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Whole glass facade in office building – Measured noise level and requirement for facade

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Abstract

The presentation will summarize calculated and measured noise level from road traffic in office building with whole glass facade. Measurements from project show that the difference between laboratory value and field value is as much as 8-10 dB for a whole glass facade. The difference is explained by the fact that a whole glass facade needs a total correction for both the effect of weakening due to profile system and area correction due to the size/dimension of the glass. Due to both of this effects, the required sound isolation from laboratory should normally be at least 8-10 dB higher than the value achieved for the facade in field. The experience is based on a new office building called Baneheia Park in Kristiansand in Norway. With a whole glassfacade with R_w+C_{tr} 46 dB in a noisy situation, both calculated and measured noise level from road traffic was L_d 39-40 dB. In Norway the required noise level in offices is L_d 35 dB from road traffic. If effect of reduced sound isolation due to profile system with polyethylene inside of the rebate (4-6 dB) and reduced effect of sound isolation due to area/dimension correction (3-4 dB) were included, the requirement for the facade in the given situation should have been minimum R_w+C_{tr} 51 dB. With such facade, the indoor noise level of L_d 35 dB would have been achieved.

1 Introduction

A new office building in Kristiansand (Baneheia Park) was designed with a whole glass facade. In the phase of designing there were different views between two acoustic companies about necessary requirement for the facade. This document gives a summary of the noise levels, the chosen facade and conclusions to be useful for similar future projects.

2 Design parameters – outdoor and indoor level

2.1 Outdoor noise level – free field value

Baneheia Park (Fjellgata 6) is located by a tunnel along a road with heavy traffic. The outdoor noise level at the office building was calculated by two companies to be L_d 74-75 dBA free field. For design of the facade L_d 75 dB was used. The traffic situation on the main road (E18) is approximately the same today and with future road system. In 2019 outdoor registration of noise for a couple of days on the building Banehaven 4A showed L_d of 69-70 dB (figure 1a and 1b) in periods with normal traffic, and very good match between this measured level and calculated L_d of 68 dBA in a calculation model on the facade/position where measurements were done.

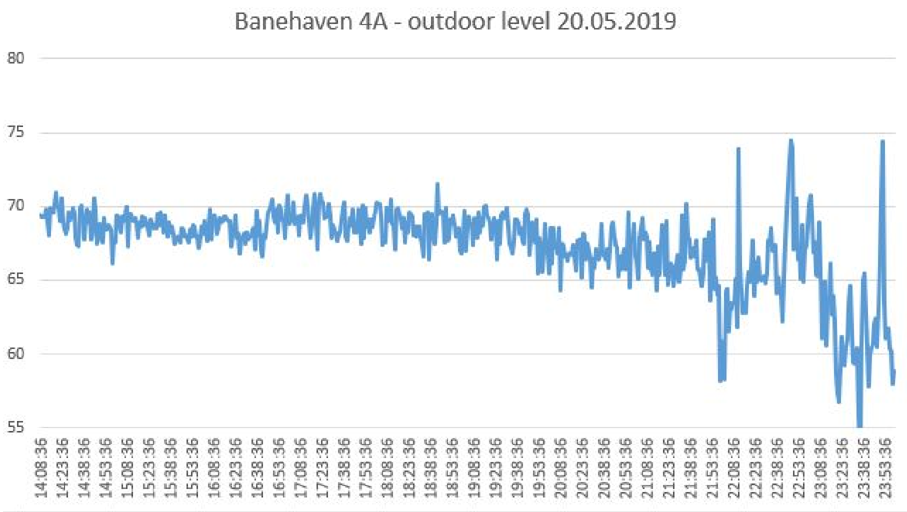


Figure 1a Outdoor measured level for Banehaven 4A at 20th of May 2019 – L_d 69 dBA from 16-19

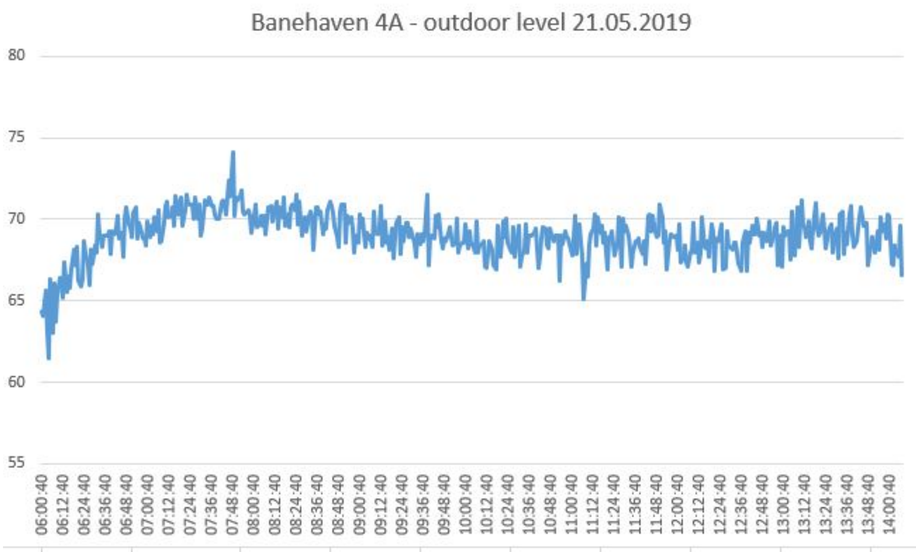


Figure 1b Outdoor measured level for Banehaven 4A at 21th of May 2019 – L_d 69-70 dBA from 08-10

The calculation model (figure 1c) also shows that representative L_d of 68 dBA at Banehaven 4A corresponds very well with representative L_d of 74 dB outside Fjellgata 6 (Baneheia Park).

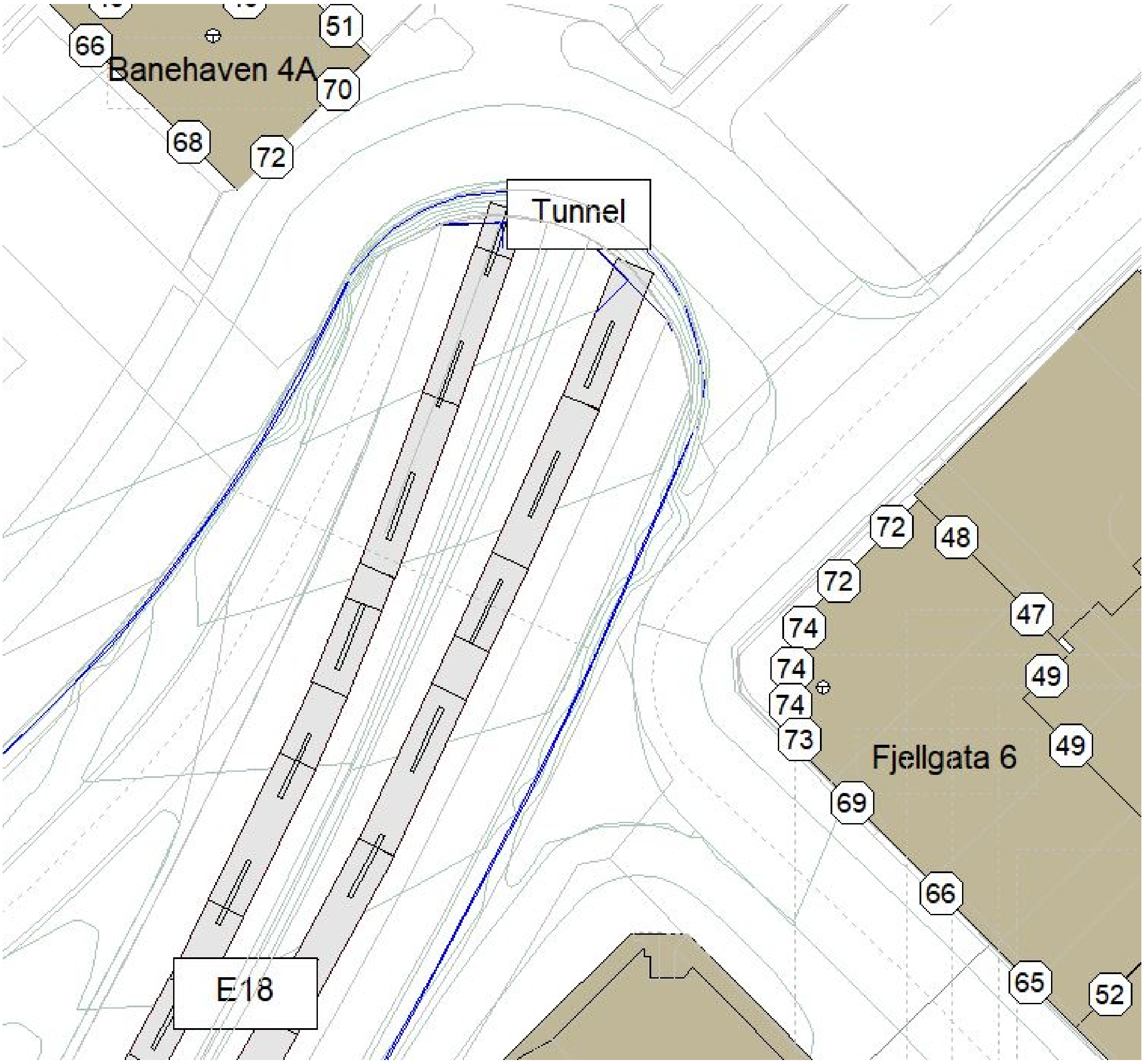


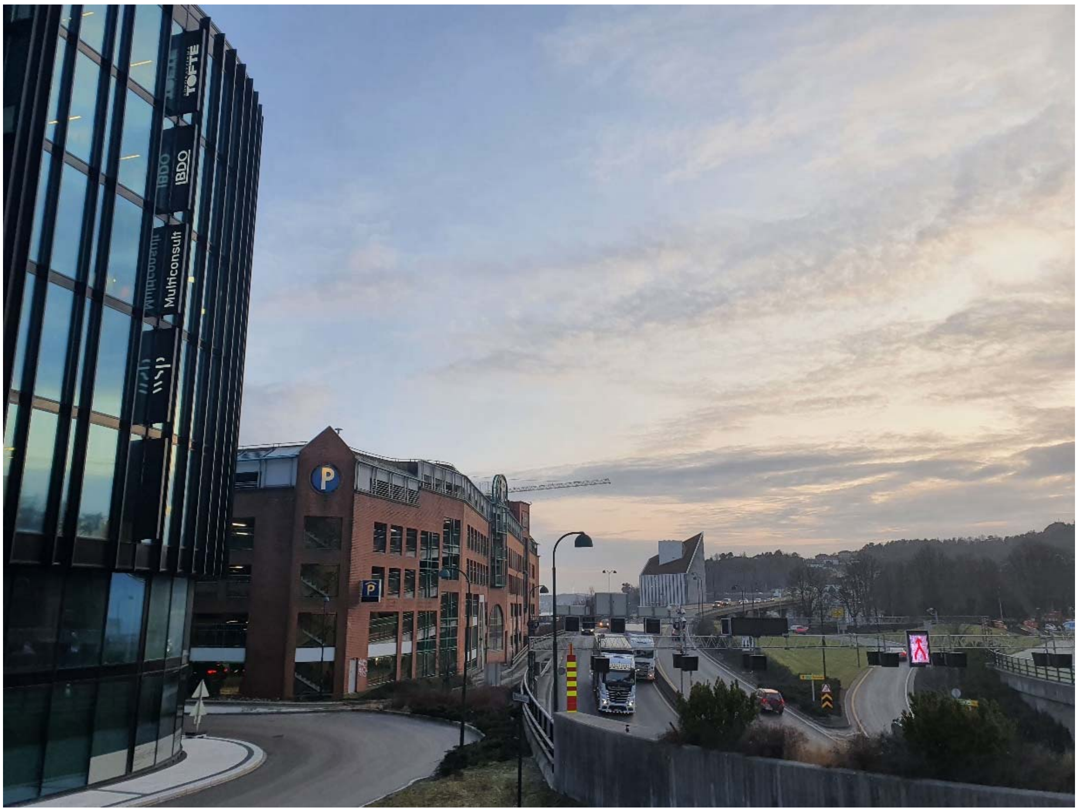
Figure 1c Outdoor calculations with Cadna for Banehaven 4A and Fjellgata 6 (Baneheia Park)

Measurements at Banehaven 4A probably show higher level than calculated due to complicated situation for modelling with the tunnel.

The free field outdoor noise level for Baneheia Park with todays traffic is (because todays and future situation are similar) L_d 74-75 dB as assumed above. The office building and road are shown in picture 1.

Picture 1: Baneheia Park, office building with whole glass facade

According to guideline 421.425 [3] from SINTEF in Norway, the sound field is assumed to be diffuse from movable noise sources like road traffic. In this case there is heavy traffic, and the noise on the facade at Baneheia Park comes from both tunnel and the bridge. The guideline from SINTEF states that the angle between the direction incidence of the noise source and the flat normal vector of the facade must be at least 63° or more to affect the sound insulation of the facade in a negative way. From the whole situation and with movable source this is not assumed to be relevant for Baneheia Park. A calculation based on distance to the road and height of 3rd floor indicates as "worst case" that the angle of incidence between traffic by the tunnel and the flat normal vector of the building is approximately 50° (picture 2).



Picture 2: Baneheia Park, traffic situation and diffuse noise field

2.2 Requirement to facade and indoor level

Other consulting company did calculations in early phase, where Multiconsult was responsible company for acoustics in the building process. There were two different views on the facade:

1. The other consulting company set requirement $R_w + C_{tr}$ 46-47 dB from laboratory with 4 dB reduction due to profile system and no other correction
2. Multiconsult set requirement $R_w + C_{tr}$ minimum 51 dB from laboratory due to 4 dB reduction for profile system and 4 dB further reduction due to area/dimensions of the facade, i.e. a total correction between field and laboratory value of minimum 8 dB.

The other consulting company distinguished between areas and set $R_w + C_{tr}$ of 47 dB as requirement for facade to cell office and $R_w + C_{tr}$ of 46 dB as requirement for facade to office landscape.

The indoor noise limit for offices in Norway is L_d 35 dBA. Measurements (continuous registering of noise level over approximately one hour) show indoor noise level of 39 dBA. This was similar to what Multiconsult predicted beforehand. The noise level was measured on days with dry asphalt February 2022:

- 9^{th} of February 16^{44} - 18^{59} L_d 39,4 dBA
- 10^{th} of February 06^{19} - 07^{19} L_d 39,3 dBA

The graph for indoor measurement in the afternoon (with no employees in the office landscape) on the 9^{th} of February is given in figure 2.

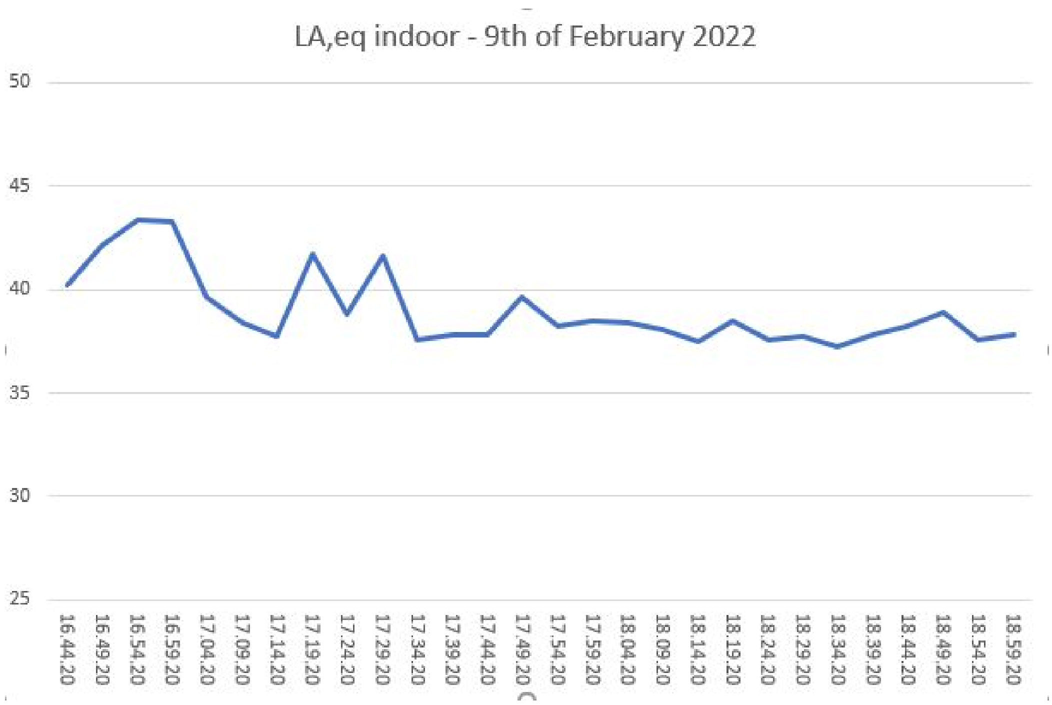


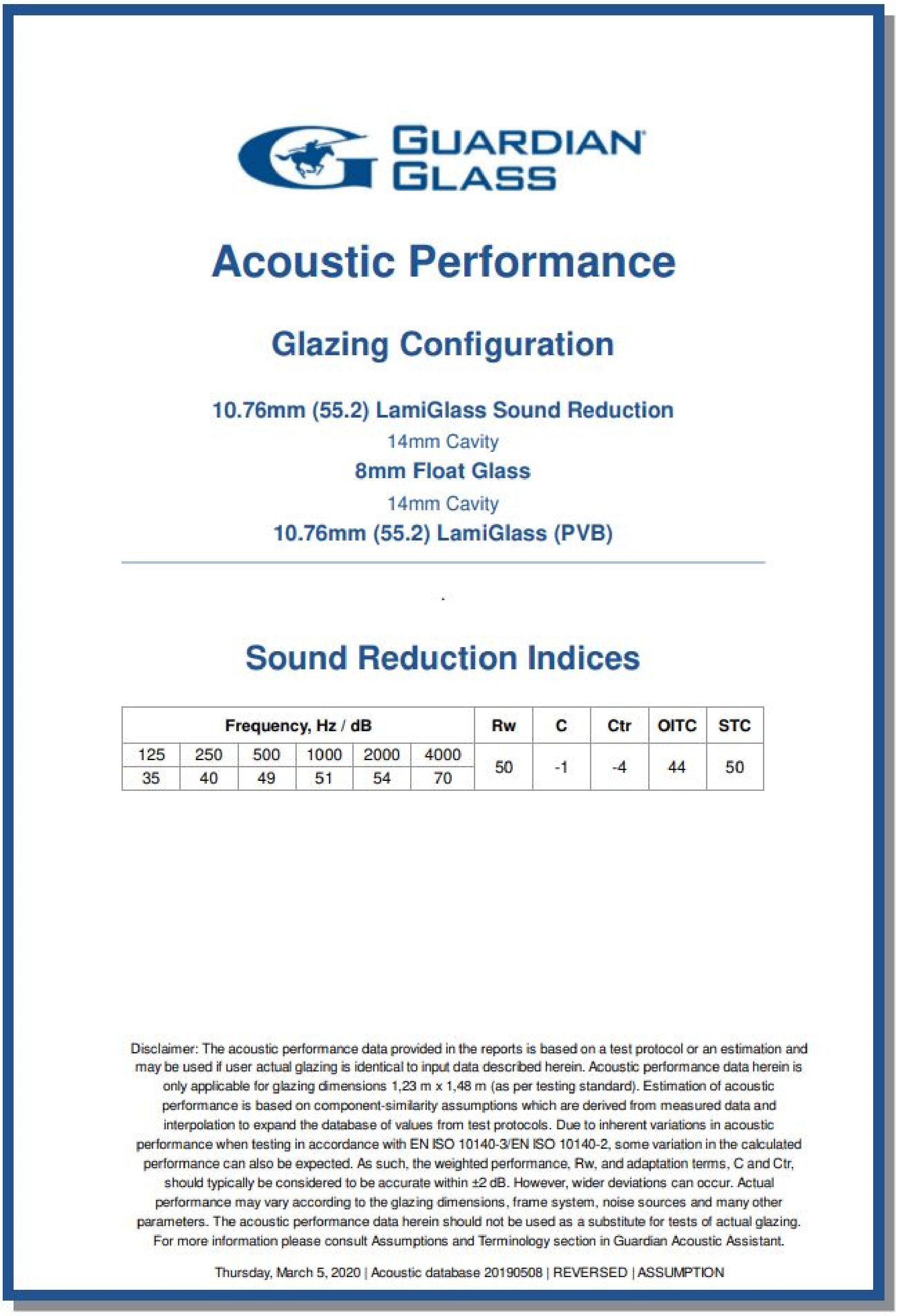
Figure 2 Measured indoor noise level in office landscape 9th of February

Earlier measurements outside (in 2019 as mentioned above) have shown constant noise level outside the facade from 06 to 19, except in rush hours. The indoor measurements morning and afternoon (as shown in picture 3) therefore represents the true value of L_d.

Picture 3: Baneheia Park, noise measurements inside in office

3 Laboratory tests of facade

Datasheet for chosen facade is shown below in figure 3.



GUARDIAN GLASS

Acoustic Performance

Glazing Configuration

10.76mm (55.2) LamiGlass Sound Reduction
14mm Cavity
8mm Float Glass
14mm Cavity
10.76mm (55.2) LamiGlass (PVB)

Sound Reduction Indices

Frequency, Hz / dB						Rw	C	Ctr	OITC	STC
125	250	500	1000	2000	4000	50	-1	-4	44	50
35	40	49	51	54	70					

Disclaimer: The acoustic performance data provided in the reports is based on a test protocol or an estimation and may be used if user actual glazing is identical to input data described herein. Acoustic performance data herein is only applicable for glazing dimensions 1,23 m x 1,48 m (as per testing standard). Estimation of acoustic performance is based on component-similarity assumptions which are derived from measured data and interpolation to expand the database of values from test protocols. Due to inherent variations in acoustic performance when testing in accordance with EN ISO 10140-3/EN ISO 10140-2, some variation in the calculated performance can also be expected. As such, the weighted performance, Rw, and adaptation terms, C and Ctr, should typically be considered to be accurate within ±2 dB. However, wider deviations can occur. Actual performance may vary according to the glazing dimensions, frame system, noise sources and many other parameters. The acoustic performance data herein should not be used as a substitute for tests of actual glazing. For more information please consult Assumptions and Terminology section in Guardian Acoustic Assistant.

Thursday, March 5, 2020 | Acoustic database 20190508 | REVERSED | ASSUMPTION

Figure 3 Datasheet for the glass facade at Baneheia Park

Laboratory tests are all done according to the standard ISO 10140-2 [2]. In Norway the test area for windows in laboratory is a height of 1,5m and a width of 1,25 m. Guideline sheet 533.109 [4] from SINTEF points at a negative area correction for windows with bigger area, and this guideline also mentions that more special dimensions (than standard) should be measured to ensure the real sound reduction of the facade.

The chosen facade is from Poland with a Ponzio system, and the laboratory test was done in Poland. The datasheet (figure 3) shows the following construction:

- 10.76 mm Lami Glass Sound Reduction
- 14 mm Cavity
- 8 mm Float Glass
- 14 mm Cavity
- 10.76 mm LamiGlass

The test from Poland was done according to ISO 10140-2 [2]. The datasheet (figure 3) states that the noise reduction of the facade is $R_w + C_{tr}$ 46 dB. It is also said that the acoustic performance is only applicable for glazing dimensions 1,23 m x 1,48 m. There is a general comment that actual performance may vary according to the glazing dimensions, frame system, noise sources and many other parameters.

From the information above, different countries seem to use the same test size of windows in laboratory. There is a general comment on different performance due to other dimensions, but the real effect of this is not clearly stated. There is today no standard method of applying test results to constructions with changed parameters such as area or size.

Investigations have shown that laboratory tests are done with a profile system on all edges in laboratory. This is done in similar ways in both Norway and Poland. The Norwegian laboratory has confirmed that tests in Norway are done in the way described in Poland, i.e.:

- Glass mounted in test opening and held on both sides by glazing beads (25 mm x 25 mm)
- Glass edge sealed on both sides with plastic sealant

Due to the given information about laboratory test (same dimension and same mounting), there is strong support for the "weakening" due to area/size of the glass in the case of Baneheia Park. Because the laboratory tests are confirmed to be similar in Norway and Poland, the experience of a facade with $R_w + C_{tr}$ of 46 dB in laboratory being 8 dB weaker in field has to be explained by the combined effect of profile system and big area/dimension of the glass. Laboratory tests cannot include flanking transmission as this is a characteristic of a given building.

4 Used profile system

The company H-glass has told that the profile system is designed by Ponzio, and is a high isolated profile system as shown in figure 4.

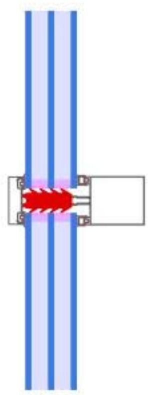


Figure 4 Facade profile used at Baneheia Park

The covering with pressure strip is from aluminium, and there is insulation of polyethylene inside of the rebate. According to this information, there is no strong weakening of the glass facade due to the chosen profile system, but comparable with isolated profiles. The weakening of the high isolated Ponzio profiles seems to correspond with the experience from Euronoise 2018 [1], where isolated profiles with mineral wool gave 4 dB reduction of noise for the combined system of glass with profiles, when the glass itself has laboratory value of $R_w + C_{tr}$ 50 dB.

5 Dimension of glass facade and guidelines

Both the Norwegian guidelines and the datasheet from tests in Poland states that other dimensions than used in laboratory may give other acoustic performance of the window. The phenomena is explained by other lateral resonant frequencies for a window of bigger size, which is mentioned and explained in theoretical books of acoustics. In a bigger window there will be other resonant frequencies than in a smaller window, and the modal density will also be highest in a bigger window.

The actual facade of Baneheia Park is divided in elements of following size:

- Width 1,25 m and height 3,15 m
- Width 0,80 m and height 3,15 m
- Width of 1,55 m and height 3,15 m

In this case, the height is much longer than "standard dimension" and seems to be the reason for other and more resonant frequencies than for standard window size.

The article from Euronoise in 2018 [1] only focuses on the effect of the profile system without considering area/size of the glass facade. For practical use, both the effect of profile system and the effect of area/dimension need to be considered when deciding what construction to use in a given situation.

6 Conclusions

A whole glass facade needs a correction for both weakening due to profile system and weakening due to area/dimension of the glass. All laboratory tests are done for “standard area”. The suggested total correction for a facade with high isolated profile system is 8-10 dB due to both effects mentioned. Further on more research should be done to clarify the “lower noise reduction” related to area/dimensions of glass facade.

Acknowledgements

May I offer my deepest thanks to the company H-glass who gave me information about the chosen solution, and Christianholm Eiendom who allowed me to present this experience for their office building.

References

[1] Hans-Walter Bielefeld and Tejav DeGanyar. Acoustical Performance of Aluminium Framed Facade Systems. *Euronoise 2018*

[2] ISO 10140-2:2021 Acoustics – Laboratory measurement of sound insulation of building elements – Part 2: Measurements of airborne sound insulation

[3] SINTEF Byggdetaljblad 421.425 Isolering mot utendørs støy. Beregningsmetode.

[4] SINTEF Byggdetaljblad 533.109 Lydisolerende egenskaper for vinduer.