Editorial

Alistair G. L. Borthwick MA, PhD, DSc, CEng, FICE
Professor of Civil and Environmental Engineering, University College Cork, Cork, Ireland

Computer models enable solutions to be obtained for immensely complicated problems in mechanics. As a result, present-day engineers are able to tackle problems well beyond the range of past generations. Examples include the non-linear analysis of complex structures, the simulation of feedback processes in natural systems, the invention of high-tech instruments for biomedical applications, and the exploration of new areas of applied science such as microfluidics. Computers are also used to interpret measured data, to calculate analytical solutions, to post-process results, etc. Given the ready availability of advanced software, engineers must develop an awareness of the risks posed by error, uncertainty, and model limitations. In particular, it is the professional responsibility of civil engineers to undertake computational analysis and design in a competent manner – and this includes understanding the fundamental mechanics on which computer models are based. Engineers should be able to assess the mathematical and numerical limitations of such models, carry out verification and validation tests, and be knowledgeable about the propagation of uncertainty, the effect of data scarcity, and risk. Although excellent guidelines exist, such as the book by Roache (1998), the Institution of Civil Engineers believes that it is time to review how computer models are applied in practice and how young engineers are educated in order to minimise the associated risk (see Borthwick *et al.*, 2012).

Volume 165 Issue EM1 of *Engineering and Computational Mechanics* contains seven full papers, covering advances in fluid mechanics, water–sediment mechanics, discrete particle interactions, elastic waves in solid materials, non-linear finite-element analyses, and the optimisation of steel structures. The papers are arranged such that they flow from fluid to solid mechanics.

The first paper, by Ophir *et al.* (2012), presents a hybrid Lagrangian multi-grid method for flow simulation. The variational principle is invoked to obtain the flow field directly from the Lagrangian for steady, irrotational, compressible flow. The solution is obtained numerically by minimising the variational functional using finite elements on a hierarchy of grids of different resolution, using a computationally efficient multi-grid procedure. The computational model is applied to two-dimensional incompressible, inviscid flow past a cylinder, three-dimensional incompressible inviscid flow past a sphere, and flow past an arbitrary body. It is shown that the method is efficient and accurate. This paper is of fundamental interest to developers and users of CFD.

Taylor *et al.* (2012) provide a means of separating small-scale periodic structure from larger-scale structure, the application

being the separation of ripples from dunes. The methodology is based on Hermite functions, and can be applied to a wide range of physical problems including the spread of contaminants in a diffusing plume. The idea derived from the analysis of measured data on the movement and evolution of laboratory-scale sandbanks in steady uniform and unsteady oscillatory flow fields. In many erodible-bed morphology experiments the larger-scale features of interest can become obscured by smaller-scale ripples, and this paper offers a general method for treating such problems. Application of the method is illustrated with reference to the interpretation of sandbank data previously acquired at the UK Coastal Research Facility.

Del Olmo *et al.* (2012) use the mechanics of discrete spherical particles to investigate the behaviour of granular media in a 1 m³ cubic cell. Spherical particles are first spilled into the cubic cell. Then the cell is subject to loading. The governing mechanics is expressed in terms of the Hertzian contact law and Coulomb slip law, and analyses undertaken for different particle grain size distributions. Results are presented in the form of numbers of contacts between particles, void ratio, and orientation of contacts. These shed light on certain phenomena relevant to soil mechanics such as settlement and surface morphodynamic changes. Very promising agreement is obtained with laboratory data on the behaviour of granular rockfill material.

Carta *et al.* (2012) consider the dispersion of elastic waves in micro-structured material. After introducing gradient elasticity theory in dynamics, the authors examine dispersion curves in heterogeneous material using an approach adopted from the spectral analysis of surface waves in geotechnical engineering. Infinite series of sinusoidal waves are generated by an impulse load, the acceleration responses are obtained at a pair of receivers a fixed distance apart, and the phase velocities of the wave components are then determined. The authors analyse the dispersion of elastic waves in a one-dimensional laminated bar and in a two-dimensional heterogeneous chequerboard plate. In both cases, very good agreement is obtained between the analytical and numerical predictions of the dispersion curves. Using spectral analysis, the authors are able to determine the inertial length scale parameter, which is particularly useful for simulating elastic wave propagation in composite materials.

Gillard *et al.* (2012) present findings from non-linear finite-element analyses of the structural response of liquefied natural gas containers to extreme cold and to earthquake excitation. The paper focuses on the integrity of a pre-stressed concrete outer container

which must be able to withstand sudden exposure to cryogenic fluid in the event of the failure of the inner containment tank. The analysis is particularly challenging given the very low temperature of liquefied natural gas (LNG). Computations are presented of the stresses that could lead to cracks developing at the cold front. The authors use computational mechanics to demonstrate that the outer wall of the tank is able to remain liquid-tight in the event of failure of the inner container during a seismic event. This paper should be of interest to designers of LNG tanks, which are widely used to store and transport natural gas.

Jackson (2012) examines the application of safety factors in non-linear analysis, noting that the concept of partial safety factors was originally derived for linear analysis. Nowadays, non-linear analysis is becoming used almost routinely for both structural design and assessment, and so the use of appropriate safety factors is a topic of major importance to structural engineers. Jackson reviews current codes of practice, and considers applications to reinforced and pre-stressed concrete structures. Model uncertainty, dead weight, and tensile strength of concrete are discussed. Example applications cover the analyses of a propped cantilever constructed from reinforced concrete and of a slender column. Jackson recommends a procedure for non-linear analysis that should be of considerable value to structural engineers.

The final paper, by Ćirović and Mitrović (2012), presents details of an algorithm for optimising the construction of a multi-storey steel frame. Here, a fuzzy genetic algorithm in conjunction with Lagrange multipliers is used to search for the global optimum solution. A demonstration case is presented of a five-storey, five-bay frame comprising 55 structural members. The model has the potential to achieve major savings for the construction industry by reducing the volume of steel required in frames, which has knock-on economic and environmental benefits. Moreover, the authors suggest that the theory presented in their paper could have repercussions for other complex engineering systems where performance needs to be optimised.

It is hoped that the readers of *Engineering and Computational Mechanics* enjoy the present issue, which is larger than previous issues due to a healthy backlog of accepted papers. The Editorial Panel is very pleased to note the balance between papers by practitioners and academics, and welcomes the submission of high quality articles.

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