Timber and Technology

Building Physics

Timbatec
Timber and Technology

Editorial

Dear partners, customers and timber enthusiasts,

Rising timber prices and long delivery deadlines are keeping the timber industry busy up and down the country. On the one hand, this is a problem – after all, we want to construct our timber buildings, not just plan them. On the other hand, it is a huge success – wood is becoming established as a building material and is even convincing a growing number of large investors. The shortage is a challenge for us – for the first time since the upswing in timber construction, we are no longer operating from a niche existence but are faced with the challenge of being able to cover the rising demand.

However, we are happy to meet the task, as developing efficient constructions and innovative products is the ultimate competence of engineers. This is why we are involved in research projects for developing timber construction. We are particularly interested in the economic use of building materials and the reutilisation of building components. We will therefore dedicate the next magazine in spring 2022 to resource-saving construction methods. This issue focuses on building physics. Because we feel comfortable in buildings with smart building physics solutions.

In summer, the buildings should not overheat and should manage without cooling as far as possible, while in winter they should not consume too much energy for heating. The living environment should be comfortable, the air not too dry, the walls and windows free of condensation. And anyone who has suffered from noise from their neighbours understands the importance of good soundproofing. At Timbatec, we place particular value on well-conceived building acoustic solutions and adequate soundproofing.

Sometimes, though, you want to be heard – the optimised timber plate tiled slab of the bandstand on the title page reflects both the sound to the audience and the sound to the musicians. This enables the best acoustic conditions to be produced.

Building acoustics and building physics project planning starts at the beginning of the planning phase. We therefore support our projects right from the start in all specialist areas, from structural analysis and design to fire protection and building physics. We have a great deal of expertise which we will be happy to share with you. May we also support you in your construction project?

Simon Hess
Manager of Building Physics Area
Timbatec Holzbauingenieure Schweiz AG

Cover picture: Bandstand in Kirchdorf in Tirol, Austria

David Schreyer

Timbatec offers an all-round package

A building is more efficient and economical if it is understood as a whole. When it comes to planning timber constructions, the best idea is to consult a timber construction engineer who has skills that go beyond mere structural design. We offer an all-round package in planning and will support you through to execution. We will also gladly develop solutions for your project where none yet exist. Our core competencies:

Timber Engineering | **Fire Protection** | **Building Physics** | **Product Development**

Sound insulation at the Wildgarten Rose Mound, Vienna

Timber construction is becoming

The city of Vienna is growing. Urban and living space for 2300 people is being created on the Rose Mound. Timbatec is supporting Building Plot 7 as the local construction supervisors

The residential buildings in the south of the quarter are fully committed to eco-conscious living. The use of wood is therefore the logical consequence. Visible wood on the ceilings as well as some of the walls create a natural, calming and pleasant homely feeling. This project focuses particularly on building physics, especially the soundproofing between the homes.

Soundproofing for housing quality
Having everything made of wood used to have its pitfalls. Today, wood can do almost anything – even exhibiting good performance with regard to sound insulation. The residents should not be disturbed by the noise from neighbouring flats. The structure-borne sound in particular, which is created when walking on floors or when moving objects on floors is disturbing.

Mass – spring – mass
The project meets the stringent requirements in Austria (see table on Page 5) thanks to a floor structure according to the principle mass – spring – mass. Chippings and cement screed are the two masses, while the impact sound insulation board between them is the spring. The good results of the sound measurements from Akustik Engineering Luckinger e.U. on the construction site confirm expectations. When the project is completed at the end of the year, the new residents will move into a home made of natural material that takes into account all modern requirements.

Wood remains visible on the façades and inside the building.

Visualisation:
schreinerkastler, Wien

Architecture
SPS Architekten, Thalgau

Construction management
Woschitz Group, Wien

Local construction supervision
Timbatec Holzbauingenieure GmbH Austria

General contractors
Strobl Bau, Preding

Sound insulation in timber construction

Timber houses used to be badly soundproofed. Today, however, modern wooden structures easily meet high sound insulation requirements. In order for that to work, sound insulation must be taken into account right at the start of planning.

Sound insulation is crucial for the well-being of building users – whether it's in the office or at home. In order for the desired values to be achieved, precise targets must be defined at the start of planning. In sound insulation planning, a clearly defined procedure proves its worth –

1. **Define sound insulation targets of a building**
2. **Define target values**
3. **Description of target values in a comprehensible language**
4. **Selection of building components**
5. **Forecast and proof of sound insulation**
6. **Implementation and monitoring of construction measures**
7. **Measurements after execution**

the first two steps are key. The sound insulation targets and requirements of a building must be defined carefully with the building owner. If the focus of a construction project is on an efficient use of resources, innovative and intelligent solution approaches are required. The sound insulation requirements from the standards must and can be complied with – even with a minimum use of materials. This requires well-planned building components.

Important impact sound insulation
Good sound insulation in timber construction means good protection from impact sound transmission – in particular in the low-frequency range. The impact sound transmission is specified with what is known as the evaluated standard impact sound level L'nT,w in decibels (dB). This value describes how well a noise from a different room can be heard. The lower the value, the lower the impact sound transmission and as a result the better the protection against disturbing impact sound.

Various requirements
Sound insulation is regulated differently in each country. In Switzerland, Germany and Austria there are no standardised requirements. What all countries have in common is that the low-frequency range under 100 Hertz is not regulated, although this has a major impact on our well-being. We perceive low-frequency sounds between 50 and 100 Hertz as a disturbing drone. Together with our customers, we define sound insulation requirements which take into account these low-frequency sounds. We base this on our experience of construction site measurements and on findings from current research projects.

Minimum requirements for impact sound protection depending on country
In Switzerland, the SIA standard 181 defines different requirements for sound insulation, depending on the noise exposure and noise sensitivity of a building. In the living area, the standard assumes a moderate noise exposure and an average noise sensitivity. This results in a minimum requirement for the impact sound of 53 dB. Below this value, walking noise is no longer disturbing for the majority of people. More stringent requirements apply in owner-occupied flats – the limit value is four decibels lower, at 49 dB. In Austria, the requirements are more stringent and a distinction is not made between owner-occupied and rented flats.

Minimum requirements of impact sound insulation depending on country

Building component	Switzerland Rent	Switzerland Ownership	Germany	Austria
	SIA 181:2020	SIA 181:2020	DIN 4109:2018	OIB Guideline 5 (2019) (OIB = Austrian Institute of Construction Engineering)
Flat partition ceiling	$L'\leq 53$ dB	$L'\leq 49$ dB	$L'_{n,w}\leq 53$ dB*	$L'_{nT,w}\leq 48$ dB
Roof terraces and recessed balconies	$L'\leq 53$ dB	$L'\leq 49$ dB	$L'_{n,w}\leq 50$ dB	$L'_{nT,w}\leq 48/53$ dB**
Arcades	$L'\leq 53$ dB	$L'\leq 49$ dB	$L'_{n,w}\leq 53$ dB	$L'_{nT,w}\leq 50$ dB

$L'_{n,w}$ evaluated standard impact sound level (measured at construction)
$L'_{nT,w}$ evaluated standard impact sound level (measured at construction, adjusted to reference reverberation time)
L' evaluated standard impact sound level with correction for volume and spectrum

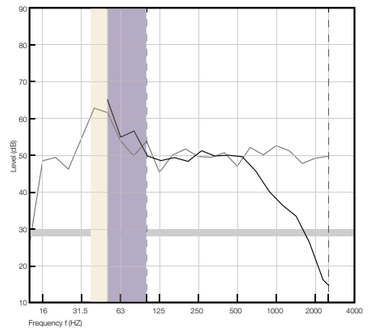
* Germany has a special regulation for lightweight ceilings and permits an evaluated standard impact sound level $L'_{n,w}$ of 53 dB. Otherwise $L'_{n,w}$ of 50 dB applies
** generally accessible area/the area allocated to the individual flat.

Sonic measurements in the low-frequency range

Apart from the usual tapping machine, we also use the Japanese rubber ball for impact sound measurements. A measurement procedure that comes close to a person's subjective perception.

The Japanese rubber ball enables us to make more realistic measurements in the low-frequency range than the tapping machine.

Photo: Nils Sandmeier



In contrast to the measuring curve of the tapping machine, the Japanese rubber ball provides information on the low-frequency characteristics and the resonance frequency. The measured as well as the calculated resonance frequency is 40 Hertz.

Good protection against impact sound transmission can be achieved by adjusting the floor structure to the lowest possible resonance frequency. This means that the lower the frequency with which a floor structure resonates, the better the impact sound insulation. The resonance frequency should be below 50 Hertz, otherwise walking noises in the low frequency range can cause disturbance. If the thickness of the underlay, the stiffness of the impact sound insulation and the loading of the wooden ceiling are correctly adjusted to each other, resonance frequencies of between 40 and 45 Hertz are easily possible.

Japanese ball
The frequencies between 100 Hertz to 3150 Hertz are defined as the evaluation range in the sound insulation standards. The tapping machine is used for measuring. With the architectural acoustics measurements, Timbatec wants to achieve more than is possible with the traditional measurement procedure. That's why the Japanese rubber ball is included in our equipment. This ball as a sound source supplies a better correlation between subjective user satisfaction and the measured value than is achieved by the conventional measurement with the tapping machine. This is because the Japanese rubber ball reproduces the low-frequency sounds under 100 Hertz well.

Continuous improvement
Quality controls with acoustic measurements after construction completion enable us to learn a lot. We are constantly developing new rule details and rely on the transfer of expertise between the disciplines of design and acoustics. This enables us to design and plan project-specific details according to customer requirements.

The impact sound test bench supplies forecasts

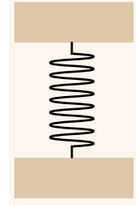
Maximum sound insulation with minimum use of resources – an interesting task for engineers. Timbatec uses the impact sound test bench to test new constructions before they are used in buildings.

Using the impact sound test bench, pre-test series can be tested efficiently and cost-effectively and ideal structures developed.

The impact sound test bench in our Zurich branch is the result of several projects with the Bern University of Applied Sciences. Piero Kessler is currently working on further development.

Photos: Timbatec

The double oscillator
Floating floor screed is the requirement for good impact sound insulation. It is one of the two masses of the double oscillator. The second mass is the timber ceiling with its loading, and in between is the impact sound insulation as a spring. If the individual layers are ideally adjusted to each other, a good level of sound insulation can be achieved with lightweight designs.



Good sound insulation can be easily achieved with heavy concrete ceilings and impact sound insulation. However, this design method scores poorly in terms of sustainability and construction process. Light timber floor slabs are much better. For sound insulation, they are weighted with an additional mass according to the current state of the art. Wood-concrete composite floors, heavy underlays and fills are common. Unfortunately, these measures considerably worsen the climate footprint of the timber as well as the complete deconstruction. This is why we are developing new floor structures with a minimum use of resources and maximum sound insulation.

Early estimation of impact sound insulation
The sound insulation characteristics of new floor structures cannot be easily calculated or simulated on a computer. They are dependent on many factors, such as frequency or the size of the room. And sound always seeks out secondary routes. For this reason, the sound characteristics of new ceiling constructions are measured in a mock-up in large-scale test benches or in an almost completed building. This is time-consuming and costly and hampers the development of new floor structures. A simple method for early assessment of the impact sound insulation of a floor structure and the ideal adjustment of the individual layers on top of each other is therefore of great interest. In our impact sound test bench, the tapping machine stimulates the ceiling construction. The measured values of the accelerometers and sound intensity measurements supply forecasts for the sound insulation value of the ceiling. This reduces the number of large-scale laboratory tests. Using different measuring methods, four bachelor theses examined whether impact sound measurements in the impact sound test bench are feasible and showed that the measurements correlate with reference ceilings in an installed state. The impact sound test bench is thus an ideal forecasting tool for optimised structures and helps wooden construction to continuously develop.

Excavation material or fill as raw ceiling loading
When choosing our building components, we set great value on a holistic approach and take into account technical, ecological and economical criteria in equal measure. We therefore do not use wood-concrete composite floors and cement-based materials. Instead, we use dry-bonded fill or, most recently, even excavation material for the raw ceiling loading. These materials score points with their ease of processing and in terms of sustainability. In our office, we have the ideal test environment for developing these innovative approaches.

Quality assurance
We do not perform measurements only in our in-house Innovation Lab – the professional installation of the components is key for soundproofing. If execution is defective, deviations can occur, which can only be eliminated at great expense. We thus invest a lot of time supporting construction projects, so that component layers and building components can be correctly disconnected from each other on the construction site and installations such as underfloor heating correctly secured.

A perfect climate for top performance

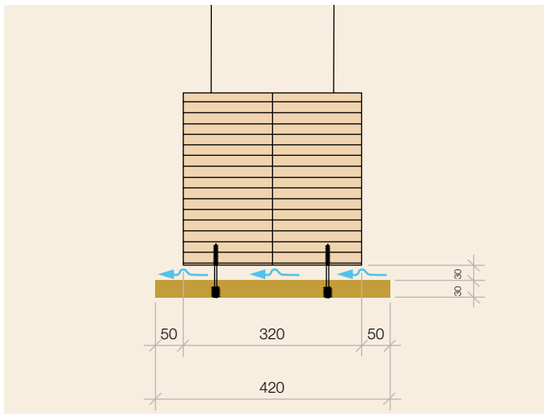
HC Ajoie started the new hockey season at the start of September. They are back in the top league for the first time since 1993 – and in the new Raiffeisen Arena in Porrentruy, a real showcase timber building made from regional wood.

The wood moisture of the supporting structure above the ice rink is monitored by a monitoring system.

Photo: keystone sda

“Thanks to early planning, the ice stadium is built from regional timber.”

Gregorie Présacco
Technical manager SIDP



The grandstand made of timber will withstand even the victory celebrations of the Ajoie fans.

Photo: Timbatec

The anti-condensation panel can simply be exchanged. It protects the timber frame as a wear layer.

The new Raiffeisen Arena in Porrentruy is the home match hall of the ice hockey rising star HC Ajoie. It is a good example of how large-scale projects can be created from regional wood. 94% of the timber used comes from Switzerland, most of it from the forests of the district of Porrentruy. Boards, beams and solid wood panels were created from this timber, used today in the stadium in processed form.

Every wood type is used appropriately
Spruce, silver fir, ash and beech were used in the Raiffeisen Arena. Which wood is used where in the design depends on the respective requirements. The pinewood was used predominantly in the construction of grandstands, for the rafters and roof beams of the two roofs and for the panels in the rooms. The strong hardwoods were used in the primary construction and in the laminated timber for the roof construction, where they enable slim profiles thanks to their high strength.

Timber grandstand
The grandstand is a construction of pinewood on pole beams – a high-performance material produced by the company Fagus Suisse located only a few kilometres away from the ice stadium in Les Breuleux. The vibration behaviour of grandstands in timber construction are not subject to any standards. Nevertheless, they should not start to vibrate when the fans all jump at the same time while singing “all together”. Timbatec performed vibration measurements after completion of construction. Here, for once, not for acoustical reasons, but to compare the structural model with the constructed reality. We can use the findings to optimise future wooden grandstands.

Humidity monitoring in the ice stadium
Wood adjusts to climatic influencing factors and creates what is known as equilibrium moisture. With a temperature of 8° Celsius and a relative air humidity of 70% – this climate must prevail in ice stadiums according to the Ice Hockey Association – the wood has an equilibrium moisture content of 13%. That is a good value. If the temperature rises fast, the wood equilibrium moisture falls – leading to the risk of shrinkage cracks. On the other hand, the cold “emission” of the frozen surface carriers a risk of condensation on the wooden surface of the timber frame. A monitoring system monitors air humidity and wood moisture content as well as temperature in the ice stadium. Timbatec can build on its experiences from the ice rink Brünnli in Hasle-Rüegsau – here too a monitoring system monitored the wood moisture content. In the event of excessive moisture fluctuations, it is planned to mount sacrificial slats made of spruce to the ash timber frame.

Building owner
Syndicat Intercommunal de Porrentruy (SIDP), Porrentruy
Architecture
Dolci Architectes Sàrl, Yverdon-les-Bains

Timber engineering
Timbatec, Delémont

Timber construction
Batipro SA, Courfaivre
JPF-Ducret SA, Bulle
Thiévent & Gerber SA, Courtedoux
A+C Corbat SA, Vendlincourt

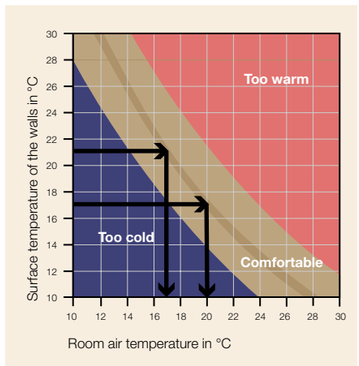
A house full of innovations

The apartment building BMW15 in Thun is an innovative flagship project in many respects. It stands on the first cellar made of wood in Switzerland, needs no heating and offers pleasant temperatures even on hot summer days.

The inhabitants of 15 Blümlimattweg enjoy comfortable flats – even without heating. The building in Thun proves that modern houses can manage without any heating at all. There are many sources of heat in buildings, such as kitchen appliances, computers and the warm water in bathrooms. People also constantly radiate heat. If, in addition, the solar radiation is used on a ideal basis and the house well insulated and designed, it does not need any heating today. The 34-centimetre thick insulation keeps the heat in the flats during the winter days.

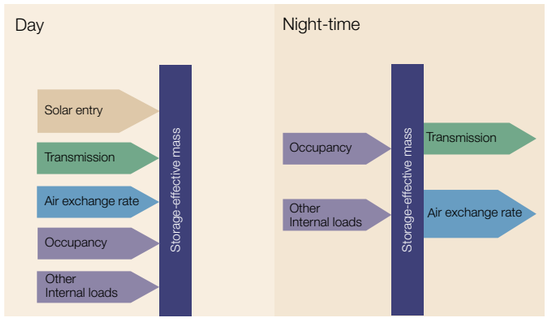
Advantage of surface temperature

Well-insulated walls are important. This is due to the fact that the lower the difference between the surface temperature of the walls, floors and ceilings to the air temperature, the more comfortable it is in a room. We therefore feel comfortable in wooden buildings with good thermal insulation – even if the room temperature is a little lower. Buildings can thus be operated on a more energy-efficient basis. In addition, wood has a perceived higher surface temperature than concrete, steel or glass, which also increases the feeling of well-being. Enabling efficient night-time cooling Due to global warning, there will be more, warmer heat days in the future with temperatures over 30° Celsius. Thermal insulation in summer is therefore becoming increasingly important. If we are to feel comfortable even on hot summer days, buildings must be able to cool down in the night. In order for windows to remain open at night, they must be burglar-proof and keep insects out. Appropriate window sizes and external shading help against the daytime heat.



Mass equals ignorance

For a long time, it was thought that summer thermal insulation could only be achieved by installing a large amount of mass. This is wrong. Old castles with their metre-thick walls might stay cool in the summer. But this is due in particular to the small windows. Modern architecture often has large window surfaces. Once heated up, too much thermal mass can become a heat trap, in particular in inner-city locations where the buildings cannot cool down sufficiently at night. Important influencing factors for good summer thermal insulation are appropriate window areas, a good sunscreen and efficient night-time cooling. This means that air conditioning is not required.



Architecture
HLS Architekten, Zurich

Building owner
Yamanakako AG, Thun

Timber engineering
Timbatec, Zürich

Large surfaces in wood
TS3 Timber Stuctures 3.0 AG, Thun

Timber construction
Stuber Holzbau, Schüpfen

First wooden cellar

What for a long time seemed utopian is now reality – Thun is home to the first apartment building with a cellar made entirely of wood. Houses without heating and without air conditioning make an important contribution to climate protection. An even greater potential for saving energy lies in the choice of construction materials.
Timber is already widespread in building construction. The next step is to abstain from using climate-damaging building materials such as steel and concrete – even in the basement levels and in the floor panels. In order for cellars to be mass-produced from wood in future, certain research issues need to be clarified. A research project at the Bern University of Applied Sciences together with Timbatec and other business partners is currently addressing these issues. The aim is to form a start-up from the group of research partners, which will be operational from 2023.

Photos from left to right:
André Maurer
Nils Sandmeier
Nils Sandmeier

“The age of oil and coal is over today. Tomorrow, it will also be over for steel and concrete.”

Stefan Zöllig
Founder of the Timbagroup and building owner of the apartment building

Careers at Timbatec

Make your next career move at Timbatec

We offer our employees three career paths: management career, professional career and project career. This is widely appreciated. Which is why we are constantly growing.

Timber construction is booming. Timber is the building material of the future – regardless of which type of construction project. That is why more and more building owners are choosing this sustainable material. For us, this means an increase in enquiries for competitions and construction projects. We can only handle all the exciting projects with a dedicated and well-trained team. That is why all our employees are entitled to 100 hours of personal further training per year. As a result, we are always up to date – be it in the field of building physics or elsewhere.

Photos:
Nils Sandmeier

"Do you want to join our team? Just get in touch – we would love to meet you."

Andreas Burgherr
Head of the Executive Board, Timbatec Holzbauingenieure Schweiz AG

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