Media release

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New test facility for lightweight structures is commissioned

Lightweight structures, yes – but quiet ones please!

For the past few weeks now Empa scientists have enjoyed access to a new research and development platform which will allow them to improve acoustic insulation in lightweight structures. On June 30, 2011 the new lightweight structures test facility was inaugurated. Operated by Empa in conjunction with the Architecture, Wood and Civil Engineering Faculty of the Bern University of Applied Sciences (BUAS-AWCE) in Biel, the test infrastructure can be used to optimize the acoustic damping properties of multi-storied wooden structures.

Lightweight construction is a technique increasingly in demand, above all in the building industry, since it is resource miserly and therefore economic. Wood, in particular, is expected in future to become increasingly important as a building material since it is a raw material which regenerates and is therefore sustainable. But lightweight structures have one major drawback. The less material used to manufacture a structural element, the less protection it offers against acoustic noise, especially at low frequencies which are perceived as particularly disturbing (think of the boom-boom effect of music with exaggerated bass tones). It is technically quite possible to make lightweight structures with good acoustically damping properties but this rapidly becomes complicated and expensive. For example in order to offer the same level of acoustic insulation as a conventional "solidly" built house, a lightweight building must have a significantly greater floor-to-floor height in order to accommodate thicker, noise abating ceiling structures. This means that for a given maximum total height a house built using lightweight construction techniques has fewer floors, which reduces its profitability or potential income. In addition the acoustic calculations currently used during the planning phase are rather imprecise so that frequently it only becomes clear after the building is completed whether or not the required level of acoustic insulation actually has been achieved using the given construction elements and materials.

To improve this situation and thereby also enable the development of new structural elements which are light and simultaneously "quiet", Empa has together with the Architecture, Wood and Civil Engineering Faculty of the Bern University of Applied Sciences (BUAS-AWCE) in Biel begun operating new research infrastructure in the form of its new lightweight structures testing facility. This consists of a 12 m high hall with 400 square meters of floor surface in which two rooms constructed using lightweight techniques and

located either side by side or one on top of the other can be studies in terms of their acoustic properties. This layout allows not just the horizontal and vertical noise propagation from one room to the other to be investigated, but also the diagonal distribution. What is special about this setup is that the two rooms rest on separate concrete floors which are mounted on elastic supports and thereby vibrationally decoupled from each other (and from the test hall). This prevents noise from one structure being transmitted through the floor to the other.

«Flanking transmission » – the problem with lightweight structures

It is precisely in terms of noise transmission (or more precisely in the path taken by noise as it propagates into the surroundings) that the lightweight construction technique faces its greatest challenge. While in conventional "massive" construction it is sufficient to measure the individual acoustic damping values of individual building elements such as walls, ceilings, doors and windows in order to predict the acoustic damping properties of the finished building, in lightweight construction is this method does not work. Lightweight construction elements are easily excited into resonance and when this occurs they transmit noise better along their long axes to neighboring structures.

In lightweight structures therefore all possible acoustic pathways over which noise can propagate must be taken into consideration, not just the most direct path (such as through a wall into the next room). All told there are at least six additional “flanking” noise transmission paths in lightweight structures compared to massive ones. And each of these can be individually acoustically measured in the new lightweight structure test facility.

A great step towards improved lightweight structure development

All kinds of lightweight structural materials can be studied in the new facility. Measurements have already been conducted on structures made of light plaster walls – and the results have already thrown up useful hints for the industrial partner involved in regard to the further development of the material. Soon the first measurements will begin as part of a major cooperative project financed by Lignum (the umbrella organization of the Swiss lumber and wood industry) and the Swiss Federal Office for the Environment (FOEN). Among other things this project is intended to precisely evaluate the acoustic damping capacity of wooden structures, thereby helping to develop components and buildings which are optimized both in terms of acoustic and mechanical properties.

At the inauguration ceremony at the end of June the Directors of Empa and BUAS handed the lightweight structure test facility over to the research staff. "I am particularly pleased that this research infrastructure will intensify our cooperative work with the universities of applied sciences," said Gian-Luca Bona, Empa's director.

Further information

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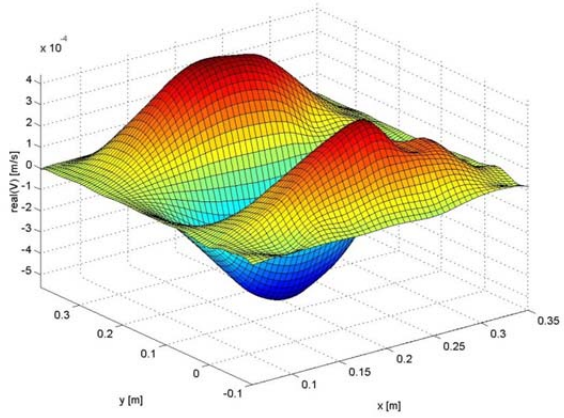
The ribbon has been cut through, the inauguration is complete. Gian-Luca Bona (left, Director of Empa) and Heinz Mueller, (right, Director of BUAS-AWCE) hand over the lightweight structures testing facility to the researchers.

A two-storey wooden building erected in the testing facility hall, allowing noise propagation from one room to the other to be measured.

Instruments measure the various different noise transmission paths in a lightweight wooden structure.



How noise appears visually: a lightweight structural element is excited into resonance by sound waves. In order to predict the acoustic damping properties of materials and components their resonant frequencies must be measured. These are the frequencies at which objects vibrate naturally and these modes are easily excited. When this happens the acoustic damping is particularly poor. Among other techniques the Scanning Laser Vibrometer is used for resonance frequency analysis.

Text and images are available in electronic form from: redaktion@empa.ch