

Editorial

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The Series (Seismic Engineering Research Infrastructures for European Synergies) project, funded within the European Union's seventh framework research programme, has provided an unrivalled opportunity for novel ideas on improving earthquake resistance of the built environment and of key elements of infrastructure to be tested at a large scale across the major seismic testing facilities in Europe. This special issue of *Structures and Buildings* serves as a repository for the some of the state-of-the-art concepts to emerge from Series testing focused on timber structures.

The opening paper by Fardis and Biskinis (2015) gives a bird's eye perspective on the Series project. After introducing the underpinning ideas and the European-wide consortium that defined this project, the paper describes the broad spectrum of testing foci – including the reinforced concrete, masonry and timber strands of activity, spanning from the historic to the modern, and encompassing building superstructures, foundations, silos, retaining walls, engineered soils and viaducts – successfully completed over the 4.5 year duration of this transnational collaborative scheme.

The remainder of the special issue focuses on seismic tests conducted by the Universities of Trento (Italy), Graz (Austria) and Minho (Portugal) on different timber structures. These include tests on full-scale buildings at the Laboratório Nacional de Engenharia Civil (LNEC) in Lisbon, Portugal, as well as tests on relevant timber components locally at the participating Universities.

These begin with the paper lead-authored by Professor Piazza of the University of Trento, which identifies at a global level the complete set of LNEC tests (for all three participating universities) conducted on four full-scale (7×5 m in plan), two- and three-storey timber houses of different layouts (Piazza *et al.*, 2015). Key details of the test specimens are presented and generic features of the tests such as the instrumentation, the seismic input accelerograms and observations on structural integrity post-testing are reported. Many of the remaining papers give detailed accounts of the key outputs from the tests on these house specimens.

Hence in the next paper, Branco *et al.* (2015a) present their LNEC testing of two-storey log houses. Such houses have long been built and used, and their corner joint details have become increasingly sophisticated. Despite this, there is a dearth of

experimental data on their seismic performance. The log house design and test setup are described and an initial attempt is made at comparing predicted and measured performances. Simple finite element (FE) modelling is shown to predict well the measured fundamental frequency, less so the next three frequencies. Exclusion of friction and self-tapping screw effects from the FE analysis are identified as reasons for these discrepancies.

The follow-up paper by Branco *et al.* (2015b) delves into the FE analysis and the key test outcomes for the log houses. We learn of a 3D FE model built using SAP2000, entailing shell elements for the exterior walls and internal partition panels along with frame elements for rafters and ridge beams, and attention to timber anisotropy. Sensitivity studies show that connection elements to model interaction between components are complicated and don't always improve predictive accuracy. The log house specimens were experimentally found to withstand peak ground accelerations up to $0.5g$.

The papers by Grossi *et al.* (2015a, 2015b) draw on results from testing at the University of Trento of full-scale timber frame shear walls comprising timber sheathing panels connected to timber studs, under both monotonic and cyclic in-plane forces. The papers first describe the variables – including hold-downs, sheathing panel material (oriented strand board (OSB) or gypsum fibre board (GFB)), fasteners and openings – incorporated into the 11-strong test specimen series. Noteworthy results are that the GFB sheathing led to 35% less racking resistance than did the OSB sheathing, that the openings only modestly affected shear wall stiffness and strength, that the absence of hold-downs reduced racking resistance by almost 50%, and that predicted stiffness and (EC5) resistance match well with the measured values.

The logical follow-up paper by Tomasi *et al.* (2015) of the University of Trento focuses on the LNEC shaking table testing of a three-storey timber frame building sheathed with OSB panels and referred to earlier by Piazza *et al.* (2015). A key finding is that while the design of the building assumed plastic behaviour, the actual specimen behaved wholly elastically throughout the tests, with little evidence of damage afterwards. This highlights the need to include mechanical contributions (e.g. from connections between perpendicular walls), which may not be explicitly allowed for in current modelling approaches.

In the final two papers, emerging from the Graz University of Technology, a two-stage experimental campaign to study the

performance and effects of cross-laminated timber (CLT) shear walls is presented. Flatscher *et al.* (2015a) first show, from tests, that commonly used fasteners exhibit good ductility, which is useful during cyclic loading of the walls, but also that vertical joint systems do not necessarily influence the load responses of the wall systems. The last paper (Flatscher *et al.*, 2015b) looks at LNEC shaking table testing of a three-storey CLT building that uses fully threaded screws to achieve continuity of the CLT wall. The results suggest that while CLT construction is simple and rapid, it can lead to structures of desirable seismic integrity. A q factor of 2.0 is proposed for CLT structures based on analysis of the test data.

The advent of engineered components such as CLT and glue laminated timber is helping to fuel a renaissance in timber construction across the globe. However, the structural analysis and design suite needed to underpin this activity by properly acknowledging the material characteristics, the jointing systems and the construction methods specific to timber structures is not yet fully developed or widely available. In recognition of this, EC5 will be updated for re-release by c. 2020. It is hoped that this special issue can be a part of the vehicle used to drive that process forward.

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