Heat-Strengthened Glass

Heat-strengthened glass is produced by heating the glass to approximately 1,300ºF and then rapidly cooling it with air. The resultant glass is thermally strengthened and approximately 2 times stronger than a piece of annealed glass. The increased strength is the result of permanently locking the outer surface molecules of the glass in compression and the center portion in a compensating tension. Heat-strengthened glass compression and tension zones are shown in the attached figure.

The characteristics of heat-strengthened glass are as follows:

It significantly reduces the breakage potential due to thermal and bending stresses. A breakage analysis using 2.3 mm heat-strengthened glass on the indoor pane in lieu of 2.2 mm annealed glass is shown below in "Thermal Breakage Analysis Using 2.3 mm Heat-Strengthened Glass". In some instances heat-strengthened glass entirely eliminates the opportunity for breakage from thermal or bending stress, significantly reducing in-field replacement costs. This is due to the compression layer stress that needs to be overcome to produce any fracture in the glass. The specification for this compression stress is a minimum stress of 3,500 PSI and a maximum of 7,500 PSI.

The glass is 2 times stronger at resisting windload compared to the same glass thickness of annealed glass. Insulating glass strength charts showing the improvement in windload performance of annealed/heat-strengthened glass over annealed/annealed glass at windloads of 30, 40 and 50 PSF are shown in Technical Service Bulletin #IG03 entitled "Glass Windload Charts".

If and when the glass fractures, the break pattern is similar to annealed glass and usually does not fall out of the opening.

Heat-strengthened glass cannot be safely cut after the heat-strengthening process, as the cut edge will have the center tension layer exposed. This could result in premature glass fracture.

In general, the benefit of using heat-strengthened glass is that it reduces breakage from thermal and bending stresses, provides an opportunity to offer larger sizes to meet windload conditions without the necessity of using thicker glasses. By using an IG construction of 2.2 mm annealed/2.3 mm heat-strengthened in lieu of a 3.0mm/3.0mm annealed, the airspace thickness can be maximized and therefore the wintertime U–factor is not compromised.

Thermal Breakage Analysis Using 2.3 mm Heat-Strengthened Glass

Glass Product	Breakage-Indoor Pane-Lites/1000 (%)	Annual Service Call Cost ($) per 100,000 Units	Annual Material Replacement Costs ($)	Annual Replacement Costs in $/Unit $/Sq. Ft. per 100,000 Units	
				$/Unit	$/Sq. Ft.
2.2/2.2 Ann	4 (0.4%)*	$80,000	$40,000	$1.20	$0.20
2.2/2.2 Ann	8 (0.8%)*	$60,000	$80,000	$2.40	$0.40
2.2/2.2 Ann	20 (2%)*	$400,000	$200,000	$6.00	$1.00
2.2/2.2 Ann	50 (5%)*	$1,000,000	$500,000	$15.00	$2.50
2.2/2.2 Ann	100 (10%)*	$2,000,000	$1,000,000	$30.00	$5.00
3.0/3.0 Ann	2 (0.2%)	$40,000	$20,000	$0.60	$0.10
2.2 Ann/2.3 HS	0.2 (0.2%)	$4,000	$2,000	$0.06	$0.01

* Breakage-Indoor Pane-Lites/1000 (%) assumes breakage levels that may be experienced in the field.

Assumptions:
1. Annual service Sall Costs assumes a $200 Service Call/Unit.
2. Annual Material Replacement Costs ($) are assumed at $100/Unit.
3. Additional Annual Replacement Costs/Units and Square Feet $ Over and Above Heat-Strengthened Glass Assumes an Average Size of 6 Square Feet per Unit.

Heat-Strengthened

Glass Compression and Tension Zones