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ANALYSIS OF LIQUEFACTION POTENTIAL OF SOIL BY FIELD TEST DATA A COMPARISION STUDY ON LIQUEFACTION SUSCEPTIBILITY BASED ON DIFFERENT APPROACHES

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ABSTRACT

One of the main concerns for structures built on sandy soils is soil liquefaction. Liquification is the process by which tightly packed, damp granular soil near the ground's surface loses strength from severe ground trembling. Existing structures fall as a result of this phenomenon, taking lives and property with them. Thus, while constructing a foundation, it is essential to comprehend the zone of liquefaction at a particular area. In light of this, a sand-rich location in Kolkata's Sonarpur neighborhood has been chosen for the current study. The goal of the current study is to assess the soil's liquefaction potential using the SPT and CPT methods in Sonarpur, which is close to Kolkata. It has been determined how resistant soils are to liquefaction, measured in terms of the cyclic resistance ratio (CRR). The article highlights the site's distinctive liquefaction zone, which may be taken into consideration when constructing the
geotechnical foundation there.

Keywords : Liquefaction Potential , SPT,CPT

1. INTRODUCTION

The process known as liquefaction occurs when saturated sand experiences cyclic or monotonic shear stresses. As a result, a significant portion of its shear resistance is lost, and the sand begins to flow more like a liquid. The process of a granular material changing from a solid to a liquefied state due to a decrease in effective stress and an increase in pore-water pressure is known as liquefaction. The loose to medium-density granular soils that tend to compress when sheared are especially susceptible to this phenomena. Pore-water pressure drainage in saturated soils can be hindered by silty or clayey seam inclusions, or it could not have enough time to happen because of sudden loading, such seismic pressures.

In this case, the pore-water pressure rises as a result of the inclination to compress. As a result, there is a drop in the frictional shear strength and a reduction in effective stress.

Since its initial coining by Mogami and Kubo (1953), the word "liquefaction" has been used to describe a wide range of processes involving soil deformations brought on by recurrent, transitory, or monotonous disturbance of saturated cohesion-less soils under undrained settings. All liquefaction processes are characterized by the production of excess pore pressure under undrained loading conditions. It is generally known that dry cohesion poor soils have a propensity to densify under both static and cyclic loads. However, fast loading occurs under undrained conditions when cohesion-less soils are saturated, therefore the trend toward densification results in

a rise in excess pore pressures and a decrease in effective stresses. Shaking causes liquefaction, a phenomenon that happens to unconsolidated silt that is soaked with water. When such material is present, the earth trembles, causing the grains to separate from one another and the substance to flow.
Liquefaction is a phenomenon wherein a mass of soil lose a large percentage of its shear resistance, when subjected to monotonic, cyclic, or shock loading, and flows in a manner resembling a liquid until the shear stresses acting on the mass are as low as the reduced shear resistance (Sladen et al, 1985)".

The one of newest definition has presented with Idriss and Boulanger:
"Loose cohesionless soils tend to contract during cyclic loading, which can transfer normal stress from the soil skeleton to pore water, if the soil is saturated and largely unable to drain during shaking. The result is a reduction in effective confining stress within the soil and an associated loss of strength and stiffness that contributes to deformations of the soil deposit. This loss of strength and stiffness due to increasing pore pressures is called liquefaction (Idriss & Boulanger, 2008)."
Following the principle of effective stress states, effective stress equals to total stress minus the porewater pressure:
$\sigma' = \sigma - u$ (1)
σ' = effective stress
σ = total stress
u = pore water pressure
If the quantity of σ remains constant, as the pore water pressure u slowly increases, the effective stress σ' gradually decreased. If the pore water pressure builds up to the point at which it is equal to the total stress, the effective stress becomes zero. As the stiffness and strength of a soil depends on the magnitude of effective stress, the soil loses its strength completely when the effective stress becomes zero and the soil is in a liquefaction state (Seed & Lee, 1966).results.

2. OBJECTIVE & SCOPE

The Objectives of the paper are given below:

1. To evaluate liquefaction potential of soil (at Sonarpur near Kolkata) firstly by SPT method
2. To evaluate liquefaction potential of soil (at Sonarpur near Kolkata) firstly by CPT method
3. To find out the depth of liquefaction and minimum factor of safety against liquefaction of the site by two in situ methods (i.e. SPT and CPT)
4. To find out the Liquefaction proneness based on the present study.
5. To highlight the site-specific liquefaction zone which may be considered for geotechnical design of foundation at the site.

The Scope of the paper are given below:

To fulfill the objective following scope has been taken up:-

a) Firstly, A suitable site has been identified near Sonarpur, Kolkata .
b) Two boreholes have been dug at the site. The Standard penetration test (SPT) is carried out within the boreholes
c) Two numbers of CPT tests i.e., CPT1 and CPT2 (aligned to the straight line with the SPT points), were carried out by giving 1000mm spacing between the respective SPT tests points.
d) cyclic stress ratio (CSR) has been determined as per (Seed and Idriss 1971) or IS 1893 Part-1 2016,
e) Based on the above collected Standard penetration test (SPT) data, cyclic resistance ratio (CRR) has been determined as per IS 1893 Part-1 2016.
f) Further, CRR value computed from SPT as well as from CPT test is compared with respect to depth for two borehole locations (i.e SPT-1 and SPT-2) and Factor of safety (FOS) against liquefaction is calculated using the following equations
FOS= CRR/CSR

3. METHODOLOGY

3.1 Determination of CSR (Seed and Idriss 1971).

The "simplified procedure" calls for the computation of two variables: (1) the cycle stress ratio (CSR), which measures the seismic demand an earthquake places on a soil layer, and (2) the cyclic resistance ratio (CRR), which measures the soil's ability to withstand liquefaction. There may be liquefaction if CSR exceeds CRR. The cyclic stress ratio CSR is calculated by the following equation (Seed & Idriss 1971):

$$CSR = \tau_{av} / \sigma'_{vo} = 0.65\,(a_{max}/g)\,(\sigma_{vo} / \sigma'_{vo})\,r_d \qquad (2)$$

Where τ_{av}= average cyclic shear stress, amax = peak horizontal acceleration on the surface of soil caused by earthquake, g =gravitational acceleration, σ_v = vertical overburden stress, σ'_{v0} = effective vertical overburden stress,

rd = Stress reduction factor.

3.2 Determination of CRR from SPT test data

(Seed and Idris, 1985) proposed $CRR_{7.5}$ equation as mentioned below

$$CRR_{7.5}=\frac{1}{34-(N1)_{60CS}}+\frac{(N1)_{60CS}}{135}-\frac{50}{[10\times(N1)_{60CS}+45]^2}-\frac{1}{200} \qquad (3)$$

Where $(N1)_{60CS}$ is the clean-sand equivalence of the corrected SPT blow count as per (Youd et al., 2001).As per IS 1893 part (1) 2016,

$$(N1)_{60CS}=\alpha+\beta\,(N1)_{60} \qquad (4)$$

$$(N1)_{60}=C_N N_{60} \qquad (5)$$

Where, $C_N=\sqrt{\frac{Pa}{\sigma' vo}}$,

σ'_{vo} = effective vertical overburden stress and $P_{a=}$atmospheric pressure.

The subscript 7.5 in the CRR7.5 term indicates that this cyclic liquefaction resistance is evaluated at a magnitude of 7.5. Note that Eq. (1) is valid only for $(N1)_{60CS}$ <30, while the sandy soil is considered unliquefiable when $(N1)_{60CS}$is greater than 30

(Idriss and Boulanger, 2006) noted that the trend of the CRR curve proposed by (Youd et al., 2001) would sharply increase as the $(N1)_{60CS}$ approaches 30, which may be irrational and would cause the unreasonable results when conducting the probabilistic analysis. They proposed a new model as follows (Idriss and Boulanger, 2006).

$$CRR_{7.5}=\frac{(N1)_{60CS}}{14.1}+\left(\frac{(N1)_{60CS}}{126}\right)^2-\left(\frac{(N1)_{60CS}}{23.6}\right)^3+\left(\frac{(N1)_{60CS}}{25.4}\right)^4-2.8 \qquad (6)$$

3.3 Determination of CRR from CPT tests data.

The CPT calculations are based on empirical correlations as mentioned below as per ROCSCIENCE INC. (2021) CPT Manual. This manual helps to find some relevant properties to determine the liquefaction potential. The Cone Penetration Test allows for a continuous soil profile and can collect up to 5 independent readings in a single sounding. These readings, notably the cone tip resistance (qc), sleeve friction (ft), and penetration pore water pressure (u2) are interpreted to give the soil parameters used to asses subsurface stratigraphy.

Corrected Cone Resistance, qt

1. The corrected cone resistance, qt, is calculated as:

$$qt=qc+u2(1-a) \qquad (7)$$

where

a = net area ratio.

In the absence of $u2$, qc = qt. (8)

2. Friction Ratio, Rf

The friction ratio is defined as the percentage of sleeve friction, fs, to cone resistance, qc, at the same depth.

$$Rf=(fs/qt)\cdot 100\% \qquad (9)$$

3. Soil Unit Weight, γ

The following relationship from Robertson expresses the soil unit weight in terms of the friction ratio and cone resistance (Robertson, 2010).

$$\gamma/\gamma w=0.27(\log Rf)+0.36[\log(qt/Pa)]+1.236 \tag{10}$$

where

Rf = friction ratio

γw = unit weight of water

Pa = atmospheric pressure

4. Total and Effective Overburden Stress, $\sigma v0$ and $\sigma v0'$

The total and effective overburden stresses are calculated using the calculated soil unit weight for each depth.

$$\sigma v0=\Sigma(zi\cdot\gamma i) \tag{11}$$

$$\sigma v0'=\sigma v0-u \tag{12}$$

where

γi = soil unit weight of the ith layer

zi = depth of the ith layer from the ground surface

5. Normalized Cone Resistance, Qt

$$Qt=(qt-\sigma v0)/\sigma v0' \tag{13}$$

6. Normalized Friction Ratio, Fr

$$Fr=[(fs/(qt-\sigma v0)]\cdot 100\% \tag{14}$$

7.Soil Behaviour Type Index, Ic

The soil behavior type index can be thought of as a representative value that combines Qt and Fr to produce concentric circles delineating Robertson’s 1990 SBT chart zones. Ic expresses the radius of those concentric circles.

$$Ic=((3.47-\log Qt)^2+(\log Fr+1.22)^2)^{0.5} \tag{15}$$

The liquefaction potential can then be obtained from IS 1893 part (1) 2016 as follows:

The CPT procedure requires normalizations of measured cone tip resistance q_c using atmospheric pressure P_a and correction for overburden pressure C_Q as follows ,

$$q_{CIN} = C_Q\,(q_c/P_a) \tag{16}$$

where q_{CIN} is normalized dimensionless cone penetration resistance

$$C_Q = \sqrt{\frac{Pa}{\sigma' vo}} \tag{17}$$

The normalized penetration resistance q_{CIN} for silty sand is corrected to an equivalent clean sand value $(q_{CIN})_{CS}$ by the following relation ,

$$(q_{CIN})_{CS} = k_C\, q_{CIN} \tag{18}$$

Where k_C = correction factor to account for grain characteristics

$$= 1.0 \text{ (for } I_C \leq 1.64) \quad (19)$$

$$-0.403I_C^4 + 5.581I_C^3 - 21.63I_C^2 + 33.75I_C - 17.88 \text{ (for } I_C > 1.64) \quad (20)$$

The $CRR_{7.5}$ can be found using following equations,

$$CRR_{7.5} = 0.833((q_{CIN})_{CS}/1000) + 0.05, \; 0 < (q_{CIN})_{CS} < 50 \quad (21)$$

$$CRR_{7.5} = 93((q_{CIN})_{CS})/1000)^3 + 0.08, \; 50 \leq (q_{CIN})_{CS} < 160 \quad (22)$$

3.4 Computation of Factor of safety (FOS) against liquefaction

Factor of safety (FOS) against liquefaction is calculated using the following equation

$$FOS = CRR/CSR \quad (23)$$

Liquefaction is said to occur if FOS is less than 1.

3.5 Identification of earthquake magnitude from peer ground motion database and earthquake zone.

As per Indian standard (IS 1893 Part-1 2016), peak ground acceleration is obtained for the study. According to the code Sonarpur is classified into the zone IV having PGA of 0.3g and seismic zone factor (Z) is considered as 0.24

4. PRESENTATION OF RESULT

4.1 On the basis of SPT

Based on the SPT data an attempt has been made to find to depth wise liquefaction potential in terms of factor of safety using simplified procedure as shown in Table- 4.1 and Table-4.2 for BH-1 and BH-2 respectively.

Table 4.1 Liquefaction potential analysis using simplified procedure for bore hole 1 (SPT-1)

Sl no.	Depth below EGL	Type of Starta	Observed SPT value	BULK Density (kn/m3)	Submerged Density (kn/m3)	Fine content(%)	Stress reduction co efficient (rd)	Total overburden pressure (σv0) KN/m2	Effective overburden pressure (σ'v0) KN/m2	Cyclic Stress ration(CSR)	MSF	kσ	Kα	CHT	CHW	CSS	CRL	CBD	C60=(CHTXCHWXCSSXCRLXCBD)	N60=(NXC60)	CN	SPT corrected (N1)60=(CNXN60)	α	β	(N1)60 CS	CRR 7.5	CRR	FOS	Conclusion
1	1.45	OL	3	18.9	9.09	97.3	0.989	27.41	27.41	0.1543	1	1	1	0.75	0.98	1.1	0.75	1.05	0.637	1.91	1.7	3.25	5	1.2	8.897	0.104	0.104	0.67	Liquifable
2	3.95	MI/CI	7	18.9	9.09	77.3	0.97	74.66	74.66	0.1513	1	1	1	0.75	0.98	1.1	0.80	1.05	0.679	4.754	1.157	5.50	5	1.2	11.6	0.128	0.128	0.84	Liquifable
3	5.45	SC	9	19.7	9.89	39	0.958	107.37	92.65	0.1732	1	1	1	0.75	0.98	1.1	0.85	1.05	0.722	6.494	1.039	6.75	5	1.2	13.1	0.141	0.141	0.82	Liquifable
4	6.95	SC	11	19.7	9.89	38.5	0.947	136.92	107.49	0.1881	1	1	1	0.75	0.98	1.1	0.95	1.05	0.806	8.871	0.965	8.56	5	1.2	15.27	0.163	0.163	0.87	Liquifable
5	9.95	SC	14	19.7	9.89	32	0.908	196.02	137.16	0.2025	1	1	1	0.75	0.98	1.1	0.95	1.05	0.806	11.29	0.854	9.64	4.8281	1.171	16.12	0.171	0.171	0.85	Liquifable
6	11.45	SM	22	19.7	9.89	28.5	0.868	225.57	151.99	0.2010	1	1	1	0.75	0.98	1.1	1.00	1.05	0.849	18.68	0.811	15.15	4.60012	1.142	21.9	0.241	0.241	1.20	Non Liquifiable
7	12.95	SM	23	19.7	9.89	28.01	0.828	255.12	166.83	0.1976	1	1	1	0.75	0.98	1.1	1.00	1.05	0.849	19.53	0.774	15.12	4.5623	1.138	21.77	0.239	0.239	1.21	Non Liquifiable
8	15.95	SM	28	19.7	9.89	27.52	0.748	314.22	196.50	0.1866	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	23.77	0.713	16.96	4.52277	1.134	23.76	0.269	0.228	1.22	Non Liquifiable
9	17.45	SM	29	19.7	9.89	27.03	0.708	343.77	211.33	0.1797	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	24.62	0.688	16.94	4.48145	1.131	23.63	0.267	0.222	1.24	Non Liquifiable
10	18.95	SM	30	19.7	9.89	26.54	0.668	373.32	226.17	0.1720	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	25.47	0.665	16.93	4.43823	1.127	23.52	0.265	0.217	1.26	Non Liquifiable
11	20.45	SM	32	19.7	9.89	25.44	0.628	402.87	241.00	0.1638	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	27.17	0.644	17.50	4.33371	1.118	23.9	0.272	0.219	1.34	Non Liquifiable
12	21.95	SM	33	19.7	9.89	24.34	0.588	432.42	255.84	0.1550	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	28.01	0.625	17.51	4.2177	1.11	23.66	0.268	0.212	1.37	Non Liquifiable
13	23.45	SM	35	19.7	9.89	23.24	0.548	461.97	270.67	0.1459	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	29.71	0.608	18.06	4.08864	1.102	23.99	0.273	0.214	1.47	Non Liquifiable

Sl no.	Depth below EGL	Type of Starta	Observed SPT value	BULK Density (kn/m3)	Submerged Density (kn/m3)	Fine content(%)	Stress reduction co efficient (rd)	Total overburden pressure (σv0) KN/m2	Effective overburden pressure (σ'v0) KN/m2	Cyclic Stress ration(CSR)	MSF	kσ	Kα	CHT	CHW	CSS	CRL	CBD	C60=(CHTXCHWXCSSXCRLXCBD)	N60=(NXC60)	CN	SPT corrected (N1)60=(CNXN60)	α	β	(N1)60 CS	CRR 7.5	CRR	FOS	Conclusion
14	24.95	SM	37	19.7	9.89	22.9	0.508	491.52	285.51	0.1364	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	31.41	0.592	18.59	4.04584	1.1	24.49	0.282	0.218	1.60	Non Liquifiable
15	26.45	SM	38	19.7	9.89	22.9	0.468	521.07	300.34	0.1266	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	32.26	0.577	18.61	4.04584	1.1	24.51	0.283	0.215	1.70	Non Liquifiable
16	27.95	SM	40	19.7	9.89	22.56	0.428	550.62	315.18	0.1166	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	33.96	0.563	19.13	4.00156	1.097	24.99	0.292	0.22	1.88	Non Liquifiable
17	29.45	SM	42	19.7	9.89	21.45	0.388	580.17	330.01	0.1063	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	35.65	0.55	19.63	3.84606	1.089	25.23	0.296	0.221	2.08	Non Liquifiable
18	30.95	SM	45	19.7	9.89	21.45	0.348	609.72	344.85	0.0959	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	38.2	0.539	20.57	3.84606	1.089	26.26	0.319	0.235	2.45	Non Liquifiable
19	32.45	SM	47	19.7	9.89	20.34	0.308	639.27	359.68	0.0853	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	39.9	0.527	21.04	3.67204	1.082	26.43	0.323	0.236	2.76	Non Liquifiable
20	33.95	SM	49	19.7	9.89	20.34	0.268	668.82	374.52	0.0745	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	41.6	0.517	21.49	3.67204	1.082	26.92	0.336	0.243	3.25	Non Liquifiable
21	35.45	SM	48	19.7	9.89	19.23	0.227	698.37	389.35	0.0637	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	40.75	0.507	20.65	3.4771	1.074	25.66	0.306	0.218	3.43	Non Liquifiable
22	36.95	SM	51	19.7	9.89	19.23	0.187	727.92	404.19	0.0527	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	43.3	0.497	21.54	3.4771	1.074	26.61	0.328	0.232	4.41	Non Liquifiable
23	38.45	SM	53	19.7	9.89	17.67	0.147	757.47	419.02	0.0416	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	44.99	0.489	21.98	3.16285	1.064	26.56	0.327	0.229	5.51	Non Liquifiable
24	39.45	SM	57	19.7	9.89	17.67	0.121	777.17	428.91	0.0341	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	48.39	0.483	23.36	3.16285	1.064	28.03	0.371	0.258	7.57	Non Liquifiable
25	40.45	SM	59	19.7	9.89	17.67	0.094	796.87	438.80	0.0266	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	50.09	0.477	23.91	3.16285	1.064	28.61	0.393	0.272	10.23	Non Liquifiable

Table 4.2 Liquefaction potential analysis using simplified procedure for bore hole 2 (SPT-2)

Liquifaction potential analysis using simplified procedure fore bore hole 2

Sl no.	Depth below EGL	Type of Starta	Observed SPT value	BULK Density (kn/m3)	Submerged Density (kn/m3)	Fine content(%)	Stress reduction co efficient (rd)	Total overburden pressure (σv0) KN/m2	Effective overburden pressure (σ'v0) KN/m2	Cyclic Stress ration(CSR)	MSF	kσ	Kα	CHT	CHW	CSS	CRL	CBD	C60=(CHTXCHWXCSSXCRLXCBD)	N60=(NXC60)	CN	SPT corrected (N1)60=(CNXN60)	α	β	(N1)60 CS	CRR 7.5	CRR	FOS	Conclusion
1	1.45	CI	3	19	9.19	95.23	0.989	27.55	27.55	0.15	1	1	1	0.75	0.98	1.1	0.75	1.05	0.637	1.91	1.7	3.25	5	1.2	8.897	0.104	0.104	0.67	Liquifable
2	4.45	MI	9	19	9.19	72.3	0.966	84.55	65.42	0.19	1	1	1	0.75	0.98	1.1	0.85	1.05	0.722	6.494	1.236	8.03	5	1.2	14.64	0.156	0.156	0.80	Liquifable
3	7.45	MI	13	19.7	9.89	59.3	0.943	146.77	98.21	0.22	1	1	1	0.75	0.98	1.1	0.95	1.05	0.806	10.48	1.009	10.58	5	1.2	17.7	0.188	0.188	0.86	Liquifable
4	10.45	SC	17	19.7	9.89	42.4	0.895	205.87	127.88	0.22	1	1	1	0.75	0.98	1.1	1.00	1.05	0.849	14.43	0.884	12.76	5	1.2	20.31	0.219	0.219	0.98	Liquifable
5	11.95	SC	23	19.7	9.89	29.9	0.855	235.42	142.71	0.22	1	1	1	0.75	0.98	1.1	1.00	1.05	0.849	19.53	0.837	16.34	4.69959	1.153	23.55	0.266	0.266	1.21	Non Liquifiable
6	13.45	SM	26	19.7	9.89	28.79	0.815	264.97	157.55	0.21	1	1	1	0.75	0.98	1.1	1.00	1.05	0.849	22.07	0.797	17.58	4.62174	1.144	24.75	0.287	0.287	1.34	Non Liquifiable
7	14.95	SM	28	19.7	9.89	27.68	0.775	294.52	172.38	0.21	1	1	1	0.75	0.98	1.1	1.00	1.05	0.849	23.77	0.762	18.10	4.53587	1.136	25.1	0.294	0.294	1.42	Non Liquifiable
8	16.45	SM	28	19.7	9.89	26.57	0.735	324.07	187.22	0.20	1	0.9	1	0.75	0.98	1.1	1.00	1.05	0.849	23.77	0.731	17.37	4.44093	1.127	24.02	0.274	0.235	1.18	Non Liquifiable
9	17.95	SM	30	19.7	9.89	25.46	0.695	353.62	202.05	0.19	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	25.47	0.704	17.92	4.33571	1.118	24.38	0.28	0.236	1.24	Non Liquifiable
10	19.45	SM	30	19.7	9.89	25.46	0.655	383.17	216.89	0.18	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	25.47	0.679	17.29	4.33571	1.118	23.68	0.268	0.221	1.23	Non Liquifiable
11	20.95	SM	34	19.7	9.89	25.46	0.615	412.72	231.72	0.17	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	28.86	0.657	18.96	4.33571	1.118	25.54	0.303	0.246	1.44	Non Liquifiable
12	22.45	SM	36	19.7	9.89	25.46	0.575	442.27	246.56	0.16	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	30.56	0.637	19.46	4.33571	1.118	26.1	0.316	0.253	1.57	Non Liquifiable
13	23.95	SM	35	19.7	9.89	24.91	0.535	471.82	261.39	0.15	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	29.71	0.619	18.38	4.27934	1.114	24.76	0.287	0.227	1.51	Non Liquifiable
14	25.45	SM	38	19.7	9.89	24.36	0.494	501.37	276.23	0.14	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	32.26	0.602	19.41	4.21992	1.11	25.77	0.308	0.24	1.71	Non Liquifiable
15	26.95	SM	40	19.7	9.89	24.36	0.454	530.92	291.06	0.13	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	33.96	0.586	19.90	4.21992	1.11	26.32	0.321	0.246	1.90	Non Liquifiable
16	28.45	SM	44	19.7	9.89	24.36	0.414	560.47	305.90	0.12	1	0.8	1	0.75	0.98	1.1	1.00	1.05	0.849	37.35	0.572	21.36	4.21992	1.11	27.93	0.367	0.279	2.35	Non Liquifiable
17	29.95	SM	45	19.7	9.89	23.86	0.374	590.02	320.73	0.11	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	38.2	0.558	21.33	4.16309	1.107	27.77	0.362	0.271	2.52	Non Liquifiable
18	31.45	SM	47	19.7	9.89	23.36	0.334	619.57	335.57	0.10	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	39.9	0.546	21.78	4.1034	1.103	28.13	0.374	0.277	2.88	Non Liquifiable
19	32.95	SM	48	19.7	9.89	22.86	0.294	649.12	350.40	0.09	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	40.75	0.534	21.77	4.0407	1.099	27.97	0.369	0.27	3.18	Non Liquifiable
20	34.45	SM	49	19.7	9.89	22.36	0.254	678.67	365.24	0.07	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	41.6	0.523	21.77	3.97481	1.096	27.82	0.364	0.264	3.58	Non Liquifiable
21	35.95	SM	51	19.7	9.89	21.24	0.214	708.22	380.07	0.06	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	43.3	0.513	22.21	3.81463	1.088	27.97	0.369	0.265	4.26	Non Liquifiable
22	37.45	SM	55	19.7	9.89	20.12	0.174	737.77	394.91	0.05	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	46.69	0.503	23.50	3.63515	1.08	29.02	0.411	0.293	5.77	Non Liquifiable
23	38.95	SM	56	19.7	9.89	19.35	0.134	767.32	409.74	0.04	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	47.54	0.494	23.49	3.49926	1.075	28.75	0.399	0.281	7.18	Non Liquifiable
24	40.45	SM	59	19.7	9.89	18.23	0.094	796.87	424.58	0.03	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	50.09	0.485	24.31	3.28145	1.068	29.24	0.422	0.295	10.72	Non Liquifiable
25	41.95	SM	60	19.7	9.89	17.88	0.054	826.42	439.41	0.02	1	0.7	1	0.75	0.98	1.1	1.00	1.05	0.849	50.94	0.477	24.30	3.20811	1.066	29.1	0.415	0.288	18.18	Non Liquifiable

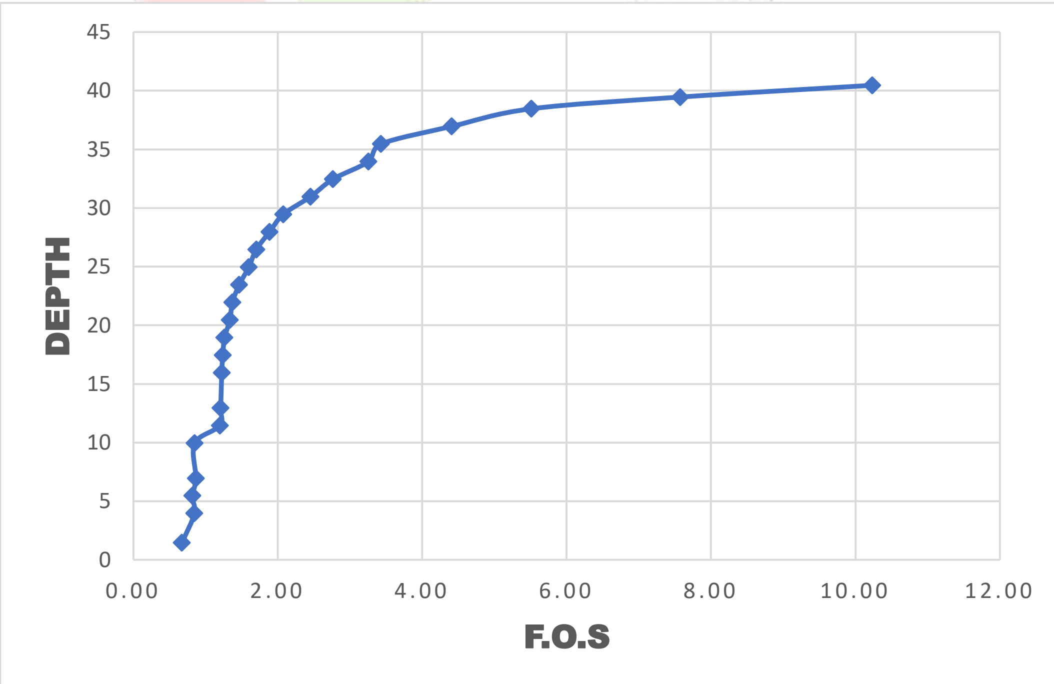

Fig. 4.1 FOS Vs depth from SPT 1(Borehole-1)

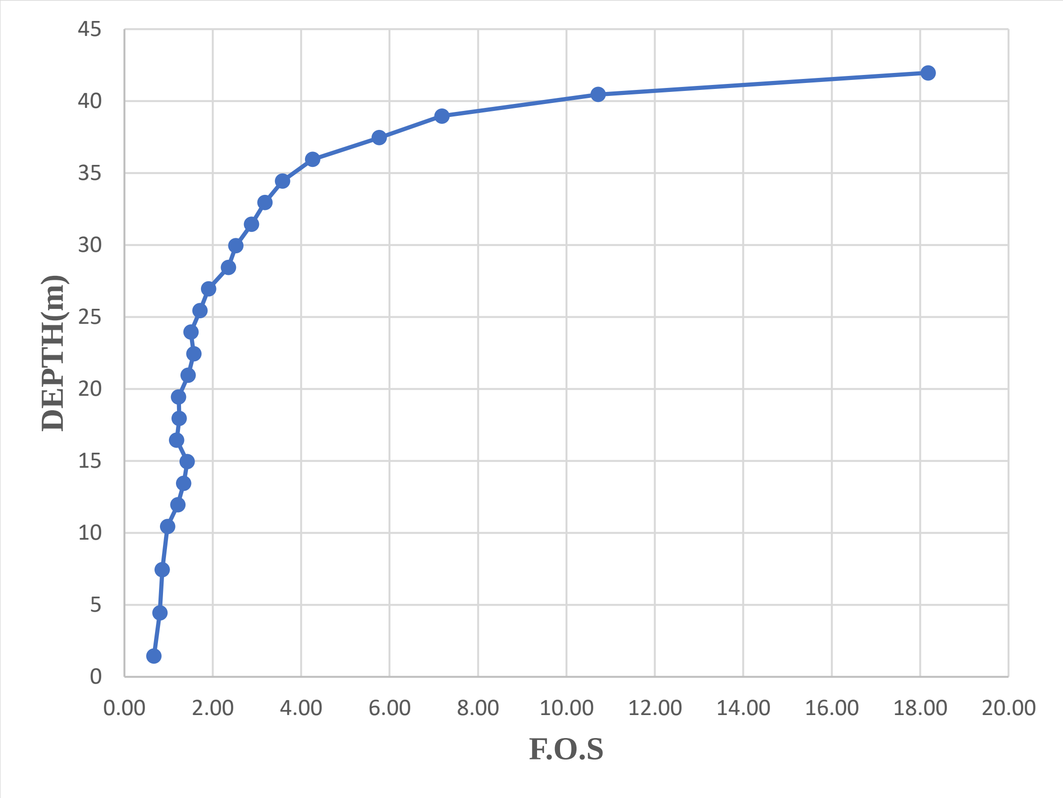

Fig. 4.2. FOS Vs depth from SPT Data (Borehole-2)

4.2. Liquefaction potential analysis using Cone Penetration test (CPT) data

Liquefaction potential analysis using Cone penetration (CPT) test has been done for CPT1 and CPT2 and shown in below mentioned table.

Table 5.3: Liquefaction potential analysis using Cone penetration test (CPT) 1 data

Number of sounding rod	Depth	RP	RP+RL	qc obtained from manual calculation as robertson equation value of Rp in 10*kg) or uncorrected qc	qc	total resistanec (x) (rp+Rl)	cone resistance (uncorrected) (y)	total resistane -cone resistance (x-y)	frictinal resistance (z) = (x-y)*b/a	corrected (fs) as IS code	fs = (((Rp+Rl)+ 1)*10- (Rp+1)*10))/150	fs	Original Rf from Pagani software as robertson	Rf obtained from corrected (qc) as IS code	If=qc/fs obtained from Pagani softwar/ Manual	If=qc/fs as Corrected qc as IS code 4968	RT	Normalized friction ratio(Fr) =(fs/(qc-σv))*100	Normalized Cone resitance (Qt)= (qc-σv)/σ'v	Ic soil behavior type index	soil type as Ic	total thrust Qt as pagani manual
	[m]	[10*Kg]	[10*Kg]	[kg/cm2]	kPa	kg/cm2	kg/cm2	kg/cm2	kg/cm2	kg/cm2	[kg/cm2]	[kPa]	[%]	[%]	[Kg]	[Kg]	[10*Kg]	in %				kg
1	0	0	0	0	0						0.00	0.00	>100	#DIV/0!	82.8	#DIV/0!	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	>250.00
1	0.20	10.00	18.00	10.14	1013.75	18.00	10.00	8.00	0.53	0.54	0.53	53.33	5.26	5.19	19.01	19.25	34	5.28	287.20	2.19	Sandy Mixture	347.75
1	0.40	10.00	19.00	10.14	1013.75	19.00	10.00	9.00	0.60	0.60	0.60	60.00	5.92	5.84	16.90	17.13	62	5.96	142.55	2.39	Sandy Mixture	627.75
1	0.60	11.00	20.00	11.14	1113.75	20.00	11.00	9.00	0.60	0.60	0.60	60.00	5.39	5.32	18.56	18.78	44	5.44	103.93	2.44	Sandy Mixture	447.75
1	0.80	11.00	21.00	11.14	1113.75	21.00	11.00	10.00	0.67	0.67	0.67	66.67	5.99	5.91	16.71	16.92	40	6.06	77.49	2.55	Sandy Mixture	407.75
1	1.00	12.00	21.00	12.14	1213.75	21.00	12.00	9.00	0.60	0.60	0.60	60.00	4.94	4.89	20.23	20.44	45	5.02	67.39	2.53	Sandy Mixture	457.75
2	1.20	17.00	28.00	17.28	1727.5	28.00	17.00	11.00	0.73	0.74	0.73	73.33	4.25	4.22	23.56	23.70	40	4.30	79.80	2.43	Sandy Mixture	415.5
2	1.40	14.00	24.00	14.28	1427.5	24.00	14.00	10.00	0.67	0.67	0.67	66.67	4.67	4.63	21.41	21.59	44	4.75	56.16	2.56	Sandy Mixture	455.5
2	1.60	15.00	24.00	15.28	1527.5	24.00	15.00	9.00	0.60	0.60	0.60	60.00	3.93	3.90	25.46	25.62	55	4.00	52.50	2.53	Sandy Mixture	565.5
2	1.80	18.00	27.00	18.28	1827.5	27.00	18.00	9.00	0.60	0.60	0.60	60.00	3.28	3.27	30.46	30.59	44	3.34	55.86	2.45	Sandy Mixture	455.5
2	2.00	16.00	26.00	16.28	1627.5	26.00	16.00	10.00	0.67	0.67	0.67	66.67	4.10	4.07	24.41	24.57	33	4.19	44.53	2.59	Sandy Mixture	345.5
3	2.20	19.00	29.00	19.41	1941.25	29.00	19.00	10.00	0.67	0.67	0.67	66.67	3.43	3.42	29.12	29.24	34	3.51	48.31	2.51	Sandy Mixture	363.25
3	2.40	20.00	29.00	20.41	2041.25	29.00	20.00	9.00	0.60	0.60	0.60	60.00	2.94	2.93	34.02	34.12	19	3.00	46.51	2.48	Sandy Mixture	363.25
3	2.60	21.00	28.00	21.41	2141.25	28.00	21.00	7.00	0.47	0.47	0.47	46.67	2.18	2.18	45.88	45.89	16	2.23	47.02	2.39	Sandy Mixture	213.25
3	2.80	20.00	29.00	20.41	2041.25	29.00	20.00	9.00	0.60	0.60	0.60	60.00	2.94	2.93	34.02	34.12	56	3.01	43.12	2.50	Sandy Mixture	183.25
3	3.00	22.00	31.00	22.41	2241.25	31.00	22.00	9.00	0.60	0.60	0.60	60.00	2.68	2.67	37.35	37.43	37	2.74	45.74	2.45	Sandy Mixture	583.25
4	3.20	24.00	33.00	24.55	2455	33.00	24.00	9.00	0.60	0.60	0.60	60.00	2.44	2.44	40.92	40.96	31	2.50	48.46	2.41	Sandy Mixture	401
4	3.40	23.00	34.00	23.55	2355	34.00	23.00	11.00	0.73	0.74	0.73	73.33	3.11	3.10	32.11	32.21	44	3.20	44.83	2.51	Sandy Mixture	341
4	3.60	25.00	34.00	25.55	2555	34.00	25.00	9.00	0.60	0.60	0.60	60.00	2.35	2.35	42.58	42.62	68	2.41	47.15	2.41	Sandy Mixture	471
4	3.80	26.00	36.00	26.55	2655	36.00	26.00	10.00	0.67	0.67	0.67	66.67	2.51	2.51	39.83	39.87	80	2.58	47.46	2.42	Sandy Mixture	711
4	4.00	28.00	40.00	28.55	2855	40.00	28.00	12.00	0.80	0.80	0.80	80.00	2.80	2.80	35.69	35.75	106	2.87	49.49	2.44	Sandy Mixture	831
5	4.20	27.00	42.00	27.69	2768.75	42.00	27.00	15.00	1.00	1.00	1.00	100.00	3.61	3.60	27.69	27.78	103	3.71	46.43	2.54	Sandy Mixture	1098.75
5	4.40	30.00	44.00	30.69	3068.75	44.00	30.00	14.00	0.93	0.94	0.93	93.33	3.04	3.03	32.88	32.95	103	3.12	50.01	2.46	Sandy Mixture	1068.75
5	4.60	32.00	46.00	32.69	3268.75	46.00	32.00	14.00	0.93	0.94	0.93	93.33	2.86	2.85	35.02	35.08	102	2.93	51.76	2.43	Sandy Mixture	1068.75
5	4.80	33.00	47.00	33.69	3368.75	47.00	33.00	14.00	0.93	0.94	0.93	93.33	2.77	2.77	36.09	36.15	98	2.84	51.82	2.43	Sandy Mixture	1058.75

Qst	αm (coeficient)	constrained modulus (Mo) Mcpt (mPa) mayne 1990	constrained modulus (Mo) Mcpt (kPa)	Soil unit weight (Y) robertson (2010)	Vertical overburden stress (Kn/m2) calculated from robertson (2010)	Vertical overburden stress (Kg/cm2) calculated from robertson (2010)	Effective Vertical overburden stress (Kn/m2) calculated from robertson (2010)	Effective Vertical overburden stress (Kg/cm2) calculated from robertson (2010)	Pre insertaion Pore water pressure (U)	Shear wave velocity(m/s) Vs=51.6Ln(fs)+18.5 (Mayne 2006)	correction factor for qc (IS 4968 Part III)	Corrected qc (IS4968)	Stress reduction factor(rd)	cyclic stress ratio (CSR)	C_Q	q_{C1N}	K_c	$(q_{C1N})_{CS}$	CRR	F.O.S	REMARKS
[KN]				kN/m3	kN/m2	kg/cm2	(Kn/m2)	kg/cm2	kN/m2			[kg/cm2]									
>250.00		0.0	0	0.00	0.00	0.00	0.00	0.00	0.00	#NUM!	0.3565	0.04	1.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
>250.00		8.3	1414.325473	17.59	3.52	0.04	3.52	0.035	0.00	223.69	0.3565	10.3565	0.9985	0.1558	5.3319	54.05	1.6328	88.257	0.1439	0.9241	Liquifiable
>250.00		8.3	1409.363009	17.72	7.06	0.07	7.06	0.07	0.00	229.77	0.3565	10.36	0.9969	0.1555	3.7630	38.15	2.2591	86.179	0.1395	0.8971	Liquifiable
>250.00		9.1	1544.390444	17.76	10.61	0.11	10.61	0.11	0.00	229.77	0.3565	11.36	0.9954	0.1553	3.0695	34.19	2.4526	83.846	0.1348	0.8682	Liquifiable
>250.00		9.1	1539.383945	17.88	14.19	0.14	14.19	0.14	0.00	235.20	0.3565	11.36	0.9939	0.1550	2.6547	29.57	3.0254	89.449	0.1466	0.9453	Liquifiable
>250.00		9.9	1674.402149	17.79	17.75	0.18	17.75	0.18	0.00	229.77	0.3565	12.36	0.9924	0.1548	2.3737	28.81	2.8890	83.232	0.1336	0.8632	Liquifiable
>250.00		14.1	2388.567825	18.16	21.38	0.21	21.38	0.21	0.00	240.12	0.494	17.49	0.9908	0.1546	2.1627	37.36	2.4143	90.201	0.1483	0.9591	Liquifiable
>250.00		11.6	1963.534679	17.98	24.98	0.25	24.98	0.25	0.00	235.20	0.494	14.49	0.9893	0.1543	2.0010	28.56	3.0798	87.973	0.1433	0.9287	Liquifiable
>250.00		12.4	2098.528199	17.88	28.55	0.29	28.55	0.29	0.00	229.77	0.494	15.49	0.9878	0.1541	1.8715	28.59	2.8897	82.607	0.1324	0.8594	Liquifiable
>250.00		14.8	2513.502467	17.95	32.14	0.32	32.14	0.32	0.00	229.77	0.494	18.49	0.9862	0.1539	1.7639	32.23	2.5204	81.246	0.1299	0.8442	Liquifiable
>250.00		13.1	2228.455243	18.03	35.75	0.36	35.75	0.36	0.00	235.20	0.494	16.49	0.9847	0.1536	1.6726	27.22	3.2513	88.505	0.1445	0.9405	Liquifiable
>250.00		15.7	2662.639093	18.09	39.36	0.39	39.36	0.39	0.00	235.20	0.6315	19.63	0.9832	0.1534	1.5938	30.94	2.8075	86.864	0.1410	0.9190	Liquifiable
>250.00		16.5	2797.601485	17.99	42.96	0.43	42.96	0.43	0.00	229.77	0.6315	20.63	0.9816	0.1531	1.5256	31.14	2.6345	82.045	0.1314	0.8578	Liquifiable
>250.00		17.3	2932.639687	17.72	46.51	0.47	44.55	0.45	1.96	216.80	0.6315	21.63	0.9801	0.1596	1.4983	32.08	2.2400	71.863	0.1145	0.7174	Liquifiable
>250.00		16.4	2787.60208	17.99	50.11	0.50	46.18	0.46	3.92	229.77	0.6315	20.63	0.9786	0.1656	1.4715	30.04	2.7582	82.849	0.1329	0.8023	Liquifiable
>250.00		18.0	3062.554436	18.03	53.71	0.54	47.83	0.48	5.89	229.77	0.6315	22.63	0.9771	0.1712	1.4460	32.41	2.5341	82.127	0.1315	0.7683	Liquifiable
>250.00		19.8	3356.747013	18.06	57.32	0.57	49.48	0.49	7.85	229.77	0.769	24.77	0.9755	0.1763	1.4217	34.90	2.3360	81.533	0.1304	0.7396	Liquifiable
>250.00		18.9	3211.629421	18.28	60.98	0.61	51.17	0.51	9.81	240.12	0.769	23.77	0.9740	0.1811	1.3980	32.92	2.7844	91.669	0.1516	0.8375	Liquifiable
>250.00		20.5	3486.567711	18.08	64.59	0.65	52.82	0.53	11.77	229.77	0.769	25.77	0.9725	0.1855	1.3759	35.15	2.3272	81.811	0.1309	0.7057	Liquifiable
>250.00		21.3	3621.467944	18.21	68.24	0.68	54.50	0.55	13.73	235.20	0.769	26.77	0.9709	0.1896	1.3545	35.96	2.4006	86.334	0.1398	0.7375	Liquifiable
>250.00		23.0	3896.301656	18.45	71.93	0.72	56.23	0.56	15.70	244.61	0.769	28.77	0.9694	0.1934	1.3336	38.07	2.4834	94.551	0.1586	0.8200	Liquifiable
>250.00		22.2	3770.31679	18.70	75.67	0.76	58.01	0.58	17.66	256.13	0.9065	27.91	0.9679	0.1969	1.3130	36.35	2.9661	107.827	0.1966	0.9982	Liquifiable
>250.00		24.7	4185.0931	18.66	79.40	0.79	59.78	0.60	19.62	252.57	0.9065	30.91	0.9663	0.2002	1.2934	39.69	2.5822	102.489	0.1801	0.8996	Liquifiable
>250.00		26.3	4459.862632	18.68	83.13	0.83	61.55	0.62	21.58	252.57	0.9065	32.91	0.9648	0.2033	1.2746	41.66	2.4464	101.929	0.1785	0.8780	Liquifiable
>250.00		27.1	4594.628928	18.69	86.87	0.87	63.33	0.63	23.54	252.57	0.9065	33.91	0.9633	0.2061	1.2566	42.33	2.4058	101.842	0.1782	0.8646	Liquifiable

Number of sounding rod	Depth	RP	RP+RL	qc obta ined from manual calculation as robertson equation value of Rp in 10*kg) or uncorrected qc	qc	total resistanec (x) (rp+Rl)	cone resistance (uncorrec ted) (y)	total resistane -cone resistance (x-y)	frictinal resistance (z) = (x-y)*b/a	corrected (fs) as IS code	fs = (((Rp+Rl)+ 1)*10-(Rp+1)*10))/150	fs	Original Rf from Pagani software as robertson	Rf obtained from corrected (qc) as IS code	If=qc/fs obtained from Pagani softwar/ Manual	If=qc/fs as Corrected qc as IS code 4968	RT	Normalized friction ratio(Fr) =(fs/(qc-σv))*100	Normalized Cone resitance (Qt)= (qc-σv)/σ'v	Ic soil behavior type index	soil type as Ic	total thrust Qt as pagani manual
5	5.00	35.00	49.00	35.69	3568.75	49.00	35.00	14.00	0.93	0.94	0.93	93.33	2.62	2.61	38.24	38.28	103	2.68	53.42	2.40	Sandy Mixture	1018.75
6	5.20	37.00	50.00	37.83	3782.5	50.00	37.00	13.00	0.87	0.87	0.87	86.67	2.29	2.29	43.64	43.66	113	2.35	55.15	2.35	Sandy Mixture	1076.5
6	5.40	38.00	52.00	38.83	3882.5	52.00	38.00	14.00	0.93	0.94	0.93	93.33	2.40	2.40	41.60	41.62	135	2.47	55.11	2.36	Sandy Mixture	1176.5
6	5.60	36.00	51.00	36.83	3682.5	51.00	36.00	15.00	1.00	1.00	1.00	100.00	2.72	2.71	36.83	36.87	146	2.79	50.82	2.43	Sandy Mixture	1396.5
6	5.80	39.00	53.00	39.83	3982.5	53.00	39.00	14.00	0.93	0.94	0.93	93.33	2.34	2.34	42.67	42.69	140	2.41	53.66	2.37	Sandy Mixture	1506.5
6	6.00	42.00	56.00	42.83	4282.5	56.00	42.00	14.00	0.93	0.94	0.93	93.33	2.18	2.18	45.88	45.89	177	2.24	56.36	2.33	Sandy Mixture	1446.5
7	6.20	44.00	58.00	44.96	4496.25	58.00	44.00	14.00	0.93	0.94	0.93	93.33	2.08	2.08	48.17	48.17	176	2.13	57.79	2.31	Sandy Mixture	1824.25
7	6.40	33.00	50.00	33.96	3396.25	50.00	33.00	17.00	1.13	1.14	1.13	113.33	3.34	3.33	29.97	30.04	160	3.46	42.22	2.55	Sandy Mixture	1814.25
7	6.60	36.00	56.00	36.96	3696.25	56.00	36.00	20.00	1.33	1.34	1.33	133.33	3.61	3.60	27.72	27.79	150	3.73	44.96	2.55	Sandy Mixture	1654.25
7	6.80	30.00	52.00	30.96	3096.25	52.00	30.00	22.00	1.47	1.47	1.47	146.67	4.74	4.72	21.11	21.19	138	4.94	36.50	2.70	Silt Mix	1554.25
7	7.00	51.00	75.00	51.96	5196.25	75.00	51.00	24.00	1.60	1.60	1.60	160.00	3.08	3.08	32.48	32.52	139	3.16	60.81	2.41	Sandy Mixture	1434.25
8	7.20	51.00	77.00	52.10	5210	77.00	51.00	26.00	1.73	1.74	1.73	173.33	3.33	3.32	30.06	30.10	209	3.41	59.53	2.44	Sandy Mixture	1452
8	7.40	86.00	110.00	87.10	8710	110.00	86.00	24.00	1.60	1.60	1.60	160.00	1.84	1.84	54.44	54.42	238	1.87	98.25	2.10	Sandy Mixture	2152
8	7.60	79.00	112.00	80.10	8010	112.00	79.00	33.00	2.20	2.20	2.20	220.00	2.75	2.74	36.41	36.43	260	2.80	88.12	2.26	Sandy Mixture	2442
8	7.80	55.00	85.00	56.10	5610	85.00	55.00	30.00	2.00	2.00	2.00	200.00	3.57	3.56	28.05	28.09	276	3.66	59.87	2.46	Sandy Mixture	2662
8	8.00	100.00	135.00	101.10	10110	135.00	100.00	35.00	2.33	2.34	2.33	233.33	2.31	2.31	43.33	43.34	267	2.34	106.69	2.15	Sandy Mixture	2822
9	8.20	103.00	153.00	104.24	10423.75	153.00	103.00	50.00	3.33	3.34	3.33	333.33	3.20	3.20	31.27	31.29	227	3.25	107.53	2.25	Sandy Mixture	2739.75
9	8.40	62.00	102.00	63.24	6323.75	102.00	62.00	40.00	2.67	2.67	2.67	266.67	4.22	4.21	23.71	23.75	256	4.32	63.20	2.50	Sandy Mixture	2339.75
9	8.60	52.00	99.00	53.24	5323.75	99.00	52.00	47.00	3.13	3.14	3.13	313.33	5.89	5.87	16.99	17.04	196	6.07	51.80	2.66	Silt Mix	2629.75
9	8.80	87.00	139.00	88.24	8823.75	139.00	87.00	52.00	3.47	3.47	3.47	346.67	3.93	3.92	25.45	25.48	239	4.00	85.03	2.39	Sandy Mixture	2029.75
9	9.00	51.00	87.00	52.24	5223.75	87.00	51.00	36.00	2.40	2.40	2.40	240.00	4.59	4.58	21.77	21.81	255	4.75	48.67	2.60	Silt Mix	2459.75
10	9.20	92.00	140.00	93.38	9337.5	140.00	92.00	48.00	3.20	3.20	3.20	320.00	3.43	3.42	29.18	29.21	284	3.49	86.46	2.34	Sandy Mixture	2627.5
10	9.40	87.00	135.00	88.38	8837.5	135.00	87.00	48.00	3.20	3.20	3.20	320.00	3.62	3.62	27.62	27.65	260	3.69	80.09	2.38	Sandy Mixture	2917.5
10	9.60	85.00	137.00	86.38	8637.5	137.00	85.00	52.00	3.47	3.47	3.47	346.67	4.01	4.01	24.92	24.95	252	4.10	76.68	2.42	Sandy Mixture	2677.5
10	9.80	65.00	115.00	66.38	6637.5	115.00	65.00	50.00	3.33	3.34	3.33	333.33	5.02	5.01	19.91	19.95	223	5.17	57.40	2.58	Sandy Mixture	2597.5
10	10.00	60.00	115.00	61.38	6137.5	115.00	60.00	55.00	3.67	3.67	3.67	366.67	5.97	5.96	16.74	16.78	236	6.16	51.93	2.67	Silt Mix	2307.5
11	10.20	84.00	140.00	85.51	8551.25	140.00	84.00	56.00	3.73	3.74	3.73	373.33	4.37	4.36	22.91	22.94	284	4.47	71.62	2.47	Sandy Mixture	2445.25
11	10.40	62.00	112.00	63.51	6351.25	112.00	62.00	50.00	3.33	3.34	3.33	333.33	5.25	5.24	19.05	19.09	267	5.42	51.79	2.63	Silt Mix	2925.25
11	10.60	60.00	115.00	61.51	6151.25	115.00	60.00	55.00	3.67	3.67	3.67	366.67	5.96	5.95	16.78	16.81	264	6.16	49.19	2.68	Silt Mix	2755.25
11	10.80	73.00	126.00	74.51	7451.25	126.00	73.00	53.00	3.53	3.54	3.53	353.33	4.74	4.73	21.09	21.12	203	4.88	58.86	2.56	Sandy Mixture	2725.25
11	11.00	65.00	127.00	66.51	6651.25	127.00	65.00	62.00	4.13	4.14	4.13	413.33	6.21	6.20	16.09	16.13	237	6.42	51.42	2.68	Silt Mix	2115.25
12	11.20	59.00	122.00	60.65	6065	122.00	59.00	63.00	4.20	4.20	4.20	420.00	6.92	6.91	14.44	14.48	221	7.18	45.91	2.75	Silt Mix	2463
12	11.40	68.00	134.00	69.65	6965	134.00	68.00	66.00	4.40	4.40	4.40	440.00	6.32	6.30	15.83	15.86	230	6.52	52.05	2.69	Silt Mix	2303
12	11.60	64.00	130.00	65.65	6565	130.00	64.00	66.00	4.40	4.40	4.40	440.00	6.70	6.69	14.92	14.95	218	6.94	48.12	2.73	Silt Mix	2393
12	11.80	71.00	140.00	72.65	7265	140.00	71.00	69.00	4.60	4.60	4.60	460.00	6.33	6.32	15.79	15.83	209	6.54	52.52	2.68	Silt Mix	2273
12	12.00	61.00	132.00	62.65	6265	132.00	61.00	71.00	4.73	4.74	4.73	473.33	7.56	7.54	13.24	13.27	255	7.84	44.30	2.79	Silt Mix	2183
13	12.20	96.00	160.00	97.79	9778.75	160.00	96.00	64.00	4.27	4.27	4.27	426.67	4.36	4.36	22.92	22.95	257	4.47	68.95	2.48	Sandy Mixture	2650.75
13	12.40	64.00	141.00	65.79	6578.75	141.00	64.00	77.00	5.13	5.14	5.13	513.33	7.80	7.78	12.82	12.85	240	8.10	45.08	2.80	Silt Mix	2670.75

Qst	αm (coefficient)	constrained modulus (M0) Mcpt (mPa) mayne 1990	constrained modulus (M0) Mcpt (kPa)	Soil unit weight (γ) robertson (2010)	Vertical overburden stress (Kn/m2) calculated from robertson (2010)	Vertical overburden stress (Kg/cm2) calculated from robertson (2010)	Effective Vertical overburden stress (Kn/m2) calculated from robertson (2010)	Effective Vertical overburden stress (Kg/cm2) calculated from robertson (2010)	Pre insertaion Pore water pressure (U)	Shear wave velocity(m/s) Vs=51.6Ln(fs)+18.5 (Mayne 2006)	correction factor for qc (IS 4968 Part III)	Corrected qc (IS4968)	Stress reduction factor(rd)	cyclic stress ratio (CSR)	C_Q	q_{C1N}	K_c	$(q_{C1N})_{CS}$	CRR	F.O.S	REMARKS
>250.00		28.7	4869.389032	18.71	90.61	0.91	65.11	0.65	25.51	252.57	0.9065	35.91	0.9618	0.2088	1.2393	44.23	2.2933	101.427	0.1770	0.8479	Liquifiable
>250.00		30.4	5163.416761	18.65	94.35	0.94	66.88	0.67	27.47	248.74	1.044	38.04	0.9602	0.2113	1.2228	46.25	2.1040	97.316	0.1657	0.7842	Liquifiable
>250.00		31.2	5298.167818	18.75	98.09	0.98	68.66	0.69	29.43	252.57	1.044	39.04	0.9587	0.2137	1.2068	46.85	2.1571	101.069	0.1760	0.8238	Liquifiable
>250.00		29.5	5012.902332	18.81	101.86	1.02	70.46	0.70	31.39	256.13	1.044	37.04	0.9572	0.2158	1.1913	43.87	2.4091	105.684	0.1898	0.8793	Liquifiable
>250.00		32.0	5427.65066	18.76	105.61	1.06	72.25	0.72	33.35	252.57	1.044	40.04	0.9556	0.2179	1.1764	46.85	2.1624	101.312	0.1767	0.8110	Liquifiable
>250.00		34.4	5842.391189	18.78	109.36	1.09	74.05	0.74	35.32	252.57	1.044	43.04	0.9541	0.2198	1.1621	49.77	2.0286	100.956	0.1757	0.7992	Liquifiable
>250.00		36.2	6136.37649	18.80	113.12	1.13	75.85	0.76	37.28	252.57	1.1815	45.18	0.9526	0.2216	1.1482	51.63	1.9539	100.877	0.1755	0.7917	Liquifiable
>250.00		27.1	4591.079378	18.92	116.91	1.17	77.67	0.78	39.24	262.59	1.1815	34.18	0.9510	0.2233	1.1347	38.54	3.0090	115.959	0.2250	1.0076	Non Liquifiable
>250.00		29.5	5005.720833	19.14	120.74	1.21	79.53	0.80	41.20	270.97	1.1815	37.18	0.9495	0.2249	1.1213	41.45	3.0281	125.504	0.2638	1.1734	Non Liquifiable
>250.00		24.5	4160.350606	19.18	124.57	1.25	81.41	0.81	43.16	275.89	1.1815	31.18	0.9480	0.2263	1.2284	38.03	3.9898	151.749	0.4050	1.7896	Non Liquifiable
>250.00		41.8	7094.896767	19.48	128.47	1.28	83.34	0.83	45.13	280.38	1.1815	52.18	0.9465	0.2276	1.0954	56.92	2.3316	132.713	0.2974	1.3066	Non Liquifiable
>250.00		41.9	7108.666864	19.57	132.38	1.32	85.29	0.85	47.09	284.51	1.319	52.32	0.9449	0.2288	1.0828	56.41	2.4632	138.958	0.3295	1.4404	Non Liquifiable
>250.00		70.7	12003.15757	19.68	136.32	1.36	87.27	0.87	49.05	280.38	1.319	87.32	0.9434	0.2299	1.0705	93.24	1.4440	134.635	0.3070	1.3353	Non Liquifiable
>250.00		64.9	11017.5547	20.01	140.32	1.40	89.31	0.89	51.01	296.81	1.319	80.32	0.9419	0.2309	1.0582	84.76	1.8120	153.585	0.4169	1.8060	Non Liquifiable
>250.00		45.1	7652.020762	19.76	144.27	1.44	91.30	0.91	52.97	291.89	1.319	56.32	0.9403	0.2318	1.0466	58.71	2.5542	149.963	0.3936	1.6981	Non Liquifiable
>250.00		82.2	13946.37394	20.17	148.30	1.48	93.37	0.93	54.94	299.85	1.319	101.32	0.9388	0.2326	1.0349	104.63	1.5348	160.585	0.4651	1.9995	Non Liquifiable
>250.00		84.7	14379.85896	20.59	152.42	1.52	95.52	0.96	56.90	318.25	1.4565	104.46	0.9373	0.2333	1.0232	106.65	1.7893	190.836	0.7263	3.1133	Non Liquifiable
>250.00		50.9	8634.219507	20.14	156.45	1.56	97.59	0.98	58.86	306.74	1.4565	63.46	0.9357	0.2340	1.0123	64.01	2.7336	174.987	0.5783	2.4712	Non Liquifiable
>250.00		42.6	7228.546592	20.26	160.50	1.61	99.68	1.00	60.82	315.06	1.4565	53.46	0.9342	0.2347	1.0032	53.41	3.7202	198.687	0.8094	3.4494	Non Liquifiable
>250.00		71.4	12122.78687	20.57	164.62	1.65	101.83	1.02	62.78	320.28	1.4565	88.46	0.9327	0.2352	0.9910	87.44	2.2435	196.172	0.7821	3.3252	Non Liquifiable
>250.00		41.7	7077.201867	19.95	168.61	1.69	103.86	1.04	64.75	301.30	1.4565	52.46	0.9312	0.2358	0.9628	50.30	3.3264	167.307	0.5155	2.1862	Non Liquifiable
>250.00		75.6	12830.71185	20.50	172.71	1.73	106.00	1.06	66.71	316.15	1.594	93.59	0.9284	0.2360	0.9713	90.69	2.0584	186.686	0.6851	2.9033	Non Liquifiable
>250.00		71.5	12124.97774	20.48	176.80	1.77	108.13	1.08	68.67	316.15	1.594	88.59	0.9230	0.2354	0.9617	84.99	2.2067	187.539	0.6934	2.9453	Non Liquifiable
>250.00		69.8	11839.2203	20.56	180.91	1.81	110.28	1.10	70.63	320.28	1.594	86.59	0.9177	0.2348	0.9522	82.25	2.3955	197.028	0.7913	3.3696	Non Liquifiable
>250.00		53.2	9033.503781	20.42	185.00	1.85	112.40	1.12	72.59	318.25	1.594	66.59	0.9123	0.2342	0.9432	62.61	3.1988	200.265	0.8270	3.5304	Non Liquifiable
>250.00		49.1	8327.764967	20.50	189.10	1.89	114.54	1.15	74.56	323.17	1.594	61.59	0.9070	0.2336	0.8731	53.58	3.7501	200.943	0.8346	3.5728	Non Liquifiable
>250.00		69.0	11701.23474	20.64	193.23	1.93	116.71	1.17	76.52	324.10	1.7315	85.73	0.9017	0.2329	0.9257	79.16	2.6103	206.616	0.9003	3.8659	Non Liquifiable
>250.00		50.8	8615.522951	20.40	197.31	1.97	118.83	1.19	78.48	318.25	1.7315	63.73	0.8963	0.2322	0.8416	53.45	3.4763	185.810	0.6766	2.9142	Non Liquifiable
>250.00		49.1	8329.783897	20.50	201.40	2.01	120.96	1.21	80.44	323.17	1.7315	61.73	0.8910	0.2314	0.8267	50.85	3.8580	196.190	0.7823	3.3803	Non Liquifiable
>250.00		59.8	10144.03619	20.53	205.51	2.06	123.11	1.23	82.40	321.26	1.7315	74.73	0.8856	0.2306	0.9013	67.16	3.0494	204.789	0.8787	3.8100	Non Liquifiable
>250.00		53.1	9018.250158	20.66	209.64	2.10	125.28	1.25	84.37	329.35	1.7315	66.73	0.8803	0.2298	0.7982	53.09	3.8615	205.017	0.8814	3.8354	Non Liquifiable
>250.00		48.3	8191.71888	20.65	213.77	2.14	127.44	1.27	86.33	330.18	1.869	60.87	0.8750	0.2290	0.7847	47.59	4.3775	208.325	0.9208	4.0219	Non Liquifiable
>250.00		55.7	9445.907763	20.75	217.92	2.18	129.63	1.30	88.29	332.58	1.869	69.87	0.8696	0.2281	0.7714	53.73	3.8747	208.183	0.9191	4.0302	Non Liquifiable
>250.00		52.3	8880.102996	20.73	222.07	2.22	131.82	1.32	90.25	332.58	1.869	65.87	0.8643	0.2271	0.7586	49.80	4.1872	208.540	0.9234	4.0655	Non Liquifiable
>250.00		58.1	9854.273035	20.82	226.23	2.26	134.02	1.34	92.21	334.87	1.869	72.87	0.8589	0.2262	0.7462	54.21	3.8615	209.328	0.9330	4.1250	Non Liquifiable
>250.00		49.8	8448.449769	20.80	230.39	2.30	136.22	1.36	94.18	336.35	1.869	62.87	0.8536	0.2252	0.7341	45.99	4.6970	216.027	1.0176	4.5180	Non Liquifiable
>250.00		78.7	13361.86213	20.85	234.56	2.35	138.42	1.38	96.14	330.99	2.0065	98.01	0.8483	0.2242	0.8499	83.11	2.6634	221.366	1.0888	4.8558	Non Liquifiable
>250.00		52.3	8876.007493	20.91	238.74	2.39	140.64	1.41	98.10	340.53	2.0065	66.01	0.8429	0.2232	0.7110	46.78	4.7437	221.890	1.0960	4.9101	Non Liquifiable

Number of sounding rod	Depth	RP	RP+RL	qc obtained from manual calculation as robertson equation value of Rp in 10*kg) or uncorrected qc	qc	total resistanec (x) (rp+Rl)	cone resistance (uncorrected) (y)	total resistane -cone resistance (x-y)	frictinal resistance (z) = (x-y)*b/a	corrected (fs) as IS code	fs = (((Rp+Rl)+1)*10-(Rp+1)*10))/150	fs	Original Rf from Pagani software as robertson	Rf obtained from corrected (qc) as IS code	If=qc/fs obtained from Pagani softwar/ Manual	If=qc/fs as Corrected qc as IS code 4968	RT	Normalized friction ratio(Fr) =(fs/(qc-σv))*100	Normalized Cone resitance (Qt)=(qc-σv)/σ'v	Ic soil behavior type index	soil type as Ic	total thrust Qt as pagani manual
13	12.60	56.00	137.00	57.79	5778.75	137.00	56.00	81.00	5.40	5.40	5.40	540.00	9.34	9.32	10.70	10.73	242	9.75	38.75	2.90	Silt Mix	2500.75
13	12.80	57.00	142.00	58.79	5878.75	142.00	57.00	85.00	5.67	5.67	5.67	566.67	9.64	9.61	10.37	10.40	199	10.06	38.81	2.91	Silt Mix	2520.75
13	13.00	57.00	144.00	58.79	5878.75	144.00	57.00	87.00	5.80	5.80	5.80	580.00	9.87	9.84	10.14	10.17	284	10.31	38.19	2.92	Silt Mix	2090.75
14	13.20	72.00	165.00	73.93	7392.5	165.00	72.00	93.00	6.20	6.20	6.20	620.00	8.39	8.37	11.92	11.95	272	8.69	47.70	2.81	Silt Mix	2948.5
14	13.40	86.00	184.00	87.93	8792.5	184.00	86.00	98.00	6.53	6.54	6.53	653.33	7.43	7.42	13.46	13.48	311	7.66	56.17	2.72	Silt Mix	2828.5
14	13.60	63.00	157.00	64.93	6492.5	157.00	63.00	94.00	6.27	6.27	6.27	626.67	9.65	9.63	10.36	10.39	310	10.06	40.40	2.90	Silt Mix	3218.5
14	13.80	98.00	200.00	99.93	9992.5	200.00	98.00	102.00	6.80	6.80	6.80	680.00	6.81	6.79	14.69	14.72	312	6.99	62.14	2.66	Silt Mix	3208.5
14	14.00	88.00	192.00	89.93	8992.5	192.00	88.00	104.00	6.93	6.94	6.93	693.33	7.71	7.70	12.97	12.99	305	7.95	54.91	2.74	Silt Mix	3228.5
15	14.20	80.00	183.00	82.06	8206.25	183.00	80.00	103.00	6.87	6.87	6.87	686.67	8.37	8.35	11.95	11.97	296	8.66	49.22	2.80	Silt Mix	3166.25
15	14.40	90.00	200.00	92.06	9206.25	200.00	90.00	110.00	7.33	7.34	7.33	733.33	7.97	7.95	12.55	12.58	312	8.22	54.61	2.75	Silt Mix	3076.25
15	14.60	78.00	185.00	80.06	8006.25	185.00	78.00	107.00	7.13	7.14	7.13	713.33	8.91	8.89	11.22	11.25	343	9.24	46.58	2.83	Silt Mix	3236.25
15	14.80	103	221.00	105.06	10506.25	221.00	103.00	118.00	7.87	7.87	7.87	786.67	7.49	7.48	13.36	13.38	396	7.70	60.78	2.70	Silt Mix	3546.25
15	15.00	114.00	198.00	116.06	11606.25	198.00	114.00	84.00	5.60	5.60	5.60	560.00	4.82	4.82	20.73	20.75	401	4.95	66.39	2.53	Sandy Mixture	4076.25
16	15.20	110.00	241.00	112.20	11220	241.00	110.00	131.00	8.73	8.74	8.73	873.33	7.78	7.77	12.85	12.87	388	8.00	63.22	2.70	Silt Mix	4134
16	15.40	76.00	198.00	78.20	7820	198.00	76.00	122.00	8.13	8.14	8.13	813.33	10.40	10.38	9.61	9.64	333	10.82	42.93	2.91	Silt Mix	4004
16	15.60	81.00	201.00	83.20	8320	201.00	81.00	120.00	8.00	8.00	8.00	800.00	9.62	9.60	10.40	10.42	325	9.98	45.16	2.87	Silt Mix	3454
16	15.80	78.00	207.00	80.20	8020	207.00	78.00	129.00	8.60	8.60	8.60	860.00	10.72	10.70	9.33	9.35	330	11.16	42.87	2.92	Silt Mix	3374
16	16.00	88.00	220.00	90.20	9020	220.00	88.00	132.00	8.80	8.80	8.80	880.00	9.76	9.74	10.25	10.27	301	10.11	47.78	2.86	Silt Mix	3424
17	16.20	87.00	224.00	89.34	8933.75	224.00	87.00	137.00	9.13	9.14	9.13	913.33	10.22	10.20	9.78	9.80	282	10.60	46.68	2.88	Silt Mix	3141.75
17	16.40	84.00	220.00	86.34	8633.75	220.00	84.00	136.00	9.07	9.07	9.07	906.67	10.50	10.48	9.52	9.54	287	10.91	44.46	2.90	Silt Mix	2951.75
17	16.60	83.00	219.00	85.34	8533.75	219.00	83.00	136.00	9.07	9.07	9.07	906.67	10.62	10.60	9.41	9.43	308	11.05	43.35	2.91	Silt Mix	3001.75
17	16.80	89.00	229.00	91.34	9133.75	229.00	89.00	140.00	9.33	9.34	9.33	933.33	10.22	10.20	9.79	9.80	315	10.61	45.92	2.88	Silt Mix	3211.75
17	17.00	89.00	230.00	91.34	9133.75	230.00	89.00	141.00	9.40	9.40	9.40	940.00	10.29	10.27	9.72	9.74	340	10.69	45.33	2.89	Silt Mix	3281.75
18	17.20	92.00	235.00	94.48	9447.5	235.00	92.00	143.00	9.53	9.54	9.53	953.33	10.09	10.07	9.91	9.93	392	10.47	46.35	2.88	Silt Mix	3539.5
18	17.40	94.00	238.00	96.48	9647.5	238.00	94.00	144.00	9.60	9.60	9.60	960.00	9.95	9.93	10.05	10.07	367	10.32	46.78	2.87	Silt Mix	4059.5
18	17.60	84.00	231.00	86.48	8647.5	231.00	84.00	147.00	9.80	9.80	9.80	980.00	11.33	11.31	8.82	8.84	408	11.81	41.23	2.95	Silt Mix	3809.5
18	17.80	98.00	245.00	100.48	10047.5	245.00	98.00	147.00	9.80	9.80	9.80	980.00	9.75	9.74	10.25	10.27	446	10.11	47.60	2.86	Silt Mix	4219.5
18	18.00	96.00	249.00	98.48	9847.5	249.00	96.00	153.00	10.20	10.20	10.20	1020.00	10.36	10.34	9.65	9.67	392	10.75	46.05	2.89	Silt Mix	4599.5
19	18.20	92.00	248.00	94.61	9461.25	248.00	92.00	156.00	10.40	10.40	10.40	1040.00	10.99	10.97	9.10	9.11	414	11.43	43.65	2.92	Silt Mix	4067.25
19	18.40	80.00	240.00	82.61	8261.25	240.00	80.00	160.00	10.67	10.67	10.67	1066.67	12.91	12.88	7.74	7.76	416	13.51	37.44	3.02	Clay	4287.25
19	18.60	78.00	241.00	80.61	8061.25	241.00	78.00	163.00	10.87	10.87	10.87	1086.67	13.48	13.45	7.42	7.44	380	14.13	36.06	3.05	Clay	4307.25
19	18.80	88.00	250.00	90.61	9061.25	250.00	88.00	162.00	10.80	10.80	10.80	1080.00	11.92	11.90	8.39	8.41	398	12.44	40.27	2.97	Clay	3947.25
19	19.00	92.00	261.00	94.61	9461.25	261.00	92.00	169.00	11.27	11.27	11.27	1126.67	11.91	11.89	8.40	8.41	394	12.41	41.63	2.96	Clay	4127.25
20	19.20	92.00	263.00	94.75	9475	263.00	92.00	171.00	11.40	11.40	11.40	1140.00	12.03	12.01	8.31	8.33	397	12.54	41.22	2.97	Clay	4095

Qst	αm (coeficient)	constrained modulus (M_0) Mcpt (mPa) mayne 1990	constrained modulus (M_0) Mcpt (kPa)	Soil unit weight (Y) robertson (2010)	Vertical overburden stress (Kn/m2) calculated from robertson (2010)	Vertical overburden stress (Kg/cm2) calculated from robertson (2010)	Effective Vertical overburden stress (Kn/m2) calculated from robertson (2010)	Effective Vertical overburden stress (Kg/cm2) calculated from robertson (2010)	Pre insertaion Pore water pressure (U)	Shear wave velocity(m/s) Vs=51.6Ln(fs)+18.5 (Mayne 2006)	correction factor for qc (IS 4968 Part III)	Corrected qc (IS4968)	Stress reduction factor(rd)	cyclic stress ratio (CSR)	C_Q	q_{C1N}	K_c	$(q_{C1N})_{CS}$	CRR	F.O.S	REMARKS
>250.00		45.7	7750.15046	20.92	242.93	2.43	142.87	1.43	100.06	343.14	2.0065	58.01	0.8376	0.2222	0.7000	40.45	5.6934	230.292	1.2158	5.4724	Non Liquifiable
>250.00		46.5	7884.27606	20.98	247.12	2.47	145.10	1.45	102.02	345.63	2.0065	59.01	0.8322	0.2211	0.6892	40.52	5.7902	234.589	1.2806	5.7916	Non Liquifiable
>250.00		46.4	7878.394169	21.01	251.33	2.51	147.34	1.47	103.99	346.83	2.0065	59.01	0.8269	0.2200	0.6787	39.90	5.9148	235.998	1.3024	5.9190	Non Liquifiable
>250.00		58.9	9991.716198	21.17	255.56	2.56	149.61	1.50	105.95	350.27	2.144	74.14	0.8216	0.2189	0.6684	49.41	4.8080	237.568	1.3269	6.0612	Non Liquifiable
>250.00		70.4	11945.75274	21.30	259.82	2.60	151.91	1.52	107.91	352.98	2.144	88.14	0.8162	0.2178	0.6583	57.88	4.1083	237.790	1.3304	6.1091	Non Liquifiable
>250.00		51.4	8719.835262	21.13	264.05	2.64	154.17	1.54	109.87	350.83	2.144	65.14	0.8109	0.2166	0.6486	42.11	5.6795	239.172	1.3524	6.2423	Non Liquifiable
>250.00		80.2	13613.84518	21.39	268.32	2.68	156.49	1.56	111.83	355.04	2.144	100.14	0.8055	0.2155	0.6390	63.85	3.6935	235.843	1.3000	6.0333	Non Liquifiable
>250.00		71.9	12207.86017	21.38	272.60	2.73	158.80	1.59	113.80	356.04	2.144	90.14	0.8002	0.2143	0.6297	56.63	4.2518	240.763	1.3779	6.4304	Non Liquifiable
>250.00		65.4	11101.13809	21.33	276.87	2.77	161.11	1.61	115.76	355.54	2.2815	82.28	0.7949	0.2131	0.6207	50.94	4.7256	240.705	1.3770	6.4620	Non Liquifiable
>250.00		73.6	12495.13249	21.45	281.16	2.81	163.44	1.63	117.72	358.94	2.2815	92.28	0.7895	0.2119	0.6119	56.33	4.3494	245.001	1.4477	6.8326	Non Liquifiable
>250.00		63.7	10809.15079	21.36	285.43	2.85	165.75	1.66	119.68	357.51	2.2815	80.28	0.7842	0.2107	0.6033	48.30	5.0450	243.696	1.4259	6.7688	Non Liquifiable
>250.00		84.3	14303.1084	21.58	289.74	2.90	168.10	1.68	121.64	362.56	2.2815	105.28	0.7788	0.2094	0.5949	62.50	3.9640	247.750	1.4942	7.1351	Non Liquifiable
>250.00		93.3	15837.16478	21.23	293.99	2.94	170.38	1.70	123.61	345.02	2.2815	116.28	0.7735	0.2082	0.7661	88.92	2.8880	256.786	1.6547	7.9474	Non Liquifiable
>250.00		90.1	15290.33167	21.73	298.33	2.98	172.77	1.73	125.57	367.95	2.419	112.42	0.7682	0.2069	0.5788	64.94	3.9801	258.482	1.6861	8.1482	Non Liquifiable
>250.00		62.0	10524.31024	21.51	302.64	3.03	175.11	1.75	127.53	364.28	2.419	78.42	0.7628	0.2057	0.5711	44.66	5.7531	256.927	1.6573	8.0581	Non Liquifiable
>250.00		66.1	11218.28748	21.51	306.94	3.07	177.45	1.77	129.49	363.43	2.419	83.42	0.7575	0.2044	0.5636	46.89	5.3600	251.320	1.5563	7.6138	Non Liquifiable
>250.00		63.6	10792.24537	21.58	311.25	3.11	179.80	1.80	131.45	367.16	2.419	80.42	0.7521	0.2031	0.5562	44.61	5.8594	261.359	1.7403	8.5681	Non Liquifiable
>250.00		71.8	12186.18325	21.65	315.58	3.16	182.17	1.82	133.42	368.34	2.419	90.42	0.7468	0.2018	0.5489	49.51	5.2561	260.253	1.7194	8.5191	Non Liquifiable
>250.00		71.1	12059.36017	21.69	319.92	3.20	184.54	1.85	135.38	370.26	2.5565	89.56	0.7415	0.2005	0.5419	48.41	5.4661	264.614	1.8031	8.9924	Non Liquifiable
>250.00		68.6	11633.29313	21.67	324.25	3.24	186.91	1.87	137.34	369.88	2.5565	86.56	0.7361	0.1992	0.5350	46.19	5.6873	262.699	1.7660	8.8649	Non Liquifiable
>250.00		67.7	11487.22733	21.66	328.59	3.29	189.29	1.89	139.30	369.88	2.5565	85.56	0.7308	0.1979	0.5283	45.08	5.7972	261.362	1.7404	8.7943	Non Liquifiable
>250.00		72.6	12321.1449	21.72	332.93	3.33	191.67	1.92	141.26	371.38	2.5565	91.56	0.7254	0.1966	0.5217	47.65	5.5091	262.533	1.7628	8.9675	Non Liquifiable
>250.00		72.6	12315.06018	21.73	337.28	3.37	194.05	1.94	143.23	371.75	2.5565	91.56	0.7201	0.1952	0.5153	47.07	5.5674	262.047	1.7535	8.9808	Non Liquifiable
>250.00		75.1	12748.2173	21.76	341.63	3.42	196.44	1.96	145.19	372.47	2.694	94.69	0.7148	0.1939	0.5091	48.09	5.4433	261.785	1.7485	9.0167	Non Liquifiable
>250.00		76.7	13022.11993	21.78	345.99	3.46	198.84	1.99	147.15	372.83	2.694	96.69	0.7094	0.1926	0.5029	48.52	5.3744	260.767	1.7291	8.9789	Non Liquifiable
>250.00		68.5	11616.02766	21.76	350.34	3.50	201.23	2.01	149.11	373.90	2.694	86.69	0.7041	0.1912	0.4970	42.97	6.1650	264.934	1.8094	9.4620	Non Liquifiable
>250.00		80.0	13569.91928	21.82	354.70	3.55	203.63	2.04	151.07	373.90	2.694	100.69	0.6987	0.1899	0.4911	49.34	5.2658	259.832	1.7114	9.0133	Non Liquifiable
>250.00		78.3	13283.80017	21.85	359.07	3.59	206.04	2.06	153.04	375.96	2.694	98.69	0.6934	0.1885	0.4854	47.80	5.5454	265.044	1.8116	9.6096	Non Liquifiable
>250.00		75.1	12736.92911	21.86	363.44	3.63	208.45	2.08	155.00	376.96	2.8315	94.83	0.6881	0.1872	0.4797	45.39	5.8932	267.489	1.8599	9.9380	Non Liquifiable
>250.00		65.1	11050.81445	21.84	367.81	3.68	210.85	2.11	156.96	378.27	2.8315	82.83	0.6827	0.1858	0.4743	39.18	6.9479	272.221	1.9561	10.5285	Non Liquifiable
>250.00		63.4	10764.69645	21.85	372.18	3.72	213.26	2.13	158.92	379.23	2.8315	80.83	0.6774	0.1844	0.4689	37.80	7.2415	273.731	1.9875	10.7769	Non Liquifiable
>250.00		71.6	12158.56786	21.89	376.56	3.77	215.67	2.16	160.88	378.91	2.8315	90.83	0.6720	0.1830	0.4637	42.01	6.4173	269.615	1.9027	10.3948	Non Liquifiable
>250.00		74.9	12712.42102	21.95	380.95	3.81	218.10	2.18	162.85	381.09	2.8315	94.83	0.6667	0.1817	0.4585	43.38	6.3125	273.835	1.9896	10.9525	Non Liquifiable
>250.00		75.0	12725.52023	21.97	385.34	3.85	220.53	2.21	164.81	381.70	2.969	94.97	0.6614	0.1803	0.4534	42.96	6.3803	274.122	1.9956	11.0700	Non Liquifiable

Table 5.4: Liquefaction potential analysis sing Cone penetration test(CPT) 2 data

Number of sounding rod	Depth	RP	RP+RL	qc obtained from manual calculation as robertson equation value of Rp in 10*kg) or uncorrected qc	qc	total resistanec (x) (rp+Rl)	cone resistance (uncorrected) (y)	total resistane -cone resistance (x-y)	frictinal resistance (z) = (x-y)*b/a	corrected (fs) as IS code	fs = (((Rp+Rl)+1) *10-(Rp+1)*10))/ 150	fs	Original Rf from Pagani software as robertson	Rf obtained from corrected (qc) as IS code	If=qc/fs obtained from Pagani softwar/ Manual	If=qc/fs as Corrected qc as IS code 4968	RT	Normalized friction ratio(Fr) =(fs/(qc-σv))*100	Normalized Cone resitance (Qt)= (qc-σv)/σ'v	Ic soil behavior type index	soil type as Ic	total thrust Qt as pagani manual
	[m]	[10*Kg]	[10*Kg]	[kg/cm2]	kPa	kg/cm2	kg/cm2	kg/cm2	kg/cm2	kg/cm2	[kg/cm2]	[kPa]	[%]	[%]	[Kg]	[Kg]	[10*Kg]	in %				kg
1	0	0	0	0	0						0.00	0.00	>100	#DIV/0!	82.8	#DIV/0!	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	>250.00
1	0.20	10.00	16.00	10.14	1013.75	16.00	10.00	6.00	0.40	0.40	0.40	40.00	3.95	3.91	25.34	25.59	31	3.96	292.73	2.08	Sandy Mixture	317.75
1	0.40	9.00	16.00	9.14	913.75	16.00	9.00	7.00	0.47	0.47	0.47	46.67	5.11	5.04	19.58	19.85	27	5.15	130.85	2.36	Sandy Mixture	277.75
1	0.60	8.00	14.00	8.14	813.75	14.00	8.00	6.00	0.40	0.40	0.40	40.00	4.92	4.84	20.34	20.65	38	4.98	77.51	2.48	Sandy Mixture	387.75
1	0.80	9.00	17.00	9.14	913.75	17.00	9.00	8.00	0.53	0.54	0.53	53.33	5.84	5.75	17.13	17.39	44	5.93	64.86	2.59	Sandy Mixture	447.75
1	1.00	11.00	19.00	11.14	1113.75	19.00	11.00	8.00	0.53	0.54	0.53	53.33	4.79	4.74	20.88	21.11	40	4.86	63.01	2.54	Sandy Mixture	407.75
2	1.20	13.00	21.00	13.28	1327.5	21.00	13.00	8.00	0.53	0.54	0.53	53.33	4.02	3.99	24.89	25.08	40	4.08	62.40	2.48	Sandy Mixture	415.5
2	1.40	15.00	24.00	15.28	1527.5	24.00	15.00	9.00	0.60	0.60	0.60	60.00	3.93	3.90	25.46	25.62	52	3.99	61.31	2.48	Sandy Mixture	535.5
2	1.60	18.00	28.00	18.28	1827.5	28.00	18.00	10.00	0.67	0.67	0.67	66.67	3.65	3.63	27.41	27.55	55	3.70	63.97	2.44	Sandy Mixture	565.5
2	1.80	24.00	33.00	24.28	2427.5	33.00	24.00	9.00	0.60	0.60	0.60	60.00	2.47	2.47	40.46	40.51	60	2.50	75.48	2.27	Sandy Mixture	615.5
2	2.00	16.00	25.00	16.28	1627.5	25.00	16.00	9.00	0.60	0.60	0.60	60.00	3.69	3.67	27.13	27.28	46	3.77	45.08	2.55	Sandy Mixture	475.5
3	2.20	17.00	27.00	17.41	1741.25	27.00	17.00	10.00	0.67	0.67	0.67	66.67	3.83	3.81	26.12	26.26	33	3.92	43.73	2.58	Sandy Mixture	353.25
3	2.40	18.00	28.00	18.41	1841.25	28.00	18.00	10.00	0.67	0.67	0.67	66.67	3.62	3.60	27.62	27.75	47	3.71	42.28	2.57	Sandy Mixture	353.25
3	2.60	20.00	29.00	20.41	2041.25	29.00	20.00	9.00	0.60	0.60	0.60	60.00	2.94	2.93	34.02	34.12	24	3.01	45.16	2.49	Sandy Mixture	493.25
3	2.80	22.00	31.00	22.41	2241.25	31.00	22.00	9.00	0.60	0.60	0.60	60.00	2.68	2.67	37.35	37.43	62	2.74	47.82	2.44	Sandy Mixture	263.25
3	3.00	19.00	28.00	19.41	1941.25	28.00	19.00	9.00	0.60	0.60	0.60	60.00	3.09	3.08	32.35	32.47	47	3.18	39.78	2.54	Sandy Mixture	643.25
4	3.20	15.00	21.00	15.55	1555	21.00	15.00	6.00	0.40	0.40	0.40	40.00	2.57	2.57	38.88	38.97	81	2.67	30.59	2.58	Sandy Mixture	501
4	3.40	22.00	32.00	22.55	2255	32.00	22.00	10.00	0.67	0.67	0.67	66.67	2.96	2.95	33.83	33.92	81	3.04	43.33	2.50	Sandy Mixture	841
4	3.60	18.00	26.00	18.55	1855	26.00	18.00	8.00	0.53	0.54	0.53	53.33	2.88	2.87	34.78	34.89	84	2.98	34.28	2.57	Sandy Mixture	841
4	3.80	21.00	31.00	21.55	2155	31.00	21.00	10.00	0.67	0.67	0.67	66.67	3.09	3.08	32.33	32.43	68	3.19	38.72	2.55	Sandy Mixture	871
4	4.00	25.00	34.00	25.55	2555	34.00	25.00	9.00	0.60	0.60	0.60	60.00	2.35	2.35	42.58	42.62	48	2.42	44.70	2.43	Sandy Mixture	711
5	4.20	23.00	32.00	23.69	2368.75	32.00	23.00	9.00	0.60	0.60	0.60	60.00	2.53	2.53	39.48	39.54	34	2.62	40.09	2.48	Sandy Mixture	518.75
5	4.40	26.00	36.00	26.69	2668.75	36.00	26.00	10.00	0.67	0.67	0.67	66.67	2.50	2.50	40.03	40.08	31	2.57	43.98	2.45	Sandy Mixture	378.75
5	4.60	28.00	40.00	28.69	2868.75	40.00	28.00	12.00	0.80	0.80	0.80	80.00	2.79	2.78	35.86	35.92	28	2.87	45.96	2.47	Sandy Mixture	348.75
5	4.80	30.00	41.00	30.69	3068.75	41.00	30.00	11.00	0.73	0.74	0.73	73.33	2.39	2.39	41.85	41.88	58	2.46	47.85	2.41	Sandy Mixture	318.75
5	5.00	27.00	39.00	27.69	2768.75	39.00	27.00	12.00	0.80	0.80	0.80	80.00	2.89	2.88	34.61	34.68	57	2.99	41.82	2.51	Sandy Mixture	618.75
6	5.20	26.00	35.00	26.83	2682.5	35.00	26.00	9.00	0.60	0.60	0.60	60.00	2.24	2.24	44.71	44.73	72	2.32	39.40	2.45	Sandy Mixture	616.5
6	5.40	31.00	42.00	31.83	3182.5	42.00	31.00	11.00	0.73	0.74	0.73	73.33	2.30	2.30	43.40	43.42	84	2.38	45.76	2.41	Sandy Mixture	766.5
6	5.60	30.00	40.00	30.83	3082.5	40.00	30.00	10.00	0.67	0.67	0.67	66.67	2.16	2.16	46.24	46.24	77	2.24	43.14	2.41	Sandy Mixture	886.5

Qst	constrained modulus (M_0) Mcpt (mPa) mayne 1990	constrained modulus (M_0) Mcpt (kPa)	Soil unit weight (γ) robertson (2010)	Vertical overburden stress (Kn/m2) calculated from robertson (2010)	Vertical overburden stress (Kg/cm2) calculated from robertson (2010)	Effective Vertical overburden stress (Kn/m2) calculated from robertson (2010)	Vertical overburden stress (Kg/cm2) calculated from robertson (2010)	Pre insertaion Pore water pressure (U)	Shear wave velocity(m/s) Vs=51.6Ln(fs)+18.5 (Mayne 2006)	correction factor for qc (IS 4968 Part III)	Corrected qc (IS4968)	Stress reduction factor(rd)	cyclic stress ratio (CSR)	C_Q	qc1n	K_c	$(q_{C1N})_{CS}$	CRR	F.O.S	REMARKS
[KN]			kN/m3	kN/m2	kg/cm2	(Kn/m2)	kg/cm2	kN/m2			[kg/cm2]									
>250.00	0.0	0	0.00	0.00	0.00	0.00	0.00	0.00	#NUM!	0.3565	0.04	1	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
>250.00	8.3	1414.418132	17.26	3.45	0.03	3.45	0.0345	0.00	208.85	0.3565	10.36	0.99847	0.15576132	5.382778036	54.56791234	1.404353301	76.63263	0.121853	0.782304	Liquifiable
>250.00	7.5	1269.547763	17.39	6.93	0.07	6.93	0.07	0.00	216.80	0.3565	9.36	0.99694	0.15552264	3.798639541	34.7100688	2.137190624	74.18203	0.117965	0.758505	Liquifiable
>250.00	6.6	1124.739489	17.17	10.36	0.10	10.36	0.10	0.00	208.85	0.3565	8.36	0.99541	0.15528396	3.106151696	25.27630943	2.676997862	67.66463	0.108812	0.700727	Liquifiable
>250.00	7.4	1259.826112	17.55	13.87	0.14	13.87	0.14	0.00	223.69	0.3565	9.36	0.99388	0.15504528	2.684701033	24.53145569	3.262876971	80.04312	0.127693	0.823585	Liquifiable
>250.00	9.0	1534.891484	17.62	17.40	0.17	17.40	0.17	0.00	223.69	0.3565	11.36	0.99235	0.1548066	2.397389523	26.70092582	2.936966744	78.41973	0.12485	0.806488	Liquifiable
>250.00	10.8	1829.188007	17.69	20.94	0.21	20.94	0.21	0.00	223.69	0.494	13.49	0.99082	0.15456792	2.185452358	29.01188005	2.66052484	77.18683	0.122767	0.794262	Liquifiable
>250.00	12.4	2104.181527	17.88	24.51	0.25	24.51	0.25	0.00	229.77	0.494	15.49	0.98929	0.15432924	2.019761264	30.85185331	2.651146237	81.79277	0.130889	0.848118	Liquifiable
>250.00	14.8	2519.121859	18.07	28.13	0.28	28.13	0.28	0.00	235.20	0.494	18.49	0.98776	0.15409056	1.885542887	34.45829626	2.482369743	85.53823	0.138205	0.896911	Liquifiable
>250.00	19.8	3354.065646	18.06	31.74	0.32	31.74	0.32	0.00	229.77	0.494	24.49	0.98623	0.15385188	1.775025435	43.08874243	1.845850811	79.53539	0.126791	0.824112	Liquifiable
>250.00	13.1	2229.052357	17.90	35.32	0.35	35.32	0.35	0.00	229.77	0.494	16.49	0.9847	0.1536132	1.682640049	27.3849668	3.041309049	83.28615	0.133728	0.870551	Liquifiable
>250.00	14.0	2383.24788	18.05	38.93	0.39	38.93	0.39	0.00	235.20	0.6315	17.63	0.98317	0.15337452	1.602718763	27.90734047	3.162258019	88.25021	0.143919	0.93835	Liquifiable
>250.00	14.8	2518.187408	18.07	42.54	0.43	42.54	0.43	0.00	235.20	0.6315	18.63	0.98164	0.15313584	1.533123794	28.22864185	3.125767088	88.23616	0.143889	0.939614	Liquifiable
>250.00	16.5	2793.1498	17.99	46.14	0.46	44.18	0.44	1.96	229.77	0.6315	20.63	0.98011	0.159687052	1.50446549	30.70990181	2.682141698	82.36831	0.131971	0.826437	Liquifiable
>250.00	18.1	3068.102157	18.03	49.75	0.50	45.82	0.46	3.92	229.77	0.6315	22.63	0.97858	0.165730797	1.477240908	33.10866185	2.467498583	81.69558	0.130708	0.788678	Liquifiable
>250.00	15.6	2643.069942	17.97	53.34	0.53	47.46	0.47	5.89	229.77	0.6315	19.63	0.97705	0.171324174	1.451611246	28.17940331	2.975880359	83.85853	0.134843	0.787066	Liquifiable
>250.00	12.4	2097.442142	17.42	56.83	0.57	48.98	0.49	7.85	208.85	0.769	15.77	0.97552	0.176565375	1.428877044	22.21903803	3.180838423	70.67517	0.112831	0.639032	Liquifiable
>250.00	18.1	3072.359907	18.15	60.46	0.60	50.65	0.51	9.81	235.20	0.769	22.77	0.97399	0.181372597	1.405148547	31.68609974	2.762288199	87.52614	0.142359	0.784896	Liquifiable
>250.00	14.8	2507.370508	17.82	64.02	0.64	52.25	0.52	11.77	223.69	0.769	18.77	0.97246	0.185883446	1.383441292	25.66283597	3.140664767	80.59836	0.128692	0.692329	Liquifiable
>250.00	17.2	2922.293142	18.13	67.65	0.68	53.91	0.54	13.73	235.20	0.769	21.77	0.97093	0.190049322	1.36191564	29.34928205	3.03192358	88.98478	0.145528	0.765741	Liquifiable
>250.00	20.5	3477.231433	18.08	71.26	0.71	55.57	0.56	15.70	229.77	0.769	25.77	0.9694	0.193943091	1.34149945	34.27531096	2.403495096	82.38054	0.131994	0.680583	Liquifiable
>250.00	18.9	3211.427849	18.05	74.87	0.75	57.21	0.57	17.66	229.77	0.9065	23.91	0.96787	0.197586388	1.322041785	31.31586479	2.670452527	83.62753	0.134391	0.680166	Liquifiable
>250.00	21.4	3626.327527	18.22	78.52	0.79	58.90	0.59	19.62	235.20	0.9065	26.91	0.96634	0.200967961	1.303037484	34.77481284	2.507277363	87.1901	0.141643	0.704804	Liquifiable
>250.00	23.0	3901.160723	18.45	82.21	0.82	60.62	0.61	21.58	244.61	0.9065	28.91	0.96481	0.204091137	1.284326559	36.84411816	2.589253112	95.39875	0.160744	0.78761	Liquifiable
>250.00	24.6	4176.014709	18.38	85.88	0.86	62.34	0.62	23.54	240.12	0.9065	30.91	0.96328	0.207026413	1.266550022	38.86725379	2.331631496	90.62411	0.149217	0.720764	Liquifiable
>250.00	22.1	3750.851715	18.44	89.57	0.90	64.06	0.64	25.51	244.61	0.9065	27.91	0.96175	0.209765916	1.24937348	34.59202824	2.794085184	96.65307	0.163971	0.781686	Liquifiable
>250.00	21.4	3625.034777	18.10	93.19	0.93	65.72	0.66	27.47	229.77	1.044	27.04	0.96022	0.212400222	1.233520716	33.08919319	2.535327223	83.89193	0.134909	0.635164	Liquifiable
>250.00	25.5	4319.884855	18.39	96.87	0.97	67.44	0.67	29.43	240.12	1.044	32.04	0.95869	0.214821885	1.21772097	38.75396987	2.351314462	91.12277	0.150366	0.699957	Liquifiable
>250.00	24.6	4174.769059	18.27	100.52	1.01	69.13	0.69	31.39	235.20	1.044	31.04	0.95716	0.217121837	1.202725184	37.07400381	2.359359342	87.4709	0.142241	0.655119	Liquifiable

Number of sounding rod	Depth	RP	RP+RL	qc obtained from manual calculation as robertson equation value of Rp in 10*kg) or uncorrected qc	qc	total resistanec (x) (rp+Rl)	cone resistance (uncorrected) (y)	total resistane -cone resistance (x-y)	frictinal resistance (z) = (x-y)*b/a	corrected (fs) as IS code	fs = (((Rp+Rl)+1) *10-(Rp+1)*10))/ 150	fs	Original Rf from Pagani software as robertson	Rf obtained from corrected (qc) as IS code	If=qc/fs obtained from Pagani softwar/ Manual	If=qc/fs as Corrected qc as IS code 4968	RT	Normalized friction ratio(Fr) =(fs/(qc-σv))*100	Normalized Cone resitance (Qt)= (qc-σv)/σ'v	Ic soil behavior type index	soil type as Ic	total thrust Qt as pagani manual
6	5.80	28.00	42.00	28.83	2882.5	42.00	28.00	14.00	0.93	0.94	0.93	93.33	3.24	3.23	30.88	30.96	85	3.36	39.19	2.56	Sandy Mixture	816.5
6	6.00	29.00	43.00	29.83	2982.5	43.00	29.00	14.00	0.93	0.94	0.93	93.33	3.13	3.12	31.96	32.03	96	3.25	39.56	2.55	Sandy Mixture	896.5
7	6.20	46.00	64.00	46.96	4696.25	64.00	46.00	18.00	1.20	1.20	1.20	120.00	2.56	2.55	39.14	39.17	112	2.62	61.52	2.35	Sandy Mixture	1014.25
7	6.40	54.00	72.00	54.96	5496.25	72.00	54.00	18.00	1.20	1.20	1.20	120.00	2.18	2.18	45.80	45.81	136	2.23	70.43	2.26	Sandy Mixture	1174.25
7	6.60	60.00	82.00	60.96	6096.25	82.00	60.00	22.00	1.47	1.47	1.47	146.67	2.41	2.40	41.57	41.58	156	2.45	76.31	2.26	Sandy Mixture	1414.25
7	6.80	61.00	85.00	61.96	6196.25	85.00	61.00	24.00	1.60	1.60	1.60	160.00	2.58	2.58	38.73	38.75	188	2.63	75.66	2.29	Sandy Mixture	1614.25
7	7.00	58.00	83.00	58.96	5896.25	83.00	58.00	25.00	1.67	1.67	1.67	166.67	2.83	2.82	35.38	35.41	194	2.89	70.17	2.34	Sandy Mixture	1934.25
8	7.20	71.00	96.00	72.10	7210	96.00	71.00	25.00	1.67	1.67	1.67	166.67	2.31	2.31	43.26	43.27	211	2.35	84.08	2.22	Sandy Mixture	2002
8	7.40	48.00	74.00	49.10	4910	74.00	48.00	26.00	1.73	1.74	1.73	173.33	3.53	3.52	28.33	28.38	158	3.63	55.43	2.48	Sandy Mixture	2172
8	7.60	61.00	88.00	62.10	6210	88.00	61.00	27.00	1.80	1.80	1.80	180.00	2.90	2.90	34.50	34.53	178	2.96	68.90	2.35	Sandy Mixture	1642
8	7.80	40.00	64.00	41.10	4110	64.00	40.00	24.00	1.60	1.60	1.60	160.00	3.89	3.88	25.69	25.75	150	4.03	44.07	2.58	Sandy Mixture	1842
8	8.00	37.00	60.00	38.10	3810	60.00	37.00	23.00	1.53	1.54	1.53	153.33	4.02	4.01	24.85	24.91	149	4.19	39.85	2.62	Silt Mix	1562
9	8.20	51.00	78.00	52.24	5223.75	78.00	51.00	27.00	1.80	1.80	1.80	180.00	3.45	3.44	29.02	29.07	137	3.55	54.03	2.48	Sandy Mixture	1559.75
9	8.40	56.00	90.00	57.24	5723.75	90.00	56.00	34.00	2.27	2.27	2.27	226.67	3.96	3.95	25.25	25.30	162	4.07	58.07	2.50	Sandy Mixture	1439.75
9	8.60	65.00	102.00	66.24	6623.75	102.00	65.00	37.00	2.47	2.47	2.47	246.67	3.72	3.72	26.85	26.89	189	3.82	66.00	2.44	Sandy Mixture	1689.75
9	8.80	77.00	116.00	78.24	7823.75	116.00	77.00	39.00	2.60	2.60	2.60	260.00	3.32	3.32	30.09	30.12	209	3.39	76.58	2.36	Sandy Mixture	1959.75
9	9.00	55.00	94.00	56.24	5623.75	94.00	55.00	39.00	2.60	2.60	2.60	260.00	4.62	4.61	21.63	21.68	197	4.76	53.45	2.58	Sandy Mixture	2159.75
10	9.20	32.00	70.00	33.38	3337.5	70.00	32.00	38.00	2.53	2.54	2.53	253.33	7.59	7.55	13.17	13.24	203	8.00	30.42	2.91	Silt Mix	2047.5
10	9.40	76.00	118.00	77.38	7737.5	118.00	76.00	42.00	2.80	2.80	2.80	280.00	3.62	3.61	27.63	27.67	173	3.70	71.22	2.41	Sandy Mixture	2107.5
10	9.60	50.00	92.00	51.38	5137.5	92.00	50.00	42.00	2.80	2.80	2.80	280.00	5.45	5.44	18.35	18.40	162	5.65	45.81	2.68	Silt Mix	1807.5
10	9.80	44.00	83.00	45.38	4537.5	83.00	44.00	39.00	2.60	2.60	2.60	260.00	5.73	5.71	17.45	17.50	146	5.97	39.49	2.74	Silt Mix	1697.5
10	10.00	44.00	87.00	45.38	4537.5	87.00	44.00	43.00	2.87	2.87	2.87	286.67	6.32	6.30	15.83	15.88	134	6.59	38.73	2.77	Silt Mix	1537.5
11	10.20	44.00	88.00	45.51	4551.25	88.00	44.00	44.00	2.93	2.94	2.93	293.33	6.45	6.42	15.52	15.57	130	6.73	38.11	2.79	Silt Mix	1425.25
11	10.40	43.00	88.00	44.51	4451.25	88.00	43.00	45.00	3.00	3.00	3.00	300.00	6.74	6.72	14.84	14.89	135	7.05	36.54	2.81	Silt Mix	1385.25
11	10.60	37.00	82.00	38.51	3851.25	82.00	37.00	45.00	3.00	3.00	3.00	300.00	7.79	7.76	12.84	12.89	133	8.21	30.82	2.91	Silt Mix	1435.25
11	10.80	40.00	88.00	41.51	4151.25	88.00	40.00	48.00	3.20	3.20	3.20	320.00	7.71	7.68	12.97	13.02	185	8.10	32.74	2.89	Silt Mix	1415.25
11	11.00	40.00	90.00	41.51	4151.25	90.00	40.00	50.00	3.33	3.34	3.33	333.33	8.03	8.00	12.45	12.50	181	8.45	32.15	2.91	Silt Mix	1935.25
12	11.20	37.00	89.00	38.65	3865	89.00	37.00	52.00	3.47	3.47	3.47	346.67	8.97	8.93	11.15	11.20	229	9.49	29.28	2.97	Clay	1903
12	11.40	69.00	125.00	70.65	7065	125.00	69.00	56.00	3.73	3.74	3.73	373.33	5.28	5.27	18.92	18.96	235	5.45	53.97	2.62	Silt Mix	2383
12	11.60	74.00	135.00	75.65	7565	135.00	74.00	61.00	4.07	4.07	4.07	406.67	5.38	5.37	18.60	18.63	238	5.54	56.90	2.61	Silt Mix	2443
12	11.80	60.00	118.00	61.65	6165	118.00	60.00	58.00	3.87	3.87	3.87	386.67	6.27	6.26	15.94	15.98	216	6.51	45.27	2.73	Silt Mix	2473
12	12.00	73.00	138.00	74.65	7465	138.00	73.00	65.00	4.33	4.34	4.33	433.33	5.80	5.79	17.23	17.26	226	5.99	54.24	2.65	Silt Mix	2253
13	12.20	68.00	134.00	69.79	6978.75	134.00	68.00	66.00	4.40	4.40	4.40	440.00	6.30	6.29	15.86	15.89	256	6.52	49.75	2.70	Silt Mix	2360.75
13	12.40	118.00	176.00	119.79	11978.75	176.00	118.00	58.00	3.87	3.87	3.87	386.67	3.23	3.23	30.98	31.00	236	3.29	85.20	2.32	Sandy Mixture	2660.75
13	12.60	78.00	151.00	79.79	7978.75	151.00	78.00	73.00	4.87	4.87	4.87	486.67	6.10	6.09	16.39	16.42	264	6.29	55.25	2.66	Silt Mix	2460.75
13	12.80	80.00	160.00	81.79	8178.75	160.00	80.00	80.00	5.33	5.34	5.33	533.33	6.52	6.51	15.34	15.36	278	6.72	55.76	2.68	Silt Mix	2740.75
13	13.00	86.00	165.00	87.79	8778.75	165.00	86.00	79.00	5.27	5.27	5.27	526.67	6.00	5.99	16.67	16.70	256	6.17	59.01	2.63	Silt Mix	2880.75
14	13.20	84.00	145.00	85.93	8592.5	145.00	84.00	61.00	4.07	4.07	4.07	406.67	4.73	4.73	21.13	21.16	255	4.88	56.84	2.57	Sandy Mixture	2668.5
14	13.40	74.00	156.00	75.93	7592.5	156.00	74.00	82.00	5.47	5.47	5.47	546.67	7.20	7.19	13.89	13.92	215	7.45	49.24	2.75	Silt Mix	2658.5
14	13.60	76.00	160.00	77.93	7792.5	160.00	76.00	84.00	5.60	5.60	5.60	560.00	7.19	7.17	13.92	13.94	225	7.44	49.80	2.74	Silt Mix	2258.5
14	13.80	84.00	165.00	85.93	8592.5	165.00	84.00	81.00	5.40	5.40	5.40	540.00	6.28	6.27	15.91	15.94	264	6.48	54.25	2.67	Silt Mix	2358.5
14	14.00	96.00	184.00	97.93	9792.5	184.00	96.00	88.00	5.87	5.87	5.87	586.67	5.99	5.98	16.69	16.72	268	6.16	61.14	2.62	Silt Mix	2748.5

Qst	constrained modulus (Mo) Mcpt (mPa) mayne 1990	constrained modulus (Mo) Mcpt (kPa)	Soil unit weight (Υ) robertson (2010)	Vertical overburden stress (Kn/m2) calculated from robertson (2010)	Vertical overburden stress (Kg/cm2) calculated from robertson (2010)	Effective Vertical overburden stress (Kn/m2) calculated from robertson (2010)	Vertical overburden stress (Kg/cm2) calculated from robertson (2010)	Pre insertaion Pore water pressure (U)	Shear wave velocity(m/s) Vs=51.6Ln(fs)+18.5 (Mayne 2006)	correction factor for qc (IS 4968 Part III)	Corrected qc (IS4968)	Stress reduction factor(rd)	cyclic stress ratio (CSR)	C_Q	qc1n	K_c	$(q_{C1N})_{CS}$	CRR	F.O.S	REMARKS
>250.00	22.9	3889.552091	18.63	104.25	1.04	70.89	0.71	33.35	252.57	1.044	29.04	0.95563	0.219215689	1.187664319	34.234424	3.094170831	105.9272	0.190536	0.869173	Liquifiable
>250.00	23.7	4024.331462	18.65	107.98	1.08	72.66	0.73	35.32	252.57	1.044	30.04	0.9541	0.221180762	1.17313432	34.98873109	3.020529529	105.6845	0.189778	0.858024	Liquifiable
>250.00	37.8	6418.231145	19.11	111.80	1.12	74.52	0.75	37.28	265.53	1.1815	47.18	0.95257	0.222936095	1.158404223	54.40155834	2.095881795	114.0192	0.217853	0.977201	Liquifiable
>250.00	44.4	7532.863939	19.17	115.63	1.16	76.39	0.76	39.24	265.53	1.1815	55.18	0.95104	0.224570032	1.144125065	62.88397387	1.804923017	113.5007	0.215981	0.961754	Liquifiable
>250.00	49.3	8367.420976	19.44	119.52	1.20	78.32	0.78	41.20	275.89	1.1815	61.18	0.94951	0.226048557	1.129970689	68.8858381	1.817736758	125.2163	0.262585	1.161632	NonLiquifiable
>250.00	50.1	8501.948241	19.55	123.43	1.23	80.27	0.80	43.16	280.38	1.1815	62.18	0.94798	0.227411911	1.116181076	69.16136989	1.891257455	130.802	0.288126	1.266977	NonLiquifiable
>250.00	47.6	8076.467685	19.57	127.34	1.27	82.22	0.82	45.13	282.49	1.1815	59.18	0.94645	0.228682482	1.102846826	65.026606	2.060661346	133.9978	0.303757	1.32829	NonLiquifiable
>250.00	58.4	9910.215534	19.65	131.27	1.31	84.19	0.84	47.09	282.49	1.319	72.32	0.94492	0.22985679	1.089879456	78.58030879	1.702552631	133.7871	0.302703	1.316919	NonLiquifiable
>250.00	39.4	6684.741998	19.55	135.18	1.35	86.13	0.86	49.05	284.51	1.319	49.32	0.94339	0.230975554	1.077486822	52.90460298	2.65172354	140.2884	0.336772	1.458043	NonLiquifiable
>250.00	50.1	8499.231088	19.68	139.12	1.39	88.11	0.88	51.01	286.46	1.319	62.32	0.94186	0.231997871	1.065346106	66.15799316	2.109055667	139.5309	0.332635	1.433786	NonLiquifiable
>250.00	32.7	5553.802427	19.39	143.00	1.43	90.02	0.90	52.97	280.38	1.319	41.32	0.94033	0.233010811	1.053950477	43.31736461	3.201298005	138.6718	0.327998	1.407649	NonLiquifiable
>250.00	30.2	5128.395612	19.31	146.86	1.47	91.92	0.92	54.94	278.18	1.319	38.32	0.9388	0.233976263	1.087851905	41.44715759	3.461413589	143.4658	0.354617	1.515612	NonLiquifiable
>250.00	41.9	7102.15327	19.62	150.78	1.51	93.89	0.94	56.90	286.46	1.4565	52.46	0.93727	0.234825266	1.032050668	53.91174677	2.65494456	143.1327	0.352709	1.502006	NonLiquifiable
>250.00	45.9	7796.576865	19.92	154.77	1.55	95.91	0.96	58.86	298.35	1.4565	57.46	0.93574	0.235563864	1.021117978	58.44624029	2.761046151	161.3728	0.470817	1.998682	NonLiquifiable
>250.00	53.3	9050.957546	20.07	158.78	1.59	97.96	0.98	60.82	302.71	1.4565	66.46	0.93421	0.236224233	1.010367405	66.92421098	2.483239985	166.1889	0.506863	2.145687	NonLiquifiable
>250.00	63.2	10725.3034	20.19	162.82	1.63	100.04	1.00	62.78	305.43	1.4565	78.46	0.93268	0.236815631	0.99982503	78.22381081	2.151364739	168.2879	0.523243	2.209496	NonLiquifiable
>250.00	45.0	7639.684692	20.07	166.83	1.67	102.09	1.02	64.75	305.43	1.4565	56.46	0.93115	0.237386937	0.989728633	55.65986402	3.167373819	176.2956	0.589574	2.4836	NonLiquifiable
>250.00	26.1	4433.380375	19.84	170.80	1.71	104.09	1.04	66.71	304.09	1.594	33.59	0.92836	0.237635854	0.960691091	32.06306517	5.749782678	184.3557	0.66271	2.788762	NonLiquifiable
>250.00	62.4	10587.70354	20.27	174.85	1.75	106.18	1.06	68.67	309.26	1.594	77.59	0.92302	0.237110736	0.970441163	75.08788501	2.345281549	176.1022	0.587899	2.479429	NonLiquifiable
>250.00	40.9	6942.070681	20.12	178.88	1.79	108.25	1.08	70.63	309.26	1.594	51.59	0.91768	0.236570618	0.923820939	47.46130076	3.805261161	180.6026	0.627842	2.65393	NonLiquifiable
>250.00	35.9	6096.47502	19.98	182.87	1.83	110.28	1.10	72.59	305.43	1.594	45.59	0.91234	0.236012487	0.90677463	41.14489882	4.257343494	175.168	0.579858	2.456897	NonLiquifiable
>250.00	35.9	6090.847911	20.10	186.89	1.87	112.34	1.12	74.56	310.47	1.594	45.59	0.907	0.235396509	0.890167966	40.39137146	4.551419672	183.8381	0.657816	2.794501	NonLiquifiable
>250.00	36.0	6104.463072	20.12	190.92	1.91	114.40	1.14	76.52	311.66	1.7315	45.73	0.90166	0.234739609	0.874116444	39.78322466	4.644645867	184.779	0.666733	2.84031	NonLiquifiable
>250.00	35.1	5958.823381	20.14	194.95	1.95	116.47	1.16	78.48	312.82	1.7315	44.73	0.89632	0.234045596	0.858607996	38.21878841	4.875630589	186.3407	0.681736	2.912835	NonLiquifiable
>250.00	30.1	5113.199234	20.09	198.96	1.99	118.52	1.19	80.44	312.82	1.7315	38.73	0.89098	0.233327996	0.843719285	32.49373897	5.795236075	188.3089	0.701005	3.004378	NonLiquifiable
>250.00	32.6	5527.546246	20.19	203.00	2.03	120.60	1.21	82.40	316.15	1.7315	41.73	0.88564	0.232563223	0.829196463	34.42201819	5.578978615	192.0397	0.738652	3.176134	NonLiquifiable
>250.00	32.5	5521.88011	20.24	207.05	2.07	122.68	1.23	84.37	318.25	1.7315	41.73	0.8803	0.231762262	0.815102738	33.83695242	5.761765162	194.9606	0.769165	3.318768	NonLiquifiable
>250.00	30.1	5115.459013	20.25	211.10	2.11	124.77	1.25	86.33	320.28	1.869	38.87	0.87496	0.230931348	0.801457338	30.97632612	6.426123075	199.0577	0.813533	3.522836	NonLiquifiable
>250.00	56.5	9589.699286	20.57	215.21	2.15	126.92	1.27	88.29	324.10	1.869	70.87	0.86962	0.230027505	0.787868118	55.66288257	3.413417367	190.0007	0.717894	3.120903	NonLiquifiable
>250.00	60.6	10283.90467	20.70	219.35	2.19	129.10	1.29	90.25	328.51	1.869	75.87	0.86428	0.229082502	0.774582504	58.59716639	3.350521381	196.3311	0.783801	3.42148	NonLiquifiable
>250.00	49.0	8318.148272	20.56	223.47	2.23	131.25	1.31	92.21	325.91	1.869	61.87	0.85894	0.228135887	0.761895938	46.9708846	4.162254683	195.5048	0.774952	3.39689	NonLiquifiable
>250.00	59.7	10132.33463	20.76	227.62	2.28	133.44	1.33	94.18	331.79	1.869	74.87	0.8536	0.227139623	0.749388564	55.9418563	3.602235574	201.5157	0.841044	3.702763	NonLiquifiable
>250.00	55.7	9445.773301	20.75	231.77	2.32	135.63	1.36	96.14	332.58	2.0065	70.01	0.84826	0.226125675	0.737294187	51.4539181	3.966928024	204.114	0.870863	3.851235	NonLiquifiable
>250.00	96.9	16439.94559	20.81	235.93	2.36	137.83	1.38	98.10	325.91	2.0065	120.01	0.84292	0.225085806	0.851776012	102.0321191	2.007177522	204.7966	0.878824	3.904395	NonLiquifiable
>250.00	63.8	10834.08741	20.92	240.12	2.40	140.05	1.40	100.06	337.78	2.0065	80.01	0.83758	0.224014591	0.714009627	56.96904312	3.674936747	209.3576	0.933393	4.166664	NonLiquifiable
>250.00	65.5	11108.19709	21.04	244.32	2.44	142.30	1.42	102.02	342.50	2.0065	82.01	0.83224	0.222912817	0.702743116	57.47560256	3.808697056	218.9072	1.05558	4.735393	NonLiquifiable
>250.00	70.4	11942.30321	21.05	248.53	2.49	144.55	1.45	103.99	341.85	2.0065	88.01	0.8269	0.221795149	0.6918145	60.73266546	3.512363068	213.3152	0.98271	4.430709	NonLiquifiable
>250.00	68.8	11675.74493	20.74	252.68	2.53	146.73	1.47	105.95	328.51	2.144	86.14	0.82156	0.220702469	0.825532799	70.93390576	3.106780697	220.3761	1.075351	4.872402	NonLiquifiable
>250.00	60.5	10269.85463	21.04	256.89	2.57	148.98	1.49	107.91	343.78	2.144	76.14	0.81622	0.219559187	0.67123308	50.9633716	4.318925999	220.107	1.07171	4.88119	NonLiquifiable
>250.00	62.1	10543.95379	21.07	261.10	2.61	151.23	1.51	109.87	345.02	2.144	78.14	0.81088	0.218398922	0.66123381	51.52664468	4.288385783	220.9661	1.083368	4.960499	NonLiquifiable
>250.00	68.7	11658.05417	21.07	265.32	2.65	153.48	1.53	111.83	343.14	2.144	86.14	0.80554	0.217227485	0.651531786	55.98286875	3.779460997	211.5851	0.960923	4.42358	NonLiquifiable
>250.00	78.6	13332.11381	21.22	269.56	2.70	155.77	1.56	113.80	347.42	2.144	98.14	0.8002	0.216027808	0.641990417	62.86691162	3.444362322	216.5364	1.024226	4.741175	NonLiquifiable

Number of sounding rod	Depth	RP	RP+RL	qc obtained from manual calculation as robertson equation value of Rp in 10*kg) or uncorrected qc	qc	total resistanec (x) (rp+Rl)	cone resistance (uncorrected) (y)	total resistane -cone resistance (x-y)	frictinal resistance (z) = (x-y)*b/a	corrected (fs) as IS code	fs = (((Rp+Rl)+1)*10-(Rp+1)*10))/150	fs	Original Rf from Pagani software as robertson	Rf obtained from corrected (qc) as IS code	If=qc/fs obtained from Pagani softwar/ Manual	If=qc/fs as Corrected qc as IS code 4968	RT	Normalized friction ratio(Fr) =(fs/(qc-σv))*100	Normalized Cone resitance (Qt)= (qc-σv)/σ'v	Ic soil behavior type index	soil type as Ic	total thrust Qt as pagani manual
15	14.20	92.00	182.00	94.06	9406.25	182.00	92.00	90.00	6.00	6.00	6.00	600.00	6.38	6.37	15.68	15.70	333	6.57	57.78	2.66	Silt Mix	2796.25
15	14.40	84.00	168.00	86.06	8606.25	168.00	84.00	84.00	5.60	5.60	5.60	560.00	6.51	6.50	15.37	15.39	330	6.72	51.95	2.70	Silt Mix	3446.25
15	14.60	73.00	162.00	75.06	7506.25	162.00	73.00	89.00	5.93	5.94	5.93	593.33	7.90	7.89	12.65	12.68	298	8.21	44.44	2.81	Silt Mix	3416.25
15	14.80	65.00	151.00	67.06	6706.25	151.00	65.00	86.00	5.73	5.74	5.73	573.33	8.55	8.53	11.70	11.73	290	8.93	38.95	2.87	Silt Mix	3096.25
15	15.00	68.00	160.00	70.06	7006.25	160.00	68.00	92.00	6.13	6.14	6.13	613.33	8.75	8.73	11.42	11.45	262	9.13	40.19	2.87	Silt Mix	3016.25
16	15.20	83.00	180.00	85.20	8520	180.00	83.00	97.00	6.47	6.47	6.47	646.67	7.59	7.58	13.18	13.20	264	7.86	48.56	2.77	Silt Mix	2744
16	15.40	78.00	179.00	80.20	8020	179.00	78.00	101.00	6.73	6.74	6.73	673.33	8.40	8.38	11.91	11.94	289	8.72	44.97	2.82	Silt Mix	2764
16	15.60	72.00	174.00	74.20	7420	174.00	72.00	102.00	6.80	6.80	6.80	680.00	9.16	9.14	10.91	10.94	340	9.56	40.91	2.88	Silt Mix	3014
16	15.80	74.00	178.00	76.20	7620	178.00	74.00	104.00	6.93	6.94	6.93	693.33	9.10	9.08	10.99	11.01	331	9.48	41.48	2.87	Silt Mix	3524
16	16.00	78.00	184.00	80.20	8020	184.00	78.00	106.00	7.07	7.07	7.07	706.67	8.81	8.79	11.35	11.37	354	9.17	43.16	2.85	Silt Mix	3434
17	16.20	68.00	178.00	70.34	7033.75	178.00	68.00	110.00	7.33	7.34	7.33	733.33	10.43	10.40	9.59	9.62	331	10.92	37.14	2.95	Clay	3671.75
17	16.40	90.00	208.00	92.34	9233.75	208.00	90.00	118.00	7.87	7.87	7.87	786.67	8.52	8.50	11.74	11.76	350	8.83	48.64	2.81	Silt Mix	3441.75
17	16.60	85.00	203.00	87.34	8733.75	203.00	85.00	118.00	7.87	7.87	7.87	786.67	9.01	8.99	11.10	11.12	384	9.36	45.31	2.84	Silt Mix	3631.75
17	16.80	82.00	205.00	84.34	8433.75	205.00	82.00	123.00	8.20	8.20	8.20	820.00	9.72	9.70	10.29	10.31	385	10.12	43.13	2.88	Silt Mix	3971.75
17	17.00	92.00	218.00	94.34	9433.75	218.00	92.00	126.00	8.40	8.40	8.40	840.00	8.90	8.89	11.23	11.25	356	9.23	47.83	2.82	Silt Mix	3981.75
18	17.20	93.00	224.00	95.48	9547.5	224.00	93.00	131.00	8.73	8.74	8.73	873.33	9.15	9.13	10.93	10.95	387	9.48	47.81	2.83	Silt Mix	3699.5
18	17.40	97.00	231.00	99.48	9947.5	231.00	97.00	134.00	8.93	8.94	8.93	893.33	8.98	8.97	11.14	11.15	447	9.30	49.25	2.82	Silt Mix	4009.5
18	17.60	98.00	235.00	100.48	10047.5	235.00	98.00	137.00	9.13	9.14	9.13	913.33	9.09	9.08	11.00	11.02	394	9.41	49.14	2.82	Silt Mix	4609.5
18	17.80	99.00	239.00	101.48	10147.5	239.00	99.00	140.00	9.33	9.34	9.33	933.33	9.20	9.18	10.87	10.89	386	9.53	49.03	2.83	Silt Mix	4079.5
18	18.00	90.00	234.00	92.48	9247.5	234.00	90.00	144.00	9.60	9.60	9.60	960.00	10.38	10.36	9.63	9.65	334	10.80	43.98	2.90	Silt Mix	3999.5
19	18.20	80.00	225.00	82.61	8261.25	225.00	80.00	145.00	9.67	9.67	9.67	966.67	11.70	11.68	8.55	8.56	345	12.23	38.62	2.98	Clay	3487.25
19	18.40	109.00	264.00	111.61	11161.25	264.00	109.00	155.00	10.33	10.34	10.33	1033.33	9.26	9.24	10.80	10.82	406	9.57	52.16	2.81	Silt Mix	3597.25
19	18.60	107.00	265.00	109.61	10961.25	265.00	107.00	158.00	10.53	10.54	10.53	1053.33	9.61	9.59	10.41	10.42	403	9.94	50.58	2.83	Silt Mix	4207.25
19	18.80	89.00	242.00	91.61	9161.25	242.00	89.00	153.00	10.20	10.20	10.20	1020.00	11.13	11.11	8.98	9.00	412	11.61	41.49	2.94	Silt Mix	4177.25
19	19.00	85.00	240.00	87.61	8761.25	240.00	85.00	155.00	10.33	10.34	10.33	1033.33	11.79	11.77	8.48	8.50	385	12.32	39.14	2.98	Clay	4267.25
20	19.20	96.00	258.00	98.75	9875	258.00	96.00	162.00	10.80	10.80	10.80	1080.00	10.94	10.92	9.14	9.16	376	11.38	43.82	2.92	Silt Mix	4005

Qst	constrained modulus (Mo) Mcpt (mPa) mayne 1990	constrained modulus (Mo) Mcpt (kPa)	Soil unit weight (Y) robertson (2010)	Vertical overburden stress (Kn/m2) calculated from robertson (2010)	Vertical overburden stress (Kg/cm2) calculated from robertson (2010)	Effective Vertical overburden stress (Kn/m2) calculated from robertson (2010)	Vertical overburden stress (Kg/cm2) calculated from robertson (2010)	Pre insertaion Pore water pressure (U)	Shear wave velocity(m/s) Vs=51.6Ln(fs)+18.5 (Mayne 2006)	correction factor for qc (IS 4968 Part III)	Corrected qc (IS4968)	Stress reduction factor(rd)	cyclic stress ratio (CSR)	C_Q	qc1n	K_c	$(q_{C1N})_{CS}$	CRR	F.O.S	REMARKS
>250.00	75.3	12785.42054	21.23	273.81	2.74	158.05	1.58	115.76	348.58	2.2815	94.28	0.79486	0.214816835	0.632716129	59.51486088	3.688040912	219.4932	1.063437	4.950435	NonLiquifiable
>250.00	68.7	11659.50903	21.11	278.03	2.78	160.31	1.60	117.72	345.02	2.2815	86.28	0.78952	0.213609036	0.623794256	53.68529313	3.950573994	212.0877	0.967216	4.527975	NonLiquifiable
>250.00	59.6	10113.59358	21.13	282.25	2.82	162.57	1.63	119.68	348.01	2.2815	75.28	0.78418	0.212389993	0.615109846	46.17168283	4.818308951	222.4694	1.103986	5.197919	NonLiquifiable
>250.00	53.0	8987.701269	21.04	286.46	2.86	164.82	1.65	121.64	346.24	2.2815	67.28	0.77884	0.211170712	0.606724771	40.68847994	5.40046242	219.7366	1.066712	5.051418	NonLiquifiable
>250.00	55.4	9401.782542	21.14	290.69	2.91	167.09	1.67	123.61	349.72	2.2815	70.28	0.7735	0.209932169	0.598497623	41.93223969	5.386203204	225.8556	1.151458	5.484907	NonLiquifiable
>250.00	67.9	11515.07577	21.27	294.95	2.95	169.38	1.69	125.57	352.45	2.419	85.42	0.76816	0.208670919	0.590395864	50.30172765	4.490667313	225.8883	1.151925	5.520294	NonLiquifiable
>250.00	63.7	10809.11247	21.30	299.21	2.99	171.68	1.72	127.53	354.53	2.419	80.42	0.76282	0.207399666	0.582494713	46.71607598	4.961224117	231.7689	1.23784	5.96838	NonLiquifiable
>250.00	58.7	9963.154349	21.28	303.46	3.03	173.97	1.74	129.49	355.04	2.419	74.42	0.75748	0.206123067	0.574814461	42.65123304	5.480535664	233.7516	1.267809	6.15074	NonLiquifiable
>250.00	60.3	10237.18712	21.31	307.72	3.08	176.27	1.76	131.45	356.04	2.419	76.42	0.75214	0.204836237	0.567313161	43.22926283	5.419231237	234.2694	1.27572	6.227999	NonLiquifiable
>250.00	63.6	10791.20826	21.35	311.99	3.12	178.58	1.79	133.42	357.02	2.419	80.42	0.7468	0.203538744	0.559979075	44.91032179	5.212606949	234.0999	1.273126	6.254958	NonLiquifiable
>250.00	55.4	9404.481556	21.35	316.26	3.16	180.89	1.81	135.38	358.94	2.5565	70.56	0.74146	0.202235772	0.552836905	38.88516579	6.191473579	240.7565	1.377827	6.812975	NonLiquifiable
>250.00	73.5	12478.45302	21.53	320.57	3.21	183.23	1.83	137.34	362.56	2.5565	92.56	0.73612	0.200909399	0.545764334	50.39451417	4.807052913	242.2491	1.402116	6.978845	NonLiquifiable
>250.00	69.4	11772.43047	21.51	324.87	3.25	185.57	1.86	139.30	362.56	2.5565	87.56	0.73078	0.199579842	0.538882836	47.06467971	5.150948975	242.4278	1.405043	7.040005	NonLiquifiable
>250.00	66.9	11346.3983	21.54	329.18	3.29	187.92	1.88	141.26	364.70	2.5565	84.56	0.72544	0.198242146	0.532153267	44.88047615	5.522036748	247.8316	1.495641	7.544517	NonLiquifiable
>250.00	75.1	12740.34634	21.61	333.50	3.34	190.28	1.90	143.23	365.94	2.5565	94.56	0.7201	0.196893434	0.525550653	49.57913469	4.978001537	246.805	1.478121	7.507215	NonLiquifiable
>250.00	76.0	12893.53055	21.66	337.84	3.38	192.65	1.93	145.19	367.95	2.694	95.69	0.71476	0.195536087	0.519083271	49.55947527	5.059311296	250.7368	1.546011	7.906526	NonLiquifiable
>250.00	79.2	13447.45307	21.71	342.18	3.42	195.03	1.95	147.15	369.12	2.694	99.69	0.70942	0.194171148	0.512751156	51.00592127	4.929641651	251.4409	1.558396	8.025889	NonLiquifiable
>250.00	80.0	13581.36739	21.73	346.52	3.47	197.41	1.97	149.11	370.26	2.694	100.69	0.70408	0.192800006	0.506556627	50.89627709	4.971125765	253.0118	1.586278	8.227585	NonLiquifiable
>250.00	80.8	13715.27366	21.76	350.88	3.51	199.80	2.00	151.07	371.38	2.694	101.69	0.69874	0.191422981	0.500495596	50.78779064	5.011729931	254.5347	1.613642	8.429717	NonLiquifiable
>250.00	73.4	12449.18083	21.76	355.23	3.55	202.19	2.02	153.04	372.83	2.694	92.69	0.6934	0.190042913	0.494579462	45.73623573	5.680958414	259.8257	1.711282	9.004713	NonLiquifiable
>250.00	65.2	11062.34788	21.72	359.57	3.60	204.57	2.05	155.00	373.19	2.8315	82.83	0.68806	0.188662452	0.488818418	40.38251153	6.480552428	261.701	1.74686	9.25918	NonLiquifiable
>250.00	89.1	15116.21115	21.92	363.96	3.64	207.00	2.07	156.96	376.63	2.8315	111.83	0.68272	0.187263812	0.483100367	53.92003966	4.878010209	263.0225	1.772239	9.463862	NonLiquifiable
>250.00	87.4	14830.07018	21.93	368.34	3.68	209.42	2.09	158.92	377.62	2.8315	109.83	0.67738	0.185861485	0.47750765	52.34080732	5.065310654	265.1224	1.813095	9.755089	NonLiquifiable
>250.00	72.5	12303.95883	21.83	372.71	3.73	211.82	2.12	160.88	375.96	2.8315	91.83	0.67204	0.184464709	0.472090085	43.24935294	6.086087156	263.2193	1.776041	9.628079	NonLiquifiable
>250.00	69.2	11737.84809	21.82	377.07	3.77	214.23	2.14	162.85	376.63	2.8315	87.83	0.6667	0.183065483	0.466795021	40.89707876	6.468529789	264.544	1.801776	9.842247	NonLiquifiable
>250.00	78.3	13290.96028	21.92	381.46	3.81	216.65	2.17	164.81	378.91	2.969	98.97	0.66136	0.181656721	0.461576214	45.58065109	5.865880863	267.3707	1.85756	10.22566	NonLiquifiable

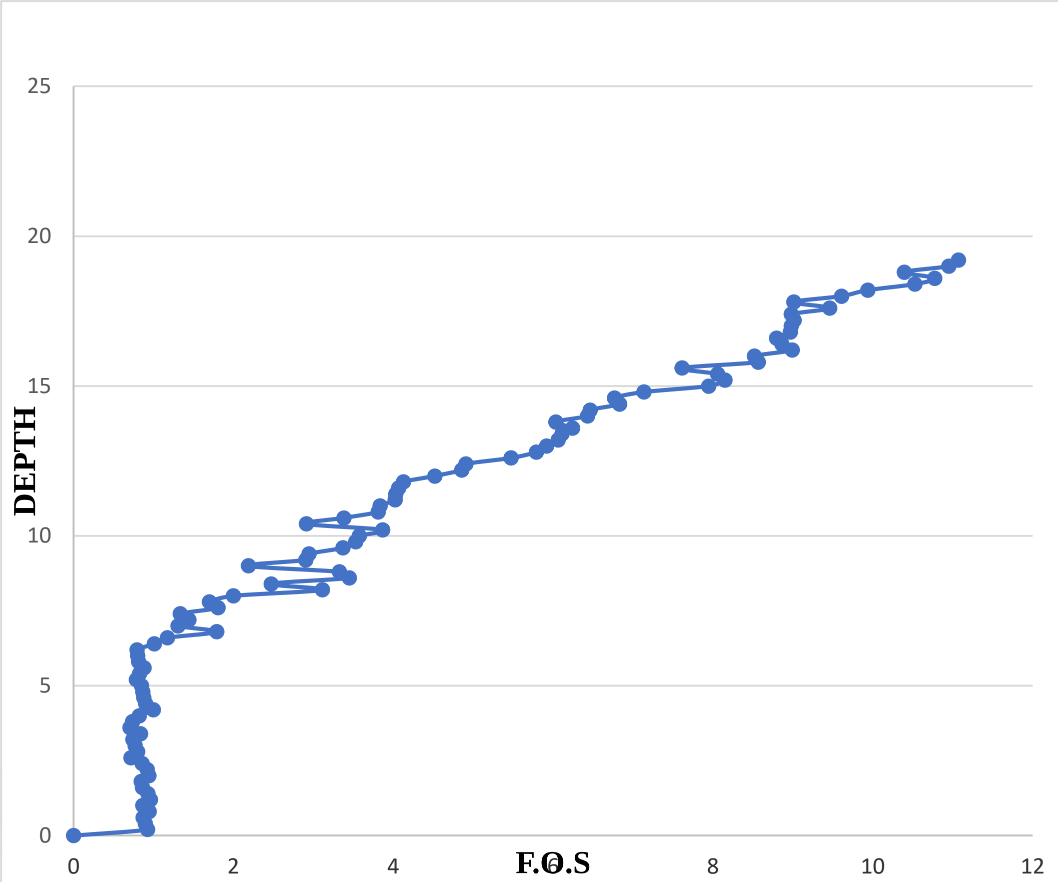

Fig. 4.3 FOS Vs depth from CPT Data (CPT-1)

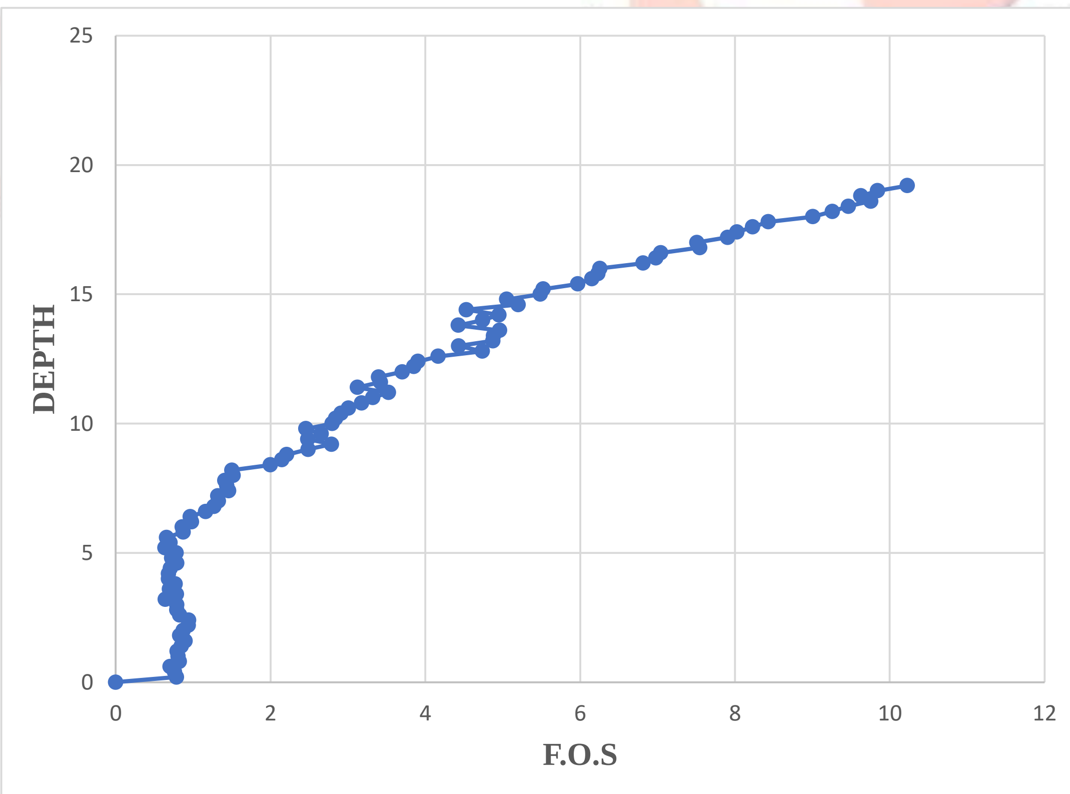

Fig. 4.4. FOS Vs depth from CPT Data (CPT-2)

5. CONCLUSIONS

The following conclusions may be drawn from the present study:

1. SPT results show liquefaction zone up to depth 9.95m below EGL at BH-1 and up to 10.50m below EGL at BH-2. It is further observed from the Tables that the minimum factor of safety of 0.67 occurring at 1.45m below GL in BH-1 and the same is 0.67 at 1.45m below GL in BH-2.
2. CPT results show liquefaction zone up to 6.20m at CPT-1 with an minimum factor of safety of 0.70 at a depth of 3.60m. Further it is seen that in case of CPT-2 the depth of liquefaction is up to 6.40m with a minimum factor of safety of 0.63 at a depth of 3.20m.

6. REFERENCES

Seed, H.B., Idris, I.M,(2011): Simplified procedure for evaluating soil liquefaction potential, Journal of Soil Mechanics and Foundation Divisions, ASCE, vol.97, no. SM9, proceedings paper 8371, pp.1249- 1473

Robertson, P.K., Campanella, R.G.(1985): Liquefaction Potential of Sands Using the CPT Journal of Geotechnical Engineering Vol. 111, Issue 3, ASCE: 0733-9410

Robertson, P. K., Wride, C. E.(1998): Evaluating cyclic liquefaction potential using the cone penetration test. *Canadiangeotechnical journal*, *35*(3), PP. 442-459, Canada.

Kramer, S. L.(1996): Geotechnical earthquake engineering. Pearson Education India.

Nath, S. K., Srivastava, N., Ghatak, C., Adhikari, M. D., Ghosh, A., Ray, S. S(2018): Earthquake induced liquefaction hazard, probability and risk assessment in the city of Kolkata, India: its historical perspective and deterministic scenario. *Journal of Seismology*

Youd, T.L. and Idriss, I.M(2003).: Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils. Jnl GGE, ASCE,

Singbal, P., Chatterjee. S., Choudhury, D.(2017): Assessment of Seismic Liquefaction of Soil Site at Mundra Port, India, Using CPT and DMT Field Tests

K Das, S Nandi, S Chattaraj, A Halder, and W Sadhukhan (2022) "Estimation of subsoil parameters and settlement of foundation for a project in Kolkata based on CPT, DMT

Figen ORHUN ÖNAL, Gülçin ÖZMEN(2016) studied on" Using Combination of SPT, DMT and CPT to Estimate Geotechnical Model for a Special Project in Turkey".

Pradeep Muley, D. K. Paul, B.K. Maheshwari researched on" Assessment of Liquefaction Potential Index for Roorkee Region.

Onal, F. O., & Özmen, G. "Using Combination of SPT, DMT and CPT to Estimate Geotechnical Model for a Special Project in Turkey

IS: 1893:2016: Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi

CPT Data Interpretation Theory Manual, ROCSCIENCE (2021) IS :4968 Part- III. Method for subsurface sounding for soil part-iii static cone penetration test

Akhila, M., Rangaswamy, K., Sankar, N.(2019): Liquefaction susceptibility of central Kerala,2019