Embankments

Geotextile Encased Columns

Ringtrac® Geotextile Encased Columns supporting geogrid reinforced landscape embankments;
Bastions Vijfwal Houten in The Netherlands

Introduction

In the South part of Houten in the Netherlands, landscape embankments (Bastions) were placed almost at the end of the housing projects. They were planned as a connection between the residential area and the natural landscape around. The landscape hills (Bastion West and East) had to be built with cohesive soils which occurred in the project areas. For these embankments on extremely soft soil, settlement calculations were performed and settlements of 1.6 m to 1.9 m for Bastion West and 0.5 m to 0.8 m for Bastion East were expected to occur. This created a problem because of the extended consolidation time estimated. In addition the considerable settlements endangered an adjacent brick wall founded on concrete piles to potentially collapse. One other concern was the global stability of the embankments especially due to the excavation of a dewatering canal around the Bastions at the toe of the embankment. Several options for the construction of the Bastions were analysed, however the use of Geosynthetic Encased Columns (GEC) was found to be the best solution with regard to the reduction of the settlements as well as to the global stability of the embankments.

Furthermore, the total construction period was shortened because 80% of the consolidation took place during the construction work.

Design

The main idea of the GEC-System is to transfer the embankment load through the soft soil to a firm stratum. Thereby, the embankment load is borne mainly by the encased columns. However, the surrounding soft soil provides lateral support to the columns and bears a minor part of the vertical surcharge. The vertical deformations as well as the load distribution between the columns and the soft soil are defined by the tensile strength and the stiffness of the encasement. Since the soft soil is involved in the transfer of vertical loads, the drainage function of the GECs, acting as vertical drains, is also important to reduce the consolidation time of the system.
A design method which allows an estimation of settlements, an analysis of the required radial tensile strength of the encasement and an analysis of the distribution of vertical stress between the columns and the soft soil was presented by Raithel (1999).

The solutions shown in table 1 were determined as the most suitable ones. Comparing the design of the Bastions it must be taken into account that the allowed settlement at Bastion West was considerably larger.

Finally, 780 columns encased with two different types of radial woven geotextiles made of high modulus Polyvinylalcohol (PVA) were planned below both Bastions.

Apart from the estimation of settlements and the dimensioning of the encasement, the global stability of the Bastions was analysed according to Raithel’s method. To achieve a sufficient global stability it was necessary to install a basal geosynthetic reinforcement layer above the columns.

For both embankments a geotextile made of Polyester (PET) with a short term tensile strength of 500 kN/m was incorporated to achieve the global stability requirements. Additionally, this reinforcement layer serves to equalize settlements, to bridge the soft soil between the columns and to control spreading forces. Beside the global stability of the Bastion embankments single slopes inside the structure were analysed. Since local cohesive soils were used as fill material, some of the steeper slopes required additional support. In all these sections geogrids made of PET with an ultimate tensile strength of 35 kN/m were used to stabilize the slopes.

Apart from the estimation of settlements and the dimensioning of the encasement, the global stability of the Bastions was analysed according to Raithel’s method. To achieve a sufficient global stability it was necessary to install a basal geosynthetic reinforcement layer above the columns.

For both embankments a geotextile made of Polyester (PET) with a short term tensile strength of 500 kN/m was incorporated to achieve the global stability requirements. Additionally, this reinforcement layer serves to equalize settlements, to bridge the soft soil between the columns and to control spreading forces. Beside the global stability of the Bastion embankments single slopes inside the structure were analysed. Since local cohesive soils were used as fill material, some of the steeper slopes required additional support. In all these sections geogrids made of PET with an ultimate tensile strength of 35 kN/m were used to stabilize the slopes.

**Construction**

The construction works at the Bastions in Houten was divided between two contractors. The GECs were carried out by the Royal BAM Group.

The construction works started with the installation of a working platform with a 1.0 m thick sand layer. From this working platform the GECs were installed, as shown in figure 3 and 4. This method used a displacement pipe with a diameter of 0.8 m. After this the geotextile encasement, type Ringtrac, was installed inside and filled with sand. As the displacement pipe was pulled out with the flaps open, the column fill was compacted by optimised vibration. The Royal BAM Group operated at both Bastions with the same equipment changing only the length of the steel pipe. Using this equipment up to 40 GECs per day were installed. The result of a load test at Bastion-East compared to the estimated settlement behaviour is shown in figure 5. After the foundation work was finished the contractor van Wyk progressed with the construction. Since all GECs were installed from the same level the length of some columns had to be adjusted.
These columns were uncovered and shortened according to the final design. Furthermore, the canals around the Bastions were excavated. After the ground surface was shaped the horizontal geotextile, type Stabilenka®, was installed. Finally the Bastion embankments were built on the prepared platform. After a period of consolidation of two months the works were planned to progress with the construction of the roads and facilities at the Bastions.
Conclusion

The use of this foundation system seems to be suitable particularly if the subsoil in place is too weak (cu < 15 kN/m²) to be treated with regular stone or gravel columns and the structure does not require completely stiff and settlement-free pile elements. The GECs are an appropriate supplement to conventional foundations systems.

Referenze

HUESKER Synthetic GmbH (1997-2005), Ringtrac® PM-Series, Data sheets and parameters, Gescher.
Van Impe W.F. (1989), Soil improvement techniques and their evolution, Balkema, Rotterdam, Netherlands, pp.63-66