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Efficiency of Vacuum Preloading on Consolidation Behaviour of Cochin Marine Clay

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Abstract

Greater Cochin area is rich in deposits of marine clay which has been identified as a problematic soil which undergoes long term settlement due to consolidation. An alternative method of consolidation by the application of vacuum pressure can be used to reduce the risks of staged construction of embankments and the consumption of large amount of filling materials. Consolidation tests were carried out on samples prepared in the consolidation cell under three different magnitudes of vacuum pressure, with and without the use of PVDs. The results obtained were then compared with the similar magnitudes of surcharge preloading. Tests were also conducted in larger specimens of soil samples, the obtained results of which were comparable with that of the oedometer samples. The coefficient of consolidation was found to increase by 65 % and the time for 90 % of consolidation has reduced by 70 %, with the use of vacuum method of consolidation.

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1. Introduction

The compression of saturated soil due to the expulsion of water from the voids under steady static pressure results in the long term settlement of structures overlying it. The major problem associated with soft clays such as marine clay is the consolidation settlement. Many cases of consolidation settlement of structures constructed over low lying areas have been reported in the Greater Cochin area. One of the most popular examples is that of the settlement problems encountered by the International Container Transshipment Terminal (ICTT) at Vallarpadam, for the past few years. Vacuum preloading can be applied when the conventional preloading is not feasible as the marine clay deposits are found to be too weak to take even a small height of embankment. The vacuum pump creates negative pressure in the drainage path. Negative pore water pressure is generated with the application of negative pressure, which results in increase in effective stress in the soil which ultimately leads to an accelerated consolidation. A nominal vacuum load of 80 kPa is normally used in design although a higher vacuum pressure of up to 90 kPa may be achieved sometimes.

Nomenclature

C_v	Coefficient of vertical consolidation
C_h	Coefficient of radial consolidation
t_{90}	Time for 90 % of consolidation
PVD	Prefabricated Vertical Drain

2. Materials Used

2.1. Marine Clay

Disturbed samples of marine clay were collected from Panampilly Nagar, Cochin, Kerala. The samples were taken from a depth of 5m from the ground level and it was greyish black in colour.

Table 1. Index Properties

Properties	Values
Specific Gravity	2.63
Liquid Limit (w_l) %	69
Plastic Limit (w_p) %	37
Plasticity Index (I_p) %	32
Shrinkage Limit (w_s) %	12
Maximum Dry Density (kN/m^3)	13.7
Optimum Moisture Content, %	27
Percentage of Clay, %	28
Percentage of Silt, %	62.64
Percentage of Sand, %	9.35
Soil Classification	MH

2.2. Prefabricated Vertical Drain

Prefabricated vertical drain with the following properties was purchased from Techfab India Industries Ltd., Mumbai.

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