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Effects of Geotextiles on Development of Rutting of Concrete Block Pavement under Repeated Loadings

by

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1 INTRODUCTION

In Japan, a concrete block pavement(CBP) has been widely used for lightly trafficed areas, such as footpaths, and parking lots. Recently, however,it began to be adopted to a carriage way area of major roads. Most of streets and arterial roads in our country generally have a high commercial vehicle ratio. Thus the pavement is exposed to heavy vehicular traffic.

To maintain the surface smoothness, evenness and riding comfort of long duration, one of the most significant matters to be considered in this case is to prevent a rutting caused by repetitions of wheel paths.

In the greater part of this country, subgrades are covered by volcanic cohesive soils of which the natural water contents are very high and the bearing capacity are considerably low; for example, the CBR is commonly 1-2%. Consequently, it is often required to strengthen a pavement structure or to improve a subgrade soil.

This paper presents results and discussions of a laboratory and a field experimental investigations on the effects of shape and paving pattern of concrete blocks on a deformation performance, and on both separating and reinforcing effects of geotextiles embedded in CBP on a poor subgrade.

2 EXPERIMENTAL PROGRAM

For the purpose of investigating fundamental behaviours of CBP subjected to repeated loadings, both a small-scale model test and a full-scale prototype test were carried out using a laboratory wheel tracking test machine and an actual moving truck, respectively.

2.1 Design of Laboratory Model Test

The size of paving blocks used for a mini-scale model test was determined on a reduced scale of 1 to 5, as shown in Table 1, by a model law based on a physical and mechanical similitude.

Table 1 Block size used for testing

1 : 5	Block size (mm) length	width	height	Contact pressure of tyre (kPa)
Prototype	220	110	75	540
Model	44	22	15	108

Figure 1 shows three different kinds of block paving patterns tested: Brick, Fishbone and Colock. Plane dimensions of the test specimen are 30cm in width and 30cm in length. A sectional elevation of the model pavement is composed of concrete block (CB), sand cushion (SC) and oil-clay plaster layers as shown in Fig.2. A fine sand employed for both a joint and a cushion layer is 0.3mm in maximum diameter and is controlled at a moisture content of about 6%.

Two kind of thin geotextiles which are spunbonded non woven polyester fabrics and have a thickness of 0.5mm are used. Type-A has soft properties (elongation - 75%) Type-B is treated to hard properties using an adhesive agent(elongation - 25%). They are laid in three cases: the upper, the middle and the lower parts of the sand cushion layer.

A wheel tracking test (WT-test) and other test: e.g. a small-size plate bearing test (6cm in diameter) were conducted for evaluating the pavement performance.

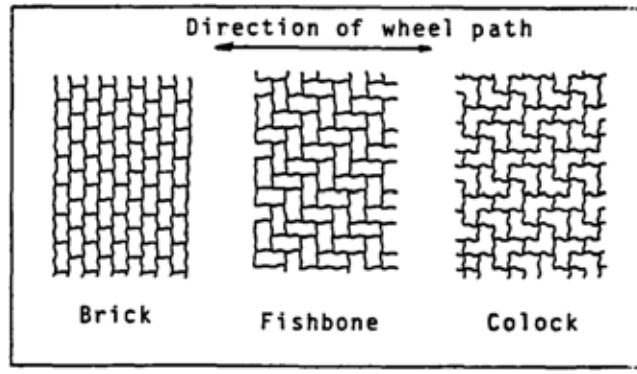

Fig.1 Block paving patterns

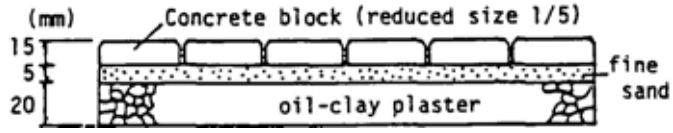

Fig.2 Sectional view of model test pavement

2.2 Design of Field Full-scale Test

Figure 3 shows seven different kinds of the field test sections (5m in width, 70m in length, 40cm in depth) which were constructed in a factory yard in Chiba prefecture.

Concrete block pavings used in each half lane are Fish bone and Colock patterns. The pavement cross-sections below CB are a sand cusion of 2cm, a crushed stone base course of 10cm, a crusher-run subbase of 20cm, and a volcanic cohesive subgrade soil of CBR = 1%.

Geotextiles are embedded in three parts as shown in Fig. 3. Type-A mentioned above is laid on the top surface of base course. Type-C that is made up of a combination of a non-woven fabric and a polymer-grid is used on the lower part of base course. Type-D that is a thick spunbonded non-woven fabric is placed on the subgrade.

A Pavement Structural Evaluation (PSD) Test that is a non-destructive testing method to measure a multi-layered pavement's performance, a surface profile test and other tests were carried out for assessing the pavement behaviours under moving wheel loadings.

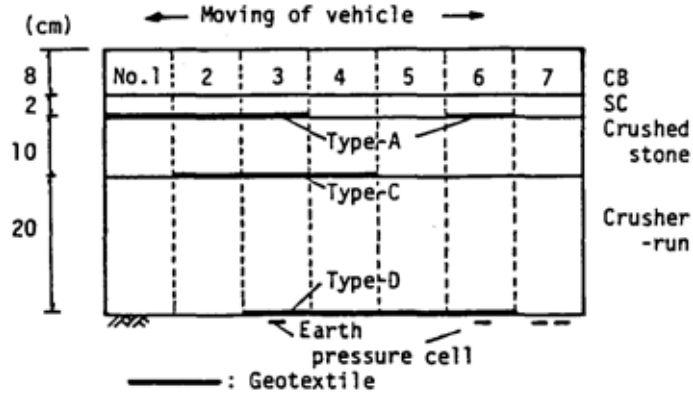

Fig.3 Sectional view of field test pavement

3 RESULTS OF EXPERIMENTAL INVESTIGATION

Main results obtained from this study are briefly discussed below.

3.1 Model Test Results

As the results of a wheel tracking test, for investigating the effects of geotextiles, the number of wheel loadings - surface deformation (rutting) relationships of a Brick paving pattern are demonstrated in Fig.4.

The separation by non-woven soft geotextiles, which are laid between the sand cushion and the clay layer, has an effect of reducing the rutting of about 35% than that of no geotextiles. Moreover, it may be seen that the hard geotextiles has a reinforcing effect in addition to the separation one.

On the contrary, to separate a sand joint from a sand cushion using a geotextile sheet makes the surface deformation behaviour unstable and hense forms the cause for increasing finally the rutting. Figure 5 shows the settlement of a sand joint under the action of wheel loadings. It is found that the geotextile on the upper part of sand cushion increases twice the settlement of a sand joint than that in the case of no geotextile. This is considered that the geotextile on SC causes a decline of interlocking action among blocks and interrupts the supply and interaction of sands from SC.

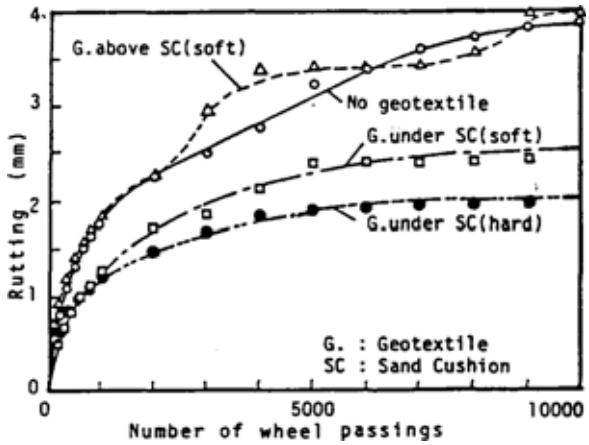

Fig.4 Development of rutting under wheel loadings

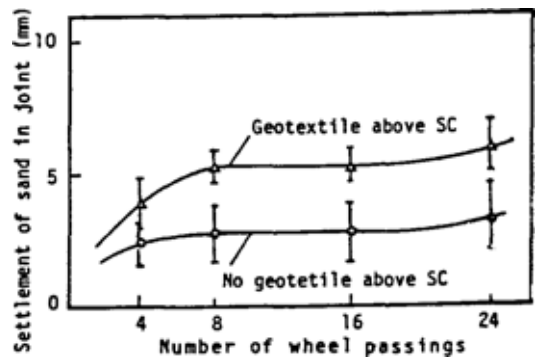

Fig.5 Settlement of sand joint under the action of wheel loadings

3.2 Full-scale Test Results

A permanent surface deformation after 250 wheel loadings of a 5-ton-truck wheel is desplayed in Fig.6.

The deformation of Colock paving is less than that of Fishbone's one, in the case of no geogrid. There is, however, no significant difference between Colock and Fishbone pavings using a geogrid in base course layer. This means that a restraint effect of a geogrid on the settlement can be discovered in the Fishbone paving.

Figure 7 shows the relation between the modulus of deformation of block layer, Ep, and the wheel loads by a PSE test. Increasing in wheel loads tends to increase in interlocking effect of block layer accompanied by increases in its moulus of deformation. It is observed from the figure that the Colock paving has a high bearing capacity for heavy traffic.

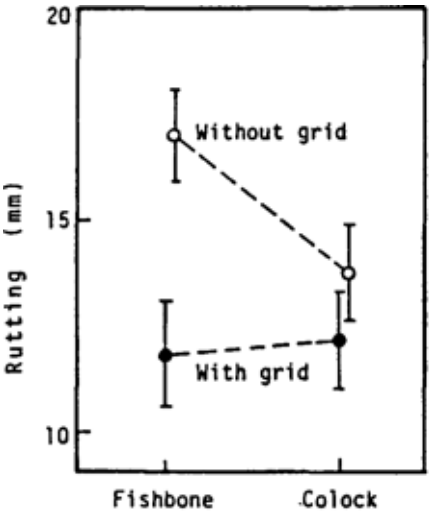

Fig.6 Effects of geogrid on rutting

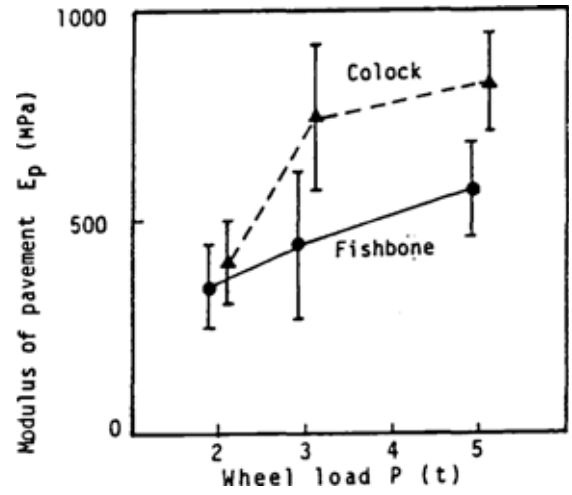

Fig.7 Modulus of deformation of CBP vs wheel load

Figure 8 demonstrates the effects of the geotextile on both the evenness index, Fi, and the ratio of pavement structural evaluation, Ep/Es; where Fi is the value of the rutting in a transverse direction multiplyed by the roughness in a longitudinal direction and then devided by the area of test pavement. It is meant that smaller the value of Fi, better the evenness of the pavement. Ep/Es is a factor of pavement structural stiffness reflecting the subgrade condition; where Ep is the modulus of deformation of pavement, and Es is the subgrade's one.

From this figure, effects of geotextiles in the case of Fishbone paving are found as follows;

(1) Although the geotextile on the upper part of base course has little effect on the pavement structural evluation, it results in maintaining the surface evenness by a prevention of carrying-away of sand particles from SC.

(2) The geogrid embedded in the base course increases in the pavement structural evaluation, and also has the effect on the surface evenness.
(3) The geotextile on subgrade has the effect on surface evenness. It is difficult, however, to assess its effect on the pavement structural evaluation, because the base course without a geotextile is constructed inevitably thicker than that with a geotextile.

It is interesting to note that each sections of Colock paving has almost the same degree of evenness regardless of the pavement structure beneath SC.

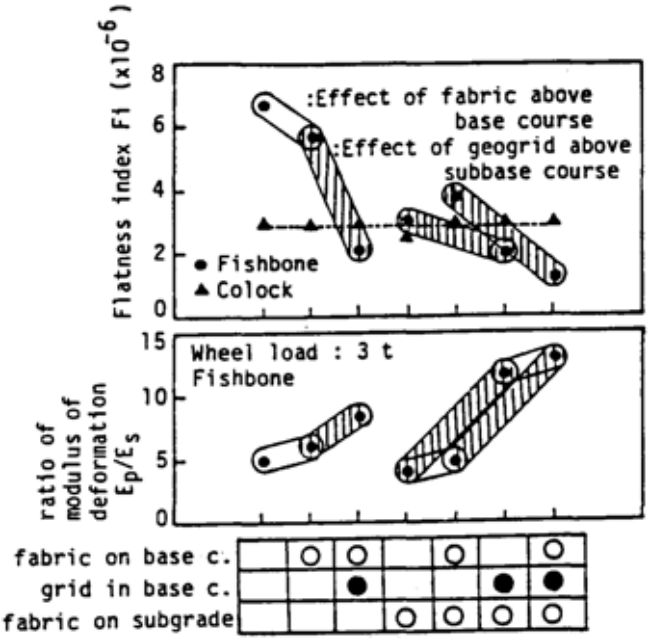

Fig.8 Effects of Geotextiles

4 CONCLUSIVE REMARKS

It was clearly evident that the application of geotextiles to CBP brought about the beneficial effects on the surface evenness under traffic loadings, and on the reinforcing the pavement structure. It was found that the Colcck paving was superior than other block pavings in several respects.

5 REFERENCES

1) Miura,Y. et al.: Evaluation of existing pavement based on deflection and radius of curvature and overlay design, Proc. 4th Int. Conf, on S.D.A.P., Vol.l, 1977
2) Shackel.B.: The evaluation and design of interlocking concrete block pavements subjected to road traffic, Tech. Rep. RP/9/80, 1980
3) Knapton,J.: Concrete block pavement design in U.K., Proc. 2nd Int. Conf, on C.B.P., 1984