The Differences between Tempered, Heat Strengthened and Heat Soaked.

This document includes brief discussions of:

- Heat strengthened and tempered glass
- "Spontaneous" tempered glass breakage and its cause
- Nickel sulphide stone inclusions
- Heat soaking of tempered glass
- Distortion in heat-treated glass

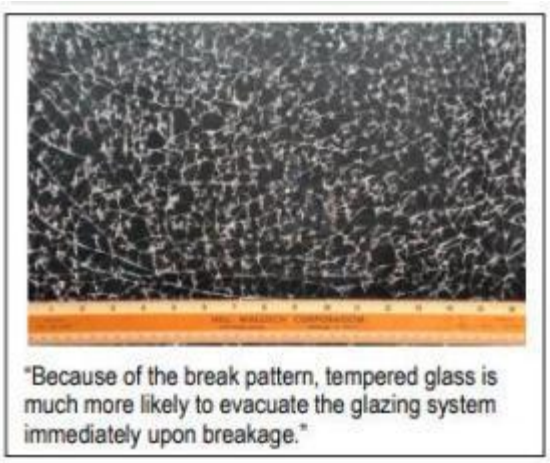
In architectural applications, heat-treated glass significantly reduces the breakage potential due to thermal stress and stress from uniform loads such as wind and snow loads. In most cases, heat-strengthened glass of the appropriate thickness and quality eliminates opportunities for breakage due to thermal stress and wind load. In cases where safety glazing is required by code or responsible design, then fully tempered or laminated heat-strengthened glass should be specified.

The Difference between Heat Strengthened and tempered glass- both are heat treated

Heat-treated glass products, whether heat strengthened or tempered, are produced in a very similar fashion using the same processing equipment. Briefly, the glass is heated to approximately 1200ºF (650ºC) and then force cooled to create surface and/or edge compression in the glass. It is by controlling the rate of cooling that determines if the glass is either heat strengthened or tempered. To produce tempered glass, the cooling is much more rapid, thus creating higher surface and/or edge compression in the glass. To produce heat strengthened glass, the cooling is slower and the resultant compression in the glass is lower than fully tempered glass yet still higher than annealed glass. The industry standard specification requirements for heat strengthened and tempered glass are set forth in ASTM C1048 "Standard Specification for Heat Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass."

Because of the compression in the glass, heat strengthened glass is approximately twice as strong as annealed glass of the same thickness. Tempered glass is approximately 4 to 5 times as strong as annealed glass of the same thickness. Except for this increase in mechanical strength, all other properties of the glass remain unchanged including glass deflection.

The most dramatic and important difference between heat strengthened and tempered glass is in the post breakage characteristics of the two products (i.e. break pattern). If heat strengthened glass should break, the pieces will be relatively large and tend to remain in the glazing system until removed. Tempered glass, on the other hand, is designed to break into innumerable small, roughly cubical pieces. In fact, it is this break pattern that qualifies tempered glass as a safety glazing material. However, because of the break pattern, tempered glass is much more likely to evacuate the glazing system immediately upon breakage. Responsible design professionals must consider the tendency of tempered glass to evacuate the opening upon breakage and the consequences must be acceptable. Responsible parties know that there is always a possibility of glass breakage; therefore the glass construction must be designed with a low probability of breakage, typically less than 8 panels per 1000 panels, but if the glass does break, the glass design must be done in a manner so that the breakage consequences are acceptable.



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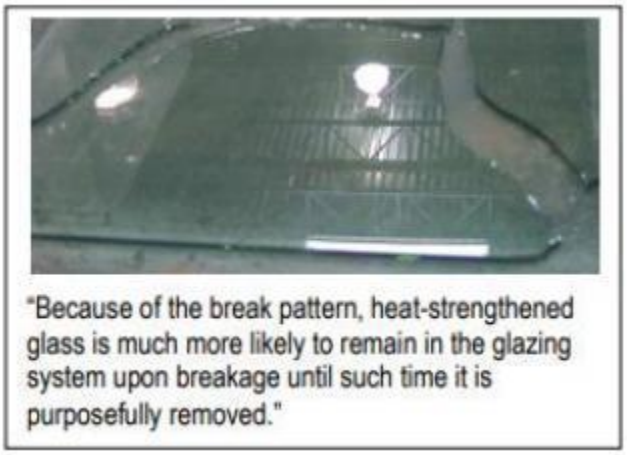

"Because of the break pattern, heat-strengthened glass is much more likely to remain in the glazing system upon breakage until such time it is purposefully removed."

Heat strengthened glass is not a safety glazing material. When safety glazing is required, either by code or design, a certified safety glazing material such as tempered or laminated glass must be used.

What is a Spontaneous Breakage and what causes it?

There are instances, after installation, of tempered glass breaking due to no apparent cause. In these cases of "spontaneous breakage", it is most often determined that the glass broke due to existing surface or edge damage that severely compromised the ability of the glass to withstand anticipated wind loads, or normal building movements; or that glass to metal contact combined with movement under wind load initiated the break. In relatively rare instances, the breakage has been traced to the presence of nickel sulphide stones in the centre tension zone of the tempered glass.

The slower cooling cycle in the furnace during heat strengthening maintains a stability within the nickel sulphide stones, however the more rapid cooling procedure for tempered glass can trap the stone which in later life temperature changes can result in movement of the stone with subsequent spontaneous breakage.

What is Heat Soaking and does it work?

The concept of heat soaking glass to reduce or eliminate spontaneous breakage due to stone inclusions has been around for decades. Heat soaking involves exposing the tempered glass to elevated temperatures for some period of time.

A typical heat soak process elevates the glass temperature to 550ºF (290ºC) for two hours. Reference BS EN 14179-1 standard. The obvious objective of the heat soak process is to achieve a "break now, not later" result, based on the assumption that any glass panels with inclusions will break during the heat soak process.

While there is general agreement on the concept and intent of the heat soaking process, there is not agreement on the outcome. Most agree that heat soaking can eliminate (by destruction) some of the problem panels, but not that heat soaking will guarantee 100% elimination of potential spontaneous breakage due to inclusions

Heat Treated Glass Distortion and Flatness

Optical image distortion may occur in all types of glass for many different reasons such as but not limited to:

. Non-uniform flatness

- Roller wave
- Kink
- Bow
- Warp

. Glazing pressure
. Wind load
. Changes in temperature
. Changes in barometric pressure
. Changes in altitude between insulating glass unit fabrication location and installation location.

With heat-treated glass, the heat-treating process itself will modify the original flatness of the annealed glass substrate and result in distortion. This is an inherent condition of all heat treated glass and results in optical distortion due to roller wave, bow, and warp.

Even with a flatness specification there is no guarantee that a specific number will insure acceptable optics; thus a full scale mock-up under job-site conditions to evaluate the optical aesthetics of a specific heat-treating process is the best way to minimize job-site surprises. In addition to the full-size mock up, where possible the following additional steps should betaken to minimize the impact of inherent heat-treated glass distortion:

. Produce all heat-treated glass for a given project on the same equipment using the same processing parameters.
. Use thicker glass as it is less prone to all types of distortion.
. Orient the heat-treated glass so that the roller wave is parallel to the windowsill / header.

The appearance of distortion may also occur due to strain patterns in heat-treated glass. Please see Vitro Technical Document, TD-115 Strain Pattern in Heat-Treated Glass for additional information. The appearance of distortion may also occur due to interference fringe patterns in insulating glass

Recommendations

. Heat strengthened glass be specified and used, except where tempered glass is mandated for safety or other purposes by code.
. Heat soaking is not aproven method of eliminating all possibility of glass breakage due to nickel sulphide stone inclusions.
. If the decision is made to heat soak coated glass, it is recommended that all tempered coated glass on the building'sfaçade be heat soaked.

It is strongly recommended a full size mock-up be viewed under actual jobsite conditions to evaluate the appearance of the heat soaked glass