Influence of Edge Design and Location of Load Introduction on the Loadbearing Capacity of Glass

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Summary

The common cause of glass failure are cracks originating at the glass edges. This circumstance becomes even more significant for load bearing glass structures, because external loads are normally introduced to the glass edge. This requires an optimisation of the support conditions. In this paper two factors involved in this problem are highlighted: the edge design and the location of the load introduction. This paper shows the first results of a research project.

Keywords: Load Introduction, Glass Edge, Edge Design, Structural Glass

1. Introduction

In signature projects, structure loads are being increasingly transferred by the glazing. An important factor for this application is the load introduction into the glazing, which is usually occurring at glass edges. Therefore, this detail of the construction has to be planned very carefully. Then as is known, the glass edge is the materials central weakness. This is observed in that cracks mostly originate at the edge of the glazing. The reason for that is the brittle material behaviour which does not allow for any deformation.

Research shows that the edge design (geometry of the edge) as well as the support conditions (measurements and location of the connector) have a significant influence on the stress distribution in a glass panel and on the load bearing capacity.

In this paper numerical research on different edge designs and locations of load introduction are presented. Experimental research are currently being conducted and will be presented at the conference.

2. Edge Formation

In order to investigate the ability to increase the load introduction of edge designs shown in a parametric study was carried out with the finite element (FE) program ANSYS 15.0. For the analysis a 2D-FE model with a depth of 1mm was used. The varied parameters were the radii R of the flat edges with rounded corners and the round edge as well as the chamfer X of the chamfered edge. For research purposes a 6mm thick glass (height 15mm) and 3 different connectors (steel, aluminium and POM) (w x h 18mm x 5mm) were chosen. As load an external displacement was set at the opposite horizontal edge. The corresponding loads were observed when achieving a tensile stress of 45MPa. Friction, which has in some cases a positive effect, was not applied.
The results of the research show that the maximal compressive stress was always located in the contact area in the direction of the displacement (here: y-axis). The location of the maximal tensile stress was dependant on the edge design. Furthermore, depending on the connector material, different edge designs have to be chosen for a better load bearing capacity.

3. Location of Load Introduction

In order to apply a glazing as a load bearing structure able to withstand external forces more research is required to minimize stress. For this reason a parametric study using a 2D FE model with the program ANSYS 15.0 was carried out. The varied parameter was the location of the blocking (different distance from the glass corner), the length was set to 50mm. and the symmetry as seen in was used. A displacement as external load was set up at the horizontal glass edge. In the initial calculations a rigid body was used for the blocking.
First results show that the location of the blocking has no influence on the stress profile between blocking and glass edge itself. Based on the position of the blocking on the glass edge the stress peak changed accordingly without any increase or decrease of their values. The loads relating to the displacement increased with a higher distance from the blocking to the glass corner with an almost equivalent stress in the glass pane. This confirms that with an increasing distance from the blocking to the glass edge the stress decreased. This results from the fact that with a higher distance from the blocking to the glass corner a bigger area of the glass pane is capable of stress distribution. For an optimized location of the blockings further investigation is necessary.

4. Conclusion

According to the presented results of the research it is possible to decrease the stress in the glass and due to that increase its loadbearing capacity by modifying the support conditions. Up to now, further investigation is necessary, because many factors still have to be taken into account. For example imperfections due to misaligned support conditions of the glass edge have not been considered yet.

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