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# LEGIBILITY OF JAPANESE CHARACTERS IN GRAPHIC FLOOR SIGNS FOR ELDERLY PEOPLE

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***Abstract***: For low-vision people and elderly people with decreased vision and cognitive function, the legibility of signs (character size, position, etc.) is an important issue. Graphic floor signs are considered more effective for low-vision people and elderly people than typical hanging signs because they are closer to pedestrians and can be larger in size. There is a growing number of improved graphic floor signs, but there are no guidelines for character sizes, colour scheme, and layout. Therefore, this study considers the character size ofgraphic floor signs that are legible for elderly people. In this study, we aimed to verify the legibility of characters installed on the floor. The test was conducted on 30 non-elderly and 30 elderly people, about Japanese Industrial Standards (JIS) S 0032 “Guidelines for the elderly and people with disabilities - Visual signs and displays -Estimation of minimum legible size for a Japanese single character”. Experiments on minimum legible sizes of characters and experiments on readability were conducted in that order. In the experiment on the minimum legible sizes of characters, we found that the minimum legible sizes of characters written on the vertical surface can be converted to the minimum size of legible characters written on the floor surface by multiplying with the coefficient of minimum legible characters on the floor surface by 2 to 3 times. In the experiment on readability, we found that the optimum character sizes are about 90 mm and 80 mm in height at a minimum for vertical and horizontal characters, respectively. These results showed that the optimum size of characters on graphic floor signs is about 90 mm.

***Keywords:*** Graphic floor signs, Legible font size, Elderly people, Sign system

## Introduction

In Japan, the Traffic Barrier-Free Transportation Act came into effect in 2000, and barrier-free public transportation facilities and buildings are being promoted. For the sign system, which is a visual display facility for leading guidance, the Act provides guidelines for information contents, expression style (including display system, lighting system, shape, and layout), and spatial location (Eco-Mo Foundation, 2020). For hanging type signs, this guideline describes the display height, layout position, layout interval, etc., so that the signs can be visually identified from a distance while moving.

On the other hand, for visually impaired and elderly people with decreased visual acuity, it is difficult to use these signs in some cases because they cannot get close enough to these signs to read them. In response to this problem, the authors have been developing pavement guidance signs mainly to support pedestrian movement around railway stations. Kitagawa (2012) examined the size, shape, and contents of pavement guidance signs based on the evaluation by five low-vision persons, installed prototype signs around two railway stations, and conducted a questionnaire survey of station users. Results showed that the graphic floor signs were easy to find and understand in railway stations where there were relatively few passengers. Omori, Yanagihara, Kitagawa and Ikeda (2014, 2016) conducted a walking experiment on low-vision persons, elderly persons, and sighted persons as subjects using prototype pavement guidance signs made experimentally by Kitagawa, finding that graphic floor signs were more legible than hanging signs. It was found that the range of visibility of graphic floor signs was completely different depending on the non-elderly, elderly, and low-vision people, and that a guide to determining the size of legible characters is necessary.

Therefore, in this study, we aimed to verify the legibility of characters installed on the floor. The test was conducted on 30 non-elderly and 30 elderly people, about Japanese Industrial Standards (JIS) S 0032 “Guidelines for the elderly and people with disabilities - Visual signs and displays -Estimation of minimum legible size for a Japanese single character”. This standard provides a method for estimating the minimum legible size for a Japanese single character of Hiragana, Katakana, Arabic numerals, and Kanji under various environments for observers of any age from young to elderly people. This standard assumes that the subjects face directly to the characters and that they are not required to read the characters written on the floor. Therefore, in this study, we estimate the minimum sizes of legible characters while changing the size and direction of the characters placed on the floor. In addition, the size of easy-to-read characters for graphic floor signs is examined.

Among the past research on station guide signs, Zheng et al. (2008a, 2008b), conducted surveys on station guide signs and search behaviour at above-ground and underground stations, describing that long-distance movement at above-ground stations require detailed information such as maps and that several information signs must be provided especially at intersections. Ikeda, Yoshida and Hirate (2017) conducted web questionnaires to evaluate the temporary signs installed additionally by station staff and reported about the installation height, concluding that these signs are often installed at eye level. However, these studies make no mention of graphic floor signs. Yusue et al.(2018a, 2019b), conducted web questionnaires of users to evaluate positive or negative elements of temporary signs installed additionally by station staff, stating that graphic floor signs fall into an intermediate category. However, the viewability of graphic floor signs is not described. Harada (2017) conducted a legibility experiment of the route maps and fare charts installed at station ticket gates, and showed that legibility is affected by the visual distance, character size, and luminance. Taso et al.(2020) evaluate the sign from the perspective of universal design and propose a new sign system based on UD. Rousek and Hallbeck (2011) evaluate the effects of colour contrasts of healthcare pictograms for participants with both non-impaired and impaired vision. High-contrast signage with consistent pictograms involving human figures (not too detailed or too abstract) is most identifiable. Kusumarini et al. (2012), examine the user's experience in shopping malls to get information and guidance about direction from the applied signage system. The experiences discussed in terms of universal design. Shi et al. (2020) studied a wayfinding sign in metro stations with two colour combinations of signs regarding the legibility. Achromatic colour combinations were more legible than chromatic colour combination.

As described above, few studies on guide signs have mentioned graphic floor signs, and there is no study on their legibility. Therefore, this study aimed to verify the legibility of the characters of graphic floor signs installed on the floor.

*Figure 1. Examples of graphic floor signs(left: guide to elevators and platforms, right:guide to gates and bus stops)*


## Methodolgy

The experimental overview is shown in Table 1. Experiments on minimum legible sizes of characters (Experiment A) and experiments on readability (Experiment B) were conducted in that order. To adjust the eye level, the subject sat in a chair, and the height of the top of the head was 164 cm. The vertical viewing angle is about 18 degrees. For the visual acuity test, a hand-held Landolt ring was used. The experiment was carried out in a dark room with controlled illuminance. After explaining the contents of the experiment to the subjects, the experiment was carried out visual acuity test, experiment A, and experiment B. Subjects were given time for light adaptation in the experiment room. In addition, the investigator instructed the subject not to look into the experimental board.

The subjects were 30 young and 30 elderly people with no history of visual trouble. The young people were mainly university students, and the elderly people were recruited by temporary staffing companies.

*Table 1. Experimental overview*

| | |
|---|---|
| **Subjects** | No medical disorders in the eyes.<br>The older (65 or more): 30 people<br>The younger (20s): 30 people |
| **Experiment condition** | Luminance level of blank space between letters on the board used in Experiment A in Figure-1：100 cd/m2<br>Average illuminance in a dark room:  500lx<br>Viewing distance: 5 m |

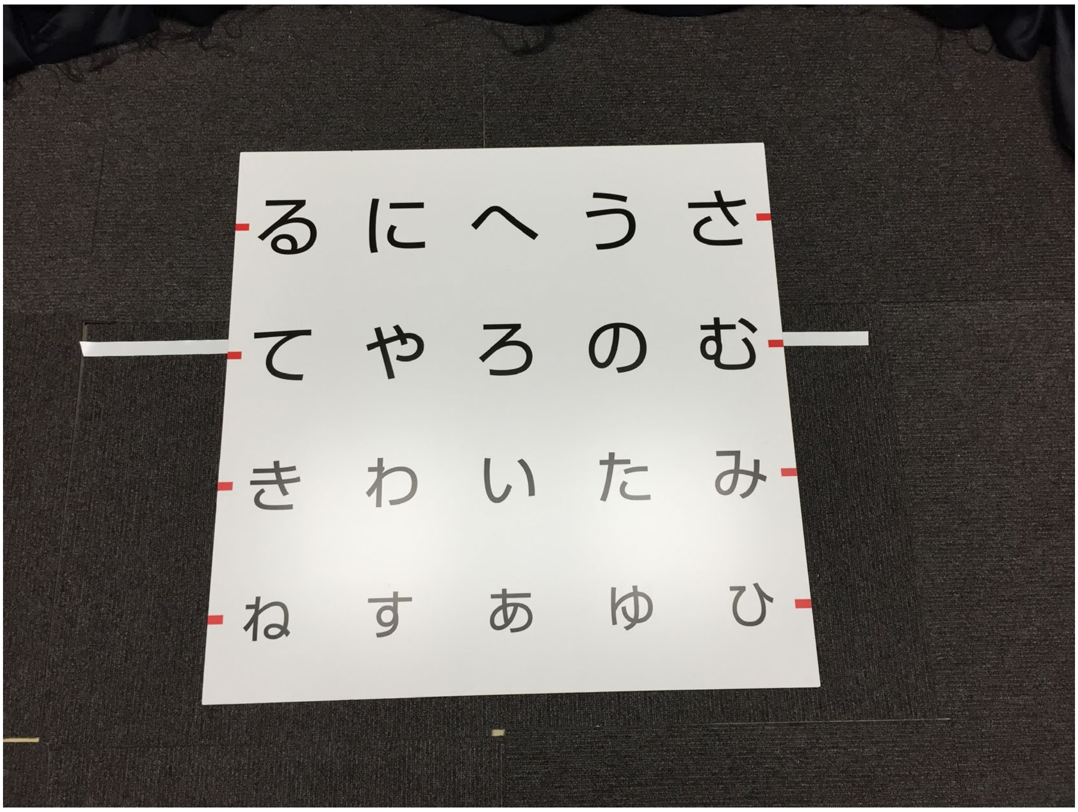
## Experiments on minimum legible sizes of characters (Experiment A)

### *Experimental method of minimum legible sizes of characters in graphic floor signs*

In Experiment A, the size of characters is changed using the board of Figure 2 to investigate the minimum legible sizes of characters on the floor surface for each subject. The minimum legible size of characters was the smallest character size in which one Japanese hiragana character can be read correctly 3 times or more out of 4 times. The character heights in Experiment A were 80, 70, 60, 50, 40, 35, 30, 25, and 20 (all dimensions in mm), and they were presented in descending order. The Japanese typefaces are mainly Mincho and Gothic. For guide signs, Gothic font is recommended in Barrier-free maintenance guidelines (Eco-Mo Foundation, 2020). The font size is commonly expressed in points, but in the guideline, the character size of the sign is expressed in mm as the character height.

The results of this survey are compared with the minimum legible characters calculated by the estimation formula of JISS0032 to obtain the coefficient of minimum legible characters on the floor surface (the average of minimum legible sizes of characters on the floor surface in Experiment A is calculated by the average of minimum legible sizes of characters calculated by the estimation formula of the minimum legible sizes of characters of JISS0032). By multiplying the minimum size of legible characters estimated from JISS0032 by this coefficient, the minimum size of legible characters can be corrected to the one written on the floor surface.

*Image 2. Board for experiment A (Hiragana index of used for vision test)*




## How to calculate minimum legible sizes of characters

The minimum legible sizes of characters are estimated from the estimation formula of JISS0032. The visual acuity Vo at a luminance of 100 cd/m$^2$ is determined by the visual distance and age. Table 2 shows the visual acuities of subjects by age. Then, the visual acuity V in observation conditions is given by the expression V=kVo, into which Vo is substituted (luminance correction coefficient k=1). The size coefficient S can be determined by the following expression, S=D/V, where D represents the visual distance and is 5 m in this experiment. Finally, the equation for the minimum size of legible characters Pmin (all dimensions in pt) can be determined by the expression Pmin=aS+b from the JIS Standard, where a and b represent the coefficients of Gothic hiragana from the JIS Standard Appendix, and a=6.4, b=3.0. In this study, we change the character size as 1pt = 0.35 mm. The font type used in this study was Gothic, which is commonly used in Japanese guide signs.

*Table 2. Visual acuity Vo of young and elderly people at a luminance of 100 $cd/m^2$*

| Subjects age | Acuity(Vo) |
|---|---|
| **20** | 1.63 |
| **21** | 1.62 |
| **22** | 1.6 |
| **23** | 1.59 |
| **25** | 1.55 |
| **65** | 1.04 |
| **66** | 1.03 |
| **67** | 1.02 |
| **68** | 1.01 |
| **69** | 1 |
| **71** | 0.98 |

## Experiments on readability (Experiment B)

In Experiment B, six types of boards written vertically and horizontally in Hiragana (ticket booth) of Figure 3, Katakana (elevator), and Kanji (general information centre) were presented to the subject in three directions: forward, sideward, and backward to evaluate the readability. The boards used in the experiment are shown in Figure 2. We used a total of 54 boards written both vertically and horizontally with 9 different character heights for experiment A and in 3 different characters - Hiragana, Katakana, and Kanji. The 54 boards were presented randomly to the subjects. The readability rating is as follows: 0. Unreadable, 1. Very hard to read, 2. Rather hard to read, 3. Neither, 4. Rather easy to read, and 5. Very easy to read. Based on these results, the average of the evaluation values of each subject is plotted to obtain an approximation expression. The optimum character size (character

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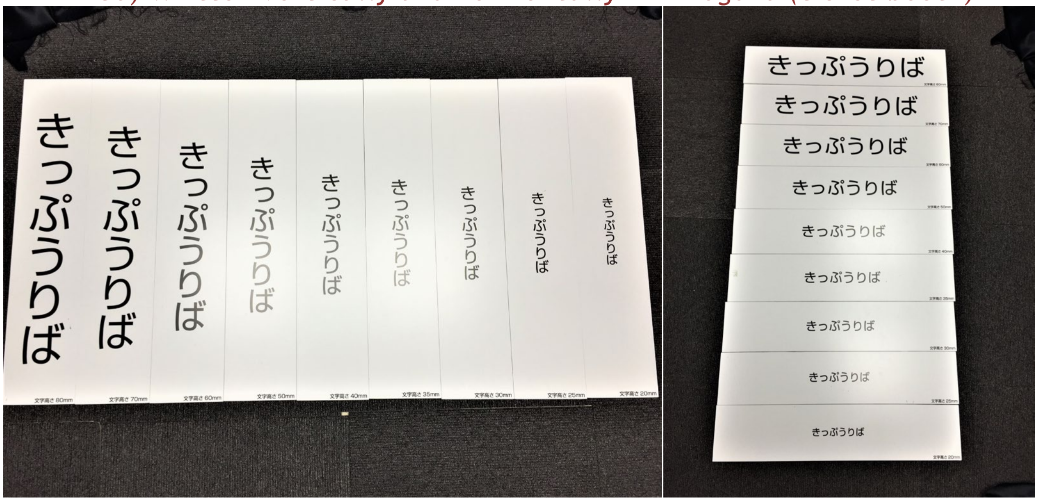
height of readability evaluation value 4.5) for the floor surface is estimated from the approximation expression.

*Figure 3. Board written in Hiragana and in Katakana*

*3a) Written vertically and horizontally in Hiragana (ticket booth)*




*3b) Written vertically and horizontally in Katakana (elevator)*

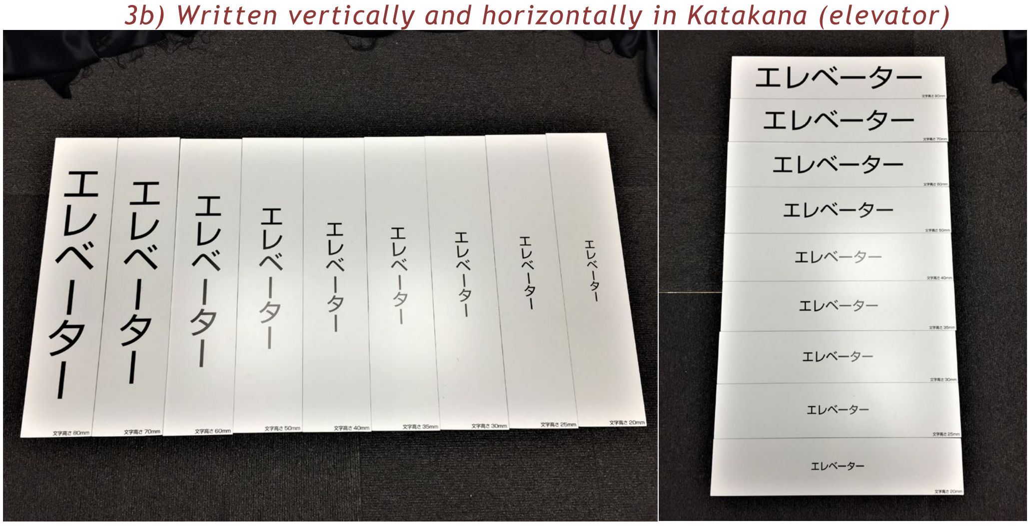
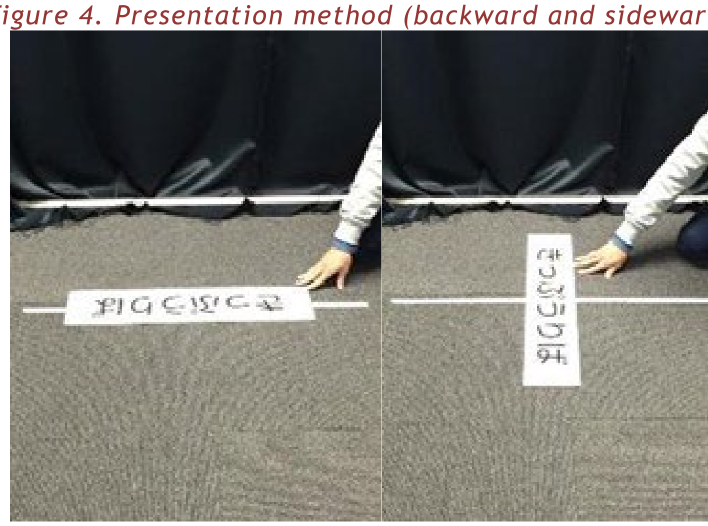



*Figure 4. Presentation method (backward and sideward)*



# Results

## Experiments on minimum legible sizes of characters (Experiment A)

In Experiment A, the average of the minimum legible sizes of characters on the floor surface was 21.33 mm for young people while the average for the elderly was 28.83 mm (Table 3).

Then, the minimum size of legible characters by JISS0032 of each subject is obtained. The results are shown in Table 4. The minimum readable character sizes for young and elderly people were 8.02 mm and 14.31 mm, respectively.

These results show that the characters are readable at a visual distance of 5 m for young people facing directly to the characters when the character height is 8.02 mm, but the height must be 21.33 mm as for the characters written on the floor. Similarly, the characters are readable for the elderly facing directly to the characters when the height is 14.31 mm, but the height must be 28.83 mm in the case of the characters written on the floor. These results showed that the coefficient of minimum legible characters on the floor surface was 2.66 (21.33/8.02) for young people and 2.02 (28.83/14.31) for the elderly, and that when installing a sign on the floor surface, the character size needs to be at least twice that for a normal sign.

However, since the minimum character size was 20 mm in this experiment, the size of minimum legible characters on the floor surface for young people can be even smaller. Thus, the coefficient of minimum legible characters on the floor surface is larger than that for the elderly.

## Experiments on readability (Experiment B)

In Experiment B, we separated vertical characters from horizontal characters according to the calculation method in 2-2, and set the largest value of optimum character sizes including the young and elderly to the optimum character size required for each character type.

As a method for calculating an optimum character size, Fig. 1 shows an evaluation approximation line of a Japanese word for “ticket booth” written vertically in hiragana. The readability was evaluated by young people from the front. In JISS0032, the readability evaluation value of 4.5 is used in this approximation expression y=0.057x + 0.5094 as a legible evaluation value. Thus, the evaluation value of 4.5 was also obtained in this study. The result is obtained as an optimum character size. Therefore, in this case, the optimum character size is 70.01 mm. All calculated results are shown in Table 6.

For young people, the optimum character sizes of hiragana (ticket booth) written vertically were 70.11 mm, 69.75 mm, and 78.04 mm when read forward, sideward, and backward, respectively. As for the elderly, the optimum character sizes were 68.50 mm, 70.34 mm, and 76.56 mm, respectively. In the case of horizontal writing, the optimum character sizes for young people were 67.31 mm, 73.26 mm, and 72.18 mm when read forward, sideward, and backward, respectively. As for the elderly, the optimum sizes were 67.12 mm, 72.85 mm, and 72.01 mm, respectively. If the largest value of these optimum character sizes is the optimum character size required for each character type, the optimum character sizes of hiragana written vertically and horizontally are 78.04 mm and 73.26 mm, respectively. The calculation was conducted on Katakana and Kanji in the same way. The results showed that the largest value is 90.96 mm when reading horizontally-written Kanji backwards. Therefore, the required character height is about 90 mm to read information written on the floor from a distance of 5 m.

*Table 3. Experimental results of minimum legible sizes of characters written on floor surfaces*

| The younger | Minimum legible font size（mm） | The older | Minimum legible font size（mm） |
|---|---|---|---|
| No.1 | 20 | No.1 | 25 |
| No.2 | 20 | No.2 | 30 |
| No.3 | 20 | No.3 | 25 |
| No.4 | 20 | No.4 | 30 |
| No.5 | 20 | No.5 | 20 |

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| The younger | Minimum legible font size（mm） | The older | Minimum legible font size（mm） |
|---|---|---|---|
| No.6 | 25 | No.6 | 30 |
| No.7 | 25 | No.7 | 30 |
| No.8 | 20 | No.8 | 30 |
| No.9 | 20 | No.9 | 30 |
| No.10 | 20 | No.10 | 30 |
| No.11 | 20 | No.11 | 30 |
| No.12 | 20 | No.12 | 20 |
| No.13 | 20 | No.13 | 25 |
| No.14 | 20 | No.14 | 25 |
| No.15 | 30 | No.15 | 30 |
| No.16 | 20 | No.16 | 30 |
| No.17 | 20 | No.17 | 50 |
| No.18 | 20 | No.18 | 25 |
| No.19 | 20 | No.19 | 25 |
| No.20 | 20 | No.20 | 20 |
| No.21 | 25 | No.21 | 35 |
| No.22 | 25 | No.22 | 20 |
| No.23 | 25 | No.23 | 25 |
| No.24 | 25 | No.24 | 60 |
| No.25 | 20 | No.25 | 25 |
| No.26 | 20 | No.26 | 20 |
| No.27 | 20 | No.27 | 25 |
| No.28 | 20 | No.28 | 40 |
| No.29 | 20 | No.29 | 30 |
| No.30 | 20 | No.30 | 25 |
| **Average** | **21.3** | **Average** | **28.8** |

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*Table 4. Minimum size of legible characters*

| The older | Age | V | S | Pmin(pt) | Character height (mm) | The younger | Age | V | S | Pmin(pt) | Character height (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No.1 | 65 | 0.8 | 6.3 | 43.0 | 15.1 | No.1 | 22 | 1.6 | 3.1 | 23.0 | 8.0 |
| No.2 | 71 | 1.0 | 5.0 | 35.0 | 12.3 | No.2 | 22 | 1.6 | 3.1 | 23.0 | 8.0 |
| No.3 | 66 | 0.8 | 6.3 | 43.0 | 15.1 | No.3 | 22 | 1.6 | 3.1 | 23.0 | 8.0 |
| No.4 | 67 | 1.0 | 5.0 | 35.0 | 12.3 | No.4 | 22 | 1.6 | 3.1 | 23.0 | 8.0 |
| No.5 | 71 | 1.0 | 5.0 | 35.0 | 12.3 | No.5 | 21 | 1.6 | 3.1 | 22.8 | 8.0 |
| No.6 | 67 | 0.8 | 6.3 | 43.0 | 15.1 | No.6 | 22 | 1.6 | 3.1 | 23.0 | 8.0 |
| No.7 | 65 | 1.0 | 5.0 | 35.0 | 12.3 | No.7 | 21 | 1.6 | 3.1 | 22.8 | 8.0 |
| No.8 | 67 | 1.0 | 5.0 | 35.0 | 12.3 | No.8 | 21 | 1.6 | 3.1 | 22.8 | 8.0 |
| No.9 | 66 | 1.0 | 5.0 | 35.0 | 12.3 | No.9 | 22 | 1.6 | 3.1 | 23.0 | 8.0 |
| No.10 | 65 | 0.8 | 6.3 | 43.0 | 15.1 | No.10 | 23 | 1.6 | 3.2 | 23.2 | 8.1 |
| No.11 | 67 | 1.0 | 5.0 | 35.0 | 12.3 | No.11 | 22 | 1.6 | 3.1 | 23.0 | 8.0 |

| The older | Age | V | S | Pmin(pt) | Character height (mm) | The younger | Age | V | S | Pmin(pt) | Character height (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No.12 | 65 | 1.0 | 5.0 | 35.0 | 12.3 | No.12 | 21 | 1.6 | 3.1 | 22.8 | 8.0 |
| No.13 | 67 | 0.6 | 7.9 | 53.8 | 18.8 | No.13 | 21 | 1.6 | 3.1 | 22.8 | 8.0 |
| No.14 | 66 | 1.0 | 5.0 | 35.0 | 12.3 | No.14 | 23 | 1.6 | 3.2 | 23.2 | 8.1 |
| No.15 | 66 | 1.0 | 5.0 | 35.0 | 12.3 | No.15 | 22 | 1.6 | 3.1 | 23.0 | 8.0 |
| No.16 | 67 | 0.8 | 6.3 | 43.0 | 15.1 | No.16 | 22 | 1.6 | 3.1 | 23.0 | 8.0 |
| No.17 | 67 | 0.6 | 7.9 | 53.8 | 18.8 | No.17 | 20 | 1.6 | 3.1 | 22.6 | 7.9 |
| No.18 | 66 | 1.0 | 5.0 | 35.0 | 12.3 | No.18 | 25 | 1.6 | 3.2 | 23.6 | 8.3 |
| No.19 | 65 | 1.0 | 5.0 | 35.0 | 12.3 | No.19 | 21 | 1.6 | 3.1 | 22.8 | 8.0 |
| No.20 | 65 | 1.0 | 5.0 | 35.0 | 12.3 | No.20 | 21 | 1.6 | 3.1 | 22.8 | 8.0 |
| No.21 | 65 | 0.8 | 6.3 | 43.0 | 15.1 | No.21 | 22 | 1.6 | 3.1 | 23.0 | 8.0 |
| No.22 | 65 | 1.0 | 5.0 | 35.0 | 12.3 | No.22 | 22 | 1.6 | 3.1 | 23.0 | 8.0 |
| No.23 | 67 | 0.8 | 6.3 | 43.0 | 15.1 | No.23 | 21 | 1.6 | 3.1 | 22.8 | 8.0 |

| The older | Age | V | S | Pmin(pt) | Character height (mm) | The younger | Age | V | S | Pmin(pt) | Character height (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No.24 | 68 | 0.4 | 12.5 | 83.0 | 29.1 | No.24 | 21 | 1.6 | 3.1 | 22.8 | 8.0 |
| No.25 | 65 | 1.0 | 5.0 | 35.0 | 12.3 | No.25 | 22 | 1.6 | 3.1 | 23.0 | 8.0 |
| No.26 | 66 | 1.0 | 5.0 | 35.0 | 12.3 | No.26 | 22 | 1.6 | 3.1 | 23.0 | 8.0 |
| No.27 | 65 | 1.0 | 5.0 | 35.0 | 12.3 | No.27 | 22 | 1.6 | 3.1 | 23.0 | 8.0 |
| No.28 | 67 | 0.6 | 7.9 | 53.8 | 18.8 | No.28 | 21 | 1.6 | 3.1 | 22.8 | 8.0 |
| No.29 | 69 | 0.8 | 6.3 | 43.0 | 15.1 | No.29 | 21 | 1.6 | 3.1 | 22.8 | 8.0 |
| No.30 | 68 | 0.8 | 6.3 | 43.0 | 15.1 | No.30 | 21 | 1.6 | 3.1 | 22.8 | 8.0 |
| | | | | **Average** | **14.3** | | | | | **Average** | **8.0** |

*Figure 1. Example of approximation expression in Experiment B*

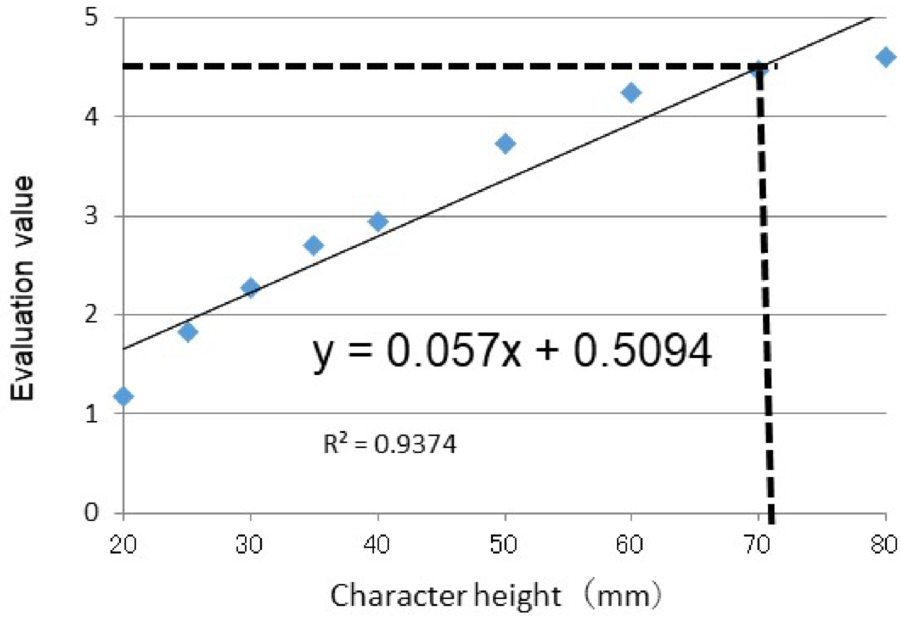


*Table 5. Optimum character size for each character type*

| Character type | Younger subjects Forward | Younger subjects Sideward | Younger subjects Backward | Older subjects Forward | Older subjects Sideward | Older subjects Backward | The good level of legible font size |
|---|---|---|---|---|---|---|---|
| **Vertical writing Hiragana** | 70.0 | 69.8 | 78.0 | 68.5 | 70.3 | 76.6 | 78.0 |
| **Horizontal writing Hiragana** | 67.3 | 73.3 | 72.2 | 67.1 | 72.9 | 72.0 | 73.3 |
| **Vertical writing Katakana** | 68.4 | 72.0 | 73.3 | 67.2 | 65.3 | 68.1 | 73.3 |
| **Horizontal writing Katakana** | 67.6 | 73.2 | 72.5 | 66.2 | 68.3 | 69.3 | 73.2 |
| **Vertical writing Kanji** | 75.6 | 77.9 | 91.0 | 73.4 | 72.6 | 82.6 | 91.0 |
| **Horizontal writing Kanji** | 70.1 | 78.9 | 77.0 | 68.4 | 74.7 | 74.0 | 78.9 |

## Discussion

The Barrier-free maintenance guidelines (Eco-Mo Foundation, 2020) stipulates that the character height is 20 mm or more at a visual distance of 4 to 5 m as an index of the size of characters used in guide signs. In the experiment on readability (Experiment B), we found that the optimum character sizes are about 90 mm and 80 mm in height at a minimum when written vertically and horizontally, respectively. These results showed that the characters in graphic floor signs should be much larger than those in normal guide signs. However, since the visual distance is 5 m in this study, an easy-to-see distance is not necessarily ensured (with a visual angle of about 18 degrees). In the future, by clarifying an easy-to-see distance of graphic floor signs, it is possible to review the optimum character sizes from an easy-to-see distance.

The optimum character sizes evaluated by young people and elderly people showed that the optimum character sizes for young people are larger than those for elderly people. The young subjects consisted of students while the older subjects were paid and hired, so the older subjects may have tried their best to see the characters. However, although there are differences in character height, the results of t-test showed that there is no significant difference in the slope of the approximation expression of each graph. This suggests that the evaluation values of young people and the elderly have the same tendency, and that it is appropriate to estimate legible character sizes from the approximate curve obtained in this study (Table 6).

Sagawa and Katakura(2013) report that the Mincho is harder to read than the Gothic. It also reports that Kanji is harder to read than Hiragana and Katakana. In Japan, Kanji, Hiragana, and Katakana are commonly used. In recent years, Chinese, Korean, and Roman characters have been used as guidance signs. Gold et al.(2009), compared the legibility of two fonts (Tiresias Signfont and FF Transit Front Neg Normal). Tiresias was recommended to the transit company for new signage.

Colour combination influences legibility (M.V.Mclean,1965). The test materials used in the experiments were letter and word boards that displayed only black letters on white background. We used the colour scheme used in visual acuity tests.

Since various characters and colour combinations are used in the guide sign, it is necessary to consider different languages, font types and colour combinations.

*Table 6. Slope of approximation expression*

| Character type | Younger subjects Forward | Younger subjects Sideward | Younger subjects Backward | Older subjects Forward | Older subjects Sideward | Older subjects Backward |
|---|---|---|---|---|---|---|
| **Vertical writing Hiragana** | 0.057 | 0.057 | 0.059 | 0.061 | 0.061 | 0.063 |
| **Horizontal writing Hiragana** | 0.052 | 0.058 | 0.053 | 0.051 | 0.059 | 0.052 |
| **Vertical writing Katakana** | 0.052 | 0.050 | 0.057 | 0.049 | 0.055 | 0.062 |
| **Horizontal writing Katakana** | 0.050 | 0.055 | 0.054 | 0.050 | 0.056 | 0.046 |
| **Vertical writing Kanji** | 0.062 | 0.057 | 0.056 | 0.069 | 0.068 | 0.065 |
| **Horizontal writing Kanji** | 0.056 | 0.063 | 0.062 | 0.062 | 0.074 | 0.064 |

## Conclusion

In this study, we estimated the minimum legible sizes of characters and the optimum characters written on the floor surface for sighted persons in reference to the JIS Standard. In the experiment on the minimum legible sizes of characters (Experiment A), we found that the minimum legible sizes of characters written on the standing surface can be corrected to the minimum size of legible characters written on the floor surface by multiplying with the coefficient of minimum legible characters on the floor surface by 2 to 3 times. In the experiment on readability (Experiment B), we found that the optimum character sizes are about 90 mm and 80 mm in height at a minimum for vertical and horizontal characters, respectively. These results showed that the optimum size of characters on graphic floor signs is about 90 mm.

## Reference

[1] Foundation for Promoting Personal Mobility and Ecological Transportation：Barrier-free maintenance guidelines ， 2020 ， http://www.ecomo.or.jp/barrierfree/guideline/data/guideline_shisetsu_202003_pdf.pdf (in Japanese)

[2] Hiroshi Kitagawa：A setting and verification of floor sign at rail way staion ， Proceedings of infrastructure planning， Voi.46,pp.1-4， 2012. (in Japanese)

[3] Kiyohiro OMORI, Takao YANAGIHARA, Hiroshi KITAGAWA, Norihiro IKEDA：Validation of Effectiveness of Graphic Floor Signs For Pedestrians With Low Vision And Normal Vision, Journal of Japan Society of Civil Engineers D3（Infrastructure Planning and Management）,Vol.70,No.5，I_961-I_969,2014. (in Japanese)

[4] Kiyohiro OMORI, Takao YANAGIHARA, Hiroshi KITAGAWA: validation of Effectiveness of Graphic Floor Signs for Elder Pedestrians, Journal of Japan Society of Civil Engineers D3（Infrastructure Planning and Management）,Vol.72,No.5,I_1105-I_1113，2016. (in Japanese)

[5] Meng-Cong Zheng, Tadao Shimizu, Kiminobu Sato: INFORMATION SIGNS BASED ON USERS' WAYFINDING BEHAVIOR IN TRANSFER BETWEEN ABOVE-GROUND STATIONS, Journal of the Science of Design, Vol.55,No.6,P.1-10,2009

[6] Meng-Cong Zheng, Tadao Shimizu, Kiminobu Sato: INFORMATION SIGNS BASED ON USERS' WAYFINDING BEHAVIOR IN TRANSFER BETWEEN UNDER-GROUND STATIONS, Journal of the Science of Design, Vol.55,No.6,pp.39-48,2009

[7] Ikeda, Y., Tsujimura, S., Yoshida, K., HIrate, K.,: Study on sign planning at a terminal station using "caption evaluation method" Basic study on the improvement of the ease of understanding of terminal stations, Journal of Architecture and Planning (Transactions of AIJ) Vol. 82, No. 738, pp. 1905-1914, 2017.8 (in Japanese)

[8] Yasue,M, Tsujimura, S, Ikeda, Y , Imanishi,M, Sano,Y: A STUDY ON USER EVALUATION ABOUT ADDITIONAL SIGN AT RAILWAY STATIONS FOCUSED ON INSTALLATION AMOUNT AND DESIGN ELEMENTS:Consideration of positive and negative elements of sign at railway stations Vol. 1, Journal of Architecture and Planning (Transactions of AIJ) Vol. 83, No. 751, pp. 1669-1667, 2018.9 (in Japanese)

[9] Yasue,M, Tsujimura, S, Imanishi,M, Ikeda, Y, Sano,Y: A STUDY ON USER EVALUATION ABOUT ADDITIONAL SIGN AT RAILWAY STATIONS FOCUSED ON INSTALLATION LOCATION:Consideration of positive and negative elements of sign at railway stations Vol. 2, Journal of Architecture and Planning (Transactions of AIJ) Vol. 84, No. 764, pp. 2099-2108, 2019.10 (in Japanese)

[10] Harada, M. : Visibility of Railway Ticket Gate Fare Charts : Influence of text size, viewing distance, and luminance to the visibility, Journal of Architecture and Planning (Transactions of AIJ), Vol. 82, No. 735, pp. 417-424, 2017.5 (in Japanese)

[11] Yung-Chin Tsao Shang-li Chu Ching-Huei Lai Shih-Yin Huang: UNIVERSAL DESIGN EVALUATION APPLIED ON STATION SIGN SYSTEM INNOVATION DESIGN, The International Journal of Organizational Innovation Volume 13 Number 1, 2020

[12] J.B. Rousek, M.S. Hallbeck: Improving and analyzing signage within a healthcare setting, Applied Ergonomics 42 (2011) 771-784

[13] Yusita Kusumarini*, Sherly de Yong, Diana Thamrin: Signage System of Malls in Surabaya: Universal interior design applications and suggestions for solution, Social and Behavioral Sciences 68 ( 2012 ) 515 – 525

[14] Yuqi Shi , Yi Zhang,*, Tao Wang,*, Chaoyang Li and Shengqiang Yuan: The Effects of Ambient Illumination, Color Combination, Sign Height, and Observation Angle on the Legibility of Wayfinding Signs in Metro Stations, Sustainability,2020

[15] Ken Sagawa, Kenji Kurakata: Estimation of legible font size for elderly people - Accessible design of characters in signs and displays and its standardization, Synthesiology Vol.6,No.1 PP.38-49,2013

[16] Deborah Gold, Biljana Zuvela, Sue Hope: Comparing Two Fonts for Signage Accessibility in a Train Station, Visual Impairment and Blindness Vol.2,No.4 PP.159-167 2009

[17] McLean, M.V. Brightness Contrast, Color Contrast, and Legibility. Hum. Factors 7, PP.521–527, 1965.

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