AMERICAN NATIONAL STANDARD ANSI/ASTM D 1181 - 56 (Reapproved 1971)

Standard Test Method for WARPAGE OF SHEET PLASTICS[1]

This Standard is issued under the fixed designation D 1181; 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.

This method has been approved for use by agencies of the Department of Defense to replace method 6054 of Federal Test Method Standard 406 and for listing in the DoD Index of Specifications and Standards.

1. Scope

1.1 This method covers the determination of the dimensional distortion of sheet plastic specimens resulting from exposure to service conditions. In particular, the method is suitable for measuring warpage such as that developed in accordance with the conditions described in ASTM Methods D 756, Test for Resistance of Plastics to Accelerated Service Conditions.[2]

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

2. Significance

2.1 This procedure is intended only as a convenient method for determination of dimensional distortion in sheet plastics, either when subjected to conditions of test such as are outlined in Procedure E of Methods D 756, or "as received" from a supplier. It is not applicable to specimens less than 1.3 mm (0.050 in.) in thickness, or where the span to be measured exceeds 21.5 cm (8.5 in.).

3. Apparatus

3.1 *Dial Indicator*—A 0-50-0 dial indicator[3] (Fig. 1) equipped with spindle extension (brass or aluminum) 3.2 mm (0.125 in.) in diameter, mounted in a small stainless steel block which shall be machined to slide laterally on a stainless steel bar. This bar shall be equipped with two supports, one stationary and the other movable. Machining shall be of such precision that movement of the indicator, while the jig is on the test plate surface, will not produce deviations in excess of ±0.013 mm (±0.0005 in.).

3.2 *Test Plate*—Stainless steel test plate, 18 by 18 by 1.3 cm (7 by 7 by 0.5 in.) with one 18 by 18-cm (7 by 7-in.) testing surface ground flat to ±0.013 mm (±0.0005 in.).

4. Test Specimens

4.1 The test specimens shall be not less than 10 cm (4 in.) nor more than 15 cm (6 in.) square, and shall be of uniform thickness. In practice, specimens 10 by 10 cm (4 by 4 in.) by the full thickness of the material are recommended, although the measuring device is capable of measuring a 15 by 15-cm (6 by 6-in.) specimen.

5. Conditioning

5.1 *Conditioning*—Condition the test specimens at 23 ± 2 C (73.4 ± 3.6 F) and 50 ± 5 percent relative humidity for not less than 40 h prior to test in accordance with Procedure A of ASTM Methods D 618, Conditioning Plastics and Electrical Insulating Materials for Testing,[2] for those tests where conditioning is required. In cases of disagreement, the tolerances shall be ±1 C (±1.8 F) and ±2 percent relative humidity.

5.2 *Test Conditions*—Conduct tests in the Standard Laboratory Atmosphere of 23 ± 2 C (73.4 ± 3.6 F) and 50 ± 5 percent relative humidity, unless otherwise specified in the test methods or in this specification. In cases of disagreements, the tolerances shall be ±1 C (±1.8 F) and ±2 percent relative

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[1] This method is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D-20.50 on Permanence Properties.

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[2] *Annual Book of ASTM Standards*, Part 35.

[3] Starrett No. 81C Dial Indicator (or equivalent), 0-50-0 by 0.001 in., center lug with top lift, jewel bearings. Tension springs removed to make the indicator the deadweight type. Spindle thrust not to exceed 10 g.

humidity.

6. Procedure

6.1 Zero the dial indicator by adjustment of its position in the sliding block while the jig is supported on the flat surface of the test plate.

6.2 Lay the specimen on the test plate (concave side up, if warped), and place over it the measuring jig, with the feet of the supporting bar resting on the test plate. Measure and record the height of the upper face of each corner, and the thickness of the specimen at each corner.

NOTE 2—Precise measurements can be made by fastening a small strip of metal foil 0.013 mm (0.0005 in.) thick, smoothly at the corners of the specimen with vaseline or stopcock grease. A suitable alarm circuit with this as one contact, and the indicator spindle as the other, will indicate immediately when the spindle contacts the specimen.

6.3 Suspend or support specimens vertically during exposure to a specified test environment. Determine warpage as in 6.2 following completion of each portion of the test cycle, or as specified.

7. Calculations

7.1 Calculate the warpage of the test specimens as follows:

$$\text{Initial warpage} = A_1 - B_1$$
$$\text{Final warpage} = A_2 - B_2$$
$$\text{Change in warpage} = (A_2 - B_2) - (A_1 - B_1)$$

where:

A_1 = average of initial corner heights,
B_1 = average initial thickness of specimen (measured at four corners),
A_2 = average of corner heights after test, and
B_2 = average thickness of specimen after test (measured at four corners).

NOTE 3—If the direction of warpage of the specimen has completely reversed, treat the final warpage $(A_2 - B_2)$ as a negative quantity. The above expression then becomes $-(A_2 - B_2) - (A_1 - B_1)$.

8. Report

8.1 The report shall include the following:

8.1.1 Initial warpage, in millimeters (or inches),

8.1.2 Change in warpage, in millimeters (or inches) (a negative value indicates a change in the direction of warpage),

8.1.3 Maximum initial and final corner heights,

8.1.4 Specimen size, and

8.1.5 Test conditions.

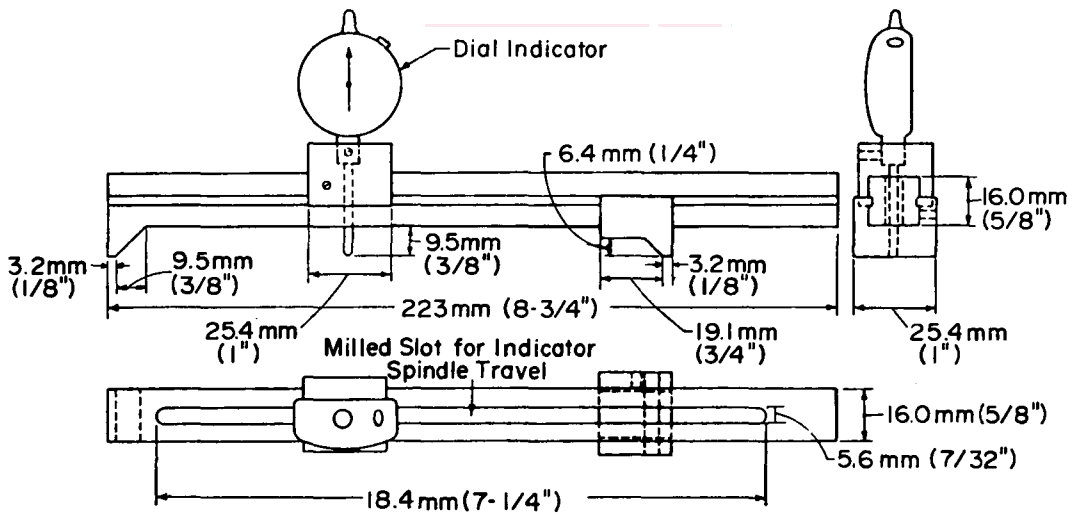

FIG. 1 Dial Indicator for Measuring Warpage of Sheet Plastics.

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