Experimental investigation of the edge distance of adhesive point-fixings in glass

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1. Introduction

The demand for architectural transparency has drastically increased the use of glass as a structural material. The overall transparency improves significantly by using so-called point-fixings [1]. Bolted point-fixings are widely used in facades and canopies. These fixings typically consist of locally installed metal pieces, of limited size, connecting the glass elements to the structure using bolts through the glass. This requires the glass panel to be drilled in corner or edge zones, and to be subsequently tempered and bolted. Due to the profound influence of the distance between the bore hole and the edge, i.e. the edge distance, investigation has been performed widely on the influence of the edge distance for glass panels supported by bolted point-fixings [2-4]. A general conclusion from literature is that the maximal occurring stresses will reduce with increasing edge distance, which results in a higher strength of the glass panel. The occurring stresses will also diminish when the diameter of the connection is enlarged.

Despite the widespread use of bolted point-fixings, a major disadvantage of this type of connections is the significant weakening by the drilling process at the holes edges, which is where high stress peaks occur due to the local transfer of forces by contact between metal and glass. The use of adhesive connections avoid this issue because the glass is directly bonded to the metal connector. Indeed, adhesive joints reduce high stress peaks by spreading the force over a larger area. Since the edge distance has a great influence on the mechanical behaviour of glass panels supported by bolted point-fixings, this distance will also play a capital role for adhesive point-fixings. However, for adhesive point-fixings this influence has not been extensively investigated yet. This work presents the results of a thorough experimental study of the influence of the corner and edge distance on adhesive point-fixings. Apart from the use of adhesive point-fixings, the use of full-scale panel testing is innovative considering that previous experiments on bolted point-fixings have been mostly performed on small-scale tests.

2. Materials and methods

A full-scale glass panel of 1 m by 2 m supported by six point-fixings with a diameter of 50 mm each is used as test specimen. The load consists of a uniform out-of-plane pressure of 395 N/m². The four connection positions for which the edge distance will be considered are 35 mm, 105 mm, 175 mm and 245 mm. To study the influence of asymmetric edge distances, all possible edge distances are tested whereby the middle edge distances are not necessarily equal to the corner distances. The stresses at the surface are measured using 25 strain gauges forming four stress paths i.e. one along the long axis of the glass plate, two along the short axis and one at an angle of 45°. The positions of the strain gauges are determined by means of a preliminary finite element analysis.

3. Results and discussion

The measured values from the strain gauges are depicted in Figure 1 along the four defined stress paths (σ_x, $\sigma_{x'}$, σ_y (1) and σ_y (2)). To make the graphs more interpretable a different line type is used for each corner distance and a different colour and marker for the edge distance. The legend is explained in Table 1.

Table 1: Legend for the graphs of Figure 1.

Corner edge distance		Middle edge distance	
	35 mm		35 mm
	105 mm		105 mm
	175 mm		175 mm
	245 mm		245 mm

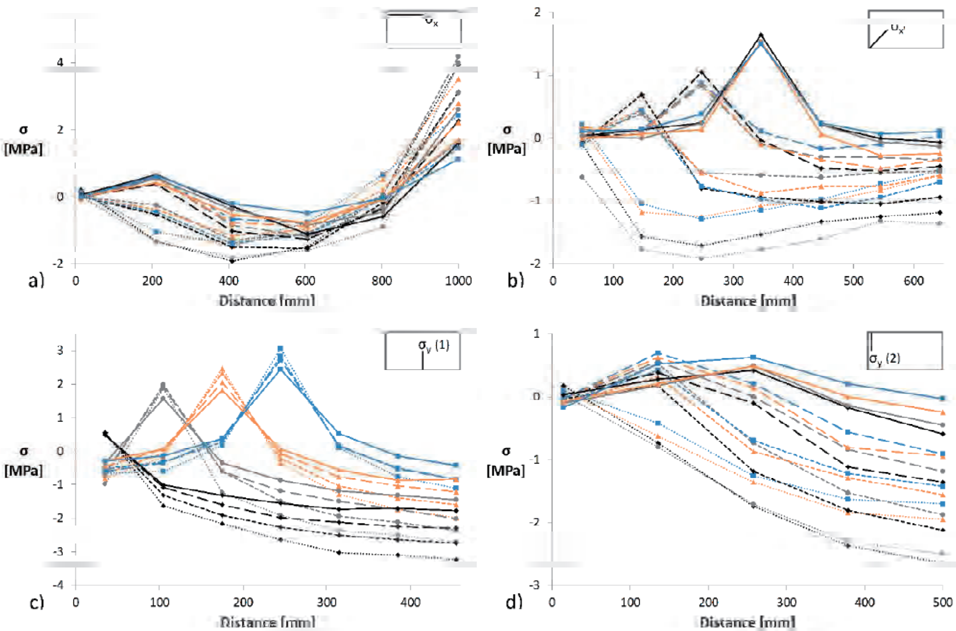

Figure 1: Influence of the corner and edge distance on the mechanical behaviour of the glass panel.

The experimental results demonstrated that the highest stresses were reached with the lowest edge distances. This is in accordance with research on bolted point-fixings [2-4]. With a low edge distance, the stresses in the field are much higher compared to a larger edge distance, where the field stresses are more uniform. However, stress peaks will occur at the connection.

4. Acknowledgements

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