# REPORT ON EXCAVATION SURVEYS ON INTERLOCKING BLOCK PAVEMENTS WITH GEOTEXTILE

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## ABSTRACT

In Japan, geotextile has been used a part of interlocking block pavement because of expecting to increase its durability. The application of geotextile for interlocking block pavement between base course and cushion sand under interlocking block prevents the cushion sand loss into the base course. The loss often causes the change of interlocking block position, damage of interlocking block, and roughness. In addition, mechanical reinforcement and water drainage are secondary functions of geotextile.

Excavation surveys of interlocking block pavement that had been in use for 2-15 years after completion were carried out at five sites in order to quantitatively confirm the effects of geotextile. Research items were rutting depth, roughness, interlocking block breakage rate, residual rate of joint sand, mixing of cushion sand into base course, the quality of joint and cushion sand, and the properties of geotextile etc.

The results of the excavation surveys can be summarized as follows.

- No damage to the geotextiles was observed when the pavements were cut.
- No change in the physical properties of the cushion sand was also found.
- The separation and filtering effects of the geotextiles was judged to be excellent.
- It was found that geotextile improved the long-term performance of the interlocking block pavements.

## 1. INTRODUCTION

Interlocking block pavements were first used in sidewalks and streets in Europe, mainly in Germany in the 1950s, and are now used in a wide range of areas including heavy-traffic roads. Since their introduction to Japan in 1973, they have served as aesthetically pleasing pavements for sidewalks, town streets, residential streets and parks, because of considering on its excellent design factors, for example, colors, shapes and surface textures. Today, the estimated annual use of interlocking blocks is about 8 million $m^2$. As sidewalks have been the main application of interlocking blocks in Japan, there are fewer examples of road applications than in Europe, but usage for roads is expected to expand.

Geotextile is defined as a planer, permeable, polymeric (synthetic or natural) textile material, which may be nonwoven, woven or knitted, used in contact with soil and/or other materials in geotechnical and civil engineering applications. In Japan, geotextile has been used as a functional material for separating the cushion sand from the base course. The annual use of geotextile products with a mass per unit area of 60 $g/m^2$ is about 1 million $m^2$, which accounts for about 10% of the total area paved with interlocking blocks.

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In addition to the separation function, geotextile helps maintain longitudinal evenness due to its reinforcement and water drainage functions, and so its usage is anticipated to increase.

To verify the effects of geotextile installed in interlocking block pavements, the authors performed a series of pavement excavation surveys at five interlocking block pavement sites that had been in use for 2 to 15 years. The performance and durability of geotextile, as well as the properties of other pavement materials (interlocking blocks, cushion sand, joint sand, base and subgrade) were studied[1,2]. This paper reports on the results of these surveys.

## 2. OUTLINE OF GEOTEXTILE

Geotextile is a fiber material used for earth structures with many successful cases of application in both Europe and Japan. In Japan, usually the term “geotextile” loosely refers to any products made of geotextile, including all sheeted products having mesh or grid configurations and composite products made of two or more materials. In accordance with the increasing use of geotextile, its scope of application has also diversified, and today the general term “geosynthetics” is used to include “geogrid”, “geonet”, “geomembrane” and “geocomposite”, in addition to geotextile. The classification of geosynthetics is shown in Fig. 1 [3].

Geotextile of the continuous fiber type in the form of nonwoven fabric sheets is usually used as a separator in an interlocking block pavement. This type of geotextile has a high tensile strength (about 30 kN/m for a mass per unit area of 300 g/m$^2$), due to the distinctive manufacturing processes in which fibers created in the fiber-forming process are directly transformed into a sheet without cutting. Applications include water drainage, filtering, reinforcement and protection.

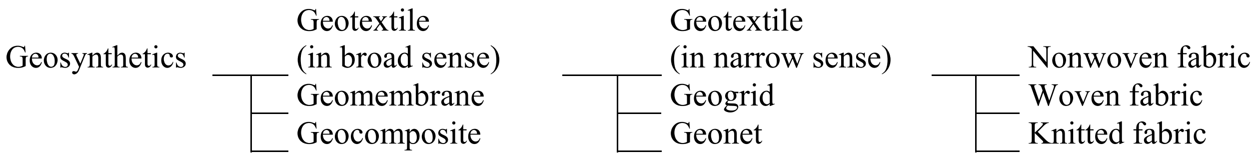

**Figure 1. Classification of geosynthetics.**

## 3. SURVEY METHOD

### 3.1 Survey sites and period

On the basis of the construction conditions, climate, land use and other conditions, the five sites listed in Table 1 were selected for the excavation survey, the purpose of which was to study the performance and durability of geotextile and the properties of other pavement materials. The sites were: One site in Hokkaido (Iwamizawa City), where geotextile was installed in sidewalk and driveway apron sections; one in Yamanashi Prefecture (Lake Kawaguchi) and three in Tokyo (Meguro-ku, Kameari in Katsushika-ku, and Senjumidori-cho in Adachi-ku), where the material was installed in road sections. The daily traffic volume of heavy vehicles at each site was less than 100 vehicles. The sites, in order of decreasing traffic volume, were: Senjumidori-cho, Meguro-ku and Kameari, Lake Kawaguchi and Iwamizawa.

The surveys were carried out between October 1999 and February 2000. The service period at the time of the surveys ranged between 2 years and 8 months to 14 years and 1 month.

**Table 1. Summary of survey sites.**

| Site | Locations | Type of road | Construction month/year | Area ($m^2$) | Remarks |
|---|---|---|---|---|---|
| 1.Iwamizawa | Hokkaido | Sidewalk & driveway apron | Nov/1990 | <5,000 | — |
| 2.Meguro-ku | Tokyo | Roadway, intersection | Mar/1990 | 2,142 | Roadway: permeable<br>Intersection: normal |
| 3.Lake Kawaguchi | Yamanashi | Roadway | Apr/1997 | 500 | 7 to 8% of slopes |
| 4.Kameari | Tokyo | Roadway (intersection) | Dec/1985 | 400 to 500 | Permeable |
| 5.Senjumidori-cho | Tokyo | Roadway (shopping street) | Jun/1994 | <3,300 | Normal |

### 3.2 Pavement configurations and materials used

The types and laying patterns of the blocks and the below-bedding-course configurations are shown in Tables 2 and 3, respectively. The types of interlocking blocks were either the wavy-sided or straight rectangular type, and those at the roadways on the Meguro-ku and Kameari sites were of the permeable type. The blocks at the Iwamizawa site were 60 mm thick (the thickness specified for sidewalks), while those at the other sites were 80 mm thick (the thickness specified for roadways). The most common laying pattern was the 90-degree herringbone bond, except for the stretcher bond at the intersection on the Meguro-ku site and the 45-degree herringbone bond at the Senjumidori-cho site.

**Table 2. Types and laying patterns of interlocking blocks.**

| Site | Type of ILBlock | Thickness (mm) | Spacer nibs | Laying pattern |
|---|---|---|---|---|
| 1.Iwamizawa | Normal, wavy-sided | 60 | No | 90-degree herringbone bond |
| 2.Meguro-ku | Roadway: Permeable, wavy-sided | 80 | Yes | 90-degree herringbone bond |
| | Intersection:Normal, rectangular | | No | Stretcher bond |
| 3.Lake Kawaguchi | Normal, rectangular | 80 | Yes | 90-degree herringbone bond |
| 4.Kameari | Permeable, wavy-sided | 80 | No | 90-degree herringbone bond |
| 5.Senjumidori-cho | Normal, rectangular | 80 | Yes | 45-degree herringbone bond |

Sand was used in the bedding course of all the pavements to the thickness of either 20 mm or 30 mm. For the base courses, either crushed stone or a permeable asphalt stabilized mixture was used; the latter was used at the sites paved with permeable interlocking blocks. Sites with heavy traffic had the subbase in place, and were paved with crusher-run. The main purpose of installing geotextile between the bedding and base courses was to prevent the loss of cushion sand. Geotextile with a mass per unit area of 60 $g/m^2$ was used at all the sites.

**Table 3. Configurations of below-bedding-course pavement.**

| Site | Bedding course | | Base course | | Subbase | | Subbase and below | |
|---|---|---|---|---|---|---|---|---|
| | Type | Thickness (mm) | Type | Thickness (mm) | Type | Thickness (mm) | Type | Thickness (mm) |
| 1.Iwamizawa | Sand | 30 | Crusher-run (C-30) | - | - | - | - | - |
| 2.Meguro-ku | Sand | 30 | Permeable ASM [a] | 40 | Crusher-run (C-30) | 120 | Sand filter layer | 100 |
| 3.Lake Kawaguchi | Sand | 30 | Crusher-run (C-30) | 100 | - | - | Anti-frost layer | 100 |
| 4.Kameari | Sand | 20 | Permeable ASM [a] | 100 | Crusher-run (C-40) | 200 | Sand filter layer | 100 |
| 5.Senjumidori - cho | Sand | 20 | Permeable ASM [a] | 100 | Crushed stone (M-40) | 150 | Crusher-run (RC-40) | 150 |

[a] Asphalt stabilized mixture

### 3.3 Survey method

Prior to the excavation surveys, measurements were taken to study the pavement performance. The measured items were the roughness, rutting depth and block breakage rate. Furthermore, as reference values for evaluating the condition, the deflection level was measured with a handy falling weight deflectometer (hereafter, HFWD), and the movement of block, block joint width and residual rate of joint sand were also measured.

The purpose of excavating the sites was to visually study the condition of cushion sand, geotextile, base and subgrade on sites that had suffered damage such as settlement, joint displacement and corner breakage of blocks, as well as the condition in the prescribed areas of the intact sites. Cushion sand was also studied for any infiltration into the base. With regard to the exposed base and subgrade, the deflection level was measured with HFWD to confirm the bearing capacity levels.

During the excavation, the joint sand, cushion sand, geotextile, base material and subgrade were sampled and their physical properties were measured. For joint sand, the amount passing through a 75-µm sieve was measured. For cushion sand, particle distributions, decantation testing and water content were measured. For particle-type base materials, particle distributions were measured. Where necessary, for roadway pavements the plasticity index and modified CBR were also measured. If permeable bituminous materials were used, laboratory permeability testing (constant head) was performed on 300-mm square specimens sampled from those sites. Subgrade was subjected to laboratory disturbed soil CBR testing to confirm the bearing capacity. For the sampled geotextile specimens, the tensile strength, tensile ductility, tear strength and permeability coefficient were measured, and the results compared with those for unused geotextile samples.

## 4. SURVEY RESULTS

The results of the property measurements taken at the five sites are shown in Table 4. The MCI (Maintenance Control Index :

## Table 4. Results of Pavement Property Measurements.

| Site | Measurement point | Defor-mation found | Years of service | Roughness (mm) | Rutting (mm) | Block breakage (%) | | MCI (MCI$_0$) | Infiltra-tion of the cushion sand into the base |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Overall | To be Replaced | | |
| 1.Iwamizawa | Footway | Base c. | 8.9 | - | 5.2 | 0.4 | (0) | (7.9) | Nil |
| | Apron | Base c. | | - | 9.0 | 2.2 | (0.3) | (6.7) | Nil |
| 2.Meguro-ku | Driveway | Base c. | 9.7 | 3.7 | 3.5 | 4. 7 | (0.6) | 6.3 | Nil |
| | Intersection | Base c. | | - | 19.5 | 0.2 | (0) | (6.7) | Nil |
| 3.Lake Kawaguchi | Driveway | Nil | 2.7 | 3.3 | 3.5 | 1.0 | (0) | 7.2 | Nil |
| 4.Kameari | Driveway | Base c. | 14.1 | 3.3 | 3.0 | 4.0 | (0) | 6.5 | Nil |
| 5.Senjumidori | Driveway | Base c. | 5.3 | 4.2 | 1.5 | 2.3 | (0.6) | 7.1 | Nil |

## Table 5. Results of the Excavation Surveys, Part 1.

| # | Site | Excavation survey | | Deflection, HFWD (mm) | | | Block movement (mm) | | Average of joint width(mm) | | Residual rate of joint sand (%) | Bedding course thickness (mm) | Cushion sand | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Location | Surface condition | ILBlock | Base course | | | | Cross section | Longitudinal section | | | Maximum size (mm) | FM | 75-μm passing (%) | Moisture content |
| | | | | D$_0$ | D$_0$ | D$_{20}$ | Max | Ave | | | | | | | | |
| 1 | Iwamizawa | F | Undamaged | 0.23 | 0.24 | 0.15 | 1.3 | 0.8 | 1.6 | 2.4 | 100 | 35.2 | 2.36 | 2.95 | 1.6 | - |
| | | A | Damaged | 0.23 | 0.25 | - | -2.1 | -0.4 | 2.3 | 2.0 | 99.3 | 46.1 | 4.75 | 3.25 | 2.6 | - |
| 2 | Meguro-ku | D | Undamaged | 0.19 | 0.24 | 0.11 | 11.0 | 4.2 | 3.0 | - | 99.7 | 37.7 | 2.36 | 1.94 | 9.7 | 13.4 |
| | | (P) | Damaged | 0.19 | 0.19 | 0.10 | 33.0 | 15.1 | 3.6 | 3.7 | 96.6 | 34.6 | 2.36 | 1.83 | 10.1 | 11.7 |
| | | I | Damaged | 0.22 | 0.36 | 0.14 | 8.0 | 2.8 | 2.0 | 2.0 | 98.9 | 26.8 | 2.36 | 1.94 | 6.3 | 14.4 |
| 3 | Lake Kawaguchi | S | Undamaged | 0.33 | 0.37 | 0.08 | -3.0 | -0.3 | 3.1 | 2.8 | 95.8 | 64.8 | 2.36 | 3.05 | 2.9 | 5.0 |
| | | L | Undamaged | 0.39 | 0.31 | 0.13 | -7.0 | -2.9 | 3.8 | 3.7 | 76.0 | 48.4 | - | - | - | - |
| 4 | Kameari | D (P) | Undamaged | 0.17 | 0.15 | 0.08 | -20.5 | -3.4 | 4.3 | 3.6 | 100 | 42.9 | 4.75 | 2.61 | 6.3 | 11.7 |
| | | | Damaged | 0.15 | 0.15 | 0.09 | 19.0 | 9.6 | 4.9 | 3.9 | 90.9 | 44.3 | 4.75 | 2.59 | 6.0 | 10.1 |
| 5 | Senjumidori -cho | D | Undamaged | 0.18 | 0.18 | 0.12 | -7.5 | -3.0 | 2.4 | 1.8 | 77.5 | 23.2 | 4.75 | 2.49 | 2.9 | 11.3 |
| | | | Damaged | 0.21 | 0.21 | 0.11 | -18.5 | -6.1 | 2.4 | 2.6 | 17.8 | 12.1 | 4.75 | 2.23 | 13.4 | 8.9 |

Notes: Excavation survey locations are as follows.
F: footway, A: driveway apron, D: Driveway, P: permeable, I: Intersection, S: slope, L: leveled.

This is rated on a scale of 0 to 10) was calculated in accordance with "The Outline of the Design and Construction Manual for Interlocking Block Pavement [4)]". The roughness was found to be 5 mm or less, which was in conformance with the maintenance value specified in " The Outline of the Design and Construction Manual for Interlocking Block Pavement" (hereafter, "the specified maintenance value"). The rutting depth was found to be 20 mm or less. Although this was below the specified maintenance value of 30 mm, some showed slightly larger values, such as 9 mm at the driveway apron section on the Iwamizawa site and 20 mm at the intersection of the Meguro-ku site.

### Table 6. Results of the Excavation Surveys, Part 2.

| # | Site | Excavation survey | | Joint sand 75-µm passing (%) | Permeable asphalt base course, Coefficient of permeability (cm/s) | Stone,maximum size (mm) | Physical property of granular material base course | | Laboratory CBR of subgrade(%) | Physical property of geotextile | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Location | Surface condition | | | | PI | Modified CBR(%) | | Tensile strength (Retention %) | Tensile Strain (Retention %) | Tear strength (Retention %) | Coefficient of vertical permeability(cm/s) | Ultimate viscosity (Retention %) |
| 1 | Iwamizawa | F | Undamaged | - | - | - | - | - | - | 49.5 | 84.0 | 49.3 | 0.5 | 97.5 |
| | | A | Damaged | 38.6 | - | 25 | - | - | - | 47.5 | 79.1 | 45.1 | 0.5 | 95.1 |
| 2 | Meguro-ku | D | Undamaged | 17.5 | $9.5x10^{-2}$ | 30 | 3.5 | - | - | 18.7 | 59.1 | 18.1 | 0.5 | 95.6 |
| | | (P) | Damaged | 21.9 | $1.3x10^{-2}$ | 30 | 6.0 | 49.6 | 52.7 | 36.2 | 56.3 | 61.5 | 0.5 | 96.4 |
| | | I | Damaged | 14.9 | $12.5x10^{-2}$ | 30 | 5.6 | - | - | 46.1 | 73.3 | 41.4 | 0.5 | 94.0 |
| 3 | Lake Kawaguchi | S | Undamaged | 13.5 | - | 30 | 4.9 | 39.1 | 21.4 | 40.4 | 74.1 | 22.7 | 0.5 | 98.9 |
| | | L | Undamaged | - | - | - | - | - | - | 21.6 | 76.6 | 17.0 | 0.5 | 97.1 |
| 4 | Kameari | D | Undamaged | 16.4 | - | 40 | 4.4 | - | 1.4 | 12.0 | 55.0 | 7.0 | NA | 91.0 |
| | | (P) | Damaged | 14.1 | - | 40 | 4.1 | 72.6 | 1.3 | 3.0 | 36.0 | 7.0 | NA | 94.0 |
| 5 | Senjumidori-cho | D | Undamaged | 4.7 | $4.8x10^{-2}$ | 40 | 3.2 | - | - | 39.0 | 57.0 | 57.0 | NA | 100 |
| | | | Damaged | 3.8 | $5.1x10^{-2}$ | 40 | 3.6 | 95.3 | 35.4 | 13.0 | 45.0 | 7.0 | NA | 101 |
| | Physical property of unused geotextile | | | - | - | - | - | - | - | (125) (N/5 cm) | (72.3) (%) | (118.9) (N) | (=>0.5) (cm/s) | (0.604) (dl/g) |

Notes: Excavation survey locations are as follows.
F: footway, A: driveway apron, D: Driveway, P: permeable, I: Intersection, S: slope, L: leveled.

The block breakage rate was found to be small; even the 14-year-old site showed an excellent value of 5% or less (specified maintenance value: 20%). The MCI was consequently found to be 6 or greater, which indicated that the pavements were in reasonably good condition, and “there was no need repair work despite having many defects”.

Infiltration of the cushion sand into the base was not observed at any of the sites, indicating that geotextile had perfectly served as a separator between the cushion sand and base. It was found that the main cause of deformation including rutting was the deformation of the base course. At the Senjumidori-cho site, traveling vehicles were producing "rattling" on the pavement. Other than this site, the damages were found to be minor, which showed that the pavements had remained in reasonably good condition.

The excavation surveys were performed both at undamaged and damaged sites. The results are shown in Tables 5 and 6. On the interlocking blocks or the base course alike, no difference was found in the deflection level measured with HFWD between the undamaged and damaged areas. However, when analyzing the interlocking blocks alone, the sites having a permeable asphalt-stabilized base (No.2,4,5) tended to show smaller values than those having a crushed-stone base (No.1,3).

The block joint width satisfied the specified maintenance value of 5 mm or less. The residual rate of joint sand showed good values of 90% or more on most of the sites, except for a very low value of 17.8% found at the damaged part of the Senjumidori-cho site where "rattling" was produced by passing vehicles. The thickness of the bedding course was found to be larger than the design thickness at most of the sites, except again for the damaged part of the Senjumidori-cho site, where it had been reduced to about half of the design thickness.

For damaged parts, there was a tendency for larger amounts of cushion sand to pass through the 75-μm sieve, the largest being 13.4% found at the damaged part on the Senjumidori-cho site. Such a level of cushion sand pulverization must have been a cause of the rattling. The amount of joint sand passing through the 75-μm sieve is specified to be 10% or less, but a large rate of 38.6% was found at the driveway apron section (a damaged area) on the Iwamizawa site. On the other hand, the damaged part of the Senjumidori-cho site showed a good rate of 3.8%. Therefore, while the loss of joint sand was a cause of the shaking and rattling, the quality of joint sand was unrelated.

At the Senjumidori-cho site, mechanically stabilized crushed stone was used as the base material. The quality of the crushed stone at the time of excavation survey satisfied the required values in terms of both the modified CBR and plasticity index (PI) of 80% and 4, respectively. Therefore, the quality of mechanically stabilized crushed stone was not a cause of the rattling. Crusher-run was used at other sites, whose quality also satisfied the required values in terms of both the modified CBR and plasticity index of 20% and 6, respectively. No problem was found in the quality of crushed stone used in the base.

At the Meguro-ku and Lake Kawaguchi sites, the sand in the filter layer or the anti-frost layer below the subbase level was sampled for laboratory CBR values of the subgrade. At the Senjumidori-cho site, the recycled crushed stone (RC-40) had been replaced with mountain sand in later underground installation work; therefore, the mountain sand was measured instead here. Large CBR values of 20 or more were observed at these sites. The subgrade at the Kameari site was clayey and showed a low laboratory CBR values of 1.3 or 1.4%. However, the inadequate bearing capacity of the subgrade did not seem to have accelerated the damage.

Having been firmly embedded in the base or another neighboring layer, geotextile was partially damaged upon sampling, and so its mechanical properties were all found to be at reduced levels. On the other hand, it was found that the ultimate viscosity factor that provides an indication of polymeric material deterioration (IVF), also an indication of polymerization degree was reduced by 10% or less, which shows that little deterioration had occurred. Also, the oldest, 14-year old Kameari site showed an adequate ultimate viscosity factor of 92.5%.

Given this, even if installed below cushion sand, there seems to be no risk of loss of geotextile durability in 14 or so years in service.

It was found that the coefficient of permeability of the mixture sampled from each site using permeable asphalt mixture in the base remained at a high level, and was equal to or greater than the required coefficient of permeability for permeable mixtures, i.e. $1.0 \times 10^{-2}$ cm/s. This must have been due to the fact that the separation function of the geotextile had remained intact.

## 5. DISCUSSION

### 5.1 Relationship between measured properties and excavation survey results

On the sidewalk at the Iwamizawa site, no noticeable unevenness or faulting on the pavement that could obstruct pedestrians was observed. The driveway apron section was also found to be in reasonably good condition without any unevenness or faulting that would hinder pedestrians, there was some settlement, minor corner breakage and cracking. The rutting depth at the driveway apron section showed a somewhat larger value of 9 mm. The excavation survey confirmed that the deeper ruts had been caused by the deformation of the base and bedding course. It is suspected that inadequate compaction caused the deformation in the base.

The permeable interlocking block pavement in the uninterrupted section on the Meguro Residential Street site was suffering joint displacement and faulting together with corner breakage due to the block displacement. These damages are thought to have been caused by interlayer slip between the blocks and cushion sand, which had been induced by the consolidation of pulverized cushion sand. The ordinary interlocking block pavement at the intersection had rutting of a rather large depth of 20 mm. This was induced by the deformation of the bedding course and permeable asphalt stabilized mixture, which occurred due to a large deflection of 0.36 mm of the permeable asphalt stabilized base, thereby reducing the bearing capacity of the base and the layers below it.

The Lake Kawaguchi Roadway was in good condition, without any defects that would obstruct the traffic either in the sloping or flat section. The residual rate of joint sand of the flat section showed a somewhat lower value of 76%, which is thought to be due to water spray from the nearby fishermen’s union.

Considering its service length, the Kameari Residential Street site (14 years and 1 month old) was also in good condition, merely suffering joint openings and settlement at the center of the intersection that were inducing corner breakage. The permeable interlocking blocks sampled from the damaged part had lost their permeability. The flexural strength was 4.1 MPa, which was above the specified value of 3.0 MPa for permeable interlocking blocks. Although the permeability had been lost, no strength deterioration was observed. The residual rate of joint sand showed a high value of 90% or more, even at damaged parts. Overall, the damages in interlocking blocks were all minor corner breakage that would not need replacement.

The Senjumidori-cho site suffered settlement, block migration and corner breakage mainly in and around the center of the roadway and producing rattling. The spacer nibs in the rattling locations had been worn out, which reduced the block joint width and thus accelerated the loss of joint sand. The excavation survey revealed that the damaged part had been excavated in the past and covered again due to a later underground installation work. It is suspected that the underground installation work carried out on that occasion induced deformation in the permeable asphalt layer of the base. Then, the subsequent rehabilitation work deformed the pavement surface, which caused the loss of joint sand and hence caused rattling. There were many interlocking blocks that needed replacement, accounting for a quarter of all the damaged blocks.

In addition to the impact of the later underground installation work, the fact that straight-type blocks, i.e. blocks with no wavy sides, were used despite the expected heavy traffic partially caused the wearing of spacer nibs and the loss of joint sand, thus causing rattling.

### 5.2 Relationship between service period, pavement performance and geotextile durability

Figure 2 shows the relationship between the number of service years and degree of roughness. A longer period in service does not necessarily mean a higher degree of roughness, which remained at around 3 mm to 4 mm. One of the reasons why the roughness remained intact would have been that the geotextile helped maintain regularity. Figure 3 shows the relationship between the number of service years and rutting depth. The ruts tend to become deeper with increasing years in service, but the deepening rate is small, and the ruts remain at favorable values of around 5 to 10 mm even after 15 years in service. Figure 4 shows the relationship between the number of service years and block breakage rate, as compared with the existing data on pavements without geotextile. The rate of block breakage is a half or less of that of pavements without geotextile, which proves the beneficial effect of installing geotextile in interlocking block pavements.

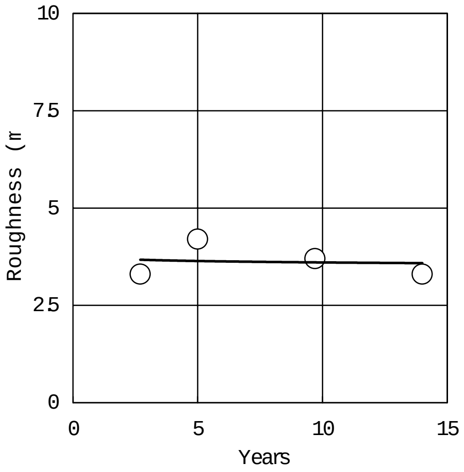

Figure 2. Relationship between Number of Service Years and Degree of Roughness.

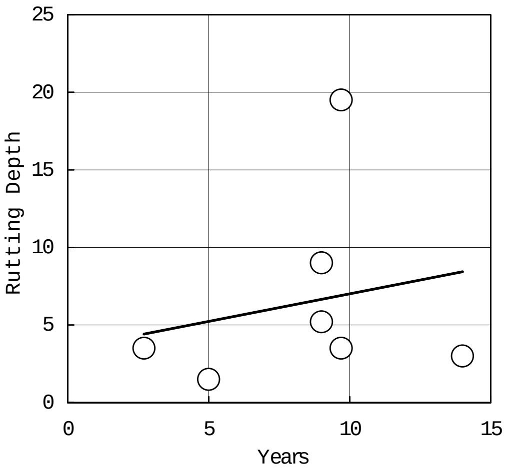

Figure 3. Relationship between Number of Service Years and Rutting Depth.

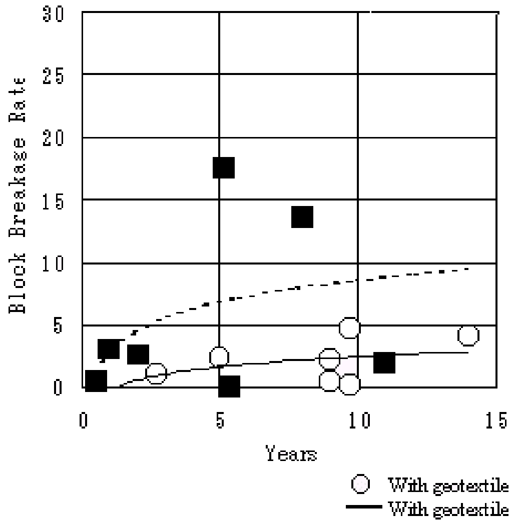

Figure 4. Relationship between Number of Service Years and Block Breakage Rate.

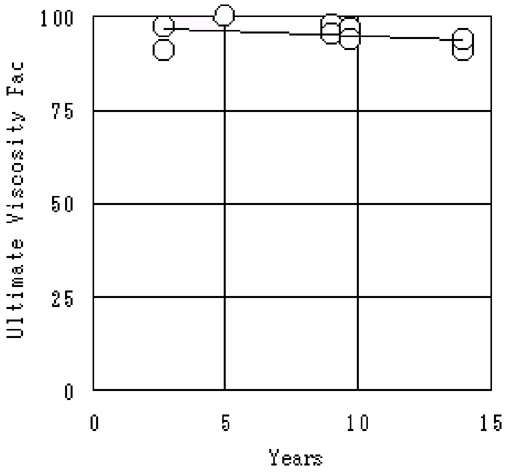

Figure 5. Secular Changes in Ultimate Viscosity Factor.

Figure 5 shows the relationship between the number of service years and ultimate viscosity factor of geotextile. This factor, which provides an indication of deterioration in a polymeric material, showed a favorable value of 90% or more even after 14 years in service. In view of the above, there is little risk of deterioration of geotextile durability after 15 or so years in service.

## 6. CONCLUSIONS

The survey results are summarized as follows.

- The interlocking block pavements with geotextile as the separator suffered little damage induced by the interlocking block layer, including the cushion sand part, and their pavement properties remained broadly unchanged.
- Both the separation function of geotextile and its durability remained intact up to 14 or so years in service.
- The block breakage rate was small, proving that the use of geotextile for interlocking block pavements offers certain advantages.
- Although the partial breakages were observed for the consolidation of pulverized cushion sand or the support lack of the layer below the base, the use of geotextile was unrelated to them.

## 7. ACKNOWLEDGEMENT

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# REPORT ON EXCAVATION SURVEYS ON INTERLOCKING BLOCK PAVEMENTS WITH GEOTEXTILE

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## A BRIEF RESUME OF YUTAKA ANDO

| | |
|---|---|
| Jan. 1951 | Born in Kochi-ken |
| Mar. 1973 | Graduated from Chiba University(Industrial Chemistry College of Engineering School) |
| Apr. 1973 | Entered Osaka Cement Co., Ltd. (Kochi Plant) |
| Apr. 1975 | Transferred to Research Center |
| Apr. 1987 | Transferred to Central Research Center |
| Oct. 1994 | Transferred to Cement-Concrete Research Center due to merging to Sumitomo-Osaka Cement |
| Apr. 1997 | Transferred to Technical Development Dept. of Building Materials Div. |
| Apr. 2003 | Transferred to Environment Concrete Group of Cement Concrete Research Center Engaging in development of permeable pavement using cement-asphalt emulsion. |