Research into Functional Evaluation of Non-slippery and Ecological Floor Material for Buses

Toshiki Nishiyama 1,2, Fuyuo Takiuchi 2, Shinji Mogi 3, Yukihito Kobayashi 3, Tadashi Hyakkan 3, Akiko Inagaki 3

1 Graduate School of Media and Governance, Keio University
2 The Institute of Areal Studies, Foundation
3 Mitsuike Corporation

E-mail bus@sfc.keio.ac.jp

Abstract

The number of elderly and physically challenged people who stumble and fall in buses is increasing in Japan. Bus companies require new ecological and durable floor material which stands long use until a bus goes out of use. So we have developed non-slippery and ecological flooring made of quartz and have evaluated the functions of a bus since 2004. The quantity of fuel consumed in producing this new type of flooring is smaller than that consumed in producing the existent material made of linoleum and rubber. And we can recycle the quartz for the floor material and can keep using the same material until a bus goes out of use. We let 343 customers and one bus company evaluate about the functions of newly-devised floor material. As a whole, about 76% of the customers rated non-slippery flooring highly. And we could get the high evaluation about the design of the material and the adaptability of their shoes to the material. Bus companies evaluated the newly-devised flooring as effective for developing universally and ecologically designed buses. Some effects brought about by this research are significant when administrative organs for the transport and bus makers set a new standard for developing buses for the future.

Key words: Non-slip, Floor material, Universal design, Ecological design, and Quartz

1. Introduction

With a recent increase in the number of aged and physically challenged people in Japan, we have had a better opinion of buses. It is important to promote the spread of universal design of flooring within a bus in order to prevent them from slipping and falling on a floor. We are studying ecological flooring made of quartz. Both passengers and bus companies rated this flooring highly.

2. Social Back Ground of This Research

2.1. An Increase in the Number of Accidents Caused by Flooring Now in Use

The Ministry of Land and Transportation reports that there were 1034 accidents within buses, including 1068 injuries in 2001 and that 57 percent of 1,068 injuries (608 persons) is caused by flooring. It is becoming an important problem to decrease the number of injuries caused by flooring.

2.2. Demand for Flooring which Has Been Devised for the Traffic Barrier-free Law

In Japan, the traffic barrier-free law took effect in autumn in 2000. This law stipulates that flooring within all the buses should not be made slippery. But one article of the law only stipulates that C.S.R. value should be more than 0.52. From now on it is necessary to produce flooring that is effective in preventing passengers from slipping and stumbling on a floor by setting an objective ceiling of C.S.R. value.

2.3. Demand for Ecological Flooring within Buses

In the 21st century, the concept of ecological design has been in the limelight. In America and Europe, it has become an important problem to combine universal design with ecological design in the field of transportation. We must try to bring an ecologically and universally designed flooring into wider use.

3. The Purpose of This Research

We gave citizens and the bus company staff a trial ride in a bus with flooring made of quartz laid. After that we asked them for their opinions about this flooring. In this research, we summed up the results of research on an improvement in flooring and the spread of it, on the basis of their opinions and evaluation.
4. The Summary of Newly-Devised Flooring

Newly-devised flooring is primarily made of quartz which excels in hardness and transparency. The flooring is the compound of quartz broken into pieces and resin called NMA which excels in strength and durability. The flooring has the following four advantages.

01. As the flooring is not slippery, passengers can avoid stumbling and falling within a bus.
02. The flooring makes it possible to decrease the number of injuries which passengers suffer at uneven parts within buses.
03. The flooring makes it possible to decrease the amount of fuel used in the manufacturing process.
04. No replacement of the flooring is required until a bus goes out of use because of its strength and durability.

The quality of the non-slippery flooring is objectively proved in a performance test carried out by a public organ as C.S.R. value shows (Table 1. : The results of the experiment which Tokyo Institute of Technology carried out). Vickers hardness (an index for the degree of hardness of the surface of metal and mineral) is more than 1000. Compared with that of flooring now in use, the value is very high. The newly-devised flooring is not worn away by long and continuous use because of hardness of its surface and high degree of C.S.R. value.

5. The Methods and Contents of This Study

In order to learn passengers’ opinion about newly-devised flooring and their degree of evaluation of the flooring, we asked the passengers to answer our questions after comparing the flooring with existent flooring. The questions are as follows:

[The Main Contents of the Questionnaires]
01. Passengers’ evaluation of flooring now in use.
02. Their evaluation of the sense of touch between their shoes and a new type of flooring.
03. Their evaluation of the design of new type of flooring.
04. Their evaluation of whether passengers can walk easily and safely without slipping on a new type of floor.
05. Their evaluation of laying a new type of floor in a bus.

In our research, with the aid of Yamanashi Kotsu, three researchers asked passengers to fill out the questionnaire in a trial bus for three days from November 11th (Thursday), 2004 to November 13th (Saturday). For this while it was clear or cloudy except for one hour’s rainfall. We got answers from 343 passengers (95 percent of the passengers) as mentioned in Table 2. On the other hand, in order to learn what various bus companies think of the use of the new type of flooring, we asked Yamanashi Kotsu company to fill out the questionnaire.

6. The Results of the Research about What Passengers Think of the Newly-devised Flooring

6.1. Passengers’ Evaluation of the Flooring Now in Use

Figure 2. shows what 343 respondents think of the flooring now in use. Some of them are afraid that they may slip on the floor on a rainy or snowy day, some when they keep standing, some when they keep standing on a rainy or snowy day and others when they are in any situations. It has turned out that 60 percent of the respondents feel uneasiness about the existent flooring made of vinyl, linoleum, or wood. We have made a detailed analysis of the results mentioned in Figure 2. according to age and sex. Though we divided the 343 respondents into some groups according to age and sex before detailed analysis, each group shows much the same tendency that all the respondents do. It is clear that the passengers do not get great satisfaction from flooring now in use in bad weather.
6.2. Evaluation of the Adaptability of Passengers’ Shoes to Newly-devised Flooring

In this research, we treat passengers’ evaluation of the adaptability of their shoes to newly-devised flooring. Figure 3 shows a ratio between 343 passengers who answer a question; “Which is better, newly-devised flooring or flooring now in use?” 77 percent of them answered that the sense of touch between shoes and newly-devised flooring is better. This percentage shows greater adaptability of shoes to new type of flooring. Judging from the passengers’ behavior, the hardness of quartz may cause some stability between their shoes and new type of flooring. We have made a detailed analysis of the results mentioned in Figure 3. according to age and sex. Though we divided the 343 respondents into some groups according to age and sex before detailed analysis, each group shows much the same tendency that all the respondents do. It is clear that passengers aren’t satisfied with existent flooring now in use because of their bad sense of touch between their shoes and the flooring.

6.3. Evaluation of the Design of Newly-devised Flooring

In our experiment we laid newly-devised blue flooring on an existent wooden floor within a bus. The color of the wall of a bus was bright green. In time of our research the blue flooring became tinted with black. On the premise of this fact, we asked the passengers what they think of the design, outer appearances and color. The respondents’ opinions are mentioned in Figure 4. Concerning the design and outer appearances, some of them said that it is a little better. 61 percent of the respondents praise newly-devised flooring. Concerning outer appearances, the passengers have put a higher value on newly-devised flooring because the rough surface of quartz gives them a vague idea of effectively preventing a slip on the floor. The design, outer appearances and color of newly-devised flooring are highly evaluated in an aging society. We have made a detailed analysis of the results mentioned in Figure 4. according to age and sex. Though we divided the 343 respondents into some groups according to age and sex before detailed analysis, each group shows much the same tendency that all the respondents do.

6.4. Evaluation of Newly-devised Flooring for Preventing a Slip on a Floor

In this section, we treat the results of the passengers’ opinions and evaluation about slipperiness on a floor. Figure 5. shows the results of the respondents’ evaluation of slipperiness on a floor. 76 percent of them answered that a restraint on a slip on a newly-devised floor is satisfactory and 10 percent of them said that the surface of the floor should be made a little smoother. Many passengers think that this flooring is effective in that they can walk on the floor easily and safely without stumbling and slipping. They place a higher value on the flooring because of the good sense of touch between shoes and the floor and the stability that they feel in stepping on the floor. We have made a detailed analysis of the results mentioned in Figure 5. according to age and sex. Though we divided the 343 respondents into some groups according to age and sex before detailed analysis, each group shows much the same tendency that all the respondents do. It is clear that the passengers are not satisfied with flooring now in use because it is slippery.

6.5. Answers to a Question about Laying Newly-devised Flooring within a Bus

44 out of 343 respondents have put a high value on this approach of ours. There were few negative opinions about newly-devised flooring without any major problems.
7. Bus Company’s Opinions about Newly-devised Flooring

We asked Yamanashi Kotsu Company to answer a written question about the use of newly-devised flooring in April, 2005 (10 months after the use of newly-devised flooring). They are as follows:

01. Newly-devised flooring made of quartz has the advantage of preventing passengers from slipping on a floor, especially on a rainy or snowy day. Moreover, passengers can walk easily and safely even on a greasy floor or on a floor with some detergent left within a bus.

02. Newly-devised flooring made of quartz is harder than that made of gum, and so on. Moreover, even if passengers step on the floor many times, the flooring can bear repeated use without any wear and tear of the floor and no replacement of the flooring is required. The use of this flooring leads to low cost, ecological design, and universal design.

03. The amount of fuel such as oil which is used in the manufacturing process is smaller. It is necessary to reduce the amount in order to popularize eco-design.

04. There are few complaints from passengers.

05. Thanks to coloring art of newly-devised flooring, it is possible to lighten the inside of a bus.

06. It is possible to sweep existent floors with a mop, but it is impossible to sweep newly-devised flooring with a mop because of less slipperiness on a floor.

07. Newly-devised flooring is heavier than existent flooring is. There is some concern that buses get lower mileage because of its weight.

08. There are some problems, but passengers put a high value on the quality of the newly-devised flooring.

8. In Conclusion

To what degree passengers and a bus company evaluate the newly-devised flooring is the main theme for our research. The flooring made of quartz contributes to the popularization of ecological design and universal design. They have rated the flooring highly in terms of ecological design and universal design. They have hoped that the flooring will be introduced into bus companies. But this research of ours was carried out in cooperation with only one bus company. In order to get better results and more detailed information, we are going to evaluate the flooring in cooperation with other bus companies including community buses and buses for welfare.

An Address of Thanks

In this research of ours, we express our sincere thanks to Yamanashi Kotsu Company for its cooperation.

Main References
