Designation: C 557 – ~~99~~03

Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing[1]

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 reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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 ~~for bonding~~ 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:*

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[1] This specification is under the jurisdiction of ASTM Committee D~~-~~14 on Adhesives and is the direct responsibility of Subcommittee D14.70 on Construction Adhesives .

Current edition approved ~~April~~ Aug. 10, ~~1999.~~ 2003. Published ~~June 1999.~~ September 2003. Originally ~~published as C 557 – 65 T.~~ approved in 1965. Last previous edition approved in 1999 as C 557 – 93~~a~~9.

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

C 1396 Specification for Gypsum ~~Wallboard~~ Board[2]
D ~~828 Test~~ 905 Test Method for ~~Tensile~~ Strength Properties of ~~Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus~~ Adhesive Bonds in Shear by Compression Loading[3]
D 907 Terminology of Adhesives[3]
E 4 Practices for Force Verification of Testing Machines[4]
~~D 1779 Specification~~
E 177 Practice for ~~Adhesive for Acoustical Materials~~[4]
~~D 4338 Test Method for Flexibility Determination~~ Use of ~~Supported Adhesive Films by Mandrel Bend~~ the Terms Precision and Bias in ASTM Test Methods[5]

3. Terminology

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

~~3.1.1 *gap-filling adhesive*, *n*—an adhesive capable of forming and maintaining a bond between surfaces that are not close-fitting.~~

~~3.1.1.1 *Discussion*—Close-fitting is relative to a given material and industry; for example, standards in construction differ from standards in electronics. Some adhesives will bond by bridging without completely filling the gap; others by filling the gap completely.~~

~~3.1.2 *shear strength*, *n*—*in adhesive joint*, the maximum average stress when a force is applied parallel to the joint.~~

~~3.1.2.1 *Discussion*—In most adhesive test methods, the shear strength is actually the maximum average stress at failure of the specimen, not necessarily the true maximum stress in the material.~~

~~3.1.3 *tensile strength*, *n*—*in an adhesive joint*, the maximum average stress when a force is applied perpendicular to the joint.~~

~~3.1.3.1 *Discussion*—In most adhesive test methods, the tensile strength is actually the maximum average stress at failure of the specimen, not necessarily the true maximum stress in the material.~~

~~3.2 *Definitions of Terms Specific to This Standard:*~~

~~3.2.1 *lot*, *n*—material from the same batch or blending operation that was processed in accordance with standard manufacturing conditions.~~

4. Significance and Use

4.1 The specification applies to ~~organic~~ 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).

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 Sample each selected lot~~

[2] *Annual Book of ASTM Standards*, Vol 04.01.
[3] *Annual Book of ASTM Standards*, Vol 15.09~~6~~.
[4] *Annual Book of ASTM Standards*, Vol ~~15.06.~~ 03.01
[5] *Annual Book of ASTM Standards*, Vol 14.02.

TABLE 1 Adhesive Properties and Performance Requirements

Test Method	Reference Number	Property	Condition	Requirements
~~Rate of shear strength~~	~~10.1.4~~	~~shear strength~~	~~24 h at RT~~	~~10 psi (69 kPa) min~~
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 RT~~	~~40 psi (276 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 RT, + cyclic lab exposure, + 2 days at RT~~	~~32 psi (220 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) 40 lb (178 N) for 24 h at RT~~	~~no bond separation~~
	10.1.7	shear strength	(a) 178 N (40 lbf) for 24 h at Std. Cond.	no bond separation
			~~(b)20 lb (89 N) for 24 h at 100°F~~	~~no bond separation~~
			(b) 89 N (20 lbf) for 24 h at 100°F	no bond separation
~~Rate of strength development~~	~~10.2.3~~	~~tensile strength~~	~~24 h at RT~~	~~15 psi (103 kPa) min~~
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 RT~~	~~25 psi (172 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 RT~~	~~75 % paper transfer, 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~~
1. Plywood	10.4.1	wet-out	spatula applied	good wetting property
~~2. Wallboard~~	~~10.4.2~~	~~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 RT~~	~~continuous (adhesive) bond line~~
Bridging	10.5	gap filling	48 h at Std. Cond.	adhesive bond line is maintained - report paper failure %
~~Adhesive aging~~	~~10.6~~	~~accelerated aging~~	~~500 h at158°F~~	~~no crack ingor chi pping~~
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 at0°F + 24 h at RT~~	~~no change in workability; 10 psi (69 kPa) shear strength, min~~
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 at100°F~~	~~no blistering, vinyl-film discoloration, or bond failure~~
	~~10.8.2~~	~~staining~~	~~1 h at RT~~	
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

7.1 The test adhesive sample size of ~~adhesives in accordance with Specification D 1779.~~ 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*—½-in. (12.7 mm) thick, complying with Specification C 1396; the dimensions are specified in each test.

8.2 ~~*Douglas Fir Plywood*—¾-in. (19.0~~5⁄8-in. (15.9 mm) ~~thick plywood-grade PSI Exterior A-A~~ or ~~A-B;~~ 19⁄32-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 ~~dimensions are specified in each test.~~ adhesion surface.

8.3 ~~*Douglas Fir Plywood*—¼-in. (6.3 mm) thick plywood grade PSI Exterior A-A or A-B; the dimensions are specified in each test.~~

~~8.4 *Douglas Fir*~~*Douglas-fir Dimension Lumber* —Nominal 2 by 4, 1½ by 1½ by 3½-in. (38.0 by 38.0 by 89.0 ~~mm) in cross section;~~ mm); No. 1, straight-grained, and knot-free; the dimensions are specified in each test.

8.5~~4~~ *Polyvinyl Acetate Adhesive* —Any commercially available product.

~~8.6 *Steel Plates*—¼-in. thick steel with two ¼-in. diameter threaded holes; the dimensions are specified in the shear-strength test method.~~

~~8.7 *Turn Key* ¼-in. Diameter Threaded Bolts—With hex nuts; dimensions are specified in each test.~~

~~8.8 *Garnet Paper*—No. 120 grit, 3/0.~~

~~8.9~~

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

~~8.10~~

8.6 *Trowels*—Plastic or metal with 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 ½-in. (127 by 127 by 6.35 mm) thick steel plate and two 1½ by 1½-in. by ¼-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 ±1 % when calibrated in accordance with Practices E 4.

8.11 ~~*Overlapping Steel Collar*—Two 2~~Wood Screw with Eyelet—#6 by 1~~ in. (51.0 by 25.4 mm) U-channels welded to a 1/16-in. (1.6-mm) thick galvanized-steel frame and assembled~~½-in. (38.1 mm) long, with a ~~flathead screw, two washers, and a nut.~~ ⅜-in. (9.5 mm) inside diameter eyelet.

8.12 ~~*W*~~*Plywood Shim*—~~¾-in. (19.0~~⅝-in. (15.9 mm) or 19/32-in. (15.1 mm) thick plywood with dimensions of 4 by~~ 1¼-in. (102.0 by 89.0 mm) with two ¼-in (6.3 mm) diameter drilled holes.~~

~~8.13 *T-bar Steel Pin*—4~~ 3½ by ⅜ in.~~ (114.0~~ (101.6 by~~ 9.5~~ 88.9 mm) for~~ insertion into perforated tensile wood block.~~

~~8.14 *Aluminum Tensile Test Jig*—4~~ shear test specimens and 4 by~~ 1⅝~~ 4 in.~~ (102.0~~ (101.6 by~~ 41.0~~ 101.6 mm)~~ T-bar perforated aluminum fixture with 1-in. (25.4 mm) long and ¼-in. (6.3 mm) diameter screw and hex nut~~ for~~ insertion of looped steel cable with a collar (Fig. 1).~~ tensile test specimens.

9. Conditioning of Materials and Specimens (Standard Conditions)

9.1 Condition the~~ Douglas fir, lumber,~~ gypsum wallboard, plywood, and~~ wallboard~~ Douglas-fir, lumber to a constant weight at 73 ± 2°F (23 ± 1°C) and 50 ± 5 % relative humidity, unless specified otherwise.

9.2 Subject all test~~ assemblies and~~ adhesives and test specimens to~~ be evaluated to~~ standard conditioning~~ (24 h~~ for time period indicated at 73 ± 2°F (23 ± 1°C) and 50 ± 5 % relative humidity~~)~~ unless specified otherwise.

10. Test Methods

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

10.1.1 *Preparation of Gypsum Wallboard-Plywood Laminates*—~~Prepare each test assembly individually from plywood and a wallboard-plywood laminate. Each~~ —Each laminate is~~ made~~ constructed by bonding a piece of 4 by 3½ by ½ in.~~ (102.0~~ thick (102 by~~ 89.0~~ 89 by 12.7 mm) gypsum wallboard front paper surface paper to a ~~¾-in. thick (19.0~~⅝-in. (15.9 mm) or 19/32-in. (15.1 mm), plywood~~ piece~~ shim of the same dimensions with a commercially available PVA adhesive. The plywood reinforces the gypsum wallboard to prevent fracture before the ultimate shear load can be achieved. The grain of the gypsum wallboard~~ facing~~ back surface paper~~ shall run lengthwise in~~ is parallel with the 3½-in.~~ (89.0) direction. After conditioning the precut ¾-in. (19.0~~ (89 mm) plywood pieces and wallboard-plywood laminates as indicated in 9.2, drill at the extremities of each two ¼ in. (6.3-mm) diameter holes as shown in Fig. 2. The distance of these holes from the pertinent edges is approximately 1.0 in. (25.4 mm).~~ direction.

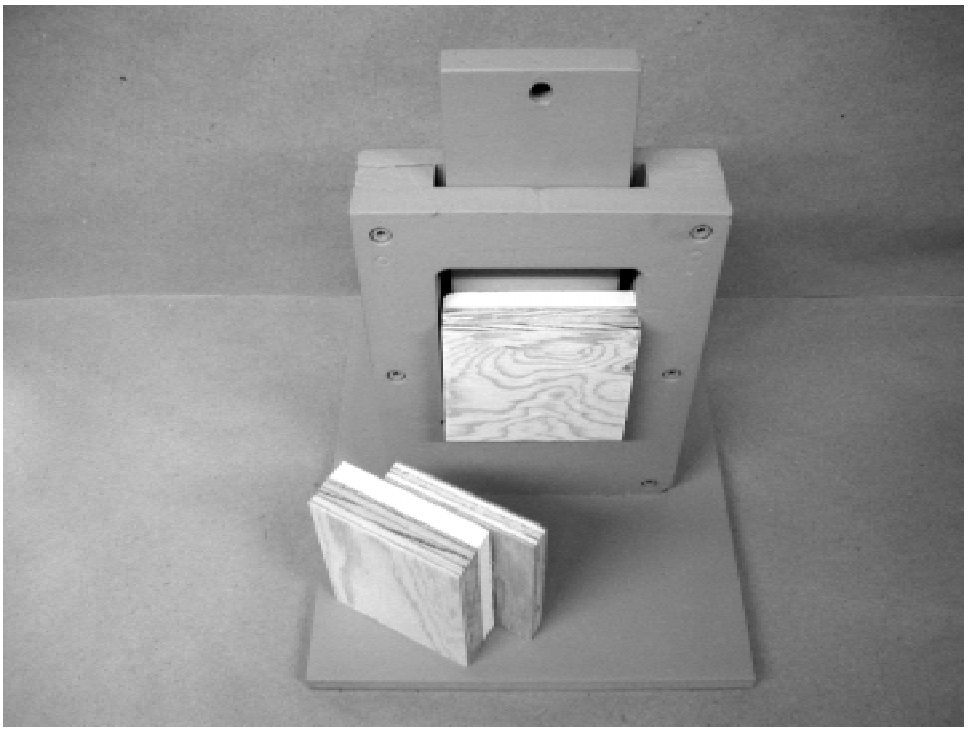

FIG. 1 Shear Strength Test Specimen in Text Fixture

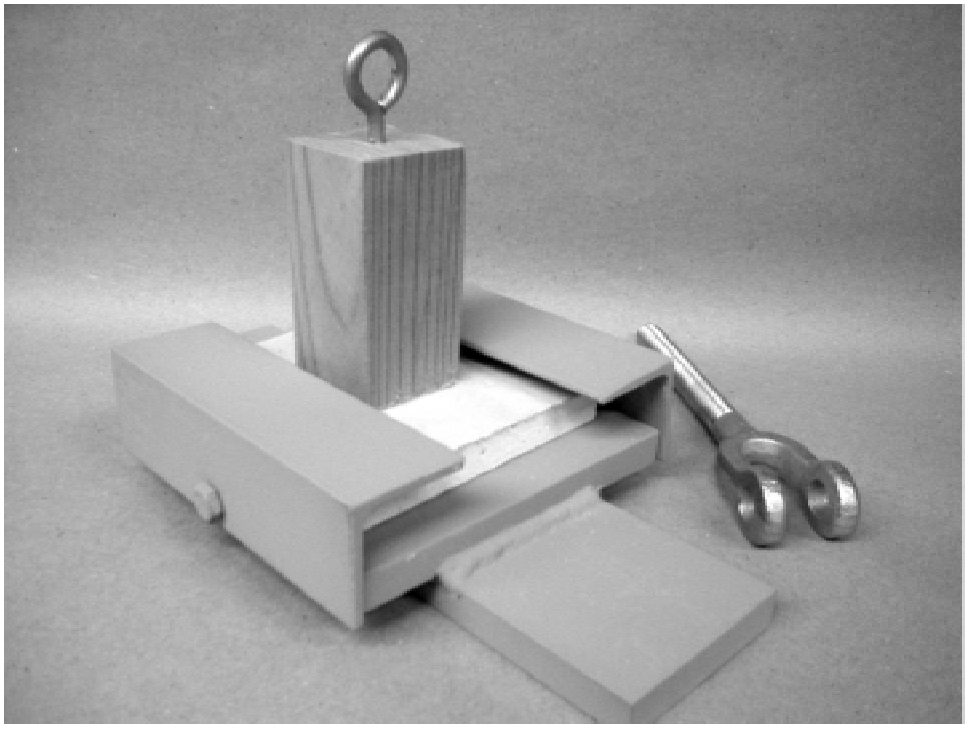

FIG. 2 Tensile Strength Specimen in Text Fixture

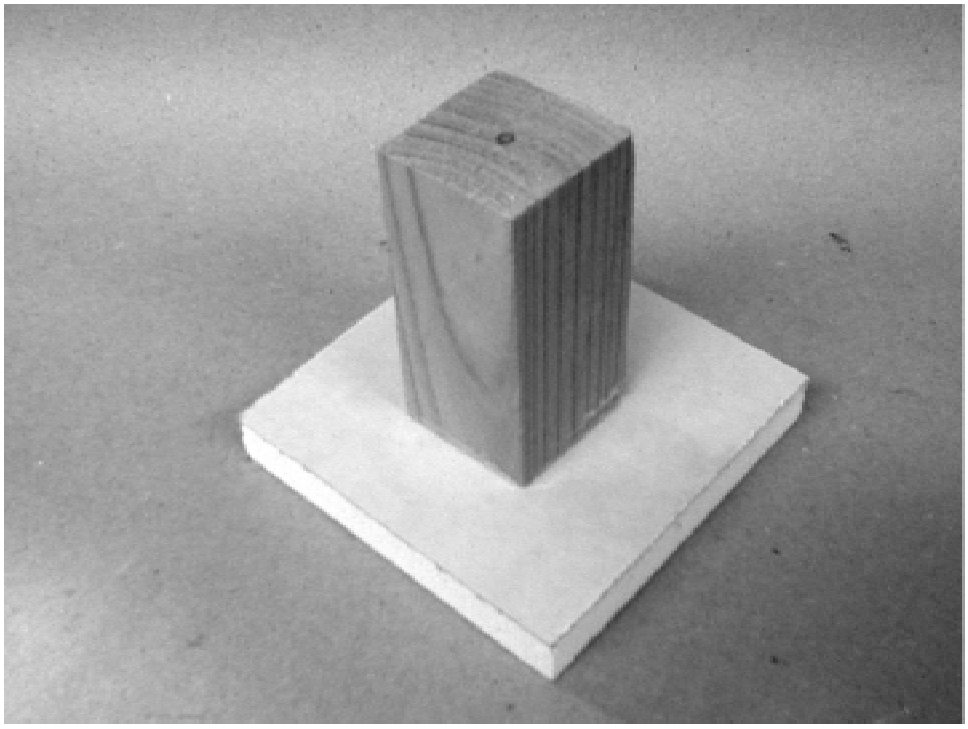

FIG. 4 Tensile Strength Test Specimen

10.1.2 *Preparation of Shear Strength Test ~~Assembly~~ Specimens*—Prepare the number of test ~~assembly~~ specimens indicated in10.1.4-10.1.7 by bonding a 4 by 3½ ~~by ¾~~ in. ~~(102.0~~ (102 by ~~89.0 by 19.0~~ 89 mm) piece ~~of the described~~ plywood to the previously prepared wallboard-plywood laminate as follows:

10.1.2.1 Spre~~a~~nd the ~~face of~~ test adhesive onto the ~~¾-in. (19.0-mm) thick~~ plywood ~~smooth with garnet paper and wipe the sanded~~ bonding surface ~~free of dust.~~

~~10.1.2.2 Spread the adhesive on the sanded surface~~ with a trowel having 3⁄16-in. (4.8-mm) deep V-notches so that the adhesive ridges are parallel to the grain of wood. ~~The trowel shall be held during~~ During application ~~as close as possible to a~~ hold he trowel

at an approximate 90° angle to the sanded wood surface to ensure the deposition of a ridge of adhesive.

10.1.2.3 Allow receiving surface.

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

10.1.2.43 Squarely position the gypsum wallboard-plywood laminate back surface paper onto the adhesive coated plywood with the overlapping exactly 2 ½ ± 1⁄16-in. (63.5 ± 1.6 mm), thus forming the 10 in.^{2}(64.5 cm^2) bonded area. See Fig. 3.

10.1.2.54 Insert six wire spacers No. 20 gage at least 2-in. (51.0-mm) long in the joint exactly 1-in. ± 1⁄16-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.

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

10.1.2.76 After the 3 to 3-½ 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 selecting completing the appropriate conditioning or aging cycle, or both, join each conditioning, test assembly with two ¼-in. (6.3 mm) steel plates the specimen in shear using a compression-shear test fixture as shown in Fig. 1. The bottom edge of identical size and perforations. These supporting steel plates are snugly fitted to the wallboard-plywood laminate rests on self-aligning seat as the test assembly by means loading is simultaneously applied to the top edge of protruding turn-key bolts the single plywood. The stress applied is parallel and hex nuts, and are subsequently attached uniformly distributed to the upper bond line shear plane and lower machine jaws requires careful orientation using shims and self-aligning apparatus as illustrated in Fig. 3. necessary. Determine the shear strength at a loading rate crosshead speed of 0.50-in./min (12.7 mm)/min). Wh Obsenrvations are made durting stress application to ensure the test assembly maientains proper alignment and the testing machine, adjust if necessary with shims to ensure that fixture operates without binding or friction throughout the stress applied is parallel to test. Record the j 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 assemblies specimens using the procedure outlined in 10.1.1 to 10.1.2.

10.1.4.2 After aging curing the assemblies 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 assemblies specimens using the procedure outlined in 10.1.1 to 10.1.2.

10.1.5.2 After aging conditioning the assemblies 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 assemblies specimens using the procedure outlined in 10.1.1 to 10.1.2.

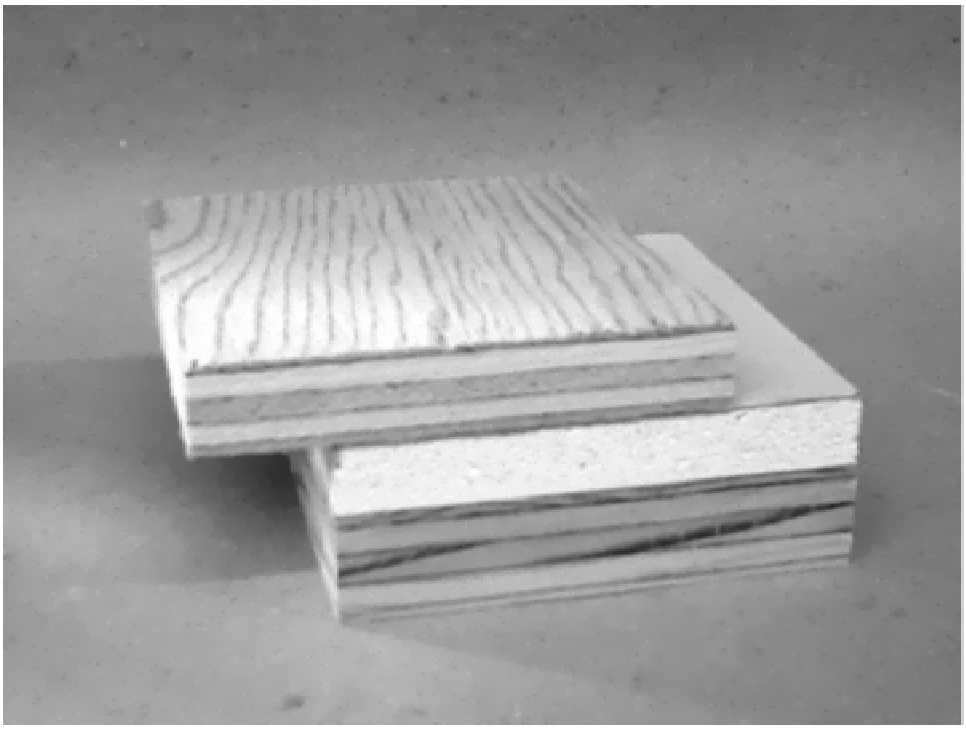

FIG. 3 Shear Strength Test Specimen Assembly

10.1.6.2 After aging conditioning the assemblies shear test specimens 14 days at standard conditions, process the assemblies shear test specimens through four complete cycles (Table 2). Store the assemblies 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 assemblies shear test specimens using the procedure outlined in 10.1.1 to 10.1.2.

10.1.7.2 Condition the assemblies shear test specimens 14 days at standard conditions.

10.1.7.3 Subject five shear test assemblies specimens to a static load of 40 lbf (178 N) at 73 ± 2°F (23 ± 1°C) and five assemblies shear test specimens to 20 lbs lbf (89 N) at 38 100.2 ± 1°C (100.2 2.0°F (38 ± 2.0°F) 1°C) for a period of 24 h. When testing, clamp the top (wallboard/plywood) of the assembly wallboard/plywood laminate should be fixed to a rigid frame and attach the frame. The full test load is applied to the bottom (plywood), making sure that perfect alignment unsupported single plywood side of the suspended assembly and the loads is achieved. adhesive bondline.

10.1.7.4 At the end of the 24- h period, examine the a test specimen bondlyine for bond indication of separation. Such separation shall be is regarded as a failure.

10.2 *Tensile Strength (Rate of Tensile Strength Development)*:

10.2.1 *Preparation of Tensile Test Assemblies Specimens*—Prepare each tensile-test assembly tensile test specimen as follows:

10.2.1.1 Condition

10.2.1.1 Prepare the number of test specimens indicated in 10.2.3 and 10.2.4. Each tensile test specimen consists of a 4 by 4 by ½- in. (101.6 by 101.6 by 12.7- mm) thick gypsum wallboard, the wooden shims, and 1½ by 1½ by 3½ in. (38.0 (38 by 38.0 38 by 89.0 89 mm) Douglas-fir lumber to standard conditions. Bond block. See Fig. 4. If necessary reinforce the wooden shim to the gypsum wallboard u by constructing a commercially available PVA adhesive. Cut gypsum wallboard-plywood laminate for testing with the method described in 10.1.1. Drill a pilot hole for the wood screw with eyelet at the approximate center top of each into the Douglas-fir block a ¼-in. (6.3-mm) wide and ¾-in. (19.0-mm) deep groove. Drill a ¼-in. (6.3-mm) thick diameter end face. The pilot hole a distance of ½-in. (12.7 mm) from is drilled straight and parallel with the top, perpendicular block's length. The wood screw with eyelet will be used for connecting the test specimen to the ¾-in. (19.0-mm) groove. test machine. Install the wood screw into the pilot hole with sufficient thread engagement to withstand the tensile force application.

10.2.1.2 Bond the wallboard back surface of a piece of ½ by 4 by 4 in. (12.7 by 102.0 by 102.0 mm) wallboard paper to one of the wood blocks Douglas-fir block by applying to the bottom by a trowel full coverage with sufficient adhesive to cause uniform squeeze-out of excess adhesive on all sides when the bond area is compressed to a line thickness of approximately 1/32 in. (0.8 mm).

10.2.1.3 Insert and position two wire spacers of, No. 20 gage, at least 2-in. (51.0-mm) 3 in. (76 mm) long into the bonded area with the spacers positioned ¼- in. (6.3 mm) from each edge of the wood block.

10.2.1.4 Compress the bonded area of each assembly tensile test specimen immediately under a load of 5 lb ± 0.1 lb (22 N) for 3 min.

10.2.1.5 Scrape all excess adhesive away from edges using a square-tipped spatula. Remove the weight and next the spacers, taking care to avoid disturbing the alignment.

10.2.1.6 Prior to testing, lower the free-cable loop of the aluminum test jig into the block's precut groove and insert a ⅜-in. (9.5-mm) diameter T-bar pin laterally through the predrilled holes just above the cable's loop, as shown in alignment. See Fig. 1. 4.

10.2.2 *Tensile-Strength Determination* —Determine the tensile strength of the adhesive on a testing machine capable of providing loading at a rate of 60 lbf (267 N)/min. Position the tensile test specimen with the Douglas-fir wood block centered between the angles. Refer to Fig. 2. The tensile test fixture is mounted to a permanent base and includes self-alignment features to ensure the stress application is perpendicular to the joint until failure. Connect the tensile test specimen to the test machine by connecting the tension rod with clevis to the wood screw with the eyelet. Ensure the test assembly maintains proper alignment throughout the test. Record the maximum tensile strength of each specimen and the average tensile strength for the 24 h and 14 day tests.

10.2.3 *Tensile Strength After 24 h* :

TABLE 2 Cyclic-Exposure Conditioning for Shear-Test Assemblies (See 10.1.6)Note 1—Four complete aging cycles to be used.

NOTE 2—Room temperature storage required over weekends.

Time, h	Temperature °FC (°CF)	Relative Humidity, %
4	100.0 (38.0)	85 ± 2
4	38.0 (100)	85 ± 2
4	40.0 (4.5)	uncontrolled
16	122.0 (50.0)	uncontrolled
16	50 (122)	uncontrolled

NOTE 1—Four complete aging cycles to be used.
NOTE 2—Room temperature storage required over weekends.

10.2.3.1 Prepare five tensile test ~~assemblies~~ specimens using the procedure outlined in 10.2.1.

10.2.3.2 After ~~aging~~ conditioning the ~~assemblies~~ tensile test specimens 24 h at standard conditions, determine the tensile strength in accordance with 10.2.2.

10.2.4 *Tensile Strength After 14 Days* :

10.2.4.1 Prepare five tensile test ~~assemblies~~ specimens using the procedure outlined in ~~10.2.1. In this test, use plywood for wallboard. The plywood shall be prepared as outlined in 10.1.2.1.~~ 10.2.1.

10.2.4.2 After ~~aging~~ conditioning the ~~assemblies~~ tensile test specimens 14 days at standard conditions, determine the tensile strength in accordance with 10.2.2.

10.3 *Adhesive Open-Time Determination* :

~~10.3.1 *Wallboard*—Prepare~~

10.3.1 Prepare five ~~assemblies~~ open-time specimens as follows:

10.3.1.1 Using a suitable template (Fig. ~~4~~ 5), spread a uniform bead of adhesive ⅜ ~~in. (9.5 mm)~~ by ⅜ by 2 in. (9.5 by 9.5 by 51 mm) ~~at least 2 in. (51.0 mm)~~ long on the back paper surface of a 2 by ~~2~~ 4 in. ~~(51.0~~ (51 by ~~51.0~~ 102 mm) piece of gypsum wallboard that has been conditioned for 24 h at standard conditions.

10.3.1.2 After conditioning the assembly for 30 min ± 1 min at standard conditions, position a 2 by ~~2~~ 4 in. ~~(51.0~~ (51 by ~~51.0~~ 102 mm) piece of gypsum wallboard centrally over the bead and before compressing the adhesive, rotate the top piece 90 degrees thus creating an X-figure overlay. Immediately place a ~~5-lb (2.3-kg)~~ 5 lb ± 0.1 lb (22 N) weight on the assembly. Remove the weight after 30 min.

10.3.1.3 After a period of 24 h under standard conditions, pull the assembly apart.

10.3.1.4 Examine the ~~assembly after testing~~ test specimen bonded area for percent of transfer and paper failure. Report the average for the five ~~assemblies.~~ test specimens.

10.4 *Substrate Wet-Out by Adhesive* :

10.4.1 *Plywood*—Prepare five ~~assemblies~~ plywood wet-out test specimens as follows:

10.4.1.1 Using a spatula, apply a~~e~~nd press a small amount of adhesive ~~on~~ to the plywood surface ~~of the Douglas fir plywood, grade PSI Exterior A-A or A-B, which~~ that has been conditioned ~~48 h~~ at ~~73 ± 2°F (23 ± 1°C) and 50 ± 2 % relative humidity.~~ standard conditions. By reversing the ~~pressure of the spatula,~~ spatula pressure, attempt to lift the adhesive from the surface.

10.4.1.2 Examine the surface of the plywood and the spatula ~~to d~~. Determine whether the failure is an adhesi~~v~~eon or cohesi~~v~~on type failure. The adhesive is considered to have wetted the plywood if the failure is cohesive.

10.4.2 *Gypsum Wallboard*— Prepare five ~~assemblies~~ gypsum wallboard wet-out test specimens as follows:

10.4.2.1 Using a spatula, apply a~~e~~nd press a small amount of adhesive on the ~~surface of the~~ gypsum wallboard ~~which~~ back paper surface that has been conditioned ~~48 h~~ at ~~73 ± 2°F (23 ± 1°C) and 50 ± 2 % relative humidity.~~ standard conditions. By reversing the pressure of the spatula, attempt to lift the adhesive from the surface.

10.4.2.2 Examine the surface of the gypsum wallboard and the spatula to determine whether the failure is adhesi~~v~~eon or cohesi~~v~~on type failure. The adhesive is considered to have wetted the gypsum wallboard if the failure is cohesive.

10.5 *Gap-Filling (Bridging Characteristics)* :

10.5.1 Construct a test frame 34 by 48 in. ~~(864.0~~ (86.4 by ~~1219.0~~ 121.9 mm) as shown in Fig. ~~4~~ 6 using nominal 2 by 4 ~~in. (51.0 by 102.0 mm) Douglas fir~~ Douglas-fir dimension lumber. ~~Nail~~ Install a middle stud at 16 in. ~~(406.0 mm)~~ on center between the two outer studs, but it is recessed ¼ in. (6.3 mm). By using a level, make sure the frame is perfectly flat. Condition the frame for 48 h at standard ~~conditions (73 ± 2°F (23 ± 1°C) and 50 ± 2 % relative humidity).~~ conditions.

10.5.2 Using a caulking gun and a suitable template (Fig. ~~5)~~ 5) spread a uniform ⅜ by ⅜ in. (9.5 by 9.5 mm) bead of adhesive along the length of the center recessed stud. After 15 min, nail or screw fasten, a ½ in. (12.7 mm) thick piece of gypsum wallboard 34 by 48 in. ~~(864.0~~ (86.4 by ~~1219.0 mm)~~ 121.9 cm) to the outside longitudinal studs using ~~10-in. (254.0-mm) nail~~ 10 in. (25.4 cm) fastener spacing. Firmly press the gypsum wallboard ~~over~~ toward the center recessed stud to ensure maximum deflecting and next allow the gypsum wallboard to spring back to its original position. Condition the test frame 48 h under standard conditions.

10.5.3 Remove the ~~nails~~ fasteners from the outside studs. Grasp one edge of the gypsum wallboard at points adjacent to each side of the recessed stud and pull outwardly at 90° to the stud. Examine the back of the gypsum wallboard and the stud and note the adhesive's gap filling or bridging characteristic~~s~~. A passing result ~~shall give a continuous~~ is when an intact adhesive bond ~~line~~

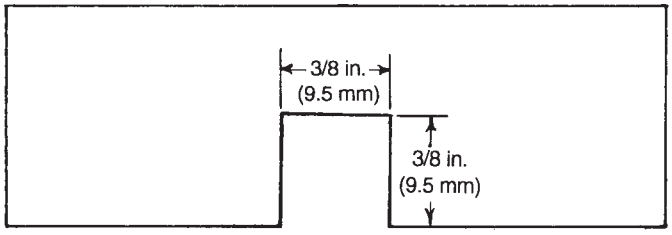

FIG. 5 Description of a Suitable Template for Uniform Bead Application

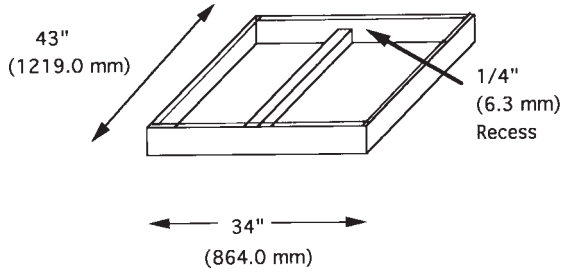

FIG. 6 Gap Filling (Bridging Characteristics) Test Stud Frame

~~if a cross-section was taken of~~ is maintained between the ~~assembly.~~ gypsum wallboard and back surface paper. Report the percent paper failure and contact length in inches.

10.6 *Accelerated Adhesive Aging (Oven Test)*:

~~10.6.1 Using Test Method D 4338 as~~

10.6.1 Cast a ~~guide, cast a~~ 12 ± 2 mil dry adhesive layer on a 2 by 6 in. (51.0 by 152.0 mm) strip of 1/32- in. (0.8- mm) aluminum panel with a blade. Place the specimen into a 150°F-(70°C) oven (humidity uncontrolled) for 500 h.

10.6.2 Allow the specimen to cool for 1 h ± 5 min at room temperature. Then slowly bend the specimen around a 1- in. (25.4- mm) steel mandrel with the adhesive side out. The specimen shall be free of cracks and show no sign of chipping away of the adhesive from the substrate.

10.7 *Freeze-Thaw Stability*:

10.7.1 Place 4 oz (118.0 mL) of adhesive in an 8-oz (236.0-mL) container, close the container tightly and store it at 0 ± 5°F (−17.8 ± 2.8°C) for 24 h and then store it at standard conditions for another 24 h.

10.7.2 After three cycles, test the samples in accordance with 10.1.4.

10.8 *Suitability as a Laminating Adhesive for Vinyl-Covered Wallboard*:

10.8.1 *Vinyl-Covered Gypsum Wallboard Compatibility*:

10.8.1.1 Place 6 oz (177.0 mL) of adhesive into a clean, dry, open, 1 pt (0.5 L) tin-lined can. Place the can into a 1 gal (3.8 L) container. Seal a piece of vinyl-covered wallboard face-up on top of the gallon container using water-impervious duct tape. Place the assembly into an oven at 110°F (43°C) for 24 h.

10.8.1.2 Remove the assembly and the vinyl-covered wallboard and evaluate for blistering, vinyl film discoloration, and bond failure.

10.8.2 *Staining*:

10.8.2.1 In two areas, apply with a caulking gun two dabs of adhesive approximately 2 in. (51.0 mm) in diameter to the face surface of the vinyl-covered wallboard. Following manufacturer's recommendations, clean both areas 1 h after application of the adhesive to the vinyl surface.

10.8.2.2 Evaluate the sample for swelling or discoloration.

~~11. Packaging and Marking~~

~~11.1 *Packaging*—The adhesive shall be packaged in standard commercial containers. The containers shall be so constructed as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the point of delivery, unless otherwise specified in the contract or order.~~

~~11.2 *Marking*—Shipping containers shall be marked with the name of the adhesive, the quantity contained therein, the name of the manufacturer, and the batch number.~~

~~12.~~ Report

1~~2~~1.1 Report the following information:

1~~2~~1.1.1 Complete identification of the material tested, including form, type, source, manufacturer's code number, etc.

1~~2~~1.1.2 Complete listing of the results in accordance with Table 1. Reference Fig. 7 for reporting test results.

12. Precision and Bias[6]

12.1 The precision information given below is in the units of measurement (psi), each of which is the average of five test determinations:

[6] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: D14–1010.

ADHESIVE: **TEST NO:**
MANUFACTURER: **DATES:**

TESTED BY:

10.1.4 24-Hour Shear	
	Date:
Specimen #	Load (lbf)
1	
2	
3	
4	
5	
Average	
Avg. psi	
Req. psi	10
Status	

10.1.5 14-Day Shear	
	Date:
Specimen #	Load (lbf)
1	
2	
3	
4	
5	
Average	
Avg. psi	
Req. psi	40
Status	

10.1.6 Cyclic Exposure Shear	
	Date:
Specimen #	Load (lbf)
1	
2	
3	
4	
5	
Average	
Avg. psi	
Req. psi	32
Status	

10.2.3 24-Hour Tensile	
	Date:
Specimen #	Load (lbf)
1	
2	
3	
4	
5	
Average	
Avg. psi	
Req. psi	15
Status	

10.2.4 14-Day Tensile	
	Date:
Specimen #	Load (lbf)
1	
2	
3	
4	
5	
Average	
Avg. psi	
Req. psi	25
Status	

10.7 Freeze Thaw Stability	
	Date:
Specimen #	Load (lbf)
1	
2	
3	
4	
5	
Average	
Avg. psi	
Req. psi	10
Status	

Shear Strength under Static Load (10.1.7)
(a) 40 lb load: _____
(b) 20 lb load: _____

Open Time (10.3): _____

Wet out (10.4.1, 10.4.2)
(a) on plywood: _____
(b) on wallboard: _____

Bridging (10.5): _____

Aging (10.6): _____

Freeze Thaw Stability (10.7): _____

Laminating suitability on vinyl-covered wallboard (10.8.1, 10.8.2)
(a) compatibility: _____
(b) staining: _____

FIG. 7 Sample Format for Reporting Test Results

	Average	Sr	SrCOV%	SR	SRCOV%	r	R
Shear Strength (psi)	66	16	24	20	30	44	57
Tensile Strength (psi)	56	10	18	14	25	18	40

where:
Sr = Repeatability Standard Deviation
SR = Reproducibility Standard Deviation
r = 95 % Repeatability Limit (within a laboratory)
R = 95 % Reproducibility Limit (between laboratories)
COV = Coefficient of Variation (Average/Standard Deviation) percentage

The table was calculated using the relationship: 95 % Limit = 2.8 × standard deviation.

12.1.1 The term repeatability and reproducibility limits are used as specified in Practice E 177.

13. Keywords

13.1 adhesive; gap-filling; gypsum wallboard; shear strength; tensile strength; vinyl; workability.

SUMMARY OF CHANGES

Subcommittee D14.70 has identified the location of selected changes to this standard since the last issue (C 557 - 99) that may impact the use of this standard.

(1) Edited Scope section by adding text and also added 1.4.
(2) Edited References section by removing unrelated references and replacing obsolete references.
(3) Edited Terminology section by deleting itemized definitions and replacing obsolete references.
(4) Added line items 4.4 and 4.5 to Significance and Use.
(5) Changed sections 7, 8, 9, and 10 by adding new materials, clarified procedure, revised test fixtures, and deleted rescinded information.
(6) Added tolerances to procedure recommendations for time, weight, and distance.
(7) Removed Packaging and Marking requirements.
(8) Revised the Gap-Filling (Bridging Characteristics) test requirement.
(9) Added Precision and Bias section.
(10) Added photographs to show the revised test fixture apparatus and test specimen construction.
(11) Added Figure 7 – a test results reporting format.