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An Analysis of the Influence of Railway Wheels Flats on Rolling Noise Emitted by Freight Trains with GDE Wagons

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Abstract

Among the various noise sources existing in a railway system, the one considered dominant varies according to the operational situation, whose analysis encompasses speed, load, rail and rolling stock conditions. Impact noise, on the other hand, is defined as the impulsive sound produced by the excitation of the wheel and rail when there is a discontinuity on these surfaces, such as a defect in a rail wheel. By means of wheel impact monitoring systems, companies evaluate maintenance to ensure the availability of the wheel in transportation. Nevertheless, in some cases the impact value is within the company's criteria, but the noise emitted by the wheel may be outside the limits established by standards, affecting the comfort of the neighbouring population. In view of the established problem, this work aims to verify the influence of defects in railroad wheels on the noise emitted by freight trains. For this, through noise measurements performed on a test train with wheel defects, it was possible to insert the noise from known defects in the passing noise of trains in normal operation. Thus, using the procedures in the rail noise measurement standard ABNT NBR 16425-4, it was identified that the defects do not influence the average noise of trains passing by. However, it was possible to analyse that the noise generated by trains is mainly result of the rolling noise of the passage of the compositions, since the peaks in the passages do not generate an increase in the final noise emitted.

Keywords: impact noise, wheel flats, rolling noise.

1 Introduction

The existence of sources of pollution is a consequence of technological and industrial development. Noise, as a source of noise pollution, has received attention from

research, since it generates discomfort and directly interferes with the health of the population. Rail traffic has contributed significantly to the generation and propagation of vibrations and noise, affecting the comfort and quality of life of residents near railway tracks [1].

The noise emitted by rail transport comes from different types of sources. Rolling noise is one of the main sources, and is caused by the wheels and rail vibrations induced in wheel/rail contact. Impact noise is the sound produced by wheel and rail excitation when there is some discontinuity in surfaces, such as rail joints and wheel irregularities. This type of noise increases rolling noise and will be addressed in the present work as a direct consequence of defects in railway wheels [2,3].

Since impact noise may be the product of a wheel defect, the relationship with the maintenance of railway vehicles is clear. Impact detectors on wayside devices assess the force on which wheels with some kind of defect exert in contact with the rail, and are of utmost importance in the maintenance of railway wheels. However, in some cases the value of the impact is within the criteria proposed by the company, but the noise emitted as a result of the impact of the wheel may be outside the limits established normatively, becoming noise pollution and affecting the comfort and health of neighbouring populations. Thus, the need arises to verify whether defects in railway wheels influence the noise of train passages.

Therefore, the present work aims to evaluate the noise emission in ore wagons, focusing on the noise emitted due to defects in railway wheels. Through noise measurements of a test train with defective wheels, the noise peak of the defect will be entered into the sound pressure level (SPL) of trains in normal operation. The influence of defects on train wheels will be analysed according to the railway noise measurement standard, NBR 16425-4 [4].

2 Methods

For the analysis of defects noise on wheels, first, measurements of sound pressure levels (SPL) were made during the passages of a test train at different speeds. The test train was arranged with different types of defects located in four pairs of wagons. With the SPL measurements of the test train passages at three different speeds, the peaks SPL of defects were analysed. Thus, the defect with the highest average SPL and low impact at each speed was obtained to be included in the SPL of the train sections in normal operation.

The SPL measurements of trains in normal operation were treated to obtain only the bearing values, free of any type of disturbances. Thus, it was possible to obtain SPL values of passages without disturbances (ideal) and include known defects of the test train, where the noises of the compositions with defects was analysed according to the procedures of the NBR 16425-4 standard [2]. The SPL peak of the defect with higher noise of the test train was included in the signal of the passage of trains in normal operation, at speeds of 48, 53 and 55 km/h.

To apply the procedures of the NBR 16425-4 standard, three different conditions were defined where it was possible to obtain a SPL value of the day/night of railway train passages (Ldn) for each of the conditions. For the calculation of Ldn, passages of at least three compositions should be considered. Therefore, for each of the defined conditions, measurements of the three trains in operation were used, varying the number of defects included in the passages. The purpose of the conditions is to analyse the influence of the number of defects in Ldn noise calculated by NBR 16425-4. Thus, the following conditions were considered:

- Condition I: Train at 55 km/h with 5 defects, ideal train at 48 km/h (without defects) and ideal train at 53 km/h (no defects);
- Condition II: Train at 55 km/h with 10 defects, ideal train at 48 km/h (no defects) and ideal train at 53 km/h (no defects);
- Condition III: 5 defects on each train (48, 53 and 55 km/h).

3 Results

Figure 1 shows the SPL of the measurements of the trains passages in normal operation (real) and after the signal treatment (ideal), before SPL inclusion of test train defects. Note there are two larger peaks that correspond to the passage of the two locomotives.

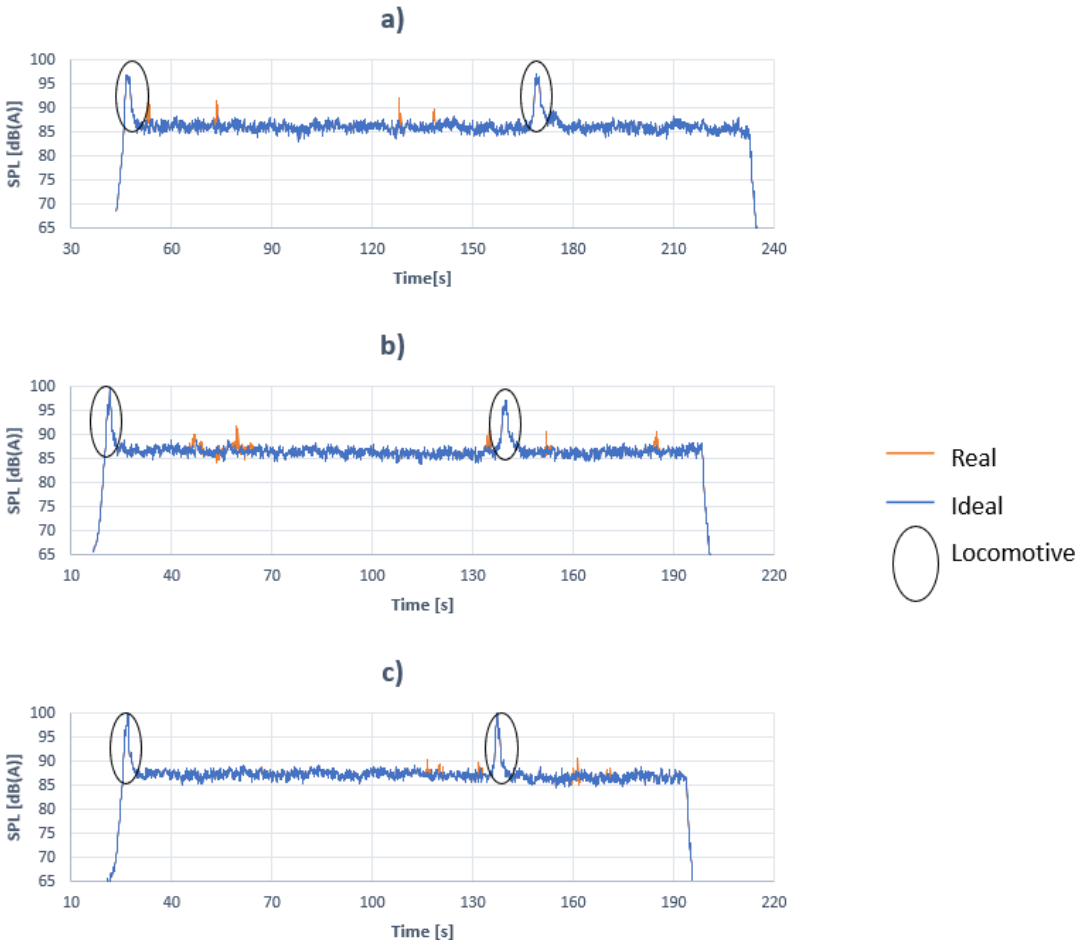

Figure 1: SPL x time - Normal operation: a) 48km/h, b) 53 km/h c) 55 km/h.

The SPL of the test train defect with peak noise was inserted, for each speed, in the rolling noise of the ideal trains. Figure 2 shows the passage of the ideal trains with the defect inserted five times for each speed and 10 times for the speed of 55 km/h. As shown in Figure 2, the defects correspond to peaks in train rolling noise.

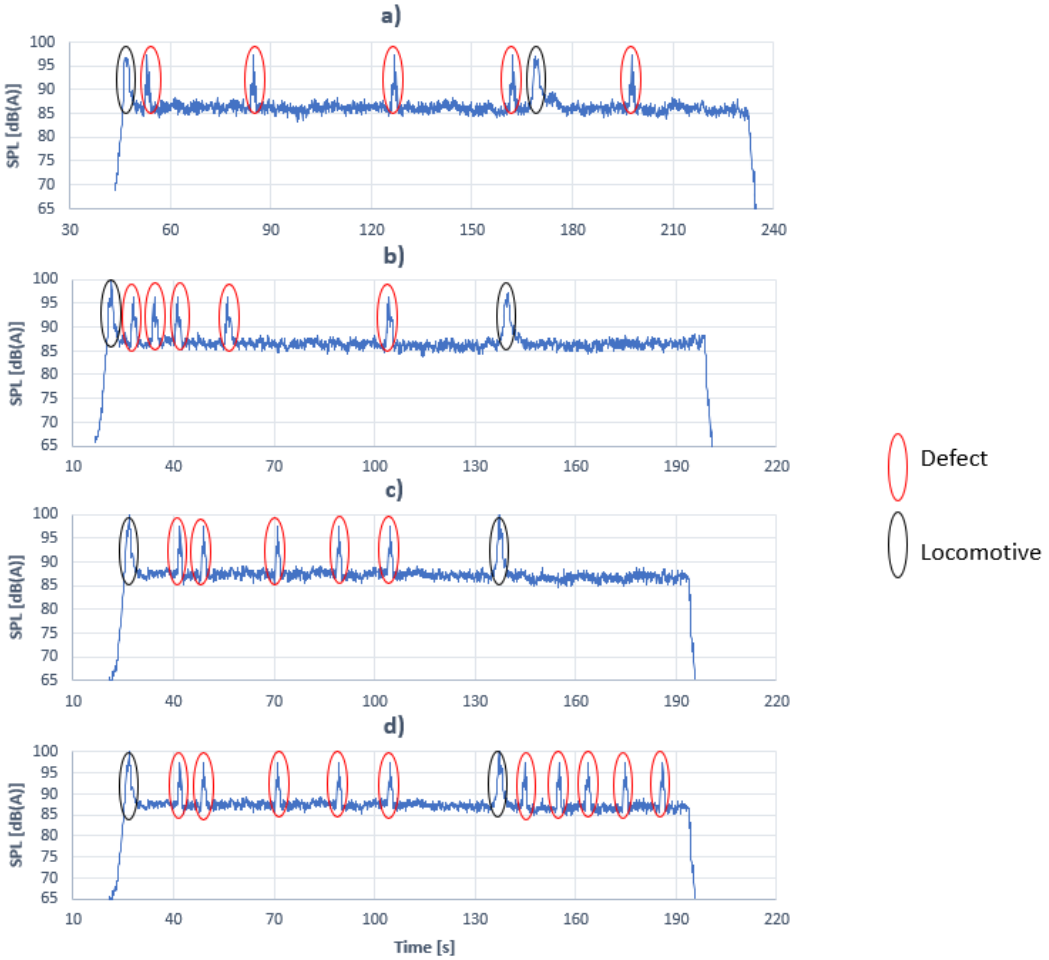

Figure 2: SPL x train passage time at a) 48 km/h - 5 defects, b) 53 km/h - 5 defects, c) 55 km/h - 5 defects, d) 55km/h - 10 defects entered.

Applying the mean SPL values of the passages with inserted defects, and performing the calculations proposed by the NBR 16425-4 standard, the value of the sound pressure level of the day/night of railway composition passages (Ldn) for each condition was obtained, as shown in Table 1. The LAeq,T,PCF values are the averages of the different passes speed for each condition.

	Condition I	Condition II	Condition III
LAeq, T, PCF [dB(A)]	87.40	87.57	87.66
Ldn [dB(A)]	78.80	78.97	79.07

Table 1: Day/night SPL of train crossings (Ldn) and average noise values (LAeq,T,PCF) for each condition.

The calculation of the Ldn value depends on the number of passages train during the day and night. Thus, it was considered that in one day, 24h (20 trains). In condition I, Ldn value, considers that 1 of the 3 trains have 5 defects. Therefore, of 20 trains that run in one day, 1/3 of these have 5 defects. In condition II, 1/3 of the 20 trains have 10 defects. In condition III, it is considered that all 20 trains that pass in one day have 5 defects. It is perceived, as shown in Table 1, the little influence of defects on the noise emitted from the passages of the composition day/night. Therefore, based on the analyses of this work, defects have no influence on the noise emitted by railway compositions.

4 Conclusions and Contributions

In this work, the influence of defects in railway wheels on the noise emitted by trains was analysed. Since railway wheels are checked and changed based on the impact value of wayside appliances, the need to arose analyse whether faulty wheels that are not flagged for verification or change can cause increased passing noise of the compositions.

Thus, measurements were performed in a test composition to analyse noise of known defects at different speeds, where a defect with the highest sound pressure levels was chosen for the analysed velocities. The defect chosen was inserted in the SPL of three train passages in normal operation with treated scrolling noise, that is, free of disturbances, where the SPL peaks caused by the defects were graphically observed.

Using the procedures of NBR 16425-4, it was possible to observe that defects in railway wheels do not cause a significant increase in the noise of the passage of compositions in 24 h. Thus, it was analysed that the noise generated by trains is mainly the result of the rolling noise of the passage of the compositions, since the peaks in the passages do not generate an increase in the final noise emitted.

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