社会開発調査部報告書

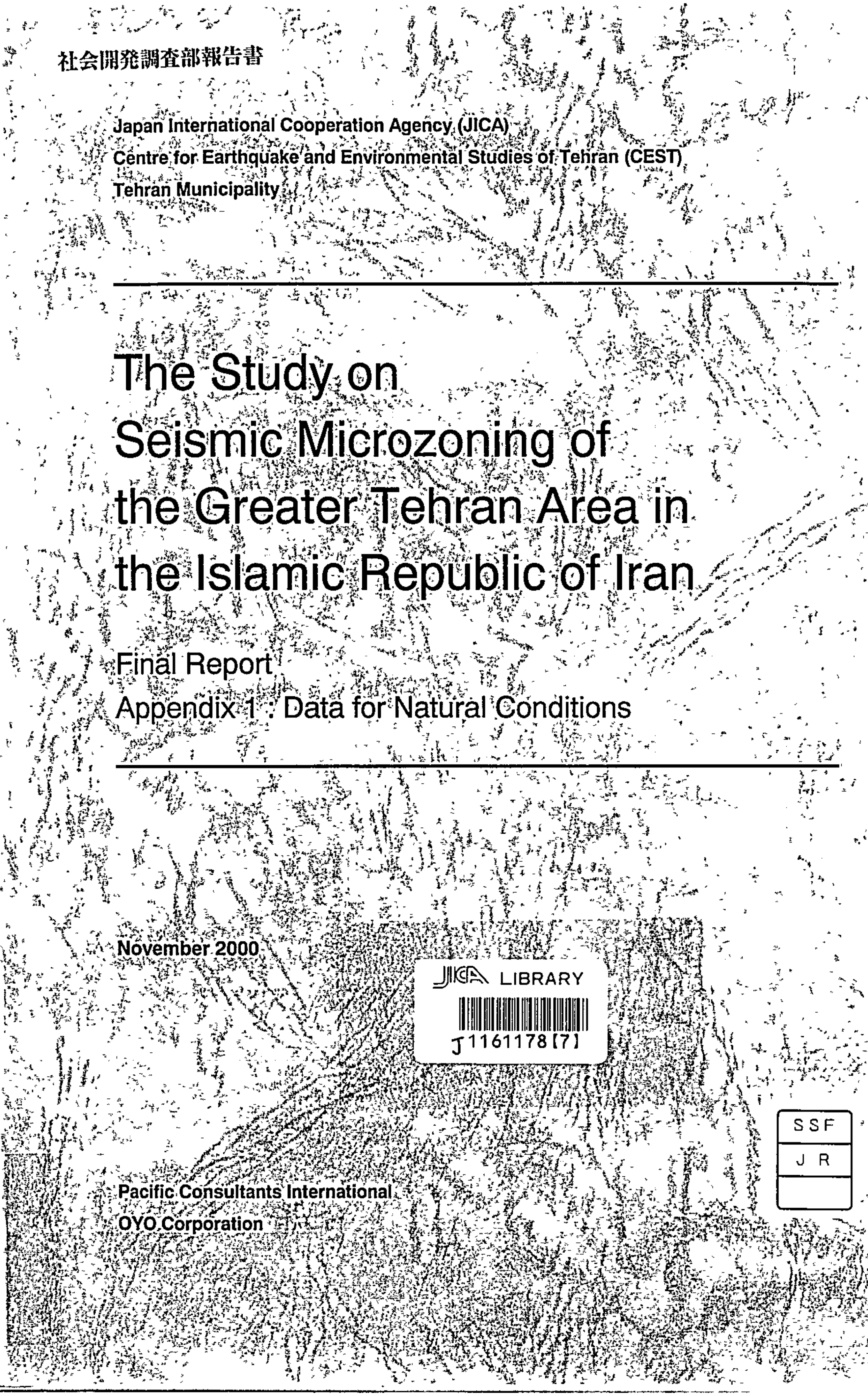
Japan International Cooperation Agency (JICA)
Centre for Earthquake and Environmental Studies of Tehran (CEST)
Tehran Municipality

The Study on Seismic Microzoning of the Greater Tehran Area in the Islamic Republic of Iran

Final Report
Appendix 1 : Data for Natural Conditions

November 2000

Pacific Consultants International
OYO Corporation



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Appendix I:

Geological Site Investigation

Geological Site Investigation

1. Boring Investigation and PS Logging

1.1. Contents of Investigation

Geological site investigation is undertaken during the project. The following items are especially taken into account.

- geological conditions covering whole the Study Area;.
- deep geological conditions down to 200m in depth;
- shear wave velocity of the ground.

The contents and quantities are as follows:

- Boring: 50 locations
- Total drilling depth: 2822 m
- Standard penetration test: 1186 tests
- PS Logging: 20 locations, Maximum depth of 200m
- Grain Size: 93 samples
- Atterberg Limits: 84 samples
- Specific Gravity: 21 samples
- Moisture Contents :284 samples
- Unconfined Compression Test: 19 samples
- Triaxial Compression Test: 17 samples

Details of contents and quantities are summarised in Table 1. Locations and elevations of the investigation site are summarised in Table 2. A location map of the investigation is shown in Figure 1.

PS logging works were undertaken with technical cooperation of Exploration Division, Institute of Geophysics, University of Tehran.

1.2. Outline of the Results

Results of the investigation are summarised in the ***Field Report*** which was submitted last November 1999. Characteristics of geological condition and ground properties are summarised in detail in Chapter 3.2 "Ground Classification". Soil property charts at some representative location are shown in Figure 2, Figure 3 and Figure 4. Typical geological cross section is shown in Figure 5.

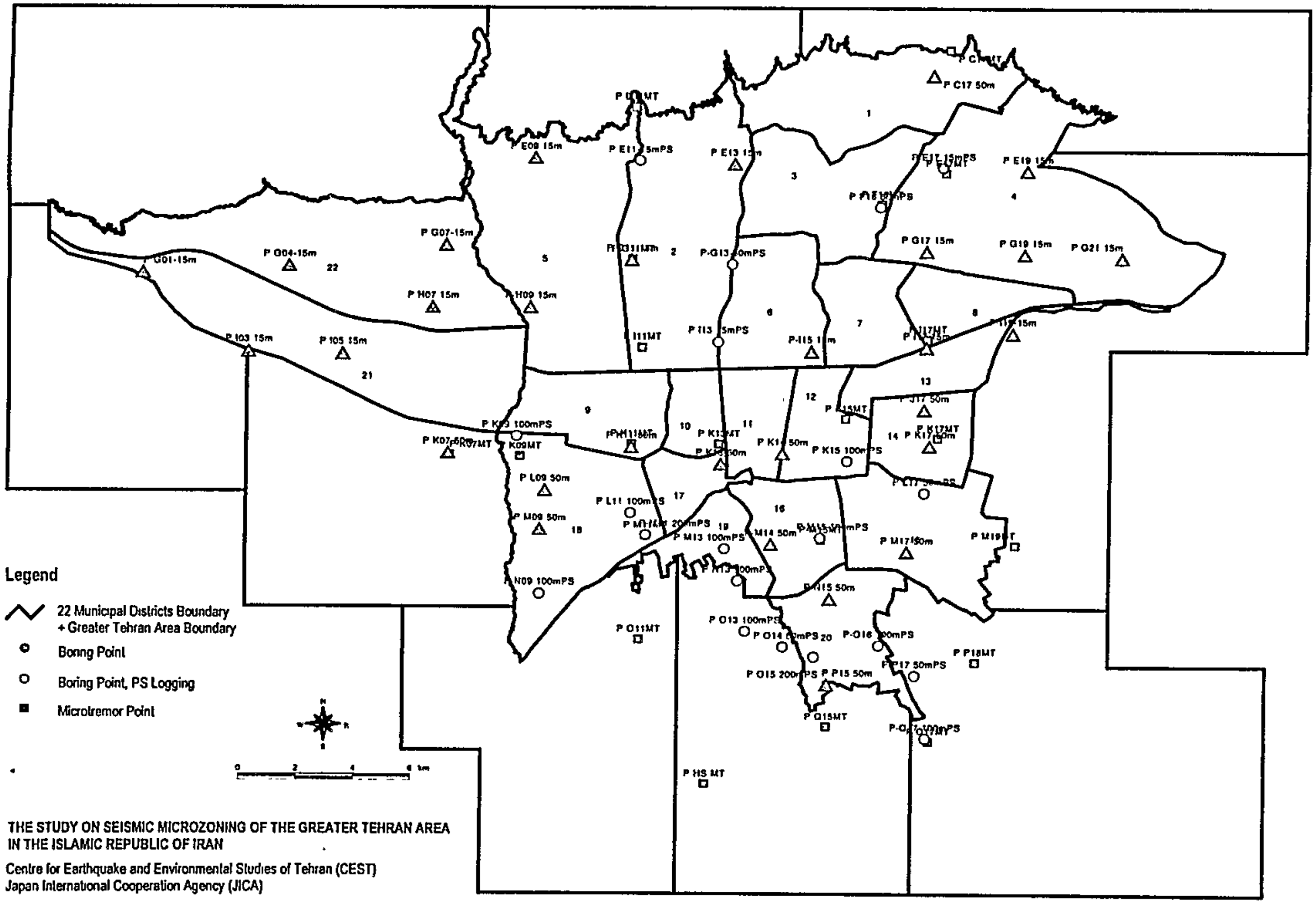
It is the first time in Tehran City to undertake a boring investigation down to a depth of 200m with standard penetration tests and PS logging. In the southern part of Tehran, overconsolidated and stiff clayey soil is distributing. Thickness of the clayey soil exceeds 200m. Shear wave velocity of this clayey soil shows 300 to 800 m/sec.

Table 1 Contents of Boring Investigation and PS logging

No.	Borehole No.	Drilling Depth (m)		SPT	PS Logging (m)	Grain Size (Sieve/Hydrometer).	Atterberg Limits	Specific Gravity	Unconfined Compression Test	Triaxial Compression Test	Moisture Content.
		Nominal	Actual								
1	C17	50	50	23	-	1	1	-	1	-	1
2	E09	15	15	8	-	-	-	-	-	-	-
3	E11	15	21	8	done	-	-	-	-	-	-
4	E13	15	15	8	-	-	-	-	-	-	-
5	E17	15	21	7	done	-	-	-	-	-	-
6	E19	15	15	8	-	-	-	-	-	-	-
7	F16	*50*	*57*	*26*	*done*	-	-	-	-	-	-
8	G01	15	15	8	-	-	-	-	-	-	-
9	G04	15	15	8	-	-	-	-	-	-	-
10	G07	15	15	8	-	-	-	-	-	-	-
11	G11	15	15	8	-	-	-	-	-	-	-
12	G13	*50*	*56.75*	*26*	*done*	-	-	-	-	-	-
13	G17	15	15	10	-	-	-	-	-	-	-
14	G19	15	15	8	-	-	-	-	-	-	-
15	G21	15	15	8	-	-	-	-	-	-	-
16	H07	15	15	8	-	-	-	-	-	-	-
17	H09	15	15	8	-	-	-	-	-	-	-
18	I03	15	15	8	-	-	-	-	-	-	-
19	I05	15	15	8	-	-	-	-	-	-	-
20	I13	*15*	*21*	*8*	*done*	-	-	-	-	-	-
21	I15	15	15	8	-	-	-	-	-	-	-
22	I17	15	15	7	-	-	-	-	-	-	-
23	I19	15	15	8	-	-	-	-	-	-	-
24	J17	50	50	25	-	-	-	-	-	-	-
25	K07	50	50	25	-	-	-	-	-	-	-
26	K09	*100*	*106.5*	*39*	*done*	-	-	-	-	-	-
27	K11	50	50	25	-	2	2	1	-	-	4
28	K13	50	50	25	-	32	23	1	1	1	32
29	K14	50	50	25	-	2	2	-	1	-	6
30	K15	*100*	*106*	*48*	*done*	*3*	*3*	*2*	-	*1*	*10*
31	K17	50	50	25	-	2	2	2	-	-	2
32	L09	50	50	26	-	1	1	1	-	-	6
33	L11	*100*	*106*	*41*	*done*	*2*	*2*	*1*	-	-	*11*
34	L17	*50*	*56*	*26*	*done*	*1*	*1*	*1*	*1*	*1*	*8*
35	M09	50	50	25	-	3	3	2	1	-	9
36	M11	*200*	*206*	*65*	*done*	*3*	*3*	*1*	*2*	*1*	*24*
37	M13	*100*	*106*	*40*	*done*	*4*	*4*	*1*	*1*	*2*	*16*
38	M14	50	50	24	-	1	1	-	1	1	8
39	M15	*100*	*106*	*43*	*done*	*1*	*1*	-	*3*	-	*12*
40	M17	50	50	25	-	5	5	2	1	-	9
41	N09	*100*	*106*	*40*	*done*	*2*	*2*	*1*	-	-	*10*
42	N13	*100*	*206*	*65*	*done*	*6*	*6*	*1*	-	-	*18*
43	N15	50	50	25	-	2	2	-	-	2	10
44	O13	*100*	*106*	*40*	*done*	*4*	*4*	*1*	*1*	*3*	*20*
45	O14	*50*	*56*	*25*	*done*	*3*	*3*	*1*	-	*2*	*10*
46	O15	*200*	*206*	*76*	*done*	*2*	*2*	-	*1*	*1*	*19*
47	O16	*100*	*106*	*40*	*done*	*3*	*3*	-	*1*	*1*	*11*
48	P15	50	50	22	-	1	1	-	1	-	5
49	P17	*50*	*56*	*26*	*done*	*3*	*3*	*1*	*1*	-	*7*
50	Q17	*100*	*106*	*40*	*done*	*4*	*4*	*1*	*1*	*1*	*16*
Total	**50**	**2600**	**2822.25**	**1186**	**20**	**93**	**84**	**21**	**19**	**17**	**284**

Table 2 Location of Boring Investigation

Borehole	Drilling Length (m)	PS Logging	Latitude		Latitude		Altitude (m)
			Degree	Minute	Degree	Minute	
C17	50	-	35	48.79	51	28.48	1664.3
E09	15	-	35	46.94	51	17.68	1560.6
E11	15	Done	35	46.86	51	20.51	1555.0
E13	15	-	35	46.79	51	23.10	1550.5
E17	15	Done	35	46.68	51	28.74	1472.5
E19	15	-	35	46.61	51	31.04	1525.5
F16	50	Done	35	45.78	51	27.05	1461.5
G01	15	-	35	44.29	51	7.16	1213.5
G04	15	-	35	44.45	51	11.05	1267.8
G07	15	-	35	44.92	51	15.27	1320.3
G11	15	-	35	44.58	51	20.30	1363.5
G13	50	Done	35	44.47	51	23.03	1350.0
G17	15	-	35	44.76	51	28.31	1225.0
G19	15	-	35	44.68	51	30.97	1340.7
G21	15	-	35	44.58	51	33.61	1662.9
H07	15	-	35	43.49	51	14.92	1272.6
H09	15	-	35	43.49	51	17.56	1263.3
I03	15	-	35	42.51	51	9.98	1183.0
I05	15	-	35	42.46	51	12.50	1205.7
I13	15	Done	35	42.71	51	22.65	1246.6
I15	15	-	35	42.50	51	25.18	1204.7
I17	15	-	35	42.57	51	28.30	1224.9
I19	15	-	35	42.88	51	30.64	1350
J17	50	-	35	41.18	51	28.24	1174.8
K07	50	-	35	40.21	51	15.35	1160.0
K09	100	Done	35	40.59	51	17.20	1167.2
K11	50	-	35	40.35	51	20.30	1140.1
K13	50	-	35	39.95	51	22.74	1131.3
K14	50	-	35	40.19	51	24.41	1126.3
K15	100	Done	35	40.01	51	26.16	1132.0
K17	50	-	35	40.36	51	28.39	1152.4
L09	50	-	35	39.36	51	17.97	1129.8
L11	100	Done	35	38.83	51	20.29	1125.5
L17	50	Done	35	39.27	51	28.25	1127.2
M09	50	-	35	38.46	51	17.84	1117.2
M11	200	Done	35	38.33	51	20.71	1110.0
M13	100	Done	35	38.00	51	22.85	1097.6
M14	50	-	35	38.11	51	24.11	1098.6
M15	100	Done	35	38.25	51	25.43	1094.2
M17	50	-	35	37.93	51	27.79	1104.3
N09	100	Done	35	37.00	51	17.84	1098.2
N13	200	Done	35	37.28	51	23.21	1090.2
N15	50	-	35	36.89	51	25.71	1073.3
O13	100	Done	35	36.15	51	23.41	1065.5
O14	50	Done	35	35.79	51	24.43	1056.7
O15	200	Done	35	35.56	51	25.28	1052.8
O16	100	Done	35	35.82	51	27.04	1062.1
P15	50	-	35	34.95	51	25.64	1046.4
P17	50	Done	35	35.14	51	28.01	1044.2
Q17	100	Done	35	33.69	51	28.30	1026.5



THE STUDY ON SEISMIC MICROZONING OF THE GREATER TEHRAN AREA
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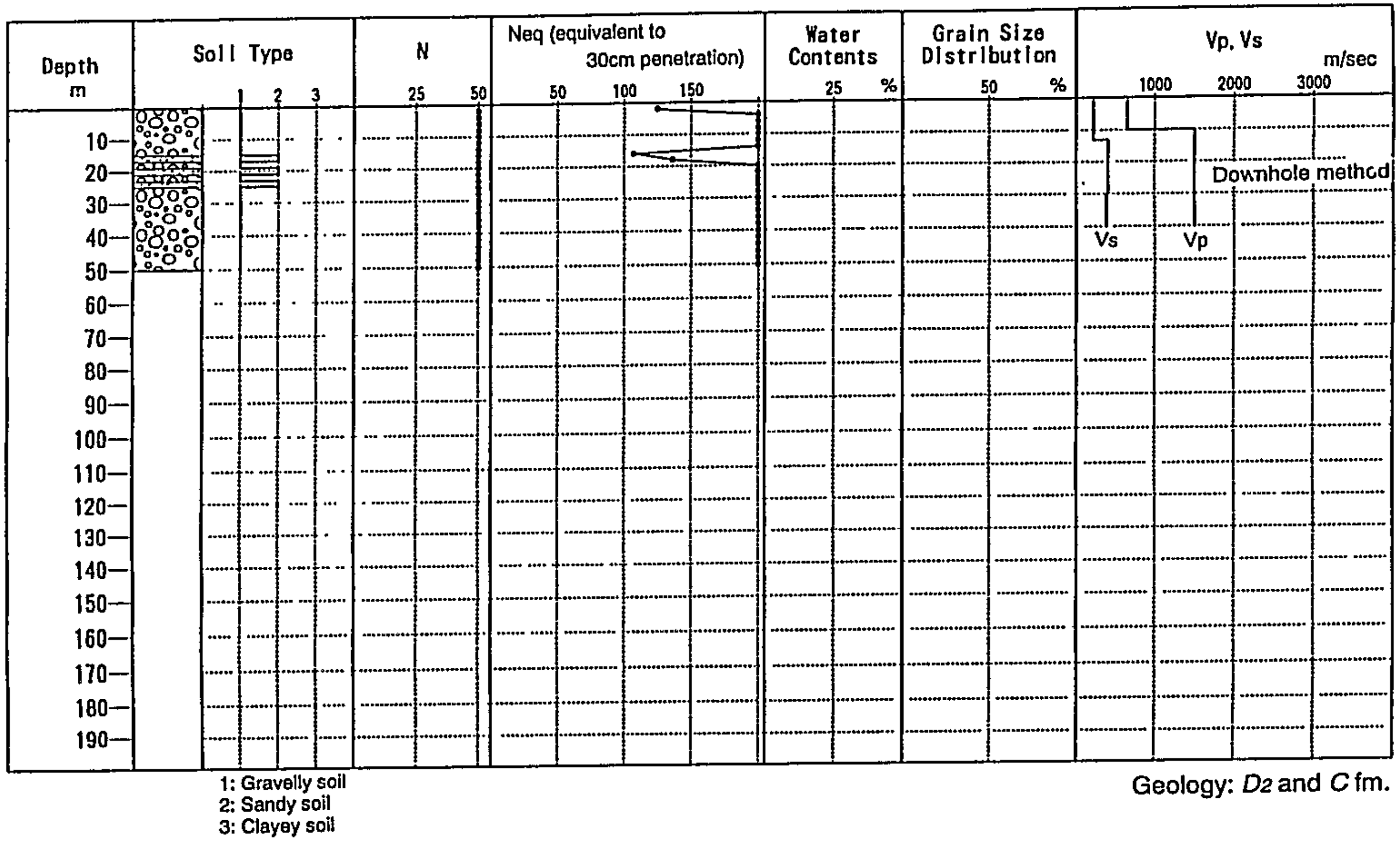
Figure 1 Location Map for Geological Site Investigation

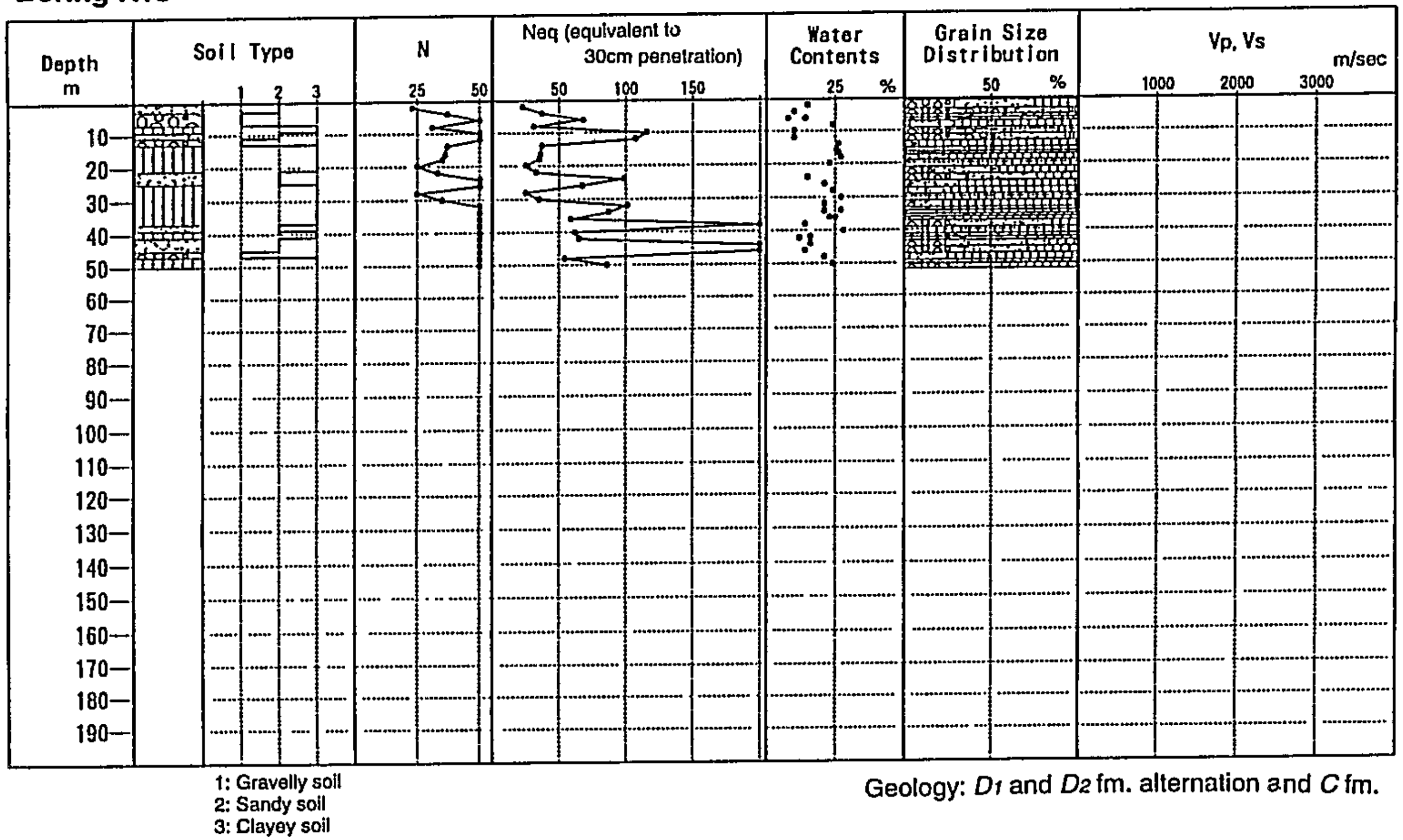
Boring G13



Geology: *D2* and *C* fm.

Figure 2 Soil Property Chart (Location G13)

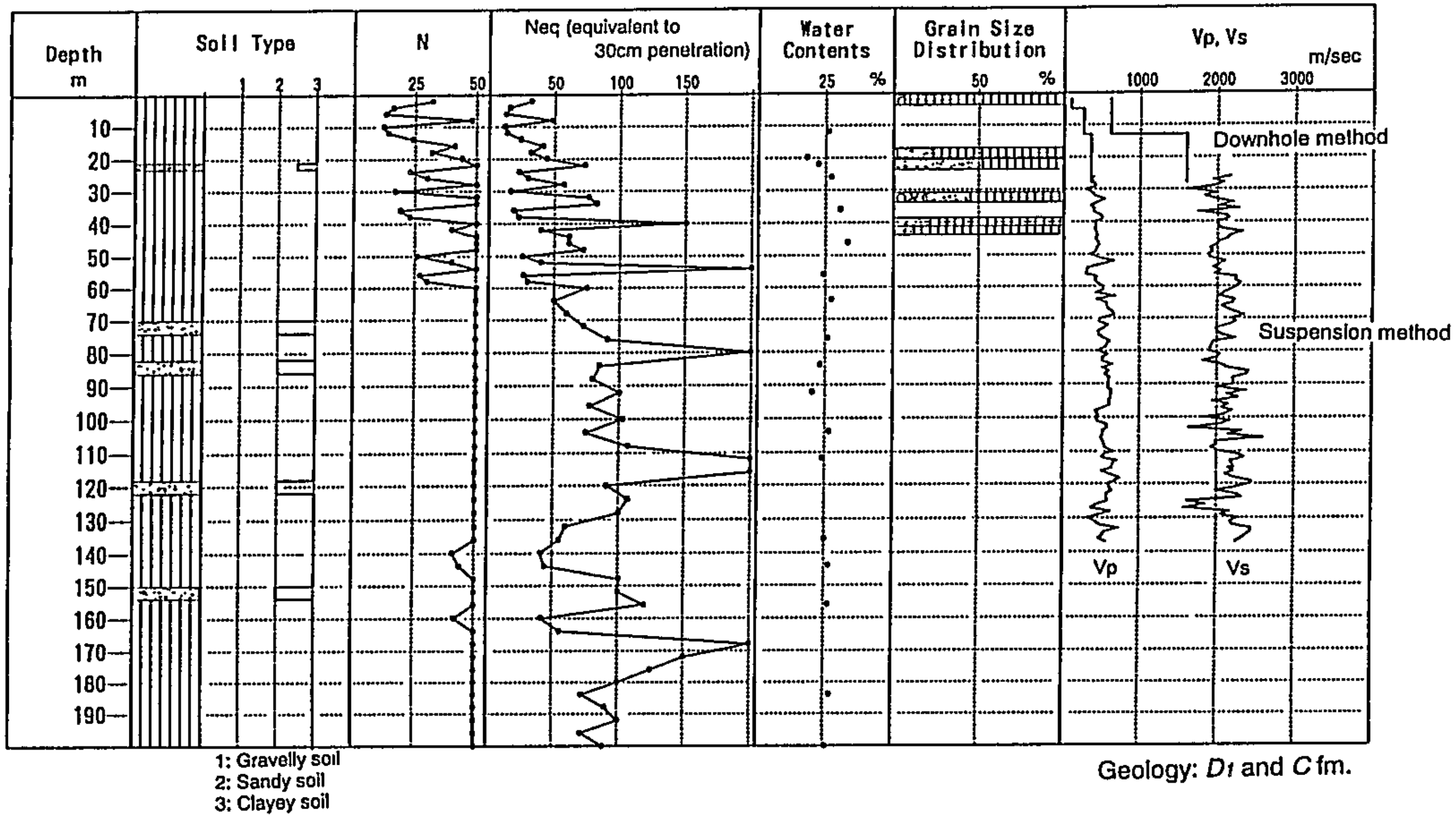
Boring K13



Geology: *D1* and *D2* fm. alternation and *C* fm.

Figure 3 Soil Property Chart (Location K13)

Boring N13



Geology: *D₁* and *C* fm.

Figure 4 Soil Property Chart (Location N13)

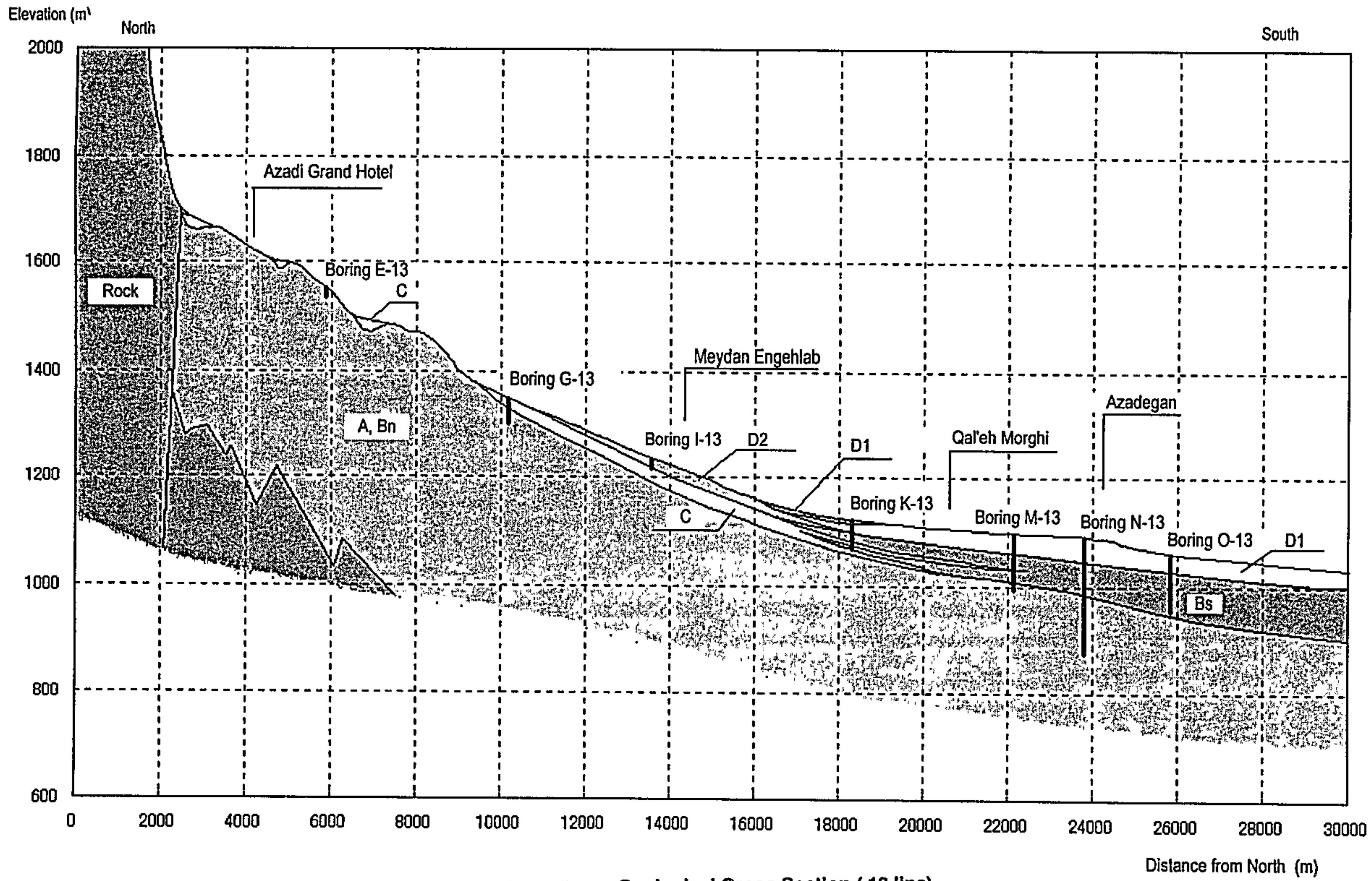


Figure 5 Geological Cross Section (13 line)

2. Microtremor Measurement

2.1. Contents of Investigation

Microtremor measurements are undertaken during the project. Total of 21 sites is selected to identify changes of properties depending on soil and rock distribution. Major observational lines and points are set as follows:

- North-South direction (variation for rock to thick quaternary soil)
- East-West direction (variation for fan sediments)
- On Rock (for reference as basement property)

The location and measurement dates/times are summarised in Table 3. A location map of the measurement is shown in Figure 1.

2.2. Outline of the Results

Results of the measurement are summarised in the Field Report which was submitted last November 1999. Power spectra diagrams at some representative location are shown in Figure 6. Characteristics of results are noise (spikes at about 1.2Hz), noise (high frequency level) and non-outstanding predominant frequencies.

2.2.1. Noise (Spikes at about 1.2Hz):

Nearly all power spectra show narrow spikes at about 1.2Hz. These spikes are clearly of instruments origin. This signal is the "beating" frequency between the seismometer and the 50Hz sampling frequency used during the measurements and the main power line frequency. Those noises are neglected.

2.2.2. Noise (High frequency level)

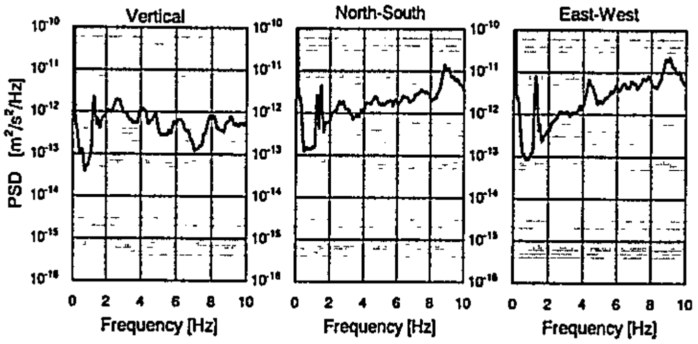
The measurements were taken from midnight to 5:00 a.m. to avoid artificial seismic noise. However, there were still heavy traffic and construction works during the measurement time. Some random noise signal is observed in frequency of over 5Hz. Those are considered to artificial seismic noise and those are also neglected.

2.2.3. Characteristics of predominant frequencies

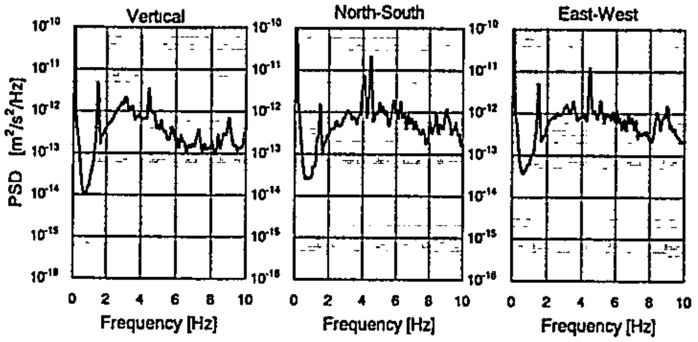
Non-outstanding predominant frequencies are observed in power spectra diagrams for almost all the locations. There are very little directional variation, vertical, north-south and east-west. Results of PS logging indicates a very simple layered structure for shear wave velocity. Non-characteristic predominant frequency is considered as an effect of the simple layered structure. Amplification properties of ground are described in Chapter 3.5.2 "Amplification of Subsurface Ground". Amplification functions are defined for each type of modelled ground. Characteristics of results of microtremor measurement agree with those of amplification functions.

Table 3 Location and Measurement Date/Time of Microtremor Measurement

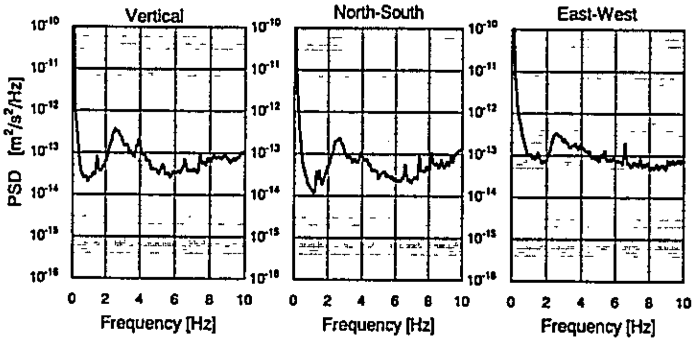
No	Site code	Date	Time	Latitude Degree Minute, Second	Longitude Degree Minute, Second	Elevation (m)
1	C17	12-Sep-99	22:34 UTC	N35, 49, 21.8	E51, 28, 55.6	1870
2	D11	13-Sep-99	22:12 UTC	N35, 48, 05.7	E51, 20, 23.3	1729
3	E17	12-Sep-99	23:39 UTC	N35, 46, 33.6	E51, 28, 50.0	1667
4	F16	12-Sep-99	01:28 UTC	N35, 45, 50.9	E51, 27, 05.2	1507
5	G11	13-Sep-99	00:48 UTC	N35, 44, 35.4	E51, 20, 19.0	1435
6	I11	13-Sep-99	02:03 UTC	N35, 42, 35.5	E51, 20, 35.2	1241
7	I17	17-Sep-99	23:47 UTC	N35, 42, 44.7	E51, 28, 19.8	1451
8	K07	06-Sep-99	23:11 UTC	N35, 40, 09.4	E51, 15, 23.3	1166
9	K09	06-Sep-99	00:31 UTC	N35, 40, 07.5	E51, 17, 17.7	1228
10	K11	06-Sep-99	02:00 UTC	N35, 40, 24.6	E51, 20, 18.4	1247
11	K13	07-Sep-99	23:34 UTC	N35, 40, 24.5	E51, 22, 40.9	1276
12	K15	07-Sep-99	00:30 UTC	N35, 40, 58.5	E51, 26, 07.1	1202
13	K17	07-Sep-99	02:47 UTC	N35, 40, 31.6	E51, 28, 36.7	1150
14	M11	15-Sep-99	00:22 UTC	N35, 38, 18.9	E51, 20, 42.0	1095
15	M15	16-Sep-99	23:02 UTC	N35, 38, 12.4	E51, 25, 27.5	1178
16	M19	09-Sep-99	21:17 UTC	N35, 38, 03.8	E51, 30, 43.4	1195
17	O11	15-Sep-99	22:35 UTC	N35, 35, 58.1	E51, 20, 31.7	1091
18	P18	17-Sep-99	21:51 UTC	N35, 35, 25.9	E51, 29, 38.8	1196
19	Q15	09-Sep-99	23:50 UTC	N35, 40, 58.6	E51, 25, 37.5	1201
20	Q17	09-Sep-99	01:55 UTC	N35, 33, 37.7	E51, 28, 23.2	1039
21	HS	16-Sep-99	22:07 UTC	N35, 32, 39.5	E51, 22, 20.1	1069



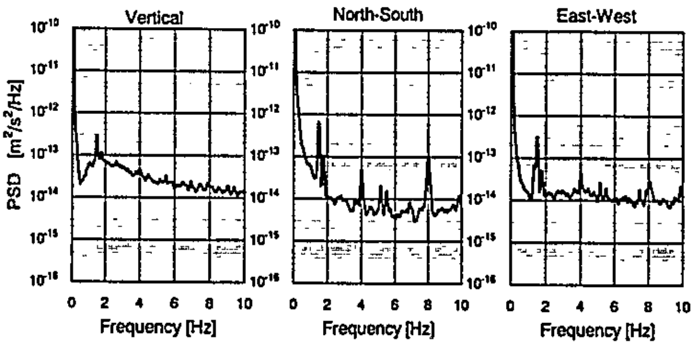
O11 (Depth to engineering sesmic bed rock : 150m)



Q15 (Depth to engineering sesmic bed rock : 50m)



G11 (Depth to engineering sesmic bed rock : 15m)

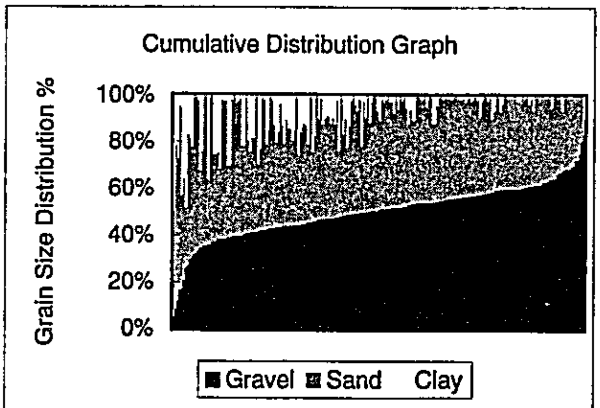


M19 (Depth to engineering sesmic bed rock : 0m)

Figure 6 **Example of power spectra density**

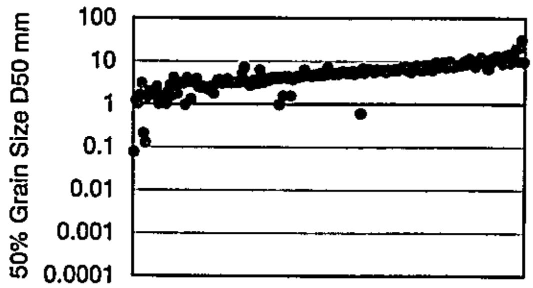
Appendix II:
Liquefaction Analysis Data

1. Soil Properties



Gravelly Soil

Number of Sample	203
Median of D50 (mm)	5
Median of SPT N value	50
Median of Fine Content Fc (%)	2.3



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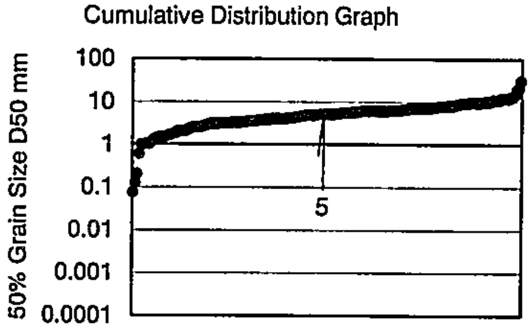

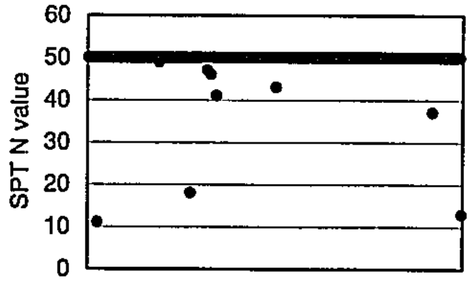

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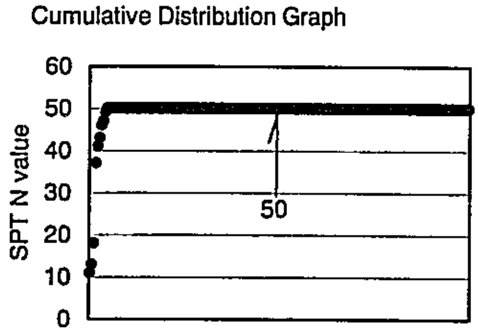

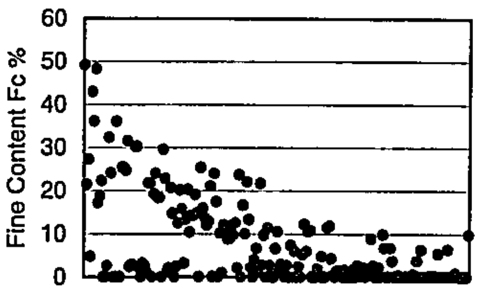

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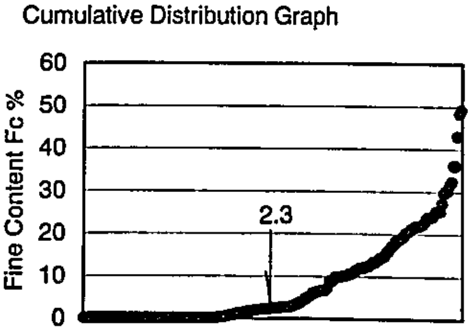
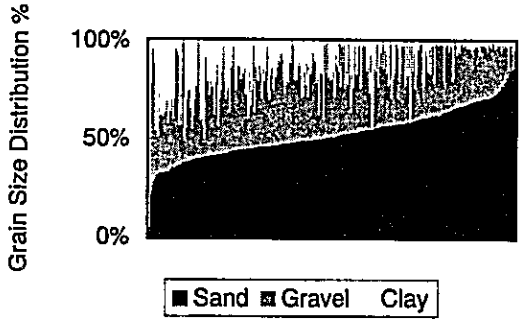
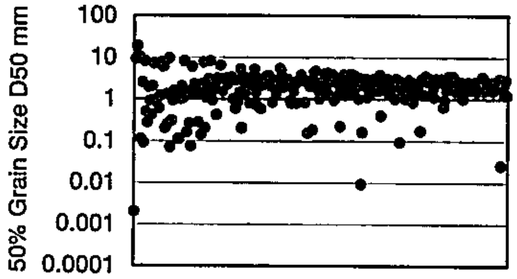


Cumulative Distribution Graph



Sandy Soil

Number of Sample	295
Median of D50 (mm)	2.1
Median of SPT N value	50
Median of Fine Content Fc (%)	14.2



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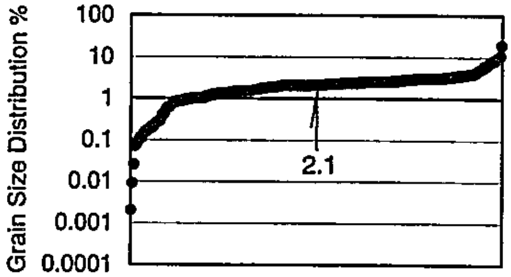
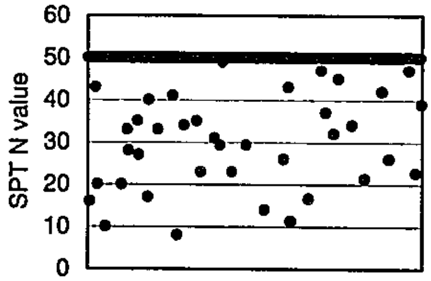
Cumulative Distribution Graph





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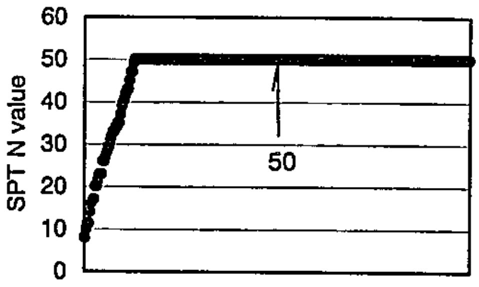
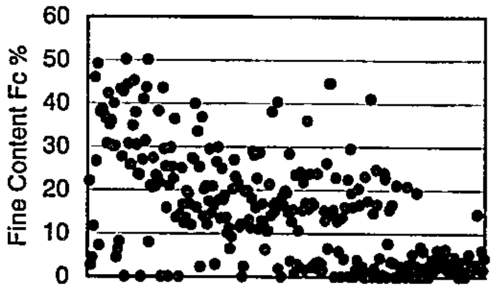
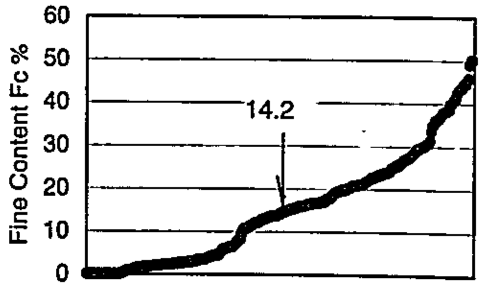
Cumulative Distribution Graph



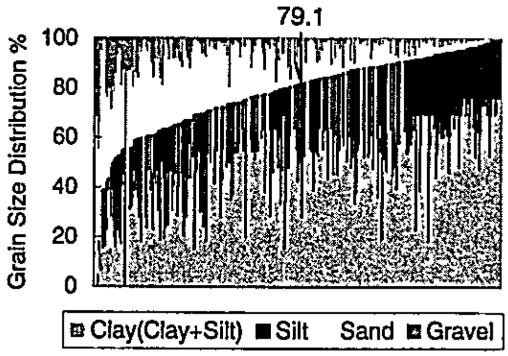


(X axis order is same with above graph)

Cumulative Distribution Graph

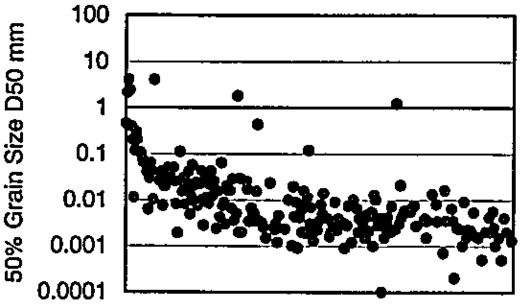


Cumulative Distribution Graph



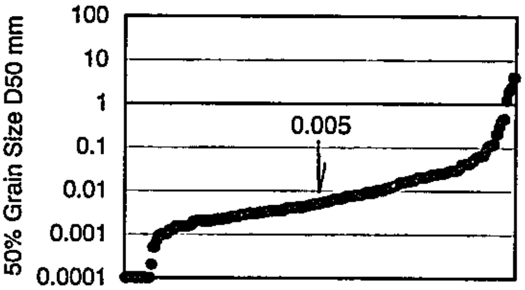
Clayey Soil

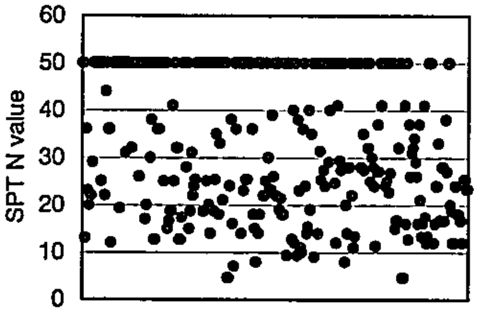
Number of Smaple	315
Median of D50 (mm)	0.005
Median of SPT N value	32
Median of Fine Content Fc (%)	79.1
Median of Clay Content Cc (%)	53.2



(X axis order is same with above graph)

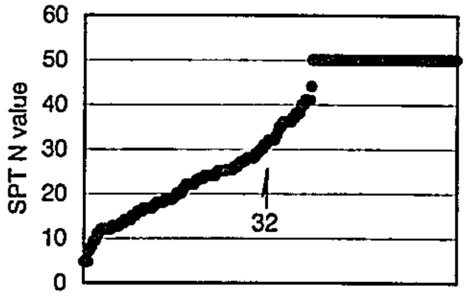
Cumulative Distribution Graph



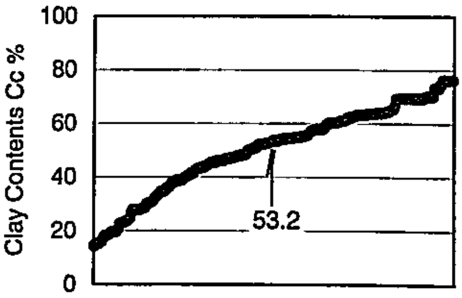


(X axis order is same with above graph)

Cumulative Distribution Graph



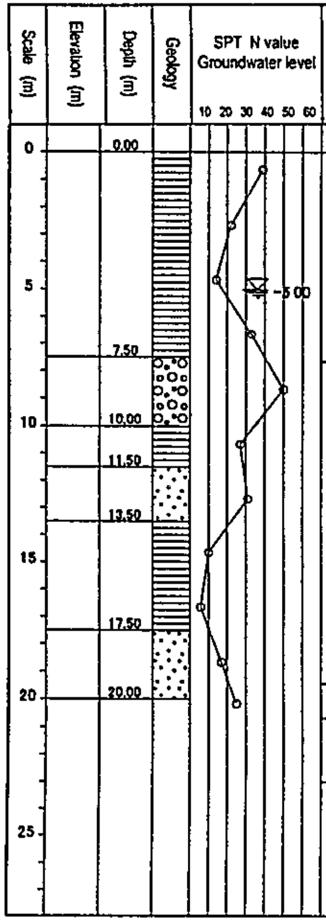
Cumulative Distribution Graph



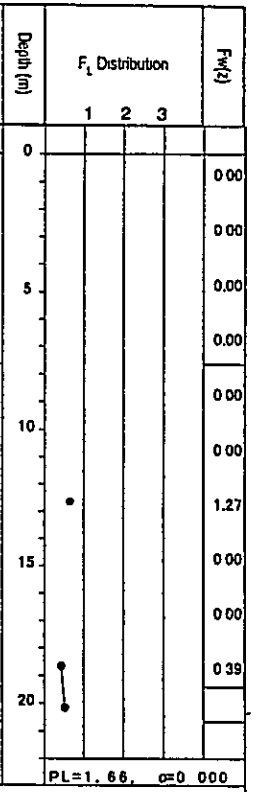
2. *Liquefaction Judgement Chart*

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No PK-15
Khc=0.42



Depth of Calculation m	Basic Data											Cyclic resistance ratio							Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm^2)	σ_v'(kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R					
0 65	I	300	3 9	0 130	0.130	0.005		25 00	2.00	2.00	79 1												0 00
2,65			2 2	0.530	0.530	0.005		25.00			79.1												0 00
4 65			1 4	0 930	0.930	0.005		25.00			79 1												0.00
6 65			3 3	1,330	1 165	0.005		25.00			79 1												0.00
8 65		295	5 0	1 753	1,388	5.000	5.000		2.20	2.20	2.3												0 00
10 65		300	2 7	2,180	1 615	0.005		25.00	2.00	2.00	79.1												0 00
12.65		251	3 1	2.591	1.826	2.100			2.10	2.10	14.2	1 000	1.084	0.233	20.859	20.7	0.316	0.316	0.810	0 483	0.654	○	1.27
14 65		200	1 0	3.000	2.035	0.005		25.00	2.00	2.00	79 1												0 00
16 65			6	3 400	2.235	0.005		25.00			79 1												0 00
18,65		206	1 7	3.811	2.446	2.100			2.10	2.10	14.2	1 000	1.084	0.233	9 185	9 115	0.204	0.204	0.720	0.471	0.433	○	0 39
20,15			2 5	4,126	2.811	2.100					14 2	1.000	1.084	0 233	12.834	12.738	0.241	0.241	0.698	0 463	0.521	○	

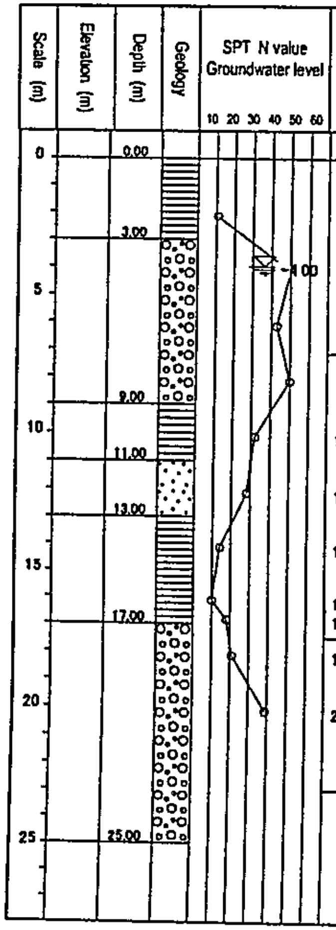


PL=1. 66, σ=0 000

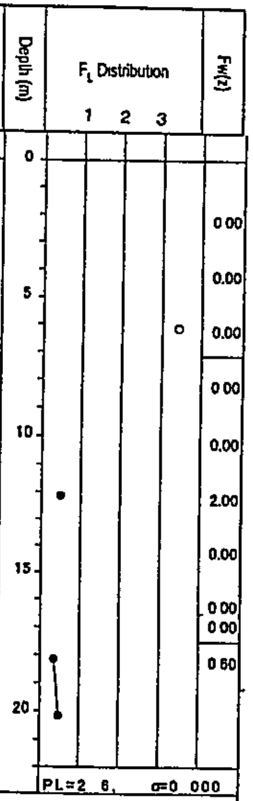
cz=1 0 (correlation factor for area)
Calculatiuon of cw is based on case for "Type 1" earthquake
Judgement . ○ to be lequified ×; not to be lequfied
F_L: ○<1 0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No PL-17
Khc=0.51



Depth of Calculation m	Basic Data											Cyclic resistance ratio							Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R					
2.15		222	11	0.430	0 430	0.005		25.00	2.00	2.00	79.1												0 00
4.15	I		50	0.853	0.838	5.000	5.000				2.3												0.00
6.15		291	43	1.293	1.078	5.000	1.000		2.20	2.20	2.3	1 000	1.000	0.000	41 114	35.224	1 897	1.897	0.908	0.555	3.418	×	0.00
8 15			50	1.733	1.318	5.000	5.000				2.3												0 00
10.15		317	32	2.150	1.535	0.005		25.00	2.00	2.00	79.1												0.00
12.15		243	28	2.582	1.747	2.100			2.10	2.10	14.2	1.000	1.084	0.233	19 456	18.308	0.300	0.300	0.818	0.612	0.490	○	2.00
14 15		241	14	2.970	1.955	0.005		25.00	2.00	2.00	79 1												0.00
16 15			10	3.370	2.155	0.005		25.00			79 1												0 00
16 85			18	3.510	2.225	0.005		25.00			79 1												0 00
18.15			21	3.783	2.378	5.000	1.000				2.3	1.000	1.000	0.000	11 598	9.937	0.213	0.213	0.728	0.592	0.360	○	0 60
20.15			38	4.233	2.618	5.000	1 000				2.3	1.000	1.000	0.000	19 982	17 119	0.280	0.280	0.698	0.576	0.488	○	
									2.20	2.20													

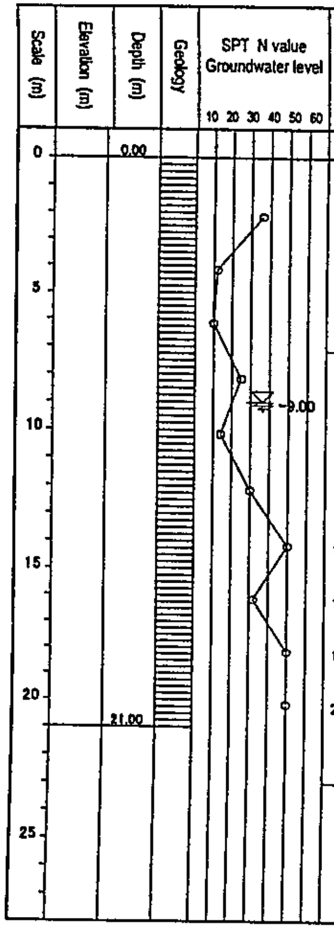


PL=2 6, σ=0 000

cz=1 0 (correlation factor for area)
Calculatuon of cw is based on case for "Type 1" earthquake
Judgement . ○ to be lequified ×: not to be lequfied
F_L. ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No PM-13
Khc=0.48



Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.15			36	0 430	0 430	0.005		25.00			79.1												0.00
4 15	I I		12	0.830	0.830	0.005		25.00			79 1												0.00
6.15			10	1.230	1.230	0.005		25.00			79.1												0 00
8.15			25	1 630	1 630	0.005		25.00			79.1												0 00
10 15		314	14	2.030	1 915	0.005		25.00	2.00	2.00	79 1												0 00
12.15			30	2.430	2.115	0.005		25.00			79 1												0.00
14 15			50	2.830	2.315	0.005		25.00			79.1												0.00
16.15			32	3.230	2.515	0.005		25.00			79 1												0 00
18.15			50	3.630	2.715	0.005		25.00			79.1												0.00
20.15			50	4.030	2.915	0.005		25.00			79 1												

Basic Data: Ground Type to Fc (%); Cyclic resistance ratio: cw to R.

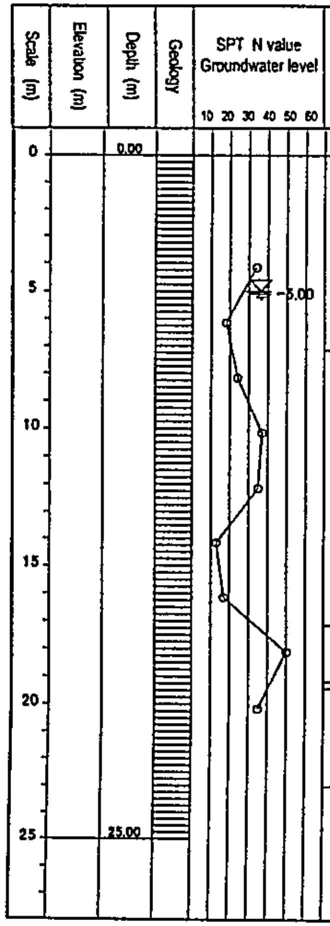
F_L Distribution 1 2 3; Depth (m) 0 5 10 15 20

PL=0 0, σ=0. 000

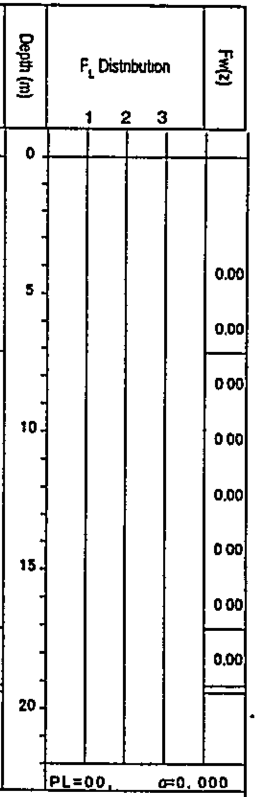
cz=1 0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement . ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No PM-14
Khc=0.47



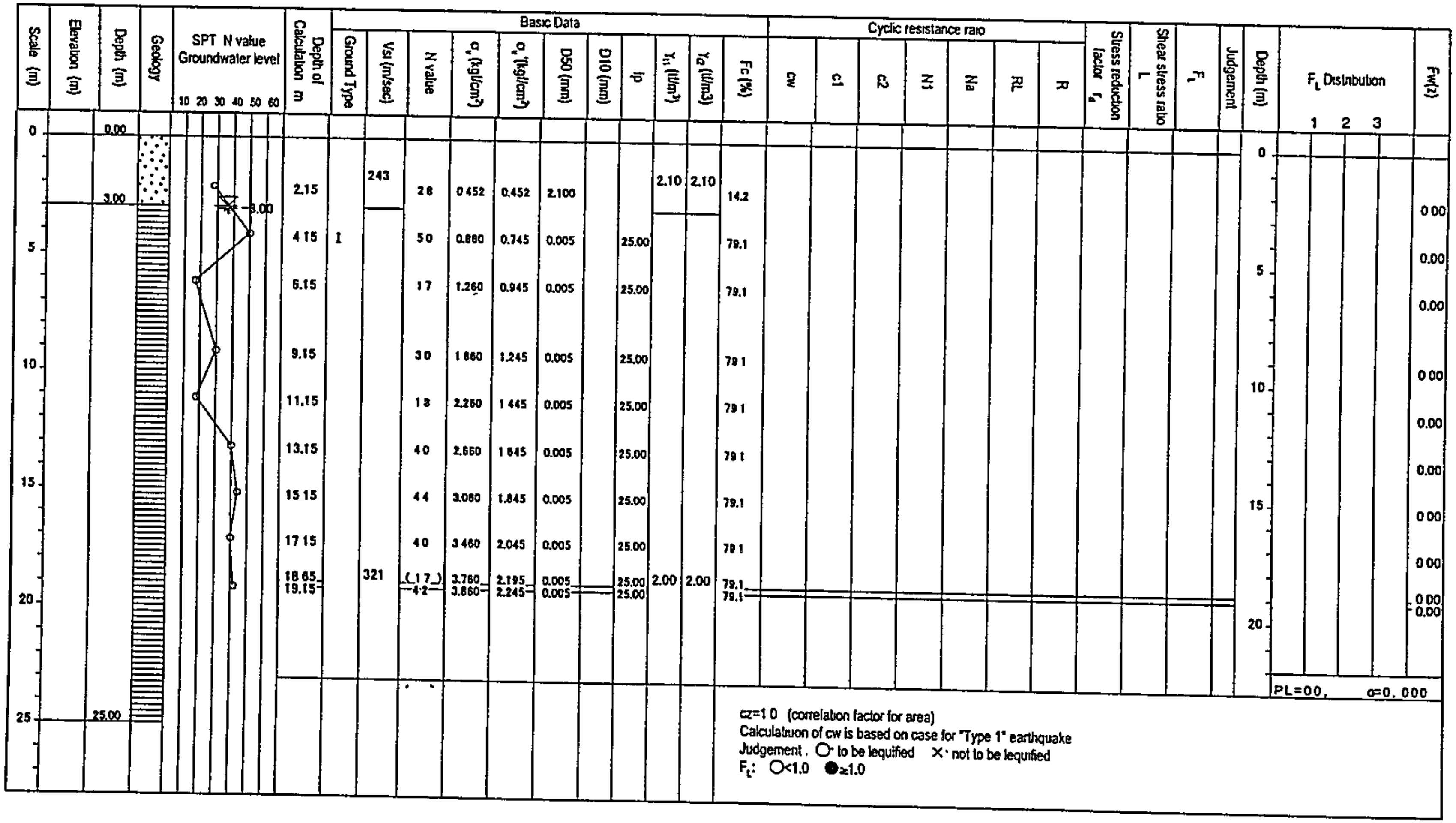
Depth of Calculation m	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm^2)	σ_v'(kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement
											Basic Data → **Cyclic resistance rao**											
4.15	I		34	0.830	0.830	0.005		25.00			79.1											
6.15			18	1.230	1.115	0.005		25.00			79.1											
8.15			24	1.630	1.315	0.005		25.00			79.1											
10.15			37	2.030	1.515	0.005		25.00			79.1											
12.15			35	2.430	1.715	0.005		25.00			79.1											
14.15			13	2.830	1.915	0.005		25.00			79.1											
16.15			17	3.230	2.115	0.005		25.00			79.1											
18.10 18.65		304	50 (17)	3.820 3.730	2.310 2.385	0.005 0.005		25.00 25.00	2.00	2.00	79.1 79.1											
20.15			35	4.030	2.515	0.005		25.00			79.1											



cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake
Judgement. ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1 0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No PM-15
Khc=0.47



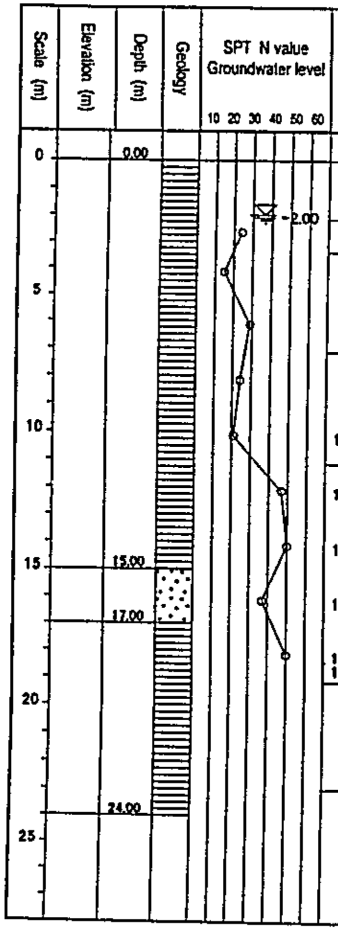
Depth of Calculation m	Basic Data											Cyclic resistance ratio							Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R					
2.15		243	28	0.452	0.452	2.100			2.10	2.10	14.2												0.00
4.15	I	321	50	0.880	0.745	0.005		25.00	2.00	2.00	79.1												0.00
6.15			17	1.260	0.945	0.005		25.00			79.1												0.00
9.15			30	1.660	1.245	0.005		25.00			79.1												0.00
11.15			18	2.260	1.445	0.005		25.00			79.1												0.00
13.15			40	2.660	1.645	0.005		25.00			79.1												0.00
15.15			44	3.060	1.845	0.005		25.00			79.1												0.00
17.15			40	3.460	2.045	0.005		25.00			79.1												0.00
18.65			(17)	3.760	2.195	0.005		25.00			79.1												0.00
19.15			42	3.860	2.245	0.005		25.00			79.1												0.00

PL=00, σ=0. 000

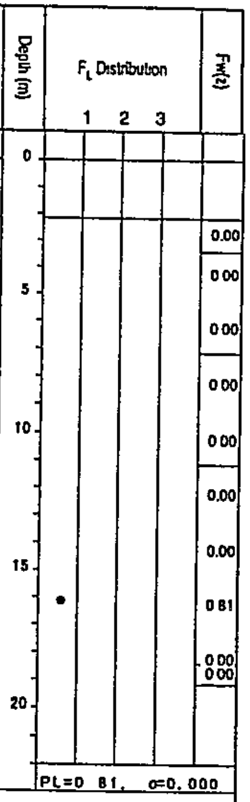
cz=1 0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake
Judgement . ○ to be lequified × · not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No PM-17
Khc=0.52



Depth of Calculation m	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.85	I 種	311	24	0.530	0.485	0.005		25.00	2.00	2.00	79 1												0.00
4 15			15	0.830	0.815	0.005		25.00			79 1												0 00
6 15			29	1.230	0.815	0.005		25.00			79 1												0.00
8 15			24	1 630	1 015	0.005		25.00			79.1												0 00
10.15			21	2.030	1.215	0.005		25.00			79.1												0 00
12.13			47	2.428	1.413	0.005		25.00			79.1												0.00
14.15			50	2.830	1.615	0.005		25.00			79 1												0.00
16.15		267	37	3.241	1.826	2.100			2.10	2.10	14.2	1.000	1.084	0.233	24.896	24.706	0.405	0.405	0.758	0.700	0 579	○	0 81
18 15		324	50	3.650	2.035	0.005		25.00	2.00	2.00	79 1												0 00
18.65			(17)	3.750	2.085	0.005		25.00			79.1												0 00

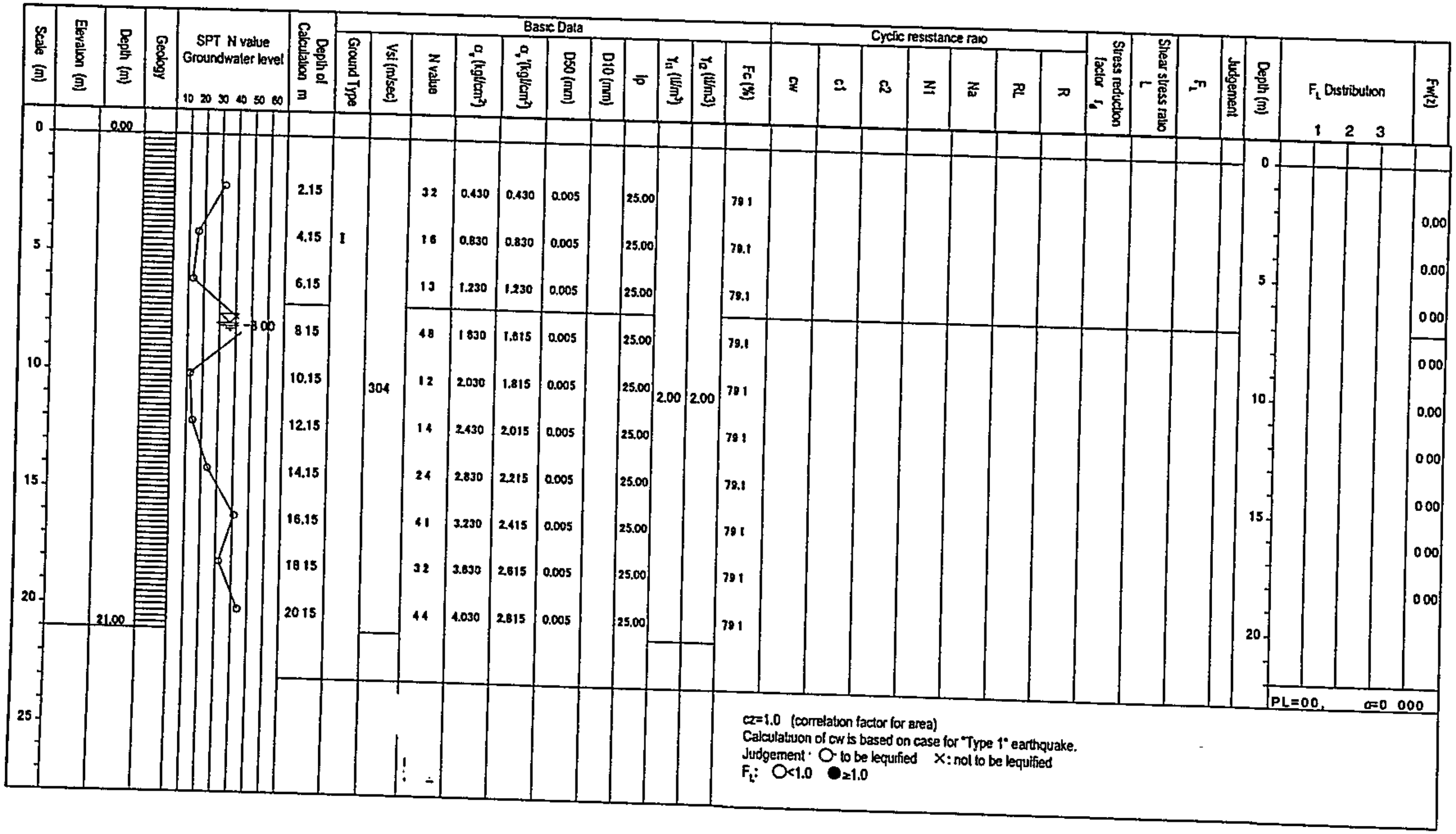


PL=0 81, σ=0. 000

cz=1 0 (correlation factor for area)
Calculatiuon of cw is based on case for "Type 1" earthquake
Judgement : ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No PN-13
Khc=0.54



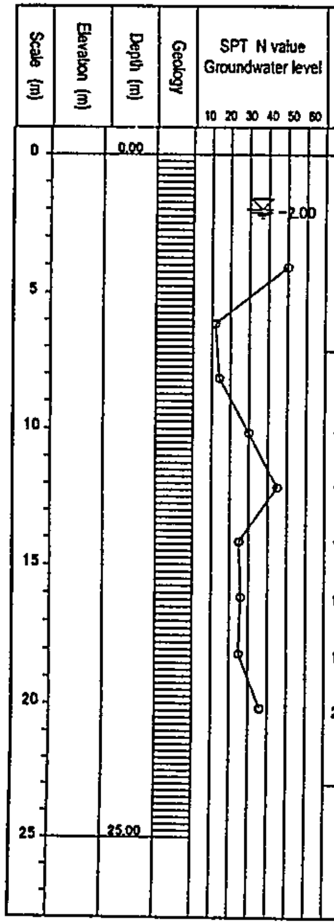
Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement
2.15			32	0.430	0.430	0.005		25.00			79.1											
4.15	I		16	0.830	0.830	0.005		25.00			79.1											
6.15			13	1.230	1.230	0.005		25.00			79.1											
8.15			48	1.630	1.615	0.005		25.00			79.1											
10.15		304	12	2.030	1.815	0.005		25.00	2.00	2.00	79.1											
12.15			14	2.430	2.015	0.005		25.00			79.1											
14.15			24	2.830	2.215	0.005		25.00			79.1											
16.15			41	3.230	2.415	0.005		25.00			79.1											
18.15			32	3.630	2.615	0.005		25.00			79.1											
20.15			44	4.030	2.815	0.005		25.00			79.1											

Basic Data: Ground Type – Fc (%); Cyclic resistance ratio: cw – R

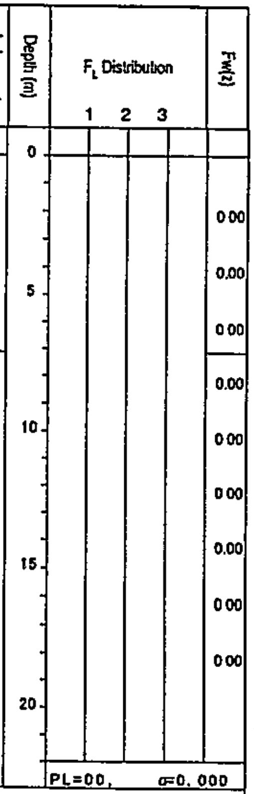
cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement · ○ to be lequified X: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No PN-15
Khc=0.49



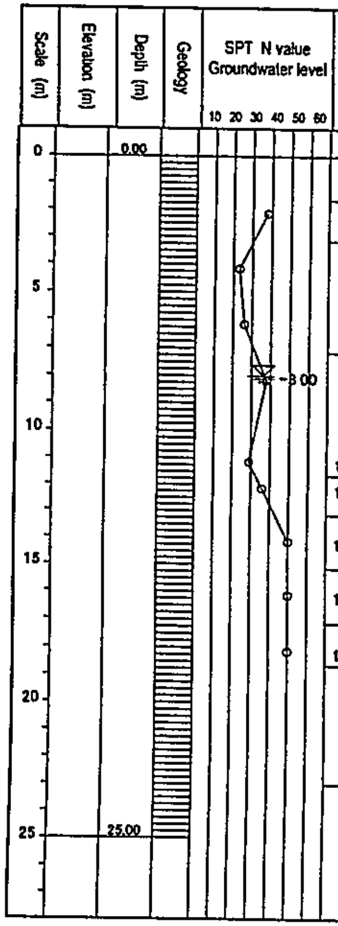
Depth of Calculation m	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.06			50	0.412	0.406	0.005		25.00			79.1												0.00
4.06	I		50	0.812	0.606	0.005		25.00			79.1												0.00
6.15			12	1.230	0.815	0.005		25.00			79.1												0.00
8.15			14	1.830	1.015	0.005		25.00			79.1												0.00
10.15			30	2.030	1.215	0.005		25.00			79.1												0.00
12.15			45	2.430	1.415	0.005		25.00			79.1												0.00
14.15		314	25	2.830	1.615	0.005		25.00	2.00	2.00	79.1												0.00
16.15			26	3.230	1.815	0.005		25.00			79.1												0.00
18.15			25	3.830	2.015	0.005		25.00			79.1												0.00
20.15			38	4.030	2.215	0.005		25.00			79.1												



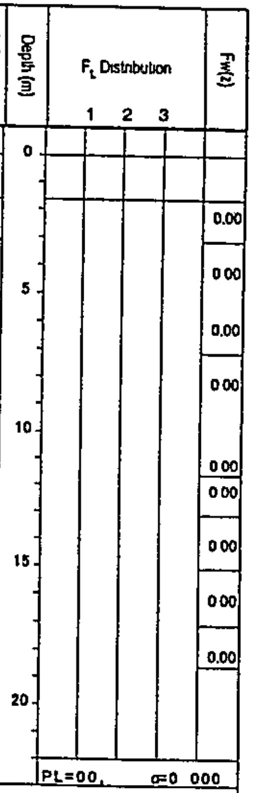
cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake
Judgement. ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No PO-13
Khc=0.61



Depth of Calculation m	Basic Data											Cyclic resistance ratio							Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R					
2.15	I	336	38	0.430	0.430	0.005		25.00	2.00	2.00	79.1												0.00
4.14			23	0.828	0.828	0.005		25.00			79.1												0.00
6.15			26	1.230	1.230	0.005		25.00			79.1												0.00
8.15			38	1.830	1.615	0.005		25.00			79.1												0.00
11.15			29	2.230	1.915	0.005		25.00			79.1												0.00
12.15			36	2.430	2.015	0.005		25.00			79.1												0.00
14.14			50	2.828	2.214	0.005		25.00			79.1												0.00
16.13			50	3.228	2.413	0.005		25.00			79.1												0.00
18.12			50	3.624	2.612	0.005		25.00			79.1												0.00

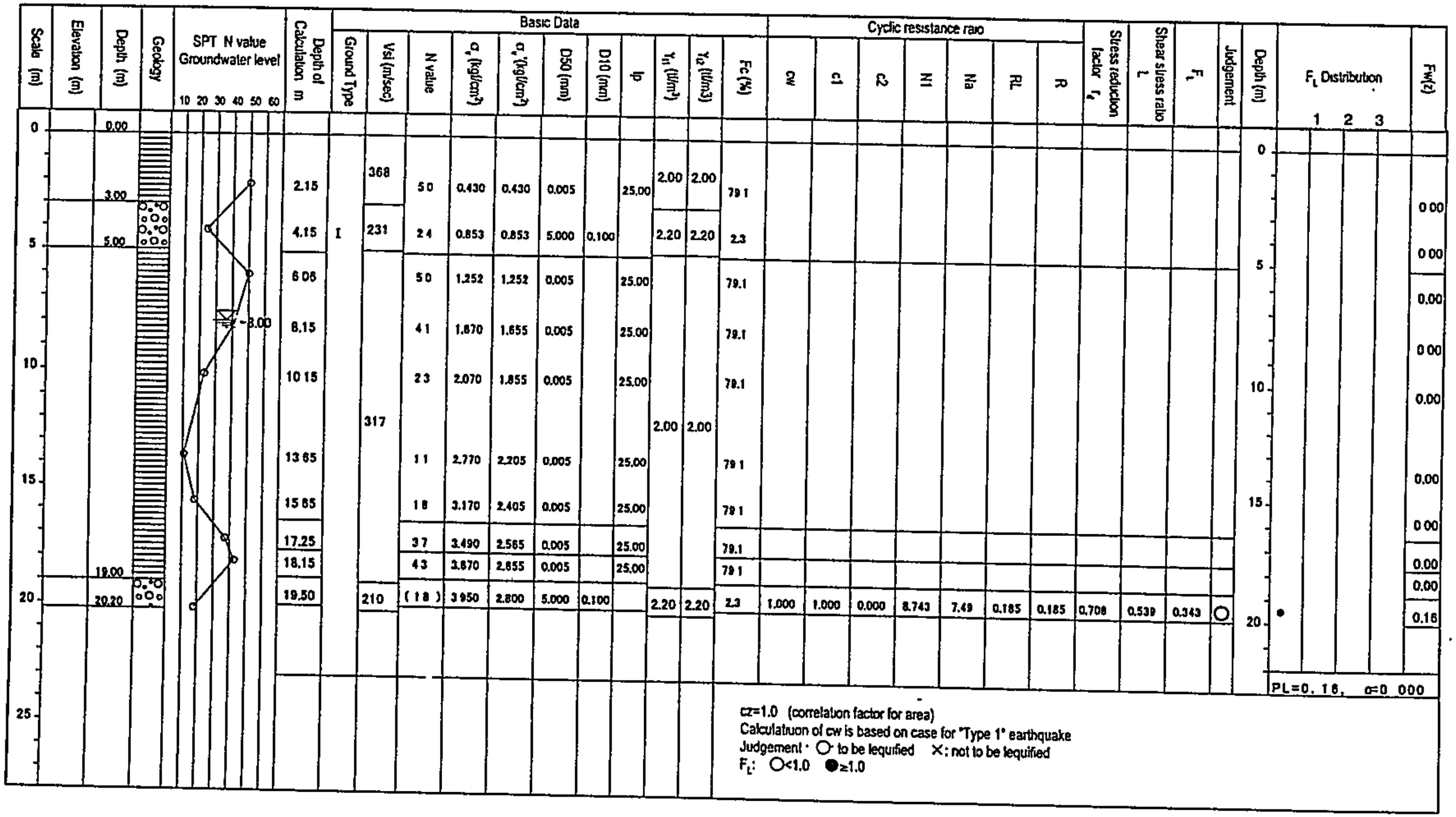


PL=0.0, σ=0 000

cz=1.0 (correlation factor for area)
Calculatuon of cw is based on case for "Type 1" earthquake
Judgement : ○ to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No PO-14
Khc=0.54



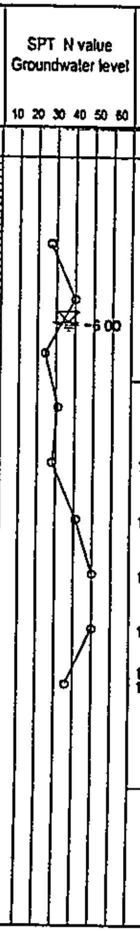
												Cyclic resistance ratio											
	Basic Data											Cyclic resistance ratio											
Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.15		368	50	0.430	0.430	0.005		25.00	2.00	2.00	79 1												0 00
4.15	I	231	24	0.853	0.853	5.000	0.100		2.20	2.20	2.3												0 00
6 06		317	50	1.252	1.252	0.005		25.00	2.00	2.00	79.1												0.00
8.15			41	1.870	1.655	0.005		25.00			79.1												0 00
10 15			23	2.070	1.855	0.005		25.00			79.1												0.00
13 65			11	2.770	2.205	0.005		25.00			79 1												0.00
15 85			18	3.170	2.405	0.005		25.00			79 1												0 00
17.25			37	3.490	2.565	0.005		25.00			79.1												0.00
18.15			43	3.870	2.855	0.005		25.00			79 1												0.00
19.50		210	(18)	3 950	2.800	5.000	0.100		2.20	2.20	2.3	1.000	1.000	0.000	8.743	7.49	0.185	0.185	0.708	0.539	0.343	○	0.16

cz=1.0 (correlation factor for area)
Calculatıon of cw is based on case for "Type 1" earthquake
Judgement · ○ to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No PO-15
Khc=0.61

Scale (m)	Elevation (m)	Depth (m)	Geology
0		0.00	
25		25.00	



Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement
3.15	I		2 7	0.63	0.63	0.005		25.00			79.1											
5.15			4 0	1.030	1.030	0.005		25.00			79.1											
7 15			2 4	1.430	1.315	0.005		25.00			79.1											
9.15			3 1	1 830	1.515	0.005		25.00			79 1											
11.15			2 8	2.230	1.715	0.005		25.00			79.1											
13 15			4 1	2.630	1.915	0.005		25.00			79 1											
15 15			5 0	3 030	2.115	0.005		25.00			79 1											
17 15			5 0	3.430	2.315	0.005		25.00			79 1											
18 65			(17)	3.730	2.485	0.005		25.00			79 1											
19 15			3 6	3.830	2.515	0.005		25.00			79 1											
									2.00	2.00												

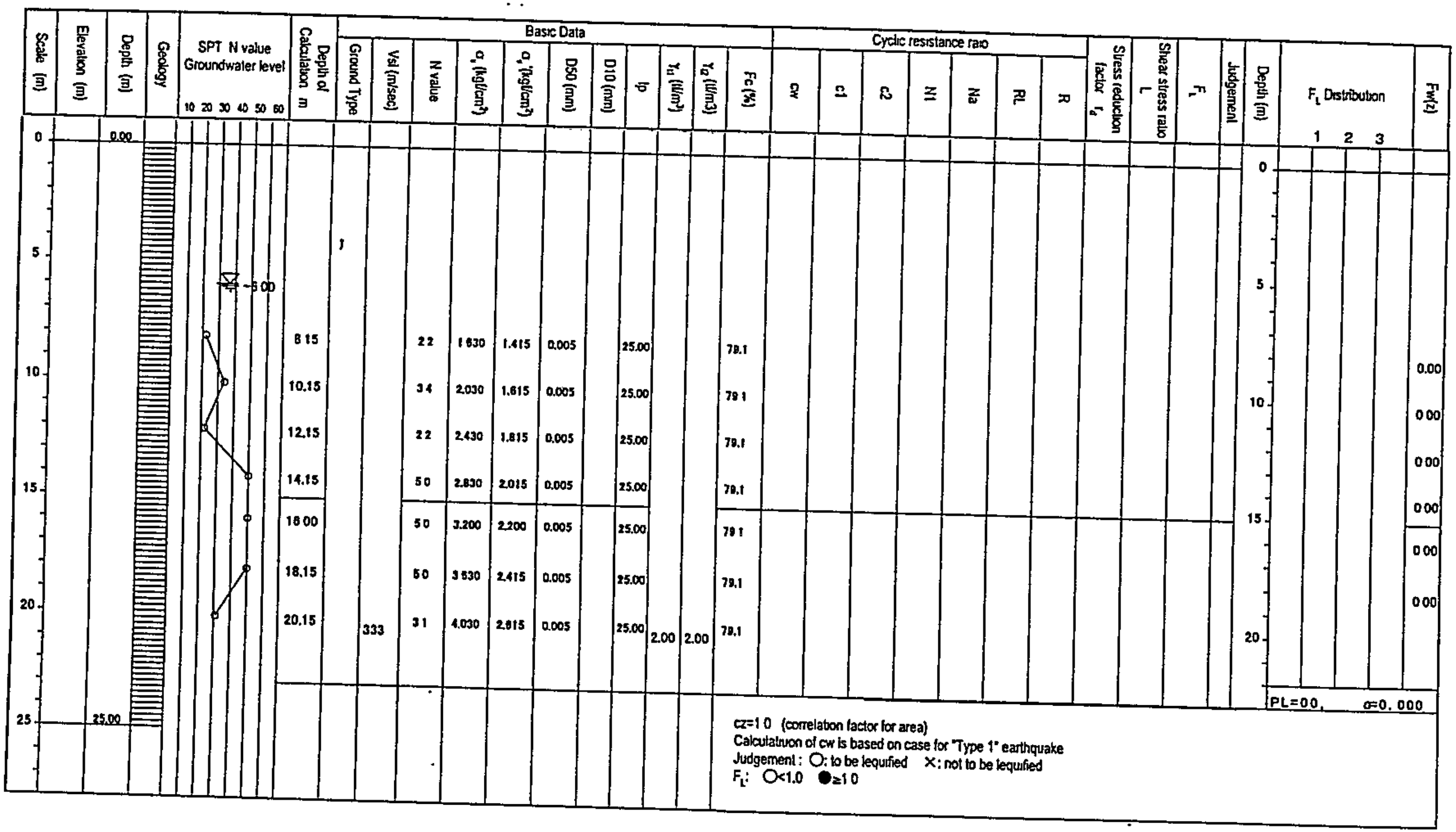
Depth (m)	F_L Distribution 1 2 3	Fw(z)
0		
5		0.00
		0 00
		0 00
10		0.00
		0 00
15		0 00
		0 00
		0 00
20		0 00
		0 00

PL=0 0, σ=0. 000

cz=1 0 (correlation factor for area)
Calculatuon of cw is based on case for "Type 1" earthquake.
Judgement : ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No PP-15
Khc=0.50

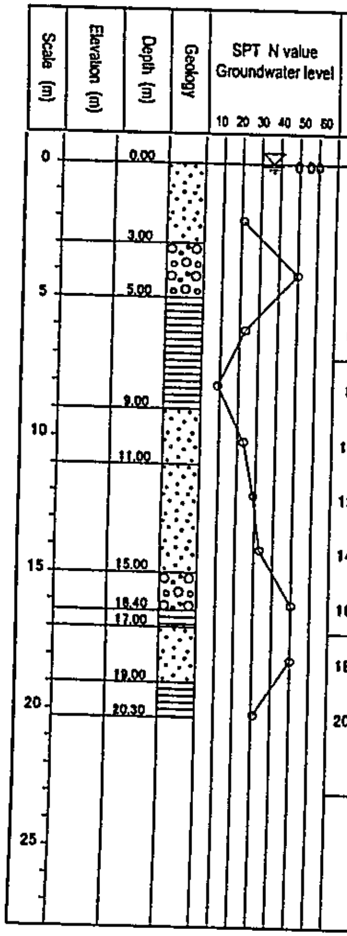


Depth of Calculation m	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
8 15			2 2	1 630	1.415	0.005		25.00			79.1												0.00
10.15			3 4	2.030	1.615	0.005		25.00			79 1												0 00
12.15			2 2	2.430	1.815	0.005		25.00			79.1												0 00
14.15			5 0	2.830	2.015	0.005		25.00			79.1												0 00
16 00			5 0	3.200	2.200	0.005		25.00			79 1												0 00
18.15			5 0	3 530	2.415	0.005		25.00			79.1												0 00
20.15		333	3 1	4.030	2.815	0.005		25.00	2.00	2.00	79.1												

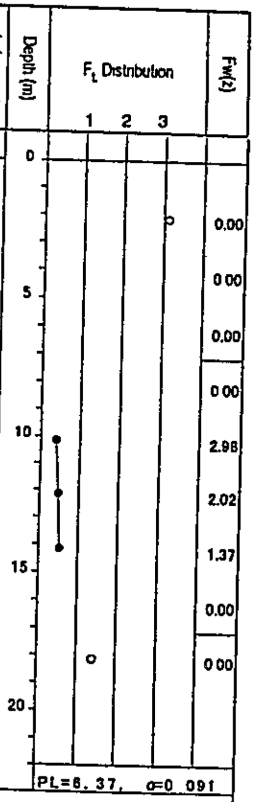
cz=1 0 (correlation factor for area)
Calculatiuon of cw is based on case for "Type 1" earthquake
Judgement : ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1 0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No PP-17
Khc=0.51



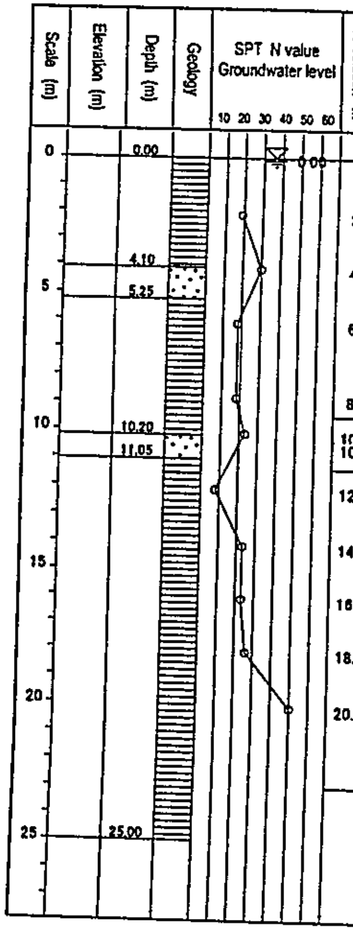
Depth of Calculation m	Ground Type	Basic Data										Cyclic resistance ratio							Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement
		Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v'(kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R				
2.15		221	21	0.451	0.236	2.100			2.10	2.10	14.2	1.000	1.084	0.233	38.121	37.83	2.935	2.935	0.968	0.943	3.112	×
4.15	I	295	50	0.883	0 468	5.000	5.000		2.20	2.20	2.3											
6.15		252	23	1.300	0.685	0.005		25.00	2.00	2.00	79 1											
8.14			9	1.698	0.884	0.005		25.00			79 1											
10.15		228	23	2.111	1.098	2.100			2.10	2.10	14.2	1 000	1.084	0.233	21 765	21.599	0.329	0.329	0.848	0.833	0.395	○
12.15		251	29	2.531	1.316	2.100			2.10	2.10	14.2	1.000	1.084	0.233	24.448	24.262	0.390	0.390	0.818	0.802	0.488	○
14.15			33	2.951	1.536	2.100					14.2	1 000	1.084	0.233	25.084	24.892	0.412	0 412	0.788	0.772	0.534	○
16.15		295	50	3.383	1.768	5.000	5.000		2.20 2.00	2.20 2.00	2.3											
18.14		295	50	3.797	1.983	2.100			2.10	2.10	14.2	1.000	1 084	0.233	31 876	31 435	0 997	0.997	0.728	0.711	1 402	×
20 15		314	31	4.208	2.193	0.005		25.00	2.00	2.00	79 1											



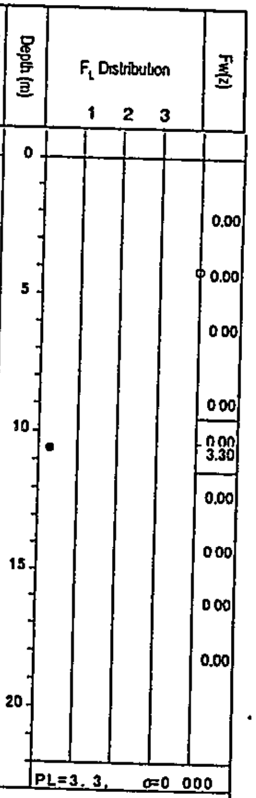
cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake
Judgement : ○ to be lequified × : not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No PQ-17
Khc=0.60



Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement
2.15		267	1 9	0 430	0.215	0.005		25.00	2.00	2.00	79 1											
4 15	I	249	3 0	0.831	0.418	2.100			2.10	2.10	14.2	1.000	1.084	0.233	45.719	45.371	9.135	9 135	0.938	1.124	8.127	×
6 15		271	1 8	1.242	0.627	0.005		25.00	2.00	2.00	79 1											
8.85			1 8	1 782	0.897	0.005		25.00			79 1											
10 15			2 3	2.042	1.027	0.005		25.00			79 1											
10 60		217	(2 0)	2.135	1.078	2.100			2.10	2.10	14.2	1.000	1.084	0.233	19 15	19 003	0.297	0.297	0.841	1 001	0.297	○
12.15		296	8	2.450	1.235	0.005		25.00	2.00	2.00	79 1											
14.15			2 3	2.850	1 435	0.005		25.00			79.1											
16 15			2 3	3.250	1 635	0.005		25.00			79 1											
18.15			2 6	3.650	1.835	0.005		25 00			79.1											
20.15			5 0	4.050	2.035	0.005		25.00			79 1											

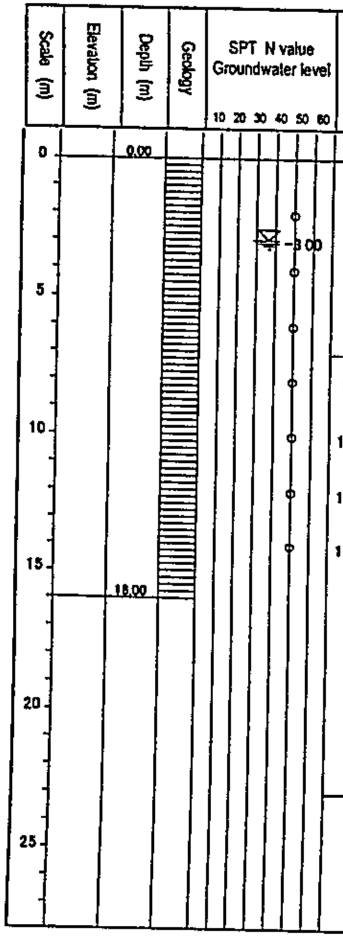


PL=3. 3, σ=0 000

cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement : ○ to be lequified × , not to be lequified
F_L : ○<1 0 ●≥1 0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S19-4
Khc=0.48



Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.07	I	368	50	0.414	0.414	0.005		25.00	2.00	2.00	79.1												0.00
4.07			50	0.814	0.707	0.005		25.00			79.1												0 00
6 07			50	1.214	0.907	0.005		25.00			79 1												0.00
8 07			50	1 814	1.107	0.005		25.00			79 1												0 00
10 07			50	2.014	1.307	0.005		25.00			79.1												0 00
12.07			50	2.414	1.507	0.005		25.00			79.1												0.00
14.07			50	2.814	1.707	0.005		25.00			79 1												0 00

Basic Data: Ground Type to Fc (%); Cyclic resistance raio: cw to R

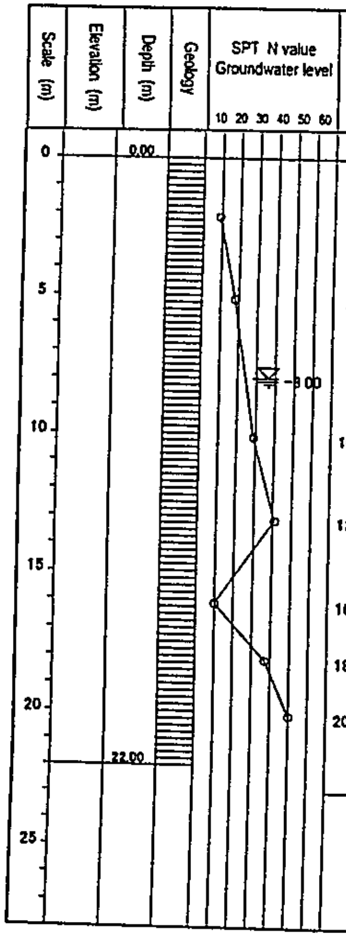
Depth (m) 0 5 10 15 20 — F_L Distribution 1 2 3

PL=0 0, σ=0 000

cz=1 0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake
Judgement · ○ to be lequified × · not to be lequified
F_L: ○<1 0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S207-1
Khc=0.55



Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.15	I	304	9	0.430	0.430	0.005		25.00	2.00	2.00	79.1												0.00
5.15			18	1.030	1.030	0.005		25.00			79.1												0.00
10.15			29	2.030	1.815	0.005		25.00			79.1												0.00
13.15			41	2.630	2.115	0.005		25.00			79.1												0.00
16.15			10	3.230	2.415	0.005		25.00			79.1												0.00
18.15			37	3.630	2.615	0.005		25.00			79.1												0.00
20.15			50	4.030	2.815	0.005		25.00			79.1												

F_L Distribution 1 2 3

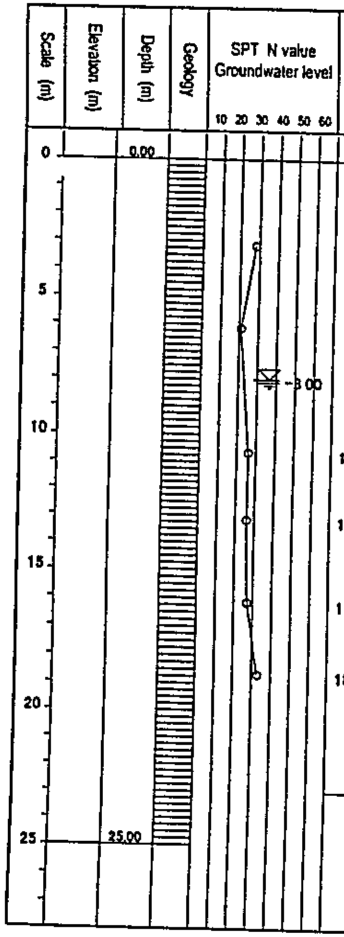
Depth (m) 0 5 10 15 20

PL=0.0, σ=0.000

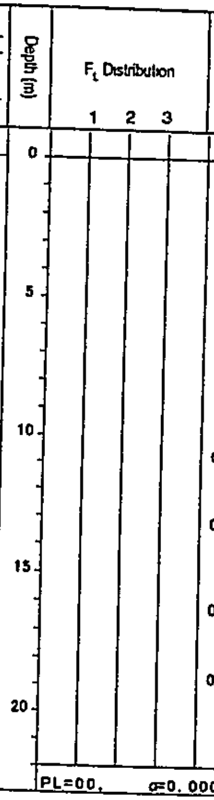
cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement : ○: to be lequified ×: not to be lequified
F_L ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S207-2
Khc=0.55



Depth of Calculation m	Basic Data: Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	Cyclic resistance ratio: cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
3.15	I	300	2 8	0.63	0.63	0.005		25.00	2.00	2.00	79 1												0 00
6.15			2 1	1.230	1.230	0.005		25.00			79 1												0 00
10 65			2 6	2.130	1 865	0.005		25.00			79 1												0 00
13.15			2 6	2.630	2.115	0.005		25.00			79 1												0 00
16 15			2 7	3.230	2.415	0.005		25.00			79 1												0 00
18.65			3 3	3.730	2.665	0.005		25.00			79.1												0.00

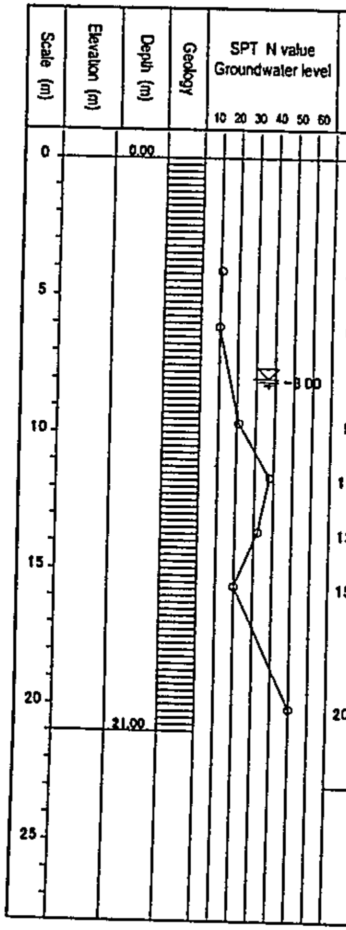


PL=0 0, σ=0. 000

cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake
Judgement : ○: to be lequified ×: not to be lequified
F_L: ○<1 0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S207-3
Khc=0.55



Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
4 15	I		11	0.830	0.830	0.005		25.00			79 1												0.00
6.15			10	1.230	1.230	0.005		25.00			79.1												0 00
9 65		280	21	1.930	1.765	0.005		25.00	2.00	2.00	79.1												0 00
11.65			38	2.330	1 965	0.005		25.00			79 1												0 00
13 65			32	2.730	2.185	0.005		25.00			79.1												0.00
15 65			20	3.130	2.385	0.005		25.00			79 1												0.00
20 15			50	4.030	2.815	0.005		25.00			79 1												

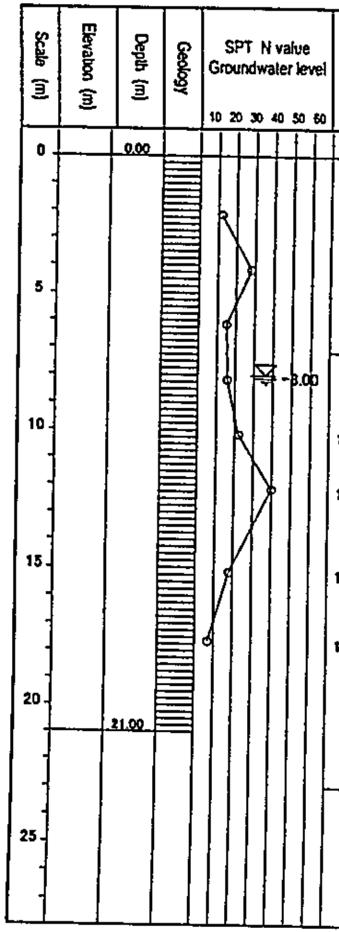
Depth (m) 0 5 10 15 20 — F_L Distribution 1 2 3

PL=00, σ=0. 000

cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake
Judgement : ○ to be lequified × : not to be lequified
F_L: ○<1.0 ●≥1 0

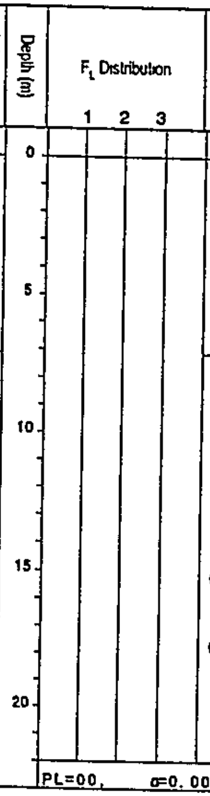
Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S207-4
Khc=0.55



Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.15	I	271	12	0.430	0.430	0.005		25.00	2.00	2.00	79 1												0.00
4.15			28	0.830	0.830	0.005		25.00			79 1												0.00
6 15			15	1.230	1.230	0.005		25.00			79 1												0 00
8.15			16	1 630	1 615	0.005		25.00			79.1												0 00
10.15			22	2.030	1 815	0.005		25.00			79.1												0.00
12.15			40	2.430	2.015	0.005		25.00			79 1												0 00
15.15			18	3.030	2.315	0.005		25 00			79 1												0.00
17 65			7	3.530	2.565	0.005		25.00			79.1												0.00

Basic Data: Ground Type to Fc (%); Cyclic resistance ratio: cw to R.

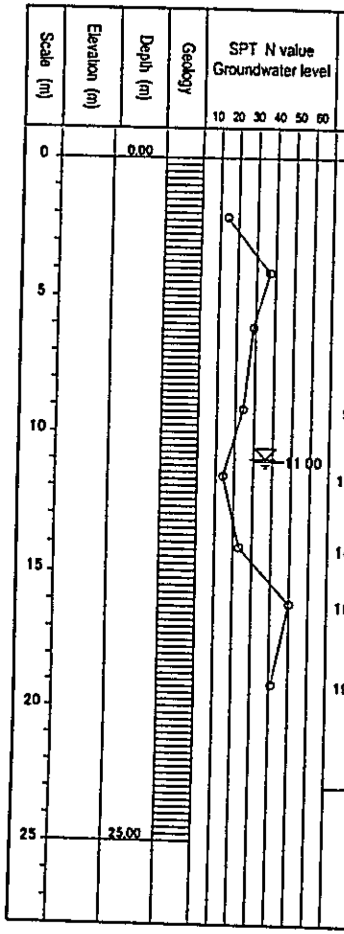


PL=0.0, σ=0. 000

cz=1 0 (correlation factor for area)
Calculatuon of cw is based on case for "Type 1" earthquake.
Judgement : ○ to be lequified × not to be lequified
F_L: ○<1.0 ●≥1 0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S207-6
Khc=0.60



Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.15			1 4	0 430	0.430	0.005		25.00			79 1												0.00
4 15	I		3 7	0.830	0.830	0.005		25.00			79.1												0 00
6 15			2 9	1.230	1.230	0.005		25.00			79 1												0 00
9 15			2 4	1.830	1.830	0.005		25 00			79.1												0 00
11 65		307	1 4	2.330	2.285	0.005		25.00	2.00	2.00	79.1												0 00
14 15			2 3	2.830	2.515	0.005		25.00			79 1												0 00
16.15			5 0	3.230	2.715	0.005		25.00			79 1												0.00
19.15			4 1	3.830	3.015	0.005		25.00			79.1												0 00

Depth (m) 0 5 10 15 20

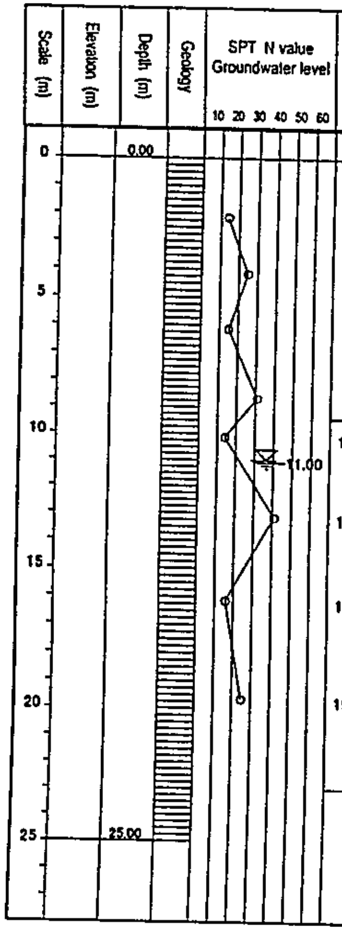
F_L Distribution 1 2 3

PL=0 0, σ=0 000

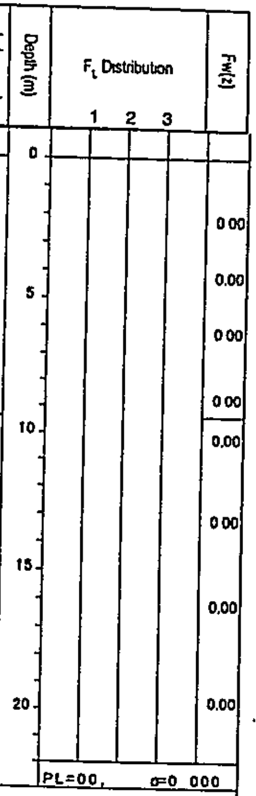
cz=1 0 (correlation factor for area)
Calculatuon of cw is based on case for "Type 1" earthquake
Judgement · ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S207-7
Khc=0.60



Depth of Calculation m	Basic Data: Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	Cyclic resistance ratio: cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.15			1 4	0 430	0.430	0.005		25.00			79 1												0 00
4.15	I		2 5	0.830	0.830	0.005		25.00			79 1												0.00
6.15			1 5	1.230	1.230	0.005		25.00			79.1												0 00
8 65			3 1	1 730	1.730	0.005		25.00			79 1												0 00
10 15			1 4	2.030	2.030	0.005		25.00			79 1												0.00
13.15		284	4 1	2.830	2.415	0.005		25.00	2.00	2 00	79.1												0 00
16.15			1 8	3.230	2.715	0.005		25.00			79.1												0.00
19.65			2 5	3 930	3.085	0.005		25.00			79 1												0.00

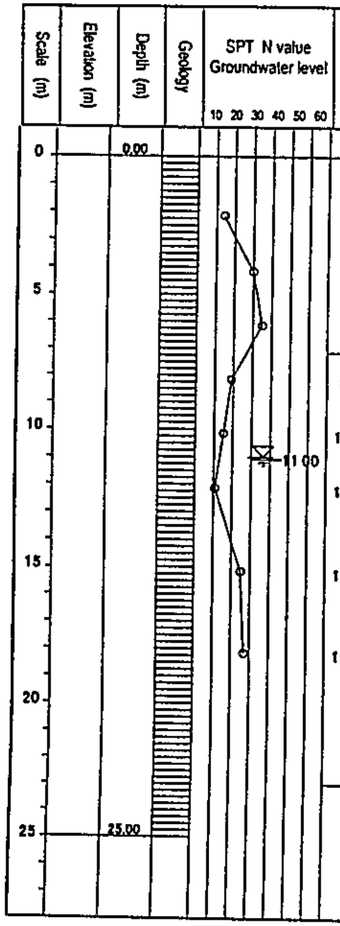


PL=00, σ=0 000

cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake
Judgement : ○ to be lequified ×: not to be lequfied
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S207-8
Khc=0.60



Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.15			14	0.430	0.430	0.005		25.00			79.1												0.00
4.15	I		30	0.830	0.830	0.005		25.00			79.1												0.00
6.15			35	1.230	1.230	0.005		25.00			79.1												0.00
8.15			19	1.630	1.630	0.005		25.00			79.1												0.00
10.15			15	2.030	2.030	0.005		25.00			79.1												0.00
12.15		280	11	2.430	2.315	0.005		25.00	2.00	2.00	79.1												0.00
15.15			25	3.030	2.615	0.005		25.00			79.1												0.00
18.15			27	3.630	2.915	0.005		25.00			79.1												0.00

Basic Data: Ground Type to Fc (%); Cyclic resistance ratio: cw to R.

F_L Distribution 1 2 3, Depth (m) 0 5 10 15 20

PL=00, σ=0. 000

cz=1.0 (correlation factor for area)
Calculatuon of cw is based on case for "Type 1" earthquake
Judgement ○ to be lequified ✕: not to be lequified
F_L: ○<1.0 ●≥1 0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No 30-1
Khc=0.49

Scale (m): 0, 5, 10, 15, 20, 25
Depth (m): 0.00, 25.00
SPT N value / Groundwater level: 10 20 30 40 50 60; -4.00

Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement
1.07		368	50	0.214	0.214	0.005		25.00	2.00	2.00	79 1											
4.07	I		50	0.814	0.807	0.005		25.00			79 1											
6 07			50	1.214	1 007	0.005		25.00			79.1											
8 07			50	1 614	1.207	0.005		25.00			79.1											
10.07			50	2.014	1 407	0.005		25.00			79 1											
12 07			50	2.414	1 607	0.005		25.00			79 1											
14.07			50	2.814	1.807	0.005		25.00			79 1											
16 07			50	3.214	2.007	0.005		25.00			79.1											
18 07			50	3 614	2.207	0.005		25.00			79 1											
20 07			50	4.014	2.407	0.005		25.00			79 1											

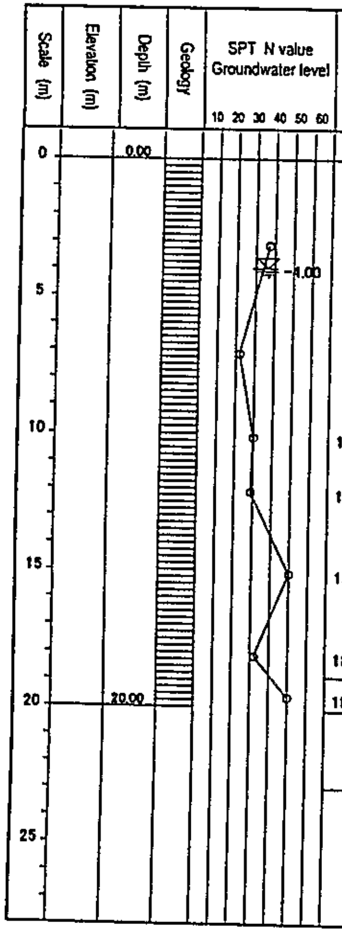
Depth (m): 0, 5, 10, 15, 20
F_L Distribution: 1 2 3
Fw(z): 0.00, 0 00, 0 00, 0.00, 0.00, 0.00, 0 00, 0 00, 0 00

PL=0 0,   σ=0 000

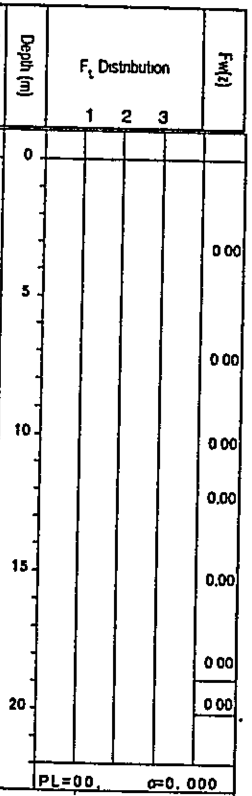
cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake
Judgement · ○· to be lequified   ×· not to be lequified
F_L· ○<1.0 ●≥1 0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S365-1
Khc=0.41



Depth of Calculation m	Basic Data											Cyclic resistance raio							Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v'(kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R					
3 15	I	330	3 7	0.63	0.63	0.005		25.00	2.00	2.00	79 1												0 00
7.15			2 2	1.430	1.115	0.005		25.00			79 1												0 00
10 15			3 0	2.030	1 415	0.005		25.00			79.1												0 00
12.15			2 9	2.430	1 615	0.005		25.00			79 1												0.00
15.15			5 0	3.030	1 915	0.005		25.00			79.1												0.00
18.15			3 2	3.830	2.215	0.005		25.00			79 1												0 00
19.65			5 0	3.930	2.365	0.005		25.00			79.1												0 00

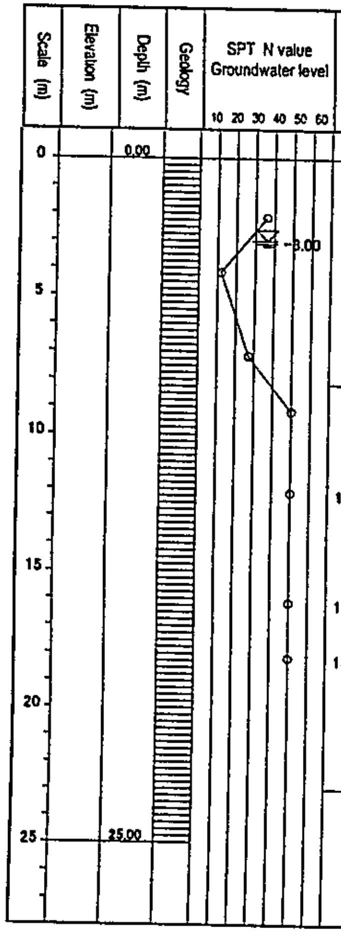


PL=0 0,   σ=0. 000

cz=1.0 (correlation factor for area)
Calculatiuon of cw is based on case for "Type 1" earthquake
Judgement : ○ to be lequified   ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S367-1
Khc=0.47



Depth of Calculation m	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.15	I	339	36	0.430	0.430	0.005		25.00	2.00	2.00	79.1												0.00
4.15			12	0.830	0.715	0.005		25.00			79.1												0.00
7.15			27	1.430	1.015	0.005		25.00			79.1												0.00
9.15			50	1.830	1.215	0.005		25.00			79.1												0.00
12.15			50	2.430	1.515	0.005		25.00			79.1												0.00
16.15			50	3.230	1.915	0.005		25.00			79.1												0.00
18.15			50	3.830	2.115	0.005		25.00			79.1												0.00

Basic Data: Ground Type to Fc (%); Cyclic resistance ratio: cw to R.

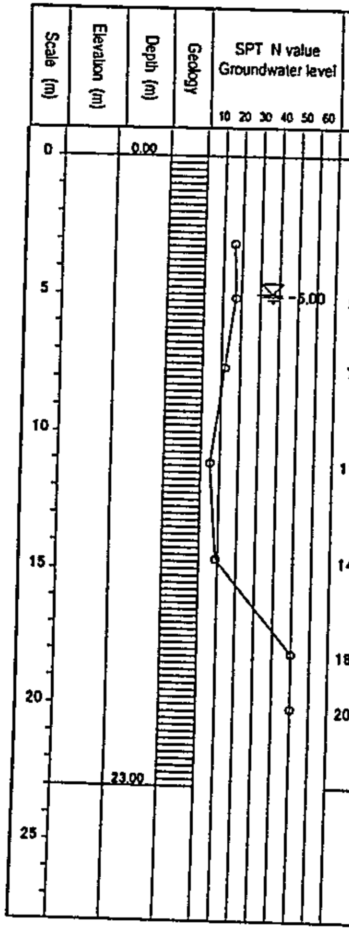
F_L Distribution: 1 2 3; Depth (m) 0 5 10 15 20

PL=0.0, σ=0. 000

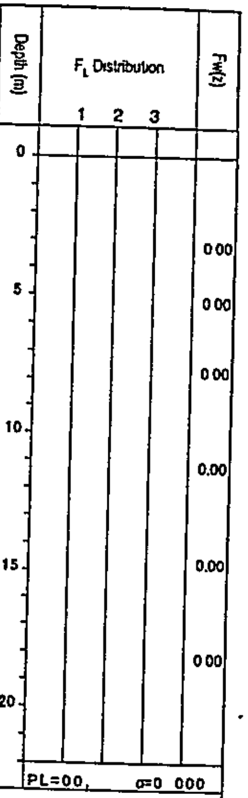
cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake
Judgement. ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S390-1
Khc=0.39



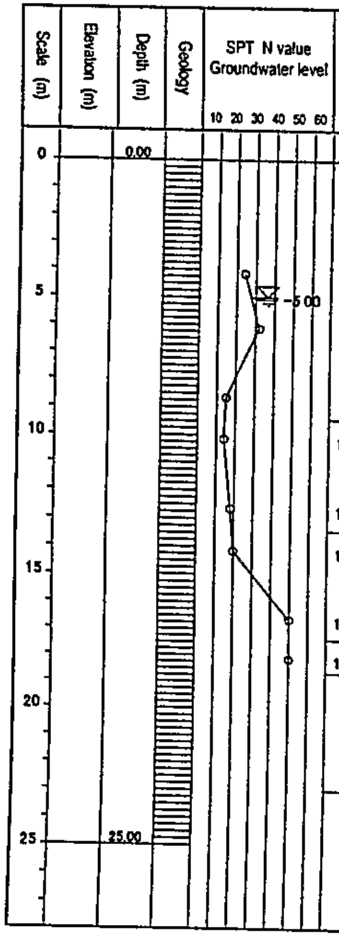
Depth of Calculation m	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement
3 15	I		1 6	0.63	0.63	0.005		25.00			79.1											
5 15			1 7	1.030	1.015	0.005		25.00			79 1											
7.65			1 2	1.530	1.265	0.005		25.00			79.1											
11.15		284	5	2.230	1.615	0.005		25.00	2.00	2.00	79 1											
14 65			9	2.930	1 965	0.005		25.00			79.1											
18.15			5 0	3.830	2.315	0.005		25.00			79 1											
20.15			5 0	4.030	2.515	0.005		25.00			79 1											



cz=1 0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement : ○ to be lequified ×: not to be lequified
F_L' ○<1 0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S390-2
Khc=0.39



Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
4 15	I	304	2 4	0.830	0.830	0.005		25.00	2.00	2.00	79 1												0.00
6 15			3 2	1.230	1.115	0.005		25.00			79 1												0 00
8 65			1 5	1.730	1.365	0.005		25.00			79 1												0.00
10 15			1 4	2.030	1 515	0.005		25.00			79 1												0.00
12.65			1 8	2.530	1 765	0.005		25.00			79 1												0.00
14 15			2 0	2.830	1 915	0.005		25.00			79 1												0 00
16 65			5 0	3.330	2.165	0.005		25.00			79 1												0 00
18 15			5 0	3 630	2.315	0.005		25.00			79 1												0 00

Depth (m) 0 5 10 15 20

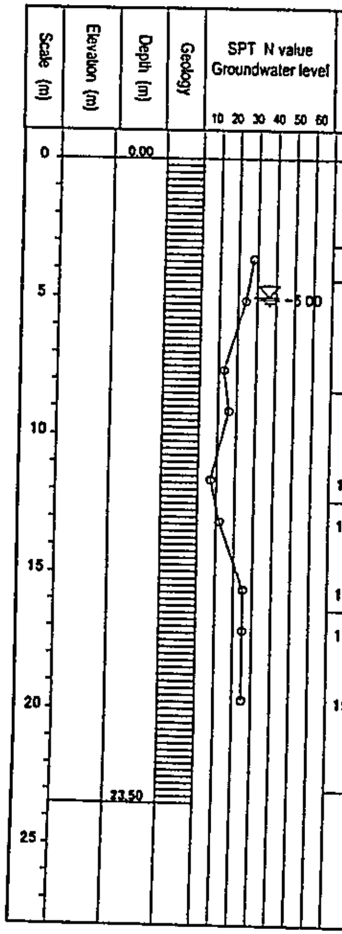
F_L Distribution 1 2 3

PL=00, σ=0. 000

cz=1 0 (correlation factor for area)
Calculatiuon of cw is based on case for "Type 1" earthquake
Judgement : ○: to be lequified ×. not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S390-3
Khc=0.39



Depth of Calculation m	Basic Data											Cyclic resistance ratio							Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R					
3 65	I	267	2 8	0.730	0.730	0.005		25.00	2.00	2.00	79.1												0 00
5 15			2 4	1 030	1.015	0.005		25.00			79 1												0.00
7 65			1 3	1.530	1.265	0.005		25.00			79.1												0 00
9 15			1 6	1.830	1.415	0.005		25.00			79 1												0 00
11 65			7	2.330	1.665	0.005		25.00			79 1												0 00
13 15			1 2	2.630	1.815	0.005		25.00			79 1												0.00
15 65			2 5	3.130	2.065	0.005		25.00			79.1												0 00
17 15			2 5	3.430	2.215	0.005		25.00			79.1												0 00
19 65			2 5	3.930	2.465	0.005		25.00			79 1												0 00

Depth (m) 0 5 10 15 20

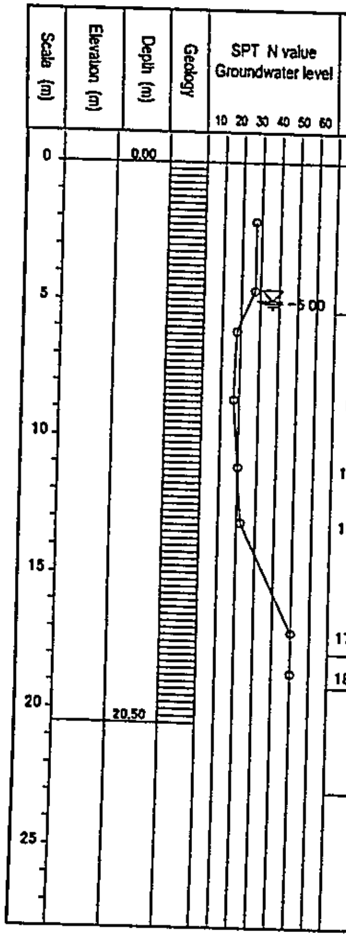
F_L Distribution 1 2 3

PL=0.0, σ=0. 000

cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

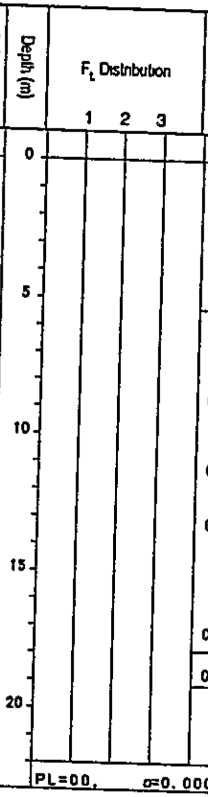
Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S390-4
Khc=0.39



Depth of Calculation m	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.15	I t	307	27	0.430	0.430	0.005		25.00	2.00	2.00	79.1												0.00
4.65			27	0.930	0.930	0.005		25.00			79.1												0.00
6.15			18	1.230	1.115	0.005		25.00			79.1												0.00
8.65			17	1.730	1.385	0.005		25.00			79.1												0.00
11.15			20	2.230	1.815	0.005		25.00			79.1												0.00
13.15			22	2.630	1.815	0.005		25.00			79.1												0.00
17.15			50	3.430	2.215	0.005		25.00			79.1												0.00
18.65			50	3.730	2.385	0.005		25.00			79.1												0.00

Basic Data: Ground Type to Fc (%); Cyclic resistance ratio: cw to R

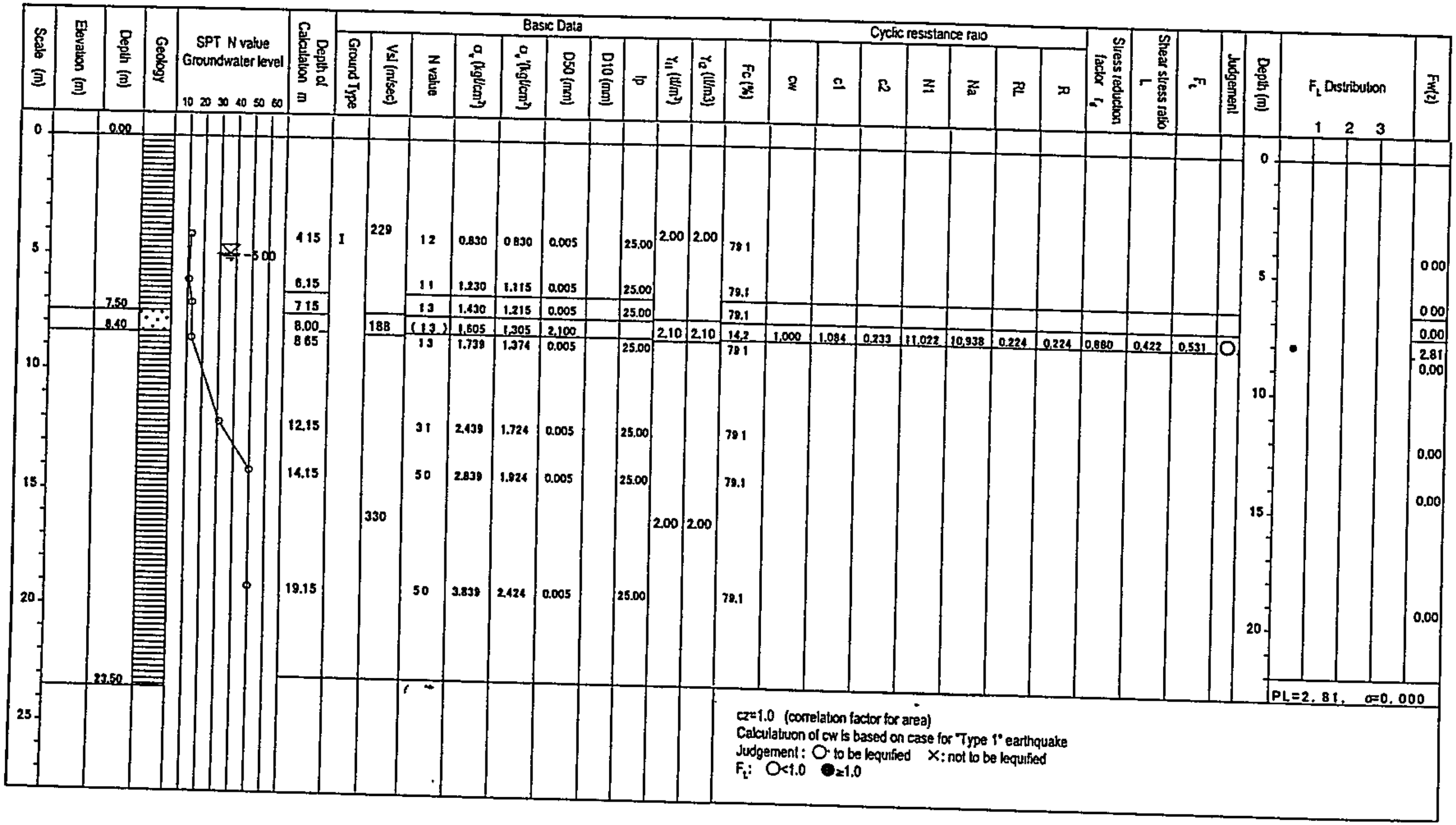


PL=0.0, σ=0.000

cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake
Judgement. ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S390-5
Khc=0.39

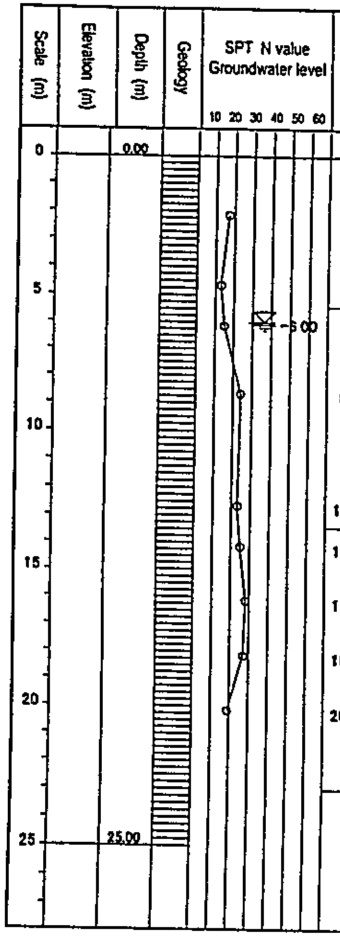


Depth of Calculation m	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
4 15	I	229	1 2	0.830	0 830	0.005		25.00	2.00	2.00	79 1												0 00
6.15			1 1	1.230	1.115	0.005		25.00			79.1												0 00
7 15			1 3	1.430	1.215	0.005		25.00			79.1												0.00
8.00		188	(1 3)	1.605	1.305	2.100			2.10	2.10	14.2	1.000	1.084	0.233	11.022	10.938	0.224	0.224	0.880	0.422	0.531	○	2.81
8 65		330	1 3	1.739	1.374	0.005		25.00	2.00	2.00	79 1												0.00
12.15			3 1	2.439	1.724	0.005		25.00			79 1												0.00
14.15			5 0	2.839	1.924	0.005		25.00			79.1												0.00
19.15			5 0	3.839	2.424	0.005		25.00			79.1												0.00

cz=1.0 (correlation factor for area)
Calculatuon of cw is based on case for "Type 1" earthquake
Judgement : ○ to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S390-6
Khc=0.41



Depth of Calculation m	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.15	I	276	17	0.430	0.430	0.005		25.00	2.00	2.00	79.1												0.00
4.65			13	0.930	0.930	0.005		25.00			79.1												0.00
6.15			15	1.230	1.215	0.005		25.00			79.1												0.00
8.65			24	1.730	1.465	0.005		25.00			79.1												0.00
12.65			23	2.530	1.865	0.005		25.00			79.1												0.00
14.15			25	2.830	2.015	0.005		25.00			79.1												0.00
16.15			28	3.230	2.215	0.005		25.00			79.1												0.00
18.15			27	3.630	2.415	0.005		25.00			79.1												0.00
20.15			18	4.030	2.615	0.005		25.00			79.1												

Basic Data · Cyclic resistance ratio

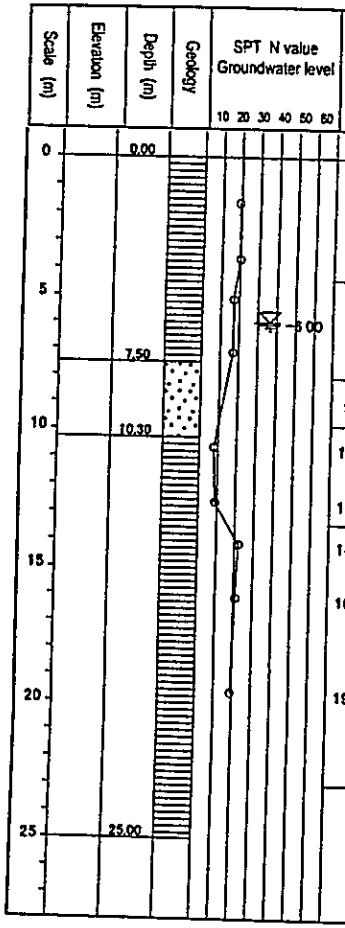
Depth (m) · F_L Distribution 1 2 3

PL=00, σ=0.000

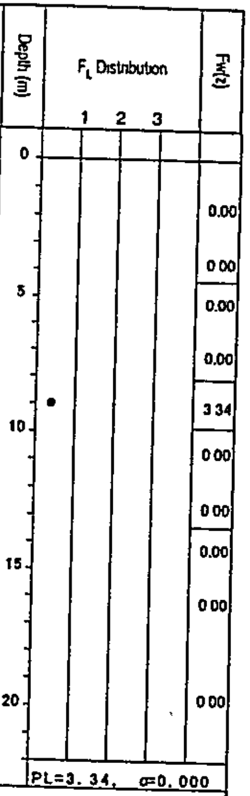
cz=1.0 (correlation factor for area)
Calculatuon of cw is based on case for "Type 1" earthquake
Judgement : ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No S390-7
Khc=0.41



Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
1 65	I	262	1 9	0.330	0.330	0.005		25.00	2.00	2.00	79.1												0.00
3 65			2 0	0.730	0.730	0.005		25.00			79 1												0 00
5 15			1 7	1.030	1 030	0.005		25.00			79.1												0.00
7.15			1 7	1 430	1.315	0.005		25.00			79 1												0.00
9.00		160	(8)	1.815	1.515	2.100			2.10	2.10	14.2	1.000	1.084	0.233	6 14	6 093	0.167	0.167	0.885	0.425	0.393	○	3 34
10 65		252	8	2.158	1 693	0 005		25.00	2.00	2.00	79.1												0 00
12.65			9	2.558	1.893	0.005		25.00			79.1												0 00
14.15			2 2	2.858	2.043	0.005		25.00			79 1												0.00
16.15			2 1	3.258	2.243	0.005		25.00			79 1												0 00
19.65			1 9	3.958	2.593	0.005		25 00			79.1												0 00

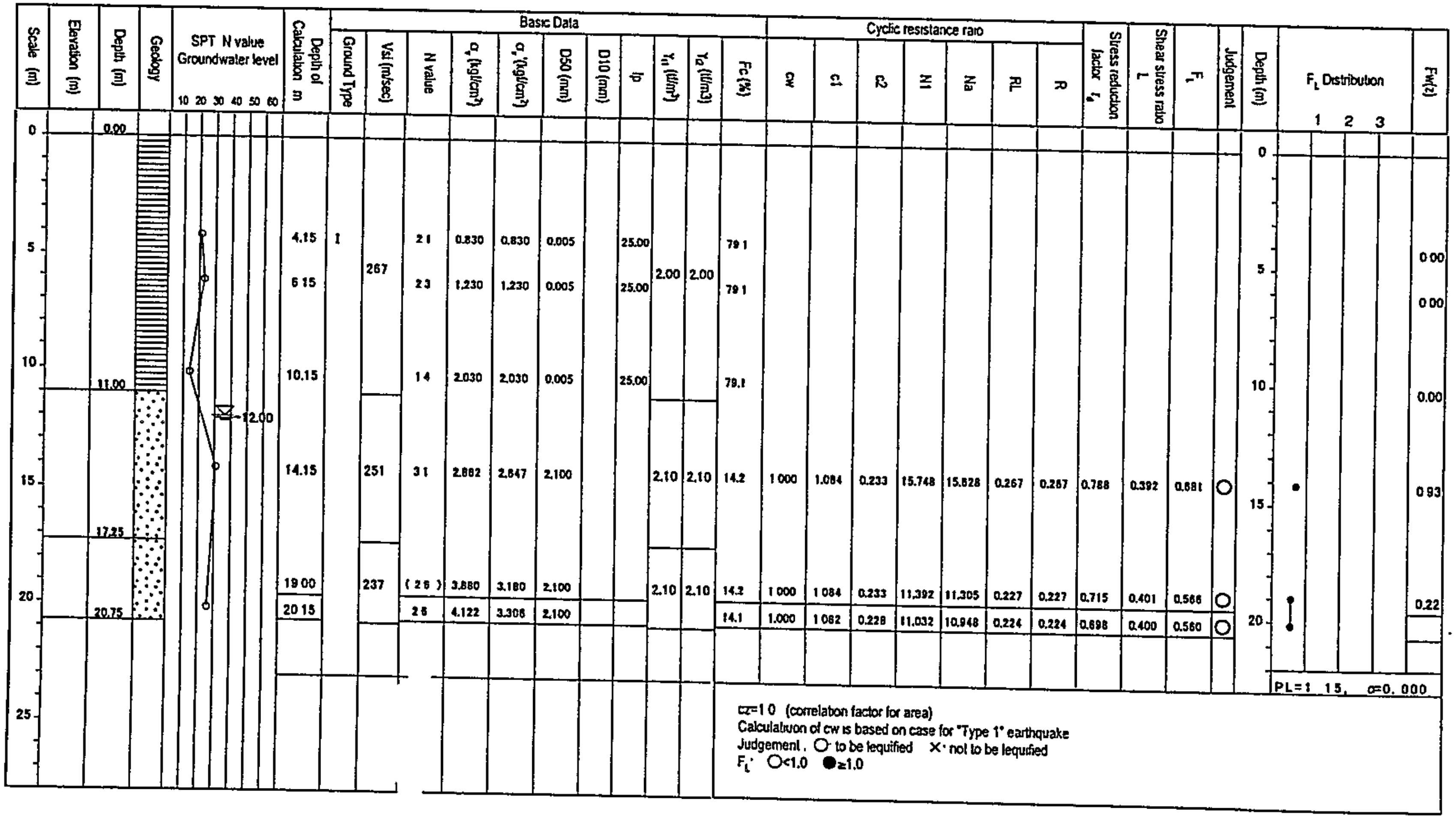


PL=3. 34, σ=0. 000

cz=1.0 (correlation factor for area)
Calculatruon of cw is based on case for "Type 1" earthquake
Judgement : ○: to be lequified ×· not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E37-16
Khc=0.46



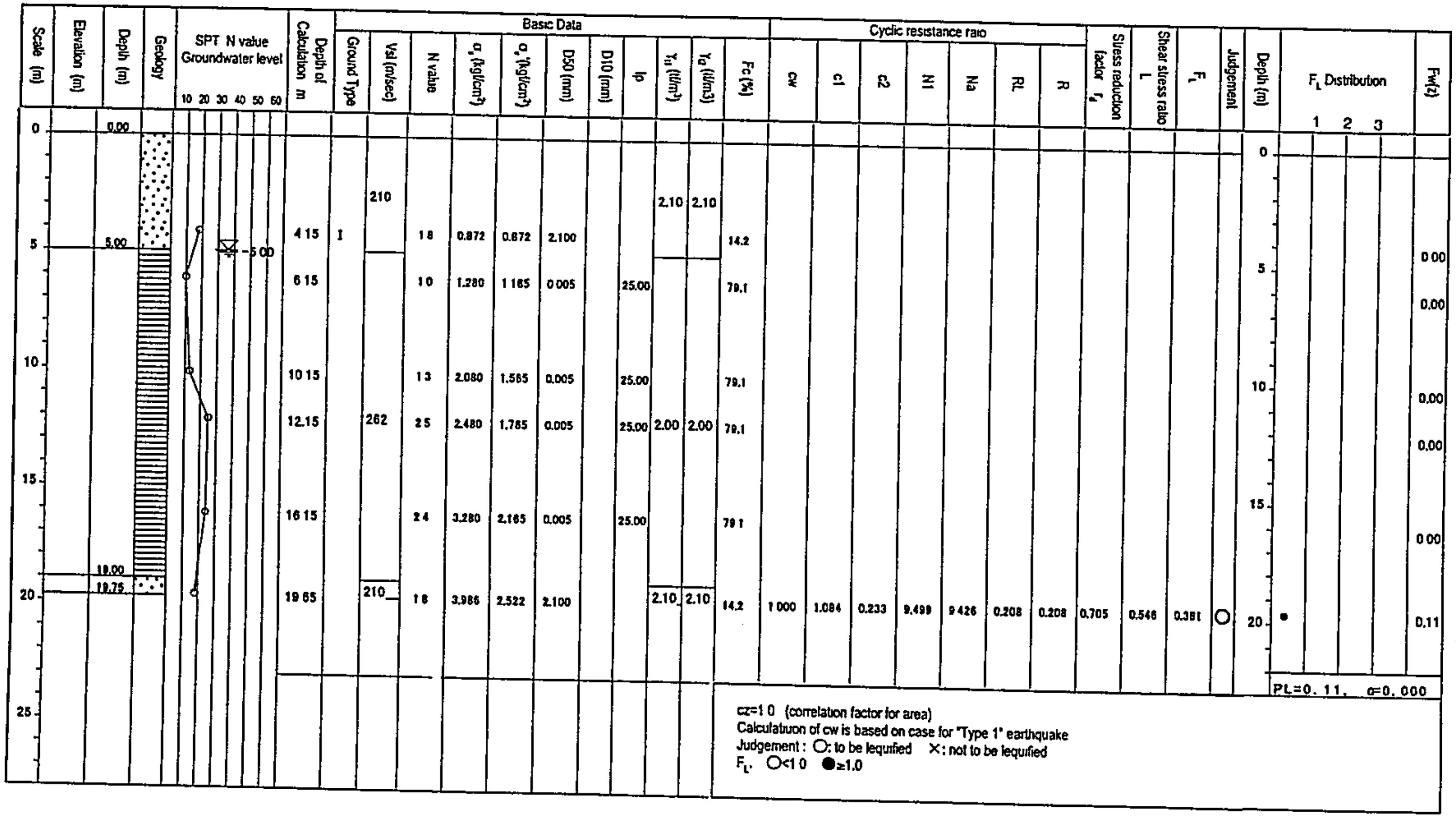
						Basic Data						Cyclic resistance raio											
Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
4.15	I	267	2 1	0.830	0.830	0.005		25.00	2.00	2.00	79 1												0.00
6 15			2 3	1.230	1.230	0.005		25.00			79 1												0.00
10.15			1 4	2.030	2.030	0.005		25.00			79.1												0.00
14.15		251	3 1	2.882	2.647	2.100			2.10	2.10	14.2	1 000	1.084	0.233	15.748	15.828	0.267	0.267	0.788	0.392	0.681	○	0 93
19 00		237	(2 6)	3.880	3.180	2.100			2.10	2.10	14.2	1 000	1 084	0.233	11.392	11.305	0.227	0.227	0.715	0.401	0.566	○	0.22
20 15			2 6	4.122	3.306	2.100					14.1	1.000	1 082	0.228	11.032	10.948	0.224	0.224	0.698	0.400	0.560	○	

PL=1 15, σ=0. 000

cz=1 0 (correlaton factor for area)
Calculation of cw is based on case for "Type 1" earthquake
Judgement . ○ to be lequified ×· not to be lequified
F_L· ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E37-17
Khc=0.49

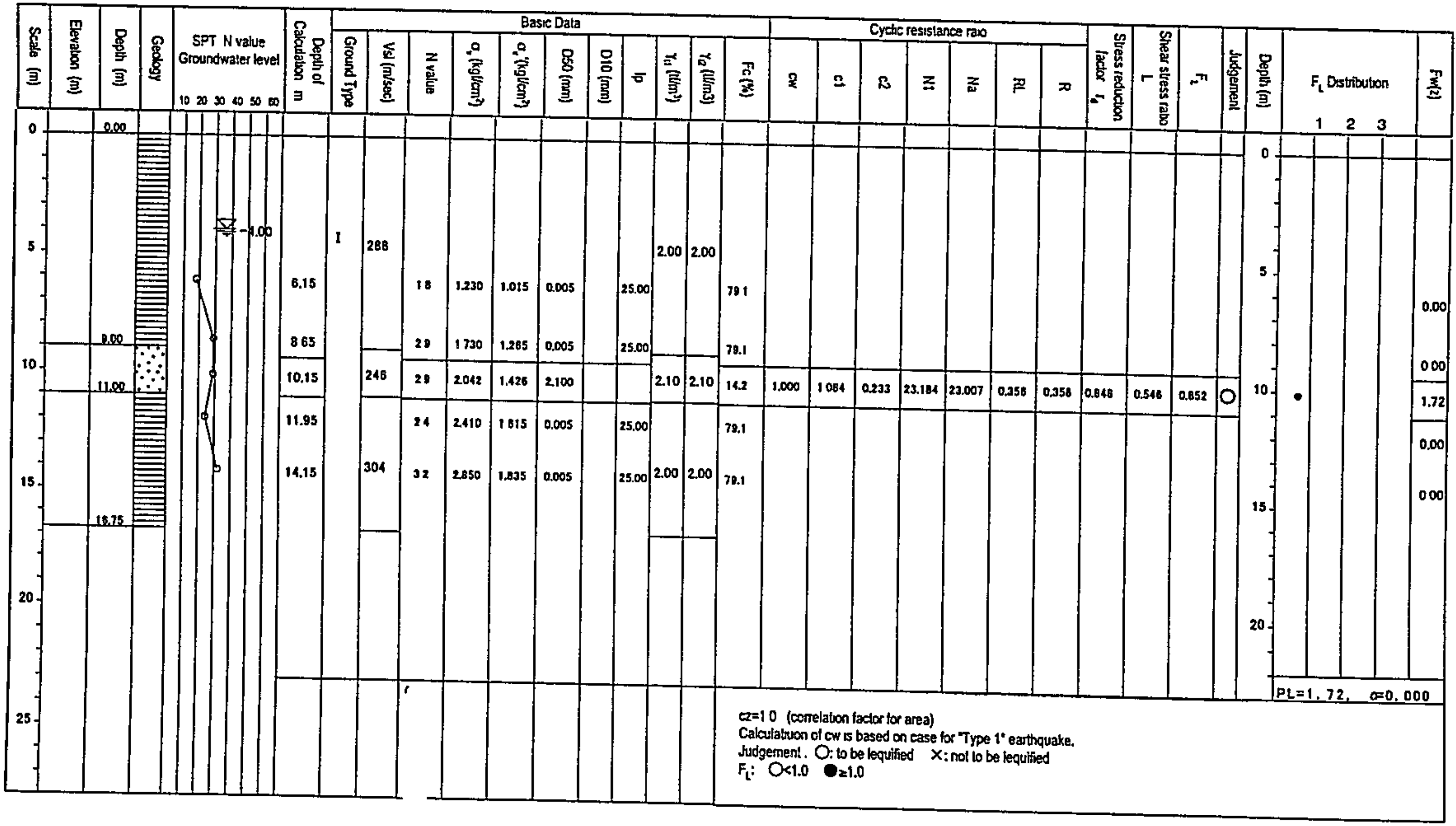


Depth of Calculation m	Basic Data											Cyclic resistance raio											
	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F$_L$	Judgement	Fw(z)
4 15	I	210	1 8	0.872	0.872	2.100			2.10	2.10	14.2												0 00
6 15			1 0	1.280	1 165	0 005		25.00			79.1												0.00
10 15			1 3	2.080	1.565	0.005		25.00			79.1												0.00
12.15		262	2 5	2.480	1.785	0.005		25.00	2.00	2.00	79.1												0.00
16 15			2 4	3.280	2.165	0.005		25.00			79 1												0 00
19 65		210	1 8	3.986	2.522	2.100			2.10	2.10	14.2	1 000	1.084	0.233	9.499	9 426	0.208	0.208	0.705	0.546	0.381	○	0.11

cz=1 0 (correlation factor for area)
Calculatuon of cw is based on case for "Type 1" earthquake
Judgement : ○: to be lequified ×: not to be lequified
F$_L$. ○<1 0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoring
Boring No E37-18
Khc=0.45

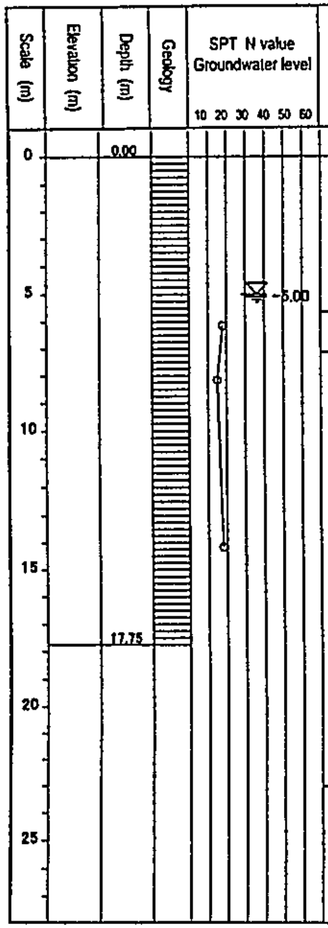


Depth of Calculation m	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
	I	288							2.00	2.00													
6.15			1 8	1.230	1.015	0.005		25.00			79 1												0.00
8 65			2 9	1 730	1.285	0.005		25.00			79.1												0 00
10.15		246	2 9	2.042	1.426	2.100			2.10	2.10	14.2	1.000	1 084	0.233	23.184	23.007	0.358	0.358	0.848	0.546	0.852	○	1.72
11.95			2 4	2.410	1 815	0.005		25.00			79.1												0.00
14.15		304	3 2	2.850	1.835	0.005		25.00	2.00	2.00	79.1												0 00

cz=1 0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement. ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E37-19
Khc=0.52



Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
	I	257							2.00	2.00													
6.15			18	1.230	1.115	0.005		25.00			79.1												0.00
8.15			15	1.830	1.315	0.005		25.00			79.1												0.00
14.15			18	2.830	1.915	0.005		25.00			79.1												0.00

Basic Data: Ground Type to Fc (%); Cyclic resistance ratio: cw to R

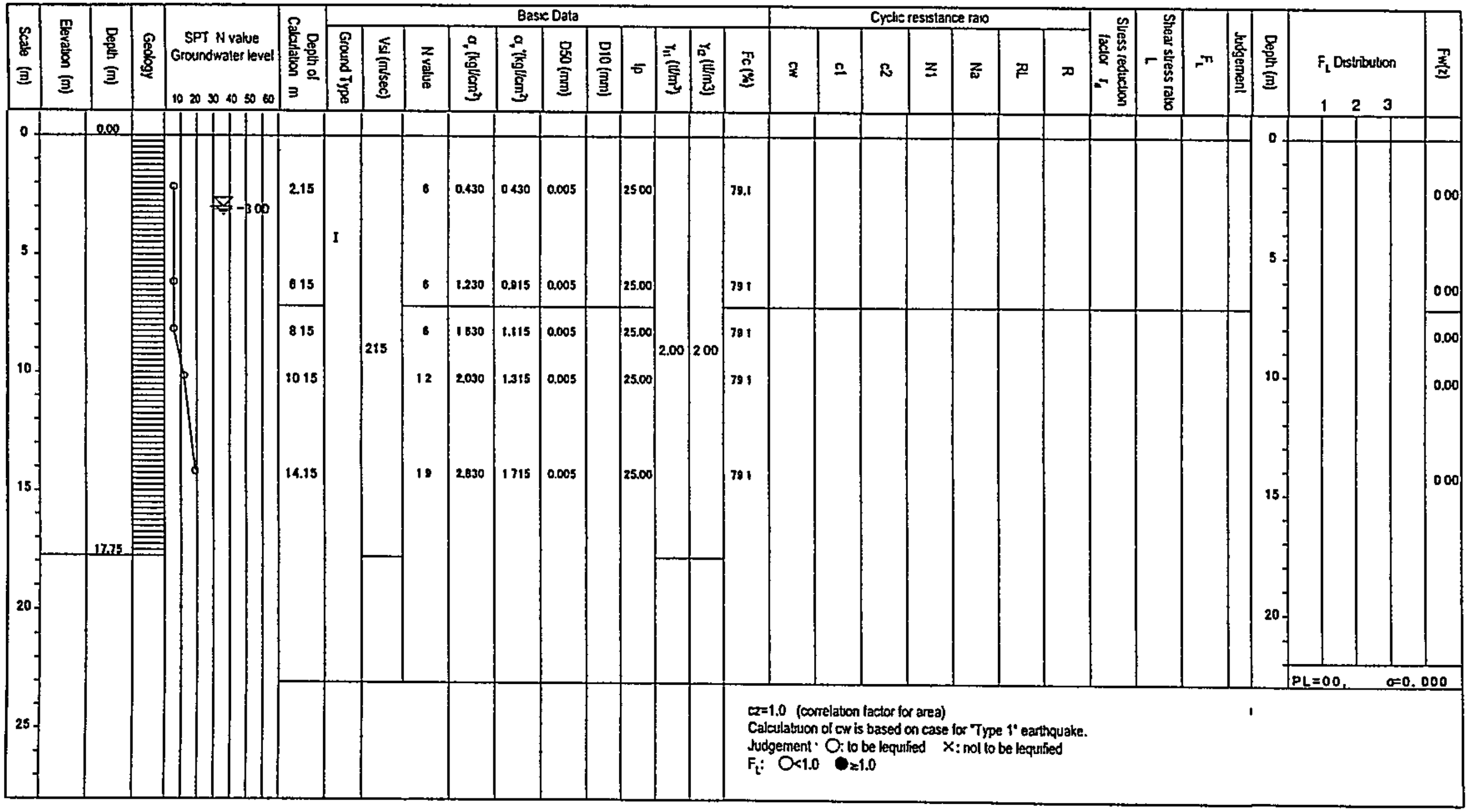
F_L Distribution 1 2 3; Depth (m) 0 5 10 15 20

PL=0.0, σ=0 000

cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement : ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E37-20
Khc=0.47

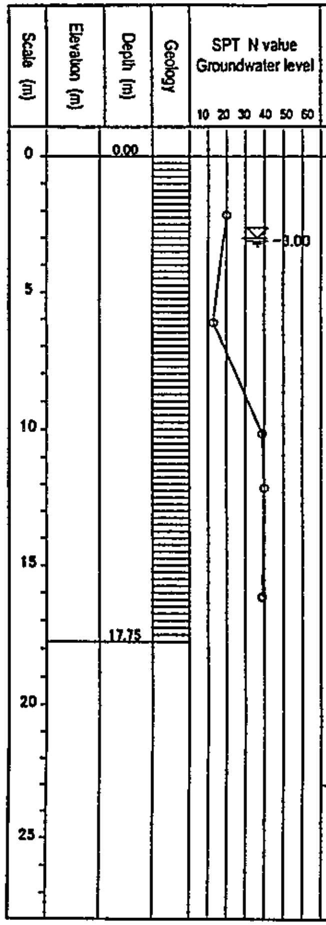


Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F$_L$	Judgement	Fw(z)
2.15	I	215	6	0.430	0 430	0.005		25 00	2.00	2 00	79.1												0 00
6 15			6	1.230	0.915	0.005		25.00			79 1												0 00
8 15			6	1 830	1.115	0.005		25.00			79 1												0.00
10 15			1 2	2.030	1.315	0.005		25.00			79 1												0.00
14.15			1 9	2.830	1 715	0.005		25.00			79 1												0 00

cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement · ○: to be lequified ×: not to be lequified
F$_L$: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E37-21
Khc=0.48



Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.15	I	311	20	0.430	0.430	0.005		25.00	2.00	2.00	79.1												0.00
6.15			13	1.230	0.915	0.005		25.00			79.1												0.00
10.15			39	2.030	1.315	0.005		25.00			79.1												0.00
12.15			40	2.430	1.515	0.005		25.00			79.1												0.00
16.15			39	3.230	1.915	0.005		25.00			79.1												0.00

Basic Data / Cyclic resistance rato

Depth (m): 0, 5, 10, 15, 20

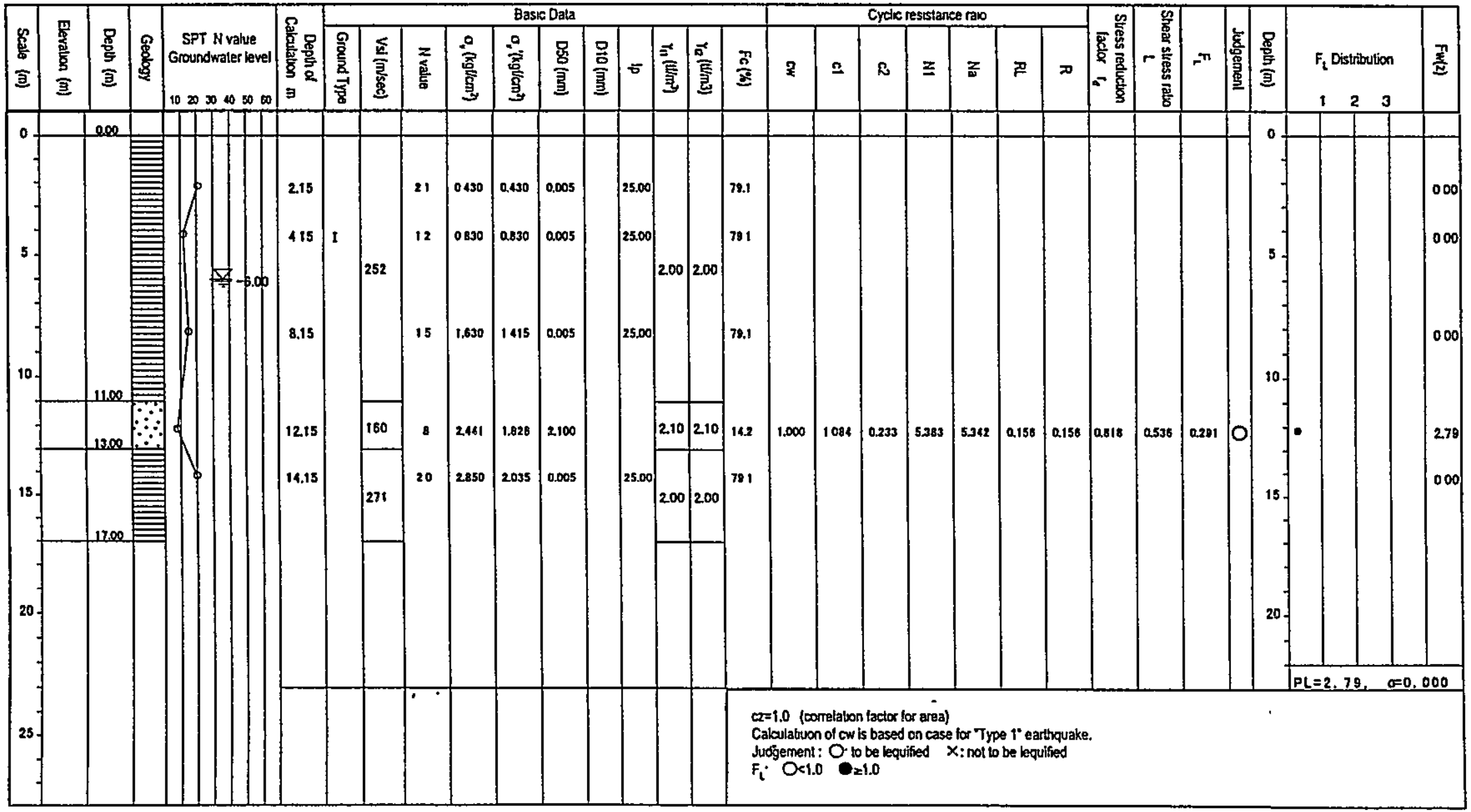
F_L Distribution: 1 2 3

PL=0.0, σ=0.000

cz=1.0 (correlation factor for area)
Calculatuon of cw is based on case for "Type 1" earthquake.
Judgement : ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E37-22
Khc=0.49

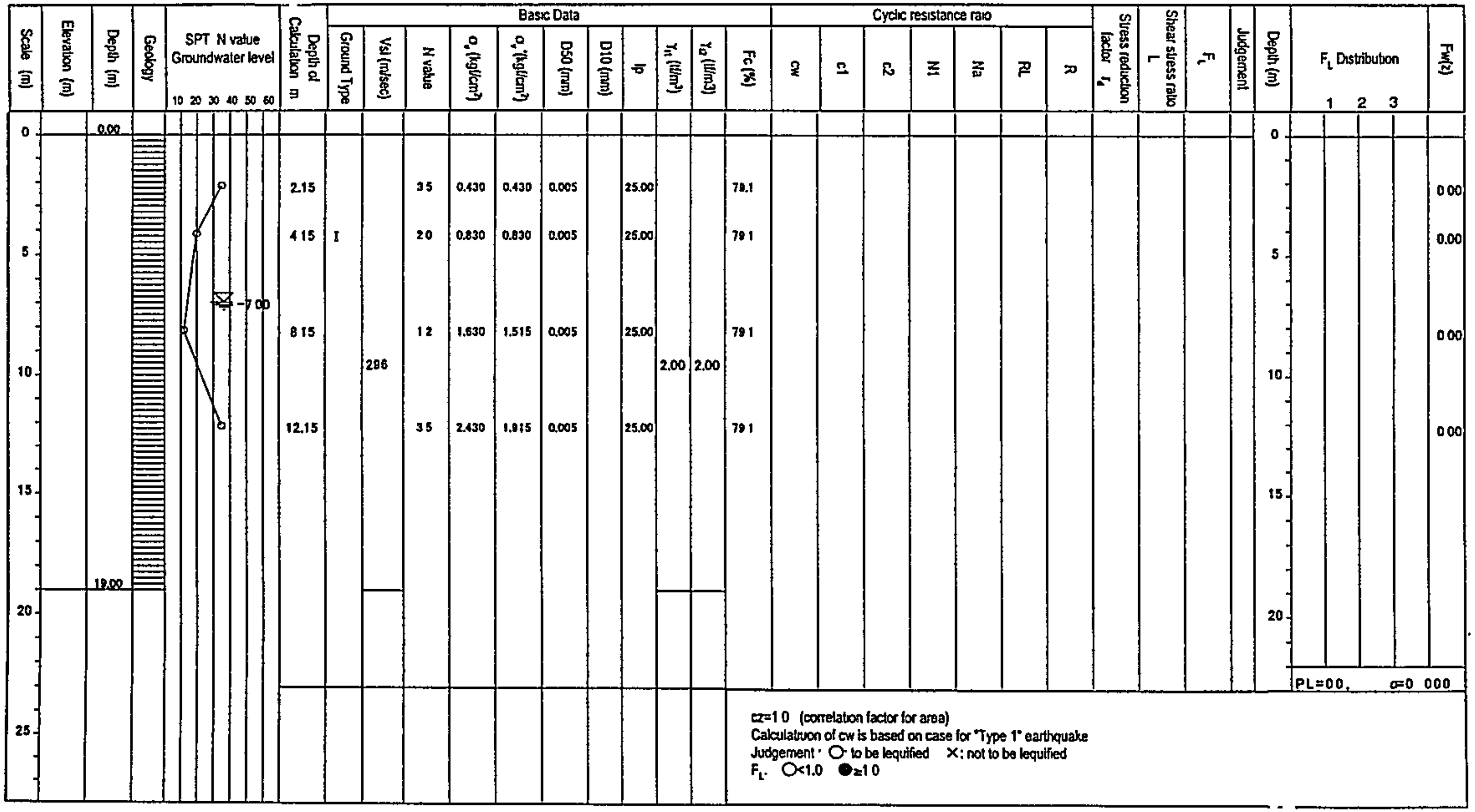


Depth (m)	Depth of Calculation m	Basic Data												Cyclic resistance ratio							Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
		Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)		cw	c1	c2	N1	Na	RL	R					
0.00																									
	2.15			2 1	0 430	0.430	0.005		25.00			79.1													0 00
	4 15	I		1 2	0 830	0.830	0.005		25.00			79 1													0 00
			252							2.00	2.00														
	8.15			1 5	1.630	1 415	0.005		25.00			79.1													0 00
11.00																									
	12.15		160	8	2.441	1.828	2.100			2.10	2.10	14.2		1.000	1 084	0.233	5.383	5.342	0.156	0.156	0.818	0.536	0.291	○	2.79
13.00																									
	14.15			2 0	2.850	2.035	0.005		25.00			79 1													0 00
			271							2.00	2.00														
17.00																									

cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement : ○: to be lequified ✕: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E37-23
Khc=0.56

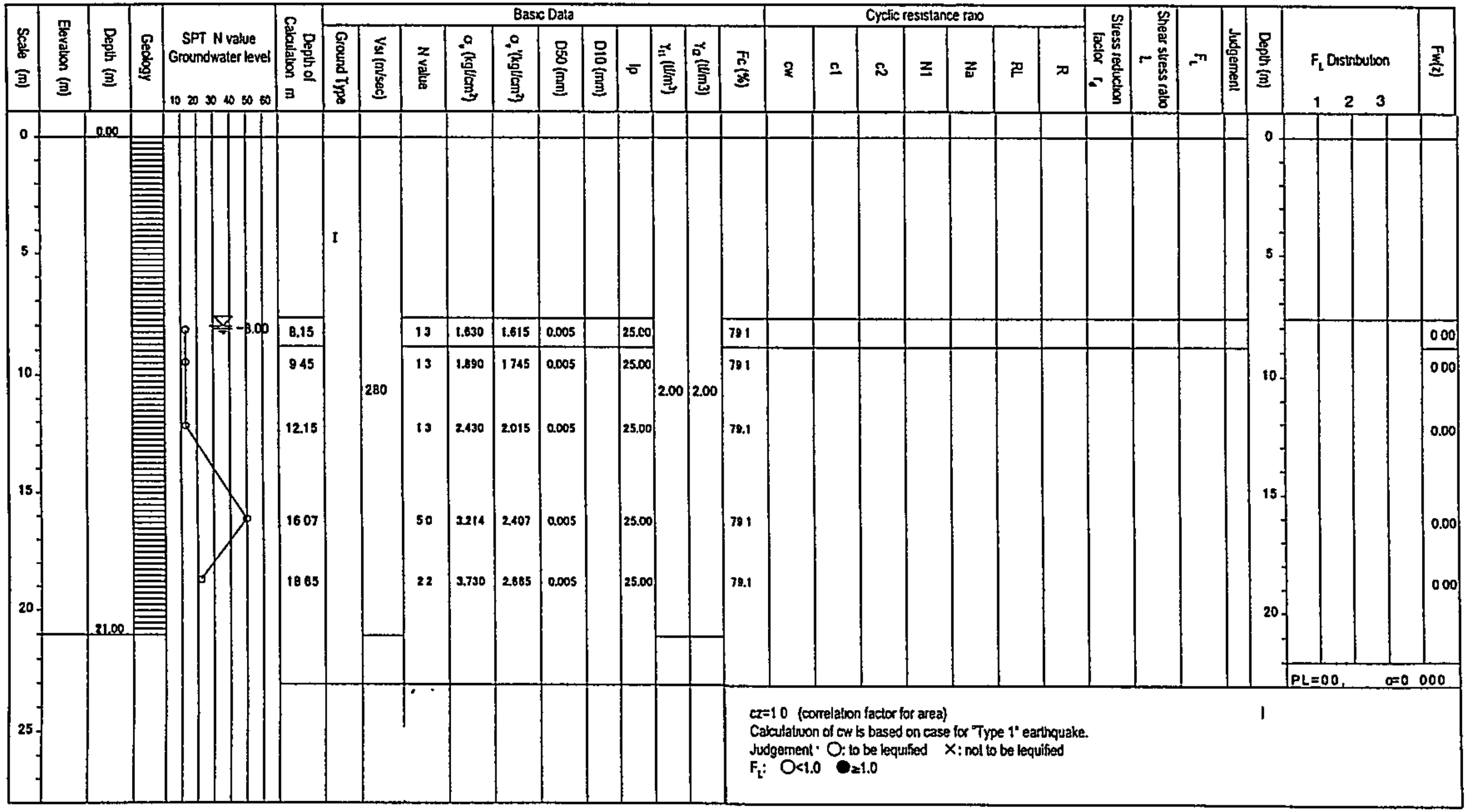


Depth of Calculation m	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.15			3 5	0.430	0.430	0.005		25.00			79.1												0 00
4 15	I		2 0	0.830	0.830	0.005		25.00			79 1												0.00
8 15			1 2	1.630	1.515	0.005		25.00			79 1												0 00
		286							2.00	2.00													
12.15			3 5	2.430	1.915	0.005		25.00			79 1												0 00

cz=1 0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake
Judgement · ○ to be lequified ×: not to be lequified
F_L· ○<1.0 ●≥1 0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E37-16
Khc=0.60

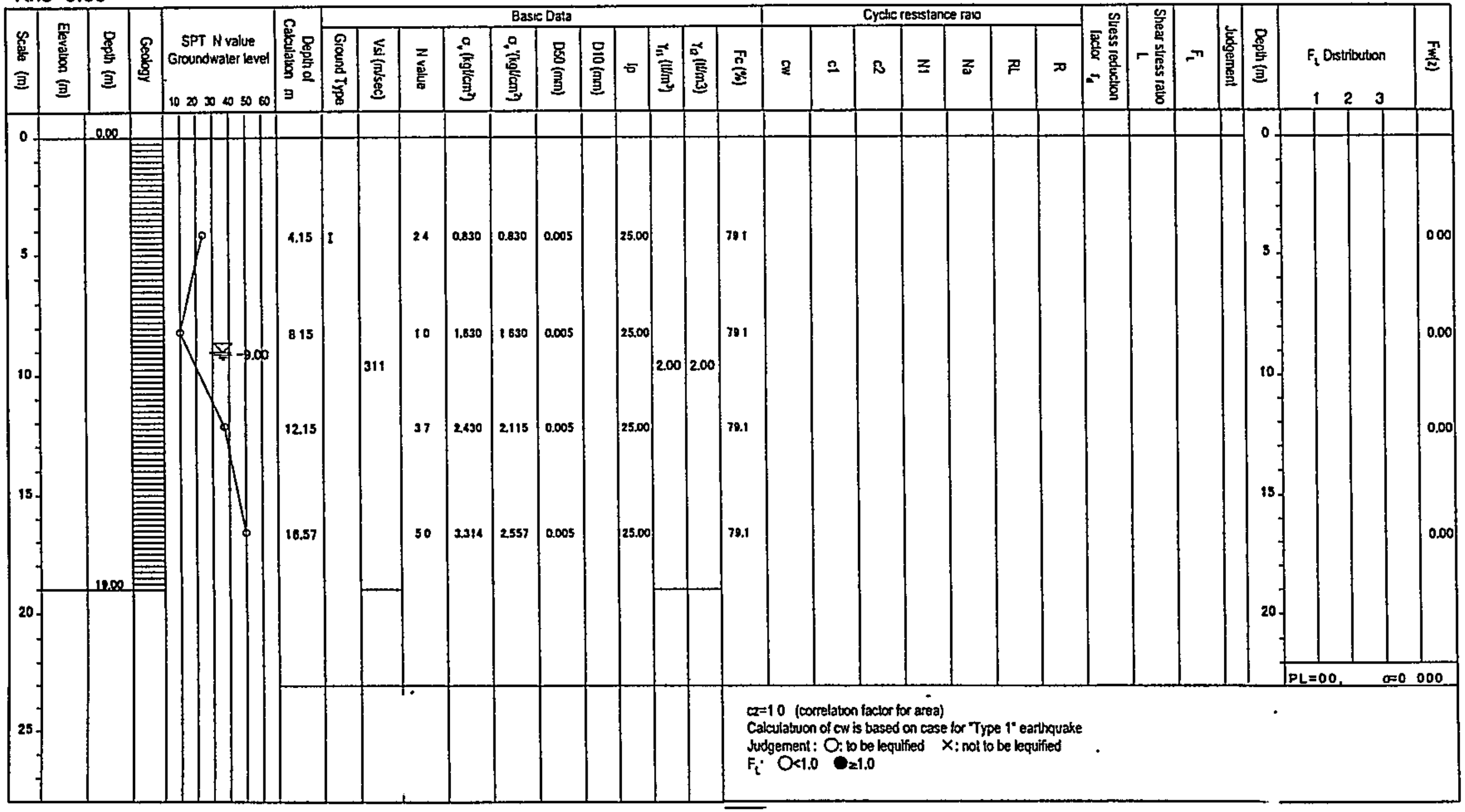


Depth of Calculation m	Basic Data											Cyclic resistance ratio							Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R					
8.15	I	280	1 3	1.630	1.615	0.005		25.00	2.00	2.00	79 1												0 00
9 45			1 3	1.890	1 745	0.005		25.00			79 1												0 00
12.15			1 3	2.430	2.015	0.005		25.00			79.1												0.00
16 07			5 0	3.214	2.407	0.005		25.00			79 1												0.00
18 65			2 2	3.730	2.885	0.005		25.00			79.1												0 00

cz=1 0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement · ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E37-24
Khc=0.60



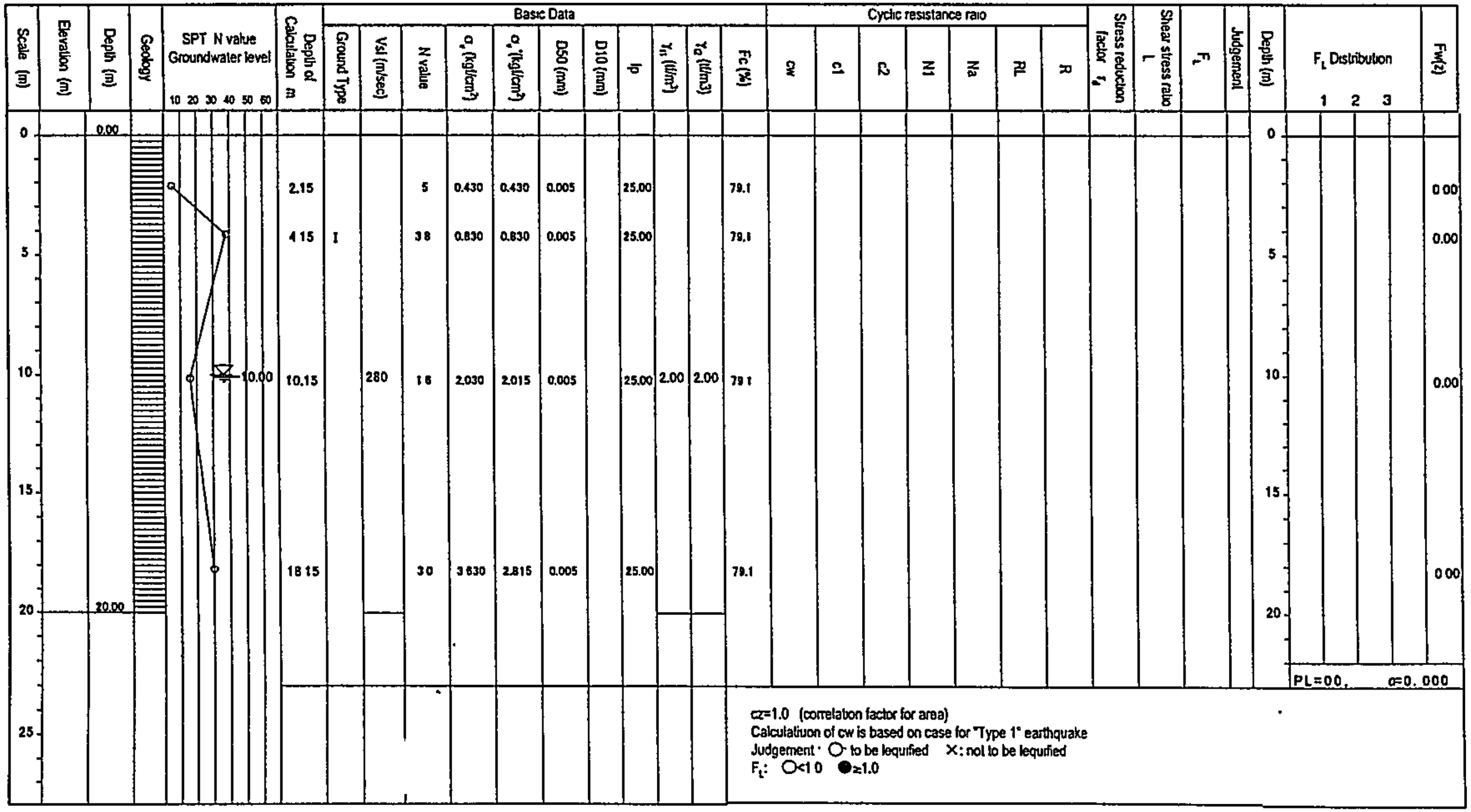
Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
4.15	I	311	2 4	0.830	0.830	0.005		25.00	2.00	2.00	79 1												0.00
8 15			1 0	1.630	1 630	0.005		25.00			79 1												0.00
12.15			3 7	2.430	2.115	0.005		25.00			79.1												0.00
16.57			5 0	3.314	2.557	0.005		25.00			79.1												0.00

PL=0.0, α=0 000

cz=1 0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake
Judgement : ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E37-25
Khc-:0.60

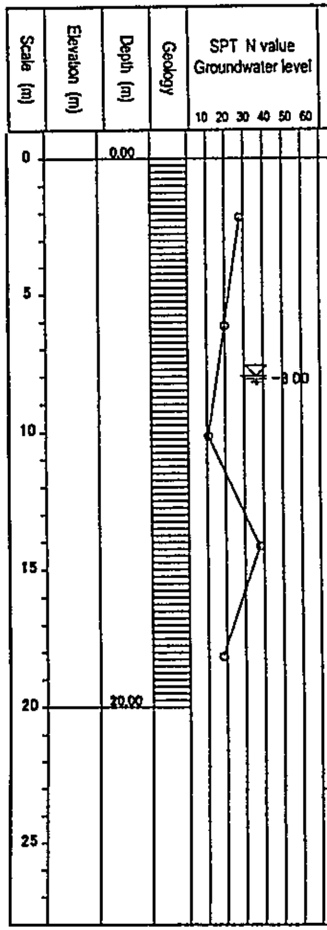


Depth of Calculation m	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F$_L$	Judgement	Fw(z)
2.15			5	0.430	0.430	0.005		25.00			79.1												0.00
4 15	I		3 8	0.830	0.830	0.005		25.00			79.1												0.00
10.15		280	1 6	2.030	2.015	0.005		25.00	2.00	2.00	79 1												0.00
18 15			3 0	3 630	2.815	0.005		25.00			79.1												0 00

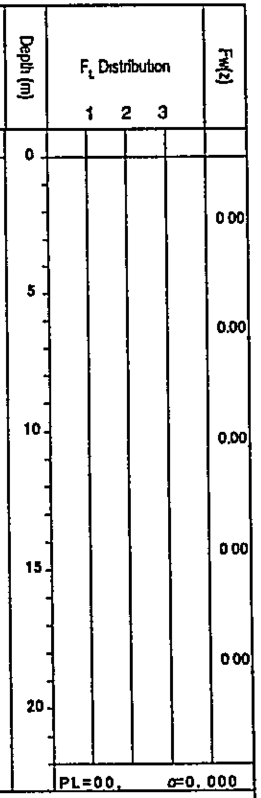
cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake
Judgement · ○ to be lequified ×: not to be lequified
F$_L$: ○<1 0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E37-26
Khc=0.60



Depth of Calculation m	Basic Data											Cyclic resistance ratio							Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R					
2.15	I	284	28	0.430	0.430	0.005		25.00	2.00	2.00	79.1												0.00
6.15			20	1.230	1.230	0.005		25.00			79.1												0.00
10.15			11	2.030	1.815	0.005		25.00			79.1												0.00
14.15			38	2.830	2.215	0.005		25.00			79.1												0.00
18.15			18	3.830	2.815	0.005		25.00			79.1												0.00

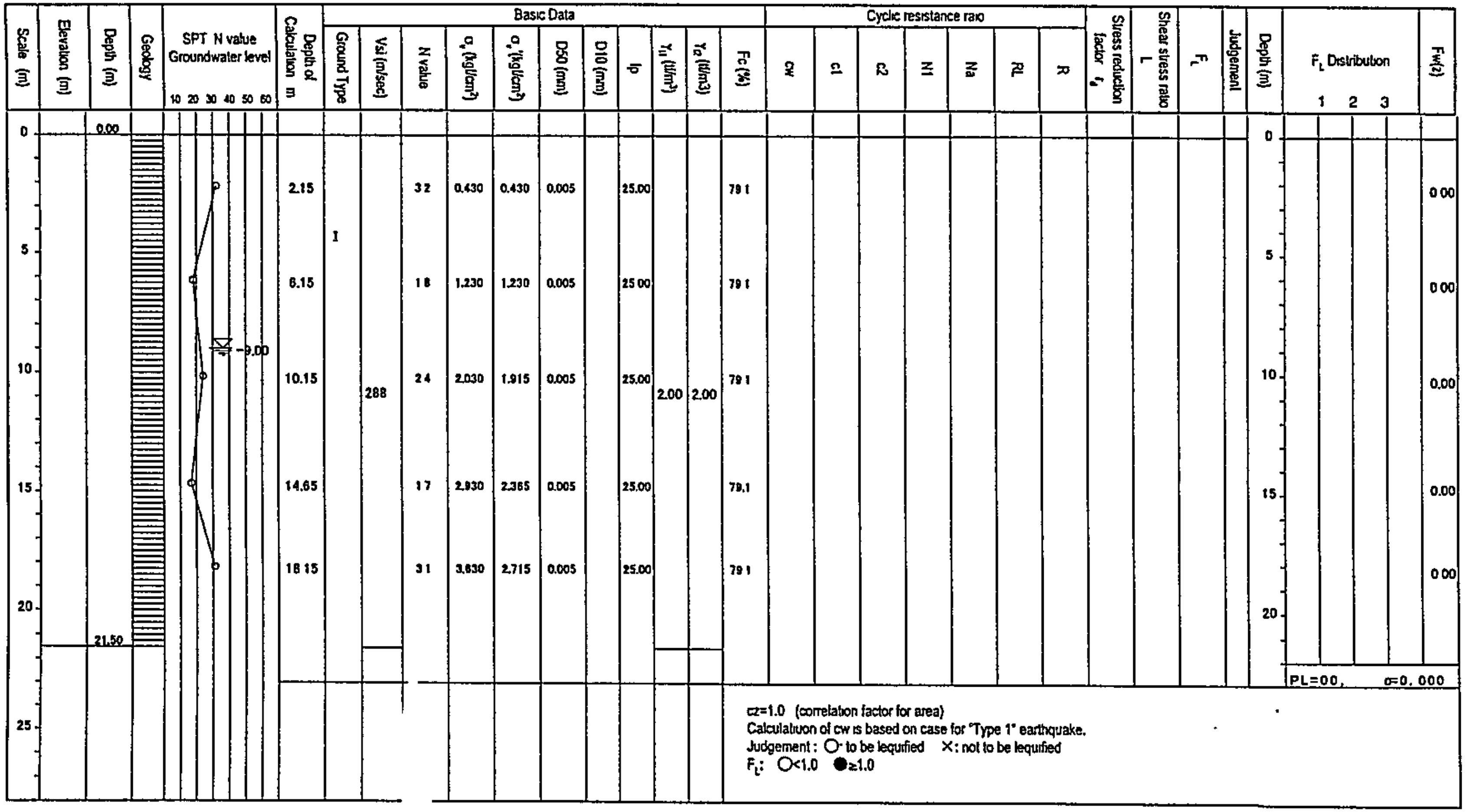


PL=0.0, σ=0.000

cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake
Judgement · ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E37-27
Khc=0.60

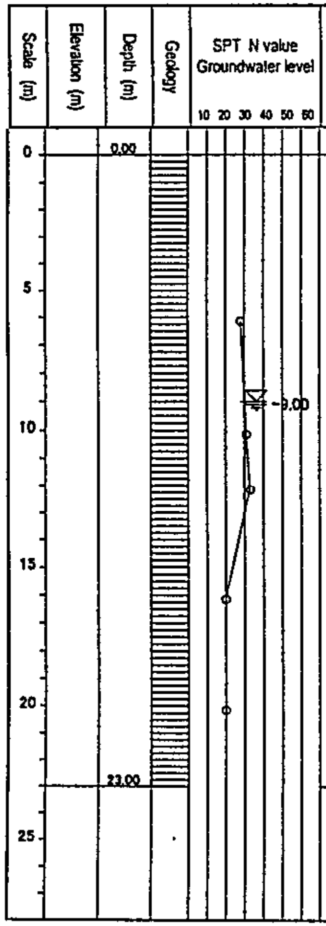


Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	Fw(z)
2.15	I	288	32	0.430	0.430	0.005		25.00	2.00	2.00	79.1	0.00
6.15			18	1.230	1.230	0.005		25.00			79.1	0.00
10.15			24	2.030	1.915	0.005		25.00			79.1	0.00
14.65			17	2.930	2.365	0.005		25.00			79.1	0.00
18.15			31	3.630	2.715	0.005		25.00			79.1	0.00

cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement : ○ to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E37-28
Khc=0.60



Depth of Calculation m	Basic Data											Cyclic resistance ratio							Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R					
	I																						
6 15			2 8	1.230	1.230	0.005		25.00			79 1												0.00
10.15			3 1	2.030	1.915	0.005		25.00			79 1												0.00
		296							2.00	2.00													
12.15			3 3	2.430	2.115	0.005		25.00			79 1												0.00
16 15			2 0	3.230	2.515	0.005		25.00			79.1												0 00
20 15			2 0	4.030	2.815	0.005		25.00			79.1												

Depth (m): 0, 5, 10, 15, 20

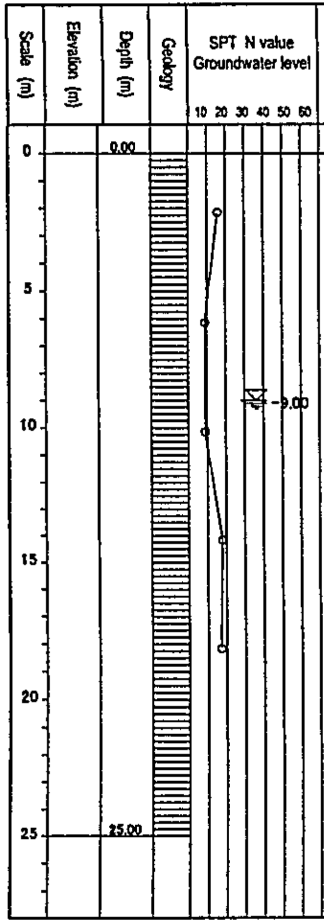
F_L Distribution 1 2 3

PL=0 0, σ=0 000

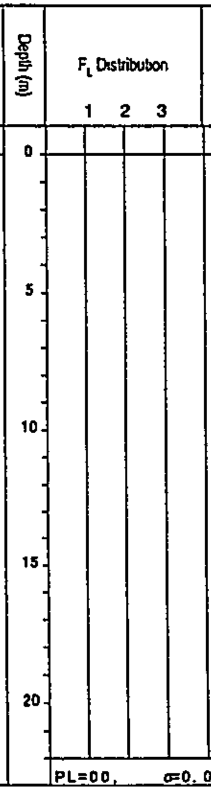
cz=1 0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement : ○ to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E37-29
Khc=0.60



Depth of Calculation m	Basic Data: Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm^2)	σ_v' (kgf/cm^2)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m^3)	γ_{t2} (tf/m3)	Fc (%)	Cyclic resistance ratio: cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.15	I		16	0.430	0.430	0.005		25.00			79.1												0.00
6.15			9	1.230	1.230	0.005		25.00			79 1												0.00
10 15			9	2.030	1.915	0.005		25.00			79 1												0.00
14.15		241	18	2.830	2.315	0.005		25.00	2.00	2.00	79.1												0 00
18 15			17	3.630	2.715	0.005		25.00			79.1												0 00

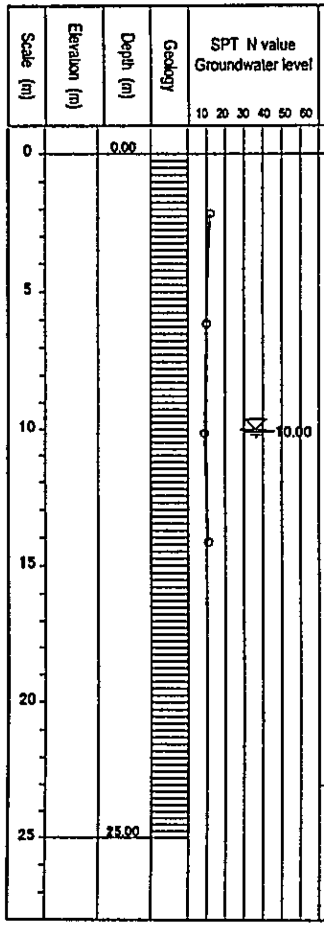


PL=0 0, σ=0. 000

cz=1 0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement . ○: to be lequified ×. not to be lequified
F_L: ○<1 0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E37-30
Khc=0.60



Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
2.15	I		12	0 430	0.430	0.005		25.00			79 1												0.00
6.15			10	1.230	1.230	0.005		25.00			79 1												0.00
10 15			8	2.030	2.015	0.005		25.00			79 1												0.00
14.15		222	11	2.830	2.415	0.005		25.00	2.00	2.00	79.1												0.00

Basic Data: Ground Type to Fc (%). Cyclic resistance ratio: cw to R.

Depth (m): 0, 5, 10, 15, 20

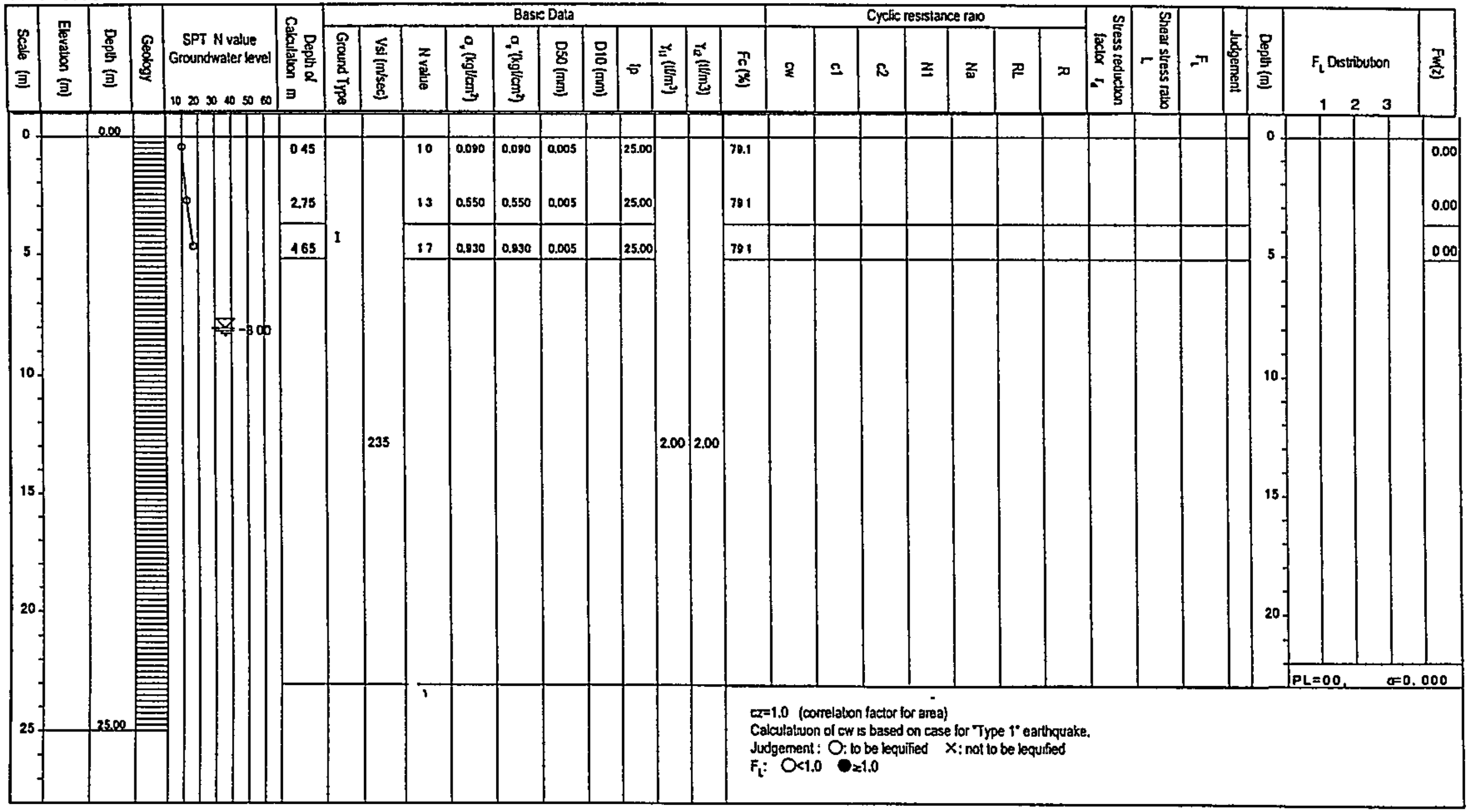
F_L Distribution: 1 2 3

PL=00, σ=0. 000

cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement : ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E49-1
Khc=0.60

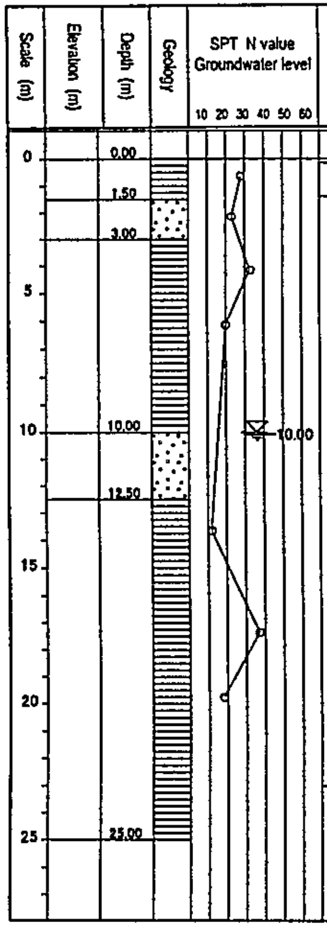


Depth of Calculation m	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
0.45	I	235	10	0.090	0.090	0.005		25.00	2.00	2.00	79.1												0.00
2.75			13	0.550	0.550	0.005		25.00			79.1												0.00
4.65			17	0.930	0.930	0.005		25.00			79.1												0.00

cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement : ○: to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E49-4
Khc=0.60



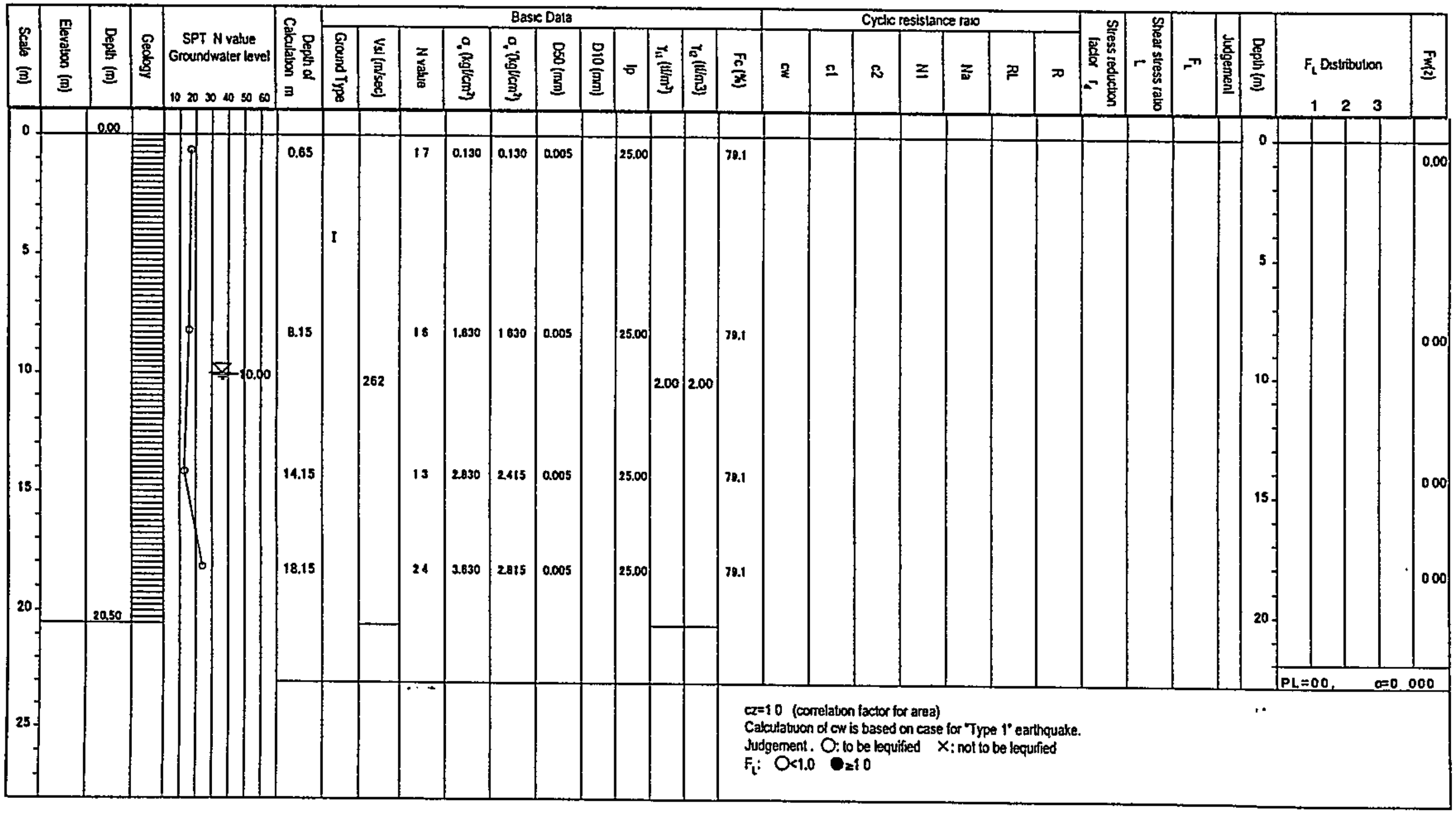
Depth of Calculation m	Ground Type	Vsi (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Depth (m)	F_L Distribution 1 2 3	Fw(z)
0 65	I	304	28	0 130	0 130	0.005		25.00	2.00	2.00	79 1														0 00
2.15		228	23	0 437	0 437	2.100			2.10	2.10	14.2														0 00
4.15		300	33	0.845	0.845	0.005		25.00	2.00	2.00	79.1												5		0.00
6.15			20	1.245	1.245	0.005		25.00			79 1														0 00
11.00		183	(12)	2.225	2.125	2.100			2.10	2.10	14.2	1.000	1.084	0.233	7.221	7 166	0.181	0.181	0.835	0.525	0.345	○	10	●	2.95
13.65		280	12	2.770	2.405	0.005		25.00	2.00	2.00	79.1												15		0.00
17 35			37	3.510	2.775	0.005		25.00			79.1														0 00
19.75			18	3.990	3.015	0.005		25.00			79.1												20		0 00

PL=2. 95, σ=0. 000

cz=1.0 (correlation factor for area)
Calculation of cw is based on case for "Type 1" earthquake.
Judgement · ○ to be lequified ×: not to be lequified
F_L: ○<1.0 ●≥1.0

Liquefaction Potential Analysis

Tehran Seismic Microzoning
Boring No E49-8
Khc=0.60



Depth of Calculation m	Ground Type	Vsl (m/sec)	N value	σ_v (kgf/cm²)	σ_v' (kgf/cm²)	D50 (mm)	D10 (mm)	Ip	γ_{t1} (tf/m³)	γ_{t2} (tf/m3)	Fc (%)	cw	c1	c2	N1	Na	RL	R	Stress reduction factor r_d	Shear stress ratio L	F_L	Judgement	Fw(z)
0.65	I	262	1 7	0.130	0.130	0.005		25.00	2.00	2.00	79.1												0.00
8.15			1 6	1.630	1 630	0.005		25.00			79.1												0 00
14.15			1 3	2.830	2.415	0.005		25.00			79.1												0 00
18.15			2 4	3.630	2.815	0.005		25.00			79.1												0 00

PL=00, σ=0 000

cz=1 0 (correlation factor for area)
Calculatuon of cw is based on case for "Type 1" earthquake.
Judgement . ○: to be lequified ×: not to be lequfied
F_L: ○<1.0 ●≥1 0

Appendix III:

Ambient Vibration Measurement

The Study on the Seismic Microzoning of the Greater Teheran Area in the Islamic Republic of Iran

Ambient Vibration Measurements on Buildings

Final Report

Prepared for:
Pacific Consultants International
JICA Study Team for the Study on the Seismic Micro-zoning

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Islamic Republic of Iran

Teheran, Iran
July/August 2000

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5.7 Data logger technical specifications

ERRATA!

Upon completion of this report we were informed that Site R4 is not "Reinforced Concrete Construction" type, but is "Steel Construction" type. So every where in the DATA-CD, R4 should be replaced by S8 and considered as a steel construction building read as S8.

1. Introduction

Based on a contract entered into on 24 June 2000 the JICA Study Team for the Study on the Seismic Micro-zoning in the Greater Tehran Area on the one party and with its principal office at c/o Centre for Earthquake & Environmental Studies of Tehran (CEST), and Magnetics Co. on the other party with its principal office Philips Building, 878 Enghelab Ave., 11317 Tehran, Islamic Republic of Iran, Magnetics Co. performed ambient vibration measurements of typical buildings in Tehran and their analysis. The measurements and data processing were performed according to 'Technical Specification for Ambient Vibration Measurements' document issued by JICA Study Team and based on discussions with JICA team before starting field work and analysis.

According to 'Technical Specification for Ambient Vibration Measurements' document, Magnetics Co. has to provide to JICA Team a 'Final Report' covering the information about fieldwork, measurements performed, results, and raw and processed time-waveforms of measurements. This document represents the final report.

2. Project outline, place and time

Ambient vibration measurements on typical building in Tehran are a part of broader microzoning project, which will contribute to better earthquake risk mitigation in broader Tehran region. Ambient vibration measurements on the buildings include following phases:

- determination of measuring buildings,
- determination of measuring sites within the buildings from civil engineering and measurement condition consideration,
- measurements of ground motion on the ground floor and top of twenty-four buildings,
- calculation of ground motion power density spectra, spectral ratios, particle motion of the top of the buildings, and
- interpretation of the results in terms of earthquake resistance civil engineering aspect and expected seismic input.

The first phase – determination of measuring buildings – was performed by CEST and JICA Study Team. During the fieldwork precise locations of measuring instruments within the building were determined. The lower sensor was set at ground level (as much as the actual building design allowed) without respect how many underground stories the buildings have. In general, to upper sensors were put on the last fully build store of the buildings. Details are given in site description.

The measurements and calculation of ground velocity power density spectra (PDS) and spectral ratios was performed by Magnetics Co. Dominant peaks in PDSs as well as in spectral ratios were determined, however based purely on the calculated results and without any association with civil engineering, or any other criteria.

JICA team will perform interpretation of PDSs and spectral ratios.

The measurements were performed between July 15, 2000 and July 27, 2000. Table 2.1 shows a list of all buildings measured and the date and time of the measurements (local time).

Table 2.1. Date and time of measurements

No	Site code	Type of the building	No. of floors	Measurement	
				Date	Time
1	R5	reinf. concr.	7	15/07/2000	15:40 - 18:10
2	S5	steel constr.	12	16/07/2000	09:35 - 12:45
3	R2	reinf. concr	17	16/07/2000	03:30 - 18:45
4	CEST	steel constr	7	17/07/2000	9:45 - 12:30
5	R8	reinf. concr	5	17/07/2000	15:00 - 18:30
6	R6	reinf. concr	6	18/07/2000	9:45 - 12:30
7	S3	steel constr	16	18/07/2000	14:30 - 18:15
8	S6	steel constr	11	19/07/2000	10:15 - 13:30
9	S14	steel constr	3	19/07/2000	15:15 - 18:30
10	S13	steel constr	4	20/07/2000	10:00 - 13:00
11	S11	steel constr	5	20/07/2000	14:45 -18:10
12	S7	steel constr	8	21/07/2000	9:30 - 13:15
13	R11	reinf. concr	4	21/07/2000	15:00 - 18:15
14	R1	reinf. concr	21	22/07/2000	11:15 - 14:15
15	S4	steel constr	13	22/07/2000	16:30 - 19:45
16	S8	steel constr	9	23/07/2000	10:15 -13:20
17	R12	reinf. concr	3	23/07/2000	15:00 - 18:00
18	R13	reinf. concr	13	24/07/2000	10:30 - 13:50
19	S1	steel constr	24	24/07/2000	18:00 - 21:45
20	R3	reinf. concr	13	25/07/2000	10:30 - 14:00
21	S2	steel constr	16	25/07/2000	15:15 - 19:00
22	R14	reinf. concr	10	26/07/2000	11:15 - 14:20
23	M1	masonry	2	26/07/2000	18:00 - 20:45
24	M2	masonry	3	27/07/2000	10:30 - 13:10
25	M3	masonry	2	27/07/2000	14:30 - 17:00
26	M4	masonry	6	27/07/2000	17:30 - 19:50

Site codes reflect design information of the buildings. S means steel construction, R means reinforced concrete construction, and M means masonry building.

All information about parameters relevant for interpretation of seismic signals is collected in Field forms, Appendix 5.1. Building properties as well as photo documentation, wind conditions, weather conditions, sensor installation details (if applicable), and information about activity of main building's noise sources (elevators, air-condition, etc.) during the measurements is given in these forms along with data acquisition parameters and general building information. For building identification purposes two pictures of it and a small map is also provided in these forms.

3. Methods and equipment used

3.1 Equipment description

3.1.1 Sensors

Kinemetrics SS-1 seismometers were used in these measurements. SS-1 is a typical short period (SP) seismometer. Its output is proportional to ground velocity. Its nominal resonance frequency is 1 Hz. Its frequency operating range is from about 0.1 Hz to over 50 Hz. Relative damping is adjusted by an external damping resistor, usually for nominal relative damping 0.7. Frequency response amplitude is asymptotically flat above resonant frequency and decays below it with –40 dB/dec slope. As it is a passive sensor it doesn't require external power. This fact and its mechanical robustness make it very suitable for fieldwork. Also it has no DC offset voltage problem since it is a passive device.

Usage of SP seismometer in ambient vibration studies facilitates fieldwork and lowers its cost.

Technical details can be found in Appendix 5.5 and on http://www.kinemetrics.com.

3.1.2 Sensor installation

On all sites we measured on the floor of existing buildings. Hard floor like concrete, ceramics, or solid brick was used.

3.1.3 Data logger

We used Kinemetrics SSR-1 S/N 104 seismic data recorder for data acquisition. The data logger has three input channels with common sampling (negligible time skew among channels) and triggering. Its nominal resolution and dynamic range corresponds to 16 bit A/D conversion. At the front end it has a preamplifier with software selectable gain among 1, 10, 100, and 1000. Frequency response is flat from DC to antialiasing filter corner frequency (-3 dB point).

We used 62.5 Hz sampling rate and a 15 Hz antialiasing filter in all channels. The reason for 62.5 Hz sampling is mitigation of 50 Hz interference. Although 50 Hz interference (through the ground and via EMI) can not be directly seen in measurements, which upper frequency range is 10 Hz, cross-modulation distortion which generates spectral components equal to the difference between sampling frequency and 50 Hz may appear in spectra. This difference equals to 12.5 Hz in our case, which is also outside our frequency range of interest, and can therefore not interfere with the measurements.

More details about data logger can be found in Appendix 5.7. and on http://www.kinemetrics.com.

3.1.4 Power, cabling, grounding, and shielding

Measuring equipment was powered by main 220 V power.

Three heavy shielded 5m long cables connected the sensors with the data logger. One of them was extendable up to 65m. 'Floating' grounding scheme was used.

That means that the shielding of sensor cables was connected to equipment boxes on both sides - to data logger case and to sensor cases. To prevent ground loops, sensors were isolated from electric ground by dry floor. No external instrumental grounding was used. .

We used standard, 10 m long, shielded RS232 cable to connect the data logger with the laptop computer for data retrieving.

3.1.5 Processing computer

During field measurements we used either IBM ThinkPad 380D or Zeos Notebook 386+ laptop computer for adjusting data acquisition parameters, data retrieving, verification, and for in-field data back up on 3.5" floppy diskettes.

3.2 Equipment preparation and verification

Complete instrumental set up was tested on July 15, 2000 at Magnetics Co. offices for potential technical imperfections and accuracy of amplitude frequency response function of all three channels. The frequency response function accuracy test was also performed on July 29, 2000 after fieldwork was finished at the same place. No changes in measuring equipment were observed, which assures accurate results.

Self noise test of the same equipment was performed in November 1999.

3.2.1 Sensor calibration data and calculation of loaded generator constant and external damping resistors

Kinemetrics SS-1 SP seismometers SS-1 S/N 2004, SS-1 S/N 2006, and SS-1 S/N 2511 with following characteristics were used in the measurements.

(1) SS-1 S/N 2004 Vertical component

Natural frequency (vertical) f_0:	0.936 [Hz]
Coil resistance R_c:	5644 [ ]
0.7 relative damping resistor R_{07d}:	4957 [ ]
Relative damping :	0.707 [-]
Open generator constant G_0:	336 [Vs/m]

Loaded generator constant calculation:

$$G_{L-V} = \frac{G_0 \cdot R_{07d}}{R_{07d} + R_c} = \frac{336 \cdot 4957}{4957 + 5644} = 157 \quad [Vs/m]$$

External damping resistor calculation.

Internal input resistance of SSR-1 data logger $R_{in\text{-}SSR}$ = 100 [k] must be taken into account in external damping resistor $R_{d\text{-}ext}$ calculation.

$R_{in\text{-}SSR}$ = 100.000 [ ]

$$R_{d-ext} = \frac{R_{in-SSR} \cdot R_{07d}}{R_{in-SSR} - R_{07d}} = \frac{1e5 \cdot 4957}{1e5 - 4957} = 5215 \ [ohm]$$

(2) SS-1 S/N 2006 N - S component

Natural frequency (horizontal) f_0:	0.986 [Hz]
Coil resistance R_c:	5799 [ ]

0.7 relative damping resistor R_{07d}: 4670 [ ]
Relative damping : 0.707 [-]
Open generator constant G_0: 338 [Vs/m]
Loaded generator constant calculation:

$$G_{L-NS}=\frac{G_0\cdot R_{07d}}{R_{07d}+R_c}=\frac{338\cdot 4670}{4670+5799}=151\quad [Vs/m]$$

External damping resistor calculation:

Internal input resistance of SSR-1 data logger $R_{in\text{-}SSR}$ = 100 [k] must be taken into account in external damping resistor $R_{d\text{-}ext}$ calculation.

$R_{in\text{-}SSR}$ = 100.000 [ ]

$$R_{d-ext}=\frac{R_{in-SSR}\cdot R_{07d}}{R_{in-SSR}-R_{07d}}=\frac{1e5\cdot 4670}{1e5-4670}=4898\ [ohm]$$

(3) SS-1 S/N 2511 E - W component

Natural frequency (horizontal) f_0: 0.955 [Hz]
Coil resistance R_c: 5918 [ ]
0.7 relative damping resistor R_{07d}: 5235 [ ]
Relative damping : 0.707 [-]
Open generator constant G_0: 352 [Vs/m]
Loaded generator constant calculation:

$$G_{L-EW}=\frac{G_0\cdot R_{07d}}{R_{07d}+R_c}=\frac{352\cdot 5235}{5235+5918}=165\quad [Vs/m]$$

External damping resistor calculation:

Internal input resistance of SSR-1 data logger $R_{in\text{-}SSR}$ = 100 [k] must be taken into account in external damping resistor $R_{d\text{-}ext}$ calculation.

$R_{in\text{-}SSR}$ = 100.000 [ ]:

$$R_{d-ext}=\frac{R_{in-SSR}\cdot R_{07d}}{R_{in-SSR}-R_{07d}}=\frac{1e5\cdot 5235}{1e5-5235}=5524\ [ohm]$$

Actual external damping resistors used were:

S/N2004 = 5220 [ ]
S/N2006 = 4920 [ ]
S/N2511 = 5490 [ ]

3.2.2 Verification of signal to noise ratio of measurements

We checked system self noise of the equipment used in this measurements in November 1999. The complete equipment set-up was installed as for a regular measurement except that all three sensors were oriented in vertical position and that their mass weight compensation springs were released. In this way they were 'clamped' by the weight of their moving mass. A 15 min record of system noise was recorded and processes exactly as mictrotremor measurements. This test is the most rigorous possible since it includes all types of instrument noise in the system – sensor self noise, data logger's quantization noise, data logger analogue noise, and all EMI induced noise. Actually this test is over-conservative at high and low frequency end of frequency band of interest. This is due to the fact that at high frequencies clamping doesn't completely prevent moving mass motion and the resultant noise may be higher than true system self-noise. Also at low frequency end clamping can not prevent minute motion of sensor mass due to temperature changes and material properties. Also here the result of this test are too pessimistic.

Note also that system noise depends on measuring site conditions. Temperature changes, EMI interference, and warm-up time of equipment change from site to site. All these factor influence system noise particularly at low frequency end.

The test measurement was performed in a seismically quiet, bed rock site outaside the town.

The resultant PDSs of the noise of all three channels are given on Fig. 3.1. System self noise is expressed as ground velocity power density in [$m^2/s^2/Hz$]. It is sensor transfer function 'corrected' (spectral division method). Therefore it can be directly compared to the ambient vibration PDSs in Appendix 5.3.

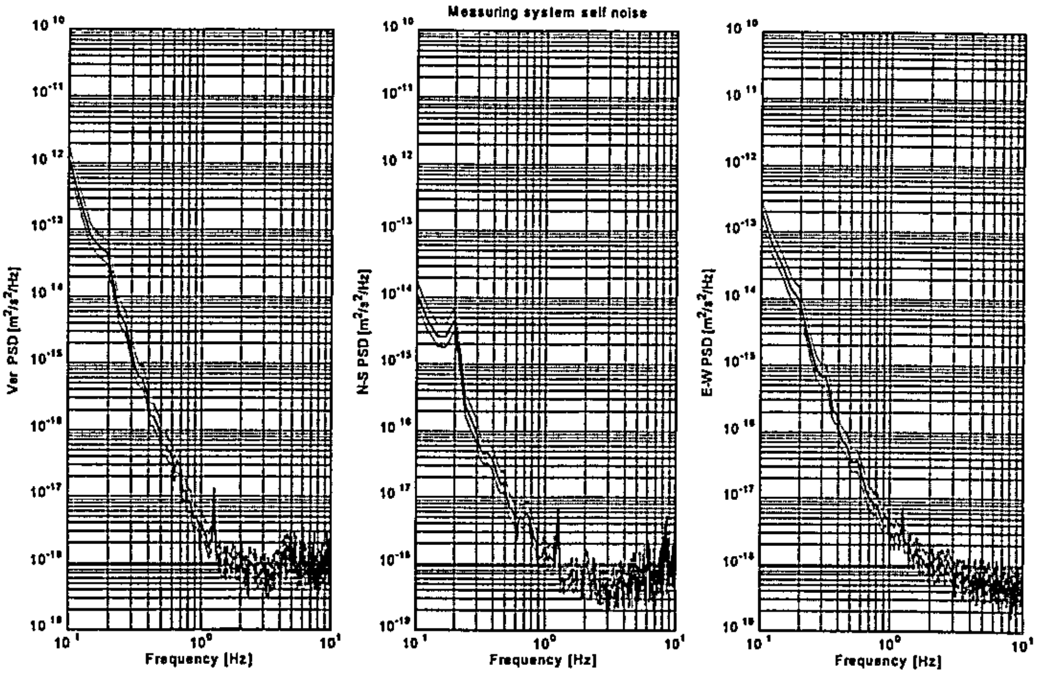


Figure 3.1 PDSs of measuring system self noise – vertical, N-S, and E-W channel

System noise is much lower than the signals measured during ambient vibration measurements in the whole frequency range of interest. High dynamic range of measurements is to some extent deteriorated at low frequency end of measurements. The S/N ratio decreases because of decreasing sensitivity of SP seismometers. However, this didn't impair the measurements.

3.2.3 Verification of instrument transfer function correction accuracy

Short period (SP) seismometers have asymptotically flat response to ground velocity above their resonant frequency (roughly 1 Hz for SS-1 sensors). Below resonant frequency their sensitivity falls wit a -40dB/decade slope. One of requirements of this study was flat data from 0.1 to 10 Hz. Therefore we have to correct sensor response. Spectral division method was used. Measured PDSs were divided by square (due to power signal) of sensor transfer function.

Parameters resonant frequency f_0, open loop generator constant Go, and relative damping of sensors are given in sensor calibration sheets. The accuracy of these factory determined parameters generally suffice for observation of spectra of seismic signals. However, when ratio of spectra is desired the accuracy of data in calibration sheets may become insufficient, particularly if the calibration of sensors was performed long time ago. Also inaccuracies of actually soldered damping resistors and internal input resistance of data logger and cables may result in slightly inaccurate loaded generator constant G_L and relative damping calculation. Therefore we fine tuned f_0, G_L , and of all sensor in such a way that a given input to all three sensors resulted in identical spectra.

All three sensors were installed as for a regular measurement, except they were all oriented horizontally and carefully aligned in the same direction (see Figure 3.2).

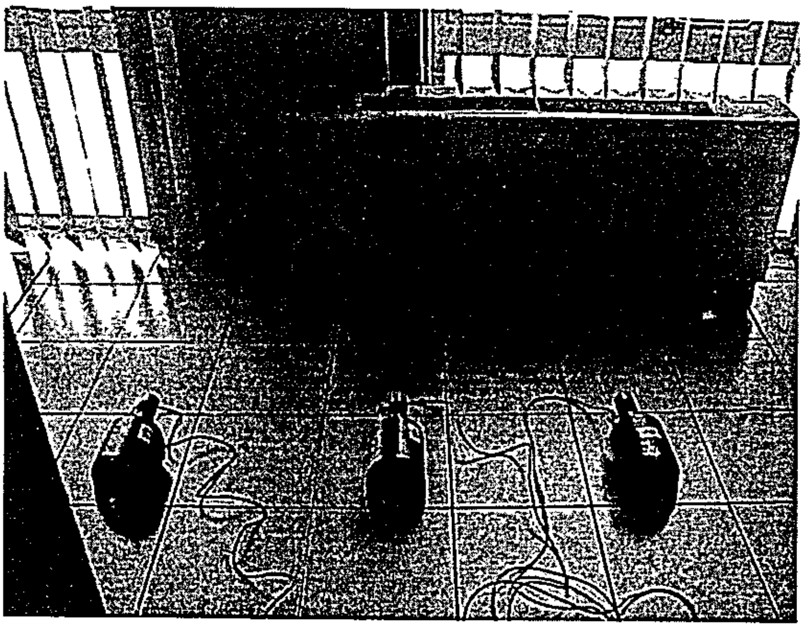


Figure 3.2 Measuring set-up for fine tuning of sensor parameters

This assures an equivalent input to all three sensors. A 20 min record of seismic noise was acquired and instrument corrected spectra calculated and plotted on the same graph. By slight changes in f_0, G_L, and we optimised the agreement of all three spectra. By observing frequency band around 10 Hz we optimised G_L (other two parameters f_0 and do not influence the response in this range). Next, observing frequency band from 0.1 to 0.4 Hz we optimised f_0 (parameter does not influence the response in this range). Finally observing frequency band from 0.8 Hz to 1.2 Hz (that is where relative damping influences the response) we optimised (other two parameters f_0 and G_L are already optimised).

The measurements were performed at Magnetics Co. in Tehran downtown, in a second floor of a seven-story building, during the day. This check was made before we started and after we finished ambient vibration measurements. No significant differences were observed. This assures that there were no changes in recording parameters during the work. Data of both tests are given on data CD attached to this report.

The final agreement of spectra of all three channels is shown on Figure 3.3. (full frequency range). Details are shown on Figure 3.4 for high frequency end, on Figure 3.5 for frequencies around sensor resonant frequency, and on Figure 3.6 for low frequency end.

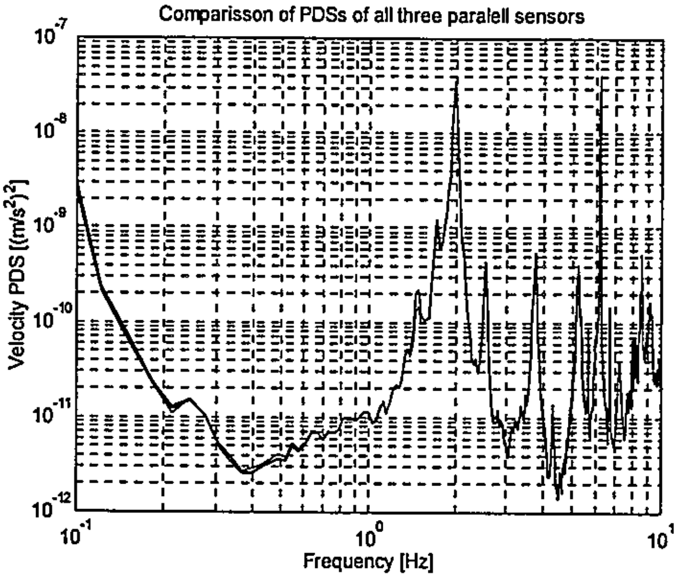


Figure 3.3 **Coincidence of PDSs of the same ground motion input to all three measuring channels (full frequency range)**

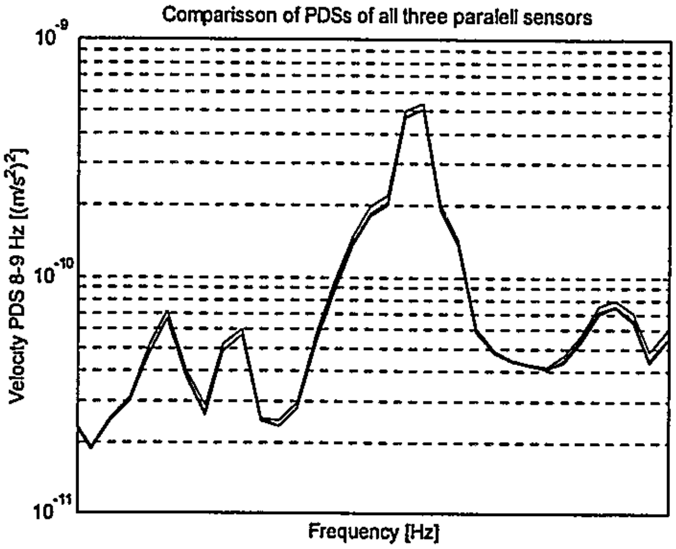


Figure 3.4 Coincidence of PDSs of the same input to all three measuring channels (detail at high frequency end from 8 Hz to 9 Hz used for G_L adjustment)

Small stochastic differences between channels observed mainly at extreme low frequencies are due to system noise and can not be nullified by sensor parameter adjustments.

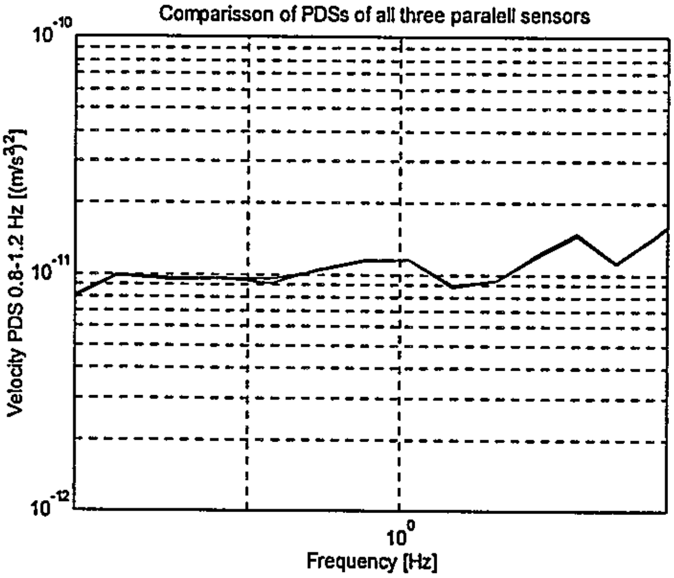


Figure 3.5 Coincidence of PDSs of the same input to all three measuring channels (frequency range from 0.8 Hz to 1.2 Hz used to adjust)

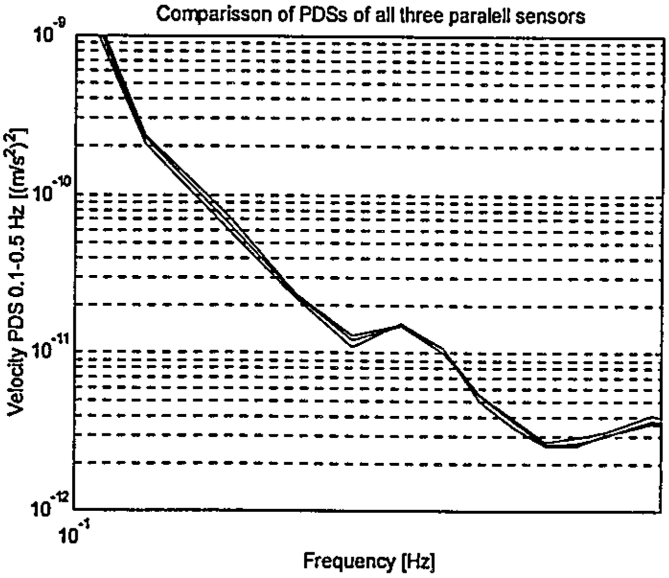


Figure 3.6 **Coincidence of PDSs of the same input to all three measuring channels (detail at low frequency end from 0.1 Hz to 5 Hz used for f_0 adjustment)**

Final sensor parameter values used in data processing are given in Table 3.2.

Table 3.2 **Sensors' parameters used in data processing**

Sensor	Loaded generator constant G_L [Vs/m]	Resonant frequency [Hz]	Relative damping [-]
SS-1 S/N 2004	157.0	1.045	0.64
SS-1 S/N 2006	154.2	1.02	0.70
SS-1 S/N 2511	158.7	0.965	0.75

3.3 Field measurement procedure

3.3.1 Physical procedure

All buildings were measured during the day. Undesired local seismic sources, which could influence only one measuring site (top or bottom), were searched for. The micro locations of measurements were agreed with CEST personnel. If at all possible elevators and air-condition generators were switched off during the measurements. Notes about general conditions were made

Seismometers were put on the ground, unlocked, connected to well marked cables, oriented (estimated accuracy of orientation is +/-3 deg from desired direction), and their moving mass position was centred.

Cables were uncoiled from the bobbin and connected to data logger. Data logger was switched on immediately after arrival to the site to allow about 15 minutes warm-up time at each site during which the electronics thermally stabilised.

Data logger was connected to Zeos Notebook 386+ or IBM ThinkPad computer via RS232 cable. The distance between sensors and the person who operated the computer during the measurements was about 5 to 10 m. Moving of people around was mitigated as far as possible.

First a brief test of incoming signals and SSR-1's main and lithium battery voltage was performed using DG9 command (DVM function). Next a short test record was made, data was retrieved and checked for unexpected man-made noise sources, peak-peak amplitude values, potential clipping, and other technical problems. Preamplifier gain was set for maximal resolution of data acquisition. Then the measurement was started manually by setting 'votes to trigger' parameter (#57) of SSR-1 to 0.

During the measurement accompanying persons prevented people to approach the measuring site.

After termination of the measurement, data were retrieved to the laptop and inspected. An immediate backup of raw data was made on diskettes.

During the measurements we experienced no technical problems with equipment.

3.3.2 Sensor excitation considerations

Ambient vibration measurements should be performed in as much as possible constant conditions without excessive disturbances of man-made seismic noise on a single measuring site. High amplitude seismic noise bursts and spikes on top only or ground floor level only, even if outside the frequency band of interest, may via spectral leakage and/or aliasing, contaminate measurements.

Man-made, natural seismic noise and wind are the main sources of building excitation. If they excite both measuring sites, top and ground floor, they are a desired signal. If only one site is excited, like walking next to ground floor sensor this may unfavourably influence spectra ratio results.

Since weather and wind conditions influence the building excitation, we gather information about these two measuring conditions as well.

The main problem in buildings are elevators and air-condition equipment (with engines on top of the buildings) and walking of inhabitants too close to the seismometers. To stop local human activities was particularly difficult on the buildings still under construction (from economic reasons).

An effective measure is to switch off elevators and air-condition equipment and to prevent walking too close to the sensors by a portable fence.

Measurements were taken during the day. Details can be from Appendix 5.1.

3.3.3 Duration of the measurement

Generally all measurement lasted 30 minutes. Only in some cases where dominant frequency was evident from time domain, we shortened the measurements. However, all measurements are longer than 15 minutes.

3.3.4 Field data verification

In field data inspection included verification of peak-peak values of the signal in scope of potential record clipping and in scope of dynamic range of data acquisition. The gain of the preamplifier in the data logger was adjusted optimally for the best data resolution. Practice showed that we could use maximal preamplifier gain 1000 on some sites only and mostly on ground floor level. Most channels were recorded with the gain 100.

Data were also zoomed-in in time domain to inspect signals in terms of other potential irregularities, technical problems, or unexpected man-made seismic noise sources. No spectra were calculated in the field.

3.3.5 Information about measuring conditions

For competent raw data editing and interpretation of spectra we gathered information about general conditions at the site and the conditions during the measurements. This included a description of weather condition, wind condition, and known man-made sources of seismic noise. Details for each site can be found in Field forms in Appendix 5.1.

3.3.6 Data backup

In the field, raw data was immediately copied to diskettes. A second backup copy of raw data was made after returning from the field and kept on a different place.

3.4 Data processing

3.4.1 Measurements order

Ideally a single three-component measurement of ambient vibration on top and at the ground floor level would suffice to obtain all desired information. For such measurement a six-channel data logger is required. Unfortunately only a three-channel recorder was available. Therefore we made three measurements on each building.

The first measurement was a two-channel measurement. Top (channel 2) and ground floor level (channel 1) vertical motion was measured. The second measurement was a three-channel measurement. Channel 1 was ground floor longitudinal motion, channel 2 was top longitudinal motion, and channel 3 was top transversal motion. The third measurement was also a three-channel measurement. The channel 1 was ground floor transversal motion, the channel 2 was top longitudinal motion and channel 3 was top transversal motion (the same as in the second measurement).

From the first measurement we get vertical top and ground floor spectra and top/ground floor motion ratio. From the second measurement, channel 1 and channel 2, we get longitudinal spectra and ratio. Channel 3 was not used in data processing. From the third measurement, channel 1 and channel 3, we get transversal spectra and ratio. From channel 2 and channel 3 we get top particle motion.

Seismometers were always oriented in such a way that positive voltage denotes ground motion up during vertical measurements and toward northern half space for the channel 2 and eastern half space for the channel 3.

3.4.2 Raw data editing

In the first step binary SSR-1's files were re-formatted to ASCII format. Kinemetrics CNVA.EXE program performed this conversion. Raw ASCII data was inspected for excessive seismic noise amplitudes, spikes, and noise bursts. All channels of a single measurement were displayed simultaneously and inspected for excessive noise interference.

On many records, too noisy portions of the signal were cut out in all channels and remaining data concatenated. No special attention was paid to discontinuities of the signal at concatenation points.

MatLab was used for editing data. Raw and edited waveforms are graphically given in Appendix 5.2 for visual inspection. Details about editing for each site can also be found in Appendix 5.2. in the form of MatLab concatenation commands.

A MatLab command line like:

```
er5m2ch1 =[ r5m2ch1(1:1000); r5m2ch1 (1100:69000); r5m2ch1 (70000:98461)];
```

means: edited data file of the site r5/measurement #2/channel 1=longinal direction contains raw data from sample 1 to 1000, from sample 1100 to 69000, and from sample 70000 to the end of the record. Samples from 1001 to 1099 and from 69001 to 69999 are wasted.

3.4.3 Processing of edited data

(1) Power density spectra (PDS) calculation

Power density spectra were generally calculated from edited data files. Only a few cases, there wan no need to edit data and the spectra are calculated from raw data. MatLabs psd.m function was used. Its details can be found in Appendix 5.4. With JICA staff we agreed for the following processing parameters:

- 1024 point data windows, resulting in 512 point spectra,
- duration of measurements from 15 to 30 minutes,
- Hanning weighting window applied,
- 25% data points window overlap,
- no confidence level of spectra calculated, and
- linear detrending of data windows is applied.

(2) Instrument correction of power density spectra

Calculated PDSs were instrument corrected by spectral division method. We divided calculated PDSs by square value (we deal with signal power!) of individual sensor transfer function to obtain flat response in frequency range from 0.1 Hz to 10 Hz. Details can be found in Appendix 5.4.

Spectra were not corrected for antialiasing filter transfer function in frequency range above ~10 Hz. The six pole analogue antialiasing filters cause certain amplitude distortion in this frequency range. Nominally the amplitude response of these filters is –3 dB down at 15 Hz. Phase distortion is unimportant.

(3) Spectral ratio calculation

We calculated three spectral ratios

- vertical top to vertical ground floor (measurement #1),
- horizontal longitudinal top to horizontal longitudinal ground floor (measurement #2),
- and horizontal transversal top to horizontal transversal ground floor (measurement #3).

Custom made MatLab .m function was used for calculations. Details are given in Appendix 5.4.

(4) Particle motion calculation

Particle motion on top of the building was determined from channels 2 and 3 and measurements #3. Both horizontal components were measured on top of buildings during these measurements. Motion velocity is displayed. Only 5000 samples of data are displayed, since this gives a better picture of particle motion. These data were taken mostly from the beginning portion of raw or in some cases of edited data. Particle motion graphs are shown in Appendix 5.3.

4. Results

4.1 Locations of the measured buildings and file coding

Buildings location are given on maps in the Field forms in Appendix 5.1. Site codes reflect buildings design. R means reinforced concrete buildings, S means steel constructions, and M means masonry buildings. Two pictures of each building are also shown for identification and a brief overview of the design of the buildings.

4.2 Results

Results are given in graphic forms for each measured building. Raw data waveforms, edited data waveforms, and zoomed (10 s duration) section of data are given in Appendix 5.2. Top and ground floor spectra along with their ratio are given in pairs for each measuring direction separately. Particle motion on the top of the building is displayed in the last graph. Spectra and ratios are shown in Appendix 5.3.

4.2.1 Raw and edited waveform data

Graphs of recorded raw signal and edited signal are published in Appendix 5.2. Both types of graphs have samples on abscissa. This facilitates editing of data, since it is easier to determine, which samples should be cut out due to an excessive man made seismic noise.

In addition, a third graph is given with zoomed signal in time domain. Ten seconds of signals are shown. This allows visual estimate of dominant period from time domain. Abscissa shows time in seconds. Note that these are uncorrected velocity signals. Low frequencies below 1 Hz are under valued in amplitude due to sensor transfer function.

Raw (.ssr, .001, .002, and .003 extension) and edited data ASCII files (.dat extension) are stored on data CD under '/data/"site-code"' subdirectory for each site separately. Data of each channel is separated (except in data logger's own files with .ssr extension). Raw data file names start with 'r', 's', or 'm' reflecting type of the building. Number of the site follows. Following 'm' and the number denote measurement number (1 = vertical, 2 = horizontal/ longitudinal, 3 =

horizontal/transversal + particle motion). Channel number is also given (ch1, ch2, ch3). Edited data file names use the same coding, but start with an 'e' (edited data). A file name 'er11m3ch3.dat' therefore means: edited transversal motion from channel 3 (top of the building) at the reinforced concrete building number 11.

These subdirectories also contain original three-channel files in SSR-1's internal binary format. Their extension is '.ssr'. These files can be converted to ASCII format using program CNVA.EXE (usage: CNVA "file name" <return>).

4.2.2 Instrument corrected power density spectra and their ratio

Ground velocity power density spectra (PDS) graphs for all sites are given in Appendix 5.3. On the left graph top and ground floor spectra a given, on the right side their ratio is given. Loglog scale of the graphs is used. Abscissa runs from 0.1 to 10 Hz as required in the 'Technical Specification for Ambient Vibration Measurements'. Ordinate runs from 1e-14 to 1e-6 [$m^2/s^2/Hz$]. The scale was adjusted for each individual building. Ratio graphs have ordinate from 0.1 to 10.000. Also here the scale was adjusted to individual results.

PDSs and ratio in ASCII format are stored in '/data/"site-code"' subdirectory for each site separately. File names start with 's' for spectra and with 'r' for ratio. Site code follows. Next two characters denote which kind of spectra is contained. The first character denotes measuring direction (v = vertical, l = longitudinal, t = transversal). The second character denotes top or ground floor (g = ground floor, t = top). Therefore, a file name 'ss3tt.dat' means: PDS of a steel construction number 3 in transversal direction measured on top of the building..

Spectral ratio graphs show top/ground floor ratio. These files start with 'r'. Site code follows. The last character denotes measuring direction. A file name 'rm1t.dat' therefore means a top/ground-floor ratio of PDSs at masonry building number 1, measured in transversal direction.

Spectral ratios in ASCII format are also stored in '/data/"site-code"' subdirectory for each site separately.

Particle motion graphs show velocity. 5000 data samples (about 80 sec) are shown. This approach results in a better insight into the motion of the top of the building than if the whole data set is plotted where mainly 'outliers' (extreme motion) becomes visible. These 5000 samples were generally taken from raw data and from the beginning of the records. Only in some cases (if the beginning showed too large disturbances) the data were taken from edited data set.

4.2.3 Determination of peak values of power density spectra measure on top of the buildings and spectral ratios

Dominant frequencies in power spectral density on top of the buildings as well as in spectral ratios were determined from graphs in Appendix 5.3.and tabulated in Table 4.1.

Table 4.1. Dominant frequencies and periods in PDSs measured on top of the buildings and spectral ratios.

Site	Frequency of PDS max peak			Frequency of max Ratio peak		
	Vertical	Longitudinal	Transverse	Vertical	Longitudinal	Transverse
	[Hz]	[Hz]	[Hz]	[Hz]	[Hz]	[Hz]
CEST	1.85	2.95	1.90	1.85	2.95	1.90
R1	0.93	1.0	0.93	1.05	1.0	1.3
R2	2.30	0.67	0.67	0.75	0.79	0.85
R3	7.0	1.2	1.2	8.0	1.6	1.2
S8	2.0	1.55	2.0	2.0	1.7	2.0
R5	1.45	2.1	1.45	2.5	2.15	2.6
R6	2.1	2.5	2.15	2.1	2.6	3.25
R8	?	3.5	3.05	3.3	3.9	3.2
R11	3.4	3.4	3.5	3.4	3.5	3.6
R12	4.7	3.6	4.7	4.7	3.7	5.0
R13	1.2	1.7	1.2	1.7	1.8	1.2
R14	1.95	1.6	1.6	2.0	2.0	2.0
S1	0.53	0.71	0.53	0.53	0.68	0.60
S2	5.2	0.82	0.80	7.8	1.2	0.87
S3	0.68	0.63	0.70	0.73	0.91	0.73
S4	1.05	0.87	1.0	1.05	0.90	0.85
S5	5.0	0.98	0.92	1.95	1.3	092
S6	5.8	086	0.90	7.8	1.8	1.0
S7	1.8	1.8	1.85	1.95	2.0	2.0
S11	2.5	3.2	2.5	?	2.6	2.6
S13	4.1	4.0	2.9	5.0	3.0	3.0
S14	2.7	4.3	2.7	2.7	3.3	3.3
M1	8.0	4.3	4.3	8.6	4.3	4.3
M2	4.6	5.4	4.6	4.6	5.3	4.7
M3	7.3?	10?	7.2	10?	10?	7.6
M4	8.9	2.35	3.05	9.3	2.8	3.05

These peaks were heuristically determined and are solely based on corresponding graphs. No association of these peaks with civil engineering details of the building has been performed. In many cases horizontal dominant frequency reflects in vertical motion as the biggest spectral peak. It was read as 'dominant' peak, although it is not associated with true vertical resonance. Without respect to such and similar cases we always read the highest peak value and did not consider smaller peaks, which may be actually of greater importance. Detailed study of all peaks and their association with civil engineering facts of the building is considered as a part of interpretation of results, which is not the subject of this report.

Note also that building name codes (site number) are not monotonous. Some buildings, which were planned to be measured from the beginning, proved to be inaccessible for the measurement during the project. Therefore some site numbers are missing.

4.2.4 Data CD description

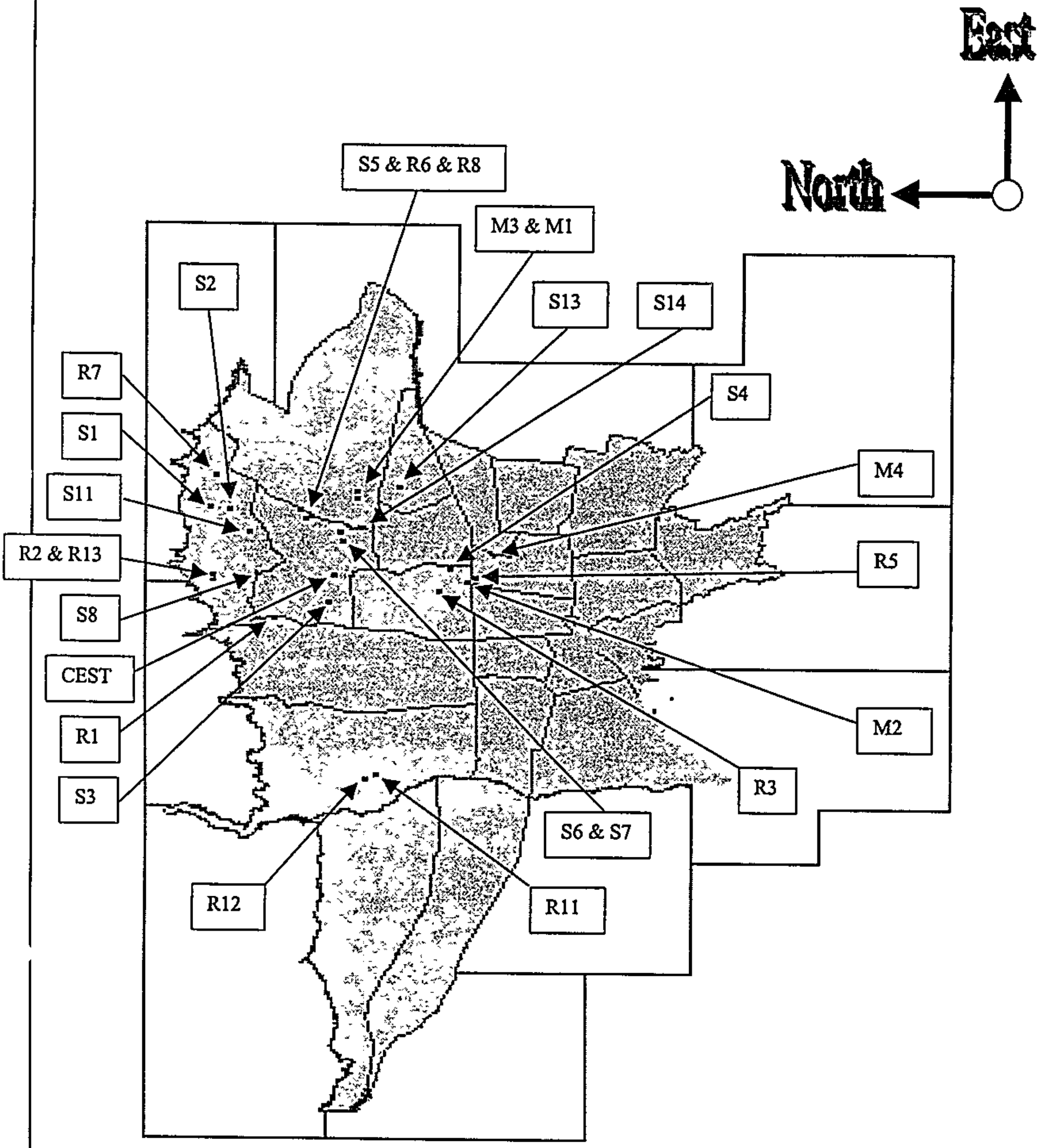
A CD is attached to this report containing:

- raw and edited signal records in original SSR-1 and ASCII format,

- calculated PDSs and spectral ratios in ASCII format,
- data files pertaining to transfer function similarity tests before and after the measurements, and
- an ASCII file (faxis.dat) containing frequency axis of spectra and ratio data files; this file should be combined (using any text processor or MS Excel) with data files for plotting purposes; first line value 'NaN' of spectra and ratio files ('not a number' in MatLab syntax) corresponds to zero frequency and should be discharged for loglog plotting,
- Kinemetrics CNVA.EXE file format conversion program (binary .ssr file format to ASCII format) and custom made MatLab '.m' functions described in chapter 5.4.3.

Raw signal files, edited signal files, PDSs, and spectral ratios are grouped together for each site in '/data/"site-code"/' subdirectories. All programs are in '/programs/' subdirectory.

5. Appendixes



Overview of the Locations of the measured sites
In the Greater Tehran Area

5.1.1 Field measuring form - Site R1

Site code: R1

Street address: Chamran Highway, Evin

Building type:
reinforced concrete construction

No. of stories: 21

Shape of the building:
rectangular

Date of measurement: 22/07/2000

Building condition: inhabited residential

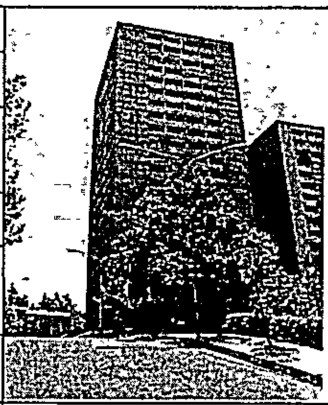
Seismic noise source conditions:
elevators stopped, air condition generators stopped, water pump stopped, some inhabitants passed ground floor measuring site

Weather condition: Clear

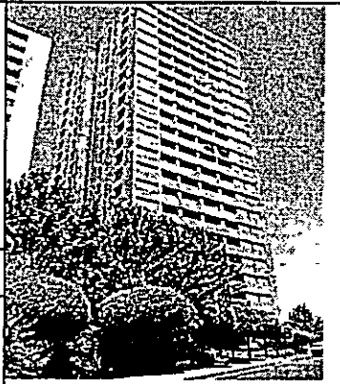
Wind condition:
slight wind, branches move

Special comments:
Atisatz apartment complex

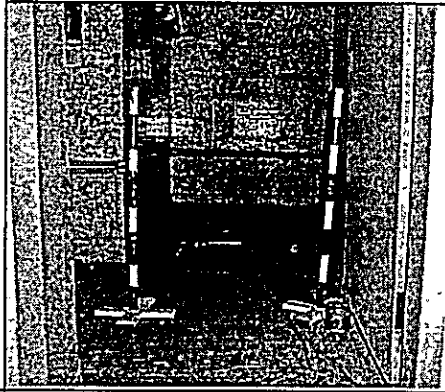
Dimensions (L x W x H):
30m x 25.6m x 66.0 m



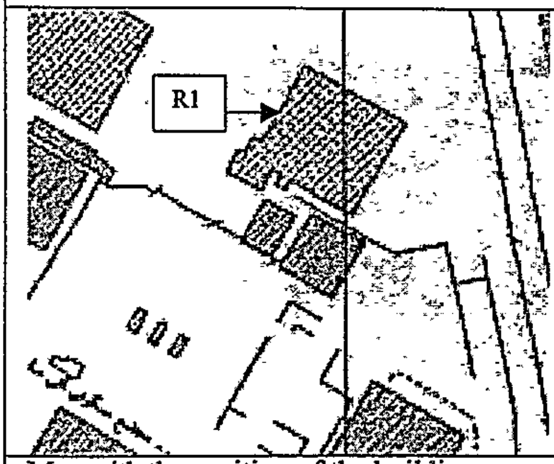
View from SE direction



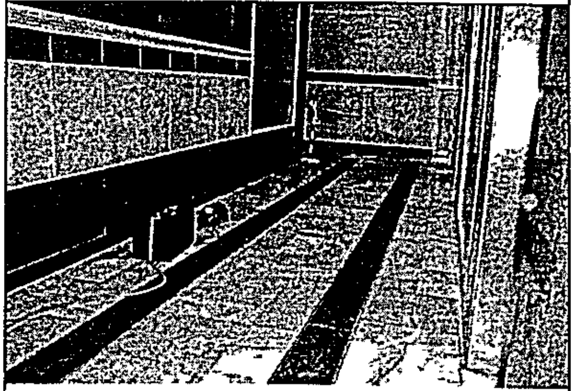
View from SW direction



Sensor setup - top of the building



Map with the position of the building



Sensor setup - ground floor

5.1.2 Field measuring form - Site R2

Site code: R2

Street address: Zardkuh St., Zaferanieh

Building type:
reinforced concrete construction

No. of stories: 17

Shape of the building:
rectangular

Date of measurement: 16/07/2000

Building condition: under construction

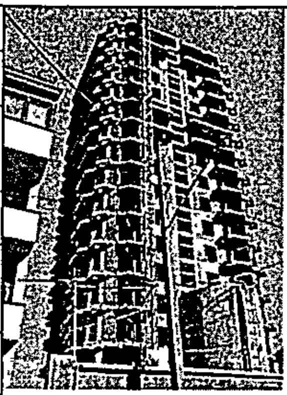
Seismic noise source conditions:
elevators, air condition generators, water pumps N/A; we were unable to stop construction works, people passing near ground floor measuring site

Weather condition: Clear

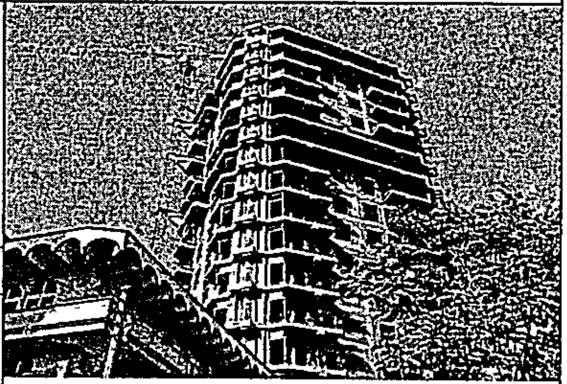
Wind condition:
slight wind, branches move

Special comments:
no special comments

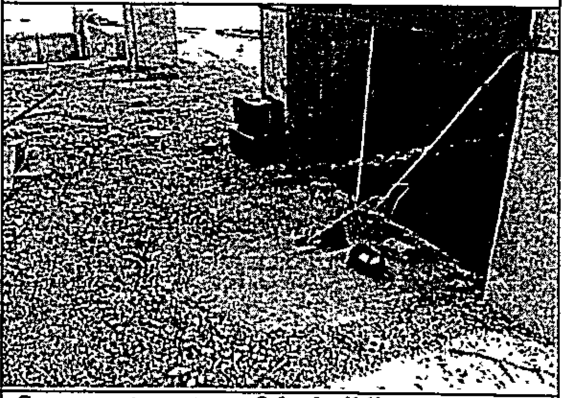
Dimensions (L x W x H):
21.9m x 21.9m x 63.5m



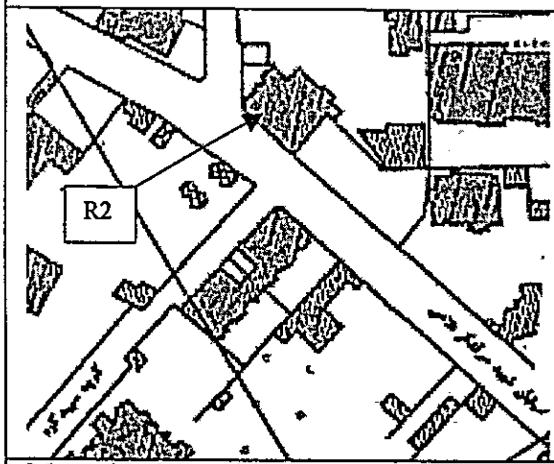
View from NE direction



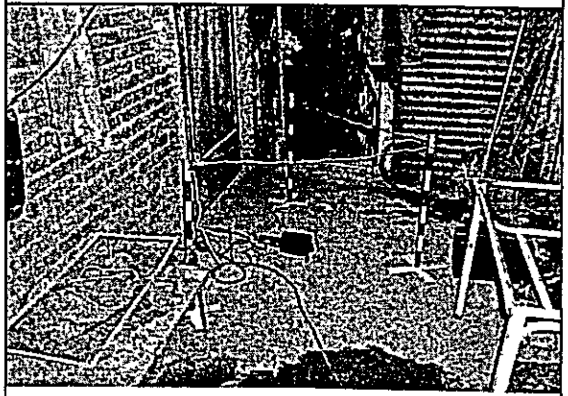
View from SW direction



Sensor setup - top of the building



Map with the position of the building



Sensor setup - ground floor

5.1.3 Field measuring form - Site R3

Site code: R3

Street address: North Hafez

Building type:
reinforced concrete construction

No. of stories: 13

Shape of the building:
rectangular, elongated

Date of measurement: 25/07/2000

Building condition: inhabited residential

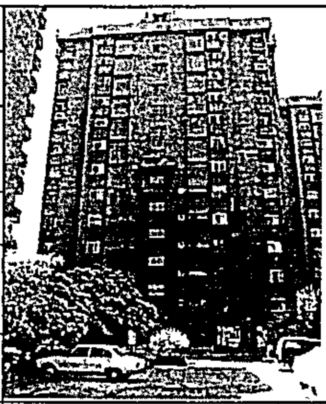
Seismic noise source conditions:
elevators stopped, air condition generators stopped, water pump stopped, some inhabitants passed nearby while measuring

Weather condition: Clear

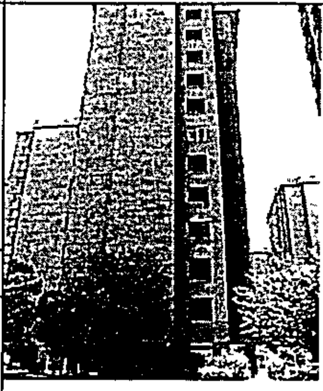
Wind condition:
slight wind, branches move

Special comments:
Behjat Abad apartment complex

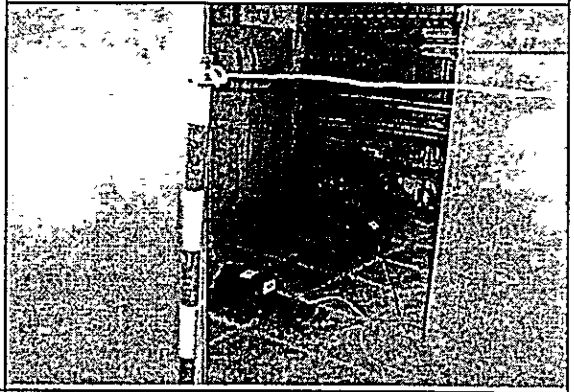
Dimensions (L x W x H):
30.0m x 15.7m x 41.0m



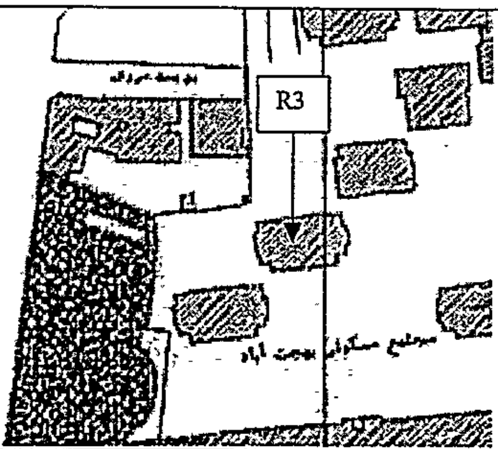
View from E direction



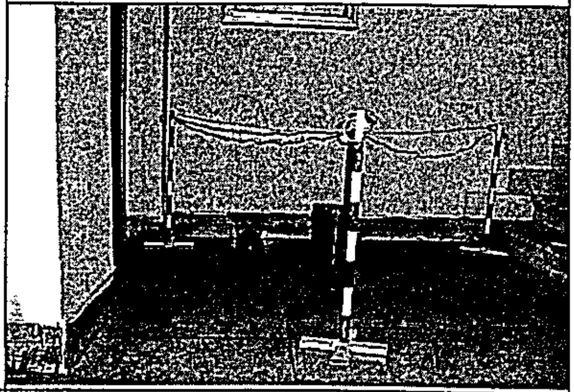
View from S direction



Sensor setup - top of the building



Map with the position of the building



Sensor setup - ground floor

5.1.4 Field measuring form - Site S8

Site code: S8

Street address: Kuhyar St., Fereshteh Ave.

Building type:
Steel structure construction

No. of stories: 9

Shape of the building:
rectangular, elongated

Date of measurement: 23/07/2000

Building condition: inhabited residential

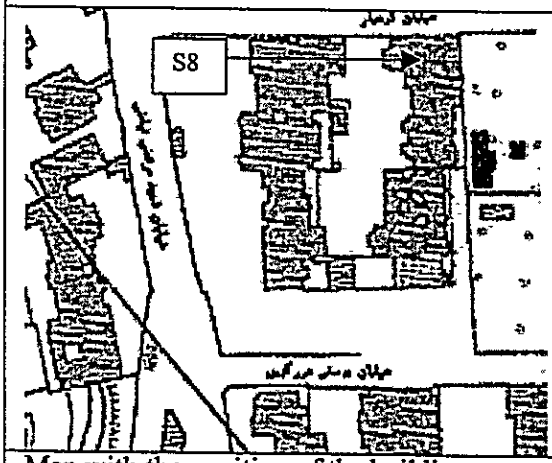
Seismic noise source conditions:
elevators stopped, air condition generators stopped, water pump remained on

Weather condition: Clear

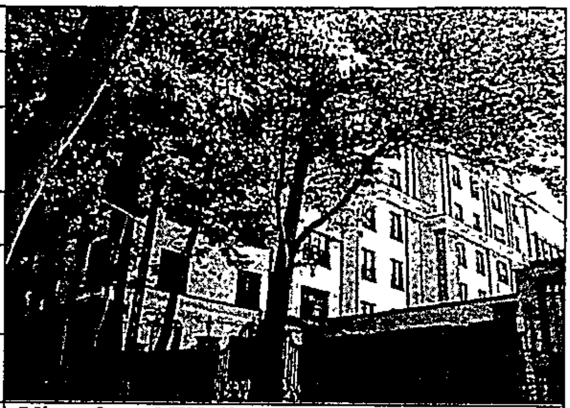
Wind condition:
no wind

Special comments:
Kouhsar apartment complex

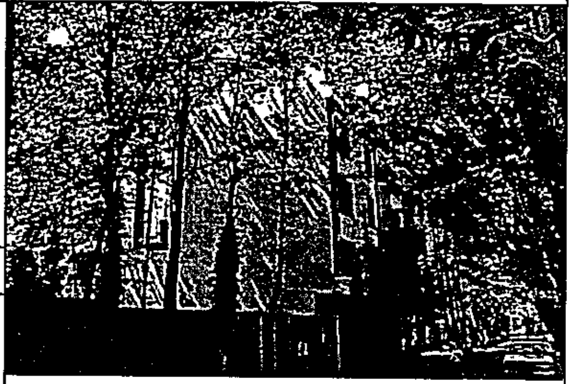
Dimensions (L x W x H):
33.0m x 28.7m x 26.1m



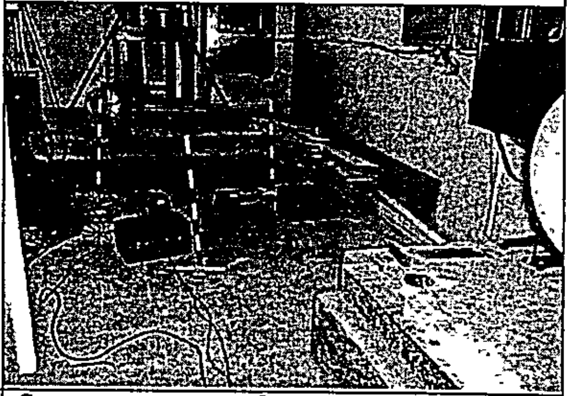
Map with the position of the building



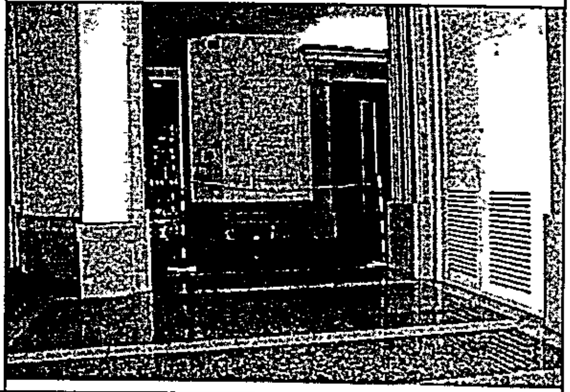
View from NW direction



View from NE direction



Sensor setup - top of the building



Sensor setup - ground floor

5.1.5 Field measuring form - Site R5

Site code: R5

Street address: Ferdowsi Sq., Enghelab Ave.

Building type:
reinforced concrete construction

No. of stories: 7

Shape of the building:
rectangular, elongated, complex, three-part

Date of measurement: 15/07/2000

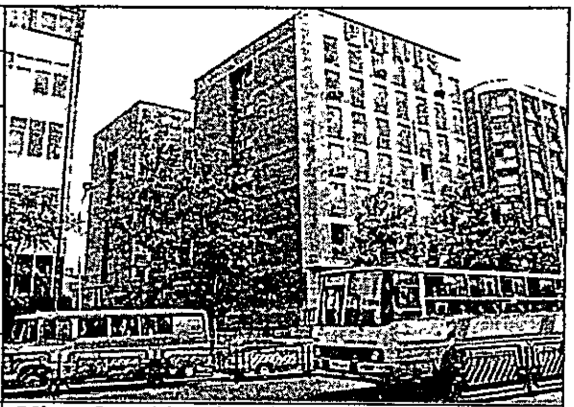
Building condition: inhabited office building

Seismic noise source conditions:
elevators stopped, air condition generators stopped, some visitors passed nearby ground floor measuring site

Weather condition: Clear

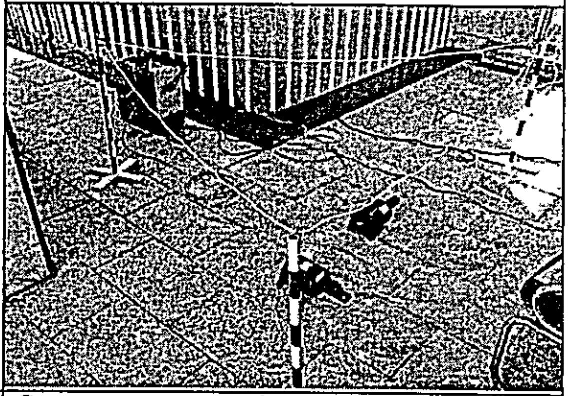
Wind condition:
slight wind, branches move

Special comments:
Phillips building
Dimensions (L x W x H):
36.0m x 15.0m x 24.0m

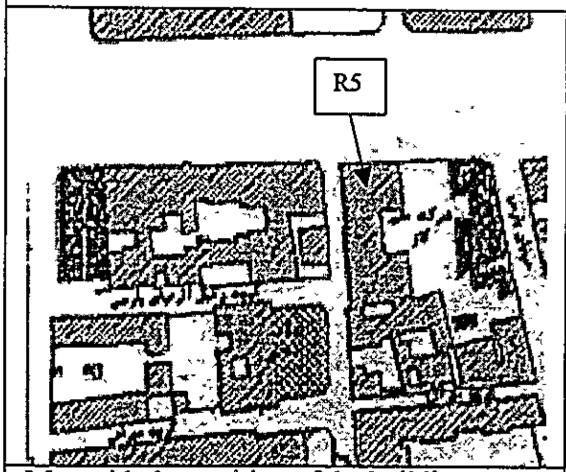


View from NE direction

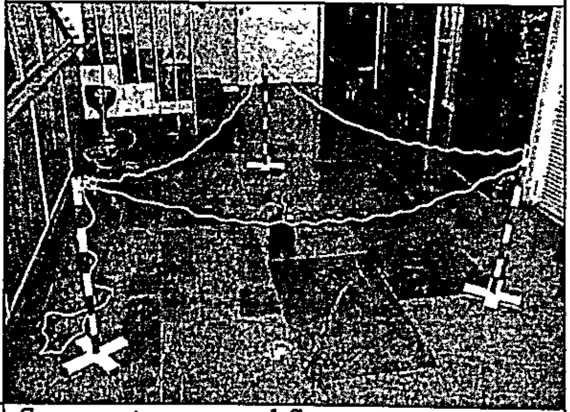
View from NW direction



Sensor setup - top of the building



Map with the position of the building



Sensor setup - ground floor

5.1.6 Field measuring form - R6

Site code: R6

Street address: Hatef St., Darous

Building type:
reinforced concrete construction

No. of stories: 6

Shape of the building:
rectangular, elongated

Date of measurement: 18/07/2000

Building condition: inhabited residential

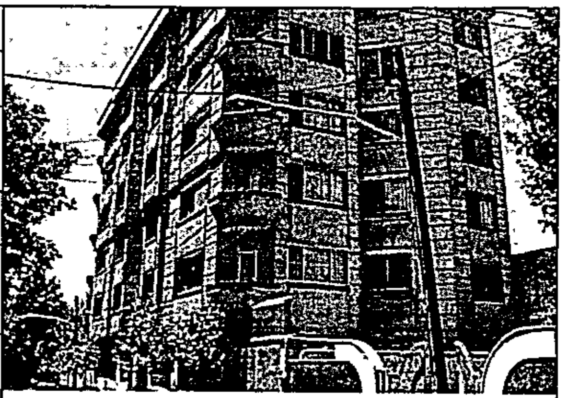
Seismic noise source conditions:
elevators stopped; air condition generators stopped, however not during the measurement #1

Weather condition: Clear

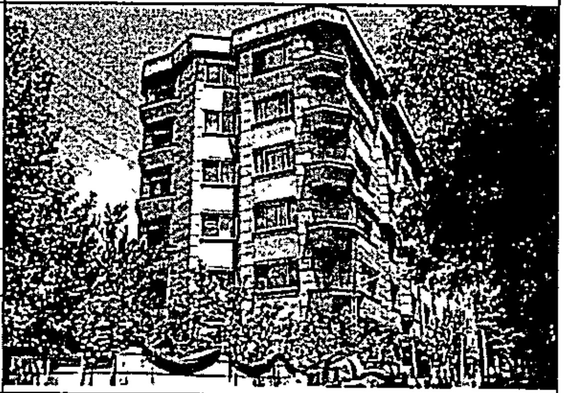
Wind condition:
no wind

Special comments:

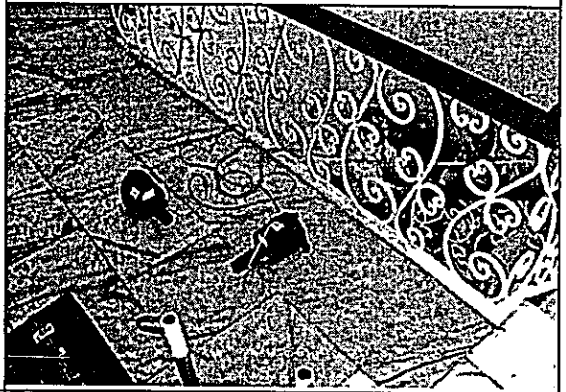
Dimensions (L x W x H):
37.0m x 15.0m x 23.0m



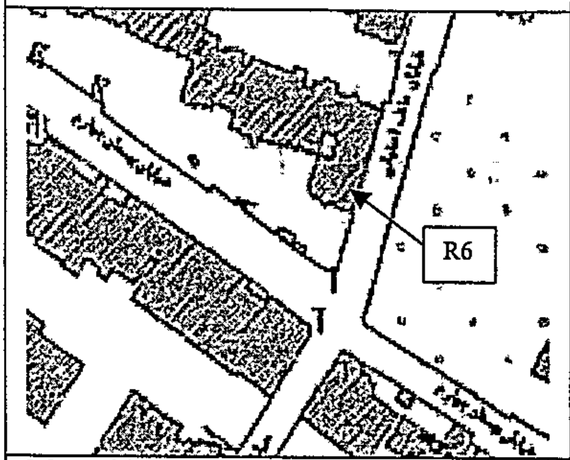
View from NE direction



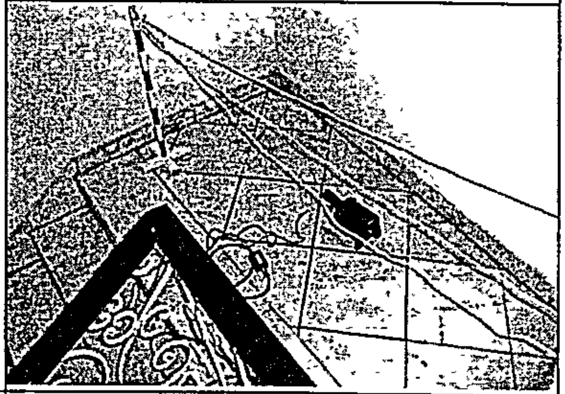
View from SW direction



Sensor setup - top of the building



Map with the position of the building



Sensor setup - ground floor

5.1.7 Field measuring form - Site R8

Site code: R8

Street address: Rom, Neyestan 8, Darous

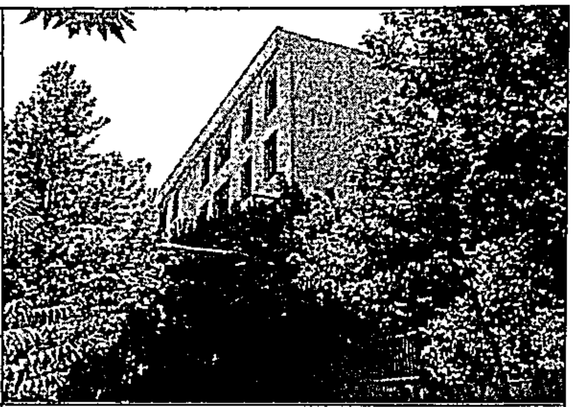
Building type:
reinforced concrete construction

No. of stories: 5

Shape of the building:
rectangular, elongated

Date of measurement: 17/07/2000

Building condition: under construction



View from NE direction

Seismic noise source conditions:
no elevators, air condition, and water pumps; we were unable to stop construction works during the measurement

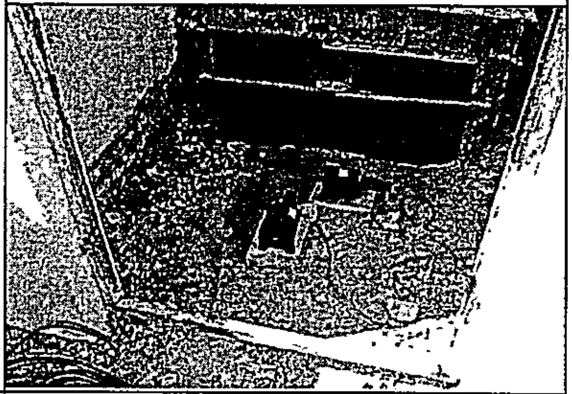
Weather condition: Clear

Wind condition:
slight wind, branches move

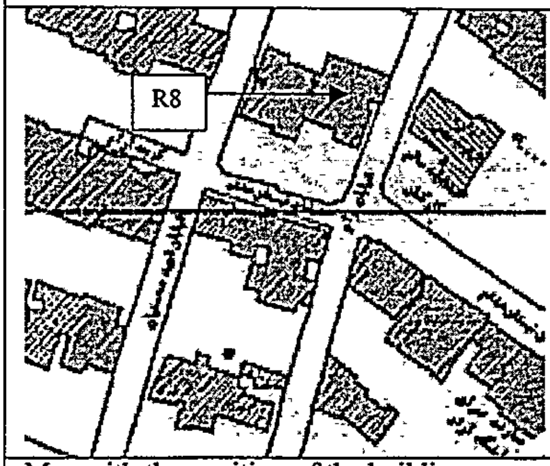
View from SW direction

Special comments:
building nearly finished

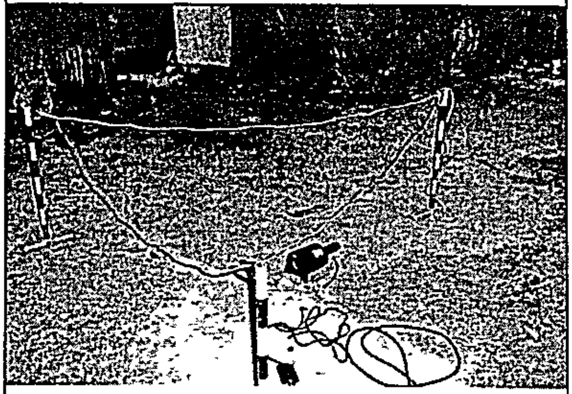
Dimensions (L x W x H):
30.0m x 21.8m x 17.0m



Sensor setup - top of the building



Map with the position of the building



Sensor setup - ground floor