WALKING CONDITION ON INTERLOCKING BLOCK PAVEMENT

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ABSTRACT

In pedestrian roads, block pavements have an advantage over asphalt pavement on landscape design: However, block pavements do not always present an advantage in walking condition, since on the surface of block pavements exist lots of block joints. In this study, the unevenness on existing interlocking block pavement and walking condition on the pavement are shown. Based on these results, the evaluation method for the walking condition on interlocking pavement is proposed.

1. PURPOSE OF STUDY

Pedestrian roads, such as sidewalks and promenades have been paved with asphalt in Japan, since asphalt is easy to pave and of low cost. Recently in urban areas, the pavement materials have been changed to blocks with attractive surfaces, such as terrazzo tile, ceramic tile, surface-painted concrete block and interlocking block with the increasing demand for better urban landscape. Of many kinds of block pavements, interlocking block pavements have been rapidly spreading in Japan, since construction cost is rather cheaper, construction term is rather shorter than other kinds of block pavements, and also interlocking block have variety of surface finishes.

On the other hand, pedestrians are increasing who give opinions that the walking condition on interlocking block pavements is uncomfortable. These opinions are supposed to be due to the unevenness on the pavement surfaces. Block pavements are generally constructed with cement mortar, however in case of interlocking block pavement, sand is used instead of cement mortar. Interlocking blocks are set on the cushion sand, and joints are filled with the sand. As blocks are not tightly fixed in the pavement, interlocking blocks are rather easier to move in the pavements. Blocks may move vertically and horizontally. These movements cause the unevenness on the surfaces.

In this paper, physical condition surveyed on existing pavement surfaces and walking condition rated by pedestrians are shown. Based on these results, the relationship

between physical condition of the surfaces and the walking condition is analyzed

2 DESIGN STANDARD OF JOINT

Standard cross section of interlocking block pavements for pedestrian roads is shown in Figure 1. Size of block is 244mm long, 117mm wide, 60mm high and edging is 6mm. Blocks are set up on the cushion sand of thickness 30mm with the distance 3mm between neighboring blocks. Consequently the width of block is 15mm. Base course is usually composed with crusher-run.

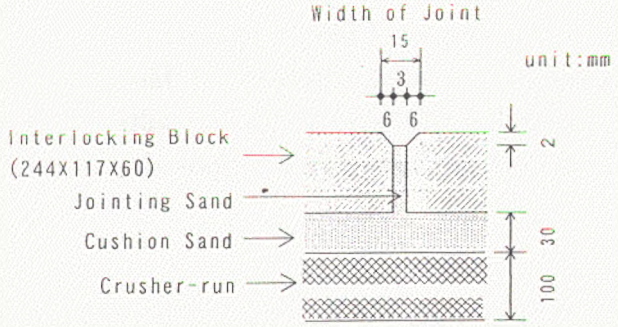


Figure 1 Design Standard of Block Joint for Pedestrian Road

3 UNEVENNESS OF SURFACE

Physical conditions of the pavement surfaces are shown in Figure 2. They are the results of the research on seven existing pedestrian roads in Osaka. Difference of the surface level between neighboring blocks and the width of joints were surveyed at approximately one hundred and seven joints on each road. The difference of surface level ranges up to 5mm, the width of the joints does between 10 and 20mm. These results show that it would be difficult to pave and maintain the pavement surface as instructed by design standard, even if the design standard would be decided.

Relations between four statistical terms showing the characteristics of the pavement surfaces, such as average difference of surface level, standard deviation on the difference of surface level, average width and standard deviation of width are shown in Figure 3. Coefficients of correlation between four terms are also shown in the figures. Although values of coefficients are different in six figures, four statistical terms correlate each other. Then, the condition of pavement surface could be described with one of four statistical terms.

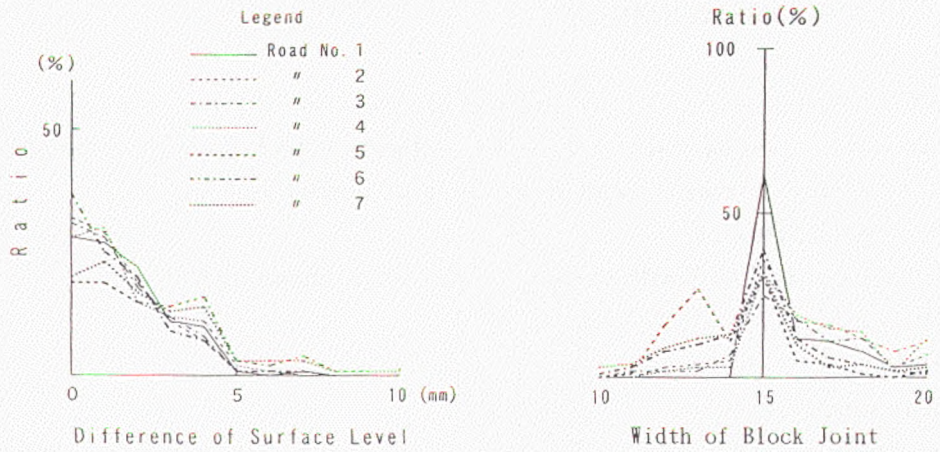


Figure 2 Distribution of Unevenness on Pavement Surface

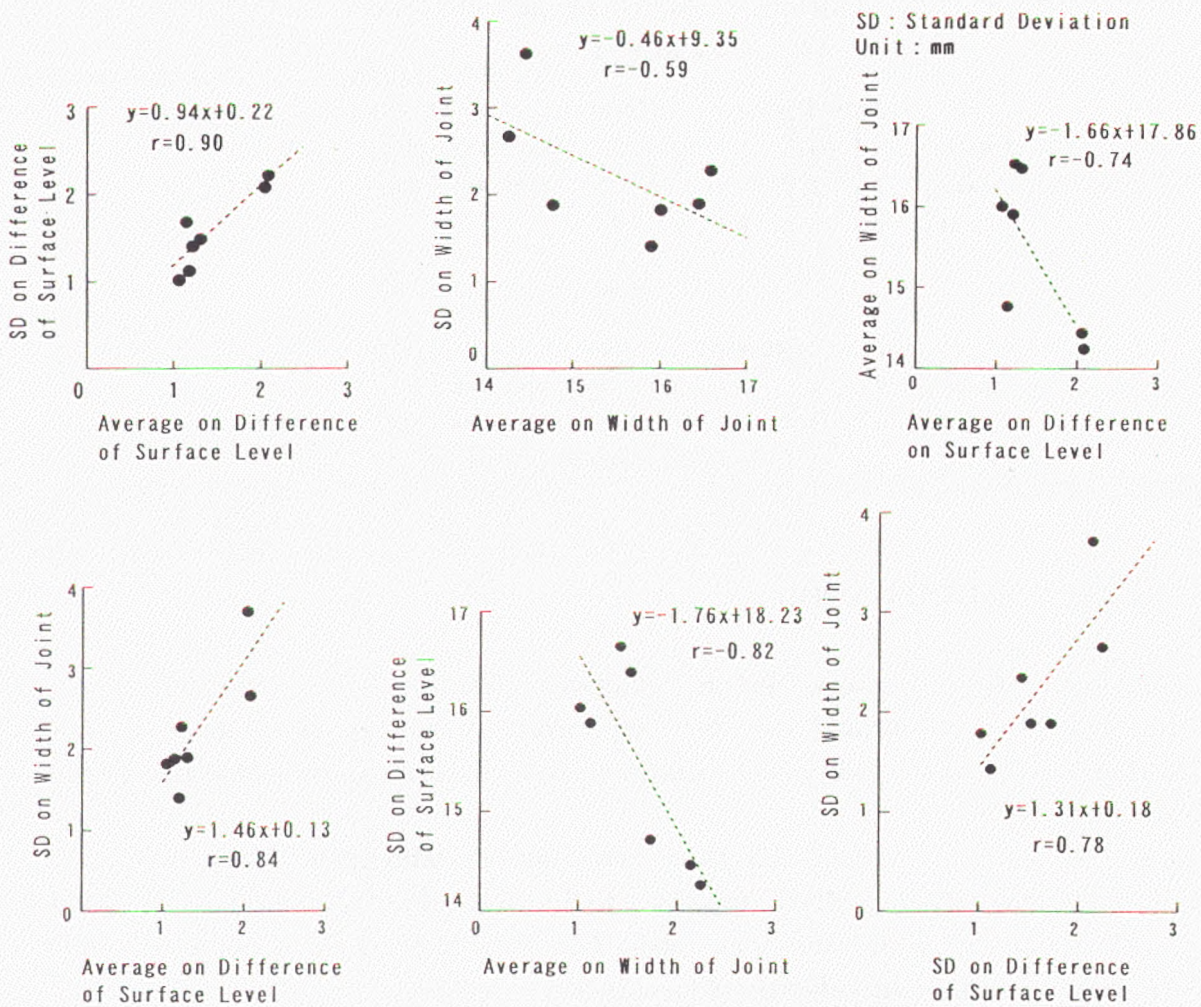


Figure 3 Relation between four statistical terms describing the surface condition

4 SENSORY TEST ON PAVEMENT

On seven pavements where the actual conditions were surveyed, sensory tests were practiced by 20-27 pedestrians to research subjective feeling relative to the walking condition. A subjective rating scale was used to assess via walking. Composition of subjects is shown in Table 1.

The scale ranges from 1 to 5 with verbal description as shown below,

1- Very comfortable
2- Comfortable
3- Difficult to judge
4- Uncomfortable
5- Very uncomfortable

Table 1 Subjects by Age and Shoe

(a) Road No. 1～6

unit:person

Age	20~29	30~39	40~49	50~59	Total	Kind of shoe
Male	6	3	6	7	22	Shoes and Sandals for Men
Female	3	2	—	—	5	Shoes and Sandals for Women
Total	9	5	6	7	27	

(b) Road No. 7

Age	20~29	30~39	40~49	50~59	Total	Kind of shoe
Male	2	3	6	4	15	Shoes and Sandals for Men
Female	4	1	—	—	5	Shoes and Sandals for Women
Total	6	4	6	4	20	

5 INDEX FOR EVALUATION

Information from Sensory Test is qualitative and descriptive, therefore must be transformed to quantitative data for comparison with numerical evenness or width of block joints. In this study, the quantitative index indicating the subjective feeling is defined as follows,

Index for Evaluation is defined as the ration of subjects who rated "Very comfortable", "Comfortable" and "Difficult to judge" to the total subject number. We call this index Subjective Index. On the other hand, above four statistical terms describing the condition of pavement surface are called Structural Indices.

Figures 4 shows the relationship between four Structural Indices and Subjective Index. Every structural index shows the correlation with subjective index. Of four coefficients of correlation, coefficient between average difference of surface level and subjective index shows the biggest value. Then, average difference of surface level is adopted as the

representative of four structural indices.

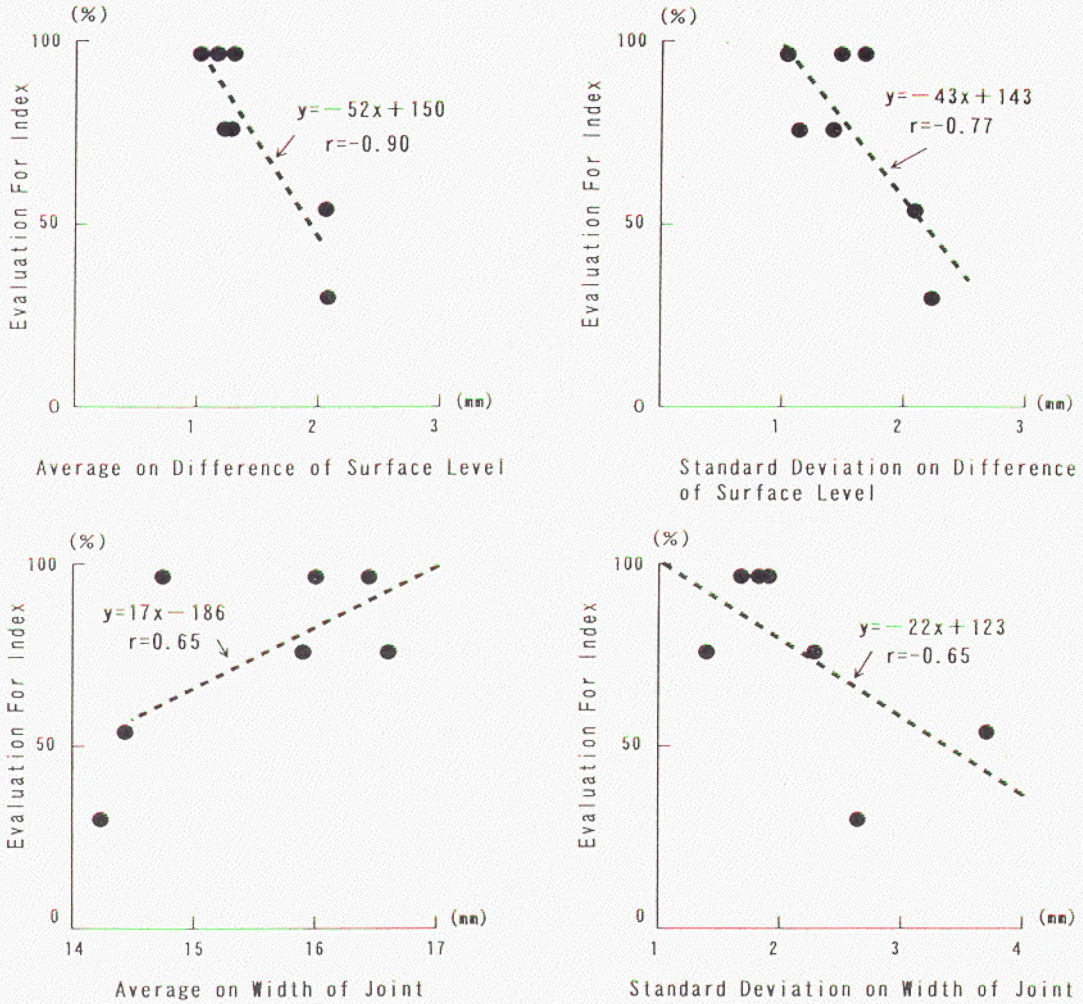


Figure 4 Relation between Structural Index and Subjective Index

6 EVALUATION METHOD

As shown in Figure 5, it is clear that subjective index decrease with structural index increase. Correlation equation between them is shown as follows,

$$Z = -52X + 150 \quad (r = 0.90) \qquad (1 < X < 2)$$

here,

Z : Subjective Index. The ration of subjects who rated in Sensory Test "Comfortable", "Slightly comfortable" and "Difficult to judge" to the total subject number. (%)

X : Structural Index. Average difference of surface level between neighboring blocks. (mm)

r : Correlation coefficient

Subjective Index shows almost 100% at 1mm, and the index decreases with Structural Index increase up to 2mm. Under 1mm, the value of subjective index is supposed to show almost 100%. By using this equation, the walking condition on interlocking block pavement can be assessed, when average difference of surface level is surveyed.

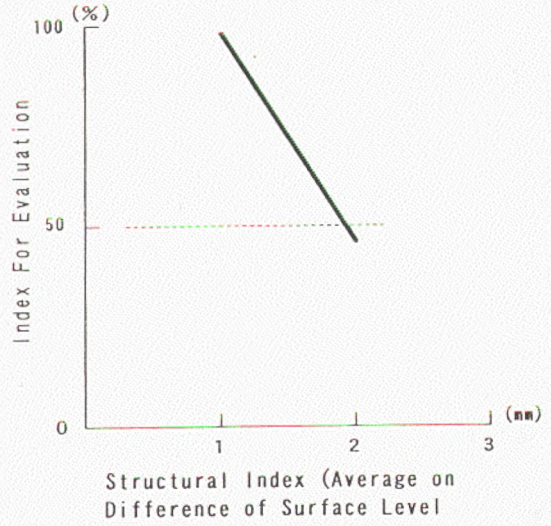


Figure 5 Relation between Structural Index and Evaluation Index

7 CONCLUSION

(1) Four structural indices describing structural characteristics of the joint condition correlate each other, such as average difference of surface level between neighboring blocks, standard deviation of the difference of surface level, average width of joints and standard deviation of the width of joints.
(2) Subjective index regarding the walking condition was lead from the results of sensory tests which researched pedestrian's subjective feeling on pavements.
(3) Of four structural indices, average difference of surface level have the strongest correlation with quantitative index showing the walking condition.
(4) Based on the equation of regression between average difference of surface level and subjective index, criteria on designing, paving and maintaining the interlocking block pavements for pedestrians is supposed to be considered.

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