

# Systematic comparison of sound insulation measured *in situ* with values calculated according to EN 12354 yields confident data of the acoustical properties of building elements

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In a project on a new Nordic building element database, input data to EN 12354 are established from laboratory data, *in situ* data and theoretical models. Each case is normalised, i.e. calculated according to EN 12354 to correct for the flanking conditions and structural reverberation. The input data of the elements are then fitted to measurements such that the mean deviation between measured and calculated values are minimized. The standard deviation is used to estimate the confidence of predicted values. Two applied cases are presented. One where the performance of a 180 mm concrete slab is calculated for various flanking conditions to find building plans where the requirement  $R'_{w}+C_{50-3150} \geq 56$  dB may be fulfilled. Secondly, input data for a floating floor is established and the performance of the assembly of hollow core concrete slabs and the floating floor is compared with *in situ* measurements. A 3 dB prediction margin to a required performance appears reasonable.

## INTRODUCTION

The standards EN 12354 (1) were developed for the purpose of estimating sound insulation in buildings from acoustic input data for building elements. J&W and Delta Acoustics & Vibration cooperate on a Nordic database project where input data to EN 12354 are established from data taken in the laboratory or *in situ* or theoretical models. There are advantages and drawbacks with all the approaches mentioned.

- Laboratory measurements may be "exact" in a limited sense (if structural losses at the testing laboratory are determined), but the data obtained are often regarded by consultants as being "impractical", "unrealistic" etc because they do not take into account low frequency room modes, flanking transmission, structural absorption and building practice *in situ*.

- Theoretically derived input data may be biased with respect to errors in the model or the material data, but random errors are often small.

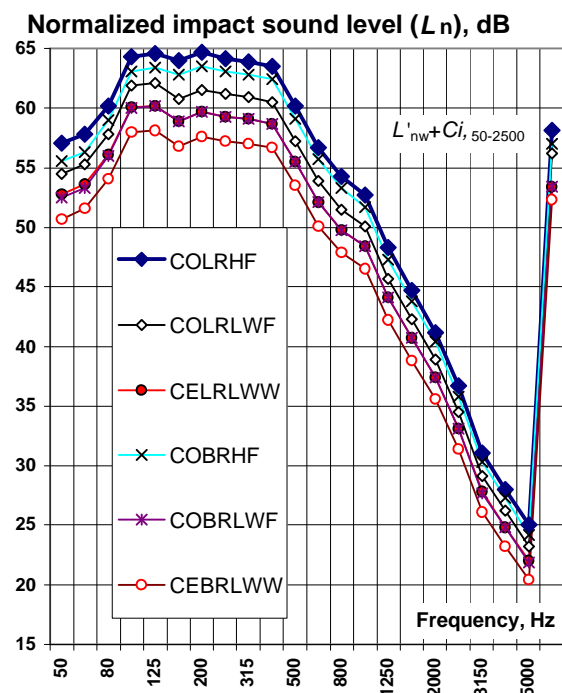
- Data taken *in situ* to find suitable input data for building elements from field measurements requires some processing. Otherwise a prohibitive data scatter on "similar" partitions will result as is shown in figure 1. They confirm our negative experience from earlier database projects. In a Nordtest project (2), a method was derived and tested thoroughly that reduces uncertainty in EN 12354 predictions. Measurement data *in situ* from many types of building elements typical for the Nordic countries were collected. Each field case was normalised, i.e. a calculation was made of the building according to EN 12354 (using the CADBA<sup>®</sup> software). The input data of the building elements were fitted as to minimize deviations

between measured and calculated values. This procedure was repeated for each of the measurements. The standard deviation of all cases was used as an indication of the confidence in predictions. The 90% confidence interval in predicting  $R'_{w}$  of heavy elements was then about 4 dB. In the J&W / Delta database project, only data from well documented building objects and satisfactory measurement conditions were included to reduce the uncertainty. For heavy elements, such as hollow core concrete slabs, the calculation model derived by Delta adapts to Annex B of EN 12354 with some modifications. The reduction of airborne sound insulation at the coincidence frequency appears to be higher than expected from theory. Impact sound of thin hollow core concrete slabs increases at higher frequencies due to reduced structural losses. These models of concrete slabs are used in the calculations described below.

## EXAMPLES OF THE INFLUENCE OF FLANKING TRANSMISSION AND STRUCTURAL LOSSES

Six cases of vertical transmission through a 180 mm massive concrete slab are calculated and presented in figure 1 below. The element input data for the slab (as would be measured in the laboratory) are indicated. The flanking transmission is calculated according to EN 12354 for some typical floor plans of dwelling houses. Three parameters are varied: 1) two sizes of room (bedroom 10.5 m<sup>2</sup> (BR) and living room 36 m<sup>2</sup> (LR) are used which change the relation between area

and perimeter of the common slab. 2) the outer walls are taken as either heavy concrete elements (HF) or light-weight plasterboard walls (LWW). 3) the rooms are placed either in a corner (CO) or in the middle of a building (CE). The scatter in results is in the order of 8 dB which means that it is not sensible to use field results to predict the performance of the building element alone unless they are “normalized” with respect to structural losses.

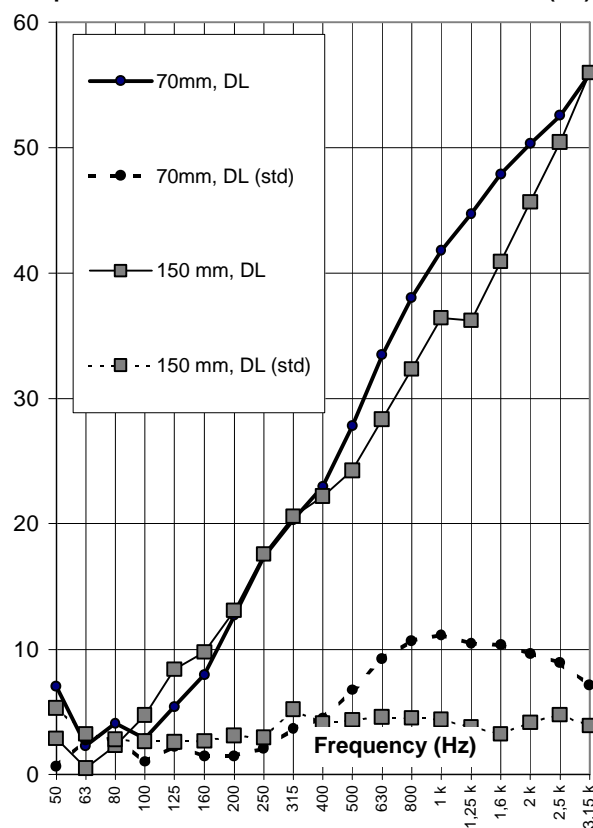


**FIGURE 1.** Impact sound insulation of a 180 mm concrete slab, as measured in the laboratory (bold line) and with six cases of flanking transmission. Legend: CO corner room, CE central location, LR living room, BR bedroom, HF heavy facades, LWW light weight facades.

## FLOATING FLOOR PERFORMANCE

Some examples are shown below, where the mean performance of a typical floating floor is estimated from measurements in 7 buildings. This wooden floor (22 mm, 15 kg/m<sup>2</sup>) is mounted on resilient pads on hollow core concrete slabs (300 kg/m<sup>2</sup>). The assembled thicknesses of the floors are 70 or 150 mm. Figure 2 show the mean impact sound improvement and the standard deviation of performance. Using these input data,  $R'_{w}+C_{50-3150}$  and  $L'_{nw}+C_{i,50-2500}$  were estimated correctly in 7 buildings within [0;-3] dB as compared to measurements *in situ*.

**Impact sound reduction: mean and standard dev. (dB)**



**FIGURE 2.** Impact sound reduction of two types of floating floor (70 mm and 150 mm height) estimated from 7 *in situ* measurements. (—) bias error (---) standard deviation.

The scatter at high frequencies for the 70 mm height are probably related to less confident building practice. The 150 mm floors are less sensible to structure borne sound bridges from ductwork in the air gap.

## ACKNOWLEDGEMENTS

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## REFERENCES

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