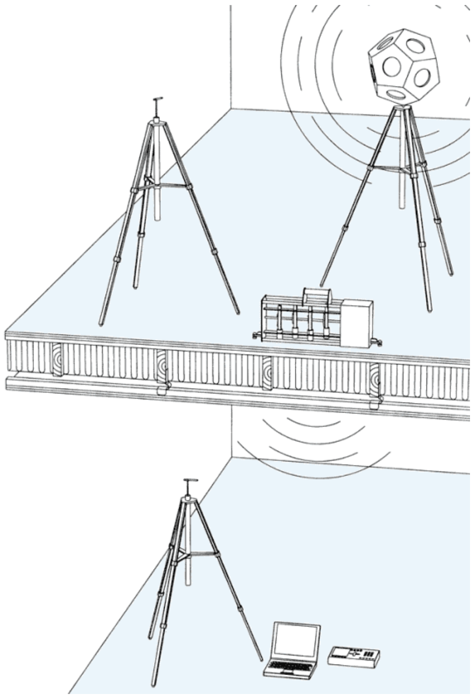
Experiences with impact measurements at low frequencies

- Introduction
- Measurement & results
- Standard deviation calculations
- Summary
- Rubber ball example



Introduction

- Spectrum adaptation term
  - EN-ISO 717-2 (1997) and 140-7 (1999)
  - $C_{i,50\text{-}2500}$ recommended parameter in Norwegian Standard NS 8175 (2005)

Sound insulation between dwellings	Impact sound insulation	
	$L'_{n,w}$ (dB)	$L'_{n,w} + C_{I,50\text{-}2500}$ (dB)
NS 8175 sound class C	$\leq$ 53	- *
Recommended	-	$\leq$ 53

* Recommended, but not normative

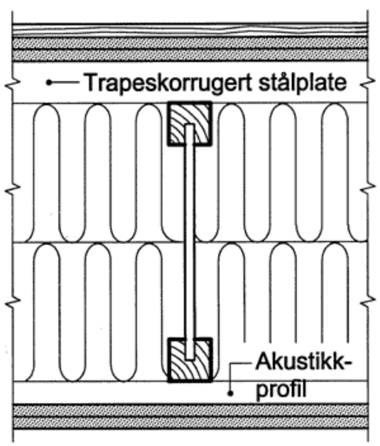
Measurements

- Measurements down to 50 Hz
  - SINTEF Building & Infrastructure:
    Laboratory & field measurements from 1997
- General requirements - Annex C
  - room dimensions (one wavelength)
  - separating distances between microphone positions
  - difficult to fulfil in small receiving rooms

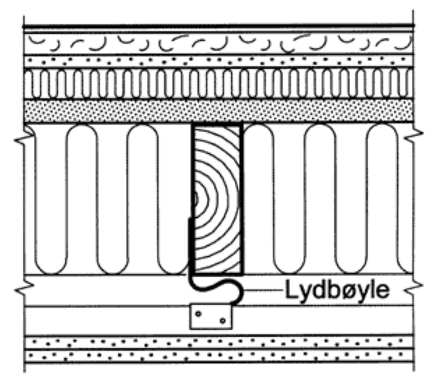
General results

- Laboratory measurements
  - some lightweight floor constructions

Construction principle	Impact sound insulation		$\sum L'_{n,w} + C_{I,50\text{-}2500}$	
	$L'_{n,w}$ (dB)	$C_{I,50\text{-}2500}$ (dB)	Min (dB)	Max (dB)
Stiff top floor	44 - 46	+ 4 to + 6	49	50
Resilient top floor	46 - 52	+ 5 to + 9	52	57



- "Stiff"
- "Resilient"



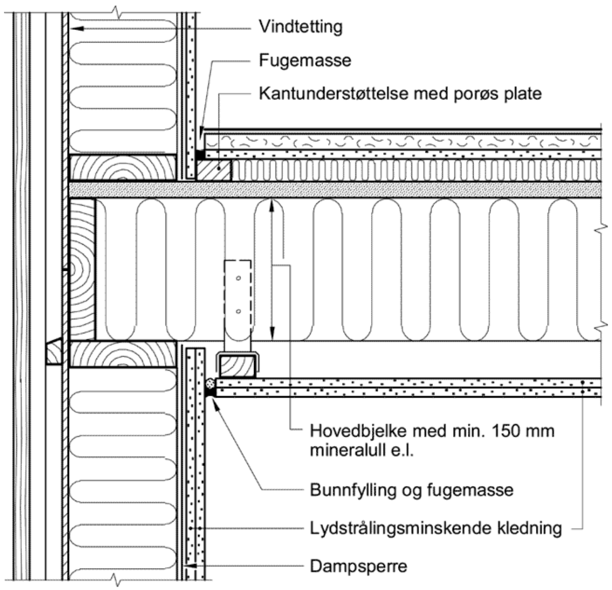
General results

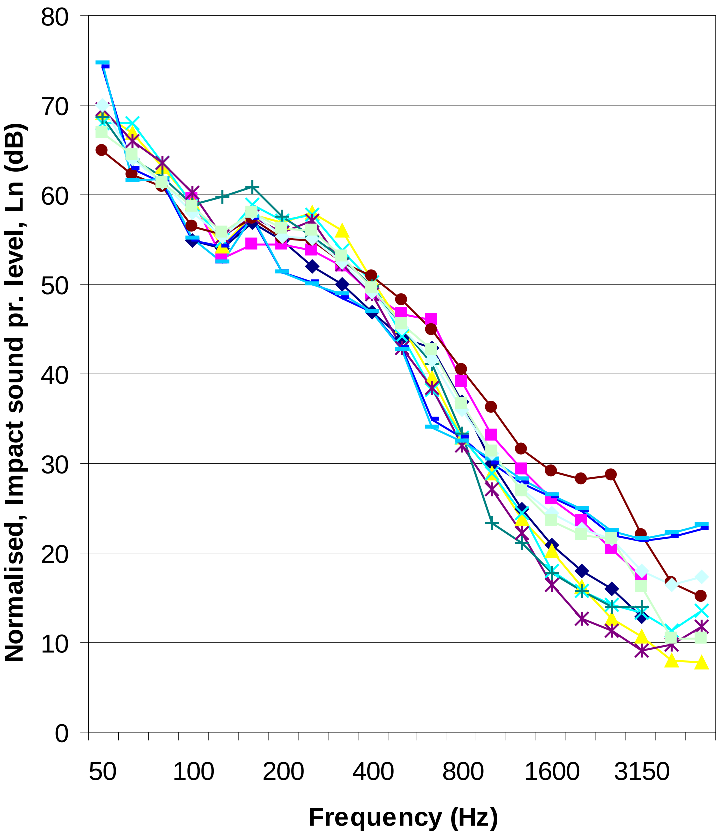
- Field measurements
  - a number of lightweight floor constructions

Construction principle	Impact sound insulation		$\sum L'_{n,w} + C_{I,50\text{-}2500}$	
	$L'_{n,w}$ (dB)	$C_{I,50\text{-}2500}$ (dB)	Min (dB)	Max (dB)
Resilient top floor and resilient ceiling	46 - 52 average = 49	+5 to +15 average = 8	54	60
Resilient top floor, cavity mass and resilient ceiling	47 – 52 average = 50	+ 5 to +8 average = 6.5	54	59

Typical results

- Lightweight floor constructions
  - both resilient ceiling
  - & resilient top floor constructions





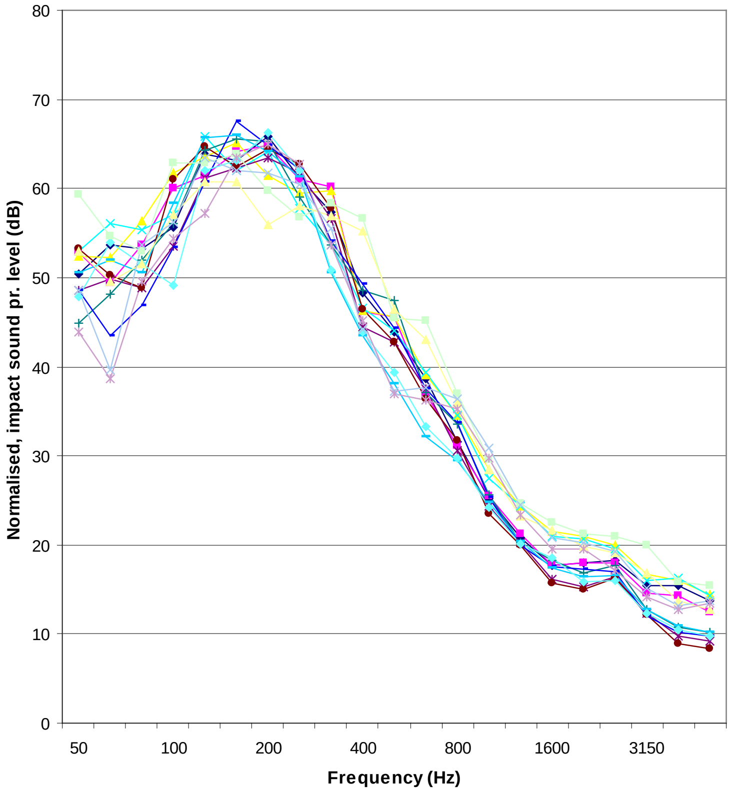
Measurement accuracy

- Reverberation time
  few or none room modes in small rooms
  (not further discussed here)
- Sound pressure level
  - what happen below 100 Hz?
- Standard deviation – analysis
  from measurements with at least:
  - 10 microphone positions
  - 5 tapping machine positions

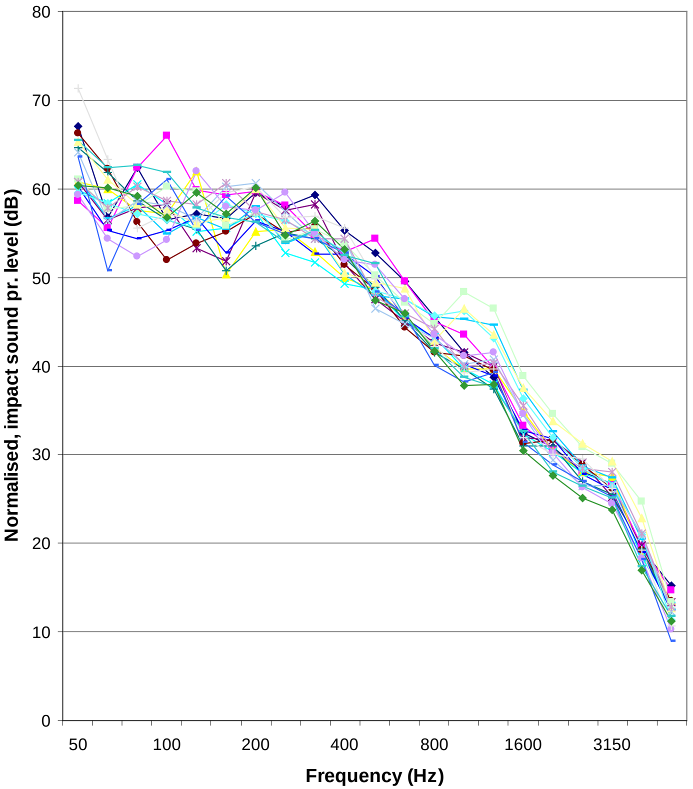
Measurement case – spreading

Examples

- Concrete floor
  - volume = 64 m³

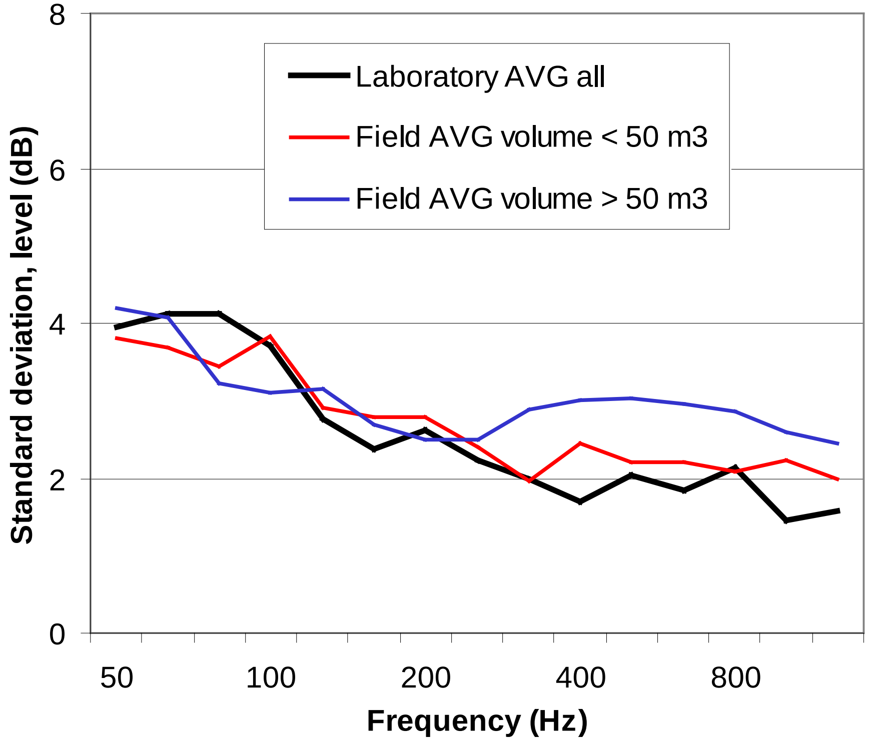


- Timber floor
  - volume = 85 m³



Standard deviation - calculations

- **Average, number of**
  - laboratory & - field measurements



Standard deviation - comments

- **Values depending on:**
  - wave field & room resonances
  - reverberation time uncertainties
  - different impact source positions
  - flanking transmission
- **Results:**
  - increased standard deviation with decreased frequency (as expected)
  - 50 to 80 Hz values not necessary higher than the 100 Hz frequency band
  - significant influence of the receiving room volume and flanking transmission

Summary

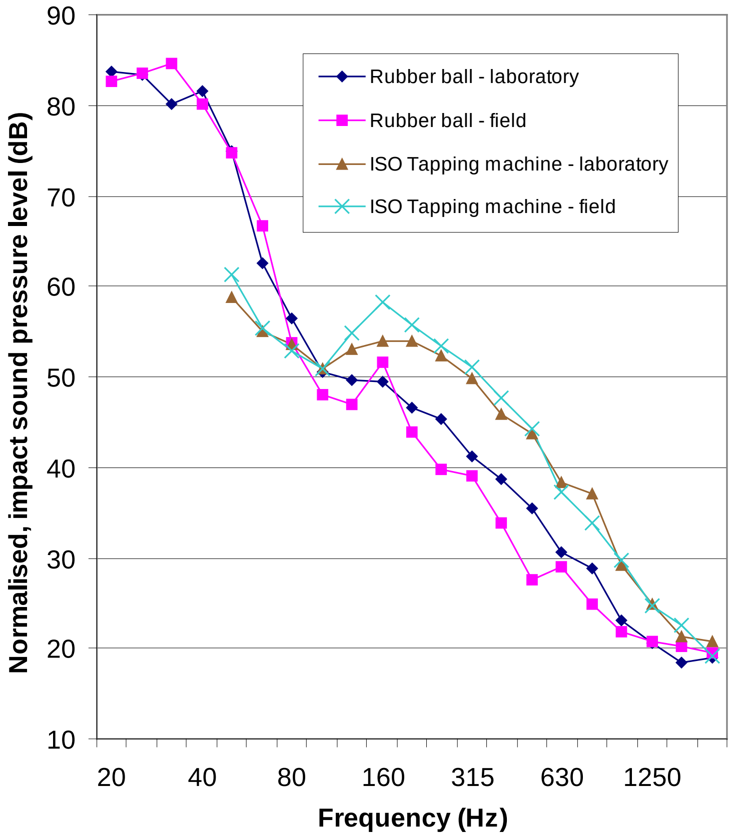
- Assumptions:
  - measurement procedures,
  - excitation & measurement positions
    at least according to EN-ISO 140-7
  - small rooms: not possible to fulfil recommendations
- Results, “total” standard deviation:
  - 50 to 80 Hz values not necessary higher than
    the 100 Hz frequency band value
  - significant influence of the receiving room
    volume and flanking transmission
  - not possible to extract the influence from
    wave field & room resonances (from such data)

Impact sound – comparison

- Two open web joist floor constructions
- Rubber ball excitation:
  - maximum L_n-values

$$L_{n,ball} = L_{\max,ball} + 10 \cdot \log\left(\frac{0.16 \cdot V}{10 \cdot T}\right)$$

- ISO Tapping machine
  - standard L_n-values



Summary – Impact sound

- ISO Tapping machine
  - sufficient energy at low frequencies
  - acceptable excitation method
- ISO 717-2 reference curve
  - not correct at low frequencies
  - necessary to develop other alternatives
- Spectrum adaptation term
  $C_{i,50-2500}$ - **relevant parameter**