

Reflections and Radiation from Facades

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Reflections from facades:

Reflections from vertical obstacles are treated differently from standard to standard. Once the standard has been selected in the run set up in Calculation, SoundPLAN checks all conditions for reflections (reflection loss of the reflecting surface, width and height of the obstacle, angle of incidence etc) and if conditions are fulfilled a contribution from a mirror source is added. The sound power of this mirror source is equal to the sound power of the real source minus the reflection loss of the surface. If an addition 'DQ-Wall' is introduced, the inserted number of dB's will be further added to the sound power.

If the reflection loss of a surface is 15 dB or more, the reflection contribution from that surface is neglected no matter the size of the surface, angle of incidence, distance between source and surface and no matter the source type (road, rail, industry).

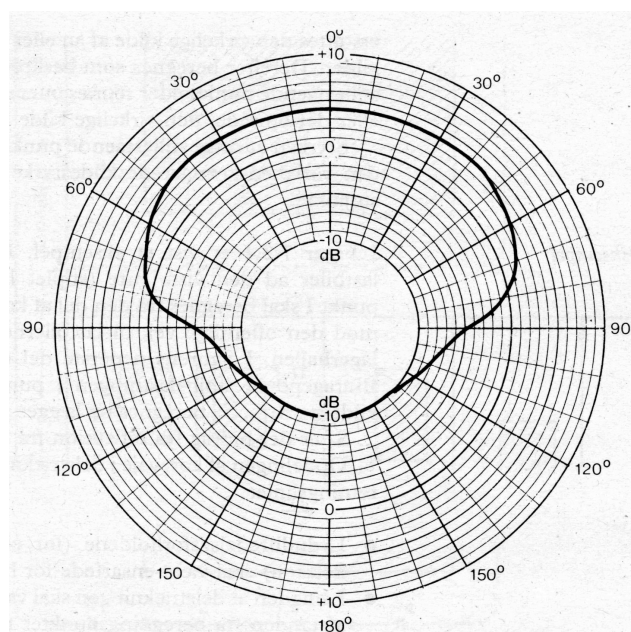
In older versions of SoundPLAN (version 7.2 and older) it was left to the user to take care of the reflections in some situations. For details see at the end of this Net Info.

Radiation from facades:

Radiation from the building itself (due to at high indoor noise level) can be modelled using sources located on the outside of the facades. Several guidelines state how to estimate the sound power level of such sources and what directivity index DI to assign to the sources. When adopting these guidelines in SoundPLAN it is important to realize, whether the DI reflects the influence from the building on the radiation only, or if it also includes the screening effect (when seen from receivers on the backside) of the building itself. For example, some (Danish) guidelines prescribe the sound power level of the radiation from an open window as:

$$L_w = L_p + 10 \times \log S - 3 \text{ dB}$$

where L_p is the sound pressure level [dB] in the open window and S is the area [m²] of the window. The (frequency independent) DI to be attached to the source is shown below:



Directivity of radiation from an opening in a facade.

E. g. in the direction right in front of the window (0°), the DI adds 4 dB to the sound power level.

Please note that in the direction towards the backside of the building (180°), the directivity is – 10 dB. This attenuation is a (very coarse) ‘substitute’ for the actual screening effect of the building itself. Consequently, these guidelines assume that the DI represents both the directivity of the radiation and the screening effect of the building; as a consequence the building object must be removed from the model and replaced by a source with the shown DI, otherwise the screening towards the backside will be overestimated and in front of the window an unwanted reflection will be included. Therefore, these guidelines cannot be used without modifications in mapping software like SoundPLAN since the building most likely affects the propagation from other sources in the model.

The only way to fulfill these guidelines 100% in a SoundPLAN calculation would be to add the result of two calculations: one calculation with the source (attached with the DI above) but without its ‘own’ building in the model and another calculation in which all other sources and all buildings are in place. For all practical means this is not manageable.

We have 3 ‘emergency exits’ which all keep the building in the model, but in spite of that in most cases can be considered as acceptable ‘workarounds’, at least when it comes to the results in front of the building. However, relative to the guidelines they all return much too low levels on the backside of the building since the calculated screening effect of the building nearly always exceeds 10 dB. For this reason, it should always be evaluated, if the contribution level on the backside of the building is significant compared to other contributions or noise limits.

- 1) Leave the source with L_w as a free source in front of the building. This leads to underestimated levels in a wide area (approx. +/- 50 ° angle of incidence, see the DI above) in front of the facade where the official directivity would have added 4 dB to the direct transmission, but the calculated reflection from the facade only adds 2,5 dB (assuming the reflection loss of the building is 1dB).
- 2) The source is attached to the façade AND the default value of $D\Omega$ -Wall (3 dB) is adjusted to 4 dB. According to the guidelines this will give the correct result in an area +/- 50° in front of the facade. In the rest of the area in front of the façade the level will be overestimate.
- 3) The source is attached to the facade, $D\Omega$ -Wall is adjusted to 0 AND the directivity from the guidelines is assigned to the source. In this case it is obtained that all levels in front of the facade fulfil the guidelines, but still the screening of the building itself will cause the level on the backside to be much too low.

SoundPLAN version 7.2 and older:

Distance between industry point source and surface more than or equal to 21 cm: All reflection conditions in the standard were checked, and if they are fulfilled, a reflection contribution was automatically taken into consideration.

Distance between industry point source and surface less than 21 cm: SoundPLAN expected a source that close to a surface to be attached with directivity that reflected the influence from the surface. This directivity could be a DI from the library. Or k-Wall (now called $D\Omega$ -Wall) on the index card Additional of the Source Properties window could be set to a value that matched the contribution for the reflection, e. g. 2 or 3 dB. It was a job for the user to pick a solution.

IF THE USER DID NOTHING NO REFLECTION WAS INCLUDED!

In case the distance source – façade was less than 21 cm and the user left the source without DI, and k-Wall at the same time was 0, the log-book in the Calculation stated a warning, if the surface was a building. The warning looked like this:

One wall in source vicinity found, but neither KOWall nor directivity assigned to source

If the surface was a noise barrier no warning was issued.

Adjusting k-Wall to a specific value made SoundPLAN add the specified number of dB to the sound power level of the source (and in return for that omit the reflection from ‘own’ surface if distance to façade was less than 21 cm). This was maybe the most pragmatic way to take care of the reflection, but also a rather coarse method since the effect was independent of frequency. However, only in rare situations it was (and still is) possible to get hold on a frequency dependent DI.

Industry line and area sources were handled the same way as stated above. All segments (found by the search triangles) of a source were treated the same way, so either all sub-sources caused a reflection (distance > 21 cm) or not (distance < 21 cm). If any part of the source was further away from the façade than 21 cm, no warning was issued in the log-book. The distance was measured from the façade and to the centre of gravity of the source.

Old projects in which k-Wall was introduced in order to take care of reflections of a source closer to the facade than 21 cm kept k-Wall when converted into 7.3 format and at the same time the mirror source was generated in the new version. **This caused higher calculation results with ver 7.3 compared to older versions!!!**