THE EFFECT OF RAILS CROSSING STREETS ON THE NOISE RATING LEVEL FROM ROAD TRAFFIC

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Foken, Wolfgang; Grundke, Dirk; Hausotte, Thomas
Westsaechsische Hochschule Zwickau (FH)
University of Applied Sciences
Dr.-Friedrichs-Ring 2A
08056 Zwickau
Germany
Tel: +49 375 536 1700
Fax:: +49 375 536 1754
E-mil: wolfgang.foken@fh-zwickau.de

ABSTRACT

In order to calculate the noise from road traffic typically prediction methods are used. In big cities often rails of trams and streets are intersecting. The crossing of the rails by cars radiates a specific impulsive noise. Generally this effect is not considered in the European prediction methods for the road traffic noise. This paper presents and discusses in detail noise data measured at a specific example resulting in a proposal for a distance and traffic density depending correction for those “rail and streets crossings” The aim is the description of the annoyance in a more realistic manner.

INTRODUCTION

In order to calculate the noise from road traffic in most cases prediction methods are used. For instance the RLS90 (Guideline for Noise Control from Roads)[1] is the relevant calculation method in Germany. Despite the strong limits for the noise rating level in Germany nearly 60% of the whole population feel annoyed by the road traffic noise [2].

The RLS 90 is an effective calculation model to determine the noise rating level because of road traffic. Simplifying, the starting point of the calculation is an average level $\mathbf{L_{mE}}$ measurable at a distance of 25m from the centre of the lane. This $\mathbf{L_{mE}}$ is a function of the amount of vehicles per hour and the percentage of heavy lorries under idealised conditions; i.e. a speed of 100km/h, a road gradient below 6% and a special road surface. The next step is to quantify the various deviations from these idealised conditions by means of corrections for the “real speed”, for the actual road gradient or the actual surface. At least a correction for the annoyance by traffic lights is used to calculate the noise rating level.

Most of our roads especially in towns do not have a homogeneous surface. The density of cast-iron manhole covers for the sewerage system or of drains often is very high. In large towns tramlines are crossing the streets. These faults of the homogeneity in most cases create an impulsive noise. Impulsiveness is one of the most important factor for the annoyance by noise [3]. The prediction method of the RLS 90 or of other European regulations do not take those impulsive noise sources into account.

The rectangular crossing of rails by cars is the origin of a very strong impulsive noise source. Therefore it seems to be necessary to quantify and to evaluate this noise source for a more realistic description of the annoyance.

NOISE MEASUREMENTS AT RAIL AND STREET CROSSINGS

In order to study the impulsive noise caused by the crossing of rails by cars an exemplary place in the centre of Zwickau (Germany) was chosen. Figure 1 shows the characteristic situation of a rectangular crossing of rails by a car. At this place the cars run over three tramlines, i.e. six rails.

Fig.: 1 Typical run over of rails by a car at the chosen place

Generally outdoor measurements with changing weather conditions are difficult and time consuming especially under the view point of statistical security. For the presented results the crossings of more than 150 cars and more than 20 heavy lorries were considered. The velocity of each car or lorry was measured with a photoelectric beam and the noise was measured with a simple microphone (1.2m height, 2.5m average distance to the nearest rail) and a data recorder. The crossings of the cars are classified into five velocity groups (0-25km/h, 25-35km/h, 35-45km/h, 45-55km/h and >55km/h. For the cars the statistical security is probable. For the heavy lorries the tendencies of the results are probable.

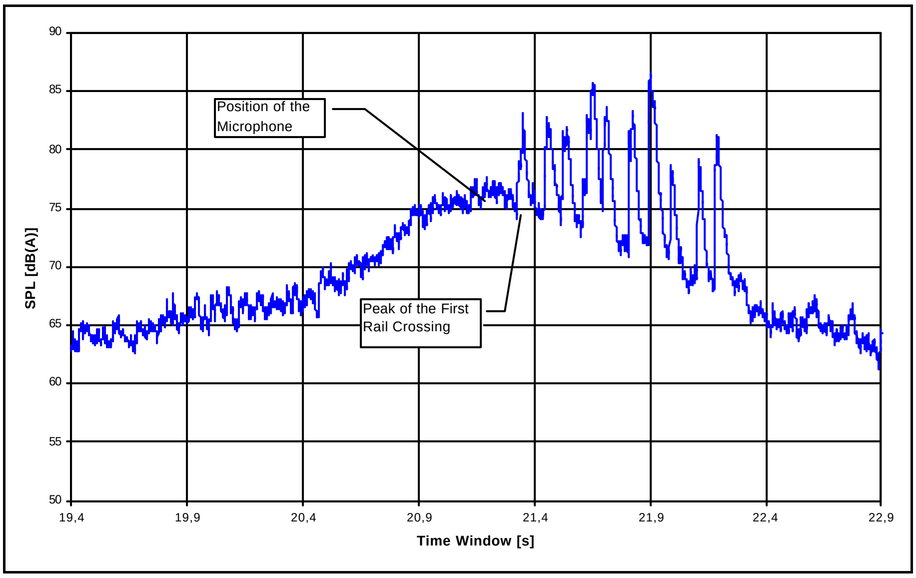

Fig. 2: Pass by level of a car – 46 km/h (VW-Golf)

Figure 2 shows the typical SPL vs. time for the pass by of a car. The six rails should create the double number of peaks in the time function of the SPL. But the superposition of peaks belonging to the run over of the front and the rear tyre nearly at the same time reduces the visible peaks in the diagram. For the further analysis of the measurements only the first rail crossing was relevant. The measured data in figure 2 could be considered as a superposition of two sound sources:

1. Pass by noise of the car without the crossing of the rail.
2. The contact of the tyres with the rails radiating the impulsive noise.

For the calculation model it is possible to describe source 2 as a point source which radiates only in quarter sphere because of the screening effects of the ground and the car body. This model also explains the lower peaks in the SPL of the rail crossings by lorries. The pass by levels of heavy lorries are much more higher than those of cars. But the impulsive noise source of cars and lorries remains in the same order. Table 1 summarises the measured and calculated acoustical data for the crossing of rails by cars and heavy lorries. In order to quantify the annoyance loudness values are added. For all data a velocity dependence is evident.

Table 1: Acoustical data of the rail crossing by cars and heavy lorries

	Velocity Group	Sound Power of the Impulsive Noise Source	Mean Value of the Peak Raise	Mean Value of the Peak Raise
Cars	0 – 25 km/h	73.6 dB(A)	5.6 dB	4.6 dB
	25.1 – 35 km/h	76.9 dB(A)	6.5 dB	8.0 dB
	35.1 – 45 km/h	79.6 dB(A)	6.9 dB	10.1 dB
	45.1 – 55 km/h	82.4 dB(A)	7.5 dB	12.2 dB
	>55 km/h	86.7 dB(A)	7.7 dB	17.9 dB
Lorries	0 – 25 km/h	-	-	-
	25.1 – 35 km/h	79.4 dB(A)	3.7 dB	7.0 dB
	35.1 – 45 km/h	84.9 dB(A)	4.5 dB	8.2 dB
	45.1 – 55 km/h	88.1 dB(A)	5.5 dB	9.0 dB
	>55 km/h	-	-	-

A good overview of the acoustical behaviour of the noise from the rail crossings is shown in figure 3. In this picture SPL and Loudness versus time are combined with their spectra versus time.

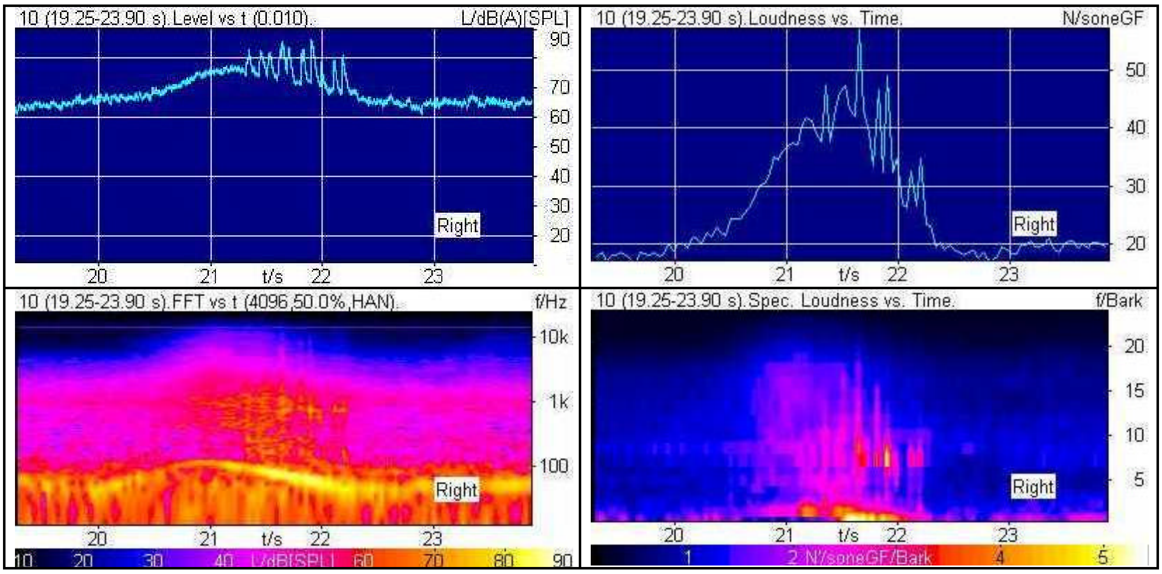

Fig. 3: Acoustical behaviour of a rail crossing by a car

BENEFIT OF THE DATA FOR THE DETERMINATION OF THE NOISE RATING LEVEL

Within the project a lot of measurements have been carried out. From the technical point of view the affect of the rail crossing on the radiated noise is quantified by means of sound pressure levels deviating from the normal pass by noise of cars. In addition, psycho-acoustical properties are calculated by means of loudness data.

On the one hand in most European countries the calculation models for the noise rating level do not use any corrections for impulsive noise components. On the other hand the annoyance by impulsive noise is unquestionable. The remaining difficulty is the implementation of the measured impulsive noise data in the process of calculations for the noise rating level and the implementation in standard businesses software products for the prediction or calculation of noise immission. Below two possibilities will be discussed.

Correction for the Impulsiveness of Rail Crossings by Cars

This method seems to be very simple. Based on the data given in table 1 for cars it is possible to interpret the mean value of the peak raise as the degree of the impulsiveness. Considering the fact that the annoyance of the impulsiveness decreases according to the distance from the rail crossings it is possible to apply a distance dependence similar to the correction for traffic lights in the RLS 90[2]. Table 2 shows a possible proposal for the method described.

Table 2: Correction for the Impulsiveness

	<10	>10 - 20m	>20 - 40m	>40 - 70m	>70 - 100m
< 30 km/h	6,5 dB	4 dB	2 dB	1 dB	0 dB
31 – 50 km/h	7,0 dB	4,5 dB	2,5 dB	1,5 dB	0,5 dB
>50 km/h	7,5 dB	5 dB	3 dB	2 dB	1 dB

Despite the simple assessment of a correction for the impulsiveness several problems are to be solved. The validation of the correction as the correct description of the annoyance is a difficult and time consuming process. This includes the question for a traffic density dependence of the correction. The implementation in standard businesses software products is impossible without software updating.

Additional Noise Source Representing the Rail Crossing by Cars

This calculation is more complicated but useful for the implementation in standard businesses software products. Obviously it is possible to add a point source (sound power according to table 1) representing the rail crossing to the normal road calculated according to the relevant calculation method (RLS 90). In this method it is necessary to determine an exposure time depending on the traffic density. Also the different regulations to calculate or predict the noise rating level by point sources and roads are questionable. A better way is to use only one regulation to calculate impulsive noise source as well as the normal road without rail crossing.

Accepting the tramline as an additional short road with a length equal to the distance of the rails it is possible to solve most of the problems. For this short road the mean value of the peak raise (according to table 1) is added to the average level $\mathbf{L_{mE}}$ for the normal road used in the German RLS90 calculation model. In order to consider the traffic density a variation of the prescribed duration $\mathbf{T_r}$ for the determination of the noise rating level is used. In the German RLS90 $\mathbf{T_r=16h}$ is valid during the day and $\mathbf{T_r=8h}$ is valid at night. For low traffic densities the duration $\mathbf{T_r}$ is reduced. Above a fixed limit of 1400 vehicles per hour $\mathbf{T_r}$ is fixed at the prescribed value. Figure 4 shows an example of a colour map representing the difference between a normal road according to the RLS90 and a road with the added short road representing the impulsive noise by the rail crossing. For the calculation a traffic density of 24.000 vehicles per day (1152 cars per hour, 288 lorries per hour) and a velocity of 50km/h was used. The colour map was calculated with the program “IMMI®”.

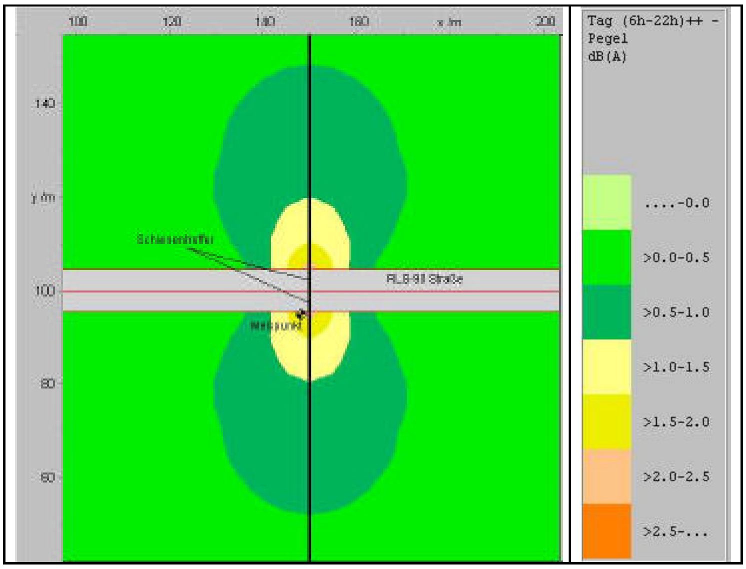

Fig. 4: Colour map of the difference between RLS90 road and the road with rail crossing

CONCLUSIONS AND FURTHER TASKS

Noise from roads is the most important annoyance in the environment. The impulsiveness of the noise increases this annoyance. There are strong regulations for the calculation and prediction of the noise rating level from road traffic. In these regulations impulsive noise sources created by rail crossings of cars are not taken into account.

Based on measured data, obtained at an exemplary place corrections for the impulsiveness by rail crossings are determinable. It is possible to implement the results of the measurements in standard businesses software products

The further step is the improvement of the statistical security. Measurements at several typical intersections of road and tramline are necessary. In addition the investigation of the mechanism of the noise source created by the tyre and rail contact would be useful.

REFERENCES

[1] Bundesminister für Verkehr, Abteilung Straßenbau. Richtlinie zum Lärmschutz an Straßen RLS90, Bonn, 1990

[2] Umweltbundesamt. Daten zur Umwelt 2000, Erich Schmidt Verlag, 2001