RAMBÖLL
ACOUSTICS

ENGINEER	DATE	REVISED	REPORT NUMBER
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Client: Balco AB
Att: Marianne Johansson

Study of sound insulation in glazed balconies

1. Summary

A measurement of the sound reducing properties of glazed balconies has been conducted in three different properties that we were directed to. Section 5 presents the sound reduction index measured and the sound reduction index calculated with regard to traffic.

The measurements show that with 50% open glazing, the sound reducing effect is around 2-3 dB and with 75% glazing, the effect can be as much as 6 dB in favourable conditions. The smallest change in sound perceptible to the human ear is 2-3 dB.

Naturally, fully closed glazing provides a higher sound insulating effect. The Bellman property had a sound reducing effect of 18 dB. The Gaffeln property achieved 13 dB while Skogsviolen showed a reduction of 10 dB.

2. Background

Ramböll Acoustics was commissioned to study the sound reducing properties of different types of balcony glazing. The main interest was in the sound reducing properties that the designs have with regard to traffic noise.

3. Some sound-related terms

3.1 About sound

Noise is usually measured in decibels A, dB(A), where the A stands for the measured figure adapted to how people perceive sound at different frequencies (pitches). The unit dB(A) is such that a decrease/increase of 8-10 dB(A) is usually perceived as a halving/doubling of the noise strength. The smallest change that can normally be perceived is 2-3 dB(A).
A rough understanding of noise levels can be gained from the following values:

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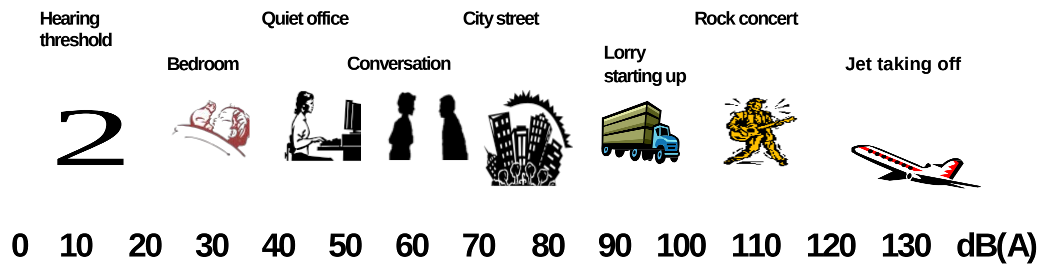

Figure 1. Examples of noise levels.

The values are approximate and depend to a large extent on distance from the sound source.

How disturbing a sound is depends not just on the level, but also on factors such as the character, how long the sound lasts and what attitude you have towards it. Noise is defined as undesired sound, but says nothing about the strength. Anyone exposed to more than 85 dB(A) as an equivalent sound level ("average sound level") for a whole working day risks damage to their hearing. Damage can also be caused by brief exposure to a maximum sound level of more than 115 dB(A). The pain barrier usually lies somewhere around 120 dB(A).

When reporting noise from traffic, two measures are used:

- *Equivalent sound level,* which is a form of average of a varying sound level over a certain period, usually 24 hours. The equivalent sound level increases with the number of passing vehicles.
- *Maximum sound level,* which is the highest momentary level recorded over the same period. The maximum level shows the risk of single passing vehicles disturbing sleep, for example. The maximum sound level is not related to the number of passing vehicles.

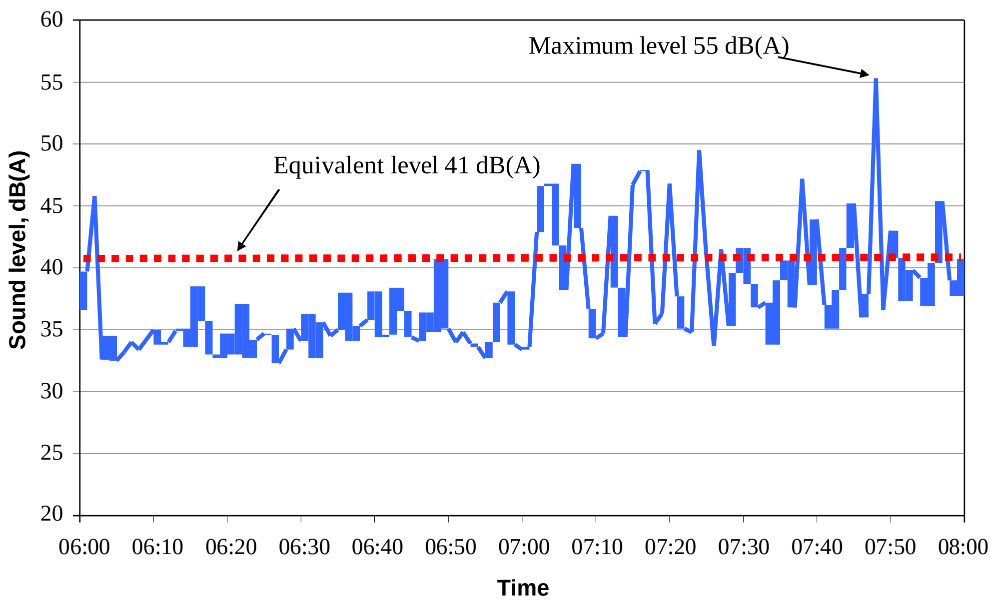

Figure 2. Example of sound level recording

3.2 Sound reduction index

Structures vary in their ability to reduce noise, depending on the type of sound. A wall, for instance, may be good at reducing sound from conversation, but may not be anywhere near as good at reducing low-frequency noise from traffic.

There are various measures used to describe how good a structure is at reducing noise. One common measure R'_{w} is widely used for various building structures, usually indoors. Sometimes what is known as a C factor is applied to this to take account of low-frequency noise. When it comes to façades and windows in façades, the normal measure is $R'_{w45, ctr}$ which is a specific measure of how good a structure is at reducing traffic noise. The values are expressed in decibels (dB).

A “simpler”, more easily understood and often reliable way of describing sound reduction is simply to describe the difference in the sound level outside and inside at a particular point. This naturally assumes that the sound source is the one you are actually interested in. It is not possible to measure the sound difference outside and inside using a loudspeaker emitting “pink noise” and then directly translate this to also apply to traffic noise.

3.3 Quiet side and degree of glazing

If you build housing which, at the façade, is calculated to have a daily equivalent sound level of over 55 dB(A), you must ensure that at least 50% of the apartment rooms face towards what is referred to as the quiet side. The idea of having a quiet side is, in part, to allow open windows for ventilation. This assumes that the space outside the window is not enclosed. The Swedish National Board of Housing, Building and Planning permits balconies to be 50% glazed, and in exceptional cases 75% glazed, in order to bring the rooms behind the balconies within the bounds of the highest permitted sound level at the façade. With a higher proportion of glazing, the internal windows are not regarded as openable towards a quiet or noise-damped side.

4. Description of measured properties

4.1 Skogsviolen, Södertälje, Sweden

Parapet/glazing: Balco Air/Balco Vision
Opening: Folding glass without frame

Address: Lundbygatan 36

The property is located in a very quiet area in terms of traffic. The purpose of the glazing is therefore probably not to reduce noise in the first instance. The glass and parapet are of extremely good quality. The frameless design means that there are gaps between the panes, which creates a weakness from a sound installation point of view when the windows are fully closed.

Picture 1. Photo of measured balcony (Skogsviolen)

Picture 2. Gaps between panes of glass (Skogsviolen)

4.2 Gaffeln, Södertälje, Sweden

Drainage: Balco CleanLine
Parapet/glazing: Balco Air
Opening: Balco Twin

Address: Västra Mälarehamnen 3A

The property is the only one studied which is located on a trafficked street. The traffic is not particularly frequent, but it still allowed measurement of the structure’s sound reducing capability with traffic as the source of noise, as a complement to measurements with loudspeakers.

Picture 3. Photo of measured balcony (Gaffeln)

Picture 4. The sound insulation is weak at the point of contact with balconies above. See more in section 5 (Gaffeln)

4.3 Bellman, Uppsala, Sweden

Drainage: Balco CleanLine
Parapet/glazing: Balco Air plus laminate
Opening: Sliding panes

The glazing forms a complement to existing inset balconies. The balconies were extended by around 60 cm and the extended sides and parapet were glazed in. The property is located in a very quiet area in terms of traffic. The purpose of the glazing is therefore probably not to reduce noise in the first instance.

Picture 5. Photo of measured balcony (Bellman)

Picture 6. The sound insulation shows certain weaknesses at the point of contact with balconies above. See more in section 5 (Bellman)

5. Measurements

5.1 General

Measurement date: 28.06.10 (Skogsviolen, Gaffeln)
29.06.10 (Bellman)
Engineer: Stefan Troëng

5.2 Instruments

The following instruments were used to take the measurements

Instrument	***Manufacturer***	***Type***	***Internal number***
Analyser	Norsonic	140	133
Microphone	Norsonic	P1225	135
Sound level meter	LarsonDavis	824	84
Calibrator	Brüel & Kjaer	4231	108
Loudspeaker	dB Technologies	Opera	130

The instruments are calibrated in line with international references

5.3 Measurement method

The measurements were largely made using a loudspeaker as the sound source. Applicable parts of the Swedish Standard “Byggakustik - Mätning av ljudisolering hos fönster, dörrar och andra byggnadsdelar i yttervägg - Tillägg till högtalarmetoden beskriven i ISO 140/5 – Fältmätningar” (Building Acoustics – Measuring sound insulation in windows, doors and other building elements in the outer wall – Supplement to the loudspeaker method described in ISO 140/5 – Field Measurements), have been used. The outdoor levels were measured using a + 6 dB measurement with a microphone taped to the window.

At the Gaffeln property, it was also possible to supplement these measurements with a simple sound check with traffic as the noise source. The traffic was too light for a more complete measurement, but it was valuable as a comparative control for the measurement with the loudspeaker. The measurement method relates, where applicable, to Nordtest Method NT ACOU 039.

5.4 Measurement results

We have chosen to report the sound reducing effect of a structure from the measurement of the difference between outside and inside, and to report a calculated theoretical sound reduction index for traffic.

5.4.1 Skogsviolen

Measurement situation, % glazing	***Difference outside /inside, ΔdB***	***$R'_{w45,ctr}$, dB***	***Comments***
50%	2	4	
75%	2	5	
100%	10	11	Leakage gaps between panes

5.4.2 Gaffeln

Measurement situation, %	**Difference outside /inside, ΔdB**	**$R'_{w45, ctr}$, dB**	**Comments**
50%	3	5	
75%	6	7	
100%	13	13	Major leakage at point of contact with balcony above

Control measurements with traffic as the noise source indicate that in this case the values for sound reduction from traffic are close to the difference outside/inside indicated in the table.

5.4.3 Bellman

Measurement situation, %	**Difference outside /inside, ΔdB**	**$R'_{w45, ctr}$, dB**	**Comments**
50%	2	2	
75%	5	5	
100%	18	15	Some leakage at point of contact with balcony above

6. Comments on the measurement results

As well as the difference in character of sound from traffic and from a loudspeaker, one major difficulty in evaluating the measurements is that the loudspeaker has certain fixed positions, while traffic as a sound source moves. If the road or railway is relatively close, the sound source will, at particular moments, have a certain angle of incidence that changes over time as the vehicle moves. This means that the sound level through a partly open glazed balcony changes depending on where the passing vehicle is, which allows you to calculate an average value for the sound level of the passing vehicle. However, when measuring with a loudspeaker, the fixed position of the loudspeaker means that the sound always has a particular angle of incidence. How the glazing is open therefore has a major significance. As far as possible, we have attempted to take account of this in the evaluation, but the values for partly open windows therefore carry some uncertainty and depend largely on how the opening relates to the sound source.

When the glazing is fully or partly open, the actual opening itself is the weakest part of the sound insulation. When fully closed, the measurements at Skogsviolen show that the weakest part is the gaps between the panes. The Gaffeln property shows a clear weakness at the point of contact with the balconies above. Such a weakness was also noted at the Bellman property. The sound insulating effect for fully closed glazing would increase if this point of contact was improved, particularly at the Gaffeln property.

The measurements show that 50% glazing achieves sound reduction in all cases of 2-3 dB and 75% glazing achieves 2-6 dB. These values are highly dependent on the angle between the glazing and the sound source and to a lesser extent on the specific design of the glazing. The sound reduction with partially open glazing is not as great, but can be important in borderline cases where just a few dB are needed in order to qualify as a quiet side.

Fully closed, the sound reduction effect is naturally considerably higher. The highest reduction is achieved at the Bellman property. One contributory factor is probably the fact that the balconies are inset, which gives excellent sound insulation on the sides. The measurements at the Gaffeln property show a sound reduction of 13 dB. The sound insulation here could be increased if the point of contact with the balcony above was improved. The lowest sound reduction was measured at Skogsviolen.

The measured values are in line with our previous experience of approximate values for sound reduction on glazed balconies.

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Reviewed

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