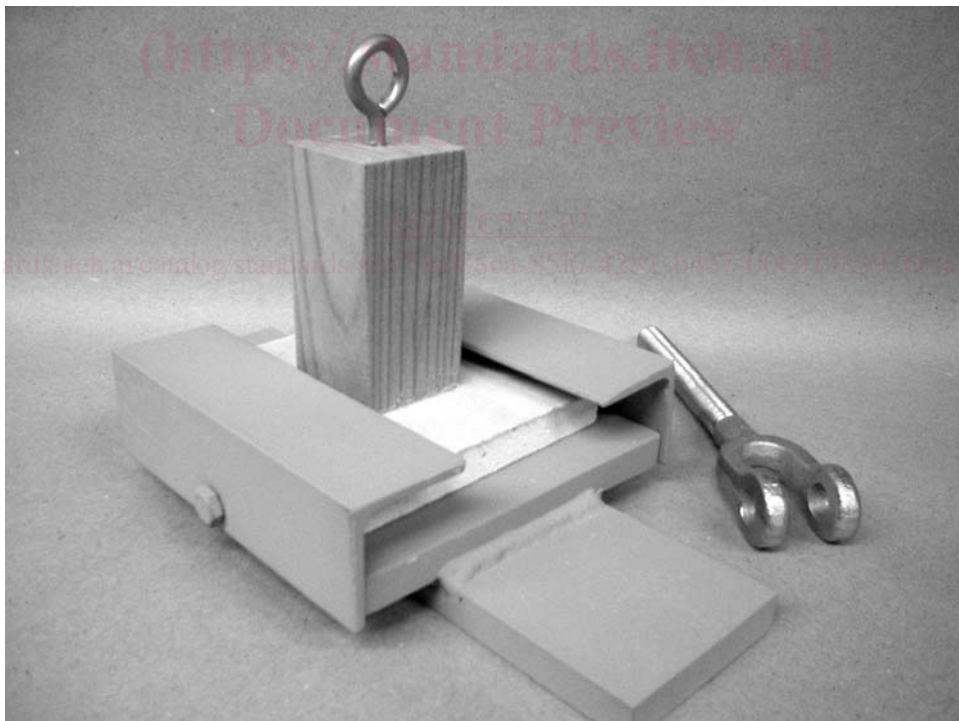


FIG. 2 Tensile Strength Specimen in Text Fixture

10.1.1 *Preparation of Gypsum Wallboard-Plywood Laminates*—Each laminate is constructed by bonding a piece of 4 by 3½ by ½ in. thick (102 by 89 by 12.7 mm) gypsum wallboard front paper surface paper to a ⅝-in. (15.9 mm) or 1⅞-in. (15.1 mm), plywood shim of the same dimensions with a commercially available PVA adhesive. The plywood rein-

forces the gypsum wallboard to prevent fracture before the ultimate shear load can be achieved. The grain of the gypsum wallboard back surface paper is parallel with the 3½-in. (89 mm) direction.

10.1.2 *Preparation of Shear Strength Test Specimens*—Prepare the number of test specimens indicated in 10.1.4-10.1.7

by bonding a 4 by 3½ in. (102 by 89 mm) piece plywood to the previously prepared wallboard-plywood laminate as follows:

10.1.2.1 Spread the test adhesive onto the plywood bonding surface with a trowel having ⅜-in. (4.8-mm) deep V-notches so that the adhesive ridges are parallel to the grain of wood. During application hold the trowel at an approximate 90° angle to the receiving surface.

10.1.2.2 Allow an open time of 30 s ± 5 s upon completion of spreading.

10.1.2.3 Squarely position the gypsum wallboard-plywood laminate back surface paper onto the adhesive coated plywood with the overlapping 2 ½ ± ⅛-in. (63.5 ± 1.6 mm), thus forming the 10 in.<sup>2</sup> (64.5 cm<sup>2</sup>) bonded area. See Fig. 3.

10.1.2.4 Insert six wire spacers No. 20 gage at least 2-in. (51.0-mm) long in the joint 1-in. ± ⅛-in. (25.4 ± 1.6 mm). Position the spacers so that one is on the centerline of the bonded area (perpendicular to the ridges), and the others are 1 in. (25.4 mm) away from the center spacers and parallel to it.

10.1.2.5 Immediately following assembly, compress each test specimen under a uniformly distributed load of 15 lb (67 N) for a period of 3 to 3 ½ min.

10.1.2.6 After the 3 to 3½ min period, remove the load, wipe the excess adhesive from the bonded edges with a square-edged spatula, and withdraw the spacers, taking care not to disturb the alignment of the bonded pieces.

10.1.3 *Shear Strength Determination*—After completing the appropriate conditioning, test the specimen in shear using a compression-shear test fixture as shown in Fig. 1. The bottom edge of the wallboard-plywood laminate rests on self-aligning seat as the test loading is simultaneously applied to the top edge of the single plywood. The stress applied is parallel and uniformly distributed to the bond line shear plane and requires

careful orientation using shims and self-aligning apparatus as necessary. Determine the shear strength at a crosshead speed of 0.50-in/min (12.7 mm)/min). Observations are made during stress application to ensure the test assembly maintains proper alignment and the fixture operates without binding or friction throughout the test. Record the maximum shear strength and the average shear strength for the 24 h, 14-day, cycle exposure, and static load test conditions.

10.1.4 *Shear Strength After 24 h:*

10.1.4.1 Prepare five shear test specimens using the procedure outlined in 10.1.1 to 10.1.2.

10.1.4.2 After curing the shear test specimens 24 h ± 1 h at standard conditions, determine the shear strength in accordance with 10.1.3.

10.1.5 *Shear Strength After 14 Days:*

10.1.5.1 Prepare five shear test specimens using the procedure outlined in 10.1.1 to 10.1.2.

10.1.5.2 After conditioning the specimens 14 days at standard conditions, determine the shear strength in accordance with 10.1.3.

10.1.6 *Shear Strength After Cyclic Exposure:*

10.1.6.1 Prepare five shear test specimens using the procedure outlined in 10.1.1 to 10.1.2.

10.1.6.2 After conditioning the shear test specimens 14 days at standard conditions, process the shear test specimens through four complete cycles (Table 2). Store the shear test specimens at standard conditions for 24 h after each cycle.

10.1.6.3 At the end of the cycling, determine the shear strength in accordance with 10.1.3.

10.1.7 *Shear Strength for Static Load:*

10.1.7.1 Prepare ten shear test specimens using the procedure outlined in 10.1.1 to 10.1.2.

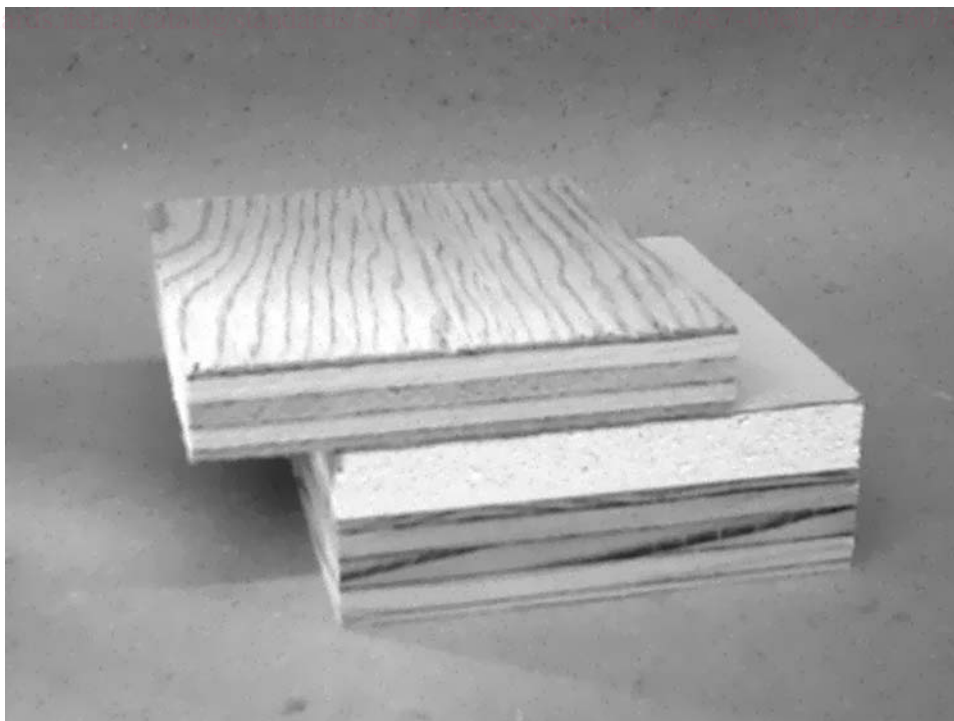


FIG. 3 Shear Strength Test Specimen Assembly