

Editorial

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The practicing engineer can sometimes wonder whether there is really much more research required into the basic engineering materials we design with. The more established engineering materials, such as steel and concrete, benefit from literally centuries of research and study, and codes of practice cover the design of all structural forms in far greater detail than ever before. Yet, as technology develops, opportunities arise to revisit what has gone before us, with the potential to bring efficiencies to the design process and further encourage innovation. As a result of ongoing research and development, shortcomings in well-established analysis and design methods continue to be identified, which is why it is so important that research papers, such as those presented in this February 2016 issue, continue to be distributed to the engineering community. The papers presented in this issue touch on what many might consider to be well-understood design problems or solutions. However, all have potentially significant consequences for design and construction and remind us of the importance of revisiting, through research, what might be considered to be well-established practice.

In the first paper, Li *et al.* (2016) bring together experimental and theoretical research from the past three decades to propose a simplified flexural design procedure for the bolted side-plating (BSP) technique of strengthening reinforced-concrete (RC) beams. Recognising that traditional methods of analysis and design of RC members are not applicable to BSP beams, a new three-stage design procedure is proposed. First the design formulas used to compute the flexural strength of conventional RC beams are modified to take into account partial interaction. Second, design equations are derived to estimate steel plate dimensions and bolt arrangement. Finally, maximum plate-RC slips and minimum strain and curvature factors are back-checked to ensure they remain within recommended design limits. It would appear that Li *et al.* have brought research on this appealing retrofitting technique to a simple and pragmatic design conclusion for the practicing engineer.

The last ten to twenty years have seen the rapid development of computer processing power, with increasing ease of access. In the second paper, staying on the theme of composite steel–concrete construction, Abbu *et al.* (2016) take advantage of the correspondingly rapid development of the finite-element method to develop and validate a three-dimensional finite-element model to simulate the behaviour of headed shear stud connectors in composite construction. Using commercially available software, they obtain strong agreement with a range of experimental data obtained from push-out tests.

Determining the capacity of shear connections and the load-slip behaviour of shear connectors commonly depends on physical push-out tests. Such physical tests are time consuming and costly, and therefore the benefits of a verified finite-element analysis method should be immediately apparent to both the manufacturer and the designer.

Dinh *et al.* (2016) present an equivalent multi-strut approach for the analysis of the non-linear response of structural frames infilled with masonry. Multi-strut solutions have been proposed by others to allow for consideration of the non-linear range, but in this paper the authors present an alternative multi-strut approach derived by analysing the individual members of the structural frame as beams on a Winkler elastic foundation, with the elastic foundation being the masonry infill. The authors also consider the influence of the gap that often exists between the infill and the underside of the upper beam. Experimental results from push-over tests are compared to the analytical results using the proposed multi-strut approach, which correspond well to varying degrees, and certainly significantly better than mono-strut approaches. It is clear that the multi-strut approach must be considered when the demand on the structure results in non-linear response, and the approach presented has a lot to commend itself. A comparison with other models proposed for capturing non-linear behaviour would be useful, and some further refinement may be required to improve correlation with experimental results.

Samanipour and Vafai (2016) present an algorithm to simultaneously solve the governing equation of a bridge, as well as the equations of motion of an actual European truck passing along a beam with different end conditions. For each support condition considered, dynamic analyses were performed for a number of span lengths and for a range of vehicle velocities in order to ascertain the dynamic amplification factor (DAF) – the factor on static loads used by bridge codes to account for dynamic actions of vehicles travelling over bridge structures. Further, the authors consider both smooth and non-smooth road profiles. This comprehensive paper confirms that bridge codes, as would be expected, adopt suitably conservative DAFs for smooth-surfaced bridges. However, the authors conclude that when the bridge profile is not smooth and, in addition, the truck speed is high, the DAF may become more than some bridge codes adopt, and in some instances significantly so. While the authors note that the damping effect of soil when in contact with some buried structural components may decrease the real factor, which hasn't been accounted for in the study presented, this caution regarding the appropriateness of codified

factors to account for dynamic effects should be noted by all bridge engineers.

The fifth and final paper by Roy *et al.* (2016) returns to the subject of composite materials, but in this instance steel and carbon composite patches. Carbon fibre-reinforced polymer repairs to fatigue cracks in steel structures can offer a simple repair where access may be restricted or in order to avoid hot works, such as welding. While there is already a significant body of work on this subject, recognising that most experimental studies reported are on repaired flat steel plates, the authors have conducted cyclic fatigue tests on a selection of more complex welded steel configurations, resembling more closely likely in-service conditions on steel structures. Results are compared against predictions from finite-element analytical models with encouraging results, both for the performance of the repairs during testing and the accuracy of the analytical predictions. These results would appear to fulfil the authors' goal of addressing the apparent deficiency in compelling evidence to allow composite crack repairs to be adopted for real structures.

To close the issue, we end with a Book review by Cruise (2016) of *Design in Modular Construction* by Lawson, Ogden and Goodier. This is a comprehensive book, focussing on the design of volumetric units, laden with case studies and bringing together the multidisciplinary design aspects in an accessible and holistic manner – a useful reference for anyone engaging with volumetric modular construction.

Again, it is encouraging to see papers from across the world, with contributors from Vietnam, Iraq, Turkey, UK, Pakistan, Iran, China and Hong Kong. I hope you find these papers both stimulating and informative. Please also remember that the journal publishes its most recent articles Ahead of Print on

its Virtual Library homepage (<http://www.icevirtuallibrary.com/content/serial/stbu/fasttrack>).

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