



Standard Test Method for Measurement of Roll Wave Optical Distortion in Heat-Treated Flat Glass¹

This standard is issued under the fixed designation C1651; 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 is applicable to the determination of the peak-to-valley depth and peak-to-peak distances of the out-of-plane deformation referred to as roll wave which occurs in flat, heat-treated architectural glass substrates processed in a heat processing continuous or oscillating conveyance oven.

1.2 This test method does not address other flatness issues like edge kink, ream, pocket distortion, bow, or other distortions outside of roll wave as defined in this test method.

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

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 Reference to these documents shall be the latest issue unless otherwise specified by the authority applying this test method.

2.2 ASTM Standards:²

C162 Terminology of Glass and Glass Products

C1036 Specification for Flat Glass

C1048 Specification for Heat-Strengthened and Fully Tempered Flat Glass

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

¹ This test method is under the jurisdiction of ASTM Committee C14 on Glass and Glass Products and is the direct responsibility of Subcommittee C14.11 on Optical Properties.

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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.

3.1.1 *peak-to-valley depth of roll wave*—characteristic depth, W , of roll wave as illustrated in Fig. 1.

3.1.2 *peak-to-peak wavelength of roll wave*—characteristic length, L , of roll wave shown as a sine-wave representing the deformed surface section as illustrated in Fig. 1.

3.1.3 *roll wave*—A repetitive wave-like departure from flatness in glass that results from heat treating the glass in a horizontal roller hearth furnace. Roll wave excludes edge effects such as edge kink and distortion influenced by assembly or installation.

3.1.4 *roll wave optical distortion*—visual distortion, D , that results from roll wave and expressed as lens power as in Eq 1.

3.1.5 *valley-to-valley wavelength of roll wave*—characteristic length, L , of roll wave shown as a sine-wave representing the deformed surface section as illustrated in Fig. 1.

4. Summary of Test Method

4.1 This test consists of moving an instrument across the glass surface in a direction parallel to the direction that the glass substrate traveled during heat processing. The instrument will primarily measure the out-of-plane deformation of the glass surface which is characteristic of the glass and known as “roll wave”. The peak-to-valley depths of the roll waves, W , and the peak-to-peak distances, L , are measured. (See Fig. 1.)

4.1.1 Other out-of-plane deformations of the glass surface may also be present which do not have the same peak and valley wave character of the roll wave, but which also result in the appearance of optical distortion in the glass.

4.1.2 The optical distortion due to the out-of-plane deformation of the surface is measured as an optical power, similar to the optical power of a cylindrical mirror or lens.

4.1.3 For those deformations that do have a wave character, the distortion can be calculated using the following formula. From the measured roll wave depth, W and the measured peak-to-peak or valley to valley wavelength of the roll wave, L , the optical roll wave distortion D is:

$$D = 4\pi^2 W/L^2 \quad (1)$$

where W and L are in metres and D is in diopters. The dimensions of diopters (dpt) is m^{-1} . The more usual unit of