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Estimation of dam site elastic moduli using engineering seismic techniques

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Abstract

Estimating elastic moduli of soil and rock requires doing detailed laboratory and geotechnical studies on drilling cores. Seismic geotechniques is one of critical stages of site engineering investigation that can estimates these dynamic properties by measuring seismic wave velocities. That is because of relationship between seismic wave's velocity and elastic parameters such as Shear modulus, Bulk modulus, Young's modulus and Poisson's ratio. The purpose of this research is identifying geologic layers, determining velocity model and finally, estimating elastic moduli of site using two seismic methods, downhole and refraction. For this purpose, seismic data obtained from three boreholes and eight refraction profiles for both compressional and shear waves. Results of seismic data processing and interpretation reveal two to three geophysical layers. Finally, given to velocity values of seismic waves and density for borehole depth intervals, elastic moduli of site were calculated.

Keywords: seismic geotechniques, downhole, refraction.

1. INTRODUCTION

Seismic geotechniques is one of critical stages of site engineering investigation that can estimates soil and rock dynamic properties by measuring seismic wave velocities. In all construction projects, Dynamic elastic moduli of geologic materials of sites are important properties that give engineers a good vision to design the structure. These properties are affected by porosity, presence or absence of fluid in voids, fluid type in voids, anisotropy, in general, and all physical properties of medium [1]. So, one can calculates elastic parameters of a medium by measuring acoustic wave's velocity. Engineering seismic techniques are implemented, generally, in refraction and borehole methods. In seismic refraction method, qualitative and quantitative properties of layers are determined by generating seismic waves at a point (shot) and recording refracted waves in form of signals (time series) along a profile [2]. These signals, in fact, are sent seismic wavelet into the earth that arrives to receivers after changing frequency band and energy decay. Geophone spacing during data acquisition depends on required accuracy to detect layer surface and desired depth [3]. Borehole seismic techniques are implemented in three forms: Down-hole, Up-hole and Cross-hole. The purpose of using these techniques is to delineate an exact velocity model of site by using surface and subsurface sources and receivers. In this paper, Down-hole technique has been used. This method has a wide application in site investigations and is implemented in two forms: single-channel and multi-channel. The source (shot) act on the surface and close to borehole and three-component geophones record seismic wave in different depths [4]. Being geophones into the borehole prevents recording unwanted signals that there are in usual acquisitions and run into trouble data processing. Furthermore, controlling and fast moving source on the surface increases the acquisition efficiency compared to other methods. The field results of a Down-hole acquisition are recorded as time- depth graphs and are presented as velocity- depth curves after processing with special algorithms. Figure (1) is a schematic form of Down-hole technique acquisition and time-depth and velocity-depth graphs. This paper is the result of a dam site seismic investigation in order to estimate elastic properties with two seismic methods: refraction and Down-hole.