Study of the space structures' performance via capacity spectrum

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Abstract

Abstract: For a ling time, structures, due to their lightness, were believed to be invulnerable to earthquake. While the Koobe earthquake in Japan in 1995 revealed that such structures should not be expected to be absolutely immune. To this end, the capacity spectrum method was utilized to evaluate the earthquake effect on the behavior of space structures. Such method gives the maximum result regarding the structure capacity and requirement based on acceleration and displacement. The comparison between the earthquake acceleration real spectrum and capacity spectrum methods was intended in this paper. The efficiency of the latter method for determining performance stages of space structures was then defined as the target point displacement. Having obtained the points of performance stages, that is, I.O or L.S and/or C.P., one could find structure weak points. To this end, after loading and selecting appropriate parameters, several structures with different heights and spans are examined from the viewpoint of static and dynamic analyses. The results indicate that the capacity spectrum method has rendered an acceptable appraisal on non-linear dynamic analysis.

Keywords: One layered space drums; Performance stage; Capacity spectrum; space structures; space structures; dynamic analysis; spectrum method;

1. Introduction

Conduction of non-linear analyses is mandatory for examination of the precise behavior of structures under earthquake force. The structures behaviors are usually examined after elastic region using non-linear dynamic analysis methods. Some accelerators pertaining to previous earthquakes are used in this method. The structure real behavior is examined assuming some hypotheses. Analysis of the structures by a special accelerator does not seems to be enough given the unique conditions of each zone especially from geotechnical viewpoint for decision on the structures behaviors. Moreover, non-linear dynamic analysis method is mainly a research method and its use is not possible in engineering offices. As a result, the research institutes have introduced capacity spectrum method based on nonlinear static analysis. Displacement and base shear at the performance point (the point implying the final situation of the structure under a special earthquake) making use of such method and estimating such structure seismic requirement and final capacity. Having obtained the coordinates of the performance point a designer can conduct a more precise design and design the different components of the structure including both structural and nonstructural in such a way that they are capable of tolerating the displacement pertaining to such point. Having briefly described capacity spectrum method the paper deals with the calculation manner of structure performance point. A drum with a 10-meter bay, four meters in height, its members 1.5 in length and all its connections rigid, is examined in the paper. Such structure lacks any mid-span support and has only support along the exterior periphery. It is influenced by dead loads of 50 kg/square meter intensity including the members' weight, connections, structure outer cover, snow load (live) to the amount of 100 kg/square meter and wind load of 100 km/h. It is then examined by Sap 2000, nonlinear dynamic and static analyses. Such structure is modeled in the form of moment resisting frame in a zone of very high seismic level and soil type II as per Steel Code 2800, Third Edition;