Noise Reduction and Long-term Effectiveness of Low Noise Road Surfaces in Urban Streets of Munich

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Introduction

In the framework of the "Konjunkturprogramm II" the Munich city council had the opportunity to test low noise road surfaces on urban streets on 7 different test facilities. From 2009 to 2011 road surfaces of existing roads with speed limits of 50 and 60 km/h were renewed and replaced by low noise pavements. Thus measurements of the noise reducing success were able to be carried out on these sites. Two different types of low-noise surfaces were tested: low noise stone mastic asphalt (SMA-LA) and thin layers (DSH-V).

In order to quantify the noise reduction of the new pavements measurements were taken immediately before and after replacing the pavements. Long term effectivenes shall be controlled by repetitive measurements every year until up to 5 years after replacement.

Scope of the measurements

Low Noise Road Surfaces are very well tested in rural areas at speeds above 70 km/h (However studies for lower speed limits hardly exist). In the framework of the „Konjunkturprogramm II" low noise surface types suitable for urban streets with speed limits of 50 km/h and 60 km/h were laid out. There are only few measurements and few reliable results for the noise reduction of these road surfaces at low speed. Especially the long-term effectiveness of the noise reducing effect has yet to be determined.

Test sites were chosen in order to demonstrate the noise reduction effects in noise hot spots with dense traffic and a great number of residents being impacted. Therefor the measurements should also deliver information about the actual noise reduction with the on-site conditions.

There were three different aspects that should be covered by the measurements:

- Noise reducing effect of the road surfaces with the on-site traffic, percentage of trucks and speed limit
- Noise reducing possibilities at different speeds
- Long-term effectiveness

Test sites and Surface Types

Out of the different low noise surfaces that are suitable for urban streets the following two surface types were testet:

- Low noise stone mastic asphalt (SMA-LA)
- Thin layers (DSH-V 0/5)

The following seven test sites were chosen for the installation of low noise surfaces. The associated streets show dense traffic volume of well above 15.000 vehicles per day:

Thin layers (DSH-V)		
Test Site	Speed limit [km/h]	Date of renewal
Wasserburger Landstraße	60	08/2010
Landsberger Straße	60	08/2010
Fürstenrieder Straße	60	08/2009
Leopoldstraße	50	04/2011
Low noise stone mastic asphalt (SMA-LA)		
Test Site	Speed limit [km/h]	Date of renewal
Orleansstraße	50	08/2010
Chiemgaustraße	60	08/2009
Moosacher Straße	60	08/2009

Table 1: Test sites and date of renewal of the surface

One additional test site with conventionel stone mastic asphalt was replaced by a new pavement of the same type which was being used as a reference test site. On this test site the long-term behaviour of a conventionel pavement was monitored. The results of these measurements will be omitted in this paper.

Measurement Procedure

The test sites show very dense traffic at daytime and even at night time. The statistical pass by method (SPB-method) of ISO 11819-1 [2] requires 100 acoustical distinguishable pass byes of passenger vehicles and 80 pass byes of 2 different types of trucks. Because of the very low percentage of trucks and the very dense traffic with pass-byes in bulk at night time (caused by traffic lights) measurement according to the SPB-method of ISO 11819-1 [2] would be too time consuming at 8 different test sites. Furthermore there would be little speed variety especially for very low speeds.

Therefore an own measurment procedure consisting of two different measurement types was developed:

- Measurement of free floating traffic
- Measurement of controlled pass-byes of a test vehicle

The micorohone position was chosen according to DIN 45642 at a distance of 7.5 m to the middle of the nearside lane in a height f 1.2 m above pavement.

Figure 1: Microphone position on a test site

In order to evaluate long term effectiveness both measurement procedures were conducted repetitively:

- Before renewal (reference measurement)
- Shortly after renewal
- Long-term measurement after one year
- Long-term measurement after two years
- Long-term measurement after three years
- Long-term measurement after five years

Measurement of free floating traffic

In these measurements the average noise level (noise emission) of free floating on-site traffic was measured. The measurements lasted 1 hour each and were repeated at three different periods of the day at each test site. The different periods of the day were in the morning, in the afternoon and in the late evening. At these periods different traffic density and percentage of trucks were expected so that the influence of heavy weight traffic on noise reduction could be observed.

With these measurments the effect of noise redution after renewal of the road surface was evaluated by comparing the measurements at the same periods of the day before and after renewal und furthermore after one and more years. Because of the slight differences in traffic volume and percentage of trucks in the annual measurements noise levels have to be converted to equal traffic volume according to DIN 45642, A.3 [1].

Measurement of controlled pass-byes of a test vehicle

In order to evaluate the influence of speed on noise reuction contolled pass-byes of a test vehicle at different speeds were measured. The measurements were conducted by using a single vehicle, which will be used in all future measurements as a reference vehicle. At least 20 distinguishable and non disturbed pass-byes at speeds of 30, 50 and 60 km/h are measured. The test vehicle as shown in figure 1 is provided by the city of Munich. Because of the dense traffic at daytime, these measurements are conducted at nighttime to avoid disturbance by the on-site traffic.

Figure 2: Test vehicle

The pass-by level are evaluated and compared to the different measurment sessions by generating the regression line over speed.

Results

Results related to surface types

The following figure shows the noise reduction of the 7 test sites according to the measurements of free floating traffic shortly after the renewal of the pavement. The values are averaged over the three periods of the day for each test site.

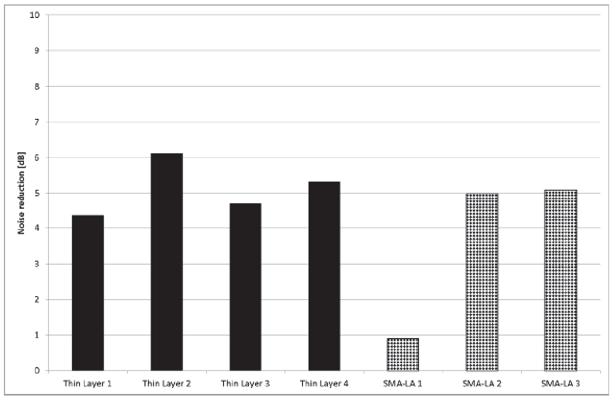

Figure 3: Noise reduction shortly after renewal

Both surface types achieved a noise reduction of about 4 to 5 dB(A) in average. On one test side with a thin layer pavement even a 6 dB(A) reduction could be observed. One test site with stone mastic asphalt showed very little noise reduction of about 1 dB(A).

The separate results for the different periods of the day show in case of the thin layer pavement a higher noise reduction in the late evening, where there is a lower percentage of trucks, and a slightly lesser noise reduction with increasing heavy weight traffic at daytime.

Results related to long-term effectiveness

Measurements of long-term effectiveness are not finished yet. First results are obtained for the noise reduction after three years. The following figure shows the average noise level $L_{Aeq,1h}$ of two test sites with a thin layer pavement for the three periods of the day. The figure shows the maximum noise reduction shortly after the renewal as seen in figure 2 and after 2 or 3 years a slight (in some cases a more distinct) increase of noise again.

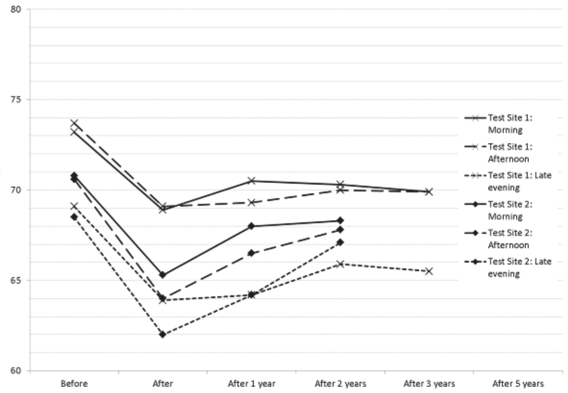

Figure 4: Long-term effectiveness of thin layer

The same depiction for the case of the stone mastic asphalts shows the following figure:

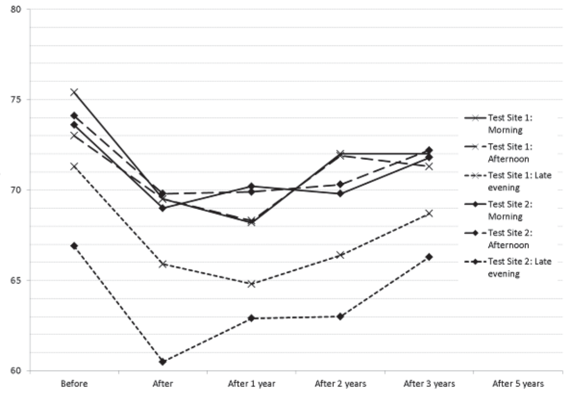

Figure 5: Long-term effectiveness of low noise stone mastic asphalt (SMA-LA)

As can be seen there is also the maximum noise reduction shortly after renewal of the pavement. In the case of the stone mastic asphalt a rapid re-increase of noise can be observed after 2 years in one case and three years in the other. Further measurements will show if this re-increase will appear in the remaining test-site.

Results related to speed dependency

The results of the controlled pass-by measurements are shown in the following figure as an example of a thin layer pavement test site:

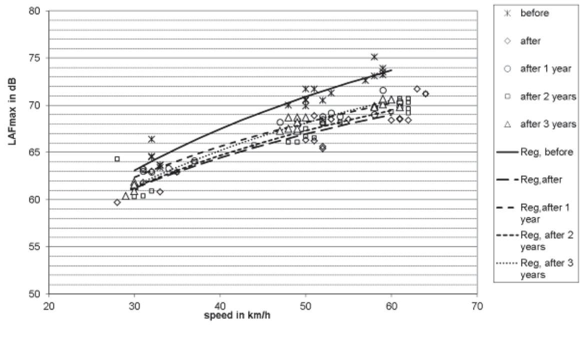

Figure 6: Speed dependency of noise reduction of a thin layer (DSH-V)

As expected the noise reduction increases with gowing speed. At the highest speed of 60 km/h the measurements score the same noise reduction value as the measurement of free floating traffic. Even at very low speed of 30 km/h in all test sites a noise reduction can be observed shortly after renewal of the pavement. In compliance to the measurement of free floating traffic a slight re-increase of noise is visisble.

Conclusions

Measurement method

- Both measurement methods show comparable results in terms of noise reduction.
- The combination of these methods was very efficient in order to measure 8 different test sites.

Thin layers

- Noise reduction was expected to be about 5 dB at 60 km/h; both measurement methods confirm the expectation
- Higher noise reduction can be observed in the evening because of less heavy weight traffic
- Noise reduction at 30 km/h is less than at 60 km/h.
- Long-term effectiveness decreases differently but mostly slightly in the test sites.

Low noise stone mastic asphalt

- Noise reduction shortly after renewal was observed to be around 5 dB(A) at 60 km/h
- Measured noise reduction exceeds the expectation.
- Long-term effectiveness showed in 2 of 3 cases a rapid re-increase of noise after the second or third year.

References

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