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Spectrum shape of road traffic noise at 50 km/h

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The spectrum shape of road traffic noise in towns and cities is of critical importance in proper prediction and measurement of indoor noise. It is also of paramount importance in designing optimal walls and windows for noise sensitive buildings. There are two very different spectra available in Norway. The paper will show that the two spectra represent extreme cases of what can be expected. The basis for the current paper is 250 measurements of outdoor road traffic noise spectra performed through more than 20 years. The study is limited to cases where the speed limit is 50 km/h. It would seem that the average spectrum shape is somewhere midway between the two spectra currently in use. The measurements strongly indicate that a measurement of local spectrum shape will improve the accuracy of prediction or indirect measurement of indoor noise significantly. Measurements of the spectrum shape of the local road traffic noise is an easy way to reduce uncertainty for projects with high outdoor noise leves where indoor noise is critical.

1 Introduction

There have been some presentations of spectrum shapes of road traffic noise at 50 km/h [1,2,3]. These presentations have in common that they are based on measurements at a limited number of sites and a modest number of passing vehicles. The data in the current paper have been collected from 93 sites with speed limit of 50 km/h. A total of more than 49000 vehicles have been included in the measurements. 4600 of these vehicles were classified as heavy.

2 Method

The measurement method can be described by measurement of traffic flow, measurement of noise levels and analysis.

2.1 Control of traffic flow

The traffic flow has been acquired by manual counting of passing vehicles during the measurement. Classification as light and heavy vehicles has been made manually during the measurement.

2.2 Noise measurement

The noise level has normally been measured in 30-minute periods. The equivalent level in 1/3-octave bands and A-weighted have been measured during this time. It has been controlled that noise from other sources have not interfered significantly with the measurement. For all measurements the position of the microphone relative to the road has been recorded.

2.3 Analysis

For each individual measurement the relative A-weighted contribution in each 1/3-octave band has been calculated. The spectrum shape of individual cases has been investigated. The only clear pattern that has been found is variation in the spectrum shapes. Different classifications of the measurements have been attempted, but no pattern has been found. There is no clear development over time, there is no systematic difference between city streets or suburban areas just barely dense enough to justify a speed limit of 50 km/h, there is no systematic variation with traffic density. The only safe conclusion is that either the variation in spectrum shape is due to some factor not yet analysed or that there is insufficient data to find a pattern.

We have chosen to compare the results with the published spectra.

3 Results

The results of our measurements are shown compared to the standard spectra in two different ways:

1. The highest and lowest contribution to A-weighted level in each 1/3-octave band compared to standard spectra
2. The shape of the measured spectra normalized to 0 dB compared to standard spectra

3.1 Highest and lowest contribution in each 1/3-octave band

Figure 1 show the highest, blue, and lowest, grey, contribution in each 1/3-octave band from alle measurements compared to published values.

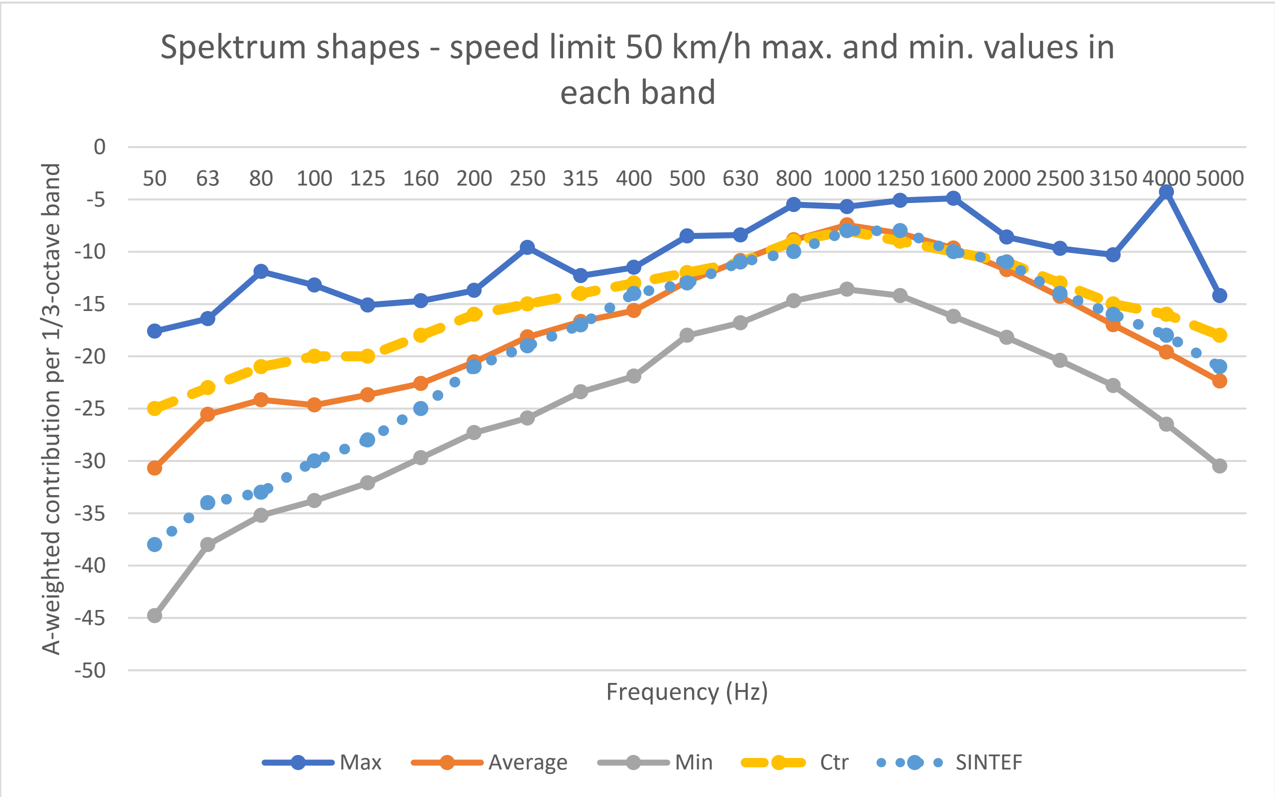

Figure 1 – highest and lowest contribution in each 1/3-octave band compared to published spectra

The highest and lowest contribution in each 1/3-octave are outside the range of the published spectra, which is to be expected.

3.2 Shape of measured A-weighted spectra relative to A-weighted total

Figure 2 shows the shape of earlier published spectra compared to the measured spectra in figure 1 normalized so that the total A-weighted level becomes 0 dB.

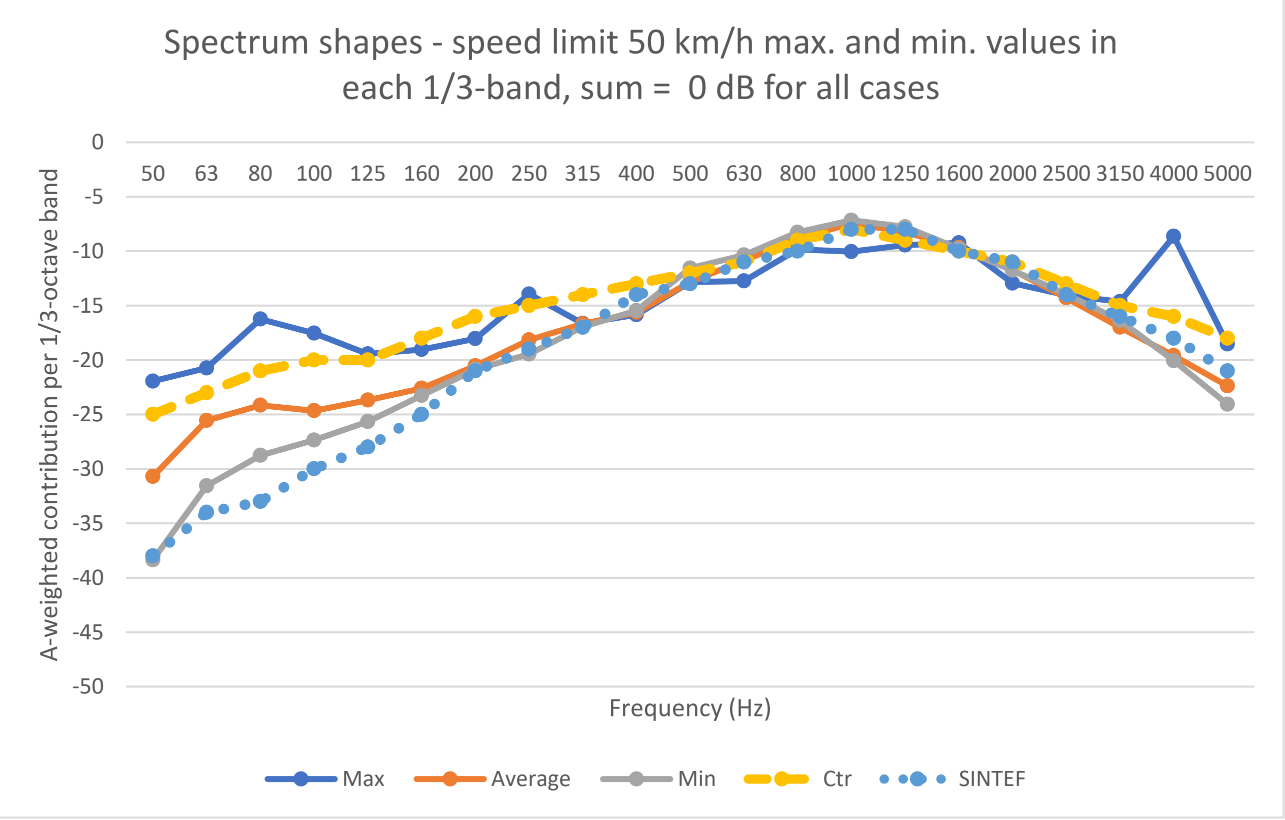

Figure 2 – highest and lowest A-weighted contribution in each 1/3-octave band – normalized to 0 dB total

4 Consequences for indoor level

Different spectrum shapes of outdoor noise at frequencies below 200 Hz is greatly reduced due to A-weighting. But the sound insulation in this frequency range is also modest. We have tested the difference in indoor level for three typical cases of Norwegian houses:

Masonry/concrete - double glazing, average of 27 cases
Lightweight wooden - double glazing, average of 22 cases
Lightweight recent with special noise window, a recent case

The spectrum of the difference between outdoor and indoor noise is shown in figure 3 below.

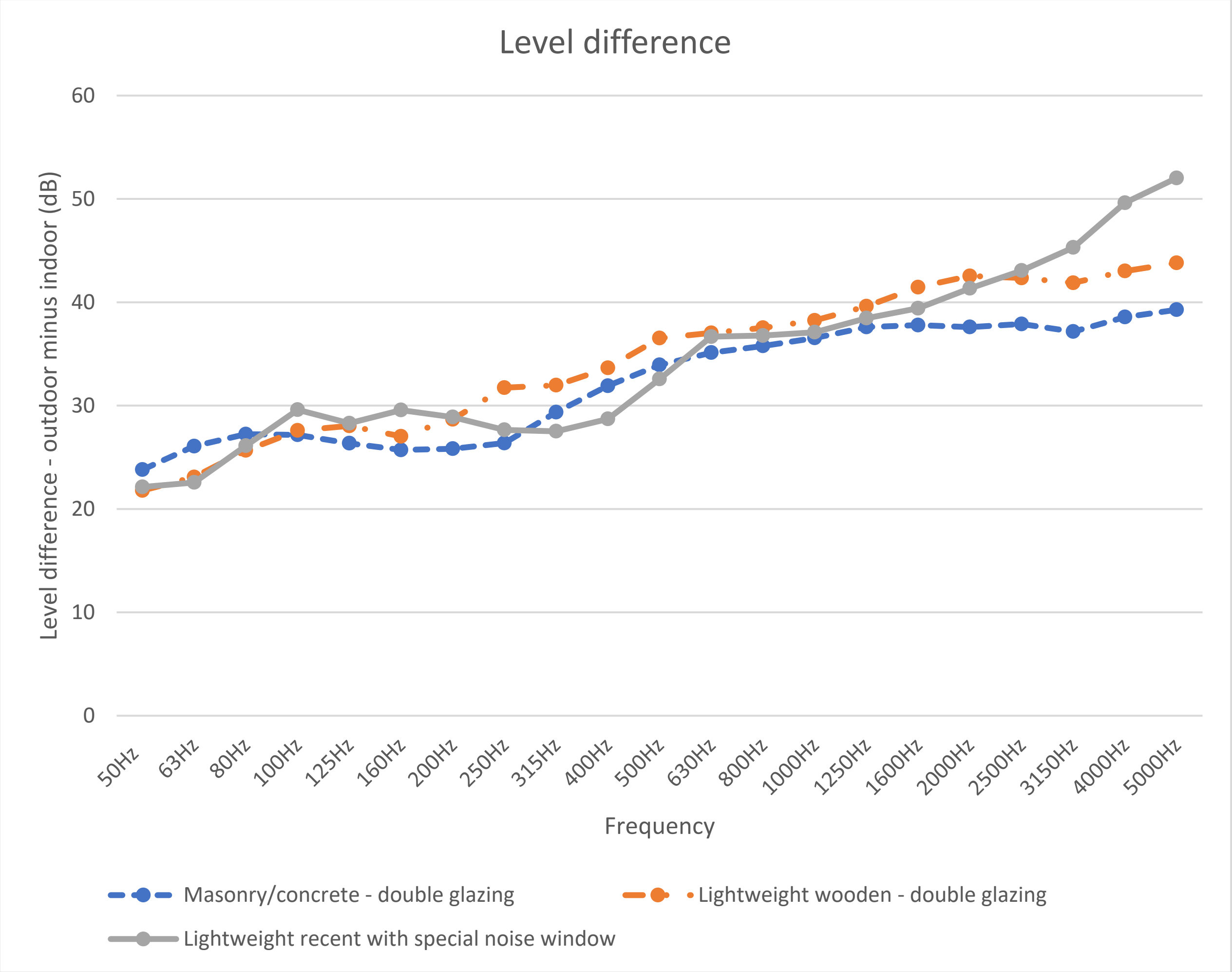

Figure 3 – Level difference between outdoor and indoor noise

The difference in A-weighted level has been calculated for each spectrum shape [4].

Table 1 below gives the results.

Case	Level difference, A-weighted, Ctr (dB)	Level difference, A-weighted, SINTEF Case (dB)	Deviation (dB)
Masonry/concrete - double glazing	32,7	35,3	2,6
Lightweight wooden - double glazing	34,7	37,8	3,1
Lightweight recent with special noise window	33,2	35,7	2,5

Table 1, difference between outdoor and indoor A-weighted noise levels.

5 Discussion

It would seem that both the earlier published spectra are representative of actual cases that can be found in the real world. Many different spectrum shapes can be found, but most of them are in the range between the two spectrum shapes. The difference between the two spectra in the frequency range 50 Hz to 400 Hz is substantial. In terms of indoor A-weighted there is a consistent difference of around 3 dB in calculated level. It could have major consequences for design of noise sensitive buildings if an incorrect local spectrum is used. A correct match between the sound insulation properties of sound insulating building elements and local noise spectrum is important. Currently there is no known way to predict which spectrum is best suited in any given case. The Ctr spectrum may overestimate the indoor level by an unknown quantity up to 3 dB, the SINTEF spectrum may underestimate the indoor level by up to 3 dB.

If at all possible the local spectrum shape should be measured in order to acquire the optimal solution to reduce indoor noise.

6 Conclusion

It has been shown that many different shapes of traffic noise spectra exist at a signposted speed limit of 50 km/h. The two published spectra seem to represent the range of possible spectra reasonably well. There is currently no other known way than measurement of local spectrum to determine whether to use one of the two published spectra or something inbetween to calculate indoor noise level correctly. Measurement of local spectrum is recommended in all critical cases with high outdoor noise levels.

References

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