Spontaneous breakage of Fully Tempered Glass – Background information

In recent years Fully Tempered Glass has often been the subject of discussion even if unwarranted. The catalyst has been spontaneous breakages, whereby Fully Tempered glass – apparently without any external influence – shattered into pieces. On this current subject of spontaneous breakage, the possibilities to reduce them and also other possible reasons for breakage, Dr. Andreas Kasper gave opinion in an interview. Dr. Kasper works in the Research and Development department of SAINT-GOBAIN GLASS GERMANY and is also a private lecturer at the RWTH Aachen in the subject of Chemistry and Technology of Glass.

What is a Nickel sulphide breakage and how does it happen?

The type of breakage caused by Nickel sulphide inclusions in glass is in a nearer sense the spontaneous breakage. It is generally on thermally tempered or Fully Tempered glass that is affected. The glass really breaks „spontaneously“ – that means with any outside influence.

The cause of spontaneous breakage lies in the glass itself. It can be traced back to Nickel sulphide inclusions, which are very rare, about one in a glass area of 300 m² at 8 mm thickness. The Nickel sulphide inclusions are so small that thay cannot be detected automatically and create a very serious threat to Fully Tempered glass.

Nickel sulphide (NiS) comes in two types: at high temperatures above 379°C it is stable. Under this, also at room temperature, it slowly changes its state. The change is even slower the lower the temperature is. Such phase changes are common in nature. The unusual with Nickel sulphide however, is that the inclusion expands. It subsequently pushes against the surrounding glass with increasing force. When it is also located in the tension zone of the Fully Tempered glass, i.e. in the inner „Half“ of the glass volume, after a certain time it creates a fissure inside

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the glass. The glass shatters „spontaneously“ with a loud crack and falls into thousands of small pieces.

How do you assess the new statutory requirements to eliminate this type of glass breakage?

Until a spontaneous breakage occurs, a long time at normal ambient temperature can pass. When a piece of glass has a Nickel sulphide inclusion, the length of time until a breakage occurs depends on the temperature to which the glass is subject. Without any better method, a „test“ was established a long time ago which destroyed such infected glass at the very end of the production sequence. This was the so-called heat soak test in accordance with the German Standard DIN 18516, which in English is abbreviated as HST.

DIN 18516 offered only a rough description of the test procedure. The tester therefore had a large „room for interpretation“, which was obviously used as it was often the case in the past that Spontaneous breakages on building occured, for example in Berlin and London.

The HST is a complex technical process. Therefore, a work group from the European Standardisation Committee began working on the question about six years ago and determined the most significant conditions which needed to be fulfilled in the heat-soaking. We – basically the SAINT-GOBAIN subsidiary Temperit AG of Hinwil in Switzerland acted as supplier of the basis data, and my work group at SGGD / R&D Department building glass as the statistical analysts and interpreters of the data – have provided the most significant contribution.

In shortened form, the new European Standard concept EN14179-1 contained the following. The glass (not the Oven atmosphere!) is heated up to a temperature between 280°C and 300°C and remains there for at least two hours (in Germany four hours), which however does not necessarily lead to a reduction of the heat-soaking test. Arrival at the temperature interval is proven by testing the glass with a thermo element attached.

This calibration must be carried out by a recognised test institute. The finished product is called ESG-H (in German) or Fully Tempered HST.

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Today all SECURIT-PARTNER® companies have the prescribed and necessary certification for heat-soaking. That means that each chamber is independently monitored and the companies take in-house production controls. The data from the manufacture of every single Fully Tempered sheet is archived for at least ten years with control tests being carried out every quarter.

Which risks exist for architects and developers, that such a spontaneous breakage occurs – relative to a building with 100 m² resp. 10.000 m² and a life span of maximum 50 Years?

Fully Tempered-HST glass, which has been manufactured according to the European Standard or the Building regulations, is to todays knowledge practically safe from spontaneous breakage.

That means that the remaining breakage risk is minimal, but it is not zero. For a building with 10,000 m² the remaining breakage risk depends on the thickness of the glass – the thicker the glass the greater the mass and therefore the more probable a breakage. If we use an average glass thickness of 8 mm and Fully Tempered HST in a curtain wall, one calculates an annual remaining breakage risk of 1 %. This means that from 100 Buildings each with 10,000 m² of FT HST only one single spontaneous breakage will occur in the year.

On a building with only 100 m², the remaining spontaneous breakage risk is therefore extremely small. That should, however, not lead to commission of the heat-Soak test for small facade projects. Untested glass has nearly one hundred times the risk of breakage compared to tested glass. This is not calculated and hypothetical, it is very real. In one particular case it has been attested that three of four untested spandrel panels shattered because of Nickel sulphide.

NiS is often quickly assumed as the reason for breakage; which other reasons for breakage can be found from experience which come into question for spontaneous failure?

So-called spontaneous breakages, i.e. breakages that are not the result of Nickel sulphide, can result for many reasons. On

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a construction site there is often an element of negligence or unnoticed impact during handling and installation. Edge damage weakens the glass and can lead to „spontaneous“ breakage even under the minimum of loading. When a glass element fits very tightly during installation but is nevertheless installed, it is possible that differing thermal expansion can cause failure. Short-term over-heating at the edge during installation e.g. welding, can cause so-called cold-fissures, which days later result in failure of the glass. Also settling of buildings, even years later, can cause unacceptable pressure on the glass and result in a series of breakages. All of these reasons for failure are normally possible to well documented when the point of failure can be found and analysed. Forced breakage of the glass using a point-load has similar characteristics – namely the so-called butterfly pattern – the same as fracture due to Nickel sulphide-inclusions. The appearance of a butterfly pattern is therefore no definite indication of Nickel sulphide-inclusion.

SECURIT-PARTNER® companies use a particular method of certification. Which advantages does this have for the processor, client and designer?

SECURIT-H is not visibly different to regular SECURIT glass. Therefore SAINT-GOBAIN GLASS has developed its own „HST-Marker“ for the SECURIT-PARTNER® companies which visibly proves that the test has been carried out. Following tempering, but prior to heat-soaking, a special blue dot is applied in the product stamp. During the test, the paint changes to a brown-beige colour. At higher temperatures however, it changes into a powder which breaks-away from the glass. It is therefore not possible to falsify the process by applying the paint before the tempering process. This paint serves primarily as an internal check and for logistics. It is ensured that glass is only packed once the heat-soak test has obviously been completed. For customers this allows them to see that the test has been carried out. Trust in the SECURIT-PARTNER® companies is therefore increased and any risk of spontaneous breakage which may cause problems at a later stage in the building are almost eliminated.

(Source: SECURIT-PARTNER, www.securit-partner.de)