8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

NONLINEAR SEISMIC SITE EFFECTS IN FILLED TOPOGRAPHIES BY SATURATED POROUS ALLUVIUM

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Keywords: Site effects, Seismic ground response, Nonlinear dynamic response, Saturated porous media, Alluvial topographies

This study aims to assess seismic ground response in alluvial topographies filled by nonlinear saturated porous alluvium by means of a hybrid numerical method, called HYBRID. For this purpose, the HYBRID numerical code that combines the finite elements method in the near field and the boundary elements method in the far field (FEM/BEM) (Gatmiri and Kamalian, 2002; Gatmiri and Dehghan, 2005), is developed to model the saturated nonlinear behaviour of geomaterials by using the coupled formulation of porous media proposed by Zienkiewicz in the following of the former presented Biot theory. In this paper, the irregularities are subjected to the vertically cyclic loading using Equation 1:

$$u(t) = A_0 \sin(2\pi t / T) \qquad (1)$$

where the amplitude, A0, is a constant value of 0.2 m; and T = 0.5 sec. It is assumed that the incident signal lasts 3 sec and the amplitude is zero as soon as it reaches t = K.Δt in which K represents the cycle number and Δt is a fixed value of 0.02 sec (Figure 1).

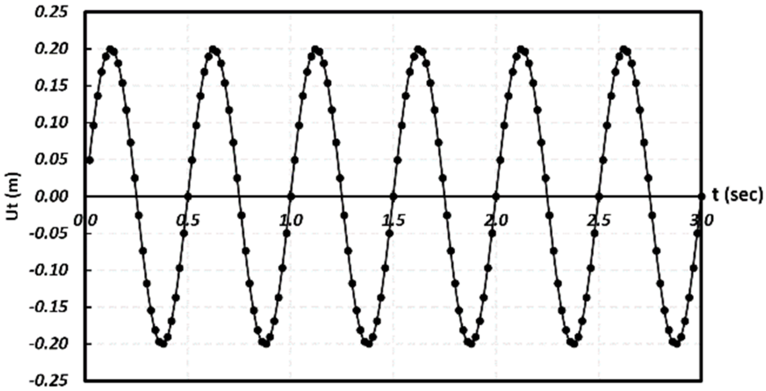

Figure 1. Sinusoidal incident wave signal over the time.

In addition, the sediments are assumed to behave according to the Hardin-Drnevich constitutive model (Hardin and Drnevich, 1972). For this purpose, first, the Hardin-Drnevich constitutive model is implemented into HYBRID. The Newton-Raphson method, which is a powerful technique for solving equations numerically, is utilized to integrate the responses over the time. In order to consider the effects of the local topographical and geological conditions simultaneously, both 1D and 2D configurations are modelled. The material parameters for bedrock and alluvia for nonlinear (Hardin-Drnevich model) behaviors are presented in Table 1.

Table 1. Characteristics of Nonlinear materials.

Characteristics	Friction Angle (Degree)	Cohesion (KPa)	K	n	e	K_0	γ (Kg/m^3)
Value	30	0	0	0.5	0.9	0.5	1.8×10^4

Responses are obtained for different geometrical points (Figure 2) at the ground surface in terms of time history of displacement. In addition, the variation of pore pressure is calculated in some in-depth points, in order to underline the excess pore pressure under the seismic cyclic loading. Furthermore, the amplification/de-amplification patterns are obtained at different geometrical points for each configuration. Finally, some recommendations based on the presented results are proposed in order to quantify nonlinear 1D and 2D saturated site effects.

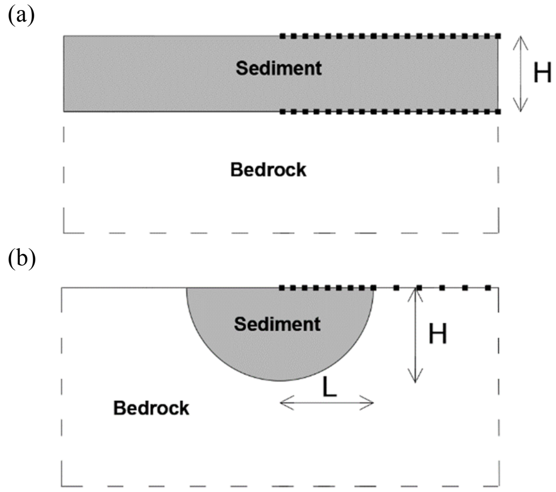

Figure 2. Observational geometrical points of models (a) 1D, (b) 2D full-filled valley.

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