TECHNICAL INFORMATION

SPONTANEOUS GLASS BREAKAGE

Spontaneous glass breakage is a common phenomenon where heat-treated glass suddenly breaks without any apparent reason. This occurrence can be related to damages during the construction phase, on-site storage, binding of the glass, thermal stress or internal defects within the glass.

To identify and minimize the causes of this phenomenon, it's important to consider that only certified manufacturers who meet high standards, by regularly monitoring the production process, can guarantee the quality of its glass, therefore, customers should be aware of any glass manipulation during the construction, storage and installation phase.

TECNOGLASS, as an industry leader, shares information about the most common reasons that can affect the glass and result in breakage.

HOW TO IDENTIFY AND MINIMIZE SPONTANEOUS GLASS BREAKAGE

DAMAGE DURING THE CONSTRUCTION PHASE

When glass is being transported and installed, it's easy and likable for the glaziers to nick or chip the glass edges with different kinds of tools. These small nicks or chips may not result in instantaneous breakage, but, over a period of time, stress concentrations can develop around the nick, leading to spontaneous breakage.

ON-SITE STORAGE

To avoid glass breakage on site storage during construction period, it's important to identify the places where the crates - that storage the glass - are going to be placed, especially for high performance coated insulating glass. Due to its heat-reflective nature, the probability of thermal stress breakage increases in these types of glass.

TECNOGLASS recommends not leaving them partially or fully exposed to sunlight to avoid the chances of glass breakage in crates.

BINDING OF GLASS IN THE FRAME

As a result of strong winds and temperature variations, glass contracts and expands, therefore, it is recommended that glass must be set on resilient blocks at the bottom with space for expansion at the sides. If there is no space provided, the glass will bind against the frame resulting in breakage.

THERMAL STRESS

Thermal stress emerges from a differential expansion within heat-treated glass caused by heating or cooling some areas of the panel. When glass is installed in a window, its edges are covered from sunlight by the window frames, therefore, the covered glass edges will be cooler than the central area of the glass which is exposed to the sun.

The expansion of the central area, due to heating, will cause the glass to stretch and at the same time, it will be resisted by the cooler covered edges, which will, consequently, create thermal stress breakage.

FEATURES WHICH INFLUENCE THE DEVELOPMENT OF THERMAL STRESS

Tensile stress

Tensile stress develops when the expansion of the central area of the panel is warmer, while the cooler covered edges are trying to resist it. When the expansion of the edges becomes sufficiently hefty, the tensile stress will exceed a critical point and breakage will form. This is a result of the glass heated non-uniformly, meaning that temperature gradients within the glass are exposed to temperature differences.

Glass edges and shadows

Temperature gradients may occur in glazed windows due to the cool covered edges of the window frames versus the heated glass central portion. The framework of the windows usually captures approximately 13 mm of glass edge making this area out of reach of sunlight. Consequently, the glass edge is cooler and temperature increase is much slower than the central area where it receives higher heating due to the sun.

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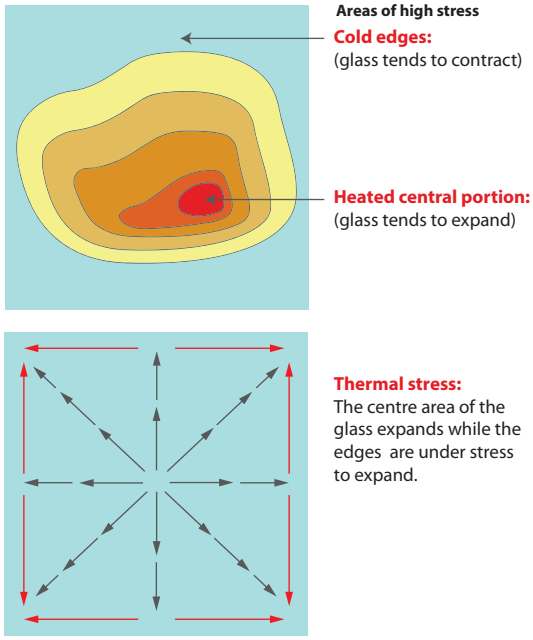
The glass edge in a window may as well presence a shade, which makes a greater case to thermal stress to occur. Shadows are commonly found across glass by balcony overhangs, eaves, mullions, columns, etc. As the shadow increases, a superior temperature difference - higher tensile stress – is created between the central glass exposed to the sun and the shaded glass area, increasing the probability of thermal stress and the likelihood of glass breakage.

PROCESS OF THERMAL STRESS BREAKAGE



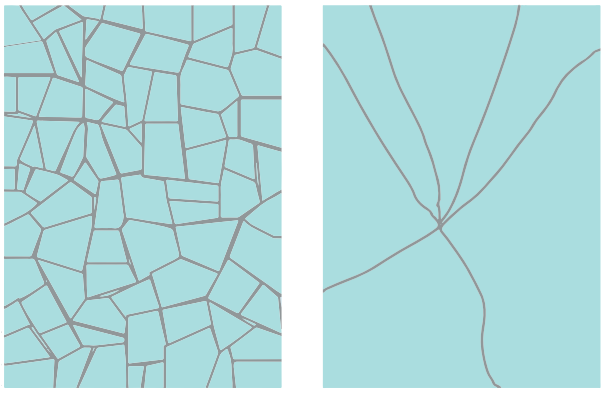
Picture 1. Process of thermal stress breakage

Types of glass

Coated and tinted glass are frequently at a higher risk of thermal stress breakage. This may occur because of the possible temperature imbalance within glass due to solar absorption at the central glass area versus the covered glass edge area. These glass types can be found in TECNOGLASS' traditional high-performance Low-E coatings on tinted glass.

These glass types require a base glass substrate, on which the coating is applied to be heat-strengthened (HS) or fully-tempered (FT). For safety glazing applications, Tecnoglass recommends fully-tempered glass since it's four times stronger than regular annealed glass of similar specifications. Unlike heat-strengthened glass, when the fully-tempered glass is broken, it breaks in to fairly small, pebble-like pieces, which reduces the chance of injuries.

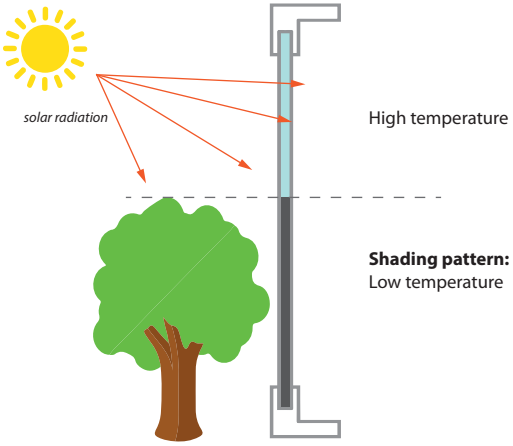
TYPES OF GLASS BREAKAGE



Picture 2. Types of glass breakage.

Outdoor shading patterns

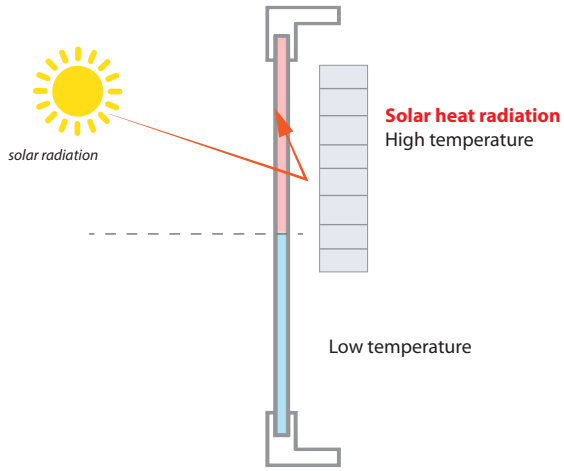
In order to avoid extreme temperature gradients, it's important to consider that shading patterns may vary seasonally. Tecnoglass recommends minimizing the project's location where less than **50%** of the glass panel is covered with a shadow as shown in picture 3.



Picture 3. Outdoor shading pattern.

Indoor shading devices

Indoor shading devices may produce temperature gradients on the glass. Picture 4 illustrates how an indoor device, like blinds, reflects the solar radiation back to the glass panel. This reduces the convection and conduction of the heat apart from the glass, increasing the probability of thermal stress, and in time, breakage.



Picture 4. Indoor shading illustration.

Heating location and orientation

In any residential or commercial project, heating vents should be carefully placed to ensure that warm air isn't being directed at the glass, which can cause a heat up and, eventually, breakage. Tecnoglass advises following this recommendation no matter the building's type or location.

INTERNAL DEFECTS WITHIN THE GLASS

Nickel sulfide (NiS) inclusion is a natural occurrence in glass, where small particles can still be present during the fully-tempered and installation process and are impossible to see. When tempering a glass containing NiS, the molecule will contract, and during the cooling process, it will expand, trying to return to its natural size resulting in glass breakage.

To avoid the risk of spontaneous breakage in fully-tempered glass, TECNOGLASS recommends using the heat soak test. Upon request, TECNOGLASS will use the test, certifying that the glass does not contain any nickel sulfide and guarantee that there is not any internal defect within the glass.

When a glass is heat soaked, the heat converts the nickel sulfide inclusion to a high-temperature state and cool it right away, resulting in glass breakage or in an optimum fully-tempered glass. All the above factors can increase or decrease the likelihood that a conventional glazed window will experience thermal stress breakage.

Therefore, TECNOGLASS strongly recommends working closely with your glass fabricator and getting a thermal stress analysis done early in your design process.

TECNOGLASS HEAT SOAK TEST

Nickel Sulfide (NiS) inclusions

Nickel sulfide is present in the glass as an imperfection barely visible to the human eye. When a glass is heat-treated in order to obtain fully-tempered glass, NiS inclusions change size as a function of time and temperature. When cooled quickly, the NiS particles are unable to change completely back to its original form. Over a certain time, NiS will slowly convert to its form but with an increase in volume that can cause breakage.

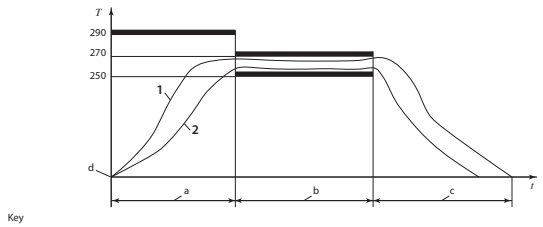
Heat Soak test

To avoid this phenomenon, TECNOGLASS uses the Heat Soak Test, subjecting tempered glass to extremely adverse conditions, therefore, the ones with nickel sulfide inclusions will break in the test.

If the glasses do not break during the test, TECNOGLASS gives a certification to guarantee that the products have successfully passed the quality control. This kind of breakage is very unusual to happen, but TECNOGLASS can run the test if clients require it to minimize the risk of spontaneous breakage later in time.

Heat Soak process

The temperature conditions to which glass is subjected is between 260°C (500°F) ± 10°C (50°F), this heating process lasts approximately 2 hours. Then, the glass enters a maintenance phase for a minimum of 2 hours. Finally, it goes to the cooling phase until the temperature of the glass reaches 70°C (158°F). The whole heat soak cycle lasts approximately 5 hours and 30 minutes.



Key

T	glass temperature at any point, °C	d	ambient temperature
t	time, h	a	heating phase
1	first glass to reach 250 °C	b	holding phase
2	last glass to reach 250 °C	c	cooling phase

Picture 5. Tecnoglass tempered glass heat soak test report, 2011.

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Tecnoglass runs this test by EN-14179-1 and EN-14179-2 standards.

If you are interested to learn more about how to identify and minimize spontaneous glass breakage or about our Heat Soak Test, don't hesitate to contact us.

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