

Architecture 595 – Mass Timber Building Systems

Instructor: Paul Fast, Founder, Fast + Epp, Gertrude Lempp Kerbis Fellow

Illinois School of Architecture, University of Illinois at Urbana-Champaign



(TallWood House UBC, photo credit: Seagate Structures.)

Course Description: Timber, particularly mass timber, is an emerging material within North America and as building structure is cultural, visual, and experiential. It is a sustainable material that becomes a predominant design element due to its scale, exposed surfaces, and haptic qualities. To take advantage of the character of mass timber, architects need exposure to the technical aspects of the material and become fluent in the design of this particular material and construction system. This technical course will prepare the students to enter the design industry well equipped with a knowledge of mass timber and its potential. The course is of particular importance given the green building goals in the built environment and increasingly being put in place by building owners and governmental authorities.

The course seeks to strike a balance between theory and practical application. Students will learn aspects of mass timber design including knowledge of various products, their respective strength characteristics, and the metrics used to measure the sustainability of mass timber products. Mass timber structural systems will be introduced through architectural and structural requirements.

Student learning will be enriched by the presentation of case studies from various building sectors including built work in the commercial, low and high rise residential, transportation and

institutional industries. Finally, a capstone project that will prompt students to apply their learning to the design of a project with defined constraints using mass timber

In this project, students will provide preliminary design for structural systems, integrate building systems, investigate procurement and sourcing plans of mass timber, explore the construction and erection methods, and conduct an embodied carbon study of the system they designed.

The course will be led by an engineer with significance design experience with the material and include multiple guest lecturers from the industry. This course is currently being tested and developed at the School of Architecture as an experimental course. The course will need to be refined, learning objectives solidified, and assignment further developed. Additionally, the course will be transitioned from the experimental stage to a more permanent offering. The organization, the inclusion in the curriculum, and instructor roles will be considered.

COURSE TOPICS

Brief History of Timber Construction in North America – Early 1990’s – 2021	Early 1900’s timber construction, advent of glue-laminated timber, development of engineered wood products and the development of mass timber.
Material Options	The various material options including nail-laminated, dowel laminated, glue laminated and cross laminated timber panels. The material characteristics and benefits of each product.
Case Histories: Nail-laminated Projects	A first-hand look at several projects using nail-laminated timber, why it was selected as material of choice and lessons learned from its application.
Gravity Design of Mass Timber	System uses and pros/cons of each mass timber framing system and when a hybrid approach should be considered. Preliminary design of column, beam, and panels for gravity loading and vibration considerations.
Lateral Design of Mass Timber	Lateral force resisting systems that are commonly paired with mass timber gravity systems, including CLT shearwalls, timber braced frames, steel braced frames, concrete cores, and more.
Case Histories: GLT	General product info, structural behavior, acoustic and fire performance, advantages & disadvantages of GLT. Project case studies completed by Fast + Epp.
Connections	Approaches to typical connections in mass timber buildings, including typical conditions, proprietary connections and custom fabricated connections.

Fire/Code/Acoustic Considerations	Fire protection for mass timber buildings and how to detail to suit the code. Review acoustic assemblies and associated STC and IIC ratings.
Case Histories: Housing (Hybrid)	Hybrid projects that include design drivers, constraints, outcomes, and procurement process.
Embodied Carbon and LCA	Embodied carbon and life cycle assessment, the life cycle stages of building materials, phases of analysis, material considerations, and carbon impacts of design decisions.
Carbon Considerations for Timber	A discussion of biogenic carbon, understanding the role of sustainably managed forests, and exploring the policy mechanisms that can be put in place to contribute towards building a global carbon sink.
Tall Wood Buildings (Keith Drive and Intro One)	The challenges of tall wood buildings such as fire, code, wind induced vibrations, large columns, etc, along with strategies to overcome them. There will be discussion on “how tall should you go, how tall could you go?”
Case Histories: Commercial	The design of the Walmart Home Office and outline how the scale of the project affected design decisions including: testing of components, detailing connections, the drawings, and structural system.
Case Histories: Composite Concrete Mass Timber	The full structural and architectural design of The Arbour – a timber-concrete-composite structure will be presented with a focus on the structural system, the architectural expression, and sustainability strategies.
Digital Project Delivery	The unique digital delivery requirement on mass timber projects from concept design through construction, including BIM, computational design, and digital models in quality control, fabrication, and delivery.
Case Histories: F+E Home Office	Case study on the Fast+Epp Home Office highlighting the various building innovations including CLT shearwalls and seismic dampers, CLT firewalls, vibration testing and electrochromatic dynamic glazing system.

Selected Readings and Other Sources

- + Systems in Timber Engineering, Josef Koib, Birkhauser: Basel, 2008;
- + Solid Wood, Joseph Mayo, Routledge: New York, 2015;
- + 2021 International Mass Timber Report, found here <https://www.masstimmerreport.com/>
- + Guest speakers will include architects and engineers with extensive experience in the design of mass timber projects.