EUROMECH Final Report

EUROPEAN MECHANICS SOCIETY

Please send this report to the Secretary-General of EUROMECH, within one month after the Colloquium.

EUROMECH Colloquium No: 371

Title: Efficient and Reliable Continuum Finite Elements for Linear and Nonlinear Analyses

Dates and location: 17. - 19. September 1997 in Bad Herrenalb / Karlsruhe

Chairman: Prof. Dr.-Ing. K. Schweizerhof, Universität Karlsruhe

Co-Chairman: Prof. Dr.-Ing. E. Ramm, Universität Stuttgart
Prof. Dr.-Ing. P. Wriggers, TH Darmstadt

Is there need of another Colloquium on the same or a related subject? Which year? Maybe in 3-4 years

Full registration fee: DM 190 Member / DM 250 Non-Member registration fee
DM 280 accommodation fee for 3 nights

What other funding was obtained? Deutsche Forschungsgemeinschaft DFG, Daimler Benz AG, The University of Karlsruhe, The Ministry of Science Research and Art of Baden-Württemberg, Karlsruher Hochschulvereinigung e.V., German Association of Computational Mechanics (GACM)

What were the participants offered?
registration fee: conference room, technical equipment, coffee break, lunch, conference banquet, conference documents
accommodation fee: dinner, breakfast, single-bed room

Number of members of EUROMECH (reduced registration fee): 32
(reduced registration also for GAMM members as associated corporation)

Number of non-members of EUROMECH (full registration fee): 35

Number of participants from each country:

Austria	1	Germany	35	Romania	
Belgium	2	Great Britain	2	Russia	1
Byelorussia		Greece	1	Slovakia	
Bosnia		Hungary		Slovenia	
Bulgaria		Ireland		Spain	2
Croatia		Italy	3	Sweden	3
Czech Republic	2	Latvia		Switzerland	1
Denmark		Lithuania		Ukraine	
Estonia		Netherlands		Yugoslavia	1
Finland		Norway		Others	6
France	3	Poland	2		
Georgia		Portugal	2	Total	67

Please turn

The response of the invited speakers and participants was very good, thus a program covering almost all interesting aspects related to the specific topic of continuum elements could be presented and discussed. 8 sessions with altogether 33 presentations were organized with a scheduled time of 25 min for the presentation and 5 min for discussion. Only one speaker had to be substituted due to a late withdrawal, but could be easily replaced as three additional papers were kept as a reserve for such a case. Prof. Scapolla was replaced by Dr. Graillet from the University of Liège, Belgium, presenting some developments concerning efficient constant algorithms between deformable bodies.

The first session on Hybrid stress, Enhanced Strain Elements was opened by Prof. Taylor, University of California, Berkeley, by an overview over the current state of the art including own recent developments. The further presentations focussed on hybrid stress elements (Texeira and Wu) and on various strain enhancement concepts for lower and higher order elements (Bischoff/Ramm, de Sa, Korelc/Wriggers). D. Braess gave a critical assessment of enhanced methods, whereas M. Berkovic presented efficient and reliable mixed finite elements both from a mathematical point of view.

The second session on Finite Plastic Deformations showed developments of enhanced strain elements for very large deformations (Armero) as well as their limits. For highly dynamic e.g. impact analyses efficient tetrahedrons were proposed by Bonet, and industrial applications were shown by Fourment, presenting very large forging problems involving also parallel computing. Colantonio focussed on iterative solvers for problems with large deformations.

This finished a day with very close contents and very detailed discussions.

The second day was divided into 4 sections. First, Shell Problems were presented starting with Sze using the concept of assumed strains also for triangular shells. Then Batoz proposed a solid like shell element for geometrically nonlinear analyses. Zarate gave an overview over new efficient shell elements for which the derivatives are computed via a finite difference type approach.

In the second session on Higher Order Approximations Zielinski presented an overview over Trefftz elements and their capabilities, in particular the advantage using higher order functions. A direct continuation towards h-p elements was given by Zdunek, who used 3D elements with rather high order functions for nonlinear thin shell analyses. The third session on h-p and meshless FE computations was somehow a further step away from traditional low order elements to high order elements with hierarchic models (Schwab) and even a complete switch with the so-called meshless approach (Liu), where the idea of elements is given up completely and functions based on a variable number of nodes are used. However, many questions remain still unsolved, as the discussions showed. Ortiz presented a completely adaptive dynamic analysis with a special focus on contact algorithms applied to fragmentation problems.

The final session on the Boundary Element Method gave some insight into the advantages and specialties of the boundary integral method. The direct step towards nonlinear analysis involving material and geometrical nonlinearities was shown by Kuhn. Steinbach proposed some parallel algorithms for BEM in 3D and Kolesnicov presented some sets of linear/exponential/trigonometrical functions and their intelligent application either for Finite Elements or with the BEM method.

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The third day with 3 sessions started in part 1 on Adaptive Analysis with Venini discussing wavelet-based schemes and the concept of multiresolutions. The latter is crucial for adaptivity. Li presented new developments concerning discontinuous Galerkin procedures for nonlinear dynamic analysis with a special focus on adaptivity in time and space. Brink proposed higher order mixed elements for the analysis of finite elastic deformation problems including adaptivity.

Crisfield discussed the limits of current approaches with lower order finite elements and their enhancements or variations. He also suggested some modifications to overcome some difficulties, however, some major drawbacks still remain. Ibrahimbegovic completed the set of approaches for continuum elements by proposing rotational degrees of freedom as a technology towards an efficient solution also for nonlinear problems. Freischläger discusssed the so-called F-bar approach to overcome locking problems for large strains.

The final session was opened by Pacoste with a discussion of the use of symbolic software for the development of linear and nonlinear FE programs. Some examples were given also showing the problems arising. Ellsiepen presented time and space adaptive FE schemes for multiphase problems such as porous media with pore fluids. Examples with rather large deformations showed the effectivity of the method. Schöberl finally proposed a multigrid method for 3D problems introducing some special developments in order to apply them also to thin structures. The high efficiency and accuracy achieved are encouraging to include this approach also for other elements.

The quality of all presentations was very high and all authors left enough time for discussion which was heavily used for exchanges of scientific arguments. The wonderful conference center and the quality of the coffee breaks encouraged for further vivid discussions.

All participants were unanimously agreeing as Prof. Taylor as the senior participant was referring in his final words to the conference as a great success, in particular, as the subject of continuum elements could really be presented from all views currently discussed in the scientific literature by both engineers and mathematicians. Also the colloquium was a very good mix of young and of experienced established researchers, as the EUROMECH council was asking for.

All authors agreed that their transparencies used for the presentations are made available through the internet such that the participants and other interested researchers have access to the contents. The organizers are currently setting up all contributions and hope to finish this task within the next 3 weeks.

The chairmen are convinced that the goal of a vivid exchange of knowlege among European and Overseas researchers could be achieved in the colloquium and thank the EUROMECH council for their support.

Karlsruhe, 17. Oktober 1997

Prof. Dr.-Ing. K. Schweizerhof