The Institution of Structural Engineers

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2014/15 Undergraduate Research Grant Scheme

Project title: Continuous Timber-Concrete Composite Floors

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Aims of research:

(1) Use of laboratory tests to quantify the load responses up to failure of two-span continuous timber-concrete composite members (CTCCMs) with different shear connector layouts.

(2) Measurement of the constitutive behaviours of the connections, concrete and timber from relevant tests.

(3) Interpretation of all test results to understand how the redistribution characteristics of the CTCCMs are influenced by the nonlinear constitutive behaviours of the connections, timber and concrete.

(4) Development of user-friendly analyses to predict the essential facets of load response of the CTCCMs.

(5) Use of these activities to hone the students' skills in experimental and nonlinear analysis research.

Description of method:

Two 2-span CTCCMs, each 6m long, will be fabricated. Both specimens will employ glulam timber joists and screw shear connectors, one with the screws vertical, the other with the screws in X-formation. All screws will be threaded into the timber, with the concrete cast around them afterwards. The specimens will be instrumented with strain gauges on the steel bars embedded in the concrete and on the glulam joists. Transducers will be placed to measure slab-beam interface slip and vertical deflections at regular intervals along both spans of each specimen. Load cells will measure applied loads and one support reaction (to render the member determinate). All instrumentation will be connected to an electronic data logger.

During tests to failure, midspan concentrated loads will be applied to each specimen symmetrically about the central support. At specified load increments (reduced near failure), instrumentation data will be recorded, observations (slab cracking, etc) written down and digital camera stills / video recordings taken. Tests will also be performed to determine the shear force vs slip curves of the connections and the relevant stress-strain properties of the timber, concrete and reinforcing steel.

The CTCCM test data will be converted to strain (both along-beam and through-depth), slip, deflection and moment distributions at different loads up to failure. Also, a finite difference analysis (FDA) will be set up by the students, to encourage development of their skills in nonlinear analysis. This FDA will use the measured nonlinear stress-strain properties of the materials and shear force-slip curves for the connectors, to predict the experimental slip / strain / deflection profiles and cracked zones. The so-verified FDA will be used to analyse practical CTCCMs, and the analysis outputs used to provide guidance on a user-friendly analysis-and-design approach for this structural form which is suited to its material and connection nonlinearities.

Benefits to structural engineering:

Timber joist-concrete slab (TJCS) composite floors show huge potential as an economic, eco-friendly structural form with stiffness and strength-to-weight advantages over other types of floor construction. To date only single span, simply supported TJCS members have been researched. Multi-span continuity can reduce depth and improve the structural efficiency of TJCS members, but

the analysis-and-design process for such members must be based on sound understanding of their nonlinear load responses up to failure, including their moment redistribution capabilities. This project will help provide that understanding, and along the way will help the students to hone their experimental and nonlinear analysis skills.

Proposed finish date: March 2015