

Session No.	Session Topic	Abstract Topic	Submission Title	Summary	First Name	Last Name	Company
5A	TESP - Engineering - Structural Components	Session Chair: DR SHENGDONG ZHANG / TONGJI UNIVERSITY					
5A	TESP - Engineering - Structural Components	Timber Engineering & Structural Performance - Engineering Focus	INFLUENCE OF RECTANGULAR WEB OPENINGS ON LOAD-CARRYING CAPACITY OF TIMBER I-JOISTS	This paper presents test results of experimental work conducted to evaluate the influence of rectangular web openings on the structural performance of timber I-joists fabricated from solid wood flanges and oriented-strand board web. Four-point bending tests were conducted on specimens with and without openings. Test samples span was equal to 9 times the depth of the I-joists with openings made at various locations in turn related to the joist depth. Effects of the size and opening locations on the load-carrying capacity of the I-joists were determined. Test results revealed that an increase in the height and width of the openings significantly reduced the load-carrying capacity when openings were placed outside pure bending areas (i.e. up to 58% when I-joist with the largest opening tested). In contrast, openings within the pure bending area have a negligible influence on the capacity.	Sini	Lu	Edinburgh Napier University
5A	TESP - Engineering - Structural Components	Timber Engineering & Structural Performance - Engineering Focus	NUMERICAL APPLICATION OF LOAD-BEARING DOUBLE-SKIN FACADE ELEMENTS IN HIGH-RISE TIMBER BUILDINGS	The paper presents a numerical application of a new developed load-bearing prefabricated light timber-framed elements with doubled-pane glazing called as double-skin façade (DSF) elements in a specially selected high-rise timber construction. Prefabricated DSF elements basically combine sustainable solutions with improved energy efficiency and living quality, however, mostly all these transparent façade elements because of energy benefits are primary asymmetrical oriented in the building envelope and if they are considered following the current standards as non-resisting against a horizontal load impact, a strong torsion effects in the building can appear. The problem of structural stability against a strong horizontal load impact of such modern timber buildings especially increase in a case of high-rise timber structures where additional bracing elements have to be used. The new developed load-bearing DSF elements can be a good answer on all these requirements. In our previous experimental and numerical studies a possible benefit of such load-bearing DSF elements was already presented, however they were not applied yet in any high-rise timber structure at all. Therefore, in the presented study a specially selected 10-storey prefabricated timber building constructed in a cross-laminated timber (CLT) structural wall system is analysed using the developed DSF elements as additional bracing elements in a sense to increase a structural lateral stability of the whole timber building. The obtained results evidently highlight the importance of the application of the new-developed load-bearing DSF elements, as their incorporation can have a significant impact on the overall structural behaviour of the high-rise structure through their influence on the evidently improved racking stiffness properties.	Miroslav	Premrov	University of Maribor, Faculty of Civil Engineering, Transportation Engineering and Architecture
5A	TESP - Engineering - Structural Components	Timber Engineering & Structural Performance - Engineering Focus	PERFORMANCE BASED DESIGN METHOD FOR TIMBER UNIT LOAD-BEARING WALL COMPOSED OF CURVED MEMBERS CONSIDERING GEOMETRIC NONLINEARITY AND PERFORMANCE OF JOINTS	This study proposes a load-bearing wall system composed of curved wooden member units, allowing designers to freely control stiffness and strength. This system allows for independent control of stiffness and strength by adjusting the unit size, sectional dimensions, or curvature. Additionally, a performance-based design method is proposed, grounded in solving an inverse problem. Applying this system to older traditional wooden buildings enables the design of load-bearing walls that accommodate the high deformation performance of these structures. Moreover, it is possible to alter the appearance without affecting performance. By considering geometric nonlinearity and the performance of bolted joints, we achieve a model that closely approximates real-world phenomena. The validity of the design method is evaluated by comparing experimental results with analytical results.	Shion	KUBOTA	0
5A	TESP - Engineering - Structural Components	Timber Engineering & Structural Performance - Engineering Focus	MOMENT JOINTS IN THE MINOR STRENGTH AXIS OF CLT PANELS	When cross-laminated timber (CLT) panels are used in buildings with irregular component geometries, the loading conditions may deviate from the major or minor strength axis of the panel. This study examines the bending stiffness of CLT panels under different cross-angles using experimental, analytical, and numerical methods. Panels with three lay-ups (3-ply, 4-ply, and 5-ply) and five cross-angles (ranging from 0° to 90°) were tested under three-point bending. The results demonstrated a nonlinear relationship between cross-angle and bending stiffness. The lowest bending stiffness was observed at intermediate cross-angles, rather than along the minor strength direction. The proposed analytical model combines the shear analogy with the Hankinson equation to approximate the bending stiffness. The model was validated through numerical simulations and used to predict the out-of-plane cross-angle bending stiffness of various CLT panel lay-ups.	Xiaoyue	Zhang	School of Civil Engineering, Chongqing University
5A	TESP - Engineering - Structural Components	Timber Engineering & Structural Performance - Engineering Focus	SCREW REINFORCEMENT AND REPAIR OF POINT-SUPPORTED CLT	Self-tapping screws (STS) can be used for shear reinforcement of point-supported Cross-laminated timber (CLT) floors; however, the effect of reinforcement zone, level, and strength axis directions are not yet fully understood. Moreover, there is a lack of understanding of the post-failure performance of point-supported CLT floors and the feasibility of repair by means of screw reinforcement. In this research, STS-reinforced intact and STS-repaired CLT panels were tested under punching shear to study the impact of different reinforcement parameters. Re-tested panels without reinforcement reached up to 85% of their initial capacity. STS reinforcement increased the load-carrying capacity of intact panels by up to 42%. And reinforced re-tested panels reached up to 96% to 124% of their initial load-carrying capacity. The non-repaired and reinforced re-tested panels reached up to 61% and 78% of their initial elastic stiffness, respectively, and repaired CLT recovered up to 90% and 98% of stiffnesses, respectively.	Houman	Ganjali	University of Northern British Columbia
5A	TESP - Engineering - Structural Components	Timber Engineering & Structural Performance - Engineering Focus	EXPERIMENTAL STUDY OF BRITTLE FAILURE OF LATERALLY LOADED CROSS-LAMINATED TIMBER CONNECTIONS WITH INCLINED SELF-TAPPING SCREWS	Self-tapping screws (STSs) are one of the most commonly used fasteners in modern mass timber construction. The new STS provision in CSA O86-24 does not formally address brittle failure of inclined STS connections due to a lack of research data. To fill this knowledge gap, a series of tests on Steel-to-CLT connections with STSs at different insertion angles, penetration lengths and lateral load directions were conducted. This study aims to develop predictive equations for plug-step shear failure mode and evaluate if the equations adopted for 90-degree STS connections in the new provision are also applicable for inclined STS connections. This study is expected to enhance the understanding of the behavior of Steel-to-CLT connections with STSs in various configurations and contribute to the development of design provisions for brittle failure of inclined STS connections.	HUIQI	WANG	University of Victoria
5A	TESP - Engineering - Structural Components	Timber Engineering & Structural Performance - Engineering Focus	EXPERIMENTAL STUDY ON GLULAM POST-BEAM JOINTS WITH INCLINED SELF-TAPPING SCREWS UNDER CYCLIC LOAD	To study the seismic performance of timber post-beam joints connected with inclined long self-tapping screws, an experimental study was carried out. 8 groups of specimens fabricated with nominal 13 mm diameter WRT self-tapping screws of SFS Intec. and Douglas fir GLULAM with 2 replicates in each group under cyclic load were tested. Impact factors such as number of screws, inclined angle, rows of screws, edge distance of screws, etc. were taken into account. The results show that the failure mode is tension failure of screws when the embedment length is long enough, the ductility coefficients of the joints are in the range of 1.70~2.52, the edge distance and the number of screws have impact on the capacities of the joints, but the inclined angles of the screws have no significant influence.	Shengdong	Zhang	Tongji University

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5B	TESP- Engineering Structural Modelling	Session Chair: DR SARDAR MALEK / UNIVERSITY OF VICTORIA					
5B	TESP- Engineering Structural Modelling	Timber Engineering & Structural Performance - Engineering Focus	Development of an innovative structural system for multistorey timber buildings with increased service life – the CRESTIMB project	CRESTIMB aims to develop an innovative timber system for multi-storey buildings with open spaces. The system will include softwood or hardwood glued-laminated timber (glulam) columns and beams connected with innovative moment resisting connections, and dowel-laminated floors. This paper focuses on the description and identification of the gravity and lateral load-resisting system, in addition to the experimental programme that aims to assess the short- and long-term performance of the system components, which includes mechanical tests on small wood samples, and full-scale tests. Test results will serve as input to an advanced numerical model to investigate the long-term behaviour of the selected components considering the complex rheological behaviour of wood under variable indoor climates, with the objective being to ensure an increased service life and the possibility of reuse.	Martina	Sciomenta	University Of L'aquila
5B	TESP- Engineering Structural Modelling	Timber Engineering & Structural Performance - Engineering Focus	DYNAMIC RESPONSE OF DIAGONAL LAMINATED TIMBER – PARAMETER STUDIES AND MODELLING APPROACHES	The paper provides an overview and preliminary results from the InnoTLT research project. The objective of InnoTLT is to evolve cross-laminated timber (CLT) into the next generation of Tailored laminated Timber (TLT) by exploring concepts that optimize mechanical performance while simultaneously ensuring adherence to circular economy principles. The current study aims at investigating the potential in terms of Diagonal Laminated Timber (DLT), where adjacent layers are oriented at a non-orthogonal direction relative to each other. Finite element parameter studies were performed, showing differences in dynamic behaviour for DLT compared to CLT. The study highlights the potential of using DLT as a means of tailoring the vibration performance. In addition, the paper discusses pros and cons as regards different modelling approaches in terms of model detailing and choice of element types.	Erik	Serrano	Lund University
5B	TESP- Engineering Structural Modelling	Timber Engineering & Structural Performance - Engineering Focus	Evaluation of the Effective Flange Width of Mass Timber Composites T-Beams Using Digital Image Correlation and Finite Element Modelling	Mass timber composites (MTCs) often consist of CLT slabs and glulam beams compositely connected with a shear connection consisting of adhesive, mechanical fasteners, or a combination thereof. The large spacing between beams in MTC panels results in longitudinal stresses in the flange(s) over the voided areas, lagging those close to the beams. This non-linear strain distribution is typically accounted for in design with an effective flange width (EFW) factor. This study evaluates the EFW for three 4.5m CLT-glulam T-beams compositely connected with a screw-glued connection. Longitudinal strains across the top of the CLT flange are obtained using digital image correlation, finite element (FE) modelling, and discrete strain gauges, and used to determine the EFW for each specimen. Overall, the DIC technique presented herein was able to provide valuable strain and deformation data which had good agreement with the discrete strain gauges and FE modelling. The EFW results showed that proposed design code guidance was not able to accurately predict the EFW of MTC panels.	Tyler	Hull	University of Waterloo
5B	TESP- Engineering Structural Modelling	Timber Engineering & Structural Performance - Engineering Focus	EXPERIMENTAL STUDY OF STRUCTURAL PERFORMANCE OF TIMBER-CONCRETE COMPOSITES USING RECYCLED AGGREGATES	This study investigates the load-slip behaviour of timber-concrete composite (TCC) with recycled aggregates within concrete constituent. Push-out tests were conducted, and the load-slip behaviour was obtained from TCC specimens made from cross-laminated timber in conjunction with normal and recycled aggregate concrete. The recycled aggregates were Incinerator Bottom Ash Aggregates. The composite actions were achieved by using screw connectors at 30°, 45° and 90° orientations. The results reveal comparable structural behaviour of TCC specimens with normal and recycled aggregate concrete layer, however, a slight reduction in slip-modulus and an increase in slip were observed in TCC with recycled aggregate concrete. Furthermore, cross-screws at 30° and 45° enhanced the load-slip performance with minimal concrete cracking. The results demonstrate that incorporating recycled aggregate material in TCC has the potential as a viable alternative to promoting sustainability in construction.	Daniel	Kumah	Edinburgh Napier University
5B	TESP- Engineering Structural Modelling	Timber Engineering & Structural Performance - Engineering Focus	A RESILIENT CLT SHEAR WALL SYSTEM FOR TIMBER BUILDINGS	Balloon-framed cross-laminated timber (CLT) shear walls are a promising solution as the primary lateral force resisting system (LFRS) for tall mass timber buildings. But this LFRS is not specified in current Canadian and American codes, and engineers have to go through lengthy peer reviews to get a balloon-type design approved. To support practitioners, this research aims to develop a practical guide to facilitate the numerical analysis of balloon-framed CLT buildings under high seismicity. Proper modelling strategies are essential to accurately predict the system performance; therefore, an overview of modelling approaches appropriate to capture the lateral response of CLT panels and connections is presented. An archetype building based on real design practice is presented and a nonlinear model is established. The model, validated with experimental data from connection and shear wall tests, will be used to simulate the seismic performance of balloon-framed CLT shear wall buildings.	Fei	Tong	University of Northern British Columbia
5B	TESP- Engineering Structural Modelling	Timber Engineering & Structural Performance - Engineering Focus	STRUCTURAL MODELING OF A NOVEL HYBRID TIMBER FLOOR SYSTEM	To maximize the amount of carbon-sequestering mass timber and demonstrate the potential for mass timber across a range of building types and scales, DIALOG and EllisDon have developed a Hybrid Timber Floor System (HTFS) that is composed of post-tensioned (PT) concrete beams, cross laminated timber (CLT) panel, and concrete topping connected to each other through self-tapping screws and kerf plates. This paper presents a study of the structural performance of this novel HTFS through a combination of testing and modelling conducted at FPInnovations. The structural performance of the self-tapping screw (STS) and kerf plate connections was tested and used as key modelling input. A refined and comprehensive three-dimensional (3D) finite element model was developed and verified against deflection and vibration measurements obtained from the full-size HTFS. The verified model was utilized to investigate the structural performance of HTFS under out-of-plane loading. The connection tests and the simulation results give an insight into the structural performance of this novel HTFS.	Zhiyong	Chen	FPInnovations
5B	TESP- Engineering Structural Modelling	Timber Engineering & Structural Performance - Engineering Focus	Numerical modelling of high-capacity shear walls with multiple rows of nails: failure modes and parametric study	A new high-capacity wood frame shear wall system with two and three rows of nails was developed in collaboration between the University of Victoria and FPInnovations in response to the increased demand for stronger shear wall systems. Test programs were carried out over a three-year period. Results showed that the proposed high-capacity shear wall system can achieve lateral resistance proportional to the number of rows of nails on sheathing edges compared to a standard shear wall. A detailed 3D numerical model of high-capacity shear walls with multiple rows of nails was developed in ABAQUS. The model was verified by the test results with good agreement. This study presents a parametric study considering wall configurations that are not included in the test programs. High-capacity shear walls with different aspect ratios, stud sizes, sheathing orientation, and hold-down types were modelled. The results were analysed in terms of load-displacement response and failure modes.	Ruite	Qiang	University of Victoria
5C	TESP- Engineering Vibrations and Acoustics	Session Chair: PROFESSOR YING HUI CHUI / UNIVERSITY OF ALBERTA					

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5C	TESP- Engineering Vibrations and Acoustics	Timber Engineering & Structural Performance - Architectural Focus, Education, Innovation & Challengers - Architectural Focus, Exemplars & Construction Case Studies - Architectural Focus	The application of hybrid timber systems to challenge conventional building typologies in an emerging market: 2 Castle Street 'Workplace Hub'	<p>One of the key differentiators of mass timber workplace buildings from more entrenched methods of construction is it's unique, inherent structural performance.</p> <p>This paper explores how the knowledge developed during the design and construction of the Oakhill Innovation Hub is being applied to evolve both education and commercial building typologies. This knowledge is being applied directly to design process of a new office tower, the 2 Castle Street 'Workplace Hub', which at completion will be one of the southern hemisphere's largest commercial buildings by both height and area metrics.</p> <p>The primary ambitions of the Workplace Hub presented two challenges to contemporary Australian commercial buildings. Firstly, the need for use of timber for its low carbon and high strength to weight ratio when compared to concrete, allowing for a larger building than would conventionally be possible above a rail corridor. Second is the emerging demand for 'post-covid' workplaces where occupants have access entirely outdoor spaces within a commercial floorplate.</p> <p>In isolation each of these could be solved easily through established mass timber systems, or conventional construction, respectively. In combination, however, they require a structural and procurement strategy that demands growth of the Australian construction sector. This case study responds to project specifics and support the maturity of mass timber within Australia. The design journey follows through multiple lenses and design implications of a hybrid mass timber structure in a commercial/workplace context.</p>	Adrian	Taylor	BVN
5C	TESP- Engineering Vibrations and Acoustics	Timber Engineering & Structural Performance - Engineering Focus	EVALUATION OF THE INFLUENCE OF SYSTEM EFFECTS ON THE LATERAL RESPONSE OF BUILDINGS WITH L- AND U-SHAPED WOOD FRAME SHEAR WALLS THROUGH SHAKE TABLE TESTS	<p>This paper presents part of the findings of a shake table test on a 3-story, 1:2 scale Light Frame Timber Building (LFTB), examining the influence of system effects. Here system effects refer to: a) the effect of transverse walls in non-planar shear wall configurations; b) out-of-plane bending diaphragm interaction with the shear walls; and c) gravity load. The study contributes to the comprehension and quantification of system effects, highlighting the benefits of component interaction in LFTBs subjected to lateral loads. Test results demonstrate that system effects significantly reduce story drift demands by increasing the lateral stiffness and damping ratio of the building with respect to those of a building in which there are no system effects. For instance, the experimental first-floor secant stiffness was higher than the value predicted by assuming planar shear walls. This underestimation decreases at higher stories, indicating that the gravity load further enhances the benefits of transverse shear walls and out-of-plane bending stiffness interaction. These findings have implications for the design and analysis of LFTBs in seismic regions: their incorporation into seismic design procedures might promote widespread adoption of LFTBs as a sustainable and resilient construction solution.</p>	Diego	Valdivieso	Centro Nacional de Excelencia para la Industria de la Madera (CENAMAD-CIM UC)
5C	TESP- Engineering Vibrations and Acoustics	Timber Engineering & Structural Performance - Engineering Focus	ASSESSING VIBRATIONAL PERFORMANCE IN DIFFERENT TIMBER FLOOR CONFIGURATIONS: AN EXPERIMENTAL STUDY	<p>The construction of timber structures offers a significant advantage in reducing the carbon footprint associated with building activities. However, to fully realize this benefit, it is essential to enable the construction of large and tall timber buildings. Achieving this goal presents certain engineering challenges, particularly concerning human-induced vibrations on timber floors, which are more pronounced in large-span or office spaces. The lightweight and lower stiffness of timber floors result in vibrating frequencies that fall within the range easily perceptible by humans. Therefore, designing timber floors with optimal vibrational characteristics, such as predominant frequency and damping, is crucial for ensuring comfort and constructability. This research investigates these challenges through a series of experiments on six timber floors, each constructed with three different structural combinations and two varying finishing conditions. The experimental procedures included heel drop, weight drop, human walking, crowd walking, and quasi-static deflection tests. This paper presents the preliminary results from these experiments, offering insights into the vibrational behavior of timber floors and their implications for future construction practices.</p>	Ihsan Engin	Bal	Hanze University of Applied Sciences
5C	TESP- Engineering Vibrations and Acoustics	Timber Engineering & Structural Performance - Engineering Focus	LONG-TERM LOADING CREEP TEST ON A FULL-SCALE STEEL BAR TIMBER COMPOSITE BEAM	<p>We have been developing a frame system formed by timber members strengthened by deformed steel bars using epoxy resin adhesive. We have reported the creep test of small-scaled specimens of composite timber beams in WCTE2018 and WCTE2021. We have been conducting, from December 2023, a new creep test for a full-scale creep test for one full-scale section- and large-span-composite beam specimen and one full-scale section glulam timber beam specimen under a natural-variable environment by 4-point bending loading. They have been adjusted to be subjected to same long-term allowable bending moment of wood at mid span and allowable shear force at both shear spans by selecting the lengths of beam and the shear spans. This paper reports approximately one-year results of the creep test of full-scale beam specimens and curvature-elapsed time curve, for the composite beam, calculated by using curvature-elapsed time curve of the glulam timber beam.</p>	TAKESHI	IZAKI	Kagoshima University
5C	TESP- Engineering Vibrations and Acoustics	Timber Engineering & Structural Performance - Engineering Focus	EXPERIMENTAL INVESTIGATION OF CLT PANELS REINFORCED WITH GFRP BARS	<p>When it comes to designing timber structures the limiting factors are usually stiffness properties of the wood products. Stiffness requirements within the serviceability limit state (deformations and vibrations) are often the most relevant criterion for the design of timber elements subjected to bending. This paper shows an experimental study undertaken to investigate the effectiveness of glass fiber reinforced polymers (GFRP) as flexural reinforcement of cross laminated timber (CLT) panels. Five panels reinforced with GFRP bars and five unreinforced (control) panels were tested up to failure in a four-point bending configuration. Identical reinforcement arrangement in both tensile and compressive zones was considered in order to achieve the maximum increase in stiffness. The mechanical properties of reinforced panels are compared to those of unreinforced panels with regard to the load-deflection behaviour, failure mode, load-carrying capacity, deformability, bending stiffness values, as well as strain distribution along the panels' depth. The experimental results demonstrated the beneficial effect of the proposed reinforcing solution in terms of strength, stiffness and ductility. No issues were evident regarding the integrity of the bond between CLT and GFRP bars.</p>	Nada	Simović	Faculty of Civil Engineering, University of Belgrade
5C	TESP- Engineering Vibrations and Acoustics	Timber Engineering & Structural Performance - Engineering Focus	VIBRATION BEHAVIOUR OF A STRESSED LAMINATED TIMBER DECK PEDESTRIAN BRIDGE	<p>Timber has gained popularity as an alternative construction material for pedestrian bridges. However, the lightweight and low mass of structural timber systems make them prone to high vibrations. Information for assessing pedestrian comfort on timber bridges is limited. Field experiments were carried out on a stress laminated timber deck pedestrian bridge using highly developed dynamic analysis methods to evaluate the vibration characteristics of the structure. Focus was on natural frequencies, mode shapes damping ratios and time history responses which are indicative parameters for assessing the vibration serviceability of structural systems.</p>	Mohammadreza	Salehi	Norwegian University of Life Sciences

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5C	TESP - Engineering Vibrations and Acoustics	Timber Engineering & Structural Performance - Engineering Focus	Experimental Investigation of Vibration Performance of a Glulam Deck Floor Supported on Glulam Beams	As mass timber panels become increasingly prevalent in mid-rise and high-rise wood structures, ensuring satisfactory floor vibration performance is essential for occupant comfort. Current design methods often overlook the impact of support conditions, assuming rigid supports and neglecting the effects of beam flexibility on floor vibration. Additionally, concrete topping on mass timber floors is a common practice for improving acoustic and fire performance, but its impact on floor vibration performance remains uncertain. This study investigates the dynamic properties and vibration performance of a full-scale glulam deck floor through experimental tests, considering the effects of beam-supported condition, non-structural sheathing panel, and concrete topping. The results indicate a significant decrease in the fundamental natural frequency when transitioning from rigid to beam support, leading to resonant responses under human walking. Although the addition of concrete topping improved vibration performance from marginal to acceptable level, measured acceleration levels exceeded AISC DG11 recommendations by four to six times, contradicting subjective evaluations. These findings illustrate the significant impact of support conditions and concrete topping on the vibration performance of mass timber floor structures, underscoring the necessity of considering these factors in future design methods. The experimental data provide practical insights for the real construction of such floor structures. More detailed data and discussion will be presented in the full paper.	Chenyue	Guo	University of Alberta; University of Northern British Columbia
5C	TESP - Engineering Vibrations and Acoustics	Timber Engineering & Structural Performance - Engineering Focus	Signal Denoising for Timber Bridge Structural Health Monitoring Using Optimized Variational Mode Decomposition	Operational and measurement noise presents a major challenge to the accuracy and reliability of structural health monitoring (SHM) systems, particularly in timber bridge applications. This study investigates the effectiveness of Variational Mode Decomposition (VMD), an advanced signal processing technique, in enhancing the quality of response measurements from a laboratory-scale pedestrian timber bridge. Acceleration and strain signals were collected under both intact and damaged conditions to perform a detailed signal analysis. VMD was applied to decompose the signals into narrowband intrinsic mode functions (IMFs), enabling the isolation of structural responses from noise. The method yielded high cross-correlation values (above 0.998) between original and reconstructed signals, confirming that critical features were preserved. Furthermore, energy retention analysis across IMFs revealed distinct patterns reflective of structural condition, with meaningful content concentrated in the lower-order modes and noise primarily captured by the final components. These findings confirm the potential of VMD as a robust preprocessing tool for noise reduction within SHM frameworks, supporting improved interpretation of structural responses in timber bridge structures.	Farshid	Abdoli	Western Sydney University
5D	STCE/TESP - Engineering - Material Properties / Codes & Regulatory Framework	Session Chair: PROFESSOR ALEXANDER SALENIKOVICH / UNIVERSITE LAVAL					
5D	STCE/TESP - Engineering - Material Properties / Codes & Regulatory Framework	Sustainability and Timber in a Circular Economy - Engineering Focus	CONTRIBUTION TO CLIMATE CHANGE MITIGATION THROUGH SOIL LIQUEFACTION COUNTERMEASURES USING LOGS	The authors propose the use of logs in liquefaction countermeasures. The major advantage of this method is that it captures carbon dioxide from the atmosphere and stocks it underground. Thus, in addition to reducing carbon dioxide emissions, atmospheric carbon dioxide would also be reduced. This is the same as creating a forest underground. This paper describes the mechanism by which the proposed liquefaction countermeasure mitigates climate change, and discusses the effects of the liquefaction countermeasure and carbon stock. Finally, the carbon stocking effect of the liquefaction countermeasures is described based on 22 cases of liquefaction countermeasures using log piles. As a result, it was found that the amount of carbon stocks in the logs driven into the ground was more than 10 times larger than the amount of carbon dioxide emitted by the construction.	Atsunori	NUMATA	Soilwood
5D	STCE/TESP - Engineering - Material Properties / Codes & Regulatory Framework	Material Performance & Durability - Engineering Focus, Sustainability and Timber in a Circular Economy - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	Advancements on the Structural Timber Optimizer (STO)	While wood-based building materials can lower emissions of the construction industry, the increased use will have impacts on forests and their ecosystems. The Structural Timber Optimizer (STO) was developed to reduce the overall material usage for wood-based building components with high structural performance. This paper presents insights on the current findings of implementing STO in the structural optimization of a multi-layered wall element made from oriented strand board. Building on prior research, the structural modelling approach was further developed to accurately represent separate parts of the components and their contact domains. While the part-based modelling approach allows for accurate structural modelling, the increased complexity and the required explicit dynamic solver increases computation time. To reduce this computation time several strategies are presented. Furthermore, the influence of objective, variables and constraints on the results of the genetic algorithm as well as other optimization parameters are analyzed and discussed in this context. With the findings of this research, optimization results with the STO are more robust, leading the way to practical applications of structurally-optimized wood-based building components.	Benjamin	Kromoser	Institute of Green Civil Engineering, University of Natural Resources and Life Sciences
5D	STCE/TESP - Engineering - Material Properties / Codes & Regulatory Framework	Sustainability and Timber in a Circular Economy - Engineering Focus	ESTIMATION OF STIFFNESS OF STANDING TREES BY VIBRATION CHARACTERISTICS	The area of Japanese forests planted with trees has remained constant in contrast to the increase in the area logged. This seems due to the fact that forest owners are unable to quantitatively evaluate the value of standing timber. The value of timber used for building materials in the Japanese timber distribution system is determined by measuring Young's modulus only after the timber has been cut from the mountain, leaves the forest owner's hands, and is sawn into lumber at a sawmill. The ultimate goal of this study was to estimate Young's modulus after sawing, in the standing timber condition so that the value of the timber could be determined at a stage when the owner of the forest could know the value of the timber. In order to clarify the possibility of estimating Young's modulus from vibration characteristics using natural frequencies of a standing tree, The Young's modulus estimated by forced bending test of the tree was compared with the Young's modulus estimated from the natural frequency of the tree. As a result, a correlation between them was obtained. In this study, the position of the center of gravity and weight of the tree were estimated values, but if theirs are estimated more correctly, it may be possible to measure them more precisely.	Kazuma	Kitamura	Osaka Metropolitan University
5D	STCE/TESP - Engineering - Material Properties / Codes & Regulatory Framework	Sustainability and Timber in a Circular Economy - Engineering Focus	Enhancing the role of timber through green public procurement (GPP): Establishing a framework and list of products and services for the Irish construction industry.	Green Public Procurement (GPP) is an increasingly popular environmental policy tool being implemented across EU to meet carbon reduction targets. GPP could be leveraged to promote the use of timber through several different avenues in the procurement process. This paper establishes a framework as part of a holistic overview of procurement and how different decision steps in procurement are influenced. In addition, the paper also identifies different list of products and services used by the public authority (PA) in the Irish construction sector. The paper identifies the use of GPP to promote green criteria, ecolabels, certification targets, lifecycle assessment (LCA) and various other steps associated with greener procurement may help promote the use of timber in construction.	Mohammed Zajeer	Ahmed	University of Galway

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5D	STCE/TESP - Engineering - Material Properties / Codes & Regulatory Framework	Timber Engineering & Structural Performance - Engineering Focus	A performance design and stochastic analysis method for determining the allowable percentage of exposed structural mass timber in a building.	Use of structural timber in buildings, is an important way of complying with new environmental regulations and meeting global and national low carbon pathways. Conversely, in light of the expansion of timber construction, prescriptive fire regulations, with required degree of passive and active protection of structural timber members can counter to the economy of construction and reduction of carbon footprint. Using recently developed predictive method of stability of exposed mass timber under natural fire in building, a method to conduct parametric and stochastic studies allowing to define, for a given type of construction, a percentage of exposed structural timber reaching target of tolerable risk is presented. The definition of absolute value targets based on the level of reliability required by Eurocodes and relative value targets (deemed-to-satisfy solutions) are discussed. The construction of scenarios, parameters and their distribution and calculation of total failure probability per lifetime for relevant criteria are defined. The implementation of the method for a given typology of construction, allowing to reach compliance with performance-based building code requirements is presented.	Francois	Consigny	Cstb / ENPC (Paris, France)
5D	STCE/TESP - Engineering - Material Properties / Codes & Regulatory Framework	Timber Engineering & Structural Performance - Engineering Focus	FEM-BASED ENGINEERING APPROACH TO ASSESS THE BEARING STRENGTH OF GLT MEMBERS WITH HOLES AND NOTCHES	In recent years, engineered timber construction has grown rapidly, with complex geometries now being erected. Advances in simulation technologies have enhanced our understanding of wood's mechanical behavior, yet this progress is not fully reflected in building codes, creating a gap for practitioners. This paper addresses how commercial finite element (FE) software bridges this gap, particularly for glued laminated timber (GLT) members not covered by Eurocode 5 (EC5). Our approach uses 2D-FE elements and linear elastic orthotropic material properties to model GLT members with holes and notches, identifying stress singularities. These calculations serve as the basis for applying linear elastic fracture mechanics (LEFM). We demonstrate that potential energy release rates GI and GII at stress singularities can be calculated using just one linear elastic 2D-FE model and mean stresses in the potential crack direction. For validation, we used several experiments of GLT beams with notches or rectangular holes found in the literature. The results showed that the proposed approach is capable of predicting the maximum loads observed in the experiments. We also conducted parameter studies to analyze the impact of meshing, element size at the notch, and the detailed geometric shape of the notch on the results. Due to the ease of use and general applicability of this approach, we recommend it for the further design of GLT members with holes and/or notches when using FE analysis.	Markus	Detter	TU Wien (Vienna University of Technology)
5D	STCE/TESP - Engineering - Material Properties / Codes & Regulatory Framework	Timber Engineering & Structural Performance - Engineering Focus	EXPERIMENTAL TESTS ON CONNECTIONS WITH DOWELS AND SLOTTED-IN STEEL PLATES UNDER CYCLIC LOADING.	In dowel-type connections, the occurrence of brittle failure modes before yielding can limit the ductility and energy dissipation of the structural system during a major earthquake. To address these challenges, experimental cyclic tests are conducted on glulam timber connections with dowels installed in single and double slotted-in steel plates. These connections are designed in various configurations based on the CSA O86 and Eurocode 5 standards. The objectives are to determine the stiffness, resistance, ductility, energy dissipation, and failure modes of the connections, and to compare the test results with the predictions of the two design standards.	Kiavash	Gholamizoj	Université Laval
5E	MPD - Engineering - characterising material properties	Session Chair: PROFESSOR KAY-UWE SCHÖBER / MAINZ UNIVERSITY OF APPLIED SCIENCES					
5E	MPD - Engineering - characterising material properties	Material Performance & Durability - Engineering Focus	EXPERIMENTAL AND NUMERICAL INVESTIGATION OF THE BENDING PROPERTIES OF OIL PALM BASED CROSS LAMINATED TIMBER	Increased population figures are leading to higher demand for palm oil and construction products. As a by-product of palm oil production, large quantities of oil palm wood (OPW) are harvested in the near future. The potential of OPW is only utilised to a limited extent. A possible field of application is the use in construction products. The usability of OPW in cross laminated timber (CLT) is therefore being investigated. Lamellas are graded according to their density and dynamic MOE, five-layer (5L) CLT elements are manufactured and subjected to bending tests. In addition, the tests are modelled using the finite element method and compared with the results of the gamma and shear analogy method. The results of the numerical and analytical methods show good agreement ($R^2 = 0.987 - 0.996$) and suggest their applicability for OPW CLT. A comparison with Norway spruce CLT shows slightly lower bending parameters (4 - 10 %) for high-performance OPW-CLT. The applicability of OPW in load-bearing building products can therefore be confirmed.	Martin	Hackel	OWL University of Applied Sciences and Arts (TH OWL)
5E	MPD - Engineering - characterising material properties	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	Factors Influencing the Finger Joint Strength in Double Laminated Beech Glu-lam	Previous research on high strength glulam producing using Fagus sylvatica (European Beech) showed that the finger joints are governing the bending strength of structural sized specimens. In single laminated glulam each finger joint represents a weakening of the lamella over the whole width. In case of a double laminated glulam this can be avoided and depending on the quality and the number of lamination the weakening can be reduced significantly. The aim of the presented research is to investigate parameters that influence the finger joint strength in double laminated glulam produced using Fagus sylvatica. The results showed that the strength of the finger joints is increasing at least over the first four weeks after production and that the arrangement of finger joints in a double laminated glulam influences its strength.	Martin	Lehmann	Bern University of Applied Sciences
5E	MPD - Engineering - characterising material properties	Material Performance & Durability - Engineering Focus	EXPERIMENTAL INVESTIGATION ON THE ROLLING SHEAR PROPERTIES OF TIMBER	The rolling shear properties of timber are important for wood products with orthogonal layouts, such as Cross Laminated Timber (CLT). In this study, rolling shear tests are conducted on silver birch timber board segments for the determination of rolling shear strength and stiffness. The test setup applied is an adaptation of the longitudinal shear tests setup described in the European standard EN 408. Where the standard method requires steel loading plates glued to the wooden test specimen, in this study birchwood longitudinal elements are glued to the birchwood rolling shear test specimens. The efficacy of utilizing all-wood specimens is investigated. For determination of the rolling shear modulus, optical point tracking is employed to measure deformations on the loading plates and on the rolling shear test specimen. Results indicate the setup to be suitable for rolling shear testing, however, the bond-line quality is found to be influential for determination of the strength and stiffness properties.	Steven	Collins	Aalto University
5E	MPD - Engineering - characterising material properties	Material Performance & Durability - Engineering Focus	Mechanical characterization of the short- and long-term behavior of glued-in rods in laminated bamboo lumber	This research contributes to the qualification of bamboo as a sustainable substitute for commonly used materials in the building industry, such as concrete or steel. The Phyllostachys edulis (Moso) bamboo is further processed into laminated bamboo lumber (LBL) to eliminate naturally grown flaws and thus, bringing it closer to technical applications. LBL exhibited strengths comparable to those of wooden materials, which underlines the suitability of bamboo as a material for the building industry. Besides the material parameters of LBL, it is from central importance to know about suitable connection types in the suggested fields of use. Glued-in rods (GIR) are a commonly used connection type in relation to building with wood. Through various material tests conducted in the course of this work, the GIR should be qualified for engineered bamboo materials as well.	Pascal	Franck	RheinMain University of Applied Sciences

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5E	MPD - Engineering - characterising material properties	Material Performance & Durability - Engineering Focus	HARDWOOD STRENGTH GRADING – CONSIDERATIONS FOR DENSITY AND COMPRESSION STRENGTH	It can be a challenge to achieve effective sorting of temperate hardwoods for density when using visual strength grading rules and some types of machine grading. Different solutions have been proposed, including using a single conservative density across hardwood strength classes, or declaring density based on direct measurements without reference to a strength class. These solutions would also affect secondary properties that are estimated from assigned density. In the European Standards, compression strength perpendicular to grain is one example. In this study, grading of a sample of UK-grown sycamore maple was simulated, using dynamic stiffness as the indicating property (IP). Characteristic (5th percentile) values of density and compression strength perpendicular to grain could not effectively be raised by rejecting pieces with low IP values. If density is used as an IP, higher compression strengths can be graded for. As expected, characteristic values for compression strength via EN 384 are much below what was observed in this study.	Marlene	Cramer	Edinburgh Napier University
5E	MPD - Engineering - characterising material properties	Material Performance & Durability - Engineering Focus	Grades and strength characteristics of low-density hardwood, Yellow poplar	The Yellow poplar tree is well-suited to the climate and soil of Korea and exhibits high growth characteristics. In Korea, however, Yellow poplar trees are consumed as low-value materials such as wood pellets, pulp, mushroom logs, and so on. Efforts have been underway to enhance its value by investigating its potential as a structural material in Korea. This study was conducted to confirm the feasibility of Yellow poplar usage as a structural member by investigating the characteristic value of bending and tensile strength. Full-size lumber was graded by machine grading. The majority of grades of Yellow poplar lumber having a cross-section of 89 x 38 mm ² were E8, E9, E10, E11, and E12. In the lowest grade, E8, among the majority of grades, the characteristic value of the modulus of rupture was smaller than the allowable stress in the Korean Design Standard. It was needed to restrict the diameter ratio of knot in wide side of the lumber, and the value of the diameter ratio of knot was 0.5. With the restriction, all of characteristic values of strength of Yellow poplar were larger than the allowable stress. In further studies, other properties for structural purposes will be investigated.	Chul-Ki	Kim	National Institute of Forest Science
5E	MPD - Engineering - characterising material properties	Material Performance & Durability - Engineering Focus	LOGGO Building System	Loggo is in the process of developing a building system to respond to the needs of the housing shortage affecting many parts of the world. The system utilises low value timber and forest bi-products to produce engineered wood products that have the potential to be used for multi-storey residential construction by deploying a modular column system in concert with a cassette flooring system for rapid on site erection. This presentation will explain the origin, applications, benefits and opportunities for this unique laminated engineered wood product. Please Note: Loggo is an industry partner of the Australian Research Council Research Hub to Advance Timber for Australia's Future Built Environment (ARC Advance Future Timber Hub). Its concepts ideally reflect the Hub's VALUE-CHAIN INNOVATION Research Node, the overarching theme being: "to develop opportunities for small diameter log resources in high-value markets. Thinnings from plantation hardwood estates will be prioritised along with residual peeler cores and other small diameter logs".	Peter	Blair	SPMA Pty Ltd (LOGGO Representative)
5F	MPD - Engineering	Session Chair: PROFESSOR PIERRE QUENNEVILLE / THE UNIVERSITY OF AUCKLAND					
5F	MPD - Engineering	Material Performance & Durability - Engineering Focus	THE BENDING PERFORMANCE OF BIONICS-INSPIRED LIGHTWEIGHT WOOD-BASED SANDWICH PANELS	The use of lightweight wood-based sandwich panels (LWSPs) is gaining traction in the construction industry due to their environmental friendliness. These panels consume fewer resources, apply smaller loads on foundations, and reduce transportation costs and CO ₂ emissions. This study was focused on the development of LWSPs of the core structure inspired by natural structures. The study involves designing LWSPs with aspen wood cores and plywood surface layers, and assessing their physical and mechanical properties, including bending capacity and bond quality. The results will provide insights into the durability and performance of these composite panels, offering recommendations for their application in structural contexts like access floor systems.	Elena	Vladimirova	University of New Brunswick
5F	MPD - Engineering	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	Finite element-based evaluation of walking-induced vibrations in timber-concrete composite floors	Long spans Timber-Concrete Composite (TCC) floors can often achieve adequate performance when considering ultimate limit state behaviour; however, serviceability criteria, such as vibrations, are usually governing in the design process. Although design codes and standards usually present vibration using simplistic expressions, the vibration performance of TCC floors is complex and involves multiple variables. In this study, a finite element (FE) modelling technique is established for CLT-concrete composite panels with screws and notched connections. The models are validated against experimental results and a parametric study is carried out to investigate the effect of multiple variables on the dynamic behaviour of those floors.	Fernanda	Scussiato Lago	University of Ottawa
5F	MPD - Engineering	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	Evaluating the Effect of Coastal Deterioration on Structural Integrity of Cross-laminated Timber	Cross-laminated Timber (CLT) is a sustainable building Mass Timber (MT) material made of a biological origin; wood. Since its introduction to North America, the biological durability of the material has been challenged due to the lack of investigation in different climates and deterioration zones. Almost all parts of the Pacific Northwest and most parts of the North Eastern regions of the United States have a high (4 out of 5) coastal deterioration zoning for wooden materials. Therefore, studying the effects of coastal deterioration such as salt-spray effects on the MT products' properties would provide helpful information and job-site measures for using these products. This work investigates the coastal deterioration of MT by measuring the effect of continuous salt spray exposure on the dimensional and mechanical properties of CLT panel samples with and without any industry-standard coating. The CLT specimens' initial density, dimensions, and bending stiffness are compared with the ones acquired after being tested and exposed to the continuous salt spray and controlled simulated moisture content, humidity, and temperature for two weeks. In addition, a Finite Element Model is assessed to provide a numerical evaluation for the experimental results. This work presents preliminary predictions for how much CLT deterioration and mass loss due to exposure to coastal salt spray could result in loss of mechanical properties.	Shay	Kurzinski	Roger Williams University
5F	MPD - Engineering	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	New dimensions - Timber projects and connections	The current trend in timber construction is towards new dimensions. The decisive dimensions in timber construction are mainly determined by the connections. The performance of different types of connections in timber construction is demonstrated in 3 different projects: In architectural construction, the new Volvo Group headquarters "World of Volvo" in Gothenburg; in classic industrial construction, the Edeka central warehouse in Marktredwitz; and in multi-storey office construction, the offices of a Bundesliga football club in Leipzig. These are steel plate to timber connections with wood screws that can be pulled out, classic rod to dowel connections with internal steel plates and, in multi-storey timber construction, the use of system connectors wherever possible.	Patric	Walter	WIEHAG Timber Construction GmbH

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5F	MPD - Engineering	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	EFFECT OF NAIL JOINT STIFFNESS ON THE IN-PLANE SHEAR AND OUT-OF-PLANE BENDING PROPERTIES OF NLT	Nail Laminated Timber (NLT) is constructed using layers of lumber connected by nail joints. To develop design methods for NLT considering the stiffness of the nail joints NLT composed of steel or aluminum nails, which have different stiffness, were produced and tested for their in-plane shear and out-of-plane bending properties. The shear strength and initial stiffness of NLT with aluminum nails were 60-65% of those with steel nails. NLT was modeled as to verify the ratio of embedment work to the total work that is the summation work caused by the shear deformation of nail joints between lumber pieces, embedment of lumber into the midsill and beam and bearing pressure and friction between lumbers. NLT with lower stiffness nail joints showed a higher rate of embedment work compared to that with higher stiffness nail joints. The bending stiffness and strength of NLTs with aluminum nails were nearly equivalent to those with steel nails. NLT was also modeled as to verify the ratio of bending deformation and rotational deformation of butt jointed lumbers. Lumber jointed by lower stiffness nails exhibited a higher rate of rotational deformation than those jointed by higher stiffness nails.	kazuki	Ito	Utsunomiya University
5F	MPD - Engineering	Material Performance & Durability - Engineering Focus, Material Performance & Durability - Practitioner Focus	DURABILITY: MEMBRANES AND TAPES FOR WOOD PROTECTION	This work originated from the desire to gain a deeper understanding of the long-term resistance of materials used for wood protection, specifically membranes and tapes. The projects described in this article all focus on durability but approach the issue from different perspectives, using various methods to achieve a high degree of ageing. This approach has provided us with a diverse array of data, obtained through different techniques, which has helped us gain a more comprehensive overview of the contributions of various factors. The products tested include membranes and adhesive tapes, which were evaluated both separately and in combination to better understand the impact of each product on overall durability of the tape-membrane system.	Sebastian	Jaimes	Rothoblaas
5F	MPD - Engineering	Material Performance & Durability - Engineering Focus, Material Performance & Durability - Practitioner Focus	Chemical Migration and Redistribution of CCA Components in Eucalyptus nitens Heartwood: Implications for Durability Under Accelerated Weathering	Chromated copper arsenate (CCA) has historically been widely used for wood preservation and remains a key industrial timber treatment despite regulatory restrictions. Its efficacy is attributed to chromium's role in binding CCA components to the wood, reducing leachability while immobilizing copper and arsenic. However, when exposed to moisture, small quantities of CCA components remain mobile, inhibiting fungal growth in untreated wood exposed through surface checks. This mechanism has been credited with enhancing the durability of shallow-treated Canadian softwoods. To determine whether a similar process occurs in hardwoods, this study investigated the migration of CCA components in Eucalyptus nitens heartwood under repeated wet/dry cycles. Results indicated that arsenic exhibited the highest leaching rates, while chromium was the least mobile, with peak leaching occurring during the initial rainfall cycles. Comparative analysis with previous studies confirmed consistent leaching patterns, reinforcing the low leachability and strong fixation of CCA. While copper and chromium levels in untreated check surfaces increased by nearly threefold, their concentrations remained below the fungitoxic threshold required to inhibit spore germination. These findings suggest that CCA migration in refractory hardwoods is insufficient to provide the same secondary protection observed in softwoods, highlighting the need for alternative treatment strategies to enhance durability in E. nitens for exterior applications.	Juan Roberto	Vargas	National Centre for Timber Durability and Design Life
5F	MPD - Engineering	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	A TEST METHOD FOR ROLLING SHEAR CREEP CHARACTERISTICS IN CROSS-LAMINATED TIMBER	One of the consequences of cross-lamination of layers in CLT elements is that all laminations in shear walls and the transverse layers in floor elements transfer shear stress in the radial-tangential plane, or rolling shear, which has a non-negligible effect on elastic and strength behavior of the laminates. However, the shear characteristics that account for out-of-plane shear deformations in laminated panels are based on sparse and outdated empirical data. Even less data exists on the shear creep behavior of wood. This study aims to develop an efficient and replicable method for the measurement of elastic rolling shear modulus and time-dependent rolling shear creep compliance in cross-laminated sections of clear wood and of structural lumber, including natural inhomogeneities characteristic for grades used in the production of CLT.	Lech	Muszynski	Oregon State University
5G	STCE - Engineering	Session Chair: DR YUTAKA GOTO / CHALMERS UNIVERSITY OF TECHNOLOGY					
5G	STCE - Engineering	Material Performance & Durability - Engineering Focus, Sustainability and Timber in a Circular Economy - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	DIGITAL TWINNING FOR ENHANCING TRANSPARENCY IN SUSTAINABILITY, SAFETY, HEALTH AND SERVICEABILITY OF TALL TIMBER STRUCTURES	Digital twin technology has recently emerged as a transformative approach in building management, enhancing transparency, sustainability, safety, health, and comfort. This paper explores how the European HORIZON project BUILDCHAIN leverages this technology to promote the use of timber as a viable material even for taller buildings, emphasizing its sustainability benefits and improving its safety and serviceability metrics. The BUILDCHAIN project integrates diverse data sources, including 4D, 5D, and 6D Building Information Models (BIM), Finite Element (FE) models, and real-time sensor data, to create dynamic, real-time virtual replicas of physical buildings. These digital twins provide a comprehensive and accessible view of building properties and performance, facilitating continuous monitoring and updating of FE models based on real-world data to ensure ongoing structural health and safety. Through the case study of two tall buildings made of CLT panels, we demonstrate the practical application of this technology and discuss how integrating data from multiple buildings can refine and re-evaluate existing design procedures and standards. This offers a new paradigm in building design validation. By enhancing transparency and incorporating advanced monitoring capabilities, the BUILDCHAIN project paves the way for more resilient, efficient, and sustainable building practices.	Noemi	Friedman	HUN-REN Institute for Computer Science and Control (SZTAKI)
5G	STCE - Engineering	Material Performance & Durability - Engineering Focus, Sustainability and Timber in a Circular Economy - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	PRELIMINARY INVESTIGATION ON THE STRUCTURAL AND HYGROTHERMAL PERFORMANCES OF CLT WITH AIRGAPS	Cross laminated timber (CLT) has been a major contributor of the expansion of the technical possibilities of timber constructions. While CLT has advantages, the production of CLT requires extensive raw material input compared to the actual needs regarding structural capacity. The required load bearing capacity can be achieved by using less raw material if the timber lamellas are arranged properly with gaps in between. Different configurations with different material efficiency result in different structural and hygrothermal performance of the panels. The overall goal of the project described in this paper is to investigate the raw material saving potential for a multi-storey structure with CLT panel with airgaps. For this purpose, the shear, bending, and water vapour permeability performances of 3-ply and 5-ply CLT panels with various airgap configurations have been examined in experiments and in numerical and analytical models. Based on the results, the load bearing structure of an 8-story residential building was designed with CLT panels with airgaps. The structure was designed to satisfy the performance requirements in ULS and SLS according to Eurocodes and for moisture safety. The result show that the material saving potential is at maximum 46% for the floor and 29% for the wall. In order to further optimize the CLT panels and verify the results, more experiments on more variety of airgap configurations will be needed.	Yutaka	Goto	Chalmers University of Technology/Tohoku University

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5G	STCE - Engineering	Material Performance & Durability - Engineering Focus, Sustainability and Timber in a Circular Economy - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	Structural Properties of Lumber from Small Logs Generated in Forest Thinning Operations	In the western United States, large quantities of small diameter logs are continuously generated through the restoration thinning operations which are performed to control forest fires. These small logs contain high proportions of juvenile wood, which differs from mature wood in terms of mechanical properties. Enabling the use of lumber from small diameter logs in structural products, such as cross laminated timber (CLT) panels, would add substantial market value to this material. However, most sawmills consider processing small logs unprofitable and the resulting lumber not qualifying for structural uses. The reason is that the design values listed in National Design Specifications (NDS) are based on commercial harvesting operations which yield high proportions of large diameter logs (containing higher proportions of mature wood). One species of particular interest is Ponderosa Pine, which grows in many regions where large-scale restoration thinning operations are currently conducted. However, results from a prior study indicate that No 2 lumber from small diameter Ponderosa Pine logs does not meet NDS requirements. The validity of these conclusions will be further investigated in the current study. Mechanical testing will be conducted using Ponderosa Pine lumber which primarily consists of juvenile wood. The sampling range is intended to cover regions where large-scale restoration thinning operations are currently carried out. Certain properties, including modulus of elasticity (MOE) will be estimated through testing of visually graded dimension lumber, while other properties will be estimated using small clear specimens. The results from this study (a set of near-minimum and mean property estimates) will be compared with the current NDS values in order to determine whether or not this lumber meets the current specifications.	Michelle	Jayawickrama	Oregon State University
5G	STCE - Engineering	Sustainability and Timber in a Circular Economy - Engineering Focus	CCLT – Development of a CLT based sandwich structure with bamboo rings as core materials	This document reports early investigations of an improvement of conventional CLT structures. The massive timber consumption and the relatively high weight of conventional CLT boards can be encountered by creating a sandwich structure using an alternative core material combined with timber top and bottom sheets. There-fore, a honeycomb core of bamboo rings called COMBOO is an option which is currently under investigation. The approach was called CCLT (COMBOO Cross Laminated Timber) and can reduce timber consumption and weight by the hollow bamboo combs. After previously received interesting results of compression tests of bamboo rings itself or bamboo rings with different top and bottom sheets and different bending tests with COMBOO and GFRP layers, the combination of the work with 4-point bending tests of the CCLT-structure is the element of this paper. A scaled approach with reduced height of the CCLT board has been chosen in this case. It contains the description of manufacturing and gives insight to the results from mechanical testing. During experiments it was found, that bending strength depends on number of layers and bamboo ring size. The results of bending tests were promising even if manufacturing of components and structure is difficult and requires transfer to industrial scale.	Andreas	Loth	Berliner Hochschule für Technik
5G	STCE - Engineering	Sustainability and Timber in a Circular Economy - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	ENHANCING MULTI-STOREY BUILDINGS WITH CLT CORES USING LVL TECHNOLOGY: DESIGN AND TESTING	Mass timber (MT) construction is gaining popularity worldwide for multi-storey buildings. However, it's important to note that despite this trend, these buildings still rely on concrete or steel cores for additional strength and stability. No one has yet succeeded in creating a timber core solution, and there is no published evidence of a timber core solution with the necessary stiffness to withstand wind or earthquake loads beyond ten levels. Preliminary research and calculations at the UoA indicate that a hybrid product that uses LVL to make CLT can be made considerably stronger and more than ten times stiffer than conventional CLT; allowing timber building cores up to twenty levels. This paper will present results of an initial experimental study carried out to verify the feasibility of using LVL-CLT shear cores in multi-storey timber buildings. The experimental study consist of testing 2 different configurations of LVL-CLT panels for stiffness and comparing these results with the stiffness of a tested ordinary CLT panel. From these results, recommendations for potential timber shearwall cores will be made.	Dr Ferdinand	Oswald	School of Architecture and Planning, University of Auckland, New Zealand
5G	STCE - Engineering	Sustainability and Timber in a Circular Economy - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	STRENGTH AND STIFFNESS OF (RELAMINATED) CLT EDGETRIMMED OFF-CUTS	Timber construction can significantly reduce the embodied carbon of buildings, but mass timber production creates non-biodegradable waste. This study investigates using cross-laminated timber edge trimming off-cuts as standard boards and relaminated timber. Four-point bending tests show comparable strength and stiffness to reference materials, but with greater covariance. Results suggest that such off-cut material could be considered even for structural purposes and, in the process, contribute to reduced waste generation and even lower embodied carbon.	Johann	van der Merwe	University of Pretoria
5G	STCE - Engineering	Material Performance & Durability - Engineering Focus, Sustainability and Timber in a Circular Economy - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	POST-FIRE STRUCTURAL REHABILITATION OF MASS TIMBER ELEMENTS	Post-fire rehabilitation of modern mass timber buildings has seen little research attention. Developing clear methodologies to rehabilitate char-damaged mass timber elements is crucial since mass timber buildings are becoming considerably more common and as such, the risk of having fire-damaged mass timber buildings is increasing. Preliminary investigation was performed in 2023 to quantify the amount of wood that needs to be removed beyond the char layer. Following this study, full-scale bending test of char-damaged mass timber glue-laminated timber decking elements reinforced with laminated veneer lumber were evaluated. The main objective of this study is to quantify the effect of different reinforcing methodologies and to validate calculation methodologies. From the test campaign, it is found that the mechanically jointed beam theory (gamma method) predicts well the level of composite action when fully threaded screws are used. When partially threaded screws are used, the friction between timber elements is sufficient to create an almost perfect composite action under low load.	Samuel	Cuerrier Audair	Fpinnovations
5H	ECCS/STCE - Engineering	Session Chair: DR LISA OTTENHAUS / THE UNIVERSITY OF QUEENSLAND					
5H	ECCS/STCE - Engineering	Exemplars & Construction Case Studies - Engineering Focus	Design of Indoor Structures Using Small-Section timber Assembly Frame and Practice of Material Recycling	There are two main types of wood use methods in architecture: construction of timber structure and wooden interior. In order to make the latter type of wooden interior, we developed a wood-based construction method "T-WOOD® SPACE Light (TWSL)" that enables the construction of indoor structures in a short period of time by utilizing a new jointing method of wood members. In this construction method, a frame unit consisting of four small-section sawn timbers is inserted from three directions to form a joint, making it easy to assemble and dismantle, and the hollow-section frame unit is lightweight and easy to transport and construct. Several interior spaces using this construction method were designed and constructed. They were exhibition booths, display panels, and on-board spaces of a trailer. In the design of the vehicle space, we designed a load-bearing wall and clarified the in-plane shear performance by shearing tests. In addition, a part of the exhibition booth was used to reuse it for partition walls, tables, and storage baskets, and the problems that arise from practicing material recycling were identified.	Tomoaki	Soma	TAISEI Corporation
5H	ECCS/STCE - Engineering	Exemplars & Construction Case Studies - Engineering Focus	Towards Sustainable Timber Construction: A Case Study of Waste Generation, Management, and Circular Strategies in Australian Sawmilling and Prefabrication Manufacturing	This paper explores a case study on waste generation during the log conversion process and waste management approaches. The study examines various types of timber-based waste generated during different sawmilling operations and how each of these types are managed in sawmilling yards in Australia. This research aims to propose recommendations for enhancing sustainability and reducing the environmental impact of the Australian sawmilling industry through proper waste management.	Harshani Dissanayake	Dissanayake Mudiyansele	The University of Melbourne

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5H	ECCS/STCE - Engineering	Sustainability and Timber in a Circular Economy - Engineering Focus, Exemplars & Construction Case Studies - Engineering Focus	DECARBONISATION STRATEGIES USING TIMBER IN NON-TRADITIONAL APPLICATIONS	Decarbonisation targets are looming large across all industries, many of which rely on carbon intensive infrastructure to support their business functions. Operational Carbon has traditionally been targeted as a key to reducing emissions and many businesses are well advanced in the pursuit of their Operational Carbon targets. As the opportunities to further reduce Operational Carbon become more and more difficult to achieve, the focus will shift to Embodied Carbon, potentially as "lower hanging fruit" in the pursuit of net-zero aspirations. Substituting timber for concrete and steel is an effective strategy in the reduction of Embodied Carbon. This paper explores the opportunities for the increased uptake of Timber in non-traditional applications primarily as a decarbonisation tool and considers the risks and opportunities that present as a result. Through a series of case studies this paper will highlight where timber is helping decarbonise our infrastructure – and where opportunities exist to go further. KEYWORDS: timber, decarbonisation, Embodied Carbon	Ralph	Belperio	Aurecon
5H	ECCS/STCE - Engineering	Timber Engineering & Structural Performance - Engineering Focus	ADVANCED STRUCTURAL DESIGN OF TIMBER BUILDINGS IN JAPAN	Since the "Act on Promotion of the Use of Wood in Buildings, etc. to Contribute to the Realization of a Decarbonized Society" came into force in Japan in 2021, Japanese companies have proposed various solutions for medium- to large-scale attractive wooden buildings. The use of timber-steel hybrid structures, in particular, is recognized as an effective structural planning strategy that complies with the Japanese fire safety regulations related to fire resistance and safety during a major earthquake and also attracts interest as an effective solution for the decarbonization of airport facilities that have specifically high CO2 emissions. According to the Japanese Building Standards Law, load-bearing timber structures must have fireproof coatings/claddings. If the timber structure only resists lateral forces like seismic and wind, it can be left exposed. Currently, Japanese architecture firm, Azusa Sekkei is working on a wooden terminal building project at Haneda Airport, the busiest airport in Japan. It will be the first building with a wooden main structure at a large airport in Japan. According to the fire regulations, all three timber-steel hybrid frame systems designed for Haneda Airport Domestic Terminal have fireproof claddings. To keep the structural timber members exposed for future projects, Azusa developed an advanced solution for a timber-steel hybrid frame system called CROSS-WOOD that allows the exposure of wooden members while enhancing the aesthetic and sustainable appeal. The concept combines traditional Japanese wood joinery techniques like "nuki" (mortise and tenon joints) and "awasebari" (flitch beams) with modern technology solutions by passing the wooden beams through the holes in the wooden columns to improve the bending strength and rotational stiffness of joints. Furthering and expanding the research and the implementation of structural wood, new wooden joinery techniques have also been developed for the "Ring Project" at Osaka Expo 2025.	Yoshiko	Kanai	Azusa Sekkei Co. Ltd.
5H	ECCS/STCE - Engineering	Sustainability and Timber in a Circular Economy - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus, Exemplars & Construction Case Studies - Engineering Focus	Sustainable Reuseable Timber-concrete Composite Structural Flooring System	With the objective to improve reusable performance and efficiency of timber-based composite floor systems, combinations of various composite materials by numerous sorts of connections, are studied. This paper illustrates the general structural design idea and the manufacturing research findings and is intended to provide a first insight into related ongoing structural research activities. The objective of the studies is to develop application-optimized multi-layered structural composite floor systems with a special focus on the joint design of the various thereby used connection types between the coupled composite layers. In simultaneous regard to structural, economical and resource efficiency on overall component level, the extent of interrelationships in the development of complex optimized system solutions can be shown. Additionally, decisive design criteria for the application of the composite floor systems shall be derived thereof. Based on this, the results of the research project present the successful technical solutions and concepts for reuse and recycling in timber construction.	Alireza	Fadai	TU Wien Vienna University of Technology
5H	ECCS/STCE - Engineering	Sustainability and Timber in a Circular Economy - Engineering Focus, Exemplars & Construction Case Studies - Engineering Focus	ENHANCING DESIGN AND PRODUCTION IN MODULAR TIMBER ARCHITECTURE WITH COMPUTATIONAL DESIGN TOOLS	This research explores integrating computational design tools to enhance design and production in modular timber architecture. It focuses on two main aspects: integrating existing analysis tools for better-informed decisions and automating modeling, analysis, and CNC fabrication of various design variations. Computational tools in modular timber construction can improve quality and productivity while allowing for architectural uniqueness. This flexibility enables creating unique solutions with the same effort as standardized ones. The research developed a computational design system with tools for structural analysis, energy simulations, cost evaluation, weight assessment, environmental impact analysis, and design-to-production processes, all integrated into a parametric planning platform. The project "àDisposition" (Innosuisse, 59217.1 IP-SBM) exemplifies this approach, aiming to develop a modular timber construction kit optimized for easy transport and temporary use of vacant buildings. Outcomes are showcased by a user-friendly configurator for planning, visualizing, analyzing, and preparing production files.	Joaquim	Escoda Llorens	University of Applied Sciences, BFH / AHB
5H	ECCS/STCE - Engineering	Timber Engineering & Structural Performance - Engineering Focus, Exemplars & Construction Case Studies - Engineering Focus	INTERACTIVE PARAMETRIC STRUCTURAL DESIGN AND OPTIMISATION TOOL FOR DESIGN FOR FRP-REINFORCED MASS TIMBER BUILDINGS	The inherent material properties of mass timber can restrict its serviceability performance, particularly for long-span floor system applications. This paper introduces a parametric analysis tool designed to compare traditional mass timber constructions with advanced hybrid fiber-reinforced polymer (FRP)-timber composites with enhanced static and dynamic serviceability behaviour. The tool evaluates span capacities for both pure mass timber and FRP-reinforced mass timber flexural elements in a typical post-and-beam building configuration. These span capacities are then integrated within a parametric computer-aided design (CAD) tool to enable interactive structural size optimisation for variable building grid size, height, number of stories, loading condition, and element spans. Since long-span timber elements are often constrained by serviceability requirements, CFRP reinforcements are assessed for their potential to increase stiffness and natural frequencies, and thus enable longer spans for the same element thickness; or reduced element thickness for the same span.	Tomas	Bravo	UQ - CIVIL
5I	STCE - Architectural	Session Chair: A/PROF MARIAPAOLA RIGGIO / OREGON STATE UNIVERSITY					

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5I	STCE - Architectural	Sustainability and Timber in a Circular Economy - Architectural Focus	The Study on Mechanical Performance and Structural Applications of Adhesive Free Engineered Wood	Regarding the issue of global change, based on the full life cycle carbon footprint assessment, engineered wood is also facing the development towards net-zero sustainability. Although many advanced modern engineered woods have excellent mechanical properties, they also have relatively high Carbon footprint, therefore, this study conducted a series of mechanical experiments on wood structural elements of beams and plates constructed without gluing. In addition to comparing different construction methods, it also found out the basic performance for future structural engineering design, and based on A full-scale experimental structure is an example of future practical applications. This study also conducted a carbon footprint assessment analysis for this example. The research content includes DLT (Dowel Laminated Timber) and NLT (Nail Laminated Timber) For two different Adhesive-Free Engineered Wood (AFEW) systems, collecting relevant international research literatures in the past few years, The research also conducted mechanical experiments on four-point bending moments to obtain different rigidity and Modulus of Elasticity. We also analyzed the failure mode and the damage causes as well from different configurations of specimen. In addition, a full-scale demonstration structure was constructed to explain the possible applications in architectural design.	CHI-JEN	CHEN	National University of Kaohsiung, Taiwan
5I	STCE - Architectural	Sustainability and Timber in a Circular Economy - Architectural Focus	THE ACOUSTIC PERFORMANCE OF LONG-SPAN HOLLOW MASSIVE TIMBER FLOOR CASSETTES DESIGNED FOR CIRCULARITY	Massive timber structures present a particularly compelling case for circularity in the built environment due to the prefabricated nature of the system components, the manner in which those components are connected, and the importance of retaining sequestered carbon. However, the conventional inclusion of concrete topping slabs atop mass timber floor panels presents a significant barrier to the deconstructability and reuse of the panels and supporting framing. A massive timber floor cassette developed and studied at Clemson University aims to combine long-spanning structural capacity with building systems integration, all while excluding conventional concrete toppings and promoting ease of disassembly and reuse. Critical to this low-carbon, timber-only approach is the acoustic performance of the system, as sound attenuation has often been a motivator for the inclusion of concrete. This paper details the planning, construction and validation of a new two-story acoustic testing chamber, followed by the results from airborne and structure-borne sound transmission tests performed on assemblies involving the experimental timber floor cassettes.	Dustin	Albright	Clemson University
5I	STCE - Architectural	Sustainability and Timber in a Circular Economy - Architectural Focus	CIRCULAR DESIGN FOR URBAN DENSIFICATION THROUGH EXTENSION CONSTRUCTION	Buildings constructed in the past century are confronted with a dilemma of outdated equipment that fails to meet the needs of contemporary usage. In costly areas, retrofitting is preferable to demolition for cultural and economic development. The proposal will use wooden modules as expansions, which have the potential to be reused and will increase the usability of the original structure, resulting in a sustainable retrofit solution. The application context of the proposal is the implementation of a vertical extension project using volumetric timber modules. Subsequently, a workflow for the implementation of a combinatorial design for modular timber products will be presented. The research scenarios will encompass multiple design influences to assess the feasibility of applying functional alterations in modular products.	Kayee Jiayi	Li	Aarhus University
5I	STCE - Architectural	Sustainability and Timber in a Circular Economy - Architectural Focus	ASSESSING THE REUSE POTENTIAL OF MASS TIMBER CONSTRUCTION USING A TEN-STORY SHAKE TABLE CASE STUDY	The continual growth in mass timber construction has stimulated discussion about how mass timber products can drive sustainability through the end-of-life stage, shifting the building sector towards a circular economy that reduces the overall demand on virgin forest resources. Moreover, the potential for mass timber buildings to function as effective carbon sinks depends on extending the service life of mass timber members via reuse. Through a collaborative effort between the University of Oregon and Oregon State University faculty, working together in the TallWood Design Institute, this study developed a framework for the reuse potential of mass timber members using the Natural Hazards Engineering Research Infrastructure (NHERI) ten-story shake-table specimen for seismic testing at the University of California San Diego. The test structure was analyzed using a digital model to determine mass timber reuse efficiency across panel type and scenarios that span a range of material reprocessing intensity, incorporating fully engineered and modelled connections as an additional parameter to reuse constraints. Finally, this project quantified reuse material efficiencies based on selected strategy and highlighted the opportunities and challenges of reuse.	Jason	Stenson	University of Oregon
5I	STCE - Architectural	Sustainability and Timber in a Circular Economy - Architectural Focus	Forest to Façade: Using Mass Timber Panels to Retrofit Low-Rise Commercial Buildings to Improve Resilience	Buildings are significant contributors to anthropogenic emissions of greenhouse gases through their construction and operations. Commercial low-rise office buildings represent a substantial subset of buildings in the United States and the majority were constructed before more stringent energy and seismic codes on the U.S. West Coast were adopted. Thus, the University of Oregon Department of Architecture and Oregon State University College of Engineering collaborated with industry partners Swinerton and Timberlab through the TallWood Design Institute to develop a low-carbon bio-based façade retrofit solution that simultaneously upgrades building resilience (i.e., energy efficiency, daylighting, passive ventilation), building aesthetics, and seismic restraint. The system was developed using a four-story steel frame case study building and employs a post-tensioned “rocking wall” mass timber lateral force resisting system (LFRS) on the building façade.	Mark	Fretz	University of Oregon
5I	STCE - Architectural	Sustainability and Timber in a Circular Economy - Architectural Focus	Parametric Library of Japanese Joinery	This research explores Japanese joinery for its potential in modern reversible architecture. The objective is to create a parametric library of Japanese joints by compiling typologies from various sources and modeling them into parametric Revit family file. These models can be integrated into BIM projects and shared across BIM software via IFC models. The goal of this study is to enhance modern building practices with sustainable and reversible design solutions inspired by traditional Japanese joinery.	Lynda	Itatahine	Kyoto University
5I	STCE - Architectural	Sustainability and Timber in a Circular Economy - Architectural Focus	OFF-SITE MANUFACTURING FOR A NEW MODULAR WOODEN ARCHITECTURE MADE IN ITALY	The industrial development project “SU.PRE.MO – from Super X-Lam To Prefabrication and 2D/3D Modularity”, organised with the support of the Provincia Autonoma di Trento, focused on modular homes for selfbuild and emergency situations, using the prefabricated CLT products of the Trento-based company. XLAM Dolomiti was the project leader. This paper describes the design activities relating to the modular house kits designed in versions from 20m2 to 120m2 by the Politecnico di Torino, in cooperation with XLAM Dolomiti. A combination of off-site manufacturing and the standard products of XLAM Dolomiti was used to produce a digital catalogue of the various building concepts with a number of possible configurations for the modular homes.	Albino	Angeli	Xlam Dolomiti S.p.A.

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51	STCE - Engineering	Material Performance & Durability - Engineering Focus, Sustainability and Timber in a Circular Economy - Engineering Focus	Mechanical properties of secondary lumber of Norway spruce	Extending the service life of the building components is essential for a circular economy. Wood as a renewable raw material, plays a crucial role in this process due to its mechanical properties and easy processing. In current studies, the focus is on the reuse of building materials. However, it is important to investigate cases where reuse is not possible due to changing dimensional requirements or damages. This study examines the bending properties of recovered wood, particularly battens with dimensions of 30/50 mm and 40/60 mm, which were processed from rafters originating from building demolition and roof truss deconstruction sites in Germany, to demonstrate their potential for structural applications. The bending tests are performed and interpreted regarding the damages from the prior use and the background information on the lumber pieces. In addition, the collected data is compared to the bending test data of battens without any prior use history. Therefore, the specimens are matched in terms of quality characteristics, dimensions, age, and wood species. The results of this study demonstrate that recovered wood can be, despite its damages from prior use and its age, a sustainable driver toward a circular orientation of the construction sector. Furthermore, adjusted criteria for the visual grading are discussed.	Florian	Böhm	Technical University of Munich