TOWARDS AN EMPIRICAL MODEL FOR IMPACT NOISE THROUGH HEAVY FLOORS

Sigmund Olafsen

Brekke & Strand akustikk as

Hovfaret 17, 0275 Oslo, Norway
so@bs-akustikk.no

ABSTRACT

The paper will present a report on the progress in the development of an empirical model for the calculation of normalized impact noise from heavy floors. This calculation model will build on field measurement results only. The parameters considered so far are as follows:

Type of heavy floor, massive or hollow core concrete
Type of floor covering
Impact absorber(s)
Thickness of primary structural floor
Floating floor
Size of partition

There are two main challenges for empirical models. The most important one is to build a sufficiently large database. Another main challenge is to find the right compromise between model complexity and available data.

The intended model is limited to normalized sound pressure level in a receiving room due to a standard tapping machine.

1. INTRODUCTION

The concepts of empirical modeling have been introduced earlier [1]. A systematic approach in gathering field data is required in order to build empirical models. The results presented in this paper are based on the 154 field measurements of impact level currently available in the StairWay database.

The model will certainly require the following parameters:

- Type of heavy floor, massive or hollow core concrete
- Type of floor covering
- Impact absorber(s)
- Thickness of primary structural floor
- Floating floor
- Size of partition

A complete way to handle all these parameters is not possible with the current amount of data. The discussion will start out with an example of the different effects. The majority of our field measurements have been made on 14 mm parquet floors, which is in effect the standard floor in current Norwegian residential construction. There's not enough data to consider other types of floor at the current state of our StairWay database.

Two other factors are sometimes important:

- Structural system, buildings with loadbearing walls tend to have higher levels of impact noise from above than buildings where the load is carried by coloumns
- Suspended ceilings which may improve or occasionally worsen the performance of the floor

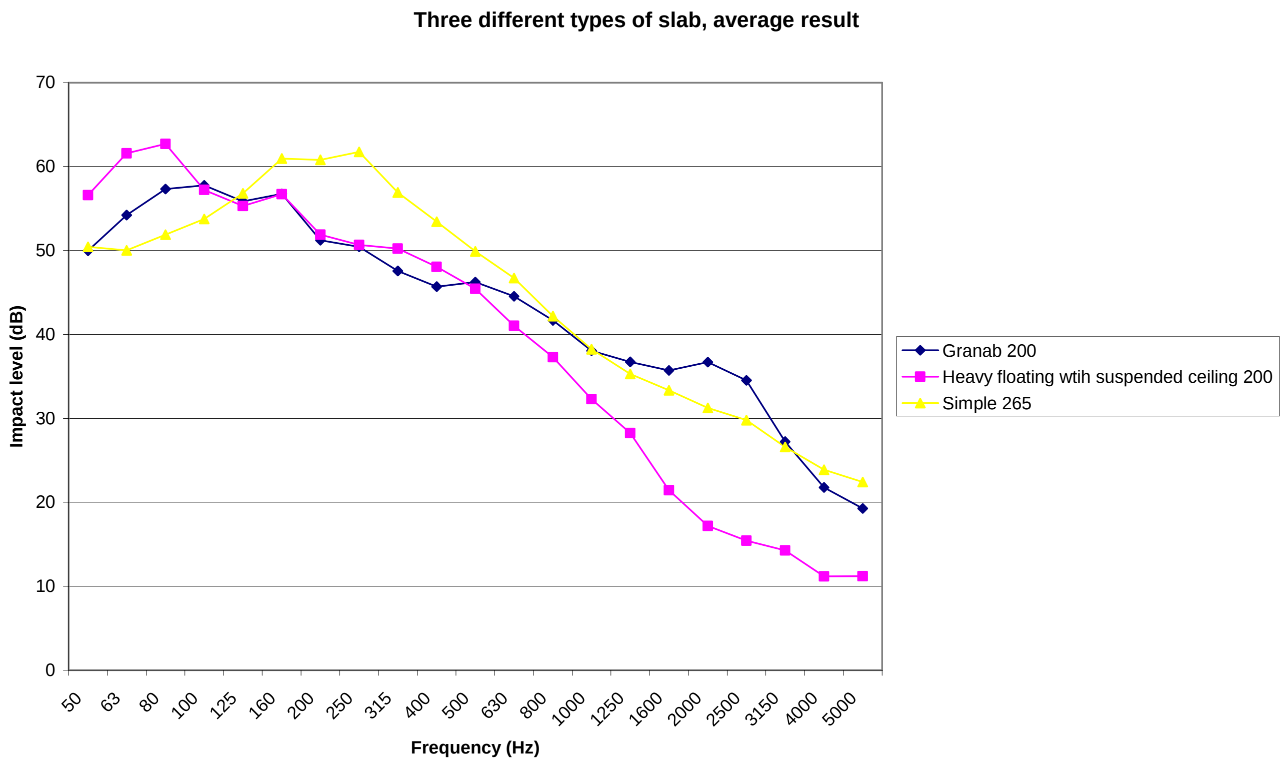
2. REASONS TO BUILD AN EMPIRICAL MODEL

The factors involved in the transmission of impact noise are interrelated in surprising ways. Some things will always be different in the real world than it is in the laboratory. A database of field experience will give insight that cannot be acquired from theoretical considerations or laboratory tests.
It's usually a much larger task to build an empirical model than to build a traditional prediction method. Empirical models will also require a calculation of the uncertainty in the results.

3. EXAMPLE 1 - PROPERTIES OF THE MOST IMPORTANT TYPES OF SOLUTION FOR HOLLOW CORE SLABS

There are two main types of slab, massive concrete or hollow core. Both have their advantages and disadvantages. Very often the builder would like to construct the cheapest building that's likely to fulfil the requirements. For ordinary residential construction in Norway, that is Ln'w less than or equal to 53 dB.

Three different principles using hollow core floors give results that are shown in the following graph.



These are averages of each of these types of floors. These are all hollow core solutions.

The blue line shows the measurements made on 200 mm hollow core concrete slabs with a Granab floor system. The Granab system is based on supports made from resilient plastic which limits the transfer of vibrations from the upper floor into the structure. Usually this system will be sufficient to ascertain that the building code's requirements can be fulfilled. But we still see that there's a problem in the low frequency range. There have been many reactions from those that live in new residences built with this system that there's too much low frequency sound from the neighbor above walking on the floor.

The red line shows another type of solution using the same main slab but with a heavy floating floor instead. Unfortunately, all these measurements were made in one project. We see that these floors perform even worse than the Granab system. In this project a suspended ceiling was also used. This seems to give a worse performance at low frequencies, but a better performance at higher frequencies.

From a comparison between the blue line and the red line it becomes clear that the Granab system actually performs better at low frequencies than a heavy floating floor. At higher frequencies, the heavy floating floor performs better due to the use of a suspended ceiling.

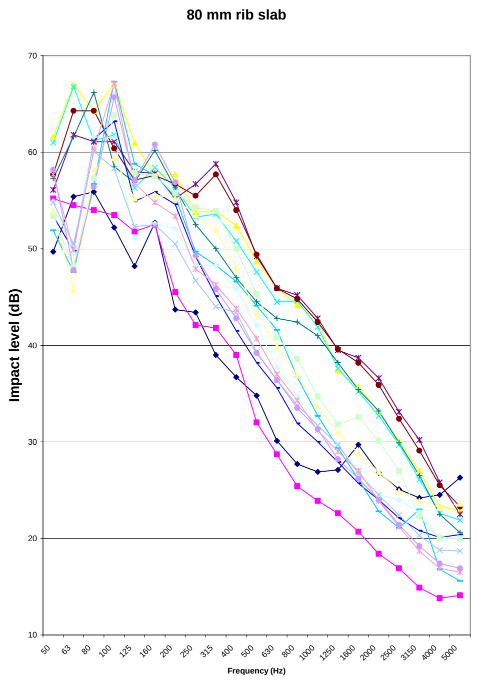
The yellow line is an average of 11 measurements from 6 different projects, and so can be assumed to be a reasonably good average. This is a heavier slab, a 265 mm hollow core, which is very much used in Norwegian construction. With these slabs, the use of damping materials above or below the structural floor is normally limited. In many of these cases only a simple 3 mm material is used under the parquet. The performance at low frequencies is good due to the high mass of the slab, but at higher frequencies it performs less well as little extra attenuation has been added. At 125 Hz to 500 Hz it performs worse due to the lack of damping material.

It would seem that all these floor solutions are carefully engineered to achieve the building code requirements at the lowest possible cost. The tested constructions are likely to fulfil requirements in most cases. Although the Ln'w is similar, these constructions have very different properties and will certainly give a different experience when the neighbor walks on the floor above. It seems clear that a thicker slab will give a substantially better low frequency performance. It also seems that the Granab floor actually performs better than a heavy floating floor solution. But a 200 mm hollow core slab may be too thin to give subjectively satisfactory impact noise insulation anyway. A 265 mm hollow core slab will usually give acceptable performance according to the building code without further measures to reduce impact sound. But the low frequency performance is still not quite good enough to avoid complaints from residents.

4. EXAMPLE 2 – VARIATIONS ON THE SAME BASIC CONSTRUCTION

The following is a case of variations between different details in a construction. The main construction is an 80 mm concrete slab with a suspended ceiling. On top of the main slab is a 25 mm impact absorber and 25 mm of leveling mass. The floor covering consists of a 14 mm parquet on different variations of absorber materials with or without a gypsum board.

These measurements were made in two different projects. A total of 16 measurements were made, some in completed apartments, some on 1 m^2 test samples.



It seems that plotting field measurement results for different types of impact absorbing materials for use under a parquet floor give a very confusing picture. Our analysis gives us three possible conclusions so far:

1. The same construction in different projects gives different results
2. Solutions with a gypsum board between the parquet and the structural slab give better results than solutions without a gypsum board layer.
3. Different absorbing materials between the parquet floor and the structure give different impact levels, mostly because of a shift in resonance frequencies.

5. CONCLUSIONS

It's currently not possible to establish an empirical method that can reasonably predict the normalized impact level from heavy floors. Hundreds of additional measurements will be required in order to predict impact levels. Fortunately such measurements are added to the StairWay database on a weekly basis.

6. ACKNOWLEDGEMENTS

Granab has furnished us with some of the field measurement data which have been used in the preparation of this paper.

7. REFERENCES

[1] Olafsen, S. "StairWay – a new approach to modeling of physical or perceived noise" *EuroNoise 2006, Tampere,* proceedings.