The Institution of Structural Engineers

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Institution of Structural Engineers Research Award 2012

Project title: Mechanics of prestressed structural glass

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Other researcher(s): One PhD student – to be advised

Aims of research:
Although recent architectural trends and the grand challenge in reducing fossil fuel dependency in the built environment have brought unprecedented opportunities, the inherent brittle fracture behaviour of glass and the lack of practical predictive tools to accommodate in routine design terms mean that glass has not been used as effectively as it might be. The objective is to demonstrate that the eigenstrain (i.e. misfit strain) technique can be used to determine the residual stress states in commercially available glass panels and, then by using this knowledge we will explore the efficacy of thin, transparent, self-adhesive glass fibre polymer (GFRP) sheets to prestress glass panels. The goal is to demonstrate that prestressed glass can withstand a wide range of loadings with an improved ductile and a safe post-fracture response in various structural applications such as in roofs/floors/staircases and partitions in buildings.

Benefits to structural engineering:
The study will provide practical tools to make use of more strong and ductile glass as a "structural material" in the construction industry. Appropriate use of glass with its unique combination of transparency, durability, relatively low cost and the very significant architectural/aesthetic potential, to build roofs/floors/staircases and partitions in buildings could significantly reduce our reliance on artificial lighting. Also the solar heat gain could be efficiently harvested for space and water heating in the buildings. The present work thus could lead to an exciting engineering innovation to fulfil the grand challenge in reducing fossil fuel dependency in the built environment and consequently to reduce the carbon footprint of the future built environment.

The results of this project would provide knowledge and confidence to architects and structural engineers to use glass as a structural material, and the consequent changes they would make in planning and design could improve the energy performance of the buildings. The work could also lead to new fields of multi-discipline research covering the areas such as architectural/structural/materials and environmental engineering and also building engineering physics; thus it will provide unprecedented opportunities for the fellow academics and practitioners. The knowledge can also be provided to businesses such as glass manufacturing companies to improve their competitiveness, productivity and performance. Hence, the work would also create numerous opportunities for academic–industry knowledge transfer partnerships. General public will also be benefited by having buildings with high quality interior environments which ensure comfort, health and productivity of its occupants.

Proposed finish date: September 2015