THE EFFECT OF INHOMOGENEITY ON SEISMIC SOIL DEPOSIT RESPONSE: A REVIEW

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Profound effect of local soil geology on damage of structures has been recognized after several post earthquakes (Seed et al., 1988). Hence, proper understanding of dynamic characteristics of the underlying soil deposits leads to seismic hazard reduction. Conventional one-dimensional analysis methods, discretizing the soil profile in a multi-layer system with constant properties within each layer, in thick and soft soil deposits may underestimate soil amplification compared to the continuous variation of rigidity with depth, i.e. inhomogeneity (Towhata, 1996). To this end, a literature review regarding the inhomogeneity effect on vibrational characteristics and base-to-surface transfer function of soil deposits under one-dimensional shear wave propagation is presented by this paper.

An inhomogeneous soil layer with zero value of shear wave velocity at the ground surface studied by Dobry et al. (1976) and non-zero case examined by Gazetas (1982). Rovithis et al. (2011) and Mylonakis et al. (2013) investigated seismic response of a single-layer (Figure 1) and two-layer inhomogeneous soil. Durante et al. (2015) by means of Rayleigh quotient procedure analysed the fundamental frequency of bi-layer heterogeneous soil deposit. Acquired solutions for estimation of the fundamental period of soil deposits were gathered by Medhat Sefvati and Kamalian (2018).

V_0 and V_H are representative of shear wave velocity at the ground surface and bottom of the deposit, respectively. Considering the inhomogeneous layer (Figure 1), mode shapes (Figure 2) and amplification function (Figure 3) were obtained. For small values of the inhomogeneity factor (n = 0.01) the mode shapes are comparable to homogeneous profile. On the contrary, with the increase of n (n > 0.5) modal amplitudes show sharp increase near the surface.

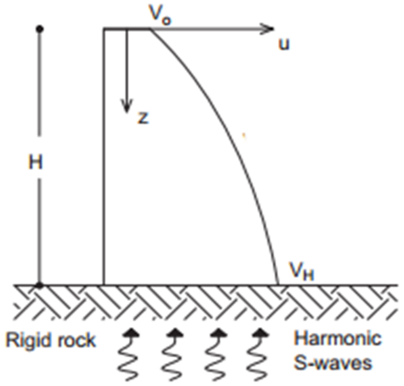

Figure 1. Single inhomogeneous layer with depth H over rigid rock (Rovithis et al., 2011).

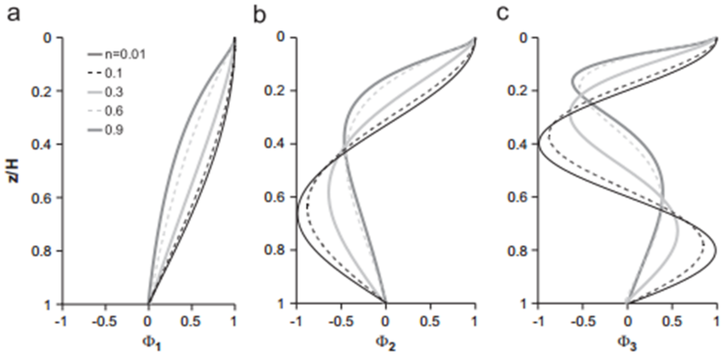

Figure 2. Normalized shapes of the first (a), second (b), and third (c) natural modes of an inhomogeneous layer over rigid base; V_0 /V_H = 0.1 (Rovithis et al., 2011).

It can be observed that for small V_0 / V_H ratios (V_0 / V_H = 0.1), increasing the inhomogeneity factor amplifies response and makes natural frequencies lower (Figure 3). For V_0 / V_H = 0.75 the effect of inhomogeneity is negligible, however. Therefore, taking the role of inhomogeneity into account for seismic response of moderately-to-strongly inhomogeneous soil is not only justifiable but also necessary.

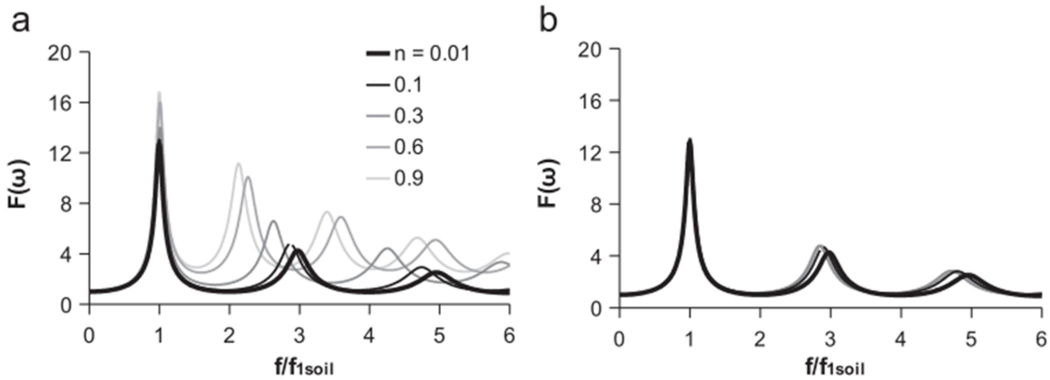

Figure 3. Effect of V_0 / V_H ratio on base-to-surface transfer function of a single inhomogeneous layer for (a) V_0 / V_H = 0.1 and (b) V_0 / V_H= 0.75 as a function of frequency; ξ = 0.5 (Rovithis et al., 2011).

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