Heat-Strengthened Glass

Heat-strengthened glass is produced by heating the glass to approximately 1,300 °F 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 (21% of the thickness) and the center portion (58% of the thickness) in compensating tension, see Figure IG06-1 below. The specification for the compression stress is a minimum of 3,500 PSI and a maximum of 7,500 PSI.

Heat-strengthened glass significantly reduces the breakage potential due to thermal and bending stresses which reduces field replacement costs. This is due to the compression layer stress that needs to be overcome to produce any fracture in the glass.

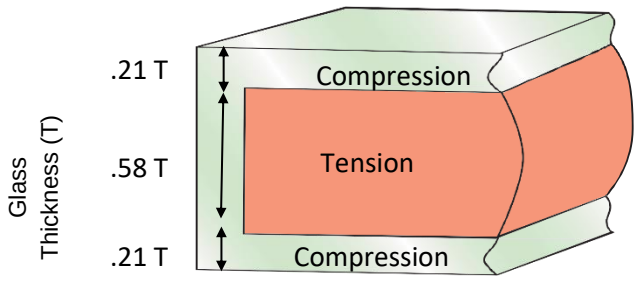

Fig. IG06-1: Heat Strengthened Glass Compression and Tension Zones

Heat strengthened glass is 2 times stronger at resisting windloads compared to the same glass thickness of annealed glass. Insulating glass strength charts showing the improvement in windload performance of heat-strengthened/heat-strengthened glass over annealed/annealed glass is shown in Technical Service Bulletin #IG03 Glass Windload Tables.

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. If cut, this could result in premature glass fracture.

The process involved in fabricating heat strengthened glass can create a bow or warp in the glass. The potential for bow and warp should be considered in the tolerance stack up of the window. This phenomenon does not affect the glass strength.

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

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Thermal Breakage Cost Analysis Using 2.3mm Heat-Strengthened Glass

Glass Products	Breakage Indoor Pane-Lites/1000 (%)	Annual Service Call ($) per 100,000 Units	Annual Material Replacement Costs ($)	Annual Replacement Costs 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%)*	$160,0000	$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 (0.02%)	$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 call 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 6 square feet per unit