

# A study on the prediction of the noise reduction performance according to applying the rail web-damper in curved track section

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#### ABSTRACT

This research plans to consider noise reduction performance of the rail web-damper in curved track section. For this purpose, we predicted vibration and noise and analyzed noise reducing elements. Firstly, the predictive value of vibration and noise was calculated by the BEM based program and numerical analysis toward the curved track section in the tunnel. Also, the actual noise value was compared with the predictive noise value from track component vibration, such as sleeper and the rail before & after applying rail web-damper.

Keywords: Railway noise and vibration, Rail web-damper, Curved track, Noise reduction, BEM

## 1. INTRODUCTION

Railway vehicle causes unpleasant noise in the curved track section rather than straight track section, because of rolling noise, which occurs from the interaction of wheel and rail, and squeal noise from curved track operation. The squeal noise becomes a main cause of internal and environmental noise in the dense floating population area, especially when the metropolitan railway across the city center, because of the small radius of the curve [1].

In order to reduce noise of curved track section, vibration isolator, rail lubricator and resilient wheel are considered as alternatives. However, these alternatives are lack of effectiveness [2], and research for reducing noise of curved track is still in progress.

In case of rail web-damper, which is expected as rolling noise reducing method, existing foreign rail web-damper is not available to propose its performance in Korea because of suitability issues from railway vehicle and track environment.

As shown in Fig.1, ail web-damper attaches to the web and the base of the rail, and considering its maintenance and vibration reduction performance from vibration absorber and damping materials shown, the web-damper uses fixing clips to be detachable.



Figure 1 - Structure of rail-web damper

In this research, noise reduction performance of rail web-damper which reduces rolling noise by reducing rail vibration in curved track section was predicted and analyzed.

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## 2. NUMERICAL ANALYSIS

#### 2.1. Modeling

In this research, radiating noise was predicted by SYSNOISE program and track components, such as rail and sleeper, were modeled by ANSYS program based boundary element method. This prediction method used vibration velocity data as input data, and calculated noise radiation from the vibration by boundary element method. Also, noise reduction performance of the rail web-damper in development was predicted and analyzed.

Assuming radiated noise of the wheel is smaller than the radiated noise of rail, the radiated noise of the wheel is excluded from modeling. Figure 2 is modeling feature, which includes rail, sleeper and slab structure.

As presented in Figure 3, the field point mash was modeled vertically up to 3m, spacing 1m apart, in order to verify result of radiation. Also, in order to compare the result with a measured noise value, two predictive points were located on 2.5m from the middle of the track, height of 0.5m and 1.2m (Point 46:0.5m, Point 45:1.2m).



Figure 2- Modeling shape for track components

Figure 3- Position of predicting noise

#### 2.2. Vibration Velocity Prediction

Prediction of radiation noise from track components is analyzed from input data, vibration velocity data of track components, and vibration velocity data of track components depends on feature of the track structure and vehicle. In this research, vibration acceleration data from rail, sleeper and a slab of track in the tunnel became input data.

Figure 4 shows vibration velocity of rail, sleeper and slab measured from radius of curve R250 section.



Figure 4 - Measured vibration velocity of track components

When the rail web-damper applied, estimated value of damping ratio of damping adhesive, which is a key component of rail web-damper, was regarded as vibration velocity [7].

Figure 5 shows test piece of isobutylene-isoprene rubber based damping adhesive. Since isobutylene-isoprene rubber possesses outstanding physical properties, wear resistance, flex resistance and shock absorption, it becomes effective impact preventing material. Also, since each test piece has different loss factor depending its thickness, isobutylene-isoprene rubber shall be selected depending feature of applying target.

Figure 6 presents measured value of damping ratio depending thickness. In order to reduce vibration optimal, 3T of Sample 01, which has 250~500Hz of reduced value, was used in this prediction. In this prediction, T may be defined as thickness, and the unit is mm (millimeter). Vibration velocity of the rail-web damper is calculated by applying the damping ratio of damping adhesive, and initial acceleration value and the rail web-damper applied acceleration value were assumed equal in this calculation.



(a) Sample 01

(b) Sample 02

(c) Sample 03

Figure 5 - Damping material for rail web-damper

Thick	Sample 01	Sample 02	Sample 03
1mm	-	-	0.16
2mm	-	0.10	-
3mm	0.15	-	-
4mm	-	0.10	0.19
6mm	0.17	0.10	0.19

 Table 1 - Damping ratio of damping material (each thick)



Figure 6 - Damping ratio of damping materials

Figure 7 is vibration velocity of rail before & after applying rail web-damper; V1 is the actual measurement value of vibration velocity before applying rail-web damper, and V2 is estimated value of vibration velocity after applying rail-web damper.



### 3. PREDICTION RESULT AND CONSIDERATION

#### 3.1. Noise Prediction by Vibration Data

Following figure and table present noise prediction result based vibration data of track components. Figure 8 shows sound level result at 0.5m and 1.2m in 1/1 octave-band



Figure 8 - Sound pressure level without rail web-damper

Table 2 shows the comparison result of actual measurement value and estimated value. Although overall value has a margin of error of 10dB(A), since it also has the margin of error of 3dB(A) under 250Hz of low frequency range, numerical analysis and analysis program verification were available.

Frequency	0.5m			1.2m		
	measured	predicted	difference	measured	predicted	difference
63Hz	57.6	60.0	2.4	57.2	60.0	2.8
125Hz	67.1	64.2	2.9	65.3	62.5	2.8
250Hz	79.0	76.1	2.9	78.7	76.0	2.7
500Hz	83.1	73.2	9.9	82.5	69.0	13.5
1000Hz	81.3	70.6	10.7	81.0	66.8	14.2
2000Hz	81.0	62.2	18.8	80.6	62.8	17.8
4000Hz	75.0	55.2	19.8	74.9	57.0	17.9
Overall	87.6	78.9	8.7	87.2	77.6	9.6

Table 2 - Sound	pressure level	comparison	between	measured	and	predicted
						r

(Unit: dB(A))

Figure 9 shows the radiation sound distribution in major band.



Figure 9 - Distribution pattern of noise level without rail web-damper

#### 3.2. Noise Reduction Performance Prediction after Applying Rail Web-Damper

The following figures show a sound level prediction of radiation sound and reduction performance analysis result of applying rail web-damper to a curved track section of the tunnel with 250m of the radius of the curve. As noise reduction performance prediction result, Figure 10 shows a comparison of sound level prediction value before & after applying web damper at 0.5m and 1.2m. The rolling noise reduced approximately 3dB(A) after applying rail web-damper. Also, since rail web-damper presents noise reduction performance over 1000Hz of high frequency range, it is expected to reduce squeal noise efficiently.



(a) Predicted the noise level (0.5m)
 (b) Predicted the noise level (1.2m)
 Figure 10 - Predicted noise reduction level after applying web-damper

## 4. CONCLUSION

As a result of modeling track components and analyzing radiated noise by using the vibration velocity of each component as input data, rolling noise approximately reduces by 3dB (A) by applying rail web-damper. According to this result, noise reducing mechanism of the rail web-damper, which reduces vibration of rail to reduce noise, is considered an effective mechanism, and effective rolling noise reduction performance of applying rail web-damper is also expected.

Further verification of noise reduction performance from test construction of rail web-damper on concrete, curved track section and improving reliability of the noise prediction method shall be necessary.

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