Editorial

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Sustainable design is becoming an increasing challenge for the practising engineer. Clients are increasingly interested in schemes that can demonstrate how the most efficient design solution in terms of embodied carbon dioxide has been achieved. There are various possibilities for using less material, the most obvious is to increase the material strength, another is to add other materials to address potential deficiencies in the base material design. Most sustainable of all is to re-use existing structures or retrofitting to extend their design life.

In this issue, we have five papers that all contribute to the body of research in different ways. The first two papers concentrate on axial performance of different forms of composite column utilising high-strength concrete (HSC). The third and fifth papers concentrate on how existing structures can be retrofitted to enhance performance under seismic and vibration serviceability, respectively. The fourth paper examines how the addition of steel fibres can enhance shear capacity while enhancing the overall ductility of the section.

To reduce material quantities and dimensions of columns, composite steel sections are often adopted to take advantage of the added ductility of steel combined with the compressive properties of the concrete. The key to efficient design is the combination of materials to provide adequate strength, ductility and fire resistance. Steel reinforced concrete (SRC) columns give the best fire resistance. Zhu *et al.* (2014) present the key results of a series of experimental tests on short SRC column sections consisting of structural steel sections embedded in HSC. HSC provides advantages of higher compressive strength but is also known to exhibit more brittle post-peak cracking behaviour, which can limit ductility. This study concentrates on the effect of the confinement steel on peak strength and post-peak ductility. Excellent agreement is obtained between experimental- and design-based values. It is concluded that stirrup type rather than spacing is the key to ensuring ductile behaviour in the post peak response.

Another approach to reduce column size is to move towards higher-strength concretes. The issue again is lack of ductility, as the higher the concrete strength the more brittle the failure mechanism. As concrete strength increases the effect of traditional confinement using the reinforcement cage becomes less effective. A better method of providing confinement in a uniform manner is to adopt a HSC-filled steel-column section. This method itself has problems, particularly in early age loading, as the relatively larger dilation of the steel tube reduces effectiveness of the confinement. Ho *et al.* (2014) investigated ways of enhancing this confinement by the provision of external supplementary rings and ties. The main conclusions were that the

external methods of stiffening enhanced both axial strength and initial stiffness. Of the two methods, the external rings were more effective than the ties. Design rules for taking advantage of both were validated.

As understanding of earthquakes and the response of buildings to seismic events continues to develop, codes are constantly being upgraded to take into account the latest research. Often, the new provisions lead to more onerous provisions for the main lateral load resisting components. This is fine for new building stock but it leaves the existing stock potentially vulnerable. Kaliyaperumal and Sengupta (2014) present the results of an experimental and modelling study looking at the performance of retrofitted reinforced concrete beam column sub-assemblages. The novel aspect of the research was that the dowels normally inserted to provide bond between existing and new concrete were omitted in favour of a simple roughening of the existing concrete surface. It was concluded that the performance of the concrete jacketed specimens was satisfactory in terms of flexural strength, ductility and energy dissipation. Moreover, this increase in performance could be readily replicated using a layered modelling approach within a common software package.

Continuing the theme of enhancing reinforced concrete element performance, Abbas *et al.* (2014) outline a numerical modelling study used to examine the enhanced behaviour of reinforced concrete beams in shear. First, the available concrete constitutive modelling techniques for concrete were introduced. Next, an explicit numerical modelling approach utilising a brittle cracking model in tension modified for percentage fibre addition was calibrated against existing beam tests designed to invoke shear failure. Then a parametric study looking at the effect of increasing fibre addition and stirrup spacing was undertaken. It was concluded that fibre addition enhances both strength and serviceability performance. Furthermore cracking was reduced and brittle shear failures were converted to a more desirable ductile flexural failure mode. Interestingly it was found that the addition of fibres beyond a certain limit did not reap further benefits. Practically, it is suggested that fibre addition could be traded against stirrup spacing and that this would be beneficial in areas of reinforcement congestion.

Finally, Skinner *et al.* (2014) present a study looking at the enhancement of potential vibration performance of timber floors by the addition of thin layers of concrete. The addition of only a thin layer was shown to effect fundamental frequency. This could provide a cost-effective method of improving the vibrational response of existing timber floors to internal footfall loading.

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