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# HIGH SOUND CLASSIFICATION OF DWELLINGS AT LOW EXTRA COSTS CALLS FOR IMPROVED BUILDING PRODUCTS AND A STRUCTURED ACOUSTIC DESIGN PROCEDURE

**C. Simmons**

KM Akustikbyran, Rullagergatan 6, SE-415 26, Göteborg, Sweden

Tel.: +46 31 72 72 500 / Fax: +46 31 72 72 501 / Email: christian.simmons@km.se

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**ABSTRACT**
The sound classification standard SS 02 52 67 is now used in Sweden to specify the requirements for sound conditions in family houses. It includes limit values for airborne and impact sound insulation and sound pressure levels. Since the advent of this standard, the building industry has set the goal to always reach higher sound class B than actually required by the national authorities C. Some difficulties arise however. The frequency range has been extended to include the 50-100 Hz bands were data are less documented. New buildings are often erected on very noisy locations. Initially, extremely heavy casted constructions were used to be on the safe side, but weight was a penalty and the construction time was not acceptable. Dry, light prefabricated elements are now preferred. This paper presents an ongoing acoustic design work, aiming at optimising the constructions and tightening their tolerances. Again, a standard plays a vital role - the EN 12354 ”Estimation of the performance of buildings from the performance of elements” (part 1-3). The use of well defined building products (elements) with sound data determined according to standardized measurement methods (e.g. EN ISO 140) makes it possible to build ”close-to-margin” but still be on the safe side. Certification and quality systems help make construction work more deterministic, which means a decrease of the general uncertainties of the acoustic performance of the building. Deliverables so far: The increased cost is not possible to determine exactly, but has been assessed to be less than 2-5 %. Constructions meet the class B requirements. Indoor air quality control measures have been taken. Environmental aspects on building materials are considered strictly.

## 1 - INTRODUCTION

Ten years ago, the building construction activity in Sweden was extremely low and it was difficult to maintain qualified research activitites within the field of building acoustics. Now, acousticians face many difficult cases which calls for better prediction and measurement methods. Fortunately, new EN standards supports this work. What is new then?

- Buildings with sound insulation and noise levels that just meet the minimum requirements in the building codes may not be accepted by the tenants. Since there are alternatives, they simply refuse to pay the rent or move out. This cause serious costs to the house owners. They now prescribe better sound climate in new houses.
- New building codes were introduced the last year, extending the frequency range of the sound insulation requirements down to 50 Hz.
- The land remaining for building on in the main cities is often exposed to high traffic noise levels.
- The ground conditions do not allow for high building weights. New construction techniques with precast concrete slabs, supporting steel structures and light-weight access floors are used for dwelling houses.

- A variety of flat plans are designed, ranging from entirely open spaces to very efficient solutions (from a sound point of view, c.f. figure 1). Rooms with noise sources may be situated next to sleeping rooms, WC and bathroom next to kitchens etc.

The standard SS 02 52 67 for the sound classification of dwellings is now used in Sweden to specify the requirements for sound conditions in family houses. It includes limit values for e.g. airborne and impact sound insulation as well as sound pressure levels. The building construction industry has set the goal to always reach the higher sound class (B) than actually required by the national authorities (C). Some difficulties arise however. The frequency range has been extended to include the 50-100 Hz bands were construction data are less documented. New buildings are often erected on very noisy locations. Initially, extremely heavy casted constructions were used to be on the safe side, but weight was a penalty and the construction time was not acceptable. Dry, light prefabricated elements are now preferred.
This paper reports a few results from an ongoing acoustic design work, aiming at optimising the constructions and tightening their tolerances. Again, a standard plays a vital role − the EN 12354 "Estimation of the performance of buildings from the performance of elements" (part 1-3). The standard enables corrections for structural reverberation time and surface area of partitions that are necessary to include in the design work in order to consider the variety of constructions, c.f. figure 1. The use of well defined building products (elements) with sound data determined according to standardized measurement methods (e.g. EN ISO 140) makes it possible to build "close-to-margin" but still be on the safe side. Certification and quality systems help make construction work more deterministic, which means a decrease of the general uncertainties of the acoustic performance of the building. Deliverables so far: The increased cost is not possible to determine exactly, but has been assessed to be less than 2-5 %. Constructions exceed the class B requirements with low weights. Indoor air quality control measures have been taken, only low-emitting materials are used. Environmental aspects on building materials are considered strictly.

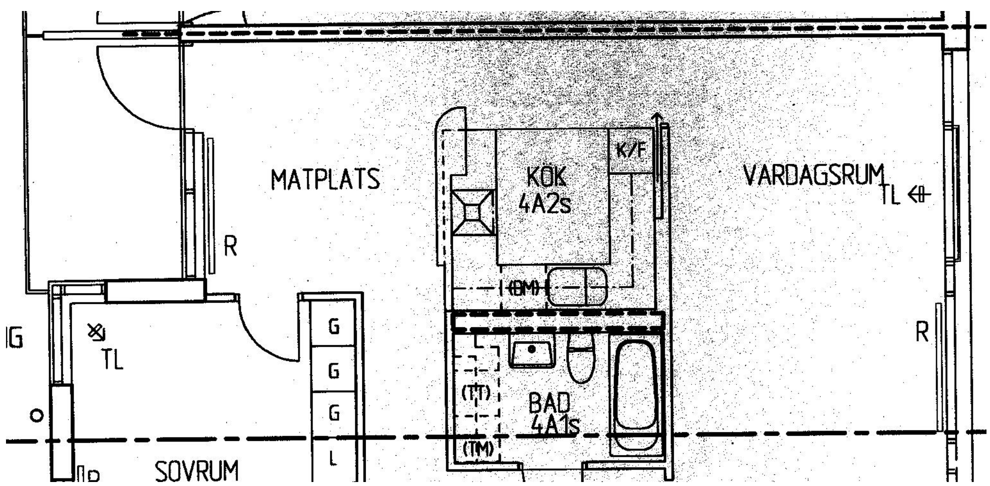


**Figure 1:** Example of a new open plan solution, with the kitchen (KOK) and bathroom (BAD) in a central group which reduces transmission of water sounds to other flats; the sound insulation of the partition wall (top of figure, typically pre-cast concrete 200 mm) with light flanking facades and full width sound exposure needs to be heavier (240 mm) to compensate for low structural losses as predicted with the BASTIAN software according to prEN 12354.

## 2 - CONSTRUCTION EXAMPLES

Access floors are constructed from floating parquet floors (22 mm) resting on resilient channels and pads (spaced 400 mm) 70-150 mm above precast hollow concrete slabs. The space inbetween is used to install all the building services. Ducts for heating, water and waste water pipes as well as cables for phone, computer, TV and electricity run without structural bridges from a single shaft to all flats facing the same stairway. The access floors increase the sound insulation at medium and large frequencies. Hollow concrete slabs may give high sound insulation at low frequencies if the supporting structures can be designed to give high structural losses. At high frequencies however, the plates do not transmit the vibrations across the junctions between the plates as efficiently and the impact sound insulation is rather poor. Thus, the two constructions complement each other, giving $R'_{\mathrm{w}}+C_{50-3150}\geq$ 60 dB and $L'_{\mathrm{nw}}+C_{\mathrm{i},50-2500}\leq$ 50 dB at a moderate weight and cost − if correctly installed. Presently, several building contractors evaluate such constructions in real buildings. They do however experience difficulties in avoiding flanking transmission and structure-borne sound bridges, which calls for improved instructions and additional solutions e.g. for the fitting of the building service equipment. A few typical results are shown below in Figures 2, 3 and 4. With unintentional sound bridges, 10-15 dB less sound insulation have been determined in several buildings.

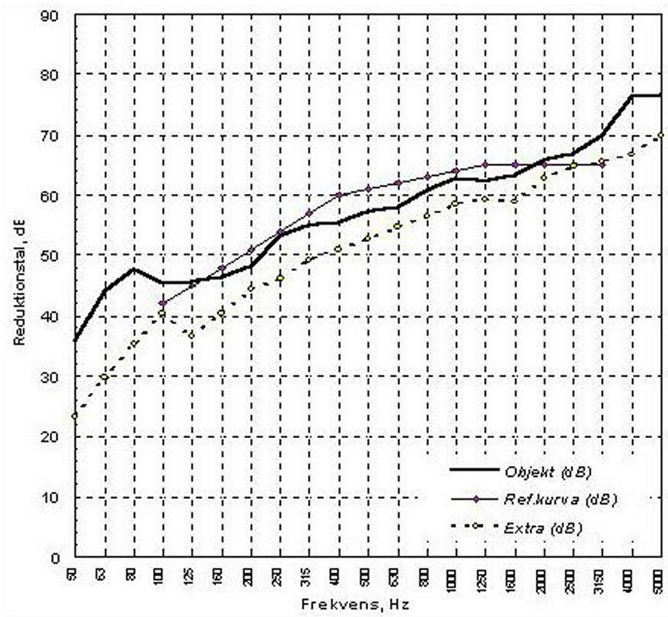


**Figure 2:** Access floor (22 mm parquet) 150 mm above hollow concrete slabs (185 mm, 9 m width of span); performance in situ: solid fat line ("Object") $R'_w+C_{50-3150} = 61$ (-1) dB); concrete slab measured without access floor: dashed line ("Extra") $R'_w+C_{50-3150} = 56$ (-2) dB; $L'_{nw}+C_{i,50-2500}$ 44 (+6) dB resp 79 (-13) dB Flanking transmission through facade (concrete sandwich elements) limit the sound insulation.

Floating floors with small air gaps or stiffer resilient layers cause horizontal flanking transmission, which unfortunately has become known as the "parquet floor resonance". This is a typical problem in attached row-houses raised on a common slab. Since light weight walls with small vibration reduction at the junctions are used in some projects, there was a concern that also the access floors could give such horizontal flanking transmission problems. Calculations with BASTIAN according to prEN 12354 reproduced the known problem with thin parquet floorings but showed that the problem would not occur with the access floor, as could be expected from the above results. The ability to show these features with a standardized calculation instead of having to make expensive practical tests was appreciated by all parties involved.
A few remarks on other parts of the buildings: Sound insulation of the facade elements, windows and air inlets were also calculated with BASTIAN. New types of windows with $R'_w+C_{tr,50-3150}$ 40 dB were to be developed. Double doors with $R'_w+C_{50-3150}$ 50 dB were developed to meet the new requirements of SS 02 52 67.

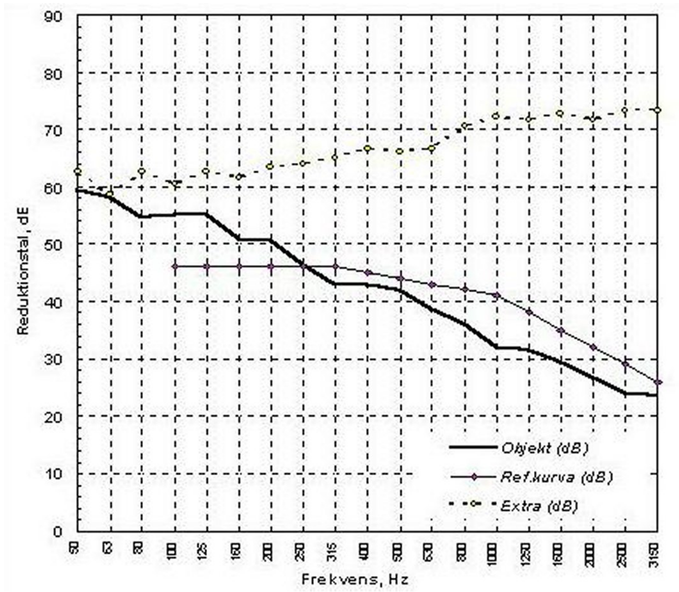


**Figure 3:** Access floor (22 mm parquet) 150 mm above hollow concrete slabs (185 mm, 9 m width of span); performance in situ: solid fat line ("Object") $R'_w+C_{50-3150}$ = 61 (-1) dB); concrete slab measured without access floor: dashed line ("Extra") $R'_w+C_{50-3150}$ = 56 (-2) dB; $L'_{nw}+C_{i,50-2500}$ 44 (+6) dB resp 79 (-13) dB Flanking transmission through facade (concrete sandwich elements) limit the sound insulation.

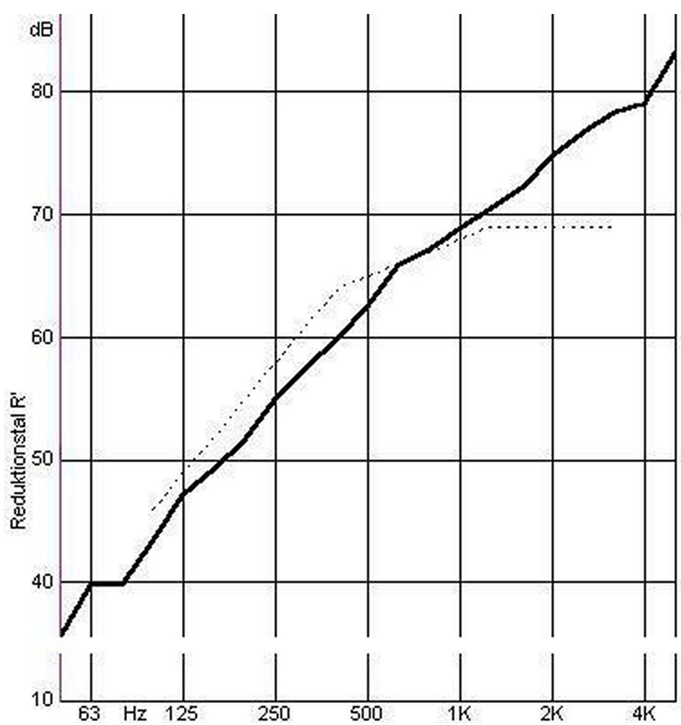


**Figure 4:** The same slab and access floor with one additional parquet layer (9 kg/m$^2$), measured in situ with suppressed flanking transmission; $R'_w+C_{50-3150}$ 65 (+0) dB.