Cyclic Response of Insulated Steel Angle Brackets Used for Cross-Laminated Timber Connections

https://research.thinkwood.com/en/permalink/catalogue2765

Author: Kržan, Meta
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Publisher: Springer

Year of Publication: 2021

Format: Journal Article

Material: CLT (Cross-Laminated Timber)

Application: Walls
Floors

Topic: Seismic
Acoustics and Vibration
Connections

Keywords: Angle Bracket
Sound Insulation
Insulation
Monotonic Test
Cyclic Tests
Wall-to-Floor
Stiffness
Load Bearing Capacity
Shear
Tensile

Language: English

Research Status: Complete

Series: European Journal of Wood and Wood Products
Summary:
In cross-laminated timber (CLT) buildings, in order to reduce the disturbing transmission of sound over the flanking parts, special insulation layers are used between the CLT walls and slabs, together with insulated angle-bracket connections. However, the influence of such CLT connections and insulation layers on the seismic resistance of CLT structures has not yet been studied. In this paper, experimental investigation on CLT panels installed on insulation bedding and fastened to the CLT floor using an innovative, insulated, steel angle bracket, are presented. The novelty of the investigated angle-bracket connection is, in addition to the sound insulation, its resistance to both shear as well as uplift forces as it is intended to be used instead of traditional angle brackets and hold-down connections to simplify the construction. Therefore, monotonic and cyclic tests on the CLT wall-to-floor connections were performed in shear and tensile/compressive load direction. Specimens with and without insulation under the angle bracket and between the CLT panels were studied and compared. Tests of insulated specimens have proved that the insulation has a marginal influence on the load-bearing capacity; however, it significantly influences the stiffness characteristics. In general, the experiments have shown that the connection could also be used for seismic resistant CLT structures, although some minor improvements should be made.

Online Access: Free

Resource Link
https://doi.org/10.1007/s00107-020-01643-5

Deconstructable Hybrid Connections for the Next Generation of Prefabricated Mass Timber Buildings
https://research.thinkwood.com/en/permalink/catalogue2809

Author: Shulman, Samuel
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Organization: University of British Columbia

Year of Publication: 2021

Country of Publication: Canada

Format: Report

Material: CLT (Cross-Laminated Timber)

Application: Floors
Hybrid Building Systems
Shear Walls

Topic: Connections

Keywords: Steel Rods
Epoxy
Push-Out-Shear Tests
Prefabrication
Disassembly
Reuse

Language: English

Research Status: Complete
Summary:

Timber has been used for building construction for centuries, until the industrial revolution, when it was often replaced by steel and concrete or confined to low-rise housings. In the last thirty years however, thanks to the development of mass timber products and new global interest in sustainability, timber has begun to make a resurgence in the building industry. As building codes and public perception continues to change, the demand for taller and higher-performance timber buildings will only grow. Thus, a need exists for new construction technology appropriate for taller mass timber construction, as well as for fabrication and deconstruction practices that respect wood’s inherent sustainable nature. With this in mind, this research program aims to develop a new hybrid shear connection for mass timber buildings that allows for easy construction, deconstruction, and reuse of the structural elements.

This report includes results of Phase 1, which focused on connections consisting of partially threaded 20M and 24M steel rods bonded into pockets formed in CLT and surrounded by thick crowns of high-strength three-component epoxy-based grout. A total of 168 specimens were designed and fabricated, and push-out shear tests carried out with a displacement-controlled monotonic loading protocol. Strength and stiffness values were assessed and effective failure modes in specimens identified. These latter, along with the recorded load-deformation curves, indicate that it is possible to develop mechanics-based design models and design formulas akin to those already used for typical dowel-type fastener timber connections. Additionally, the specimens were easily fabricated in the lab and quickly fastened to the test jig by means of nuts and washers, suggested such connections have a strong potential for prefabrication, disassembly, and reuse.

Online Access: Free

Resource Link


Developing a Large Span Timber-based Composite Floor System for Highrise Office Buildings Phase I

https://research.thinkwood.com/en/permalink/catalogue2803

Author: Zhang, Chao
Lee, George
Lam, Frank

Organization: University of British Columbia

Year of Publication: 2021

Country of Publication: Canada

Format: Report

Material: CLT (Cross-Laminated Timber)
LVL (Laminated Veneer Lumber)
LSL (Laminated Strand Lumber)
Glulam (Glue-Laminated Timber)

Application: Floors

Topic: Design and Systems
This project proposes a timber-based composite floor that can span 12 m and be used in the construction of 40+ story office buildings. This floor system integrates timber panels and timber beams to form a continuous box girder structure. The timber panels function as the flanges and the timber beams as the web. The beams are spaced and connected to the flange panels so that sufficient bending stiffness of a 12 m span can be achieved via the development of composite action.

The current phase of this project studied the performance of the connections between timber elements in the proposed composite member. Six types of connections using different flange material and connection techniques were tested: Cross Laminated Timber (CLT), Laminated Strand Lumber (LSL), Laminated Veneer Lumber (LVL), and Post Laminated Veneer Lumber (PLVL). Glulam was used as the web. The majority of the connections used self-tapping wood screws except one had notches. The load-carrying capacity, stiffness, and ductility of the connections were measured. The stiffness of CLT, LSL, and PLVL connections was in the same range, 19-20 kN/mm per screw. Amongst the three, LSL had the highest peak load and PLVL had the highest proportional limit. The stiffness of the two LVL screw connections was around 13 kN/mm. The notched LVL connection had significantly higher stiffness than the rest, and its peak load was in the same range as LSL, but the failure was brittle.

LVL was used to manufacture the full scale timber composite floor element. With a spacing of 400 mm, the overall stiffness reached 33689 N mm²×10⁹, which was 2.5 times the combined stiffness of two Glulam beams. The predicted overall stiffness based on Gamma method was within 5% of the tested value, and the estimated degree of composite action was 68%. From both the test results and analytical modeling, the number of screws may be further reduced to 50% or less of the current amount, while maintaining a high level of stiffness.

Future work includes testing the composite floor under different screw spacings, investigating the effect of concrete topping, and the connections between floor members and other structural elements.

Resource Link

Diaphragm shear and diagonal compression testing of cross-laminated timber

https://research.thinkwood.com/en/permalink/catalogue2858

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Berg, Sven
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Organization: Luleå University of Technology
Publisher: Springer
Year of Publication: 2021
Country of Publication: Sweden
Format: Journal Article
Material: CLT (Cross-Laminated Timber)
Application: Floors
Walls

Topic: Mechanical Properties
Keywords: Diagonal Compression Test
Diaphragm Shear Test
Shear Modulus

Language: English
Research Status: Complete
Series: SN Applied Sciences

Summary:
To learn the characteristics of a cross-laminated timber (CLT) panel, it is crucial to perform experimental tests. This study presents two experimental test methods to measure the in-plane shear modulus of CLT panels. This characteristic can be measured by multiple methods such as the picture frame test, the diagonal compression test, and the diaphragm shear test. In this study, the same CLT panels are tested and evaluated in the diaphragm shear test and the diagonal compression test to see if more reliable results can be achieved from the diaphragm shear test. This evaluation is done by experimental tests and finite element simulations. The theoretical pure shear simulation is used as a reference case. Finite element simulations are made for both edge glued and non-edge glued CLT panels. Nine CLT panels are tested in the diaphragm shear test and the diagonal compression test. During ideal conditions (uniform material properties and contact conditions), all three simulated methods result in an almost equal shear modulus. During the experimental testing, the diagonal compression test gives more coherent results with the expected shear modulus based on finite element simulations. Based on the diaphragm shear test results, the CLT panels behave like edge glued, but this situation is dismissed. However, during ideal conditions, the diaphragm shear test is seen as a more reliable method due to the higher proportion of shear in the measured area.

Online Access: Free

Resource Link

https://doi.org/10.1007/s42452-021-04826-8
Effect of cast-in-place concrete application on moisture distribution in timber-concrete composite floors with notched connections, investigated via finite element simulations

https://research.thinkwood.com/en/permalink/catalogue2902

Author: Lukacevic, Markus
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Raimer, Thomas
Eberhardsteiner, Josef
Füssl, Josef

Organization: TU Wien
Publisher: Elsevier
Year of Publication: 2021
Country of Publication: Austria
Format: Journal Article
Material: Timber-Concrete Composite
Application: Floors
Topic: Moisture
Keywords: Notches
Moisture Uptake
Sealing
Language: English
Research Status: Complete
Series: Journal of Building Engineering

Summary:

Timber-concrete composite (TCC) structures are an efficient way to combine the advantages of cross-laminated timber (CLT) and concrete plates. By cutting notches into the timber part and applying the concrete on top, efficient shear connections can be formed, eliminating the need for additional use of any type of fasteners. However, fresh concrete releases moisture after application, which is absorbed by the highly hygroscopic wood and can lead to a critical reduction in mechanical properties or to problematic situations due to a difference in expansion behavior. Therefore, a separating foil is usually applied between the two materials, which represents an additional time and cost effort and can also negatively influence the connection properties or make the use of notch-only connections impossible. Thus, we investigate numerically what effects the exclusion of such a foil has on the moisture distribution in the CLT plate. Further, the moisture propagation after a fictitious installation on site is analyzed by applying realistic indoor climates to the open wood surface on the bottom of the CLT plate for a period of two years. In addition, the numerical model allows us to study the effect of local sealings of the most critical wooden part, the end-grain surfaces in the notch region. We were able to confirm that, especially in the unsealed case, locally high moisture contents can occur in the critical region next to the notch, where the highest shear stresses are also to be expected. However, by fully sealing the end-grain surfaces in these regions, the moisture levels and thus the risk of failure could be reduced efficiently. The use of such detailed moisture simulations, where moisture uptake due to bleeding of fresh concrete has been calibrated based on experiments, allows the long-term moisture behavior of such critical situations to be studied and effective solutions to be developed.

Online Access: Free

Resource Link

https://doi.org/10.1016/j.jobe.2021.103005
Experimental Investigation on Axial Compression of Resilient Nail-Cross-Laminated Timber Panels

https://research.thinkwood.com/en/permalink/catalogue2832

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        Suleiman, R. Ahmed

Organization: Western University
              Shenyang Jianzhu University

Editor: Billah, Muntasir

Publisher: MDPI

Year of Publication: 2021

Country of Publication: Canada
                       China

Format: Journal Article

Material: CLT (Cross-Laminated Timber)

Application: Floors
             Walls

Topic: Mechanical Properties

Keywords: Nails
          Axial Compression
          Nail-Cross-Laminated Timber
          Slenderness Ratio

Language: English

Research Status: Complete

Summary:

Conventional cross-laminated timber is an engineered wood product consisting of solid sawn lumber panels glued together. In this study, the structural behavior of solid wood panels of Nail-Cross-Laminated Timber (NCLT) panels connected with nails instead of glue was studied. The failure mode and nail deformation of the novel NCLT panels under axial compression load using eight full-scale NCLT panels was investigated. The effects of four key design parameters, namely, the nail type, number of nails, nail orientation angle, and nail slenderness ratio on axial compression performance of NCLT panels were also analyzed. In addition, a formula for predicting the axial compression bearing capacity of NCLT panels was developed. For calculation of the slenderness ratio, the moment of inertia of the full section or the effective section was determined based on the nail type, number of nails, angle of nail orientation and number of layers of the plate. Results showed that specimens connected by tapping screws had best compressive performance.

Online Access: Free

Resource Link

https://doi.org/10.3390/su132011257
Finite element analysis of alternative load paths to prevent disproportionate collapse in platform-type CLT floor systems

https://research.thinkwood.com/en/permalink/catalogue2901

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Berg, Sven

Organization: Luleå University of Technology
University of Northern British Columbia

Publisher: Elsevier
Year of Publication: 2021
Country of Publication: Sweden
Canada

Format: Journal Article
Material: CLT (Cross-Laminated Timber)
Application: Floors
Topic: Design and Systems
Keywords: Mass Timber
Structural Robustness
High Fidelity Model
Progressive Collapse
Structural Integrity
Component Model

Language: English
Research Status: Complete
Series: Engineering Structures

Summary:

Multi-storey buildings require mitigation of consequences of unexpected or accidental events, to prevent disproportionate collapse after an initial damage. Cross-laminated timber (CLT) in platform-type construction is increasingly used for multi-storey buildings, however, the collapse behaviour and alternative load paths (ALPs) are not fully understood. A 3D non-linear component-based finite element model was developed for a platform-type CLT floor system to study the ALPs after an internal wall loss, in a pushdown analysis. The model, which accounted for connection failure, timber crushing and large displacements, was calibrated to experimental results and then adapted for boundary conditions corresponding to typical residential and office buildings. Subsequently, five parameters (floor span, connection type, vertical location of the floor, tying level, horizontal wall stiffness) were varied, to study their effects on the ALPs in 80 models. The results showed that three ALPs occurred, of which catenary action was the most dominant. Collapse resistance was mainly affected by the floor span, followed by the axial strength, stiffness and ductility of the floor-to-floor connection, the weight of the level above and the floor panel thickness. This study provides an approach to model ALPs in a platform-type CLT floor system to design disproportionate collapse resistant multi-storey CLT buildings.

Online Access: Free

Resource Link

https://doi.org/10.1016/j.engstruct.2021.112362
From Canada to the World: FPInnovations' Three-Generation Floor Vibration Research and Code Implementation

https://research.thinkwood.com/en/permalink/catalogue2826

Author: Hu, Lin
Cuerrier-Auclair, Samuel
Qian, Cheng
Dale, Angela

Organization: FPInnovations

Year of Publication: 2021

Country of Publication: Canada

Format: Report

Material: CLT (Cross-Laminated Timber)
Light Frame (Lumber+Panels)

Application: Floors

Topic: Acoustics and Vibration

Keywords: Lumber Joists
Engineered Wood Joists
Mass Timber
Floor Vibration-controlled Design Method
CSA 086
National Building Code of Canada

Language: English

Research Status: Complete

Series: InfoNote

Summary:
FPInnovations’ involvement in various codes and standards technical committees aims to monitor, contribute or propose changes for improvement as well as to create new standards to include new wood products and systems based on knowledge developed from FPInnovations’ research activities. Involvement also allows FPInnovations to be aware of any potential changes to codes and standards and to recognize and address threats and opportunities for wood use. Codes and standards exist to protect consumers but are written to reflect the current practices and knowledge based on a consensus agreement by committee members. FPInnovations’ involvement in codes and standards committees helps to align the coming changes with new wood products. This InfoNote reports on FPInnovations’ contribution to the floor vibration-control design methods on codes and standards implementation and research.

Online Access: Free

Resource Link

https://library.fpinnovations.ca/en/permalink/fpipub7936

The Influence of Floor Layering on Airborne Sound Insulation and Impact Noise Reduction: A Study on Cross Laminated Timber (CLT) Structures
The use of timber constructions recently increased. In particular, Cross Laminated Timber floors are often used in multi-story buildings. The development of standardization processes, product testing, design of details and joints, the speed of construction, and the advantages of eco-sustainability are the main reasons why these structures play a paramount role on the international building scene. However, for further developments, it is essential to investigate sound insulation properties, in order to meet the requirements of indoor comfort and comply with current building regulations. This work presents the results obtained by in field measurements developed using different sound sources (tapping machine, impact rubber ball, and airborne dodecahedral speaker) on Cross Laminated Timber floors, changing different sound insulation layering (suspended ceiling and floating floors). Results clearly show that the influence on noise reduction caused by different layering stimulated by diverse noise source is not constant and furthermore that no available analytical model is able to correctly predict Cross Laminated Timber floors acoustic performances.
Micro-notches as a novel connection system for timber-concrete composite slabs

https://research.thinkwood.com/en/permalink/catalogue2841

Author: Müller, Katharina
Frangi, Andrea

Organization: ETH Zurich
Publisher: Elsevier
Year of Publication: 2021
Country of Publication: Switzerland

Format: Journal Article
Material: DLT (Dowel Laminated Timber)
Timber-Concrete Composite

Application: Floors
Topic: Connections
Mechanical Properties
Design and Systems

Keywords: Connection Systems
Experimental Investigations
Sustainable Construction
Micro-notches

Language: English
Research Status: Complete
Series: Engineering Structures

Summary:

Timber-concrete composite slabs are more and more in use: the combination of timber and concrete combines the advantages of both materials and offer a valid solution for the increasing demand for sustainable construction. The connection between timber and concrete is the crucial element, yet its potential regarding material and time expenses is not exploited. This paper presents the novel connection system micro-notches, an interlocking concept between timber and concrete with indentations in the millimetre range. Micro-notches provide a continuous shear transfer without additional steel fasteners such as screws or dowels. The paper presents the development of the micro-notch concept in an extensive experimental program supplemented with analytical and numerical models, a calculation model, and practice-relevant guidelines. The results of the investigations show that micro-notches feature an approximately rigid composite action between timber and concrete and a sufficient shear strength for the use in office and residential buildings.

Online Access: Free

Resource Link

https://doi.org/10.1016/j.engstruct.2021.112688
Multi-criteria decision analysis of timber–concrete composite floor systems in multi-storey wooden buildings

https://research.thinkwood.com/en/permalink/catalogue2865

Author: Movaffaghi, Hamid
Yitmen, Ibrahim
Organization: Jönköping University
Publisher: Taylor&Francis Group
Year of Publication: 2021
Country of Publication: Sweden
Format: Journal Article
Material: Timber-Concrete Composite
Application: Floors
Topic: Design and Systems
Keywords: Multi-criteria assessment
Sustainability
Serviceability
Analytical Hierarchy Process
Language: English
Research Status: Complete
Series: Civil Engineering and Environmental Systems

Summary:
This study aims to present a multi-criteria decision analysis (MCDA) for comprehensive performance evaluation of the alternative design of timber–concrete composite (TCC) floor system. Considered objectives are serviceability and sustainability performance with associated criterion as (1) comfort class regarding springiness and vibrations, (2) architectural quality with associated criterion as open spaces, (3) environmental aspect with associated criterion as CO2 emissions and (4) cost aspect with associated criterion as the total costs. Analytical Hierarchy Process (AHP) and Complex Proportional Assessment (COPRAS) as the methods in the multi-criteria analysis have been combined for (1) determining the weighting of criteria based on the survey results, (2) verifying the consistency ratio of decision matrix made by experts and (3) for ranking and selecting the optimal concept design among design candidates. According to the results, the TCC floor with the span length of 7.3 m belonging to comfort class A has got the highest ranking. However, sensitivity analysis indicates that the TCC floor with a 9.0 m span length belonging to comfort class A shall be selected as the optimal concept design. The study contributes by developing a complete concept design tool for TCC floor systems using AHP combined COPRAS methods to handle both beneficial and non-beneficial criteria.

Online Access: Free

Resource Link

https://doi.org/10.1080/10286608.2021.1934826

Nonlinear Static Seismic Response of a Building Equipped with Hybrid Cross-Laminated Timber Floor Diaphragms and Concentric X-Braced Steel Frames
Simplified seismic design procedures mostly recommend the adoption of rigid floor diaphragms when forming a building’s lateral force-resisting structural system. While rigid behavior is compatible with many reinforced concrete or composite steel-concrete floor systems, the intrinsic stiffness properties of wood and ductile timber connections of timber floor slabs typically make reaching a such comparable in-plane response difficult. Codes or standards in North America widely cover wood-frame construction, with provisions given for both rigid and flexible floor diaphragms designs. Instead, research is ongoing for emerging cross-laminated-timber (CLT) and hybrid CLT-based technologies, with seismic design codification still currently limited. This paper deals with a steel-CLT-based hybrid structure built by assembling braced steel frames with CLT-steel composite floors. Preliminary investigation on the performance of a 3-story building under seismic loads is presented, with particular attention to the influence of in-plane timber diaphragms flexibility on the force distribution and lateral deformation at each story. The building complies with the Italian Building Code damage limit state and ultimate limit state design requirements by considering a moderate seismic hazard scenario. Nonlinear static analyses are performed adopting a finite-element model calibrated based on experimental data. The CLT-steel composite floor in-plane deformability shows mitigated effects on the load distribution into the bracing systems compared to the ideal rigid behavior. On the other hand, the lateral deformation always rises at least 17% and 21% on average, independently of the story and load distribution along the building’s height.

Online Access: Free
A Numerical Study of the Stiffness and Strength of Cross-Laminated Timber Wall-to-Floor Connections under Compression Perpendicular to the Grain

https://research.thinkwood.com/en/permalink/catalogue2839

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Serrano, Erik
Bader, Thomas

Organization: Linnaeus University
Lund University

Editor: Brandner, Reinhard

Publisher: MDPI

Year of Publication: 2021

Country of Publication: Sweden

Format: Journal Article

Material: CLT (Cross-Laminated Timber)

Application: Walls
Floors

Topic: Connections
Mechanical Properties

Keywords: Parametric Study
Perpendicular to the Grain
Elasto-Plastic Behaviour
Numerical Modeling

Language: English

Research Status: Complete

Series: Buildings
Summary:

The use of cross-laminated timber (CLT) in multi-story buildings is increasing due to the potential of wood to reduce green house gas emissions and the high load-bearing capacity of CLT. Compression perpendicular to the grain (CPG) in CLT is an important design aspect, especially in multi-storied platform-type CLT buildings, where CPG stress develops in CLT floors due to loads from the roof or from upper floors. Here, CPG of CLT wall-to-floor connections are studied by means of finite element modeling with elasto-plastic material behavior based on a previously validated Quadratic multi-surface (QMS) failure criterion. Model predictions were first compared with experiments on CLT connections, before the model was used in a parameter study, to investigate the influence of wall and floor thicknesses, the annual ring pattern of the boards and the number of layers in the CLT elements. The finite element model agreed well with experimental findings. Connection stiffness was overestimated, while the strength was only slightly underestimated. The parameter study revealed that the wall thickness effect on the stiffness and strength of the connection was strongest for the practically most relevant wall thicknesses between 80 and about 160 mm. It also showed that an increasing floor thickness leads to higher stiffness and strength, due to the load dispersion effect. The increase was found to be stronger for smaller wall thicknesses. The influence of the annual ring orientation, or the pith location, was assessed as well and showed that boards cut closer to the pith yielded lower stiffness and strength. The findings of the parameter study were fitted with regression equations. Finally, a dimensionless ratio of the wall-to-floor thickness was used for deriving regression equations for stiffness and strength, as well as for load and stiffness increase factors, which could be used for the engineering design of CLT connections.

Online Access: Free

Resource Link

https://doi.org/10.3390/buildings11100442
Parameter identification for a point-supported cross laminated timber slab based on experimental and numerical modal analysis

https://research.thinkwood.com/en/permalink/catalogue2855

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Organization: University of Innsbruck
Publisher: Springer
Year of Publication: 2021
Country of Publication: Austria
Format: Journal Article
Material: CLT (Cross-Laminated Timber)
Application: Floors
Topic: Serviceability
Acoustics and Vibration
Keywords: Modal Analysis
Complex Mode Shape
Point-Supported
Language: English
Research Status: Complete
Series: European Journal of Wood and Wood Products

Summary:

In this paper, the dynamic properties of a point-supported cross-laminated timber slab are studied in order to determine the elastic material parameters on this basis. A detailed experimental modal analysis of the slab with dimensions 16.0 m x 11.0 m is performed, and seven modes including the natural frequencies, damping ratios and mode shape components at 651 sensor positions are identified. The found mode shapes are complex due to environmental influences that occurred during the two-day measurement campaign. This error is corrected by eliminating these influences. A finite element model of the slab is presented, whose parameters in terms of material properties and boundary conditions are determined by a model updating procedure. Based on the modal properties of the seven experimentally identified modes, an accurate and robust parameter set is obtained, which can be used in further numerical studies of the considered CLT to check serviceability limit criteria.

Online Access: Free

Resource Link

https://doi.org/10.1007/s00107-020-01641-7
The vibration of cross laminated timber (CLT) floor is closely related to human-induced loadings. However, research and prediction approaches regarding human-induced vibration of the CLT floor have been mostly limited to a single-person excitation condition. This paper presents new prediction approaches to the vibration response of the CLT floor under multi-person loadings. The effect of multi-person loadings on the vibration performance of a CLT floor was investigated through numerical modelling, experimental testing and analytical investigation. A finite element model was developed through a computational software to perform an accurate analysis of human-induced loadings. An analytical model was established to predict human-induced vibration of the CLT floor under multi-person loadings. Experimental tests were conducted to validate the numerical modelling. Results of both numerical modelling and experimental testing showed that the vibration performance of the CLT floor under multi-person loadings was almost double that under single-person loadings. Thus, multi-person activities are more likely to cause the occupants feelings of discomfort. A method for predicting the human-induced vibration of the CLT floor under multi-person loadings was then developed. The measured response, numerical modelled response, and predicted response were compared using an existing design metric, vibration dose value (VDV). The results were largely consistent. It is therefore concluded that the proposed prediction method will enable engineers to design timber floor systems that consider multi-person loadings.
This paper describes selected observations, measurements, and analysis from a series of large-scale experiments on cross-laminated timber (CLT) slabs that were exposed to fire from below, using four different heating scenarios, with a sustained mechanical loading of 6.3 kN m per metre width of slab. The deflection response and in-depth timber temperatures are used to compare the experimental response against a relatively simple structural fire model to assess the load bearing capacity of CLT elements in fire, including during the decay phase of natural fires. It is demonstrated that the ventilation conditions in experiments with a fixed fuel load are important in achieving burnout of the contents before structural collapse occurs. A mechanics-based structural fire model is shown to provide reasonably accurate predictions of structural failure (or lack thereof) for the experiments presented herein. The results confirm the importance of the ventilation conditions on the fire dynamics, burning duration, and the achievement of functional fire safety objectives (i.e. maintaining stability and compartmentation), in compartments with exposed CLT.
The scope of this guide focuses on the design of mass timber floor systems to limit human-induced vibration. The primary performance goal is to help designers achieve a low probability of adverse comment regarding floor vibrations in a manner consistent with the vibration design guides for steel and concrete systems. This includes excitation primarily from human walking as observed by other people in the building. Some treatment of design for sensitive equipment in response to human walking is also discussed. This design guide covers the range of currently available mass timber panels, including cross-laminated timber (CLT) manufactured from either solid sawn or structural composite lumber (SCL) laminations, nail-laminated timber (NLT), dowel laminated timber (DLT) and glue-laminated timber (GLT), as well as their support framework of timber beams.

The target user of this guide is a design professional with working knowledge of mass timber structural design and some background knowledge of structural dynamics as related to floor vibrations. It may be particularly useful to design engineers with limited experience with vibration analysis, experienced multi-material engineers familiar with vibration analysis but unfamiliar with mass timber vibration, and applications engineers assisting manufacturers in the development of solutions and proposals for projects.
Acoustically-Tested Mass Timber Assemblies

https://research.thinkwood.com/en/permalink/catalogue2639

Organization: WoodWorks
Year of Publication: 2020
Country of Publication: United States
Format: Report
Material: CLT (Cross-Laminated Timber)
NLT (Nail-Laminated Timber)
Glulam (Glue-Laminated Timber)
MPP (Mass Plywood Panel)
Application: Floors
Walls
Topic: Acoustics and Vibration
Keywords: Mass Timber
Sound Transmission Class
Impact Isolation Class
Assembly
Language: English
Research Status: Complete
Online Access: Free

Resource Link


Apparent Sound Insulation in Mass Timber Buildings

https://research.thinkwood.com/en/permalink/catalogue2616

Author: Mahn, Jeffrey
Quirt, David
Mueller-Trapet, Markus
Hoeller, Christoph
Organization: National Research Council of Canada. Construction
Publisher: National Research Council of Canada. Construction
Year of Publication: 2020
Country of Publication: Canada
Format: Report
Material: CLT (Cross-Laminated Timber)
NLT (Nail-Laminated Timber)
DLT (Dowel Laminated Timber)
This Report presents the results from experimental studies of the airborne sound transmission of mass timber assemblies, together with an explanation of the calculation procedures to predict the apparent sound transmission class (ASTC) rating between adjacent spaces in a building constructed of mass timber assemblies.

The experimental data which is the foundation for this Report includes the laboratory measured sound transmission loss of wall and floor assemblies constructed of Cross Laminated Timber (CLT), Nail-Laminated Timber (NLT) and Dowel-Laminated Timber (DLT), and the laboratory measured vibration reduction index between assemblies of junctions between CLT assemblies.

The presentation of the measured data is combined with the presentation of the appropriate calculation procedures to determine the ASTC rating in buildings comprised of such assemblies along with numerous worked examples.

Several types of CLT constructions are commercially available in Canada, but this study focused on CLT assemblies with an adhesive applied between the faces of the timber elements in adjacent layers, but no adhesive bonding between the adjacent timber elements within a given layer. These CLT assemblies could be called “Face-Laminated CLT Assemblies” but are simply referred to as CLT assemblies in this Report. Another form of CLT assemblies does have adhesive applied between the faces of the timber elements in adjacent layers as well as adhesive to bond the adjacent timber elements within a given layer. These assemblies are referred to as “Fully-Bonded CLT Assemblies” in this Report. Because fully-bonded CLT assemblies have different properties than face-laminated CLT assemblies, the sound transmission data and predictions in this Report do not apply to fully-bonded CLT assemblies.

Online Access: Free

Resource Link

https://doi.org/10.4224/40001816
Calculating the Fire Resistance of Wood Members and Assemblies: Technical Report No. 10

Organization: American Wood Council
Year of Publication: 2020
Country of Publication: United States
Format: Report
Material: CLT (Cross-Laminated Timber)
Application: Columns, Beams, Floors, Walls, Wood Building Systems, Decking
Topic: Fire Design and Systems
Keywords: Connections, Exposed Wood Members, Fire Tests, Beam Column Connection
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