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Glass faults and inspection criteria.

A guide to AS/NZS 4667 - 2000

Introduction

Glass for buildings supplied and installed in Australia is almost exclusively manufactured using the float process. Glass made using this process (float glass) is extremely flat and contains few faults, however it is not fault free. Occasionally small seeds and other surface imperfections can make it through the float glass manufacturer's fault detection scanners and into stock packs of glass.

Float glass is converted into many applications and subject to various processes such as:

- Applied coatings to the glass surface (Low E for insulation, Solar Reflective for solar control, self-cleaning etc)
- Cutting (manual or machine)
- Processing the glass (edge working, drilling, shaping, etc.)
- Laminating (the adhesion of 2 or more components of glass using various interlayers)
- Toughening/Tempering (reheating glass to approximately 600 degrees Celsius then rapidly cooled)
- Insulating glass manufacturing (construction of a sealed unit)
- Combinations of all of the above

Glass is handled/moved numerous times during these manufacturing processes. Add on any transportation and handling during the glazing process, it is easy to see that damage or wear to the product needs to be factored into the end result.

At the same time, consumers, building owners and designers have a reasonable expectation that glass installed into their products or projects will be to a "reasonable" quality standard. In addition, some glass may be under more scrutiny than others. (For example comparing a residential glass splash-back, which consumers will view up close, compared to a painted panel cladding a multi-level building where no-one will get near it.)

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Relevant Quality Standard - AS/NZS 4667:2000 – Quality requirements for cut to size and processed glass

To bridge gaps between what can reasonably be manufactured and a customer's quality acceptance levels, a standard for glass quality this standard was published as a flat glass industry guide to acceptable quality. This was seen to be a minimum standard which most glass processing businesses would hope to improve on.

In this standard there are tables and charts showing the maximum allowable imperfections (including seeds, scratches and other imperfections) for processed and cut to size glass.

Architectural Glass commonly purchased as "single" or "Double glazing" (IGU) understandably provides a high standard of vision and the following is a guide to the quality that can be expected and assessed using this standard.

Inspecting the glass should be carried out as early as reasonably practicable following installation or supply.

How to check for blemishes

1. Clean the glass in accordance with manufacturers recommendations
2. Stand in the room no less than 3 metres away from the glass and look directly through it. Glass must be viewed at 90 degrees to the window
    a. Inspect the glass in natural daylight, but not in direct sun or with visible moisture on the surface of the glass.
    b. Where it is not possible to stand at the correct distance then stand as far away as you can from the glass.
    c. Exclude 50mm wide band around edge of the glass from the check when viewing IGUs.

What to expect when viewed as described

While AS/NZS 4667-2000 is the definitive reference, generally flat transparent glass, including laminated or toughened or coated glass is acceptable if;

- There are no bubbles in the glass greater than 5mm in diameter.
- A panel of glass contains one bubble between 1mm and 5mm in diameter per 1.6m x 1.6m of area.
- There are bubbles smaller than 1mm in diameter.
- Scratches should not be visible from 3m or more.

The obtrusiveness of blemishes is judged by looking through the glass, not at it, under natural light. It must be understood that the glass used in single and double glazing is a processed glass, and so as a consequence, blemishes are to be expected.

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Insulating glass units with optical defects such as smears, finger prints or other dirt on the cavity faces of the glass, or extraneous material in the cavity are unacceptable when observed in natural light conditions. (Ie not in direct sun)

Contents of AS/NZS 4667-2000

The standard sets to limit quality for the following areas:

Dimensional tolerances for glass – Section 6 - Table 1 – *Sets limits on accuracy of dimensions including diagonals for squareness.*

Thickness tolerances for glass – Section 6 - Table 2 – *Outlines the allowable tolerances on both glass and interlayer thickness and potential combinations of both*

Flatness Requirements – Section 7 and Table 3 - *Allowable Bow and localized warping*

Glass Quality – Section 8 – Defined blemishes allowed per Table 4 – *Allowances for seeds and handling scars and edge quality.*

Test Methods for all of the above are outlined in section 9

Why can't we observe faults in direct sun?

When very bright light is shone onto and through glass surfaces, it highlights any residue material or imperfection on the glass surfaces. This is accentuated the more angular the light source is to the surface of the glass. This can be demonstrated when shining a bright light on a sharp angle across the surface of the glass or even driving into the sun and peering through what is otherwise a clean windscreen.

In addition glass is generally processed in factories and other Industrial environments, and whilst glass washing processes are generally engaged to meet standards, they are never the less commonly dusty environments. Any residues, including those from cleaning compounds, can leave a faint trace onto glass surfaces, which whilst in general light conditions are not noticeable, may become more apparent in full sun conditions. It would be untenable and impractical to inspect every glass component in full sun or direct light conditions.

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Effects of different Glass Types

Toughened or tempered glass may show visual distortions which are accentuated in reflection from the now distorted surface. In addition, colour or shadows from the toughening process, known as polarisation marks (commonly observed through Polaroid sunglasses) are also a physical property of toughened/tempered glass and the processes used in creating it, and cannot be considered a fault or blemish.

Glass is generally toughened in a horizontal roller hearth furnace, where glass is carried through and oscillated on ceramic rollers under high heat (approx. 600 Degrees C). These rollers can have small particles of glass dust deposited from many previous panels which have invariably passed through on them. These fine particles will adhere to the bottom surface of the glass and can be felt when running a blade very gently across the bottom surface. These microscopic particles can also become more apparent in direct sun. If the glass is bowed in the toughening process whilst in the furnace, these particles can become more apparent and concentrated as a faint white stripe down the centre of the panel. The adhesion of these fine glass dust particles to the bottom surface is another factor against the use of razor blades when cleaning glass as they can drag these adhered glass particles across the glass surface and cause scratching.

Laminated glass may have more blemishes due to it being made of several layers, however some level of haze can also be made out from some interlayers, under direct light conditions.

Low emissivity or reflective coatings may produce transient visual effects. In some lighting conditions the coating may look like a transparent film or produce a haze, i.e. a cloudy look to the surface. Again some of these can be accentuated by toughening. The nature of some coatings also leads them to vary in off angle colour. This may result in differing hues reflected in adjacent panels. Tolerances for these should be checked with the coated glass manufacturer and where ever possible, same batches used for completion of larger projects.

Insulated Glass Units have a level of double reflection caused by multiple surface reflections and can vary from pane to pane. Insulated glass units incorporate a sealed internal airspace. Changes in relative air pressure from that within the unit, and that outside, may cause glass panels to either balloon out or concave in. This is also a natural characteristic of the product. Another less common effect is *Brewster's Fringes – the rainbow effect. These s*mall transitory rainbow effects are produced by the glass refraction of light, due to high quality flat glass sheets being placed parallel to each other.

Insulated glass units are also covered within their own manufacturing standard AS/NZS 4666-2012. Quality and dimensional aspects of spacers, seals and their appearance are comprehensively covered within that standard.

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Summary

Remembering that glass must be viewed at 90 degrees to the window, to reduce any effect that an angular perspective will accentuate.

Lastly, when looking through glass panels, the colour of any back ground material may also have an effect to highlight or reduce the ability to see imperfections. Dark backgrounds will accentuate any imperfections and must not be used when subjecting glass to the limits placed within the standard.

Unfortunately some observations can be somewhat subjective, which is why the standard does set out to define some minimum dimensions and quantities for faults. Some manufacturers will have more detailed customer acceptance tolerances covering allowable distortion and faults which may augment those in the standard.

Often it is a balancing act. Customers will vary widely with quality expectations, versus the range of glass processors with differing equipment levels and quality controls.

Hopefully this document can give insight into both the standard and what a consumer can reasonably expect from their product and what can generally or reliably be produced.

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The Australian Glass Group issues technical bulletins to provide clarity on a range of technical aspects of high performance glass, including glass properties, performance, application and other interest areas

Some parts of this document have been provided by the Australian Glass and Glazing Association (AGGA), of which we are a member. We acknowledge and thank AGGA for their assistance in compiling this document.