Dynamic Analysis of Masjed Soleiman Embankment Dam Using Recorded Earthquake Signals and TFD Method

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Abstract

Dynamic analysis of embankment dam using recorded accelerograms on dam body is a powerful tool for designers and researchers. In this research, recorded earthquake signals are used to analysis the dynamic response of Masjed Soleiman embankment dam. In dynamic analysis, recorded signal in the gallery station is used as input motion and by assuming different masses for foundation; the seismic response of the dam is evaluated. The calculated responses are compared with recorded accelerograms on midheight and crest of the dam. In comparison, the modern signal processing method, Time-Frequency Distribution (TFD), is used. The analysis results indicate that TFD results show that %25 and % 50 mass foundations have closer results to the recorded earthquake signal.

Keywords: Embankment dam, dynamic analysis, TFD method.

1. INTRODUCTION

Evaluating the dynamic behavior of embankment dams during earthquakes and finding a way to consider the variation of material properties are of the most problems related to researchers and designers engaged in numerical analysis of these types of dams. The seismic behavior of embankment dams can be evaluated by in-situ dynamic tests (such as processing recorded earthquake signals on dam body), experimental methods (i.e. experiments using large shaking table, centrifuge tests) and numerical methods [1].

Mononobe in 1936 considered earth dams as deformable bodies and introduced the shear beam model. The developed shear-beam model was exploited in the 1960's and 1970's to interpret the results of full scale tests. Since 1980 several improved analytical models have appeared [1, 2 and 3]. Since 1990's, 3-D finite element analysis improved and now new problems such as reservoir-dam-foundation interaction, using boundary element-finite element in frequency domain to study dam's response to P, SV and Rayleigh excitation, spatial variation of ground motion and modern signal processing methods are studied [4, 5, 6, 7 and 8]. Using recorded earthquake signals on dam body is a very powerful tool to study complicated problems related to the seismic behavior of embankment dam during an earthquake event. Several previous studies have used ground motion data to estimate modal responses of embankment dams during seismic events [9, 10, and 11]

Mejia and his co-workers used the accelerograms recorded by the instrument station at the abutment to calculate the dynamic response of the Ririe dam. This rock-fill dam is located in southeastern Idaho, about 25 Km northeast of the city of Idaho. the October 28, 1983 Mt. Borah earthquake triggered five strong-motion instruments installed at the crest, left abutment, downstream toe and outlet tower of Ririe dam [12].

Recently, for the first time in Iran, the recorded earthquake, explosion, ambient and forced vibration tests are used to evaluate dynamic characteristics of an embankment dam. Dynamic characteristics of Masjed Soleiman embankment dam, the highest embankment dam in Iran, are extracted based on classical and modern signal processing methods [13, 14].

At this time, there are some basic questions in numerical modeling of embankment dams. One of the most important matters is selecting the mass foundation in the modeling of embankment dams subjected to seismic excitations. Because of the limitations in the available softwares, the mass-less foundation assumption is considered in the dynamic response of dam-foundation interaction problem. This assumption; neglecting the mass foundation, can be led to some errors or approximations in the exact solution of the problem. It should be noted that this approach is useful to dynamic analysis having free-field motion as the input excitation, but in most cases, the free-field motion is not available. The present study, investigates the mentioned problem.