

inter.noise 2000
The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE

I-INCE Classification: 1.3

EXPERIENCE WITH NOISE AND TRAFFIC CALMING IN NORWAY

T. Berge

SINTEF Telecom and Informatics, SINTEF Telecom and Informatics, dept. of acoustics, N-7465, Trondheim, Norway

Tel.: + 47 73 59 27 28 / Fax: + 47 73 59 14 12 / Email: truls.berge@informatics.sintef.no

Keywords:
TRAFFIC CALMING, DRIVING BEHAVIOR, BUMPS, PAVEMENT STONES

ABSTRACT
In the period 1993-1995, the Public Road Administration in Norway carried out a test project on traffic calming in 5 small villages. In all these villages, the main street was originally not functioning well, neither aesthetically or from a safety point of view. The main goal for the project was to make the streets "environmental friendly" and increase the safety for pedestrians, cyclists and vehicle drivers. Besides these factors, a second goal was also to reduce the traffic noise levels. SINTEF was asked to do some measurement of noise and driving behavior before and after rebuilding of the street at one of the 5 locations. At 2 other locations, the noise measurements were performed only after rebuilding of the street. In particular, the noise was measured at pedestrian crossing areas, where special stones were used to increase the attention to the drivers and from an aesthetic point. The paper will present the results from the noise measurements and the driving behavior (speed profile measurements), and discuss important factors in traffic calming schemes regarding noise.

1 - INTRODUCTION
In the period 1993-1995, the Public Road Administration in Norway carried out a test project on traffic calming in 5 small villages. In all these villages, the main street was originally not functioning well, neither aesthetically nor from a safety point of view. The main goal of the project was to make the streets "environmentally friendly" and to increase the safety for pedestrians, cyclists and vehicle drivers. Besides these factors, a second goal was also to reduce the traffic noise levels. SINTEF was asked to do some measurement of noise and driving behavior before and after reconstruction of the street at one of the 5 locations, Rakkestad. At two other locations, noise measurements were performed only after rebuilding of the street. In particular, the noise was measured at pedestrian crossing areas, where special stones were used to increase the attention to the drivers and to improve the aesthetics of the street.

2 - DRIVING BEHAVIOR
On of the main change of the street was that a normal two street crossing was reconstructed as a roundabout, pedestrian crossings were marked with different pavement stones, and at the entrance of the area, the lanes were divided. In the roundabout, the driving behavior was measured by registration of the speed profiles at 4 defined positions before and after the reconstruction. Figure 1 shows one example of the results from these measurements [1]. The results show that the average speed of vehicles entering the roundabout is reduced with approx. 5-6 km/h, comparing to the normal crossing, while the speed out of the roundabout is the same as before. This result is typically for the driving behavior for all the directions: the speed of vehicles approaching the roundabout is reduced, the speed through the roundabout may be a little less, while the speed out is approx. the same, when comparing the speed profiles before and after reconstruction. A reduced speed will normally give a lower noise levels, however, this can to some extent be compensated by a higher rate of acceleration out of the roundabout. No noise measurements were performed close to this roundabout.

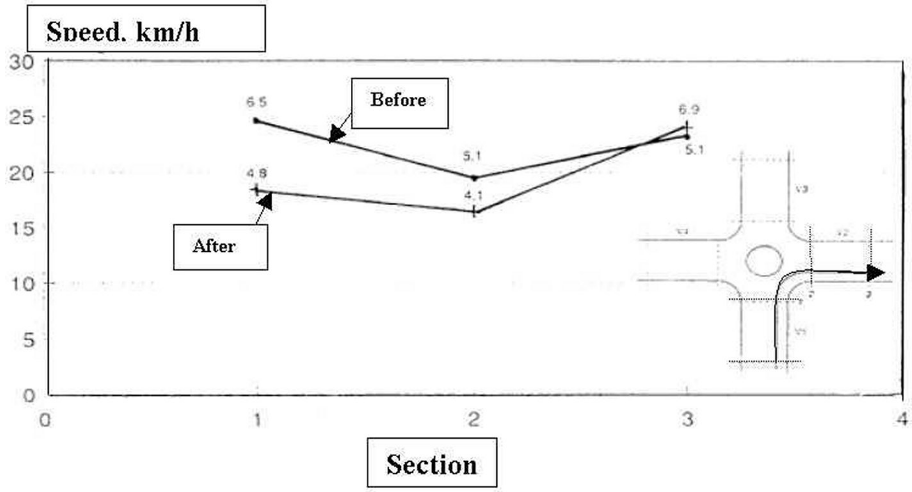

Figure 1: Average speed profiles in a roundabout, before and after construction; the standard deviation at each section is marked.

3 - NOISE MEASUREMENTS

At Rakkestad, 24hrs L_{Aeq}-levels were measured at 3 different locations along the street. Table 1 shows the results from these measurements [2]. The difference in L $_{Aeq}$-levels is very small, in the order of 1 to 1.5 dB(A). The average speed reduction after the reconstruction of the street is approximately 21% (from 42 to 33 km/h). The ADT is approx. unchanged, about 7000.

Measuring point	Before L_{Aeq} dB(A)	After L_{Aeq} dB(A)	Reduction dB(A)
1	68.6	67.3	1.3
2	70.4	69.4	1.0
3	69.9	68.6	1.3

Table 1: Measurement of 24 hrs L_{Aeq}-levels before and after rebuilding of the street.

Such a speed reduction should normally also give a noise reduction of approx. 3-4 dB(A), depending on the number of heavy vehicles. The reason this is not obtained here, is mainly the influence of an increase in the noise levels at certain pedestrian crossings, fairly close to the measuring points. The crossings are designed as shown in figure 2. The material is essential rather large paving stones with a rough surface. The height of the area is only slightly increased, but not so much that the vehicle speed is reduced at this section of the street. After the re-opening of the street, there were a number of complaints from shops and people living close to these pedestrian crossings. There were complaints on both noise and vibration levels, especially from the passing of heavy trucks with empty trailers.

Measurements were performed at one of the crossings of passing vehicles with and without a trailer. The A-weighted maximum noise levels were measured together with vehicle speed. The measurements were performed with the original bump with paving stones and repeated two years later, when stones and bumps were removed and replaced with a normal dense asphalt concrete surface. Now, normal painting marked the area of the pedestrian crossing. Figure 3 shows the results of the measurements on light vehicles. With the original bump, the maximum noise levels of light vehicles with empty trailers could be in the range of 75 to 80 dB(A) and around 90 dB(A) for trucks with trailers. On average, the noise levels of passing vehicles were reduced with 3-5 dB(A) when the bump was removed. The L_{Aeq}-levels were also recorded at some houses close to pedestrian crossings. After removing the bump and stones, the levels were reduced in the order of 2 dB(A) outside and 4 dB(A) inside the building.

At another of the 5 villages selected for traffic calming, we were able to compare pass-by noise levels on bumps with different types of stone [3]. A passenger car was driven over two different bumps with speeds ranging from 15 to 40 km/h; one bump with rough paving stones and another with brick stones with a very smooth surface. The results were compared with pass-by levels of the same vehicle on a section of a normal dense asphalt concrete road surface without a bump. The results are given in figure 4. From this figure, we can draw the following conclusions:

- at a speed around 15 to 20 km/h, there is no significant increase in noise levels for this vehicle over a bump, regardless of the road surface

Figure 2: Pedestrian crossing with pavement stones.

- there is no significant difference in noise levels over the bump, when using a material with a smooth surface
- when using a rough surface, the **increase** in noise levels can be 4-6 dB(A) at speeds in the range of 25 to 40 km/h.

The effect of the bumps can be significantly different on heavy vehicles, especially with empty trailers. For this type of vehicle, it seems that the road surface of the bump is not so critical as the design of the bump.

4 - CONCLUSIONS

When designing roads intended for traffic calming, one has to evaluate **all** the different measures used with respect to noise, **before** actually constructing the street. The use of pavement stones with a rough surface to e.g. mark pedestrian areas combined with bumps is critical and should be avoided. If the vehicle speed at such locations is more than 30 km/h, the increase in noise and vibration levels can be significant and thus cause complaints from neighbors. Different measures like roundabouts, a central reserve, etc. can reduce vehicle speeds, but also cause an uneven driving behavior. Traffic calming streets normally have a posted speed of 30 km/h. If the initial speed was 50 km/h; there is a potential reduction of noise levels of light vehicles in the order of 7-8 dB(A). Noise from heavy vehicles is not speed dependent at speeds below 50 km/h, so the total noise reduction could depend on the percentage of heavy vehicles. Some measurements performed in Germany [4] indicate a potential reduction of L_{Aeq}-levels of approx. 3 dB(A) when reducing speed from 50 to 30 km/h. The distance between different measures along the street is also important. If the distance between say, two bumps is too long, many drivers would accelerate their vehicles and an uneven driving behavior could increase the noise in the street rather than reducing it. So careful design is an important rule, if one shall improve safety and aesthetics, reduce gas emissions **and** lower the noise immission levels. If this is done properly, the average pass-by noise level for passenger cars should decrease 3-4 dB(A) and 0-2 dB(A) for heavy vehicles.

REFERENCES

1. **T.Berge**, *MPG-Rakkestad/Os. Pre-investigation, noise and driving behavior. SINTEF DELAB Report SFT40 A94125 (In Norwegian)*, 1994
2. **T.Berge**, *Noise measurements in environmental streets in Hokksund. SINTEF DELAB Note 40-NO950286 (In Norwegian)*, 1995
3. **T.Berge**, *Noise measurements in the environmental street in Rakkestad, June 1999. SINTEF Telecom and informatics, Note 40-NO990112. (In Norwegian)*, 1999
4. **G.Kemper, H.Steven**, Geräuschemissionen von Personwagen bei Tempo 30.*Lärmbekämpfung*, Vol. 31, pp. 36-44, 1984

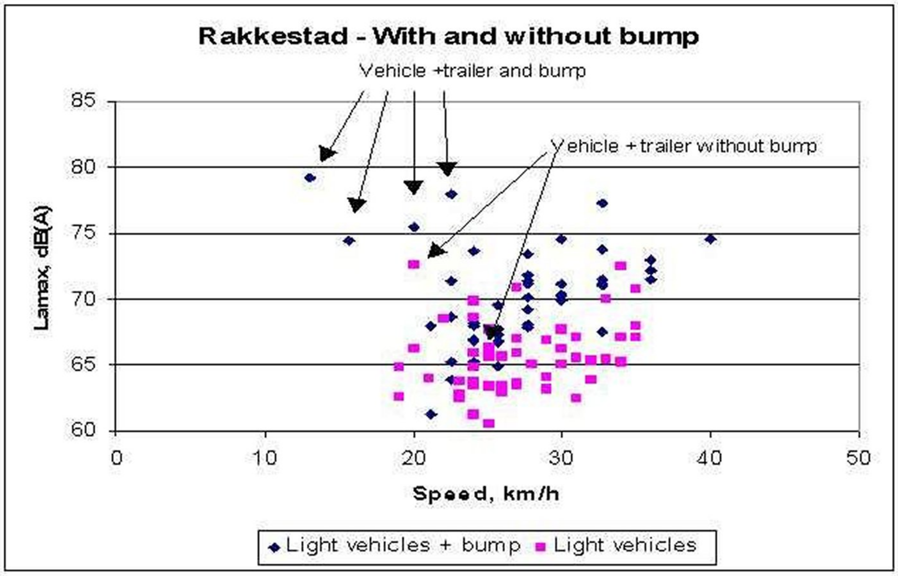

Figure 3: Lamax-levels from light vehicles passing a pedestrian crossing with and without pavement stones; vehicles with trailers are marked; distance = 7.5 m.

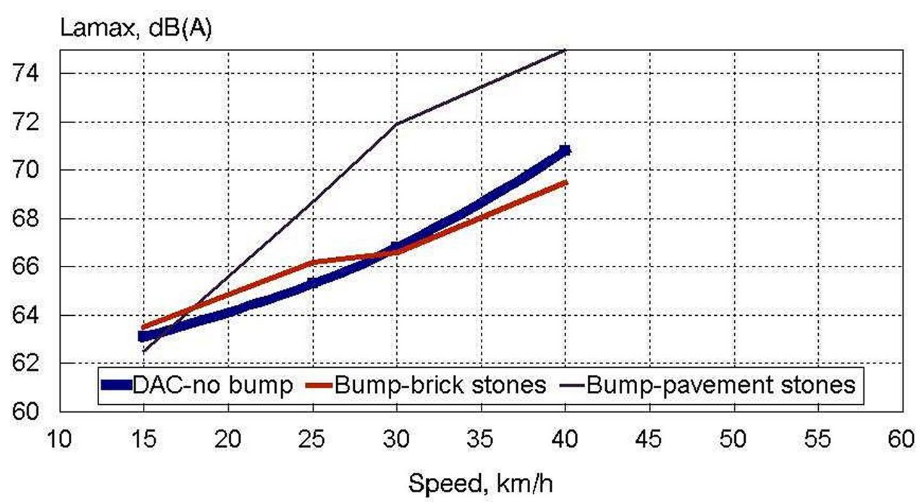

Figure 4: Lamax-levels of a light vehicle passing a bump with brick stones and pavement stones, compared to levels at a dense asphalt concrete surface.