

Session No.	Session Topic	Abstract Topic	Submission Title	Summary	First Name	Last Name	Company
8A	TESP - Engineering	Session Chair: PROFESSOR ERIK SERRANO / LUND UNIVERSITY					
8A	TESP - Engineering	Timber Engineering & Structural Performance - Engineering Focus	AN EXPERIMENTAL INVESTIGATION INTO THE STRUCTURAL PERFORMANCE OF TIMBER I-JOISTS WITH CIRCULAR WEB OPENINGS	This study investigates the structural behaviour of I-joists with circular openings of various sizes at different locations along the length of joist. The concepts of high shear zone, combined shear bending zone and pure bending zone were introduced in this research. A four-point bending test was conducted to determine the load-carrying capacity, stiffness and failure modes of I-joists with and without openings. It was found that openings in high shear and combined shear bending zones had a similar impact on the capacity of I-joists with larger openings leading to higher reductions. Most of the joists with an opening located in the high shear and combined shear bending zone exhibited brittle shear failure. In contrast, the presence of openings in the pure bending zone has no effect on the load-carrying capacity of joists and resulted in the failure modes similar to I-joist with no holes.	Sini	Lu	Edinburgh Napier University
8A	TESP - Engineering	Timber Engineering & Structural Performance - Engineering Focus	AN EXPERIMENTAL STUDY ON DIFFERENT SHEAR RESISTANCE MECHANISMS OF JAPANESE CLT CONCRETE COMPOSITE SLABS	Japan has fewer examples of TCC design than other countries, and a general design method has not yet been established. In this paper, to compare the structural performance of different TCC slab shear keys and to obtain basic data on the structural performance when incorporated into floor slabs. Elemental and full-scale bending tests were conducted with two types of shear keys, a notch type and a inclined screw type. While the notch type has greater stiffness and bearing capacity, the results was not so large when compared as TCC slabs.	yuka	konishi	Ove Arup & Partners Japan Ltd
8A	TESP - Engineering	Timber Engineering & Structural Performance - Engineering Focus	DESIGN AND STRUCTURAL PERFORMANCE OF WOOD FRAMING WITH "FLEXIBLE WOOD"	Aiming to expand new possibilities for the use of wood, this study focused on "Flexible Wood" a composite material made by laminating and bonding wood veneers with a adhesive sheet. This wood material is freely deformable, allowing curved surfaces and curvilinear designs to be constructed without advanced processing or technology. However, its use has been limited to furniture and other applications due to its characteristic of deforming easily when bending stress is applied. Therefore, in order to expand the use of this material, this study devised a method of using it as a face material that serves as a resistance element to in-plane shear forces where bending stress does not act, and attempted to use it as a structural member. A wooden pergola was designed and prototyped by attaching strips of "Flexible Wood" to a laminated wood frame in such a way as to weave them into the front and back of the frame using curves. The full-scale wooden pergola was subjected to experiments to confirm its fracture performances and to compare its strength and stiffness values with those calculated by the assumed resistance mechanism.	Eito	Atsuzawa	TAISEI Corporation
8A	TESP - Engineering	Timber Engineering & Structural Performance - Engineering Focus	Effect of design configuration on global stiffness of volumetric timber modules	Volumetric modules are promising in terms of their potential for reusability. Currently, the industry is confronted with the challenge of ensuring the structural capability of volumetric modules while simultaneously fulfilling the criteria for creating large openings for façades and windows. Therefore, this study examines the impact of design configurations on the structural performance of volumetric timber modules to enhance their application in buildings, utilising practical data from the Danish building industry. Numerical analyses of the volumetric product are carried out using a high-fidelity model including the fasteners to determine the response to different external loads. The original model is subjected to various design configurations to investigate their impact on the overall stiffness of the volumetric module.	Kayee Jiayi	Li	Aarhus University
8A	TESP - Engineering	Timber Engineering & Structural Performance - Engineering Focus	Development of Simple Seismic Reinforcement Method of Traditional Wooden -Application of Lattice Bearing Wall-	In Japan, many buildings prior to the revision of seismic standards lack seismic performance. In order to promote seismic retrofitting, a simple and cost-effective seismic retrofitting method was developed. The test specimens are compared with the existing specimens and the newly constructed and reinforced specimens to evaluate the strength of the specimens. Based on the test results, we can select method based on the required strength and cost.	TANI	TATSUYA	Osaka Metropolitan University
8A	TESP - Engineering	Timber Engineering & Structural Performance - Engineering Focus	Use of Trembling Aspen Lumber to Produce Glued-laminated Timber Beams: Bending Performance	Trembling aspen (<i>Populus tremuloides</i>) is known for its rapid growth and widespread distribution in North America. Given the significant standing volume of trembling aspen in Alberta, Canada, this research was aimed at exploring the feasibility of using trembling aspen lumber to produce high-value engineered wood products - Glued-laminated Timber Beam.	Meng	Gong	Faculty of Forestry & Environmental Management, University of New Brunswick
8A	TESP - Engineering	Timber Engineering & Structural Performance - Engineering Focus	Large-scale in-plane testing of timber-frame diaphragms and comparison of performance with design models	Large-scale diaphragm tests representative of current Australian practice for timber-framed buildings are undertaken to determine the in-plane ultimate capacity, stiffness, and failure mechanism. Tests are conducted for two diaphragm specimens with a span of 6.3 m and a width of 2.4 m. The specimens are constructed using particleboards fastened to timber trusses with metal webs using screws. The observed failure mode included splitting of the top chord of open-web joists, shear failure of screws, tearing-out failure of particleboard near edge screws, and flexural failure of the particleboard. The shear capacity and displacement of the diaphragm specimens are compared with existing design models, including principles of mechanics using the sheathing-to-framing connection shear strength. The mean strength prediction using the connection shear strength values over predicts the ultimate load recorded in the experiments. Further, the displacement predicted by the design equation developed for blocked diaphragms needs to be amplified to match the displacements observed in the experiment.	Anita	Amirsardari	Swinburne University of Technology
8A	TESP - Engineering	Timber Engineering & Structural Performance - Engineering Focus	EFFECT OF CONNECTION GEOMETRY ON THE JOINT CAPACITY OF AN LVL LOADED PERPENDICULAR TO THE GRAIN	The geometry of timber connections significantly affects the joint capacity of timber loaded perpendicular to the grain, which is essential for the structural integrity of timber constructions. However, Australian standards primarily focus on bolt properties and spacing to determine connection strength, potentially neglecting the influence of connection geometry. This study investigated how variations in connection width and height impact the tensile capacity of bolted timber connections while adhering to Australian standard bolt spacing. Additionally, it examined the effect on tensile capacity when bolt spacing was reduced below the standard. The study compared design values of connection strength according to Australian standards with experimental results to assess load limits under different bolt column and row spacing configurations and bolt diameters. Alongside the standard bolt spacing for perpendicular-to-grain tensile strength, two alternative bolt spacing configurations were tested in this experimental study of LVL timber bolted connections. This study's findings highlighted the impact of using reduced bolt spacing, deviating from Australian standards, on the tensile capacity of bolted timber connections. Furthermore, it revealed limitations in the standard's ability to predict joint capacity in such cases accurately. An image-based analysis was also used to explore the strain field within the bolted timber connection, providing insights into connection behavior and failure patterns.	SAFAT	AL-DEEN	The University of New South Wales
8B	TESP - Engineering Connections	Session Chair: PROFESSOR ALEXANDER SALENIKOVICH / UNIVERSITE LAVAL					

Session No.	Session Topic	Abstract Topic	Submission Title	Summary	First Name	Last Name	Company
8B	TESP - Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	Rotational performance of pre-engineered slotted beam-hanger connection	An innovative pre-engineered slotted beam-hanger (PSBH) connection, mainly used for mass timber buildings, was proposed. This paper presents an experimental investigation on the rotational behavior of the PSBH connections designed for glulam timber frame structures. Four full-scale post-to-beam connection specimens were tested to examine the effect of tensile screw length and stiffener shapes on the rotational behavior of the PSBH connections. Their failure modes, rotational stiffness, and moment resistance capacity were analyzed. When the length of the tensile screws increased from 155 mm to 220 mm, there was a significant enhancement in moment resistant and rotational stiffness due to a change in the failure mode. However, the ultimate moment and rotational stiffness of the rectangular-stiffened connection are slightly higher than those of the trapezoid-stiffened connection. Comparing numerical and experimental results demonstrated that the numerical model could accurately predict the failure modes of the connection.	Xiaoyue	Zhang	School of Civil Engineering, Chongqing University
8B	TESP - Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	STEEL PLATE CONNECTIONS FOR TWO-WAY SPANNING CLT - CONCRETE COMPOSITE FLOORS	In this study, steel plate connections for two-way spanning cross-laminated timber (CLT)-concrete composite floors (CLTCC) were investigated. Initially, the impact of shear connections between the CLT panel and the concrete layer in both strength directions, as well as the moment connection between CLT panels in the minor strength direction, on the structural performance of point-supported CLTCC floors was studied numerically. Subsequently, shear tests were conducted for the connection properties of the proposed steel plate connections in both major and minor directions. Additionally, four-point bending tests were performed on both CLT and CLTCC beams in the minor strength direction, featuring a moment joint at mid-span. The numerical results indicated that the two-way action of the CLTCC floors was predominantly influenced by the connection shear and rotational stiffness along the minor strength axis. Experimental results showed that the T-bar steel plate with self-tapping screws provided twice the shear connection stiffness compared to the steel kerf plate in the minor strength direction. The bending performance of CLT beams in the minor strength direction with a bottom laminated veneer lumber (LVL) spline and a top steel T-bar plate approached that of continuous CLT. CLTCC beams with the steel T-bar plate serving as both the shear and moment connections exhibited approximately three times the moment capacity and nine times the bending stiffness compared to bare CLT beams.	Jianhui	Zhou	University of Northern British Columbia
8B	TESP - Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	STRUCTURAL PERFORMANCE OF MENGKULANG LAMINATED VENEER LUMBER (LVL) TRUSS JOINTS USING PUNCHED-METAL-PLATE CONNECTIONS: EXPERIMENTAL AND NUMERICAL STUDY.	This study investigated the structural performance of Mengkulang laminated veneer lumber (LVL) truss joints with punched-metal-plate connections, focusing on load-carrying capacity and joint behaviour. The inherent mechanical properties of Mengkulang LVL as a stand alone material such as shear, tensile, and compressive strengths were assessed in accordance with BS EN 408 and ASTM D143. The values were determined based on EN 384 and subsequently used for the numerical analysis of the joints. The joints were evaluated for their load carrying capacity and deformation behaviour under forces applied both parallel and perpendicular to the timber grain according to BS EN 1075 and EN 26891. Results showed a non-linear load-slip relationship, with failures including plate tearing, buckling, and teeth withdrawal due to wood grain failure. Compression joints exhibited ductile behaviour, whereas tension joints displayed brittleness. Numerical validation of the three-dimensional geometry models using ANSYS Workbench showed good agreement with experimental results, with failure evaluations confirming the characteristics of the joints. The validated models facilitated a parametric study on plate orientation at the heel joint. Future research should enhance numerical analysis approaches and consider additional parameters.	Nor Azizah	Muhammad	Public Works Department Malaysia
8B	TESP - Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	ENHANCING THE SEISMIC PERFORMANCE OF HOLD-DOWN TIMBER TO CONCRETE CONNECTIONS VIA DUCTILE ANCHORS	Providing ductility in mass timber building connections is currently the best strategy to build seismic resistant timber buildings able to dissipate seismic energy. Borrowing from the steel-baseplate arena, ductile anchor connections are proposed in this paper to enhance mass-timber buildings' seismic performance by providing a reliable ductile mechanism at the wall-concrete footing location. Ductile-anchor connections are shown to sustain large deformation by energy absorption and hysteretic behavior, without significant loss of strength and capacity, hence protecting the connection from premature and unwanted brittle failures. The experimental program described in this paper collects relevant data in support of the design of connections able to exhibit a superior ductility in response to seismic loading and extreme excitations, preserving the integrity of mass timber buildings.	Ramin	Sarange	San Diego State University
8B	TESP - Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	Brittle failure of CLT connections with inclined self-tapping screws	Cross-laminated timber (CLT) is increasingly used in construction, but its brittle nature under tension or shear poses design challenges since the crosswise layup makes CLT behave differently from solid timber or glulam. Self-tapping screws (STS) are versatile fasteners in timber construction, acting in shear when installed perpendicular to the connection interface or in withdrawal when inclined. The 2024 edition of the Canadian Standard for Engineering Design in Wood (CSA O86) includes design provisions for STS, but guidance on estimating brittle failures of STS connections in CLT remains limited. This paper presents experimental investigations assessing the performance of CLT connections with inclined STS and steel side plates. Multiple configurations, considering CLT layup, screw penetration length, and screw edge distance were tested. The results were compared to CSA O86 predictions, providing insights for accounting for the brittle failure of CLT connections with inclined STS.	Alexander	Salenikovich	Université Laval
8B	TESP - Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	Experimental investigation on the performance of novel bolted glulam beam-to-column connections under the coupling effects of tension and bending	This paper aims to enhance the resilience of structural progressive collapse resistance by optimizing the connection performance under large deformation. Two novel bolted glulam beam-to-column connections were proposed: the one with supplementary bolts and the one with supplementary hold-downs. To simulate the stress condition of large deformation during the structural progressive collapse and to validate the effectiveness of various methods, monotonic tests considering the coupling effects of tension and bending were performed on 4 groups of specimens, including the standard bolted beam-to-column connection, the self-tapping screws reinforced connection, and the two novel ones. Then, the failure modes and primary performance parameters were analyzed. The results indicate that the ductility of the self-tapping screws reinforced connection is increased by 28% compared with the standard connection. In addition, the connection with supplementary bolts exhibits a significant enhancement, boasting a 158% increase in moment capacity and a 56% increase in maximum rotational angle over the standard one. Moreover, the connection with supplementary hold-downs has reached the highest effective stiffness improvement at 71% in comparison to the standard connection.	Xuebing	Zhao	Tongji University
8B	TESP - Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	PRESS GLUED CONNECTIONS WITH STAPLES AND NAILS – AN EFFICIENT ALTERNATIVE TO CURRENT STANDARDISATION?	Current European standards do not permit the use of staples or nails for structural press glued connections. Nevertheless, this method has the potential to offer a quick and cost effective alternative to the already established screw press bonding technique. The objective of this study was to examine the influence of the pressing pressure that can be generated on a portal system through the utilisation of staples or nails, as well as the influence of manufacturing tolerances. The findings indicate that bonding this way can deliver acceptable results as long as there are no production inaccuracies. However, the typical level of inaccuracy results in insufficient bonding.	Valentin	Räber	Bern University of Applied Sciences

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8C	TESP - Engineering Flooring , incl Gottstein & Timber Queensland Study Tour Presentation	Session Chair: DR SARDAR MALEK / UNIVERSITY OF VICTORIA					
8C	TESP - Engineering Flooring , incl Gottstein & Timber Queensland Study Tour Presentation	Timber Engineering & Structural Performance - Engineering Focus	Dynamic performance assessment of full-scale CLT and CLT-concrete composite floors	This study investigates the dynamic performance of full-scale CLT and CLT-concrete composite floors through comprehensive vibration testing, including walking and impact hammer tests. Experimental 8-meter-long flooring systems were fabricated and instrumented with a dense network of 21 accelerometers to capture vibration responses induced by walking and impact excitations. Experimental modal analysis was employed to extract dynamic properties such as natural frequencies and damping ratios, as well as to determine peak accelerations. The findings highlight the potential of CLT-concrete composite floors in modern construction to improve the vibration performance of lightweight timber floors and to meet rigorous serviceability criteria.	Ulrike	Dackermann	University of New South Wales
8C	TESP - Engineering Flooring , incl Gottstein & Timber Queensland Study Tour Presentation	Timber Engineering & Structural Performance - Engineering Focus	Vibration performance of a Beamless Cross Laminated Timber-Concrete Composite Slab Band Floor System in 10-storey Limberlost Place	Solid cross-laminated timber (CLT) panels are not suitable for long-span floors due to their relatively low density and bending stiffness, which lead to issues with deflection and vibration. Timber-concrete composite (TCC) floor systems can offer enhanced strength and stiffness, thereby improving serviceability. Fast + Epp developed an innovative large-span beamless structural system comprising CLT-concrete composite slab bands with perpendicular CLT infill panels. This study examines the vibrational properties of the proposed beamless floor system through both laboratory and field tests. Dynamic characteristics were evaluated using experimental modal analysis and ambient vibration tests. Additionally, subjective evaluations and acceleration responses to human walking were collected. Preliminary results indicate that the types of shear connections have minimal impact on the natural frequencies of the slab bands. While the standalone slab bands exhibited unacceptable vibration performance in the lab tests, the complete composite floor system demonstrated acceptable performance in field tests. These experimental findings provide practical insights for the vibration design 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
8C	TESP - Engineering Flooring , incl Gottstein & Timber Queensland Study Tour Presentation	Timber Engineering & Structural Performance - Engineering Focus	NUMERICAL MODELING OF ROCKING CLT SHEAR WALL CONSIDERING THE WALL-TO-FLOOR INTERACTIONS	The rocking behavior of cross-laminated timber (CLT) shear walls is a crucial kinematic motion that significantly contributes to efficient energy dissipation in CLT buildings. During rocking behavior, the shear wall inevitably interacts with adjacent members; and, consequently, wall-to-floor interactions can cause localized damage on floors, alter force demands on connectors, and generate unexpected forces in secondary structural members. However, many studies on the rocking CLT shear walls have treated them as independent components of the lateral force-resisting system. To achieve a realistic structural simulation of the rocking wall, this work first develops the beam-spring model incorporating the inelastic properties of floors. The beam-spring representation is then integrated into a 3D model, which is used to compare structural response based on varying floor properties to assess wall-to-floor interactions. Simulation results are validated against the test data. It is confirmed that the deformability of the CLT floor affects the lateral response of the rocking wall, primarily due to shifted demands of deformation and energy dissipation among different connectors.	Chaoyue	Zhang	The Hong Kong University of Science and Technology
8C	TESP - Engineering Flooring , incl Gottstein & Timber Queensland Study Tour Presentation	Timber Engineering & Structural Performance - Engineering Focus	AN INVESTIGATION INTO THE INFLUENCE OF TRANSVERSE BRIDGING SPINES ON THE VIBRATIONAL PERFORMANCE OF TIMBER FLOORS	Adding bridging elements between joists that form transverse bridging spines is an effective method of minimising excessive vibration levels in wood floors associated with human discomfort. The effectiveness of a bridging spine depends upon its flexural rigidity which accounts for the bridging element rigidity and its connection mechanism to the joist. This paper presents an experimental study that was conducted to quantify a broad range of flexural rigidities of bridging spines. A ribbed-plate model which requires the spine flexural rigidity was used to predict static deflection and fundamental natural frequency of a timber floor by taking into account the measured flexural rigidities. Results show that an increase in bridging flexural rigidity to some extent can reduce up to 40% of static deflection. It was found that all types of transverse bridging spines have a small influence on fundamental natural frequency.	Aamir	Khokhar	Edinburgh Napier University, United Kingdom
8C	TESP - Engineering Flooring , incl Gottstein & Timber Queensland Study Tour Presentation	Timber Engineering & Structural Performance - Engineering Focus	PUNCHING SHEAR PERFORMANCE OF POINT SUPPORTED CLT	Cross-laminated timber (CLT) is a suitable material for point-supported floors where panels are directly supported by columns. Punching shear capacity is a key property in the design of point-supported CLT floors. CLT punching shear is directly related to the rolling shear (RS) strength of the boards and is enhanced by concurrent compression perpendicular to grain stresses. In this research, through punching shear tests on a total of 193 full-scale panels, the effect of various parameters on the punching shear capacity of CLT floors was investigated. Furthermore, the adjustment factor of RS strength in punching shear was determined. Having a center column, support area, timber species, and the out-of-plane stiffness of the load distribution plate were the main factors affecting the punching shear capacity of the panels.	Houman	Ganjali	University of Northern British Columbia
8C	TESP - Engineering Flooring , incl Gottstein & Timber Queensland Study Tour Presentation	Timber Engineering & Structural Performance - Engineering Focus	Gottstein & Timber Queensland Study Tour Outcomes for Vibration and Acoustic Knowledge on Mass Timber Structures and Future Research Directions.	As a result of a comprehensive study tour conducted by Mr Faircloth (funded by both the Gottstein Fellowship and Timber Queensland) current designing practices and preferences for mass timber structures have been documented. These trends across 13 countries, generated by 112 individual discussions, were evaluated against a literature review concentrated on vibration and acoustic advancements on mass timber products and structures. Join this talk to hear about these findings in more detail.	Adam	Faircloth	Queensland Department of Primary Industries
8D	TESP - Engineering - Design Challenges for Timber Buildings	Session Chair: ANDREW DUNN / TIMBER DEVELOPMENT ASSOCIATION					
8D	TESP - Engineering - Design Challenges for Timber Buildings	Timber Engineering & Structural Performance - Engineering Focus	A SURVEY ON THE DYNAMIC PROPERTIES OF MID- AND HIGH-RISE MASS TIMBER BUILDINGS	Understanding the dynamic properties of timber buildings is crucial for optimal and safe designs. However, there is no specific formula in the building codes to estimate the elastic period of timber buildings. Different vibration testing on the existing timber buildings allows researchers and engineers to form a database for developing empirical formulas for fundamental period estimation to assist future design. This study surveys the ambient and forced vibration tests on 31 buildings in both field and lab scale conducted on timber buildings with various structural systems. The measured fundamental periods and damping ratios are compared with the recommended values in the building codes. The results showed timber buildings with the same height but different structural systems do not have identical fundamental frequencies, which indicated the necessity of either deriving specific empirical formulas for timber buildings with different lateral force resisting systems (LFRS) or adding other general properties of the building, such as plan dimensions in the empirical formulas.	Samira	Mohammadyzadeh	UNBC

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8D	TESP - Engineering - Design Challenges for Timber Buildings	Timber Engineering & Structural Performance - Engineering Focus	SEISMIC DESIGN OF TIMBER BUILDINGS IN NZ - THE NEW NZS AS 1720.1	This paper describes and reviews the new building code requirements for seismic design of timber buildings in New Zealand. The new design requirements are based on a hierarchy of seismic design, allowing the choice of varying levels of ductility, ranging from fully elastic design to nominal ductile, limited ductile, or fully ductile structures. A capacity design procedure is then used to ensure that ductility occurs in certain selected Potential Ductile Elements (PDEs), while more vulnerable elements known as Capacity Protected Elements (CPEs), are protected by overstrength calculations. The paper describes the new design process as used in New Zealand, its uniqueness as a performance based design method, and identifies significant gaps in knowledge where future research is required.	Daniel	Moroder	PTL Structural & Fire
8D	TESP - Engineering - Design Challenges for Timber Buildings	Timber Engineering & Structural Performance - Engineering Focus	Demonstrating Lateral System Equivalence of a Novel Mass Timber Material through a FEMA P795 Methodology	A test program was designed and implemented to demonstrate equivalency between a novel veneer-based mass timber material and cross-laminated timber (CLT) shear walls. Full-scale 2.4 m by 2.4 m walls were tested reverse-cyclically using Special Design Provisions for Wind and Seismic (SDPWS) prescribed connections to characterize lateral performance. Three different materials, the novel veneer-based panel and two CLT layouts with different species, and two panel aspect ratios, 2:1 and 4:1, were investigated. Additionally, the walls were tested on a steel base and loading arm to better standardize the testing approach, compared to the previous research that used CLT boundary conditions. Equivalency was determined following the FEMA P795 methodology. The walls exhibited higher strength and displacement capacity at the 4:1 aspect ratio compared to the 2:1 aspect ratio for all materials. The novel material met equivalence parameters at a 2:1 aspect ratio with the Code prescribed nail and met equivalence parameters at both aspect ratios with a shorter nail.	Ian	Morrell	Tennessee Technological University
8D	TESP - Engineering - Design Challenges for Timber Buildings	Timber Engineering & Structural Performance - Engineering Focus	FINITE ELEMENT ANALYSIS OF REPLACEABLE STEEL PERFORATED PLATE FUSES IN TIMBER BRACED FRAMES	Mass timber braced frames enhance the resilience and ductility of tall timber buildings in seismic areas. Traditional mechanical fastener systems often fail due to material variability and prediction model limitations. To address this, a novel End Brace Connection (EBC) system using perforated steel plates has been introduced as seismic fuses. This system aims to effectively dissipate seismic energy, minimize damage to timber elements, and allow for easy post-seismic replacement. This study employs finite element analysis (FEA) to explore the behavior of replaceable steel perforated end plate connections in timber braced frames. The objective is to identify the optimal failure mechanisms and perforation configurations that maximize ultimate deformation. The research builds upon previous experimental work, which demonstrated that different perforation shapes impact performance. Long oval configurations were identified as promising but required further validation through numerical simulations. Finite element models were developed using Abaqus® to replicate experimental conditions and stress-strain behaviors. The models were calibrated using tensile coupon tests and subjected to cyclic loading protocols to ensure accuracy. A mesh independence study determined the optimal mesh configuration for balance between accuracy and computational efficiency. The results showed that increasing the slot length significantly improved ultimate deformation, though it reduced energy dissipation. Conversely, increasing the number of slots enhances energy dissipation. Combining both parameters achieved 100% of the reference deformation under monotonic loading while maintaining equivalent energy dissipation. The study confirms the potential of perforated steel plates as effective seismic fuses in timber braced frames, offering a promising approach for improving structural integrity and post-seismic repairability.	Yahia	Ahmed	University of alberta
8D	TESP - Engineering - Design Challenges for Timber Buildings	Timber Engineering & Structural Performance - Engineering Focus	GLUED-IN WOODEN ROD AND LAMINATED DENSIFIED WOODEN ROD AS REINFORCEMENT FOR COMPRESSION PERPENDICULAR TO THE GRAIN	For the design of high-rise timber buildings, the accumulation of self-mass and the resultant permanent deformation is a critical matter, especially at the occurrence of compression perpendicular to the grain (CPG). Metal fasteners, e.g., self-tapping screws, are conventional reinforcements against CPG deformation in timber members. This study investigates the technique of utilizing glued-in wooden rods and laminated densified wooden (LDW) rods as CPG reinforcements. Test series are first planned to characterize the single-fastener behavior by applying direct loading on a single glued-in wooden or LDW rod. Thereafter, the global behavior of utilizing one single wooden or LDW rod as CPG reinforcement for glulam members is planned to be investigated. Possible associated failure modes are planned to be observed and then classified to propose analytical prediction formulas. Experiments on multiple numbers of glued-in wooden or LDW rods as CPG reinforcements are also planned, both to validate afore-derived analytical formulas and to investigate the effective numbers when applying multiple fasteners.	Yue	Wang	KTH Royal Institute of Technology
8D	TESP - Engineering - Design Challenges for Timber Buildings	Timber Engineering & Structural Performance - Engineering Focus	ANALYZING COMPLEX TIMBER DIAPHRAGMS USING AN EQUIVALENT TRUSS METHOD	This paper introduces an efficient, yet accurate analysis method that can be used to model the real stiffness of timber diaphragms in a 3D model. Known as Equivalent Truss Method (ETM), this approach employs truss elements to simulate the sheathing shear stiffness and the nail slip, beam elements to model framing members (including chords, drags, and boundary studs), and springs to represent splices. The ETM enables accurate analysis of irregular diaphragms with multiple re-entrant corners, cantilevers, out-of-plane offset in walls, and buildings with non-parallel wings. The full 3D model of the building, assembled using ETM, distributes lateral loads based on relative stiffness of diaphragms and shear walls (semi-rigid analysis), while considering torsional effects. To calibrate and validate the model, the data from previous tests on diaphragms, as well as the data from a new series of tests that was performed as part of this project, are used. The calibrated model is then used to analyze a complex building assuming rigid, semi-rigid, and flexible diaphragms and to compare the lateral load distribution to vertical elements and the building deformation under each assumption. Results show that analyzing timber buildings assuming fully flexible or rigid diaphragms can result in underestimating overall building deflection and inaccurate load distribution.	Esmael	Rahmani	MiTek
8D	TESP - Engineering - Design Challenges for Timber Buildings	Timber Engineering & Structural Performance - Engineering Focus	Prolam PLX Portal Frame for Residential Buildings	Prowood is a market lead innovative wood lamination company based in Motueka, New Zealand, who manufacture the Prolam range of products. The companies main products are glulam posts and beams, however it has recently developed new innovative products in response to market demand, using lower grade Radiata Pine timber. The first PLX product developed was a PLX20 Lintel that utilises SG6 timber and steel flanges epoxied together to form a lintel with an equivalent stiffness of 21GPa. Following this the company developed a PLX Portal that is customizable to fit any opening up to 6.0m which can be rapidly assembled on site. The development team went through extensive testing to develop a portal system that can be supplied via mechants, specified by architects, provides >150BUS (7.5kN) bracing capacity, minimizes thermal bridging and meets the building regulations. The PLX Portal has been tested to the BRANZ P21 methology and is a structural bracing solution within the scope of NZS3604 Residential Timber Buildings. The product has been in the New Zealand market for 1.5 years and is being specified on an every increasing number for projects.	John	Woodman	Prolam NZ

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8E	EIC / STCE - Engineering - Design for Wind & Seismic load events / Structural Behaviour	Session Chair: PROFESSOR PIERRE QUENNEVILLE / THE UNIVERSITY OF AUCKLAND					
8E	EIC / STCE - Engineering - Design for Wind & Seismic load events / Structural Behaviour	Timber Engineering & Structural Performance - Engineering Focus, Education, Innovation & Challengers - Engineering Focus	Reduction of floor vibrations using wooden and other dampers	The vibration behaviour of floors is gaining increasing importance. As the cross-sections of large span floors are often very material-intensive due to the vibration design, other methods to reduce the vibrations should be searched for. In bridge constructions, dampers often are used to reduce vibrations. Observations from our research indicate, that large span floors have similarities to footbridges. Therefore, various dampers were tested on a large floor test bench. Following initial successes, the study was extended to investigate a total of four different damper configurations. The results demonstrate that dampers can significantly reduce vibrations at resonance frequencies. However, no clear trend was observed for transient vibrations.	Johannes	Ruf	Biberach University Of Applied Sciences Institute for Timber Design
8E	EIC / STCE - Engineering - Design for Wind & Seismic load events / Structural Behaviour	Timber Engineering & Structural Performance - Engineering Focus, Education, Innovation & Challengers - Engineering Focus	ACTIVE VIBRATION CONTROL OF TIMBER FLOORS AND HUMAN-INDUCED EXCITATIONS	The significance of the vibration characteristics of floors is established across the entire construction sector. However, the low self-weight of timber, which has positive effects in many aspects, is also a reason why provisions towards sound insulation must oftentimes be undertaken. One approach to solve this challenge is to provide additional mass. This practice, in turn, impairs the dynamic behaviour in the low frequency range and highlights the relevance of related solutions for timber construction. To manipulate the dynamic response of structures is a challenge that can be solved in different ways. The variability of excitation and the randomness of human-induced vibrations with respect to time and location placed the focus of the present research on active controlled damping systems. It has already been shown that the floor vibrations can be actively influenced in a specific manner. Regarding the fundamentals of active vibration control, it is possible to act against unwanted vibrations. The objective of the research presented here is to show how different active vibration dampers can positively influence the vibration characteristics and ensure the comfort or rather serviceability of the floors. Of great interest is the performance of these active dampers with respect to the challenging human-induced excitations. Experimental investigations with cross laminated timber (CLT) panels and corresponding floor structures in combination with active vibration reduction will be presented. Benchmarked by measurements, appropriate calculation models are of practical interest. Furthermore, the comparison between experimental tests and numerical analysis is also part of this research.	Thomas	Hillberger	Universität Innsbruck (UIBK)
8E	EIC / STCE - Engineering - Design for Wind & Seismic load events / Structural Behaviour	Timber Engineering & Structural Performance - Engineering Focus, Education, Innovation & Challengers - Engineering Focus	A Bayesian model updating framework for seismic damage identification in mortise and tenon connections	The performance degradation of traditional timber structures caused by man-induced or natural hazards is a pressing issue for the preservation and protection of historical timber structures. A reliable numerical model capable of identifying structural damages is key for seismic assessment of the existing traditional timber structures. However, damage identification based on Finite Element (FE) models usually requires a great deal of computation effort, and updated models can hardly be applied for performance evaluation. This paper proposes damage parameters for mortise and tenon connections, considering the seismic damage characteristics of the wooden tower. The Bayesian method is embedded into a parameterized model to automate the updating process, and the bottom-level timber frames of a Tang-style wooden pagoda in Shanghai is considered for modelling and damage identification. The predicted results agree well with actual damage results, confirming the suitability and stability of the proposed Bayesian framework in identifying damage of joints. Earthquake disaster investigations have indicated that underlying timber frames are more susceptible to damage. This paper takes the bottom-layer frame of a seven-story Tang-style timber pagoda in Shanghai as research object and builds a numerical model to identify and evaluate the damage status of mortise and tenon joints. Several timber structure models are built, which simulate seismic damage with cyclic loading. Models contain different loads and boundary conditions, and thus the robustness of the proposed approach is verified. The identified parameters fit well with the predefined severity of actual damage, and the updated model demonstrates energy dissipation capabilities similar to real damaged conditions. The proposed framework have narrowed down damage parameters, while effectively assessed the hysteresis behavior of damaged timber frame in the updated model.	Jingliang	Dong	Tongji University
8E	EIC / STCE - Engineering - Design for Wind & Seismic load events / Structural Behaviour	Education, Innovation & Challengers - Engineering Focus, Education, Innovation & Challengers - Architectural Focus, Education, Innovation & Challengers - Practitioner Focus	Wood products for climate change mitigation in the Asia-Pacific region	Global use of wood products is growing with increasing demand for housing, furniture, clothing, paper, packaging, chemicals and other products. Increasing stocks of carbon in wood products can reduce CO2 emissions and mitigate climate change. These climate mitigation benefits of wood products depend on wood being produced in sustainably managed forests in which carbon stocks are maintained. Emission reduction can be achieved by optimizing harvest to increase wood supply while maintaining carbon stocks and providing ecosystem services, more efficiently processing and using wood; extending wood product lifetimes, including through recycling and reuse and substituting wood for energy intensive materials. The Seoul Forest Declaration at the 2022 World Forestry Congress called for the full potential of legal, sustainably produced wood to support transformation of the building sector, to provide renewable energy and to supply innovative new materials. At the Congress, a Ministerial Forum called for a significant increase in use of sustainable wood-based solutions within Nationally Determined Contributions (NDCs) under the Paris Agreement. Focussed on the Asia-Pacific region, this paper provides considerations in on factors to consider in including harvested wood products in NDCs and other climate policies.	Rodney	Keenan	Food and Agriculture Organization of the United Nations
8E	EIC / STCE - Engineering - Design for Wind & Seismic load events / Structural Behaviour	Material Performance & Durability - Engineering Focus, Sustainability and Timber in a Circular Economy - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	EXPLORING CORRELATIONS BETWEEN NON-DESTRUCTIVE AND DESTRUCTIVE TESTS FOR THE MECHANICAL CHARACTERIZATION OF EXISTING TIMBER STRUCTURES	The paper focuses on the mechanical characterization and assessment of the state of preservation of existing timber structures. Non-destructive tests (NDT) have great potential in estimating the mechanical properties of wood through in situ investigations, offering an alternative to destructive laboratory tests (DT). However, their effectiveness depends on the presence of reliable correlations between the NDT parameters and the physical and mechanical properties of wood estimated through DT. In this study, a statistical analysis of data obtained from NDT and DT on a sample of ancient timber members in structural dimension from South Italy is presented and the corresponding correlations are showed. The paper includes a brief description of the sample, a focus on the statistical methodology and the results. It also offers a critical analysis of the correlation laws, highlighting those most reliable for in situ investigation.	Beatrice	Faggiano	University of Naples Federico II

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8E	EIC / STCE - Engineering - Design for Wind & Seismic load events / Structural Behaviour	Material Performance & Durability - Engineering Focus, Sustainability and Timber in a Circular Economy - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	The effect of heating time on the mechanical properties of wooden structural members after heating and cooling for continuous use after fire	In this study, the effects of heating time on mechanical properties of Japanese cedar after heating-cooling were clarified for the continuous use of medium-large scale wooden buildings after fire. The authors clarified the effects of heating time on modulus of elasticity (MOE), modulus of rupture (MOR) and equilibrium moisture content (EMC) in the air-dried condition after heating-cooling. The effects of heating time on MOE and MOR were large, at 210°C for 30 minutes and 8 hours MOE was 0.95, 0.85 and MOR was 0.92, 0.52, when the value of 60°C was set to 1.00. The effect of heating time on EMC was also large, at 210°C for 30 minutes and 8 hours EMC was 9.16%, 7.34%. The effect of heating time on mechanical properties in the air-dried condition has been clarified, so the effects of heating time on mechanical properties in the oven-dried condition after heating-cooling are clarified. Furthermore, the full paper will clarify the effects of heating time and moisture content on mechanical properties after heating and cooling by comparing mechanical properties as a parameter of heating time in air-dried and oven-dried conditions. Ultimately, the effects of heating time, heating temperature and moisture content on mechanical properties of wood will be clarified to contribute to the verification method for continuous use after fire.	Souchirou	Yamashita	Waseda University
8E	EIC / STCE - Engineering - Design for Wind & Seismic load events / Structural Behaviour	Material Performance & Durability - Engineering Focus, Sustainability and Timber in a Circular Economy - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	Mechanical properties of recycled vs new high-density Australian hardwoods	Native Australian hardwoods are among the densest, strongest, and most durable timber species in the world. These exceptional properties, as well as their relatively scarce availability as new sawn timber, means that they are often sourced as high-value recycled timbers when used in contemporary construction. However, the structural potential of this material is limited by the relatively scarce available data on their mechanical properties. Preliminary testing on this topic indicates that re-processing recycled timber increases its mechanical properties closer to that of virgin timber, and that current grading limitations on Australia's recycled hardwoods can be relaxed.	Duncan	Hossy	University of Queensland
8F	MPD - Engineering - Structural Behaviour	Session Chair: PROFESSOR KEITH CREWS / THE UNIVERSITY OF QUEENSLAND					
8F	MPD - Engineering - Structural Behaviour	Material Performance & Durability - Engineering Focus	REAL-LIFE PERFORMANCE OF SHAPE-OPTIMIZED TIMBER BEAMS	The creation of sustainable living spaces drives the utilisation of mass timber products like GLT and CLT across the globe. They not only sequester significant amounts of carbon but also effectively complement fossil-based building materials in mid- to high-rise buildings. However, they also require a significant amount of raw material. In order to improve their resource efficiency, the optimisation of the shape in order to account for the actual stress distribution within the building member is a promising approach to get more out of the natural resource wood. The presented investigation shows the real-life performance of three-dimensionally optimized GLT beams under four-point bending. Two shape optimisations were conducted and a total of 34 samples (17 reference and 17 optimised beams) were tested until failure. The maximum force, deflection and deformation was recorded and compared with the reference cross-section. The results showed that real-life material savings of about 30% can be achieved without any loss of the load-carrying capacity or the deflection limits of GLT beams.	Paul	Mayencourt	BOKU University, UC Berkeley
8F	MPD - Engineering - Structural Behaviour	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	IMPROVING STRUCTURAL ROUNDWOOD CLASSIFICATION BY DIGITAL 3D-MEASUREMENT	The paper addresses the use of small-diameter oak logs as a sustainable construction material. Knowledge of the mechanical properties is essential for structural applications. Therefore, the modulus of rupture has been investigated to provide one part of the missing knowledge to the construction industry. In the first step, the raw material was characterized by a quality assessment. Half of the logs were partially sawn for an easier use in construction. Subsequently, the geometries of the logs were measured using 3D laser triangulation technology, followed by destructive bending tests. A program developed in the Python programming language calculated the moment of inertia from these geometries. The results of the calculated modulus of rupture using the moment of inertia derived from the measured geometries have been compared with those received from calculation rules given in European normative testing standards. The different calculation results scatter less when the moment of inertia is derived by 3D measurement of the geometries. The influence of the sawing process aligns with similar tests on softwood logs. This knowledge will contribute to a more efficient use of round hardwoods in construction.	Maximilian L.	Müller	Mainz University of App Sc, Holzbauforschung Mainz, Germany
8F	MPD - Engineering - Structural Behaviour	Timber Engineering & Structural Performance - Engineering Focus	FATIGUE OF TIMBER CONNECTIONS: A COMPREHENSIVE REVIEW OF FAILURE MECHANISMS AND DESIGN LIMITATIONS	Fatigue is a critical factor affecting the long-term structural integrity of buildings, particularly in load-bearing components subjected to frequent cyclic loading. As the use of engineered timber expands in high-rise structures, bridges, and other infrastructure, understanding fatigue performance is crucial for ensuring structural reliability and safety. Despite its significance, fatigue remains an under-investigated issue in timber construction, with no standardized design guidelines available. Timber connections play crucial roles in overall fatigue performance, and the fatigue behavior of which is highly influenced by timber's anisotropic structure, natural defects, moisture variations, and creep effects, contributing to complex damage accumulation. This paper presents a comprehensive review of fatigue mechanisms in timber structures, focusing on fatigue strength and fatigue-induced damage mechanisms of different kinds of timber connections, highlighting gaps in fatigue performance for timber structures. The findings of this review help bridge the knowledge gap, promoting the necessity of developing of fatigue-resistant design guidelines for improved long-term performance of timber structures.	Zhengyao	Li	Chalmers University of Technology
8F	MPD - Engineering - Structural Behaviour	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	TORSION OF REINFORCED GLUE LAMINATED TIMBER BEAM	The construction industry urgently needs to reduce greenhouse gas emissions by promoting the more efficient use of carbon and energy-intensive construction materials like steel and concrete in conjunction with materials such as sustainably sourced timber with significantly lower carbon and energy footprint than conventional construction materials. Despite extensive research on timber composite systems (i.e., timber-concrete, steel-timber, and timber-timber), the effect of torsional loading on timber composite sections is unexplored. Most of the previous studies on timber composites have focused on bending moment and shear force (predominantly plane stress state). There is a big gap in understanding the structural behaviour of composite timber beams subjected to loadings that involve torsion. This study investigated the behaviour of a Glue Laminated Timber (GLT) beam with threaded bar reinforcement and reinforced concrete (RC) blocks at the ends under torsional loading. The RC blocks represent fixed supports (torsional restraints) and are only connected with the GLT beams with threaded bars. From this test, we explored how the torsion is transferred from the GLT beams to fixed-end supports. Also, finite element modelling (FEM) of the specimen was performed using ABAQUS and the results from the analysis showed that the maximum shear stress on the GLT beam corresponding to 50 mm displacement was 1.83 MPa without the GLT beam failing.	Rumia	Tasmim	UNSW

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8F	MPD - Engineering - Structural Behaviour	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	DEVELOPMENT OF UHPC NODES FOR TIMBER STRUCTURES	The use of mass timber structures is becoming more commonplace as sustainable systems. During fire incidents, however, the conventionally used metallic connectors could be the weakest link. To overcome this, innovative precast ultra-high-performance concrete (UHPC) nodes are introduced. This paper introduces the concept and the details of fabrication, testing and experimental results of specimens tested at Fast + Epp's Concept Lab in Vancouver. A finite-element model (FEM) using ABAQUS, which was validated against tests, was used to perform a parametric study. This was followed by additional experiments to evaluate the use of deformed rebars in the proposed nodes. The initial results showed a high potential, with an increase in capacity up to 243% with the addition of rebars. This study also proposed analytical models to estimate the load capacity of the UHPC nodes.	Mid	Shahnawaz	Fast + Epp Structural Engineers Inc.
8F	MPD - Engineering - Structural Behaviour	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	EFFECT OF THICKNESS OF ADHESIVE ON SHEAR PROPERTIES OF WOOD-STEEL JOINT	To contribute to achieving carbon neutrality 2050 by increasing the use of harvested wood products, the Korean Forest Service is trying to expand public wood buildings. Since public wood buildings often require large spans, it is important to ensure the rigidity of the structural materials, and various studies are being conducted in Korea. One of them is considering wood-steel joints using adhesives, and this paper contains the results of a study to establish the basic shear properties of wood-steel joints composed of epoxy. To investigate the influence of the thickness of the adhesive layer on the shear property of wood-steel joints, pull-out tests were performed on joints made with four different adhesive layer thicknesses. The results showed that the highest shear performance was achieved when the adhesive layer thickness was 1.5 mm, with shear strength and shear stiffness of 23.0 kN and 248.2 kN/mm, respectively. Further research is being conducted to calculate the shear modulus of wood and adhesive by using digital image correlation, and to predict the shear modulus of wood-steel joints.	Chul-Ki	Kim	National Institute of Forest Science
8G	STCE - Engineering / Architecture - Advancing the Circular Economy	Session Chair: DR YUTAKA GOTO / CHALMERS UNIVERSITY OF TECHNOLOGY					
8G	STCE - Engineering / Architecture - Advancing the Circular Economy	Sustainability and Timber in a Circular Economy - Engineering Focus	REUSE OF WOOD IN STRUCTURAL PRODUCTS – A GAIN?	There is increasing interest in the reuse and recycling of wood in construction, but still many important unsolved questions about how it should be done safely and economically. Some important research projects, carried out in recent years, have addressed some of these questions, and the first conclusions have appeared. One major challenge of this research is the variability of the resource, and the difficulty of obtaining representative sampling. It is even more important than it is for new timber, to be able to meaningfully compare results across projects and draw insights from combined analysis. This paper summarises results about performance of reuse and recycling of wood in timber products, focusing on advantages and limitations in order to promote cascading processes in the timber industry.	DANIEL	FERNANDEZ LLANA	Timber Construction Research Group - Universidad Politécnica de Madrid (GICM - UPM), Spain
8G	STCE - Engineering / Architecture - Advancing the Circular Economy	Sustainability and Timber in a Circular Economy - Engineering Focus	Recovered Timber Grading System	There is a big amount of timber to potentially recover from construction and demolition sector that could be suitable for reusing or recycling as structural material. Recovered timber should be properly graded before reuse it and the current standards for new timber are not fitting well for recovered timber. Recently, several research projects tested recovered timber for grading purposes. Regarding mechanical properties, a combination of non destructive testing, mainly based on longitudinal vibration, and some visual parameters (knots and slope of grain) was shown as a promising method to estimate them. Furthermore, there are other reusability aspects that should be taken into account (length, cross-section, warp, pregrading, metals, hazardous substances, degradation due to insects, etc.). Most of the research studies were performed over a limited number of specimens due to the difficulties to recover a big batch of timber from the same structure. There is new European project called TIREX dealing with an extensive recovered timber testing campaign using timber from several locations in Europe.	DANIEL	FERNANDEZ LLANA	Universidad Politécnica de Madrid (UPM), Spain
8G	STCE - Engineering / Architecture - Advancing the Circular Economy	Sustainability and Timber in a Circular Economy - Engineering Focus, Sustainability and Timber in a Circular Economy - Architectural Focus, Sustainability and Timber in a Circular Economy - Practitioner	CAN THE SIRKTRE CONSORTIUM FACILITATE FOR 8% OF THE NORWEGIAN PARIS CLIMATE TARGETS WITH THEIR CIRCULAR SOLUTIONS?	The Norwegian SirkTRE project was initiated to accelerate the circular economy transition in the Norwegian timber construction and beyond. The project will in 2025. SirkTRE aims to enable a value cycle that adopts reuse and material recycling of post-consumer wood in Norway. The ambition, proposed in 2021, is to facilitate for 1/3 of today's wood waste into building products by 2030, which would result in the reduction of the Norwegian climate footprint by 8% CO ₂ -e. This publication explains the calculation of the expected impact and compares these with the new insights about the project impact by reflecting and collecting environmental impact data on experiences and achievements in SirkTRE.	Kristine	Nore	OMTRE AS
8G	STCE - Engineering / Architecture - Advancing the Circular Economy	Sustainability and Timber in a Circular Economy - Engineering Focus	THE REUSE POTENTIAL OF RECLAIMED LOGS AND GLULAM BEAMS FOR OPTIMISED ENGINEERED WOOD PRODUCTS	The ongoing work presented in this paper aims to optimally use reclaimed logs and glulam beams to produce new engineered wood products. The procedure includes preparing the source material, mapping the geometry and determining the strength and stiffness properties of the new boards by visual and non-destructive mechanical grading. According to a combinatorially optimised distribution, new elements will be glued to a new product. For the final products, the stiffness and strength of the member, the shear strength of the glue line, and the integrity of the bond line in fire will be determined.	Sandra	Kajula	Tallinn University of Technology
8G	STCE - Engineering / Architecture - Advancing the Circular Economy	Material Performance & Durability - Engineering Focus, Sustainability and Timber in a Circular Economy - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	ASSESSMENT OF STRENGTH AND STIFFNESS PROPERTIES OF RECLAIMED STRUCTURAL TIMBER OF NORWAY SPRUCE	This study researches 56 reclaimed Norway spruce timber specimens (48x98 mm) using both destructive and non-destructive testing methods. It evaluates these specimens against three visual grading standards (INSTA 142, UNI 11119, NS 3691-3) and destructive tests, focusing on enhancing grading precision by locally grading specimens near the destructive test breaking point (destructive zone). Despite extensive research on aged timber grading, the study underscores the ongoing need for further refinement of these methods. The primary goal was to accurately assess old timber to prevent unnecessary demolition of structurally sound material. Knot measurements were pivotal in visual grading, with UNI 11119 noted for simplicity while other standards offered more comprehensive approaches. Among the standards evaluated, INSTA 142 provided the highest estimation of bending strength, reaching up to strength class C30. However, the visual grading strength values were still significantly lower than the actual test results. On average, the standards underestimated bending strength by 50-54%, with the Norwegian NS 3691-3 standard showing the greatest underestimation. The velocity measurements of sound wave propagation, conducted locally and across the fiber, were highly sensitive to the wood's condition (e.g., defects, damage), potentially leading to significant variations within specimens. Thus, this method can not be considered to reliably predict timber strength properties. In conclusion, it can be stated that visual strength grading standards can conservatively estimate wood into strength classes up to C24 or C30. This method is reliable and leaves room for error in favor of the assessor but may result in the structure being significantly over-dimensioned from a material optimization perspective.	Maarja	Kauniste	Tallinn University of Technology

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8G	STCE - Engineering / Architecture - Advancing the Circular Economy	Sustainability and Timber in a Circular Economy - Architectural Focus	A Digital Framework for Robotic Processing of Reclaimed Timber	Reusing timber elements in construction is a promising path toward extending its lifecycle and easing the pressure on forest resources. Direct use of elements from disassembled timber buildings in new construction offers the path of least energy expenditure. However, such direct use of reclaimed timber elements presents challenges due to material degradation, inconsistent changes in form due to environmental exposure, and existing cutouts for joints or other features. While the automated production and processing of timber elements is a mature field, it generally relies on material consistency and standardization of dimensions and properties. Therefore, this research prototypes a digital framework that leverages 3d laser scanning and robotic fabrication to detect geometric variations, cutouts, and material inconsistencies in reclaimed timber elements and account for them in the design process of new timber buildings. The method identifies existing joint cutouts and features such as cracks and wane and incorporates them into a digital mapping of the available resources onto the digital design model. Further processing is thus concentrated only on necessary areas, and existing joints are machined into new connection details as much as possible. The resultant framework demonstrates an adaptive and surgical approach to processing reclaimed timber elements, mitigating the challenges of their reuse and increasing the number of elements that can be included in new construction.	You-Wei	Yen	Royal Danish Academy
8G	STCE - Engineering / Architecture - Advancing the Circular Economy	Sustainability and Timber in a Circular Economy - Engineering Focus	LIFE CYCLE CARBON FOOTPRINT ANALYSIS OF CROSS-LAMINATED TIMBER (CLT) MULTI-STORY BUILDING: IMPACT OF MATERIAL OPTIMISATION AND SUBSTITUTION STRATEGIES	Cross-laminated timber (CLT) is increasingly proposed as a low-carbon alternative to steel or concrete in mid-rise multi-storey structures. In this study, the embodied carbon footprint of a CLT multi-storey building is analysed in a life cycle perspective, and strategies to optimise the carbon footprint are explored, based on material optimisation and substitution. The analysis shows that the production stage accounts for 72% of the life cycle embodied carbon footprint, and the effective post-use management of the materials arising from the end-of-life stage can give a significant climate benefit. A reduction of up to 5.5% of the life cycle carbon footprint can be achieved when employing the material optimisation and substitution strategies. This, together with effective post-use management of the building materials results in a reduction of up to 19% of the life cycle carbon footprint of the studied CLT building. Overall, this study shows that the life cycle embodied carbon footprint of a CLT building can be further reduced through material-related strategies.	Carl	Larsson	Linnaeus University
8G	STCE - Engineering / Architecture - Advancing the Circular Economy	Sustainability and Timber in a Circular Economy - Architectural Focus	FIRST BUILDING - SETTING A NEW BENCHMARK	As the inaugural building of Bradfield City Centre, the First Building, Advanced Manufacturing Readiness Facility (AMRF) is more than a high-performance facility. It is a prototype for circular, future-focused urban development. At its core, the project rethinks the life cycle of buildings, embedding circular economy principles through a design that prioritises adaptability, reuse, and material stewardship. Conceived as a modular, prefabricated timber structure, the building is designed for disassembly, with every component mechanically fixed for future relocation, reconfiguration or repurposing. This approach not only reduces construction waste and embodied carbon, but establishes a scalable framework for resilient, regenerative architecture in emerging cities. Bradfield's 'First Building' marks a defining moment in the creation of Australia's newest city in 100 years. It is a bold statement about the future of the built environment - designed with adaptability, circularity, and resilience, it sets a new benchmark for how cities can grow sustainably.	Jeff Morgan, Liz Westgarth & Yann Frampton		Hassel Studio
8H	TESP - Engineering - Dynamic Testing & Fire Engineering	Session Chair: PROFESSOR HIROSHI ISODA / KYOTO UNIVERSITY					
8H	TESP - Engineering - Dynamic Testing & Fire Engineering	Timber Engineering & Structural Performance - Engineering Focus, Timber Engineering & Structural Performance - Practitioner Focus	MAJOR FINDINGS FROM SHAKE TABLE TESTS OF A FULL-SCALE TEN STORY MASS TIMBER BUILDING	Mass timber construction is a relatively new way of utilizing wood material for modern, high-performance buildings at both large and small scales. It gives rise to the currently trending conception of wooden sky-scrapers. This presentation will provide an overview of a multi-year research project towards seismically resilient tall wood buildings. Specially, the major results and findings will be discussed from the NSF-funded NHERI TallWood Project which aims at developing a resilience-based seismic design methodology for tall wood buildings. The project team completed a series of shake table tests on a full-scale 10-story mass timber building in 2023, which represents the world's tallest full-scale building ever tested on a shake table. Due to the timing of the test program, only preliminary outcome was presented in the 2023 WCTE. This presentation will be focused on detailed results and findings based on analysis of the data obtained from the test program.	Shiling	Pei	Colorado School of Mines
8H	TESP - Engineering - Dynamic Testing & Fire Engineering	Timber Engineering & Structural Performance - Engineering Focus	NUMERICAL MODELING OF THE SEISMIC PERFORMANCE OF A 10-STORY MASS TIMBER BUILDING	Mass timber buildings with post-tensioned rocking wall lateral force-resisting systems are now possible in areas of high seismicity and offer benefits such as fast construction, architectural uniqueness, reduced carbon footprint, and the potential for design for deconstruction. Additionally, these systems provide an opportunity to improve upon the usual collapse prevention performance for buildings in large earthquakes by developing design methods that enable resilient performance while maintaining an efficient design, creating a competitive lateral force-resisting system. To better understand the behavior and performance of seismically resilient mass timber buildings with mass timber rocking wall lateral force-resisting systems, the Natural Hazards Engineering Research Infrastructure (NHERI) TallWood Project designed and tested a 10-story building specimen at the NHERI outdoor shake table (LHPOST) at the University of California, San Diego. The walls were initially designed using a linear force-based procedure and were then validated using nonlinear response history analysis in OpenSees. This presentation will compare the nonlinear numerical analysis predictions of seismic performance with the experimental results. Results indicate that the nonlinear modeling methods provide a good prediction of seismic performance while also highlighting areas that can be improved.	Jeffrey	Berman	University of Washington
8H	TESP - Engineering - Dynamic Testing & Fire Engineering	Timber Engineering & Structural Performance - Engineering Focus	Experimental Fire Testing of STS-Retrofit Glulam Beam Connections with Minimal Fire Protection	The main objective of this study is to investigate the enhancement of the fire behaviour of damaged glulam beam connections retrofitted using self-tapping screws (STS). In this paper, the results of fire endurance tests on two full-size glulam beam-end bolted connections with two different wood-steel-wood (WSW) configurations retrofitted using STS after being deliberately damaged through physical testing are presented. In both configurations, the metal connecting components, bolt's heads and nuts and steel plates were protected with wood plugs and strips, respectively, to provide minimal fire protection using eco-friendly material like wood. Based on the fire test results, the utilization of STS prevented any propagation of the already existing splits in the damaged connections at elevated temperatures. Ultimately, this resulted in full recovery of the fire resistance time of the STS-retrofitted connections. Accordingly, a simple yet effective STS retrofitting technique has been experimentally proven to enhance the fire resistance of damaged glulam beam-end bolted connections with the two WSW connection configurations presented in this paper.	Sam	Salem	Lakehead University

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8H	TESP - Engineering - Dynamic Testing & Fire Engineering	Timber Engineering & Structural Performance - Engineering Focus	NUMERICAL STUDY ON FIRE PERFORMANCE OF TIMBER-CONCRETE COMPOSITE BEAMS	The timber-concrete composite is a useful example of timber hybrid structures following the recent increase in medium and large timber structures. However, there are very few studies on the mechanical behaviour of timber-concrete composite beams in fire. Therefore, the high resistance and heat-absorbing capacity of RC slabs are generally ignored in fire design. If the high fire performance of the timber-concrete composite can be taken into account, a more reasonable design can be achieved, e.g. a more extended span for the same beam cross-section. Therefore, in this paper, the influence of RC slabs on glulam beams in a fire is numerically evaluated by thermal stress analysis and the mechanism behind the enhanced fire resistance of timber-concrete composite beams is clarified using the cross-sectional stress distribution. The characteristic mechanical phenomena between slab and beam with different thermal properties are discussed using the temperature distribution in the cross-section. The issues to be considered in the design process are clarified. A four-point bending test analysis was conducted on a glulam beam exposed to ISO standard fire. Two types of cross-sectional models were used: fully timber-concrete composite beam and glulam beam. The fire resistance time of the composite beam was approximately twice that of the glulam beam under the same load. The reason is that most of the cross-section of the RC slab was still effective even at 120 min, whereas the glulam beam lost most of its strength due to charring. The RC slab carried high compressive stresses at the compression edges, which remained close to ambient temperature, even at the end of the heating. The entire cross-section of the glulam beam resisted the tensile stress. As a result, the composite beam maintained a larger distance between the centers of compressive and tensile stresses in the ultimate fire condition than the glulam beam, resulting in a higher bending resistance in the fire.	Taiga	Iwase	Chiba university
8H	TESP - Engineering - Dynamic Testing & Fire Engineering	Timber Engineering & Structural Performance - Engineering Focus	FLEXURAL PERFORMANCE OF STEEL-TIMBER-CONCRETE COMPOSITE FLOORS EXPOSED TO 2 HOURS OF STANDARD FIRE	Revitalizing long-span, high-rise wood buildings is essential to achieving a carbon-neutral 2050. In order to solve the strength deviation problem of wood, composite members of steel and concrete are being researched. In this study, we propose a steel-timber-concrete composite floor structures that can be applied to high-rise wood buildings. The proposed system utilizes a lightweight deck plate system to improve constructability, and is expected to improve bending performance and fire resistance by compounding Z-type steel and concrete joists. For this purpose, non-loaded furnace experiments and FEM heat transfer analysis were conducted to analyze the temperature rise tendency over time and the bending performance at room temperature and fire. If Z-type steel or concrete joists are composited with CLT, the bending performance at room temperature can be improved, and the latent heat effect of concrete can be expected to provide fire resistance for 1-3 hours in a standard fire.	Sung-Mo	Choi	University Of Seoul, Korea
8H	TESP - Engineering - Dynamic Testing & Fire Engineering	Timber Engineering & Structural Performance - Engineering Focus	BURNABILITY OF WOODEN LOUVERS AND ITS FACTORS: FLAME SPREAD ALONG PARALLEL WOODEN BOARDS	A series of simple flame-spreading tests along a channel was conducted to investigate fire risks of wooden vertical louvers. A pair of wood boards (either MDF or sugi) were burnt facing each other, and flame spread was observed. It was found that flame do not extinguish within the height of 6 times the source flame if blades 112mm wide are aligned approximately every 100mm or denser. Over 6kW/m ² of incident heat flux was observed even at the H (height) > 1.5L _f (flame height). This value was considerably higher compared to a flat wall configuration. It was also found that the increase in heat flux values in L _f < H region was well estimated from radiative heat flux from the opposing blade.	Ryo	Takase	Forestry and Forest Products Research Institute
8H	TESP - Engineering - Dynamic Testing & Fire Engineering	Timber Engineering & Structural Performance - Engineering Focus	Resilient Seismic Design of Tall Mass Timber Buildings: Comparison of Two Full-Scale Tri-Axial Shake Table Tests	This paper details the design, construction, testing, and focuses on a systematic comparison of full-scale shake table testing of a 10-story and subsequently a 6-story mass timber building as part of the NHERI TallWood and NHERI Converging Design research projects at the largest shake table in the United States. The primary goal of these projects was to develop and validate seismic design approaches for tall and mid-rise wood buildings in high seismic regions. Advancements in materials, components, and building systems over the past decade have enabled the construction of taller mass timber structures. However, many current mass timber buildings often rely on concrete cores or steel bracing for lateral force resistance as they are built taller and taller due to limited mass timber options approved by codes and industry preferences for traditional systems. This paper focuses on a systematic comparison of structural responses between the 10-story and 6-story buildings to examine the differences and similarities in dynamic behavior.	John	van de Lindt	Colorado State University
8I	TESP - Practitioner / Engineering	Session Chair: DR MARK DEWSBURY / UNIVERSITY OF TASMANIA					
8I	TESP - Practitioner / Engineering	Timber Engineering & Structural Performance - Engineering Focus	CREEP BEHAVIOR OF CROSS-LAMINATED TIMBER-CONCRETE COMPOSITE FLOOR SYSTEM ON FIXED END CONDITION.	Some research is being conducted on cross laminated timber-concrete composite (TCC) floor as a new technology. In this study, the long-term performance evaluation of TCC floor with fixed-end conditions under the uncontrolled condition was investigated as a creep test. In the fixed-end condition, the upper concrete part of the fixed end has tensile force, so the concrete and timber part are borne the both the tensile and the compressive force. Based on the characteristic, it was calculated flexural stiffness by using γ-method and the calculated value was higher than the experimental value. It is necessary to consider the concrete cracks, the fixed stiffness of end part and so on, to fill the gap.	kentarou	hatachi	Hiroshima University
8I	TESP - Practitioner / Engineering	Timber Engineering & Structural Performance - Engineering Focus, Timber Engineering & Structural Performance - Practitioner Focus, Education, Innovation & Challenges - Engineering Focus	Design and testing of ductile moment-resisting timber frame connections	The use of wood products in large-scale residential and commercial construction has grown significantly in recent years. However, limitations still exist, particularly in the context of moment-resisting frames, where a lack of efficient connection systems has made design challenging. This paper presents the development of a new moment-resisting beam-column connection (BCC) for large-scale timber frames. This new connection was developed using key performance targets, considering structural performance, cost, and environmental impacts. It was tested with glue-laminated timber (GLT) and laminated veneer lumber (LVL) beams and columns at three different scales. Using capacity design principles, ductile failure modes in the steel elements were achieved. A full design process is presented together with design tables to support the uptake and application of this new technology.	Kilian	Krauss	The University of British Columbia

Session No.	Session Topic	Abstract Topic	Submission Title	Summary	First Name	Last Name	Company
8I	TESP - Practitioner / Engineering	Timber Engineering & Structural Performance - Practitioner Focus	The Advanced Manufacturing Facility First Building	<p>The Advanced Manufacturing Research Facility (AMRF) First Building is due for completion in August 2024 in the Western Sydney Aerotropolis containing a locally sourced mass timber mezzanine floor and roof which covers the 3,500 square metre building footprint. This paper describes the engineering design of the mass timber structure, which feature a softwood cassette floor system supporting a green roof and twin timber beams in a layered grillage system spanning up to 18 metres.</p> <p>Through the design and delivery of this project it was found that the Australian timber manufacturing industry has matured to the point that both simple and complex mass timber structural typologies can be delivered using locally sourced timber, which may help to alleviate concerns about the supply chain of mass timber structures for future projects. It was also found that the Australian Standard AS1720.1 is not adequate for the design of large-scale mass timber buildings due to the limited methods for designing timber connections, and it is recommended that this standard is updated to be in line with the Eurocode 5 standard to reduce barriers to the design of mass timber structures in Australia.</p>	Nicholas Matthew	Boey Burke	Northrop & Savcon
8I	TESP - Practitioner / Engineering	Timber Engineering & Structural Performance - Engineering Focus, Timber Engineering & Structural Performance - Practitioner Focus	Bonding performance of MUF and PUR adhesives for glued laminated timber	<p>Beech wood still has a lot of untapped potential in timber construction, despite its good mechanical properties. It has a high density and strength, but at the same time is not biologically durable and is dimensionally unstable. Beech wood can be successfully bonded with typical wood adhesives, but problems often occur in delamination tests due to unfavourable shrinkage and swelling when the bonded components are exposed to moisture fluctuations or immersed in water.</p> <p>The aim of this study was to determine the bonding performance of melamine-urea-formaldehyde (MUF) and polyurethane (PUR) adhesives in the production of beech GLULAM and hybrid GLULAM made from beech and spruce. The experiment was divided into two sections. In the first part, beech lamellas were bonded with MUF, PUR and PUR in combination with a primer to form a GLULAM. In the second part, hybrid GLULAMs made of beech and spruce were bonded with the same adhesives. To test the adhesives, small beams with five 20 mm thick lamellas were produced. The two outer lamellas were made of beech wood, while the three inner ones were made of spruce wood.</p> <p>For beech GLULAM only, all adhesive bonds were found to have a much higher shear strength (about 14 MPa) than required by the EN 14080:2013 standard. All adhesive bonds in a hybrid GLULAM made of beech and spruce also met the requirements, but the shear strength was lower (about 10 MPa). Adhesive bonds between spruce and beech achieved slightly higher average strength values than adhesive bonds between spruce only. The highest shear strengths were achieved with PUR adhesives in combination with a primer, followed by MUF and PUR adhesives without primer. The results show that beech and spruce wood can be successfully bonded to form a hybrid beam using MUF and PUR adhesives. The adhesive bonds between beech and spruce wood show an effective bonding performance and fulfil the standard requirements.</p>	Milan	Šernek	University of Ljubljana, Biotechnical Faculty
8I	TESP - Practitioner / Engineering	Timber Engineering & Structural Performance - Engineering Focus, Timber Engineering & Structural Performance - Practitioner Focus	DEVELOPMENT OF AN INTEGRATED SEISMIC SIMULATION SYSTEM FOR TIMBER STRUCTURES	<p>Timber structures are characterised by a lighter weight than other structural types, and the lateral load level for checking the ultimate behaviors is relatively low. Consequently, many shaking table tests to investigate that ultimate behaviors using full-scale wooden houses have been conducted. Since 2005, a series of shaking table tests have been conducted utilising the E-Defense shaking table and other tables capable of inducing complete structural collapse. This has resulted in the accumulation of a substantial corpus of experimental data, which can be subjected to comparative analysis with numerical simulations. The experimental data has been used to verify and improve the accuracy of numerical analysis methods that can track a building until collapse.</p> <p>This report will present a numerical analysis method developed for the purpose of reproducing the strongly nonlinear behaviour of wooden buildings in response to extremely large earthquake motions. It will also provide an example of the application of this method as software. In particular, it will introduce a method for visualising the seismic performance of low-rise wooden houses based on time history response analysis. It will then present an example of linking this method with CAD for wooden houses sold in Japan, and finally, it will demonstrate the application of this method as structural design software for mid-rise wooden structures.</p>	Takafumi	Nakagawa	Kyoto University
8I	TESP - Practitioner / Engineering	Timber Engineering & Structural Performance - Engineering Focus	NUMERICAL AND EXPERIMENTAL INVESTIGATIONS ON LATERAL PERFORMANCE OF A 3-STORY CLT STRUCTURE	<p>The Japanese CLT Manual proposed a structural modeling approach for the lateral design of CLT panel construction. However, its accuracy has yet to be validated. This study aims to validate the proposed modeling method by numerical modeling based on the CLT Manual and comparing it with the results from a quasi-static cyclic test conducted on a 3-story narrow-panel platform-type CLT structure. This paper focuses on comparing the hysteresis of story drift and the local deformation behavior of rocking walls obtained from the numerical model and experimental tests. The story drift of the numerical model is significantly larger than the experimental value, and the rotation of rocking walls exceeded the target 1/200 radian under the predicted lateral load level during testing. The numerical model is considered to be conservative. Modifications to the material strength and connection stiffness parameters are recommended to improve the predictive accuracy of the numerical modeling method in the CLT Manual.</p>	Minchih	Hou	Kyoto University
8I	TESP - Practitioner / Engineering	Timber Engineering & Structural Performance - Engineering Focus, Timber Engineering & Structural Performance - Practitioner Focus	Experimental study on the dynamic progressive collapse response of post-and-beam mass timber buildings	<p>This paper presents an experimental study on a 3D post-and-beam scaled mass timber substructure subjected to a sudden interior column removal. The experimental design and setup are introduced and the preliminary results of the tested substructure, focusing on understanding its dynamic behavior, the load redistribution mechanisms under large displacements and the contributions of different elements in resisting progressive collapse are presented and discussed.</p>	Nikshan	Amatya	Griffith University