Transparent Façade Solutions with Bonded Glass-Steel Beams

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Summary

The combination of steel and glass used as a hybrid structural element such as a mullion or transom generates a higher level of transparency in facades. In spite of its positive attributes, the brittleness and the lack of plastic deformation of glass increase the risk of a spontaneous failure and the entire loss of load-bearing capacity after breakage of each glass panes independently of the glass type. However, this typically results in over-design with high safety factors if laminated glass beams are used. The combination of glass beams with the ductile material steel provides an optimised load-bearing capacity with increased robustness. In a modified four-point bending test the load-bearing behaviour of various cross sections of hybrid beams was examined. The test results demonstrated a considerably improved structural and post-breakage behaviour of the hybrid beams compared to conventional glass beams.

Keywords: hybrid structures, transparent beams, bending stiffness, glass, steel.

1. Introduction

The main materials for transoms and mullions of curtain wall systems are steel and aluminium. However, these materials can not solve satisfactory the desire for maximum transparency in facades. The effect is, that beams, columns, fins or frames are more and more made of glass today. So the enclosing function of glass becomes a secondary part and the load-bearing and stiffening function the more important. Thereby special attention should be given to the structural design because currently there are no regulations for such load-bearing glazing elements. Especially the brittleness of glass leads to unprofitable oversizing of structural elements. As a result of this the ultimate limit state of bearing capacity and serviceability is increased. Further reason for oversizing is also the post-breakage behaviour after glass breakage that must be taken into account while designing. Recent research demonstrates that - independently of the type and combination of glass used - this performance of glass beams is not ensured [1, 2, 3].

Against this background the research project HybridGlasSt studies hybrid glass beams consisting of laminated glass and steel which can combine the transparent characteristic of glass and the ductility and rigidity of steel. Those elements could be used for mullions and transoms in modern glass facades. The connection of the materials is based on a linear bonding with a transparent acrylate adhesive, which is distinctive of having a short curing time in comparison to many other adhesives [4]. So the chosen adhesive can provide advantages in production times and manufacturing processes. The linearly bonded joints enable continuous load distributions which avoid local stress as often exist in conventional structures. For the planned application the adhesive has to have a high strength to distribute loads and a sufficient elasticity to compensate elongations due to temperature alterations. As acrylate adhesives are known for their dependence to temperature, medium, duration and level of load [5] first of all the project concentrates on vertical facades systems for interior areas.

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