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AGE INFLUENCE OF ISO TEST TRACK USING MODIFIED ASPHALT

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ABSTRACT
We have investigated the age influence of tire/road noise on the ISO test track and some results were reported at Inter-Noise 98. During two years after construction, the surface aging has led to approximately 2dB(A) increase of coast-by tire/road noise. From the indoor experiments of the core specimens, it is observed that the surface aging is due to the decrease of the sound absorption of the surface which is caused by the deterioration of the asphalt binder at high road temperature. To minimize the age influence of the surface, we have tried to construct a new ISO test track. The specification of the surface is just the same with the ISO standard, but the modified asphalt is used instead of the straight asphalt binder. We obtained the results that the noise increase during two years is very small and it is much more effective for the surface aging to use the modified asphalt.

1 - INTRODUCTION

ISO 10844 test track has been developed to minimize the variation in vehicle noise measurements for use with ISO 362 test procedure at different testing locations, but now it is also used for tire/road noise testing. In order to minimize the contribution of tire/road noise for total vehicle noise, the surface constructions and characteristics were designed to reduce tire/road noise emission less than other non-porous surfaces.
At the first step, tire/road noise on our ISO test track was measured and compared with the initial level. The mechanism of the surface aging was also investigated by comparison with the change of the surface characteristics and the indoor experiments using core specimens. Furthermore, we tried to construct a new ISO test track using modified asphalt to minimize the surface aging.

2 - SURFACE AGING MECHANISM OF ISO TEST TRACK

2.1 - Age influence of tire/road noise and surface characteristics

We have investigated the age influence of coast-by tire/road noise on our ISO test track using a passenger car (PC) and a commercial vehicle (TB) tires during three years. The measurement conditions were based on ISO WD13325 [1] and the measured noise levels were corrected by E' temperature correction method in equation (1). The required characteristics such as residual voids content, sound absorption coefficient and texture depth have been conformed to ISO 10844 requirements [2].
As shown in Figure 1, coast-by tire/road noise for both tires increased year by year especially in summer time. Total noise increase during the first two years after construction was 2.3dB(A) for PC and 1.9dB(A) for TB. Texture depth and residual voids content were slightly changed after construction, but they were not in relation to the increase of tire/road noise. Normally the sound absorption shall be measured by the impedance tube method using core specimens. But we measured it directly on the surface with B&K impedance tube and the results were almost as same as that of core specimens. The averaged sound absorption coefficient in the range between 400 and 1.6kHz decreased during summer time just like tire/road noise and it shows a good correlation with the series of noise levels in Figure 2.

2.2 - Surface aging mechanism

At first, we thought the wheel passing lane of the ISO test track was compacted by vehicle tires during summer time and then the sound absorption coefficient was decreased. But there was no difference in

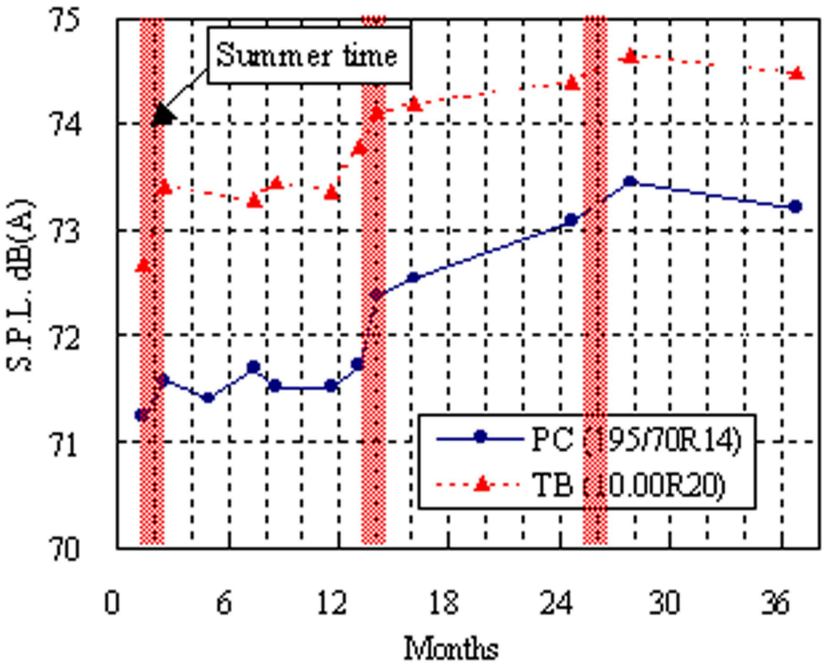

Figure 1: Age influence of tire/road noise on ISO test track.

sound absorption between the wheel tracks and the other places. Then we supposed that the surface aging was not caused by the compaction of the surface, but by the deterioration of asphalt binder. From the indoor deterioration test using core specimens of ISO test track, it was observed that the surface aging is caused by the following mechanism [3].

- 1st step: Asphalt binder is deteriorated by water, oxygen and ultraviolet rays
- 2nd step: The deteriorated asphalt is exfoliated from the surface of aggregate
- 3rd step: At high temperature in summer time, the exfoliated asphalt is melted and finally the cavity of the surface is filled with it

3 - AGE INFLUENCE OF ISO TEST TRACK USING MODIFIED ASPHALT

3.1 - Indoor deterioration test

To minimize the age influence of the surface, the deterioration characteristics of asphalt binders were investigated. As the surface aging is caused by the melted asphalt, we considered the use of the modified asphalt. Several types of the modified asphalt were selected and the indoor deterioration tests were conducted using the core specimens. The typical binder properties between straight and modified asphalt are shown in Table 1. The softening point of modified asphalt is at least 30°C higher than straight asphalt.

Grade	Straight asphalt	Modified asphalt
Penetration value	$60 \sim 80$	$35 \sim 55$
Softening point	$44 \sim 52$°C	> 75°C

Table 1: Properties of asphalt binder.

To accelerate the deterioration of the asphalt binder, the core specimens were put into water and kept at the temperature of 55°C for 5hrs in the heating chamber. After two days dry up, the sound absorption coefficients were measured and compared the difference with the initial level as Figure 3. The decrease of sound absorption for the modified asphalt was 60% less than the straight asphalt. The result of indoor deterioration test shows the advantage of the modified asphalt.

3.2 - Effect of modified asphalt for age influence of tire/road noise

Based on the indoor experiments of the core specimens, we tried to construct a new ISO test track to minimize the surface aging. The specification of the surface is just the same with the ISO 10844 standard

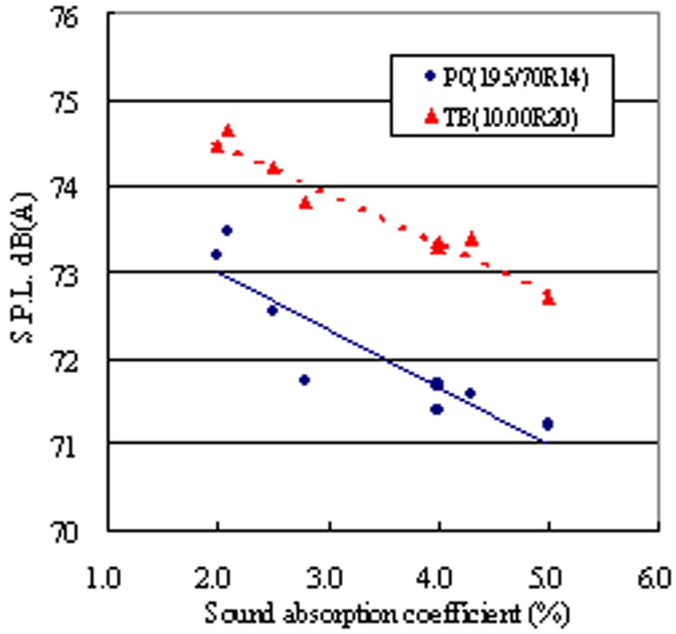

Figure 2: Relation between tire/road noise and sound absorption coefficient.

except the type of asphalt binder. There are different types of modified asphalt, but we chose one which has a softening point higher than 90°C.
The age influence of the new surface was measured during two years using the same PC and TB tires. Temperature correction method using air or road surface temperature is suggested internationally, but the accuracy is not yet sufficient. We have investigated a new temperature correction method using the temperature gradient of elastic modulus E' of tread compound and the accuracy was much improved than constant correction method [4].
The measured noise levels were corrected by the following equation.

$$\Delta S = -6.76 \times \Delta E'30 \tag{1}$$

where

- ΔS: Temperature gradient of tire/road noise for air temperature
- ΔE'30: Temperature gradient of E'30/E' (Constant value for each tread compound)
- E'30: The value of E' at 30°C

As shown in Figure 4, the increase of coast-by tire/road noise during two years after construction was only 0.8 dB(A) for PC and 0.7dB(A) for TB. The total noise increase is 1.2∼1.5dB(A) less than our ISO standard test track. Figure 5 shows the comparison of the frequency analysis during 20 months surface aging for PC and there is no big difference.
Figure 6 shows the comparison of the sound absorption between both surfaces. The sound absorption coefficient of the straight asphalt decreased 2.5% during two years especially in summer time, but the modified asphalt is almost keeping the initial condition.
To confirm the advantage of the modified asphalt, another coast-by noise test was conducted. After the surface construction, we measured the coast-by tire/road noise using two group of tires which have different sizes and patterns. Those tires were retested again after two years and the noise levels corrected by the E' method are compared as shown in Figure 7. They show a good correlation and the absolute values are almost same. These data indicate that the modified asphalt is much effective for the age influence of ISO test track.

4 - CONCLUSIONS

Age influence of coast-by tire/road noise on the ISO test track has been investigated. During two years after construction, the surface aging has led to approximately 2dB(A) increase of coast-by tire/road noise especially in summer time. From the indoor experiments of the core specimens, it is observed that the

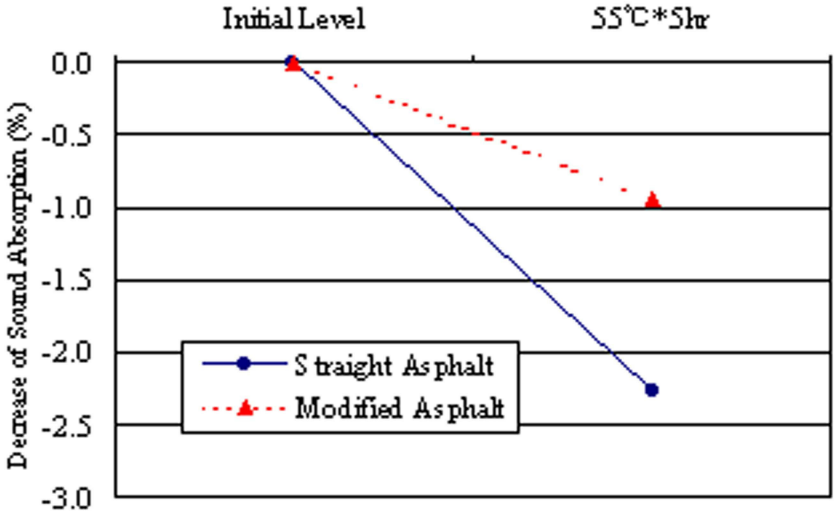

Figure 3: Decrease of sound absorption after indoor deterioration test.

surface aging is due to the decrease of the sound absorption which is caused by the deterioration of the asphalt binder at high road temperature.
To minimize the age influence of the surface, we have tried to construct a new ISO test track. The specification of the surface is just the same with the ISO standard, but the modified asphalt is used instead of the straight asphalt binder. We obtained the results that the noise increase during two years is very small and it is much more effective for the surface aging to use the modified asphalt.

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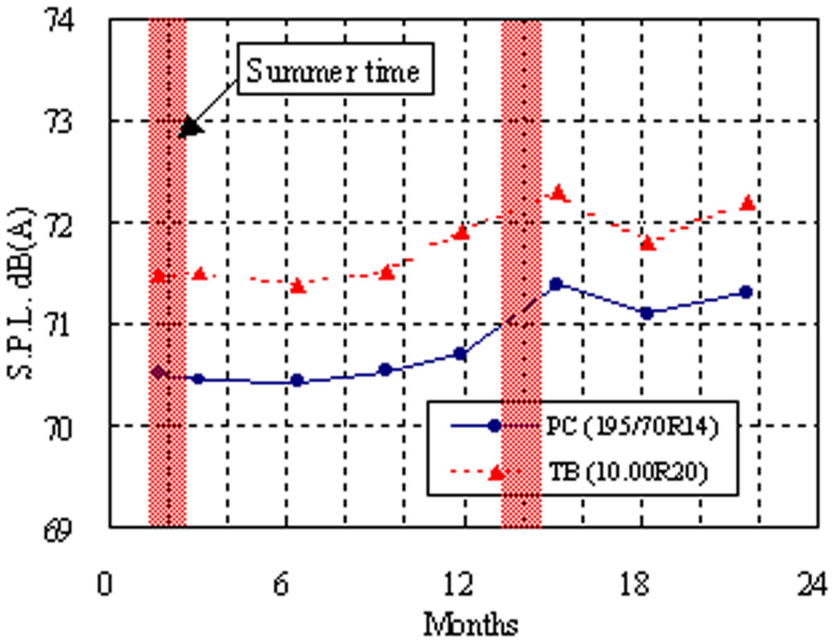

Figure 4: Age influence of tire/road noise on new ISO test track using modified asphalt.

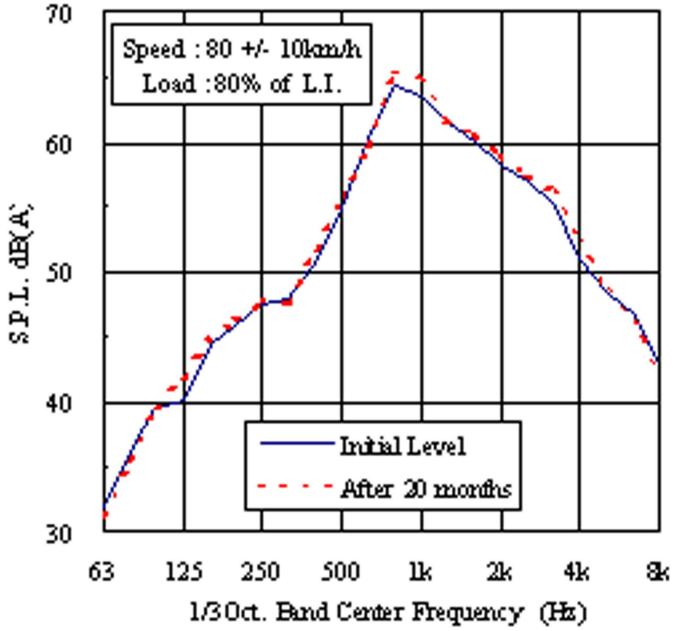

Figure 5: Comparison of frequency analysis during 20 months surface aging (PC) on ISO test track.

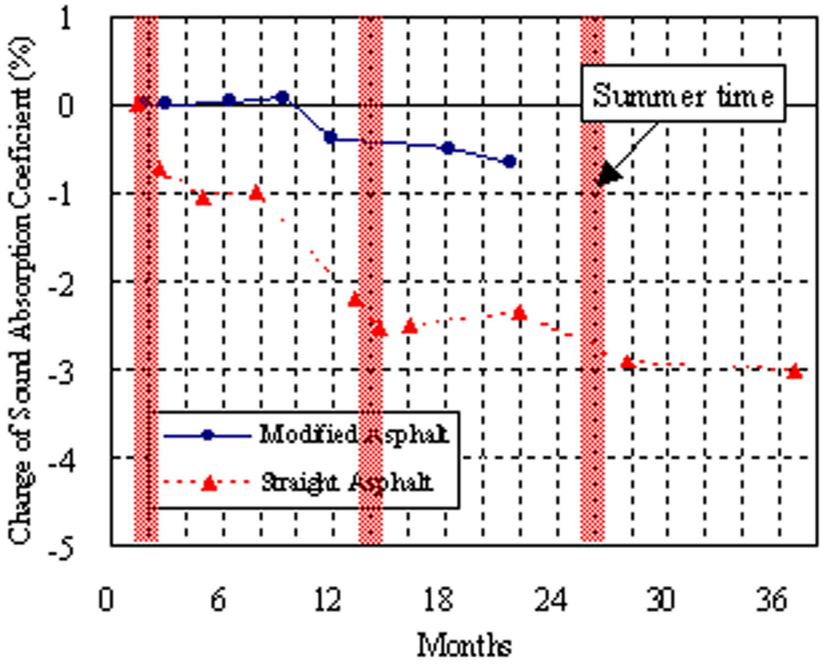

Figure 6: Comparison of sound absorption between straight and modified asphalt on ISO test track.

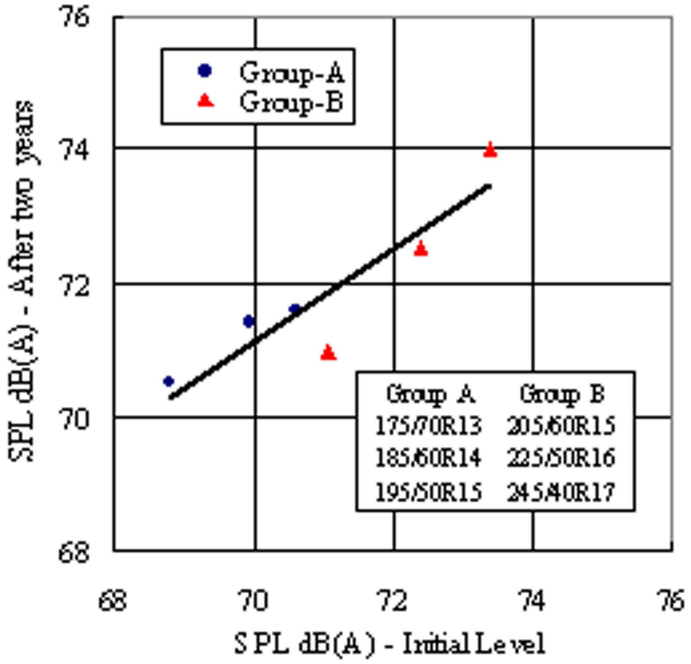

Figure 7: Age influence of tire/road noise during two years on modified asphalt.