# EFFECT OF SOIL DEPTH ON SEISMIC SITE AMPLIFICATION

Mohammad Reza SOGHRAT
*PhD Student, IIEES, Tehran, Iran*
*m.soghrat@iiees.ac.ir*

Mansour ZIYAEIFAR
*Associate Professor, IIEES, Tehran, Iran*
*mansour@iiees.ac.ir*

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Average shear wave velocity of the top 30 m, $V_{S,30}$, is used to estimate the site effect in many Ground Motion Prediction Equations (GMPEs) or to classify the site class in many design codes. For example, Iranian code (Standard No. 2800), Eurocode 8 and ASCE 7 consider only the $V_{S,30}$ that many researchers believe that the single parameter cannot represent the site amplification characteristics. A few of design codes consider an additional parameter same as the depth of soil (Adhikary et al., 2014) or natural site period to classify sites. Moreover, the obtained uniform hazard spectrum resulted from seismic hazard analysis can be unreliable (especially in soft soil classes) if the GMPEs do not consider the depth of soil stratum especially in soft soils. In addition to investigation of the effect of soil depth on the response obtained on ground surface, a comparison between the influence of small near events and large distant ones is done.

Five various soil sites have been selected for this study that details of their profiles are reported by Adhikary et al. (2014). The analyses to show the effect of soil depth have been done by EERA program (Bardet et al., 2000) in three different soil depths; 30, 60 and 200 m. Three records from small near events and three another records from large distant ones were selected to explain the effect of soil depth and geology specification. It should be noted that to compare, all six records are normalized to 0.1g, so the PGA of records on bedrock is equal.

The results show that considering the only $V_{S,30}$ underestimate the spectral response in long periods (greater than 1 sec) obtained from large distant events. For example, a site profile, Region M3- Delhi (Adhikary et al., 2014), is selected and analyzed. The specification of mentioned site profile is shown in Table 1 and the variation of fundamental period and soil depth are shown in Figure 1.

Table 1. Details of the site profile, Region M3, Delhi (Adhikary et al., 2014)

| Layer number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thickness (m) | 5 | 5 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 100 |
| Unit weight (kN/m3) | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Vs (m/s) | 206 | 243 | 287 | 317 | 339 | 358 | 374 | 388 | 401 | 412 | 423 | 499 |

The comparison of considering different soil depths have been done in Figure 2. The spectral responses in depth of 30 m (Profile 1), 60 m (Profile 2) and 200 m (Profile 3) are normalized to bedrock response.

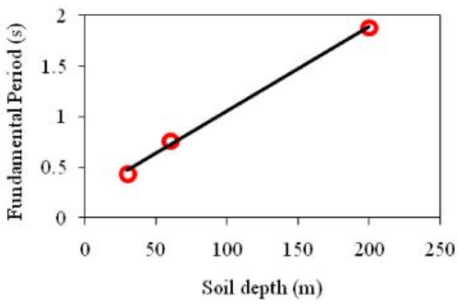


Figure 1. The variation of Fundamental period and soil depth

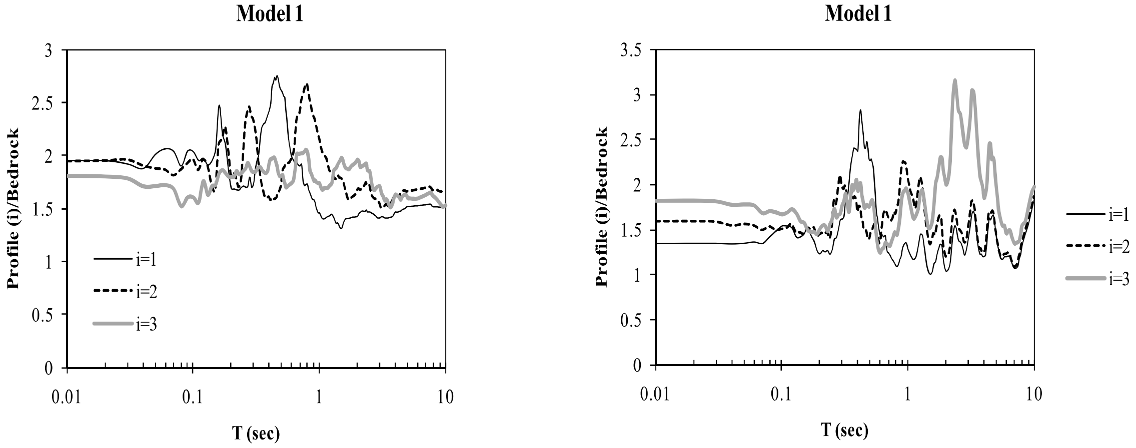


Figure 2. The effect of different soil depths on spectral responses; small near event (left) and large distant (right)

Finally, this study shows that considering only the $V_{S,30}$ to predict the site effect may be insufficient to accurately estimate the spectral amplitude, specially, in long periods. When we consider the different soil depths (the soil can be homogenous or inhomogeneous), the fundamental period as a function of thickness of soil profile is changed. Thicker soil profiles have longer fundamental period. Hence, large distant earthquakes which are rich in low frequency component can amplify the response on deep soil profile.

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