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Computers and Structures 84 (2006) 1173–1176
Computers & Structures
www.elsevier.com/locate/compstruc

Editorial

Computational Models for Multilayered Structures and Composite Structures

This special issue includes extended, reviewed and revised papers presented at The Seventh International Conference on Computational Structures Technology (CST 2004) and The Fourth International Conference on Engineering Computational Technology (ECT 2004) held from 7–9 September 2004. The venue for both these conferences was the National Civil Engineering Laboratory (LNEC) in Lisbon, Portugal.

This special issue on "computational models for multilayered structures and composite structures". The contributions were invited from two mini-symposiums held at the Computational Structures Technology Conference.

The first paper by Sen Gupta, Allix, Boucard and Fanget deals with the prediction of the dynamic response of a three-dimensional Carbon/Carbon of (3D C/C) up to failure. A domain decomposition method is adopted in the numerical calculation. The multi-resolutional finite element method is applied in the paper by Kaminski to study interface defects in unidirectional composites. The calculations show the crucial role played by interface in the macro-scale behaviour. The application of the Stiffness Averaging Method is presented in the paper by Tessitore and Riccio. The method is applied in the FE framework to represent the complex architecture of the Non-Crimp Fabric composite materials. The governing equations for a spinning composite beam of a circular cross section featuring the bending-twist effect are obtained in the paper by Banerjee and Su. Hamilton's principle is employed and free vibration, as well as static instability responses, are determined.

The remaining eight papers deal with laminated multilayered structures. These cover some of the most significant and latest contributions to the field of computational modelling of multilayered flat and curved structures. An example of the use of Reissner Mixed variational Theorem (RMVT) to develop very accurate finite elements for the quasi-three-dimensional analysis of stress states in laminated plates is given in the paper by Demasi. The advantages of using full implementation of RMVT with respect to static condensation at element level (that permits the elimination of additional transverse stress nodal variables) are clearly illustrated. In particular it has been found that the full implementation becomes mandatory if accurate evaluation of transverse normal stress is required. Numerical substation of higher order, advanced plate elements developed in both the Equivalent Single Layer (ESL, the whole layers are seen as an equivalent plate) and the Layer Wise (LW, each layer is considered as an independent plate) frameworks are discussed in the paper by D'Ottavio, Ballhause, Wallmersperger and Kröplin. Classical benchmarks of thin and thick structures show the elements behaviour with respect to locking phenomena. The Unified Formulation (UF) is used to develop and compare the large variety of finite elements considered. The same finite elements of the latter paper are discussed for thermo-mechanical problems by Robaldo. Up to fourth order expansion in the thickness directions has been implemented for the displacement variables. The analysis has been devoted to evaluate the influence of temperature profile $T(z)$ in the stress response of thermally loaded plates. The case of assumed temperature profile is compared to the case of $T(z)$ coming from the solution of a heat conduction problem. A mixed variational theorem for multilayered composites in the thermoelastic cases is proposed by Benjeddou and Andrianarison. The paper extends RMVT by adding transverse thermal field-temperature increment relation as a constraint via a Lagrange multiplier. A new Heat Mixed Variational Theorem (HMVT) is therefore proposed. A layer wise plate model is developed and applied to sandwich structures by Moreira and Rodriguez. The viscoelastic behaviour is accounted for by a thin viscoelastic core. The results achieved are extensively compared with those obtained by using a layered combination of standard plate and solid elements. The accurate description of high shear pattern is achieved by the proposed finite element model.

Investigation of multilayered shells has been conducted in the last three papers. Dau, Polit and Touratier present the latest developments of their research work on finite element modeling of composite, layered structures. The zig-zag model, which accounts for interlaminar continuity of transverse shear stresses is, in this work, extended to

0045-7949/$ - see front matter
doi:10.1016/j.compstruc.2006.03.004

geometrically non-linear analysis. Von Kármán non-linear strain displacement relations are considered along with a finite element C^1 description able to avoid the shear locking phenomenon. A family of geometrically exact assumed stress–strain multilayered solid-shell elements are presented in the paper by Kulikov and Plotnikova. The proposed finite elements formulation is based on a strain-displacements relation which is written in general reference system coordinates which are invariant under rigid-body motion. Three-dimensional analytical integration is used to allow the use of coarse meshes. The multi-quadratics, numerical technique is extended to shell by Ferreira, Roque and Jorge. Such a mesh-less technique is based on asymmetric global multi-quadratic radial basis functions method that was proposed by Hardy and Kansa. The Vlasov–Reddy displacement model is employed to fulfill homogenous conditions on transverse shear stresses on the top or bottom surfaces of the shell.

The papers published in this special issue discuss some of the most significant topics on composite structures and their modelling. The papers include some of the most promising methods for computational models for multilayered structures and composite structures. We should like to take this opportunity to thank all authors for their valuable contributions as well as the anonymous reviewers for their comments and suggestions.

The Invited Lectures from CST 2004 are published in: Progress in Computational Structures Technology, B.H.V. Topping and C.A. Mota Soares (eds.), Saxe-Coburg Publications, Stirling, Scotland, 2004. The Invited Lectures from ECT 2004 are published in: Progress in Engineering Computational Technology, B.H.V. Topping and C.A. Mota Soares (eds.), Saxe-Coburg Publications, Stirling, Scotland, 2004.

We are grateful to: Professor A. Benjeddou, Professor C.M. Mota Soares, Professor E. Carrera, Professor R. Rolfes, Dr. Ing J. Teßmer, Dr. M.H.B.M. Shariff, Dr. J. Plesek, Dr. P.L. Ribeiro, Professor A. Eriksson, Professor K. Marti, Professor G.I. Schuëller, Professor C.N. Chen, Professor I. Doltsinis and Professor V.D. da Silva who organised special sessions at the CST 2004 Conference. We are also grateful to those who organised special sessions at the ECT 2004 Conference: Professor G. Montero, Dr. M. Müller-Hannemann, Professor A. Suleman, Professor F. Hadipriono and Dr. J. Duane.

We wish to acknowledge and express our gratitude to the conference sponsors:

- Technical University of Lisbon,
- Instituto Superior Tecnico, Lisbon,
- National Laboratory for Civil Engineering (LNEC), Lisbon,
- International Journal of Computers and Structures (Elsevier Science Ltd.), and
- Advances in Engineering Software (Elsevier Science Ltd.).

These conferences could not have been organised without the help and support of many people. We would like to thank Professor Cristovão Mota Soares (IST) for all his kind help during the planning and organisation of these conferences. No trouble, task or problem was too great for him and we are grateful for his perseverance. We are also grateful to Professor Carlos Pina (Deputy President of the National Laboratory for Civil Engineering) who so kindly helped us with the logistics of using the LNEC conference facilities. We are also grateful to Professor José Lopes da Silva, Rector of the Technical University of Lisbon, for formally opening the Conferences and for his kind support.

We are grateful to Jelle Muylle and Judy Tait (Civil-Comp Press) for their organisational skills, which were greatly appreciated. We are all grateful to Andrea Marques (Instituto Superior Tecnico) for her valuable assistance before and during the conference.

We should like to thank the members of the CST 2004 Conference Editorial Board for their help before and during the conference: Professor H. Adeli, USA; Professor S. Ahmad, Bangladesh; Professor E. Alarcon, Spain; Professor H. Altenbach, Germany; Professor T. Aoki, Japan; Professor E. Arantes e Oliveira, Portugal; Professor F. Armero, USA; Dr. H. Askes, Netherlands; Dr. C.E. Augarde, UK; Dr. A. Bahreininejad, Iran; Professor J.R. Banerjee, UK; Professor C.C. Baniotopoulos, Greece; Dr. T. Baranger, France; Professor A. Baratta, Italy; Professor H.J.C. Barbosa, Brazil; Professor R.C. Barros, Portugal; Dr. F. Bartolozzi, Italy; Professor K.J. Bathe, USA; Professor J.-L. Batoz, France; Professor S. Baxter, USA; Professor A.A. Becker, UK; Professor A. Benjeddou, France; Professor N. Bicanic, UK; Professor M.L. Bittencourt, Brazil; Professor Z. Bittnar, Czech Republic; Professor P. Boisse, France; Professor M. Bonnet, France; Professor P. Bouillard, Belgium; Professor M.A. Bradford, Australia; Professor F.A. Branco, Portugal; Professor D. Briassoulis, Greece; Dr. M. Brunig, Germany; Professor M.L. Bucalem, Brazil; Professor T. Bulenda, Germany; Dr. J.W. Bull, UK; Professor O.S. Bursi, Italy; Professor A. Carpinteri, Italy; Professor E. Carrera, Italy; Professor F. Casciati, Italy; Professor J.M.A. Cesar de Sa, Portugal; Dr. S. Chandra, India; Dr. D. Chapelle, France; Professor C.-N. Chen, Taiwan; Professor W.F. Chen, USA; Dr. W. Chen, USA; Professor G.D. Cheng, China; Dr. R.C. Cheng, USA; Professor J.L. Chenot, France; Professor Y.K. Cheung, Hong Kong; Professor G. Chiandussi, Italy; Professor C. Cinquini, Italy; Professor J.Y. Cognard, France; Professor M. Cuomo, Italy; Professor V.D. da Silva, Portugal; Professor S. De, USA; Professor R. de Borst, Netherlands; Professor J.B. de Paiva, Brazil; Professor G. De Roeck, Belgium; Professor C.S. Desai, USA; Prof. P.R.B. Devloo, Brazil; Dr. M. Dhanasekar, Australia; Professor I. Doltsinis, Germany; Dr. J. Duane, USA; Professor N.F.F. Ebecken, Brazil; Professor I. Elishakoff, USA; Professor A. Eriksson, Sweden; Professor H.A. Eschenauer, Germany; Pro-

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We should also like to thank the members of the ECT 2004 Conference Editorial Board for their help before and during the conference: Professor K. Abe, Japan; Professor M.H. Aliabadi, UK; Professor A.J. Baker, USA; Professor Z.P. Bazant, USA; Professor A.I. Beltzer, Israel; Professor A.C. Benim, Germany; Professor M. Bercovier, Israel; Professor R.I. Borja, USA; Professor T. Burczynski, Poland; Dr. F. Cai, Japan; Dr. W. Chen, USA; Dr. H.-P. Cheng, USA; Dr. B. Codenotti, Italy; Dr. S. Commend, Switzerland; Dr. M. Connell, Sweden; Dr. J.R. Corney, UK; Professor L. Damkilde, Denmark; Dr. K. Davey, UK; M. Dayde, France; Professor G. Degrande, Belgium; Dr. S. del Giudice, Italy; Dr. C. Di Napoli, Italy; Professor E. Dick, Belgium; Professor I.S. Duff, UK; Dr. B. Feijo, Brazil; Professor W. Frank, Germany; Professor U. Gabbert, Germany; Dr. D.F. Griffiths, UK; Professor B. Gustafsson, Sweden; Professor W.G. Habashi, Canada; Dr. M. Hirokane, Japan; Dr. S.R. Idelsohn, Argentina; Professor K. Ikeda, Japan; Professor M.H. Imam, Saudi Arabia; Professor A.R. Ingraffea, USA; Dr. M. Isreb, Australia; Professor Y. Jaluria, USA; Professor P.K. Jimack, UK; Professor A Kecskemethy, Germany; Professor T.G. Keith Jr., USA; Professor T. Kerh, Taiwan; Professor V.K. Koumousis, Greece; Professor V.M. Kovenya, Russia; Professor D. Kulasiri, New Zealand; Professor B. Kumar, UK; Dr. L. Lämmer, Germany; Dr. C.-H. Lai, UK; Professor J. Lampinen, Finland; Dr. P.A.A. Laura, Argentina; Professor T. Laursen, USA; Professor S.W. Lee, USA; Dr. G. Lonsdale, Germany; Dr. R.I. Mackie, UK; Dr. F. Magoules, France; Professor M. Malafaya-Baptista, Portugal; Professor K. Matsuno, Japan; Professor G.A. Maugin, France; Professor J.C. Miles, UK; Professor G. Molnarka, Hungary; Professor R. Montenegro, Spain; Professor G. Montero Garcia, Spain; Dr. J.P. Morris, USA; Dr. M. Müller-Hannemann, Germany; Professor M. Napolitano, Italy; Dr. P. Neittaanmaki, Finland; Professor A.K. Noor, USA; Professor H. Okuda, Japan; Professor K. Onishi, Japan; Professor J. Oudin, France; Professor P.C. Pandey, India; Professor C.D. Perez-Segarra, Spain; Professor S. Pietruszczak, Canada; Professor A. Portela, Portugal; Professor A. Preumont, Belgium; Professor R. Pusch, Sweden; Professor Z. Ren, Slovenia; Dr. D. Robinson, UK; Professor C. Romanel, Brazil; Professor H. Roth, Germany; Professor P. Sagaut, France; Professor K. Saitou, USA; Dr. S. Samarasinghe, New Zealand; Dr. P. Santi, Italy; Professor M. Schaefer, Germany; Dr. K. Schneider, France; Dr. G. Seed, UK; Professor A. Shabana, USA; Professor W. Shyy, USA; Dr. J. Sienz, UK; Dr. J. Sobieski, USA; Professor D.B. Spalding, UK; Professor P. Steinmann, Germany; Professor S.-H. Suh, Korea; Professor B. Sunden, Sweden; Professor J.C.F. Telles, Brazil; Professor H.R. Thomas, UK; Professor T. Tomiyama, Netherlands; Professor N. Tosaka, Japan; Dr. A.S. Usmani, UK; Professor W.S. Venturini, Brazil; Professor V.R. Voller, USA; Professor L.T. Watson, USA; Professor J.R. Williams, USA; Professor M. Wolfshtein, Israel; Dr. P.K. Woodward, UK; Professor L.C. Wrobel, UK; and Dr I. Zelinka, Czech Republic.

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