Editorial

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This issue of *Engineering and Computational Mechanics* contains papers dealing with the propagation of seismic waves through soils, the detection of defects within composite materials and the use of composite straps to strengthen reinforced concrete structural members. As would be expected, the papers embrace analytical and numerical approaches to modelling the mechanics of the problems addressed. Interestingly however, for application of the models to engineering design and testing, two of the contributions go beyond the mechanics to include stochastic optimisation methods for best solution.

The first paper by Majtenyi (2014) addresses a fundamental issue in seismology and geotechnical engineering, namely the propagation of normal compressive stress waves – P-waves in seismology terms – through granular material. The author considers the particular case of a stress wave propagating from an overlying rock into and through a soil; the rock movement creates a boundary condition for the soil, which is considered nonlinear, compressible and has air-filled voids. The analysis yields the evolution of the wave profile as the stress wave penetrates the soil, and includes development of a stress-dependent propagation velocity function and a relationship between normal stress and particle velocity. The results are illustrated using a numerical example in which a stress wave with speed 5700 m/s propagates into dry sand.

The high stiffness-to-weight ratio of composites means that they are widely used in the manufacture of structures for which structural stiffness is of paramount importance. Long-established in the aerospace industry, composite materials have become increasingly prevalent within civil engineering (see, for example, Garden, 2004). Indeed, this journal devoted a themed issue to the subject of composite materials in 2011 (volume 164, issue EM3). One issue relating to the use of laminated composite materials is their susceptibility to damage; material layers can become separated under fatigue or impact loading, or because of manufacturing defects. For this reason a host of methods have been proposed for testing composite materials, an overview of which is presented by the authors of the second paper in this issue, as part of the introduction to their paper describing a new method for efficient detection of delamination in laminated composite plates under compressive load (Rezaiee-Pajand *et al.*, 2014). Their method combines a higher-order finite-element formulation with genetic algorithm (GA) optimisation. The finite element model is described in detail and the authors demonstrate its ability to predict plate deflections and buckling loads for laminated plates

with known delaminations. The authors then illustrate the coupling of the finite element method with the GA optimisation and conclude that the combined method offers an accurate and efficient approach for detecting both the location and magnitude of delamination in damaged plates.

The third paper by Yapa and Lees (2014) has resonance with Rezaiee-Pajand *et al.* (2014) in that it too features composite material and stochastic optimisation. However, whereas Rezaiee-Pajand *et al.* are concerned with detecting defects within the composite material itself, Yapa and Lees focus on the use of composites to strengthen structural elements. Their particular focus is on enhancing the shear strength of reinforced concrete beams using pre-stressed carbon fibre reinforced polymer (CFRP) straps. The design of the strengthening involves selection of the number of straps and their location, stiffness and level of prestress. For efficient and accurate optimisation of the design, Yapa and Lees explore the use of two stochastic optimisation algorithms – particle swarm optimisation (PSO) and genetic algorithm (GA) – combined with two analytical methods for determining the shear strength of cracked reinforced concrete beams. Using examples, they show that the methods are effective in efficiently evaluating beam shear strength capacity and in optimising the design of the strap strengthening, but they make the point that convergence to the optimum solution depends on choice of optimisation method with the underlying shear strength model.

REFERENCES

- Garden HN (2004) Use of advanced composites in civil engineering infrastructure. *Proceedings of the Institution of Civil Engineers – Structures & Buildings* **157**(6): 357–368, <http://dx.doi.org/10.1680/stbu.2004.157.6.357>.
- Majtenyi SI (2014) Stress wave penetration into non-linear granular materials. *Proceedings of the Institution of Civil Engineers – Engineering and Computational Mechanics* **167**(2): 56–66, <http://dx.doi.org/10.1680/eacm.13.00005>.
- Rezaiee-Pajand M, Shahabian F and Tavakoli FH (2014) Delamination detection in buckling laminated composite plates. *Proceedings of the Institution of Civil Engineers – Engineering and Computational Mechanics* **167**(2): 67–81, <http://dx.doi.org/10.1680/eacm.13.00020>.
- Yapa HD and Lees JM (2014) Optimisation of shear strengthened reinforced concrete beams. *Proceedings of the Institution of Civil Engineers – Engineering and Computational Mechanics* **167**(2): 82–96, <http://dx.doi.org/10.1680/eacm.13.00022>.