Dynamic Characterization and Vibration Analysis of a Four-Story Mass Timber Building

https://research.thinkwood.com/en/permalink/catalogue2213

Author:	Mugabo, Ignace
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Publisher:	Frontiers Media
Year of Publication:	2019
Country of Publication:	Switzerland
Format:	Journal Article
Material:	CLT (Cross-Laminated Timber)
	Glulam (Glue-Laminated Timber)
Application:	Wood Building Systems
Topic:	Acoustics and Vibration
Keywords:	Operational Modal Analysis
	Albina Yard
	Finite Element (FE) Model
	Frequency
	Damping
	Mode Shapes
Language:	English
Research Status:	Complete
Series:	Frontiers in Built Environment
Online Access:	Free

Resource Link

https://doi.org/10.3389/fbuil.2019.00086

Study to Validate the Floor Vibration Design of a New Mass Timber Building

https://research.thinkwood.com/en/permalink/catalogue2634

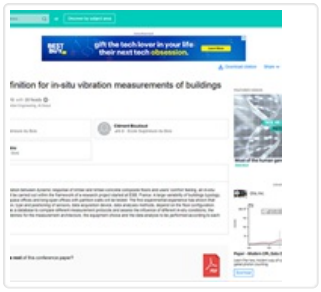
Organization:	KPFF
Country of Publication:	United States
Material:	CLT (Cross-Laminated Timber)
	Timber-Concrete Composite
Application:	Floors
Topic:	Acoustics and Vibration
Keywords:	Vibration Performance
	Damping
	Span Length
	Prediction
Research Status:	In Progress
Notes:	Project contact is Jacob McCann at KPFF

Summary:

As interest has grown in using mass timber for commercial building projects, so too has the need to better understand the vibration characteristics of mass timber floor systems. Vibration requirements typically drive the spans and thicknesses of mass timber floors. Our team has a unique opportunity to close several crucial knowledge gaps while designing the new Health Sciences Education Building (HSEB) at the University of Washington, which is under design and is scheduled to start construction in the summer of 2019.

Case Study for Design Guide – The HSEB will be designed using the U.S. Mass Timber Floor Vibration Design Guide. Vibration performance will be measured to further validate or refine the model calibration suggestions put forth in the Design Guide.
Damping Measurements – The HSEB will contain a wide variety of program spaces with varying damping characteristics that will be measured and correlated.
Stiffness Measurements – Laboratory and in situ testing will be performed on a several floor framing systems. This will include a variety of span lengths and member depths. It will also include composite behavior of concrete and CLT floors with different connection types.

The results of this study will allow for more accurate predictions of floor vibrations. This will significantly reduce the cost of mass timber systems in way that is repeatable and scalable for future architects and engineers.



Guidelines Definition for In-Situ Vibration Measurements of Buildings

https://research.thinkwood.com/en/permalink/catalogue1980

Author:	Lanata, Francesca
	Boudaud, Clément
	Amouzou, Kodzo Vioto
Year of Publication:	2018
Country of Publication:	Korea
Format:	Conference Paper
Material:	Timber-Concrete Composite
Application:	Floors
Topic:	Acoustics and Vibration
Keywords:	Vibrations
	TCC
	Guidelines Definition
	Users' Comfort
	In-Situ Measurements
Language:	English
Conference:	World Conference on Timber Engineering
Research Status:	Complete
Online Access:	Free

Resource Link

https://www.researchgate.net/publication/325756394_Guidelines_definition_for_in-situ_vibration_measurements_of_buildings

Ambient and Forced Vibration Testing and Finite Element Model Updating of a Full-Scale Posttensioned Laminated Veneer Lumber Building

https://research.thinkwood.com/en/permalink/catalogue1103

Author:	Worth, Margaret
	Omenzetter, Piotr
	Morris, Hugh
Year of Publication:	2012
Country of Publication:	New Zealand
Format:	Conference Paper
Material:	LVL (Laminated Veneer Lumber)
Application:	Wood Building Systems
	Shear Walls

Topic:	Seismic
	Wind
	Acoustics and Vibration
Keywords:	Post-Tensioned
	Full Scale
	In Situ
	Finite Element Model
	Dynamic Performance
Language:	English
Conference:	New Zealand Society for Earthquake Engineering Conference
Research Status:	Complete
Notes:	April 13-15, 2012, Christchurch, New Zealand

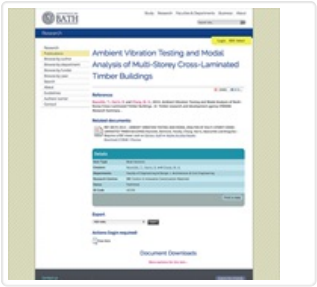
Summary:

The Nelson Marlborough Institute of Technology Arts and Media building was completed in 2011 and consists of three seismically separate complexes. This research focussed on the Arts building as it showcases the use of coupled post-tensioned timber shear walls. These are part of the innovative Expan system. Full-scale, in-situ dynamic testing of the novel building was combined with finite element modelling and updating to obtain an understanding of the structural dynamic performance within the linear range. Ambient testing was performed at three stages during construction and was combined with forced vibration testing for the final stage. This forms part of a larger instrumentation program developed to investigate the wind and seismic response and long term deformations of the building. A finite element model of the building was formulated and updated using experimental modal characteristics. It was shown that the addition of non-structural elements, such as cladding and the staircase, increased the natural frequency of the first mode and the second mode by 19% and 24%, respectively. The addition of the concrete floor topping as a structural diaphragm significantly increased the natural frequency of the first mode but not the second mode, with an increase of 123% and 18%, respectively. The elastic damping of the NMIT building at low-level vibrations was identified as being between 1.6% and 2.4%

Online Access:	Free

Resource Link

http://db.nzsee.org.nz/2012/Paper020.pdf



Ambient Vibration Testing and Modal Analysis of Multi-Storey Cross Laminated Timber Buildings

https://research.thinkwood.com/en/permalink/catalogue237

Author:	Reynolds, Thomas
	Bolmsvik, Åsa
	Vessby, Johan
	Chang, Wen-Shao
	Harris, Richard
	Bawcombe, Jonathan
	Bregulla, Julie
Year of Publication:	2014
Country of Publication:	Canada
Format:	Conference Paper
Material:	CLT (Cross-Laminated Timber)
Application:	Wood Building Systems
Topic:	Acoustics and Vibration
	Wind
	Serviceability
Keywords:	Modal Properties
	Multi-Storey
	Damping
Language:	English
Conference:	World Conference on Timber Engineering
Research Status:	Complete
Notes:	August 10-14, 2014, Quebec City, Canada

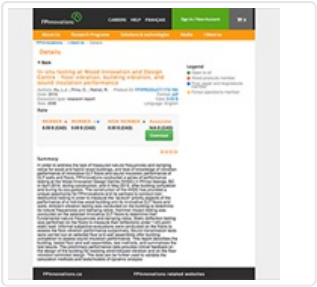
Summary:

The ambient movement of three modern multi-storey timber buildings has been measured and used to determine modal properties. This information, obtained by a simple, unobtrusive series of tests, can give insights into the structural performance of these forms of building, as well as providing information for the design of future, taller timber buildings for dynamic loads. For two of the buildings, the natural frequency has been related to the lateral stiffness of the structure, and compared with that given by a simple calculation. In future tall timber buildings, a new design criterion is expected to become important: deflection and vibration serviceability under wind load. For multi-storey timber buildings there is currently no empirical basis to estimate damping for calculation of wind-induced vibration, and there is little information for stiffness under wind load. This study therefore presents a method to address those gaps in knowledge.

Online Access:	Free

Resource Link

http://opus.bath.ac.uk/42195/



In-Situ Testing at Wood Innovation and Design Centre: Floor Vibration, Building Vibration, and Sound Insulation Performance

https://research.thinkwood.com/en/permalink/catalogue284

Author:	Hu, Lin
	Pirvu, Ciprian
	Ramzi, Redouane
Organization:	FPInnovations
Year of Publication:	2015
Country of Publication:	Canada
Format:	Report
Material:	CLT (Cross-Laminated Timber)
Application:	Walls
	Floors
Topic:	Acoustics and Vibration
Keywords:	Natural Frequency
	Damping Ratio
	Static Deflection Testing
	Vibration Performance
	Sound Transmission
Language:	English
Research Status:	Complete

Summary:

In order to address the lack of measured natural frequencies and damping ratios for wood and hybrid wood buildings, and lack of knowledge of vibration performance of innovative CLT floors and sound insulation performance of CLT walls and floors, FPInnovations conducted a series of performance testing at the Wood Innovation Design Centre (WIDC) in Prince George, BC in April 2014, during construction, and in May 2015, after building completion and during its occupation. This report describes the building, tested floor and wall assemblies, test methods, and summarizes the test results. The preliminary performance data provides critical feedback on the design of the building for resisting wind-induced vibration and on the floor vibration controlled design. The data can be further used to validate the calculation methods and tools/models of dynamic analysis.

Online Access:	Free

Resource Link

https://www.bcfii.ca/sites/default/files/report/FPI/3243.pdf

Vibration and Sound Insulation Performance of Mass Timber Floors with Concrete Toppings

https://research.thinkwood.com/en/permalink/catalogue2548

Organization:	University of Northern British Columbia
Country of Publication:	Canada
Material:	CLT (Cross-Laminated Timber)
	DLT (Dowel Laminated Timber)
	NLT (Nail-Laminated Timber)
	Timber-Concrete Composite
Application:	Floors
	Ceilings
Topic:	Acoustics and Vibration
Keywords:	Concrete Topping
	Acoustic Membrane
	Exposed Mass Timber Elements
Research Status:	In Progress
Notes:	Project contact is Jianhui Zhou at the University of Northern British Columbia

Summary:

The impact sound perceived in the lower volume in a building is radiated by the vibration of the ceiling transmitted from the vibration of the floor generated by an impact source in the upper volume. Thus, the dynamic behaviour of a floor is one crucial intermediate step to understand the impact sound insulation performance of such a floor. A key to reducing the impact sound is to isolate the structural floor from the subfloor. Floating floor construction is a common way of improving the impact sound insulation, which is to float a concrete topping on the mass timber floor with an elastic layer in between. There are two types of floating floor solutions, a) with a continuous elastic layer and b) with point bearing elastic mounts as shown in Figure 1. This study will investigate both solutions and will provide guidance on how to adopt both solutions for mass timber floors with an exposed ceiling.

The objectives of this project are:
1. To measure the sound insulation performance of mass timber floors with full-scale concrete topping on various continuous elastic interlayer materials
2. To measure the sound insulation performance of mass timber floors with full-scale concrete topping on discrete elastic load mounts

Vibration Serviceability Performance of Mass Timber Floors with Beam and Column Supports

https://research.thinkwood.com/en/permalink/catalogue2818

Organization:	University of Northern British Columbia
Country of Publication:	Canada
Material:	CLT (Cross-Laminated Timber) DLT (Dowel Laminated Timber) NLT (Nail-Laminated Timber)
Application:	Floors
Topic:	Acoustics and Vibration
Keywords:	Frequency Span Length Vibration Performance Mass Timber Dynamic Behavior Footfall Excitation
Research Status:	In Progress
Notes:	Project contact is Jianhui Zhou at the University of Northern British Columbia

Summary:

Floor vibration performance could govern the allowable span of mass timber floors. The objectives of this project are:

1. to develop a mobile app to collect data from lab and field mass timber floors for acceleration-based performance criteria;
2. to investigate the dynamic properties of mass timber floors under different boundary conditions;
3. to adopt frequency equations to predict the fundamental frequencies of mass timber floors under different boundary conditions;
4. to develop numerical modeling strategies for predicting vibration response of mass timber floors under footfall excitations.

Mass Timber Rocking Panel Retrofit of a Four-Story Soft-Story Building with Full-Scale Shake Table Validation

https://research.thinkwood.com/en/permalink/catalogue833

Author:	Bahmani, Pouria van de Lindt, John Iqbal, Asif Rammer, Douglas
Publisher:	MDPI
Year of Publication:	2017
Country of Publication:	United States
Format:	Journal Article

Material:	CLT (Cross-Laminated Timber)
	Light Frame (Lumber+Panels)
Application:	Wood Building Systems
Topic:	Seismic
Keywords:	FEMA
	Full Scale
	Retrofit
	Seismic
	Shake Table Test
	Soft-Story
	US
Language:	English
Research Status:	Complete
Series:	Buildings

Summary:

Soft-story wood-frame buildings have been recognized as a disaster preparedness problem for decades. There are tens of thousands of these multi-family three- and four-story structures throughout California and other cities in the United States. The majority were constructed between 1920 and 1970, with many being prevalent in the San Francisco Bay Area in California. The NEES-Soft project was a five-university multi-industry effort that culminated in a series of full-scale soft-story wood-frame building tests to validate retrofit philosophies proposed by (1) the Federal Emergency Management Agency (FEMA) P-807 guidelines and (2) a performance-based seismic retrofit (PBSR) approach developed within the project. Four different retrofit designs were developed and validated at full-scale, each with specified performance objectives, which were typically not the same. This paper focuses on the retrofit design using cross laminated timber (CLT) rocking panels and presents the experimental results of the full-scale shake table test of a four-story 370 m2 (4000 ft2) soft-story test building with that FEMA P-807 focused retrofit in place. The building was subjected to the 1989 Loma Prieta and 1992 Cape Mendocino ground motions scaled to 5% damped spectral accelerations ranging from 0.2 to 0.9 g.

Online Access:	Free

Resource Link

https://doi.org/10.3390/buildings7020048

Measurement of Airborne Sound Insulation of 8 Wall Assemblies Measurement of Airborne and Impact Sound Insulation of 29 Floor Assemblies

https://research.thinkwood.com/en/permalink/catalogue1864

Author:	Sabourin, Ivan
Organization:	National Research Council of Canada
Publisher:	National Research Council Canada. Construction
Year of Publication:	2015
Country of Publication:	Canada
Format:	Report
Material:	CLT (Cross-Laminated Timber) Glulam (Glue-Laminated Timber)
Application:	Floors Walls
Topic:	Acoustics and Vibration
Keywords:	Transmission Loss Impact Sound Pressure Level
Language:	English
Research Status:	Complete
Series:	Nordic Engineered Wood Report
Online Access:	Free

Resource Link

http://doi.org/10.4224/23000205