

Sound, vibrations and springiness in lightweight buildings

AkuLite is a national Swedish project involving all research institutions active in the field, leading industries and leading consultants. Vinnova and Formas are the public funders and have been active since the initiation of the work in 2007. The project started in late 2009 and will be finalised in early 2013.

Multi storey family houses with lightweight frames are becoming more and more common in the Nordic countries. The development is accelerating in Sweden mainly due to two reasons:

- The demand on non combustible materials was removed from the Swedish legislation in 1994.
- A national strategy on “Mer trä i byggandet” (more use of wood in the building sector) was adopted in order to stimulate the lightweight building industry, in particular building with wood.

Driving forces are sustainability, industrialization and cost reductions in the construction sector. However, noise and vibration disturbances experienced by residents might become a problem, even if the building code

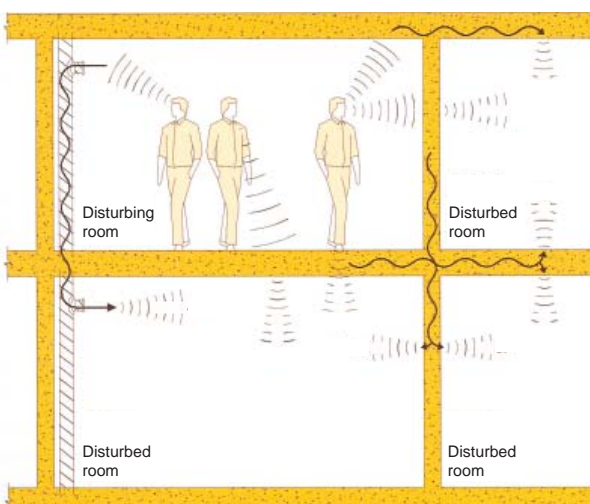
requirements are fulfilled. Sound and vibration have thus become the new hindrance. The aim of this project is to develop sound and vibration criteria that fit better with human experience in lightweight buildings. The project includes development of methods, collection of data, analysis based on statistical methods and development of criteria. The project partners participate actively in international standardization for rapid and efficient implementation in the building industry. This will strengthen the competitiveness of lightweight structures compared to heavyweight structures and remove obstacles for international trade. The project contributes to build long term competence together among the participating research and industry partners.

State of the art

The current acoustic (= sound and vibration) requirements in multi storey family houses have their origin in those times when multi storey wooden houses were not allowed. In spite of some adjustments that were made in the Swedish regulations in 1999, the acoustic requirements are still adapted

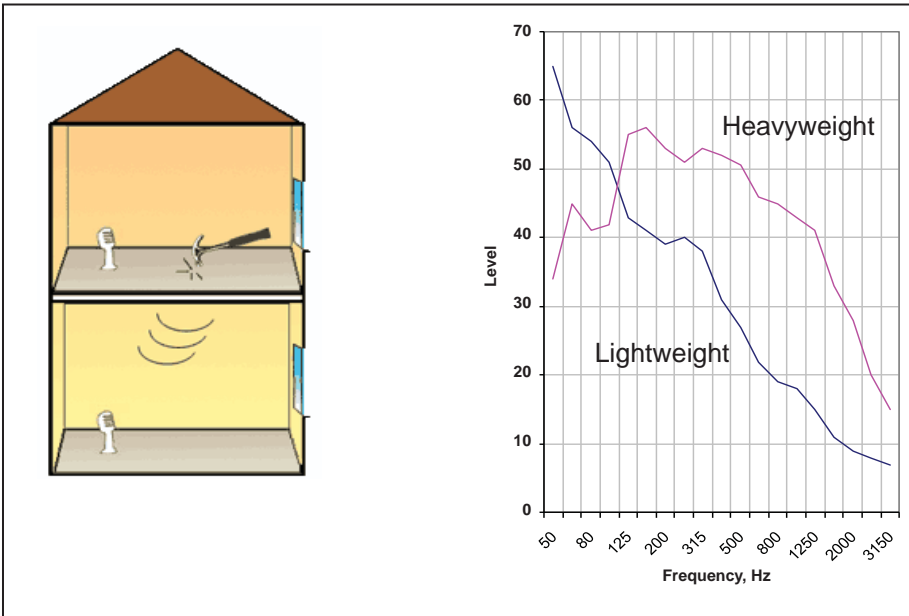
to traditional heavyweight building technique. This imply a clear disadvantage in competitiveness for multi storey family houses with lightweight frame systems – the acoustic quality in a lightweight building structure is perceived differently as compared to a heavyweight building structure of the same class. In particular it is the low frequency impact and airborne sound as well as vibrations that might become very evident and disturbing in lightweight structures (Acoustics in wooden buildings, State of the art 2008, SP Rapport 2008:16).

An analysis of industrial needs points out large risks for the wood building and other lightweight industries regarding the future development if no research efforts are initiated in certain prioritised areas. It is also stated that it is very important that the efforts should be taken in a certain priority order. Parts of this is also relevant and urgent in order to fulfil the Constructions Products Directive’s essential requirements on protection against noise as well as the Swedish building code BBR.



AkuLite aims are to:

- develop objective criteria of sound insulation, impact noise, vibrations and springiness giving an evaluation of the acoustic quality that is independent of the type of building frame system
- implemente the new knowledge in international research and standardization
- further develop the competence within building acoustics (in particular regarding lightweight structures) at the participating research organisations in the long term perspective
- increase cooperation between actors in the innovation system; universities, institutes, consultants and industry
- increase the knowledge base in the industry and among consultants for future development and increased competitiveness of lightweight structures



The sound insulation in lightweight structures is different than in heavyweight structures, especially at low frequencies that may be critical for the human perception.



Research group. Fredrik Ljunggren, LTU, Krister Larsson, SP Acoustics, Anders Olsson, LNU, Delphine Bard, LTH, Klas Hagberg, SP Trätekt and WSP, Birgit Östman, SP Trätekt, Anders Ågren, LTU and Göran Sandberg, LTH. Chalmers absent at picture.



Limnologen in Växjö, a lightweight building, recently got a Swedish award. Acoustics and vibrations have been evaluated within AkuLite.

Sound insulation in buildings

It is not uncommon that people complain about poor impact sound insulation in lightweight buildings even though the requirements of the high Swedish acoustic classes A or B are fulfilled, a situation which is less common with heavyweight frames. The subjectively evaluated sound insulation may differ significantly between buildings with heavy and light frames with equal objective measures. The frequency range used for evaluation in Sweden is 50-3150 Hz while other European countries use only 100-3150 Hz. The smaller frequency range is sufficient for heavyweight structures while the 50-80 Hz bands have been included in Sweden to improve the situation for light frames, but still with many pitfalls.

Buildings with lightweight frames have in general relatively poor sound insulation at low frequencies compared to heavier structures and it is probably vital for the subjective impression. Typical low frequency sources are people walking, running children or different kinds of technical installations, e.g. washing machines, powerful HiFi and home cinema systems.

Funding and organisation

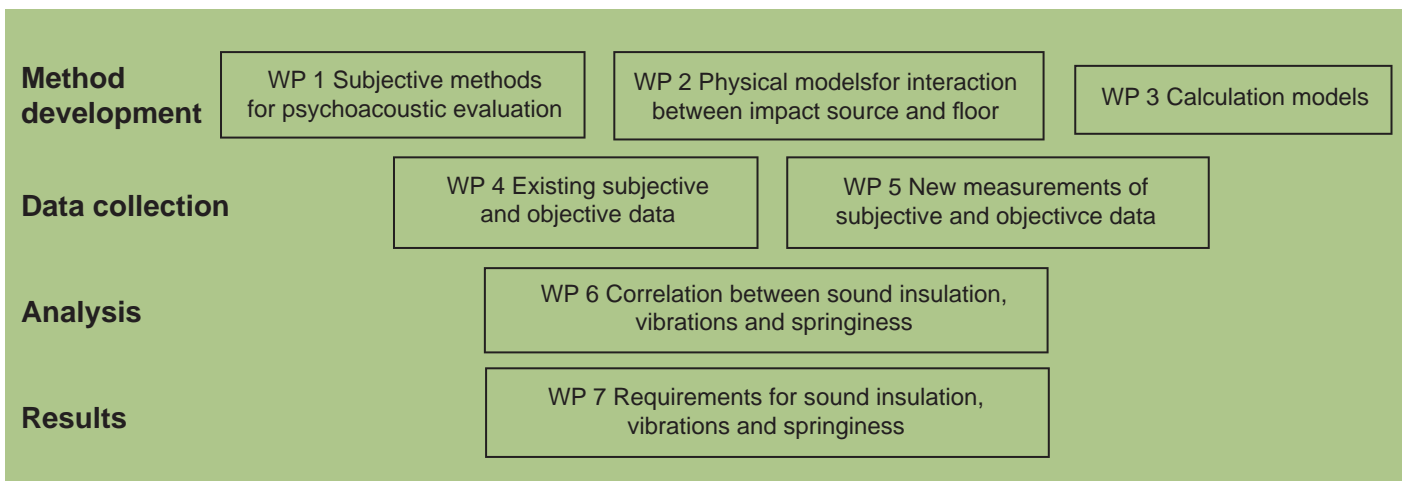
AkuLite is financed by the public funding organisations VINNOVA, Swedish Governmental Agency for Innovation Systems and the Swedish Research Council Formas and by in kind and cash contributions from the participating industries.

It is organised in seven work packages led by the research partners and coordinated by SP Trätekt.

Steering and industrial groups and a scientific advisor assist the project coordinator.

Scope

AkuLite is strongly focused on topics of common interest for the entire industry, i.e. on such work that cannot be expected to be solved by the single industries themselves without external scientific and financial support. The project focuses on the development of objective measures which correspond well with subjective experience, irrespective of frame system.



AkuLite project structure with seven workpackages, WP 1-7

Results

The results so far are mainly from WPs 1-5.

WP 1 Subjective data has produced a questionnaire to be used for the subjective evaluation. It has been further developed within the COST network TU 0901 and has thus a broad support within Europe. The questionnaire is available both in English, German and Swedish and will be used in several other projects.

*Contact: Pontus Thorsson, Chalmers
pontus.thorsson@akustikverkstan.se*

WP 2 Physical models is developing characteristics for footsteps and tapping machines. A first model has been presented.

*Contact: Krister Larsson, SP Acoustics
krister.larsson@sp.se*

WP 3 Calculation models has performed measurements of combined floor and wall structures to be used

for verifications of a prediction model of sound transmission in lightweight structures.

*Contact: Delphine Bard, LTH
delphine.bard@acoustics.lth.se*

WP 4 Existing data has evaluated the uncertainty in existing measuring methods, performed subjective evaluation according to the questionnaire from WP 1. It has also evaluated ten existing building projects.

Contact: Klas Hagberg, SP Träteck and WSP, klas.hagberg@sp.se

WP 5 New measurements has performed detailed measurements in several building object according to special instructions for field studies. All measurements are performed for an extended frequency range 20-5000 Hz to be able to analyse the total sound experience.

*Contact: Fredrik Ljunggren, LTU
fredrik.ljunggren@ltu.se*

WP 6 and WP 7 Correlation and Requirements for sound insulation, vibrations and springiness will use the results from WPs 1-5 and is in a starting phase.

*Contact: Kirsi Jarnerö, SP Träteck
kirsi.jarnero@sp.se*

Publications



The results from AkuLite have been presented in scientific and technical papers, conference papers, reports, so far more than 40 publications. The results have also been presented at several seminars and workshops.

A special report series has been created for AkuLite. The very first publication in this series is a guideline "Ljudisolering i trähus - en handbok för konstruktörer" (Sound insulation in timber houses - a handbook for engineers). It's written by Prof em. Sten Ljunggren from KTH, the Royal Institute of Technology in Stockholm and published as SP Report 2011:10.



Modern floor structures have been evaluated by subjective and objective measurements.

International cooperation

Akulite has a strong corporation with European projects, mainly AcuWood and Silent Spaces, with two COST network, one on acoustics in timber structures and another on national regulations, and with international standardization both within CEN and ISO. In all cases there is a joint exchange of results and experiences.

Results from AkuLite have been presented at several conferences worldwide. AkuLite WP leaders had an own session together with the National Research Institute in Canada at Forum Acusticum in Aalborg Denmark in June 2011. They were invited to an acoustics seminar in Switzerland in May 2011. And USA that has long tradition in timber building has expressed its appreciation about the Swedish

AkuLite coordinator



Klas Hagberg, SP Trätekt and WSP
Project leader AkuLite
phone: +46 (0)702-132 610
klas.hagberg@wspgroup.se
klas.hagberg@sp.se

initiatives during the conference ICA 2010. John Lo Verde from a consultant agency said: "Finally – this is exactly the way the research has to take in order to move forward within building acoustic research".

Further contacts



Bengt Adolphi, Setra Group
Chairman Industrial group
phone: +46 (0)705-93 13 36
bengt.adolphi@setragroup.se



Sten Ljunggren,
Prof emeritus
Scientific advisor
phone: +46 (0)70-661 35 88
sten.ljunggren@telia.com



Birgit Östman, SP Trätekt
Senior advisor
phone: +46 (0)10-516 62 24
birgit.ostman@sp.se

Industries

CBBT, Centrum för Byggande och Boende med Trä
TCN, TräCentrum Norr
TMF, Trä- och möbelföretagen
Christian Berner
Derome Hus
EuroProfil
Gyproc
Götenehus
Knauf Danogips
Lindab
Lindbäcks Bygg
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Gärdhagen akustik
Ramböll Sverige
Simmons akustik & utveckling
Tyréns
WSP Acoustics
ÅF Sound and vibrations

R&D organisations

Chalmers
LNU Linnæus University, Växjö
LTU Luleå Technical University
LTH Lund Technical University
SP Acoustics
SP Trätekt

Public funding



The Swedish Research Council Formas
Contact:
Jacob Silva Paulsen,
jacob.paulsen@formas.se



VINNOVA, Swedish Governmental Agency for Innovation Systems
Contact: Eva Esping,
eva.esping@vinnova.se



Industrial group chaired by Bengt Adolphi, second from the left.



The Swedish Research Council for Environment,
Agricultural Sciences and Spatial Planning