Geosynthetics: Applications, Design and Construction, De Groot, Den Hoedt & Termaat (eds)
 ISBN 90 5410 836 3

Embankment foundation on geotextile-coated sand columns in soft ground

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ABSTRACT: This contribution reports on the technical experiences with geotextile-coated sand columns used in the foundation of an approximately 6m high railway embankment based on a soft ground of clay-peat layer up to 7m. The sand columns (1.5m in diameter) have been coated with a sewn geotextile composite of polyester threads and a filter cloth. The bearing behaviour of the columns is influenced by the mobilized soil reaction in the soft layers in combination with the occurring ring tensile forces in the geotextile. Details on the execution of the foundation are given and measuring results concerning strain, forces and deformations in the geotextiles and foundation elements are presented.

1. INTRODUCTION

The foundation of traffic road embankments on soft soil or peat is normally treated by exchanging soft soils or by improving soil with sand columns. By using sand columns, the supporting effect of soft ground is in some cases not sufficient. In this paper, a new foundation method is reported, in which sand columns are inserted into bearing layer and the radial supporting of sand columns is strengthened by using geotextile coating combined with surrounding soft ground. In this case, the geotextile is loaded by ring tension forces.

This method was first applied in widening a 6m high railway embankment, which was built on a soft subsoil consisting of clay and peat with a thickness of 7m. One of the constraining conditions of this construction was that the widening of the embankment should be finished within one month. The railway operation on the new embankment should be started again after a construction period of about 4 months. Therefore, it was demanded on the foundation method that only very small settlements of the new embankment were allowed after the completion of filling.

2. GROUND CONDITIONS AND FUNTAMENTALS OF THE FOUNDATION METHOD

2.1 *Ground and soil parameters*

Fig. 1 shows the existing and planned foundations with soil layers and parameters. The existing embankment has a very low stability. The soft gound conditions can be discerned from the settlement basin of the existing embankment, which has a maximum settlement between 1.2m and 1.5 m.

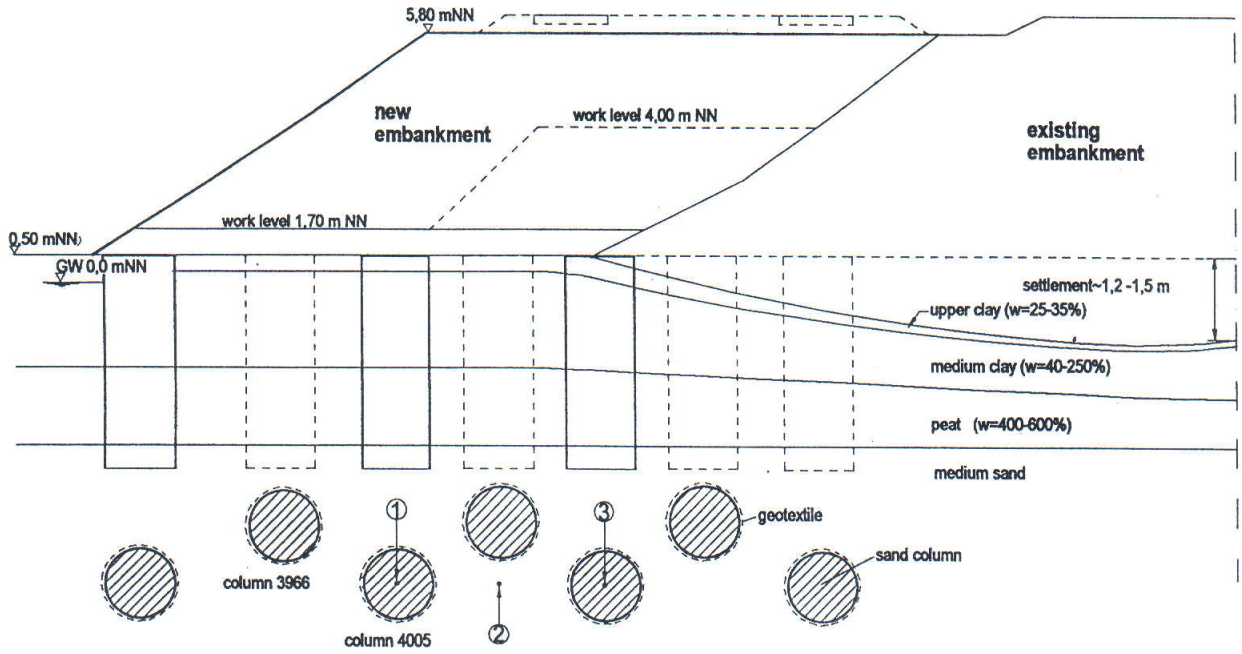

Fig. 1 Soil conditions and location of foundations

2.2 *Construction procedure of sand columns and filling*

The geotextile-coated sand columns were arranged in a form of column grid having a axial distance of 2.2m to 3.0m in the direction of embankment profile and 1.25m in the longitudinal direction. In the first step, a pre-filling of 1.2m thickness with sand acting as the first working level was carried out on the existing ground surface from NN+0.5m to NN 1.7m. Then, the rows of sand columns were constructed from this working level. These sand columns should not reach into the toe of the slope of the existing embankment. The sand columns, which were not constructed in the first step, were built in a following step with the help of the second working level about 3,50 m above the existing ground surface. The division of the column construction into two working steps proved to be necessary to prevent the stability failure of the existing railway embankment under dynamic loading resulting from the driving of casings.

The construction of sand columns was carried out in the following steps:

a. Dynamic driving of casings by means of a tube having a diameter of 1.5m

b. Soil excavation within the casing by using half-bowl grab to about 0.50 m into the sand layer. The remaining part of the middle sand beneath the bottom of the excavation within the casing, which has a thickness of about 1m, plays a role as stopper against the pressing of groundwater into casing, so that the further construction can be carried out under dry condition.

c. Inserting of a sixfold sewn geotextile, which is made up of composite of polyester threads and a filter cloth. This coating has a diameter of 1.58m larger than that of casing. The geotextile tubes were cut in length and sewed in the construction site.

d. The columns were then filled with fine to middle sand. In this procedure, the geotextile tube was fixed with pre-stressing belts. A funnel was placed upon the casing and the sand was filled into