Impact sound insulation predictions for light weight floors.

An idea:

Potential modal response of the floor and its effect on impedance
Context

Light weight floors are commonly used in many countries.

There is a design and compliance demand for accurate prediction of IICs.

**Wanted:**

a *quick* prediction method to *engineering* accuracy
Existing theory

Cremers theory for massive floors:

$$ISPL = F_{\text{rms}}^2 \left[ \text{Re}[Y] \left( \frac{1}{\omega \eta \rho_s S} \right) \right] \rho c S \sigma$$

- **Force:** $F$, hammer of a tapping machine
- **Floor:** $\text{Re}[Y]$, $\eta$, $\rho_s$, $S$
  - Infinite plate model for $\text{Re}[Y]$
- **SPL:** $\sigma$, $S$, $\rho c$
Existing theory

- INSUL
  Sound insulation prediction software
- **Comparison:**
  150mm Concrete slab (NRC)
  Insul prediction (based on Cremer)
Existing theory

For light weight floors, Rabold et al (2010) provides a nice summary

• As before:

\[
\text{ISPL} = \frac{F_{\text{rms}}^2}{\text{Re}[Y]} \left( \frac{1}{\omega \eta \rho_s S} \right) \rho c S \sigma
\]

• Force can be adjusted to account for:
  - Contact stiffness
    (Ver, 1971)
  - Floors with higher admittance
    (Brunskog & Hammer, 2003)
  - Relative velocity of the floor and hammer
    (Rabold et al, 2010)
Existing theory

- **Comparison:**
  - 19mm OSB (NRC) \( \text{IIC 18} \)
  - Available theory \( \text{IIC 21} \)
NRC Measured data

![Graph showing normalized impact sound pressure level (dB) vs. frequency (Hz). The graph includes lines for 13-15mm Ply floor, 13-15mm Double ply, 100mm Concrete floor, and Reference contour.](image)
NRC Measured data
NRC Measured data

• Possible causes:

\[
ISPL = F_{\text{rms}}^2 \left[ \text{Re}[Y] \left( \frac{1}{\omega \eta \rho_s S} \right) \right] \rho c S \sigma
\]

F, \text{Re}[Y], \eta, \sigma

• Mayr, Gibbs et al (2008) have shown \text{Re}[Y] depends on beam admittance in the low frequency region

• The most plausible cause is \text{Re}[Y]
Conjecture

- That the observed mid-frequency trend is due to the modal response of the floor panel and its effect on admittance.

- Specifically, the modes associated with the length of the floor and the width between adjacent joists.
Modes

- Modes: Formulae from Warburton (1954)
- Edge conditions: Floors screw fixed at regular intervals along joists
  More than simply supported, less than clamped
- Admittance: Formula from Hopkins (2007) for admittance envelope

\[
\frac{4}{2\pi f \rho_s \eta}
\]
A worked example

- 19mm OSB (NRC)
- **Edge conditions:**
  - Simply supported $\approx 65\text{Hz}$
  - Clamped $\approx 145\text{Hz}$
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Further work

- Measurements and validity testing required
- Limitation: Conjecture based on NRC data only
- Modes to coincide with those over the entire floor plate