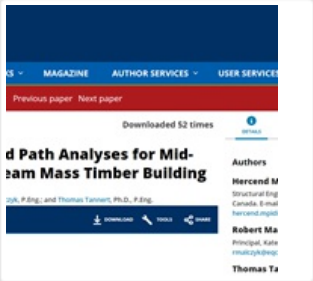


Alternative Load Path Analyses for Mid-Rise Post and Beam Mass Timber Building

https://research.thinkwood.com/en/permalink/catalogue2448

Author:	Mpidi Bita, Hercend
	Malczyk, Robert
	Tannert, Thomas
Year of Publication:	2020
Format:	Conference Paper
Material:	CLT (Cross-Laminated Timber)
	Glulam (Glue-Laminated Timber)
Application:	Wood Building Systems
	Columns
	Beams
Topic:	Design and Systems
Keywords:	Post and Beam
	Load
	Linear Static Alternative Load Path Analysis
	Collapse Resistance
	Load Distribution
	Disproportionate Collapse
	Gravity Loads
	Latera Loads
Language:	English
Conference:	Structures Congress
Research Status:	Complete
Online Access:	Free

Resource Link

https://ascelibrary.org/doi/abs/10.1061/9780784482896.008

Alternate Load-Path Analysis for Mid-Rise Mass-Timber Buildings

https://research.thinkwood.com/en/permalink/catalogue1233

Author:	Mpidi Bita, Hercend
	Tannert, Thomas
Organization:	Structures Congress
Publisher:	American Society of Civil Engineers
Year of Publication:	2018
Country of Publication:	United States
Format:	Conference Paper
Material:	CLT (Cross-Laminated Timber)
Application:	Floors
	Wood Building Systems
Topic:	Design and Systems
	Seismic
Keywords:	Alternate Load-Path Analysis
	Disproportionate Collapse
	Lateral Loads
Language:	English
Conference:	Structures Conference 2018
Research Status:	Complete
Notes:	April 19–21, 2018, Fort Worth, Texas

Summary:

This paper presents an investigation of possible disproportionate collapse for a nine-storey flat-plate timber building, designed for gravity and lateral loads. The alternate load-path analysis method is used to understand the structural response under various removal speeds. The loss of the corner and penultimate ground floor columns are the two cases selected to investigate the contribution of the cross-laminated timber (CLT) panels and their connections, towards disproportionate collapse prevention. The results show that the proposed building is safe for both cases, if the structural elements are removed at a speed slower than 1 sec. Disproportionate collapse is observed for sudden element loss, as quicker removal speed require higher moments resistance, especially at the longitudinal and transverse CLT floor-to-floor connections. The investigation also emphasises the need for strong and stiff column-to-column structural detailing as the magnitude of the vertical downward forces, at the location of the removed columns, increases for quicker removal.

Online Access:	Payment Required

Resource Link

https://doi.org/10.1061/9780784481349.017

Finite Element Modelling of the Cyclic Behaviour of CLT Connectors and Walls

https://research.thinkwood.com/en/permalink/catalogue1653

Author:	Aranha, Chrysl Branco, Jorge Lourenço, Paulo Flatscher, Georg Schickhofer, Gerhard
Year of Publication:	2016
Country of Publication:	Austria
Format:	Conference Paper
Material:	CLT (Cross-Laminated Timber)
Application:	Walls
Topic:	Mechanical Properties Seismic Connections
Keywords:	Shear Tests Axial Tests Cyclic Loads Force-Displacement Curves Numerical Model
Language:	English
Conference:	World Conference on Timber Engineering
Research Status:	Complete
Notes:	August 22-25, 2016, Vienna, Austria p. 3533-3540

Summary:

The characterization of the behaviour of connectors used in Cross-laminated Timber (CLT) structures is an important aspect that needs to be considered in their seismic design. In this paper, the data from shear and axial tests conducted on connectors have been used to define their force-displacement curves under cyclic loads using the SAWS model in OpenSees. The component curves were then incorporated into the corresponding wall models and the results were compared with their experimental counterparts, in order to determine the validity of the finite element model. Thereby, the non-linear behaviour was restricted to the connectors while the walls themselves were composed of linear orthotropic shell elements. The models were found to provide a good estimate of the initial stiffness and maximum load capacity of the wall specimens. The effects of vertical loading and the presence of openings were determined based on analyses run on the calibrated model.

Online Access: Free

Resource Link

http://hdl.handle.net/20.500.12708/172

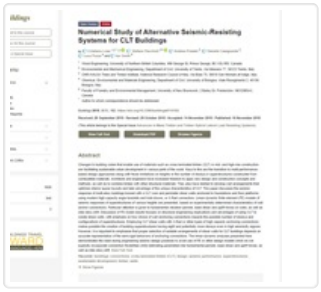
Radiation Efficiency Of Cross Laminated Timber Panels By Finite Element Modelling

https://research.thinkwood.com/en/permalink/catalogue2422

Author:	Zhou, Jianhui
Publisher:	Canadian Acoustical Association
Year of Publication:	2019
Country of Publication:	Canada
Format:	Journal Article
Material:	CLT (Cross-Laminated Timber)
Application:	Wood Building Systems
	Walls
	Floors
Topic:	Acoustics and Vibration
Keywords:	Finite Element Modelling
	Abaqus
	Sound Radiation Efficiency
	Boundary Conditions
Language:	English
Research Status:	Complete
Series:	Journal of the Canadian Acoustical Association
Online Access:	Free

Resource Link

https://jcaa.caa-aca.ca/index.php/jcaa/article/view/3320



Numerical Study of Alternative Seismic-Resisting Systems for CLT Buildings

https://research.thinkwood.com/en/permalink/catalogue2176

Author:	Loss, Cristiano
	Pacchioli, Stefano
	Polastri, Andrea
	Casagrande, Daniele
	Pozza, Luca
	Smith, Ian
Publisher:	MDPI
Year of Publication:	2018
Country of Publication:	Switzerland
Format:	Journal Article
Material:	CLT (Cross-Laminated Timber)
Application:	Walls
	Shear Walls
Topic:	Connections
	Design and Systems
Keywords:	Seismic Performance
	Superstructures
Language:	English
Research Status:	Complete
Series:	Buildings
Online Access:	Free

Resource Link

https://doi.org/10.3390/buildings8110162

Finite Element Modelling of Heat and Moisture Transfer through Cross Laminated Timber Panels

https://research.thinkwood.com/en/permalink/catalogue2414

Author:	Tripathi, Jaya
	Rice, Robert William
Publisher:	North Carolina State University
Year of Publication:	2019
Country of Publication:	United States
Format:	Journal Article
Material:	CLT (Cross-Laminated Timber)
	LSL (Laminated Strand Lumber)
Application:	Wood Building Systems
	Walls
Topic:	Moisture
	Fire
Keywords:	Hygrothermal
	Finite Element Modelling
	Spruce
	Panels
	Hybrid
Language:	English
Research Status:	Complete
Series:	BioResources
Online Access:	Free

Resource Link

https://ojs.cnr.ncsu.edu/index.php/BioRes/article/view/BioRes_14_3_6278_Tripathi_Finite_Element_Modelling_Heat_Moisture

Finite Element Modelling of Moisture Related and Visco-Elastic Deformations in Inhomogeneous Timber Beams

https://research.thinkwood.com/en/permalink/catalogue425

Author:	Ormarsson, Sigurdur
	Dahlblom, Ola
Publisher:	ScienceDirect
Year of Publication:	2013
Country of Publication:	Netherlands
Format:	Journal Article
Material:	Glulam (Glue-Laminated Timber)
Application:	Beams

Topic:	Mechanical Properties
	Moisture
Keywords:	Inhomogeneous
	Finite Element Model
	Axial Deformation
	Lateral Deformation
	Shrinkage
	Mechanosorption
	Visco-Elastic
Language:	English
Research Status:	Complete
Series:	Engineering Structures

Summary:

Wood is a hygro-mechanical, non-isotropic and inhomogeneous material concerning both modulus of elasticity (MOE) and shrinkage properties. In stress calculations associated with ordinary timber design, these matters are often not dealt with properly. The main reason for this is that stress distributions in inhomogeneous glued laminated members (glulams) and in composite beams exposed to combined mechanical action and variable climate conditions are extremely difficult to predict by hand. Several experimental studies of Norway spruce have shown that the longitudinal modulus of elasticity and the longitudinal shrinkage coefficient vary considerably from pith to bark.

The question is how much these variations affect the stress distribution in wooden structures exposed to variable moisture climate. The paper presents a finite element implementation of a beam element with the aim of studying how wooden composites behave during both mechanical and environmental load action. The beam element is exposed to both axial and lateral deformation. The material model employed concerns the elastic, shrinkage, mechano-sorption and visco-elastic behaviour of the wood material. It is used here to simulate the behaviour of several simplysupported and continuous composite beams subjected to both mechanical and environmental loading to illustrate the advantages this can provide. The results indicate clearly both the inhomogeneity of the material and the variable moisture action occurring to have had a significant effect on the stress distribution within the cross-section of the products that were studied.

Online Access:	Free

Resource Link

http://orbit.dtu.dk/files/51980775/Paper_Ormarsson_Dahlblom_2012_ReSub_Final.pdf

Evaluation of the Mechanical Properties of Cross Laminated Bamboo Panels by Digital Image Correlation and Finite Element Modelling

https://research.thinkwood.com/en/permalink/catalogue533

Author:	Archila-Santos, Hector
	Brandon, Daniel
	Ansell, Martin
	Walker, Pete
	Ormondroyd, Graham
Year of Publication:	2014
Country of Publication:	Canada
Format:	Conference Paper
Material:	Other Materials
Topic:	Mechanical Properties
Keywords:	Bamboo
	Finite Element Model
	Compression
	Shear
	Digital Image Correlation
Language:	English
Conference:	World Conference on Timber Engineering
Research Status:	Complete
Notes:	August 10-14, 2014, Quebec City, Canada

Summary:

Guadua angustifolia Kunth (Guadua) is a bamboo species native to South and Central America that has been widely used for structural applications in small and large scale buildings, bridges and temporary structures. Guadua remains a material for vernacular construction associated with high levels of manual labour and structural unpredictability. The aim of this work is to develop standardised industrial structural products from Guadua and to measure and predict their mechanical behaviour. Cross laminated Guadua (CLG) panels comprised of three and five layers were manufactured and their mechanical properties evaluated by testing small and large specimens in compression and shear. The digital image correlation (DIC) method was used to measure strain variations in the X, Y and Z axes on the surface of small CLG panels with strain gauge measurements on the reverse face. The deformation of large CLG panels was measured using DIC on the front face and transducers on the reverse face. The results from mechanical tests and DIC were compared and a finite element (FE) model developed that predicts the response of the material. Overall, this study provides guidelines for structural design with engineered bamboo products which are of key importance for their mainstream use.

Online Access:	Free

Resource Link

http://schd.ws/hosted_files/wcte2014/b5/ABS378_Archila_web.pdf

Quantifying the Impacts of Moisture and Load on Vertical Movement in a Simulated Bottom Floor of a 6-Storey Platform Frame Building

https://research.thinkwood.com/en/permalink/catalogue2619

Author:	Wang, J.
	King, L.
Organization:	FPInnovations
Year of Publication:	2013
Country of Publication:	Canada
Format:	Report
Material:	Light Frame (Lumber+Panels)
Application:	Wood Building Systems
Topic:	Moisture
	Design and Systems
Keywords:	Mid-Rise
	Vertical Movement
	Moisture Content
	Shrinkage
	Load-Induced Movement
Language:	English
Research Status:	Complete

Summary:

Vertical movement of wood frame buildings has become an important consideration in recent years with the increase of building height in Europe, North America, and Asia up to 6-storeys. This movement is composed of wood shrinkage and load-induced movement including initial settlement and creep. It is extremely difficult to identify the relative contributions of these components while monitoring full size buildings. A laboratory test was therefore designed to do this under controlled environmental and loading conditions. Two identical small-scale platform frame structures with dimensional lumber floor joists were designed and constructed, with built-in vertical movement and moisture content monitoring systems. The two structures were first conditioned in a chamber to achieve an initial moisture content (MC) about 20% to simulate typical MC on exposed construction sites in wintertime in Coastal BC. After the two structures were moved from the conditioning chamber into the laboratory environment, using a unique cantilever system, Structure No. 1 was immediately loaded to measure the combined shrinkage and deformation in the process of drying. Structure No. 2 was not loaded until after the wood had dried to interior equilibrium moisture content to observe the shrinkage and load-induced movement separately. The load applied on the two structures simulated a dead load experienced by the bottom floor of a six-storey wood frame building. The vertical movement and MC changes were monitored over a total period of six months. Meanwhile, shrinkage coefficients were measured by using end-matched lumber samples cut from the plate members of the two structures to predict the shrinkage amounts of the horizontal members of the two structures.

The results suggested that a load must be applied for movement to “show up” and occur in a downward direction. Without loads other than the wood weight, even shrinkage could show as upward movement. Monitoring of Structure No. 1 appeared to separate the contributions of wood shrinkage, initial settlement (bedding-in movement), and creep reasonably well. The entire movement amount reached about 19 mm after six months, which was comparable to the vertical movement measured from the bottom floor of a 4-storey wood-frame building in BC. Shrinkage accounted for over 60% of the vertical movement, with the other 40% contributed by load-induced movement including initial settlement and creep (when elastic compression was neglected); the magnitude of creep was similar to the initial settlement amount. Structure No. 2 showed less vertical movement but an increased settlement amount at the time of loading, indicating the presence of larger gaps between members when the wood was dry (with an estimated MC of 11%) before loading. Depending on construction sequencing, such settlement should occur with increase in loads during construction and can therefore be ignored in design. However, this test suggested that there may be a need to consider the impact of creep, in wet climates in particular, in addition to wood shrinkage.

This laboratory test will be maintained for a longer period to observe any further vertical movement and the relative contributions of shrinkage and creep. Similar tests should be conducted for structures built with engineered wood floor joists, given the fact that most mid-rise platform buildings use engineered wood floor joists instead of lumber joists.

Online Access: Free

Resource Link

https://library.fpinnovations.ca/en/permalink/fpipub39705

Assessing Cross Laminated Timber (CLT) as an Alternative Material for Mid-Rise Residential Buildings in Cold Regions in China—A Life-Cycle Assessment Approach

https://research.thinkwood.com/en/permalink/catalogue1209

Author:	Liu, Ying
	Guo, Haibo
	Sun, Cheng
	Chang, Wen-Shao
Publisher:	MDPI
Year of Publication:	2016
Country of Publication:	Switzerland
Format:	Journal Article
Material:	CLT (Cross-Laminated Timber)
Application:	Wood Building Systems
Topic:	Energy Performance
Keywords:	Life-Cycle Assessment
	Cradle-to-Grave
	China
	Cold Regions
	Severe Cold Regions
	Energy Consumption
	Mid-Rise
	Residential
Language:	English
Research Status:	Complete
Series:	Sustainability

Summary:

Timber building has gained more and more attention worldwide due to it being a generic renewable material and having low environmental impact. It is widely accepted that the use of timber may be able to reduce the embodied energy of a building. However, the development of timber buildings in China is not as rapid as in some other countries. This may be because of the limitations of building regulations and technological development. Several new policies have been or are being implemented in China in order to encourage the use of timber in building construction and this could lead to a revolutionary change in the building industry in China. This paper is the first one to examine the feasibility of using Cross Laminated Timber (CLT) as an alternative solution to concrete by means of a cradle-to-grave life-cycle assessment in China. A seven-storey reference concrete building in Xi'an was selected as a case study in comparison with a redesigned CLT building. Two cities in China, in cold and severe cold regions (Xi'an and Harbin), were selected for this research. The assessment includes three different stages of the life span of a building: materialisation, operation, and end-of-life. The inventory data used in the materialisation stage was mostly local, in order to ensure that the assessment appropriately reflects the situation in China. Energy consumption in the operation stage was obtained from simulation by commercialised software IESTM, and different scenarios for recycling of timber material in the end-of-life are discussed in this paper. The results from this paper show that using CLT to replace conventional carbon intensive material would reduce energy consumption by more than 30% and reduce CO2 emission by more than 40% in both cities. This paper supports, and has shown the potential of, CLT being used in cold regions with proper detailing to minimise environmental impact.

Online Access:	Free

Resource Link

https://doi.org/10.3390/su8101047