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Effect of dam-reservoir interaction on modal characteristics of arch dams due to weak and strong ground motions

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Abstract

Dam-reservoir interaction affects modal characteristics of dam but its effect's amount depends on amplitude of excitations and water level of reservoir. In this paper, effect of dam-reservoir interaction on modal characteristics of arch dams due to weak and strong ground motions investigated. Finite element models of dam-reservoir-foundation and dam-foundation systems excited due to weak and strong ground motions and modal parameters of the system extracted by Frequency Domain Decomposition (FDD) and Continues Wavelet Transform (CWT) method based on dam responses to investigate the relation between amplitude of excitation and effect's amount of dam-reservoir interaction on natural frequencies of the system. Effect of reservoir water level on natural frequencies of the system is also investigated.

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

1. INTRODUCTION

Dam-reservoir interaction is a complicated problem that becomes more important especially in large arch dams. The interaction effect clearly depend on stiffness of the structure and also the magnitude of the vibrations. The arch dams because of their low stiffness in comparison to other type of dams such as concrete gravity dams are more subjected to interaction effect. The relation between dynamic characteristics of the structure and dam-reservoir interaction is not as simple as the stiffness and it depend on the amplitude of ground motion. In this paper, dam responses are used to investigate the effect of dam-reservoir interaction on modal characteristics of the dam due to different levels of vibrations. The acceleration which selected to study should contain wide range of frequency to involve all dam body frequencies. In addition, the recorded dam responses with wide range of frequencies are not always available due to technical problem or nature of recorded acceleration. In this paper, the effect of dam-reservoir interaction on modal characteristics of Karun IV arch dam due to strong and weak ground motions investigated. Because of technical problem in dam site, the recorded dam responses are not available so the finite element model of the dam-reservoir-foundation is used to calculate dam responses due to different vibrations. In case of strong vibrations because of large deformation of dam body, the plastic domain of concrete involved. In this paper, effect of considering plastic behavior of concrete investigated. There are several methods to transform structural response to frequency domain to identification the modal parameters of the structure such as Pick Picking (PP) method, Continues Wavelet Transform (CWT) method [1, 2], Stochastic Subspace Identification (SSI) method [3] and Frequency Domain Decomposition (FDD) method [4-6]. The acceleration time-history of dam response transformed to frequency domain by Frequency Domain Decomposition (FDD) method to identify system frequencies. It is notable that white noise with wide range of frequency is used to excite all natural frequencies of the system. The frequencies of the Karun IV system in both strong and weak ground motion obtained by considering elastic and Elastoplast behavior of arch dam to investigate the effect of plastic behavior of the material on modal characteristics of the Karun IV arch dam. Damping ratios for all identified modes are also calculated based on applying half power method to single frequency signals which obtained by decomposing structure response to identified frequency.

2. SYSTEM IDENTIFICATION

System identification is used to obtain modal characteristics of the structures to observe any changes. OMA are output based methods which extract modal parameters based on dam responses regardless to the input signal. Different methods are used to this purpose such as Pick Picking (PP), FDD and Stochastic Subspace