Case Study

GEO-ENVIRO ENGINEERS

GROUND IMPROVEMENT FOR HIGH EMBANKMENTS OVER VERY SOFT CLAY

INTRODUCTION

High level highway embankments up to 6m high had to be constructed for the Calicut Bypass Phase III project in the state of Kerala in 2003. Of the total 6 km length of high embankment to be constructed, approximately 3 km length had to be constructed over marshy areas. The depth of very soft clay varied from 2m to 9m. There was concern regarding stability during construction as well as future consolidation settlement due to the very soft clay.

The initial design for embankment construction envisaged removal and disposal of the very soft and weak top clay layers and construction of the embankment in several stages over a very long period. Conventional ground improvement methods such as sand or gravel drains were found too expensive. The volume of very soft clay to be removed was difficult to determine with any accuracy and its disposal was an environmental problem. The long period for construction was unacceptable and a cheaper but effective ground improvement alternative had to be found. Finally it was decided to improve the soft clay in-situ with the use of Prefabricated Vertical Drains or PVD.

SUB SOIL CONDITION

Soil investigation confirmed very soft clay up to depth of 9m from existing ground level. Firm/stiff clay existed below the soft clay. Laboratory tests on undisturbed soil samples confirmed that the very soft silty clay was fully saturated, highly compressible (CH) with very low shear strength.

EMBAANKMENT CONSTRUCTION

After installation of PVD, embankment construction was carried out up to 9m high in three stages with waiting period between filling stages to allow gain in strength of the consolidating soft clay. A woven geotextile was provided as basal reinforcement cum separator to avoid instability in soft clay as no removal of soft clay was carried out.

PRE-FABRICATED VERTICAL DRAIN (PVD)

PVD was installed at design spacing of 1.3m c/c triangular to achieve sufficient consolidation within a period of 2-3 months between embankment stages.

The PVD used was 100mm wide and 4mm thick with a non-woven filter jacket and a polypropylene drainage core at the centre, supplied in rolls 200m in length. The PVD was installed using a drain stitcher.

A drainage filter blanket consisting of gravel was spread over the installed PVD to freely drain the expelled pore water from the PVD during clay consolidation.

SOIL INSTRUMENTATION

Platform settlement gauges and Casagrande Piezometers were installed at selected locations to monitor ground settlement and changes in pore water pressure during the embankment construction and clay consolidation. Stages of embankment construction were regulated as per design and also after sufficient clay consolidation has taken place under each stage of construction to ensure adequate embankment stability under all stages of construction.

DISCUSSION OF RESULTS

Ground settlement and pore pressures dissipation during embankment construction and for a period of more than six months after completion were monitored. The ground settlement due to clay consolidation was lower than estimated theoretically. Maximum settlement recorded was 725 mm.

Pore pressure measurements showed considerable variations. However they were helpful to ensure that excess pore pressures do not affect embankment stability adversely.

CONCLUSIONS

High embankments for a major highway project over very soft clay deposits were successfully constructed using prefabricated vertical drains or PVD. Together with woven geotextile fabric as basal reinforcement the embankment construction was carried out in three stages without having to remove any soft clay. Considerable savings in time and cost were achieved as a result of the adopted method.

(Work carried out under Bharat Geosystems Pvt Ltd)

Reference: Radhakrishnan.R (2006) Ground improvement for Embankments over Soft Clay, IGC -2006, Chennai PP.631 -633.

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