Railway-noise reduction effect and aged deterioration properties of softer rail pad

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ABSTRACT

To lower the elastic rigidity of the track is known as one of the countermeasures against railway-noise. In this study, a field test in which the standard rail pads were replaced by the softer rail pads were conducted in order to evaluate the railway-noise reduction effect of the softer rail pads. In addition, the noise measurements were conducted in another field where the softer rail pads were installed at several periods up to 60 months and the material properties of some of the installed rail pads were measured. As the results, the relationship between railway-noise reduction effect and the aged deterioration properties of the softer rail pads was evaluated quantitatively.

Keywords: structure-borne noise, spring static constant, I-INCE Classification of Subjects Number(s): 02.1

1. INTRODUCTION

To lower the elastic rigidity of the track is known as one of the countermeasures against the structure-borne noise. As one actual method of lowering the elastic rigidity of track, rail pads of standard spring constant were replaced by softer rail pads in some sections of the slab track. However since a cyclic loading accompanied by train run and the other environmental deterioration factors such as sunshine, rain and varying temperature may promote the aged deterioration of the softer rail pads in actual track, the softer rail pads are presumed to be deteriorated gradually and to loss a part of railway-noise reduction effect. Therefore, some field tests in which the railway-noise was measured in a viaduct before and after replacing with the softer rail pads and after some periods passed from the replacement and the material properties of some of the installed softer rail pads were measured in order to evaluate the effect of railway-noise reduction and the influences of the aged deterioration of the softer rail pads.

2. OUTLINE OF FIELD TEST

Standard rail pads installed on the slab track on a railway viaduct, (nominal static spring constant 60MN/m) were replaced by softer rail pads (nominal static spring constant 30MN/m). The replaced softer rail pads were produced by Japanese vulcanized rubber manufacturer, which were made of Styrene-butadiene rubber, and whose size were 180×140×12mm. The noise levels at places just beneath the viaduct and 25m distant from the center of near side track were measured before and after the softer rail pads were replaced.

Furthermore, two more measurements were conducted as follows;

1) In another field of the railway viaduct, the standard rail pads were replacing along approximately 120 m and a rail grinding was executed there a month after the replacing of rail pads. The measurements of noise were conducted at following three times; (1)before the replacement of rail pads, (2)after the replacement of rail pad and (3)after rail grinding.
2) The measurements of noise were conducted in the same field with that mentioned in 1) at periods

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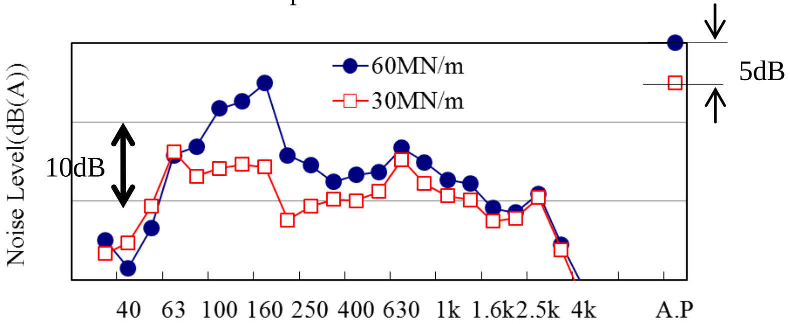
of 0.5,1, 2, 4, 8, 12, 24, and 60 months after the replacement of the rail pads. Moreover, 16 pieces of softer rail pads installed on one slab track were collected at the almost same periods with those of noise measurements in turn from the edge of the field, and there material properties such as a static spring constant were measured.

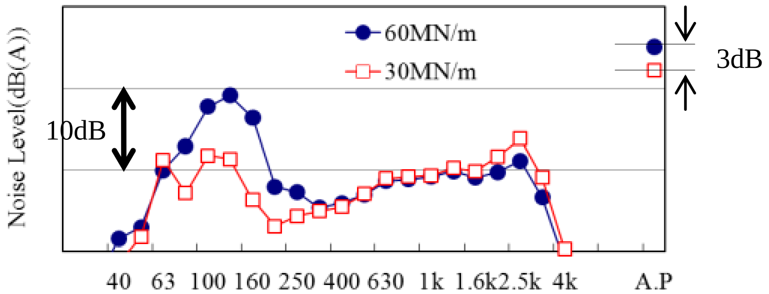
3. Results and discussions

3.1 Railway-noise reduction effect of softer rail pad

Figure 1 shows the result of the measurement of noise level before and after replacing with the softer rail pads. As shown in Fig. 1, it is revealed that the noise levels from 100 to 250 Hz are drastically reduced at both points just beneath the viaduct and that distant from the near side track center after replacing with the softer rail pads. From Fig.1, it is indicated that the reduction in all pass value of noise level by replacing to the softer rail pad is approximately 5dB for the point just beneath the viaduct, 3dB for the point distant from the track center. The reason why the noise reductions are so drastic is considered as follows; as shown in figure 2, the area under the measured viaduct has a large quasi-closed space, and the structure-borne noise is conceived to be resonated in the space. Consequently, in this field, the noise reduction effect by the softer rail pad is amplified because the contribution of the structure-borne noise surpasses other noises.



(a) Just beneath the viaduct



(b) At the point 25m distant from the track center

Figure 1 – The result of the measurement of noise level before and after the replacing with the softer rail pads.

Figure 2 Views of the measurement point

3.2 The effect of replacement of softer rail pad and rail grinding

Figure 3 shows the results of the noise measurements at the point just beneath the viaduct in the deferent field from that of the section 3.1 before and after the replacement of rail pads and the rail grinding. From this, it was revealed that the noise level was reduced around 63Hz after the replacement and the noise reduction effect reaches 7dB at 63Hz. On the other hand, the noise increased over 400Hz after the replacement. This reason is thought because in this field the area under the viaduct is quasi-opened space as different from that mentioned in 3.1 section, and the contribution of noise generated between wheel and rail is greater. Generally speaking the vibration of rail rather increases, which causes an increase of the noise between wheel and rail after replacing with the softer rail pads[1)].

As shown in Fig.3, it was confirmed that after the rail grinding the railway-noise became smaller than even those of track with the standard rail pads no less than those with the softer rail pads before rail grinding in the frequency range where the noise level increased by replacing with softer rail pads. Consequently, it was confirmed that the all pass value of the noise level of track with softer pads after rail grinding was smaller than that of track with standard rail pad before rail grinding. This is probably due to the decrease of noise between rail and wheel by rail grinding.

From these results, in order to design the countermeasures against railway-noise, it is necessary to measure the noise and predict the contributions of each noise sources quantitatively.

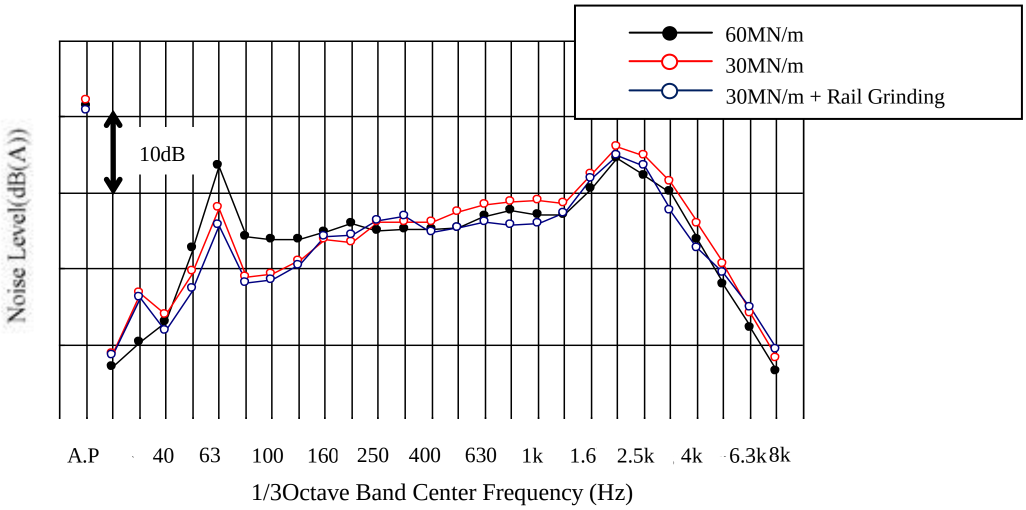


Figure 3 – The result of the measurement of noise level when rail grinding was conducted.

3.3 Change of the static spring constant of softer rail pad by aged deterioration

The sizes and the static spring constants of 16 pieces of the softer rail pads collected form each slab track in the test field at every period of 0.5,1,2,4,8,12,24,60 months after the replacement were measured. The static spring constant was measured with an electro-hydraulic load testing machine by the following method; the load of 0−100-10-40-10-100-0kN was implied on the test piece in order and the static spring constant was calculated with the difference of displacement and that of load when the load was increased from 10kN to 50kN in the third increasing load process.

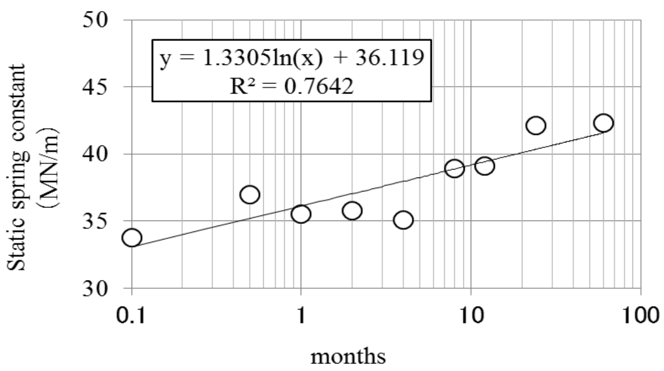


Figure 4 – The relation between the static spring constant and aging.

As the results of the measurement of sizes of the pieces installed in 60 months, it was confirmed that the increases of breadth and the length was put in within 1% and the decrease of thickness was not more than about 3.2%.

Figure 4 shows the relation between the static spring constant and installation periods. From this, it was found out that the spring constant almost simply increased with an increase of the installation time because the softer rail pads became hard owning to the aged deterioration. Compared with the values of new test pieces, the spring constants of those installed in 60 months increased by about 25%

3.4 Aged change of railway-noise level

The noise at the point 25m distant from the track center was measured at the periods of 0.5,1,2,4,8,12,24,60 months after replacing of rail pads. As the results, the noise values from 20Hz to 8kHz were observed to have only slight changes through the period from 0.5 to 60 months after the replacement of rail pads.

Figure 5 shows the relationship between the static spring constants described in the previous section and the noise levels at 63Hz which were picked up from each measuring result described in this section and the installation period. As shown Fig. 5, there seems to be little correlation between the noise levels and changes of static spring constants. Therefore, the increase of the static spring constant to this extent may not influence the railway-noise reduction effect clearly.

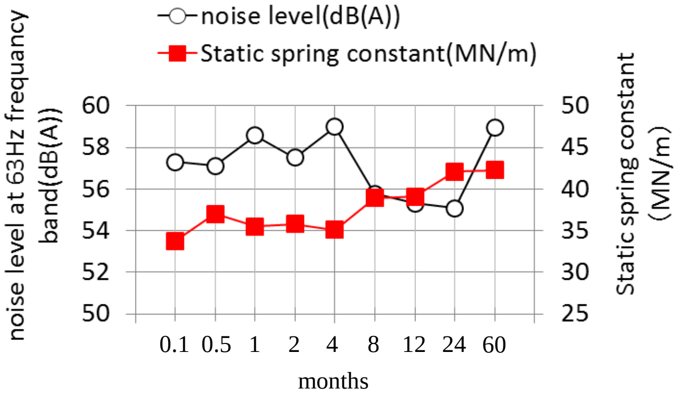


Figure 5 – The relation between the static spring constant and the noise level at 63Hz frequency band.

4. CONCLUSIONS

The conclusions of this study are as follows

As the results of field test in which the railway noise was measured in a railway viaduct before and after the standard rail pads were replaced by softer rail pads, it was confirmed that the softer rail pad has apparent effect in the field where the contribution of structure-borne noise surpasses other noise.

As the result of noise measurement conducted in another field of railway viaduct before and after a rail grinding, it is recognized that the rail grinding has a reduction effect for the noise between rail and wheel.

The static spring constants of softer rail pads collected from the field at some periods after the replacement were measured. As the result, the static spring constant increased almost simply and that of pieces installed in 60 months increased by about 25% from that of new pad.

As the result of noise measurement at the same periods with the collections above mentioned, it is presumed that the increase of the static spring constant of the softer rail pads to this extent may not influence the railway-noise clearly.

REFERENCES

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