COMPARISON OF NOISE CHARACTERISTICS BETWEEN HIGH SPEED RAILWAY TRAIN AND ORDINARY TRAIN IN CHINA

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This article takes China's high-speed rail train and ordinary train as the research object. Through the comparison and analysis of the measured data, the following main conclusions are obtained: The noise value of the high-speed train passing is relatively mild, while the ordinary train’s fluctuates, and the noise value of the front part is higher. The body part shows regular fluctuation. The results of vertical attenuation test show that, the noise value of ordinary train increases first and then decreases; the maximum sound pressure level is 6 meters away from the rail surface. The sound pressure level of high-speed trains increased gradually 1.2 meters to 10 meters away from the rail surface; the spectrum monitoring results show that the high-speed train has a high noise value below 1250Hz, that is, the sound energy of the middle and low frequency parts is higher. When the ordinary train’s headstock passes, the sound energy of the low frequency parts is higher. When the body of the ordinary train passes, the sound energy is high in the range of 1000~2000Hz frequency which is mainly wheel rail noise.

Keywords: high-speed rail train, ordinary train, Noise characteristics

1. Introduction

The Beijing-Tianjin intercity high-speed train is China's first intercity high-speed railway with a speed of over 300 kilometres per hour, which opened on August 1, 2008. It is China's first high-speed railway passenger line. The Beijing–Tianjin intercity railway has a current length of 116.939 km (fare mileage: 120 km), of which roughly 100 km is built on viaducts and the last 17 kilometres on an embankment, 14% of the total length. The foundation treatment mainly adopts CFG pile, bored pile, pipe pile and so on, laying CRTS II type of slab type slag free track structure type. The bridge accounts for 86% of the total length of the line. The main bridge is a double line simply supported box girder. Before mid-2009, the railway used CRH2 trains for service. With effect from mid-2009, only CRH3 trains are used for intercity services on the line. The maximum speed of CRH3 was 394.3 km / h in the test, and the speed of CRH2 was 383 km / h in the test. This railway line allows speeds up to 350 km/h. A trip between Beijing and Tianjin takes 30 minutes.

The Beijing-Tianjin intercity high-speed railway is mostly built on viaducts. There are more sensitive points on both sides of the line, densely populated, and the noise pollution is more prominent. In order to understand the noise characteristics of high-speed railway, this paper analyses the noise of Beijing Tianjin intercity high-speed train and compares it with the ordinary train of Jing Shan railway.

2. Measurement method

In order to understand the noise characteristics of high-speed railway and ordinary railway, we choose The Beijing-Tianjin intercity high-speed rail and Jing Shan railway as the testing objects. We test the noise in both horizontal and vertical directions.
Noise measurement points are set up separately from the centre line of the outer rail 18m, 30m, 60m and 90m in the horizontal direction. A multi-channel noise analyser is used for measurement, and the layout of the measurement point is shown in Figure 1. The microphone is located at the height of the 1.2m above the ground.

![Figure 1 Layout of vertical monitoring points](image1)

In the vertical direction, noise measurement points are set at 1.2m, 3.5m, 6m, 8m and 10m at the distance from the rail. A multi-channel noise analyser is used for measurement, and the layout of the measurement point is shown in Figure 2. The microphone distance is located at the centre line of the outer rail 25m.

![Figure 2 Layout of vertical monitoring points](image2)

### 3. Analysis and comparison of test results

#### 3.1 Time domain test results at different heights
Figure 3 Time history of Beijing-Tianjin inter-city train’s pass-by.

The figure shows: The Beijing-Tianjin inter-city trains through when the noise value is relatively flat and the Jing Shan railway train fluctuations, the front part of the noise value is higher, the body part shows the regularity of fluctuations, mainly for the wheel rail noise and impact sound between train rail and track crevice.

3.2 The attenuation law of noise transmission in horizontal direction

The noise propagation law of the Beijing-Tianjin high-speed rail train and the Jing-Shan railway train is shown in Figure 5.
The horizontal attenuation test results show that the noise decreases with the increase of distance. The railway line has a certain height, and it has a certain shielding and attenuation effect on the noise at the distance of 18m.

The noise attenuation of the Beijing-Tianjin high-speed rail train is not very obvious because of the high frequency components in the noise frequency of the high-speed train.

3.3 The attenuation law of noise transmission in vertical direction

The vertical transmission law of the Beijing-Tianjin high-speed rail train and the Jing-Shan railway train is shown in Figure 6.
It is shown that:

(1) with the increase of height, the Jing Shan railway noise sound level increase first, reach the maximum value (at a distance of 6 meters from the rail surface), then decreased at 6-10 meters, but the difference is small. According to the attenuation of sound pressure, sound pressure level decreases with the increase of the height. The sound pressure level of the Beijing Tianjin high-speed rail trains has been increased from 1.2 meters to 10 meters. According to the attenuation of the sound pressure level and the attenuation of the Jing Shan railway, the Beijing Tianjin high-speed rail will reach the maximum value at a certain height, and the height, the sound pressure level decreased gradually.

(2) The sound pressure level of 125 Km/h railways in Jing Shan exceeds that of 228.6Km/h's Beijing Tianjin high-speed train. It can be seen that at the same speed, the noise of high-speed rail train is smaller than that of ordinary train.

3.4 Spectrum characteristics

According to ISO 3095-2005, the measurement point of railway noise source is 25 meters away from the track and 3.5 meters from the rail surface. Therefore, the test data of this point is selected for spectrum analysis.

Figure 7 the frequency spectrum of the Beijing-Tianjin intercity train’s pass-by.

Figure 8 the frequency spectrum of the Jing Shan railway train’s pass-by.
As shown in the picture, the frequency spectrum changes with time when the Beijing Tianjin high-speed rail and the Jing Shan railway train pass through. It is known from the diagram that the noise value of the Beijing Tianjin high-speed train below 1250Hz is high, that is, the sound energy of the middle and low frequency parts is high.

When the locomotive of the Jing Shan railway train passes, the low-frequency part has larger acoustic energy. When the body passes, the sound energy is mainly in the frequency range of 1000~2000Hz, which is mainly the wheel rail noise.

![Comparison of spectrum](image)

Figure 9 Comparison of spectrum

Figure 9 is the total spectrum value passed by the train. The spectrum analysis results show that there are significant differences in frequency characteristics of different trains: The main peak of Beijing Tianjin high-speed train is 80Hz; the main peak of Jing Shan railway train are 50Hz and 1600Hz. In the low frequency section below 630Hz, the sound energy of the Beijing Tianjin high-speed rail is higher than that of the ordinary Jing Shan railway train.

4. Conclusion

This paper analyses and compares the noise characteristics of the Beijing Tianjin high-speed rail train and the Jing Shan line general railway train. Through the measurement analysis and research, the following main conclusions are obtained: The noise of high-speed train is different from that of ordinary train, and there is no obvious rhythm of wheel rail noise; the results of the horizontal attenuation test show that the noise decreases with the increase of distance. The noise attenuation of the Beijing-Tianjin high-speed rail train is not very obvious because of the high frequency components in the noise frequency of the high-speed train.

The results of vertical attenuation test show that: the Jing Shan railway noise sound level increase first, reach the maximum value(at a distance of 6 meters from the rail surface), then decreased at 6-10 meters. The sound pressure level of the Beijing Tianjin high-speed rail trains has been increased from 1.2 meters to 10 meters. According to the attenuation of the sound pressure level and the attenuation of the Jing Shan railway, the Beijing Tianjin high-speed rail will reach the maximum value at a certain height, and the height, the sound pressure level decreased gradually.

Spectrum monitoring results show that: the noise value of the Beijing Tianjin high-speed train below 1250Hz is high, that is, the sound energy of the middle and low frequency parts is high. When the locomotive of the Jing Shan railway train passes, the low-frequency part has larger acoustic energy. When the body passes, the sound energy is mainly in the frequency range of 1000~2000Hz, which is mainly the wheel rail noise. The main peak of Beijing Tianjin high-speed
train is 80Hz; the main peak of Jing Shan railway train are 50Hz and 1600Hz. In the low frequency section below 630Hz, the sound energy of the Beijing Tianjin high-speed rail is higher than that of the ordinary Jing Shan railway train.

In this paper, some exploratory work has been done on the noise characteristics of high-speed railway. Because of the large number of construction of high-speed railway, many types of train types have appeared, and the following work can be carried out.

1) The railway prediction model is mainly composed of the sound source and attenuation factor of the train and the accuracy of the sound source of the train directly affect the follow-up prediction. Therefore, a large number of test and analysis can be carried out for the existing high-speed railway trains to obtain the sound source of different types of trains. A strong database of noise source of high-speed railway in China is set up. According to these data, the strong database of noise source of China's high-speed railway can be set up.

2) The conditions along the railway are complicated and many factors to be taken into consideration. In the field of noise correction, there are still many places to be further studied.

REFERENCES