

Session No.	Session Topic	Abstract Topic	Submission Title	Summary	First Name	Last Name	Company
11A	TESP - Engineering Connections	Session Chair: PROFESSOR ALEXANDER SALENKOVICH / UNIVERSITE LAVAL					
11A	TESP - Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	LOOPED STRAP CONNECTIONS	The uplift forces on roofs can be quite severe, particularly in cyclonic regions. Roof-to-wall connections (RWCs) must be robust enough to safely resist expected loads from high wind events. Several RWC details in the Australian Standard for residential timber-framed construction AS1684 describe a steel strap wrapped over a rafter, looped under the top plate, and nailed into the back of the top plate. Supporting data could not be found for these details. We tested 21 different configurations of looped strap RWCs and found that the design load of 13kN in AS1684 is appropriate if quality steel strap is used.	Craig	Cowled	Queensland University of Technology
11A	TESP - Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	EXPERIMENTAL INVESTIGATION OF SLOTTED-IN PLATE MOMENT CONNECTIONS IN TIMBER FRAME BUILDINGS	The use of bolts in slotted-in plate moment connections is a common practice in timber construction. In the past decades, the number of research work explaining the load transfer mechanism of moment connections has increased. However, the design and application guidelines are still limited. In this paper, bolted slotted-in plate moment connections with multiple configurations are experimentally tested. The results are used to verify the EN 1995-1-1 equations and to investigate the service conditions. First, shear tests on single bolt are conducted followed by single moment connection and then by a double moment connection. The results showed that the connections are controlled by the fastener behaviour, therefore a sufficient prediction is necessary. The deviations with the rigid model approach has shown the need for an improved model.	Elif	Appavuravther	Hasselt University
11A	TESP - Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	INVESTIGATING NOVEL STEEL-TIMBER CONNECTIONS AND THE EFFECTS OF KNURLING THROUGH EXPERIMENTAL DIRECT SHEAR TESTING	Throughout the U.S., engineers are coupling steel beams and girders with mass timber panel floors for building construction. However, even though these designs are being constructed, there are knowledge gaps as it pertains to (1) stiffness of the floors for vibration and (2) diaphragm design for seismic applications. Most of the previous research on steel-timber hybrid floors has investigated the flexural strength of the floors and there is limited data on the stiffness characteristics of these floors for serviceability limit states (e.g., vibration). This research will (1) quantify and investigate the in-plane force-slip behaviour of connectors for steel-timber hybrid diaphragms and (2) examine how CLT deck orientation can influence the potential for composite action for beams and girders. A comprehensive testing plan has been developed to quantify the behaviour of composite connectors for steel-timber hybrid floors at low amplitude loading. Three different connectors were tested: (1) 90-degree self-tapping screws to be installed from below the CLT, (2) powder actuated fasteners driven through the CLT and into the steel beam from above, and (3) MTC screws installed from above. The experimental investigation consists of individual beam tests subjected to three different loading scenarios. The three tests are, first, a hammer test that provided data for the vibrational characteristics of the steel-timber hybrid by exciting a range of mode shapes. Second, a low amplitude cyclic flexural test loaded the specimen to 40% of the theoretical maximum flexural capacity of the beam providing composite action characteristics as service level loading. Lastly, a direct shear test was performed, loading the specimen to failure, and providing valuable post peak data for seismic design. The results from the tests described will provide valuable data for numerical simulations and inform design methodologies for steel-timber hybrid floors under varying loading conditions.	Detlef	Laughery	Oregon State University
11A	TESP - Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	PERFORMANCE OF TWO-STOREY PLATFORM-TYPE CLT SHEAR WALLS	This paper presents an experimental parameter study on the lateral performance of two-storey platform-type cross-laminated timber (CLT) shear wall structures using self-tapping screw connections. The test program included five reversed cyclic tests to investigate the effects of three key factors: additional floor mass, different angle bracket connections between floors, and different tension strap connections between floors. The findings demonstrated a notable influence of TS on the flexibility of the second floor and its role in promoting consistent drift behavior throughout the building's height. Sliding and panel distortion exhibited minimal influence on overall lateral deflection. Additionally, an enhancement in lateral resistance was evident upon the introduction of gravity loads.	Mohammad	Masroor	University of Northern British Columbia
11A	TESP - Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	Block Tear-Out Resistance of High-Performance Hybrid Grout-Steel-CLT Connections for Balloon-type Shear Walls: Experimental Study	This study aims to evaluate the performance of a novel hybrid grout-steel connection for balloon-type cross-laminated timber (CLT) shear walls. Three different connection configurations with various grout diameters were fabricated and tested. The connections were subjected to pull-out shear loading in the direction parallel to the face laminations of the CLT panel. The objective of the testing campaign was to determine the effect of end-distance and grout diameter on the connection's performance, namely the initial stiffness, the yield and maximum load-carrying capacity, the failure mode, and post-peak behavior. This information will be used further to set minimum end-distance requirements to avoid brittle failure of the joints under static loading. The research outcomes are expected to provide a reliable dataset for the development of design equations for designing resilient, high-performance connections for mass timber buildings.	Cristiano	Loss	The University of British Columbia
11A	TESP - Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	EVALUATION OF WOOD-TO-WOOD CONNECTIONS OF THE SPECIES Camptosperma panamense Standl. USING BOLTS AND NAILS SUBJECTED TO LATERAL LOADING	The present work presents the behavior of wood-to-wood connections with bolted and nailed connections subjected to lateral load using air-dried wood from Camptosperma panamense Standl., a native Colombian species of low density, for the adaptation of the connection design methodology in the new Colombian Seismic Resistant Standard. Ten (10) experimental tests were carried out per connector, observing that bolted connections presented a higher safety factor with respect to nailed connections, where for bolted connections, where for bolted connections, a single value below the minimum safety factor was obtained, while for nailed joints three (3) cases were presented. In addition, they found significant differences between the densities worked, indicating that the density of the wood used in the calculations has a considerable impact on safety factors.	Diana	Ibáñez	Universidad Distrital Francisco José de Caldas
11A	TESP - Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	NUMERICAL SIMULATION OF THE EFFECTIVE NUMBER OF FASTENERS IN DOWEL-TYPE TIMBER CONNECTIONS	Standard design codes implicitly address brittle failure modes in single-row multiple-dowel connections by considering an effective number of fasteners. This parameter accounts for the group effect, which considers the load distribution and interaction among the dowels. Consequently, the load-carrying capacity of a single-row in multiple-dowel connections is lower than the sum of the capacities of individual dowels. Empirical expressions for the effective number of fasteners have been proposed in the literature and are currently used in the design. This study investigates the parameters influencing the effective number of fasteners of timber-to-timber and steel-to-timber connections with stocky dowels, meaning they do not undergo plastic deformations, through a numerical approach grounded in linear fracture mechanics. The numerical model aligns well with previous experimental results and provides a novel approach for predicting crack initiation and assessing the group effect based on a realistic load distribution among the dowels, while taking advantage of high computational efficiency.	Jorge	Branco	University of Minho, Department of Civil Engineering
11B	TESP - Engineering Robustness & Natural Disaster Resilient Structures	Session Chair: PROFESSOR HIROSHI ISODA / KYOTO UNIVERSITY					

Session No.	Session Topic	Abstract Topic	Submission Title	Summary	First Name	Last Name	Company
11B	TESP - Engineering Robustness & Natural Disaster Resilient Structures	Timber Engineering & Structural Performance - Engineering Focus	RELIABILITY ANALYSIS OF WIND EXCITED TALL MASS-TIMBER BUILDINGS WITH ROCKING POST TENSIONED CROSS LAMINATED TIMBER SHEAR WALLS	The current code-based wind design of main wind force resisting systems (MWFRSs) only considers buildings' linear-elastic capacity, resulting in costly designs requiring commercially unavailable timber cross sections. In contrast, performance-based wind design (PBWD) enables optimal design solutions by allowing nonlinear-inelastic deformation in components of MWFRSs and reliability analysis. In this paper, a stochastic simulation-based PBWD framework is proposed to design and estimate the wind reliability of tall mass-timber buildings with rocking post-tensioned cross-laminated timber (PT-CLT) shear walls. The framework integrates stochastically generated wind tunnel-based load time histories, nonlinear response history analysis (NLRHA) using three-dimensional numerical models, and a stratified sampling scheme to propagate uncertainties. Experimental tests of ductile links in PT-CLT walls were conducted using newly developed wind-loading protocols to determine modelling parameters for NLRHA. The framework was implemented to design and perform a reliability analysis of a 16-storey prototype wind-excited mass-timber building hypothetically located in Toronto, Canada. The results indicate that the proposed PBWD framework is practical and effective for designing and analyzing wind reliability of tall mass-timber buildings with PT-CLT shear walls as MWFRS.	Nahom	Berile	McGill University
11B	TESP - Engineering Robustness & Natural Disaster Resilient Structures	Timber Engineering & Structural Performance - Engineering Focus	BUCKLING PERFORMANCE OF NAIL LAMINATED TIMBER FOR BEARING SHEAR WALL, BUCKLING TESTS AGAINST VERTICAL LOAD FOR LOAD-BEARING WALLS	The goal of this study is to construct a formula that will serve as a design standard for NLT load-bearing walls. As a first step in this research, we assumed a case in which NLT was used as a load-bearing wall, and verified the buckling load due to vertical loads, structural performance, and behavior. Tests were conducted using parameters such as the number of butt joints, differences in nail pitch, and the presence or absence of plasterboard.	Runa	Kato	Nippon Institute of Technology
11B	TESP - Engineering Robustness & Natural Disaster Resilient Structures	Timber Engineering & Structural Performance - Engineering Focus	STUDY ON ESTIMATION OF SHEAR STRENGTH OF PLYWOOD SHEATHED SHEAR WALLS WITH SMALL OPENINGS	In recent years, the expansion within medium and large scale wooden buildings has received much attention. However, the change from residential scale to medium and large scale brings challenges in various aspects, such as changes in building design methods and preparation of codes. Small openings are made in interior walls to install ducts, outlet boxes, switch boxes, etc. In the past, for small residential buildings, it was not a problem to consider shear walls with small openings as non-shear walls. This was because the entire building had a surplus of earthquake resistance. However, as buildings have become larger, the required earthquake resistance has increased. There is no longer a margin for the earthquake resistance of the entire building, and it is necessary to verify the loss of performance due to small openings. In addition, the current standards for small openings have no experimental or theoretical basis, and their applicability to high-strength shear walls is also unclear. It is urgent to establish a new method to accurately calculate the performance of shear walls with small openings in order to promote medium and large wooden buildings and create a sustainable society. Therefore, the purpose of this study is to verify the effect of small openings on the shear capacity of plywood sheathed shear walls and to propose a method for calculating the capacity of plywood sheathed shear walls with small openings. No reduction in shear capacity due to small openings was observed for walls with low maximum strength on the residential scale or for small openings that did not require reinforcement. On the other hand, shear walls with high maximum strength, such as those used in medium- to large-sized wood-frame buildings, showed reduced shear capacity due to small openings that required reinforcement. Shear failure of the plywood was the primary cause of the reduction in maximum strength. It was confirmed that the remaining width of the plywood bore the shear strength.	Yuta	Sakai	National Institute for Land and Infrastructure Management
11B	TESP - Engineering Robustness & Natural Disaster Resilient Structures	Timber Engineering & Structural Performance - Engineering Focus	Full-scale experimental testing of a low-damage, resilient, two-storey Cross Laminated Timber (CLT) wall structure	A full-scale, two-storey Cross-Laminated Timber (CLT) structure is being constructed at the University of Auckland, designed with a focus on low-damage and resiliency. The structure's design incorporates innovative low-damage wall-to-floor shear keys, among other innovative connections. The performance of the structure will be tested in-plane, out-of-plane, and bi-directionally to obtain a realistic assessment of the system. This approach will allow for the observation and examination of the intended design of connections, shear keys, and the overall structure. The goal is to demonstrate that the structure can endure significant drifts while maintaining complete displacement and force compatibility, without any damage to the CLT members and without yielding any of the connections and fasteners.	Pierre	Quenneville	The University of Auckland
11B	TESP - Engineering Robustness & Natural Disaster Resilient Structures	Timber Engineering & Structural Performance - Engineering Focus	A STUDY ON DISPLACEMENT ESTIMATION OF LATH-MORTAR UNDER EARTHQUAKE	The lath-mortar as an external facing member is to be constructed onto several overlapping members, such as plywood, furring strips, and wooden laths, where these members are attached to a timber frame by nails. Therefore, there was an issue that made it complicated to evaluate the differential displacement between a lath-mortar and a timber frame under earthquakes. Therefore, the goal of this study was set to establish a structural model of the external wall with lath-mortar for enabling FEM analysis. Firstly, static shear loading tests of lath-mortar external wall specimens were conducted to understand the behavior of a lath-mortar under earthquakes, where it was found that plywood between a timber framework and a lath-mortar increases the maximum shear force remarkably. Next, the analysis of a joint, which consists of several overlapping members attached by some nails, was carried out, and the shear force-displacement relationship of the combined nail joint was clarified. Finally, the shear force-drift angle relationships of the lath-mortar external wall specimens could be estimated successfully by FEM analysis using the shear force-displacement relationships of the combined nail joint.	Masato	Nakao	Yokohama National University
11B	TESP - Engineering Robustness & Natural Disaster Resilient Structures	Timber Engineering & Structural Performance - Engineering Focus	SEISMIC COLLAPSE ASSESSMENT OF TIMBER BRACED FRAMES WITH FRICTION JOINTS USING FEMA P695 METHODOLOGY	Little research has been conducted on the behaviour of timber seismic load resisting systems using friction joints (FJs), particularly those involving timber braced frames (TBFs). This paper proposes seismic design parameters for timber braced frames with friction joints (TBFFJs) and evaluates their performance using the FEMA P695 methodology. A hysteresis model is developed and implemented in OpenSees and validated against existing experimental results. A total of three multi-storey (3-, 6-, and 12-storey) structures with TBFFJs were analyzed using the proposed model to validate the design methodology. Static pushover and incremental dynamic analyses using 44 ground motions were conducted and adjusted collapse margin ratio were compared with allowable limits provided in FEMA P695. Response modification factors are determined and proposed based on the results of these analyses.	Christian	Viau	Carleton University
11B	TESP - Engineering Robustness & Natural Disaster Resilient Structures	Timber Engineering & Structural Performance - Engineering Focus	INNOVATIVE ADHESIVE BONDING IN TIMBER-CONCRETECOMPOSITE SYSTEMS: TOWARDS A COMPETITIVE CEILING SYSTEM	The construction industry is facing increased pressure to adopt resource-efficient practices due to escalating global sustainability challenges. This has led to a search for innovative and eco-friendly building materials, designs, and processes to address these concerns. One promising approach is the development of timber-concrete-composite (TCC) ceiling systems. TCC systems offer significant potential by combining the advantages of timber and concrete, providing enhanced structural performance while addressing ecological and economic aspects. This method has the potential to overcome various challenges associated with traditional TCC systems, such as reliability, durability and affordability. Despite the recognized potential of the continuous bonding of concrete and timber, a significant knowledge gap remains due to the lack of comprehensive data on the adhesive joint's structural performance. For a full understanding of how these hybrid components performs under load, a systematic investigation is essential to generate reliable data for future design approaches. The presented study includes a series of experimental investigations on full-scale ceiling elements, with different lengths, bonding techniques, as well as cross sections. Each specimen was subjected to a full scale four-point bending test to evaluate its load-bearing behavior until failure. The experimental results demonstrate a high bending stiffness of the investigated systems, directly affecting the serviceability. The results underline the significant potential of adhesive bonded TCC ceiling systems, declaring them as a competitive option based on the high structural performance. It shows that further research is required, particularly regarding the long-term behavior and its limitations in design.	Florian	Brosch	BOKU University

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11C	TESP - Engineering - Material Properties	Session Chair: PROFESSOR ARIJIT SINHA / OREGON STATE UNIVERSITY					
11C	TESP - Engineering - Material Properties	Timber Engineering & Structural Performance - Engineering Focus, Education, Innovation & Challenges - Engineering Focus	Investigations on STCC-Shallow floor beams: comparison between strain-based derived bending resistances and results of numerical models	To limit the emission of greenhouse gases, the 'Green Deal' and the Taxonomy Regulation were introduced in the European Union. This inevitably leads to a change in the construction industry, with the aim of reducing carbon dioxide emissions to (net) zero by 2050. The consideration of constructional timber can also be purposeful. For steel construction, this means expanding the composite construction method from steel-concrete to steel-timber and possibly also steel-timber-concrete composite (STCC) solutions. While for steel-concrete composite (SCC) shallow floor beam design rules are being proposed [3], so far for steel-timber composite (STC) there exists no design rules. In this contribution, STCC shallow floor beams are investigated, targeting a reduction of the floor height and so either a reduction of the building height or the construction of more floors for a same building height. In the investigated solutions, timber is replacing the steel sheet and most of the concrete met in traditional steel-concrete beams. This change in material results in a different load bearing behavior and different mechanical characteristics which need to be accounted for when evaluating the overall bending capacity. The paper shows the results of investigations on steel-timber-concrete shallow floor beams using a strain limit approach for the prediction of the bending capacity and	Adil	Ahmad	University of Luxembourg
11C	TESP - Engineering - Material Properties	Timber Engineering & Structural Performance - Engineering Focus	INFLUENCE OF MATERIAL PROPERTIES OF COMPONENTS ON ROOF CURVE IN TEMPLE ARCHITECTURE	The roof curve of Japanese traditional architecture called "Nokizori" influences the proportions of the architecture and is one of the most important aspects. The traditional Japanese wooden roof construction method developed from ancient times to the early modern period and reached its perfection. The roof is divided into two layers, and the eaves are supported by an element called "Hanegi", which is placed between the two roofs. As the eaves deflect under the weight of the roof, changes in the material properties of the components are thought to cause changes in Nokizori. We investigated Nokizori at the renovation site and performed static deadweight analysis to understand the effect of the Young's modulus of the components on Nokizori. The results of the analysis indicated that the component that could affect Nokizori was Hanegi.	Natsuki	Horie	Toyo University
11C	TESP - Engineering - Material Properties	Timber Engineering & Structural Performance - Engineering Focus	COMPARATIVE STUDY OF CREEP MODELS FOR WOOD AND TIMBER EXTRAPLOATED OVER 100 YEARS IN CONSTANT CLIMATE	This work examines the accuracy of some creep models to determine which one is better able to capture the rheological deformation of spruce over medium and long time periods. A series of analytical works were done to determine a model that not only fits the best with the available experimental data but also has a lower number of elements and parameters among the examined creep models.	Mohsen	Naghdinab	Materials Testing Institute (MPA), University of Stuttgart
11C	TESP - Engineering - Material Properties	Timber Engineering & Structural Performance - Engineering Focus	Experimental Analysis of the Influence of the Fastener Material and Loaded End and Edge Distances on the Embedment Strength Parallel to the Grain in Glued Laminated Timber	Embedment strength is an important parameter that governs the ductile load-carrying capacity of timber joints with dowel-type fasteners. This property is dependent upon several factors, such as the fastener material and the size of the test specimens. Therefore, this paper tested the embedment strength parallel to the grain using smooth steel dowels and densified wood dowels with a diameter (d) of 12mm, in glued laminated timber with different loaded end distances (4d, 7d, 8d, 9d) and edge distances (2d, 3d, 4d). It was found that the embedment strengths of the specimens using smooth dowels with edge distance of 2d were significantly lower than those of the specimens with edge distance of 3d, and the embedment strengths of the specimens using smooth steel dowels and densified wood dowels did not show statistically significant difference, when the edge distance of specimens is not less than 3d.	Hongfang	Guo	Dalian University of Technology
11C	TESP - Engineering - Material Properties	Timber Engineering & Structural Performance - Engineering Focus	Study On Flexural Behavior Of Cold Formed Steel-Oriented Strand Board Composite Joists	An environmentally friendly composite joist was proposed, which is comprised of top and bottom flanges made of cold-formed thin-walled hat-section steel connected with a web made of oriented strand board (OSB) by fasteners. The push-out tests were firstly carried out to compare the load-carrying capacity and stiffness of the cold-formed steel-OSB joints with different fasteners, i.e., cross slot countersunk head self-drilling self-tapping screws, hexagon flange head self-drilling self-tapping screws and hexagon bolts. It was found that the joints with the cross slot countersunk head self-drilling self-tapping screws have the best mechanical performances. Then, the composite joists were tested under the four-point bending, and their flexural performance was compared with that of I-joists. The load-carrying capacity of composite joists with a screw spacing of 50 mm was 90% of that of I-joists, and their flexural stiffness was higher than that of I-joists.	Shi-Yuan	Jiao	Dalian University of Technology
11C	TESP - Engineering - Material Properties	Timber Engineering & Structural Performance - Engineering Focus	Statistical Length Effect on the Compression Strength of Australian Radiata Pine Solid Sawn Timber	This study investigates the length effect on the compression strength of Australian Radiata Pine solid sawn timber. Using Monte Carlo simulation, 8,816 samples with dimensions of 35 x 90 mm and grades of MGP10, MGP12, and MGP15 were analysed. Results showed a significant length effect on compression strength, affecting both the 50th and 5th percentiles, with a slight grade dependence. Additionally, a two-parameter lognormal distribution for different grades and lengths was proposed for application in stochastic structural design approaches.	Abbas	Abbara	University of South Australia (UniSA)
11C	TESP - Engineering - Material Properties	Timber Engineering & Structural Performance - Engineering Focus	EVALUATION OF EQUIVALENT SHEAR STIFFNESS AT EACH RENOVATION STAGE IN THE TRADITIONAL WOODEN BUILDING	In this study, we investigated the vibration characteristics of traditional wooden buildings in the renovation stage. We conducted constant microtremor measurements of the building three times: (1) before the roof frame was constructed, (2) after the roof frame was constructed, and (3) after the roof was tiled, and compared the natural frequencies and natural vibration modes. Furthermore, by calculating the equivalent shear stiffness of the target building and comparing the results of each measurement, we confirmed the influence of the building's equivalent stiffness on the vertical load of the roof weight. In addition, the results of a parametric study in which the equivalent stiffness of the vertical structural surface was replaced with the rotational stiffness of the joint, showed that when changing from (2) after the roof frame was constructed to (3) after the roof was tiled, the equivalent stiffness of the vertical structural surface is 2.08 times.	Hina	Takizawa	Toyo University
11C	TESP - Engineering - Material Properties	Timber Engineering & Structural Performance - Engineering Focus	Process combination peeling and sawing of large-diameter timber: thick peeled products for yield-optimized structural laminated timber products	Coniferous roundwood of common qualities is usually industrially processed in chipping-sawing lines which are widely limited to log diameters of < 45 cm. The raising stock of large-diameter softwood in the DACH region, especially of Norway spruce, necessitates to rethink the processing to sawn wood and thereof produced products. This paper discusses a process combination of rotary-peeling and sawing for large-diameter roundwood of Norway spruce. Thereby, the aims are a higher yield, extended thickness range of thick peeled products (TPPs; thickness > 6 mm) by also providing a first physical / mechanical characterization of them and thereof produced laminated peeled products (LPPs) demonstrating, exemplarily, also their high-potential for the production of linear and planar structural laminated timber products (SLTPs).	Markus	Tripolt	Institute of Timber Engineering and Wood Technology, Graz University of Technology
11D	TESP - Engineering - Concentrated loadings & reinforcing methods	Session Chair: PHILIPP DIETSCH / KARLSRUHE INSTITUTE OF TECHNOLOGY					

Session No.	Session Topic	Abstract Topic	Submission Title	Summary	First Name	Last Name	Company
11D	TESP - Engineering - Concentrated loadings & reinforcing methods	Timber Engineering & Structural Performance - Engineering Focus	Quantification of Positional Imperfections of Self-drilling Screws and Examination of the Technical Causes	Unwanted contact and collision between adjacent screws are technical problems with respective safety relevance. They are being caused by positional imperfections which arise both systematically and randomly during insertion. To investigate the underlying mechanisms of such imperfections, approximately 1000 screw-in tests were carried out in GLT, CLT, and LVL. For varying parameters, the deviation between the planned and actual exit points of the screws were determined. The results show that the angle $\alpha$ between the screw axis and the grain direction of the wood, the screw slenderness and tip design influence the magnitude of positional imperfections significantly.	Eva	Baldauf	Timber Structures and Building Construction, KIT
11D	TESP - Engineering - Concentrated loadings & reinforcing methods	Timber Engineering & Structural Performance - Engineering Focus	A NEW NODE-FOCUSED EXPERIMENTAL APPROACH TO INVESTIGATE LOAD-BEARING BEHAVIOR IN TIMBER TRUSSES	To investigate the complex load-bearing behavior of trusses, particularly at the nodes, tests of complete trusses or partial sections of trusses would be necessary. However, these tests can require significant effort. Therefore, a new test method was developed to examine individual nodes, focusing on the most stressed ones. A test setup was designed to generate the internal force and moment ratios found in real trusses. It allows for variations in the connection angles of the individual members with manageable effort. Additionally, it enables adjustments in the ratio of internal forces and moments of the components in order to investigate the effects of moment loadings in trusses that deviate from ideal frameworks. Consequently, the numerous varying parameters enable a comprehensive analysis of the load-bearing behavior of a truss joint, while significantly reducing the effort compared to commonly used methods.	Lisa	Stimpfle	Materials Testing Institute, University of Stuttgart
11D	TESP - Engineering - Concentrated loadings & reinforcing methods	Timber Engineering & Structural Performance - Engineering Focus	EXPERIMENTAL STUDY ON PULL—OUT STRENGTH OF TIMBER JOINTS INCORPORATING HIGH-DAMPING RUBBER “EFFECTS OF EMBEDMENT LENGTH AND THICKNESS OF HIGH-DAMPING RUBBER”	This study examined wooden structural joints incorporating high damping rubber, with the objective of achieving wooden structural joints possessing high strength, rigidity, toughness and damping performance for use in medium/high-rise and medium/large-scale wooden structural buildings. The joints improve toughness by shear failure of the high-damping rubber layer prior to shear failure of the adhesive layer and timber. The study conducted pull-out test on wooden structural joints of varied the diameter of steel rod, embedded depth, thickness of high damping rubber, and adhesion area of high-damping rubber. And elucidated the load-displacement relationship and destruction characteristics. The study also elucidated the effects of the parameters on pull-out strength and rigidity, for the purpose of proposing a mechanical model that takes the effects of the parameters into consideration. The experimental results will contribute to the development of the mechanical model.	Komei	Morimune	Meiji Univ
11D	TESP - Engineering - Concentrated loadings & reinforcing methods	Timber Engineering & Structural Performance - Engineering Focus	Influence on the load-bearing behavior of screws using toothed metal inserts in shear planes	In addition to economic efficiency, the performance of fasteners in timber structures is primarily determined by load-carrying capacity, stiffness, ductility, and the required minimum end and edge distances. Engineering-type fasteners can be distinguished between dowel-type fasteners, area-measured connections, and bonding systems. Actual timber constructions mainly use dowel-type fasteners, particularly self-tapping, fully- or partially-threaded screws. Screws offer many advantages, including their flexibility and versatility, as well as their reasonable load-carrying capacities. However, they have some disadvantages, including their relatively low stiffness, especially in shear load applications, and the fact that they require quite large end and edge distances in timber elements. In contrast to dowel-type fasteners, toothed plate connectors and nail plates demonstrate considerably higher load-carrying capacities and stiffnesses. However, the installation of these shear connectors frequently necessitates the use of hydraulic devices to press the tooth into the timber elements. The following work demonstrates a potential method for optimising the geometry and tooth shape of common nail plates in a way that enables the generation of required press-in forces by self-tapping, partially-threaded screws with washer heads. The use of this technology, consisting of simple steel strips with toothed surfaces, to reinforce conventional screw connections in shear planes offers a wide range of potential applications with enhanced efficiency resulting primarily from a significant increase in stiffness.	Roland	Maderebner	University of Innsbruck
11D	TESP - Engineering - Concentrated loadings & reinforcing methods	Timber Engineering & Structural Performance - Engineering Focus	REINFORCEMENT FOR COMPRESSION PERPENDICULAR TO THE GRAIN BY MEANS OF ADHESIVELY BONDED BIRCH TIMBER PRODUCTS	The strength of timber when loaded perpendicular to the grain is significantly lower than when being loaded parallel to the grain. For softwoods, the compression strength perpendicular to the grain is approximately one-tenth of the strength parallel to the grain. Typical methods to increase the bearing strength of a timber beam at the supports include enlarging the support length and/or inserting reinforcing screws at the beam's support. In this study, two new methods of reinforcement for stress perpendicular to the grain are investigated through laboratory tests and analytical methods. The proposed methods utilize birch timber products which are adhesively bonded to the beam at the supports, i.e., where high bearing stresses occur. The adopted birch products are two, namely: plywood with varying thicknesses and rods with a diameter of 19 mm. The laboratory test results show that the bearing capacity of softwood beams can be significantly increased if reinforced either by means of birch plywood plates or bonded-in birch rods. The results pave the way for a new eco-friendly reinforcement technique. A simple analytical model to predict the load-bearing capacity for stress perpendicular to the grain of beams reinforced with the proposed technique is also proposed.	Tianxiang	Wang	KTH Royal Institute of Technology
11D	TESP - Engineering - Concentrated loadings & reinforcing methods	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	Large-scale experiment of a new hollow-core timber slab system	The state of development of a new hollow-core slab system is presented. This concept enables large spans as well as the placement of columns at arbitrary positions, thanks to an integrated reinforcement concept. The system considers CLT plates as flanges and a discrete set of GLT elements in the inside, serving as web elements. The reinforcement for the point supports is based on a large LVL block placed between both CLT plates. The paper presents the results of a full-sized experiment set to study the performance of the connection in the region of the point support. The experimental results are compared to a finite element model, which is then used to better understand the failure behavior of the slab.	Cristóbal	Tapia	Materials Testing Institute, University of Stuttgart
11D	TESP - Engineering - Concentrated loadings & reinforcing methods	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	MEASUREMENT OF RESIDUAL STRESSES USING THE DRILL HOLE METHOD AND STRAIN GAUGES ON TIMBER MATERIALS	Internal stresses are of great importance in the design of modern machine parts. This applies to metal components in mechanical engineering as well as wood products. The state of the art is to measure internal stresses in metallic alloys using the hole-drilling method. In addition to metallic alloys wood products are also highly stressed components. Therefore, the aim is to determine the stresses in wood samples using the hole-drilling method.  Two types of wood materials are tested for their internal stresses, the first being natural laminated wood with 5 layers per millimetre. The second material is press laminated wood with a layer thickness of 3 mm. The laminated wood has a very thin structure and is therefore considered to be quasi-isotropic in an exceptional way. The study found significant stresses in tested wood materials. A proposal for the measurement of anisotropic materials is made.	Christian	Heikel	Ostfalia University of Applied Science
11E	ECCS/STCE - Architectural/ Engineering	Session Chair: DR EUGENIA GASPARRI / THE UNIVERSITY OF SYDNEY					

Session No.	Session Topic	Abstract Topic	Submission Title	Summary	First Name	Last Name	Company
11E	ECCS/STCE - Architectural/ Engineering	Timber Engineering & Structural Performance - Engineering Focus, Timber Engineering & Structural Performance - Architectural Focus, Exemplars & Construction Case Studies - Architectural Focus	Experimental and analytical study of connections for light and pure timber constructions with bent wood	This research focuses on developing connections for an innovative pavilion demonstrator using bent wood. The techniques of bending and compressing wood are employed here. The starting point for the demonstrator design was a spherical polyhedron with 132 pentagonal faces (132-Pentagon Polyhedron), which offers a highly symmetrical geometry from only three different shapes. The core of this work is to demonstrate the load-bearing capacity of the entire structure and especially the connections. For this purpose, models were created using the finite element method program. These models were used to determine the internal forces and stress distributions, which were then utilized for the design. Based on these results, the connections used in the structure were designed. Two types of mechanical connections are being tested: one purely wood-based (utilizing compressed wood) and the other incorporating steel bolts. The experimental phase involves bending, shear and push-out tests on the samples to evaluate their performance. This study aims to enhance the sustainability and structural efficiency of timber constructions by reducing reliance on adhesives. Key findings and methodologies are detailed in this paper, providing insights into the mechanical properties and feasibility of these connections	Siavash	Mahjourian Namari	TU Dresden
11E	ECCS/STCE - Architectural/ Engineering	Sustainability and Timber in a Circular Economy - Architectural Focus, Exemplars & Construction Case Studies - Architectural Focus	Timber-Based Prefabricated Systems in Deep Renovation: A Circular Economy Perspective on Case Studies and Insights for the Australian Context	The building and construction industry, as a major contributor to global energy consumption and carbon emissions, plays a critical role in achieving the United Nations' carbon neutrality target by 2050. With a significant portion of the current building stock expected to remain in use within this timeframe, extensive renovation efforts are essential to enhance energy performance and sustainability. Prefabricated elements are considered a pivotal technology for renovations, characterized by reduced construction time, minimized waste, and improved quality control. Timber-based prefabricated systems are particularly advantageous due to their low embodied carbon, ease of processability, and adaptability. While the traditional linear approach of 'take-make-use-dispose' can lead to negative environmental impacts, integrating circular economy principles—featuring waste reduction, material efficiency, and product recycling—provides a more sustainable solution, yet these principles often not widely recognized or systematically implemented. This report analyzes case studies of deep renovation projects utilizing timber-based prefabricated systems through a circular economy lens, highlighting their potential to significantly enhance sustainability in building renovations. Insights are specifically tailored to the Australian context, providing valuable guidance for practitioners and stakeholders. By emphasizing the integration of circular economy principles, this review underscores the importance of innovative renovation practices in achieving long-term environmental goals.	yingnan	chen	The University of Sydney
11E	ECCS/STCE - Architectural/ Engineering	Sustainability and Timber in a Circular Economy - Architectural Focus	Comparative Study of Unitised Curtain Wall and Unitised Timber Envelope Systems: Pathways to Reducing Embodied Carbon and Enhancing Circularity in Facade Design	About 40% of global greenhouse gas emissions stem from building activities, and nearly one-third of material consumption is linked to construction and demolition processes. Shifting from linear (take-make-dispose) economic models to a circular model is key to reducing the environmental impact of buildings and minimizing waste. Facades play an important role in reducing building carbon footprints. Timber facades could offer significant benefits thanks to timber's circular potential as a natural and renewable material lightweight and easy to manufacture, assemble and disassemble. To date, there is a lack of circular facade design. This paper addresses this knowledge gap, investigating the role of timber-based facades in reducing resource consumption, carbon emissions and waste in construction. Using quantitative methods, the study validates facade design strategies to reduce global warming potential (GWP) and waste. The findings will contribute to informing the facade industry on the key benefits of timber facades and the implementation of design strategies towards more sustainable and circular buildings.	Hamad	Alabdulrazzaq	The University of Sydney
11E	ECCS/STCE - Architectural/ Engineering	Sustainability and Timber in a Circular Economy - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	Performance of particleboard incorporating recycled rubber from waste tyres	Recycling end-of-life tyres (EOLT) is a critical global challenge, aggravated by the increasing demand for tyres and their short lifespan. This study explored the effect of incorporating recycled rubber particles from EOLT into particleboard on the properties of the resulting panels. Particleboard panels were manufactured and tested for performance according to the Australian Standard AS/NZS 4266.1 (2017), and the results were benchmarked against Australian Standards (AS 1859.1 2017). These tests included bending strength and stiffness, density, thickness swelling, internal bond, and other key performance properties. The findings demonstrated that particleboards incorporating recycled rubber reduced the bending stiffness but still can meet/exceed the requirements for standard (STD) and moisture-resistant (MR) particleboard. Internal bond strength and moisture resistance for all particleboards tested surpassed the requirement for STD and MR particleboard. Increasing the rubber content improved moisture resistance, and it was observed that particleboards with rubber could meet moisture resistance and high-performance standards without the need for added wax.	Chandan	Kumar	Department of Agriculture and Fisheries
11E	ECCS/STCE - Architectural/ Engineering	Sustainability and Timber in a Circular Economy - Engineering Focus	Multi-parametric evaluation of innovative CLT connections developed for DfMA and DfD	The environmental impact of the construction industry largely contributes to the total human footprint. Several studies have shown that the use of timber products as construction material can lead to a substantial reduction of the environmental impact, but this alone is not enough. A change in the construction industry toward a Circular Economy (CE) is necessary, maximizing reuse and recycling. To achieve this, the disassembly phase must be considered at an early stage in the design of a structure. Recently the standard ISO 20887, presenting the principles regarding the Design for Disassembly (DfD), has been published: the standard highlights the central role of connections to permit disassembly and presents many principles of DfD that are common to Design for Manufacture and Assembly (DfMA). This paper has two main goals. In the first part, a holistic approach is presented to identify the key parameters that make a connection suitable for DfAM and DfD. These parameters were obtained considering the principles provided in the ISO 20887 standard. A comparison is then presented between innovative and traditional connections taken as case studies, in order to evaluate their advantages and disadvantages.	Pietro	Rigo	University of Bologna
11E	ECCS/STCE - Architectural/ Engineering	Exemplars & Construction Case Studies - Engineering Focus	THE GRADING OF THE MODULUS OF ELASTICITY OF WOOD FOR THE MANUFACTURING OF GLULAM BEAMS TO MEET ARCHITECTURAL CONFIGURATIONS	The grading of timber allows for the selection and placement of each lamella in the cross-section of the structural element according to its strength class. Through the evaluation of the modulus of elasticity and visual grading, it is possible to manufacture pieces with the same cross-section but different mechanical resistance capacities, determined based on the structural design calculation. The objective of this work was to demonstrate how the method of timber grading by the modulus of elasticity enabled the architectural configuration of beams with the same cross-section to span different lengths, optimizing costs and the built environment. The preliminary grading method ensures the physical and mechanical characterization in the use of the material, as well as enables the maximum utilization of the material.	Carlito	Calil Neto	Rewood   @brarewood
11E	ECCS/STCE - Architectural/ Engineering	Exemplars & Construction Case Studies - Engineering Focus	CONTRIBUTING TO CANADA'S EFFORTS TO DECARBONIZE THE CONSTRUCTION SECTOR USING WOOD	In Canada, several recent initiatives by industry and governments to expand the use of wood in construction have led to an increase in the number of mass timber buildings across the country and enhanced manufacturing capability. To support this momentum, the Government of Canada launched the Green Construction through Wood (GCWood) program in 2017 to help expedite market acceptance and foster commercial uptake of wood-based products and systems. Given the uptake and success of the GCWood program, the Government of Canada renewed the GCWood program for three more years starting April 2023. The renewed GCWood program is structured and delivered through two main streams: demonstration projects and accelerating construction transformation. This paper provides an overview of the GCWood program activities, focusing on showcasing the design and construction of several demonstration projects and ongoing efforts and activities funded by the program to accelerate construction market transformation.	Ying	Hei Chui	University of Alberta

Session No.	Session Topic	Abstract Topic	Submission Title	Summary	First Name	Last Name	Company
11F	MPD - Engineering - Fire	Session Chair: HARALD KRENN / KLH Massivholz GmbH					
11F	MPD - Engineering - Fire	Material Performance & Durability - Engineering Focus	X-ray Computed Tomography Based Estimation of Charring Around Knots in Sawn Timber	The charring behavior in and around knot regions has not been studied as extensively as clearwood, leaving a knowledge gap regarding its characterization. This study aims to investigate the charring behavior in and around knots in Scots pine and Norway spruce using computed tomography (CT) scanning, which enables a noninvasive 3D evaluation of charred regions in the proximity of knots. In our study, the impact of extractives and fiber orientation on charring rates and depths was quantified. Samples containing knots were charred by surface contact to a heated steel cuboid. Semi-automatic image processing tools were developed to identify charred regions and quantify charring depths. This paper discusses the experimental setup, data processing techniques, and the implications of extractives content in the charring behavior of wood. The results show that there is a positive correlation between higher extractive content in knot wood and lower charring rates and reduced surface hardness in samples before and after burning.	Rostand	Moutou-Pitti	Universite Clermont Auvergne
11F	MPD - Engineering - Fire	Material Performance & Durability - Engineering Focus	THE INFLUENCE OF ELEVATED TEMPERATURE ON THE STRENGTH AND STIFFNESS OF TIMBER	Besides charring and the temperature distribution within a fire-exposed cross-section of a timber element, the temperature influence on the mechanical properties (strength and stiffness) is crucial for precise analytical and numerical fire design methods. Most research in the past focused on the behaviour of timber at elevated temperatures or while the temperature rises, but the research on the behaviour of the material properties when cooling down again is limited. Therefore, small-scale experiments on almost flawless timber were carried out. The results show two antidromic effects that occur simultaneously. Their strength depends on the material temperature and the kind of <i>timbered building</i> .	Christoph	Kurzer	TUM
11F	MPD - Engineering - Fire	Material Performance & Durability - Engineering Focus	Thermal analysis of glulam for the development of new reduction factors for strength and stiffness in fire	This paper presents the thermal results from several unloaded fire tests of glued laminated timber beams with various cross-sections. The temperature measurements from the tests are used for calibration of new effective thermal properties of timber needed to later numerically estimate the mechanical behavior of the one-side fire exposed beams loaded in bending. The basic one-dimensional charring rate of the tested beams is determined based on the temperature measurements from the tests, and also from 3D models of the cleaned burnt specimens. Using the calibrated effective thermal properties of timber, the temperature profiles of the cross-sections as well as the mechanical behavior of one-side fire exposed beams loaded in bending are successfully numerically simulated.	Alar	Just	TalTech
11F	MPD - Engineering - Fire	Material Performance & Durability - Engineering Focus	Experimental Determination of Timber Char Rates Under Simulated Fully Developed Fire Exposure Conditions	Char rates of timber exposed to the standard fire-resistance heating regime are well documented. However, char rate data for timber exposed to more severe heating regimes, that better represent fires in modern buildings, is limited. To generate data to address this knowledge gap, standardised test configurations, thermocouple arrays and test procedures were developed.  Radiata pine specimens were exposed to the standard heating regime, as a benchmark, and the more severe hydrocarbon heating regime (H1100) and a H1200 heating regime, the latter being similar to the hydrocarbon heating regime but with an increased steady state temperature of 1200°C, from which char rates and temperature profiles were obtained. The tests demonstrated that a single char rate could be derived for timber exposed to the standard heating regime. However, significantly higher char rates were observed for the more severe heating regimes and three char rates were required to adequately define the charring behaviour with the highest char rate occurring in the first 15 to 20 minutes, reducing to an intermediate level and final steady state rate through the remainder of the test. Sections of the test specimens were also protected with 1- and 2-layers of fire-grade plasterboard to obtain indicative char rate data applicable to these protected specimens.  The test program has developed a simplified test configuration, instrumentation and test procedures to facilitate the derivation of char rates for wood products under a range of fire exposures. The results confirmed the need to evaluate the performance of elements of construction under a range of test conditions rather than using a single heating regime. Indicative results on the impact of fire protective board coverings were also obtained but it should be noted that retention of board systems is not easily modelled at smaller scale and board failures (fall off times) still needs to be verified at full scale.	BORIS	ISKRA	Forest and Wood Products Australia
11F	MPD - Engineering - Fire	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	COMPARISON OF PERFORMANCES OF BOND LINES IN DIFFERENT SMALL-SCALE TESTS	The evolution of fire testing methodologies for engineered wood products is transitioning from traditional large-scale timber fire tests to more efficient and cost-effective small-scale testing techniques. So far, large-scale fire tests have been essential for evaluating the fire behavior of timber. However, these tests require a lot of resources and are time-consuming and complex. To address these challenges, alternative approaches like tension and shear tests at elevated temperatures or cone heater tests are being investigated. This study explored the aforementioned small-scale testing methods, using different adhesive families for comparison. The results of the small-scale test methods were compared with model scale fire tests and better correlations were seen when comparing the fire tests to cone heater tests and tests conducted at elevated temperatures near the temperature of charring (~270°C). Weaker or no correlations were found at lower elevated temperatures. Another objective of this study is to identify whether there is a correlation between the small-scale cone heater tests and the tests conducted at elevated temperatures themselves, in order to evaluate the potential of testing at elevated temperatures to serve as an alternative for cone heater fire testing.	Jane Lise	Vihmann	Tallinn University of Technology
11F	MPD - Engineering - Fire	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	THE INFLUENCE OF ADHESIVES, WOOD SPECIES AND MANUFACTURING TECHNIQUES ON THE FIRE PERFORMANCE OF ENGINEERED WOOD	The fire performance of engineered wood products is crucial to ensure safety and reliability in timber buildings. Key factors such as adhesives, wood species, manufacturing technologies, etc. can impact the fire performance significantly. Adhesives with high thermal strength are essential for maintaining structural integrity under fire conditions. The choice of wood species affects density and combustion properties, both important when it comes to the ignition and charring of wood. Different manufacturing techniques can contribute to the thermal performance and structural resilience in fire. To ensure accurate predictions of fire resistance, it is crucial to standardize fire testing protocols, considering and controlling as many factors as possible (like moisture content, heat flux, environmental conditions alongside with previously mentioned factors). This research dives deeper into the influence of adhesives, wood species, and manufacturing technologies on the fire performance of engineered wood products. By understanding and controlling these parameters, we can enhance the fire safety of engineered wood products. The three aforementioned parameters are examined, emphasizing the need for controlled fire testing to compare results and predict the behavior of engineered wood elements in physical buildings.	Jane Lise	Vihmann	Tallinn University of Technology

Session No.	Session Topic	Abstract Topic	Submission Title	Summary	First Name	Last Name	Company
11F	MPD - Engineering - Fire	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	Experimental study on the bending resistance of cross-laminated timber exposed to ISO 834-1 standard fire	In a fire, the load-bearing capacity of a timber structure is influenced not only by charring but also by the elevated temperatures behind the char layer. The Eurocode accounts for this increased temperature in solid timber by subtracting a compensating zero strength layer (ZSL) from the cross-section in addition to the char depth. However, this approach does not directly apply to cross-laminated timber (CLT) structures, which have transverse layers that do not carry load in the direction of the span and feature glue lines. If the glue fails to keep the lamellae in place during a fire, the charring performance and temperature distribution differ from solid timber. This paper assesses the load-bearing capacity of a CLT panels exposed to a standard fire conditions, including falling off the charred layers. The assessment is based on fire tests conducted on two different CLT structures and the measured temperatures within the CLT panels. The structural capacity is compared to the value calculated using the ZSL method. The findings indicate that the glue failure significantly increases the charring rate, impacting the equivalent ZSL differently when glue lines do not hold the layers. The fire test revealed that glue lines led to falling lamellae, increased charring rates, and affected load-bearing capacity and ZSL height.	Mika	Alanen	Tampere University
11F	MPD - Engineering - Fire	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	CHARRING CHARACTERISTICS OF TIMBER ELEMENTS EXPOSED TO NATURAL FIRE	This paper analyzes the charring behavior of timber exposed to natural fire using the advanced PYCIF model, which integrates heat and mass transfer model with pyrolysis reaction. Timber cross-sections are exposed to fire curves generated by Ozone software, and key metrics such as final charring depth, onset, and end times of charring are monitored. The analysis identifies strong correlations: the final charring depth links to the fire curve maximum temperature, while the onset and end times of charring correspond to the fire curve reaching 300 °C during heating and cooling phases. These findings highlight the potential for simplified methods to predict charring in timber elements exposed to natural fires.	Robert	Pečenko	University of Ljubljana, Faculty of Civil and Geodetic Engineering
11G	TESP/STCE/EIC - Sustainability	Session Chair: TOBY HODSDON / ARUP					
11G	TESP/STCE/EIC - Sustainability	Timber Engineering & Structural Performance - Engineering Focus	Adaptive Timber Exoskeletons: Sustainable Seismic Retrofitting with CLT Panels	The extensive renovation of existing buildings is essential to mitigate seismic risk and environmental impacts. To prioritize safety and sustainability, retrofit strategies should minimize disruption and adopt a Life Cycle Thinking (LCT) approach to reduce long-term costs and impacts. Timber-based materials, particularly CLT panels, offer significant potential for seismic retrofitting due to their mechanical, thermal, and environmental properties. This paper explores timber exoskeletons as a possible solution for seismic retrofitting, emphasizing the need for re-engineering connections to meet specific design criteria such as damage control, ease of assembly/disassembly, and flexibility. Exoskeletons, as external lateral force resisting systems, provide superior performance and displacement control by collecting the building inertia forces at floor levels and transferring the seismic action to the foundations. The design process emphasizes damage control at the Life Safety Limit State (LSLS), for which adaptive solutions appear to be optimal. Numerical simulations using a reference 3-story RC building demonstrate the superior performance of shell configurations. Overall, timber exoskeletons represent a promising solution for sustainable seismic retrofitting, with significant potential for application to low-rise buildings.	Jacopo	Zanni	University of Bergamo
11G	TESP/STCE/EIC - Sustainability	Timber Engineering & Structural Performance - Engineering Focus	AUSTRALIAN PLANTATION EUCALYPTUS NITENS AS AN ALTERNATIVE BUILDING MATERIAL	Eucalyptus, Australia's iconic hardwood tree genus, offers a promising option for the development of new building materials. Research by Australian and international universities has focused on unlocking the full potential of fast-growing plantation Eucalyptus species beyond traditional wood pulp production. This paper discusses the key research activities by researchers at the University of Tasmania related to the use of plantation-grown Eucalyptus nitens (E. nitens) in fabricating engineered wood products. The results of previous research have demonstrated there are more uses for plantation E.nitens, increasing its value and making it a more versatile resource to be used in EWPs. It also shows the ongoing transformation of plantation Eucalypts use in Australia and worldwide. The narrative highlights key findings, challenges, and potentials related to producing timber products such as CLT and GLT from E. nitens. It discusses the research efforts in evaluating the material, product performance, and capacity to utilise plantation E. nitens in making engineered wood products, which is a crucial process for designing effective and reliable EWPs. By analysing research findings, this paper aims to explore how previous findings on plantation E. nitens have both restrained and expanded the critical role it may play in the development of more sustainable and diversified EWPs for the Australian and global building industry.	Azin	Ettelaei	University of Tasmania
11G	TESP/STCE/EIC - Sustainability	Sustainability and Timber in a Circular Economy - Practitioner Focus	TIMBER CIRCULARITY: SOLUTIONS FOR END-OF-LIFE TIMBER IN A CIRCULAR BIOECONOMY	Timber is an ideal resource for the circular bioeconomy with the potential to aid the transition towards a net positive future. Timber products, including preservative treated timber (PTT) and engineered wood products (EWP), can allow greater high value use of wood resources, have increased strength and durability, and store carbon. Adhesives and treatments become problematic however when resources are to be circulated into new applications. With the Australian Government calling for a circular economy by 2030, it is vital that solutions for end-of-life timber are determined. The circular economy requires resources to be reused or recycled rather than moving linearly from use to landfill. The Australian context is unique in terms of regulatory issues and the vast distances between cities, requiring a variety of solutions which may include scalable or mobile technology. The Timber Circularity project is a three-year national project that aims to understand end-of-life resources available and potential solutions that will meet regulatory and logistical challenges. A matrix of solutions has been developed based on a hierarchy of high- to low-value opportunities. Three solutions of different values in the matrix have been examined for pilot projects which will begin in early 2025.	Penelope	Mitchell	University of the Sunshine Coast
11G	TESP/STCE/EIC - Sustainability	Timber Engineering & Structural Performance - Engineering Focus	SHEAR PROPERTIES OF ADHESIVE JOINTS FOR I-SHAPED SECTION TIMBER-GLASS COMPOSITE BEAMS	Timber-glass as a novel composite structure, which has gained widespread attention in timber engineering due to its advantages in sustainability, low-carbon footprint, light transmission, and aesthetic appeal. To better understand the performance of adhesive joints between timber flange and glass web for I-shaped section timber-glass composite beams, multiple single shear connection joints were designed and next they were subjected to monotonic loading test studies and finite element simulations. The parameters studied included bonding width, bonding length, adhesive layer thickness, and timber grain direction. The failure modes, load-bearing capacity, stiffness, and ductility of the connected joints under these parameters are discussed and analyzed, which will provide a valuable reference for the design of the joints.	Huifeng	Yang	Nanjing Tech University
11G	TESP/STCE/EIC - Sustainability	Sustainability and Timber in a Circular Economy - Engineering Focus, Sustainability and Timber in a Circular Economy - Practitioner Focus, Timber Engineering & Structural Performance - Engineering Focus	ROTATIONAL BUTT FRICTION WELDING OF BAMBOO AND WOOD	Natural, renewable raw materials such as wood or bamboo are increasingly important for industrial applications as they are environmentally friendly to produce and dispose of. The use of renewable raw materials allows for substitution of petroleum-based products and can significantly reduce CO2 emissions. Renewable raw materials generally decompose much faster than most petroleum-based plastics, provided that no chemical adhesives are used to bond the natural, renewable raw materials. In order to reduce the proportion of petroleum-based adhesives, investigations into the rotational butt welding of bamboo and wood were carried out. This article presents further fundamental investigations of rotational butt welding of various woods, bamboo and their joints.	Ralf	Förster	BHT Berlin

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11G	TESP/STCE/EIC - Sustainability	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus, Education, Innovation & Challenges - Engineering Focus	DEVELOPMENT OF A PREFABRICATED ADHESIVELY BONDED JOINT FOR BAMBOO STRUCTURES	Despite its ecological benefits, bamboo's application in modern construction is limited due to the complexities of connecting its round cross-sections. The construction industry is a significant contributor to global warming due to its environmental impact. As a result, responsible builders are implementing sustainability measures to limit their carbon footprint and improve other environmental aspects of their operations. Continuing our previous research on connecting Douglas fir ( <i>Pseudotsuga menziesii</i> Franco.) roundwood in a material-appropriate way for large-span truss structures, the promising results led to an expansion of the round-to-round jointing topic to other renewable building materials with a particular emphasis on sustainable bamboo structures made from <i>Guadua angustifolia</i> Kunth. This paper explores the development and testing of adhesive bonding techniques for bamboo structures, focusing on the inner layer bonded with biocomposites. The research includes the implementation of ecologically harmless adhesives and experimental research of the bond strength between biocomposite and inner bamboo layer and results in a joint that avoids punctual splitting by the absence of fasteners. The preliminary results demonstrate a robust bond. The evaluations have not finished yet and will be presented in the full paper.	Kay-Uwe	Schober	Mainz University of App Sc, Holzbauforschung Mainz, Germany
11H	TABD/STCE - Case Studies, incl Sydney Fish Market Presentation by Rubner / Theca	Session Chair: A/PROF MINGHAO LI / UNIVERSITY OF BRITISH COLUMBIA					
11H	TABD/STCE - Case Studies, incl Sydney Fish Market Presentation by Rubner / Theca	Sustainability and Timber in a Circular Economy - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus, Timber Architecture & Biophilic Design - Engineering Focus	Engineering Alchemy - Turning Concrete Into Timber: The Galkangu Bendigo GovHub Story	Galkangu Bendigo GovHub is a state-of-the-art community asset and workplace in central Victoria, and Australia's largest mass timber frame using 100% Australian supplied Glue Laminated Timber (glulam) and Cross-Laminated Timber (CLT).  This paper explores how Arup's collaborative approach and design innovation enabled the client's aspirations to be met, with significant use of highly sustainable construction materials and advanced off-site construction techniques.	Mark	Ayers	Arup
11H	TABD/STCE - Case Studies, incl Sydney Fish Market Presentation by Rubner / Theca	Timber Architecture & Biophilic Design - Engineering Focus, Timber Architecture & Biophilic Design - Architectural Focus, Exemplars & Construction Case Studies - Architectural Focus	Urban densification - Case study of a school expansion using TS3 technology	Many school building need expansion for capacity. So does the school building in Richterswil, CH, which needed an expansion of 1500 square meters during the five weeks of summer holidays. This could only be realized by two additional timber structure storeys with the TS3 technology. A biaxial load-bearing flat ceilings with spans of 7x10 metres could be installed on the same load-bearing structure of the existing concrete building. The floor-wall system allowed the façade to be designed independently of the supporting structure. The timber construction and closing of the building was realized during the summer break, while the less noisy interior work was done during the school operation with no negative influence. All advantages of timber construction in addition with the specialized TS3 technology were convincing for the expansion.	Bettina	Franke	Timbatec
11H	TABD/STCE - Case Studies, incl Sydney Fish Market Presentation by Rubner / Theca	Sustainability and Timber in a Circular Economy - Engineering Focus	Advanced LCA methods for sustainable timber solutions: A review	This presentation, as part of a wider report, provides a focused review of the latest advancements in the life cycle assessment (LCA) methods for timber. Given the rising severity of natural disturbances, it has become increasingly important to consider the suitability of current forest management practices and to adopt approaches that promote forest resilience.  This work argues that current best practice LCA methods lack the resolution needed to compare different forest management approaches when assessing timber products. Therefore, methods that go beyond current best practice are reviewed. These methods relate to both the improved accounting of forest carbon fluxes and the biodiversity impacts of land use. The limitations of these methods are discussed along with the future opportunities they present.	Matthew	Leeder	University of Bristol
11H	TABD/STCE - Case Studies, incl Sydney Fish Market Presentation by Rubner / Theca	Sustainability and Timber in a Circular Economy - Engineering Focus	TIMBERTRACKER: AN OPEN-SOURCE WEB FRAMEWORK FOR VISUALISING SUPPLY AND DEMAND IN FUTURE CONSTRUCTION TIMBER VALUE CHAINS	The future development of Australia's built environment must tackle two key challenges: improving access to affordable housing and transitioning to net-zero in construction. Given that the majority of Australian housing is built using timber framing, a key barrier to addressing these challenges is the growing gap between the escalating market demand and the limited supply of sustainably-sourced structural sawn timber. This paper presents an open-source, interactive web framework developed to communicate and visualize this resource gap, termed "TimberTracker". The website integrates open data sources available for timber supply, building design, and urban planning information ecosystems, to enable better understanding of the timber resources required for Australia's current and future housing ambitions. The timber consumption data analyses consider demand-side factors contributing to Australia's growing need for structural timber. The timber production data analyses supply-side factors affecting domestic timber availability. Evaluated information is reported through an interactive geospatial map, for timber resource supply and demand requirements for Australian Local Government Areas up to 2050.	Joseph	Gattas	School of Civil Engineering, University of Queensland
11H	TABD/STCE - Case Studies, incl Sydney Fish Market Presentation by Rubner / Theca	Sustainability and Timber in a Circular Economy - Engineering Focus	Carbon Accounting on the Production of Timber-based Products	Carbon accounting of wood products involves assessing the carbon stored in wood products, considering factors such as production, consumption, and end-use. If we focus on the production stage, forestry carbon accounting is still in its infancy. This study first reviews current methods for carbon emissions (CE) calculations and finds that life cycle assessment (LCA) is the most used approach. The functional units of existing studies are not uniform, and there is no consensus on biogenic carbon calculations. Therefore, it is important to improve the transparency of the planting stage to provide a more comprehensive assessment inventory. In addition, dynamic LCA studies including temporal and spatial aspects are expected to improve the accuracy of carbon accounting. Finally, regulations or guidance are encouraged to eliminate uncertainties and improve comparability between wood products.	Yi	Qian	The University of Melbourne
11H	TABD/STCE - Case Studies, incl Sydney Fish Market Presentation by Rubner / Theca	Timber Architecture & Biophilic Design - Architectural Focus	Fisher & Paykel Global HQ Campus - Mass Timber Diagrid Innovation - delivering so much more than environmental sustainability	The scope of the project was to rebuild the global headquarters corporate and product development campus of Fisher & Paykel Appliances on a new site in Auckland, New Zealand. The principal building is a 10,000msq mass timber diagrid 2 & 3 story office building suspended above the land and enclosing an oasis of regenerated native NZ flora. The proposal develops a repetitive elemental low-carbon construction system to demonstrate global innovation consistent with the clients' core values. The project has achieved a fast to build componentized mass timber system delivering a campus wide carbon neutral outcome. It has also employed, biophilic design principles, indigenous people's consultation, and high amenity staff facilities to deliver a socially, culturally, and environmentally sustainable outcome.	Rich	Naish	RTA Studio

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11H	TABD/STCE - Case Studies, incl Sydney Fish Market Presentation by Rubner / Theca	SPECIAL SESSION - 30 MINUTE PRESENTATION	SYDNEY FISH MARKET	<p>Located in Blackwattle Bay, Pyrmont—just two kilometres west of Sydney’s CBD—the market is the third-largest fish market in the world.</p> <p>A standout feature of the new market is its striking 230-metre-long, wave-like timber roof, engineered by Theca Timber’s partners, Rubner. Made from 1,800 m<sup>3</sup> of spruce glue-laminated timber (GLT) and over 50 tons of steel, the roof’s sweeping form ties the entire structure together, giving the market a bold and elegant identity.</p> <p>More than just an architectural statement, the roof plays a crucial role in the market’s sustainability strategy. Designed to collect rainwater for reuse and harness solar energy, it also uses natural ventilation to extract warm air while shielding workers from harsh southerly winds. Sustainability extends to logistics. The European GLT beams were shipped as single elements in the hull of a bulk cargo carrier and delivered by barge—never touching Australian roads. This approach minimised pollution and reduced disruption to the local community.</p> <p>As Rubner’s partners in Australia, Theca Timber was involved from the early stages, providing expertise to help Multiplex accurately price the project during the tender phase. The key challenge was ensuring the most efficient and sustainable transport method while enabling rapid manufacturing and on-site assembly. Theca Timber and Rubner supported Multiplex with advanced timber construction expertise, Design for Manufacture and Assembly (DfMA) strategies, and a sophisticated transport methodology—playing a crucial role in securing the winning bid.</p>	Florian Gianluigi Paolo Adam	Hittaler Traetta Aschieri Shears	Rubner / Theca Timber
11I	EIC/MPD - Engineering / Architectural	Session Chair: DAVID ZHANG / MULTINAIL					
11I	EIC/MPD - Engineering / Architectural	Material Performance & Durability - Engineering Focus, Sustainability and Timber in a Circular Economy - Engineering Focus, Education, Innovation & Challenges - Engineering Focus	ENHANCING MATERIAL DURABILITY AND SUSTAINABILITY: INVESTIGATING TIMBER MOISTURE MANAGEMENT IN TIMBER STORAGE FACILITIES.	<p>This study investigates effective moisture management strategies within timber storage facilities, focusing on their critical role in enhancing timber’s durability and sustainability. Utilizing a mixed-methods approach, the study combines quantitative moisture content (MC) measurements of timber products across six facilities in Adelaide with qualitative insights from twelve semi-structured interviews with industry experts. The research highlights the dynamic nature of timber moisture levels due to varying environmental conditions and storage practices.</p> <p>The findings reveal that, although significant seasonal variations in MC were not observed, differences in storage conditions within facilities led to varying moisture levels, with MC ranging from 4.9% to 21.3%. Proper storage practices, such as adequate protective measures and appropriate stacking, are emphasized as essential for maintaining consistent MC levels. Facilities with controlled environments reported fewer issues related to both excessive dryness and wetness.</p> <p>The study concludes that stable moisture content is vital for preserving timber quality and structural integrity. It highlights the importance of continuous monitoring and optimized storage practices to prevent degradation. By contributing valuable knowledge to timber management, this research supports the advancement of sustainable practices in the construction industry.</p>	Oluymide	Akinawonu	University of South Australia
11I	EIC/MPD - Engineering / Architectural	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus, Education, Innovation & Challenges - Engineering Focus	IMPACT OF OPAQUE AND TRANSPARENT THIN INTUMESCENT COATINGS ON THE HEAT RELEASE RATE OF MASS TIMBER	<p>Exposed timber remains a challenge in the safe construction of mid- to high-rise mass timber buildings. During a fire, heat that is released from the flaming combustion of timber elements can significantly alter the intensity and duration of the fire event. Therefore, understanding the Heat Release Rate (HRR) of mass timber during the different phases of a fire is key, as it can impact both the fire growth and thermal exposure severity to the structure. This study examines the influence of opaque and transparent thin intumescent coatings on the HRR of timber by deriving critical flammability properties, to provide insights into the fire behaviour of bare and coated timber. Bench-scale fire experiments of CLT (cross-laminated timber) blocks were conducted using a calorimetry apparatus under three constant incident radiant heat fluxes of 25, 50, and 75 kW/m<sup>2</sup>. For the coated timber samples, different coating types were used – two opaque (A, B) and one transparent (C) at varied thicknesses. The results suggest that opaque coatings (A, B) contribute to improved fire performance of mass timber during both the early and fully developed fire phases, whereas transparent Coating C is primarily effective in the early phase, delaying ignition, limiting flame spread, and reducing heat release.</p>	Stavros	Spyridakis	The University of Queensland
11I	EIC/MPD - Engineering / Architectural	Education, Innovation & Challenges - Engineering Focus	Comprehensive Analysis of Point Supported Timber Construction: Structural and Fire Safety Insights	<p>With the introduction of Tall Mass Timber construction types to the Codes in the United States in 2021, there has been an increase in the exploration and construction of these types of buildings. While the new construction types provide a prescriptive path to approval, they also require a series of new, often nuanced, structural and fire safety requirements. At the same time there is an increase in the demand for affordable housing, particularly in urban areas. Point-support, beam-less, mass timber systems have emerged as a popular solution in the 8 to 18 stories range. Sandy Pine, a 12-story building in Portland, Oregon, is one such project to utilize this system and is unique in the fact that over 60% of the CLT ceiling surface will be exposed. To demonstrate compliance, the structural and fire engineers relied upon existing and project specific testing, and worked closely together, particularly on the structural and fire performance of the building’s connections.</p>	Eric	McDonnell	Holmes
11I	EIC/MPD - Engineering / Architectural	Education, Innovation & Challenges - Engineering Focus, Education, Innovation & Challenges - Architectural Focus, Education, Innovation & Challenges - Practitioner Focus	ASSET OWNER RESEARCH: ROADBLOCKS TO TIMBER USE	<p>One of the primary objectives of Timber Unlimited is to accelerate the adoption and increase the volume of timber used in commercial construction, aiming to boost the number of buildings with low carbon footprints. This study conducted by Timber Unlimited in 2023 explored the motivations and barriers faced by asset owners in Aotearoa New Zealand when considering timber as a primary material for commercial buildings, beyond its aesthetic benefits. The goal was to provide insights that will positively influence decision-makers’ perceptions and choices, thereby creating more opportunities for timber use. The study uncovered significant gaps in knowledge and best practices related to building with timber among asset owners. While many recognize timber’s strong sustainability credentials, they often struggle to find hands-on expertise, which leads to the perception that timber is “exclusive.” The study found that it is essential to facilitate the transfer of knowledge from experienced practitioners to those less familiar with timber. Highlighting hybrid construction projects, which combine timber with other materials, can also help ease the transition. Furthermore, improving regulatory frameworks is crucial to streamline the building consent process for timber construction.</p>	Lisa	Oliver	Holmes & NZ Timber Design Society
11I	MPD - Engineering - Adhesives	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	MODE I FRACTURE ENERGY OF HARDWOOD GLUELINES VIA TESTS	<p>The engineered wood products (EWPs) are characterized for a wide use of structural adhesives. The glue-lines between the board’s faces play a key role to guarantee the stability and load-bearing features of structural elements. One of the most revealing properties to assess the bonding quality and behavior is the fracture energy (or toughness), which could be estimated by performing suitable tests. Previous works were focused on the bonding properties of structural adhesives with softwood species, nevertheless, the widespread interest on hardwoods and the major bonding issues of those species, led to focus on two of the most interesting species in Europe and Italy: beech and chestnut. The fracture toughness behavior of two different categories of adhesives for structural applications was investigated, namely melamine-urea-formaldehyde (MUF) and phenol-resorcinol-formaldehyde (PRF). The results revealed different fracture toughness behavior between the various adhesives and bond line thickness. The fractured surfaces are also characterized by means of optical microscopy.</p>	Martina	Sciomenta	University Of L’quila

Session No.	Session Topic	Abstract Topic	Submission Title	Summary	First Name	Last Name	Company
111	MPD - Engineering - Adhesives	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	MODIFICATION OF MELAMINE FORMALDEHYDE-BASED ADHESIVES FOR THE MANUFACTURING OF CROSS-LAMINATED TIMBER (CLT) FROM JABON WOOD	Adhesive is an essential element that requires meticulous consideration throughout the production process of Cross-Laminated Timber (CLT). This study aims to investigate the bonding performance of Jabon wood-CLT manufactured with modified melamine formaldehyde (MF)-based adhesives for cold-pressing applications. The commercial MF adhesives (MF-0) and modified ones (MF-1) at three different rates, 250, 280, and 300 g/m <sup>2</sup> were applied in this study. The MF-1 was composed of MF-0 by adding 5% citric acid, 3% polymeric 4,4-methylene diphenyl diisocyanate (pMDI), and 10% wheat flour. The results show that the MF adhesive can be modified by incorporating citric acid and pMDI, enabling it to be utilized in the production of CLT using cold pressing application. Adding these substances enhanced the adhesive viscosity and shortened the gelation time. In comparison to MF-0, MF-1 has a larger contact angle and a lower K-value due to its increased viscosity. However, this modification results in adhesive performance of MF-1 (300 g/m <sup>2</sup> ) that complies with EN 16531:2021. Increased spread of the MF-1 led to improved bonding strength, reduced delamination, and enhanced wood failure. MF-1 demonstrated a higher stress-strain curve and stiffness compared to MF-0 indicates that it provides enhanced performance for bonded wood products as CLT.	Naresworo	Nugroho	Department of Forest Products, Faculty of Forestry and Environment, IPB University, Indonesia
111	MPD - Engineering - Adhesives	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	Long-term behavior of rods glued in hardwoods under static loading, elevated temperatures and humidity environment	Glued-in rods (GIR) are nowadays an integral part of timber engineering's catalogue of joints. While of widespread use, there are still open topics to be addressed, e.g., the behavior under elevated temperatures and humidity. First the adhesives are tested for their suitability by a dynamic mechanical analysis (DMA) and their individual glass transition temperature T <sub>g</sub> is determined. Most adhesives in industry exhibit a glass transition temperature, which is close to the temperatures relevant for design. At temperatures close to T <sub>g</sub> a significant drop in the load capacity of adhesives is to be expected. Afterwards, the pull-out strength of different hardwood-adhesive-combinations is tested under laboratory conditions, as well as higher temperatures. The results of the preliminary tests are then used to design testing rigs for the long-term investigations of the GIR. Service classes I to III are to be explicitly examined as part of the investigations in order to characterize the performance of the GIR under increased environmental conditions.	Pascal	Franck	RheinMain University of Applied Sciences