MOVE FROM SOIL/ROCK: SITE RESPONSE BASED ON THE DIFFERENCE IN THE VS PROFILE FOR THE GMPE AND THE SITE-SPECIFIC VS PROFILE

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Abstract

The traditional approach used to incorporate site response into the ground-motion hazard analysis is to compute a design spectrum for a rock-site condition and then propagate the rock motion from the base of the soil model to the surface. The rock-site ground motion is computed for a given VS30 value which is often assumed to represent the outcropping motion at a depth at which the VS is equal to the VS30. For example, the ground motion computed for VS30=600 m/s is assumed to apply to the layer at depth with VS=600 m/s. There are two problems with this assumption. First, a site with a given VS30 value will have a gradient in the VS(z) profile so that the Vs at the surface is much lower than the VS30 value. As a result, the assumption that VS=VS30 leads to overestimation of the motion at depth. Second, the VS30 value is not a fundamental physical parameter for site response. The VS30 works in GMMs because the VS30 tends to be correlated with the deeper VS(z) profile that is the fundamental physical parameter for site response. The VS30 should be thought of as an index for the full VS(z) profile and not a key parameter by itself.

Adjusting the ground motion for an average site condition given by the GMMs to the site-specific condition requires first understanding what site condition is represented by the GMM, then computing the site factor to account for the differences. To be able to correct for the differences in the VS(z) profile implicit in the GMM and the site-specific VS(z) profile, requires knowing the VS(z) profile for the GMM. Current GMMs do not provide the VS(z) profiles that go with the GMM, but that is changing. An example of VS(z) and kappa for California that are estimated as part of the GMM development process is shown using the NGA-W2 data set. For each VS30 value, there is a full VS(z) profile and the kappa. These models provide a more complete description of the site condition that goes with the ground motions computed using the GMM. They also make it clear that VS30 is not the important physical parameter for site effects and their use should lead to clear handoffs between hazard analyses and site response studies.

The VS(z) profile correction method described in Williams and Abrahamson (BSSA 2021) is an alternative to the soil-over-rock approach routinely used in earthquake engineering practice. The approach is not new and has been used for Vs-kappa corrections to adjust a GMM from one region to another, but it has not been widely used for site response studies. This approach is similar to the standard soil-over-rock analysis, but it uses different input motions and involves performing two site response analyses -- one for the generic profile associated with the GMM(s) and one for the site-specific profile -- then applying the ratio of the two site response analysis results to correct the design spectrum for the reference site condition developed using the GMMs. An example application of the method is shown.