Elegant and safe structures made of glass

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Barbara Siebert, born 1967, received her civil engineering degree from TU München. After some years as employee in a consulting office, she is now working in her own consulting office Ingenieurbüro Dr. Siebert with special field of application of glass. The doctor's thesis about the calculation of point helded glasses was accepted 2003

Summary

Glass becomes more and more popular for applications in building structures. Examples are facades, large overhead glazing`s and constructions completely made of glass. On the one hand side the architect wants to design an elegant and transparent structure; on the other hand side the engineer wants to design a robust and safe structure. It is possible to fulfil these two demands. Glass is a brittle material, so it is important to design very careful – for both: the architect and the engineer. So many points are important for the design: The details, the background of the theory of glass a close to reality Finite Element analysis, and often testing of glass.

Keywords: glass structure, façade, remaining load carrying capacity, Finite element analysis.

1. Introduction

For design glass constructions many aspects like knowledge about the basics of the material glass, the remaining load carrying capacity and a careful static analysis of the brittle material glass are important. For more information see full paper.

2. Office building in Rosenheim

The design of the office building dating from the 1960s as well as the redesign was planned by Schleburg Architects, Rosenheim.

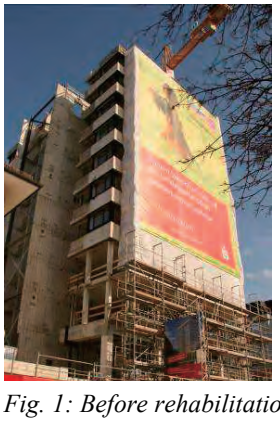

Fig. 1: Before rehabilitation

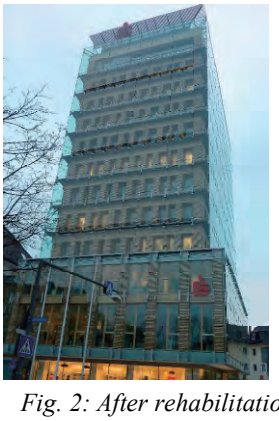

Fig. 2: After rehabilitation

Fig. 3: Details

The dominating glazing parts of the secondary façade have a size of 2.5m x 2.5m, in the 11th floor the glazing height increases to 4.3m. The glass panels are visually broken up by openable louvres which are 0.55m high and 1.25m wide, they are linearly supported along their short edges. The louvers are used for natural ventilation and will also open in case of any smoke emission. The wind

loads were determined based on a wind study which was carried out for the double skin façade. As the gap between outer and inner façade is to be accessible for cleaning and maintenance the outer façade has to resist also impact loads. Therefore besides the structural analysis with FEA impact tests had to be carried out. For the louvers also additional requirements regarding remaining load carrying capacity after glass breakage had to be taken into consideration. For the secondary glazing of the façade a special permit from the authorities was needed.

3. HVB tower in Munich

The high rise building of "Hypo-Vereinsbank" in Munich, erected 1981 and a landmark in Munich is at present under rehabilitation (Henn architects). To get a green building, amongst other topics the old facade is replaced by a modern double skin facade. The building is classified as a historic monument, meaning that renovation is subject to strict conditions. The outer appearance of the building has to remain unchanged. Remarkable features of the building are the curved edges, which are only partially covered by the German regulations for glass. The glazing of the existing façade is produced in 1981 with a special low-e coating for a selective filtering of the solar radiation. Until now there were made of course technical progress and improvements concerning the coatings of glass. Closely related to this the color of possible coatings changed the last 35 years. To match the former appearance of the façade an extensive sampling was done on site. Finally there was found a solution which matches the "original" color the best. In the corner of the building special bent elements were used, according the state of the art in form of triple insolation units. This application is not covered by the German regulations. The calculation of the glass, e.g. for the climatic loads in the inner of the IG-unit, is a "new technological territory". It was necessary to design a very slim new element with all technical characteristics of a double skin façade – with the same appearance of the old façade. Especially the necessary openings for ventilation have to be implemented into the element. This was done inter alia with very small drillings in the metal sheet. It was necessary to fix the new elements with a higher weight to the existing concrete floors of the building. Because of the not sufficient parapet height the element acts as anti-drop device.

Fig. : Change of Elements

Fig. 5: Nearly completed façade

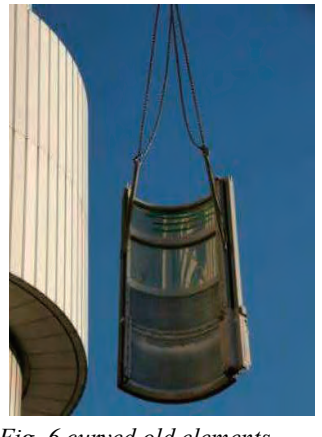

Fig. 6 curved old elements

4. Conclusion

For transparent glass constructions many points are important: choosing the right kind of glass, doing the static analysis very carefully, looking to the interaction between substructure and glass and looking to the remaining load carrying capacity. So the design and structural analysis of these constructions may be very sophisticated. In this paper two examples of high rise buildings were presented. Both are old buildings which were redesigned recently. These two examples shows that it is possible to build elegant and transparent structures which are also robust and safe structures.

5. References: See full paper