Designation: D 1623 – 78 (Reapproved 1995)

Standard Test Method for Tensile And Tensile Adhesion Properties Of Rigid Cellular Plastics[1]

This standard is issued under the fixed designation D 1623; 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 test method covers the determination of the tensile and tensile adhesion properties of rigid cellular materials in the form of test specimens of standard shape under defined conditions of temperature, humidity, and testing machine speed.

1.2 Tensile properties may be measured using any of three types of specimens:

1.2.1 *Type A* may be preferred in those cases where enough sample material exists to form the necessary specimen,

1.2.2 *Type B* may be used where only smaller specimens are available, as in sandwich panels, etc.

1.2.3 *Type C* covers the determination of tensile adhesive properties of a cellular plastic to a substrate as in a sandwich panel or the bonding strength of a cellular plastic to a single substrate.

NOTE 1—The values stated in SI units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[2]

D 638 Test Method for Tensile Properties of Plastics[2]

D 883 Terminology Relating to Plastics[2]

3. Terminology

3.1 Definitions of terms applying to this test method appear in the Appendix to Test Method D 638.

4. Apparatus

4.1 *Testing Machine*—A testing machine of the constant-rate-of-crosshead-movement type comprising essentially the following:

4.1.1 *Grips*—Grips for holding the test specimen shall be the self-aligning type; that is, they must be attached to the fixed and movable members in such a way that they will move freely into alignment as soon as any load is applied, so that the long axis of the test specimen will coincide with the direction of the applied pull through the center line of the grip assembly. Universal-type joints immediately above and below the specimen holdler are recommended. The test specimen shall be held in such a way that slippage relative to the grips is prevented, insofar as possible. For Type A specimens, use the grips shown in Fig. 1 and Fig. 2. For Type B specimens, one suitable assembly is shown in Fig. 3 and Fig. 4. For Type C specimen, a suitable assembly is shown in Fig. 5.

4.1.2 *Load Indicator*—Use a suitable load-indicating mechanism capable of showing the total tensile load carried by the test specimen when held in the grips. Choose an indicator that will permit precision to within ±1 %.

4.1.3 *Extension Indicator*—If measurement of the extension is desired, use a suitable instrument for determining the distance between two fixed points on the test specimen at any time during the test.

4.2 *Specimen Cutter*—For Type A specimens use a suitable lathe cutter (see Fig. 6).

5. Test Specimen

5.1 All surfaces of the specimen shall be free of large visible flaws or imperfections. If it is necessary to place gage marks on the specimen, do this in such a way as not to affect the surfaces of the test specimen. Gage marks shall not be scratched, punched, or impressed on the specimen.

5.2 When testing materials that are suspected to be anisotropic, prepare duplicate sets of tension test specimens having their long axes respectively parallel and normal to the suspected direction of anisotropy.

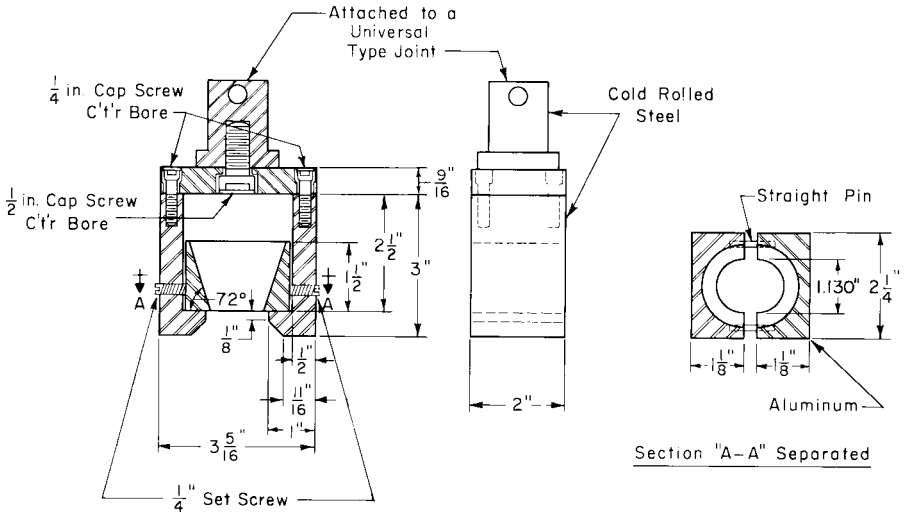
5.3 *Preparation of Type A Specimens*—The recommended Type A test specimen shall conform to the dimensions given in Fig. 7. It may be prepared by normal molding procedures wherever possible, but the "skin" effect which results cannot be eliminated and will cause a variance in the final result. Another method of preparation of the specimen, which would not have this objection, is to machine the desired geometry on a small lathe, using the cutter shown in Fig. 6. Insert a 50.8 by 50.8 by 152-mm (2 by 2 by 6-in.) block of the material to be tested in the four-jaw chuck, previously centered. Prepare the other end

[1] This test method is under the jurisdiction of ASTM Committee D-20 on Plastics, and is the direct responsibility of Subcommittee D 20.22 on Cellular Plastics.

Current edition approved May 26, 1978. Published February 1979. Originally published as D 1623 – 59 T. Last previous edition D 1623 – 72.

[2] *Annual Book of ASTM Standards*, Vol 08.01.

FIG. 1 Details of Grips for Tension Test on Type A Specimen

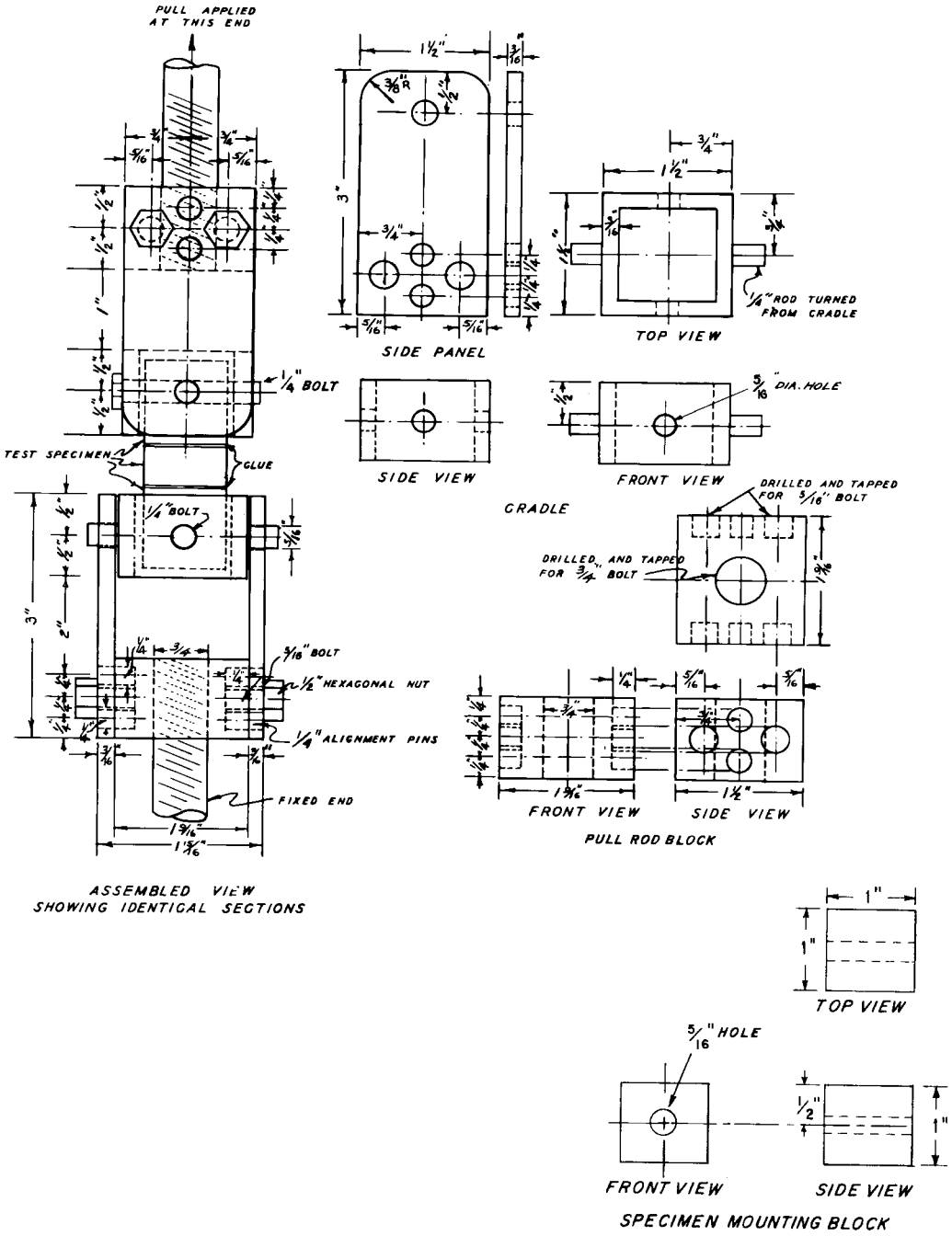


Metric Equivalents

in.	⅛	¼	½	9/16	11/16	1	1.130	1½	2	2¼	2½	3	3 5/16
mm	3.18	6.35	12.7	14.3	17.5	25.4	28.7	38	51	57	64	76	84

FIG. 2 Grip Assembly for Type A Specimen

of the block to receive the 60-deg tapered end of the tailstock center. Set the lathe at its highest speed. The appropriate rate of entry of the cutter blade will depend on the density of the foam. Advance the cutter until it reaches a stop, at which time the diameter of the specimen test section shall be 28.7 mm (1.129 in.) [645 mm^2 (1 $in.^2$) cross section]. Using a band saw, cut off the excess sample end (up to the taper); the specimen is now completed. The lathe assembly and completed specimen are shown in Fig. 8. The recommended gage length shall be 25.4 mm (1 in.) with a radius of curvature of 11.9 mm (15/32 in.) at



Metric Equivalents

in.	3/16	1/4	1/2	5/16	3/4	1	1 1/2	1 9/16	2	3
mm	4.76	6.35	12.7	7.9	19.0	25.4	38	40	51	76

FIG. 3 Details of Grips for Tension on Type B Specimen

each end joining it to the grip surface, which is at an angle of 18 deg to the center line. However, in no case shall the gage length be less than 12.7 mm (½ in.).

NOTE 2—For specimens that exhibit excessive slippage in the jaws, a lower tensile strength may be obtained. Where this occurs, it is recommended that a 6.35-mm (¼-in.) shoulder be left on the specimen ends next to the tapered area, or the specimen ends be dipped momentarily in a molten paraffin wax (temperature not in excess of 80°C (175°F), or both.

5.4 *Preparation of Type B Specimens*—Type B test specimens shall be round or square and shall have a minimum cross-sectional area of 645 mm^2 (1 $in.^2$). Bond the loading fixture to the test specimens by a suitable method which does not affect the material under test, taking care that the bonding pressure is not great enough to cause compression of the specimen. The adhesive curing temperature shall be low

FIG. 4 Grip Assembly for Type B Specimen

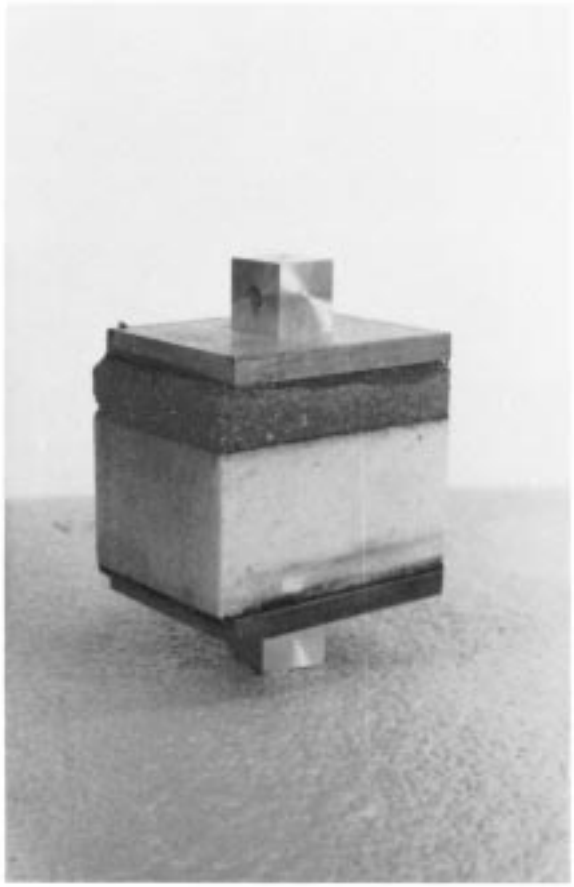


FIG. 5 Grip Assembly for Type C Specimen

enough to cause no effect on the specimen to be tested.

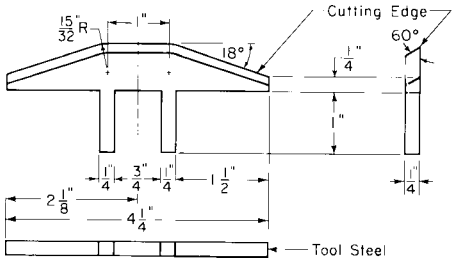
5.5 *Preparation of Type C Specimen*:

5.5.1 Type C Specimen shall be square, with a minimum length and width dimension equal to, or greater than, the thickness.

5.5.2 Care and caution shall be exercised in preparing the specimen so that the bond is not affected. The speed of the saw blade, the number of teeth per inch, and other cutting variables shall be considered in specimen preparation, in order to avoid excess vibrations or heat which would weaken the bond.

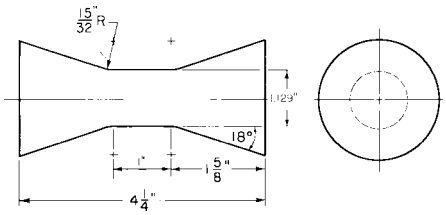
5.5.3 When adhesion test involves only one surface, the other side shall be trimmed to provide a smooth, parallel bonding surface.

5.5.4 Bond the loading fixture to the test specimen substrate by a suitable method that does not affect the material under test.



Metric Equivalents						
in.	¼	15/32	¾	1½	2⅛	4¼
mm	6.35	11.9	19	38	54	108

FIG. 6 Cutter for Preparing Type A Specimen



Metric Equivalents				
in.	1.129	15/32	1⅝	4¼
mm	28.7	11.9	41	108

FIG. 7 Dimensions of Type A Specimen

6. Conditioning

6.1 *Conditioning*—Condition the test specimens at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 5 % relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D 618, for those tests where conditioning is required. In case of disagreement, the tolerances shall be ± 1°C (±1.8°F) and ±2 % relative humidity.

6.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 5 % relative humidity, unless otherwise specified. In case of disagreement, the tolerances shall be ±1°C (±1.8°F) and ±2 % relative humidity.

7. Number of Test Specimens

7.1 A minimum of five specimens shall be tested. Specimens that break at some obvious flaw shall be discarded and retests made, unless such flaws constitute a variable that is to be studied.

8. Speed of Testing

8.1 The standard speed of testing shall be such that rupture occurs in from 3 to 6 min. A suggested rate of cross head movement is 1.3 mm (0.05 in.)/min for each 25.4 mm (1 in.) of test section gage length.

9. Procedure

9.1 Measure the cross-sectional dimensions of the test section to the nearest 0.025 mm (0.001 in.) at several points, and record the minimum value.

9.2 Zero the load indicator with all of the upper hardware in place (including an upper specimen mounting block if Type B is used) but no specimen attached.

9.3 Place the specimen in the assembly, and adjust the entire assembly to align it properly as to central axis. (If Type A is used, tighten the ¼ in. set screws in the sides of the holders so that the split collars are held firmly together and are in axial alignment.)

9.4 Determine and record the load at the moment of rupture. If an extensometer is used, a complete stress-strain curve may be obtained thereby. Also determine and record the extension at the moment of rupture of the specimen.

10. Calculation

10.1 *Tensile Strength*—Calculate the tensile strength by dividing the breaking load in kilonewtons (or pounds-force) by the original minimum cross-sectional area of the specimen in square metres (or square inches). Express the result in kilopascals (kilonewtons per square metre) (or pounds-force per square inch) to three significant figures.

10.2 *Elongation*—Calculate the percentage elongation, when determined, by dividing the extension at the moment of rupture by the original distance between gage marks and multiplying by 100. Report the percentage elongation to two significant figures.

10.3 Calculate the standard deviation (estimated) as follows and report it to two significant figures:

$$s = \sqrt{(\Sigma X^2 - n\bar{X}^2)/(n-1)} \quad (1)$$

where:

s = estimated standard deviation,
X = value of a single observation,
n = number of observations, and
$\bar{X}$ = arithmetic mean of the set of observations.

11. Report

11.1 The report shall include the following:

11.1.1 Complete identification of the material tested, including type, source, code numbers, form, principal dimensions, previous history, etc.

11.1.2 Type of specimen used, Type A, Type B, or Type C.

11.1.3 Conditioning procedure used if different from that specified in Section 6.

11.1.4 Atmospheric conditions in test room if different from those specified in Section 5.

11.1.5 Number of specimens tested if different from that specified in Section 7.

11.1.6 Rate of crosshead movement,

11.1.7 Tensile or tensile adhesion strength of each specimen, average value and standard deviation.

11.1.8 Percentage elongation of each specimen, average value and standard deviation,

11.1.9 Date of test.

12. Precision and Bias

12.1 A task group has been formed to study this area and their results will be included at a later date.

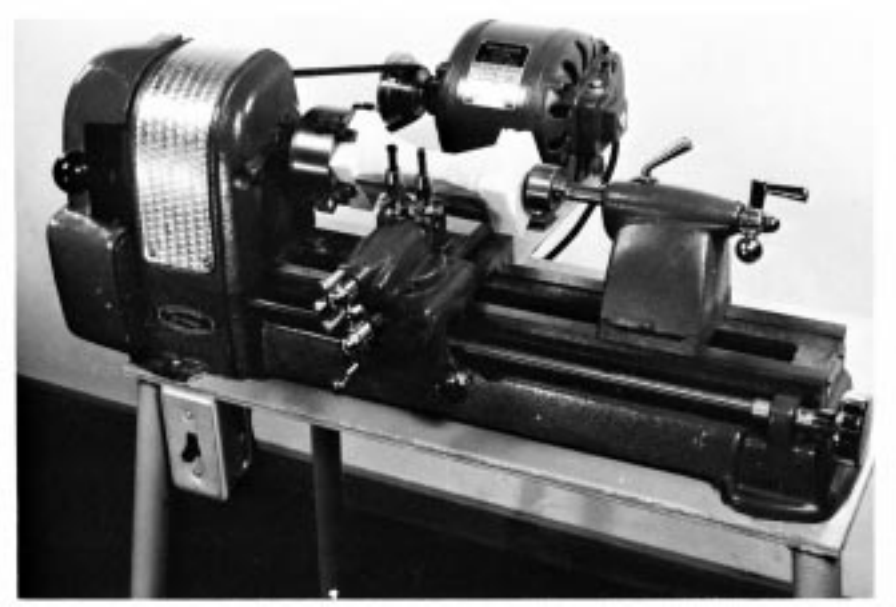


FIG. 8 Lathe Assembly with Machined Specimens