A THEORECTICAL AND EXPERIMENTAL INVESTIGATION OF THE COLLAPSE OF SHALLOW RETICULATED DOMES

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Abstract

A numerical and experimental study of the collapse and post-collapse behaviour of shallow reticulated domes is carried out. The numerical analysis is based on an Updated Lagrangian, materially and geometrically nonlinear, displacement based finite element program. The formulation incorporated in the program can detect plasticity, instability and finite deflection effects in the space frame structure.

The solution of the nonlinear stiffness equations is designed so that critical points on the equilibrium path are identified in the results. A method is developed to obtain the bifurcation path of a perfect reticulated dome, once it is established that there is a bifurcation point on its equilibrium path. Limit point behaviour is detected automatically.

A constitutive matrix is derived for the three dimensional beam elements that take's into account the effect of shear stresses on plasticity using the von Mises yield criterion. These effects are also taken into account in the equilibrium check calculations. The growth of plasticity is monitored both along the beam and across its cross-section.

Three different types of shallow reticulated model domes were tested experimentally in a purpose built test rig. The rig allows displacement control type of loading to be simulated. This facilitates monitoring the behaviour of the domes even after the occurrence of the first limit load. The experimental results presented are compared with the corresponding numerical predictions and the good agreement obtained demonstrates the validity of the theory.