Sound Insulation of Aluminium and Timber Glass Facades

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The procedure for calculation the total sound reduction index of facades according to EN 12354-3 (Airborne sound insulation against outdoor sound) is discussed and compared with measured values of the single components.

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) focussing the sound levels and calculating the indoor sound pressure level, or

2) focussing the building aspects and calculating the sound insulation of the façade.

Often it is a mixture of both aspects depending on the input data or the required solutions you have to work on.

In most cases the maximum sound pressure level inside is specified or fixed (i.e. 30 dB(A) for a living room according to DIN 4109), so one has to consider the sound reduction of the façade as the important element. According to EN 12354-3, the total sound power ratio is the sum of direct transmission and flanking transmission factors for all paths concerned.

In 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 just the main elements of a façade, namely glasses and panels and the small elements like frames and air inlets or shutters are relevant.

Thus the total sound reduction R_{res} of a façade is composed as a energetic sum of normal elements with the 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:

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

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

Examples for the sound reduction of the frame, the insulating glasses (depending on the gas filling and the dimensions), the panels of different damping material (stiff for thermal insulation and soft for acoustical insulation) are shown. A special aspect is the junction to the concrete floor or light weight walls; this 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, it is not part of the flanking effect; sound insulation measurements of profiles are presented.

Regarding the sound transmission between two adjacent rooms, either for the vertical and for the horizontal sound transmission the direct and flanking transmission are calculated energetically following the calculation model of EN 12354-1.

The results for timber glass facades and aluminium glass facades show the resulting sound reduction index as follows

$$R' = -10 \cdot \lg\left(10^{-\frac{R_{Dd}}{10}} + \frac{l_{lab}}{l_f} \sum 10^{-\frac{R_{ij}}{10}} \right) \quad dB \qquad (1)$$

where the flanking transmission index R_{ij} has the form of

$$R_{ij} = D_{n,ij} + 10 \cdot \lg\left(\frac{l_{lab}}{l_f}\right) + 10 \cdot \lg\left(\frac{S_S}{A_0}\right) \quad dB \qquad (2)$$

with $D_{n,ij}$ from lab measurements or R_{ij} as an expression for the vibration reduction index K_{ij} as

$$R_{ij} = \frac{R_i + R_j}{2} + \Delta R_{ij} + K_{ij} + 10 \cdot \lg\left(\frac{S_S}{l_0 \cdot l_{ij}}\right) dB \qquad (3)$$

$$K_{ij} = \frac{D_{v,ij} + D_{v,ji}}{2} + 10 \cdot \lg\left(\frac{l_{ij}}{\sqrt{a_i \cdot a_j}}\right) \quad dB \qquad (4)$$

For facades $a = S/l_0$ holds.

Results of laboratory measurements for horizontal and vertical transmission direction show for timber and aluminium facades that K_{ij} is an invariant quantity.

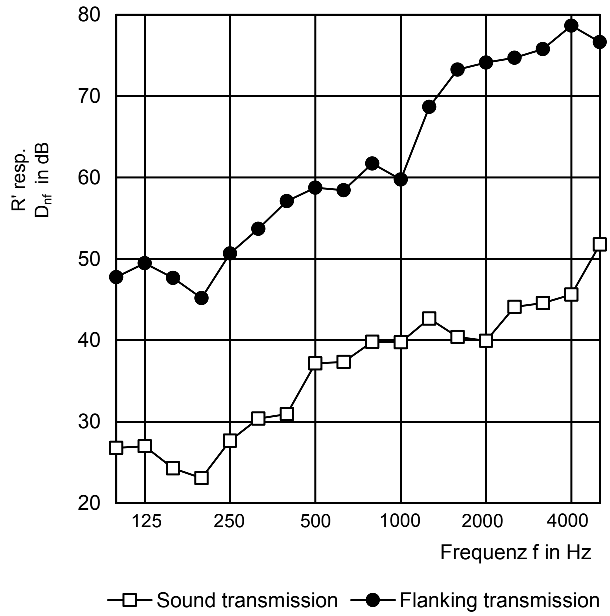

Fig. 1 Flanking and transmission sound reduction of aluminium facades

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

[2] R. Schumacher and B. Saß, "Vertikale Längsschallübertragung bei Aluminium-Glas-Fassaden", DAGA 2002