

# Analysis on the Long Term Effect of Trial Test Road Constructed on Batu Pahat Soft Clay (BPSC) at Recess UTHM

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**Abstract.** The reinforcement used in soil for construction of roads on the soft clay is very important as it will determine the level of service of the road after it was built. Damage or defects on the road surface to be an indicator of the level of the road has dropped and shows the deformation of the road. For this research, an analysis has carried out on the long-term effect of trial test road constructed on Batu Pahat Soft Clay (BPSC) at RECESS UTHM. Through this research, the reinforcement using Rawell Geosynthetic Clay Liner (RGCL) was the best with the stability is 14964 N, a low flow is 2.69mm, stiffness modulus is 1766 MPa, the peak load is 739.4 N and a lower horizontal deformation which is 1.71  $\mu$ m compared Woven Geotextile section and section without geotextile [1][9]. In terms of deformation can be seen clearly from physical observations that section without geotextile suffered significant damage than others. Settlement of road can also be analyzed by a longitudinal section that plotted based on the result of leveling work. After that, settlements are more visible way on the right side of the road trial. Through lab tests conducted, it indicate that the coring samples obtained from sites of each section meets the specifications set by the Jabatan Kerja Raya (JKR) in terms of stability, flow and stiffness [1]. Through this study, a trial road built on soft soil can be used as a test site because of the uniqueness of these roads which has three different types of reinforcements.

**Keywords:** Soft soil, ground modification, settlement.

## 1. Introduction

Research Center for Soft Soil (RECESS) UTHM was built to study the soft ground in Malaysia. The research on soft clay is mostly done on site RECESS UTHM and one of them is the construction of trial road that built on soft clay by using three different types reinforcement of soil. The main problem for the soft clay soil are has a high moisture content rate resulting settlement problems [7][6]. Soil type has characteristics such as moisture content between 23% to 69%, a specific gravity of between 2.18 and 2.65, plastic limit of 20% to 35%, liquid limit of 37% to 66%, the plastic from 17% to 31% and sensitivity of soil between 2.5 to 7.3 (m<sup>2</sup>/year). Soil particle size is less than 0.002mm. Therefore, before the road construction done on the ground, the soft clay has to be stabilized [1]. This research



was made to assess the settlement and deformation of road pavements constructed 11 years ago, when it was built in 2003. The type of pavement that was built in the trial road in RECESS UTHM is flexible pavement. Most of the roads in Malaysia were built of flexible pavement because of its low cost compared to rigid pavement [9]. The flexible pavement, each layer being built which is the highest load bearing capacity in the top and at the bottom has a low load bearing capacity [2].

## 2. Research Methodology

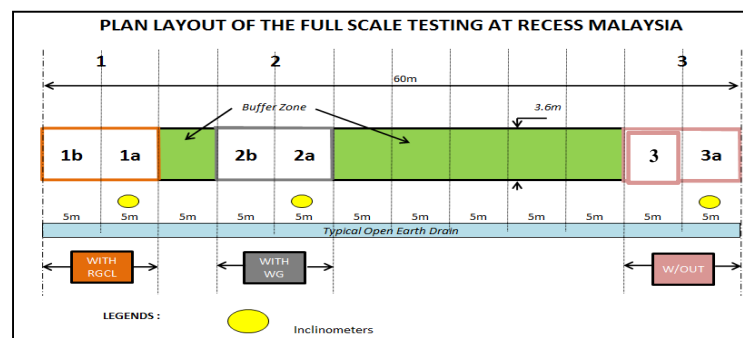
The information of research consists of the research location and plan layout of trial road. This information is provided to give understanding about trial road that constructed at RECESS UTHM. The research methodology carried out in order to ensure that a comparative study and analysis between previous and current conditions of the trial road is done to reflect the appropriate objectives.

### 2.1 Research Location

The study was conducted at the Research Center for Soft Soil (RECESS) UTHM. In 2003, this road was built at RECESS UTHM. The site is located on the campus of Universiti Tun Hussein Onn Malaysia (UTHM) and RECESS is the only research center on soft ground in Malaysia. The research site is located about 20 km from the center of Batu Pahat. The topography of the area is flat with the surface of the original height was about 1.35 until 1.80 m above the sea level. Ground water level for this area is from 0.5 m to 0.63 m from the ground [3].

### 2.2 Plan Layout of Trial Road

Figure 2.1 shows the plan layout of trial road that constructed on Batu Pahat Sofy Clay (BPSC) at RECESS UTHM. The road was built with two types of geotextiles which is Rawell Geosynthetic Clay Liner (RGCL) and Woven Geotextile (WG) while one part is being built without the use of geotextile [4]. The section that called as Buffer Zone (BZ) is a section that separates the two type reinforcement of soil. Besides that, the section without geotextile has three parts, 3a, 3b and 3c while WG section has two parts 2a and 2b. Section RGCL also has two parts which is 1a and 1b. The length of this road is 60 m and it has 12 sections where each section is 5 m meanwhile the road width is 3.6 m.



**Figure 2.1.** Plan Layout of Trial Road.

- (a) **Site Investigation.** Site investigation are carried out to know the condition of the trial road by doing the site visit. During the site visit, found that each section of the road has longitudinal cracking. Furthermore, the location of inclinometer and bore holes are determined based on the plan layout of the trial road. The boundary between the section are cannot be seen during the site visit and need to measure it to ensure that every section position that have in this trial road.
- (b) **Levelling.** Levelling is a process of measurement the height difference between points on the earth by referring to datum [5]. For carried out the leveling, the bench mark or temporary bench mark must be known in order to start the leveling work. So that, the bench mark at Parit

Jelutong are taken as the reference point with reference number J1512. After that the temporary bench mark are determined near to the research location by referring the bench mark. So that, the settlement of longitudinal section and cross section of the trial road can be known by carried out the leveling.

- (c) **Sampling Process.** Coring method is used to get the sample for the laboratory testing. A total of 20 samples are taken where six sample of each section which are without geotextile, Woven Geotextile (WG) and Rawell Geosynthetic clay liner (RGCL). The two sample are taking in the buffer zone part. The figure 3.1 shows the samples that have been drilled on the road.



**Figure 3.1.** The coring sample.

- (d) **Laboratory testing.** The experiments conducted in the laboratory are by using coring samples that taken on site. The experiments involved are Marshall test and Indirect tensile stiffness modulus test. **Marshall test.** The purpose of this test is performed to determine the stability and flow for each sample which has been in coring. Marshall test was based on ASTM D1559-59 (ATM, 19992A). In this test the sample is soaked at a temperature of 60 ° C for 30 to 40 minutes before the testing the sample. **Indirect tensile stiffness modulus test.** This experiment made is to identify stiffness modulus, peak load and horizontal deformation of coring samples that taken on the road trial in RECESS UTHM. The value obtained from this experiment will be compared for each section involved. The indirect tensile stiffness modulus is a non-destructive method and has been widely used for determination of stiffness modulus values. Two different temperature used for this test which are at a temperature of 20°C and 40°C for 2 hours. After that, the samples will be tested using a universal testing machine.

### 3. Results and Analysis

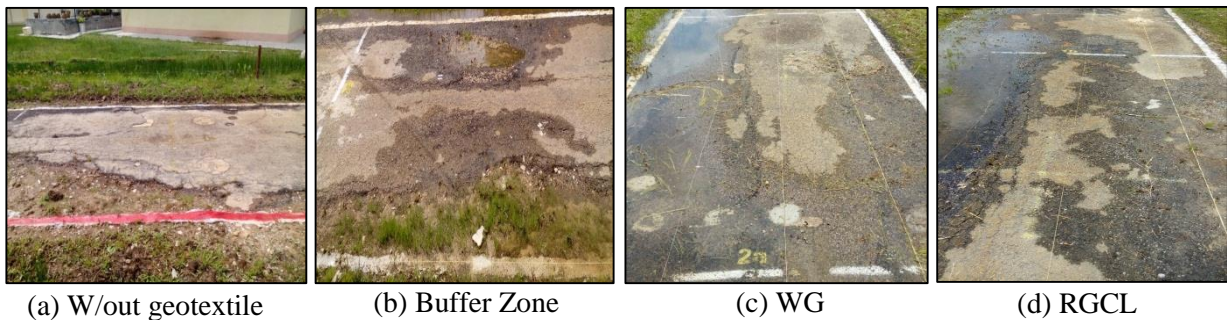
Result and analysis consists of physical observation, analysis between the different section of road, analysis on longitudinal section and analysis on Marshall test and Indirect tensile stiffness modulus test. Physical observation of the road that was built in RECESS trial involving the observation of the condition of the road. Overall, it appears at the beginning is the way it looks abandoned and overgrown with grass (Figure 4.1). This is because the road is no longer used for traffic and with any type of vehicle. The last time the road was resurfaced and the burden with traffic is in 2010. In addition, during rains the road will be stagnant with water (Figure 4.2). This is due to the existing drainage cannot cope with the flow of rain water.



**Figure 4.1.** Condition of the trial road.      **Figure 4.2.** Condition of road during rainy day

### 3.1 Analysis between the different sections of road

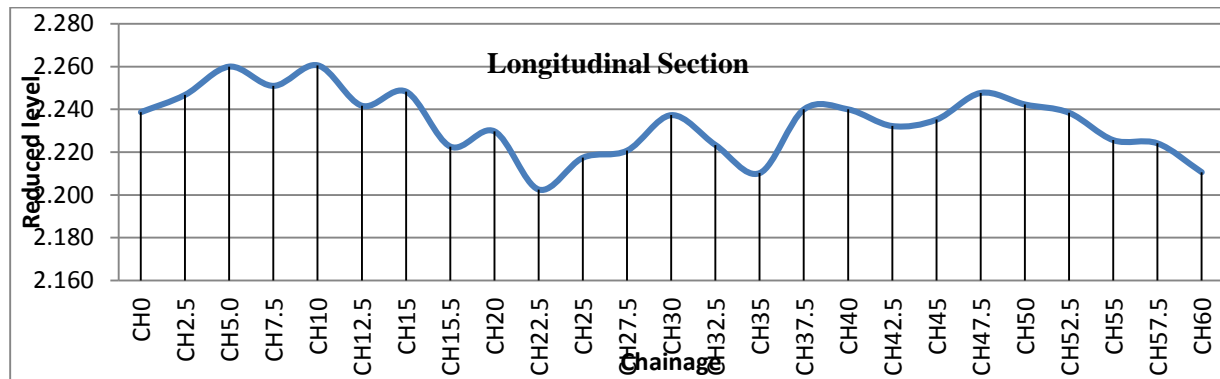
Based on the observations, the Figure 4.3(a) are suffered severe damage between all of the sections. The red line shows the state of the road is no longer have pavement and overgrown with grass. Damage to roads is more to the left side of the road. In addition, transverse cracks can also be seen in this section. For the Figure 4.3(b) show on the left side of the road pavement layer is not seen as section without geotextile. After the road is cleaned, the grass begins to grow back visible on the pavement, which was covered with soil. Settlement can be seen on the right side of the road because there is stagnant water at the area. Figure 4.3(c) shows condition of trial road of WG section. In this section, the pavement still visible after cleaning the road. However, on the right of road shows the settlement occurred and stagnant water could be seen. In addition, the longitudinal cracks appear on the surface of the road for this section. Inconsistencies pavement layer can also be seen in this section because there is a layer of pavement that looks higher. Road conditions on RGCL section shown in Figure 4.3(d). In this section, the longitudinal cracks are seen on the surface of the road. Settlement clearly visible on the right side of the road that leads to stagnant water in that area. Pavement still visible in this section.



**Figure 4.3.** Different condition of road between sections

### 3.2 Analysis on longitudinal section

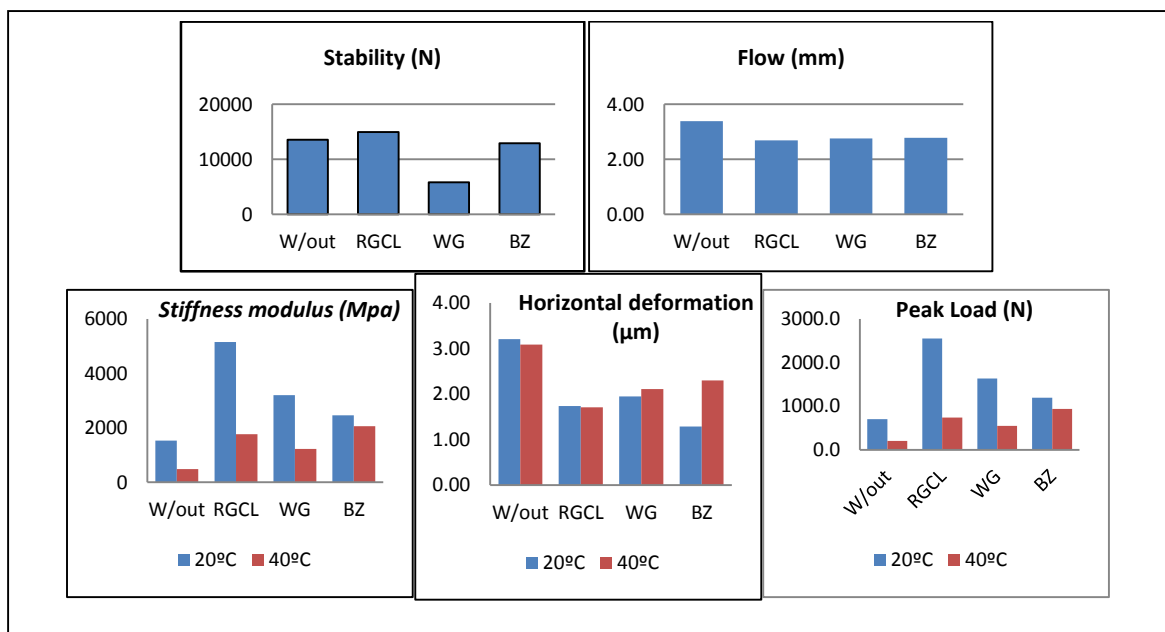
Based on a longitudinal section of the graph shown in Figure 4.4 below, the highest position for the mid-point attempts in RECESS road is not uniform. There is a difference of settlement rate on these roads due to the different type of reinforcement of soil. Through a longitudinal section of the graph, the highest settlement rate experienced by road from the chainage 10 until chainage 35.



**Figure 4.4.** Longitudinal section trial road at RECESS UTHM.

### 3.3 Analysis on Marshall test and Indirect tensile stiffness modulus test

Based on figure 4.5, the results obtained from the Marshall test showed the stability and flow of the samples while the indirect tensile stiffness modulus test that showed the stiffness modulus, horizontal deformation and peak load behaviour. In terms of stability, the RGCL is highest compare than others which is 14,964 N meanwhile in terms of flow the RGCL is the lowest compared to other sections which is 2.69mm. The indirect tensile stiffness modulus test was carried out with two different temperature conditions i.e. 20°C and 40°C. The RGCL section showed the high stiffness modulus 1,766 Mpa and peak load of 739.4 N whereas the lowest value in terms of horizontal deformation is 1.71  $\mu\text{m}$ . The results found from these two different tests showed that RGCL section has the ability to prevent water from seeping into the layers of road, thus giving higher stability, stiffness modulus and peak load, but with lower value in terms of flow and horizontal deformation.



**Figure 4.5.** Result from Marshall test and Indirect tensile stiffness modulus.

#### 4. Conclusion

After 11 years of construction, the defects can be seen on the pavement surface of the trial road constructed. During the rainy days, this trial road will be flooded with water because there were no proper drainage nearby the trial road area. The deformation of road surface can be seen at all sections and section without geotextile was adversely affected compared to the other sections. In terms of settlement, it was found that from the longitudinal section observations, the highest settlement rate experienced by the road was from chainage 10 until chainage 35, which is in the center of the road. In terms of laboratory testing, they showed that, the RGCL section have highest stability, stiffness modulus and peak load which are 14,964 N, 1,766 Mpa and 739.4 N respectively. The RGCL section was also found to have lower value of flow which is 2.69mm and lower value of horizontal deformation which is 1.71 $\mu$ m compared to section without geotextile and WG section. As a conclusion, the RGCL prevented water from seeping into the layer of road make the RGCL section the best section after 11 years of construction as a trial road on Batu Pahat Soft Clay (BPSC) at RECESS UTHM. This was proven after analysing the results obtained on the site and also through the laboratory testing results. It is hoped that this research will contribute towards better land transportation system which will be competitive and relevant with other systems especially the urban rail system. [8]. It was said that a better transportation system will depend on its infrastructural quality and its efficiency depends on the level of service it shows during its operation [1]. Thus, it is important to understand the long term effect of a structure constructed as it will ensure the sustainability, resilient and safety for the users and the community at large.

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