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Comparative study of Cone penetration test (CPTu) and Field van shear test (FVST) on marine clay at Land Reclamation site, URAN, NAVI Mumbai

Shubham A. Chinchole[1], Seema T. Borole[2], Dr. A. B. Saner[3]
[1] *PG student Geotechnical Engineering, Department of Civil Engineering, Matoshri College of Engineering, and Research Centre, Nashik, Maharashtra.*
[2] *Assistant Prof., Department of Civil Engineering, Matoshri College of Engineering, and Research Centre, Nashik, Maharashtra.*
[3] *Professor and Head, Department of Civil Engineering, Matoshri College of Engineering, and Research Centre, Nashik, Maharashtra.*

Abstract:
There are many methods to do Land reclamation work, In this paper focus on offshore Land reclamation work done by Preloading of Surcharge and Prefabricated vertical drains(PVD) concept. Preloading and PVD are easy implementation, widely used concept of offshore land reclamation work. Geotechnical Instrumentation plays an important role to monitoring on reclamation work. In geotechnical engineering several in-situ method to find behavior, type, properties, Degree of consolidation, etc. of subsurface soil strata. Cone penetration test (CPTu) and Field van shear test (FVST) are purposely used in preloading reclamation to calculate undrained shear strength of soil.
In this paper comparative analysis of Cone penetration test and Field van shear test based on results accuracy, cost effective, number of parameter obtained from both tests. And finally which test is most suitable for proposed soil strata will discuss.
Keywords: *Land reclamation, Marine Clay, Cone Penetration test, Van shear Test, Undrained Shear strength*

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I. INTRODUCTION

Land reclamation on soft compressible clays for vital facilities requires some form of ground improvement work. The prefabricated vertical drain with preloading method is a popular and well accepted method of soil improvement for compressible soils. At Uran, Navi Mumbai coastal area for the study of marine clay behavior and properties find by Cone Perpetration Test (CPTu) and Field Van Shear Test (FVST).

The use of field instrumentation is essential for assessing the degree of consolidation of the marine clay under the reclaimed fill as this assessment is paramount to ascertain when the surcharge can be removed. Instrumentation monitoring will provide a continuous record of the soft soil behavior under the fill and surcharge load from the point of the initial instrument installation. In coastal land reclamation projects, instruments are installed either off-shore prior to reclamation or on-land after reclamation to the vertical drain installation platform level.

II. METHODOLOGY

2.1 Land reclamation construction site at Navi Mumbai having soft marine clay strata at depth of 6.0 m from mean chart datum (MCD). To improve soil characteristics land reclamation done by Prefabricated vertical drained with preloading method. Before removing of surcharge load it has to be conform that under lying soil strata is reach to desired value of consolidation.
2.2 The test was conducted on top of reclaimed area having surcharge level of 5.5 m over a period of 3 month. Cone penetration test and Field van shear test was carried out to find undrained shear strength from same level.
2.3 The respective test is conducted from top of clay strata, so boring has to be done by Hydraulic boring machine till top of clay.
2.4 Compare both results and discuss which test is best for such type of clay.

III. TESTS AND RESULTS

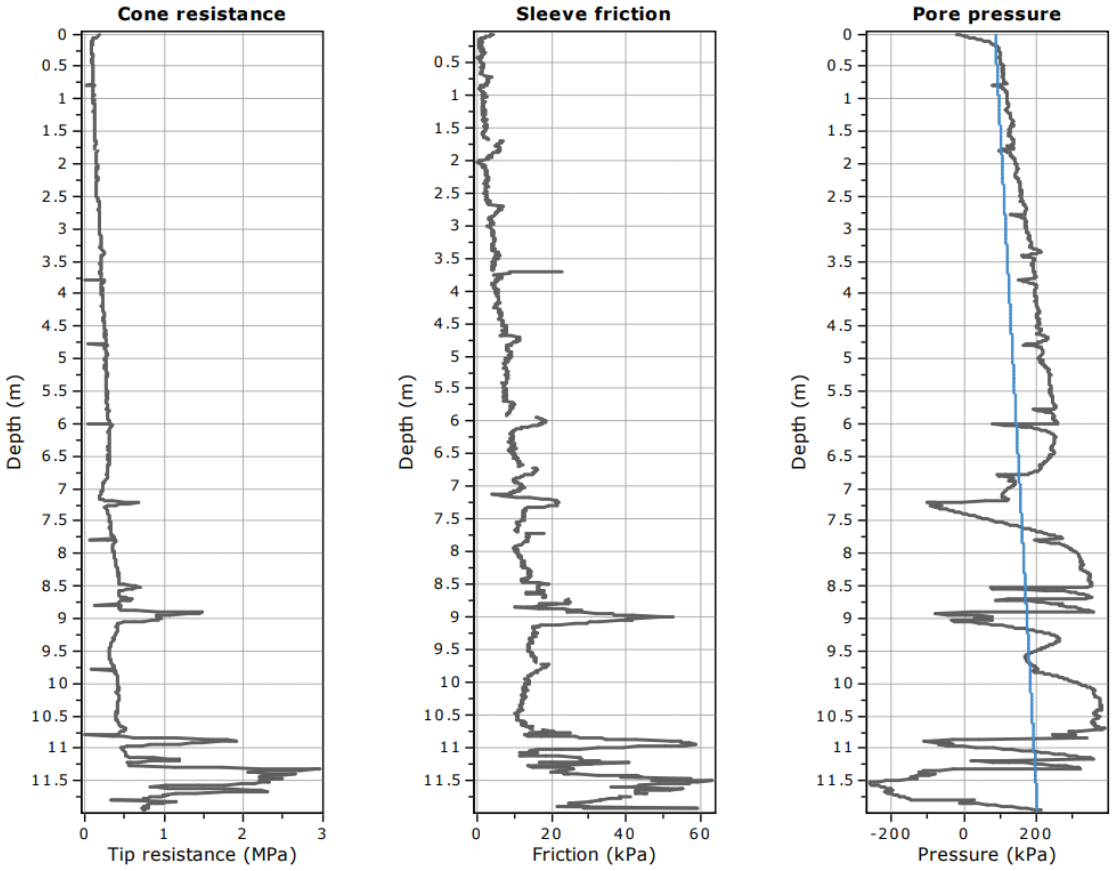
3.1 Cone Penetration Test (CPTu*)*

Ground improvement is carried out to reduce the potential for soft clay to experience large deformations during static or cyclic loading. When saturated clays experience static, cyclic loading from mechanical vibrations or an earthquake, they tend to reduce in volume by means of consolidation settlement. If drainage cannot occur, generated pore pressure reduces after application of load and long term consolidation settlement will takes places which ultimately increased the cost of maintenance. The softened soil deforms under the extant shear stresses causing lateral and vertical movements of structures and sloping ground. The prefabricated vertical drain with preload help to reduce the generated excess pore water pressure by providing drainage path and achieves the consolidation settlement within very small period of time. In CPTu, an electronic steel probe is hydraulically pushed to collect continuous measurement of the resistance of ground with electronic internal sensors. The measurements comprise penetration depth, cone resistance, sleeve friction and pore pressure also evaluate the geostratigraphy, soil types, water table and engineering parameters of the ground.

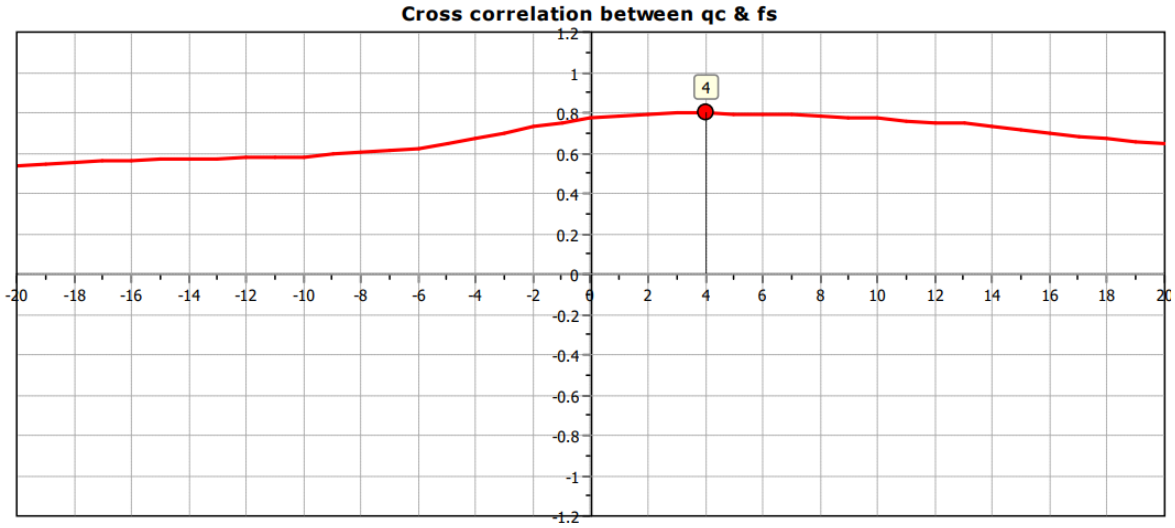
Equipment:-

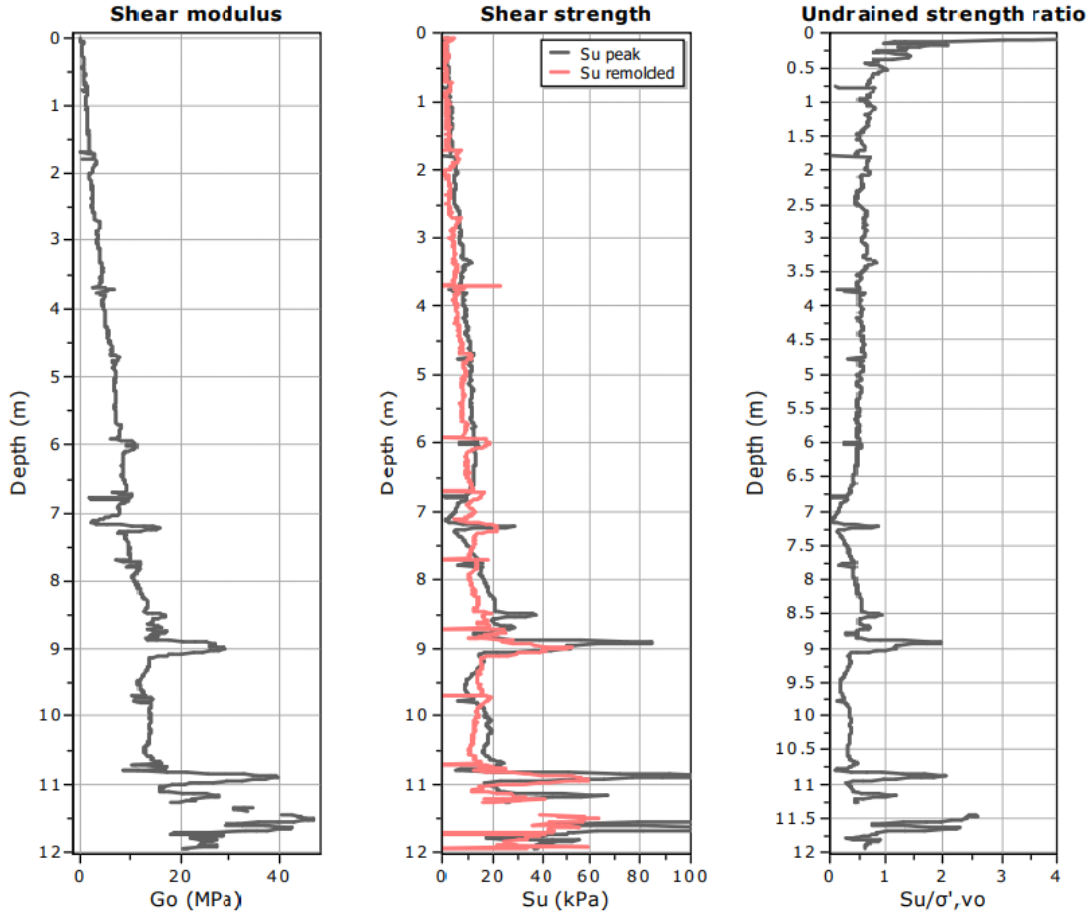
A CPTu system includes the following components:

1. PiezoCone and Pusher
2. Hydraulic pushing system with rods,
3. Cable or transmission device,
4. Depth recorder
5. Data acquisition unit.



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).





Results:

CPTu Borehole	Depth (mcd)	$(t_{50})^{0.5}$	t_{50} (s)	t_{50} (year)	G/S_u	C_h (m^2/s)	C_h (m^2/year)	M (mpa)	K_h (m/s)
A-01	- 6.00	16.8	283	8.98E-006	2190.26	1.36E-005	428	0.20	6.77E-007

3.2 Field Van Shear Test (FVST)

The Vane Shear Test is most appropriate for the determination Shear Strength of Saturated clays, especially of the 'soft' to 'medium' consistency. The test is especially appropriate for determining the shear strength of sensitive soils which are highly susceptible to sampling disturbance.

Equipment required:-

The vane shear test apparatus consists of a four-blade stainless steel vane attached to a steel rod that will be pushed into the ground. The height of vane is usually twice its overall widths and is often equal to 10 cm or 15 cm.

1. Torque wrench.
2. Drive head.
3. Extension rods, usually D20/D22x1000 mm
4. Spanner for extension rod.
5. 37.5, 50, 75, 100 mm diameter Vane

Initial Dail Gauge Reading	0
Max Dial Gauge Reading	148
Displacment in cm	0.1
Proving Ring Divisions	101.0
Proving ring Factor	1.073 Kg
Torque to shear the soil M kg.cm	16.039 Kg-cm
dia. Of vane D (mm)	50

Height of Vane = 2 x dia. Of vane
H = 2 D

S = $\left[\frac{3M}{11D^3}\right] x\ 10^3$

S = Shear Strength in kg/cm^2

S = 3 x 16.039204 / (11 x 50 ^3) x 10 ^3

S = 0.0350 kg/cm^2

Results:

Borehole No.	Depth (mcd)	Initial Dial Gauge readingin Div.	Max. Dial Gauge Reading in Div.	Diff. (FR-IR)	Torque kg.cm	Shear Strength kg/cm^2	Shear Strength kpa
A-01	- 6.00	0	148	148	16.04	0.035	3.499

IV. DISCUSSIONS

From above tests result, the value of undrained shear strength of marine clay is near about same which are obtained from both tests. Clay top get at level of -6.00 mcd (i.e. 11.5 m from top of surcharge). At initial level of marine clay strata undrained shear strength value varies upto 10 Kpa having preloading level 5.5 mcd over period of 3 months.

V. CONCLUSION

From above comparative analysis conclude are as follows,

- Cone penetration test is more convenient than the Field van shear test.
- Results are getting more accurate and precise in CPT
- In CPT, along with Undrained shear strength eighteen different values with graphs are obtained.
- From van shear test, Pore water pressure can not be estimated, but by Dissipation test pore water pressure found in CPT.
- Cost of van shear test is slighty cheaper than the rate of cone penetration test.

Overall from study of results of CPT and Van Shear test, Cone penetration test is more suitable for marine clay strata at Navi Mumbai.

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