LONGITUDINAL DYNAMIC ANALYSIS OF PRELOADED SYSTEMS DUE TO REPETITIVE IMPACT–LOADING

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SUMMARY

The paper presents a comparison of two methods for the piecewise linear-elastic dynamic analysis of prestressed and preloaded systems with varying boundary conditions due to repetitive impact loadings. The impacts are initialized by the changings of the structural arrangement of a system, the impact-loadings are depending on the deformation response of the structure, thus vibrations and impact-loadings are in interaction. The changings are defined by the state of internal and external gaps. It is assumed that the dynamically excited system remains elastic, while the gaps response rigid-free between the contact-points.

Based on the Finite Element Method the system is represented as lumped or consistent mass model and the differential equations are solved uncoupled by a modal analysis. In the impact analysis one advantage in using the modal form is the possibility of valuation the chosen discrete element system relative to the influence and accuracy of the used upper eigenmodes.

The gap behaviour is simulated by a numerical treatment of the stiffness so that changing the corresponding terms in the stiffness matrix no variation in the structural arrangement has to be done, that means the number and order of degrees of freedoms remain constant.

The rod-elements used are one-dimensional longitudinal, so that gaps can open only due to normal stresses. The preloading may be originated by an external load or by prestressing without bonding.

The first of the two compared methods is the commonly used complete deformation analysis. The opening of gaps in structural systems which are preloaded is followed up by releasing the stored internal elastic energy. This additional loading condition in this case is represented by an additional initial deformation vector, superimposing with the currently determined dynamic-deformation response. The problem is to define these additional initial deformation vectors for several possibilities of structural arrangements especially in the case of prestressing when the reference axis is changing, too.

The second method contains only the additional values due to the impact loadings and not the complete resulting external force and the complete initial deformation vectors. The evaluation of the additional initial deformation vector is replaced and simplified by using a sparse force vector which is externally applied to the gaps at contact points.

Both methods result in the same complete deformation response. The comparison of the two methods is made in modal terms for the case of preloading and prestressing and is applied to a modal finite element analysis. The reliability of this process is demonstrated using a simple lumped-mass system. The second method is applied to the dynamic analysis of an actual burst-protection-system of a nuclear power plant.