Contribution to final conference FP0702

WP 2: Vibration measurements

Net-Acoustics for timber based lightweight building and elements

Anders Homb, SINTEF Building & Infrastructure

October 2012

Content of the e-book

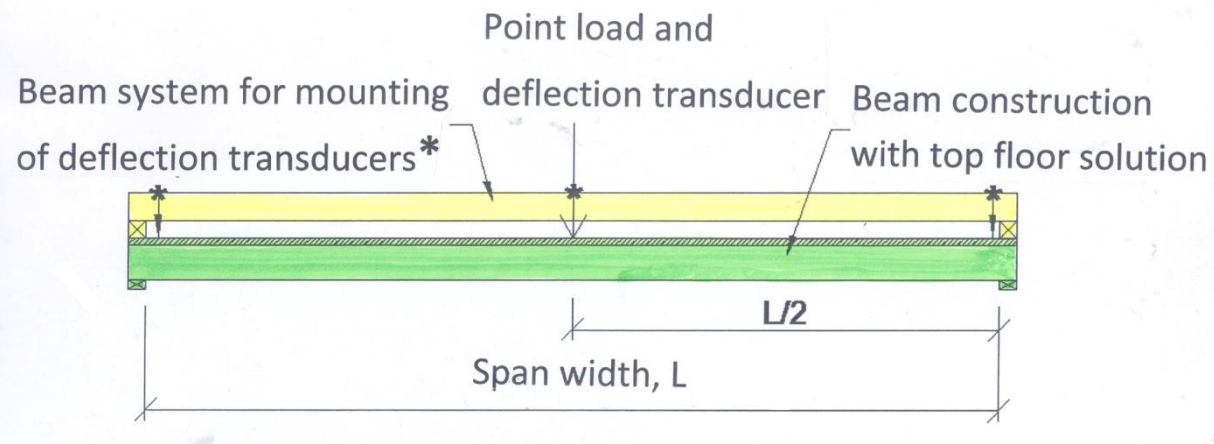
- Measurements of floor deflections: chapter 4
- How to measure floor vibrations: chapter 5
- Assessment of walking-induced floor vibrations according to the SBR Guideline: chapter 6
- References: all chapters

Presentation - overview

- Floor deflections
- Floor vibration, excitation principles
- Analysis and characterization of floor vibrations
- Damping measurements
- Methods specific for the assessment of floor vibrations
  - Eurocode 5
  - Canadian method
  - SBR Guideline

Floor deflection measurements

- **Principles**



- **Transducer mounting – separate from floor construction**

  When field measurements:

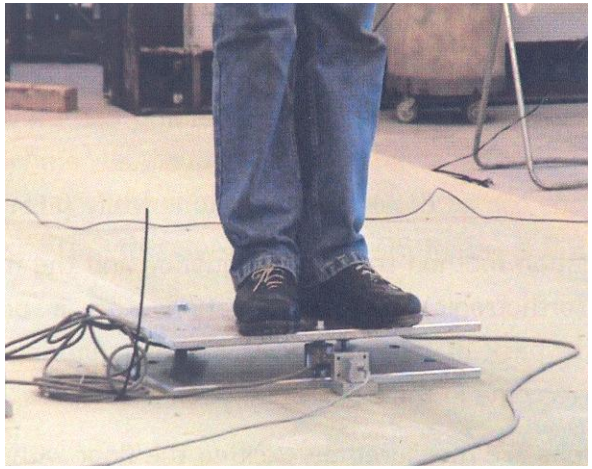
  - supported at load bearing positions
  - supported transversely if low transverse stiffness of the floor

Floor deflection measurements, contin.

- **Measurement of global deflection**
  both point load and transducers "down" to beams or stiff plate on beams
  necessary to "short-circuit" soft floor coverings, underlayer products or resilient floor products
- **Measurement at weakest position**
  Normally in center of the span width

Floor vibration measurements
Excitation principles

- **Impact sources**
  Modal hammer
  + simple
    need statistical treatment
  ÷ for field use
- **Heel impact**
  + simple
    need statistical treatment
- **Reproduceable impact**
  + useable also in field
  ÷ more complicated

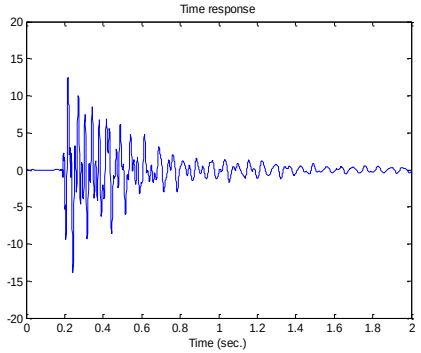


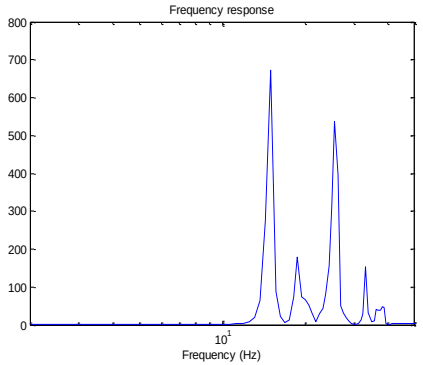
Floor vibration measurements
Excitation principles, continued

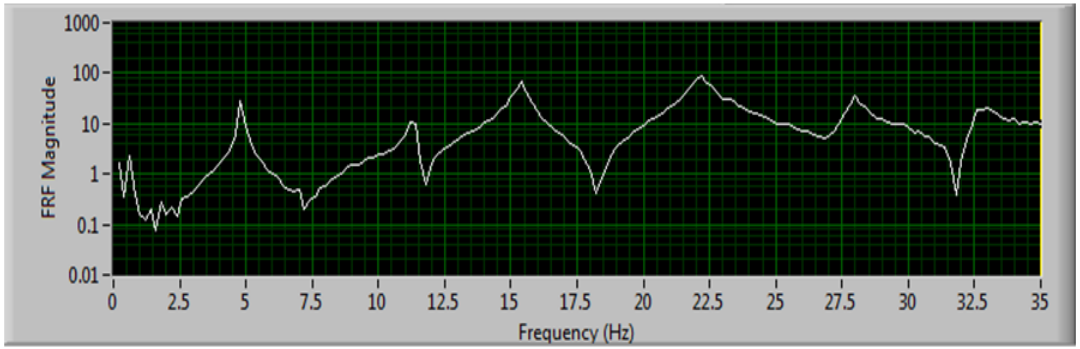
- **Shaker excitation**
  - different excitations, for instance sine, random, broadband
  - require skilled operators, therefore most common studying complex structures
- **Both impact and shaker excitation applicable for floor vibration measurements**

Floor vibration measurements
Analysis & characterization

- **Fundamental frequency**
- - from FFT-spectra
- - from Frequency Response Function (FRF)

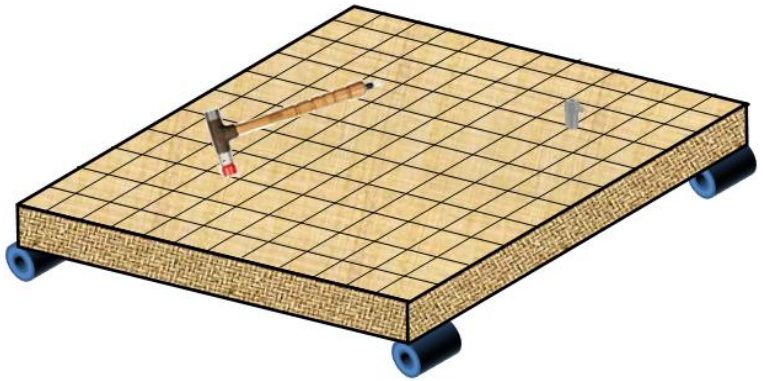


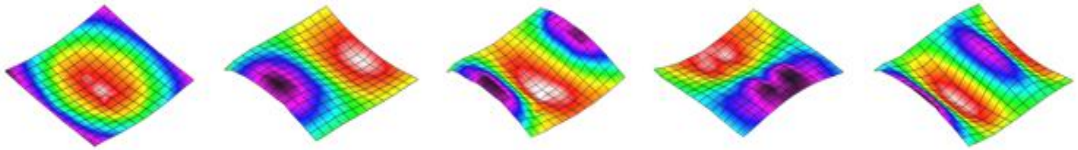




Floor vibration measurements
Analysis & characterization

- **Modal analysis**
  - FRF calculation and curve-fit
  - Mode shape
  - Modal damping
- **Example of experimental setup**
- **Experimental mode shapes**





Floor vibration measurements
Analysis & characterization

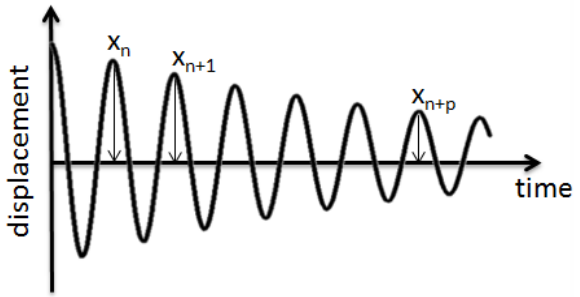
- **Integrated parameter from the transfer function**
  according to SBR guideline method to determine the OS-RMS_{90} - value
- **Integration of acceleration level**
  (seldom used)

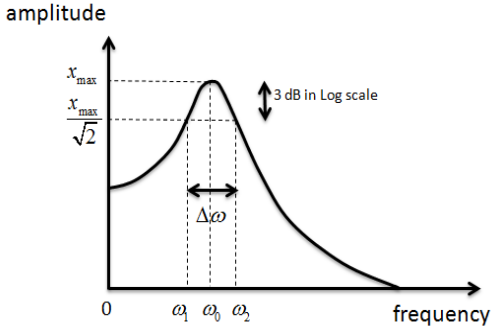
$$a_{RMS} = \sqrt{\frac{1}{T} \cdot \int_0^T a^2(t)\, dt}$$

Damping measurements, low frequencies

- **Impact excitation**
- a) logaritmic decrement or envelope fitting:
  from time domain spectra
- b) half-power bandwidth:
  from FFT spectra or FRF's
- c) modal damping:
  from curve-fit of FRF's

- **Shaker excitation**
  - all methods based on FFT spectra or FRF's



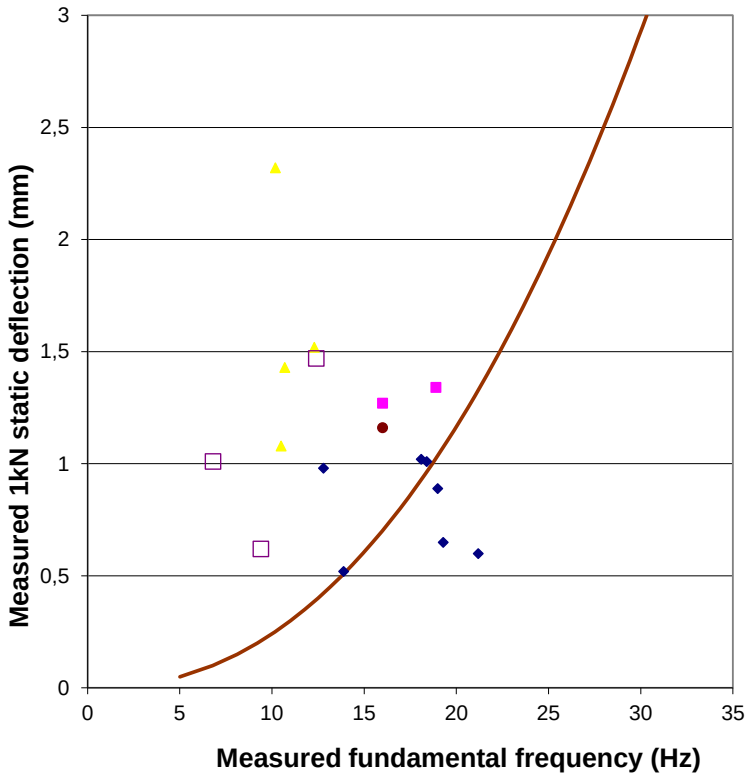


Methods specific for the assessment of floor vibrations Eurocode-5 parameters

- **Maximum impulse velocity response, v_{max}**
  measurement method not suggested – or verified
- **Fundamental frequency, f_o**
  according to page 8
- **Damping**
  only default value for calculations are given
  If measurements -according to page 11, accuracy?
- **Static deflection, Δ**
  according to page 4 & 5

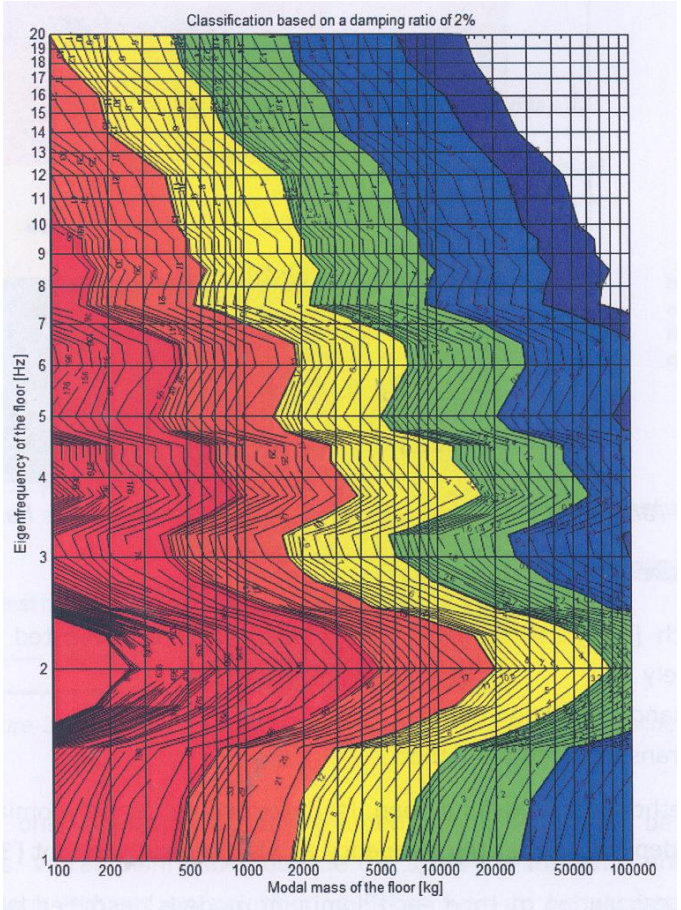
Methods specific for the assessment of floor vibrations
Canadian design-guide method

- **Fundamental frequency, f_0**
  according to page 8
- **Static deflection, Δ**
  according to page 4 & 5
- **Criteria diagram example**
  - solid line = criteria curve
  - markers = measured floors



Methods specific for the assessment of floor vibrations SBR Guideline

- **OS-RMS$_{90}$ value**
  transfer mobilities
  from point of excitation
  to point of observation
  convoluted with the walking load
  spectra, see also page 10
- **Isograph, damping dependent**
  suggested, but values not verified
  If measurements:
  according to page 11, accuracy?



Summary

- **Eurocode 5**
  - measurement method not suggested or verified
  - calculation method not verified with respect to human perception
- **Canadian method**
  - measurement methods verified
  - criteria verified with respect to human perception
  - damping not included
- **SBR Guideline method**
  - measurement method verified, sufficient accuracy (?)
  - damping, indirectly included but how to determine?

Further work

- **Harmonization of methods**
  - interesting or possible?
- **Decision on quantities**
  - depends on the method
- **Damping properties**
  - special need
  - validation of measurements & calculations