SESSION 9

Wednesday 25th June 2025
2:00pm to 3:30pm

Session No.	Session Topic	Abstract Topic	Submission Title	Summary	First Name	Last Name	Company
9A	ECCS / EIC / TESP - Practitioner / Engineering	Session Chair: DR MARK DEWSBURY / UNIVERSITY OF TASMANIA					
9A	ECCS / EIC / TESP - Practitioner / Engineering	Exemplars & Construction Case Studies - Practitioner Focus	QFES North Coast Regional Headquarters and Maryborough Fire and Rescue Station	The Maryborough Fire and Rescue Station, and North Coast Regional Headquarters facility comprises 3 new purpose-built timber buildings and the alterations and additions to an existing 1950's Art Deco Fire Station. The new Regional Headquarters and training tower, and the new Fire Station turnout and Engine Room are entirely built from Cross Laminated Timber and Glu-Laminated Timber. The project is a demonstration of the use of sustainable, renewable materials in a State Government Building, an exemplar for future buildings of this typology that seek to genuinely reduce carbon emissions, with this building saving approximately 500 Tonnes of CO2 from entering the atmosphere.	Kim	Baber	School of Architecture, University of Queensland
9A	ECCS / EIC / TESP - Practitioner / Engineering	Timber Engineering & Structural Performance - Engineering Focus, Exemplars & Construction Case Studies - Architectural Focus, Exemplars & Construction Case Studies - Practitioner Focus	Timber basements – From challenge to technology and proofed solution	Due to the need of more suistanable solutions in the construction sector, even timber construction should start with a timber basement! Concrete basements are standard today - this should change for sustainable buildings. Timber basements are more environmentally friendly and can be installed in much less time. However, we need a proven concept, proper waterproofing and long-term performance. New parameters have to be determined, especially for structural aspects, because of the light weight. For the long-term behaviour, various building physics estimates are made. The results were validated by experimental test series, a monitoring campaign and a pilot project on five apartment buildings. The results confirm that timber basements are feasibleand reliable.	Bettina	Franke	Timbatec
9A	ECCS / EIC / TESP - Practitioner / Engineering	Exemplars & Construction Case Studies - Practitioner Focus	CASE STUDIES FROM FINLAND: IMPROVING THE PRODUCTIVITY OF INDUSTRIAL WOOD APARTMENT BUILDING CONSTRUCTION	Since the early 1990s, Finland has been actively engaged in the development of multi-story timber-frame buildings. According to the size specifications outlined in the current Finnish fire regulations as of January 1, 2018, it is feasible to build residential, office, hotel, and care center with timber frames and facades, extending up to 8-story. As of June 2024, Finland has completed the construction of 180 wooden apartments buildings exceeding 2-story, totaling about 6,000 apartments. Despite positive feedback from residents, clients, and builders, wooden apartment buildings have not yet achieved sufficient competitiveness for widespread adoption. To enhance the productivity and competitiveness of industrial wooden apartment building construction in Finland by 20%, a two-year research project was undertaken from (2020-2022). This project was funded by both the industry and the Finnish Ministry of the Environment. It included two extensive case studies in Finland, utilizing modular volumetric construction methods and encompassing about 770 apartments in total. The study concluded that competitiveness of wooden apartment buildings can be significantly improved by standardizing design solutions and optimizing both industrial modular manufacturing and on-site operations. Furthermore, productivity gains can be realized through enhanced design management, the implementation of effective project and contract models, and improved site logistics.	Markku	Karjalainen	Tampere University
9A	ECCS / EIC / TESP - Practitioner / Engineering	Education, Innovation & Challengers - Practitioner Focus	GLUED WIDE-SPAN TIMBER TRUSSES – A DESIGN AND EXPERIMENTAL APPROACH	The aim of this research work is to develop a resource-efficient, economical, and aesthetically sophisticated timber structure for wide-span hall constructions. Based on the idea of a resolved timber truss, a completely new type of load-bearing structure has been developed. This structure relies fundamentally on glued truss nodes to transfer occuring tensile forces. To enable a largely moment-free construction, a special compression contact joint has also been designed for transferring compression forces. As a result of this design process, the system axes align ideally in a single point of intersection. Gluing timber trusses has long been an enormous challenge, often investigated but never fully successful. This has now been made possible thanks to the newly developed truss geometry and accompanying glued truss nodes. A complex, parameterized structural design model has been developed and the results of the calculations were validated through extensive tests using specially developed test setups. Easy disassemby for a circular economy has also been considered.	Jan L.	Wenker	Brüninghoff Group
9A	ECCS / EIC / TESP - Practitioner / Engineering	Timber Engineering & Structural Performance - Engineering Focus	DEVELOPMENT OF AN ENGINEERED WOOD PRODUCT BASED ON A MARKET STUDY	The mass timber products have benefits related to sustainability, prefabrication, costs, and flexibility in construction planning and execution. However, in Brazil, when compared to other market solutions, they still have a higher cost. The engineered product that uses the largest quantity of cubic meters per square meter is the slab, which has three solutions: CLT (Cross Laminated Timber), NLT (Nail Laminated Timber), and the structured composite board (wall board). The wall board, being a simpler solution, is more financially accessible, with a lower cost per square meter. However, most of the time, it does not meet the aesthetic requirements of architecture, thus requiring an additional finish (ceiling). In this context, this work aims to develop a product that is structurally and financially viable for mass timber structures, thereby being competitive with other materials in the market.	Carlito	Calil Neto	Rewood | @brarewood
9B	TESP- Engineering Fire Engineering	Session Chair: PROFESSOR SAM SALEM / LAKEHEAD UNIVERSITY					
9B	TESP- Engineering Fire Engineering	Timber Engineering & Structural Performance - Engineering Focus	ROBUSTNESS ANALYSIS OF TALL TIMBER BUILDING SUBJECTED TO COMPARTMENT FIRE	The construction of tall timber building is gaining popularity around the world leveraging on its inherent characteristics such as renewablility and high strength-to-weight ratio. But timber is prone to the fire damage due to its combustibility. The robustness of timber building exposed to fire is still not well understood. This paper presents the robustness analysis of a 12-story timber frame-core wall building subjected to compartment fire. First, component-level numerical models (column model and beam model) exposed to standard fire heating are developed and validated by the experimental tests. Subsequently, a numerical model of the timber building is developed based on the calibrated component models. The developed building model is subjected to the compartment fire after imposed dead load and live load. Finally, the framework to assess the robustness of timber building exposed to the compartment fire is proposed. The robustness of the designed timber building exposed to fire is quantified through calculating the robustness index considering different fire scenarios and direct failure and indirect failure caused by the fire damage.	Tongchen	Han	0

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9B	TESP- Engineering Fire Engineering	Timber Engineering & Structural Performance - Engineering Focus	Fire safe design of hybrid steel-timber construction systems	As part of the research project "BraStaHo" (Fire safety of hybrid steel-timber construction systems), two hybrid steel-timber construction systems are being investigated under fire exposure using the standard fire curve. The primary objective is to evaluate the fire protection capacity of timber claddings for steel beams over various time periods and assess the factors influencing its effectiveness. Initial validation tests have demonstrated that different construction configurations impact the fire protection capacity of solid timber cladding. By utilizing different profile sizes in ongoing tests, a robust data set will be generated, which will be validated and verified through numerical simulations. The goal is to establish construction details and cladding thicknesses to meet various fire resistance requirements. Additionally, slim floor type construction systems are being examined. Experimental investigations have provided initial insights into the combustion behavior of these systems, with a particular focus on the support conditions and cavities, as these parts pose the highest risk for component failure and smoke propagation. The deformation behavior of the floor under fire conditions has also been studied. The aim of these tests is to develop fire-safe support details and predict the thermal behavior of this construction in the event of a fire.	Patrick	Dumler	TUM Chair of Timber Structures and Building Construction
9B	TESP- Engineering Fire Engineering	Timber Engineering & Structural Performance - Engineering Focus	Investigating the thermal penetration in structural timber elements exposed to natural fires	Fire safety concerns, particularly the combustibility of wood, pose significant challenges for the advancement of modern timber buildings. Traditional fire safety assessments often overlook the cooling phase of fires, during which timber structures can continue to lose strength and stiffness. This study employs numerical models and experimental data to analyse the thermal penetration in structural timber elements throughout a fire, considering both heating and cooling phases. The findings show that, during the cooling phase, the load-bearing capacity of timber elements decreases due to ongoing heat penetration, with the zero-strength layer playing a critical role. The research emphasises the need to include the cooling phase in fire safety assessments for timber structures, particularly for columns. Ignoring this phase can lead to unsafe underestimations of structural risks, highlighting the importance of considering thermal penetration and the resulting heated timber with reduced mechanical properties.	Andrea	Lucherini	Slovenian National Building and Civil Engineering Institute (ZAG)
9B	TESP- Engineering Fire Engineering	Timber Engineering & Structural Performance - Engineering Focus	Quantifying Fire Behaviour in Gaps in CLT Panel-to-Panel Connections	The tolerances of mass timber construction results in small gaps between mass timber panels. The Fire Design Specification prescribes that when gaps within elements exceed 3 mm the mass timber within the gap must be treated as fully fire-exposed surfaces. Therefore, many of these gaps must be filled with fire protection material. However, the process of protecting these gaps is time consuming and costly. To evaluate the influence of gaps on fire dynamics and char propagation, the authors performed a series of experiments on cross laminated timber panel-to-panel connections to evaluate the influence of connection type and gap size. Temperatures and airflow were measured to quantify the fire behavior of the mass timber connections. Each specimen was exposed to the standard fire (ASTM E119) for up to two hours and then allowed to cool naturally. This testing methodology quantifies temperatures and airflow throughout both heating and smoldering. The testing results will inform the future design of mass timber buildings.	Wyatt	Garrett	Oregon State University
9B	TESP- Engineering Fire Engineering	Timber Engineering & Structural Performance - Engineering Focus	PREDICTIVE CAPABILITIES OF FIRE DYNAMICS SIMULATOR OF FLAME SPREAD ON TIMBER IN ENGINEERING APPLICATIONS: AN EVALUATION	Predicting ignition and fire growth of engineered timber products holds significant relevance in the fire safety community, given the extensive application of these materials as structural elements in buildings. Furthermore, understanding the charring process of wooden materials is crucial for predicting their structural performance when exposed to a fire hazard. This article presents an effort to evaluate the engineering code Fire Dynamics Simulator (FDS) in terms of predicting heat impact, fire spread and charring on intermediate-scale wooden panels. Experimental tests were carried out on combustible (spruce wood) panels, representing fire spread on wooden surfaces. The samples were exposed to a propane burner with a power ranging from 30 to 100 kW. The model parameters were calibrated against the experimental results, allowing good qualitative prediction of the incident heat flux on the panel. A coupled engineering pyrolysis model was then used to characterize the flame spread, in terms of charring depth and heat release contribution of the combustible surface.	Alain	Coimbra	CSTB
9C	TESP- Engineering Connections	Session Chair: MATT SMITH / SIMPSON STRONG-TIE					
9C	TESP- Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	ROBUSTNESS ANALYSIS OF INNOVATIVE CONNECTIONS FOR POST-AND-BEAM MASS TIMBER BUILDINGS	The paper focuses on characterizing innovative beam-to-column connections with slotted holes to facilitate structural assembling, ensure hinged structural behavior and promote catenary behaviour under large deformations, particularly in scenarios involving column removal. The research unfolds in three stages: 1) Experimental characterization of the connection's constitutive laws; 2) Parametric study varying beam and slotted hole lengths referring to a simplified 2D post-and-beam subassembly; 3) Robustness analyses of a 3D post-and-beam archetype building under column removal scenarios using Alternative Load Path Linear and NonLinear Analyses. Results indicate that slotted holes, proposed in the innovative beam-to-column connections, enhances the structural robustness facilitating effective activation of Alternative Load Paths such as catenary effects. Finally, structural robustness of a 4-storey post-and-beam building assembled using the prosed innovative beam-to-column connection was numerically analyzed considering Alternative Load Path shenarios.	Ernesto	Callegari	Rotho Blaas
9C	TESP- Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	Connections with small diameter fasteners in European hardwoods	In Europe, it is expected that the availability of hardwood species as construction material will increase in the coming decades due to climate change and the resulting forest conversion. When building with hardwoods, also connections with relevant European hardwood species such as beech and birch are necessary, where dowel-type fasteners with small diameters play a special role, as such fasteners are usually inserted without predrilling. A feasibility study to identify suitable fasteners that can be inserted without predrilling was carried out, leading to selection criteria based on the ratio of fastener diameter to insertion length. Used fasteners were staples and nails, and used hardwood products were laminated veneer lumber made of beech and birch solid timber. For selected fasteners, input parameters needed for the design of timber connections were determined and used to calculate expected load-carrying capacities of connections between hardwood products and wood-based panels. Comparing experimental with calculated values, the applicability of the European Yield Model for connections with small diameter fasteners in European hardwoods could be confirmed.	Carmen	Sandhaas	Karlsruhe Institute of Technology

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9C	TESP- Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	STEEL BAR-TIMBER COMPOSITE BEAM-COLUMN CONNECTION ADOPTING STEEL DAMPER	We have been developing a frame system consisting of steel bar-timber composite members which can perform better than those of reinforced concrete structure. The steel bar is deformed bar, which is embedded near outer in cross-section of the composite member and bonded with epoxy resin adhesive. Bending stiffness of the composite member is estimated to be approximately five times as much as conventional glulam timber for beam and approximately twice for column. Also, the bending capacity of the composite member is estimated to be approximately three times for beam and approximately twice for column. We developed wet and dry method for connecting column and beam, and now we have been improving the latter method. The improvements include a new manufacturing process for the composite timber, a change to threaded steel bar, a change in the shape of the steel parts used for the connection, and a change to steel damper. This paper presents the improvements, those advantages, and a loading test to investigate the performance of the improved connection.	MASANORI	NAKAMURA	0
9C	TESP- Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	Stiffness of timber connections with dowel-type fasteners under lateral load	When designing structural timber systems, serviceability limit states (SLS) can govern the final design solutions. Deformations in mechanical timber connections play a key role in controlling common SLS, such as vibration and deflection, which are dependent on the stiffness of the connections. Therefore, reliable models to predict the deformation or stiffness of timber connections are required for design purposes. Early timber connection stiffness models were largely based on the theory of beam on elastic foundation (Winkler foundation). Winkler theory tends to lead to an over-estimation of the deformation due to not considering shear effects. Recently, new theories, such as semi-infinite elastic foundation, were applied to address the limitations of Winkler foundation theory. In this project, models based on the semi-infinite elastic foundation are being developed to predict deformations in connections.	Tao	Gui	University of Alberta
9C	TESP- Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	HIGH CYCLE FATIGUE AND STIFFNESS DEGRADATION OF A CROSS-LAMINATED TIMBER SCREWED CONNECTION	A series of monotonic, short-cycle fatigue, and high-cycle fatigue tests were conducted on a cross-laminated timber (CLT) connection using self-tapping fully-threaded screws. The CLT-to-CLT connection was loaded in pure shear and both reverse and non-reverse cyclic tests were performed. The data from these tests were used to characterize the high-cycle fatigue behavior. A S-N curve was fitted to the data and compared to the fatigue verification values from EuroCode 5 as well as other studies. Additionally, the stiffness degradation of the connection was quantified and curves corresponding to the Palmgren-Miner damage were determined.	Wechiang	Pang	Clemson University
9D	TESP - Engineering Structural Behaviour	Session Chair: PROFESSOR ARIJIT SINHA / OREGON STATE UNIVERSITY					
9D	TESP - Engineering Structural Behaviour	Timber Engineering & Structural Performance - Engineering Focus	PRESTRESSING AS A METHOD OF REDUCING THE EFFECT OF CONCRETE SHRINKAGE IN ADHESIVELY BONDED CLT-CONCRETE COMPOSITE PANELS	Gluing timber panels and fresh concrete for shear connection can be considered very effective and almost perfectly rigid, but the effect of concrete shrinkage has a negative effect on the increase in deflection. It is only possible to eliminate these deformations with sufficient cambering, which cannot be achieved with normal support during construction, but only with the help of prestressing. The technical solution of the prestressed adhesively bonded CLT-concrete composite panel consisted of arching the CLT panel in the anchoring device up to the level of 1/100 of the span and subsequent application of glue and fresh concrete. After the concrete hardened and the anchorage was released, prestress was introduced into the composite panel. The measurements confirmed that the chosen value of camber at the level of achieving the design resistance of the CLT panels in bending proved to be adequate to eliminate the deflection due to self-weight and concrete shrinkage and to overcome the negative effect of the fresh concrete gluing.	Viktoria	Bajzecerova	TU Kosice, Faculty Of Civil Engineering
9D	TESP - Engineering Structural Behaviour	Timber Engineering & Structural Performance - Engineering Focus	Analysis of Cross Laminated Timber Floors with the Vierendeel Method	Simply supported and continuous cross laminated timber (CLT) floors with uniformly distributed loads and point loads were analysed using the Strut-Tie Method (STM). The resulting deflections and stresses were compared against the results from the Gamma Method, the Shear Analogy Method and a 2D plane strain continuum finite element method (FEM) model. This research has been undertaken as part of a larger research project to establish a simplified and flexible method of analysing complex timber-concrete composite (TCC) floors. The STM has been recommended in literature as an ideal method for practical analysis and design as it overcomes many of the limitations of the Gamma and Shear Analogy Method while remaining simpler in it's application than 3D FEM commonly used in TCC research, however there is limited information published on its usage. The STM models were created using different end release conditions and element formulations. Comparing results of the STM, Gamma and Shear Analogy Method models against the 2D FEM model, it was found that the STM with rigid connections between the CLT layers and the Timoshenko beam formulation performed as well as the more common Gamma and Shear Analogy methods and is therefore recommended for future use of the STM. Recommendations for future research are made for extending this method such that it can be used for analysing timber-concrete-composite floors that use CLT as the timber component.	Nicholas	Boey	Northrop Consulting Engineers
9D	TESP - Engineering Structural Behaviour	Timber Engineering & Structural Performance - Engineering Focus	Experimental Testing of an In-Situ Strengthening Process for CLT Panels	The primary uses of CLT in building projects is when used as a floor, wall or roof element. In these applications, the behaviour and load bearing potential of CLT elements is driven by the cross-section stiffness in the out-of-plane direction of the CLT panels whether this is in 3 layer, 5 layer or 7 layer panels. Situations frequently arise in the design of CLT buildings where the in-plane bending of CLT panels needs to be considered. Most commonly this occurs where a CLT panel is acting as a beam or lintel. Other situations also arise where CLT is acting as a shear wall, CLT is applied as a floor diaphragm or a CLT wall is acting as a deep beam. In beam-type applications, CLT potentially offers some interesting advantages resulting from the cross-laminated structure including and improved resistance to splitting around supports, penetrations and connections and improved bearing capacity at supports. While well-established calculation and design methods for out-of-plane section properties of CLT are available, there is comparatively little information available to designers when calculating the in-plane bending and shear strength. The material properties and manufacturing processes mean that CLT cannot be calculated using the same approach as a solid timber or glulam section. XLam has carried out testing of CLT beams to investigate in-plane failure modes of CLT. Increased understanding of the in-plane behaviour of CLT could encourage designers to consider a greater number of beam-type applications such as portal frames, deep/long span rafters.	Tom	Watts	XLam

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9D	TESP - Engineering Structural Behaviour	Timber Engineering & Structural Performance - Engineering Focus	STRUCTURAL BEHAVIOUR OF TIMBER-CONCRETE COMPOSITES INCORPORATING RIBBED CONCRETE LAYER	This study investigates the structural applicability of lighter and stiffer timber-concrete composites employing ribbed concrete layers. Push-out tests were conducted and the structural performance of the composites was assessed by examining the applied load and the relative slips between timber and concrete. Specimens fabricated from cross-laminated timber in conjunction with ribbed concrete sections with interlayer screw connections of orientation at 30°,45° and 90°. The findings reveal that timber-ribbed concrete composites have similar structural characteristics to those with solid concrete layers but with a minor reduction in ultimate slip modulus and an increase in the slip of the composites. In contrast to screws at 90°, cross-inclined screws at 30° and 45° resulted in improved load-slip performance and reduced concrete cracking. The results show the potential of using a ribbed concrete layer as an appropriate approach to improving efficiency in timber-concrete composite structures.	Aamir	Khokhar	Edinburgh Napier University, United Kingdom
9D	TESP - Engineering Structural Behaviour	Timber Engineering & Structural Performance - Engineering Focus	Determination of the racking strength and stiffness of CLT panels manufactured from C16-grade Irish timber	This study examines the racking strength and stiffness of CLT panels manufactured from C16-grade timber using Irish Sitka spruce. The timber obtained from Sitka spruce in Ireland is typically graded as C16. In Europe, CLT is primarily manufactured with C24-grade timber and most of the research available is for C24-grade material. Full-scale panels using C16-grade CLT are subjected to racking resistance tests. Subsequently, finite element models are developed for parametric studies, which are validated using the experimental results. These experimental results and numerical models shall inform the use of C16-grade in combination with typical connections used in a mass timber system.	Rimjhim	Kashyap	University of Galway
9D	TESP - Engineering Structural Behaviour	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus, Education, Innovation & Challengers - Engineering Focus	CHARACTERIZATION OF THE FIRE PERFORMANCE OF TROPICAL TIMBERS FOR STRUCTURAL USE IN COLOMBIA	Wood is an extremely versatile material, widely used in structural applications. However, it also presents various attributes related to combustion and flammability. The wood's response to fire is not uniform across all species; it varies considerably depending on the type of wood and its specific characteristics. Factors such as anatomical structure, density, hardness, and moisture content play a crucial role in how wood reacts to fire. In particular, some tropical woods with relatively low densities may perform better than those with higher densities, influenced by additional characteristics such as the content of extractives and minerals. The aim of this study is to evaluate the fire response of six tropical species found in Colombia, which are used in structural design. To achieve this, laboratory tests	César	Rengifo	Universidad Distrital Francisco José de Caldas
9E	STCE - Engineering - Advancing the Circular Economy in Europe	Session Chair: DR DANIEL F. LLANA / TECHNICAL UNIVERSITY OF MADRID					
9E	STCE - Engineering - Advancing the Circular Economy in Europe	Sustainability and Timber in a Circular Economy - Engineering Focus, Sustainability and Timber in a Circular Economy - Practitioner Focus, Exemplars & Construction Case Studies - Practitioner Focus	Pilot Project: Modular Construction with Secondary Materials in a Circular Economy	Our research has shown the technical feasibility of using secondary timber, recovered from demolition, as feedstock for the manufacture of mass timber. In this pilot project, we apply our research in the context of a case study modular building. The pilot demonstrates circular economy innovation at building scale. Timber has been gathered that would otherwise have entered demolition waste streams and been chipped and incinerated or downcycled. The timber has instead been prepared for reuse and manufactured into 'glued-laminated secondary timber' (glulamST), as the building's structural frame, and 'cross-laminated secondary timber' (CLST), as wall and floor panels. The components are developed as a kit-of-parts that can be adapted for application to other building typologies, and are designed for disassembly, upgrade and future reuse. The physical manifestation of the pilot will be presented using images of its exhibition at various locations. Findings relating to cost and carbon will be presented. We conclude with a discussion of next steps and the potential to scale this innovation to an industrial level.	Colin	Rose	University College London
9E	STCE - Practitioner- Advancing the Circular Economy in Europe	Sustainability and Timber in a Circular Economy - Practitioner Focus	Towards a circular value chain of wood from existing buildings in the UK	The reuse of timber is one of the opportunities identified in the UK timber in construction policy roadmap published in 2023 for reducing the GHG emissions associated with the construction sector. New design approaches can facilitate deconstruction and thus reuse of timber elements in the future, but the reuse of timber from current existing buildings remains a complex problem, requiring a different approach. This paper investigates the challenges and opportunities of salvaging timber from existing buildings and reusing timber for structural purposes. It considers opportunities for both direct reuse of timber members, and the use of the reclaimed material for the manufacturing of new engineered wood products. The research is based on a review of the literature and a series of interviews with stakeholders of the demolition and construction sectors in the UK. The perceived challenges for salvaging and reusing wood were found to be interdependent and related to the time and logistics for enabling reclamation, the reconditioning of the reclaimed wood and a supply chain for sourcing the materials. We outline the key challenges identified and explore the potential opportunities that could be paving the way for a circular timber construction now.	Martha	Godina	University of Cambridge
9E	TESP - Engineering - Advancing the Circular Economy in Europe	Timber Engineering & Structural Performance - Engineering Focus	Pure-Timber Connections with Beech, Birch, and Laminated Densified Wooden Dowels: Experimental and Analytical Investigations	The use of wood dowels has been expanding in recent years within timber engineering, particularly in the development of adhesive-free engineered wood products. Adhesive-free timber structures offer advantages such as enhanced recyclability, improved reusability, and a reduced environmental impact. Typically, metal fasteners e.g. screws, dowels or the like are employed in timber engineering applications, mainly due to issues such as mechanical performance, ease of application and economy. Despite the proven performance and widespread adoption of metal connectors, the timber industry is increasingly considering wood-based connectors, such as wood dowels (also referred to as "pegs"), as eco-friendly alternatives. This paper concerns an experimental and analytical investigation on connections with birch gusset plates and dowels of various wood species. In particular, the study presents a mechanical characterization of the proposed connection along with a description of the failure modes observed. The investigations include dowels made of beech, birch and densified wod. For the sake of comparison, a number of connections with birch plywood and and screws made of steel were also tested. Based on the results obtained by testing the proposed connections, along with results from additional embedment tests, the authors have developed a model to predict the strength of the proposed connection. The model takes into account not only the bending and enbedding capacity of the dowel but also its shear strength.	Yue	Wang	KTH Royal Institute of Technology

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9E	ECCS - Engineering - Advancing the Circular Economy in Europe	Exemplars & Construction Case Studies - Engineering Focus	Production feasibility study on studs from reclaimed timber	The study explores the feasibility of reclaimed timber as glulam lamellae. Reclaimed timber was collected at a waste management site, cleaned, and visually strength graded according to the Nordic INSTA 142 and according to a proposed grading standard for reclaimed timber. The grading results show a systematic downgrading of the best timber quality according to the proposed standard. In general the quality of the RT is good as more than 90% of the 85 pieces fulfilled the requirements of the best two strength classes. Seven protoypes of glued studs, 250 cm in length, with selected layers of reclaimed timber, were produced in an industrial line using a state-of-the-art 1k-polyurethane adhesive. The use of reclaimed timber as supplement for 1st generation timber was possible without adjustments of the industrial production process. The studs` modulus of elasticity, bending strength, density as well as the shear strength of the bond lines will be investigated. The mechanical properties of the different prototypes are expected to challenge the current rules for grading of reclaimed timber.	Karl-Christian	Mahnert	Norwegian Institute of Wood Technology
9E	TESP - Engineering - Advancing the Circular Economy in Europe	Timber Engineering & Structural Performance - Engineering Focus	RECENT DEVELOPMENTS ON TAILORED LAMINATED TIMBER	The paper gives an overview of the research project InnoTLT and preliminary results. The aim of InnoTLT is to develop cross-laminated timber (CLT) into next generation Tailored Laminated Timber (TLT) by studying concepts to optimize the mechanical performance while, at the same time, assuring compliance with principles of a circular economy. A general objective is to reach a 20% improvement in performance-to-material usage ratio, in relation to standard CLT of today. Walls and floors are the main areas of studies, early results from these studies are presented. An approach for early product design in terms of real-time and combined evaluation of LCA and structural response is also presented. The results show a great potential for the industry to optimize their products, both in terms of technical performance, and in terms of environmental and climatic impact.	Erik	Serrano	Lund University
9E	STCE - Practitioner - Advancing the Circular Economy in Europe	Material Performance & Durability - Engineering Focus, Sustainability and Timber in a Circular Economy - Engineering Focus	AN INNOVATIVE FOUNDATION SYSTEM FOR TIMBER BUILDINGS: STEEL WELDMESH GABION BOXES INFILLED WITH AGGREGATES	An adequate foundation systems for timber buildings has to guarantee both bearing capacity and durability of the wooden elements, providing a clear separation layer between the ground and the upper structure. Commonly, designers use reinforced concrete (slab or beams) to realize this structural detail. Concrete foundations, often casted directly into the ground, provide an adequate solution but, at the same time, is in conflict with the main properties of timber constructions as prefabrication, lightness and low environmental impact. This paper presents an innovative prefabricated foundation system realized with steel weldmesh gabion boxes infilled with stone aggregates developed to be removed at the end of life of timber structure. The results of the experimental tests, conducted to characterize the mechanical behaviour of the foundation system, are presented in this paper.	Matilde	Benatti	National Research Council of Italy (CNR-IBE)
9F	TESP Engineering - Connections	Session Chair: NICHOLAS BENECKE / SPAX INTERNATIONAL					
9F	TESP Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	BEHAVIOUR OF PERFOBOND CONNNECTIONS IN TIMBER-CONCRETE COMPOSITES	Adhesively bonded plates in timber-concrete composites (TCC) are gaining popularity due to their high strength and stiffness. Such advanced mechanical performance is targeted for long span solutions with the use of timber as a construction material. In this work, perfobond connectors, commonly used in steel-concrete composites (SCC) have been investigated both at the connection and beam level by means of experimental tests. The results are then used to validate a finite element model and, subsequently, further complement the experiments in the understanding of the behaviour of TCC floor beams integrating these connectors. The study has concluded/highlights the properties necessary for a strong, stiff and a ductile perfobond plate.	Elif	Appavuravther	Hasselt University
9F	TESP Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	Experimental study on the performance of wood connections under simulated wind/earthquake rate of loading	This paper presents the effects of simulated seismic and wind loading rates on the performance of mass timber connections and light wood frame connections/systems. Monotonic tests and reversed cyclic tests were conducted on Cross Laminated Timber (CLT) connections, specifically spline joints, hold-down connections, and angle brackets. Furthermore, additional tests were conducted, including light wood frame stud-to-sheathing connections/walls, and Glulam-CLT diaphragm connections. For each configuration, two groups of specimens were tested under two different loading rates. One group was tested at a regular/standard rate of loading, resulting in failure within 5 to 10 minutes, while the other group was subjected to a high rate of loading, simulating seismic or wind loads, with failure occurring within 2 to 10 seconds. The results of the tests revealed that for most connections, the average peak load increased under the higher loading rate compared to the regular loading rate.	Jianan	Chen	University of British Columbia
9F	TESP Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	THE EFFECT OF SPECIMEN SIZE ON WETTING-INDUCED STRESS IN SELF-TAPPING SCREWS IN STEEL-TO-WOOD CONNECTIONS	When a steel-to-wood connection fabricated with self-tapping screws (STSs) is subjected to wetting exposure, due to the hygroscopic characteristics of wood, tensile stress develops in the STSs, meanwhile compressive stress arises in the wood. The wetting-induced stress may lead to the failure of the STS, typically characterized by the fracture of the STS. This type of failure has been typically attributed to the excessively long STS penetration and/or extensive increases of moisture content in wood. However, for a steel-to-wood connection with single STS, the size of the wood specimen may also play a critical role in the magnitude of the wetting-induced stress in STS and wood. In this study, numerical analysis was performed based on 8 mm and 13 mm diameter STSs, and wood specimens with different size were included. By investigating the relationship between the peak wetting-induced stress in STSs and the size of the specimen, size effect of specimen on wetting-induced stress in STS was revealed, which will facilitate the development of analytical tools for this problem.	Lina	Zhou	University of Victoria
9F	TESP Engineering Connections	Material Performance & Durability - Engineering Focus, Timber Engineering & Structural Performance - Engineering Focus	Enhancing Mechanical Performance of Dowel Laminated Timber through Dowel Configuration and Bolted System Integration	Dowel Laminated Timber (DLT) is an all-wood engineered product made from layers of laminae and hardwood dowels. DLT uses hardwood dowels driven into pre-drilled holes in laminae, as the dowels absorb moisture and expand, they mechanically fasten the layers together by friction. The primary function of wooden dowels is to secure laminae positions through volume changes and friction, maintaining DLT integrity and performance. Therefore, this study will explore improvements in DLT manufacturing process to optimize its mechanical performance. The species use as laminae and dowels are Japanese cedar and Taiwan acacia, both domestically sourced in Taiwan. Improvements to DLT performance are primarily achieved through two methods: (1) configuring the insertion angles of dowels to prevent laminae from loosening, and (2) increasing the number of dowels to increase the surface area that secures the laminae together. Additionally, this study will integrate with industrial products and propose a high-performance DLT that uses a bolted system in a non-adhesive setup. Performance enhancements in DLT will be assessed by experimental variables such as the angle of dowel insertion, the number of dowels, and differences in nut tightness.	Yu-Liang	Hsu	National Cheng Kung University

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9F	TESP Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	ADHESIVELY BONDED AND HYBRID CLT PANEL-TO-PANEL JOINTS	Cross-laminated timber (CLT) panels are increasingly used in floor construction with the individual panels often connected with self-tapping screws (STS) through surface spline, half-lap, and butt joints. An alternative solution is provided by using the TS3 technology which connects butt joints through adhesives and creates a near-rigid connection, enabling the utilization of the two-way resistance of CLT panels. However, TS3 joints fail in a brittle manner. In this study, the mechanical properties of screwed, TS3, and hybrid TS3-screw connections between CLT in the major and minor strength directions were investigated using out-of-plane 3-point and 4-point bending and in-plane shear tests. The tests showed that the failure is brittle for TS3 joints and ductile for STS joints, while the hybrid joints had similar stiffness as the TS3 joints and can reach similar ductility as the screwed joints.	Houman	Ganjali	University of Northern British Columbia
9F	TESP Engineering Connections	Timber Engineering & Structural Performance - Engineering Focus	Impact of Timber Growth Conditions on Screw Withdrawal Capacity	Ductility in timber structures is primarily achieved through connections. While the Australian mass timber industry is growing radpidly, the current Australian Timber Standard AS1720.1 – 2010 contains outdated connection design methods based on experimental research from the 1970s. European-made metal fasteners, such as self-tappings screws (STSs), are popular in Australian mass timber construction, but have shown discrepancies between experimental and predicted screw withdrawal capacity. It is therefore critical to examine the characteristic of Australian timber products that affect behaviour of European STSs to understand and better predict performance. This research is focused on a) identifying influencing factors of screw withdrawal capacity, b) establishing a link between timber origin, including the growth conditions, on withdrawal capacity, and c) evaluating predictive models to suggest improvements for current design standards such as AS1720.1 – 2010.	Lisa-Mareike	Ottenhaus	The University of Queensland
9G	TESP - Engineering	Session Chair: A/PROF BEATRICE FAGGIANO / UNIVERSITY OF NAPLES FEDERICO II					
9G	TESP - Engineering	Timber Engineering & Structural Performance - Engineering Focus	DEVELOPMENT OF RIGID STRUCTURES USING CROSS-SECTIONAL COLUMNS WITH STANDARD MATERIALS FOR WOODEN FRAME CONSTRUCTION	The purpose of this research is to develop a wooden rigid frame structure using standard materials and hardware. Using wooden frame construction method columns, the columns are fastened to each other in a cross-shaped cross-sectional view to form a cross-sectional column. The cross-sectional columns are used for the column portion of the gate-type rigid frame to form a wooden rigid frame structure. The parameters are the method of joining the columns and the distance between the screws for timber structures. The test results showed that the initial stiffness was low for all the tested specifications. This is due to compression perpendicular to the grain in the wood. Therefore, the current specifications have low initial stiffness, making it difficult to realize a cross-column rigid-frame structure. Therefore, it is effective to reduce compression perpendicular to the grain in the wood to improve the initial stiffness.	Ryota	Kawashima	Nippon Institute of Technology
9G	TESP - Engineering	Timber Engineering & Structural Performance - Engineering Focus	Machine learning-aided performance-based plastic design of multi-story cross-laminated timber buildings	The construction sector is a major contributor to greenhouse gas emissions, posing significant threats to ecosystems and human livelihoods, highlighting the urgent need for sustainable construction practices. Timber, particularly cross-laminated timber (CLT), presents a promising solution due to its ability to sequester carbon dioxide, offering an environmentally friendly alternative to concrete and steel. Recently, CLT made of rubber and coconut wood has successfully been developed. This research aims to apply the CLT material to develop innovative seismic-resistant structures. The research involves developing finite element models, performing nonlinear dynamic analysis (NRHA), and applying Machine learning (ML) to optimize structural design. Ultimately we propose a performance-based plastic design method for multi-story CLT buildings.	Eknara	Junda	Nakhon Pathom Rajabhat University
9G	TESP - Engineering	Timber Engineering & Structural Performance - Engineering Focus	New innovative resource-efficient timber-concrete-composite ceiling system – experimental and analytical investigations	Timber-concrete-composite (TCC) ceiling systems have enjoyed increased popularity in recent years. The fundamental concept involves utilizing materials based on their inherent properties: concrete to withstand the compression forces occurring at the top of the composite slab and timber to resist the tension forces occurring at the bottom. Of the many existing systems, a majority consists of a continuous concrete and timber layer with solid cross sections. In this paper, a newly developed TCC system focusing on the most efficient use of materials by creating a neutral, material-saving zone between the concrete and timber layers, is presented. In order to transfer the occurring shear forces between timber and concrete, special vault shaped molds are used as lost formwork to create shear cams. The first part of the paper deals with a brief introduction of the new system as well as the preliminary design process. Subsequently, large-scale experiments in the form of bending tests under a uniform distributed load are shown to determine the actual load-bearing behaviour. Initial results from small scale slip-block tests aimed at defining the shear performance, required for the later design process, are also discussed. The results serve as a foundation for further studies and for determining an appropriate design basis for this novel system.	Philipp	Holzhaider	0
9G	TESP - Engineering	Timber Engineering & Structural Performance - Engineering Focus	RELIABILITY EVALUATION OF TIMBER-CONCRETE COMPOSITE FLOOR SYSTEMS WITH RESPECT TO TIMBER SHEAR FAILURE	Timber-concrete composite (TCC) floors are popular design in mass timber buildings due to their enhanced acoustic and thermal performance. Self-tapping screws (STSs) are particularly effective connectors in TCC floors because they can provide a high degree of composite action. Despite their prevalent use, the structural reliability of TCC floors has not been properly evaluated. In this study, reliability analyses of a wide range of TCC floors with STSs as connectors were conducted using the first-order reliability method (FORM) with respect to timber shear failure. This paper discusses results from the reliability analysis study which was part of a larger study that considered all ultimate and serviceability limit states. The reliability indices of the timber shear limit state showed that the current design was unconservative when using the current resistance factor of 0.9 in the Canadian timber design standard. A resistance factor of 0.7 is more appropriate for timber shear design in TCC floors.	Yue	Li	University of Alberta
9G	TESP - Engineering	Timber Engineering & Structural Performance - Engineering Focus	DEVELOPMENT OF HYBRID MULTI-ANGLED LAMINATED TIMBER PLATE FOR MITIGATING ORTHOTROPY	Recently, as global efforts intensify against climate change and the pursuit of carbon neutrality gains prominence, timber is getting more attention for its low embodied energy. Accordingly, timber, as a construction material, is gaining popularity. Even though timber has excellent strength to weight ratio, among other properties, all the current engineered timber products are designed to carry load in one direction. Even cross-laminated timber is designed as beam element, while the cross-layer provides dimensional stability. For complex loading scenario, such as, bi-axial bending or membrane loading, various stacking sequence with different fibre orientation can overcome this limitation. This study focuses on developing structural timber element that mitigate the orthotropic effect by laminating thin timber veneers with different fiber orientation. The research aims to compare stiffness and strength of multi-angle laminated timber models against other conventional laminated configurations. The results indicate that multi-angle laminated timber exhibits relatively high stiffness compared to other models and approaches nearly isotropic properties.	Mahbube	Subhani	Deakin University

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9H	TESP - Engineering - Seismic / Vibrations	Session Chair: DR SARDAR MALEK / UNIVERITY OF VICTORIA					
9H	TESP - Engineering - Seismic / Vibrations	Timber Engineering & Structural Performance - Engineering Focus	EFFECT OF SPRAY-APPLIED RIGID POLYURETHANE FOAM ON SEISMIC PERFORMANCE OF TIMBER HOUSE	Rigid Polyurethane Foam (RPF) is widely used as insulation in Japan. Though the RPF is a non-structural member, it was said that there was a possibility it increases the seismic performance of plywood shear walls. For this reason, to clarify the effect of RPF, a static shear loading test of two plywood shear wall specimens was conducted, where one specimen was sprayed with RPF. Compared with the non-RPF plywood specimen, it was found that RPF confines the rotation of plywood. With the confining effect of RPF, the shear stiffness and the maximum shear force of the plywood specimen increased to approximately 170% and 130% respectively. To estimate the effect of RPF in an existing timber house, with the test result, the earthquake response of a two-storied timber house was calculated by the time history response analysis. The response story drift was 0.0230 rad without RPF, while the one with RPF was 0.0036 rad under the JMA Kobe earthquake wave in 1995. It came to be clarified that there is an effect of RPF on the seismic performance of plywood shear walls in this study, it is needed to estimate the influence of the thickness and temperature of RPF in further research.	Tomoki	Furuta	Aichi Shukutoku University
9H	TESP - Engineering - Seismic / Vibrations	Timber Engineering & Structural Performance - Engineering Focus	INFLUENCE OF FLOOR EFFECTS ON THE SEISMIC PERFORMANCE OF CROSS-LAMINATED TIMBER STRUCTURES	Despite the seismic performance of cross-laminated timber (CLT) structures having been widely investigated, detailed influence mechanisms of floors on seismic performance of CLT structures is still lacking. In this paper, the influence of nail-laminated timber-concrete composite (NLTCC) floors on the seismic behaviour of CLT structures was investigated. Nonlinear finite element models for CLT structures were developed, within the Open System for Earthquake Engineering Simulation (OpenSees). A series of parametric analyses was conducted, considering stiffness of wall-to-floor connections and in-plane stiffness of NLTCC floors. The structural mode shapes and periods were compared. The seismic performance, such as inter-story drift, displacement, and peak floor acceleration, were obtained from nonlinear dynamic time history analyses. The influence of stiffness of wall-to-floor connections and in-plane stiffness of NLTCC floors on structural seismic performance was quantified.	xiaowei	qu	Tongji University
9H	TESP - Engineering - Seismic / Vibrations	Timber Engineering & Structural Performance - Engineering Focus	FREQUENCY CONTRIBUTIONS TO DYNAMIC RESPONSES OF JOISTED TIMBER FLOORS: A WAVELET TRANSFORM APPROACH	Vibration performance of timber floors is a key aspect of designing this floor. Due to the lightweight property of the timber floors, the presence of imposed loads such as furniture can be expected to change the vibration performance of the floor. This study aims to evaluate the contribution of frequency bands to the vibrational performance of joisted wood floors due to the effect of different furniture arrangements. For this purpose, the study presents an experimental investigation of the dynamic responses of a joisted wood floor under human-induced excitation. Two signal processing tools, the discrete wavelet transform (DWT) and continuous wavelet transform (CWT), have been used to analyse the dynamic responses. The DWT decomposes a signal into different frequency bands and quantifies the contribution of each frequency band to the overall energy content of the signal. The CWT performs time-frequency analysis, offering a detailed insight into how the frequency content of the signal varies over time.	Mohammadreza	Salehi	Norwegian University of Life Sciences
9H	TESP - Engineering - Seismic / Vibrations	Timber Engineering & Structural Performance - Engineering Focus	ANALYSIS OF THE PREDICTED COLLAPSE DIRECTION TENDENCIES OF HOUSES CAUSED BY THE 2024 NOTO PENINSULA EARTHQUAKE	Recently, earthquakes have occurred frequently in the Noto Peninsula of Ishikawa Prefecture, resulting in significant damage to numerous wooden buildings. Japanese seismic standards have been continuously refined based on past earthquake experiences; however, the seismic performance required now is different from the standards in place at the time of the buildings' construction. A field survey conducted following the 2024 Noto Peninsula Earthquake revealed severe damage to wooden houses constructed before 1981. To predict seismic damages, it is important to find out the seismic performance of the existing buildings. In addition, it is necessary to obtain accurate structural characteristics of all the target buildings to evaluate their performance. Consequently, a survey utilizing the method proposed after the 2007 Noto Peninsula Earthquake was conducted to predict the structural damage to buildings following the 2024 Noto Peninsula Earthquake. In this study, limit capacity calculation and time-history response analysis were conducted by the analysis software "wallstat," incorporating seismic data from the 2024 Noto Peninsula Earthquake. The results of the analysis were compared to determine the tendencies of their seismic response to predict the typical structural damage in the Noto Peninsula.	Yuki	Hashimoto	Kyoto University
9H	TESP - Engineering - Seismic / Vibrations	Timber Engineering & Structural Performance - Engineering Focus	IMPACTS OF BEAM HANGER ROTATIONAL STIFFNESS ON COLUMN RESISTANCE AND LATERAL DESIGN OF POST-AND-BEAM FRAMES	Mass timber frames with deep beams are being increasingly adopted to reduce floor vibrations and deflections. At beam-to-column joints, pre-engineered beam hangers provide shear capacity and allow for fast installation. In current design practice, a pinned condition is typically assumed for such shear connections, permitting columns to be designed as axially-loaded members. However, when frames undergo lateral deflections, these beam hangers may display rotational stiffness due to various interlocking mechanisms, inducing bending moments to columns. Subjected to combined moments and axial forces, columns may provide a lower resistance than designed for. This issue has drawn concerns of building authorities and practicing engineers. In this project, beam-hanger-induced moments and their impacts on column design are investigated through finite element analysis and full-scale experimental tests on a one-storey two-bay frame. Parametric analyses are used to determine the influence of semi-rigid connections on the design of columns and the lateral-force-resisting system.	Fei	Tong	University of Northern British Columbia
9H	TESP - Engineering - Seismic / Vibrations	Timber Engineering & Structural Performance - Engineering Focus	EVALUATION OF SEISMIC PERFORMANCE OF MID-RISE TIMBER BUILDINGS WITH SLIDING BASE SYSTEM	This research proposes a sliding base system for mid-rise timber buildings and evaluate its seismic performance by the time history seismic response analysis. The sliding base system is one of the base isolation system, consisting of base concrete, sliding materials, and raft foundation. The case study building is a four-story timber frame building designed in accordance with the Japanese building standard act. A two-dimensional model for the case building was developed in OpenSees to perform time history response analysis. The sliding base was modelled by Coulomb friction elements to consider the variation of friction forces caused by pressure variation between the sliding elements. The coefficient of friction was set to 0.2 based on the mechanical property of the sliding material. The maximum story drift angle and acceleration response of the building subjected to severe earthquakes were significantly reduced by installing a sliding base system, indicating that the proposed system is effective to enhance seismic performance of mid-rise timber buildings. This result provides practitioners with alternative solutions for timber buildings constructed in earthquake-prone areas.	Al	TOMITA	Kyoto University
9I	ECCS - Architectural	Session Chair: PROFESSOR GREGORY NOLAN / UNIVERSITY OF TASMANIA					

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9I	ECCS - Architectural	Sustainability and Timber in a Circular Economy - Architectural Focus, Exemplars & Construction Case Studies - Architectural Focus	DIGITAL ARTISAN: AUGMENTED REALITY AIDED UPCYCLING FOR RECLAIMED TIMBER BOARDS	This research employs augmented reality (AR) to assist artisans in upcycling reclaimed timber boards into free-form structures. It proposes a tailored AR-aided workflow that prioritizes human judgment and creativity in construction processes by evaluating different scenarios. This cyclical workflow iterates through surveying, nesting, cutting, and assembling. The approach bypasses the need for extensive inventory management and labeling processes by surveying limited knowledge of the material stock in each iteration. With the assistance of AR, artisans can make intuitive decisions on material nesting and get clear instructions for cutting and assembling. The AR application involves visualization, model processing, user interface design, and algorithm development, fostering an environment that values human input alongside technological advancements. It visualizes nesting boundaries and material efficiency, documents nesting patterns, updates cutting lines, and designates assembly locations, thus ensuring a seamless integration of digital feedback into the physical construction process. Overall, the proposed workflow facilitates the integration of digital and physical processes, revealing the potential of AR technology in advancing circular construction practices.	Qiming	Sun	ETH Zurich
9I	ECCS - Architectural	Sustainability and Timber in a Circular Economy - Architectural Focus, Timber Engineering & Structural Performance - Engineering Focus, Exemplars & Construction Case Studies - Architectural Focus	Inventory-Constrained Design Method for Whole Tree Branching Structures	Timber sourced from plantation forests is an in-demand resource, being natural, renewable, and possessing low embodied carbon.However, it is a finite resource, so the efficient material and structural use of timber in architecture is essential for maximising economic and carbon storage value.This paper introduces a digital design methodology for branching structures, aiming to design a branching structural system supporting a given canopy area and constructed from a given inventory of whole trees. The proposed methodology encompasses three key stages: space-filling canopy distribution, branching topology generation, and inventory-constrained form-finding. The latter is based on the Combinatorial Equilibrium Method (CEM) and incorporates a material length constraint such that each structure uses a single entire tree from a forest inventory. The developed digital design tool could be applied to case studies, using material efficiency benchmarks for inventory utilisation and residue waste generation from part processing. Findings of this study support improved material design efficiency in timber and whole timber construction.	Joe	Gattas	The University of Queensland
9I	ECCS - Architectural	Sustainability and Timber in a Circular Economy - Architectural Focus, Exemplars & Construction Case Studies - Architectural Focus	Bloque M-Experimental: Timber as an alternative to build housing projects in Colombia.	Bloque M-Experimental is a 4-story multifamily housing project, built in timber. The 11.5 meter high structure was built with columns and glulam timberen beams up to 12.5 meters in length. Walls and floor plates are a mixture of solid timber and OSB sheets. It is the first housing building fully designed and built in timber in Colombia, and possibly one of the few experiences in South America. The design process began in 2013, as a laboratory to demonstrate that timber could be a technical and financially viable alternative, compared to traditional concrete and ceramic masonry technologies. With the development of the project, problems related to structural calculation issues, construction license, availability and supply of timber, labor, construction process, facilities, finishes, acceptance by users, etc. were identified. The project was completed and began to be inhabited in February 2018. Within the results obtained, it was demonstrated that a housing project with these characteristics was technically and financially feasible to build. The final cost, considering that it is the first building of its kind, was similar to one built in concrete and masonry.	Diego	Velandia	Universidad de Los Andes.
9I	ECCS - Architectural	Exemplars & Construction Case Studies - Practitioner Focus	Green Commons - APU new university building , Beppu, Oita , Japan	“Green Commons”, Ritsumeikan Asia Pasific University(APU), is a university building in Beppu City, Oita Prefecture. The symbol of this building is the three-story Atrium in the center called "Commons", which is designed with a wooden frame structure that have the warmth of wood and openness. Glued-in-rod connction are used for the column-beam joints. Large spans are achived by using semi-rigid joints in the gable roof structure and the Vierendeel structure.	Yasuhito	Kinoshita	Takenaka Coporation
9I	ECCS - Architectural	Timber Engineering & Structural Performance - Architectural Focus, Exemplars & Construction Case Studies - Architectural Focus	Grafting of Traditional Chinese Roofing Structures among Modern China’s Catholic Church Buildings in the Late 19th Century from the Lens of Ningbo Jiangbei Church	The late 19th century marked a significant transformation in China's society, transitioning into a semi-colonial and semi-feudal society. The influx of Western culture and architectural technology had a significant impact on indigenous traditional Chinese construction. Church buildings in this era, as symbols of Western culture, combined Western and Chinese architectural elements and techniques, forming a unique architectural style. Based on the Ningbo Jiangbei Church, compared with other Gothic churches in the same era(1840-1919), the study highlights how Western and Chinese architectural elements were grafted, particularly in the use of traditional Chinese roofing structures. The research reveals that despite the Gothic facade, the church maintained significant traditional Chinese architectural features, reflecting the adaptability of Chinese construction techniques to meet Western design requirements. These buildings, to some extent, demonstrate the attitudes and responses of traditional craftsmen to foreign technological influence, providing clues for the development of modern Chinese timber architecture. The application of traditional frameworks in modern buildings also heralded the transition of traditional timber structures towards modern adaptations.	Rongzhu	Gu	Shanghai Jiao Tong University
9I	ECCS - Architectural	Exemplars & Construction Case Studies - Architectural Focus	Living House – CLT Affordable, fast to build and Carbon Zero House	The scope of the project was to develop an affordable 3-bedroom house that could be built in 6 weeks and achieve negative carbon whole of life certification. The proposal develops a 36 CLT panel ‘flat pack’ CLT mass timber house that has been optimised to become an ultra-low labour, fast-to-build house. The average NZ traditional timber frame house cost is 40% labour, 60% materials, Living House is only 10% labour. The average cost of a government-built 3-bedroom house in NZ is NZ$585,000, and a Living House is NZ$335,000. In April 2025 we completed building a prototype house in Rotorua, NZ. It was proven that it could be completed in 6 weeks for NZ$335,000 and it has been certified negative 140kg/CO2/m2.	Rich	Naish	RTA Studio