# Soft soil stabilizes Malaysia highway

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ABSTRACT: The Pan Borneo Highway Project is located in Malaysia, with highway from Sarawak to the Saba. The purpose is to open up the traffic in these two areas and provide a fast and safe traffic road. Since the highway project has a total length of 2000 kilometres, the topography along the line is very complex. This highway will pass through areas of soft soil. In order to prevent the drainage of the structure due to uneven drainage and poor drainage of the road- during the rainy season. Geosynthetics material were considered in the design to enhance the nature of the soil and increase the stability and service life of this highway. In order to solve the soft soils issues encountered by the Highways, High-performance polypropylene geotextile is used for embankment stability. Geotextile has high strength to supply soil confining pressure, also improve soil behaviour.

## 1 INTRODUCTION

The project is located in Malaysia. With the economic growth of East Malaysia, the demand for road construction has also increased rapidly. The Federal Ministry of Engineering of Malaysia has proposed the plan of Pan Borneo Highway Sarawak (PBHS) for the local people to have a fast and safe highway. Go to various regions, such as Figure 1 for the location map of this project. This expressway spans the whole of Malaysia. The road topography is very complicated, and because the surface soil of the formation is a soft soil, it is necessary to improve the soil properties to achieve road stability.

Since the road is 2000 kilometres long, the project plans to upgrade the expressway standard to JKR R5, so the maximum design speed limit can reach 100 km/h and the minimum lane width is 3.5 m. Therefore, to expand the highway to meet the requirements of this design specification

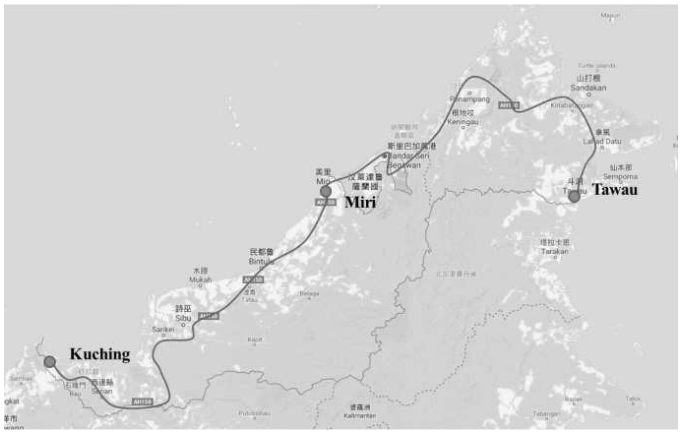


Figure 1. The Pan Borneo Highway topography location

## 2 GEOLOGICAL CONDITION

The Pan Borneo Highway is mainly a highway built along the coastline. The main roads are mainly located in the alluvial soil. The borehole works are carried out within the scope of the project before the design, the soil samples are collected, and the laboratory is designed by the laboratory. Soil parameters required to understand the distribution of existing soil layers. From the sampling and test results, it can be seen that the soil layer distributes the peat layer, the soft clay layer, the clay layer, the hard clay layer and the sand from top to bottom as shown in Figure 2. The soil parameters of each soil layer are shown in Table 1. It can be seen from Table 1 that the soil shear strength of the peat soil and the soft clay layer is not

good. In order to improve the condition of the local weak soil, the method of using the reinforced embankment is selected, and the geotextile is used to improve the soft fall of the soil. A plurality of borehole were set up in the engineering area before the design to collect the soil samples, and the soil parameters required for the design were designed by the laboratory to understand the distribution of the existing soil layers. From the sampling and test results, it can be seen that the soil layer distributes the peat layer, the weak clay layer, the clay layer and the hard clay layer from top to bottom as shown in Figure 2. The soil parameters of each soil layer are shown in Table 1. It can be seen from Table 1 that due to the poor strength of the soil in the peat soil and the soft clay layer, in order to improve the condition of the local soft soil, the method of using the reinforced embankment is selected, and the geotextile is used to improve the soil soft.

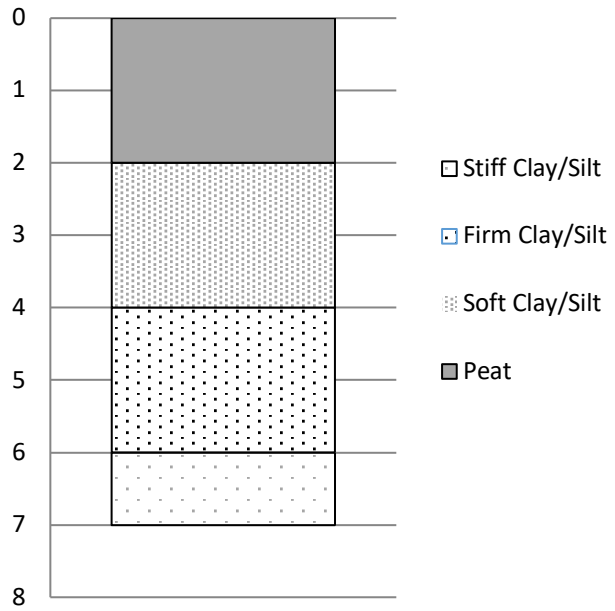


Figure 2. The soil layer distributes

Table 1. The soil parameters

| Soil properties | γ (kN/m$^3$) | C/Cu (kPa) | ϕ |
|---|---|---|---|
| Peat | 17.5 | 0 | 30 |
| Soft Clay/Silt | 16.5 | 3/5 | 22 |
| Firm Clay/Silt | 17.0 | 3 | 25 |
| Stiff Clay/Silt. | 18.0 | 3 | 26 |
| Sand | 18.0 | 10 | 35 |

## 3 PROJECT DESIGN

### 3.1 *Design parameters*

Due to the local soil is complex, the design unit considers the long-term and short-term use of the structure, and based on the geological drilling data, the soil parameters used for design analysis are summarized in Tables 2 and 3:

Table 2. Undrained parameters

| Material Properties | Unit Weight (kN/m$^3$) | Undrained Parameters | | |
|---|---|---|---|---|
| | | | C/Cu(kPa) | |
| | | ψ | New fill | With history of fill |
| New Fill | 18.0 | 30 | | 3 |
| Existing Fill | 18.0 | 30 | | 3 |
| Surcharge Material | 17.5 | 30 | | 0 |
| Soft/very soft | 16.5 | - | Characteristic Curve | 0.2Po + Characteristic Curve |
| Firm/Stiff | 17.0 | - | | 5N |
| Very Stiff | 18.0 | - | | 90 |
| Hard | 18.0 | 35 | | 10 |
| Rock | 24.0 | 40 | | 20 |

Table 3. Drained parameters

| Material Properties | Unit Weight (kN/m$^3$) | Drained Parameters | | |
|---|---|---|---|---|
| | | | C/Cu (kPa) | |
| | | ψ | New fill | With history of fill |
| New Fill | 18.0 | 30 | 3 | |
| Existing Fill | 18.0 | 30 | 3 | |
| Surcharge Material | 17.5 | 30 | 0 | |
| Soft/very soft | 16.5 | 22 | 3 | 5 |
| Firm/Stiff | 17.0 | 25 | 3 | |
| Very Stiff | 18.0 | 26 | 3 | |
| Hard | 18.0 | 35 | 10 | |
| Rock | 24.0 | 40 | 20 | |

### 3.2 *Design section*

The design cross section of the project is based on the standard cross section design drawing, as shown in Figure 3. The design section has a width of 28 m and a road thickness of 77 cm. It is divided into four layers, as shown in Table 4. (AC Wearing Course, AC Binder Course, Road Base Course, Road Sub-Base Course), designed road vehicle load 10 kPa, this project is used for soft soil road reinforced, using two polyester fibre geosynthetics to improve the nature of soft soil As shown in Table 5, the detailed specifications of the woven fabrics are shown in Table 5. Figure 4 shows the situation before the construction. It can be seen that the existing water is easy to accumulate, and the drainage is poor. First, the road is excavated to the bottom of the design to lay a layer of Geotextile GT70-II PP woven fabric. To block the face and backfill sand and use the water permeability of the weave to isolate the backfill and the existing soil. Geotextile GT 400-I PET woven fabric is shown in Figure 5. This layer of woven fabric is mainly used for soil reinforcement and the backfill material belongs to sandy soil. Because Geotextile GT 400-I PET is a high-strength sand line, which can be applied to soil reinforcement, this is the case. The woven fabric has good filtering and isolation properties, and the PET woven fabric has an elongation of less than or

equal to 10 % and a strength of 180 kN/m at 5 % strain, which can increase the strength of the soil without causing structural deformation due to the load of the vehicle above. Moreover, the Apparent Opening Size after the weaving process of the woven fabric can effectively drain the soil without losing soil. When refilling the material, it needs to be tamped as shown in Figure 6, and the compaction density is 90 %. After the completion of the backfilling, as shown in Figure 7, the asphalt layer is finally laid to complete the reinforced road.

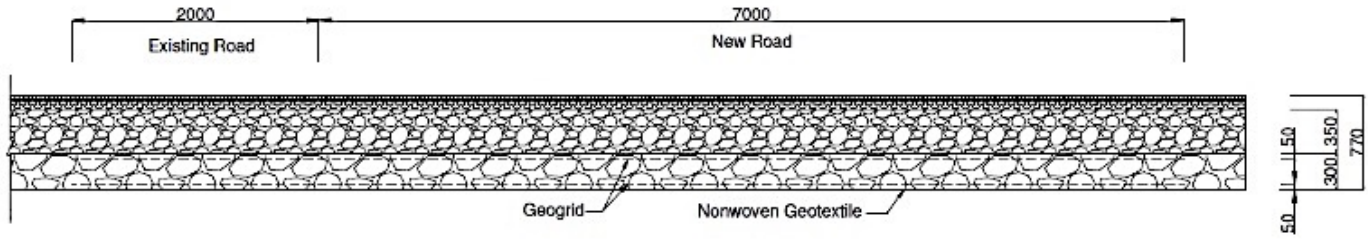


Figure 3. Standard cross section

Table 4. The pavement layer

| PAVEMENT LAYER | DEPTH (M) |
|---|---|
| AC Wearing Course | 0.5 |
| AC Binder Course | 0.7 |
| Road Base Course | 3.5 |
| Road Sub-Base Course | 3.0 |
| Total Pavement Depth | 7.7 |

Figure 4. Before construction in the site.

Table 5. Geotextile specification

| Geotextile item | Nominal Tensile Strength (MD/CD) (kN/m) | Ultimate Elongation (MD) (%) | Tensile Strength at 5% Strain (kN/m) | Remark |
|---|---|---|---|---|
| Geotextile GT70-II PP | 70/70 | ≦15 | ≧35 | Need to provide Creep、Durability、Chemical and Installation Damage test report |
| Geotextile GT400-I PET | 400/50 | ≦10 | ≧180 | |

### 3.3 *Stability analysis*

According to the design specifications proposed by the Malaysian Land Project, as shown in Table 6, it is applied to the soft ground embankment to be reinforced. The projects considered have bearing capacity (short-term) and edge-breaking stability (short and long-term), and the minimum safety factor is 1.4, 1.2, 1.3. The design period is 75 years.

Table 3. Malaysia Geotechnical Design Code

| Design Component | Mode of Failure | Minimum Factor of Safety | Design Life (durability of material) | Remark |
|---|---|---|---|---|
| Embankment on Soft Ground | Bearing (short term) | 1.4 | 75 yrs | 7 years post construction settlement |
| | Local& global slope stability (short term) | 1.2 | | I. Within 10 m from bridge approach<100 mm |
| | Local& global slope stability (long term) | 1.3 | | II. road <250 mm (total settlement) |

Figure 5. Laying out Geotextile complete


Figure 6. Backfill soil and compaction.

Figure 7. After backfill complete.

## 4 CONCLUSIONS

This project uses two polyester fiber woven fabrics Geotextile GT 70-II PP and Geotextile GT 400-I PET for site improvement. Due to the soft soil and poor drainage in Malaysia, the characteristics of weaving fabrics, such as weaving strength, are used. It can provide the surrounding force of the soil. The AOS of the woven fabric can effectively remove the infiltration water and not lose the soil. It can be quickly constructed by using the stiffening method. It can use the existing soil backfilling without destroying the original appearance of the site, in addition to saving costs. Sustainable development, more able to provide a fast and safe highway.

Therefore, the project covers a large area, and the quality control of the relative geotechnical materials is also very important. Geosynthetics factory has its own laboratory to conduct product testing, provide factory inspection, control product quality, and the project is also ongoing, and the two parties cooperate well. It's also provides a high-quality production line of geotechnical materials.

## 5 REFERENCES

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