

- All cavity floors with resilient metal channels directly attached to the joists and with *no* sound absorbing material in the cavity (11 floors).

Other categories did not contain enough data to allow meaningful analysis.

For analyses with IIC as the dependent variable, floors with concrete toppings or resilient toppings were excluded from the regression analysis. The resilience of the floor layer struck by the tapping machine strongly influences the level of impact sound generated by the ISO tapping machine. This important variable needs specific measurements for its characterization but the project deliberately did not focus on this aspect of sound insulation; it is a problem sufficiently complex that it needs a separate study.

For all the analyses, the physical variables found to be significant were the mass per unit area of the sub-floor and the ceiling, joist depth and spacing, resilient metal channel spacing, and the thickness and density of the sound absorbing material. Other parameters did not correlate with STC or IIC. In particular, adding the mass of the floor framing as an independent variable or in combination with other variables decreased the correlation. In many cases not all of these variables were significant especially when the number of cases was low.

Some of these groups provided fairly satisfactory regression equations that could be used for prediction within the limits of the variables used to generate the equations. However, regression equations developed from solid wood joist data predicted sound insulation for other types of beams poorly; the I-joists and trusses had depths much greater than the deepest solid joist tested (286 mm). For simplicity, all joist types were assumed to be similar and data for all types (solid wood, wood I-joists, wood trusses and steel joists) were analyzed together. The regression equations found were

$$STC = 7.1 + 23.9 * \log_{10}(Layers) + 0.0086 * JstDepth + 0.0066 * JstSpace + 0.017 * InsThick + 0.0085 * RCspace + 0.030 * InsDensity, r^2 = 0.92, 110 \text{ cases}$$

$$IIC = 10.6 + 22.2 * \log_{10}(Layers) - 0.010 * JstSpace + 0.016 * InsThick + 0.012 * RCspace, r^2 = 0.92, 102 \text{ cases}$$

where *Layers* is the total mass per unit area of the floor and ceiling layers in kg/m², *InsDensity* is in kg/m³, and all other dimensions are in mm.

It is surprising that the IIC rating shows a negative dependence on joist spacing. There is no obvious explanation to be found in this analysis. More detailed study using one-third octave band data may provide insight.

For STC, 90% of all the predictions fell within ± 1 dB of the measured values, 96% within ± 2 dB, and 94% of the predictions were no more than 1 dB below the measured values. For IIC the corresponding values are 75%, 92% and 89%.

Accuracy of prediction for different types of sound absorbing material

Representative regression equations that are generally applicable are only obtained when there is a reasonably uniform distribution of the values of each predictor variable. Since the majority of the measurements were made using glass fiber batts as the sound absorbing material, the regression equations predict the results for this material well. Not enough data were collected for the other types of sound absorbing material to get the same accuracy of prediction for them. The coefficient for the variable insulation density in the STC regression equation is 0.03. Thus

increasing density from 10 to 30 kg/m³ should increase the STC by 0.6 dB (This corresponds approximately to a change from glass fiber batts to rock fiber batts). There is no dependence on the density of the sound absorbing material in the regression equation developed for IIC. The data in Fig. 1 come from three sets of floors where more direct comparisons were made. This figure suggests that changing from glass fiber batts to rock fiber batts should increase the STC and IIC by about 1 point, if not more. The corresponding plot for IIC also suggests about a 1 point advantage from using rock or cellulose fiber. More measurements are needed to clarify this issue.

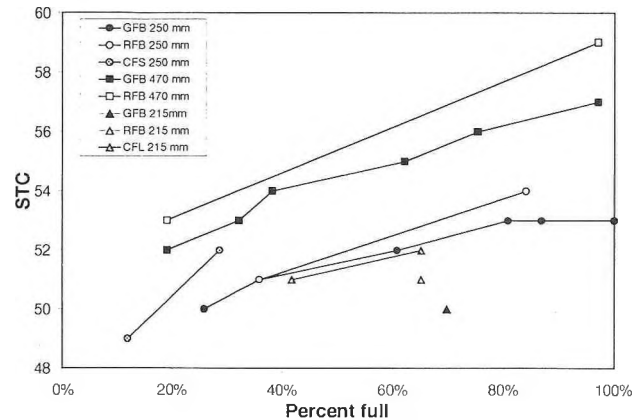


Figure 1: STC for three different floor systems with different joist types and depths with varying amounts of sound absorbing material in the cavity. The floors used solid wood joists (250 mm), steel joists (215 mm) and wood I-joists (470 mm).

References.

- ¹ ASTM E90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
- ² ASTM E413 Classification for Rating Sound Insulation.
- ³ ASTM E492 Standard Test Method for Laboratory Measurement of Impact Sound Transmission through Floor-ceiling Assemblies using the Tapping Machine.
- ⁴ ASTM E989 Standard Classification for Determination of Impact Insulation Class.
- ⁵ "Summary Report For Consortium On Fire Resistance And Sound Insulation Of Floors: Sound Transmission Class And Impact Insulation Class Results", A.C.C. Warnock and J.A. Birta, IRC-IR-766, 1998.