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An application of base sheet in a highway embankment: A case study in Thailand

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Abstract: One of the various methods for improving the stability of the road embankment is to reinforce the embankment by a certain mean. The reinforcement are always used to sustain the tensile stress induced in the embankment since the embankment materials are normally low in tensile strength. A research project was conducted to investigate the performance of the nonwoven fabric thin sheet which is used to reinforce the embankment at the base. The fabric is also expected to be able to prevent the contamination of the embankment material by the intruding mud below, and this accelerates the consolidation of the subsoils. The testing was performed at a site selected from a portion of the constructing highway linking Somrong and Bangboh. The test tesults show some ability of the base sheet in improving the embankment stability and strength, and assisting the consolidation of the underneath subsoils especially the mud at the surface of the original ground.

1. INTRODUCTION

In the design of road embankment on soft soil foundation, the author recommends five main points that should be taken into consider-ation. They are:-

1. the stability of the embankment,
2. the wheel track settlement or rutting,
3. the fast settlement rate of the embankment that influences the road life,
4. the sagging settlement in the cross direction,
5. the weakness of road pavement due to induced tensile stresses in the embankment.

In conventional designs, the first four points can be practically solved within reasonable range of expenses. The last one is still a lack of proper knowledge and understanding. However it is not seriously considered in the design even though some methods have been proposed because most of them are still not cost effective.

The research work was proposed as the first step to deal with the problems. The concept is to test the effectiveness of to base sheet to reduce the tensile stress in the embankment and hence strengthen the pavement structure. Unfortunately only one product of soft base sheets is used in the test embankments. Some results are obtained and presented in this paper. Still little knowledge has been gained and a proper solution in still needed.

2. THE TEST EMBANKMENTS

Two embankment tests were carried out. One is in the central part of the country and the other is in the south. Instruments were installed to observe the excess pore pressure settlements and lateral movement (see Figure 1). To measure the elongation of the contact surface between the embankment and the original ground surface, a certain kind of instrument was designed and installed above the base sheet. Unfortunately the instrument failed during the embankment test and the key test result was not obtained.

Subsoil investigations were done in prior to the test construction to find the natural properties of the subsoils. Some basic properties are shown in Figure 2.

The embankment were done by the increment loading method. The first embankment lift is thickest and much thicker than the later ones.

The pavement strength was measured by means of the Benkleman's beam deflection test method. The measurements were carried out after the construction.

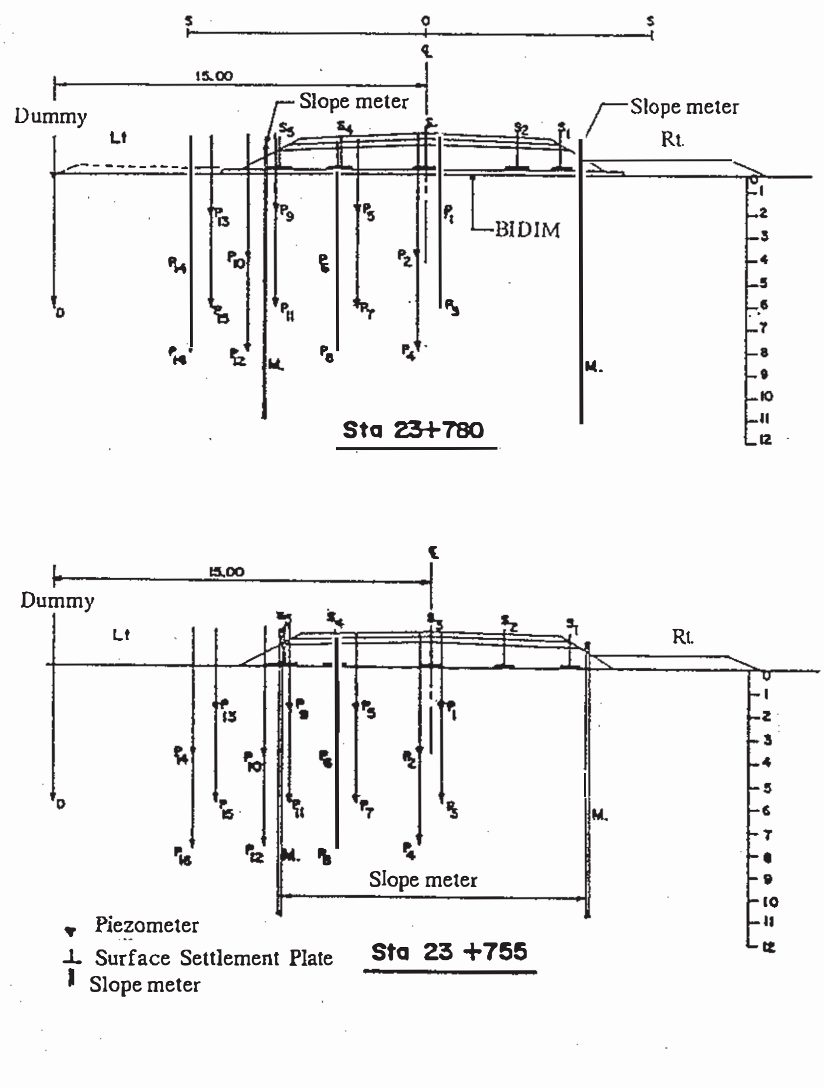

Figure 1. Instrumentation

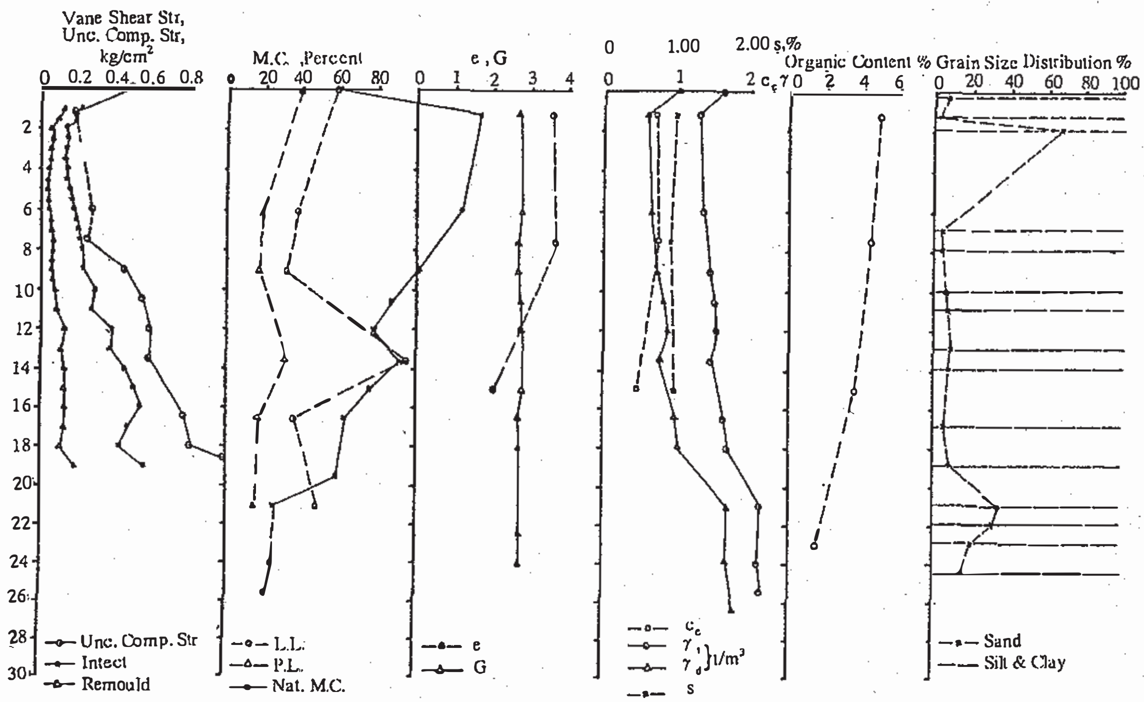

Figure 2. Subsoil Properties

3. LOAD-ELONGATION BEHAVIOR OF THE BASE SHEET

The base sheet used in the embankment test is a nonwoven fabric which is rather soft and elongable. The result of the extension test as shown in Figure 3 shows that the material is highly elongated during the early stages of load application. After a certain amount of elongation, the material stiffness is suddenly developed. The applied load is sharply increased to a certain level of loading magnitude and suddenly collapsed.

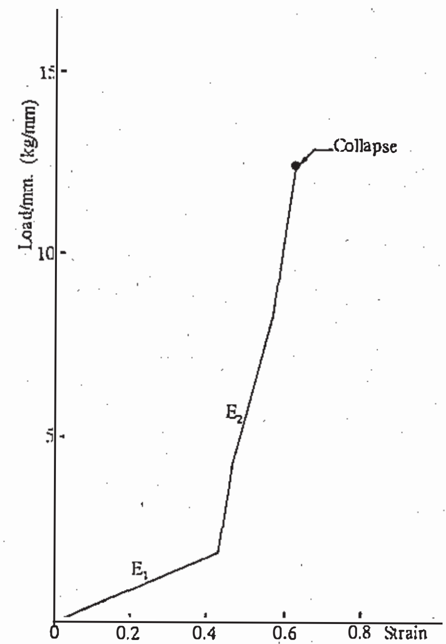

Figure 3. Behavior of Base Sheet Under Load

4. ACCESS PORE PRESSURE AND SETTLEMENT PREDICTIONS

The access pore pressure induced by the embankment weight was found to be predictable by:-

$$\Delta u = \Delta \sigma_{oct} \quad \text{..............(1)}$$

where the octahedral stress was obtained from the Bossinesq stress equation.

As for the settlement prediction, the simple one dimensional consolidation solusion as shown in the following equation is used.

$$S_c = \frac{C_c}{1 + eo} H. \log \frac{(\sigma_c + \sigma_v)}{\sigma_c} \quad ...(2)$$

The settlement-time relationship is calculated by assuming the linear variation of the access pore pressure with depth.

5. THE TEST RESULTS

(1) Rather good agreement between the observed and calculated access pore pressures were found (Figure 4).

(2) The results of measured excess pore pressures versus embankment heights indicates high shear flow occured in the area more than 3.5 meters offset from the center of the embankment. The results were found to be similar for those embankments with or without the base sheet.

(3) The settlement prediction by using the simple analytical method was found to be inadequate to predict the settlement see

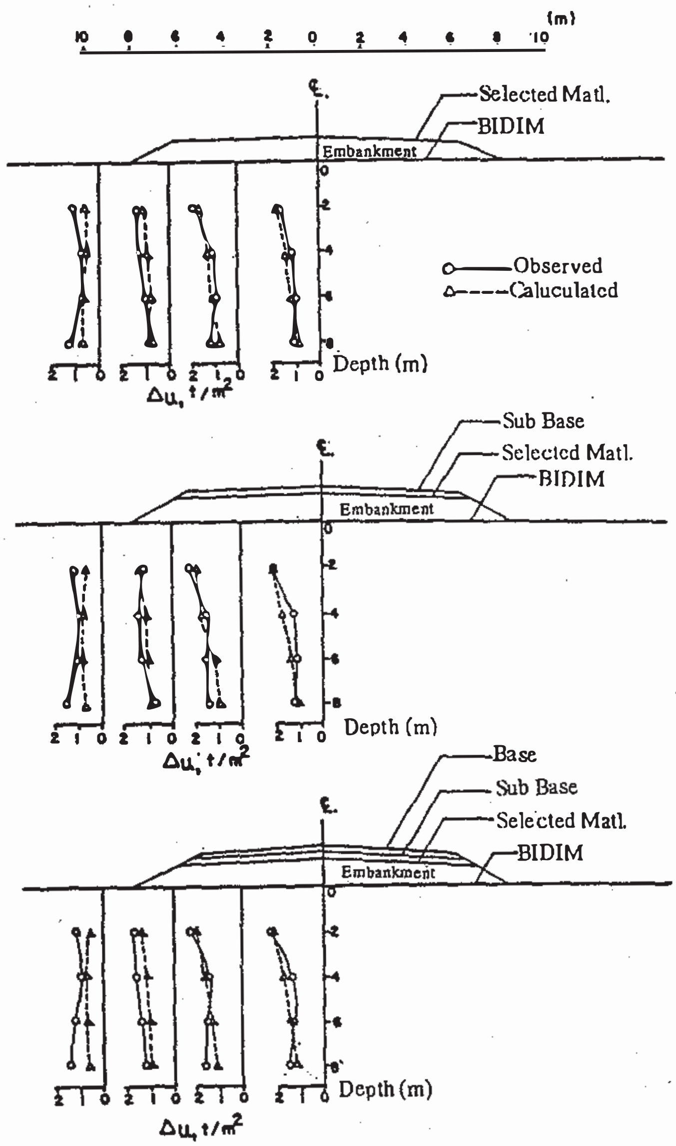

Figure 4. Comparison of Excess Pore pressure section No. II Km. 23+780

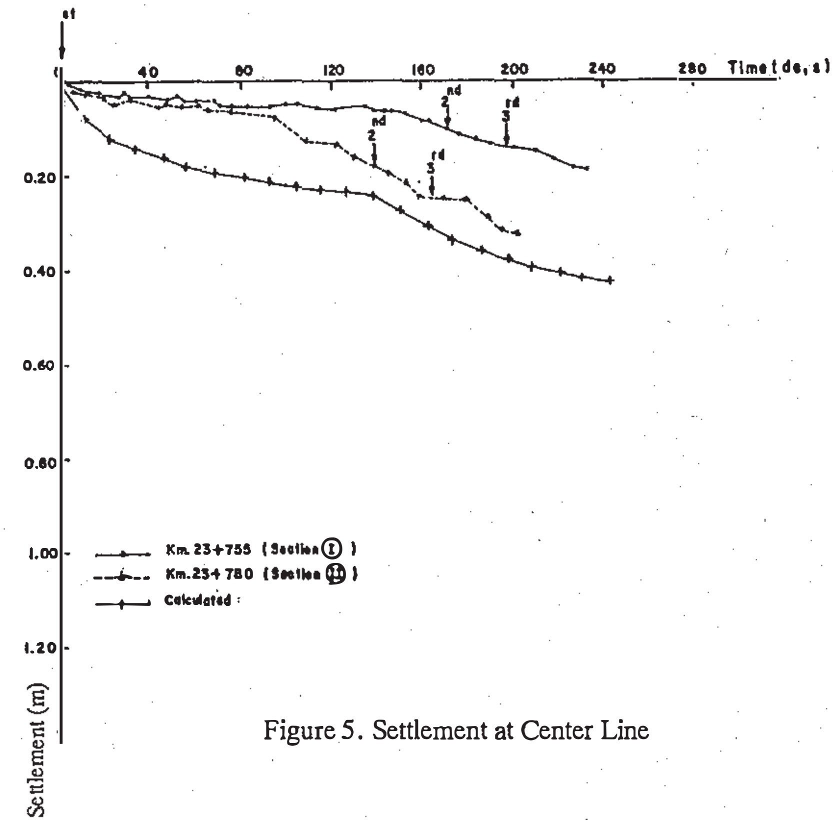

Figure 5. Settlement at Center Line

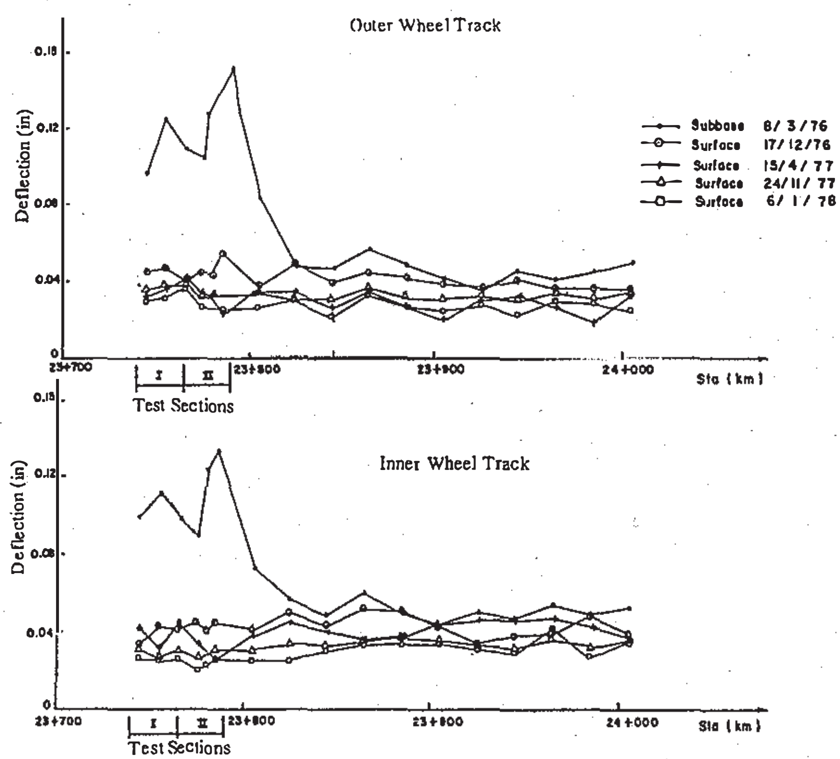

Figure 6. Comparison of Apparent Deflection on the Left Lane of Bang Pli-Bang Bho Hwy.

also Figure 5. It is suggested that the settlement correction factor due to two-dimensional stress effect should by applied, and the settlement calculation should be done by using the measured excess pore pressure in stead of the calculated one.

(4) The result of the Benkleman's beam deflection measurement as shown in the Figure 6 indicates stronger embankment for the one which is reinforced by the base sheet.

6. CONCLUSION

The results of the test embankments do not reveal a concrete solution for the research objectives which intend to seek a certain means for reducing tensile stress in the earth embankment on soft soil foundation. Anyhow, it can be concluded that the geofabric base sheet does not have much effect on the behavior of the normal embankment in terms of the induced excess pore pressure and the settlement as expected, but it does have some impact on increasing the embankment strength and accelerating the settlement. Further research work should be done in combination with proper tensile stress measuring instrument to find the capability of the base sheet reinforcement.

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