HANDBOOK 47 – CONTROL MEASUREMENTS OF CALCULATED FACADE SOUND INSULATIONS

Edvard Falch

KILDE Akustikk AS
P.O.Box 6134 PT
N-5892 Bergen, Norway.
edvard.falch@kilde-akustikk.no

ABSTRACT

Calculated facade sound insulation for traffic noise are controlled by measurements in 23 resident buildings (57 rooms) using sound insulation data from (the predecessor of) Handbook 47 (Norwegian Building Institute) and measurements of difference noise levels (outdoors–indoors) according to Norwegian Standard 8174. The deviation between calculated and measured values are typical within ±3 dB for modern buildings. The facade sound insulation for older buildings are typically underestimated up to approx. 5 dB. The traffic sound distribution in small/medium and large rooms leads to typical measurements uncertainties of ±2 dB for the A-weighted equivalent SPL.

1. INTRODUCTION

In 1990 a new 4-lane motor vehicle road south of Bergen (Norway) was constructed and a plan for reinforcing the façade sound insulation for a large number of resident houses along the road was established in order to comply with noise regulations for maximum indoor equivalent noise levels along new roads, $L_{A,eq,24h}$ <= 35 dB.

In 2002 a test sample of 23 resident buildings were controlled by calculations and measurements [4] to check if the indoor noise regulation limit was met after having performed the necessary building works according to the plan. From this work measurements of façade sound insulation in 57 rooms using traffic noise as sound source are compared to the former calculated façade sound insulation. Furthermore, the measurement uncertainty is demonstrated by calculating the standard deviation from all single point measurement results.

2. CALCULATED AND MEASURED FAÇADE SOUND INSULATION

Comparison of calculated (1990) and measured (2002) façade sound insulation is carried out for 23 houses including 57 rooms. The majority of buildings are with light-weighted wooden insulated facades. Input data for calculating the façade sound insulation were collected in accordance to the predecessor [1] of NBI Handbook 47 [2], using a methodology similar to that described by Heggøy [3]. Handbook 47 (H47) from the Norwegian Building Institute contains a simplified calculation method for sound insulation against external noise together with data for sound insulation of different building elements (external walls, windows, ventilation inlets and roof constructions). H47 (from 1999) states that the typical difference between calculated and measured values of façade airborne sound insulation for road traffic sound levels, (i.e. the difference between the outdoor façade level and indoor averaged sound level, both A-weighted), is expected within ±2 dB. (The predecessor to H47 from 1988 states differences within ±3 dB)

Controlling indoor noise levels by measurements is a combination of calculated outdoor noise L_u (at the façade) and measured façade sound insulation ΔL using standard "difference measurements" as described in Norwegian Standard 8174 [5]. (NS 8174 is close to ISO 140-5). Road traffic noise from the actual road near by is applied as noise source. The façade sound insulation ΔL is the averaged difference between a fixed outdoor measurement position (on the façade) and several short time ($L_{eq,\ 2min}$) indoor measurements carried out simultaneously with outdoor measurements in the fixed point. All measurements are in 1/3-octave bands. Hence, the indoor noise level in 1/3 octave bands is $L_i = L_u - \Delta L$. For comparison with calculated levels all measured indoor sound levels are normalized to reverberation time 0,5 s. Assuming a standard traffic noise spectrum for the outdoor measurement position [2] A-weighted levels for indoor noise are calculated.

Table 1 shows A-weighted comparison results of calculated and measured facade sound insulation:

Comparison results, dBA:	Difference between Calc. and Meas.	No. of test rooms	SUM
No. of test rooms where calculated facade sound insulation are less than measured.	0 – 3 dB	25	
	3 - 6	4	
	6 - 9	1	
	> 9	0	30
No. of test rooms where calculated facade sound insulation are higher than measured.	0 – 3	17	
	3 - 6	9	
	6 - 9	1	
	> 9	0	27
			57

Table 1. *Difference between calculated and measured façade sound insulation*.

The comparison between "H47 calculations" (from 1990) and control measurements of facade sound insulation (2002) shows that 74 % (42 of 57 test rooms) are within ±3 dB, and 54% are within ±2 dB.

There is no tendency to underestimate or overestimate the facade sound insulation by using H47 for calculations, all test rooms considered, although there seem to be a certain tendency to underestimate the calculated facade sound insulation where facade improvements not (yet) are carried out. In this group older buildings are over-represented compared to modern buildings. However, underestimating the facade sound insulation leads to higher indoor level. H47 as such tends to produce conservative results in pre-situations where facade improvement may be considered.

3. TRAFFIC SOUND DISTRIBUTION IN TESTED ROOMS

4-6 difference levels are collected and averaged for each the test room. In smaller and medium sized rooms (up to approx. 40 m^3 room volume) 4 level differences are collected. (Total 58 rooms). In larger rooms (above approx. 40 m^3 room volume) 5-6 level differences are collected. (Total 9 rooms).

Within each of these two room groups the standard deviation of the single level difference (dB) is calculated, considering the deviation from the averaged difference level in each room. The standard deviation indicates the uncertainty of the measuring procedure used here. The result are shown in Table 2.

Room volume (approx.)	Below 40 m^3	Above 40 m^3
No. of rooms	58	9
Measurement points per room	4	5-6
1/3 Octave bands (Hz)	Standard deviation (dB)	
50	3,0	3,1
63	2,8	3,1
80	2,9	3,3
100	2,3	1,9
125	2,2	1,8
160	2,0	1,5
200	1,5	1,6
250	1,4	1,7
315	1,3	1,2
400	1,1	1,5
500	1,0	1,1
630	0,9	1,3
800	0,9	1,3
1000	0,9	1,6
1250	1,0	1,8
1600	1,1	1,4
2000	1,1	1,3
2500	1,2	1,2
3150	1,3	1,3
4000	1,9	1,4
5000	2,5	1,7
A-weighted SPL:(as measured)	0,9	1,2

Table 2. *Standard deviation of single point measurement results in small/medium (58) and large (9) rooms, using outdoor road traffic as noise source in difference measurements according to* [5]

Calculated standard deviation is rather high (up to 3 dB) in the lower frequency region (as expected) but much lower in the frequency mid-range /typical 1 dB) where A-weighted noise traffic level is dominating. This is confirmed by direct measurements of A-weighted difference levels (see Table 2). The standard deviation increases above 1000 Hz, most likely due to background noise.

Smaller/medium room tends to have slightly smaller standard deviation compared to larger rooms, but the difference is not sustainable.

Assuming Normal (Gaussian) distribution of the test sample, one may expect for measurements of façade sound insulation an uncertainty within (approx.) ±1 dB for 67% of a sample, ±2 dB for 95% of a sample and ±3 dB for the whole sample.

4. CONCLUSIONS

Table 1 indicates that using sound insulation data from H47, applying a methodology similar to that described by Heggøy [3], typically leads to uncertainties of ±2-3 dB for the façade sound insulation, at least for modern buildings and facade improved buildings. Other cases, i.e. older building, the procedure typically leads to underestimated facade sound insulation (more than -3 dB) and as such to conservative results for indoor noise levels in situations where facade improvement may be considered.

Table 2 shows that measurements of façade sound insulation using difference measurements and road traffic noise as sound source, typically has an uncertainty ±2 dB for the A-weighted equivalent SPL. For an engineering method intended for field-purposes this is fully acceptable.

5. REFERENCES

[1] Norwegian Building Institute: ”Isolering mot utendørs støy”. *NBI*, Anvisning 19, 1979. *(Norwegian text)*

[2] Norwegian Building Institute: ”Isolering mot utendørs støy”. *NBI* , Håndbok 47, 1999. *(Norwegian text)*

[3] Heggøy, B “H47 – A practical tool for estimaton of façade insulation? *Paper presented at BNAM 2004*

[4] Falch, E., and Pedersen, N. P. "RV553/E39, Fjøsanger-Hop. Etterprøving av støyprognose 1990 og ny støyprognose 2015" *KILDE Akustikk AS,* rapport 758, 2002. *(Norwegian text)*

[5] Norwegian Standard Organisation.: ”Måling av lydnivå fra vegtrafikk”. *Norges standardiseringsforbund*, NS 8174, 1989. *(Norwegian text)*