Selected problems of the nonlinear analysis of structure stability(*)

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The following three problems are reported: i) computation of the stability boundary for multiple parameter loads, ii) postcritical analysis of arches under follower loads, iii) modification of the reduced basis methods for the nonlinear analysis of structures.

Referring to above mentioned problems the attention is focused on working out appropriate methods of solution and algorithms. Displacement version of the finite element method and total Lagrangian formulation are used. The incremental FE equations are completed by augmented equations (constraint equation, load program equation) which makes it possible to treat displacement and load parameter equivalently.

A new algorithm for the computation of contour lines on the stability surface has been worked out in the space of independent load parameters. The main idea of the algorithm lies in an automatic choice of the load program fulfilling the condition of zero value of the stability determinant.

An incremental form of the constraint equation in the configuration space is used as well. Numerical examples performed for simple bar structures under double and three parameter loads confirm the effectiveness of the presented approach.

(*) 1. Z. WASZCZYSZYN, CZ. CICHOŃ, *Non-linear stability analysis of structures under multiple parameter loads*, Eng. Computations, (in press).

2. W. RECZEK, *Large deflections of arches under follower loads*, Proc. VIII Polish Conf. on Comp. Methods in Struct. Mech., Warsaw, 1987.

3. A. SAFJAN, Z. WASZCZYSZYN, *A reduced basis method for nonlinear analysis of structures*, ibid.

In the case of follower loads the initial load matrix (correction matrix) appears to be nonsymmetric in general and different approximations are introduced to do computations easier and more effective in the case of quasi-static problems. In the paper influence of different approximations on the critical values of load parameter and postcritical behaviour of circular arches under external pressure are analyzed. Depending on approximations the interation process can be poorly convergent and even divergent.

In the frame of methods of reduced basis an approximate solution is computed in a subspace R generated on the basis vectors, where $n \times N$ and N is the number of DOF of the original structure. New sets of basis vectors are proposed related to correction vectors of the Newton–Raphson method and eigenvectors of the tangent stiffness matrix. The effectiveness of the proposed approach has been checked on the numerical examples of structures approximated by plane FE.

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