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Standard Test Method for Determination of the Linear Coefficient of Thermal Expansion of Plastic Lumber and Plastic Lumber Shapes Between –30 and 140°F [~~–34.4~~(–34.4 and ~~60°C~~]60°C)[1]

This standard is issued under the fixed designation D6341; 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.

1. Scope

1.1 This test method covers the determination of the coefficient of linear thermal expansion for plastic lumber and plastic lumber shapes to two significant figures. The determination is made by taking measurements with a caliper at three discrete temperatures. At the test temperatures and under the stresses imposed, the plastic lumber shall have a negligible creep or elastic strain rate, or both, insofar as these properties would significantly affect the accuracy of the measurements.

1.1.1 This test method details the determination of the linear coefficient of thermal expansion of plastic lumber and plastic lumber shapes in their "as manufactured" form. As such, this is a test method for evaluating the properties of plastic lumber or shapes as a product and not a material property test method.

1.2 The thermal expansion of plastic lumber and shapes is composed of a reversible component on which ~~may be superimposed~~ it is possible to superimpose changes in length due to changes in moisture content, curing, loss of plasticizer or solvents, release of stresses, phase changes, voids, inclusions, and other factors. This test method is intended to determine the coefficient of linear thermal expansion under the exclusion of non-linear factors as far as possible. In general, it will not be possible to exclude the effect of these factors completely. For this reason, the test method can be expected to give a reasonable approximation but not necessarily precise determination of the linear coefficient of thermal expansion.

1.3 Plastic lumber and plastic lumber shapes are currently made predominately with recycled plastics where the product is non-homogeneous in the cross-section. However, it is possible that this test method ~~may~~will also be applicable to similar manufactured plastic products made from virgin resins or other plastic composite materials.

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

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.*

NOTE ~~1—There is no similar or equivalent ISO standard.~~ 1—There is no known ISO equivalent to this standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing

D883 Terminology Relating to Plastics

D4065 Practice for Plastics: Dynamic Mechanical Properties: Determination and Report of Procedures

D5033 Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics

E831 Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis

3. Terminology

3.1 *Definitions:*

3.1.1 *plastic lumber*, *n*—a manufactured product composed of more than 50 weight percent resin, in which the product generally is rectangular in cross-section and typically supplied in board and dimensional lumber sizes, may be filled or unfilled, and may be composed of single or multiple resin blends.

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[1] This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.20 on Plastic ~~Products.~~Lumber.

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[2] 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.

3.1.2 *plastic lumber shape*, *n*—a plastic lumber product which is generally not rectangular in cross-section.

3.1.3 *resin*, *n*—a solid or pseudosolid organic material often of high molecular weight, which exhibits a tendency to flow when subjected to stress, usually has a softening or melting range, and usually fractures conchoidally. **(D883)**

3.1.3.1 *Discussion*—In a broad sense, the term is used to designate any polymer that is a basic material for plastics. (1982)

3.2 Additional definitions of terms applying to this test method appear in Terminology D883 and Practice D5033.

4. Summary of Test Method

4.1 This test method is intended to provide a means of determining the coefficient of linear thermal expansion of plastic lumber and plastic lumber shapes, which ~~may or may not~~have the potential to contain inclusions and voids. This test method is a product test method, and not a materials test method. Furthermore, this test method is not designed to provide more than two significant figures of accuracy in the result. The test method involves using solid, full cross-sectioned members (see Note 2), as manufactured, of approximately 12 in. ~~[300 mm]~~(300 mm) in length. ~~The~~ In view of the low thermal conductivity of these materials it is impractical to make dynamic temperature variations in a reasonable length of ~~time impractical.~~ time. Therefore, measurements are taken on each sample after conditioning 48 h or more at three discrete temperatures, –30, 73.4, and 140°F, ± 3.6°F ~~[–34.4,~~(–34.4, 23, and 60°C, ± ~~2°C],~~2°C), no more than 1 min after removal from the temperature chamber. The measuring device used is a caliper capable of measuring to the nearest 0.001 in. ~~[0.025 mm],~~(0.025 mm), and is utilized at ambient temperature.

NOTE~~2—Hollow cross-section products may be evaluated~~ 2—It is acceptable to evaluate hollow cross-section products with this test method provided it can be shown that negligible dimensional changes occur in the prescribed measurement time interval.

5. Significance and Use

5.1 The coefficient of linear thermal expansion, α, between temperatures T_1 and T_2 for a specimen whose length is L_0 at the reference temperature, is given by the following equation:

$$\alpha = \frac{1}{L_0} \cdot \frac{L_2 - L_1}{T_2 - T_1} = \frac{1}{L_0} \cdot \frac{\Delta L}{\Delta T} \quad (1)$$

Where L_1 and L_2 are the specimen lengths at temperatures T_1 and T_2, respectively. α is, therefore, obtained by dividing the linear expansion per unit length by the change in temperature.

5.2 The nature of most plastics and the construction applications for which plastic lumber and plastic lumber shapes are used, make –30 to 140°F ~~[–34.4~~(–34.4 to ~~60°C]~~60°C) a practical temperature range for linear thermal expansion measurements. Where testing outside of this temperature range or when linear thermal expansion characteristics of a particular plastic are not known through this temperature range, particular attention shall be paid to the factors mentioned in 1.2 ~~and special preliminary investigations by thermo-mechanical analysis, such as that prescribed in Practice~~ and it is possible that special preliminary investigations by thermo-mechanical analysis, such as what is prescribed in Practice D4065 for the location of transition temperatures, ~~may~~will be required, in order to avoid excessive error. If such a transition point is located, a separate coefficient of expansion for a temperature range below and above the transition point shall be determined. For specification and comparison purposes (provided it is known that no transition exists in this range), the range from –30 to 140°F ~~[–34.4~~(–34.4 to ~~60°C]~~60°C) shall be used. (For reference, glass transition and melting point temperatures of typical resins used in plastic lumber products are given in Appendix X2 of this test method.)

6. Apparatus

6.1 *Conditioning Chamber*, capable of conditioning test specimens at temperatures in the range of –30 to 140°F, ± 1.8°F ~~[–34.4~~(–34.4 to 60°C, ± ~~1°C],~~1°C), at humidity levels of 50 ± 5 %.

6.2 *Caliper*, capable of measuring the length of the specimen with an accuracy of 0.001 in. ~~[0.025 mm].~~(0.025 mm). For a given test or test series, the same caliper shall be used for all measurements. The calipers shall be kept and used at room temperature (73.4°F ~~[23°C]).~~ (23°C)).

6.3 *Thermometer or Thermocouple* , capable of an accuracy of ±0.2°F ~~[±0.1°C]~~(±0.1°C) when measuring the temperature of the conditioning chamber.

7. Test Specimen

7.1 Test specimens for determining thermal expansion of plastic lumber and plastic lumber shapes shall be cut from the "as manufactured" profile. Great care shall be taken in cutting and machining the ends so that smooth, flat, parallel surfaces and sharp, clean edges result and are parallel to within 1/300 of the specimen length perpendicular to the long axis of the specimen. Plastic lumber is generally non-uniform through the cross-section; machining operations other than those required to provide flat, parallel ends shall not be carried out. A line parallel to the length shall be marked with an indelible ink marker on an uncut surface along the full length of the specimen. Length measurements of the sample are to be carried out on the surfaces adjacent to the drawn lines (on the cut faces) at each end of the specimen, at a location very near the ends of the line.

7.2 The standard test specimen shall be in the form of a right cylinder or prism whose length is a minimum of 12 ± 0.25 in. ~~[300~~(300 ± 6.4 ~~mm]~~mm) (see Note 3).

NOTE~~3—This test method may be utilized~~ 3—It is acceptable to utilize this test method to determine the linear coefficient of thermal expansion for