The Sound Insulation of Facades

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The procedure of calculating the total sound reduction of facades according to EN 12354-3 is discussed and compared with measured values of the single components.

Only the isolation indices of small elements (standard sound level difference $D_{n,e}$) and normal components like glasses and panels (sound reduction index R) have to be respected for the resulting isolation index, especially flanking contributions from the irradiating sound field can be neglected.

From the emission sound pressure level (i.e. traffic noise) to the indoor sound pressure level (i.e. in the receiving room to be protected) there are two general ways to proceed:

1) regarding the sound levels and calculate the indoor sound pressure level, or

2) regarding the building aspects and calculate the sound insulation of the out partition or façade.

So you have either the point of view of the immission protection or that of the building acoustics. Often it is a mixture of both aspects and it depends on the input data or the required solutions you have to work on.

The emission sound pressure level is given or will be calculated, the propagation of sound is known or can be calculated by special programs or will be measured in front of the façade as a 2m-level or in the near field of the surface, so for the total façade with parts of different areas and with unknown shapes (shape correction ΔL_{fs}) you get for the inner sound pressure level L_2

$$L_2 = L_1 - R' - \Delta L_{fs} + 10 \cdot \lg\left(\frac{S}{A}\right) + \text{corr. terms} \qquad (1)$$

For the calculation of the $L_{2,res}$ in a room, the contribution of

- maybe some facades or outer partition walls of a room,
- maybe some parts of different elements of a façade,
- maybe different outer sound pressure levels of different sources ,
- maybe different shapes of the façade construction

have to be respected by energetically addition with the areas respectively (Summation over r and k):

$$L_2 = 10 \cdot \lg\left(\sum_r \left(\frac{S_r}{A} \cdot \sum_k 10^{\frac{L_{1,rk} - R'_{rk} - \Delta L_{fs,rk}}{10}}\right)\right) \text{dB} \qquad (2)$$

In most cases the room sound pressure level is given or fixed (i.e. 30 dB(A) for a living room according to DIN 4109), so you have to consider the sound reduction of the façade as the important calculating element. According to EN 12354-3 (Airborne sound insulation against outdoor sound [1]), the total sound power ratio τ is the sum of direct transmission and flanking transmission factors for all paths concerned, see Fig. 1:

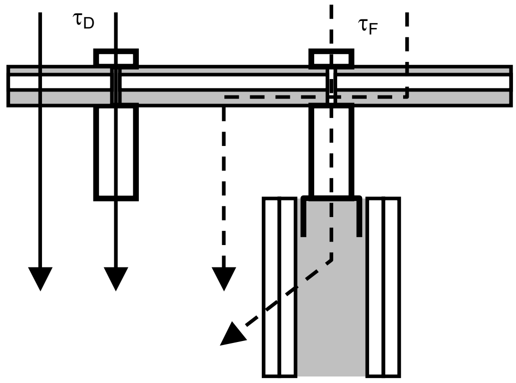

Fig. 1 Transmission paths of glass facades

$\tau = \tau_D + \tau_F$ whereas

$\tau_D = \Sigma_i \tau_{n,i} + \Sigma_i \tau_{e,i}$ for all direct paths with

$$\tau_n = \sum_i \frac{S_i}{S} \cdot 10^{-\frac{R_i}{10}} \qquad \text{for normal elements}$$

$$\tau_e = \sum_i \frac{A_0}{S} \cdot 10^{-\frac{D_{n,e,i}}{10}} \qquad \text{for small elements, and}$$

$\tau_F = \Sigma_i \tau_{f,l}$ for all flanking paths

You can add to the small elements the transmission factor for sealed slits and joints as

$$\tau_S = \sum_i \frac{l_0 \cdot l_{S,i}}{S} \cdot 10^{-\frac{R_{S,i}}{10}} \qquad \text{for slits and joints}$$

In the usual practical cases we can neglect the flanking transmission factor (it is 20 dB lower), the sealed slits (when the elements are sealed densely or the opening parts have a good sealing) and joints (the vibration index for connections and joints K_{ij} should be high enough), so that only the normal elements of a façade stands, namely glasses and panels and the small elements like frames and air inlets or shutters.

Thus the total sound reduction R_{res} of a façade is composed as a energetic sum of normal elements with sound reduction index R together with the area S and small elements with standard sound level difference D_n and the in situ geometrical values respectively.

$$R_{res} = -10 \cdot \lg\left(\sum_i \frac{S_i}{S_{ges}} \cdot 10^{\frac{-R_i}{10}} + \sum_j \frac{A_0}{S_{ges}} \cdot 10^{\frac{-D_{n,e,j}}{10}}\right) \text{dB}$$

and it holds as well for the weighted number quantities $R_{w,res}$ and $R'_{w,res}$ for the situ with adaption of the corresponding geometrical quantities.

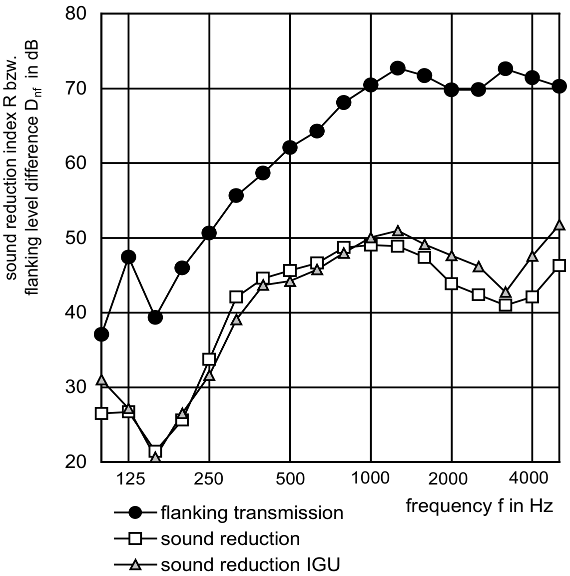

Fig 2: Comparison of flanking transmission and sound reduction of an glass façade (horizontal direction)

All we need is the knowledge of the insulation datas of the components of the façade to combine energetically to the total element. Examples for the sound reduction of the frame, the isolating glasses (depending on the gas filling and the dimensions), the panels of different thermal damping material (stiff for thermal isolation and soft for acoustical isolation) are shown. A special aspect is the junction to the concrete floor or the concrete or light weight walls; this problem is to be treated as a transmission problem of the intermediate part (profile or panel) to contribute i.e. to the sound reduction of the wall and is not part of the flanking effect. Examples of these profile sound isolation measurements are presented.

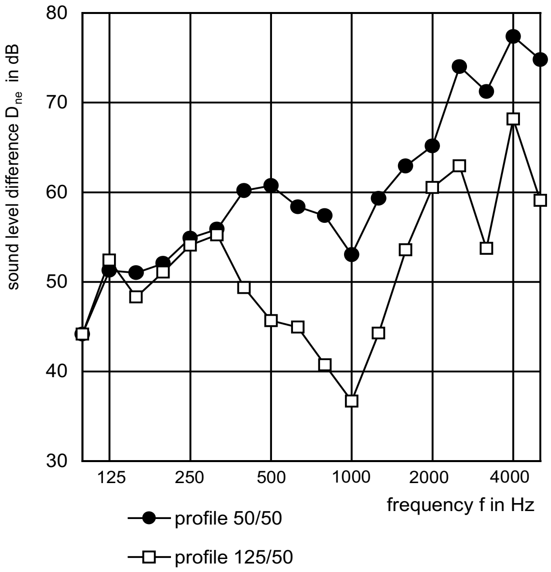

Fig. 3: Sound reduction index of profiles as small elements

Table 1: Examples of Sound reduction od Facades and IGU

Façade	Weighted sound reduction index R_w ($C;C_{tr}$) in dB	
Frame, glass	Glass unit	Façade
Aluminium, 10/14/9GH	43 (-2;-5)	44 (-2;-5)
Steel, 6/12/2	33 (-1;-4)	33 (-1;-4)
Aluminium, 13GH/20/9GH	51 (-3;-9)	48 (-2;-5)
Aluminium, 6/16/4	37 (-4;-8)	38 (-3;-7)

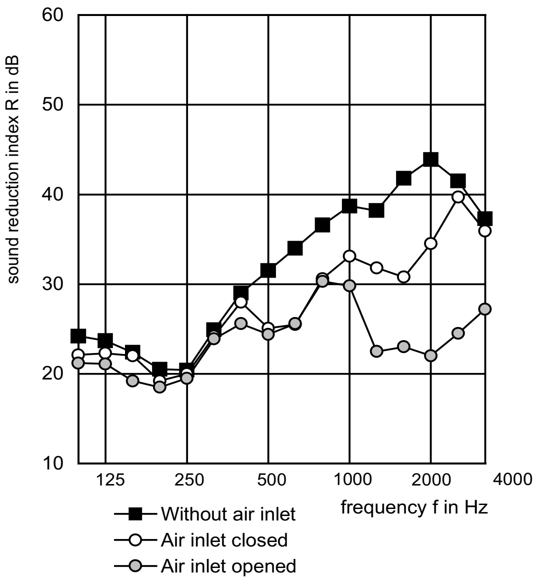

Fig. 4: Sound reduction of an Façade element with /without ventilation or air inlet

Literature:

[1] EN 12354-3:2000, "Building acoustics – Estimation of acoustic performance of buildings from the performance of elements – Part 3: Airborne sound insulation against outdoor sound"

[2] R.Schumacher and B.Saß, "Flanking Sound Transmission by Timber-framed Glass Facades"; J.of Building Acoustics Vol.6, No3&4, 1999

[3] R. Schumacher, B. Saß, M. Pütz: „Überprüfung des Einflusses von Stoßstellen bei Fassaden", report of ift Rosenheim, 2000

[4] M. Bächle: „Verbesserung der Schalldämmung von Pfosten-Riegel-Profilen", Diplomaed work at FH Rosenheim / ift, 2001