System identification of arch dam based on continues wavelet transform

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Abstract

Operational Modal Analysis (OMA) is one of the best and effective methods for health monitoring of structures. Any changes in the modal parameters could be a sign of the changes in structural properties or ambient conditions of the structure. An important application of system identification in structural dynamics is the determination of natural frequencies and damping ratios during operation. In this paper, Continues Wavelet Transform (CWT) is used to extract modal parameters (natural frequencies and damping ratios) of Karun III double curved arch dam in Iran. Modified Morlet wavelet is used to extract natural frequencies then signal decomposed to single frequency signal to eliminate modes interference to calculate damping ratios exactly using half power method.

Keywords: Modal identification, dam-reservoir interaction, FDD, ground motion.

1. INTRODUCTION

The significance of maintenance of large structures like dams and multi span bridges are unavoidable. Maintenance of structures contains observing the behavior and also measuring dynamic properties of the structures. Operational Modal Analysis (OMA) is a system identification method based on structural responses to extract dynamic parameters (natural frequencies and damping ratios) of large structures like dam due to unknown inputs. OMA is an output only method that is not depend on the amplitude of the motion and how it apply to the dam [1]. Actually this independency of input force is the most important advantage of this method in comparison to classical system identification methods. Measuring input force might include errors and difficulties because of the vibration source is not clearly known. In OMA, the dynamic parameters of the structure can be extracted using techniques in time, frequency or time-frequency domain methods. Pick Picking (PP) is a frequency domain method in which peaks of Power Spectral Density (PSD) selected as the natural frequency system. This method is used in this article just for more confidence about results. Frequency domain methods such as Frequency Domain Decomposition (FDD) transform signal to frequency domain and select system frequencies during processes [2-4]. In FDD method the PSD of output signal calculated and decomposed to its singular values. As the first singular value has more energy than the others, the peaks of the first singular value selected as the system frequencies. Stochastic Subspace Identification (SSI) is one of the time domain methods [5]. Continues Wavelet Transform (CWT) is a time-frequency domain method [6, 7]. The advantage of the CWT than other time-frequency method is variability of time and frequency resolutions which made CWT to a multi resolution method. In this article, the CWT is used to extract natural frequencies of the Karun III dam. The accelerations used in the identification process are in three different levels from crest to mid height of the dam due to august 2012 earthquake. There are two other motions which used to verify the identified frequencies due to first motion. To extract damping ratios dam responses then decompose to identify frequencies to eliminate modes interference. The single frequency signals used to extract damping ratios by applying half power method.