NUMERIC THERMAL BRIDGE SIMULATION IN WINDOW CONSTRUCTION ASSESSMENT: A CASE STUDY PERTAINING TO VACUUM-GLASS WINDOWS

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INTRODUCTION & PROJECT DESIGN

This contribution is a work report on recent efforts in the field of computational assessment of contemporary, highly insulating window designs based on vacuum glazing. Thereby, recent developments of the third-party funded project FIVA (Fensterprototypen mit integriertem Vacuumglas – window prototypes with implemented vacuum glazing), follow-up of the successful MOTIVE and VIG-SYS-RENO projects (reported on in previous contributions at the VSS conference series), are discussed.

As already indicated in past publications [1][2], the availability of durable vacuum glass panels allow for the construction of new window constructions, which – if designed in an appropriate fashion - offer a similar thermal performance than conventional triple glazing windows, but featuring smaller system size, thickness, and weight. Based on the ideas developed in the MOTIVE project, the authors could assemble a research and development team together with stakeholders from renowned window construction companies (Internorm, Gaulhofer, Katzbeck, Svoboda, Wick) as well as with stakeholders of supportive technology suppliers (IeB Eisele, Maco). This R&D team is now (ongoing efforts from 2018 – 2020) investigating into progressing the ideas of MOTIVE into higher technology-readiness-levels toward new window constructions for the market that implement vacuum glazing. The project consists of several work packages addressing different aspects, such as fundamental construction principles, implementation of supportive technologies, acoustical performance, and thermal performance of different construction concepts. To successfully establish useful and operable window construction, an iterative ping-pong-process between the technical design work and virtual testing of the thermal performance via numeric thermal bridge simulation was implemented. The specifics of the simulation efforts of window constructions that integrate vacuum glass are illustrated in this contribution.

SIMULATION SETTINGS

The numeric simulation tool used to generally investigate into the thermal performance of the vacuum glazing – based window constructions was AnTherm [3], a finite point solving modelling and simulation tool. As in any other finite point/finite element tool a crucial element is the smallest cell size. As vacuum glass products regularly encompass a very small vacuum gap between two glass panes, the minimum cell size needs to be dimensioned based on the gap thickness. Thus the minimum cell dimension was set to 0.1 mm. In the currently happening simulation efforts, the simulations have been based on (extreme) steady state boundary conditions (20°C inside temperature, -10°C external temperature, and focus on 2D assessment. Both aspects will be changed (to

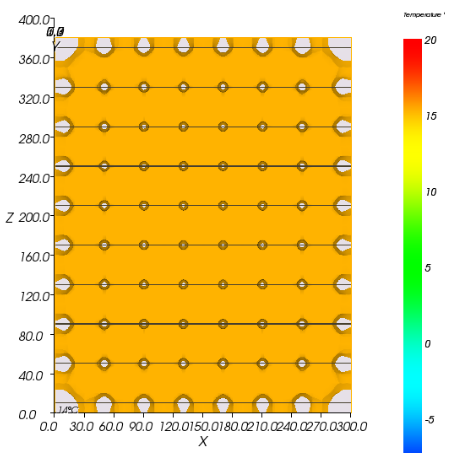

Figure 1: Temperature distribution on a vacuum glass pane (first published in [4])

transient and 3D-assessment), once major design decisions have been conducted regarding the different, currently developed window designs.

PRELIMINARY PREVIEW ON RESULTS

(i) Performance of typical vacuum glazing panes: Figure 1 shows simulation model and heat map on a typical vacuum glazing (including pillars and edge seal). The temperature differences between undistorted field and pillars are clearly visible, however in a negligible range (due to the very small dimension of the pillars in comparison to the overall window pane).

(ii) Result example (glazed versus wooden transom): As a sneak preview two transom designs (one consisting of a traditional wooden element, the other of two overlapping vacuum glass panels) are shown. Thereby, surface temperatures suggest that the by-far "lighter" appearance of the vacuum glazing element transom features a thermal performance that is comparable to the "bulky" wooden transom.

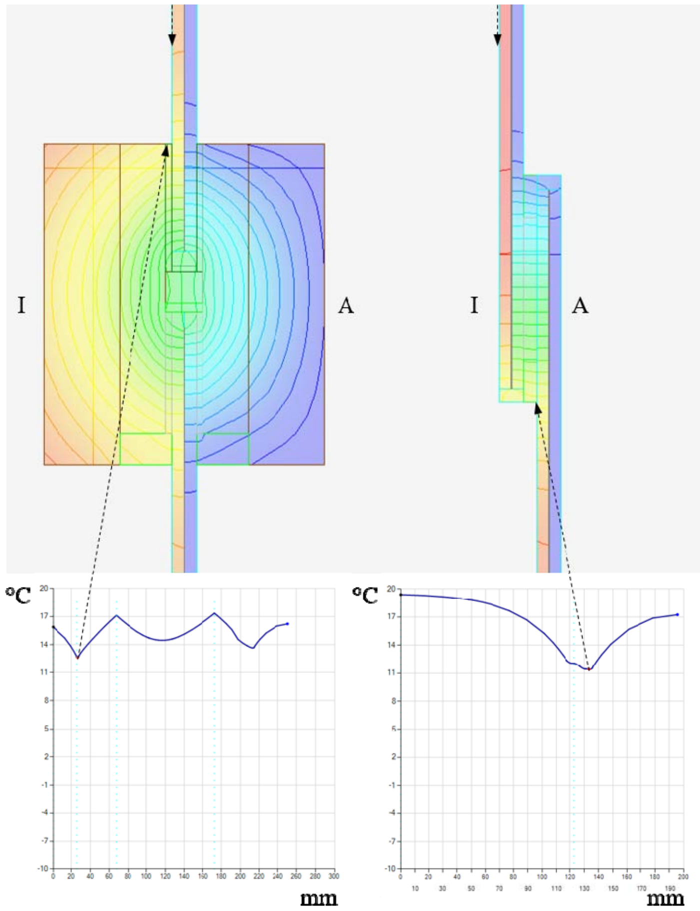

Figure 2: False-colour image and inside surface temperature distribution of two different transom designs (left: Wooden element, right: overlapping vacuum glazing panels)

CONCLUSION & ACKNOWLEDGEMENT

This extended abstract provided a glimpse on ongoing efforts pertaining to the thermal performance evaluation of novel vacuum-glass based window designs. Thereby, the principle performance of vacuum glass was illustrated, as well as a small case study pertaining to the performance of transom elements. The presented research efforts were in part funded by the Austrian Research Promotion Agency (FFG, project FIVA, project number: 867352).

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[3] AnTherm – Numeric thermal simulation environment (www.antherm.eu)

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