International Workshop on the Uncertainties in Nonlinear Soil Properties and their Impact on Modeling Dynamic Soil Response

View from Practice
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Site effects in engineering practice in the Pacific Northwest are most commonly addressed through the use of one-dimensional equivalent-linear codes (e.g. SHAKE) and occasionally with nonlinear codes (e.g. WAVE, D-MOD or some variation of DESRA). Occasionally, a finite difference program such as FLAC may be employed, particularly if soil-structure interaction issues are significant.

Our experience with these programs is that they can be inadequate for modeling the conditions we typically encounter including liquefiable soils, predominantly silty soils, highly overconsolidated soils, and the strong influence of basin effects. For liquefiable soils, the nonlinear codes we have used or contracted with others to run can give spurious results—either very low or unusually high response. In modeling the potentially liquefiable silty soils, we have typically chosen between modeling them as sand (using EPRI (1993) curves) or as clay (using Vucetic & Dobry (1991)), depending on the plasticity index of the soil.

We also do not know the effect that repeated glaciations may have had on the dynamic properties of soils in our region. Extensive glacial ice sheets over the region as recently as 13,500 years ago commonly result in overconsolidation ratios on the order of 10 to 30 for soils within 100 feet of the existing ground surface. While there were some limited efforts in the 1970's to develop nonlinear dynamic properties for these highly overconsolidated soils, there is a lack of adequate testing and accepted nonlinear dynamic properties for these soils.

The Pacific Northwest region is also hampered by the lack of instrumentation and recorded historical earthquake data. Although the recent Nisqually earthquake substantially increased the database, there are still questions about the appropriate level of shaking at the "rock" level for performing back-analyses. With one-dimensional codes, we have been able to partially model some of the recorded response, but significant questions remain over the contribution to modeling error from the choice of input motion, dynamic soil properties, and the influence of the Seattle Basin(s).

In addition, as the State of Washington adopts the 2003 IBC this summer and other major projects consider ground motions with return periods of 2,500 years, the level of ground shaking we are asked to model has increased significantly (e.g. from pga of about 0.3g to greater than 0.5g or 0.7g). Existing analytical methods are challenged by these higher levels of shaking.

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