gFT glass & façade technology research group
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UNIVERSITY OF CAMBRIDGE
Department of Engineering

The Glass & Façade Technology (gFT) Research Group provides solutions to real world challenges in the field of structural glass and façade engineering through fundamental and application-driven research

Bi-annual Newsletter ***Summer 2010 Issue***

Recent News

1 Welcome to the Glass & Façade Technology (gFT) Research Group's first newsletter. This bi-annual publication will give insight to the activities within the group along with notable international developments in academia and industry.

2 The Institution of Structural Engineers study group on Façade Engineering and Structural Glass is planning a one-day industry-academia workshop and its annual distinguished lecture at the IStructE HQ in October 2010. Further details will be available shortly on http://www.istructe.org/technical/study_groups.asp?CID=1013 and The Structural Engineer Journal. Alternatively you may register by contacting Eleanor Voss (eleanor.voss@gft.eu.com).

3 With the support of EPSRC, Corus and gFT have teamed up to develop a new generation of steel-glass composite structures in which novel connections will enable both glass and steel to contribute to the global load bearing capacity of glazed structures. Shelton Nhamoinesu is currently researching the in-service and post-fracture performance of a basic steel-glass composite system that will form the basis of his future numerical and experimental work.

4 The recent developments in design methods for glass structures have been reviewed in a recent paper by Dr. Mauro Overend. The paper is published in 20th July edition of *The Structural Engineer*.

Upcoming Events

IStructE Facade Engineering and Structural Use of Glass Study Group Workshop

Date: October, 2010

Location: IStructE HQ, London

Meeting of the European Research Network on Structural Glass

Date: 28th September, 2010

Figure 1: Performance monitoring of switchable suspended particle glazing undertaken at the Department of Engineering in 2010. Showing clear state and bleached state. Further information is available on our website.

Launch of the European Research Network on Structural Glass

A new European research network was launched in Brussels on the 7th and 8th of April 2010.
The research network (COST Action TU0905), funded through the Intergovernmental Framework for European Cooperation in Science and Technology, will boost research collaboration in the field of glass engineering. The aims of the network are to unify ongoing research activities within the European research community and foster new international research and development collaborations. The research network focuses on the development of improved design methods and novel high performance structural glass products that will lead to a safer and energy efficient use of glass in buildings. The research network will also support researcher mobility and the development of a glass educational pack for universities across Europe. Academic and industry-based experts from a total of 22 European countries are already participating in the four interconnected working groups:

WG1: Predicting complex loads on glass structures

WG2: Material characterization and material improvement

WG3: Post-fracture performance and integrated design approaches

WG4: Novel glass assemblies

The gFT research group played a central role in securing the funding for this network and we are continuing to support and participate in the network activities. Dr. Mauro Overend has been elected to chair Working Group 3 and Kenneth Zammit and Qian Jin are currently developing the online resources for the research network. The network website (www.glassnetwork.org) is expected to be launched during the next meeting in Düsseldorf on 28th and 29th September.

Adhesive Connections between Steel and Glass

Despite the growing popularity of all-glass façades, there has been little development in glass joining techniques. Until recently the only option for high stress applications was to use bolted connections and fully toughened glass. This is surprising in that bolted connections in glass are inherently inefficient due to stress concentrations around the bolt holes and flaws induced during the drilling process. However, the recent developments in adhesive technology provide an opportunity to produce high-strength steel-glass adhesive joints. Adhesives conceptually seem a good choice as they evenly distribute the load and reduce stress concentrations.

As a result of the growth of this new sector the gFT research group has tested several adhesives currently available on the market. The testing was partly supported through the Steel Construction Institute's 'Innoglast' project funded by the European Union and partly funded by an EPSRC industrial case studentship in association with Hourglass Ltd. The adhesives tested were a two-part silicone adhesive Dow Corning DC993; a silicone adhesive Dow Corning DC895; a two-part polyurethane adhesive SikaForce 7550 L15; two-part acrylic adhesive Holdtite 3295; a UV-cured acrylic adhesive Bohle 682-T and a two-part modified epoxy adhesive 3M 2216B/A. Preliminary experiments were conducted to determine the visco-elastic and elasto-plastic properties of each adhesive. These were followed by experimental investigations to determine the performance of the steel-glass joints, consisting of:

•Single lap shear tests based on ASTM D1002-99. This was adapted for glass to metal joints rather than metal to metal.

•T-peel tests, also based on the guidelines in ASTM D1876-93.

Furthermore, the five adhesives and the two types of steel-to-glass connections were modelled using both analytical and FE models.

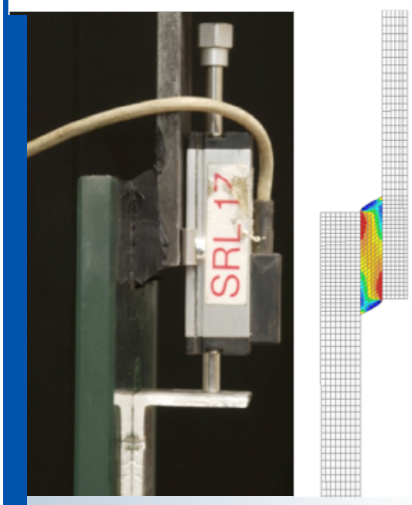

Figure 2: DC993 single-lap shear experimental test set up (left) and numerical model (right)

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The FE analysis was carried out using LUSAS 14.3. A 2-D model was constructed for each type of connection. The numerical model captures the visco-elastic and elasto-plastic properties of the adhesives, and provides good predictions of the strength and stiffness of the connections. The tests demonstrated that adhesives have the potential to outperform bolted connections and that they can be accurately modelled offering improved adhesive joint design.

Energy Appraisal of Retail Units

There is a vital need to implement energy efficiency measures in all range of businesses in the UK to achieve carbon reduction targets of 34 % below 1990 levels by 2020. A project to characterize the real-world performance of retail outlets through an in-depth monitoring study is currently being conducted.

The research involves setting up and deploying an energy performance toolkit consisting of a wide range of wireless sensors to monitor the main factors that affect energy consumption in retail stores. A real-time power meter determined the heating, cooling, lighting and equipment loads while the diurnal differences in measured energy consumption were correlated with external conditions and staff behavior. Thermal comfort indices were determined by means of small, wireless temperature and humidity sensors throughout the shop floor. Data from these sensors and wireless smart plugs provided an insight into the internal conditions that triggered the staff's adjustment of heating and cooling controls. Weather stations were setup externally above the stores which measured external temperature, humidity and wind characteristics.

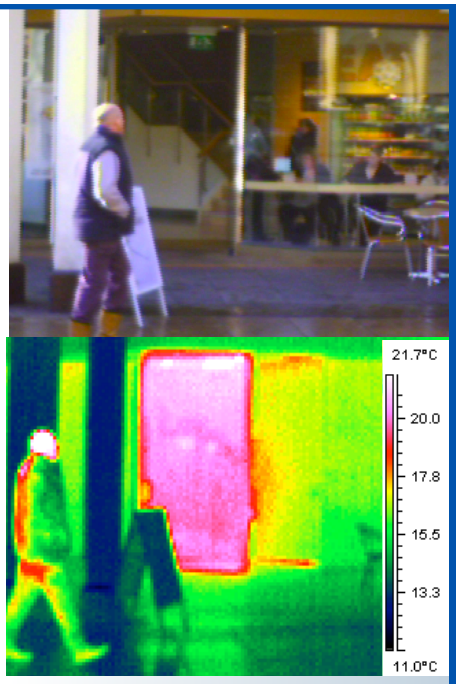

Figure 3: Infra-red image of an open external door

This local weather data not only enabled correlations between internal and external conditions but also captured variations in urban microclimates and the resulting differences in energy use between sheltered and exposed stores.

The project has so far characterized the heating season performance and the cooling season monitoring is currently underway. The project findings, that will be published in Autumn 2010, will aim to encourage retailers to take positive steps for both economic and environmental reasons while enhancing their corporate reputation. We are planning to develop this suite of sensors into a fully integrated wireless building performance toolkit that can be deployed with ease on large buildings.

The current research is being undertaken by gFT Research Group funded by The Close the Door Campaign with the support of the Esmée Fairbairn Foundation.

The Glass and Facade Technology Research Group

From Left: James , Shelton, Murat, Kenneth, Eleanor, Qian, Mauro