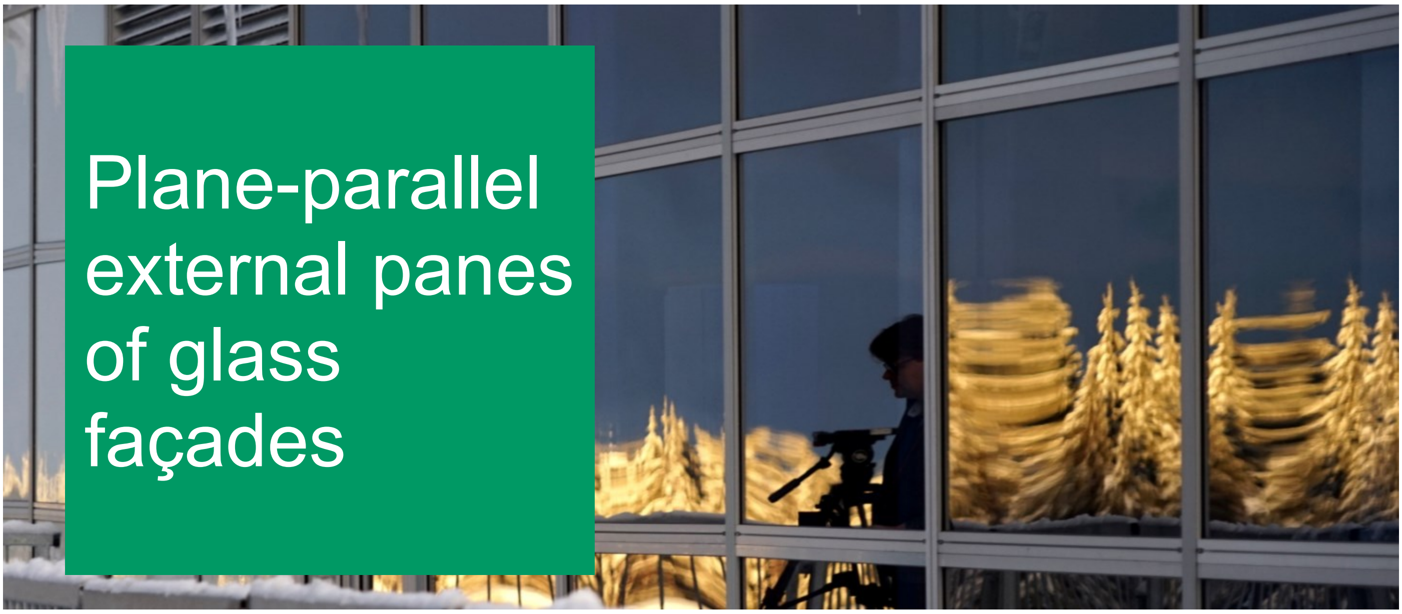

Plane-parallel external panes of glass façades

The Basics

There are two limit states considered in the design of an insulating glass pane:

- Ultimate limit state (tension in the glass)
- Serviceabilty (deflection)

The ultimate limit state, or also verification of ultimate limit state, is considered to be achieved when the loads on the glass pane do not cause it to break. To confirm this, the structural engineer must define the material strengths, the load conditions and the accompanying coefficients before performing the calculation. Standardized values and calculation methods ensure that certain national and international safety standards are met.

Verification of serviceability refers to—as the word itself says—the serviceability of the glazing. This involves ensuring that the function or serviceability of the glass element is not impaired under loads. For instance, it is stipulated that windows exposed to wind loads must not deflect excessively, or glass floors must not deflect disproportionately when walked on. Based on these limits, the glass panes are dimensioned by the structural engineer.

Broadened Requirements

For quite some time now, in German-speaking countries, additional requirements regarding the stiffness of the glass panes have been included in invitations to tender. This is by no means a verification of ultimate limit state or serviceability. Rather, it is an attempt by the specialist planners and trades issuing the invitations to tender to influence the visual appearance of the façade. The intention is to prevent the reflections of the façade from showing obvious distortions or to prevent concave surfaces from affecting nearby surfaces.

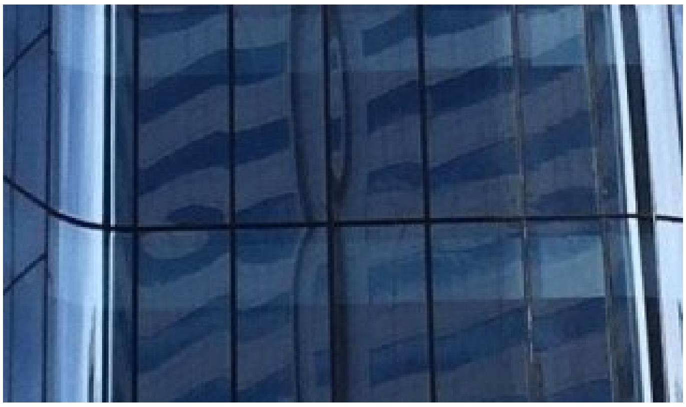

Image 1: Distortions on the glass façade

Image 2: Concentrated light reflections on nearby surfaces

That's why the following note is appearing all too frequently in invitations to tender: "The glass statics must ensure
that the external glass pane has a higher stiffness than the internal one ...". Similar requirements have been in place in English-speaking countries for many years. Through these requirements, the specialist planners want to ensure that the glass elements in the façade are as plane or flat as possible, and that no deformations are visible. The deformations of the glass panes are based on loads caused by the hermetically sealed space between the panes.

Double-pane or Insulating Glass Effect

Insulating glass panes consist of at least two or more glass panes, which are hermetically sealed all around by an edge seal system. This prevents pressure equalization between the gas in the inter-pane space and the ambient air. This prevents any of the filler gases from escaping or moisture from penetrating into the inter-pane space.

Due to changing boundary conditions, such as temperature and air pressure that are determined by weather conditions, the gas in the space between the panes has the tendency to contract or expand, resulting in concave or convex deformation of the glass panes. The larger the volume in the space between the panes, the more clearly visible are the deformations of the panes. Accordingly, the deformations are usually more pronounced in triple glazing. These influences are system-related and cannot be avoided.

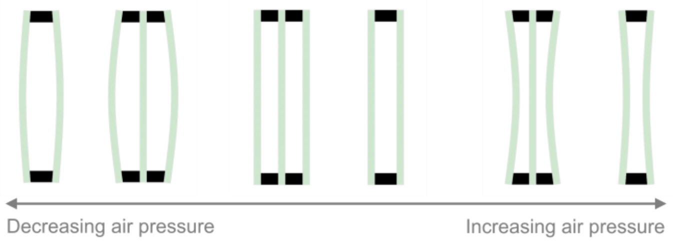

Fig. 1: Illustration of deformations of the glass pane depending on air pressure and installation location.

The End Product

Had there been only limited requirements for the glazing, it would be much easier to take them into consideration. The glass assemblies to be used are mostly limited by requirements for solar, thermal, or bird protection. In addition, fall protection requirements are often added for modern glazed buildings. Therefore, it may make sense, from an application point of view, to make the inner impact pane from laminated safety glass.

The external pane could possibly be made of float glass. This results in an exemplary glass assembly (from the outside to the inside): 8mm float glass / 16 mm inter-pane space / 66.2 laminated safety glass from float glass. However, this glass assembly would not meet the previously mentioned cosmetic requirements.

If the glass assembly were reversed to meet the new requirements, it would be necessary to temper the internal pane to minimize the risk of injury when people collide with it. This results in the following theoretical configuration: 66.2mm laminated safety glass from float glass / 16 mm inter-pane space / 8 mm tempered safety glass.

In this example, the requirements for stiffness of the internal and external pane are now fulfilled. However, this increases both the price for the end customer and the CO_2 footprint of the building envelope, which is not something that should be of interest in the current developments.

An appropriate prioritization of the factors to be taken into account (ultimate limit state, serviceability, building physics or application technology related requirements and aspects of sustainability) can only be made by the property owner and his specialist planners, and will accordingly have an impact on the costing of the façade.