9th International Congress on Civil Engineering, May 8-10, 2012
Isfahan University of Technology (IUT), Isfahan, Iran

Equivalent Earthquake Loads for Some Families of Barrel Vaults Parabolic Shapes

Morteza Yousefi Dadrass[1], Hossien Ebrahimi[2]

1- Civil Engineering Department, Islamic Azad University, Kerman Branch, Kerman, Iran
2- Civil Engineering Department, Shahid Bahonar University of Kerman, Kerman, Iran

Yousefi.civil@yahoo.com (Morteza Yousefi Dadrass)
Ebrahimi@mail.uk.ac.ir (Hossien Ebrahimi)

Abstract

Double layer barrel vaults parabolic shape, are a group of 'Lattice space structures' that are one of the most common choices for covering large areas. These structures are also used as temporary shelters after strong and destructive earthquakes. Unfortunately, the available research results on the seismic behaviour of these structures are rather scarce and there is no universally accepted code of practice for assessing the earthquake loading for these structures. In the peresent work, the dynamic characteristics of the double layer barrel vaults parabolic shape are studied and the analysis of eigen values for determining periods of structures, mode shapes, mass participation factor, damping characteristics of structures have been used. Then with applying different accelerograms and time history analysis the effects of horizontal and vertical components of earthquakes on these structures investigated. And some formulae are suggested for assessing the horizontal and vertical effects of earthquakes.

The nonlinear analysis of structures is used and with investigated of ductility of the structures the behaviour factor of structures is determined .To investigated nonlinear behaviour of barrel vaults parabolic shape a recently developed method, namely "pushover analysis method",is employed for the barrel vaults parabolic shape. The results of this analysis show that barrel vaults parabolic shape are brittle structures and may involve progressive collapse after buckling of some elements.

Keywords: Double layer barrel vaults parabolic shape, Dynamic characteristics, Nonlinear analysis, Behavior factor, Pushover analysis method

1. INTRODUCTION

Space structures are widely used to cover large areas. Lattice space structures are among the mostly used families of the space structures. Also, among the common configurations of this family are the parabolic shape double layer barrel vaults. Static behaviour of the space structures are studied vastly, while the dynamic and seismic behaviour of these structures have attracted increasing attention in the last few years. The reason of the increasing attention on the seismic behavior of the space structures is that, despite the early assumption that these structures are a seismic structures; recent actual observations have shown that the space structures, too, may become vulnerable to earthquakes [1~2].

Among the remarkable studies of the seismic behaviour of the space structures, one can refer to the works carried out by the Japanese researchers such as Kato, Ishikawa et al [3~10].

In the current work, a popular family of the parabolic shape barrel vaults is selected for the purpose of studying the earthquake effects on them. Firstly, dynamic characteristics of the parabolic shape barrel vaults are discussed. Then linear and non-linear behaviour of the parabolic shape barrel vaults including the post-buckling behaviour of these structures are studied. Also, for assessing the equivalent earthquake loading on the parabolic shape barrel vaults some formulae are presented. These formulae will ease the required task of the seismic analysis of the parabolic shape barrel vaults considerably.

Notice that in the paper we have used "barrel vaults" instead of "parabolic shape barrel vaults".

2. CONFIGURATION AND CHARACTERISTICS OF THE BARREL VAULTS

A frequently used pattern of the double layer barrel vaults, that is, the square-on-square offset pattern, is employed for this work. Three configurations with rise to span ratios of 0.15, 0.30 and 0.45 are selected for the barrel vaults. The length, span and depth of the parabolic shape are kept constant for the barrel vaults and these are 40 m, 30 m and 1.5 m, respectively. Fig 1 shows the configuration of the selected barrel vaults.