NUMERICAL ANALYSIS OF CIRCULAR ELASTIC-PLASTIC PLATES UNDER CYCLES OF PRESSURE AND TEMPERATURE

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SUMMARY

The so-called load control program (LCP), i.e. relation $f(p, T) = 0$, can often be determined in the space of load parameters: p – pressure, T – temperature. The curve Φ_{M_i} bounding a neutral domain (ND) of elastic response refers to the point M_i on the curve f after plastic deformations are developed in a structure. The neutral domain is then modified if the LCP goes beyond domain of the curve Φ_{M_i} , i.e. if $M_i \rightarrow M_{i+1}$. In general the ND depends both on coordinates of M_i and history of the loading process.

In the paper a numerical approach is considered to compute ND for circular plates. Elastic-plastic material with combined isotropic-kinematic strain-hardening is adopted. Material characteristics are assumed to be functions of temperature in incremental equations of the theory of plastic flow. Small strains are assumed but geometrical and equilibrium equations are derived for moderately large deflections. Distribution of temperature in the plate is assumed to be known in every point of the plate ξ , as the function (ξ, T) .

The canonic set of equations formulates a boundary-initial-value problem. The method of solution lies in computation of a sequence of boundary-value problems, first along the LCP curve f , then along the ND curve Φ , which are parametrized by the time-type parameter τ . The BV problem is solved by means of forward numerical integration (modification of the shooting method). Coordinates of points $N_j(p, T)$ on the ND curve are computed by use of an iterative procedure. This procedure is based on a directed search, starting from the previous point N_{j-1} .

Computations have been carried out for ideal circular and annular plates, for linear and piece-wise LCP. A non-linear relation between the yield point and temperature has been assumed.

Results of computations point out great modification of the ND curves if plastic deformation increases. Besides quantitative changes (decreasing of the area of the ND) the change of the shape of the ND curve (different number of corners, concave sides) is stated. A remarkable dependence of the considered curves on the yield point decrease in consequence of temperature increase is also pointed out.

The results obtained confirm and generalize the conclusions known either from the analysis in a single cross-section or from very simple structures (thick-walled tubes).

Now investigations are being carried out for analysis of the ND curves at geometrical non-linearities. The algorithm is being generalized also for computation of the shakedown domain of the plate for loads $0 \leq |p| \leq p_L$ and $0 \leq T \leq T_L$ and for straight paths of the primal LCP $p = kT$.