HEAT SOAK TESTING

VIRACON TECH TALK

Fully tempered glass is susceptible to spontaneous breakage due to the presence of nickel sulfide inclusions. To mitigate the risk of breakage, fully tempered glass can be heat soak tested. This document outlines the process and benefits associated with heat soak testing.

HEAT SOAK TESTING

Fully tempered glass may break without warning due to the expansion of nickel sulfide inclusions present within float glass. To avoid the risk of spontaneous breakage in fully tempered glass, a common practice, and Viracon's recommendation, is to use fully tempered glass only when it is required by code or to meet design loads. When fully tempered glass is required, heat soak testing is recommended to minimize the risk of spontaneous breakage.

FULLY TEMPERED GLASS USE

Fully tempered glass is typically used because of its increased strength over heat strengthened and annealed glass. Unfortunately, as a result of this increased strength and lack of understanding about nickel sulfide inclusions, fully tempered glass may be automatically specified in applications where it is not required.

Broader industry awareness of spontaneous breakage caused by nickel sulfide inclusions has increased the tendency to specify fully tempered glass only in areas where it is required. Circumstances remain, however, where the use of fully tempered glass is required by code or design loads. For example, floor-to-ceiling glass, where a walking surface is present on both sides of a glass unit, generally requires fully tempered glass.

HEAT SOAK TESTING

In situations where fully tempered glass is required to meet safety glazing requirements, or for added strength, Viracon recommends a heat soak test. This test can be provided by Viracon for a minimal charge, comes with an enhanced warranty and provides the building owner added assurance that significant spontaneous breakage will not occur.

The Formation of Nickel Sulfide Inclusions

In order to understand the heat soak test, it is important to understand how inclusions contribute to breakage. In the float glass manufacturing process, soda ash, lime, silica sand, salt cake and other ingredients are combined and melted in a furnace at temperatures near 2870°F (1576°C). After melting, the molten glass is formed by introducing it to the tin bath where it floats on top of a layer of molten tin to form the desired glass thickness. After the float glass has been formed, it is cooled in an annealing lehr. Proper annealing uniformly cools the glass surface, edges and core to reduce residual stress within the glass.

Undissolved particles of the batch material, called inclusions, are formed within the glass during the manufacturing process. There are a number of types of inclusions which may be found in float glass and, for the most part, are simply aesthetic imperfections. The float glass manufacturers take extraordinary steps in sourcing the highest quality materials for use in the batch mixture to reduce the number of inclusions that may occur. ASTM C1036, the industry standard for flat glass, lists the allowable size and minimum separation between inclusions for each glass quality level.

ASTM C1036 generally refers to undissolved particles as point blemishes–gaseous inclusions, knots, dirt and stones. As stated previously, some of these inclusions may cause glass breakage, the most notorious being nickel sulfide (Figure 1). Nickel sulfide inclusions are formed when minute nickel-rich particulates combine with sulfur in the furnace fuels or other glass batch materials. These inclusions tend to be less than 1/64" (0.4mm) in diameter and are impossible to totally eliminate, all glass has some present.

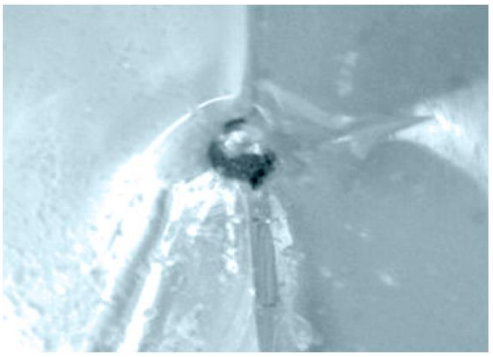

FIGURE 1: MAGINIFIED NICKEL SULFIDE INCLUSION .006219"

Breakage Potential

Even though annealed glass may have nickel sulfide inclusions present, breakage from these inclusions is unlikely due to the very low residual stresses in annealed glass. The same can be said of heat strengthened glass which has carefully controlled surface compression levels. ASTM C1048, the industry standard for heat treated glass, requires heat strengthened glass to have a surface compression between 3,500 and 7,500 psi (24 to 52 MPa). Viracon has been producing heat strengthened glass with a surface compression between 4,000 and 7,000 psi (28 to 48 MPa) for more than 30 years and, within this time, has not experienced a single incidence of spontaneous breakage in heat strengthened glass.

Fully tempered glass, according to ASTM C1048, must have a minimum surface compression level of 10,000 psi (69 MPa). As a result of the high residual stresses in fully tempered glass, the potential for spontaneous breakage from nickel sulfide inclusions exists. When this occurs, there is a distinct break pattern (Figure 2).

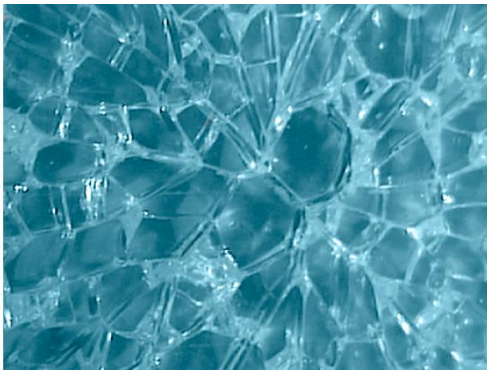

FIGURE 2: FULLY TEMPERED GLASS, NICKEL SULFIDE BREAK PATTERN

When glass is heat treated, nickel sulfide inclusions undergo a phase change as a function of time and temperature. If located near the central tension core of the glass, the expansion of the inclusions can provide sufficient stress to spontaneously break the glass. The inclusion expands at a rate greater than the glass and literally causes the glass to break from within.

The Heat Soak Process

When fully tempered glass is heat soak tested, the glass is placed in an oven and subjected to temperatures of 500°F±18°F (260°C±10°C) in accordance with EN 14179-1. The dwell time at peak temperature is another critical factor in the heat soak process. Careful temperature controls must be enforced to establish when the hold time or dwell time begins. Viracon has determined that a two-hour dwell time is capable of reducing the potential for spontaneous breakage in heat soak tested glass. At Viracon, heat soak testing has been offered since 1988 and we have not had a single incidence of spontaneous breakage occur in heat soak tested glass. With the two-hour dwell time, Viracon's heat soak test will minimize the potential for spontaneous breakage from nickel sulfide inclusions to its lowest level.

Warranty

Viracon offers a limited warranty for heat soaked, fully tempered glass that breaks due to verifiable nickel sulfide inclusions. See Viracon's heat soaked tempered glass standard limited warranty for full details: www.viracon.com/warranties.

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