Acoustics in wooden buildings – State of the art 2008
Industrial needs - 2009

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Acoustics is an important performance characteristic for building with wood and a prerequisite for the acceptance of wooden buildings by building industry, building owners and consumers. However, the research in this area has been limited in Sweden during recent years. Therefore, a national Swedish consortium was initiated by SP Trätek in 2007 in order to utilise available resources more efficiently and to maintain and develop the competence in the field of Acoustics in wooden buildings. The consortium consists of all national R&D performers, leading industry companies and leading consultants.

Acoustics concerns both sound and vibration, and for wooden constructions there are some important features that differ from those in concrete and other heavy constructions. The building industry has learnt that building in wood with high acoustic quality demands, is connected with large risk since the acoustic behaviour shows large variability. By increasing the knowledge on wood, the risks will be reduced, which will aid the decision process and strengthen the positive qualities of choosing wood.

Vibrations are a very rare problem in heavy weight structures and normally not considered when studying normal housing activities. However, in a light weight structure they often occur, they are felt and they may cause shaking of glass cabinets etc. A walking person or a jumping / playing child may cause a combination of vibrations and low frequency noise, so does a bubble bath or washing machine. Some studies regarding vibrations and its subjective experience exist, however the combined influence of vibration and noise is an unknown area.

The first result from the Swedish consortium is a State of the art report /1/. It includes a list of suggested further work topics including the character of the problems involved, wherefrom it can be concluded that there are large similarities between the R&D needs for lightweight buildings in general and wooden buildings in specific. The ideas for further work are

- Characterisation and identification of large variations in sound insulation
- Prediction of sound insulation in wooden (and other) buildings
- Low-frequency sound insulation
- Evaluation of sound insulation
- Prediction models for volume buildings
- Noise-reducing devices and Low frequency installation noise
- Vibrations in lightweight long span floors

A further study on industrial needs /2/ resulted in a list of needs written in order of priority.

1. Establish a well founded criteria for evaluation of impact sound insulation in order to make various sound classes A, B or C reasonably comparable to the sound classes of heavy building structures
   - Take various types of living accommodations into consideration
   - Connect to the needs of airborne sound insulation (optimizing)
   - Take the source of energy into consideration (impact sound machine and other sources)
2. Connect the criteria to the experience of vibrations or establish separate criteria for vibrations – how will vibrations affect the valuation of sound (including structure borne sound from machines in houses with light weight structures)?
   o Is the human behaviour affected by the structural material?
   o Take common structure borne noise sources in residential houses into consideration (for instance washing machines including rotating units, bubble bath, etc)

3. Study long term effects regarding various methods for reduction of flanking transmission.
   o Consider the material characteristics of the interlayer to minimize flanking transmission and wind anchorages and their influence on sound insulation over time.

4. Facilitate the trade / export with light weight building system in through increased harmonization of the regulations, which is favourable also for heavy structures within the Nordic countries, within Europe and internationally.

5. Develop calculation methods with well known security margin which might be applied on light weight structures. The development will take place in close cooperation with the working group within CEN TC126 / WG 2 / AHG 3. To achieve this it is needed
   o increased knowledge amongst light weight constructions and its anisotropic characteristics
   o knowledge amongst various joints and their behaviour, flanking transmission

The main reason for this order of priority is of course to address correct means of control in order to develop light weight structures (floors) which will become competitive with regard to impact sound / vibrations. Competitive both in general terms but also to consolidate its position compared to heavy building structures. The sound insulation in light weight structures is normally completely controlled by the sound levels in the lowest frequency bands while sound insulation in heavy structures do not exhibit this “unbalance”. As long as the experienced sound insulation from a certain sound class mostly is worse for light weight structures despite it is objectively similar (in terms of single number values) compared to heavy structures, this imply an obvious disadvantage for the light weight industry. Today, there is far too big scope for serious mistakes and shortage with current regulation and standards.

The most immediate parts above are also important in order to be able to fulfil the essential requirement “Protection against noise” of the European Construction Productive Directive (CPD) for buildings with light weight structures.

References
COST – seminar 2009-05-27

Acoustics in wooden buildings—State of the art 2008

Industrial needs, VINNOVA 2009
A group of researchers, consultants and industry

- Chalmers
- DTU
- KTH
- LTU
- NCC
- Saint Gobain
- SP Acoustics
- SP Trätek
- WSP
- VXU
- ÅF-Ingemansson

Building with wood increases. Today it comprises a significant part of the total production of multi storey residential buildings – if adding other light weight buildings > 15%
State of the art – further work

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Industrial needs – Vinnova 2009
Establish a well founded criteria for evaluation of impact sound insulation in order to make various sound classes A, B or C reasonably comparable to the sound classes of heavy building structures

- Take various types of living accommodations into consideration
- Connect to the needs of airborne sound insulation (optimizing)
- Take the source of energy into consideration (impact sound machine and other sources)

Connect the criteria to the experience of vibrations or establish separate criteria for vibrations – how will vibrations affect the valuation of sound (including structure borne sound from machines in houses with light weight structures)?

- Is the human behaviour affected by the structural material?
- Take common structure borne noise sources in residential houses into consideration (for instance washing machines including rotating units, bubble bath, etc)

Study long term effects regarding various methods for reduction of flanking transmission.

- Consider the material characteristics of the interlayer to minimize flanking transmission and wind anchorages and their influence on sound insulation over time. Secure the fulfilment of BBR section 2.1.

Facilitate the trade / export with light weight building system in through increased harmonization of the regulations, which is favourable also for heavy structures (In the long term point 5 is also very important)

- within Europe
- International

Develop calculation methods with well known security margin which might be applied on light weight structures. The development should take place in close cooperation with the working group within CEN TC126 / WG 2 / AHG 3. To achieve this it is needed

- increased knowledge amongst light weight constructions and its anisotropic characteristics
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**Building regulations in Sweden**

- Noise requirement text and….
  - General advice connected to classification standard – SS 25267 and SS 25268
- Requirements on building material included in buildings
  - General advice – material characteristics for essential products in the building should be specified
1994 it became permitted to build multi storey houses with wood in Sweden

Fulfilling sound class B (4 dB higher) should be enough........
- Or?
Two buildings, one wooden – one concrete, what will the consumer choose?

- **OBJECT 01 (wood)**
  - Do you have any specific demands?
    - I want a dwelling with good sound climate
  - The building fulfil sound class A
    - Can you verify?
  - I have measurement minutes from an accredited measurement company

- **OBJECT 02 (concrete)**
  - Do you have any specific demands?
    - I want a dwelling with good sound climate
  - The building fulfil sound class A
    - Can you verify?
  - I have measurement minutes from an accredited measurement company

![Measurement chart](image1)

Acoustician – May I take a look at the measurement curve?

- **OBJECT 01 (wood)**
  - \( L_{\text{eq},n} = 35 \text{ dB} \)
  - \( L_{\text{eq},C_{4000-2000}} = 46 \text{ dB} \)
  - \( R_{\text{eq},50-3150} = 61 \text{ dB} \)
  - **Perfect**

- **OBJECT 02 (concrete)**
  - \( L_{\text{eq},n} = 48 \text{ dB} \)
  - \( L_{\text{eq},C_{4000-2000}} = 48 \text{ dB} \)
  - \( R_{\text{eq},50-3150} = 61 \text{ dB} \)
  - **Perfect**

![Measurement chart](image2)
How do this affect humans?

Living accommodation – more input is needed!

- Could be an option for light weight industry……
  - Right system on right place – better optimizing cheaper

- Requirements in:
  - Dwellings for elderly?
  - Student premises ?
  - Occasional dwellings
  - etc
Why do the requirements fail?

- Development of regulations when light weight buildings were not allowed

- Strict regulations some decades ago – uninteresting with new techniques

- Historically – the building industry is not very "research minded" due to strict control from the national authorities

- And then suddenly – fire regulations open for new techniques. But what happens within other technical areas……….

Flanking transmission

Elastic layer to minimize flanking transmission (there exist system with other innovative sound reducing devices)
Calculations – make it possible to replace products, Avoid full scale modelling

- Heavy structures – use software and adapt to any country, small work...

- Light weight structures..... – build a new test building every time entering a new market.

- In the long run – prediction models are needed

Revision of EN ISO 717 – a good opportunity!

- Possibility to influence content of ISO 717 – research will give fast feedback

- Facilitate trade with system manufacturer – wooden industry!

- COST
Is it possible to build good light weight floor structures?

- YES – but success requires ………..
- That the development is directed towards right evaluation principles
- That wooden structures are optimized more effective (floor structures, walls, etc)
- That economical savings are not made for the most sensitive building parts
- That the developer is absorbant and understands the importance of every single detail and that he or she is surrounded with the right manufacturer and building contractor and consultants.
- Openminded attitude regarding sound and vibration characteristics in order to promote the development
- Openminded attitude regarding costs of different production methods in order to improve and become more effective
- RESEARCH and development within an area that definitely affect those who are living in the houses. Fire and strength do not…..
  - If wrong not possible to take care of it properly

\[ L'_{n,w} + C_{1,50-2500} = 52 \text{ (sound class B) (gräns 52 dB)} \]
\[ L_{new} = 57 \text{ (sound class B) (gräns 57 dB)} \]
**Volumes**

\[ L_{n,w} + C_{150-2500} = 51 \text{ (soundclass B)} \] (gräns 52 dB)

\[ L_{new} = 57 \text{ (sound class B)} \] (gräns 57 dB)

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**THANK YOU!**