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Surveying Acoustic Properties of Timber Buildings in Norway through Academia–Industry Collaboration and Student Research

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Timber construction is promoted as a sustainable solution for buildings, yet acoustic performance remains a critical challenge. Field measurements play a key role in validating design assumptions, understanding construction variability, and informing future solutions. However, systematic data collection from real buildings is resource-intensive and often fragmented. The 3LYD project, initiated by the Norwegian Wood Cluster, aims to establish a shared database of field measurements for wooden floor systems and to facilitate experience exchange between academia, industry, and acoustic consultants. This paper presents the methodology and outcomes of Work Package 1.3, led by NTNU, which focused on generating supplementary field measurement data for wood buildings in Norway through structured student involvement while ensuring measurement quality.

The initial phase of this study in 2025 included representative selection of 13 buildings with timber-based floor systems, including new and old buildings with wood joists, prefabricated systems, and cross-laminated timber (CLT). 22 floor constructions were tested corresponding to 18 different assembly examples. The student studies addressed topics such as measurement uncertainty and variation of results from same construction details between rooms and between buildings, renovation measures, low-frequency performance, and comparisons between simulations and field results and subjective perception.

This paper analyses and introduces only the measurement results. The results are presented for three categories: existing (old) wood joist floors, new wood joist floors, and CLT floors. New wood joist floors and two refurbished old floors complied with the NS8175:2012 requirements with deviations of 1-2 dB considered within measurement uncertainty. However, when evaluated against NS 8175:2019, which introduces low-frequency spectrum adaptation terms, the results were weaker: several new constructions did not meet airborne sound requirements, while improved constructions showed limitations in meeting impact sound criteria. Overall, the results provide empirical findings and contribute to development of pre-accepted solutions, while demonstrating the potential of structured academia–industry collaboration to generate high-quality, practice-relevant data.

1 Introduction

Neighbour noise is associated with annoyance, stress, perceived privacy, and residential satisfaction, and it is one of the most frequent complaints in multi-dwelling buildings [1-9]. Studies indicate the importance of low frequency performance on human perception, thereby calling update in building regulations [10]. Meanwhile, the increased use of timber in construction has become a central topic in both national and international agendas, driven by sustainability goals and the industrialization of building processes. While timber construction offers environmental benefits, its acoustic performance particularly at lower frequencies continues to present challenges due to their relatively low mass.

In Norway, the current building regulation - TEK17 [11] refers to NS 8175:2012 [12], which has been revised with NS 8175:2019 [13]. The updated standard places increased emphasis on low-frequency sound, introducing new challenges for the construction industry (Table 1). Another challenge is that the existing design guidelines and market solutions typically declare acoustic performance only down to 100 Hz. Less data is available in the lower frequency range. To address this gap and support the future implementation of NS 8175:2019, increased empirical knowledge from field measurements is required.

Table 1: Requirements for partitions between dwellings (Data from [12-13])

	A	B	C	D
NS8175:2012	$R'_w+C_{50\text{-}5000} \geq 63$	$R'_w+C_{50\text{-}5000} \geq 58$	$R'_w \geq 55$	$R_w \geq 50$
	$L_{n,w}+C_{i,50\text{-}2500} \leq 43$	$L_{n,w}+C_{i,50\text{-}2500} \leq 48$	$L_{n,w} \leq 53$	$L_{n,w} \leq 56$
NS8175:2019	$R'_w+C_{50\text{-}5000} \geq 62$	$R'_w+C_{50\text{-}5000} \geq 58$	$R'_w+C_{50\text{-}5000} \geq 54$	$R_w \geq 50$
	$L_{n,w}+C_{i,50\text{-}2500} \leq 46$	$L_{n,w}+C_{i,50\text{-}2500} \leq 50$	$L_{n,w}+C_{i,50\text{-}2500} \leq 54$	$L_{n,w} \leq 56$

In this context, the 3LYD project was initiated by the Norwegian Wood Cluster, bringing together industry and research partners, including wood manufacturers, architects, acoustic consultants, and research institutions. This project aims to gain more knowledge on acoustic behaviour of typical wood constructions in Norway, prepare a database and enable robust pre-accepted solutions [14].

Currently, field measurements conducted on behalf of developers are rarely accessible beyond the commissioning client and the consulting company, limiting knowledge transfer and cumulative learning across projects. The 3LYD project seeks to overcome this limitation by systematically collecting and structuring field data, with a particular focus on floor systems in multi-storey timber buildings. Residential buildings are prioritized, followed by schools and office buildings.

Within this framework, Work Package 1.3 investigated whether students could meaningfully contribute to the collection of high-quality field measurement data while simultaneously strengthening competence development in timber acoustics. This paper presents the methodological framework with quality assurance strategy, and outcomes of student involvement in AP1.3, focusing on both technical and educational dimensions.

2 Methods

The initial phase of the project was carried out during the 2024–2025 academic year and forms the basis for the results presented in this paper. The work is ongoing, with continued involvement of master's students and further data collection and analysis.

2.1 Student involvement

Bachelor students from NTNU's Department of Civil and Environmental Engineering (Trondheim) and Department of Manufacturing and Civil Engineering (Gjøvik) were integrated into the project through a structured framework combining: (1) recruitment and assignment of research topics, (2) targeted education and training in acoustic measurements, (3) hands-on supervised fieldwork, and (4) student research conducted under joint supervision from academic staff and industrial partners (acoustic consultants).

Preparations for the student involvement included a review of available timber construction systems and identification of suitable buildings for measurement, as well as communication with potential partners, development of draft project topics

and introductory outreach to potential students. All participating students had some basic knowledge of acoustics through building physics courses, however, have not focused specifically on acoustics before.

Within the 3LYD project, students received an intensive acoustics education covering the fundamental concepts related to building acoustics, measurement techniques, and relevant international and Norwegian standards. The training was organized into three modules:

1. The first module introduced key concepts, safety procedures, demonstration of measurement equipment and a hands-on measurement in the classroom setting. At the end of this module, students selected their topics and assigned to do preliminary research.
2. The second module was delivered as a two-day intensive workshop covering calculation methods, measurement procedures, relevant standards, example constructions, and simulation approaches. Students worked with sample floor plans and measurement datasets to practice planning, calculation and reporting. After the second module their assignment was to analyse the given measurement data.
3. The third module consisted of supervised field measurements conducted in a case building, allowing students to apply the knowledge in a real context and experience challenges.

Following the training, students carried out their thesis work in 2/3-people groups and received critics in one-on-one supervision. Each student group was guided by two academic supervisors with complementary expertise in acoustics and construction, as well as an assigned industrial partner from the 3LYD consortium. This supervision setup enabled multidimensional discussions and facilitated linking the theory to practice.

While each student project addressed a different research question, all included a common methodological framework involving field measurements of floor systems in wooden residential buildings. Standardized documentation and reporting formats were defined to ensure consistency and quality, including annotated floor layouts (a legend plan showing rooms of interest), measurement plans for each room, dataset including sound levels and reverberation times at each measurement position, sound insulation analysis reports, documentation of measurement conditions and photos.

2.2 Measurements and supplementary methods

The selected building sample initially comprised 11 buildings and was further supplemented through the measurement tasks during TBM4321 *Building Acoustics* elective course to provide additional insights. In total, 13 buildings with timber-based floor systems were investigated, including both new (5) and existing (4) buildings with wood joists, prefabricated building (1) with joist floor system, and cross laminated timber - CLT (3) buildings. Across these buildings, 22 floor constructions were tested, corresponding to 18 distinct assembly types. Two of the buildings were under refurbishment which enabled before & after tests for three joist floors.

All sound insulation measurements were conducted in accordance with ISO 16283-1 [15] and ISO 16283-2 [16] using fixed microphone positions (10 sound source-microphone position combinations for airborne and 8 for impact sound). Reverberation time was measured following ISO 3382-2 [17] using the interrupted noise method, with measurements performed in at least three positions and repeated twice at each position. Acoustic imaging was applied by two student groups using Seven Bel camera systems to identify potential sound leakage paths. In addition, three groups performed numerical simulations using Insul and COMSOL to complement the field measurements. One group conducted a perception-based study, developing a questionnaire aligned with the example format proposed in COST TU0901 [18].

Table 2 presents an overview of the study topics, implemented methods and building sample.

Table 2: Overview of studies

Study topic	**Methods**	**Building and measurement sample**
1.Analysis of measurement deviations in new buildings with floors with wood joists	Measurement	3 new buildings with wood joists, 7 rooms
2.Comparison of new and old wood joist constructions and performance improvement	Measurement, simulation	1 old and 2 new buildings with wood joists (only 1 new building was included here)
3.Acoustic performance in student dorms and comparison with survey findings	Measurement, image, survey	2 new buildings with (a) prefabricated wood joists (b) CLT
4.Acoustic improvement of existing floors	Measurement, simulation, image	1 old building with wood joists, 2 rooms before and after refurbishment
5.Low frequency behaviour of different floor constructions	Measurement, simulation (modal anlys.)	1 new building with CLT and concrete, 1 old building with wood joist before refurbishment (+ suppl. measurements after refurbishment)
Supplementary measurements (TBM4321 Building Acoustics elective course)	Measurement	2 old buildings with wood joists after refurbishment and 1 CLT building

2.3 Analysis of results

The students were responsible for the analysis conducted as part of their thesis work. For the inclusion of data in the 3LYD database as well as for presenting the research results in this paper, the data were reviewed by the first author. The measurement data and findings were compiled and evaluated for completeness, consistency, correct implementation of methods, and accuracy of calculations. Two of the results were eliminated due to insufficient documentation and discrepancy at measurement data. The results were compared to national requirements and deviations were marked.

Hereafter the paper presents only the results from measurements excluding the supplementary methods implemented by the students. Table 3 gives the construction descriptions for tested sample.

Table 3: Test sample

Old Wood Joist Constructions & Improvement				
Case ID*	**Construction description**	**Cons. Yr.**	**Location**	**Function*****
511_before	15mm Parquet, 2mm Underlay, 20mm Wood subfloor | 18cm Joists, Mineral Wool in cavity | 20mm Wood ceiling planks	1955	Trondheim	Bedroom
511_after	15mm Parquet, 2mm Underlay, 20mm Wood subfloor | 18cm Joists, Mineral Wool in cavity | 20mm Wood ceiling planks, 50mm Resilient Mount and battens, 2 layers 13mm Gypsum Board	1955, refurb: 2025	Trondheim	Bedroom
411_before	15mm Parquet, 20mm Wood subfloor | 23cm Joists, Clay Infill in cavity (ca 10-15cm) | 2 layers 20mm Wood subfloor planks (40mm at overlaps, 20 mm local), Mineral Wool50mm	1934	Lillehammer	Living room
411_after	15mm Parquet, 20mm Wood subfloor | 23cm Joists, Clay Infill in cavity (ca 10-15cm) | 20mm Wood subfloor planks (40mm at overlaps), Mineral Wool50mm, 5mm Resilient Mount and battens, 13mm Gypsum Board	1934, refurb: 2025	Lillehammer	Living room
412_before	20mm Wood subfloor | 20cm Joists, Clay Infill in cavity (ca 10-15cm) | 20mm Wood subfloor planks (40mm at overlaps), 17mm Wood ceiling planks, 11mm MDF	1934	Lillehammer	Bedroom
412_after	15mm Parquet, 2mm Underlay, 13mm Gypsum Board, 20mm Wood subfloor | 20cm Joists, Clay Infill in cavity (ca 10-15cm) | 20mm Wood subfloor planks (40mm at overlaps), 17mm Wood ceiling planks, 11mm Medium Density Fibreboard	1934	Lillehammer	Bedroom
611_after	15mm Parquet, Underlay, *13mm Gypsum Board*** (new floor), 20mm Wood subfloor | ca 23cm Joists, Clay Infill in cavity | 20mm Wood ceiling planks, *50mm Battens***, 20mm Wood ceiling planks (new ceiling)	1939, refurb: ~2000	Trondheim	US: Bedroom DS: Living room
New Wood Joist Constructions				
Case ID*	**Construction description**	**Cons. Yr.**	**Location**	**Function**
111 121	14mm Parquet, 1mm Underlay, 10mm Gypsum Fibre Board, 24mm Impact Mat (wood fibre) with UnderFloor Heating, 22mm Particle Board, 25mm Impact Pads (polyurethane), 22mm Particle Board | 35cm Joists, 30cm Mineral Wool in cavity | 25mm Resilient Channels, 2 layers 13mm Gypsum Board	2025	Gjøvik	Living room
112 113 122	14mm Parquet, 1mm Underlay, 2 layers 13mm Gypsum Board, 22mm Particle Board, 25mm Impact Pads (polyurethane), 22mm Particle Board | 35cm Joists, 30cm Mineral Wool in cavity | 25mm Resilient Channels, 2 layers 13mm Gypsum Board	2025	Gjøvik	Bedroom
131 132	14mm Parquet, 22mm Particle Board, 13mm Gypsum Board, 20mm Impact Mat, 22mm Slotted Particle Board | 25cm I-Joists, 20cm Mineral Wool in cavity | 50mm Resilient Mount and battens, 2 layers 13mm Gypsum Board	2025	Gjøvik	US: Bedroom DS: Living room
221	21mm Parquet, 13mm Gypsum Board, 36mm Impact Mat (wood fibre), 22mm Particle Board | 30cm Joists, Sprayed Mineral Wool in cavity | 50mm Resilient Mount and battens, 2 layers 13mm Gypsum Board, 48mm Battens, 15mm Wood ceiling planks	2021	Ringebu	Living room
321 (prefab.)	Linoleum, 22mm Particle Board | 27cm Joists, Mineral Wool in cavity | 9mm Particle Board | 25mm Impact Pads (polyurethane), 20cm Joists, Sprayed Mineral Wool in cavity | 15mm Gypsum Fibre Board, 12mm Particle Board	2024	Gjøvik	Bedroom (Dorm)
Cross Laminated Timber Constructions				
Case ID*	**Construction description**	**Cons. Yr.**	**Location**	**Function**
521 (reference)	3mm Linoleum, 37mm Screed, 30mm Impact Mat | 20cm Reinforced Concrete slab | Suspended Ceiling (ca.25cm), Wood Fibre Ceiling (ca.20mm)	2016	Trondheim	US: Kindergarten DS: Office
522	3mm Linoleum, 37mm Screed, 30mm Impact Mat | 14cm Cross Laminated Timber slab | Suspended Ceiling (ca.30cm), Rock Wool Ceiling Tiles (ca.20mm)	2016	Trondheim	Kindergarten
311	Linoleum, 50mm Screed, 40mm Impact Mat | 12cm Cross Laminated Timber slab | 15cm Suspended ceiling, Mineral Wool in cavity, 2 layers 13mm Gypsum Board	2024	Gjøvik	Bedroom (Dorm)
621	Linoleum, 2 layers 22mm Particle Board, 50mm Impact Mat (mineral wool) | CLT170 | Suspended ceiling (ca.60cm), Rock Wool Ceiling Tiles (ca.20mm)	2021	Trondheim	Office
***Case ID: Group–Building–Room, ** Assumption based on the known thicknesses, *** US: Upstairs, DS: Downstairs**				

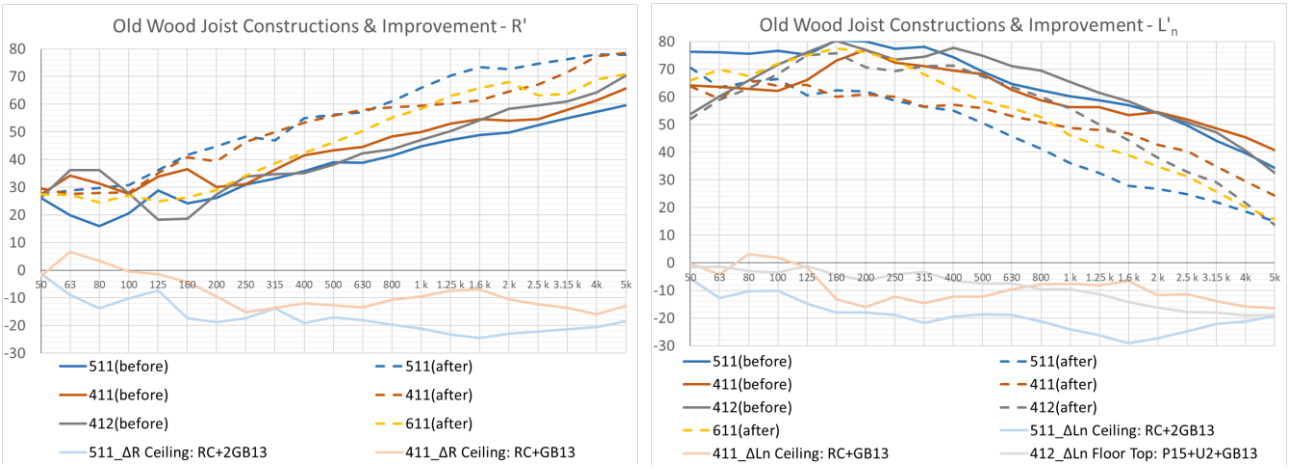
3 Measurement results

3.1 Old Wood Joist Constructions & Improvement

Old wood joist constructions were significantly below the limit values (Table 4, Figure 1). Construction 511 and 411 met both NS8175:2012 and NS8175:2019 requirements for airborne sound insulation after refurbishment of ceiling with new gypsum board ceiling attached to resilient mounts. While showing only 1-2 dB deviation from NS8175:2012 impact sound insulation requirements, both failed NS8175:2019 requirements due to weak impact sound insulation at low frequencies. Both 412 and 611 performed better at high frequency impact sound insulation due to refurbishment at floor cover. Although taken from the same house, the non-refurbished constructions of 411 and 412 performed differently with 411 having 5 dB better R'_w and $L'_{n,w}$. These two constructions were different in flanking paths (411 transferring load to a reinforced concrete wall while 412 to traditional wood skeleton system) and in covers (411 having an additional parquet finish, 412 having an additional wood plank ceiling). 411, 412 and 611 had clay infill between the beams (a traditional *stubbeloftsleire*) while 511 had mineral wool infill and the effect of additional mass can be seen in the low frequency.

Table 4: Measurement results for old wood joist floors and comparison with requirements

Old Wood Joist Constructions & Improvement		**Measurement results**		**Adverse deviation from the requirements**							
ID	**Construction**	**R'_w ($C,C_{50\text{-}5000}$)**	**$L'_{n,w}$ ($C_i,C_{i,50\text{-}2500}$)**	**R'_w**		**$R'_w+C_{50\text{-}5000}$**		**$L'_{n,w}$**		**$L'_{n,w}+C_{i,50\text{-}2500}$**	
				Res.	**Dev.**	**Res.**	**Dev.**	**Res.**	**Dev.**	**Res.**	**Dev.**
511(before)	P15+U2+W20 | J180 (MW) | W20	41(-1;-1)	72(0;1)	41	14	40	14	72	19	73	19
511(after)	P15+U2+W20 | J180 (MW) | W20+[RM50]+2GB13	57(-2;-2)	54(1;5)	57	0	55	0	54	1	59	5
411(before)	P15+W23 | J230 (CI) | 2W20_ovl(40/20)+MW50	46(-1;0)	66(0;0)	46	9	46	8	66	13	66	12
411(after)	P15+W23 | J230 (CI) | 2W20_ovl(40/20)+[RM50](MW)+GB13	56(-3;-3)	55(0;3)	56	0	53	1	55	2	58	4
412(before)	W23 | J200 (CI) | 2W20_ovl(40/20)+W17+MDF11	41(-3;-2)	71(0;0)	41	14	39	15	71	18	71	17
412(after)	P15+U2+GB13+W23 | J200 (CI) | 2W20_ovl(40/20)+W17+MDF11	_	66(0;0)	_	_	_	_	66	13	66	12
611(after)	P15+U+GB13(?)+W20 | J230 (CI) | W20+[B60](?)+W20	46(-2;-2)	67(0;1)	46	9	44	10	67	14	68	14



(a) (b)

Figure 1: Old wood joist floors (a) Sound reduction index, (b) Normalized impact sound level

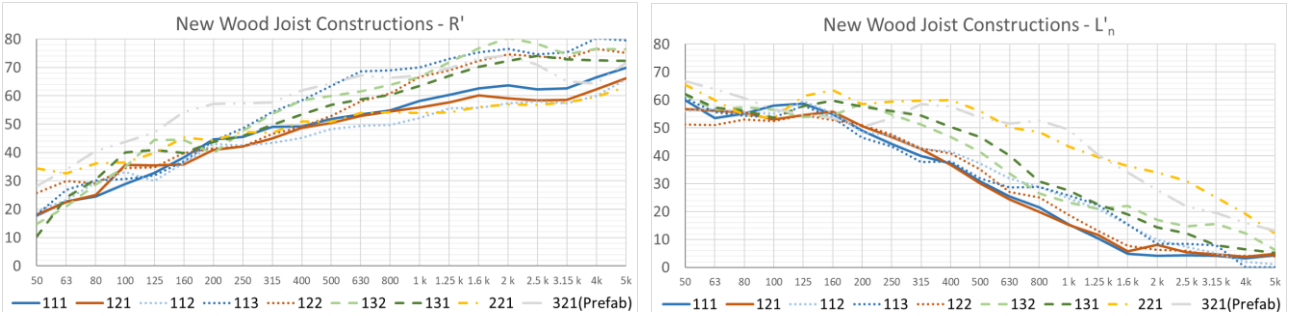
3.2 New Wood Joist Constructions

New wood joist constructions met the airborne sound insulation requirements of NS 8175:2012, and impact sound insulation requirements of both NS 8175:2012 and NS 8175:2019 (Table 5, Figure 2). Some samples showed 1-2 dB adverse deviation which can be considered within the range of measurement uncertainty. Sample 112 was taken from a room where there was a shaft wall which is believed to had impacted the results. This construction performed 4dB lower than the current airborne sound insulation requirements, while exhibiting similar impact sound insulation with other constructions sharing the same assembly. Assembly variants incorporating underfloor heating (111 and 121, Figure 3a) showed slightly reduced acoustic performance compared to alternative configurations without underfloor heating (112,

113, and 122) in both cases. The prefabricated building was composed of modular rooms stacked on each other, which means the floor here included two joist systems and a better detached system. Consequently, the airborne sound insulation met class-A requirements of both standards, however the impact sound insulation met class-C for only NS 8175:2012.

Table 5: Measurement results for new wood joist floors and comparison with requirements

New Wood Joist Constructions		**Measurement results**		**Adverse deviation from the requirements**							
ID	**Construction**	**R'_w ($C,C_{50\text{-}5000}$)**	**$L'_{n,w}$ ($C_i,C_{i,50\text{-}2500}$)**	**R'_w**		**$R'_w+C_{50\text{-}5000}$**		**$L'_{n,w}$**		**$L'_{n,w}+C_{i,50\text{-}2500}$**	
				Res.	**Dev.**	**Res.**	**Dev.**	**Res.**	**Dev.**	**Res.**	**Dev.**
112	P14+U1+2GB13+PB22+IP25+PB22 | J350 (MW300) | [RC25]+2GB13	51(-2;-2)	45(2;5)	51	4	49	5	45	0	50	0
113	P14+U1+2GB13+PB22+IP25+PB22 | J350 (MW300) | [RC25]+2GB13	57(-3;-4)	44(2;6)	57	0	53	1	44	0	50	0
122	P14+U1+2GB13+PB22+IP25+PB22 | J350 (MW300) | [RC25]+2GB13	55(-2;-1)	44(0;2)	55	0	54	0	44	0	46	0
111	P14+U1+FGB10+IM24(H)+PB22+IP25+PB22 | J350 (MW) | [RC25]+2GB13	54(-2;-3)	46(2;4)	54	1	51	3	46	0	50	0
121	P14+U1+FGB10+IM24(H)+PB22+IP25+PB22 | J350 (MW) | [RC25]+2GB13	53(-1;-3)	44(1;5)	53	2	50	4	44	0	49	0
132	P14+PB22+GB13+IM20+SPB22 | J250(I) (MW200) | [RM50]+2GB13	60(-3;-8)	48(0;4)	60	0	52	2	48	0	52	0
131	P14+PB22+GB13+IM20+SPB22 | J250(I) (MW200) | [RM50]+2GB13	58(-1;-8)	50(0;3)	58	0	50	4	50	0	53	0
221	P21+GB13+IM36+PB22 | J300 (MW) | [RM50]+2GB13+[B48]+W15	54(-1;-4)	54(0;2)	54	1	50	4	54	1	56	2
321(Prefab)	Li+PB22 | J270 (MW) | PB9 | J200 (MW) | FGB15+PB12	66(-1;-3)	51(-;5)	66	0	63	0	51	0	56	2



(a) (b)

Figure 2: New wood joist floors (a) Sound reduction index, (b) Normalized impact sound level

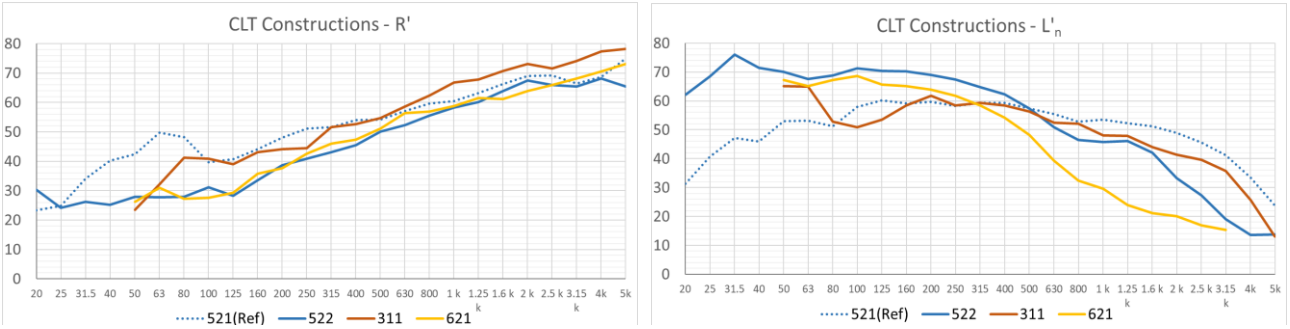
Considering 111,112,113,121,122 as identical constructions (although shows slight variety due to underfloor heating as explained above) the standard deviation is found as 2.2 dB for R'_w (1.7 dB without 112) and 0.9 for $L'_{n,w}$. For 131 and 132 which are exact identical, standard deviations for both R'_w and $L'_{n,w}$ are 1.4dB.

3.3 CLT Constructions

Only three CLT buildings were measured (Table 6, Figure 3). The lower performances are likely to be connected with buildings being originally designed for other functions (kindergarten and office). One of the buildings had mixed construction including reinforced concrete floor (521) at lower floor (load transfer to concrete walls) and CLT (522) at upper floor (load transfer to CLT walls). The rooms had same dimensions and volume (88 m^3). Both had absorptive suspended ceiling while 311 had gypsum board suspended ceiling. The results of the reinforced concrete slab were presented as a reference.

Table 6: Measurement results for CLT floors and comparison with requirements

CLT Constructions		**Measurement results**		**Adverse deviation from the requirements**							
ID	**Construction**	**R'_w ($C,C_{50\text{-}5000}$)**	**$L'_{n,w}$ ($C_i,C_{i,50\text{-}2500}$)**	**R'_w**		**$R'_w+C_{50\text{-}5000}$**		**$L'_{n,w}$**		**$L'_{n,w}+C_{i,50\text{-}2500}$**	
				Res.	**Dev.**	**Res.**	**Dev.**	**Res.**	**Dev.**	**Res.**	**Dev.**
521(Ref)	Li3+Sc37+IM30 | RC200 |[SC250]+WFC2	59(-1;0)	56(-2;-2)	59	0	59	0	56	3	54	0
522	Li3+Sc37+IM30 | CLT140 |[SC300]+RWC2	51(-2;-1)	60(0;2)	51	4	50	4	60	7	62	8
311	Li+Sc50+IM40 | CLT120 | [SC15] (MW)+2GB13	58(-1;-1)	53(0;3)	58	0	57	0	53	0	56	2
621	Li+2PB22+IM50 | CLT170 |[SC600]+RWC2	52(-2;-2)	57(1;3)	52	3	50	4	57	4	60	6



(a) (b)

Figure 3: CLT floors (a) Sound reduction index, (b) Normalized impact sound level

Measurements in this building were extended down to 20 Hz, considering the literature pointing to importance of those frequencies on human perception particularly for impact sound [10]. Nevertheless, results in this range should be interpreted with caution. The measurement equipment used was not optimized for this purpose, as both the loudspeaker and tapping machine are significantly less effective in this range. In parallel, background noise levels were higher in this range, which was among others due to vibrations related to human activities, and interfered with the low levels at receiver room (L_2) especially for the concrete slab case. Furthermore, the standard deviation between measurement positions was significantly higher at low frequencies. As an example, the maximum standard deviation observed in the lowest frequencies compared to those at the 63Hz and 500 Hz octave bands were as follows:

- For 521 Tapping m. L_2: 5.7/3.3/2.4 dB, Loudspeaker L_1: 7.7/5.2/2.2 dB, L_2: 7.4/4.5/1.8 dB, T: 1.5/0.3/0.07s
- For 522 Tapping m. L_2: 5.7/4.6/2.3 dB, Loudspeaker L_1: 9.9/4.2/2.0 dB, L_2: 7.4/3.2/1.7 dB, T: 4.6/3.8/2.02s

4 Conclusion

By establishing a shared database through collaboration between academia, research institutes, consultants, and industry partners, the 3LYD project contributes to strengthening the empirical foundation needed for the development of pre-accepted acoustic solutions and share of experience on timber buildings.

The measurement results presented in this study, grouped across old and new wood joist floors and CLT systems, indicate that new timber joist constructions, as well as improvements applied to existing floors, generally comply with or stay in a reasonable margin from the requirements of NS 8175:2012. However, when assessed against the updated NS 8175:2019 standard, which places greater emphasis on low-frequency performance through spectrum adaptation terms, the results reveal clear limitations. Considering the importance of low frequencies on human perception and the ambitions for creating healthier and more comfortable living environments, the findings highlight the need to further investigate and develop construction solutions as well as other design and planning strategies.

The results also point to the necessity of revising existing pre-accepted solutions and industry guidelines, which are largely based on performance down to 100 Hz. Supporting the implementation of NS 8175:2019 requires a broader empirical basis derived from field measurements such as those generated within the 3LYD project.

From a methodological perspective, the structured involvement of students proved to be an effective approach for both data generation and competence building.

- The study demonstrated that student-led field measurements, when embedded in a robust quality assurance framework, can produce data of practical value for both research and industry.
- Standardized reporting formats, hands-on approach and workshop-based training and close supervision supported reproducibility, and data quality.
- The supervision model, combining academic expertise in acoustics and construction with input from experienced acoustic consultants, enabled multidimensional evaluation and facilitated knowledge exchange between academia and industry.
- The collaboration provided students with early exposure to professional practice and contributed to building a future workforce with strengthened competence in timber acoustics.
- In addition, the presentation of student work to project partners in a formal meeting, and networking can be considered as a significant early experience for students.

Overall, the study highlights the dual benefit of such collaborative frameworks: advancing knowledge through systematic data collection while simultaneously supporting education and professional development. The approach presented here may serve as a transferable model for similar initiatives aiming to bridge gaps between research, practice, and competence development in building acoustics.

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Table A.1: Bachelor students, supervisors and collaborators

Students	Academic supervisors	Industrial partner	Contributor
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Frode Aksnes, Ludvik Bottolfsen, Linnea Winsvold	Jan Steinar Egenes, Ayca Sentop Dumen	Sweco (Alain Bradette)	SevenBel
Ellinor Skaaraas, Fride Thea Rørvik, William Oksdøl	Ayca Sentop Dumen, Saule Tulebekova	Sweco (Kjell Olav Aalmo)	Sit