13th European Conference on Soil Mechanics and Geotechnical Engineering
25th – 28th August 2004
Prague, Czech Republic

Geosynthetic applications in a high-speed railway project

Applications géosynthétiques dans un projet de ligne ferroviaire à grand vitesse

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KEYWORDS: geogrids, geosynthetics, ground improvement, piled embankments, railway

ABSTRACT: The geotechnical design of a high-speed railway project in Malaysia involved the design of embankment formations for train speeds of 160 km/h. Geosynthetic applications in the project included geogrid reinforced piled embankments with individual pile caps, geogrids for ground treatment beneath culverts, geotextiles for removal and replacement works and geotextiles at the top of the subgrade layer.

1 INTRODUCTION

The high-speed railway project is between Rawang in the state of Selangor and Ipoh in the state of Perak in Peninsular Malaysia with a project length of approximately 180 km. This paper discusses the applications of geosynthetics in the Rawang to Bidor stretch of 110 km. The geotechnical design of the project includes ground improvement of the existing foundation to sustain the imposed dead and traffic loads for train speeds of 160 km/h. The design requirements of the project is a maximum post construction settlement of 25mm in 6 months and a differential settlement of 10mm in 10 meters. Geosynthetics were used extensively in the project for an array of ground improvement works.

2 GEOGRID REINFORCED PILED EMBANKMENTS WITH INDIVIDUAL PILE CAPS

Piled embankments were designed for use along the mainline track and for the bridge approach transitions. Piling allows for the embankments to be constructed rapidly without any slowdown in the construction rate or sequence. Piled embankments will also eliminate the effect of settlement and stability problems. It can be safely assumed that all the embankment loads will be transferred through the piles down to the dense underlying formation below. Piled embankment with geogrids and individual pile caps are supported by three distinct actions: the piles reinforce and stiffen the underlying subsoil, the piles give direct support to the embankment transferred through arching action between adjacent pile caps and finally where a membrane is used and laid over the pile caps its tension will provide support and prevent lateral spreading of the embankment. The advantage of using geogrids is that geogrids absorb the stress induced during construction until arching is formed and prevents lateral movement of the soil. The geogrid used in the project was Emas Kiara type KiaraGrid, KG 400/200 with MD-400 kN/m and CD-200 kN/m respectively. A sand blanket is also provided just below the pile cap to provide a working platform and some lateral restraint on the pile during driving. Piles of size 250 mm x 250 mm (Concrete Grade 45) were installed at 1.5 m spacings. The geogrid design was carried out as per BS8006 (1995) and incorporated the published method of Hewlett & Randolph (1988) utilizing allowable strain (ultimate) $\varepsilon = 12\%$ and allowable strain (serviceability), $\varepsilon = 5\%$.

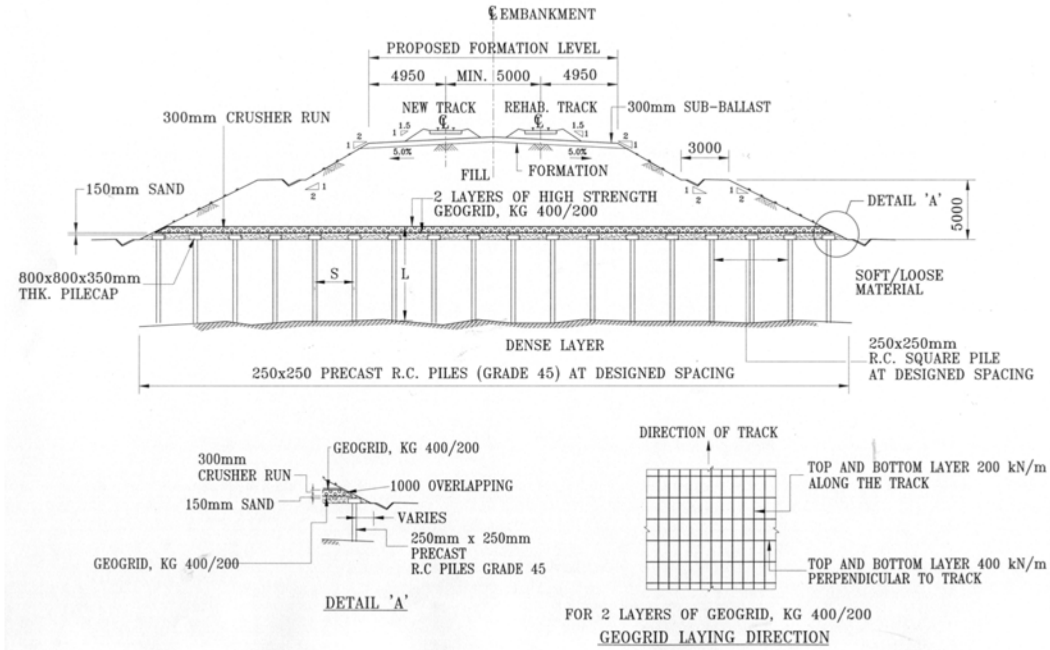

Figure 1. Geogrid reinforced piled embankments with individual pile caps.

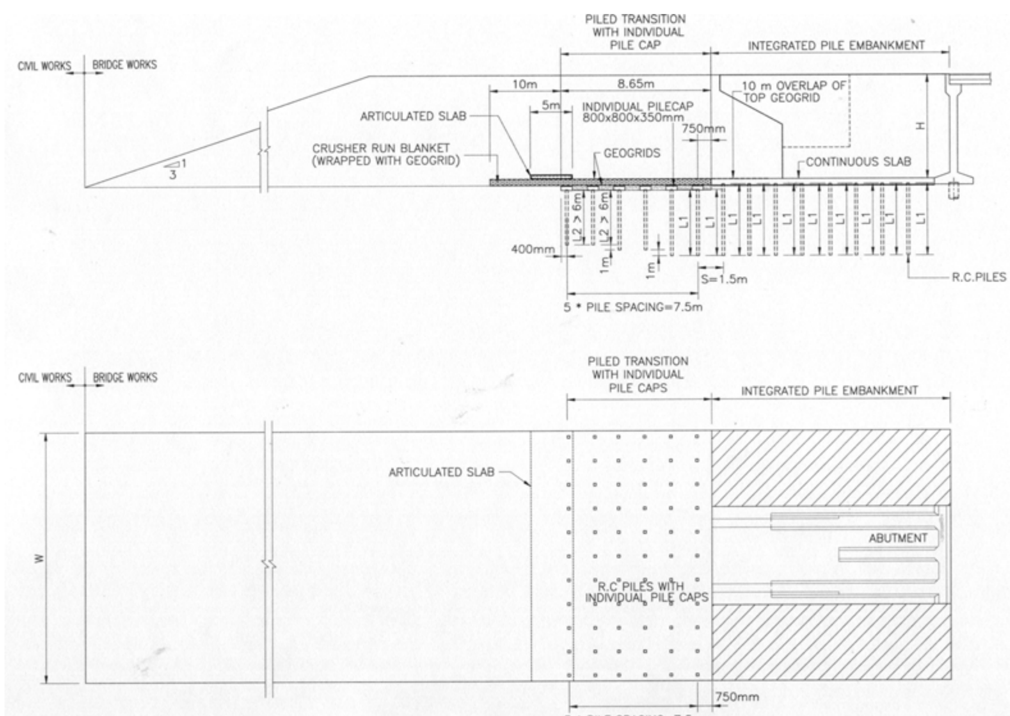

Figure 2. Bridge approach transition using geogrid reinforced piled embankments.

3 GEOGRID REINFORCED CULVERTS

The ground treatment design for the culverts provides for 2 layers of high strength geogrids with crusher run and sand blanket. High strength geogrids were used in the project to provide the necessary tension forces to resist the punching force at the base of box and pipe culverts. Furthermore, the use of this geogrid reinforcement system would negate the effects of the culvert "hard point" and provide a gradual transitional elastic modulus between the rigid point of the culvert and the adjacent ground. The geogrid used was Emas Kiara type KiaraGrid, KG 400/200.

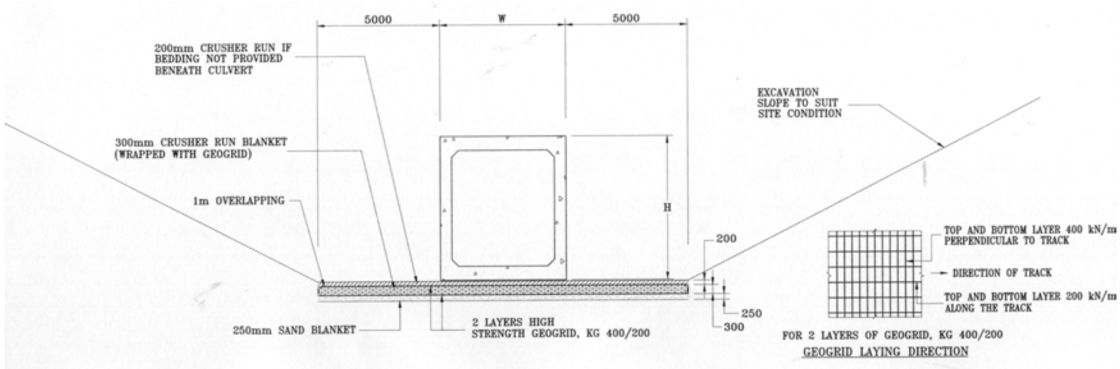

Figure 3. Geogrid reinforced box culverts in removal/replacement areas.

4 GEOTEXTILES AT THE BASE OF EXCAVATION WORKS

Non-woven geotextiles were provided as a separation layer at the base of the excavation works. The non-woven geotextiles were installed at the base of excavations in removal/replacement areas to ensure an effective separation between the cohesive in-situ soils and the backfill suitable fill. Among the geotextile used was Emas Kiara type KiaraTex, KET 20.

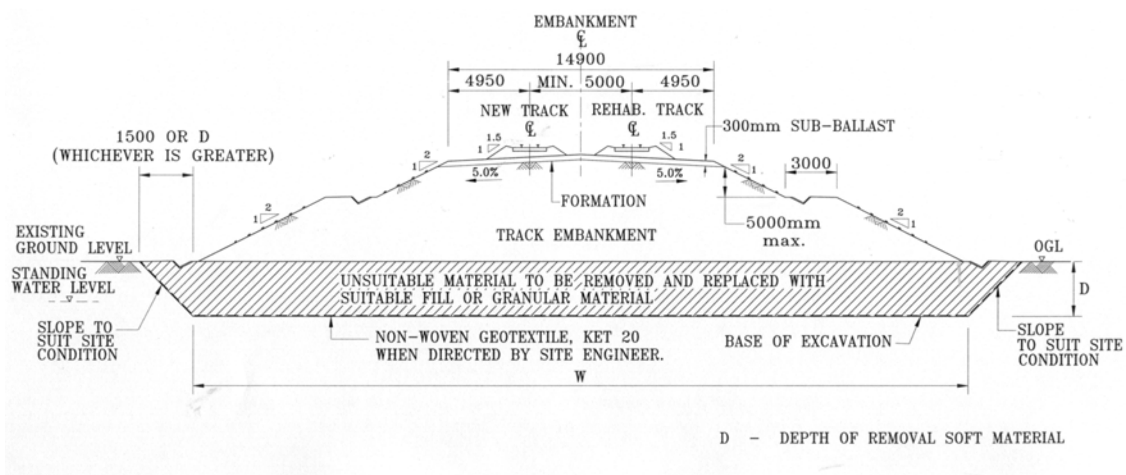

Figure 4. Geotextile filter fabrics in removal/replacement areas.

5 GEOTEXTILES ON SUBGRADE LAYER

Non-woven geotextiles were also laid on the top of subgrade layer under the sub-ballast in this railway project. The purpose of the non-woven geotextile under the sub-ballast is primarily as a separator, filter and drainage layer. Among the non-woven geotextile used was Emas Kiara type KiaraTex, KET 20.

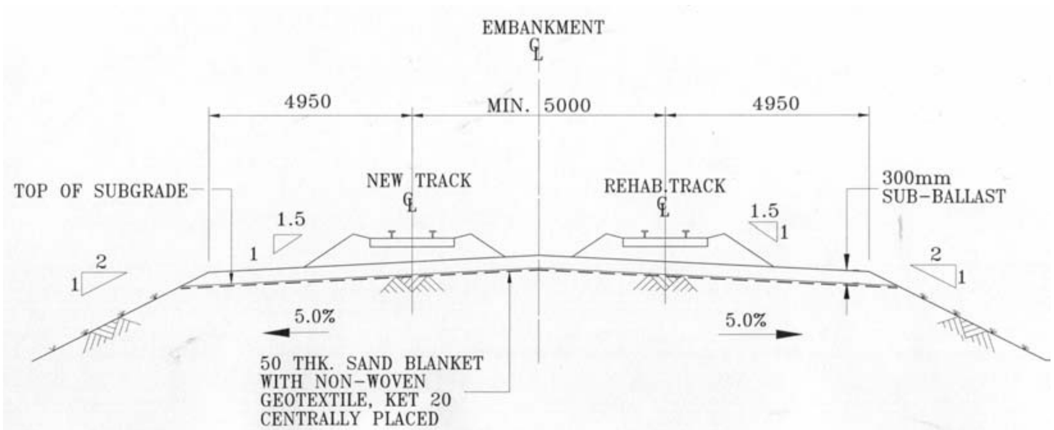

Figure 5. Non-woven geotextile on top of subgrade layer.

6 CONCLUSION

In this paper, various applications of geosynthetics in a high-speed electrified railway project have been highlighted. It is evident that in such large modern ground improvement projects, the use of geosynthetics to solve relevant geotechnical problems cost effectively is of high significance and importance. The project is currently ongoing and the laying and performance of these geosynthetics has been highly satisfactory to date.

7 ACKNOWLEDGEMENT

The authors would like to thank DRB-Hicom for their consent to publish this technical paper. The authors would also like to thank S.K.Rao of Ranhill Consulting for his assistance in the drafting works and Emas Kiara Sdn. Bhd. for furnishing detail test results and properties of the geosynthetic products.

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