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Introduction

When glass is formed from its molten state, the surfaces cool quicker than the body of the glass, creating a controlled stress profile. This stress profile is important for how we provide glass design recommendations for building applications. In its annealed form, glass can be cut and processed, and further heat treatments at high temperatures can lock in much higher stress levels to significantly increase its strength.

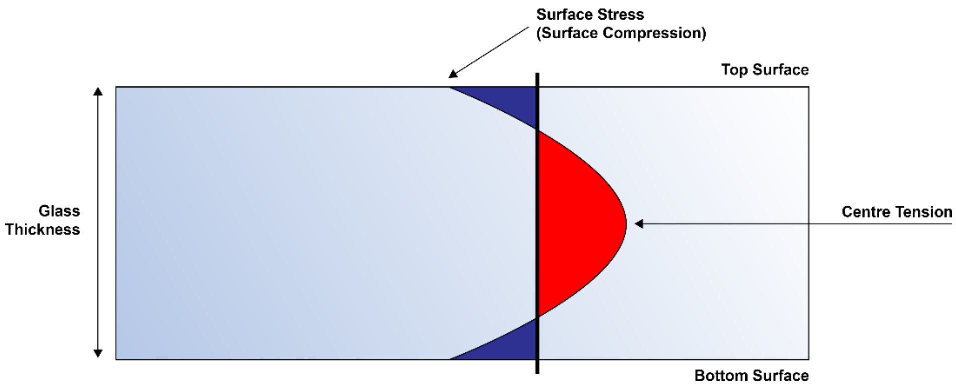

Diagram 1. Surface Stress

The ultimate strength of a ductile material is the maximum stress it can withstand under tension before it starts to fracture or break, typically exhibiting significant plastic deformation before fracture. In contrast, brittle materials like glass tend to fracture without noticeable deformation, making tensile stress the critical factor rather than compressive strength. Glass, in particular, has extremely high compressive strength.

When glass is subject to load it naturally deflects, it has one face under compression and the other in tension. The resistance of glass to compressive stress is very high, its resistance to tensile stress is significantly lower and effected by any imperfections in the glass, such as surface flaws and bubbles, which can significantly reduce its actual strength.

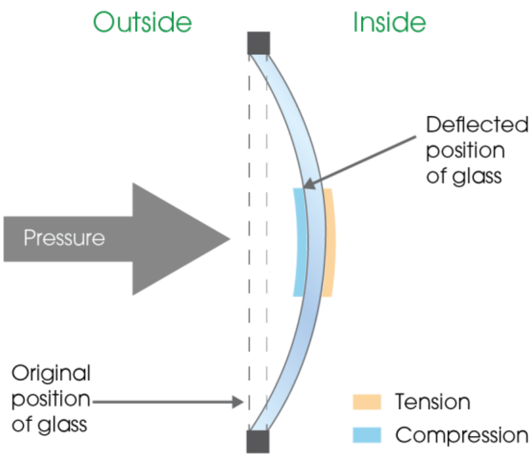

Diagram 2. Deflection – Tension and Compression

These physical properties underscore the importance of controlling deflection in glass. While glass can deflect under load to reasonable levels easily, it is still a brittle material - if deflection exceeds the material's ability to resist, it can fracture, which must be avoided.

A glass panel deflects or bends when exposed to loads such as wind, human impact, interaction, structural support and/or other load conditions. The bending typically occurs at a central point of the glass pane, depending on how it is supported, and can also affect the glass's appearance. Factors such as glass type (and strength), interlayer behavior and support conditions influence how much the glass will deflect.

Factors Affecting Glass Deflection

Load Types

- **Wind Loads:** Imposed wind actions specified in AS/NZS 1170.2 or AS 4055.
- **Dead Loads:** including glass weight (and snow/ice actions in alpine regions) for overhead glazing.
- **Live Loads:** Concentrated point loads of various areas and duration as specified in AS/NZS 1170 (all parts) and incorporated into the glazing standard AS 1288 both for sloped overhead glazing requirements (section 6) and barrier design (section 7), which include combinations of all load types where required. Live loads are also intended to replicate likely impacts of typical human interaction based on the occupancy type and building use.

Glass Type and Construction

- **Monolithic Glass:** Standard single-pane construction with linear-elastic response to load application i.e. ability to deflect and return to its original shape once the load is removed.
- **Laminated Glass:** The deflection of laminated glass is dependent on both temperature and load duration. For short-term loads, like wind, it behaves similarly to monolithic glass. At higher temperatures, the interlayer becomes softer, reducing its ability to transfer shear forces between the glass layers and can lead to increased deflection under load. This is more relevant under sustained loading (Long-term loads).
- **Toughened and Heat-Strengthened Glass:** While strength increases, the elastic modulus (the stiffness or elasticity of a material) remains the same. These treatments do not reduce deflection but can increase safe stress limits and resistance to breakage.
- **Insulated Glass Units (IGUs):** The addition of a sealed cavity can give rise to air pressure factors which can deflect panes outward or inward such as atmospheric effects due to changes in elevation, temperature, and barometric pressure which create loads on IGUs. These effects are governed by physical laws and not considered manufacturing defects.

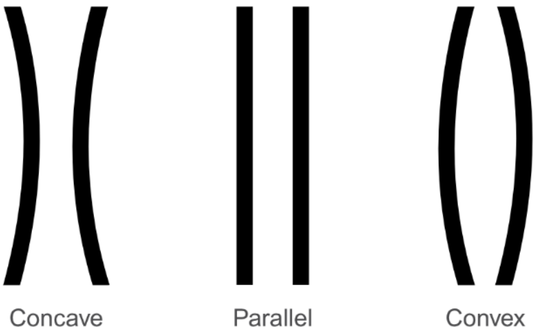

Diagram 1. IGU Deflection Distortion

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Support Conditions

- **Fully (Four-Edge) Supported** - Deflection tends to be central to the panel.
- **2 or 3 Edge Supported** - When a glass pane has unsupported edges, the stress and deflection under load are significantly higher compared to a pane with four edges supported.
- **Point Supported e.g. spider fittings** - Require engineering analysis to assess localised stresses around points of support and deflection.
- **Base Cantilevered Designs e.g. frameless balustrades** - Need careful analysis of maximum deflection limits and assessment of stress levels around supports, as well as assessment of breakage behaviour if failures occur. Commonly require engineering and/or testing to assess compliance.

Aspect Ratio and Panel Size

- Panels with high aspect ratios are more prone to bending and require additional thickness or structural reinforcement to manage movement within acceptable limits. Square panels of the same area are considered stronger than those of the same area, but with higher aspect ratios.

Industry Guidelines and Standards

Viridian Glass provides the following overview for general awareness of applicable deflection standards in Australia. These are based on industry-recognised documents:

AS 1288:2021 – Clause 3.3.3

- Maximum glass deflection under serviceability limit state (SLS) actions:
  - **Span / 60** for supported panels.
  - **Height / 30** (or cantilever length / 30) for cantilevered panels.

AS 1288:2021 – Clause 9.5.2.3

- For stiffening fins, the maximum SLS deflection should be:
  - **Span / 60** for the panel.
  - **Span / 240** for the structural fin.

Noting also that in general 4-sided window glazing, deflections of 20mm or more are commonly considered unsightly, even when they fall safely within the panel dimension guidance of the various windload charts and tabled solutions. Increasing glass thickness to keep deflection under 20mm is a common recommendation.

Design Strategies to Reduce Deflection

The following strategies may assist in controlling deflection and improving glazing performance:

Strategy	Purpose
Increase Glass Thickness	Reduces centre span deflection exponentially.
Reduce Panel Span	Employ mullions or transoms to divide glazing into smaller lites.
Optimise Support Conditions	Four-edge support or adding engineered fixings to increase system stiffness.
Tailor IGU Cavity Depth	Taking the smallest dimension of the IGU panel and dividing by 150 or maximum glass deflection limited to spacer thickness x 1.5 whichever is greater as a general guide for spacer thickness. Atmospheric effects can be assessed by external engineers to minimise the risk of Newton Rings and pressure imbalance across the cavity.

These options should be evaluated by qualified building professionals as part of an overall glazing design strategy.

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Project Specific Responsibility and Scope

Controlling deflection is a key requirement in glazing design to meet compliance with industry standards and regulations. The purpose of this outline is to highlight and increase awareness of the importance of deflection and its relationship with glass and installation.

Viridian Glass may assist with general guidance when sufficient project data is provided but does not accept design responsibility where consultation or engineering services have not been formally engaged.

Conclusion

Deflection is an inherent and predictable characteristic of glass under load. While it cannot be eliminated, it can be managed through considered design and material selection. Viridian Glass provides product options and technical guidance to support appropriate glass performance for architectural applications.

This document is issued for general information only. No warranty or liability is implied or accepted by Viridian Glass in relation to its use. All glass design decisions should be made in consultation with qualified professionals familiar with the specifics of the project.

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