Software analysis of Consolidation with using PVD and PHD on Plaxis 2D

Md Shaquib ,Mohsin Sarfaraz
(B.Tech (Civil Engineering) Student, GNIOT Greater Noida,UP, India)
Ms. Sanghati Mutsuddi Asst. Professor:-Civil Department
GNIOT Greater Noida ,UP, India

Correspondence author: sanghati.ce@gniot.net.in

Abstract: "Consolidation is mechanical process by which soil changes volume gradually in response to a change in pressure of soil. This project focused to increase the rate of consolidation by using PVD and optimization of no's of PVD. A particular area has been selected near Yamuna River bank, Delhi-Mumbai highway site passes through Kalindi Kunj. Soil properties has been determined to understand the present condition of soil. To calculate the rate of consolidation we have used a finite element-based software, PLAXIS 2D. Prefabricated vertical drain is in use from past few years, but the optimisation of no's PVDs are still in progress. In this project we have tried to optimize the no's of PVD and PHD used for consolidation.

Keywords: Consolidation, PVD, PHD, Optimize, plaxis,

INTRODUCTION

General: In the process of Consolidation volume of soil decreases and that occurs slowly. In fully saturated soil with low permeability conditions consolidation takes due to partial drainage of pore water". This process continues until the excess pore water pressure caused by the increase in total stress is completely removed. Primary consolidation is the main component of consolidation and can be reasonably. A general theory for consolidation, which incorporates three-dimensional flow, is quite complex and is only used for solving very limited problems in geotechnical engineering. For most practical problem solving, it is sufficient to assume that seepage, deformation and strain in soils only occur in one direction, as one-dimensional consolidation, namely in the vertical direction (one-dimensional consolidation).

Importance of study: Foundations are the most important components of any structures and any damage to either the foundation or the foundation results in catastrophic failure of super structure. Hence, focus should be on providing a strong base to any structure. Bearing capacity and consolidation of soil is a parameter widely used in the design of foundation and the objective of design engineer to provide and proportion a found that keeps the stresses in foundation soil well within the limits of safe bearing capacity. It is well established that safe bearing capacity of soil is affected by various factors such as the depth of Ground water table (GWT), soil properties, layering of soils, size and shape of the foundation, depth of foundation etc. among many other factors.

Problem statement: The present work focuses on numerical analysis using plaxis for evaluation of consolidation rate of soil of ground water situation on ground adjecent to structure. Finite element analysis is carried out considering the soil to satisfy Terzaghi 1D equation criteria. Parametric studies are made design tables and charts are presented to establish the effect of above mentioned factors on consolidation of soil.

Objectives of present study:

1. To increase the rate of consolidation using PVD.
2. To compare the results of evalutaion of soil consolidation from PLAXIS and those from conventional theories.
3. To make the project cost effective.
4. To compare the different soil consolidation using PLAXIS 2D to increase consolidation rate.

Scope of present study:

- The present study is limited to soft soil. Hence only cohesive soil has been considered . Cohesionless soil need to be considered.
- In India most of the places only PVD has been used where as PHD is also a solution of ground improvement by increasing the rate of consolidation .
- Effect of ground water table can be considered.
- Using of Geo-synthetic material for drainage purpose can also be considered.

Materials and methodology:

Materials: The soil was collected from Delhi-Mumbai highway site passes through kalinda kunj.
Methods:

1. Specific gravity by pycnometer method
2. Liquid limit
3. Plastic limit
4. Hydrometer test
5. Standard proctor test

Prefabricated vertical drain (PVD):

PVD is a soil improvement method that accelerates the consolidation process by shortening the drainage path of pore water in soft soil layers, so that water can be dissipated quickly. The use of PVD maximizes the consolidation of the radial direction by placing high-permeability materials in the soil. A clearer explanation can be seen in the drawing of land subsidence with vertical drainage and without using vertical drainage concerning time as follows. In soil improvement with initial loading, the problem that arises is the length of the settlement process. This often occurs in soil layers that are quite deep and have low permeability. To speed up consolidation and save time for subsidence on soft soil, the method used is to create a vertical channel that has high permeability, namely vertical drainage.

Fig: Front view of PVD

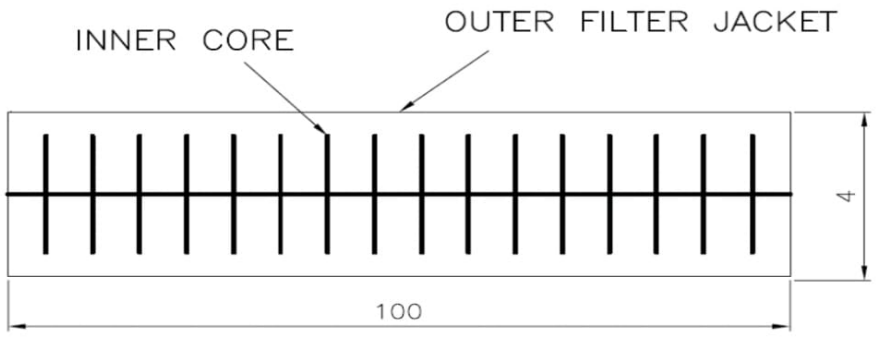


Fig: Dimension of PVD

Figures and tables:

In this project soil was collected from Delhi-Mumbai highway site passes through kalinda kunj. These were obtained and tested to evalutae their basic characteristics, compaction and direct shear test. The soil sample, thus obtained are oven dried ,pulverized and subjected to different laboratory test.

Table1: Properties of soil

S.No.	Parameter	Soil
1	In situ density (kN/m^3)	14.48
2	In situ moisture content (%)	30.80
3	Specific gravity	2.40
4	Grane size distribution	Medium graded soil
5	Liquid limit (%) Plastic limit (%) Plasticity index (%)	55.80 33.415 20.415
6	Soil classification	CH
7	Consolidation characteristics maximum dry density (kN/m^3)	

	Optimum moisture content (%)	15.31 20.5
8	Cohesion(kN/m^3)	33.30
9	Angle of internal friction	0
10	Modulus of elasticity(kN/m^2)	20000
11	Poisson`s ratio	0.3

Table2: Comparison of the derivation analysis of the Terzaghi method PLAXIS 2D

Index	Analysis	Non effect smear zone	PVD+Effect smear
Total drop(mm)	98.45	102.6	100.3
Decline prediction Difference (mm)	0.5	1.4	1.50
Precentage Difference Decrease (%)	0.45	1.43	1.58

Table3: comparison of minimum pore water pressure that occurs in the final consolidation phase

Index	Plaxis 2D	
	PVD +Effect smear	Non PVD
Minimum pore water pressure (kN/m^2)	-0.0003340	-0.00120
Difference in pore water pressure (kN/m^2)		0.000703
Precentage difference minimum pore water pressure		62.20

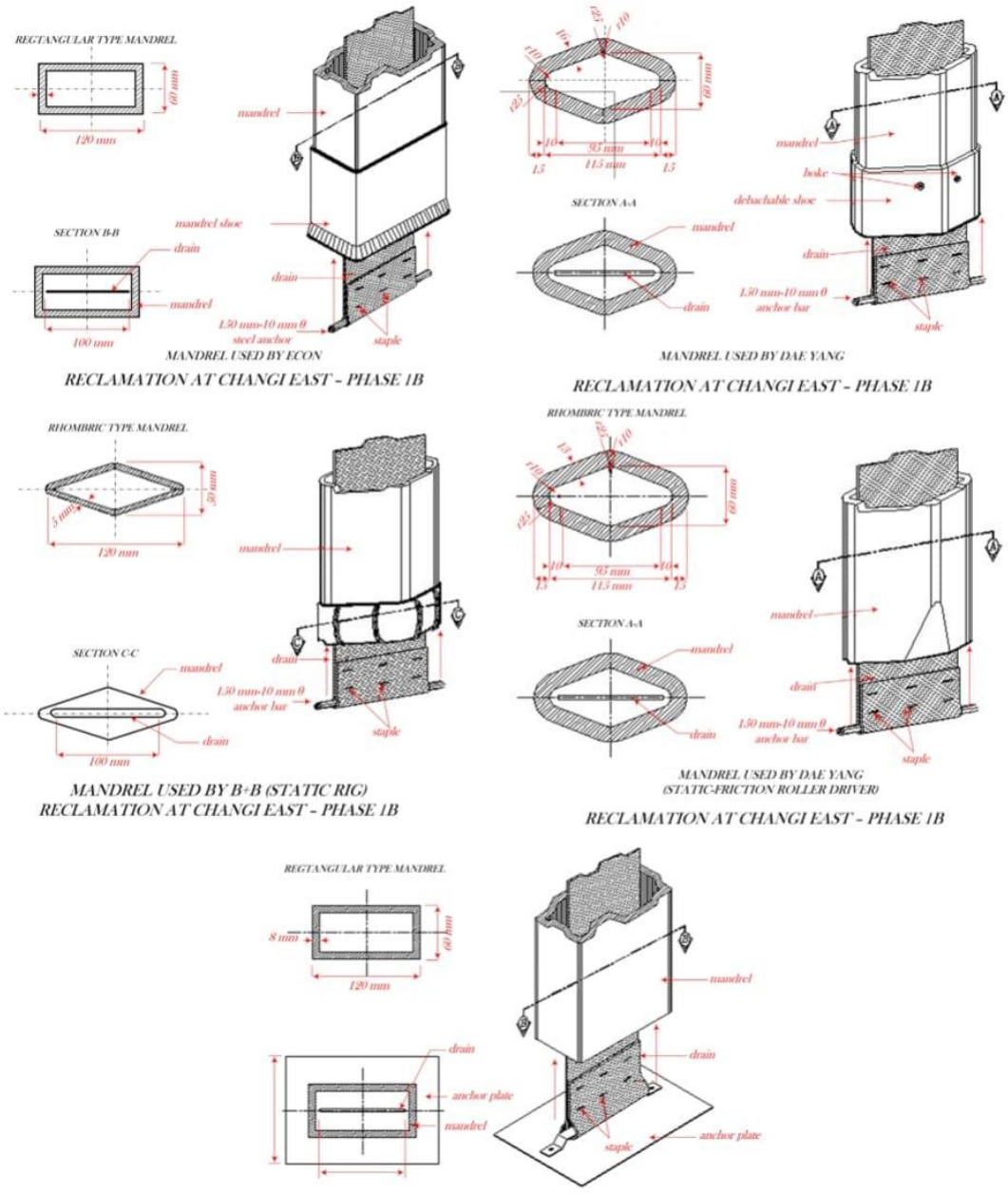


Fig: Installation of PVD

Type	Core	Filter	Dimension(mm)
Kjellmann	Paper	Paper	100*3
PVC	PVC	PVC	100*2
Geodrain	PE	Cellulose	95*2
Colbond	Polyster	Polypropyline	100*6

Fig: Types & Installation

Prefabricated Horizontal Drain (PHD)-

Prefabricated Horizontal Drain (PHD) is a composite tape-shaped material consisting of a core and a jacket that are installed horizontally with a certain installation method that functions as a drain**.**

Fig: PHD (Prefabricated Horizontal Drain)

Fig: Installation Of PHD

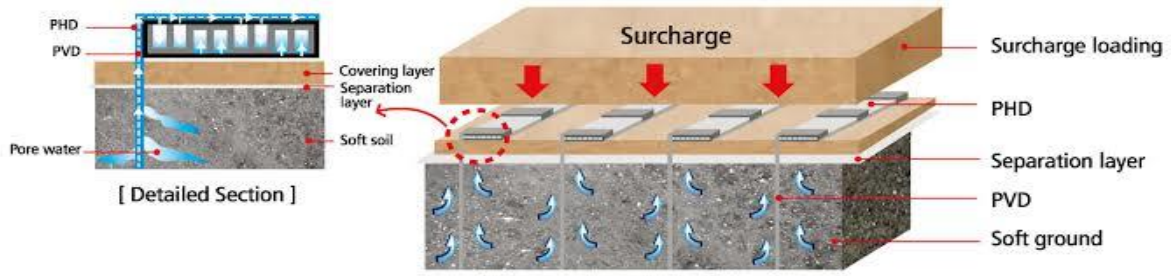
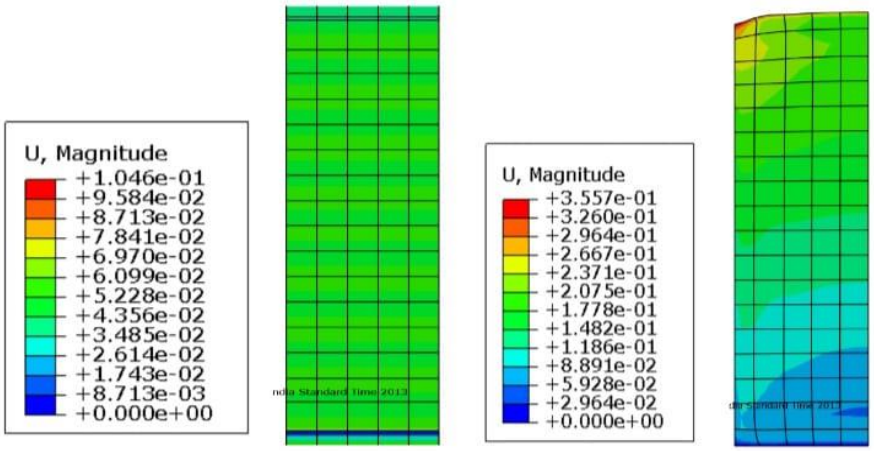
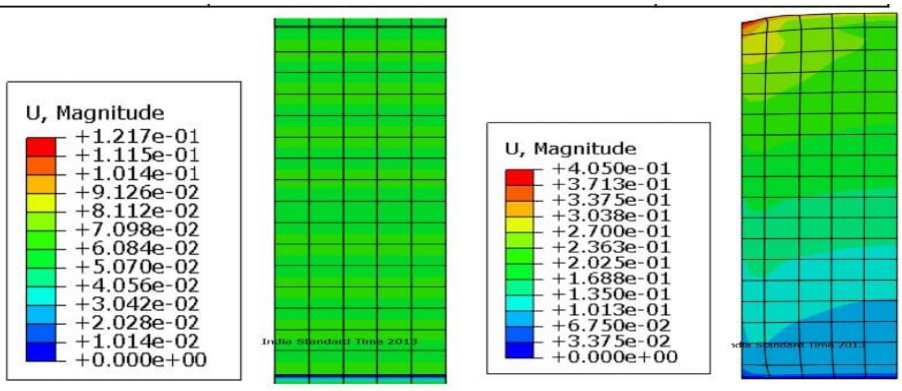


Fig: Mechanism of soft ground improvement using PVD & PHD

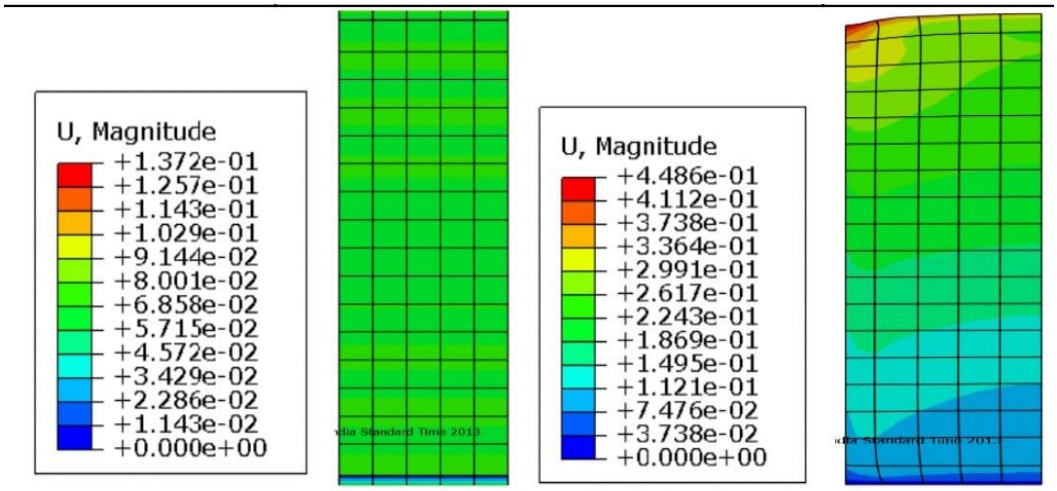
PLAXIS 2D- PLAXIS 2D is a Finite Elements software package for the two-dimensional analysis of deformation and stability in geotechnical engineering and rock mechanics. Design of geotechnical structures such as excavations, dams, embankments and tunnels. PLAXIS 2D calculates deformations, soil stresses, water flow and pressures, structural forces and even thermal flow for both 2D plane strain and axisymmetric problems.Many different soil models are included in order to take into account specific behaviour of for instance clay, sand and rock as well as the specific behaviour under loading, unloading and reloading of soil.PLAXIS 2D provides a CAD-like environment for fast and efficient model creation, allowing user to dedicate more time to interpret the results.



Without PVD	Settlement at time t=1s	With PVD



Without PVD	Settlement at time t=30s	With PVD



Without PVD	Settlement at time t=60s	With PVD

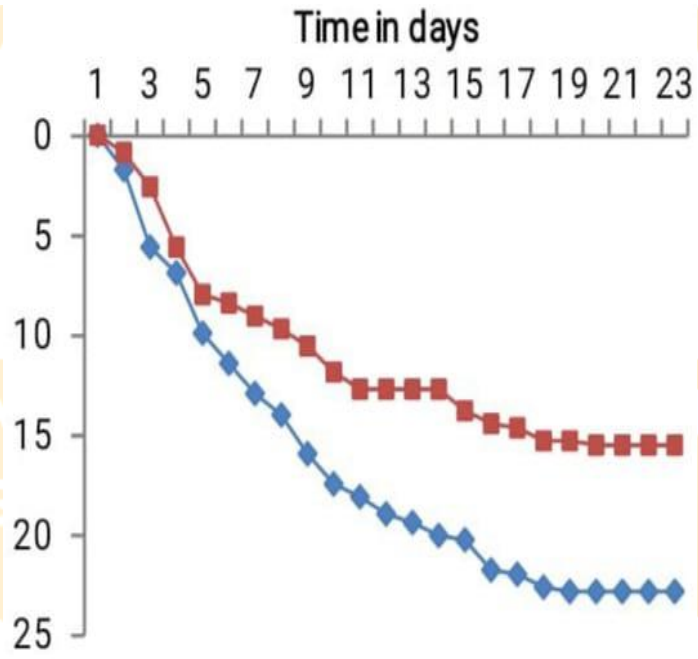


Fig : Surface settlement in large scale consolidometer test

(with PVD and without PVD)

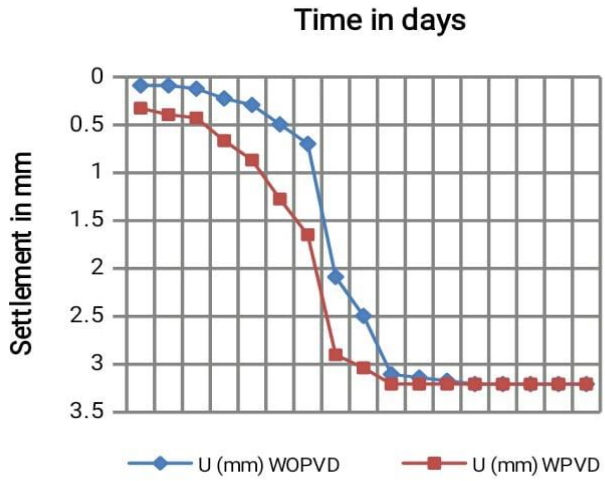


Fig: Comparative surface settlement of soil with & without PVD

Conclusion:

1. PLAXIS has been used to estimate the bearing capacity of soil with Mohr-Coulomb's failure idealization with considerable success.

2. Medium mesh generation is found to provide reasonably accurate results satisfying the desired convergence criteria.

3. The values of ultimate bearing capacity achieved by test and from terzaghi's equation are almost near.

4. For varying D/B ratio gives good ultimate bearing capacity. That is as the D/B ratio increases the bearing capacity also increases.

5. As the D/B ratio increases the settlement will be decreases.

6. The load displcement a curves show from plaxis has reduces displacement as the D/B ratio increases.

9. The plaxis software is useful for further work.

Scope for futurev work:

1. The present study is limited to 2D plain strain idealization; it can be extended to 3D solution.

2. Study is restricted to homogeneous isotropic soil medium; other plastic models can be considered.

3. Work can be extended to layered soils, soil with irregularities.

4. Effect of ground water table can be considered.

5. Other shape of foundations can be considered.

6. Axisymmetry problems can be analyzed using PLAXIS.

7. Other than Mohr-Coulomb model, advanced soil models such as Hardening Soil model, Soft Soil Creep model and user defined models can be used.

Refrences:

[1] S. K. Prasad (2013) “soil bearing capacity on slope”.

[2] IS 2720(part 3/sec.1) 1980 Methods of test for soil, part 3, “Determination of specific gravity section 1 fine grained soils” UDC 624.131.431.1, BIS, manik bhavan,9 bahadur shah zafar marg, New Delhi 110002.

[3] IS 2720(part 4) 1985 Methods of test for soil, part 4, “Determination of grain size analysis” UDC 624.131.431.6, BIS, manik bhavan,9 bahadur shah zafar marg, New Delhi 110002.

[4] IS 2720(part 5) 1985 Methods of test for soil, part 5, “Determination of liquid and plastic limit” UDC 624.131.532.3, BIS, manik bhavan,9 bahadur shah zafar marg, New Delhi 110002.

[5] IS 2720(part 7) 1980 Methods of test for soil, part 7, “Determination of water content dry density relation using light compaction” UDC 624.131.378 BIS, manik bhavan,9 bahadur shah zafar marg, New Delhi 110002.

[6] IS 2720(part 13) 1986 Methods of test for soil, part 13, “Determination of direct shear test” UDC 624.131.439.5, BIS, manik bhavan,9 bahadur shah zafar marg, New Delhi 110002