PRE-FABRICATED VERTICAL DRAINAGE SYSTEM FOR GROUND IMPROVEMENT

INTRODUCTION

The soil condition and its behavior differ from region to region in our country. The northern part of India in general has alluvial silt, whereas the southern part of country particularly, in the coastal areas deep deposits of soft silty clays and soft marine clays exist. In areas with deep soft clay strata construction of new facilities is fraught with many problems. Soft silty clay and soft marine clay soils are characterised by low shear strength, high compressibility and low bearing capacity. During consolidation of soft clays under loading, large ground settlements take place over long periods of time owing to low permeability of clays. Such large ground settlement may be detrimental to structures constructed.
In such situations sub-soil needs strengthening and therefore special measures to improve or stabilize soft soil should be taken before the construction activity over such clays.

To shorten the consolidation time, consolidation process is accelerated by means of artificial drainage. Prefabricated vertical drains are artificially created drainage paths which can reduce settlements from years to months. Due to this reason, most settlement occurs during the construction phase itself, and post-construction settlements are reduced to a minimum.

SOFT SOIL CONSOLIDATION METHODS

For constructing any structure over soft compressible clays, it is therefore necessary to accelerate the process of soft clay consolidation thereby increasing its bearing capacity and to reduce post-construction settlement. To accelerate soil consolidation the following methods are available.

- *Pre-loading*
- *Stage Construction*
- *Sand Drains*
- *Pre-fabricated Vertical Drains (PVD)*
- *Vacuum Assisted Consolidation*

The choice of the method adopted depends upon cost, the importance of the structure, applied loading, site conditions and time period available for construction etc. Therefore, it is important to select the appropriate method for a given situation. Today the most cost-effective way to improve the soft clays is by installing PVD and adopting pre-loading in stages. Where time for consolidation is really short or

Availability of pre-load material has limitations, PVD with vacuum consolidation is adopted.

PRE-FABRICATED VERTICAL DRAIN (PVD)

Pre-fabricated Vertical Drain (PVD) is a manufactured product consisting of a synthetic filter jacket surrounding a plastic core. Because of its shape, it is also known as Band drain, Wick drain, etc. It is a band-shaped drain, having 100mm width and 3 to 5mm thickness (Fig-1). The inner core is embossed with alternating rows of high and low studs or grooves and is wrapped with a filter fabric. The core is designed in such a way as to allow free flow of water

along the core. The filter fabric made usually with needle punched/thermally bonded geotextile has designed permeability and apparent opening size to allow maximum flow at the same time preventing clogging of the filter due to fine clay and silt particles transported with the pore water. The PVD is supplied in rolls 200-300m long and is inserted into the ground to required depths using special drain stitcher rigs. Generally, installation takes place up to the full depth of the compressible soils. PVD has now replaced conventional sand drains for soil consolidation in most cases due to easy & speedy installation and unlike sand drains, they are flexible to accommodate settlement and lateral movements which take place in soft clay during loading and consolidation phases.

Due to its speed, cost and proven ability to accelerate soft soil consolidation, it is the most common method adopted for soft soil consolidation these days. The PVD is designed with minimum area of cross section to minimize soil disturbance during installation at the same time to ensure that adequate discharge capacities are maintained at all times, even under the most severe conditions.

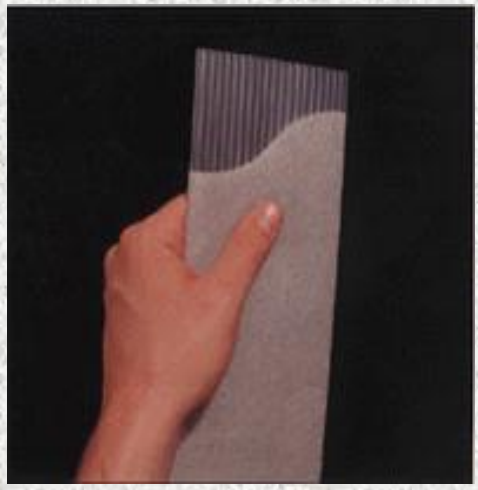

Fig. 1 Typical Prefabricated Vertical Drain (PVD)

PVD INSTALLATION

PVD vertical drainage system is installed in order to accelerate the consolidation process by helping to discharge excess pore pressure in the soft sub soil quickly.

The installation of PVD is usually done with the aid of special PVD stitcher. The machinery consists of heavy duty excavator and a stitcher attachment (Fig.2).

The installation is done by penetrating the soft soil with a hollow steel mandrel which contains the PVD and a drain shoe attached at the bottom of the mandrel. The cross section of the mandrel is kept small to minimize soil disturbance during installation. The drain shoe anchors the drain at the depth required and also prevents soft clay intrusion into the hollow mandrel during installation.

Fig. 2 Typical PVD Installation stitcher

DRAINAGE FILTER

A drainage filter layer is provided directly above the installed PVD for easy flow of pore water expelled from the PVD during the clay consolidation. Clean sand or stone chips (small aggregate) or any other permeable material may be used for this purpose.

GEOTEXTILE SEPARATOR

Non-Woven/Woven geotextile either PP or PE is usually used as a separator between the drainage filter and soil fill above. In the case of embankment construction over soft clays, woven geotextile is used as a separator as well as a basal reinforcement. The geotextile panels should be either stitched together or suitably lapped to ensure adequate strength.

VACUUM CONSOLIDATION

In this recent development, PVD together with a vacuum is created below ground level is used to further accelerate the consolidation process. Due to its cost, this method is adopted only in special cases where preloading is expensive or time available for consolidation is very short. Special methods are usually required to avoid leakage of created vacuum. Good knowledge of sub-soil conditions are also necessary before adopting this method.

CONCLUSION

There are several methods available for improving the ground to support structures being constructed over soft clays. However, the choice of method for ground improvement will finally depend on cost, availability of materials and machinery and time for implementation.

Prefabricated Vertical Drains have gained much popularity in accelerating the consolidation of soft soils due to its speed of installation, ready availability, quality control and its lower cost compared to other methods for ground improvement. PVD and pre-load method is perhaps the best choice to improve soft sub soils for embankment construction and land reclamation projects as pre-loading forms a part of such construction.

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