Linear Buckling Analysis Considering No-Compression Property of Metal Grid Shells Stiffened by Tension Braces

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Abstract

In order to analyze the buckling behavior of reticulated shells which are stiffened by cables or large slenderness ratio braces without pre-tension, it is necessary to take no-compression property of braces into consideration. In this paper, a method of linear buckling analysis considering no-compression property of braces is proposed.

Analysis models in this paper are reticulated shells with two-way grid pattern (Fig.1). The braces which cannot bear compressive force and do not have pre-tension are arranged on the diagonals of the grid. Since all the braces are compressed when the uniformly-distributed load acts on the shell, the stiffness of the braces does not contribute to the rigidity of the shell at the moment when the first buckling occurs (the bifurcation point shown in Fig.2). However, the braces restrain the post-buckling deformation by changing from compression to tension immediately after the buckling. For this reason, the buckling does not occur practically, and another buckling with different mode occurs at a higher load (the limit point shown in Fig.2).

This paper proposes a method to evaluate the above-mentioned complicated buckling behavior by linear buckling analysis. The eigenvalue analysis is performed taking into account the no-compression property of the braces in the linear stiffness matrix and the geometric stiffness matrix. The pre-buckling deformation and the post-buckling deformation are expressed by modes, and the ratio of the magnitudes of them is represented by one parameter. It is possible to calculate the second buckling load (the limit point), which is not the first buckling load (the bifurcation point) that hardly produces the post-buckling deformation, by obtaining the value of the parameter by simple iterative calculation of equilibrium condition.

In order to examine about the validity of the proposed method, the results of the proposed method are compared with the results of the nonlinear buckling analysis with the geometrical nonlinearity and the material nonlinearity which takes the no-compression property into consideration. Through the result, it is shown that the buckling behavior of the reticulated shell stiffened by the tension braces is predictable by the proposed method.

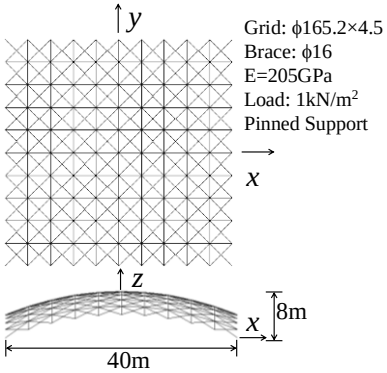


Fig.1 Model for Analysis

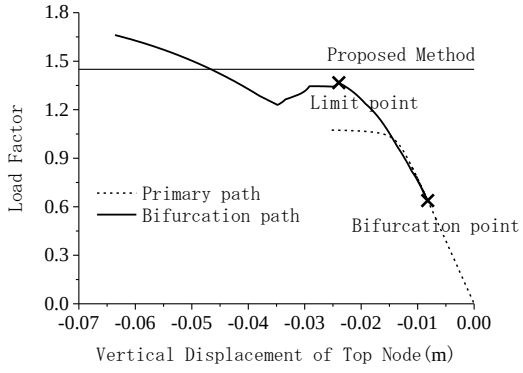
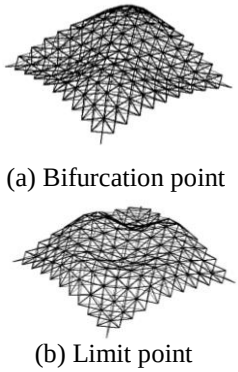


Fig.2 Relation Between Load and Displacement



(a) Bifurcation point

(b) Limit point

Fig.3 Buckling Modes