Technical Bulletin

1011 – Breakage of Toughened Glass

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Australian Glass Group®

TB 1011 – Breakage of Toughened Glass

Toughened glass has a high mechanical strength and high resistance to thermally generated stresses due to the surface compression induced into it during the toughening process. However, toughened glass is not unbreakable and the causes of breakage of toughened glass are many and varied.

Examples are;

- Edge damage
- Edge defects
- Surface damage
- Edge or surface impact
- Excessively high temperature differences
- Structure movement or seismic drift overloading the glass at the edges
- Excessive stress loading around holes, notches, cut outs etc.
- Rare inclusions in the raw glass such as nickel sulphide (these relate to spontaneous breakage)
- Improper glazing (including glass on metal contact)

AGG is a glass processor, not a glass manufacturer. While AGG purchase glass from only reputable manufacturers known to consistently produce glass of suitable quality which includes (but is not limited to) significantly reduced contaminants, AGG deals with a raw material that it has no control over. Therefore, AGG cannot be responsible for impurities or contaminants that may still inadvertently exist in microscopic quantities. It is not possible for either a glass manufacturer or processor to detect such inclusions in the glass either through visual assessment or existing technologies in glass processing machinery.

AGG's brand for Toughened glass (clear, tint, coated) is **Tempershield®**

In addition, AGG are not responsible for excessive stresses imparted to glass in a design or installation, or for breakage reasons beyond AGG's control. Toughened safety glass breakage poses a minor risk of injury when compared to the potential for injury from breakage in annealed glass.

See our White Paper on **Heat Treatment of Glass** for more detail.

Fracture Origin

If breakage does occur in toughened glass, it is often possible to determine the origin and cause of breakage provided that the fragmented glass remains in position until an inspection is performed by an AGG staff member. Depending on the glazing system it may not be possible for the glass to remain in situ after breakage; in which case it is impossible to positively identify the origin & cause of glass breakage.

AGG NSW
140 Gilba Rd
Girraween, NSW
P: (02) 9896 0566
F: (02) 9896 0190

AGG VIC
81-83 Rushdale St
Knoxfield, VIC
P: (03) 9730 7400
F: (03) 9730 7488

AGG TAS
39 South Arm Rd
Rokeby, TAS
P: (03) 6247 1625
F: (03) 6247 6843

Australian Glass Group®
agg.com.au | info.agg.com.au | 1300 768 024

Heat Soaked Toughened Glass

An option to significantly reduce the probability of spontaneous breakage is to use heat soaked toughened glass, which is Toughened Safety Glass that has then been Heat Soak Tested in a seperate heat soak chmaber after the toughening process. The heat soak test essentially cycles the toughened glass through appropriate temperatures and pressures for a specific amount of time (per international standards) in order to force the phase change of any inclusion stones. This is a destructive test and we would rather identify and cause a break here than at a future time after installation and in situ.

While the heat soak test serves to uncover inclusions, it is not a 100% guarantee as some inclusions may 'survive' the test and remain within the glass. However, the probability of spontaneous breakage occurring in toughened glass that has been heat soaked is significantly lower than that of toughened glass that has not been heat soak tested.

Note: The purpose of Heat Soaking is to reduce not eliminate the likelihood of Toughened Safety Glass breaking spontaneously after installation. While the heat soak process does not guarantee against spontaneous breakage after glazing, it is a safeguard and should be considered when specifying toughened glass whether laminated, monolithic, single or double glazed in areas where;

- Safety from glass fallout is a concern
- There may be a risk of the building being classified as unsafe if there is a breakage
- The reduction in structural strength/capability of the glass poses risks
- Access for replacement is difficult/inconvenient
- The cost of glass replacement is high
- Specifier's intent is to minimise potential replacements

Note: The above are in addition to the heat soaking requirements of **AS 1288.**

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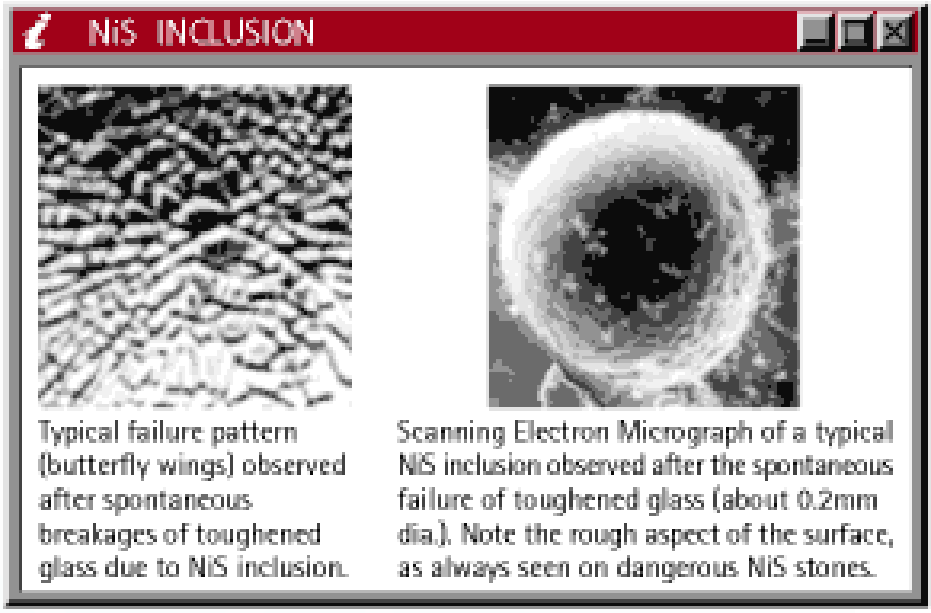
Overview of Inclusions and 'spontaneous breakage' in Toughened Glass

Toughened float glass, widely applied in architectural applications can occasionally be associated with 'spontaneous breakage' ie. it 'pops' without any warning and or apparent reason. These breakages can occur at any point in time after the glass has been tempered, with the highest probability being within the first five years. Spontaneous breakage is still possible after the five year mark. Spontaneous breakage in toughened glass is due to the rare presence of what are commonly called 'inclusion stones' in the glass. These are typically Nickle Sulphide (NiS) but can be comprised of other materials. These inclusions introduce stresses whilst undergoing phase change, which is briefly explained below.

Inclusion stones are very small, typically 0.1 to 0.5mm in diameter and may not be entirely eliminated by automatic online scanners deployed on float glass production lines. Hence, these cannot be fully controlled at the source and may be inadvertently present in the glass prior to processing. These inclusions can change their crystalline phase (Alpha to Beta) whereby these expand some time after the glass was tempered. In tempering, an inclusion stone shrinks more than the surrounding glass during the quench (cooling) stage. The sudden quench 'freezes' the inclusion in its smaller Alpha phase, not giving the inclusion stone sufficient time to make the transition to its' Beta phase where the inclusion is larger and more stable. With the passage of time, the phase change occurs along with a volumetric expansion that introduces stresses within the glass and may shatter the glass from within. The ensuing break pattern in the glass is consistent with the 'dice like' fragments characteristic of toughened glass. The likelihood of spontaneous breakage, however remote, can vary between different batches of glass. At the location of the inclusion, a distinct localised 'butterfly wings' fragmentation pattern occurs and therefore is able to be verified as the cause of breakage.

AGG recognise that toughened glass is prone to spontaneous breakage for the aforementioned reasons as stated above, and offer specialized heat soak testing of toughened glass to minimise the possibility of spontaneous breakage as an additional processing option.



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