



Designation: C474 – 11

# Standard Test Methods for Joint Treatment Materials for Gypsum Board Construction<sup>1</sup>

This standard is issued under the fixed designation C474; 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 These test methods cover the physical testing of joint compound, paper joint tape, glass-mesh joint tape, and an assembly of joint compound and paper joint tape.

1.1.1 Joint treatment materials are specified in Specification C475/C475M.

1.1.2 The joint treatment material described in this standard are for use with gypsum board installed in accordance with Specification C840.

1.2 The test methods appear in the following order:

	Section
Joint Compound Tests:	
Viscosity	5
Shrinkage	6
Check Cracking	7
Putrefaction	8
Joint Tape Tests:	
Tensile Strength	9
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Paper Joint Tape Tests	
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Assemblages of Paper Joint Tape and Joint Compound:	
Bond of Paper Joint Tape to Joint Compound	15
Cracking of Joint Compound at Tape Edges	14
Glass-Mesh Joint Tape Test	
Skewness	13

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in brackets are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 The text of this standard references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.5 *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.*

<sup>1</sup> These test methods are under the jurisdiction of ASTM Committee C11 on Gypsum and Related Building Materials and Systems and are the direct responsibility of Subcommittee C11.02 on Specifications and Test Methods for Accessories and Related Products.

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## 2. Referenced Documents

2.1 *ASTM Standards*:<sup>2</sup>

C11 Terminology Relating to Gypsum and Related Building Materials and Systems

C472 Test Methods for Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete

C475/C475M Specification for Joint Compound and Joint Tape for Finishing Gypsum Board

C840 Specification for Application and Finishing of Gypsum Board

C1396/C1396M Specification for Gypsum Board

D685 Practice for Conditioning Paper and Paper Products for Testing<sup>34</sup>

D828 Test Method for Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus<sup>34</sup>

D3699 Specification for Kerosine

D3882 Test Method for Bow and Skew in Woven and Knitted Fabrics

E100 Specification for ASTM Hydrometers

2.2 *TAPPI Standard*:

T 411 Thickness (Caliper) of Paper, Paperboard, and Combined Board<sup>5</sup>

## 3. Terminology

3.1 *Definitions*—For definitions of terms relating to gypsum, see Terminology C11.

3.2 *Definitions of Terms Specific to This Standard*:

3.2.1 *bond, n—in joint systems*, the quality of adhesion between the paper joint tape and joint compound.

3.2.1.1 *Discussion*—A0 % bond means that no paper fiber is adhering to the joint compound. A100 % bond means that there is cohesive failure of the paper joint tape.

<sup>2</sup> 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.

<sup>3</sup> Formerly under the jurisdiction of Committee D06 on Paper and Paper Products, this standard was withdrawn in 2010 in accordance with section 10.5.3.1 of the *Regulations Governing ASTM Technical Committees*, which requires that standards shall be updated by the end of the eighth year since the last approval date.

<sup>4</sup> Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

<sup>5</sup> Available from Technical Association of the Pulp and Paper Industry, Technology Park, P.O. Box 105113, Atlanta, GA 30348.

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

3.2.2 *check cracking, n—in joint systems*, short, narrow cracks randomly oriented in the surface of the dried joint compound.

3.2.3 *joint compound, powder, n*—A drying-type or setting-type cementitious material to be mixed with water.

3.2.4 *joint compound, ready-mix, n*—A drying-type cementitious material that is factory mixed in ready-to-use form.

## 4. Specimen Preparation

### 4.1 Joint Compound, Powder:

4.1.1 Mix 300 g of joint compound, powder, with approximately 150 to 160 mL of water.

4.1.2 Allow the specimen to stand for 30 min (**Note 1**), remix and adjust the temperature to  $77 \pm 2^\circ\text{F}$  [ $25 \pm 1^\circ\text{C}$ ] by placing the container holding the specimen in warm or cool water.

**NOTE 1**—Allow setting type compounds to stand for one half of their setting times, as determined by Test Methods **C472** but not more than 30 min, prior to remixing.

4.1.3 Measure the viscosity in accordance with Section 5.

4.1.4 If the measured viscosity is not between 480 and 520 Brabender units, repeat 4.1.1-4.1.3 through with an increase or decrease in water as necessary.

4.1.5 Record the volume of water used to adjust the viscosity to  $500 \pm 20$  Brabender units (see **Note 2**).

**NOTE 2**—Making note of the volumes of water, in millilitres per 100 g of material, used to adjust the viscosity, will facilitate specimen preparation in other tests.

### 4.2 Joint Compound, Ready-Mix:

4.2.1 Remix joint compound, ready-mix, to reincorporate any separated ingredients. Adjust the temperature to  $77 \pm 2^\circ\text{F}$  [ $25 \pm 1^\circ\text{C}$ ] by placing the container holding the specimen in warm or cool water.

4.2.2 Measure the viscosity in accordance with Section 5.

4.2.3 If the viscosity is more than 520 Brabender units, add water to achieve a viscosity of  $500 \pm 20$  Brabender units (see **Note 2**).

4.2.3.1 If the original sample viscosity is less than 480 Brabender units, test as received.

## JOINT COMPOUND

### 5. Joint Compound Viscosity

#### 5.1 Significance and Use:

5.1.1 This test method provides a procedure for measuring joint compound viscosity.

#### 5.2 Sampling:

5.2.1 Sampling shall be in accordance with Specification **C475/C475M**.

#### 5.3 Specimen Preparation:

5.3.1 Prepare specimens in accordance with Section 4.

#### 5.4 Apparatus:

5.4.1 *Viscosity Specimen Container*, metal or plastic with an open top having an inside diameter of  $2\frac{1}{2}$  to 3 in. [65 to 75 mm] and a height of  $2\frac{1}{2}$  to 3 in. [65 to 75 mm].

5.4.2 *Viscometer*<sup>6</sup>, adjusted to operate at  $78 \pm 1$  r/min, and with a 250 cm-g sensitivity cartridge.

5.4.3 *Viscometer Pin*, having dimensions as follows:

	in. [mm]
Shaft diameter	$0.187 \pm 0.015$ [4.75 $\pm$ 0.38]
Pin diameter	$0.094 \pm 0.015$ [2.39 $\pm$ 0.38]
Immersion depth (from bottom of spindle)	$1.625 \pm 0.015$ [41.3 $\pm$ 0.38]
Length of pin projecting from shaft	$0.750 \pm 0.015$ [19.1 $\pm$ 0.38]
Upper pin from bottom of shaft	$0.313 \pm 0.015$ [7.95 $\pm$ 0.38]
Lower pin from bottom of shaft	$0.125 \pm 0.015$ [3.28 $\pm$ 0.38]

#### 5.5 Procedure:

5.5.1 Fill the viscosity container with the mixed specimen until level with the top of the container.

5.5.1.1 Remove all air bubbles by puddling the sample container with a spatula and sharply rapping the bottom of the container on a hard flat surface.

5.5.2 Lock the filled container in the center of the viscometer spindle platform. Raise the platform until the level of the specimen reaches the mark on the viscometer pin and lock the platform in place.

5.5.3 Start the viscometer. Read the viscosity after the pen starts to trace a straight line (usually within 1 min). If the tracing remains inconsistent, estimate the average viscosity reading.

#### 5.6 Report:

5.6.1 Report the viscosity of the joint compound specimen in Brabender units.

#### 5.7 Precision and Bias:

5.7.1 Precision and bias of this test method have not been determined.

## 6. Shrinkage

### 6.1 Significance and Use:

6.1.1 This test is used to measure the amount of shrinkage in joint compound. The degree of correlation between this test and service performance has not been determined.

### 6.2 Sampling:

6.2.1 Sampling shall be in accordance with Specification **C475/C475M**.

### 6.3 Specimen Preparation:

6.3.1 Specimen preparation shall be in accordance with Section 4.

### 6.4 Apparatus:

6.4.1 *Plastic or Rubber Film*, approximately 5 by 5 in. [130 by 130 mm]. Any thin, flexible film that peels clean from a partially dried patty may be used.<sup>7</sup>

6.4.2 *Balance*, having a sensitivity of 10 mg (**Fig. 1** and **Fig. 2**).

6.4.3 *Beaker, Ring Stand, and Wire Cradle* (see **Fig. 1**).

6.4.4 *Forced Air Drying Oven*, capable of being maintained at 90 to 120°F [32 to 49°C].

6.4.5 *Spatula*, having a blade approximately 4 in. by  $\frac{1}{2}$  in. [100 by 13 mm].

6.4.6 *Steel-Reinforced Broad Knife*, a 5 to 8 in. [130 by 200 mm] drywall broad knife reinforced by a steel bar, 1 in. [25

<sup>6</sup> The sole source of supply of the apparatus known to the committee at this time is the Brabender "Visco-Corder" Model VC-3, manufactured by C.W. Brabender Instruments Inc., South Hackensack, NJ. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee<sup>1</sup>, which you may attend.

<sup>7</sup> Rubber dental dam dusted with talc, polyethylene, or PTFE films have been found satisfactory for this use.

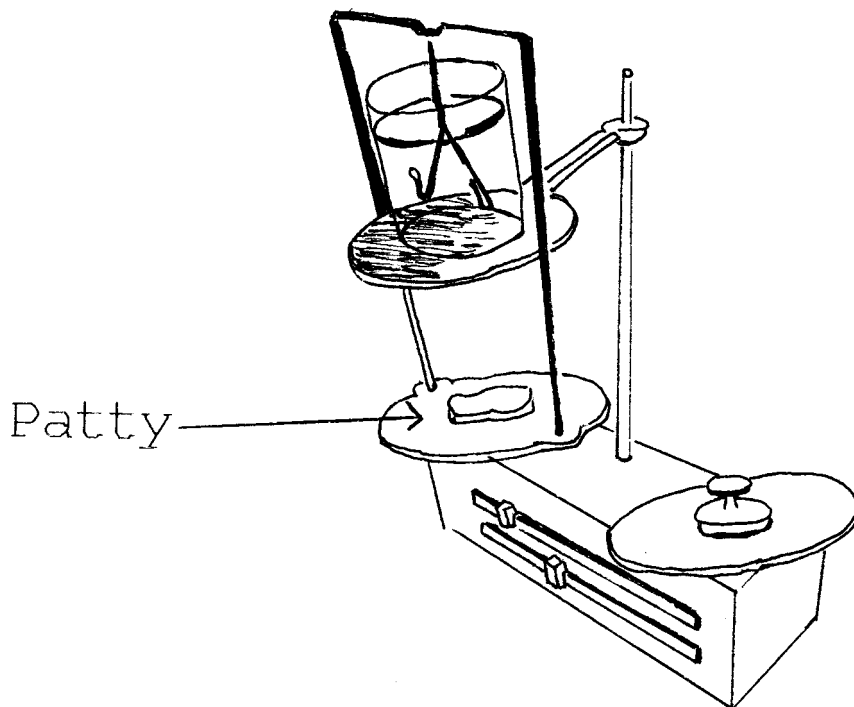


FIG. 1 Wire Cradle in Kerosine

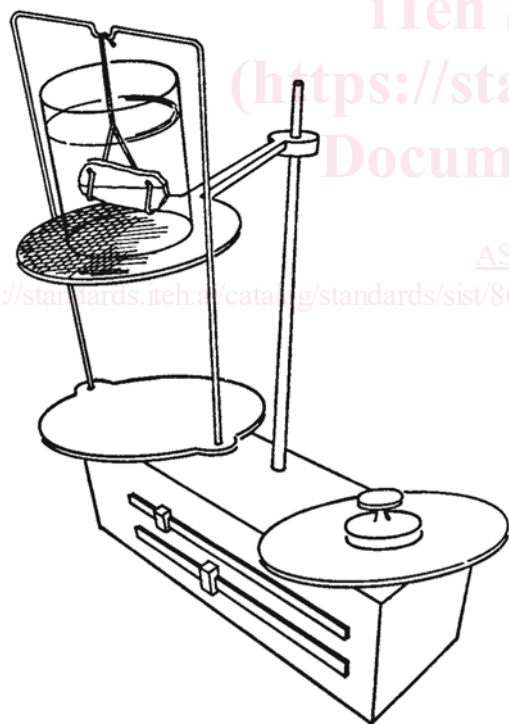


FIG. 2 Patty Immersed in Kerosine

mm] wide by  $\frac{1}{8}$  in. [3 mm] thick, by the knife width, attached to the back of the knife blade  $\frac{1}{4}$  in. [6 mm] from the edge.

6.4.7 *Hydrometer*, having a range of 0.7 to 0.8 sp gr, in accordance with Specification E100.

6.4.8 *Volumetric Container*, a container which has a volume between 25 and 300 cm<sup>3</sup>.

6.5 *Reagents and Materials:*

6.5.1 *Displacement Fluids.*

6.5.1.1 *Mineral Spirits*, odorless.

6.5.1.2 *Kerosine* (see Specification D3699).

6.6 *Preparation of Apparatus:*

6.6.1 *Support Plates*—Cover three plastic or glass plates with plastic or rubber film.

6.6.2 Obtain and record the tare weight of each assembly.

6.7 *Calibration:*

6.7.1 *Volumetric Container*—Determine the container volume in cubic centimetres and its tare weight in grams.

6.7.2 *Mineral Spirits, Kerosine*—Using the hydrometer, determine the specific gravity and record the result as density  $M$ , g/mL.

6.8 *Determination of Density of Wet Compound:*

6.8.1 Prepare a specimen to determine the density of wet compound by weighing the specimen in the volumetric container.

6.8.1.1 Adjust the temperature to  $70 \pm 2^\circ\text{F}$  [ $21 \pm 1^\circ\text{C}$ ] by placing the container holding the specimen in warm or cool water.

6.8.1.2 Puddle the specimen within the container with the spatula to remove entrapped air bubbles.

6.8.1.3 Finish filling the container and strike off the surface flush with the top using the steel-reinforced broad knife.

6.8.1.4 Weigh the filled container to the nearest 0.01 g. Record the weight of the filled container.

6.8.1.5 Determine the net weight of the compound in the volumetric container by subtracting the weight obtained in 6.8.1.4 from the weight obtained in 6.7.1.

6.8.1.6 Divide the net weight obtained in 6.8.1.5 by the volume of the container obtained in 6.7.1. Record the result as wet compound density  $G$ , g/mL.

$$G = \frac{\text{total weight} - \text{container tare weight}}{\text{volume of container}} \quad (1)$$

### 6.9 Preparation of Specimen to Determine Wet and Dry Volume:

6.9.1 Place approximately 30 g of specimen onto each prepared support plate (see 6.6.1).

6.9.1.1 Spread the specimen into an elongated patty  $\frac{3}{16}$  to  $\frac{1}{4}$  in. [5.0 to 6.5 mm] thick with a spatula.

6.9.1.2 Remove any specimen remaining on the spatula and add to the patty.

NOTE 3—The patty may be scored across its narrowest width to facilitate breaking the patty after it is dry.

6.9.1.3 Weigh and record the total weight of each patty, film, and plate.

6.9.1.4 Determine the net weight of each specimen by subtracting the tare weight of its support plate weight and the weight obtained in 6.9.1.3.

6.9.1.5 Divide the net weight obtained in 6.9.1.4 by  $G$ . Record as wet volume of patty  $V$ , mL.

$$V = \frac{\text{wet patty weight} - \text{support plate tare weight}}{G} \quad (2)$$

### 6.10 Determination of Dry Volume:

6.10.1 Dry patties at a temperature between 100 and 120°F [32 to 49°C] for 16 to 24 h.

6.10.1.1 When testing setting type joint compounds, place the patties in the drying oven 1 h after the setting time has been reached as determined by Test Methods C472.

6.10.1.2 When testing drying type joint compounds, place the patties in the drying oven immediately after weighing.

6.10.2 Strip off the plastic or rubber film, and continue to dry under the conditions specified in 6.10.1 until constant weight is reached.

6.10.3 Immerse each patty in a beaker of the displacement fluid, such that they do not touch the sides of the beaker, for a minimum of 4 h, until constant weight is reached.

NOTE 4—Each patty may be broken into two or three pieces to fit in the beaker without touching the sides.

6.10.4 Remove each patty from the displacement fluid. Using a cloth moistened in the same fluid, lightly blot off the excess fluid from the surface of the patty.

6.10.5 With the wire cradle suspended in the beaker of displacement fluid, weigh each patty in air on the pan of the balance (Fig. 1), and record as its air weight.

6.10.6 Next, weigh each patty in the wire cradle, ensuring that the patty is completely immersed in the liquid and that it does not touch the sides of the beaker (Fig. 2). Record these weights as the immersed weight.

6.10.7 Subtract the immersed patty weight obtained in 6.10.6 from the air patty weight obtained in 6.10.5. Record as  $D$ , the weight difference, which is the weight of fluid displaced by the dried and then saturated patty.

6.10.8 Divide  $D$ , the weight difference, by  $M$ , the density of the displacement fluid determined in 6.7.2, and record as dry volume of patty,  $R$ , mL.

$$R = D/M \quad (3)$$

### 6.11 Calculation of Shrinkage:

6.11.1 Calculate the percent shrinkage as follows:

$$\% \text{ shrinkage} = [1 - (R / V)] \times 100 \quad (4)$$

where:

$R$  = volume of the dry patty, and

$V$  = volume of the wet patty.

### 6.12 Report:

6.12.1 Take the average of the three patties tested. If there is a difference between the percent shrinkage of the three patties of more than 1.5 %, completely retest an additional three specimens and take the average of the six.

### 6.13 Precision and Bias:

6.13.1 Precision and bias of this test method have not been determined.

## 7. Check Cracking of Joint Compound

### 7.1 Significance and Use

7.1.1 This test method is used to measure the degree and type of field and edge cracking of joint compound. The degree of correlation between this test and service performance has not been determined.

### 7.2 Sampling:

7.2.1 Sampling shall be in accordance with Specification C475/C475M.

### 7.3 Specimen Preparation:

7.3.1 Prepare specimens in accordance with Section 4, except use a quantity of 100 g.

### 7.4 Apparatus:

7.4.1 Rod, metal or glass,  $\frac{1}{8}$  in. [3.2 mm] in diameter by 7 in. [180 mm] in length.

7.4.2 Steel-Reinforced Broad Knife, as defined in 6.4.6.

7.4.3 Gypsum Wallboard, Specification C1396/C1396M.

7.4.3.1 To determine compliance to Specification C475/C475M, Specification C1396/C1396M gypsum wallboard shall be used.<sup>8</sup>

7.4.4 Electric Fan, capable of forcing a continuous current of air at a velocity of 350 to 450 ft/min [1.8 to 2.3 m/s] at a distance of approximately 3 ft [1 m].

### 7.5 Procedure:

7.5.1 Place the rod on a piece of gypsum wallboard and place some of the specimen next to the rod.

7.5.2 Form a 3½ to 4 in. [90 to 100 mm] wide wedge of the specimen with the steel-reinforced broad knife, with the rod on one side and the wallboard on the other side to guide the knife.

7.5.2.1 Hold the broad knife at an angle less than 45° with respect to the plane of the wallboard. Draw the broad knife over the specimen two or more times to leave the surface smooth.

7.5.3 Remove the rod and adjust the wedge to a 5 in. [130 mm] length.

7.5.4 Immediately place the wedge-shaped specimen in front of the fan blowing over the surface of the wedge for 8 to 16 h. The current of air shall be maintained at 70 to 85°F [21 to 29°C] and 45 to 55 % relative humidity.

<sup>8</sup> Other substrates may be used to evaluate the effect that they have on the performance of the joint compound and assemblies of joint compound and joint tape.

**7.6 Report:**

7.6.1 Report the type and amount of cracking in both the thick half and the thin half of the wedge.

**7.7 Precision and Bias:**

7.7.1 Precision and bias of this test method have not been determined.

**8. Putrefaction**
**8.1 Significance and Use:**

8.1.1 This test method is used to evaluate the tendency of the joint compound to putrefy. The degree of correlation between this test and service performance has not been determined.

**8.2 Sampling:**

8.2.1 Sampling shall be in accordance with Specification **C475/C475M**.

**8.3 Apparatus:**

8.3.1 *Humidity Cabinet*, a chamber capable of maintaining 85 to 95°F [29 to 35°C] and 85 to 95 % relative humidity.

8.3.2 *Glass Container*, capable of being sterilized in an autoclave, having a minimum volume of 250 mL.<sup>9</sup>

8.3.3 *Cover*, made of glass or aluminum foil large enough to cover the glass container and capable of being sterilized in an autoclave.

8.3.4 *Autoclave*, capable of maintaining 260°F [130°C] at 21 psi [145 kPa] steam pressure for not less than 15 min.

**8.4 Preparation of Apparatus:**

8.4.1 Sterilize the glass container and cover in an autoclave at 21 psi [145 kPa] and 260°F [130°C] for 15 min or more.

**8.5 Procedure:**

8.5.1 *Joint Compound, Powder*—Mix 50 g of joint compound with water, as determined in 4.1 in the glass container. Allow it to soak 30 min and then remix. Place the cover over the glass container and place in the humidity cabinet.

8.5.2 *Joint Compound, Ready-mix*—Select an unopened container that has not exceeded the producer's specified shelf life.

8.5.2.1 Open the container. If the material in the container has separated, mix thoroughly.

8.5.2.2 Remove 100 g of joint compound, ready-mix, from the container.

8.5.2.3 Put the specimen in the glass container and cap with the cover.

8.5.2.4 Place in the humidity cabinet.

**8.6 Interpretation of Results:**

8.6.1 Observe daily for putrefaction.

**8.7 Report:**

8.7.1 Report the number of days required to produce putrefaction.

**8.8 Precision and Bias:**

8.8.1 Precision and bias of this test method have not been determined.

**9. Tensile Strength**
**9.1 Significance and Use:**

9.1.1 This test method is used to evaluate the cross-directional strength of joint tape used to reinforce the joints created by gypsum wallboard construction. The degree of correlation between this test and service performance has not been determined.

**9.2 Sampling:**

9.2.1 Sampling shall be in accordance with Specification **C475/C475M**.

9.2.2 A sample for the purpose of testing shall consist of not less than 12 ft [3.6 m] of tape from each roll.

9.2.3 Take ten specimens in the cross direction at not less than 1 ft (300 mm) intervals. Cut each specimen to 1 in. [25 mm] by roll width.

**9.3 Apparatus:**

9.3.1 The apparatus shall be in accordance with Test Method **D828** except that the distance of the jaw spacing shall be reduced to  $\frac{1}{2} \pm \frac{1}{64}$  in. [12.7  $\pm$  0.4 mm]; the rate of elongation shall be 0.66 in./min  $\pm$  5 s [17 mm/min  $\pm$  5 s].

**9.4 Procedure:**

9.4.1 Condition the specimens for a minimum of 24 h at 72  $\pm$  4°F [22  $\pm$  2°C] and 50  $\pm$  2 % relative humidity.

9.4.2 Test in accordance with Test Method **D828** with equipment as set forth in 9.3.

**9.5 Interpretation of Results:**

9.5.1 Accept or reject results of the individual test specimens in accordance with Test Method **D828**.

9.5.2 If any results are rejected, test additional specimens so that there are at least ten test results for the evaluation of any unit of tape.

**9.6 Report:**

9.6.1 Report test results as pounds-force per inch (Newtons per millimetre) of width of specimen.

**9.7 Precision and Bias:**

9.7.1 Precision and bias statements as listed in Test Method **D828** are suitable for use with this product.

**10. Width**
**10.1 Significance and Use:**

10.1.1 This test method is used to determine the average variation in width of the joint tape. The degree of correlation between this test and service performance has not been determined.

**10.2 Sampling:**

10.2.1 Sampling shall be in accordance with Specification **C475/C475M**.

**10.3 Specimen Preparation:**

10.3.1 Cut a specimen of joint tape not less than 12 ft [3.5 m] long from the roll to be tested.

**10.4 Apparatus:**

10.4.1 *Steel Rule, Caliper Rule*, or other measuring device capable of resolving  $\frac{1}{32}$  in. A metric device must be capable of resolving 1.0 mm.

**10.5 Procedure:**

<sup>9</sup> Deep Petri dishes and 250 mL beakers have been found suitable for this purpose.

10.5.1 Measure the width of the specimen in ten places, at least 1 ft [300 mm] apart, to the nearest 1/32 in. [1.0 mm]. Record each measurement.

10.6 Calculation of Results:

10.6.1 Determine the maximum and minimum widths. Calculate the average width.

10.6.2 Determine the difference between the maximum and minimum width by subtraction.

10.7 Report:

10.7.1 Report the average width, and the difference between the maximum and minimum width.

10.8 Precision and Bias:

10.8.1 Precision and bias of this test method have not been determined.

11. Thickness

11.1 Significance and Use:

11.1.1 This test method is used to determine the average thickness of joint tape. The degree of correlation between this test and service performance has not been determined.

11.2 Sampling:

11.2.1 Sampling shall be in accordance with Specification C475/C475M.

11.3 Specimen Preparation:

11.3.1 Cut a specimen of tape not less than 12 ft [3.5 m] long from the roll to be tested.

11.3.2 Condition the specimen for a minimum of 24 h as described in Practice D685.

11.4 Apparatus:

11.4.1 Paper Micrometer having circular faces of 0.25 to 0.33 in.<sup>2</sup> [160 to 215 mm<sup>2</sup>] in area. Faces shall be under steady pressure of 7 to 9 psi [50 to 60 kPa].

NOTE 5—For details see TAPPI T 411, except waive Section 7.

11.5 Procedure:

11.5.1 Measure the thickness of the specimen in 10 places, between the edges, at least 1 ft [300 mm] apart. Skived areas on the tape edges shall not be included in the area measured for thickness.

NOTE 6—Skiving is not present on all tapes.

11.5.2 Record the thickness to the nearest 0.001 in. [0.01 mm].

11.6 Report:

11.6.1 Report the average thickness.

11.7 Precision and Bias:

11.7.1 Precision as reported in the TAPPI Standard T 411 states that the within-laboratory repeatability is 1.25 % and the laboratory reproducibility is 5.50 %.

PAPER JOINT TAPE

12. Dimensional Stability

12.1 Significance and Use:

12.1.1 This test method is used to determine the lengthwise and crosswise expansion characteristics of the paper joint tape used to reinforce the joints created in gypsum wallboard construction. The degree of correlation between this test and service performance has not been determined.

12.2 Sampling:

12.2.1 Sampling shall be in accordance with Specification C475/C475M.

12.3 Specimen Preparation:

12.3.1 Cut not less than three specimens of tape 10 to 16 in. [250 to 400 mm] long from the roll to be tested.

12.3.2 Condition the specimens for a minimum of 16 h at 72 ± 4°F [22 ± 2°C] and 50 ± 2 % relative humidity.

12.4 Apparatus:

12.4.1 Steel Rule, Caliper Rule, Cathetometer or other measuring device capable of resolving 0.005 in. over a minimum span of 10 in. A metric rule must be capable of resolving 0.10 mm over a minimum span of 250 mm.

12.4.2 Sharp Knife, 4 to 5× Magnifying Glass, Pencil.

12.4.3 Glass Container at least 2½ in. [65 mm] deep and 6 in. [150 mm] in diameter.

12.5 Reagents and Materials:

12.5.1 Water, distilled or deionized.

12.6 Procedure:

12.6.1 Place the conditioned specimens on a flat surface.

12.6.1.1 At about ½ in. [10 mm] from each end of the paper tape, cut two ½ in. [10 mm] long reference marks for the length-wise measurement crosswise of the tape with a sharp knife.

12.6.1.2 Place the rule on the tape so that one edge is centered lengthwise.

12.6.2 Move the rule so that starting mark (A) coincides with the reference mark at one end of the tape. Record the value at A. Take the reading at the other reference mark. Read to the nearest 0.005 in. [0.10 mm]. (See Fig. 3).

NOTE 7—Measuring from the 1 in. [25 mm] mark and subtracting this value may be a useful method to obtain an accurate measurement. Reading the rule with a magnifying glass of 4 to 5× is recommended.

12.6.3 Place the rule across the width of the tape.

12.6.3.1 Align the starting mark (B) of the rule with one edge of the tape. Record the value at B.

12.6.3.2 Take the reading at the opposite edge of the tape. Mark the location of this crosswise measurement by drawing a 1½ in. [40 mm] long pencil mark across the tape without marring the edges of the tape. (See Fig. 4.)

12.6.4 Roll up the tape and submerge it in the container full of water at 72 ± 4°F [22 ± 2°C].

12.6.5 After 30 min, remove the tape from the water and roll it out on the flat surface. Repeat the lengthwise and crosswise measurements.

12.7 Calculation of Results:

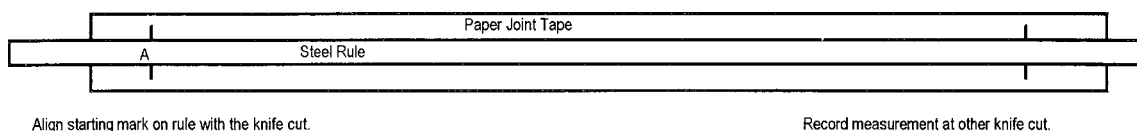


FIG. 3 Arrangement for Length Expansion Measurement