PRACTICAL APPLICATIONS FOR CONSTRUCTION AND THE BUILT ENVIRONMENT

Innovation & Research FOCUS

www.innovationresearchfocus.org.uk

AUGUST 2015 IRF102

IN THIS ISSUE

OUR SPONSORS

Loughborough University
Centre for Innovative and Collaborative Construction Engineering
Department for Business Innovation & Skills
CIOB THE CHARTERED INSTITUTE OF BUILDING
ice Institution of Civil Engineers
The Institution of Structural Engineers
CENTRE FOR WINDOW AND CLADDING TECHNOLOGY
ROYAL ACADEMY OF ENGINEERING

Structural strength when you need it

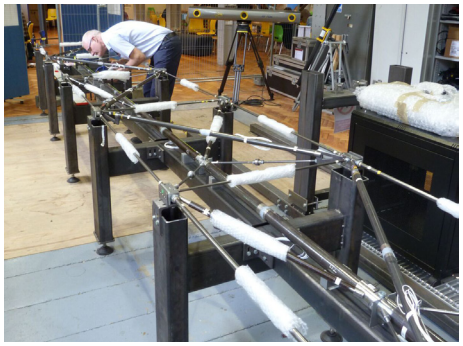
Most structures are designed to withstand a worst case loading that will only occur rarely. In these cases, the structure is effectively overdesigned for most of its life. As part of an on-going UCL-Expedition R&D collaboration, an adaptive truss prototype developed by EngD Researcher Gennaro Senatore demonstrates that it is possible to save much material in structures by optimal material distribution and controlling deflections through strategically located sensors and actuators.

This 6m long high-tech cantilever truss is not only enabling a novel research experiment, it also demonstrates a new engineering design philosophy where strength is dealt with separately to movement. The steel members making up the truss have been sized to prevent collapse, but instead of adding more material, the more onerous requirements of deflection and movement are precisely controlled by linear electric actuators keeping the truss rigid.

The novel design approach extends further so that day-to-day loads (which are typically a fraction of the full design loading) do not need the actuators to kick in. Only when larger infrequent loads occur, such as crowds on a bridge a few times per year or a football stadium full for 90 minutes once per week, do the actuators operate to control movement – so over the life of the structure little operational energy is needed. Compared to a conventional structure, this new engineering thinking has led to a prototype with 80% less material, 76% less whole-life energy and six times more slender.

How does the prototype work?

A large scale prototype has been built in the civil engineering laboratory at UCL, to help establish the practicalities



and validate some of the findings of the theoretical studies. The prototype is a 6m long cantilever transparent platform supported by a very slender space frame (40:1 span to depth, only 150mm deep). The frame consists of 45 passive steel members and 10 electricity powered linear actuators.

The platform is designed to withstand the weight of a person walking on it.

The deflection of the platform will be controlled in real time by a state of the art control system. The frame is fully instrumented to monitor the stress in the passive members, the deflected shape and operational energy used.

How could this change the industry?

This technology will transform the way we think about buildings. In a world which is going through massive and critical changes as a result of climate change, depletion of cheap fossil energy and financial challenges, it is lean, low-carbon, smart and adaptive. The project also demonstrates the benefits of cross discipline teams with civil, structural, mechanical, electronics and control engineering all involved. The trend to build taller, slender structures and associated concerns about their environmental impact make adaptive structures a potentially transformative technology.

This project is part of research conducted by UCL's Centre for Urban Sustainability and Resilience and the Department of Civil, Environmental and Geomatic Engineering. It has been funded by the Institution of Civil Engineers, the Institution of Structural Engineers, EPSRC and Expedition Engineering. For further information please contact Rabinder Phull (02076 652237; E-mail: Rabinder.phull@ice.org.uk).

ice Institution of Civil Engineers