Silent Timber Build for the European market (Silent Timber Build)

FINAL REPORT

Title of the research project	**Silent Timber Build for the European market**
Coordinator of the project	Klas Hagberg

BASIC PROJECT DATA

Project period	01.08.2014-31.07.2017
Contact information of the coordinator (institute/unit, address, telephone, fax, e-mail)	Rise Research Institutes of Sweden Lindholmspiren 7A 417 56 Göteborg Tel. +46 10 516 62 80 Fax. - E-mail inf@ri.se
URL of the project	http://www.silent-timber-build.com

FUNDING

Total budget in EUR	[amount in EUR]
Public funding from WoodWisdom-Net Research Programme:	Total funding granted in EUR by source:
Austria Federal Ministry of Agriculture, Forestry, Environment & Water Management (BMLFUW)	120 000 EUR
France Ministry of Agriculture, Fisheries and Forestry Resources (MAAF)	195 000 EUR
Germany Agency for Renewable Resources (FNR)	150 000 EUR

Norway	
The Research Council of Norway (RCN)	248 000 EUR
Sweden	
Swedish Governmental Agency for Innovation Systems (VINNOVA)	323 400 EUR

Other public funding:

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Other funding:

CEI-Bois, Belgium	200 000 EUR
Lignum, Switzerland	240 000 EUR
Industry (in-kind) Sweden, Germany, France, Norway	531 600 EUR

PROJECT TEAM (main participants)

Klas Hagberg, Lic Eng, proj.manager	(M)	RISE	Sweden
Delphine Bard, Ass prof, Lecturer	(F)	Lund Univ, Eng. Acoustics	Sweden
Anders Homb, PhD, Researcher	(M)	Sintef	Norway
Catherine Guigou Carter, PhD, Researcher	(F)	CSTB	France
Jean-Luc Koujoumji, PhD, Researcher	(M)	FCBA	France
Gerard Borello, PhD, Manager	(M)	InterAC	France
Moritz Spaeh, PhD, Group manager	(M)	IBP, Fraunhofer	Germany
Heinz Ferk, M.Sc, Lab. manager	(M)	TU Graz	Austria
Hansueli Schmid, Dipl. Eng, project man.	(M)	Lignum	Switzerland
Tomi Toratti, PhD, Senior specialist	(M)	Fed. of the Finnish Woodworking Ind.	Finland

DEGREES (if relevant)
Degrees earned or to be earned within this project.

2014	MSc	M	Nicolas Vardaxis, 1990 M.Sc. 2014	Chalmers / Lund	Delphine Bard / Klas Hagberg Lund Univ / WSP / Rise
2016	PhD	M	Juan Negreira, 1986 PhD 2016,	Lund Univ	Delphine Bard, Lund Univ.
2016	MSc	M	Wolfgang Hauer, 1991 M.Sc. 2016	TU Graz	Heinz Ferk, TU Graz
2016	MSc	M	Tobias Augustsson, 1986 M.Sc. 2016	Chalmers/WSP	Jens Forssén/ Klas Hagberg Chalmers/WSP/Rise
2017	MSc	M	E. Lundgrenn, 1992 M.Sc. 2017	NTNU	Anders Homb, Sintef / NTNU

PROJECT SUMMARY REPORT

Sound insulation and vibration characteristics of buildings represent the design parameters always deciding the structural dimensions and build-up of the floor- and wall assemblies in a building, no matter what is the structural material. It is not the statics, not the fire regulations, not energy requirements or any other technical aspect, it is always the sound insulation and / or the vibration characteristics that state the dimensions, at least for multi-family houses where requirements adapted to subjective evaluation are effectual. As soon as the design criteria of sound insulation and vibration are fulfilled, then the predicted sound insulation and vibration are expected to be satisfactory, e.g. the main structural dimensions in the building should then be decided since they are normally big enough to cover the needs for other technical aspects. This is at least valid for normal high rise multifamily buildings. Therefore, the results from this research project is of vital importance for the further development of wooden structures. Calculating and optimizing the structural components will imply further development of wood in buildings and make the production reduce in cost. The project results comprise a design guide involving for separate reports (to be broadcasted in September 2017 during the WoodRise conference in Bordeaux). Together they provide an extensive description of possibilities to facilitate prediction of and optimization of the sound insulation characteristics concerning floor and wall assemblies comprising wood as bearing structural element.

Hence, the guide is the result from the project WWN+ project “Silent Timber Build”, granted in the 4th joint call of WoodWisdom-NET research programme. Its results comprise guidelines regarding sound insulation and vibrations that can be used as designing wooden floor and wall assemblies and their connections, in order to develop a completed building that can correspond to habitants’ expectations in each specific case. The entire results from the research project are broadcasted in several different ways, amongst those (see also detailed specification in annex A):

a) The report series mentioned (design guide).
b) Certain measurement data useful as input to future standardization.
c) A commercial SEA software aimed for wood constructions SEAWOOD.
d) A European online Atlas with various floor and wall assemblies, partly developed within Silent Timber Build. It also comprises an online auralization tool, that is developed in order to listen to the different floor partitions prior to choose the final solution. The atlas also comprises a certain section with Silent Timber Build floor structures and a verified solution from the parallel WWN+ project HCLTP.
e) All will be available on www.Silent-Timber-Build.com

1.1 Introduction

1.1.1 Background

Wooden multi storey family houses are becoming more common. This development must be promoted and research has to be in advance in order to provide the right knowledge to the industry. Driving forces are sustainability, industrialization and cost reductions in the construction sector. Through previously finished and still ongoing projects, AkuLite, AcuWood and also some other projects in France, Switzerland and the Nordic countries, for example the Finnish project ÄKK ("user – oriented development of sound insulation in buildings") and one Swedish project in Luleå Technical University, the industry have the basis they need to develop systems towards future sound insulation design criteria. Design criteria that are, at least to some extent, expected in future ISO standards.

However, wooden structures still have a very serious shortcoming in the design stage compared to the historically "well established" concrete industry. Due to lack of satisfactory prediction models it is not possible to predict the final results satisfactory. Thus, that is therefore a natural step in research or it will become the next hindrance for future development. Therefore, this project has focused on development of prediction tools (see objectives) which is a natural and necessary transition from ongoing projects.

The work has been carried out by a team comprising the best setup of researchers together with companies with one common goal, to develop models that easily can be turned into practical use fast and efficient. It has been done by interaction between the partners and parallel projects. In addition, the results provide ISO and CEN standardization with new knowledge for wooden structures to further develop current ISO/CEN standards. These standards can then be used as basis for commercial software development, available for consultants throughout Europe. Today, commercial reliable software is primarily available for heavy structures. Hence project members have participated (and still do) in international research and standardization in order to achieve rapid implementation of new knowledge and then to coordinate activities in Europe and globally, see basic principles in figure 1.

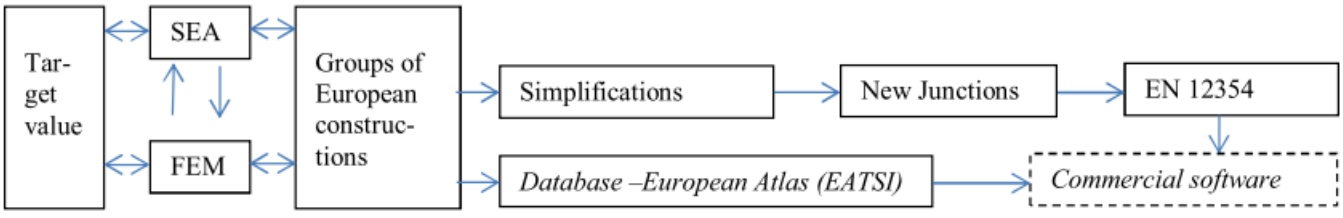

Figure 1. Schematic and simplified overview of the project idea

1.1.2 Objectives

The overall objectives of the project are to make multi storey buildings with wooden structures (could be family dwellings, student dwellings, elderly dwellings and similar) more competitive by:

- developing accurate prediction tools. They are needed to provide designers with new tools, as already available for concrete and steel structures, thus eliminating the need to build “test houses” when timber frame structures are considered. The prediction tools for vibrations and sound insulation will be developed in a manner that makes them usable for easy transferring into current EN-standards and in the extension to commercial software.
- applying and disseminating knowledge regarding new requirements adapted to wooden building systems that provide competitive sound insulation at all frequencies affecting human comfort, starting at very low frequencies where necessary.
- describing competitive and efficient solutions on the European market that is optimized to fulfil modern requirements and preconditions. It also includes a description on how the assembled combination of floors, walls and couplings influences sound insulation. They will be accessible in guidelines and examples in a new European database, developed within the project, that have the potential to fulfil future requirements
- increasing and disseminate the knowledge about the prediction models and efficient solutions among the industry and consultants using the new European database but also other sources.

1.2 Results and discussion

Modelling prerequisites – FEM/SEA

The main aim has been to develop prediction tools applied for wooden constructions as they might appear no matter if it is joist constructions, CLT or any other wooden structural bearing solution. Included in this is also to create necessary basis for enough accuracy for any European wood construction. It implies development of new methods but also to understand how input forces primarily from the ISO tapping machine (for measuring impact sound) affects the results of impact sound levels, specifically in the low frequency region. This section also describes how models are developed, in order to provide expected accuracy and then how to further improve the models in order to optimize floor and wall assemblies. The Work Package preparing the models has been closely linked to the other work packages. This implies that the prediction model results can be compared to expected values for the construction group considered (based on measurements) for any European construction, see below. From that, optimization of floor assemblies and refining of the model is possible.

For details regarding theory and modelling prerequisites, see report from WP1 that will be finished/published during august or early September 2017.

Additionally, a large amount of data was collected to provide input to future standardization by measuring damping through junctions. One extensive measurement series was carried out by the project partner Rothoblaas and another by FCBA in Bordeaux in France.

Validation of prediction tools and constructions – grouping, verification measurements and trend analysis

Current existing European wooden floor- and wall assemblies comprises a huge number of variables. The building materials involved in various solutions are numerous. All these variables make it difficult to predict and really identify what is most essential in order to optimize the structure in terms of acoustics and vibrations. When modelling, how can we really be sure that the correct assumptions are carried out and in the extension, that the results are trustable? That is the reason why this project started with collection of current data available in different countries but also additional laboratory measurements within the project and then a grouping of the building systems (floor assemblies primarily), followed. The grouping was made in order to detect any relations between important variables that might be used in order to make rough estimations of the floor assembly sound insulation characteristics. Hence, as a new wooden floor assembly is modelled, the grouping can be helpful to use as comparison with “measured” values, even if the modelled floor assembly itself is not measured.

The grouping does not cover all systems in spite of trying to collect as many data as ever possible during the project. Hence the grouping and its results have to be used carefully, it is as mentioned in the heading a “trend analysis”. Nevertheless, it is a safety for the engineers creating acoustic models that the model is properly modelled to start. As changes are carried out in the model in order to improve a floor assembly the grouping can be used yet again in order to estimate if the results are probable and reliable, a minor confirmation for the engineer.

The grouping could be even more extensive, but it is a first attempt. It might need future updates in the further development of the wooden building sector. The grouping principles is found in report no 2 that will be published within one month as well. The results from the grouping indicate that it is far more efficient to use wood joist floor assemblies compared to homogeneous CLT structures. The floor assemblies become less heavy, still performing better in terms of acoustics.

European ATLAS

Finally, a European ATLAS is available as a complement to the grouping above. The ATLAS is hosted by the project partner LIGNUM at www.lignumdata.ch. The ATLAS is not developed as a whole during this project but it has been completed and with a complex listening tool has been developed within Silent Timber Build, which is now available on line, details will be presented in report from WP 3 within one month as well. The listening tool has been part of WP 3 and implies that it is possible to listen to the results of a floor assembly facilitating for the user to understand the objective numbers that is given in the ATLAS. During the project floor assemblies have been added to the database and in particular one floor assembly is now available and it is a floor developed within the parallel project, HCLTP. Hence, it is possible to create a floor assembly, develop a model based on SEA or FEM and calculate, compare with

grouping values in order to secure the model, refine the model, put it online in the database, and finally listen to the results and compare to other floors.

For the careful designer it is a possibility that could be of great benefit.

1.3 Conclusions

Using the results from the project, modelling and prediction of wooden structures is far more easily accessible and more precise today. A software has been developed further (SEAWOOD) allowing any wooden structure to be modelled. A big improvement has been done regarding the sound source and the description of the forces operating on wooden structures. A grouping has been done considering the most “sensitive prediction” in terms of annoyance – impact sound of floor assemblies. The grouping facilitates comparisons of the modelled results with “measured” values for the actual floor assembly ➔ increasing the safety margins and the confidence of the engineer. Floor assemblies can be connected to an aural impression for better understanding of the numbers using the online listening tool hosted by Lignum. A helpful toll, prior to take final decision regarding which layup to choose.

The software SEAWOOD is not yet a “simple” tool for any engineer, but the software is a powerful tool in the design process and available for advanced computing. Together with the previous work within the COST action FP 0702 the input and knowledge for a general engineering software is coming close.

The cooperation with the parallel WWN+ work “HCLTP” has been of great benefit, since we have been able to model a structural element that is tested and developed based on its load bearing capacities and production abilities. Some basic changes were proposed from Silent Timber Build in order to optimize it also in terms of acoustics, still not to worsen other technical characteristics.

1.4a Capabilities generated by the project

The project results will open up for a new way to design wooden structures. “Test buildings” are not necessary any more since the skilful acoustic engineer can make safe estimations of structural components and also when those components are compounded to one building. Still a lot of material input data are deficient and sometimes lacking but that do not prevent modelling since the models can be “verified“ to some extent by using the grouping results.

As for the concrete industry, the wooden building sector can turn into more “design” sector regarding acoustics. More calculations and development promoting smarter and more optimized solutions can take place, replacing prevailing design principles based on assumptions and experience, with too much safety margins creating costs for the industry. That is certainly an opportunity for new businesses.

1.4b Utilisation of results

The project results have been used in many ways so far, directly in national wooden projects together with the industrial representatives, but also in cooperation with the WWN+ "HCLTP" project when developing their Hybrid plates also to fulfil certain acoustic requirements.

The plan is to deliver a "design guide" containing four reports.

1. A summary report (WP5)
2. One report describing the modelling prerequisites and input for standardization (WP1)
3. One report describing the grouping and trend analysis (WP2)
4. One report describing the ATLAS (available electronically at www.lignum.ch) and corresponding listening tool (WP3)

They will all be uploaded to www.silent-timber-build.com beginning of September and hopefully they can be a helpful tool to facilitate design of wooden constructions. A seminar will be held during the WoodRise conference in Bordeaux in September 2017.

1.5 Publications and communication

In the attached dissemination sheet five articles reports are indicated with an asterisk. However, it is not yet fully completed and it is the total delivery that is of interest. Hence, the report series comprising results from each WP will perhaps at the end be the main publications since they also refer to papers and scientific articles.

1.6 National and international cooperation

During the project a number of connections have been developed. In general, the industrial partners have been following the project with great interest and also provided a lot of input and involvement during Master thesis projects and laboratory measurements. The industrial partner Rothoblaas arrived in the project after it has started and has been very active and provided an extensive setup of measurements useful as input for future standardization. The WWN+ projects Wood2New and in particular the project HCLTP have created a number of new links and interesting collaboration both during the project but also or the future. We have mutually participated in meetings in order to extend the knowledge of wood design in terms of other technical aspects.

The project has also gained a lot of attention from outside Europe implying invitations also to Canada and US to present the idea and the expected outcome (see dissemination list).

In general, the project Silent Timber Build has involved many partners itself, which means that transnational cooperation has been necessary in order to provide results and to transfer these results to a national level. It has been challenging but also very inspiring. Additionally, the project has extended more than expected, due to an extensive and fruitful collaboration from other projects during the three years.

Updated 2017-08-07

Silent Timber Build dissemination 2014 – 2017

Working partners: FCBA, CSTB, InterAC, LTH, Sintef, TU Graz, IBP Fraunhofer, Lignum, Tecnalia, Finnish Wood etc				
Dissemination, how and where	***Titel, description***	***Author / presenter***	***Made by /Planned by When?***	***Uploaded to website?***
Working reports (without official search numbers)				
Interims report for FNR Germany	Zwischenbericht ERA-WoodWisdom: Leise Holzgebäude für den europäischen Markt (Silent Timber Build) from 13.05.2015	M. Späh, P. Leistner	05/2015	No
Internally	Force identification of Shock Machine - Test campaigns in FCBA for Silent Timber Build project	G. Borello	2015-11-01	No
Official report for the Austrian government	Official intermediate report	Ferk	08/2015	No
Interims report for FNR Germany	Zwischenbericht: Ergebnisse und Stand des Vorhabens; ERA-WoodWisdom: Leise Holzgebäude für den europäischen Markt (Silent Timber Build) from 28.04.2016	M. Späh	04/2016	No
Interim report for Norgeshus	Vibration transmission measurements of the "Kvartett" building concept	A.Homb	11/2016	No
Interim report for Norgeshus	Sound insulation measurements of the "Kvartett" building concept	A.Homb	05/2016	No
European J. Wood and Wood Prod.,74(3): 353–67. http://dx.doi.org/10.1007/s00107-015-0976-z	Vibration serviceability performance of timber floors.	Weckendorf, J., Toratti, T., Smith, I., & Tannert, T	2015	No
DAGA 2016	A Contribution concerning Boundary Condition Effects that need to be considered using SEA for Calculation of Direct Sound Transmission	W. Hauer H. Ferk	03/2016	
BauSIM 2016	Numerical calculation of the direct sound transmission using a combined finite element - statistical energy analysis approach	W. Hauer H. Ferk	09/2016	

DAGA 2017	Zum Einfluss der modalen Kopplung von Prüfräumen und Prüfobjekten auf Messungen des Schalldämm-Maßes einer Brettsperrholzplatte im tieffrequenten Bereich	W. Hauer H. Ferk	03/2017	
Silent Timber Build	Modelling prerequisites – FEM/SEA Impact and Airborne Sound	Delphine Bard et.al	09/2017	No
Silent Timber Build	Validation of prediction tools and constructions – grouping, verification measurements and trend analysis	Anders Homb et.al.	09/2017	No
Silent Timber Build	European Timber Sound Insulation Atlas	Hansueli Schmid et.al	09/2017	No
Silent Timber Build *	Design Guide – Silent Timber Build – WWN+ Summary	K. Hagberg, T Toratti	09/2017	No

Dissemination, how and where	*Titel, description*	*Author / presenter*	*Made by /Planned by When?*	*Uploaded to website?*
Popular publications				
Bygg&Teknik nr 3 2015	Silent Timber Build – för Framtidens trähus (In swedish)	K.Hagberg	2015	Yes
Bygg&Teknik nr 3 2016	Silent Timber Build – beräkning av ljudisolering i träkonstruktioner rycker allt närmare	K.Hagberg	2016	Yes
Bygg&Teknik nr 3 2016	FEM beräkningar av ljudiolering i byggnader med trästomme (In Swedish)	D. Bard; N. Vardaxis	2016	Not yet
Bygg&Teknik nr 3 2017	Beräkning av ljudisolering i trästommar med SEAWood (in Swedish)	K.Hagberg; T.Augustsson	2017	
Adresseavisen 23.4.2014	Fremtid i tre (in Norwegian)	Time, B., Homb, A., Malo, K.A., Haugen, T.	2014	No

Dissemination, how and where	*Titel, description*	*Author / presenter*	*Made by /Planned by When?*	*Uploaded to website?*
Product development in connection to companies / industrial partners				
	A number of cooperation but not broadcasted			

Dissemination, how and where	*Titel, description*	*Author / presenter*	*Made by /***Planned by** *When?*	*Uploaded to website?*
Handbooks				
SINTEF Building & Infrastructure: Building detail sheet	No. 522.511 Lydisolerende etasjeskillere med trebjelkelag i boliger (in Norwegian)	A.Homb	09-2016	Subscription needed
SINTEF Building & Infrastructure: Building detail sheet	No. 522.512 Lydisolerende etasjeskillere med trebjelkelag. Målte verdier (in Norwegian)	A.Homb	09-2016	Subscription needed

Dissemination, how and where	*Titel, description*	*Author / presenter*	*Made by /Planned by When?*	*Uploaded to website?*
Seminars, workshops				
Presentation at specific low frequecy workshop, Paris France	SILENT TIMBER BUILD Presentation of the project and more specifically prediction in the low frequency range	C. Guigou-Carter J.L. Kouyoumji	CIDB,CINOV-GIAC and SFA	Yes
Presentation at SP day 2015	Massivträhusens akilleshäl på väg att botas	K. Hagberg	2015-04-15	Yes
Forum Holz|Bau|Nordic 2014	*Timber and sound – what works well and what does not.* Presentation at Nordic Wood Building Conference: Forum Holz|Bau|Nordic Trondheim 14. Trondheim 24.-26.09.2014	Homb, A.		
NAL-kurs, Oslo 2014	*Lydoverføring i trebygninger med flere etasjer*. Foredrag ved NAL-kurset "Prosjektering av urban trearkitektur". Norske arkitekters landsforbund, Oslo 17.10.2014	Homb, A.		
NTF-kurs, Gardermoen 2015	*Gitterbjelkelag og lyd. Løsninger og utfordringer.* Foredrag på kurs "Trekonstruksjoner". NTF i samarbeid med Treteknisk, Gardermoen, 3. og 4. februar 2015.	Homb, A.		
STB-seminar, Stochholm 2015	Seminar "Silent Timber Build". In cooperation with Swedish Wood and Swedish Wood Building Council, Stockholm 28-29. April 2015 – see www.silent-timber-build.com	Project team	28-29 April 2015	Yes
NTNU workwhop, Trondheim 2015	*Etasjeskillere; Dagens løsninger og framtidens optimaliserte konstruksjoner*. Workshop Trekonstruksjoner. Institutt for konstruksjonsteknikk, NTNU, 3. juni 2015	Homb, A.		
SP "Trähusdagar" 2016, Skövde Sweden	Silent Timber Build – prediction models for wooden structures	K. Hagberg	March 2016	Not yet
TEKNA-kurs, Trondheim 2016	Krav og anbefalinger til lydisolasjon i trekonstruk-sjoner. Lyd og vibrasjoner til gitterbjelkelag. Foredrag ved kurset "Lyd og brannprosjektering av trekonstruksjoner"	A.Homb	Jan 2016	No
Digitale Fertigung im Holzbau 18/19Okt. 2016 Weinfelden, Swizerland	Vom Bauteilkatalog Schallschutz zur BIM Bibliothek für den Holzbau	H. Schmid	October 2016	

Dissemination, how and where	*Titel, description*	*Author / presenter*	*Made by /Planned by When?*	*Uploaded to website ?*
Conference papers				
Internoise 2014 Melbourne	Challenges for acoustic calculation models in "Silent Timber Build", Part 2	J-L KOUYOUMJI, D. Bard, G Borello, C GUigou	Nov 2014	Yes
Internoise 2014 Melbourne	Challenges for acoustic calculation models in "Silent Timber Build", Part 1- FEM	D. Bard, J Negreira, J-L KOUYOUMJI, G Borello, C GUigou	Nov 2014	Yes
Internoise 2014 Melbourne	Challenges for acoustic calculation models in "Silent Timber Build", Part 2	J-L KOUYOUMJI, D. Bard, G Borello, C GUigou	Nov 2014	Yes
Internoise 2014 Melbourne	Low frequency sound transmission in multifamily wooden houses	K. Hagberg, D. Bard	Nov 2014	Yes
Internoise 2014 Melbourne	Acoustic Solutions for Wooden Intermediate Floors	A Liebl, O Bartlomé	Nov 2014	Yes
Internoise 2014 Melbourne	Comparison of the results of a laboratory experiment and a field study with regard to acoustic quality in wooden buildings and recommendations for classification of acoustic quality	A Liebl, M Spaeh, O Bartlomé, M Kittel	Nov 2014	Yes
Internoise 2014 Melbourne	Laboratory facilities for sound transmission measurements – validation by measurement and simulation methods	M. Meissnitzer B Buchegger H. Ferk	Nov 2014	Yes
InterNoise 2014, Melbourne	Measurements of junction vibration level differences of timber framed constructions. *Proceedings Inter.noise 2014.* Melbourne 16-19. november 2014, Austalia.	A.Homb	Nov 2014	Yes
InterNoise 2014, Melbourne	Dynamic Laminate Model for Broadband Frequency Prediction	G Borello, A Duval	Nov 2014	Yes
Internoise 2014 Melbourne	Determination of vibration acceptability and annoyance design indicators for human response to wooden-floor vibrations.	J. Negreira, A. Trollé, K. Jarnerö, L-G. Sjökvist, D. Bard.	Nov 2014	NO
ICSV Beijing 2014	NEW RESEARCH CREATE BASIS FOR FUTURE COMPETETIVE WOODEN STRUCTURES	K. Hagberg	July 2014	Yes
ICSV Beijing 2014	Challenges for acoustic calculation models in "Silent Timber Build"	D Bard, G. Borello, C. Guigou, J. Negreira, J-L Kouyoumji	July 2014	
ICSV Beijing 2014		O Bartlomé	July 2014	
Internoise2015 San Francisco	Predicting Sound Transmission Loss of timber framed walls and floors using SEA, in "AcouBois" project of the French wood industry	J-L KOUYOUMJI	August 2015	

Internoise2015 San Francisco	Prediction of the acoustic performance of lightweight wood-based floor	C. Guigou C. Coguenanff	August 2015	Yes
Internoise2015 San Francisco	Vibration response of lightweight building elements under structural excitation	S. Bailhache M. Villot	August 2015	Yes
Harrogate 2015 – Institute of Acoustics	ACOUSTICS IN TALL WOOD BUILDINGS, RECENT RESEARCH AND FUTURE CHALLENGES	K Hagberg, D Bard	October 2015	Yes
Les Rencontres Acoustique et Techniques, Paris	Développement de modèles prédictifs basses fréquences pour les constructions bois dans le cadre du projet européen Silent Timber Build	C Guigou, JL Kouyoumji	June 2015	No
DAGA 2016, Aachen, GER	The determination of radiation efficiencies of plates used for timber constructions in reverberation chambers	Wolfgang Hauer	03/2016	Not yet
WCTE 2016, Vienna	Experimental analysis of flanking transmission of different connection systems for CLT panels	A. Speranza, L. Barbaresi, F. Morandi	August 2016	No
WCTE 2016, Vienna	Modelling guidelines for simulating low frequency vibroacoustic performance in wooden T-junctions	J., Negreira, A. Sjöström, D. Bard	August 2016	No
WCTE 2016, Vienna	Silent Timber Build – Development of low frequency vibroacoustic prediction tools for lightweight wooden constructions.	D. Bard, C. Guigou-Carter, C. Coguenanff, J. Negreira	August 2016	No
WCTE 2016, Vienna	Frequency spectra of typical European wooden joist constructions. Proceedings World Conference on Timber Engineering	A.Homb, C. Guigou-Carter, K. Hagberg, H. Schmid	August 2016	Not yet
IMAC XXXIII Orlando	Numerical prediction tools for low-frequency sound insulation in lightweight buildings	J., Negreira, D. Bard	February 2015	No
ICA 2016, Buenos Aires	Modelling of the tapping machine for finite element prediction tools – Preliminary parametric studies.	J., Negreira, D. Bard	Sept 2016	No
ICA 2016, Buenos Aires		K. Hagberg	September 2016	
ICA 2016, Buenos Aires	Reverse sea to predict flanking transmission in timber framed constructions (Silent Timber Build, special session)	J-L Kouyomji G Borello H Ferk	September 2016	
ICA 2016, Buenos Aires	Hybrid cross-laminated timer floors. Comparison of measurements and calculations. Proceedings 22nd International Congress on Acoustics	A.Homb	September 2016	Not yet
ICA 2016, Buenos Aires	Experimental analysis of flanking transmission in CLT structures	L. Barbaresi, F. Morandi, M. Garai, A. Speranza	September 2016	
ICSV 2017, London	Acoustic performance prediction for wood frame based floors	C. Guigou C. Coguenanff	July 2017	No
ICSV 2017, London	Multi-criteria optimization of a wood based floor	C. Coguenanff C. Guigou	July 2017	No
ICSV 2017, London	Lightweight floor: step by step comparisons between	C.	July 2017	No

	measured and simulated quantities	Coguenanff C. Guigou, M. Spaeh		
Internoise 2017, Hong Kong	SILENT TIMBER BUILD – modelling acoustic characteristics of timber structures	K. Hagberg, D. Bard	August 2017	

Dissemination, how and where	*Titel, description*	*Author / presenter*	*Made by /Planned by When?*	*Uploaded to website?*
Other international presentations				
Mass Timber Session in Harrogate UK	ACOUSTICS IN TALL WOOD BUILDINGS, RECENT RESEARCH AND FUTURE CHALLENGES	K Hagberg	October 2015	Yes
Mass Timber Workshop in Madison USA	Acoustic prediction models create basis for future competetive wooden structures http://www.woodworks.org/	K Hagberg	Nov 2015	Yes
Forum Wood Building Nordic Espoo 2016	Silent Timber Build – WWN+	K. Hagberg	June 2016	No
WCTE 2016	Arranging a session in the conference WCTE	D.Bard	August 2016	
ICA 2016 Buenos Aires, Argentina	Arranging a session regarding ´Calculation models for wooden structures – Silent Timber Build´	K. Hagberg; J-L Koujoumji	Sept 2016	
AIA; Symposium Advanced research in timber construction, Bolzano Italy	Silent Timber Build – WWN+	J-L Kouyomji; K. Hagberg	March 2017	
WWN+ seminar, Edinburgh, UK	Presentation of project “Silent Timber Build”	K. Hagberg	April 2017	
Vancouver British Colombia	Innovative Swiss Timber Architecture	H. Schmid	February 2017	
HolzBauSpezial | Bauphysik, Kurhaus, Bad Wörishofen (DE)	Bauteilkatalog Schallschutz als integrierte BIM Lösung	H. Schmid	March 2017	
Final seminar Woodrise Bordeauz	Presentation of STB results	JLK, KH, CG, DB, HF	Sept 2017	
ECCOMAS MSF 2017, Ljubljana	Presentation of STB (cooperation with HCLTP)	K. Hagberg	Sept 2017	

Dissemination, how and where	*Titel, description*	*Author / presenter*	*Made by /Planned by When?*	*Uploaded to website ?*
Scientific articles				
Journal Paper, Building Acoustics *	Impact sound insulation of wooden joist constructions. Collection of laboratory measurement and trend analysis.	A.Homb, C. Guigou, K. Hagberg, H. Schmid	Vol. 23(2), p 73-91 2016	No
Journal Paper, Building Acoustics *	Impact sound insulation of cross-laminated timber/massive wood floor constructions. Collection of laboratory measurement and result evaluation.	A.Homb, C.Guigou-Carter, A.Rabold	Vol. 24(1) 2017	No
Journal Paper, Applied Acoustics, 105:1–12	Low frequency vibroacoustic investigation of wooden T-junctions	J. Negreira, A. Sjöström, D. Bard	2016	No
Journal Paper, Journal of Sound and Vibration, 340: 383–408	Psycho-vibratory evaluation of timber floors – Towards the determination of design indicators of vibration acceptability and vibration annoyance	J. Negreira, A. Trollé, K. Jarnerö, L-G. Sjökvist, D. Bard	2015	No
Journal Paper, Engineering Structures, 83: 7–16	The effect of modelling acoustic media in cavities of lightweight buildings on the transmission of structural vibrations.	O. Flodén, J. Negreira, K. Persson, G. Sandberg.	2015	No
Journal Paper, Building Acoustics, 21(4): 251–276 *	Characterisation of an elastomer for noise and vibration isolation in lightweight timber buildings.	J. Negreira, P-E. Austrell, O. Flodén, D. Bard	2014	No
Submitted to Applied Acoustics	Airborne sound insulation between dwellings, from 50 Hz – Twenty years of experience in Sweden	F. Ljunggren, C. Simmons, R. Öqvist	2017	No
Journal paper, Applied Acoustics	Correlation between sound insulation and occupants' perception – Proposal of alternative single number rating of impact sound, part II	F. Ljunggren, C. Simmons, R. Öqvist	2017	No
Acoustical Society of America - POMA-D-17-00015 *	Experimental analysis of flanking transmission in CLT structures	L. Barbaresi, F. Morandi, M. Garai,		

		A. Speranza		
Journal Paper	Evaluation methods for sound transmission in numerical calculations, especially at lower frequencies	H. Ferk, Hauer	Under prep. Planned 2017	Noy yet

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Master thesis works and dissertations				
WSP	FEM modelling for a CLT structure	N. Verdaxis	2014-09	Yes
Master Thesis GRAZ	Calculation of the sound reduction index of a simplified timber construction using an SEA-environment	Wolfgang Hauer	07/2016	
PhD Thesis	Vibroacoustic Performance of Wooden Buildings - Perception and Prediction	Juan Negreira	May 2016	Not yet
Master Thesis NTNU	Beregning og måling av lavfrekvent trinnlydisolasjon til bjelkelag. Masteroppgave ved Institutt for bygg- og miljøteknikk, IVT-Fakultetet (in Norwegian)	E.Lundgrenn	February 2017	No
Chalmer / LTH / WSP	Evaluating SEA modelling of lightweight building elements containing cross laminated timber	T Augustsson	2016	

Dissemination, how and where	*Titel, description*	*Author / presenter*	*Made by /Planned by When?*	*Uploaded to website?*
Web page / Newsletters				
Web	www.silent-timber-build.com	STB		
Web	European Atlas http://bauteilkatalog.lignum.ch/	Lignum		
Laboratory for Building Physics Web page	”A new way to test and calculate wood based constructions.”	GRAZ		
Träguden (Swedish)	Updating a design web page in Sweden www.traguiden.se	Swedish Wood		