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Finland is known as a land of ice and snow. Thus good knowledge of arctic technology is very important for us. When constructing in arctic conditions, unusually large stresses are often caused by large temperature variations and by ice and snow loads.

The analysis in fracture mechanics was first developed mainly because of the safety analysis required in nuclear power plants, but later the methods were applied increasingly in other fields of industry as well.

The departments at the technical universities have pioneered the research and the training of specialists in steel structures and welding technology in Finland. Because of robot and laser technology the latter field is of governing interest.

In this description some of today’s activities in the sphere of computational mechanics in Finland have been collected. It consists of a short list of research interests and projects, finite element and computer-aided engineering software at five universities and at the technical research centre of the state. In the section on recent research reports a list of some recent publications from these institutions is given.

At Helsinki University of Technology the research activity in computational mechanics concentrates mainly on four departments. The research topics at the Department of Civil Engineering (M. J. Mikkola) are:

(a) Non-linear problems of structural mechanics:
   (i) geometrical and material non-linearities
   (ii) static and transient dynamic problems
   (iii) beams, frames, plates and shells
   (iv) metal and reinforced concrete structures.

(b) Constitutive equations and concrete based on continuous damage theory.

(c) Numerical analysis of box girders.

(d) Structural analysis of fire-exposed steel structures.

The research projects at the Department of Mechanics (E.-M. Salonen) are:

(a) Applications of the finite element method:
   (i) free surface flows in hydraulics
   (ii) plate bending with non-conforming elements.

(b) Non-linear phenomena and chaos:
   (i) chaos in an impact oscillator
   (ii) chaos in Duffing’s oscillator.

At the Institute of Mathematics (J. Pitkärand) the research in computational mechanics is devoted to the theoretical aspects of the finite element method, especially to:

(a) Mixed finite element methods.
(b) Multigrid methods.

At the Institute of Mathematics (J. Pitkärand) the research in computational mechanics is devoted to the theoretical aspects of the finite element method, especially to:

At the University of Oulu the research in computational mechanics is taking place mainly in two departments. At the Laboratory of Technical Mechanics (M. Määttänen) the research projects are:

(a) Ice-structure dynamic interaction.
(b) Ice forces against offshore structures.
(c) Mechanical vibrations, e.g. applied to paper machines.
(d) Large displacement material non-linear (including viscosity) FEM analysis.
(e) Post-buckling behaviour of plates on elastic foundations.

At the Department of Mathematics (J. Saranen) theoretical aspects of FEM, the boundary element method and the collocation method are studied. The research projects are:

(a) FEM solution of compressible and incompressible flows.

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(b) BEM solution of non-smooth potentials.
(c) Fast solvers of BEM.
(d) FEM analysis of high-speed elevator vibration.

The FEM/CAE programs used are ADINA, FINEL, NASTRAN, NONSAP, STRUOL, and CAODS 4. The Department of Mechanics uses mainly its own program development.

Lappeenranta University of Technology is the youngest technical university in Finland (opened in 1969). In computational mechanics the research is being done at the Department of Mechanical Engineering (H. Martikka and M. Suviolahti). The main research interests are
(a) In design of machine elements:
   (i) CAD
   (ii) optimization of machine elements and mechanisms.
(b) Steel structures:
   (i) plastic capacity of joints
   (ii) weld fatigue, residual stresses due to welding
   (iii) elastic-plastic fracture mechanics
   (iv) optimization of structures.
(c) Workshop engineering research.
(d) Practical applications of photoelasticity.
(e) Secondary stresses of structures.
(f) FE software for microcomputers.
(g) Thermal stresses in continuous casting of steel.

The FEM programs used are ADINA, ANSYS, NASTRAN, SAP IV, SAP VI, and TWODEPEP. CAE software: 1-DEAS included GEOMOD, MODAL PLUS, SUPERTAB, SUPERB and SYSTAN. Moreover, the structural optimization program STARS is used.

At the University of Jyväskylä the research in the sphere of computational mechanics is being carried out at the Department of Applied Mathematics (P. Neittaanmäki). The research projects in this field are
(a) FEM in contact problems.
(b) Optimum structural design in contact problems.
(c) Computation of stresses and strains by post-processing techniques with linear elements.
(d) Optimization of the water spray cooling in continuous casting of steel.
(e) Multigrid methods.
(f) FEM in microcomputers.

The FEM programs used are: ANSYS, INTERLIB (developed by INRIA, France), ELPPACK, and TWODEPEP. Because the research is focused on new methods or special problems locally developed programs have been used.

The Technical Research Centre of Finland (VTT) is a polytechnical consultative research establishment dealing with almost all areas of technology. In structural mechanics there are activities altogether at nine laboratories covering different fields of technology such as mechanical and civil engineering, naval architecture, geotechnics and nuclear engineering; both experimental and theoretical work is widely carried out. In addition to the conventional calculations, measurements and testing, VTT has developed advanced methods in several areas, some of which are
(a) Arctic technology
(b) Fracture mechanics and fatigue
(c) Dynamic measurements

General purpose finite element programs are used in VTT. We mention ADINA, ADINAT, PFEC, SAP VI, PIPEBREAK, JTROCK, CRACK, FEFLOW, MAGENON, COUPLE, STRUDEL-II, and FLUSH. For further information contact J. Vanne.

The Finnish State Computer Centre (VTKK) at Espoo supports the software development of universities. Moreover, though the computer net, FUNET, the universities can use the software and computers of VTKK. The engineering software of VTKK includes, among others, ADINA, ELLPACK, BASPL, NAGFEM, NASTRAN, PHOENICS, PIGS, SPICE 2, SUPERTAB, and TWODEPEP. For further information contact M. Käpyaho.

RECENT RESEARCH REPORTS

(1) Helsinki University of Technology, SF 02150 Espoo, Finland
(a) Department of Civil Engineering
M. Mikkola, and M. Tuomala, ‘Comparative study of the nonlinear response of plane and arches’.
M. J. Mikkola, ‘Über die nichtlineare Berechnung von Tragwerken unter statischer und dynamischer Belastung’.
(b) Institute of Mechanics
(c) Department of General Sciences
(1) Institute of Strength of Materials
Erkki Pennala, Mika Niinen and Sami Saarinen, ‘Report of racking tests carried out on timber framed wall panels sheeted with 6.5 mm Finnish conifer plywood’.
(c2) Department of Mathematics
Matti Suviolahti, ‘The use of layered photoelastic coatings in the determination of stress concentrations on pressure vessels and on related structures and components’.

M. Suviolahti, ‘Collection of practical examples in structural analysis solved using the MSC Nastran I’.

M. Suviolahti, ‘Error in the conventional eccentric stiffening beam formulation in connection with shell structures’.

M. Suviolahti, ‘Practical examples solved using the STARDYNE I’.

M. Suviolahti, ‘FEM analysis with codings of practical structural problems and the idealizations and modellings necessary in their solutions 3’.

(b) Department of Physics and Mathematics

J. Haslinger, P. Neittaanmäki and T. Tiihonen, ‘Shape optimization of an elastic body in contact based on penalization of the state inequality’.

J. Haslinger, V. Horák and P. Neittaanmäki, ‘Shape optimization in contact problems with friction’.

J. Haslinger and P. Neittaanmäki, ‘Shape optimization in contact problems’.

P. Neittaanmäki and E. Laitinen, ‘Optimization of cooling conditions in continuous casting’.

P. Neittaanmäki, P. Koikkalainen and C. A. Marinov, ‘On the computation of the delay time in some parabolic problems’.

A. Kaarna and P. Neittaanmäki, ‘CAE/FEM’.


(5) University Jyväskylä, Department of Mathematics, Seminaarintaku 15, SF 40100 Jyväskylä, Finland.

P. Neittaanmäki and T. Tiihonen, ‘Sensitivity analysis for a class of optimal shape design problems’.

P. Neittaanmäki (ed.), Proceedings of the Numerical Analysis, Summer School at Jyväskylä.

J. Haslinger and P. Neittaanmäki, ‘On the existence of optimal shapes in contact problems —perfectly plastic bodies’.

(6) Technical Research Centre of Finland (VTT), SF 02150 Espoo, Finland.

Pekka Oksanen, ‘Friction and adhesion of ice’.


The Seventh International Conference on Port and Ocean Engineering under Arctic Conditions, Volumes 1–4, Helsinki, Finland.