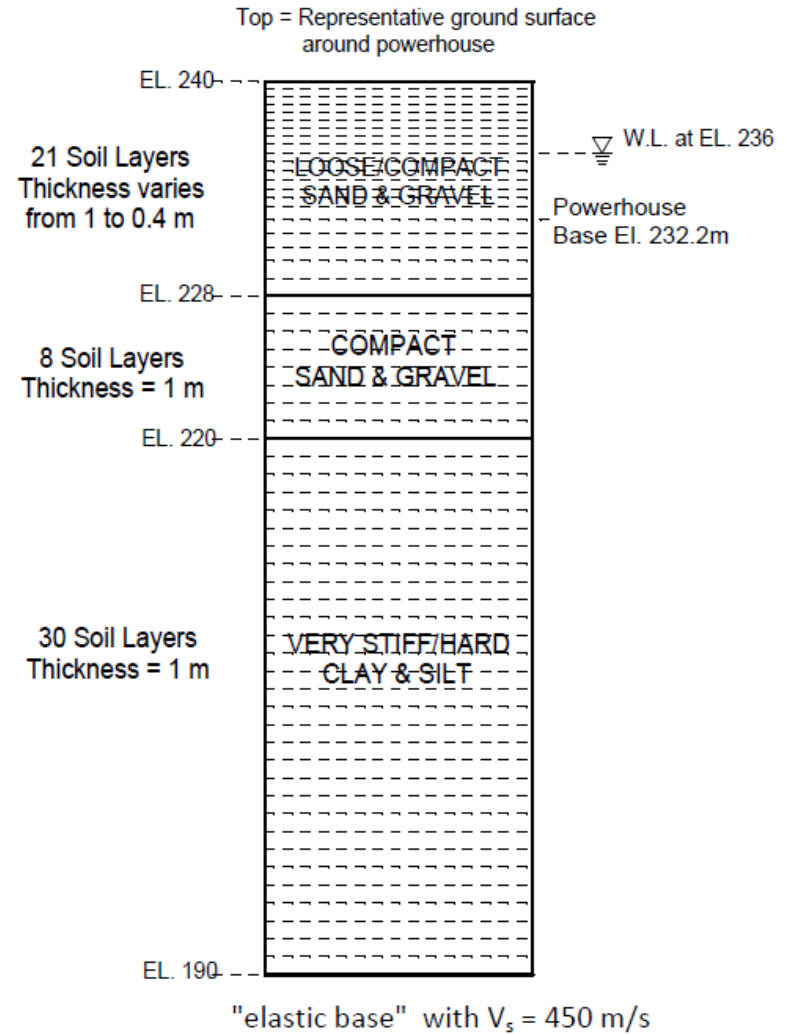


- 2.4 Example 2 – prepared in March 2018
Comparison between SHAKE and VERSAT
1D at low-moderate level of earthquake
shaking: 1D soil column - MODEL

1D Soil Column Model



- 2.4 Example 2: Comparison between SHAKE and VERSAT-1D at low-moderate level of earthquake shaking: **7 input crustal ground motions**

Table 2.1 Meta Data of the Seven Crustal Earthquake Records

No.	Short Name	NGA Record Number	Earthquake Name	Year	Station Name	Magnitude	Mechanism	Rjb (km)	Rrup (km)	Vs30 (m/sec)
1	FTR	63	"San Fernando"	1971	"Fairmont Dam"	6.6	Reverse	26	30	634
2	CPE	164	"Imperial Valley-06"	1979	"Cerro Prieto"	6.5	strike slip	15	15	472
3	SCN	369	"Coalinga-01"	1983	"Slack Canyon"	6.4	Reverse	26	27	648
4	SJR	472	"Morgan Hill"	1984	"San Justo Dam (R Abut)"	6.2	strike slip	32	32	544
5	G06	769	"Loma Prieta"	1989	"Gilroy Array #6"	6.9	Reverse Oblique	18	18	663
6	CHL	989	"Northridge-01"	1994	"LA - Chalon Rd"	6.7	Reverse	10	20	740
7	LV3	1029	"Northridge-01"	1994	"Leona Valley #3"	6.7	Reverse	37	37	499

Set	Dir	N points	dt [sec]	Max.Accel. [g]	Max. Vel. [m/s]	Max. Disp. [m]	Arias Int. [m/s]	Duration 5%-95%[sec]
7 Crustal EQ Records - Horizontal (X) and Vertical (Z)								
1	X	6112	0.01	0.202	0.167	0.038	0.342	17.86
2	X	6382	0.01	0.131	0.082	0.041	0.562	33.7
3	X	5999	0.01	0.139	0.147	0.026	0.175	13.51
4	X	5673	0.005	0.125	0.131	0.071	0.408	21.98
5	X	7998	0.005	0.136	0.126	0.05	0.261	13.23
6	X	3107	0.01	0.106	0.087	0.017	0.183	9.08
7	X	1600	0.02	0.145	0.163	0.04	0.316	12.54

- 2.4 Example 2: Comparison between SHAKE and VERSAT-1D at low-moderate level of earthquake shaking: **soil profiles and parameters**

Table 2.2 Soil Unit Weights and Shear Wave Velocities for SHAKE and VERSAT-1D

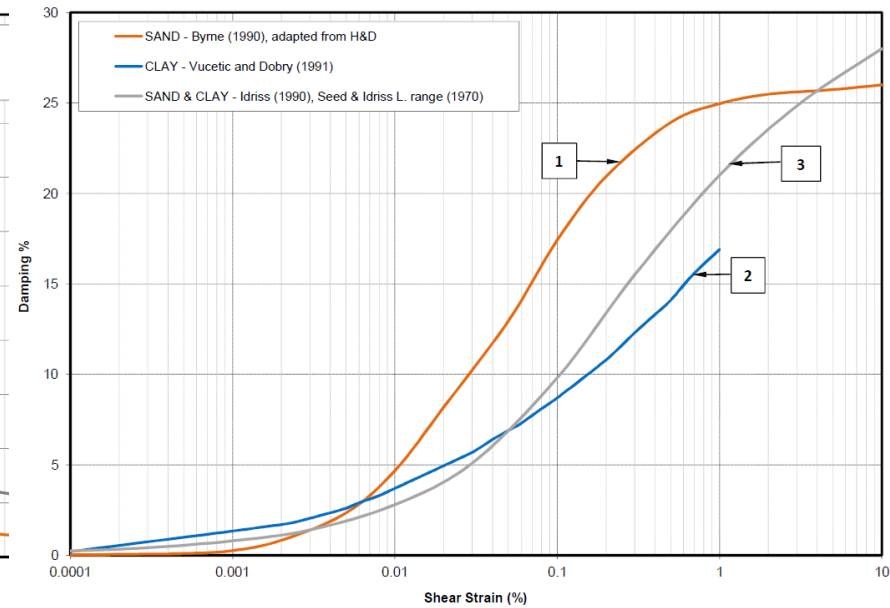
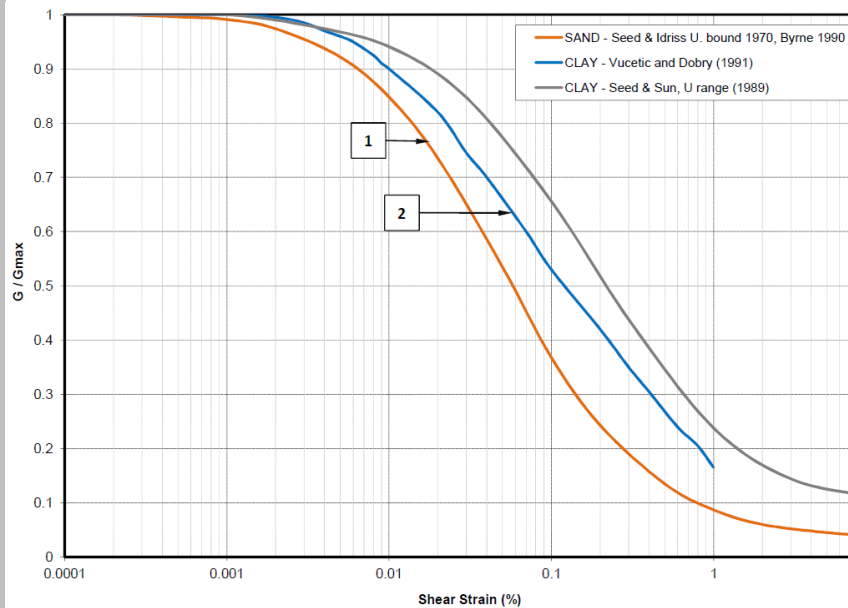
No.	Soil Layer Description	Unit Weight (kN/m ³)	Shear Wave Velocity, V_s (m/s)
1a	Wet Loose to Compact Sand and Gravel (above water level)	19.5 (a.wt)	160
1b	Saturated Loose to Compact Sand and Gravel (below water level)	21.2 (b. wt)	300
3	Compact Gravel to Gravel	21.2	400
4	Very Stiff to Hard Clay and Silt	20.4	360
5	Very Dense/Hard Silt and Sand	21.7 ("elastic base" input)	450

Table 2.3 Soil Stiffness and Strength Parameters for VERSAT-1D (*viscous damping 0.5% for mass & stiffness*)

Layer	VERSAT-1D Soil Zone #	Soil Layer Description	G_{max} (kPa)	K_G	c (kPa)	ϕ (°)	R_f
1a	M1	Wet Loose to Compact Sand and Gravel (a.wt)	50887	502	0	3	1500
1b	M2	Saturated Layer 1a (b.wt)	194495	1920	0	35	1500
3	M3	Compact Gravel to Gravel	345770	3413	0	35	1500
4	M4	Very Stiff to Hard Clay and Silt	269505	2660	30	25	750
Elastic base		Very Dense/Hard Silt and Sand	Elastic base, $V_s = 450$ m/s				

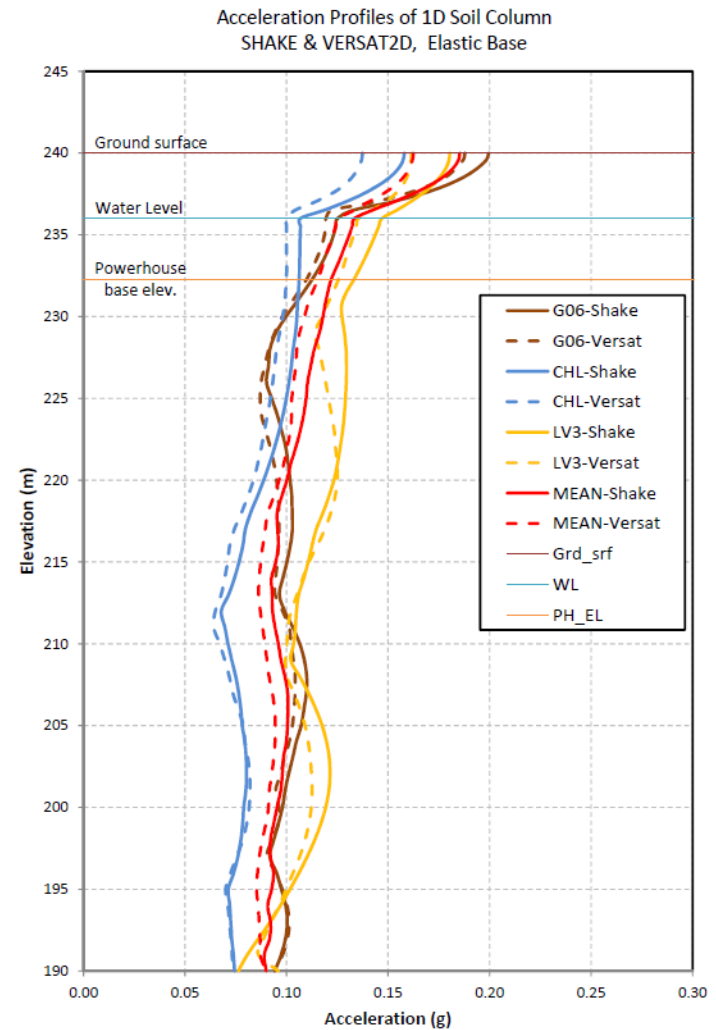
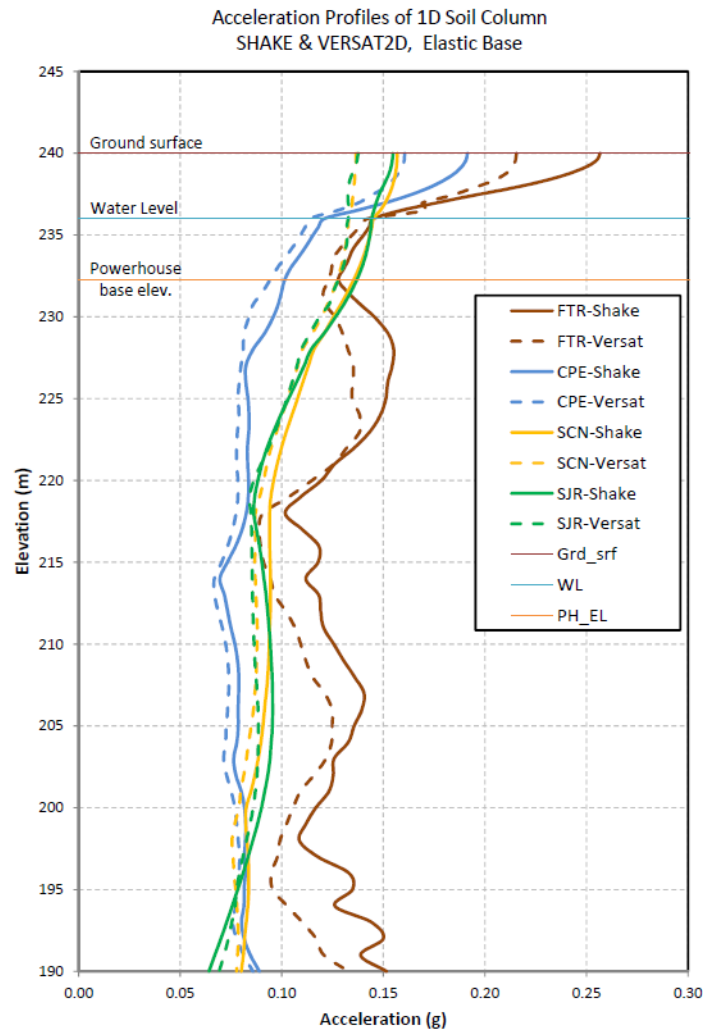
- 2.4 Example 2: Comparison between SHAKE and VERSAT-1D at low-moderate level of earthquake shaking:

G/G_{max} , and damping curves used in SHAKE analyses



2.4 Example 2 Comparison between SHAKE and VERSAT-1D:

RESULTS - at low-moderate level of earthquake shaking, *SHAKE equivalent linear approximation is able to produce very good representation of true soil nonlinear hysteresis behavior*



Dynamic effective stress analysis using the finite element approach by Dr. G. Wu

2. Non-Linear

• 2.4 Example 2 Comparison between SHAKE and VERSAT-1D:

RESULTS - at low-moderate level of earthquake shaking, *SHAKE equivalent linear approximation is able to produce very good representation of true soil nonlinear hysteresis behavior*

