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STRESS WAVE PROPAGATION IN THE INSTITUTE OF THEMOMECHANICS.

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Abstract: *The paper is devoted to a survey of old, recent and contemporary stress wave propagation tasks having been studied in the Institute of Thermomechanics (IT) within the period of the last sixty years. Scientific deeds as well as people who deserve admirations for achieving them are mentioned. Problems and employed analytical and numerical methods are shortly listed.*

Keywords: ***Historical survey, Stress wave propagation in solids, Institute of Thermomechanics.***

Investigation of stress wave propagation in solids was initiated by Rudolf Brepta in sixties of the last century. R. Brepta devoted his attention to analytical approaches based on the Fourier transform applied to spatial variables appearing in governing partial differential equations describing the wave processes in solids, followed by the Laplace transform applied to time variables.

The stress waves were treated within the scope of elastic continuum assumptions, i.e. small displacements and small strains mainly for isotropic elasticity satisfying equations

$$\frac{\partial \sigma_{ji}}{\partial x_j} = \rho \frac{\partial^2 u_i}{\partial t^2}, \quad \varepsilon_{ij} = \frac{1}{2}\left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i} \right), \quad \sigma_{ij} = C_{ijkl}\, \varepsilon_{kl}\,.$$

At the end of sixties R. Brepta succeeded in building up an efficient team composed of young and enthusiastic people. In quick succession there came, listed in the order of their appearance, J. Beneš, F. Valeš, M. Okrouhlík, H. Šebková, J. Červ, and J. Trnka. Later the team was complemented by E. Veselý, I. Huněk, L. P. Plešek and I. Tvrdík.

The scope of problems having been solved by R. Brepta and by his team is, even by today's standard, impressive. The most significant tasks are listed in chronological order here.

Dispersion of longitudinal waves in prismatic bars of square and rectangular cross-sections, waves in one and two-dimensional lattices, torsional impact on thin discs, longitudinal impact of cylindrical bars, lateral impact of thick plates, transversal impact on a thin strip – F. Valeš, eccentric impact a thin bar – H. Šebková, a thin disc suddenly loaded by a radial point force and torsional impact on a shaft – J. Červ.

In most cases analytical formulas for time distribution of displacements, velocities and stress components were derived, programmed and numerically evaluated.

Later on, at the beginning of seventies, a systematic investigation of side effects and dispersion errors of discrete methods began. The dispersion phenomenon, originally treated by Brillouin, were mainly applied to finite element method approach to the solution of transient tasks in continuum mechanics leading to stiff differential equations whose solutions critically depend on the correct choice of time-step operator and the time step itself.

It appears that the dispersion topic is still alive. Today's investigation of this task in the IT is carried by a representative of younger generation of researchers, namely by Radek Kolman, a bright guy, who substantially contributed not only to the study of dispersion but also to that of isogeometric approach to discretization methods as well as to accuracy analysis of time integration operators.

Now, the stress wave propagation and impact tasks are pursued within a scope of computational mechanics and finite element technology. A substantial enhancement to IT personnel dealing with

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computational mechanics, appeared back in 2003 when – after the SVUSS was dissolved – was the arrival of capable researches equipped with profound engineering skills accompanied by deep knowledge of mechanics, mathematics and programming. At that time J. Plešek, S. Pták and J. Dobiáš came to IT. All of them substantially contributed – among other things – to solving new stress wave tasks, getting new grants, and to subsequent publications of their results in good journals.

As an example one could mention a new contact-search approach implemented in contact impact procedures of PMD (Package for Machine Design – a home-made general finite element code, developed and maintained in IT) developed by Dušan Gabriel. His unique approach is based on the search of contact in Gauss points avoiding thus ambiguity of definitions of corner node normals.

Together with colleagues from Uppsala University a lot of effort was also devoted to efficiency of a percussive rock drilling process with consideration of wave energy radiation into the rock.

Another recent example of improvement of finite element technology – resulting in creating more efficient equation solvers for very large matrices, needed, among other things, for solution of transient tasks – is a new efficient code developed by P. Pařík based on fill-in minimization.

Computational skills, needed for solving complicated problems of engineering practice – included those related to fast transient tasks – are being constantly amended and revised. A comprehensive educational text, based on our experience, concentrating on classical and new computational methods was compiled recently.

Also our experimental colleagues who contributed to progress in understanding the nature of stress wave propagation should be mentioned. One of the founding fathers was M. Prokopec, who was Brepta's coauthor of the first Czech book devoted to stress wave propagation. J. Beneš, E.Veselý, J. Trnka and Z. Převorovský were his successors.

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