

Table 5.1 - Number of Penetration Tests in Loose Samples

Loose Static	Stress Conditions					
	Low		Intermediate		High	
Cone Type	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$
10-cm <sup>2</sup>	1	1	5	1	2	2
15-cm <sup>2</sup>	5	2	0	5*	0	4**

$D_{cc}/d_{cp}$  = Chamber to cone ratio

\* 3 Tests with Impact Mass Vibrator Included

\*\* 2 Tests with Impact Mass Vibrator Included

Total = 28 Tests

Loose Vibratory	Stress Conditions					
	Low		Intermediate		High	
Cone Type	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$
10-cm <sup>2</sup>	4	1	6	1	3	1
15-cm <sup>2</sup>	5	2	0	4	0	2

Total = 29 Tests

Total Loose = 57 Tests

Table 5.2 - Number of Penetration Tests in Medium Dense Samples

Medium Dense Static	Stress Conditions					
	Low		Intermediate		High	
	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$
10-cm <sup>2</sup>	5	1	2	1	3	1
15-cm <sup>2</sup>	8	1	0	0	0	0

$D_{cc}/d_{cp}$  = Chamber to cone ratio

Total = 22 Tests

Medium Dense Vibratory	Stress Conditions					
	Low		Intermediate		High	
	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$
10-cm <sup>2</sup>	7	2	1	1	3	1
15-cm <sup>2</sup>	0	0	0	0	0	0

$D_{cc}/d_{cp}$  = Chamber to cone ratio

Total = 15 Tests

Total Medium Dense = 37 Tests

Total Number of Tests = 94  
(Loose and Medium Dense)

Table 5.3 - Number of Combined Penetration Tests in Loose and Medium Dense Samples

Loose Combined	Stress Conditions					
	Low		Intermediate		High	
	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$
10-cm <sup>2</sup>	0	0	0	1	0	0
15-cm <sup>2</sup>	0	1	0	0	0	0

$D_{cc}/d_{cp}$  = Chamber to cone ratio

Total = 2 Tests

Medium Dense Combined	Stress Conditions					
	Low		Intermediate		High	
	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$
10-cm <sup>2</sup>	2	1	0	0	0	0
15-cm <sup>2</sup>	0	0	0	0	0	0

$D_{cc}/d_{cp}$  = Chamber to cone ratio

Total = 3 Tests

Total Number of Tests = 5

Table 5.4 - Number of Dummy Cone Tests in Loose Samples

Loose Dummy Cone Tests Static	Low Stress Conditions	
	Cone Location	
	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$
Cone Type		
10-cm <sup>2</sup>	0	0
15-cm <sup>2</sup>	3	0

$D_{cc}/d_{cp}$  = Chamber to cone ratio

Total = 3 Tests

Loose Dummy Cone Tests Vibratory	Low Stress Conditions	
	Cone Location	
	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$
Cone Type		
10-cm <sup>2</sup>	0	0
15-cm <sup>2</sup>	3	0

$D_{cc}/d_{cp}$  = Chamber to cone ratio

Note: 15-cm<sup>2</sup> Cone Located at High  $D_{cc}/d_{cp}$ , Penetration at Low  $D_{cc}/d_{cp}$

Total = 3 Tests

Total Number of Tests = 6

Total Number of Tests = 105  
(All Tests)

Table 5.5 - Number of Penetration Tests Using Counter Rotating Mass Vibrator

Cone Type	Stress Conditions					
	Low		Intermediate		High	
	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$
Loose	0	0	6*	1*	0	0
Medium Dense	0	0	6*	0*	0	0

$D_{cc}/d_{cp}$  = Chamber to cone ratio

\* Tests Were Run With Vibration Frequencies Between 15 and 55 Hz

Total = 13 Tests

Table 5.6 - Static Penetration Test Results in Loose Samples

Static Penetration Tests									
20<Dr%<30									
Test	Cone Type	Dry/Sat	$\sigma'_v$ (kPa)	$\sigma'_h$ (kPa)	$u_b$ (kPa)	$q_c$ (kPa)	$\Delta u$ (kPa)	$f_s$ (kPa)	$D_r$ (%)
12/16/99	10	Sat	55	27	6.8	1864	1.06	0.74	21.9
11/18/99	10	Sat	35	17.5	6.8	1198	0.68	1.52	29.1
10/04/99	10	Sat	51	25	6.8	1705	1.46	0.48	26.4
09/29/99	10	Sat	6.8	3.4	6.8	231	0.02	0.29	21.1
08/15/99	10	Sat	110	55	6.8	3415	1.13	2.50	25.3
08/10/99	10	Sat	110	55	6.8	3385	1.24	0.64	23.3
06/29/99	15	Sat	6.8	3.4	6.8	242	0.34	2.30	21.5
06/24/99	15	Sat	6.8	3.4	6.8	235	0.31	1.75	23.5
06/22/99	15	Sat	6.8	3.4	6.8	215	0.01	1.45	26.1
06/16/99	15	Sat	6.8	3.4	6.8	242	0.42	2.51	21.4
06/03/99	15	Dry	55	27	0	1820	0.00	1.82	24.8
06/02/99	15	Dry	55	27	0	1780	0.00	1.96	25.6
05/26/99	15	Sat	48	21	65	1580	-1.98	NA	25.2
05/18/99	15	Sat	110	55	125	3511	2.82	20.24	25.2
05/12/99	15	Sat	56	28	61	1719	2.39	5.90	21.3
04/22/99	15	Sat	55	27	63	1771	0.51	20.69	24.8
03/26/99**	15	Sat	99	43	136	3050	0.91	15.23	20.1
02/26/99**	15	Sat	81	54	37	2401	-0.64	10.88	20.6
02/22/99**	15	Sat	46	18	72	1382	1.89	2.53	21.7
02/05/99**	15	Sat	52	24	65	1578	-4.88	6.05	22.6
01/22/99**	15	Sat	59	32	57	1937	2.08	7.31	24.8
12/17/98	15	Sat	53	25	64	1846	-3.34	9.47	23.5
11/12/98	15	Dry	55	26	0	1719	0.00	4.24	24.9
10/01/98	15	Dry	103	52	0	3138	0.00	3.16	22.3
03/14/98	15	Dry	101	51	0	3195	0.00	30.50	24.3
02/25/98	15	Sat	101	51	7	3409	NA	25.45	25.9
11/25/97	15	Sat	202	102	7	6430	NA	32.48	26.4

\*\* Vibratory tests performed with pneumatic impact vibrator

Note: Stress conditions are at sample center

Note:  $q_c$ ,  $\Delta u$ , and  $f_s$  values were obtained from penetration test data at sample center

NA = Not Available due to equipment problems

Table 5.7 - Static Penetration Test Results in Medium Dense Samples

Static Penetration Tests									
50<Dr%<60									
Test	Cone	Dry/Sat	$\sigma_v'$ (kPa)	$\sigma_h'$ (kPa)	$u_b$ (kPa)	$q_c$ (kPa)	$\Delta u$ (kPa)	$f_s$ (kPa)	$D_r$ (%)
11/09/99*	10	Sat	35	17.5	6.8	1480	0.04	8.11	51.5
10/29/99*	10	Sat	33	15.5	6.8	1466	-0.01	0.05	56.4
10/15/99*	10	Sat	110	55	6.8	5057	-1.46	35.14	58.2
09/16/99	10	Sat	6.8	3.4	6.8	262	NA	0.42	55.1
08/23/99*	10	Sat	55	27	6.8	2522	0.96	0.48	56.3
07/22/99	10	Sat	6.8	3.4	6.8	255	1.01	0.66	53.4
07/19/99	10	Sat	6.8	3.4	6.8	295	0.44	0.66	51.0
07/13/99	15	Sat	6.8	3.4	6.8	265	0.04	0.85	51.2
07/09/99	15	Sat	6.8	3.4	6.8	313	0.76	33.01	57.4

\* Data Noted is from High  $D_{cc}/d_{cp}$  location

Note: NA = Not Available due to equipment problems

Note: Stress Conditions and  $q_c$  measurements are at Sample Center

Note:  $q_c$  value was obtained from actual penetration test data

Table 5.8 - Vibratory Penetration Tests in Loose Samples

Vibratory Penetration Tests									
20<Dr%<30									
Rotary Turbine Vibrator									
Test	Cone	Dry/Sat	$\sigma_v'$ (kPa)	$\sigma_h'$ (kPa)	$u_b$ (kPa)	$q_c$ (kPa)	$\Delta u$ (kPa)	$f_s$ (kPa)	$D_r$ (%)
12/16/99	10	Sat	55	27	6.8	1361	0.65	0	21.9
11/18/99	10	Sat	35	17.5	6.8	782	1.03	11.26	29.1
10/04/99	10	Sat	51	28	6.8	1446	2.43	8.93	26.4
09/29/99	10	Sat	6.8	3.4	6.8	71	1.26	0	21.1
08/15/99	10	Sat	110	55	6.8	3530	0.58	12.2	25.3
08/10/99	10	Sat	110	55	6.8	3499	0.74	3.12	23.3
06/29/99	15	Sat	6.8	3.4	6.8	81	1.02	2.64	21.5
06/24/99	15	Sat	6.8	3.4	6.8	88	0.76	1.54	23.5
06/22/99	15	Sat	6.8	3.4	6.8	92	1.2	0.46	26.1
06/16/99	15	Sat	6.8	3.4	6.8	82	0.75	1.08	21.4
06/12/99	15	Sat	110	55	135	3416	-0.23	4.89	21.6
06/09/99	15	Sat	44	21	68	1128	-0.16	6.7	25.5
06/07/99*	15	Sat	55	27	63	1718	0.31	14.26	22.6
05/26/99*	15	Sat	48	21	69	1510	-1.96	NA	25.2

\* Air Flow Rate Through Vibrator Was Too Low

Note: Stress conditions and test data are at sample center

Note:  $q_c$ ,  $\Delta u$ , and  $f_s$  values were obtained from average of the *representative* test data

NA = Not Available Due to Equipment Problems

Vibratory Penetration Tests									
20<Dr%<30									
Pneumatic Impact Vibrator									
Test	Cone	Dry/Sat	$\sigma_v'$ (kPa)	$\sigma_h'$ (kPa)	$u_b$ (kPa)	$q_c$ (kPa)	$\Delta u$ (kPa)	$f_s$ (kPa)	$D_r$ (%)
03/26/99	15	Sat	99	43	136	3050	0.91	15.23	20.1
02/26/99	15	Sat	81	54	37	2401	-0.638	10.88	20.6
02/22/99	15	Sat	46	18	72	1382	-1.89	2.53	21.7
02/05/99	15	Sat	52	24	65	1578	-4.88	6.05	22.6
01/22/99	15	Sat	59	32	57	1937	-2.08	7.31	24.8

Note: Stress conditions and test data are at sample center

Note:  $q_c$ ,  $\Delta u$ , and  $f_s$  values were obtained from average of the representative test data

Table 5.9 - Vibratory Penetration Tests in Medium Dense Samples

Static Penetration Tests			50<Dr%<60						
Rotary Turbine Vibrator									
Test	Cone	Dry/Sat	$\sigma'_v$ (kPa)	$\sigma'_h$ (kPa)	$u_b$ (kPa)	$q_c$ (kPa)	$\Delta u$ (kPa)	$f_s$ (kPa)	$D_r$ (%)
12/24/99*	10	Sat	55	32	6.8	1080	0.23	0.56	53.9
11/03/99*	10	Sat	110	55	6.8	4873	-1.77	34.85	56.3
09/16/99*	10	Sat	6.8	3.4	6.8	98	NA	NA	55.1
08/03/99*	10	Sat	55	27	6.8	2281	1.2	0.12	52.1
07/22/99*	10	Sat	6.8	3.4	6.8	114	1.99	0	53.4
07/19/99*	10	Sat	6.8	3.4	6.8	80.2	1.95	0	51.0

Note: NA = Not Available Due to Equipment Problems

Note: Stress Conditions and  $q_c$  Measurement Are at Sample Center

\* Data Noted is from High  $D_{cc}/d_{cp}$  Location

Table 5.10 - Statistical Parameters for Tests in Loose Samples

Loose Static		Stress Conditions					
		Low		Intermediate		High	
Statistical Parameters		Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$
10-cm <sup>2</sup>	$\sigma$	NA	NA	2.19	NA	1.49	0.46
	Mean	34.52	32.25	31.37	32.57	32.72	31.92
	RT	32.74	32.74	33.01	33.01	33.67	33.67
	n	1	1	5	1	2	2
15-cm <sup>2</sup>	$\sigma$	1.31	1.85	NA	2.92	NA	2.45
	Mean	31.92	29.69	NA	31.10	NA	32.01
	RT	32.74	32.74	33.01	33.01	33.67	33.67
	n	5	2	0	5	0	4

 $D_{cc}/d_{cp}$  = Chamber to cone ratioRT = Representative Trendline Value ( $q_{c(N)}$ )

NA = No Analysis Performed Due to Limited Test Data

 $\sigma$  = Standard Deviation

n = Sample Size

mean = mean ( $q_{c(N)}$ ) value

Loose Vibratory		Stress Conditions					
		Low		Intermediate		High	
Statistical Parameters		Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$
10-cm <sup>2</sup>	$\sigma$	1.62	NA	1.55	NA	2.06	NA
	Mean	12.22	12.05	24.64	25.35	31.89	32.23
	RT	12.38	12.38	25.57	25.57	31.70	31.70
	n	4	1	6	1	3	1
15-cm <sup>2</sup>	$\sigma$	1.07	1.18	NA	1.25	NA	1.51
	Mean	11.22	12.90	NA	26.86	NA	31.51
	RT	12.38	12.38	25.57	25.57	31.70	31.70
	n	5	2	0	4	0	2

Table 5.11 - Statistical Parameters for Tests in Medium Dense Samples

Medium Dense Static		Stress Conditions					
		Low		Intermediate		High	
Statistical Parameters		Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$
10-cm <sup>2</sup>	$\sigma$	2.07	NA	NA	NA	NA	NA
	Mean	40.35	41.78	32.76	43.29	30.88	40.93
	RT	40.5	40.5	42.85	42.85	43.0	43.0
	n	3	1	1	1	1	1
15-cm <sup>2</sup>	$\sigma$	1.59	NA	NA	NA	NA	NA
	Mean	62.41	42.23	NA	NA	NA	NA
	RT	40.5	40.5	NA	NA	NA	NA
	n	2	1	0	0	0	0

 $D_{cc}/d_{cp}$  = Chamber to cone ratioRT = Representative Trendline Value ( $q_{c(N)}$ )

NA = No Analysis Performed Due to Limited Test Data

 $\sigma$  = Standard Deviation

n = Sample Size

mean = mean ( $q_{c(N)}$ ) value

Medium Dense Vibratory		Stress Conditions					
		Low		Intermediate		High	
Statistical Parameters		Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$	Low $D_{cc}/d_{cp}$	High $D_{cc}/d_{cp}$
10-cm <sup>2</sup>	$\sigma$	0.81	0.84	NA	NA	NA	NA
	Mean	14.36	15.96	30.57	39.27	29.92	42.26
	RT	14.71	14.71	40.31	40.31	43.0	43.0
	n	2	2	1	1	1	1
15-cm <sup>2</sup>	$\sigma$	NA	NA	NA	NA	NA	NA
	Mean	NA	NA	NA	NA	NA	NA
	RT	NA	NA	NA	NA	NA	NA
	n	0	0	0	0	0	0

Table 5.12 - Regression Curve Parameters - Normalized Penetration Resistance

Loose - Static	Stress Conditions		
Quadratic Curve Parameters	Low	Intermediate	High
$y_0$	74.896	32.1362	22.208
a	8.892e-1	-8.3837e-3	-1.451e-1
b	4.362e-3	4.3934e-5	-1.0401e-4

$$q_c/\sigma_v' = y_0 + ax + bx^2$$

Loose - Vibratory	Stress Conditions		
Quadratic Curve Parameters	Low	Intermediate	High
$y_0$	23.750	24.1070	23.3698
a	2.845e-1	8.190e-2	-1.1483e-1
b	1.772e-3	1.3529e-3	-4.8905e-5

Medium Dense Static	Stress Conditions		
Quadratic Curve Parameters	Low	Intermediate	High
$y_0$	62.855	45.5317	22.8723
a	5.9856e-1	1.5835e-1	-4.7320e-1
b	3.918e-3	1.6351e-3	-2.7154e-3

Medium Dense Vibratory	Stress Conditions		
Quadratic Curve Parameters	Low	Intermediate	High
$y_0$	53.0908	52.6357	24.3080
a	9.800e-1	3.510e-1	-4.629e-1
b	6.2444e-3	2.4897e-3	-2.6715e-3

Table 5.13 - Regression Curve Parameters - Pore Pressure Ratio

Loose - Static	Stress Conditions		
Quadratic Curve Parameters	Low	Intermediate	High
$y_0$	0.1512	0.0507	0.0245
a	2.1437e-3	2.991e-4	5.4827e-4
b	8.987e-6	-1.2916e-6	2.1615e-6

$$\Delta u/\sigma'_v = y_0 + ax + bx^2$$

Loose - Vibratory	Stress Conditions		
Quadratic Curve Parameters	Low	Intermediate	High
$y_0$	0.4723	0.0574	0.0282
a	6.9261e-3	1.1842e-3	5.9541e-4
b	3.3518e-5	4.9809e-6	2.1548e-6

Medium Dense Static	Stress Conditions		
Quadratic Curve Parameters	Low	Intermediate	High
$y_0$	-0.0369	0.01528	-0.03454
a	-1.3044e-4	2.439e-4	1.6100e-4
b	1.2881e-6	2.5060e-7	2.5702e-6

Medium Dense Vibratory	Stress Conditions		
Quadratic Curve Parameters	Low	Intermediate	High
$y_0$	0.6171	-3.8992e-3	-5.3396e-3
a	5.4383e-3	-5.8704e-4	3.7999e-4
b	1.2385e-5	-3.9004e-6	2.8211e-6

Table 5.14 Comparison of Measured Penetration Resistance in Loose Samples to that Obtained from Cavity Expansion Theory

Static Penetration Tests			20<Dr%<30			q <sub>c</sub> (kPa)	Cylinder Free Field		Cylinder Calibration Chamber		CF=1-q <sub>c10</sub> /q <sub>c15</sub> (CONPOINT) (%)	AR=1-q <sub>c(cav)</sub> /q <sub>c(meas)</sub> (%)	
Test	Cone	Dry/Sat	σ <sub>v</sub> ' (kPa)	σ <sub>h</sub> ' (kPa)	u <sub>b</sub> (kPa)		q <sub>c</sub> (CONPOINT)		q <sub>c</sub> (CONPOINT)			15cm <sup>2</sup>	10cm <sup>2</sup>
							15cm <sup>2</sup>	10cm <sup>2</sup>	15cm <sup>2</sup>	10cm <sup>2</sup>			
12/16/99	10	Sat	55	27	6.8	1864	2660	2660	1630	1803	-10.61	NA	3.27
10/04/99	10	Sat	55	28	6.8	1705	3487	3487	1630	1803	-10.61	NA	-5.75
09/29/99	10	Sat	6.8	3.4	6.8	231	691	691	263	297	-12.93	NA	-28.57
08/15/99	10	Sat	110	55	6.8	3415	4162	4162	2868	3120	-8.79	NA	8.64
08/10/99	10	Sat	110	55	6.8	3385	4162	4162	2868	3120	-8.79	NA	7.83
06/29/99	15	Sat	6.8	3.4	6.8	242	691	691	263	297	-12.93	-8.68	NA
06/24/99	15	Sat	6.8	3.4	6.8	235	691	691	263	297	-12.93	-11.91	NA
06/22/99	15	Sat	6.8	3.4	6.8	215	691	691	263	297	-12.93	-22.33	NA
06/16/99	15	Sat	6.8	3.4	6.8	242	691	691	263	297	-12.93	-8.68	NA
06/03/99	15	Dry	55	27	0	1820	2660	2660	1630	1803	-10.61	10.44	NA
06/02/99	15	Dry	55	27	0	1780	2660	2660	1630	1803	-10.61	8.43	NA
05/26/99	15	Sat	48	21	65	1580	2225	2225	1276	1482	-16.14	19.24	NA
05/18/99	15	Sat	110	55	125	3511	4162	4162	2868	3120	-8.79	18.31	NA
05/12/99	15	Sat	56	28	61	1719	2660	2660	1630	1803	-10.61	5.18	NA
04/22/99	15	Sat	55	27	63	1771	2544	2544	1531	1697	-10.84	13.55	NA

Table 5.14 (Cont.)

Static Penetration Tests			20<Dr%<30			q <sub>c</sub> (kPa)	Cylinder Free Field		Cylinder Calibration Chamber		CF=1-q <sub>c10</sub> /q <sub>c15</sub> (CONPOINT) (%)	AR=1-q <sub>c(cav)</sub> /q <sub>c(meas)</sub> (%)	
Test	Cone	Dry/Sat	σ <sub>v</sub> ' (kPa)	σ <sub>h</sub> ' (kPa)	u <sub>b</sub> (kPa)		q <sub>c</sub> (CONPOINT)		q <sub>c</sub> (CONPOINT)			15cm <sup>2</sup>	10cm <sup>2</sup>
							15cm <sup>2</sup>	10cm <sup>2</sup>	15cm <sup>2</sup>	10cm <sup>2</sup>			
03/26/1999*	15	Sat	99	43	136	3050	3556	3556	2343	2568	-9.60	23.18	NA
02/26/1999*	15	Sat	81	54	37	2401	4046	4046	2814	3055	-8.56	-17.20	NA
02/22/1999*	15	Sat	46	18	72	1382	2029	2029	1118	1250	-11.81	19.10	NA
02/05/1999*	15	Sat	52	24	65	1578	2420	2420	1431	1588	-10.97	9.32	NA
01/22/1999*	15	Sat	59	32	57	1937	2882	2882	1823	2011	-10.31	5.89	NA
12/17/98	15	Sat	53	25	64	1846	2477	2477	1481	1643	-10.94	19.77	NA
11/12/98	15	Dry	55	26	0	1719	2544	2544	1531	1697	-10.84	10.94	NA
10/01/98	15	Dry	103	52	0	3138	4013	4013	2739	2983	-8.91	12.72	NA
03/14/98	15	Dry	101	51	0	3195	3958	3958	2695	2936	-8.94	15.65	NA
02/25/98	15	Sat	101	51	7	3409	3958	3958	2695	2936	-8.94	20.94	NA
11/25/97	15	Sat	202	102	7	5430	6278	6278	4731	5062	-7.00	12.87	NA

Note: Stress conditions and q<sub>c</sub> measurement are at sample center

Note: q<sub>c</sub> value was obtained from actual penetration test data

\*Note: Vibratory tests performed with pneumatic impact vibrator, therefore included with static test results

CF = Cone Factor

AR = Agreement Relationship

NA: Not Available Due to Absence of Test Data for a Particular Cone

Table 5.15 Comparison of Measured Penetration Resistance in Medium Dense Samples to that Obtained from Cavity Expansion Theory

Static Penetration Tests			50<Dr%<60			q <sub>c</sub> (kPa)	Cylinder Free Field q <sub>c</sub> (CONPOINT)		Cylinder Calibration Chamber q <sub>c</sub> (CONPOINT)		CF=1-q <sub>c10</sub> /q <sub>c15</sub> (CONPOINT) (%)	AR=1-q <sub>c(cav)</sub> /q <sub>c(meas)</sub> (%)	
Test	Cone	Dry/Sat	σ <sub>v</sub> ' (kPa)	σ <sub>h</sub> ' (kPa)	u <sub>b</sub> (kPa)		15cm <sup>2</sup>	10cm <sup>2</sup>	15cm <sup>2</sup>	10cm <sup>2</sup>		15cm <sup>2</sup>	10cm <sup>2</sup>
11/03/99	10	Sat	110	55	6.8		5167	9866	9866	5105	5660	-10.87	NA
09/16/99	10	Sat	6.8	3.4	6.8	335	2872	2872	682	752	-10.26	NA	-124.478
08/03/99	10	Sat	55	27	6.8	2680	7138	7138	3012	3375	-12.05	NA	-25.933
07/22/99	10	Sat	6.8	3.4	6.8	315	2872	2872	682	752	-10.26	NA	-138.730
07/19/99	10	Sat	6.8	3.4	6.8	345	2872	2872	682	752	-10.26	NA	-117.971
07/13/99	15	Sat	6.8	3.4	6.8	355	2872	2872	682	752	-10.26	-92.113	NA
07/09/99	15	Sat	6.8	3.4	6.8	362	2872	2872	682	752	-10.26	-88.398	NA

Note: NA = Not Available Due to Equipment Problems

Note: Stress Conditions and q<sub>c</sub> Measurement Are at Sample Center

Note: q<sub>c</sub> value was obtained from actual penetration test data

CF = Cone Factor

AR = Agreement Relationship

NA: Not Available Due to Absence of Test Data for a Particular Cone

Table 5.16 ANOVA and Regression Analysis Using a Type III General Linear Model

## A. Loose

Source	DF	Type III SS	Mean Square	F Value	Pr > F
STRESS	2	395.98	197.99	90.52	0.00
VIBRATE	1	629.42	629.42	287.75	0.00
STRESS*VIBRATE	2	357.72	178.86	81.77	0.00
TYPE	1	1.22	1.22	0.56	0.47
STRESS*TYPE	2	3.03	1.51	0.69	0.52
VIBRATE*TYPE	1	0.91	0.91	0.42	0.53
STRESS*VIBRATE*TYP	2	7.83	3.91	1.79	0.21
CENTER	1	0.21	0.21	0.10	0.76
STRESS*CENTER	2	1.29	0.65	0.29	0.75
VIBRATE*CENTER	1	2.73	2.73	1.25	0.28
STRESS*VIBRATE*CENTER	2	1.84	0.92	0.42	0.66
TYPE*CENTER	1	1.24	1.24	0.57	0.46
STRESS*TYPE*CENTER	0	0	.	.	.
VIBRATE*TYPE*CENTER	1	7.13	7.13	3.26	0.09
STRE*VIBR*TYPE*CENTER	0	0	.	.	.

## B. Medium Dense

Source	DF	Type III SS	Mean Square	F Value	Pr > F
STRESS	2	243.951	121.975	48.72	0.0005
VIBRATE	1	321.7056	321.7	128.5	0.0001
STRESS*VIBRATE	2	557.154	278.577	111.27	0.0001
TYPE	1	178.65	178.65	71.36	0.0004
STRESS*TYPE	0	0	.	.	.
VIBRATE*TYPE	0	0	.	.	.
STRESS*VIBRATE*TYPE	0	0	.	.	.
CENTER	1	0.5529	0.5529	0.22	0.6582
STRESS*CENTER	2	74.1735	37.086	14.81	0.0079
VIBRATE*CENTER	1	0.0404	0.0404	0.02	0.9038
STRESS*VIBRATE*CENTER	2	2.122	1.0611	0.42	0.006
TYPE*CENTER	1	164.642	164.642	65.76	0.0005
STRESS*TYPE*CENTER	0	0	.	.	.
VIBRATE*TYPE*CENTER	0	0	.	.	.
STRE*VIBR*TYPE*CENTE	0	0	0	.	.

Table 5.17a - Statistical Analysis of Penetration Test Data - Loose

Data Analysis for Soil Liquefaction  
General Linear Models Procedure

STRESS	VI BRATE	N	Mean	SD
h	n	6	32. 2183333	0. 84601221
h	v	4	31. 7875000	0. 93510695
l	n	7	31. 7028571	1. 9742485
l	v	7	11. 9642857	1. 09267039
m	n	5	31. 5000000	1. 87056141
m	v	4	25. 3725000	1. 09399497

  

STRESS	TYPE	N	Mean	SD
h	10	6	32. 2333333	0. 8051501
h	15	4	31. 7650000	0. 9797449
l	10	4	22. 7600000	12. 3038395
l	15	10	21. 4630000	10. 1938381
m	10	6	28. 3233333	3. 8188096
m	15	3	29. 6833333	3. 4933413

  

STRESS	CENTER	N	Mean	SD
h	c	7	31. 8742857	0. 7380799
h	o	3	32. 4466667	1. 1599282
l	c	6	21. 9600000	10. 4334098
l	o	8	21. 7387500	11. 0177823
m	c	5	29. 3940000	3. 5741754
m	o	4	28. 0050000	3. 9002692

  

VI BRATE	TYPE	N	Mean	SD
n	10	9	32. 3733333	1. 10789214
n	15	9	31. 2633333	1. 84244403
v	10	7	23. 2885714	8. 27605870
v	15	8	18. 6712500	9. 53066845

  

VI BRATE	CENTER	N	Mean	SD
n	c	10	31. 6520000	1. 95061700
n	o	8	32. 0262500	1. 04567050
v	c	8	23. 1662500	9. 08521395
v	o	7	18. 1514286	8. 70548185

  

TYPE	CENTER	N	Mean	SD
10	c	7	28. 6500000	7. 8594041
10	o	9	28. 2033333	6. 8405464
15	c	11	27. 3909091	7. 4475787
15	o	6	21. 5733333	11. 3884462

Table 5.17a (Cont.)

STRESS	VI BRATE	TYPE	N	Mean	SD
h	n	10	4	32.3200000	1.01544736
h	n	15	2	32.0150000	0.60104076
h	v	10	2	32.0600000	0.24041631
h	v	15	2	31.5150000	1.50613744
l	n	10	2	33.3850000	1.60513239
l	n	15	5	31.0300000	1.79489554
l	v	10	2	12.1350000	0.12020815
l	v	15	5	11.8960000	1.32924038
m	n	10	3	31.7700000	0.70682388
m	n	15	2	31.0950000	3.52846284
m	v	10	3	24.8766667	0.56580326
m	v	15	1	26.8600000	.

STRESS	VI BRATE	CENTER	N	Mean	SD
h	n	c	4	31.9650000	0.44064347
h	n	o	2	32.7250000	1.49199531
h	v	c	3	31.7533333	1.14220547
h	v	o	1	31.8900000	.
l	n	c	3	31.3000000	3.08097387
l	n	o	4	32.0050000	1.08767336
l	v	c	3	12.6200000	0.97000000
l	v	o	4	11.4725000	1.00407088
m	n	c	3	31.5866667	2.63632952
m	n	o	2	31.3700000	0.19798990
m	v	c	2	26.1050000	1.06773124
m	v	o	2	24.6400000	0.55154329

VI BRATE	TYPE	CENTER	N	Mean	SD
n	10	c	4	32.7300000	1.2608727
n	10	o	5	32.0880000	1.0166219
n	15	c	6	30.9333333	2.0845879
n	15	o	3	31.9233333	1.3170168
v	10	c	3	23.2100000	10.2587914
v	10	o	4	23.3475000	8.1739602
v	15	c	5	23.1400000	9.5824449
v	15	o	3	11.2233333	1.0675829

Table 5.17a (Cont.)

STRESS	VI BRATE	TYPE	CENTER	N	Mean	SD
h	n	10	c	2	31.9150000	0.45961941
h	n	10	o	2	32.7250000	1.49199531
h	n	15	c	2	32.0150000	0.60104076
h	v	10	c	1	32.2300000	.
h	v	10	o	1	31.8900000	.
h	v	15	c	2	31.5150000	1.50613744
l	n	10	c	1	34.5200000	.
l	n	10	o	1	32.2500000	.
l	n	15	c	2	29.6900000	1.85261977
l	n	15	o	3	31.9233333	1.31701683
l	v	10	c	1	12.0500000	.
l	v	10	o	1	12.2200000	.
l	v	15	c	2	12.9050000	1.18086832
l	v	15	o	3	11.2233333	1.06758294
m	n	10	c	1	32.5700000	.
m	n	10	o	2	31.3700000	0.19798990
m	n	15	c	2	31.0950000	3.52846284
m	v	10	c	1	25.3500000	.
m	v	10	o	2	24.6400000	0.55154326
m	v	15	c	1	26.8600000	.

Table 5.17b Statistical Analysis of Penetration Test Data-Medium Dense

Data Analysis for Soil Liquefaction (Medium Dense)					
General Linear Models Procedure					
Level of STRESS	Level of VI BRATE	N	Mean	SD	
h	n	2	35.9050000	7.1064232	
h	v	2	36.0900000	8.7256977	
l	n	7	47.1271429	10.5519851	
l	v	4	15.1600000	1.1491156	
m	n	2	38.0250000	7.4458344	
m	v	2	34.9200000	6.1518290	
Level of STRESS	Level of TYPE	N	Mean	SD	
h	10	4	35.9975000	6.4980324	
l	10	8	27.9362500	13.7319158	
l	15	3	55.6800000	11.7022434	
m	10	4	36.4725000	5.8573736	
Level of STRESS	Level of CENTER	N	Mean	SD	
h	c	2	41.5950000	0.9404520	
h	o	2	30.4000000	0.6788225	
l	c	4	28.9850000	15.0431701	
l	o	7	39.2271429	19.6947977	
m	c	2	41.2800000	2.8425693	
m	o	2	31.6650000	1.5485639	
Level of VI BRATE	Level of TYPE	N	Mean	SD	
n	10	8	38.8387500	4.6083819	
n	15	3	55.6800000	11.7022434	
v	10	8	25.3325000	11.6321669	
Level of VI BRATE	Level of CENTER	N	Mean	SD	
n	c	4	42.0575000	0.9826961	
n	o	7	44.2171429	13.0805208	
v	c	4	28.3650000	14.3784341	
v	o	4	22.3000000	9.1899329	
Level of TYPE	Level of CENTER	N	Mean	SD	
10	c	7	34.2085714	12.5285267	
10	o	9	30.4344444	10.1711407	
15	c	1	42.2300000	.	
15	o	2	62.4050000	1.5909903	
Level of STRESS	Level of VI BRATE	Level of TYPE	N	Mean	SD
h	n	10	2	35.9050000	7.1064232
h	v	10	2	36.0900000	8.7256977
l	n	10	4	40.7125000	1.8381762
l	n	15	3	55.6800000	11.7022434
l	v	10	4	15.1600000	1.1491156
m	n	10	2	38.0250000	7.4458344
m	v	10	2	34.9200000	6.1518290

Table 5.17b (Cont.)

Level of STRESS	Level of VIBRATE	Level of CENTER	N	Mean	SD
h	n	c	1	40.9300000	.
h	n	o	1	30.8800000	.
h	v	c	1	42.2600000	.
h	v	o	1	29.9200000	.
l	n	c	2	42.0050000	0.3181981
l	n	o	5	49.1760000	12.1912194
l	v	c	2	15.9650000	0.8414571
l	v	o	2	14.3550000	0.8131728
m	n	c	1	43.2900000	.
m	n	o	1	32.7600000	.
m	v	c	1	39.2700000	.
m	v	o	1	30.5700000	.

  

Level of VIBRATE	Level of TYPE	Level of CENTER	N	Mean	SD
n	10	c	3	42.0000000	1.1952824
n	10	o	5	36.9420000	4.9455556
n	15	c	1	42.2300000	.
n	15	o	2	62.4050000	1.5909903
v	10	c	4	28.3650000	14.3784341
v	10	o	4	22.3000000	9.1899329

  

Level of STRESS	Level of VIBRATE	Level of TYPE	Level of CENTER	N	Mean	SD
h	n	10	c	1	40.9300000	.
h	n	10	o	1	30.8800000	.
h	v	10	c	1	42.2600000	.
h	v	10	o	1	29.9200000	.
l	n	10	c	1	41.7800000	.
l	n	10	o	3	40.3566667	2.07572477
l	n	15	c	1	42.2300000	.
l	n	15	o	2	62.4050000	1.59099026
l	v	10	c	2	15.9650000	0.84145707
l	v	10	o	2	14.3550000	0.81317280
m	n	10	c	1	43.2900000	.
m	n	10	o	1	32.7600000	.
m	v	10	c	1	39.2700000	.
m	v	10	o	1	30.5700000	.