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A STUDY ON THE CHARACTERISTICS AND PREDICTION METHOD OF NOISE FROM CONCRETE RAILWAY BRIDGE

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Abstract. *When it comes to railway passing through the urban area, structure born noise from the structure supporting the track serves the secondary noise source, worsening the ambient noise. Noise on bridge is greater than at-grade section by more than 3dB, requiring investigation of noise propagation by type of structure and countermeasures urgently. The study thus is intended to investigate the characteristics of the noise generated by the train passing the concrete bridge which is very common and analyze the result by distance, type of train and speed so as to establish the countermeasure to reduce the noise around railway bridge. Measured noise data was used to develop the simple equation for predicting the noise through regression analysis. Acoustic modeling of the topography was carried out to input Mithra, the railway noise prediction analysis program and noise prediction was compared with measured value to determine the possibility and feasibility of noise prediction from the software aspect.*

1 INTRODUCTION

Railway noise prevention measures are classified into two categories. The primary measure to identify and eliminate the cause and another is to shut off the route of the noise to reach to the noise receiving point. Eliminating the cause of the noise must be the most be the most effective countermeasure but it takes time and cost to identify the cause and develop the improvement measure, besides technical difficulties. Thus, it's necessary to predict the noise from noise source to receiving point so as to isolate the propagation pathway and reduce the noise reaching at receiving point, which is dubbed secondary countermeasure.

To effectively establish the countermeasure by isolating the route, predicting the noise at receiving point is more than important. The importance of accurate noise prediction through appropriate acoustic modeling and experience is a must in developing the successful sound insulation approach because noise prevention measure to maximize the investment effect begins with accurate noise prediction. In fact, fact-finding investigation over large area requires a huge time and cost and establishing the countermeasure satisfying the railway noise standard and follow-up verification can hardly be achievable without noise prediction based on software background. To enhance the reliability of predicting environmental noise based on software background, sufficient prediction data for various topographic features and determining the empirical tolerance are needed. Optimum countermeasure would possibly be obtained through such efforts.

In this study, thus, concrete bridge which has caused noise problem was designated to predict the noise accurately at the noise receiving point and the characteristics of noise source was evaluated through measuring test. Using Mithra (CSTB in France), the railroad noise analysis program, acoustic modeling of topography was carried out to predict the noise, which was then compared with measured value to determine the possibility and feasibility of noise prediction through software method.

2 NOISE MEASUREMENT TEST

2.1 Object and measuring method

Ambient noise was measured on concrete bridge by distance (height) as shown in Fig 1 and 3. Measurement points were at 2.5m wayside, 1,5m height and 1,5m below the bridge, 25m away from the bridge at 1.5m height. Fig 2 & 4 show the measurement.

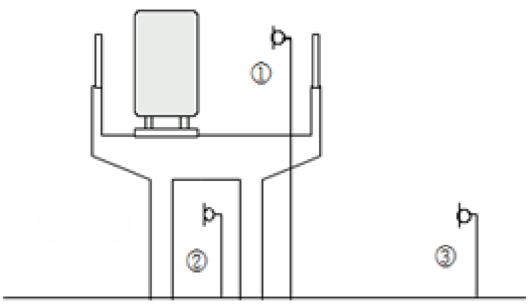

Figure 1: Point A on concrete bridge

Figure 2: Measuring on Point A on bridge

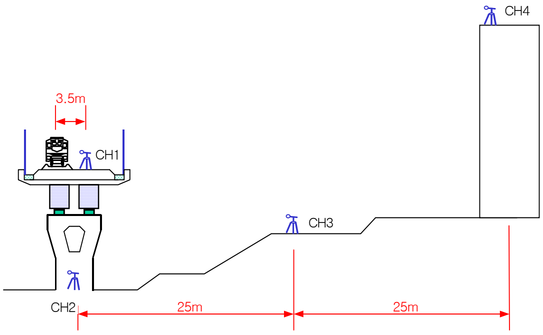

Figure 3: Point B on concrete bridge

Figure 4 : Measuring on Point B on bridge

2.2 Analysis of noise measurement result on concrete bridge by distance and height

Table shows the noise measurement result by type of vehicle and distance. When comparing acoustic pressure at wayside and 25m from wayside which was considered noise source while train is passing, acoustic pressure was reduced by 15.6dB(A).

Train speed on up track was faster than down track and when it comes to Moogunghwa, noise on down track was greater by 1~4 dBA in passing noise and maximum noise level. Saemaeul also showed the noise on down track was greater by 1~2dBA than up track in passing noise and maximum noise level.

Noise reduction by 6～8 dBA between top and bottom of the bridge was monitored and when it comes to Moogunghwa, noise level on road 25m from the center of the bridge was similar with the rooftop of 19-story building, which means diffraction effect by sound barrier wall and the effect by increased distance to the rooftop were similar each other.

Train	Track	No of car	Speed (km/h)	Distance, ( ) is height (m)				Note
				2.0 (G1.0)	0.0 (L1.5)	25.0 (G1.5)	50.0 (G1.5)	
Saemaeul	A Brid	8.7	97.7	91.6	85.4	75.6	-	Temperature: 12.5℃ RH : 91 % Wind : Breeze Weather: clear Background noise: 42～45dB(A)
	B up	8.5	97.4	93.7	86.4	-	-	
	B down	8.5	108.2	94.4	88.0	-	-	
	mean	8.57	101.10	93.23	86.60	75.6	-	
Moogunghwa	A Brid	9.25	95.0	90.5	85.8	75.0	-	
	up	10.0	98.9	93.9	87.7	73.3	73.5	
	down	9.25	96.0	96.0	89.0	74.0	78.0	
	mean	9.50	96.63	93.47	87.50	74.10	75.75	
Cargo	mean	13.8	87.0	94.2	90.0	76.9	-	
Tongil	mean	6.0	87.0	92.2	88.8	73.9	-	

Table 1: Mean noise level by type of vehicle and distance

In NdB(A)

	Receiving point 3.5m	Receiving point : 0.0m Bottom: 1.5m	Receiving point 25m	Receiving point 50m	Note
Sae-maeul	0.0789V+85.946	0.0497H+81.858			V: ve-locity
Moogung hwa	0.2326V+73.45	0.1313V+74.888	-0.0239V+76.443	0.2484V+52.665	

Table 2: Noise prediction equation by speed, type of vehicle and distance

Summarizing the characteristics of noise by distance and speed, running speed on concrete bridge was cargo train (87Km/h) < Tongil (87Km/h) < Moogunghwa (96.6Km/h) <Saemaeul (101.1Km/h) Noise level by train operation at wayside was Tongil (92.2dB(A)) < Saemaeul (93.2dB(A)) < Moogunghwa (93.5dB(A)) < cargo train (94.2dB(A)) and noise level at 25m from noise receiving point was Tongil (73.9dB(A)) < Moogunghwa (74.1dB(A)) < Saemaeul (75.6dB(A)) < cargo train (76.9dB(A)) It indicates noise level by train operation was attributable to type of vehicle than speed. Noise attenuation to receiving point (25m) at wayside was 10～22dB or 16dB on average

3 NOISE PREDICTION USING MITHRA

3.1 Noise prediction on concrete bridge

The model for analysis of railway noise on concrete bridge was developed using measured noise level by type of vehicle and speed and topographic data. Topographic data in the region was input into Mithra program and aerial view obtained as a result was represented in Fig 5. For Moogunghwa and Saemaeul train, predicted noise level while train is passing is described in Table 3 and 4.

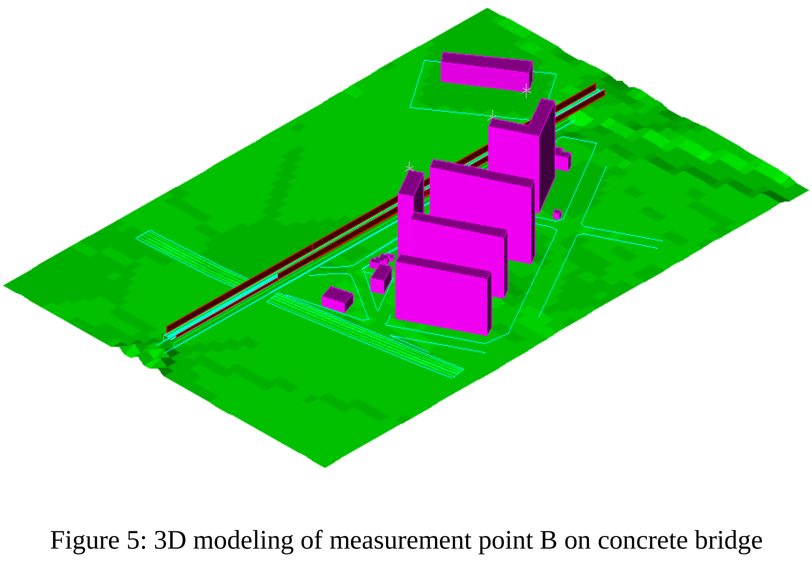

Figure 5: 3D modeling of measurement point B on concrete bridge

Category	Moogunghwa Up 83km/h		Saemaeul Down 106km/h	
	Predicted	measured	Predicted	measured
Top of bridge	91.4	92.8	95.1	96.0
25m	72.4	87.0	74.5	88.3
F1	70.8	72.6	73.1	73.5
F5	73.2		75.5	
F10	76.3		80.1	
F15	76.7		79.9	
F19	75.8		78.6	
Rooftop	72.9	72.3	76.8	77.4

Table 3: Mithra value based on modeling while train is passing

Category	Predicted	measured	Note
Top of bridge	82.4		
25m	59.3		
F13	69.3	69.2	
Rooftop	66.1	66.8	Saemaeul Moogung-hwa Cargo
F13	68.6		
Rooftop	65.7	66.7	

Table 4: Equivalent noise Mithra value based on modeling

3.2 Analysis of noise level after installing sound barrier wall and noise reducer

To analyze the noise reduction performance of sound absorption-type barrier wall and noise reducer on top of the wall, measured data is indicated in Table 5. At the point 25m away at 1m height with noise reducer, noise reduction by 2dB (A) was monitored. Fig 6 & 7 shows 1-hour equivalent sound level distribution at day & night

(dBA)

Type of sound barrier wall	Location of noise receiving point (distance from down track)				Insertion loss (I) -25m	Insertion loss (II) -50m
	4m	17m	25m	50m		
Sound absorption 3m	99.7	88.0	72.5	71.8	9.3	3.7
Sound absorption 4m	99.7	88.9	70.2	71.5	11.6	4.0
Sound absorption 3.5m +reducer	100.4	89.0	69.1	69.6	13.4	6.6

Table 5: Mean noise level and insertion loss when Moogunghwa is passing

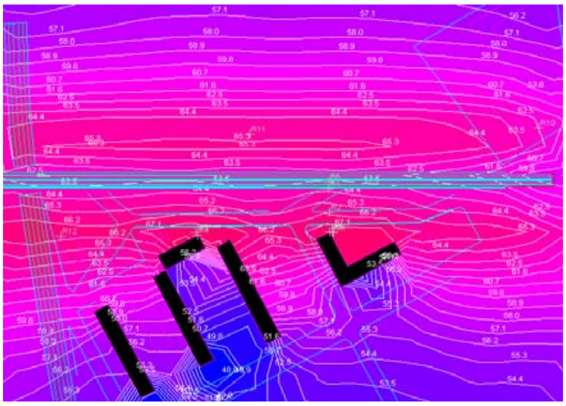

Fig 6: Distribution of 1-hour equivalent noise level at daytime

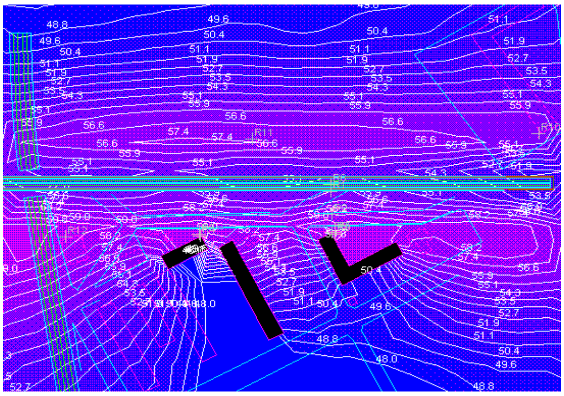

Fig 7: Distribution of 1-hour equivalent noise level at nighttime

4 COMPARISON AND ANALYSIS OF NOISE PREDICTION VALUE AND MEASUREMENT VALUE

In case of concrete bridge, prediction value by speed was based on 25m from noise receiving point for Moogunghwa. And mean value of prediction value by distance and by speed was obtained and compared to measurement value as indicated in Table 6. Noise prediction value by height of noise receiving point is calculated by prediction equation in Table 2 and the difference with measurement value at 42m distance and 5.2m height was indicated in Table 7

Category	Prediction value		Measured value	Gap
	By speed	Mean		
Bridge A (95km/h)	74.17	77.84	75.0	2.84
Up (98.9km/h)	74.08	77.80	73.3	4.50
Down (96km/h)	74.15	77.83	74.0	3.84

Table 6: Predicted value Vs measured value concrete bridge

	Predicted	Measured	Gap
Saemaeul	78.77	78.43	0.34
Mugung-hwa	81.84	81.5	0.34
Cargo	80.38	80.1	0.28

Table 7: Predicted value Vs measured value by height of noise receiving point

As indicated in Table, noise prediction at 25m from noise receiving point has the error range of 2.84～4.50dB(A) which varied slightly by 0.28～0.34dB(A) depending on height of noise receiving point, indicating prediction equation based on regression analysis was acceptable. Except noise prediction by building floor, only a slight error was monitored, demonstrating it will be useful as prediction data when applying this prediction equation to railroad bridge and for more accurate equation, more measurement data shall be applied to regression analysis to produce accurate prediction equation

5 CONCLUSION NOISE PREDICTION USING MITHRA

As part of the efforts for noise prediction, noise was measured on concrete bridge by type of train (Saemaeul, Moogunghwa, Tongil, cargo and motor car), train speed, distance and height of noise receiving point and the data was collected and compiled. Noise characteristics was analyzed by bridge and mean noise level by category was calculated, which was then used for regression analysis. Based on result, simplified equation for noise prediction by train speed was produced. The result of this study is summarized as follows.

(1) Noise prediction equation by distance and type of vehicle was developed to predict the noise level.

(2) As a result of comparing the prediction value according to above equation and measurement value, the error range was 2.84～4.50dB(A) and the difference by height of noise receiving point was insignificant indicating 0.28～0.34dB(A)

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