LARGE DISPLACEMENT OF ELASTIC BUCKLING OF SPACE STRUCTURES

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Abstract

Light weight space structures are a product of structural optimisation and are thus prone to suffer from elastic instability. For simple structures with only a few effective degrees-of-freedom the failure mode and the associated failure load can be calculated, but the problems associated with stability are often intractable for a complex space structure particularly when it is also sensitive to small initial imperfections in geometry.

A nonlinear stiffness matrix based computer program is used to investigate the stability of such structures, whose likely failure modes are determined by examining the tangent stiffness matrix of the structure near its collapse load. For a structure whose exact initial geometry is known the actual behaviour under any given load can be calculated. Where the imperfections are unknown the initial geometry is altered by adding those combinations of small imperfections that will excite the likely failure modes. A separate analysis for each of these cases reveals the degree of imperfection sensitivity of the respective failure mode in the structure. Limit point behaviour is correctly analysed because the program is geometrically nonlinear but the present procedure can also take into account possible bifurcation behaviour.

Experiments on four different model structures were performed, in which both bifurcation type and limit point behaviour were observed. Separate tests on a large dome produced a snap-through collapse in one case and collapse involving member buckling in another. Where the exact initial geometry was unknown the addition of a suitable set of imperfections produced results in agreement with the experiments. In cases where more significant real imperfections could be measured before the tests, good agreement was obtained between experiment and analysis.