Editorial

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Society expects the civil engineering profession to support continuous improvement in the quality and sustainability of the built environment. Delivering on this expectation will require development of materials with better physical and environmental properties, as well as refinement of design techniques to enable more efficient use of these materials.

New materials derived from sustainable sources offer the promise of reduced embodied carbon content in new construction. Bamboo offers both low carbon construction and the potential to make better use of locally available resources in many parts of the world. A great deal of work has been done historically to support the use of bamboo in building construction but raw bamboo retains disadvantages including variability of geometry and physical properties, as well as the inherent imperfections common to natural materials. The use of engineered bamboo products, such as Laminated bamboo lumber (LBL), can overcome these limitations to provide a consistent and reliable construction material.

To be able to make use of new materials such as LBL in practical construction their behaviour as structural elements must be well understood. The first paper of this issue documents experimental studies on LBL columns under eccentric loading to enable better understanding of the performance of this engineered bamboo product (Li *et al.*, 2019). Research of this type is essential to bridge the gap between an understanding of basic mechanical properties of the material and a set of codified design rules suitable for widespread adoption.

Alongside new materials, ongoing improvement of existing materials can lead to improved performance and better sustainability outcomes. Even concrete, a material which has been in constant use and development since Roman times, continues to benefit from ongoing research to improve our understanding of its behaviour and to develop new forms of the material. Self compacting concrete (SCC) is a relatively recent development that, as its name suggests, achieves compaction through flow under its own weight without segregating. Removing the need for vibration of the concrete provides immediate health and safety benefits as well as the potential for faster construction. SCC can also provide a finished structure with excellent durability.

Our second paper documents experimental work undertaken to understand the effect of different constituents on the constructability, strength, durability and sustainability of SCC

concrete mixes (Deilami *et al.*, 2019). Experimentally studying the impact of different constituents on the behaviour of the concrete mix during placement and in the finished state paves the way to the development of further improvements to mix designs. In this case the improvements to health and safety outcomes and the improvements to the durability of concrete structures can lead to long term benefits for both the users of the infrastructure and those who build it.

The construction of floors using composite steel and concrete construction provides substantial benefits in cost effectiveness and is widely used, particularly where longer spans are required. Composite action between steel beams and the concrete slab is typically achieved through the use of headed shear studs. Design rules for these shear studs have generally been developed with reference to physical testing, as the complex non-linear behaviour of the concrete at the interface makes development of a theoretical model difficult. Physical testing is, however, time-consuming and costly to undertake. Digital technology in the form of advanced analysis tools offers the opportunity to undertake ‘Virtual Testing’, where a physical test is simulated by numerical means.

To be useful the virtual test must capture all relevant physical effects, typically requiring a highly detailed modelling and analysis process calibrated against physical testing. The principal benefit of virtual testing is to enable a greater range of parametric studies to be undertaken for a given amount of experimental work. Virtual testing can also offer a greater degree of understanding of the internal behaviour of the element under test.

Our third paper (Abada *et al.*, 2019) documents the calibration of a virtual testing process to conduct the European Standard push-out tests for headed studs. The authors calibrated a numerical simulation to reproduce the results of experimentally conducted Eurocode push-out tests. They were then able to use a virtual testing methodology to enable exploration of new design alternatives without the need for further extensive physical testing. In particular, the authors were able to use virtual testing to understand the sensitivity of stud behaviour to concrete strength, decking thickness, rib shape and stud spacing, and provided guidance to others in the conduct of virtual testing of this element.

The use of modern digital analysis tools also permits a better understanding of structure behaviour during design events by

enabling a performance-based design approach to be used. Performance based design can permit a more efficient final design when compared to traditional prescriptive approaches as the desired outcome (i.e. required performance) is directly designed for. Performance-based design is used extensively in the field of seismic engineering, particularly for non-typical structural forms such as high-rise construction. In our fourth paper (Emani and Halabian, 2019), the authors propose an alternative performance-based design methodology that aims to better capture the ductility and damage distribution within a high rise building during a seismic event. Refinement of the design process, taking advantage of the advances in analysis techniques made possible by digital technology, gives the profession opportunities to seek ongoing improvements to the quality, efficiency and sustainability of the built environment.

As material technology and design approaches continue to develop at an ever-greater rate, the need to share knowledge and learn from others remains as important as ever. This journal exists to support the sharing of knowledge in the field of Structures and Buildings for the benefit of the international civil engineering industry and all those active in this field are encouraged to share their work with the profession as a whole.

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REFERENCES

- Abada G, Bernard F, Lim S and Tehami M (2019) Simulations of push-out tests: influence of several parameters and structural arrangements. *Proceedings of the Institution of Civil Engineers – Structures and Buildings* **172**(5): 340–357, <https://doi.org/10.1680/jstbu.17.00109>.
- Deilami S, Aslani F and Elchalakani M (2019) An experimental study on the durability and strength of SCC incorporating FA, GGBS and MS. *Proceedings of the Institution of Civil Engineers – Structures and Buildings* **172**(5): 327–339, <https://doi.org/10.1680/jstbu.17.00129>.
- Emami AR and Halabian AM (2019) Spatial distribution of seismic responses in tall buildings. *Proceedings of the Institution of Civil Engineers – Structures and Buildings* **172**(5): 358–381, <https://doi.org/10.1680/jstbu.17.00087>.
- Li H, Liu R, Lorenzo R, Wu G and Wang L (2019) Eccentric compression properties of laminated bamboo columns with different slenderness ratios. *Proceedings of the Institution of Civil Engineers – Structures and Buildings* **172**(5): 315–326, <https://doi.org/10.1680/jstbu.18.00007>.
- Masoodi AR (2019) Analytical solution for optimum location of belt truss based on stability analysis. *Proceedings of the Institution of Civil Engineers – Structures and Buildings* **172**(5): 382–388, <https://doi.org/10.1680/jstbu.17.00187>.