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Can Traffic Noise be calculated ?

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ABSTRACT

According to the European Noise Directive 2002/49/EC road traffic noise is calculated based on traffic flow data and noise propagation models. These models are working sufficiently well on flat terrain and standard noise propagation conditions. Problems arise in cases of complex situations like e.g. elevated roads (bridges) and non flat terrain. Other differences between calculations and measurements result from the fact that some parameters effecting the noise level can not be described adequately. Thus measurements are still an option/must to get sensible noise levels for certain situations and locations. Based on various measurements like data from HARMONOISE, for example, a comparison between measured and calculated noise levels will be presented including also the influence of noise propagation conditions due to changes in meteorological conditions as well as comparing different noise calculation models (e.g. Germany, France).

1. INTRODUCTION

Since 2007 all European countries have produced strategic noise maps according to the EU Directive 2002/49 [1]. In most countries these maps are calculated on the basis of available traffic data and calculation models like the interim methods given in the EU directive [1] or national regulations. Based on these maps noise action plans shall be derived. In most cases this is an acceptable procedure and the agreement between calculated and “real” levels are fairly good. Unfortunately, at least in Germany no or only little validations of the calculations have been done. Validations of the calculated values are especially recommended in situations which are difficult to model and where the available propagation models are at their limits. An other point is the annoyance of the noise which depends not only on the A-level, but also on the spectral structure of the noise and should be taken into account of any action planning. For two examples of motorways running across a valley calculations - RLS90 [2] and NMPB [3] - shall be compared with measured noise levels and the noise spectra will be compared with the “average” spectra expected from traffic noise. The RLS90 is the German regulation for calculating road traffic noise, where as then NMPB is the French regulation for road traffic noise calculations. The RLS90 is only using A-weighted levels and no meteorological effects where as both is included in the NMPB.

The first example of the comparison between calculations and measurements are data taken for the HARMONOISE project. For this site measurements at 5 different distances are available. One of the measurements was close to the road in order to separate the traffic modelling from the noise propagation model. For this example only the level differences between the nearby

site and the other sites will be compared. Thus the differences are only due to the noise propagation.

For the second example measurement data for only one site is available. For this case a direct comparison between the calculated and the measured levels will be made. Thus differences in levels can either be due to input data and/or noise propagation.

In a third example a more simple situation will be analysed, i.e. a fairly flat terrain and a small distance between road and meaurement.

2. RESULTS ROAD -BRIDGE 1

For the fist example measurements were carried out for the HARMONOISE [4] project in summer 2002 for about 3 weeks at 5 points at different distances from a motorway. The distances between the center line of the motorway and the 5 sites were MP1 25 m, MP2 150 m, MP3 300 m, MP4 600 m and MP5 1200 m The motorway, running north south, has 4 lanes and a large percentage of HGV during the night. Since no detailed traffic data was available for the measurement period only the level differences between MP1 at 25 m and the other points will be compared. All calculations and data evaluation for the measurements are for down wind conditions. The locations of the measurement sites and the terrain model are depicted in the figures below.

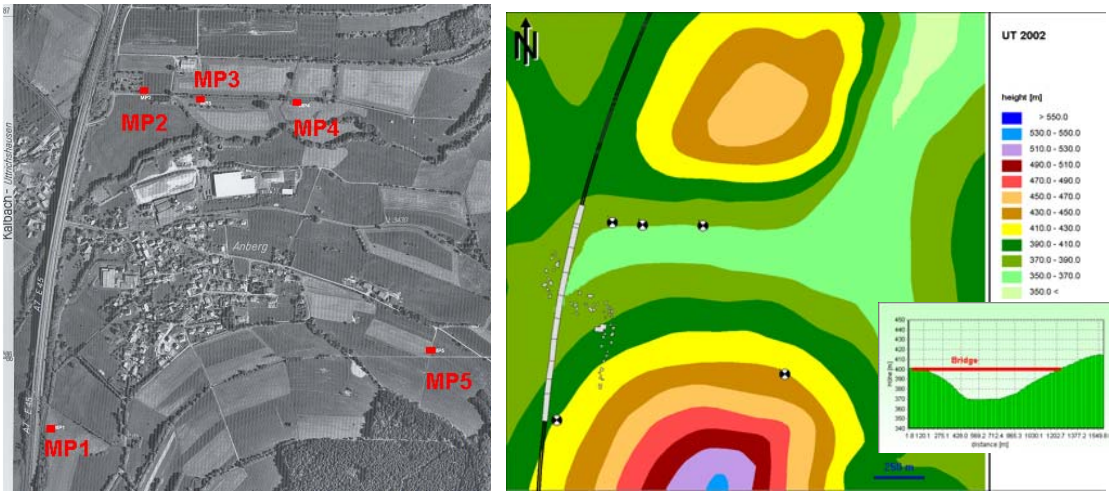

Figure 1: Measurement sites and ground profile

Table 1 is giving a comparison between the measured differences MP1-MPx and the difference calculated by RLS90 and NMPB. The last row in the table is giving the maximum difference between the measured and the calculated levels. The color is referring either to NMPB or RLS90, i.e. for the yellow colored cells the NMPB are showing the largest difference where as for the green colored cells the RLS90 is giving the largest difference compared to the measured values.

Table 1: Comparison between level differences from calculations and measurements

	MP1-MP2		MP1-MP3		MP1-MP4		MP1-MP5	
	day	night	day	night	day	night	day	night
	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
NMPB	11.6	9.9	15.2	13.5	21	19.4	31	33.6
RLS90	11.1	11.1	15.3	15.3	21.4	21.4	29.7	33.2
meas.	14.6	14	18.3	17.4	22	21.7	28.7	30.8
max. diff	3.5	4.1	3.1	3.9	1	2.3	-2.3	-2.4

Depending on the distance between the measurement site and the road the differences between calculations and measurements are running from -2.4 to +4 dB. The best agreement is to some surprise not close to the noise source but at medium or larger distances.

3. RESULTS ROAD -BRIDGE 2

For the second example, also a motorway (A52 at the Ruhr valley) running across a valley, more detailed information about the traffic data was available. The problem in this situation is not only a difference in level but the large difference in the frequency spectra of the noise. Right now it is not clear what is causing these spectra. The road surface was renewed and the bridge was re-forced. Fig. 2 is showing an arial photo of the motorway crossing the valley and the measurement site which was about 62 m from the center line of the motorway. The height of the bridge above ground at the measurement site is 40 to 50 m. The measurement data is covering a period of about 2 weeks in September 2008.

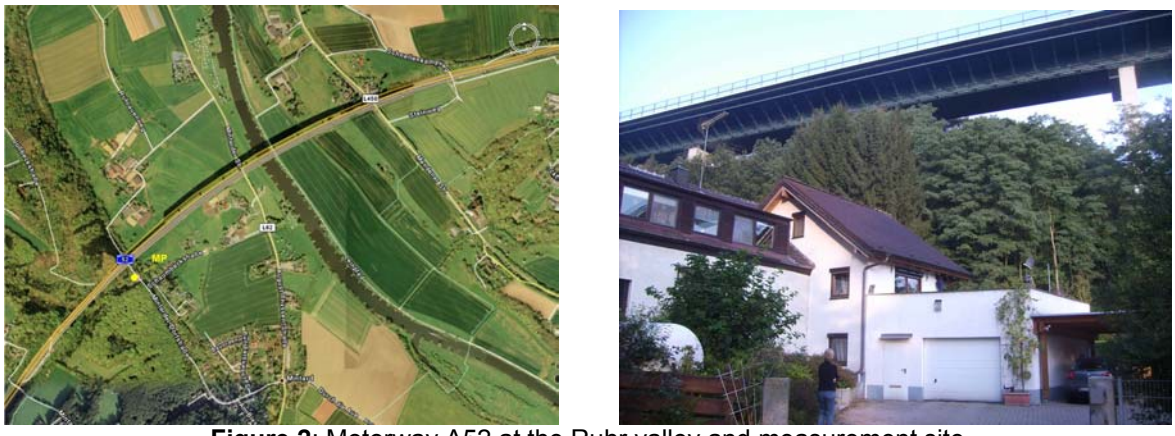

Figure 2: Motorway A52 at the Ruhr valley and measurement site

Table 2 shows a comparison between the different calculations and the measured values.

Table 2: Comparison between calculations and measurements

	day dB(A)	night dB(A)
NMPB	54.7	49.3
RLS90	57.2	51.3
measurements	62.5	57.5

The differences between the calculated and the measured levels are quite large. For daytime the deviation on average between the calculated and the measured level is about 6.5 dB and for the night time it is about 7 dB. These large differences are likely not to be the result of insufficient traffic data. Since the distance between the bridge and the measurement site is fairly small it is more likely that the screening effect in the calculation models is not correct for this situation. Another reason might be either due to the road surface or/and the bridge itself. This conclusion is supported by the frequency spectra which are very different from standard spectra. The two figures below show narrow band spectra for two motorways: the spectra of Fig. 3 were taken at the measurement site and the spectra of Fig. 4 were taken at a motorway on a flat terrain.

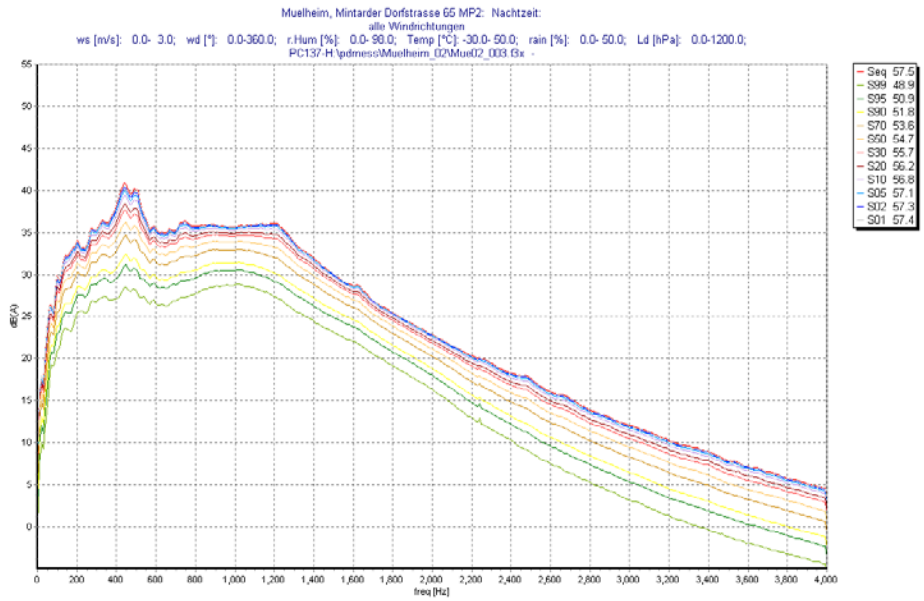

Figure 3: Frequency spectra of the A52 (bridge)

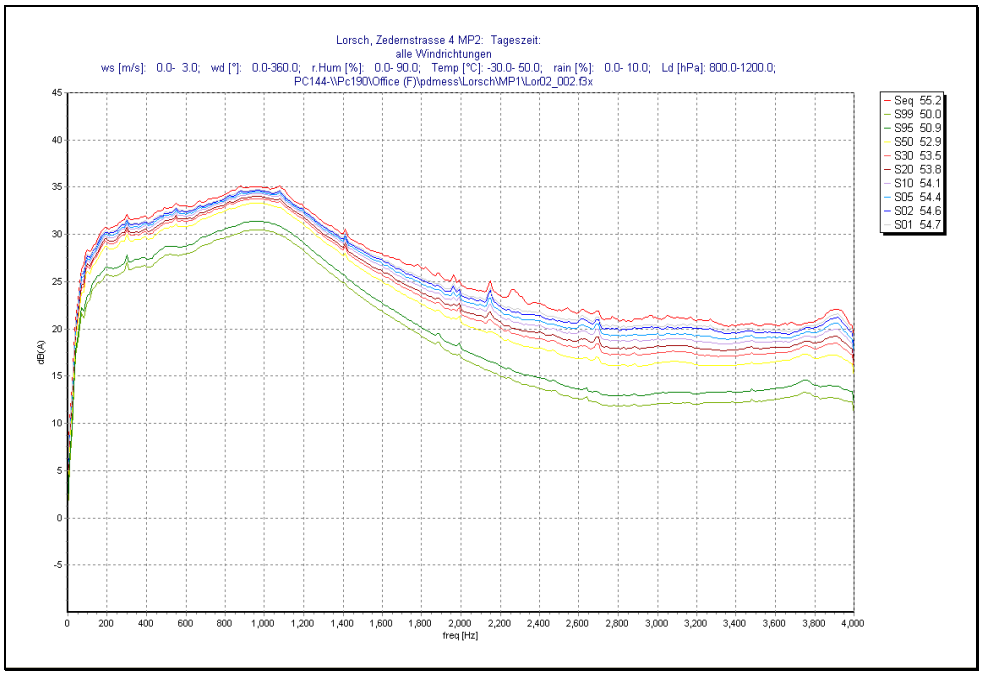

Figure 4: Typical spectra of traffic noise (A67)

Different from the typical spectrum of traffic noise the spectrum of the A52 shows a maximum between 400 and 500 Hz and a plateau up to 1200 Hz. Typically the spectrum of road traffic noise has its maximum at 1000 Hz.

4. RESULTS FLAT TERRAIN

The third example of the comparison between calculations and measurements are a local road with 1 lane each direction an a measurement point about 25 m distance from the center line of the road. The results of the measurements and the calculated values, only RLS90 calculations are given in Table 3.

Table 3: Comparison between calculations and measurements, flat terrain

	day dB(A)	night dB(A)
RLS90	64.8	59.9
measurements	65.3	58.3

In this case the deviation between measured and calculated values is on average day and night about 1 dB.

5. CONCLUSIONS

The two above examples have shown that for certain complex topographical situations the differences between calculated noise levels and measurements can be fairly large. Beside the difference in A-weighted levels there can also be a large discrepancy in the frequency spectrum of the noise, causing annoyance even if the levels are within the noise limits. For the strategic noise mapping and the action planning these two examples give some hints to check the calculated levels by measurements, especially for situations where the calculation models are at their limits.

ACKNOWLEDGMENTS

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REFERENCES

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