Glass Informational Bulletin **GANA TD 06-0413**

Methods of Measuring Optical Distortion in Heat-Treated Flat Architectural Glass

Introduction

As a result of heat-treating glass, optical distortions may arise from out-of-plane deformations of the glass surface. Currently, there are no industry-wide standards that specify acceptable values for these optical distortions; however, there are existing methods/instruments to measure them. The methods/instruments referenced in this document are designed and intended for in-plant use only. These methods for measuring distortion cannot be applied in the field on vertical glazing and cannot be used on insulating glass units.

Definitions

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

Millidiopter (*mdpt*) - The *diopter* (D or dpt) is the unit of measurement for distortion (lens power) in a curved surface equal to the reciprocal of the focal length (1/f). A *millidiopter* equals 1/1000 of a diopter and is the accepted unit for quantifying the magnitude of roll-wave distortion in flat glass.

Optical Distortion – Alteration of viewed images caused by variations in glass flatness or inhomogeneous portions within the glass.

Methods to Evaluate Distortions

Surface Contact Gauges

Surface contact gauges (e.g., "Flat-Bottom Gauge", "Three-Point Contact Gauge" or similar devices) are used for measuring roll wave in accordance with ASTM C1651 *Standard Test Method for Measurement of Roll Wave Optical Distortion in Heat-Treated Glass*.

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These devices are generally used off-line and are moved across the glass surface (making contact) perpendicular to the rollers in the furnace (parallel to the direction of travel). The devices will measure out-of-plane deformation of the glass surface, i.e., roll wave peak-to-valley depth. This measurement, in inches or millimeters, can then be converted to optical power and expressed in millidiopters (mdpt).

Digital Photography Methods

Digital imaging methods are used to measure optical distortion. One digital imaging method is described in ASTM C1652 / C1652M *Standard Test Method for Measuring Optical Distortion in Flat Glass Products Using Digital Photography of Grids*.

Depending on their design, these devices can be used on-line or off-line. They are non-contact and measure the entire surface of the glass. Using digital cameras, lighting systems and fixed reflected images, these systems can have a measurement resolution of 5 mdpt. Computer software analyzes the digitized–images and displays a surface distortion waviness (roll wave, edge kink, edge lift, picture framing, oil-canning or bi-stability, hammer or pocket distortion, corner lift and any other type of optical distortion), or quantifies the lens power or optical distortion (mdpt) for approximately each square inch (645.16mm^2) of the entire glass surface.

Information from these systems may be presented in many ways, including maximum distortion (in roll wave peak-to-valley depth and mdpt), and positive and negative lens power. Image analysis software can also project a 3D visualization of optical topography.

Note: The ASTM C14.11 Subcommittee on Optical Properties will conduct an inter-laboratory Round Robin Test to determine the Precision and Bias of this test method.

REFERENCES

ASTM C14.11 Subcommittee is part of ASTM C14 Committee on Glass and Glass Products available at www.astm.org

- ASTM C1651 *Standard Test Method for Measurement of Roll Wave Optical Distortion in Heat-Treated Glass*
- ASTM C1652 / C1652M *Standard Test Method for Measuring Optical Distortion in Flat Glass Products Using Digital Photography of Grids*

Consult the *Tech Center* section of the Glass Association of North America (GANA) website (www.glasswebsite.com) for additional Glass Informational Bulletins and flat glass industry reference resources.

The Glass Association of North America (GANA) has produced this Glass Informational Bulletin solely to provide information regarding methods for measuring distortion. This bulletin makes no attempt to provide all information or considerations in the methods for measuring distortion The user of this Bulletin has the responsibility to ensure their awareness of the methods for measuring distortion. GANA disclaims any responsibility for any specific results related to the use of this Bulletin, for any errors or omissions contained in the Bulletin, and for any liability for loss or damage of any kind arising out of the use of this Bulletin.

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