EXTRALUM

Technical Bulleting.

Architectural Glass Thermal Breaking.

Introduction.

Thermal breakage is a relatively common phenomenon in glass and can occur for several reasons. Thermal stress in the glass usually occurs as a result of direct exposition of glass to sunlight.

When the energy hits the glass, one part is transmitted directly, another part is reflected, and the remnant is absorbed by the mass of the glass. The absorbed energy heats the glass, generating a state of expansion of molecules (and therefore, glass expansion)

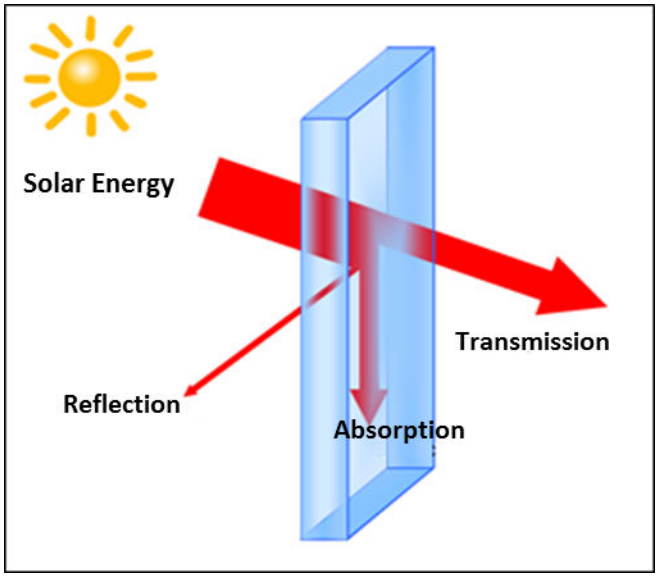


Figure 1. Thermal behavior of the glass.

If the glass heats evenly, the entire panel expands. If the glass is heated non-uniformly (e.g. center of glass hot and cold edges), temperature gradients (differences) are generated in the total area of the glass, creating thermal stress. The amount of heat stress is depending on the temperature difference within the glass. Thermal breakage occurs when the stress value caused by thermal stress exceeds the value of the glass edge resistance.

To avoid thermal breakage, it is very important to determine the variables that determine it.

Glass type.

Certain types of tinted glass and glass with reflective coating and/or Low-E coating are inherently prone to experience thermal breakage.

Reflective glass and some high-performance tinted glasses have high solar energy absorption rates, in the range of 70% to 80%. In most cases these products require the glass to be heat treated (heat-strengthened or tempered) to eliminate the risk of thermal breakage.

In some cases, the need for heat treatment in tinted glasses, installed in sites with marginal shade or facade orientation conditions, should be analyzed.

As a rule, as the energy absorption of the glass increases also increases the risk of experiencing thermal breakage. The absorption of solar energy is also influenced by the thickness and configuration of the glass. Thicker glass, of the same color or coating has a higher absorption percentage.

Edge Quality.

In conventional window applications, temperature gradients or differences occur in a thin area between the edges covered by the frames and the central area of the glass exposed to the sun's rays. The edges of the glass are usually covered by more than 12 millimeters, which slightly insulates them from the sun's rays. As a result, when the sun warms, the temperature of the edges of the glass increases more slowly than center of the glass.

When the edges of the glass are hidden or shaded, greater heat stress is generated because the shade does not allow the temperature to increase in the same way as it increases in the center of the glass. As a result of cold edges or the large temperature difference between the center and edges of the glass, there is a higher tension in the glass that looks for weak points at the edge (micro cracks, bumps, shells) to free and cause the break.

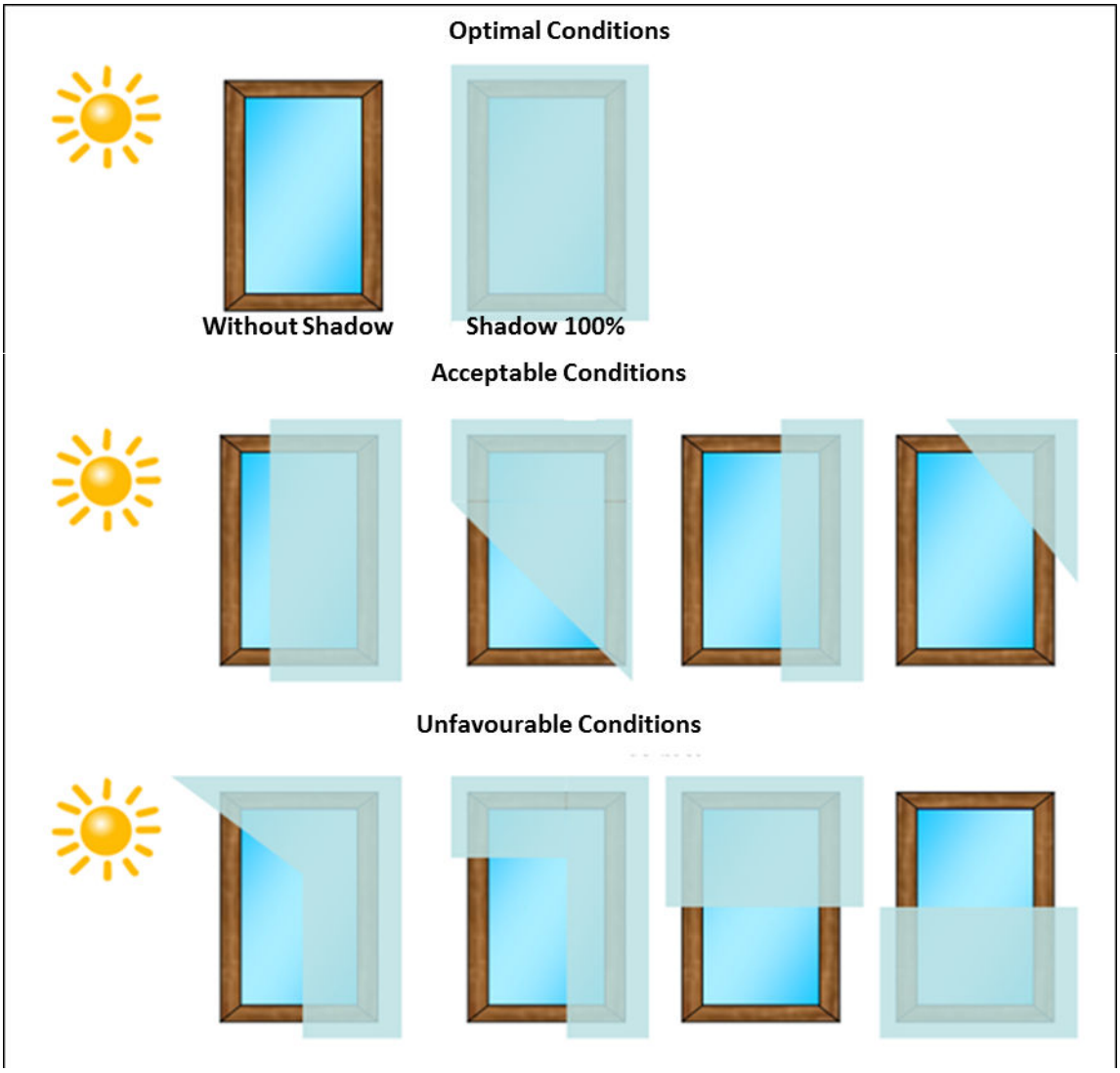
It is important to note that the cut edge (sharp) can withstand a tension of approximately 2400 psi. Due to the coefficient of thermal expansion of float glass, a difference of 1°C in the glass area produces approximately 100 psi of tension. Thus, in a normal window with edges at 21°C and the center of the glass at 48°C, by the effect of the incident sunlight, you have a differential of 27°C. As a result, the tension will be 2500 psi (100 psi greater than resistance), which is enough to cause thermal breakage.

A way to improve glass ability to resist a thermal stress is by quality edges working as grinding or polishing. These processes reduce a series of small defects around the glass

External shadow patterns.

Outside shadow patterns can have different effects on glass. Under certain marginal conditions, even color glasses without reflective coating should be heat treated (see Figure 4).

- Line 1 represents the optimal shade conditions, 100% of the glass is at the same condition.
- Line 2 represents acceptable conditions, more than 50% of the glass is in shade.
- Line 3 represents unfavorable conditions, more than 25% of the glass is in shade.
- Line 4 represents the high risk conditions, less than 25% of the glass and the perimeter is in shadow.



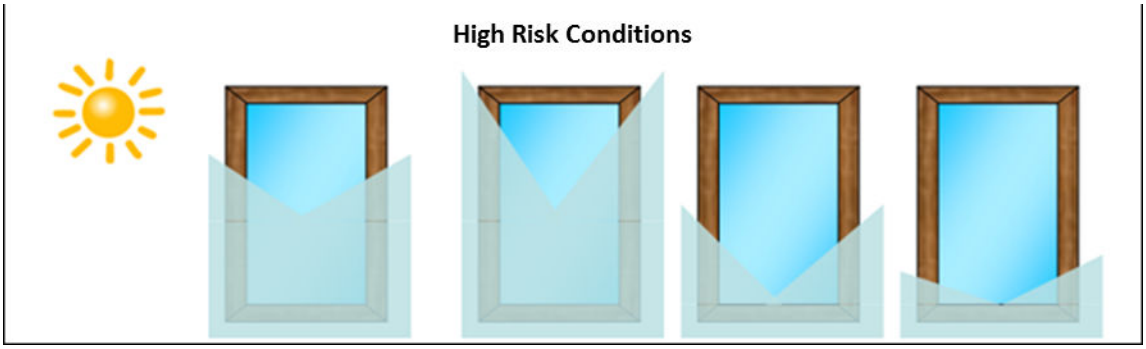


Figure 4. Shadow conditions.

Glass Thickness and Size.

The risk of thermal breakage increases as the glass area and thickness increases, due to potential problems in cutting, handling and installation. Any damage to the edges of the glass will have a negative impact on the thermal safety of the glass.

Edge Coverage.

The risk of breaking increases when the edge of the glass is covered by more than 40 millimeters by the frame.

Inner Shadow.

Clear blinds or curtains reflect heat back to the glass, increasing the breakage factor. Dark curtains absorb heat, so they reduce the breakage factor. If there is a space of 50mm or more around the perimeter of the curtain or blind, the glass will be considerably ventilated and therefore the break factor will be lower.

Cooling or Heating Devices.

Hot or cold air currents directly applied to the glass surface can create excessive temperature differences, resulting in thermal breakage. Air currents should not be directed towards the glass.

Films applied to glass surface.

The application of reflective or security films, paper, paint or polarized, increase the possibility of thermal breakage. Extralum S.A. does not recommend the application of films of any kind on the interior or exterior surface of the glass.

Break pattern.

The typical thermal break pattern is characterized by starting at an edge and at an angle close to 90°. Thermal fractures due to low stress conditions may result from damage to the edges of the glass during manufacture, handling or installation. See Figures 6 and 7.

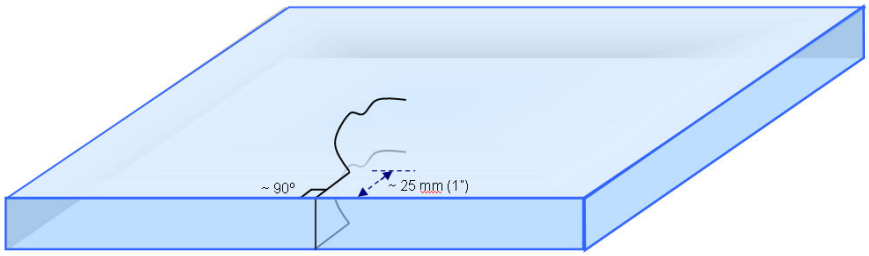


Figure 6. Low stress thermal break pattern (< 1500 psi). The break starts perpendicular to one edge (90°) and continues for at least 25mm (1 inch) but does not end at another edge.

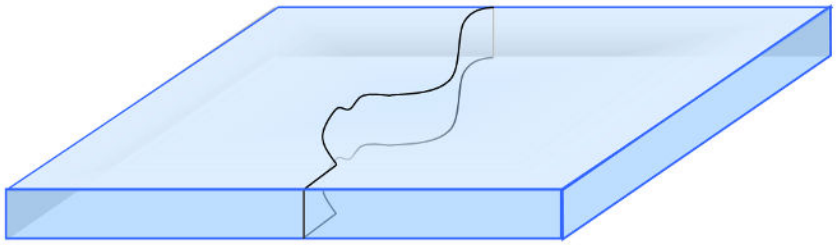


Figure 7. Low-stress thermal break pattern (1500 psi). The break starts perpendicular to a 90° edge) and ends at another edge.

High stress breaks are indicators that the glass is unable to withstand the thermal stress of the environment or installation. To minimize the risk, a heat-treated glass will be required. See Figure 8.

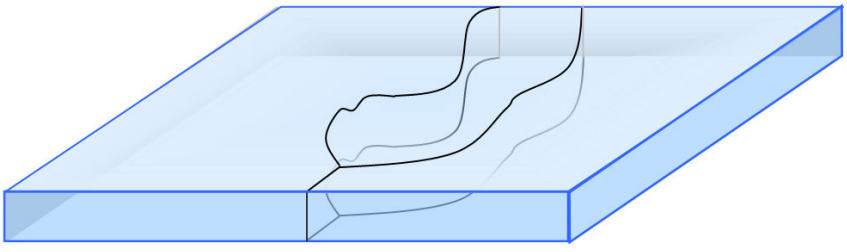


Figure 8. High-stress thermal break pattern (3500 psi). The break starts perpendicular to an edge (90°) and branches in two or more directions.

The risk of thermal breakage should be determined during the design phase of the project. In the same way as with the spontaneous breakage of tempered glass, Extralum S.A. does not extend any guarantee, nor recognition of claim for breaking glass for any possible cause or theory.

If you have any questions, consult the Sales Department of Extralum, S.A.