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NOISE CONTROL FOR A BETTER ENVIRONMENT

Experimental investigation on the rolling noise and train interior noise reduction effect with tuned particle impact damper

Jie, Jin[1]
Department of Mechanical Engineering, Hanyang University
Wangsimni-ro 222, Seongdong-Gu, Seoul 04763, Republic of Korea

Hyo-In, Koh[2]
Korea Railroad Research Institute
Uiwang 437-757, Republic of Korea

Junhong, Park[*]
Department of Mechanical Engineering, Hanyang University
Wangsimni-ro 222, Seongdong-Gu, Seoul 04763, Republic of Korea

ABSTRACT

Railway noise has become a major issue and rolling noise which is generated by the surface roughness of wheel and rail plays an important role to the railway noise. In order to reduce the rolling noise, tuned particle impact damper was developed in previous study. The proposed damper has superior vibration reduction capability in a specific target frequency domain, and also has good damping in the broadband frequency range by the inelastic particle collision effect. To analyze the vibration and noise reduction performance of the tuned particle impact damper, testing samples were installed 150m long over the rail track between the Wangil and Geomdanoryu station, Inchon, South Korea. The vibration reduction effect was verified before and after the installation. The rolling noise and train interior noise were also measured during the train was in operation. The difference of equivalent noise level, frequency characteristic and sound quality index were analyzed .

Keywords: Railway, rail impact damper, tuned absorber, rolling noise, interior noise
I-INCE Classification of Subject Number: 30 General

1. INTRODUCTION

Train is considered as an environment-friendly transportation system. Sound from the operating trains are causing environmental noise problems on nearby residential areas. Rolling noise is an important sound source due to the operating trains, which is generated from the vibrating rails and wheels due to the irregular corrugations on the surface. In order to reduce the rolling noise, this study proposed tuned particle impact damper and the noise reduction effect was investigated.

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[1] kigloo910@gmail.com
[2] hikoh@krri.re.kr
[*] parkj@hanyang.ac.kr

2. Verification of noise reduction effect by tuned particle impact damper

Tuned particle impact damper was proposed in this study as a device that combined the characteristic of tuned absorber and impact damper. As a result, it has superior vibration reduction capability in a specific frequency domain, and also has good damping in the broadband frequency range by the inelastic particle collision effect. To verify the vibration and noise reduction effect from tuned particle impact damper, testing samples were installed 150 m long over the rail track between the Wangil and Geomdanoryu station, Inchon, South Korea. Experiments were conducted before and after the proposed damper was tightened.

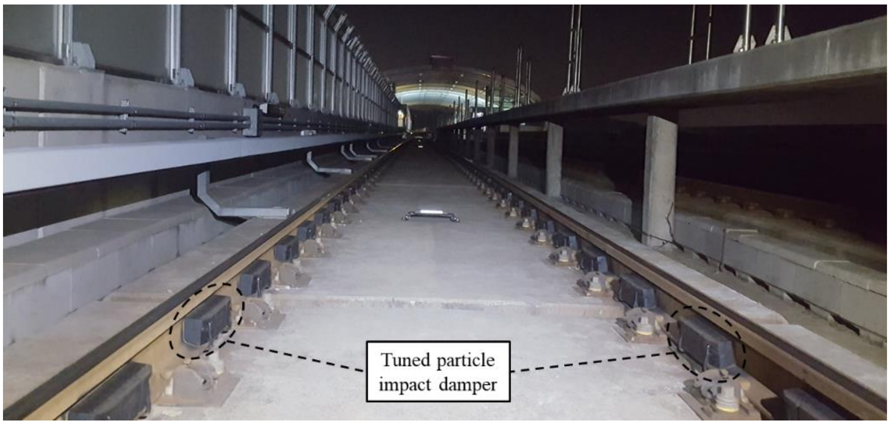

Figure 1. Tuned particle impact dampers on actual track

2.1 Measure the rail vibration and rolling noise

To measuring the rail vibration and train rolling noise, accelerometer was attached below the rail at middle position of rail span. Two microphones were installed at a horizontal distance of 1.75 m, 7.5 m from the sleeper centre respectively to measure the rolling noise at near and far field. The Short Time Fourier Transform (STFT) was progressed to compare the vibration and rolling noise reduction effect through time varying frequency spectrum. The STFT is as follows:

$$X(\tau,\omega) = \int_{-\infty}^{\infty} x(t)w(t-\tau)e^{-j\omega t}dt \tag{1}$$

where $x(t)$, $w(t)$ are the signal to be transformed and the Hann window respectively.

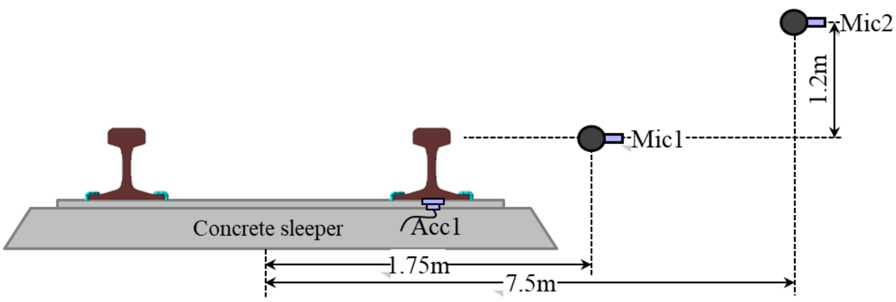

Figure 2. Sensors for measuring rail vibration and rolling noise

2.2 Measure the train interior noise

In order to confirm the interior noise reduction effect due to the tuned particle impact damper, sound pressure level was measured through noise book(Head acoustics). Considering the ear position of sitting on the window side, the microphone was installed at a distance of 120 cm in height and 10 cm from the windshield. The equivalent noise level was calculated to evaluate the proposed damper effect to the train interior noise.

$$L_{Aeq,Tp} = 10\log 10\left[\frac{1}{N}\int_{t_1}^{t_2}\frac{p^2(t)}{p_{ref}^2}dt\right] \quad (2)$$

where $p(t)$, N are the measured sound pressure, quantity of data respectively.

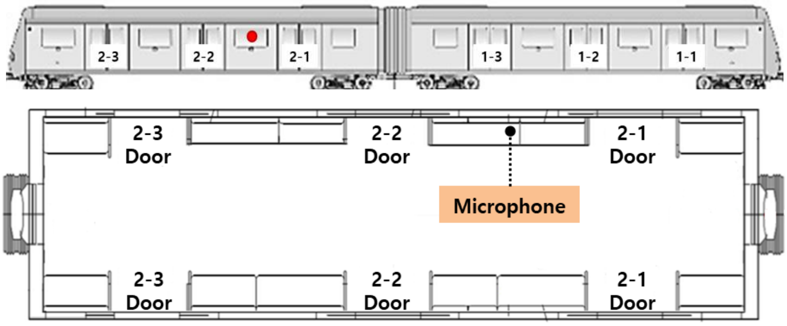

Figure 3. Verification of train interior noise reduction effect

3. RESULT

The vibration response is reduced not only at the target frequency of tuned particle impact damper, and also has broadband reduction effect due to the inelastic impact particle. Sound pressure level reduced about 6.5 dBA at target frequency and the equivalent rolling noise level decreased about 4.3 dBA at 100~5000 Hz. As the installation interval increases, the train interior noise reduction duration was also improved. At the frequency domain of 100~5000 Hz, the equivalent interior noise level decreased about 3.2 dBA.

4. CONCLUSIONS

This study presents a new concept of tuned particle impact damper by using the target frequency reducing principle of dynamic absorber and the inelastic impact effect of the impact damper. By calculating STFT and equivalent noise level through the experimentally measured data, the rolling noise and train interior noise reduction effect from the tuned particle impact damper was verified. Therefore, it is expected to play an effective role in reducing environmental noise around the track.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

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