

Annual Report 1998

Nonlinear Site Response due to Low and High Frequency Base-Rock Motions

(Research for Working Group B: Ground Motion Modeling)

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The main purpose of the investigation is to examine how the accelerograms obtained from the SCEC linear 3-D basin response studies can be used for nonlinear site response estimations. The accelerograms obtained from the 3-D linear simulations are known to have frequencies lower than actual field frequencies recorded during past earthquakes. On the other hand, the results of the research done in the past show that the frequency content of the input excitation motion can have significant effect on the outcome of a nonlinear site response analyses.

To advance the understanding of the effects of frequency of incoming motion on the intensity and characteristics of ground shaking for the area of Los Angeles, and to improve methods for dealing with these effects, a series of 1-D nonlinear site response analyses is being conducted using the excitation inputs with different frequencies. The computer code DESRAMOD2, which is a modification of the original computer program DESRA-2 (Lee and Finn, 1978), is utilized. The DESRA-2 and DESRAMOD2 models can calculate a nonlinear response of stratified soil profile composed of different layers of soil due to the base excitation applied in the form of an accelerogram.

The particular soil profiles used in this exercise are a couple of profiles from the Downtown Los Angeles, which have been included in the SCEC Geotechnical Database (Doroudian and Vucetic, 1995). The DESRAMOD2 input parameters of these two soil profiles were determined and/or estimated, and the theoretical DESRAMOD2 profiles are prepared for a parametric study. Several test runs of the computer program DESRAMOD2 have been performed to confirm its readiness for the planned parametric study. The parametric study will consist of conducting the nonlinear site response analyses using in a systematic manner base excitation acceleration inputs with different frequency contents, but with basically the same peak acceleration values. Some of these input accelerograms will be prepared by modifying the accelerograms obtained during past earthquakes, while some will be accelerograms derived from the SCEC 3-D basin response studies.

For the DESRAMOD2 nonlinear site response analyses, the selection of appropriate dynamic and cyclic nonlinear soil properties, which are used as the input, are extremely important. In this proposal, the term “dynamic” loading means fast monotonic loading and the term “cyclic” loading means repetitive loading. These properties will be carefully selected based on the: (i) available geological and geotechnical field data from the two locations selected, (ii) geotechnical soil classification characteristics available in the SCEC geotechnical database for these two locations, and (iii) results of the geotechnical cyclic tests conducted on various soils from the Los Angeles basin in the past, (iv) many new results of the high-quality geotechnical cyclic tests conducted recently on Los Angeles basin soils as parts of different SCEC and other projects (e.g. Matesic and Vucetic, 1998; Vucetic et al., 1998), and (v) well-established correlations between the soil classification and cyclic properties (Dobry and Vucetic, 1987; Vucetic, 1994a; Vucetic, 1994b; Vucetic and Dobry, 1991).

In Figure 1 results of typical simple shear tests (Bjerrum and Landva, 1963; Doroudian and Vucetic, 1985) conducted at UCLA to determine input parameters for nonlinear site response analyses are presented. How such results are applicable for the nonlinear site response analyses is illustrated in Figure 2.

References:

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La Cienega, L2-2, 20.6-21.0 feet					
DSDSS TEST-STEP 4					
Type of soil: CL					
LL	27.3	PI	9.9	%Silt	-
e_0	0.554	S_0 (%)	98.24	%Clay	-
σ'_v (kPa)	128	OCR	n/a	w (%)	20.15
γ_c (%)	0.0034	H_c (mm)	19.710	G_s	2.70

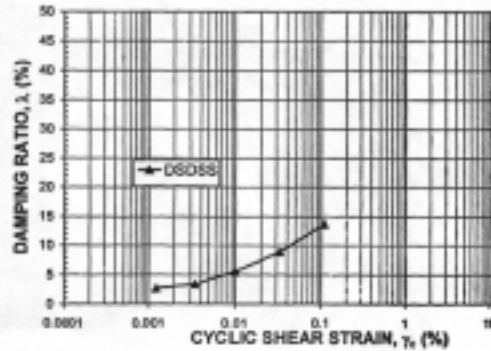
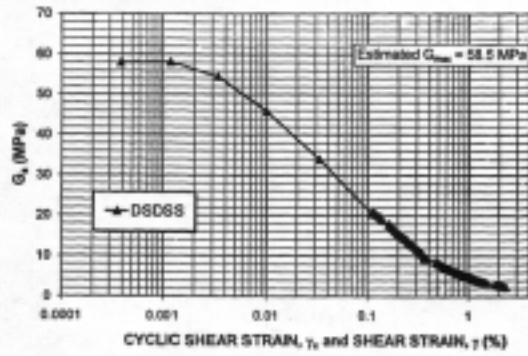
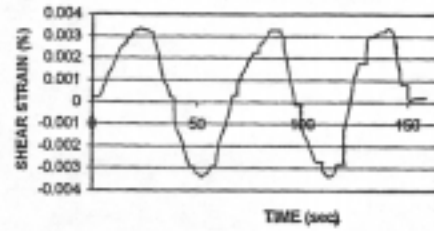
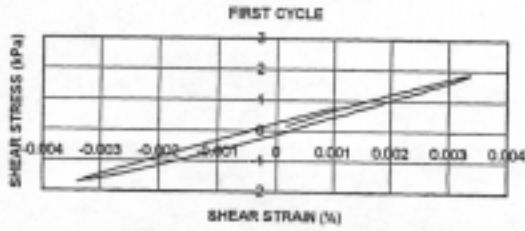


Figure 1: Results of typical cyclic simple shear tests obtained at UCLA Soil Dynamics Laboratory

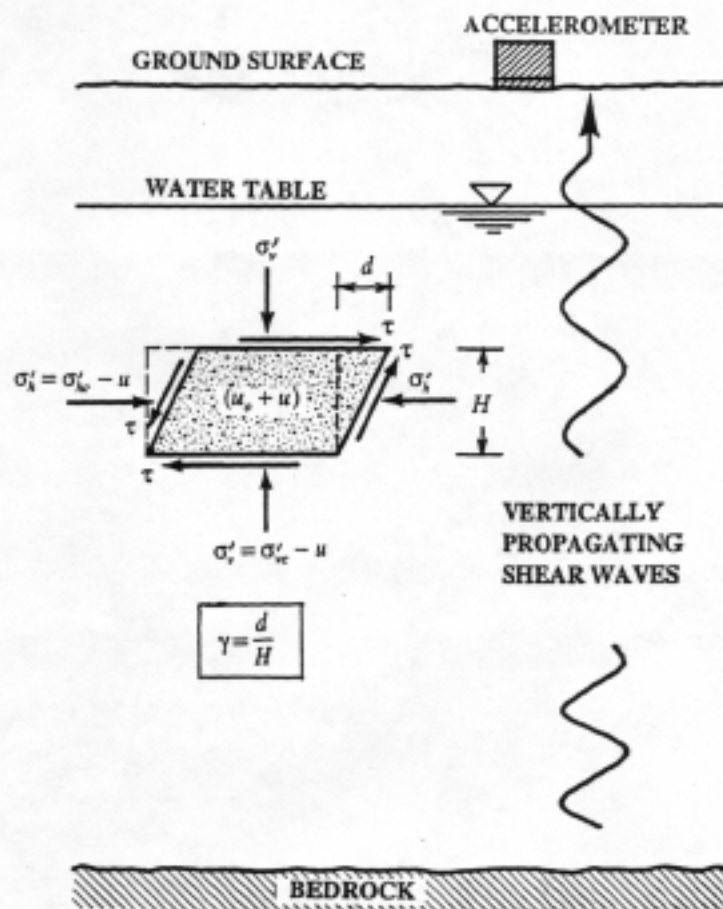


Figure 2: Application of simple shear test conditions to nonlinear site response analyses