

**Basal Reinforced Embankment on Soft Soils
Pengerang Integrated Petroleum Complex (PIPC),
Daerah Kota Tinggi, Johor**



Mirafi® PET – Pengerang Integrated Petroleum Complex (PIPC), Daerah Kota Tinggi, Johor

Project Data

Project	: Mirafi® PET High Strength Reinforcement Geotextiles for Basal Reinforced Embankment on Soft Soils – Pengerang Integrated Petroleum Complex (PIPC), Daerah Kota Tinggi, Johor
Year of construction	: 2017 - 2019
Client	: JKR PIPC
Material	: TenCate Mirafi® PET

Introduction:

Pengerang Integrated Petroleum Complex (PIPC) is a project development in Pengerang, Kota Tinggi District, Johor, Malaysia. It is one of the largest investments in the Pengerang district and is located on a single plot of land measuring about 20,000 acres. Development of the PIPC boosts Malaysia's economy and creates huge job opportunities for the nation. As PIPC is strategically located at the south-east tip of Peninsular Malaysia, it offers access to existing major international shipping lanes and excellent road network to Singapore and other major ports in Peninsular Malaysia. Approximately 22km of access road was constructed to build road connections with high strength geotextiles as basal reinforcement to promote a stable embankment and a cost-effective engineering solution.

Problem:

The access road is one of the primary components of the project which can shorten transportation distance and time. A series of basal reinforced embankments have been designed by the consultant to form the access road network based on earthwork cut and fill profiles of the existing ground terrain (see Figure 1a & 1b). Based on the road elevation, the embankment height of the access road is within 2.5m to 19.5m. The Pengerang site area mainly consist of alluvial soil such as sand, silt, clay and peat. Eighteen standard penetration tests were carried out at the reinforced embankment access road. Boreholes were drilled underneath until the hard layer, and the SPT reading was collected at every 1.5m center to center depth. Based on the soil investigation report, the foundation typically comprised 4.0m of soft soil followed by 11.0m of medium stiff silt and subsequently the hard layer (see Figure 2). The top layer of the foundation with soft high plasticity silt and clay layer was unable to support the high road embankment. Figure 3a& 3b show the soft soil condition on site.

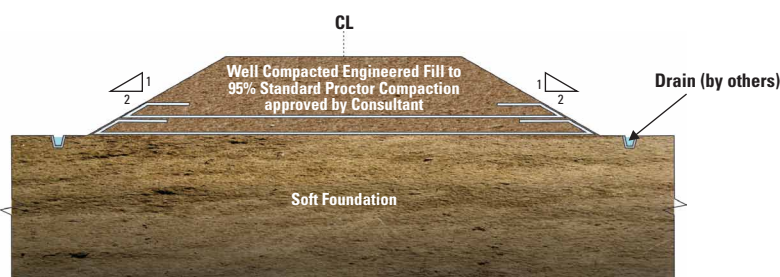


Figure 1a. Typical section – Reinforced embankment with TenCate Mirafi® PET high strength geotextile

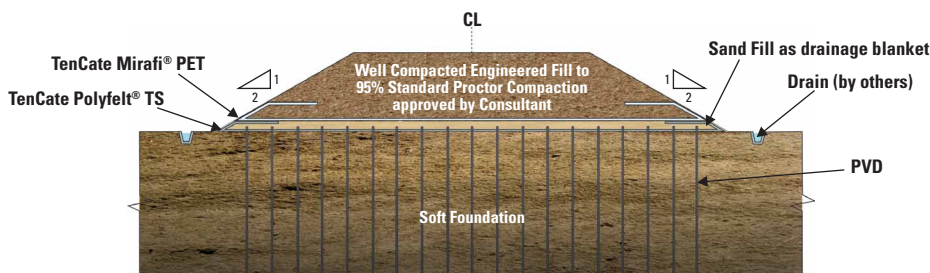


Figure 1b. Typical section – Reinforced embankment with TenCate Mirafi® PET high strength geotextile and Prefabrication Vertical Drain (PVD)

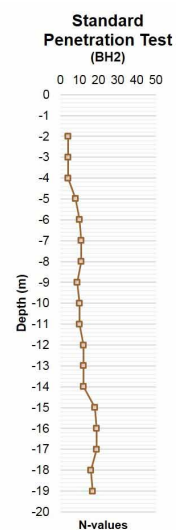


Figure 2. SPT reading based soil investigation report

Mirafi® PET – Pengerang Integrated Petroleum Complex (PIPC), Daerah Kota Tinggi, Johor



Figure 3a. Soft soil condition on site



Figure 3b. Soft soil condition on site

Solution:

With a high embankment sitting on soft ground foundation, proper design is critical in ensuring the stability of the embankment. Prefabrication Vertical Drain (PVD) was proposed to some parts of the access road embankment to accelerate the consolidation of soft soil. TenCate Polyfelt® TS50 non-woven geotextile was used as a separator geotextile to prevent the intermixing of backfill soil and existing soft soil. TenCate Mirafi® PET high strength geotextile was used as an engineering solution for the construction of the basal reinforced embankment. Different grades and layers of high strength geotextile was proposed accordingly for the basal reinforced embankment design corresponding to the different geometry of embankment and foundation conditions. TenCate Mirafi® PET high strength geotextiles such as Mirafi® PET200-50, Mirafi® PET400-50 and Mirafi® PET1000-50 was incorporated in the reinforced embankment with 1 layer to 6 layers for moderate to critical conditions. Multiple layers of high strength geotextiles with tensile strengths of 1000kN/m was needed to function as basal reinforcement to support a 19.5m height road embankment.

Installation of Geotextile:

The soft layers such as very soft clay or peat was removed and replaced with engineered fill prior to laying the geotextiles. Large or sharp objects that might puncture or tear the geotextiles was also removed. Polyfelt® TS50 as a separator geotextile, was placed on the foundation. Granular material was backfilled on top of the separator geotextile as a drainage blanket. Subsequently, PVD was installed by vertically vibrating a hollow steel mandrel into the required depth of the soft foundation soil (see Figure 4). Mirafi® PET was laid in layers continuously in primary machine direction perpendicular to the alignment of the access road embankment (see Figure 5). Selected engineered backfilling was carried out by bulldozers to spread out evenly and was compacted with heavy machinery until the final design platform level was established as per the construction drawings (see Figure 6 & 7). Embankments with more than one layer of high strength geotextile was required to have a 0.5m spacing with suitable backfill material placed in between each layer of the geotextile. In the case of embankments without PVD, Mirafi® PET was laid directly on the prepared subgrade without the drainage blanket.



Figure 4. Installation of Prefabrication Vertical Drain (PVD)



Figure 5. TenCate Mirafi® PET high strength geotextile laid on soft foundation

Mirafi® PET – Pengerang Integrated Petroleum Complex (PIPC), Daerah Kota Tinggi, Johor



Figure 6. Embankment backfilling on top of TenCate Mirafi® PET high strength geotextile



Figure 7. Compaction of embankment fill by heavy machinery

Summary:

Embankments constructed with basal reinforcement using geosynthetics enabled the maximization of embankment height and minimization of embankment area. The simple installation of geosynthetics allowed the construction to be finished within a tight time schedule. Basal reinforcement involving PVD minimized the settlement and increased the consequent rate of gain in foundation shear strength. Hence, the access road embankment for Pengerang Integrated Petroleum Complex was completed on schedule and the use of geosynthetics resulted in significant cost savings compared to other conventional methods.

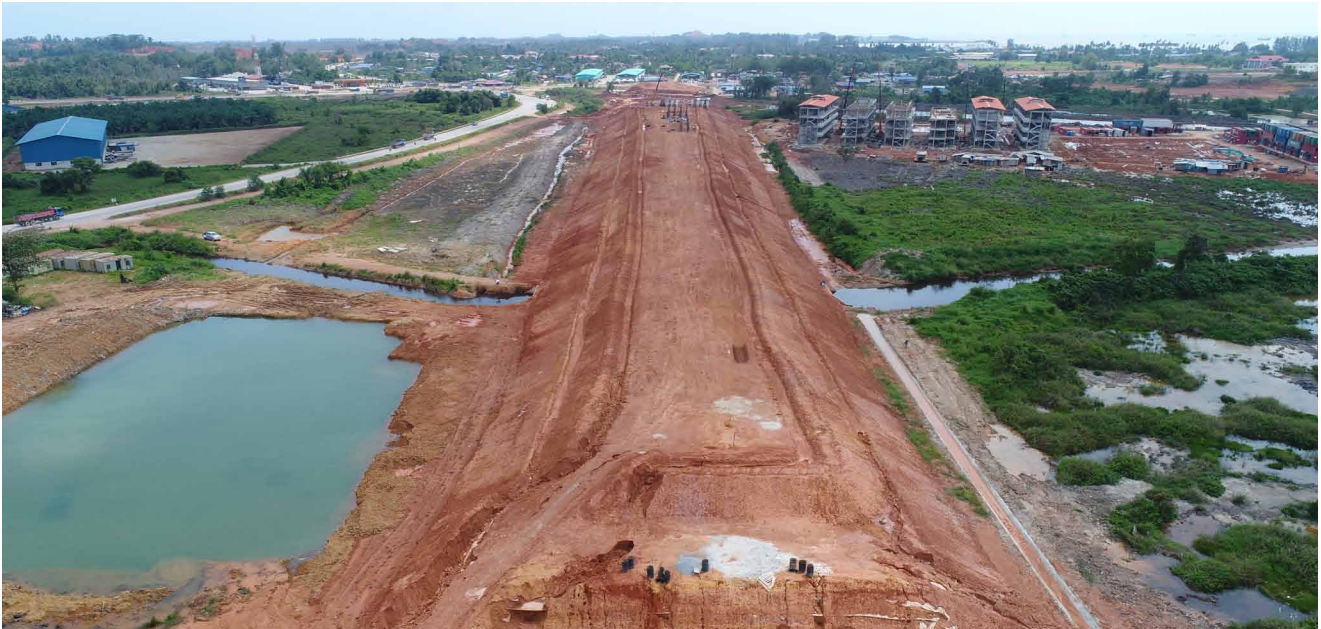


Figure 8. Access road embankment overview

Mirafi® is a registered trademark of TenCate.

Further details of this application and products can be obtained by contacting your nearest TenCate Technical Support Office.

Unauthorized reproduction and distribution prohibited. This document is provided as supporting service only. The information contained in this document is to the best of our knowledge true and correct. No warranty whatsoever is expressed or implied or given. Engineers wishing to apply this information shall satisfy themselves on the validity of the input data relative to the applicable soil and engineering conditions and in doing so assume design liability.