Structural stability analysis of stadium roof

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Abstract

In this paper the stability of single layered reticulated shell stadium roof is analyzed. Preliminary structure geometry is obtained by process of structural optimization according to the tension-compression analogy, which is originally developed for the form finding problems of tensile structures [1]. Span of the shell is 30,15 m in the minor, and 51,83 m in the major direction while the height of the shell is 5,82 m. The grid pattern is approximately square (5/5 m). All elements are steel tube profiles 159×6,3 mm with welded joints and support nodes are hinges.

Final coordinates of nodes are defined by solving nonlinear system of equations in the procedure of form finding of tensile structures. System of equations is solved using force density method for gravity loads. The procedure is applied iteratively until given conditions are satisfied [2]. With this procedure more optimal distribution of axial forces is obtained while influence of bending moment for vertical load is reduced to minimum [3].

Stability analysis is carried out and postbuckling behavior of the shell is observed [4]. Equilibrium paths are obtained by the finite element method considering geometrical and material nonlinearity to determine load capacity of the structure. The bifurcation points are detected and postbuckling equilibrium paths were developed for various imperfections which are assumed in the form of buckling models and its linear combination. Several values of extreme amplitudes are considered for each imperfection. Finally, the sensitivity diagrams are constructed and the imperfection sensitivity of the shell is obtained. The shape of the structure is the result of optimization process and the buckling modes are close to each other. Consequently, postbuckling branches sharply decrease resulting with extreme imperfection sensitivity.

References

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