Study on Equivalent Static Seismic Force of Free-Form Reticulated Shell Roofs Supported by Substructures

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Abstract

The present paper discusses about equivalent static seismic force distributions of free-form reticulated shells with edge beams supported by substructures as illustrated in Fig.1, and proposes a scheme to the seismic force. The shell roofs investigated in this paper are shallow steel single layer reticulated shells consisting of rigidly jointed tubular members, and the shapes are generated by a shape optimization considering minimization of strain energy for dead load. The substructures are composed of buckling restrained brace.

First, in order to analyze response characteristics of the upper structure, dynamic eigenvalue analysis is performed. Based on the analysis of effective mass ratio and maximum strain energy corresponding to each mode, the response of the shell roof structure is revealed to be mainly due to the response of the first mode. Therefore, an equivalent two degree of freedom model as shown in Fig.2 for simulating the vibration of the superstructure and the substructure is estabulished, and the equivalent static static load of the roof structure taking the response characteristics of the substructure into consideration is evaluated. This methodology has already been applied to single layer cylindrical lattice shell roofs.

Several numerical parameters, yield shear coefficninets and initial shear stiffness, are set to investigate the infrucnece on seismic force to parameters. Finally, comparisons between the maximum responses obtained from the time history response analysis and the maximum responses obtained from the proposed equivalent seismic load are illustrated, and the validity of the equivalent seismic force of the free-form reticulated shells is examined.

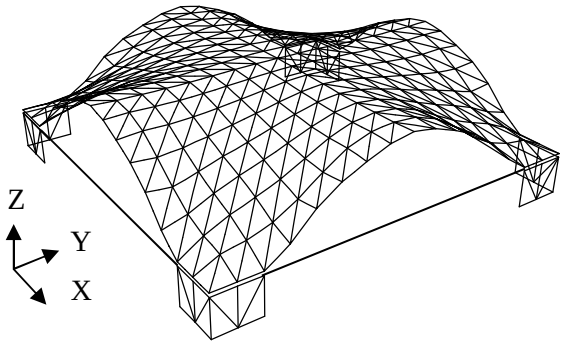
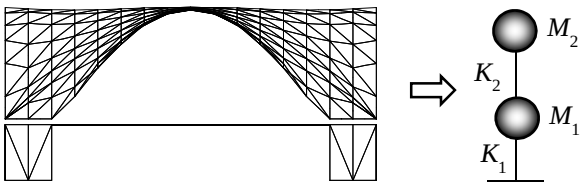


Fig.1 Free-form reticulated shells with edge beams supported by substructures



(a) Full model (b) 2 DOF model

Fig.2 Numerical model for simulating the vibration of the superstructure and the substructure