A REVIEW ON "CASE STUDY OF GROUND IMPROVEMENT OF SOFT SOIL"

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ABSTRACT

The paper present a case study of ground improvement of soft soil using PVD's and a geotextile for the construction of bridge approach for Amona-Khandola bridge in Goa, India

I. INTRODUCTION

The Amona-Khandola Bridge was 510 m long two lane bridge across river Mandovi in Goa with approach of 300 m on Khandola side and 1500 m on Amona side. The height of embankment near abutment on Amona side was about 10 m. During the soil investigation for the project, it was revealed that there exists a very soft compressible clay layer of about 5 m in depth on amona side for a stretch of about 200 m. Standard penetration tests of these soil samples indicated the "N" value of this stratum was zero. Further laboratory tests conducted on the undistrubed samples showed that cohesion(cu) was in the range from 0.16 to 0.64 kg per sq.m. Whereas (phi) observed was zero.

II. NECESSITY

Because of very poor sub soil strata, its high compressibility and heavy load due to high embankment, there was possibility of shear failure of subsoil deposit and problem of embankment settlement for longer period. The stability analysis also indicated that the factor of safety was less than 1.4. Hence the improvement of ground was necessary before taking up embankment works. As such, /Ground improvement using band drain and Geo-textile was adopted. This bridge will act as a major link between Bicholim and Tiswadi taluka reducing the distance by almost 25 kms. Presently three ferries are operating for transportation involving huge expenditure and hence there was urgency to complete the bridge project in time bound manner.

This type of soil was characterized by soft structure and big pore capacity, normally filled with water (pore water). When heavy load of embankment was placed on such soft compressible saturated clay, settlements will occur due to compressibility of soil for long period depending upon the rate of discharge of pore water.

III. BAND DRAINS

The vertical drains/ Band drains system enable pore water to flow and escape freely due to development of smooth flow path. Thereby reduction in pore pressure and increase in settlement rate. Thus enabling quick construction of embankment without risk of bearing capacity failure and long term settlement problems.

3.1 Material

Band drains used were of a pre-fabricated strip, which was very suitable for water transportation. The flexible core was manufactured of a high quality polypropylene having grooves on the both sides through which water can flow unimpeded. The core was wrapped in a strong and durable Geo-textile filter fabric with excellent filtration properties, allowing free access of pore water in to the drains. At the same, the filter fabric prevents piping of fines from adjacent soils thus preventing the clogging of drain. The physical and mechanical properties of the Band drain used for the project.

3.2 Design Aspects

The drain distance was calculated by adopting the Barron formula.

Ch=D2/8t [in D/d-3/4+1/4(d/D2] in (I-U)

where Ch = Consolidation Coefficient

For horizontal flow (m2 /s)

d = drain diameter (m)

D = diameter of the drain's influence zone(m) and

U = average degree of Consolidation at horizontal flow.

The drains can be installed in square or triangular pattern. The drain installation in triangular pattern was adopted.

Consolidation settlement for approach road on Amona side was worked out as per WAS 8009- Part I as 618.41 mm using Boussinesq pressure distribution under the maximum embankment height near abutment with bulk density of embankment fill as 1.90 g/cc, and consolidation time was worked out as 3.5 months assuring Cv=2.5 m2 / year for soft soil for 80% consolidation.

IV. GEOTEXTILES

While constructing high embankment on such soft compressible saturated soils, there was often a risk of bearing capacity failure because of increased shear stresses than permissible before consolidation of subsoil, due to rapid construction. In order to overcome the said problem Geo-textile layer having high tensile strength was placed at the interface of subsoil and embankment fill material. The Geotextile placed on soils acts as reinforcement due to its high frictional properties and its ability to absorb the tensile forces.

4.1 Material

Geo-textile used was high quality woven fabric made from polyester yarns in longitudinal direction and polyami in the transverse direction. The geo textile used was having properties.

V. STAGES OF CONSTRUCTION

5.1 1st Stage

5.1.1 Laying of 800 mm thick layer of earth over existing Ground level.

The nature of ground was marshy and partially gets flooded during high tide, hence for the ease of construction and movement of the machinery and equipments a layer of 800 mm thick earth was laid over the existing ground.

5.1.2 Installation of Band drains

The installation of Band drain was done with the help of drain sticher attached to poclain machine. A rectangular steel plate was used to install prefab drain in order to prevent damage and smearing of the drain. /The tip of a roll of Bank drain fitted to the side of the sticher, was guided into the sticher runs over a transportation roll and was laid down into the mandrel. At the bottom of mandrel, the Band drain was provided with anchor plate, which was pulled against the bottom of the mandrel.

The mandrel was then pushed into the soil with power. Considering the soft compressible stratum in the range of 0 to 5 m, it was proposed to install the band drains up to 6m depth. As soon as the required depth of 6m was reached it was pulled back immediately. Because of the cohesive nature of the soil, the anchor plate to which the Band drain was attached remained in the soil. As soon as the bottom of the mandrel was pulled up, the Band drain was cut off, after which another anchor plate was fitted and sticher was moved to the next location and the installation process was continued. Total 580000 no's, of Bank drains have been installed.

5.1.3 Laying of 200 mm thick layer of sand blanket.

200 mm thick sand layer was laid over the ground after installation of Band drains and hand compacted and given a gradual slope towards the toe. This sand blanket acts as drain path for the pore water squeezed out through band drains due to surcharge and was taken and collected in the toe drains provided on the both sides filled with boulders/pebbles.

5.1.4 Laying of Geo-textile over sand blanket

The Geo-textile was laid over the sand blanket. Wrap back length of 3.30 m was provided on the both sides to achieve the required anchorage capacity. The overlap of 500 mm was kept in both the directions. Sand bags were placed on the both ends to ensure the exact positioning of the Geo-textile. Geo-textile was then stretched and anchored at both the ends with the help of 1.0 m long anchor rods of 16 mm dia placed at 1.0 m c/c. Construction of embankment over the Geo textile was taken up in layers after removal of the anchor rods.

5.1.5 Installation of monitoring instruments

1) Settlement gauges: Settlement gauges were then installed at requisite locations for monitoring the settlements as per guidelines given in IRC-75. The stand pipe was protected from surrounding soil by PVC pipe casing, Proper care was taken to protect settlement gauges installed during embankment construction and its compaction,
2) Piezometers: Piezometers were used to measure fluid pressure in the pores of saturated soils (pore pressure). The knowledge of the pore pressure is very useful in controlling the rate of construction and in analysis of stability of embankment and its settlement. Casagrade porous tube piezometers were installed for monitoring of pore pressure. The piezomenters were installed in bore holes. As the pore pressure increases or decreases the water level inside the stand pipe rises of falls, the height of water above filter tip was equal to the pore pressure. The readings of water level (pore pressure) in the piezometer were taken with the help of electronic water level indicator.

5.1.6 1st stage construction of embankment up to 4.0 m height.

1st stage construction of embankment up to 4.0 height was taken up as per MORTH specification. Temporary Surcharge was also simultaneously constructed along with embankment construction to prevent slope failure till the subsoil attains the requisite bearing capacity after consolidation.

5.1.7 Monitoring of settlement and pore-pressure

After completion of 1st stage construction of embankment with Temp. Surcharge up to 4.0 m height the day to day readings of settlement and pore pressure were taken. Monitoring of these settlement and pore pressure readings was done till the desired consolidation settlement was achieved and settlement and pore pressure reading were stabilized.

5.2. 2nd stage

Removed of temp Surcharge and 2nd stage construction of embankment up to final formation.

After confirming that the desired consolidation settlement was achieved and settlement readings and pore pressure reading were stabilized 2nd stage of construction of embankment up to the final formation was taken up. The material used for temp. Surcharge during 1st stage of construction was removed and utilized for embankment work of 2nd stage of construction to achieve economy.

VI. CONCLUSION

The desired consolidation settlement was achieved within a period of 100 days by adopting the technique of Band drains and Geotextile which otherwise could have taken about 550 days or more considering the subsoil properties.

Thus it can be concluded that the rapid construction of high embankments on soft compressible saturated soils is possible by using Bank drains and Geo textile technique without a risk of bearing capacity failure during construction stage and problems of settlement of embankments for longer period.

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