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SEISMIC NONLINEAR BEHAVIOUR OF RECTANGULAR ALLUVIAL VALLEYS SUBJECTED TO VERTICALLY PROPAGATING INCIDENT SV WAVES USING THE SPECTRAL FINITE ELEMENT METHOD

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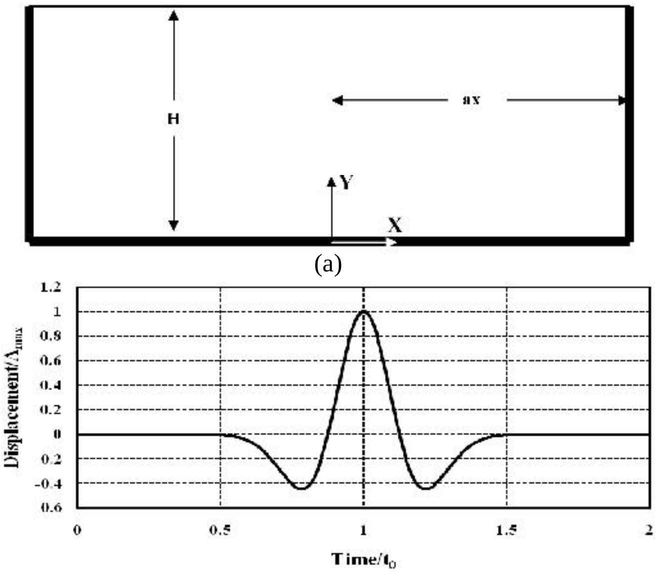
This paper, investigates the effect of soil's nonlinear behavior in soil amplification and seismic site effects due to the local topography and geotechnical characteristics. It focuses on 2D Rectangular alluvial valleys subjected to vertically propagating incident SV waves. The geometry of the 2-D homogenous Rectangular alluvial valley investigated by this study is defined in Figure1-a where ax and H denote the half-width of the soil layer along the ground surface and its depth at the center line, respectively. A broad range of 2D Rectangular alluvial valleys resting on a rigid bed rock with different shape ratios (H/ax) of 0.2, 0.4, 0.6, 0.8, 1.0 and 2.0 were considered. The incident SV waves were chosen as the well known Riker type (Figure1-b).

In order to solve nonlinear wave propagation problems, a two-dimensional software named as (NASEM) was developed based on the spectral finite element (SFEM) formulation in the time domain. The Spectral Finite Element Method (SFEM) is a high-order technique with important advantageous over the classic FEM as well as the BEM. The SFEM which has all advantages of the classic FEM, including the capability to solve non-linear problems in spite of the BEM, has been strengthened with a special group of interpolation functions. The software developed is capable of executing seismic site response analysis of linear and nonlinear 2D alluvial valleys in time-domain with low computational volume. The accuracy, efficiency and applicability of the software were demonstrated in some numerical examples by comparing the computed results with those obtained by some well known finite element codes (Najafizadeh et al., 2014).

A numerical parametric study has been carried out to study the seismic response of rectangular alluvial valleys subjected to vertically propagating incident SV waves. The behavior of the alluvial was assumed nonlinear and the surrounding rock was assumed to behave rigidly. The nonlinear behavior of the soil deposits was simulated by Manzari - Dafalias constitutive model (Manzari and Dafalias, 1997; Dafalias and Manzari, 2004).

It was seen that the amplification pattern of the valley and its frequency characteristics depend strongly not only on its shape ratio, but also on its nonlinear behavior. In each rectangular alluvial valley and irrespective of its shape ratio, by increasing the PRA, the natural period of the site increases while the PGA's on the ground surface amplification ratio decreases. The maximum amplification ratio along the ground surface occurs at the center of the valley and when one moves from each of the corners towards the center, the maximum amplification ratio of the ground surface increases. Figure 2 demonstrates the horizontal acceleration time history curve obtained by the nonlinear SFEM at top of the centerline.



(a)

(b)

Figure 1. a: Geometry of the 2-D homogenous rectangular alluvial; H and ax denote the thickness and the half-width of the soil layer, respectively; b: Displacement time history of the incident wave

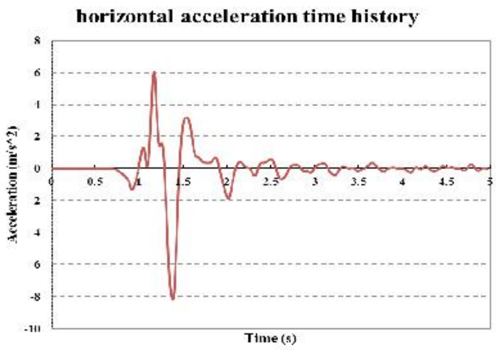


Figure 2. Acceleration time history at top of the center line obtained by the SFEM code

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