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

Autumn / Winter 2011 Issue

Recent News

1 Many congratulations to former gFT group member Murat Basarir who graduated in March after successfully defending his dissertation on 'Energy appraisal of retail units' and completing his MPhil in Engineering. Murat is currently based at Arup's Istanbul office.

2 The Glass & Façade Technology Group is hosting Martin Botz from the University of the Federal Armed Forces in Munich. In collaboration with gFT group members, Martin is undertaking experimental and numerical work to characterise the time dependent mechanical properties of laminated glass interlayers.

3 The gFT group welcomes a new research student Marco Zaccaria. His research on chemically strengthened glass is funded by EPSRC and Trend Marine Ltd and aims to develop a new generation of monolithic fire resistant glass.

4 gFT successfully organised the Space, Strucuture and Skin 2011 research symposium on 2 September 2011, at the University of Cambridge. It was the second conference hosted by the group following the successful Engineered Skins symposium last year. 64 industrial and academic delegates from across Europe attended the event.

5 Dr. Mauro Overend was Awarded the Guthrie Brown Medal by the IStructE in June this year for his paper on 'Recent developments in design methods for glass structures' published on the 20th of July 2010. The medal was presented by the IStructE President Professor Roger Plank at this year's IStructE Awards Luncheon.

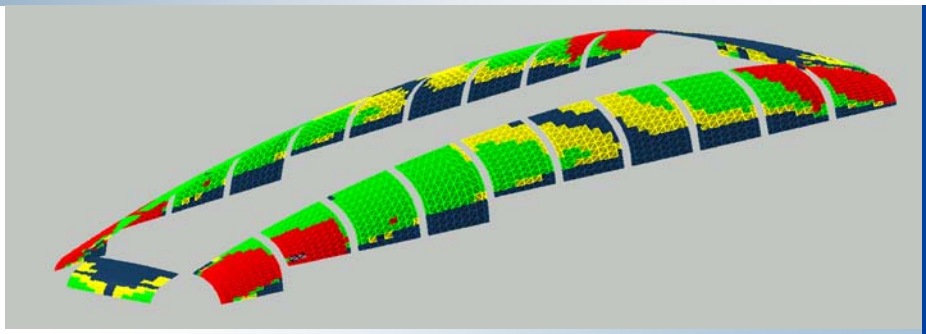

Figure 1: Heuristic manufacturability evaluation for a real-world case study

Knowledge-based evaluation of façade design

One of the benefits of Building Information Modelling (BIM) is the transfer of design information between applications used by design and construction teams. This has yet to be fully exploited in the façades sector. Research performed by Eleanor Voss within the gFT group aims to examine the extent to which tools such as the International Foundation Class (IFC) schema can be used to promote and facilitate information sharing. The research focuses on knowledge-based design evaluation using information stored in a Building Information Model.

The IFC schema has been developed as a neutral, construction industry-wide method of transferring digital project information. The intention is to improve interoperability in the industry thereby improving collaboration whilst reducing errors and re-keying. Many proprietary BIM applications already support IFC functionality.

Alongside work by BuildingSMART to develop the schema, others, including TNO Building Research, have developed toolboxes to use with the schema when developing IFC applications. Eleanor's research includes the development of a bespoke application using the TNO Building Research toolbox. The application pulls in the relevant information from the project BIM to perform a manufacturability evaluation of the façade panelisation scheme.

The evaluation uses a store of expert knowledge of manufacturing constraints to assess each panel. The results are stored in an IFC file for visualisation. The IFC schema's Property Set function provides the flexibility the project requires and allows the transfer of user defined attributes. The TNO Building Research DLL file provides a rapid approach to developing bespoke IFC based applications.

The application has been tested successfully on a selection of real-world projects, ranging from those with complex geometry (fig 1) to those with a high number of different panel materials and finishes. The next steps of the research will include using the IFC schema to transfer bespoke project attributes along the supply chain.

The research is supported by Ramboll and EPSRC.

Wind engineering of complex façades

Wind-induced pressures are often the controlling factor in sizing, detailing and performance of a façade. Unfortunately, there are several instances where these pressures cannot be determined from codes of practice, or are too small or complex to be included in conventional wind tunnel testing. These situations are increasingly commonplace as a result of energy

Figure 2: External shading model

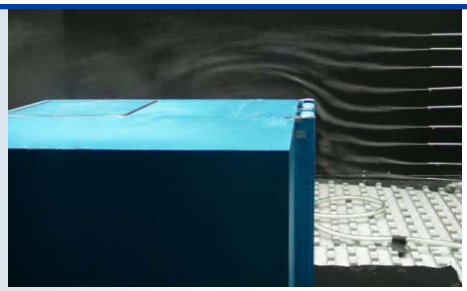

Figure 3: Flow over model during wind tunnel testing

efficient façade designs, such as those involving external shading devices and multiple skins.
Wind tunnel testing of a double-skin façade and external horizontal louvers has recently been completed by Kenneth Zammit of the gFT group in collaboration with BMT Fluid Mechanics and the support of EPSRC. Tests were carried out on a 1:10 scale model, to capture the detailed pressure gradients occurring on intricate surfaces typical of such façades.
A large model scale was used in this study, allowing the instrumentation of far more detailed façade elements. This is a deviation from standard wind tunnel practice, where buildings are modelled at scales in the region of 1:200 to 1:400. The large scale model, shown in Figures 2 and 3, were instrumented locally with 450 pressure transducers, which would not be possible at smaller scales. The setup was also designed to be modifiable, allowing the assessment of different geometric parameters such as shading angle and ventilation aperture. The data captured from these tests is currently being analysed, however indications are that this approach may give substantial design savings.
In certain locations, such as edge louvers, pressures have been measured which are higher than code recommendations. These investigations are central to Kenneth's research as they demonstrate how Computational Fluid Dynamics can be reliably used to augment wind tunnel data, thereby predicting the wind pressures on intricate façades with a high degree of accuracy. Although this work focuses on specific façade types, it is expected that the fundamental research undertaken should be easily transferable to other façade typologies.

The carbon negative building façade

A proof-of-concept project on how state-of-the-art glazing technologies might be used to create a carbon negative building envelope has recently been completed at the University of Cambridge.

In the study, the lifecycle performance of electrochromic (EC) glazing (Fig. 4) was compared with that of a high performance static solar-control (SC) glazing. The energy demand of a typical office room was assessed using building simulation software EnergyPlus for different facade orientations and different geographical locations (London, Abu Dhabi and Singapore). Window-to-wall ratios were also considered and the ones that generated the lowest energy demand were identified. Furthermore a lifecycle assessment was undertaken to account for embodied energy of the glazing units.

It was found that EC glazing delivers net lifetime carbon savings of 13.0% in London, 10.8% in Abu Dhabi and 7.6% in Singapore, when compared to SC glazing. The maximum net carbon saving of 329 kgCO_2 per square metre of office floor space was achieved for a south facing façade in Abu Dhabi. The greatest relative reduction is 20.5% for a south facing façade in London (Fig. 5). It was also found that potential savings diminish with room depth and that when considered in the context of a real-world building, the cash value of the carbon savings at the current carbon price were found to be negligible.

The study was undertaken by Richard Boyd, assisted by Qian Jin and supervised by Dr Mauro Overend. A more detailed summary of this was published in the CISABT 2011 conference and may be viewed on the gFT website.

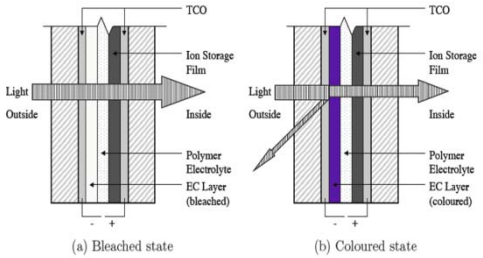

Figure 4: Schematic representation of EC glazing

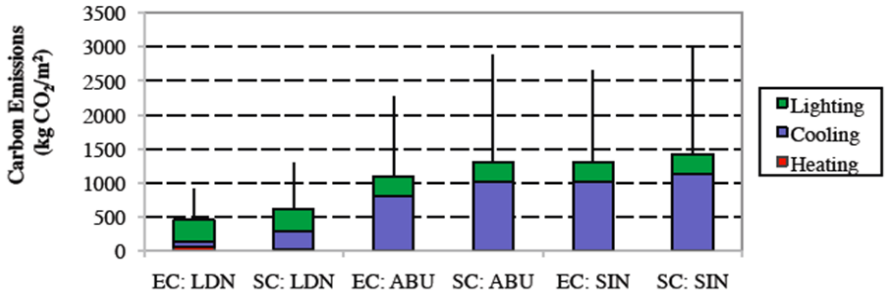

Figure 5: Carbon emissions for south-facing façades with best-case window-wall ratios. The vertical lines above each bar represent the carbon emissions for the worst window-wall ratios.

For further information on our research activities please visit www.gft.eu.com or contact: info@gft.eu.com

The gFT research team has produced five research publications since January 2011. These and previous publications may be accessed at www.gft.eu.com/04_our_publications