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A simplified approach to impact sound insulation rating without using a tapping machine

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Abstract
The aim of this study is to investigate a simplified approach for obtaining ratings of impact insulation of floor which requires only airborne sound measurements and correction factors depending on the particular type of floor finish.
One third octave frequency-dependent correction factors have been obtained by processing published results of both airborne and impact insulation on floors. The uncertainty of predicted Ln, w values using correction factors shows a good agreement with ISO recommended limits.
The proposed technique has value in reducing the cost and effort for field insulation measurements. Further work is underway to refine the method and to extend the range of constructions for which we have correction factors.

1 Introduction

We have been researching alternative and simplified ways of measuring or verifying insulation performance which are adequate for screening buildings---and which can provide dependability of result comparable with that of an ISO field test. Here we report on an approach we are considering for screening the impact insulation in buildings which may obviate the need for using a tapping machine.

If the use of a tapping machine can be avoided there are several advantages. Chief amongst these is the fact that transporting and manipulating the heavy machine on site is not required. Further, the use of an alternative technique may offer a way round the poor signal to noise ratios that can be experienced on site when using the fixed-power tapping machine.

In previous work we have proposed deriving the impact insulation of floors from measurements of R/TL. However, this requires the measurement to be adjusted for the type of floor surface by means of correction factors.

This presentation extends the concept of correction factors [1] based on the theory of the relationship between transmission loss and normalized impact pressure level [2]. The work repeated here investigates the sound reduction index and normalized impact sound pressure level relationship on floors with different floor coverings

The data sources are both from laboratory data (including INSUL prediction software) and approximately 2000 field measurements. A full range of correction factors for floor coverings is investigated based on these data. The floor constructions are divided into groups of timber-joist, steel-joist floor and concrete floors.

2 The relationship between airborne and impact insulation

A theory of the relationship between the airborne sound reduction index and the normalized impact sound pressure level has been derived by Heckl and Rathe[2].The relationship is as follows

$$Ln + R = 43 + 30\lg F$$

For one octave band measurements (1)

$$Ln + R = 38.6 + 30\lg F$$

For one third octave band measurements (2)

Various assumptions are made for this relationship: a hard surface, high impedance and negligible flanking transmission [2].

The correction factor concept was developed in a previous paper [1] and initially tried out on a series of floor surfaces measured at laboratory facilities, for example in the Acoustics Research Centre (New Zealand) and also data published by the National Research Council, Canada.

This paper extends the idea to include more types of floors and flooring finishes from software predictions and field measurements.

3 Correction Factors determined by INSUL software

INSUL's[3] impact insulation procedure is based on Cremer's theory of point force excitation, and so can be used to evaluate vertical impact noise radiation for massive, rigid homogeneous constructions. INSUL does not calculate impact noise radiation in the horizontal or diagonal directions nor for light weight timber-joist floor constructions. Like any prediction tool it is not a substitute for test data. Comparisons with test data show that INSUL predictions are generally within 3-5 IIC points for most constructions.[3]

Figure 1 shows correction factors from a range of carpets and underlays on a 150mm Concrete floor. The prediction data was calculated from airborne and impact sound test on the bare concrete slab (without ceiling) from INSUL. The curves indicate – as we would expect - the heavier the carpet, then generally the bigger the required correction factors.

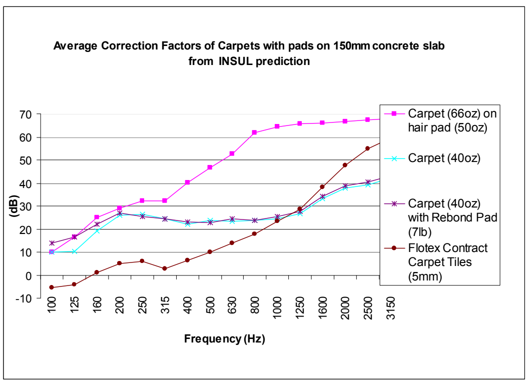

Figure 1 – Correction factors of a series of carpet and pad on 150mm Concrete slab derived from INSUL prediction software

4 Correction Factors determined from field measurements

The following correction factors are derived from data on approximately 2000 floors from field measurements. Most of these data come from commercial and residential apartment buildings in the US. The floor constructions are mainly timber-joist, steel-joist and concrete slab. Correction factors for these floors systems cover a range of floor finishes including carpet and underlay, vinyl tile, and engineered wood.

When comparing the laboratory measurement and field measurement, we must note that the effect of flanking transmission may make the results differ. However, generally, we would expect such differences to not exceed 3dB.

4.1 Correction Factors determined from Wood-Joist Floors

Figure 2 shows correction factors for different kinds of carpets and underlays (110 field measurements) on wood-joist floors. Those curves show similar trends. The typical floor construction is: variety manufactures' carpet and underlay as a floor finish, various thickness gypsum concrete, diverse acoustical mat(Quiet Qurl) and boards(OSB) as a subfloor, multiform wooden joist(TJL open web Trusses), batts insulation and a ceiling of multi-layer of gypsum board on resilient channels.

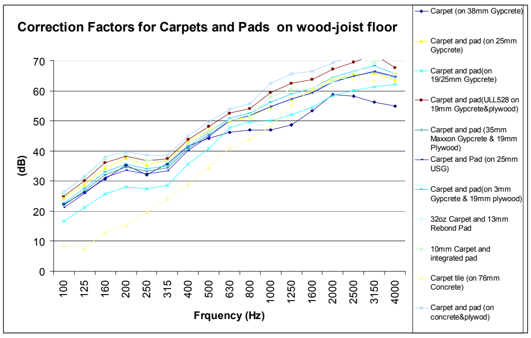

Figure 2- Correction Factors for Carpets and Pads on wood-joist floor

Figure 3 presents the correction factors for vinyl tile (70 measurements), and engineered wood (18 measurements). The mostly wooden floor construction is: vinyl tile or engineered wood as a surface, gypsum concrete and plywood as subfloor, wood-joist construction (460mm open web Trusses), batts insulation, and generally one or two layers of gypsum board on resilient channels as a ceiling panel. The engineered wood exhibits a higher correction factor value than vinyl tile indicating a better impact insulation performance.

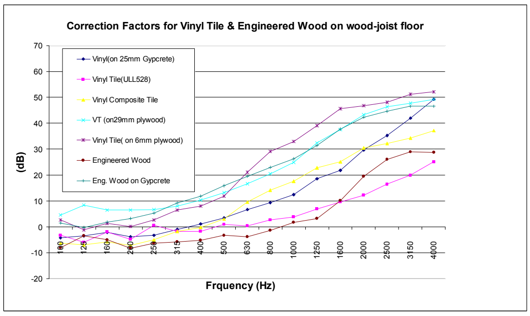

Figure 3- Correction Factors for Vinyl Tiles and Engineered Wood on wood-joist floor

The correction factors for gypsum concrete are illustrated in figure 4. Although the gypsum concrete would not be a finished floor surface the benefit of having correction factors for it is as a reference floor, useful for checking out the ceiling construction or selecting the different material of floor surfaces or verifying the floor constructions. The correction factors for different thickness of gypsum concrete were obtained from 220 field measurements.

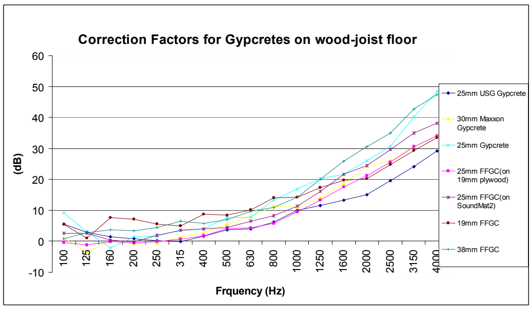

Figure 4- Correction Factors for Gypsum Concrete Wood on wood-joist floor

Correction factors for different floor surfaces, including cork, maple wood, particle board, linoleum, and plywood and wood surfaces are given in figure 5. Those kinds of surfaces are not as common as others, but it is valuable to have correction factor for a comprehensive library in the future. The floor construction is similar to that used for obtain the correction factors shown in fig. 3&4 as above, expect for the wood decking.

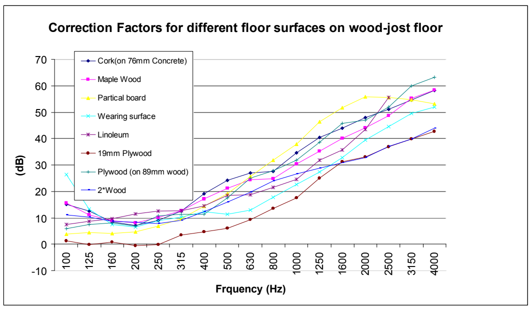

Figure 5- Correction Factors for different floor surfaces on wood-joist floor

4.2 Correction Factors determined for Steel-Joist Floors

Figures 6 and 7 present the results for different types of floor finishes on steel-joist sub-floors. Typically these floor constructions are steel-framing (Dietrich steel joists) with or without a wire hung ceiling.

Figure 6 shows the correction factors with carpets and underlays, ceramic tiles, and gypsum concrete.

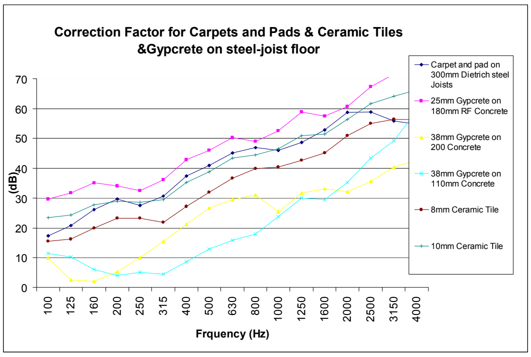

Figure 6- Correction Factors for Carpets and Pads & Ceramic Tiles & Gypcrete on steel- joist floor

Figure 7 shows correction factors for engineered wood on top of 200mm concrete on the steel joists. Floating engineered woods sit on 6mm cork, AcousticMat2, Enkasonic, shaw premium and 3mm quiet walk. The correction factors for engineered wood exhibit quite similar trends.

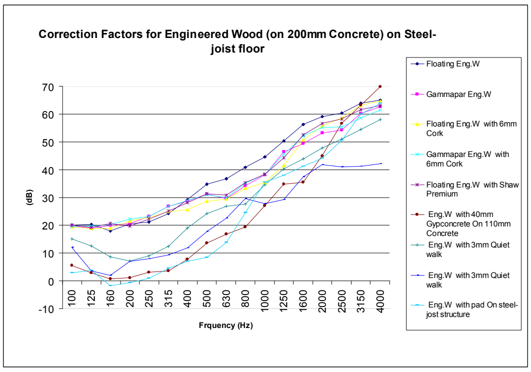

Figure 7- Correction Factors for Engineered Wood (on 200mm Concrete) on steel- joist floor

4.3 Correction Factors determined for Concrete Floors

Figure 8 shows correction factors for engineered wood and carpets & pads on Concrete floors. The thicker the concrete slabs, the bigger the correction factors.

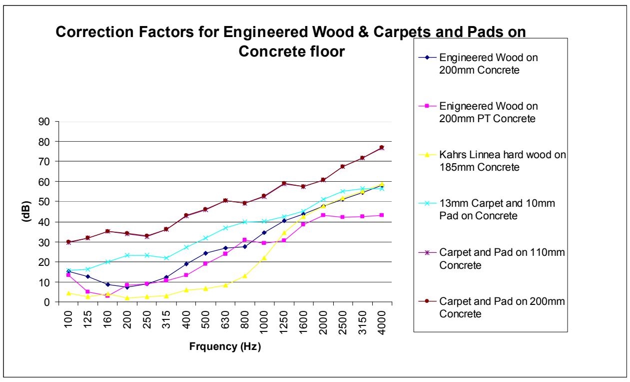

Figure 8- Correction Factors for Engineered Wood and Carpets & Pads on Concrete floor

Correction factors found for gypsum concrete, weartop and laminated floor on a 200mm Concrete floor are illustrated in figure 9.

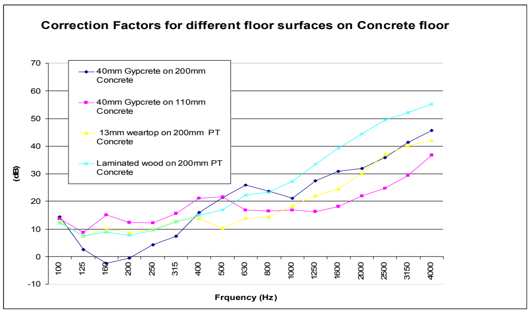

Figure 9- Correction Factors for different floor surfaces on Concrete floor

5 Conclusions

An analysis of measured data has shown that it should be possible to use airborne sound measurement to predict floor performance of impact insulation from field measurements, without actually making impact insulation measurements with a tapping machine. This requires a correction factor for the type of floor finish. Correction factors have been obtained for a wide range of floor finishes and constructions.

Future work is necessary to develop a full range of correction terms for all types of floor constructions and surfaces used in buildings and to consider whether the idea can be applied to the case of horizontally transmitted sound, also to see if a comparison of measured vales with prediction using relevant correction factor might be useful in diagnosing errors in building. A further step is to produce a data library of floor finishes on common constructions which is searchable as an aid for architects and researchers.

Acknowledgement

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References

[1] Dodd George and Li Ming Improving Techniques for Screening Impact Sound Insulation 19th ICA conference

[2] M. Heckl and E.J. Rathe Relationship between the Transmission Loss and the impact-noise isolation of floor structure J. Acoust.Soc.Am. 35, 1825 (1963)

[3] http://www.insul.co.nz/index.html