SURVEY CONCERNING LUMINOSITY OF GUIDE BLOCKS AND IL BLOCKS PAVEMENT FOR THE VISUALLY IMPAIRED

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ABSTRACT

The Barrier-Free Transportation Law was passed in 2000 in Japan. It focuses on the necessity of easing the physical burden of movement for senior citizens and physically impaired, by creating a barrier-free transportation space, to improve the convenience and safety of movement. Also, yellow colored blocks are used generally for sidewalks and the like to guide the visually impaired (guide blocks), to increase the luminosity larger than the surrounding road surface area.[1)]

Furthermore, from the viewpoint of universal design, the following points are being pursued for guide block and surrounding road surface colors, including its combinations:

- There should be no problem for guiding visually impaired.
- Consideration of the landscaping so that it feels natural to those who are not physically impaired.

Under these circumstances, the Japan Interlocking Block Pavement Engineering Association (JIPEA) has rearranged past research cases concerning brightness measurements of pavement road surfaces in Japan, and conducted evaluations of luminosity measurement methods appropriate for determining the luminosity of interlocking blocks (IL blocks) and guide blocks.

This report introduces research cases of road surface brightness levels in Japan, and describes evaluation results of luminosity measurements of IL blocks and guide blocks.

1. CURRENT SITUATION OF HANDLING LUMINOSITY IN JAPAN

1.1 Evaluation cases to date

In Japan, guidance for the visually impaired is generally conducted through the use of protruding yellow blocks on sidewalks and the like. However, this does not mean that ample guidance information was provided to them in the past. And by the increase of landscape pavement, there are cases where it is difficult to distinguish between the colors of the guide blocks and surrounding blocks for those who can differentiate the contrast between colors to some degree.

Given this situation, Akiyama et al. conducted surveys of the current status of guide blocks, as well as surveys and research into the affects to the visually impaired from colors, dimensions, and block materials.[2)] Here, importance is attached especially to the contrast between the colors of the guide blocks and surrounding pavement. A questionnaire survey was conducted regarding the visibility for those with poor eyesight and what is unnatural for those with unimpaired eyesight, to evaluate color combinations that are both easy to see for those with poor eyesight and natural to those with unimpaired eyesight.[3)4)5)] This study evaluated the color contrast and guide block visibility by brightness; the evaluation results are shown in Fig. 1.

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These evaluation results serve as a vital resource to show the direction of the contrast between guide blocks and surrounding pavement in Japan.

Contrast Between Guide Blocks and Surrounding Pavement

- Recommended Luminosity Range=**1.5-2.5**
  - Range at which those with poor eyesight can distinguish guide blocks…**Luminosity≥1.5**
  - Natural Range for those with unimpaired eyesight・ **Luminosity≤2.5**

$$\text{Luminosity} = \frac{\text{Guide Block Brightness (cd/m}^2\text{)}}{\text{Surrounding brightness (cd/m}^2\text{)}}$$

Brightness (cd/m^2): Brightness measurements were made by expressing brightness per unit area and per three dimensional angle of light energy (emitted light amount) measured by comparative angles (frequency difference for each electromagnetic wavelength)

- Brightness Measurement Method

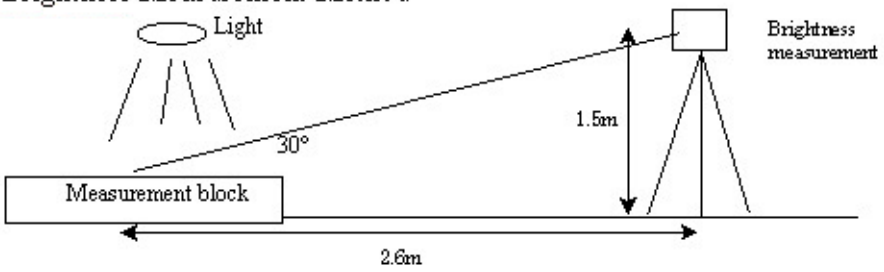

Figure 1. Evaluation results concerning luminosity by Akiyama, et al.

1. INITIATIVES OF THE MINISTRY OF LAND, INFRASTRUCTURE AND TRANSPORT AND AUTONOMOUS BODIES

In accordance with the Barrier-Free Transportation Law passed in 2000, the Ministry of Land, Infrastructure and Transport and a number of regional autonomous bodies have set recommended values and the like for the luminosity of guide block and surrounding pavement colors, aiming for development of road equipment that takes into consideration the smooth guidance systems for persons visually impaired. The range for this luminosity has been set based on the research results of the previously mentioned Akiyama and evaluation results of various institutions. The recommended range of luminosity set by the Ministry of Land, Infrastructure and Transport and autonomous bodies is generally 2.0 or above; some institutions recommend 2.5 or above.

2. EVALUATION CONCERNING LUMINOSITY

2.1 Outline of the Evaluation

As noted previously, originally, even a great deal of IL block pavement are used for its landscape and design, discussion were needed for surface color that takes visually impaired persons into consideration. At that point, evaluations were conducted on the combination of guide block and IL block (surrounding pavement) colors, with a focus on luminosity.

Table 1 below shows the main evaluation items and outlines the luminosity measurements.

- Relationship between light intensity and brightness
- Effect of differences of brightness measurement methods on luminosity

Table 1. Luminosity Measurement Outline.

Item	Details, Qualifications, etc.	Characteristics, etc.
Block for measurement	▪ Guide blocks (yellow) ▪ IL blocks - Standard type - Permeable type - Polished-surface type, etc.	General standard type blocks were used for measurement
Measuring devices for brightness, etc. (brightness measurement), etc.	▪ Non-contact type colorimeter ▪ Contact type colorimeter ▪ Illuminometer	Illumination measurement when non-contact type is used
Non-contact type luminosity measurement method	▪ Based on the measurement method in Fig. 1 ▪ In-room measurement ▪ Changes in brightness according to lighting	Luminosity calculated using brightness measurement values at the same light intensity
Contact type luminosity measurement method	▪ Light intensity conditions unified ▪ No controls on measurement environment	Conditions for light intensity, etc. are same, so comparisons between brightness measurement levels can be made

3.2 Relationship between Light Intensity and Luminosity

3.2.1 Relationship between changes in light intensity and luminosity

Luminosity were measured using yellow guide, when the light intensity was changed from a range of $1*10^2$lx to $1*10^5$lx. Measurement was done using non-contact type brightness measurements. Fig. 1 shows the method. Fig. 2 shows the measurement results. It can be seen from Fig. 2 that the relationship between light intensity and brightness is nearly on a diagonal line; and that the same block brightness is 10 times larger when the light intensity value is 10 times greater. From this, the luminosity of guide blocks and IL blocks is measured, upon which the absolute conditions for using brightness measured under the same conditions can be determined.

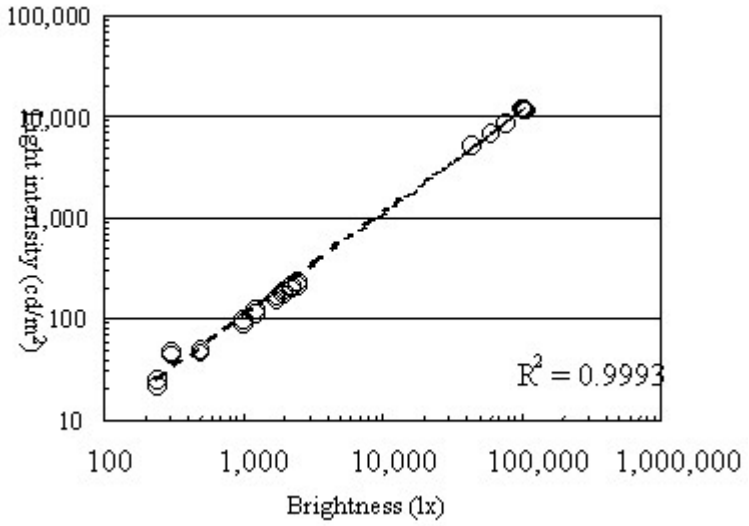

Figure 2. Relationship between light iintensity and brightness.

3.2.2 Comparisons of luminosity under different light intensity conditions
Fig. 3 shows a comparison of luminosity for guide blocks and IL blocks measured under different light intensity conditions (1,500lx, 750lx). Here as well, measurements are based on Fig. 1, and non-contact type brightness measurements were used.

Fig. 3 also shows that there is no difference in luminosity even if measured at different light intensity. Thus, when measuring luminosity, if the measurement value at the same brightness is used, there is no relationship to high light intensity; the same luminosity can always be acquired. Therefore, when seeking the luminosity between blocks, no controls in particular are needed when measuring light intensity if brightness is measured at the same light intensity.

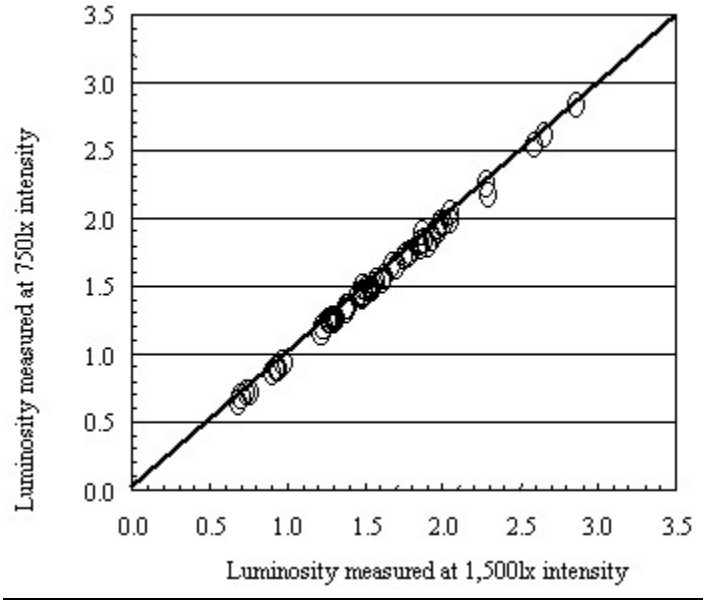

Figure 3. Relationship between lighting changes and luminosity.

3.3. Effects of Differences of Brightness Level Measurement Methods on Luminosity

3.3.1 Differences in measurement devices and luminosity
Confirmation tests were conducted to determine whether or not the type of measurement device (contact and non-contact) used had an effect on the luminosity being measured (Fig. 4). One contact type device and two non-contact type devices were used to measure luminosity. Measurements with the non-contact type are based on Fig. 1 (Brightness=1,500lx).

These results show that there are no restrictions in particular for measurement devices when measuring luminosity. It was shown that there would be no problems if measurements were done under the same conditions using the same devices. However, in terms of measurement device characteristics, the surface area for the contact type measurement is about φ6-10mm, depending on the device, with a tendency to be easily affected by the block surface shape and aggregate colors. In contrast, when the non-contact type was used with the Fig. 1 method, a surface area of about φ80mm could be maintained as the measurement area, and thus more brightness can be reflected in the block surface compared to the contact type.

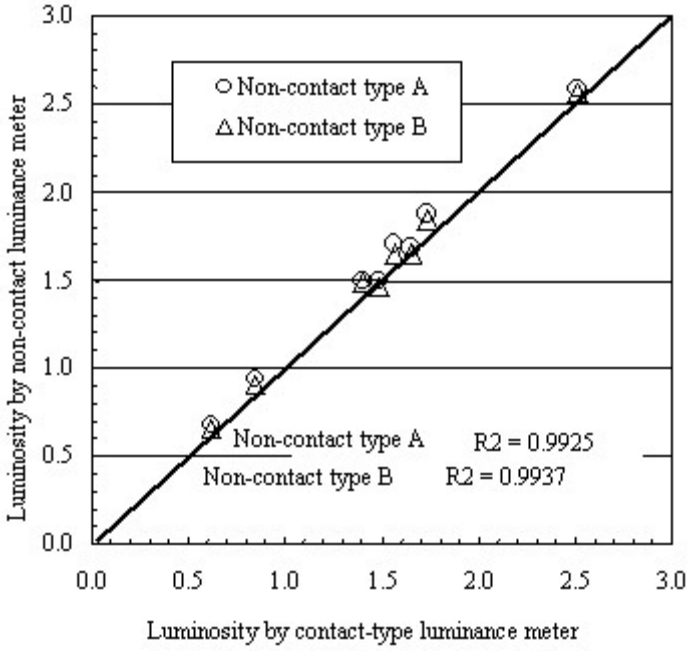

Figure 4. Relationship between differences in measurement device types and luminosity.

3.3.2 Differences in measurement methods and luminosity (non-contact brightness measurement)
When non-contact brightness measurements were used, it is estimated that measured luminosity will differ when there are differences in the lighting angle and the distance between the measurement device and block for measurement. Confirmation tests were conducted for verification.

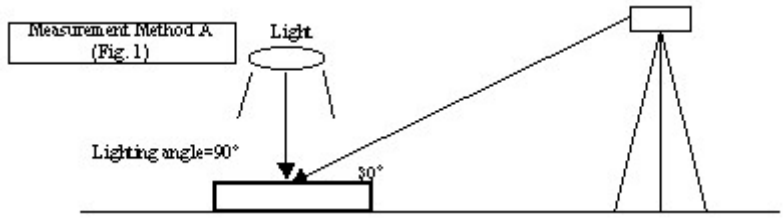

Figure 5. Measurement method.

The confirmation tests, as shown in Fig. 5, use measurement method A based on Fig. 1, and measurement method B using a lighting and measurement degree angle of 45º.

The test results are shown in Fig. 6. It can be seen in Fig. 6 that even when the lighting and measurement angle changes, there is no significant change in the measured luminosity, and nearly the same results were obtained.

Measurement method A estimates the angle of eyesight for people walking. When the brightness of the IL blocks is measured, this method can ensure the greatest possible measurement surface area of the central portion of the blocks, and thus this is planned to be a standard method in the future. However, when there are small rough spots on the block surface, there may be changes in brightness values depending on the lighting angle. It is therefore necessary to confirm the impact of this in the future.

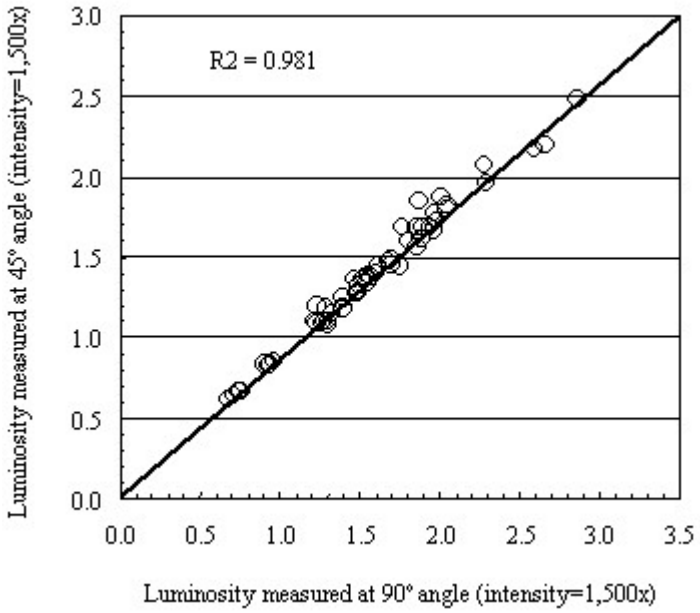

Figure 6. Relationship between different measurement methods and luminosity.

3.4. Summary of the Evaluation Results

A summary of the results of this evaluation is as follows.

- Since light intensity has a large effect on brightness, it is necessary to make calculations using the same light intensity conditions when measuring luminosity.
- Since it is necessary to reflect the block surface shape and average shades of color in the luminosity measurement results, it is desirable to use measuring equipment that can handle a large surface area for measurement.
- When using non-contact type measurements, the measurement method shown in Fig. 1 is desirable, but there is no problem if luminosity is calculated using brightness measured under the same conditions such as for the distance between the measuring device and block and the placement of lighting, etc.

4. CONCLUSION

One method to smoothly guide the visually impaired, is to increase the luminosity of the guide blocks and surrounding pavement. However, this will result in some loss to the landscape depending on the color tones used. It is important to conduct evaluations on color combinations that are natural to those with unimpaired vision. In this paper, we have introduced related Japanese initiatives and evaluation cases concerning luminosity for IL block pavement. Given these evaluation results and other information, we would like to propose color combinations for guide blocks and IL blocks that are acceptable to those with unimpaired vision as landscaping pavement, based on the premise of safe and smooth guidance for those with impaired vision.

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A BRIEF RESUME OF TAKASHI HONDA

Entered Machida Corporation in 1993 and worked at R & D Center for the last 10 years.

Engaged in developing 5 eco-mark granted recycle interlocking blocks, Nox-decomposing concrete block using photo-catalyst, interlocking block having both water permeability and retentivity and tactile block with magnetic iron oxide.

Recently working for further development of recycle concrete block and establishment of JIS.

A BRIEF RESUME OF MINORU HATA

Engaged in research and development of interlocking block for 20 years since he entered Taiheiyo Cement Corporation.

Engaged mainly in evaluation of interlocking block applied to motorways, development of composite interlocking block using tile and natural stone, development of high strength permeable interlocking block for motorways and development of water retentive interlocking block..