Plast. Program for static elastic-plastic analysis of plates and shells

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PROGRAM STATYCZNEJ ANALIZY SPRĘŻYSTO-PLASTYCZNEJ PŁYT I POWŁOK PLAST

PLAST PROGRAM FOR STATIC ELASTIC-PLASTIC ANALYSIS OF PLATES AND SHELLS

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Summary

The note deals with a short description of a finite element programm for elastic-plastic analysis of plates and shells. The code is published in [1] and is distributed with the book. It is possible to use it in the analysis of anizotropis, layered, elastic-plastic plates and shells undergoing large displacements. The Huber-Mises yield condition is apphed.

Streszczenie

W artykule omówiono program metody elementów skończonych do analizy sprężysto-plastycznej płyt i powłok. Program opublikowano w pracy [1]. Programem można analizować konstrukcje anizotropowe, warstwowe, sprężysto-plastyczne doznające dużych przemieszczeń. Wykorzystano hipotezę wytrzymałościową Hubera-Misesa.

The note deals with a short description of a finite element program for elastic-plastic analysis of plates and shells. The code is published in [1] and is distributed on 1.44MB (DOS) diskette with the book.

The overall structure of the program is similar to the well-known program PLASTOSHELL of Figueiras and Owen [2]. However, there is implemented a new shell finite element. The element was developed by Huang and Hinton [3,4]. The most significant feature of the element is the assumption of Triembrane and shear strains, so in consequence, it is not necessary to employ the reduced and selective integration rules.

It is possible to analyze anisotropic, layered, elastic-plastic plates and shells undergoing large displacements. The Huber-Mises yield condition is applied.

Following methods of the solution of the nonlinear finite equilibrium equation are implemented: differential stiffness method, updating of the tangent stiffness matrix after the first iteration and modification of the tangent stiffness matrix when, after an iteration, unloading occurs even in one Gauss point.

The authors of the note are of the opinion that the program has one disadvantage, namely, that it is necessary to define the shell by two equally spaced surfaces. The better method seems to be the definition of the midsurface and the thicknesses of the shell given at the nodes.

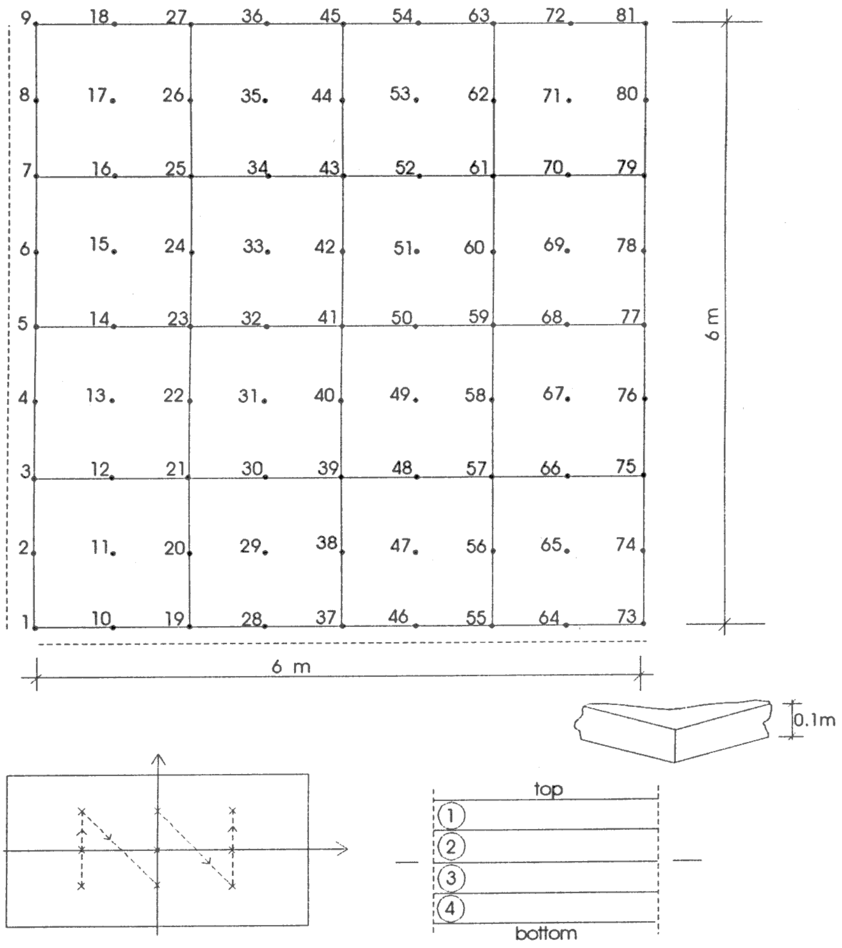

Fig. 1.

The microcomputer AT386 under UNIX with Weitek coprocessor to run the program. The NDP Fortran compiler is also used. The calculation of a test example which provided with the source code are been are performed. The obtained results are the same as in [1].

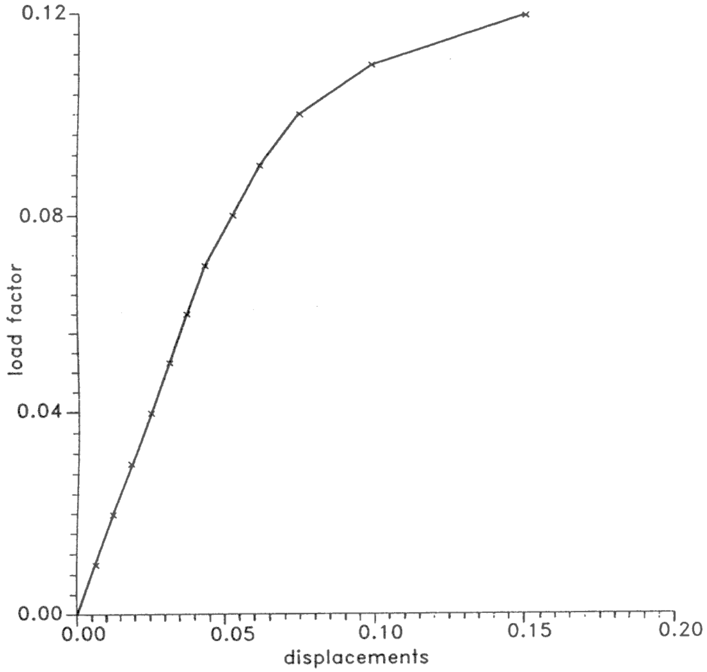

Fig. 2.

To check if the program can be used in student teching for the 5th year of graduate studies, calculations of a 16 element example also performed have been. The square plate of $12 \times 12\,\mathrm{m}$ and $0.4\,\mathrm{m}$ thickness is shown in Fig. 1 and the following material properties have been adopted: isotropic, elastic-plastic material with isotropic hardening, Young modulus $E = 3 \times 10^4\,\mathrm{kN/m^2}$, Poisson's ratio $\nu = 0.3$, hardening modulus $H' = 300\,\mathrm{kN/m^2}$, yield stress for uniaxial tension $\sigma_{pl} = 30\,\mathrm{kN/m^2}$. The plate is loaded with uniform pressure p.

The relatien of the vertical displacement versus load factor at point 1 (the central point of the plate) is given in Fig. 2. The isolines of the vertical displacements for the loading step 9 are given in Fig. 3. The development of plastic zones in 8th and 9th loading steps are shown in Figs. 4 and 5, respectively.

When using the AT386 machine the user time is about 10 minutes depending on the displacements what seems to be acceptable if such a test could be given to a student as a class project. Using AT286 computer it is unacceptable because the computer time is about 0.5 hour for one step only.

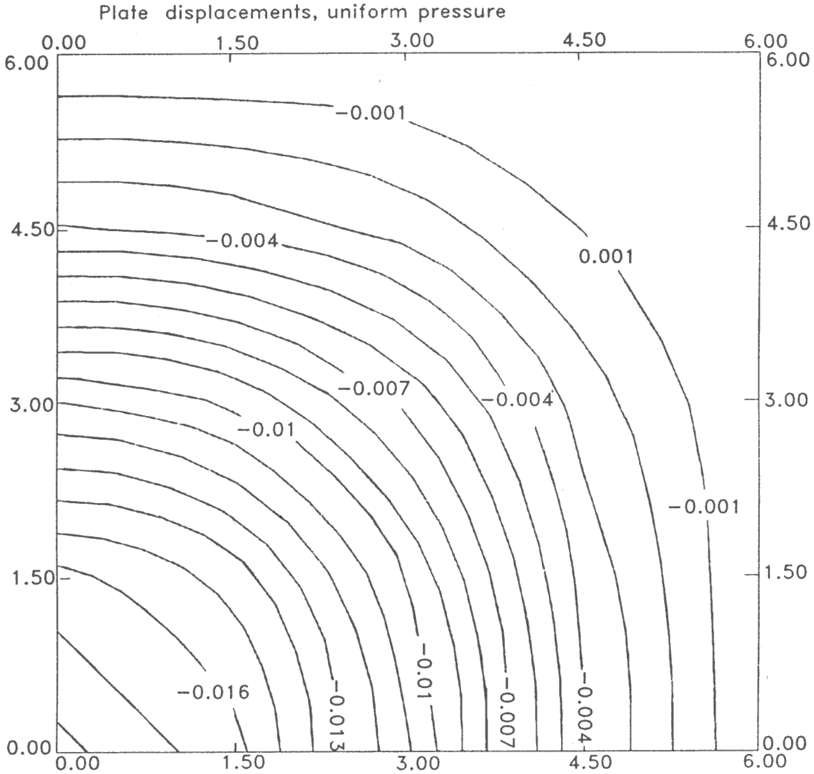

Plate displacements, uniform pressure
0.00
1.50
3.00
4.50
6.00
-0.001
-0.004
0.001
-0.007
-0.004
-0.01
-0.001
-0.016
-0.013
-0.01
-0.007
-0.004

Fig. 3.

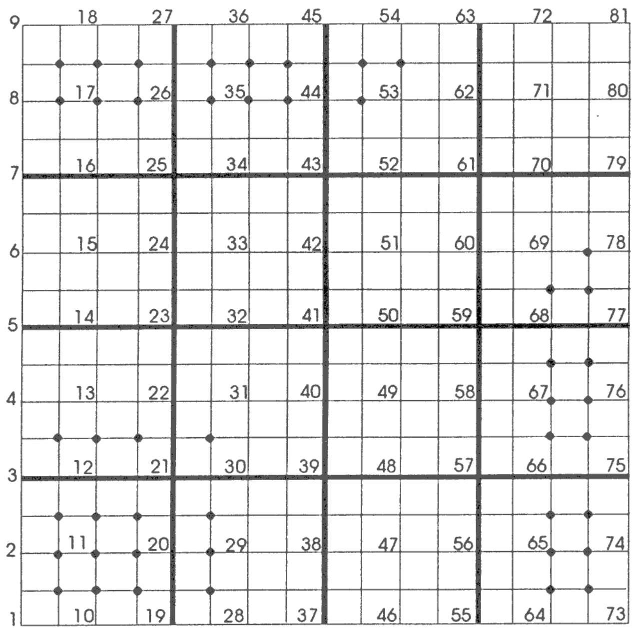

Fig. 4.

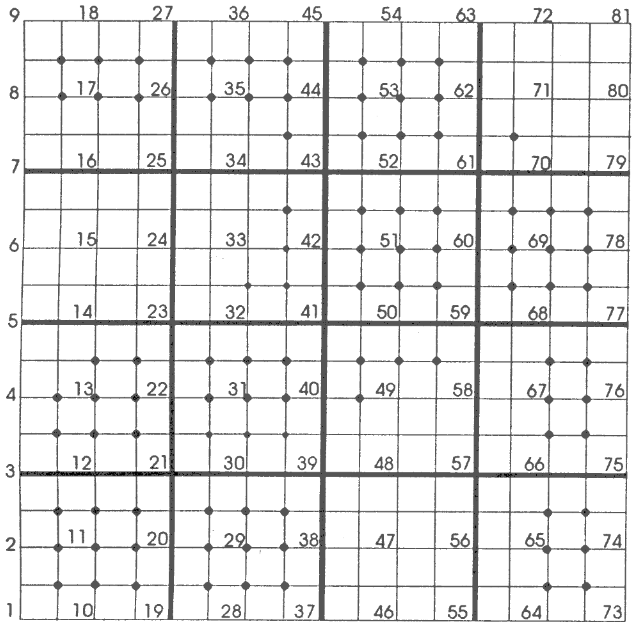

Fig. 5.

Considering the detailed and very careful presentation of the material, an overview of the Mindlin theory of plates with the finite element discretization, detailed description of the implemented shell element and illustration of it with a wide number of benchmarks, the book may be used as a textbook for students who specialize in the theory of structures on civil engineering faculties.

References

[1] Hou-Cheng Huang, *Static and Dynamic Analyses of Plates and Shells – Theory,* Software and Applications, Springer – Verlag 1989.

[2] Hinton E., Owen D.R.J., *Finite Element Software for Plates and Shells*, Pineridge Press, 1984.

[3] Huang H.C., Hinton E., *Elatic – Plastic and geometrically nonlinear analysis of plates and shells using a new nine node element*, In: Proceedings of symposium on finite element methods for nonlinear problems, Vol. 1, Trondheim, Norway, 1985.

[4] Huang H.C., *Implementation of assumed starin degenerated shell elements*, Comp. Struct., Vol. 25, pp 147-155, 1987.