Editorial

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Biographical notes: Long-Yuan Li is a Senior Lecturer at Aston University. His primary expertise is in computational mechanics and finite element modelling applied to various physical problems. He has published more than 100 papers in technical journals. He is a Fellow of the Institution of Structural Engineers and the Alexander von Humboldt Foundation (Germany) and a Member of the UK Society for Computational Mechanics in Engineering, the Concrete Society and the International Society for Interaction of Mechanics and Mathematics.

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Mathematical modelling of engineering, physical and biological science problems has been an active research field with a long history. Using mathematical models, one can find useful and verifiable descriptions and explanations of phenomena in the natural world and also assist in developing process understanding and optimal operation and control or design of engineering systems. This Special Issue is intended to present original research related to mathematical modelling for various engineering, physical and biological science problems.

Some of the papers presented in this Special Issue were invited and others were submitted from the call for papers. An attempt has been made to, as much as possible, cover a wide range, from traditional structural to modern biological material problems. The contents of the studies are briefly described as follows.

'The challenge in the determination of strength parameters for simulation models of human movements', by Pui W. Kong (USA). This study presents a method of determining in vivo strength parameters for simulation models of human movements. Peak isometric, concentric and eccentric knee extensor torques of a male participant were measured on an isovelocity dynamometer. Torque-velocity and torque-angle relationships were determined using either dynamometer data alone or together with synchronised kinematic data obtained from video recordings. This was to investigate the feasibility of developing a simple method which required minimal equipment and data processing time. Results show that joint torque parameters determined from simple methods are not sufficiently accurate and therefore are not recommended to determine parameters for simulation models of human movements.

'A constitutive formulation to elastic media having different Young's moduli and Poisson's values in tension and compression', by Zhi-ming Ye (China), Benqi Guo (Canada) and Huanran Yu (China). This paper presents a new formulation of constitutive equations to different Young's moduli at tension and compression. Historically, the theories of different Young's moduli gave the characteristics with the same Poisson's ratio but with different tension modulus and compression modulus. This could lead to incompatibility between the normal stress and the shear stress in the unit element. In order to overcome this incompatibility, it is necessary to use the theory of fundamental continuum mechanics to modify the material constitutive relationship, to ensure any assumptions made in deriving the basic equations are consistent.

'Mathematical modelling of a 'post-Northridge' steel connection', by Ali Mehrabian and Achintya Haldar (USA). The behaviour of an attractive 'post-Northridge' partially restrained connection is studied and a mathematical model to capture its behaviour is proposed

considering loading, unloading and reloading behaviour. Because of its many desirable features, the analytical form of the Richard equation is used for developing the model using actual full-scale, ATC-24 protocol test data. It is observed that the proposed procedure captured the loading behaviour for this type of connection reasonably well. It is suggested that the unloading and reloading parts of *M*-curves required for seismic analysis can be theoretically generated by using Masing Rule, following the suggestion made by others. Some of the important desirable features of the connection are noted. Although it is a partially restrained connection, its initial stiffness is similar to that of bolted, a single web angle with top and seat connection, generally considered to be a fully restrained connection. Thus, a steel frame with the connection studied is not expected to show weakness in satisfying serviceability requirements. Furthermore, the beam develops full plastic moment and the ductility of the connection and its seismic energy dissipation characteristics are expected to be significantly better than the corresponding fully restrained and 'pre-Northridge' connections.

'Experimental and numerical modelling of interfacial behaviour between galvanised steel and aerated concrete', by Xiao-Ting Chu and Thomas Neitzert (New Zealand). The aim of this paper is to present a novel numerical model by using an experimentally and analytically obtained local interfacial description of the mechanical behaviour between aerated concrete and galvanised steel for finite element analysis. A local bond-slip model was determined which involves a pure shear pull-out test and the determination of parameters of a local bond-slip model by using analytical solutions. These were then applied to a finite element simulation by using ABAQUS' user-defined subroutine. Comparisons between the analytical solution and the developed novel method which applies experimental bond-slip behaviours to finite element simulations are presented.

'A genetic based hybrid intelligent controller for looper tension in steel rolling mills', by S. Thangavel, V. Palanisamy, K. Duraiswamy and S. Chenthur Pandian (India). Most of the industrial applications are non-linear. The fuzzy logic controller is the most useful approach to achieve adaptiveness in the case of non-linear systems because fuzzy logic control provides a systematic method of incorporating human expertise and implementing a non-linear system. Neural networks are integrated with fuzzy logic to form a neuro fuzzy system. A genetic algorithm is used to search for optimal fuzzy rules and membership functions of neuro fuzzy system in order to give optimal output and hence form the Hybrid Intelligent Controller (HIC). This paper demonstrates the effectiveness of HIC in optimising the looper height in steel rolling mills compared with conventional controllers. The simulation result depicts that HIC quickly restores the speed of the main drive and hence the looper height is quickly reduced to its optimal (zero) value which in turn ensures the safe working condition of steel rolling mills.

'Computational fluid dynamic modelling of water cooling mechanism during thermal spraying process', by S. Kamnis and S. Gu (UK). In this paper, a Computational Fluid Dynamic (CFD) model is developed to examine the heat transfer process through the water cooling mechanism in a High Velocity Oxygen Fuel (HVOF) thermal spraying system. The water cooling configuration is composed of a series of discrete holes through the copper-made thermal spraying gun. Unstructure grid is employed for both liquid and solid regions and the water cooling model is fully integrated with the gas flow dynamics where combustion, turbulent flow and free jet expansion are included. The numerical results indicate that the water flow direction has noticeable influence on the cooling efficiency due to the variation of heat capacity of water and the current cooling mechanism has no noticeable effect on the gas flow dynamics within the thermal spraying gun.

'Modelling, identification and simulation applied to neutralisation systems', by Sérgio Paiva and João Manzi (Brazil). This paper is concerned with the modelling of a neutralisation system for the treatment of water or wastewater. A generic dynamic model was developed for the system consisting of a mixture of several strong and weak acids, based on the fundamentals of reaction invariants and on the concept of fictitious acid, which allowed a significant reduction in the degrees of freedom of the system. A particular equation for identifying the model parameters was also developed. The results obtained by simulation were compared to the experimental measures, showing that the model and the recursive identification structure are appropriate for representing the considered systems.

'The simulation of temperature field in the laser forming of steel plates', by Hong Shen, Zhenqiang Yao, Yongjun Shi and Jun Hu (China). The laser forming of metal plates is a flexible forming process that forms sheet by means of thermal stresses induced by external heat source instead of using external forces. The stresses are generated by temperature gradient induced by laser. In this paper, a finite element analysis model including convective and radiation boundary conditions to predict the three-dimensional temperature field is established for a metal plate under the influence of a moving Gaussian heat source. The effects of various laser forming parameters on temperature distributions are investigated using the established model. By using variable scanning velocities a constant temperature gradient in the plate plane is achieved, which can be used to accurately form differently desired shapes of the plate.

'Simulation results on the reactive power compensation process on electric arc furnace using PSCAD-EMTDC', by Manuela Panoiu, Caius Panoiu, Ioan Sora and Mihaela Osaci (Romania). It is very well known that the electric arc furnace has a three-phase charge – one of the most important generators of harmonic currents, reactive power and unbalanced conditions in electrical power systems. To study how the reactive power compensation installation works it is necessary to know the values of the electrical parameters of the arc furnace electrical installation as well as how to model the electric arc. To simulate the electrical installation function it is necessary to use highly performing models of the electric arc. There are many models of the electric arc in

simulations presented in the literature but from results using these models the authors consider that the three-phase electric arc is a balanced charge. This paper presents the reactive power values obtained by simulation for different steps of the reactive power compensation installation under the hypothesis that harmonics filters are connected. The simulations are performed using the PSCAD/EMTDC program.