WATER CONTROL DESIGN STRATEGIES: A FOCUS ON EXTERROTED ENCLOSURES

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The purpose of this research is to present design strategies that support the longevity of mass timber structures through effective envelope design. Multistory timber construction systems are increasingly being utilized as a sustainable alternative to traditional steel-frame or concrete structures, but require thoughtful moisture control detailing to ensure their long-term integrity. While mass timber systems were initially conceptualized as “mass” systems, modern design trends and building marketability favor “exterroverted” forms with plenty of exterior glazing, balconies, and skylights. These “exterroverted” features interrupt the continuity of protective envelope assemblies and so require attentive detailing to ensure their durability. Building enclosure systems are analyzed by their degree of “exterversion”, implemented structural system, and incorporation of specific durability strategies through case studies. These case studies have been selected for their effective detailing of exterroverted assemblages across a range of archetypal forms. In the process of researching these durability techniques, I analyzed construction details and interviewed designers for first-hand information.

INTROVERTED

EXTROVERTED

Abstract

Generational changes in the typology of mass timber structural systems have been identified with a trend towards increasing openness, interior/exterior connection, and greater architectural expression. Structural strategies have evolved from "introverted", column: fully panelized systems to "exterroverted" post-and-beam systems. In panelized schemes, the envelope is an integral part of both lateral and load-resisting systems. With post-and-beam systems, the envelope becomes isolated from the structure.

Deflection

This is any design strategy that prevents water from making contact with the wood. This is the most critical aspect of durability design, as other strategy can compensate for inadequate deflection. At the scale of the entire building, this can present as overhangs or other protective mechanisms. At the elemental level, flashing can provide deflection.

Distance

Mass timber structures should be situated above ground level to prevent contact with moisture in the earth. At the scale of the building and assemblies, this is usually achieved with a concrete podium, terraces, or basements. At the structural level, allowances and evaluative non-water-proof vulnerabilities, like the end grain of CLT panels, in additional examples in situations such as inlets prone to the attack of moisture, which create distances between timber elements and cover their stakes.

Drainage

Envelope assemblies can include secondary drainage planes behind the cladding. This, along with weepholes, creates an exit path for water that may end up within the assembly. Point drainage can be created within the envelope assemblies can include secondary drainage planes behind the cladding. This, along with weepholes, creates an exit path for water that may end up within the assembly. Point drainage can be created within the envelope assemblies can include secondary drainage planes behind the cladding. This, along with weepholes, creates an exit path for water that may end up within the assembly. Point drainage can be created within the envelope assemblies can include secondary drainage planes behind the cladding. This, along with weepholes, creates an exit path for water that may end up within the assembly.

Drying

In service areas or other circumstances may need not adapt to the mass timber structure in contact with water. Fundamentals cascade through structures to dry out. As an example, stripping within GLT roof assemblies provides a gap for air to circulate, creating opportunities for drying and vapor diffusion.

Durability

The timber’s ability to withstand degradation can be enhanced with preservatives and water-repellent coatings. These will require reapplication over time. Certain species of timber, especially the timber’s ability to withstand degradation can be enhanced with preservatives and water-repellent coatings. These will require reapplication over time. Certain species of timber, especially

Methods

Case studies were chosen according to the following criteria: 1) Projects were pioneers or champions of CLT and other mass timber products in their context 2) Availability of archival data and willingness of designers to share more detailed information 3) Location within a climate zone that experiences relatively high levels of precipitation (see fig. on right) 4) Presence of horizontal, load-bearing CLT panels as an integral (and potentially vulnerable) part of the exterroverted system.

Analysis of case studies was conducted through interviews with designers, reviews of published work, and reviews of construction documents. In most cases, unsupervised documentation was generously provided by the firms to assist in analysis. Interviews were semi-structured and based around three main questions regarding the firm’s previous design projects and the degree of "extroversion", implemented structural system, and incorporation of specific durability strategies through case studies. These case studies have been selected for their effective detailing of exterroverted assemblages across a range of archetypal forms. In the process of researching these durability techniques, I analyzed construction details and interviewed designers for first-hand information.

Conclusions

Comparison of the case studies revealed decreased interdependence of structure and envelope, leading to some cases of disorganization of the enclosure (case studies 5 and 6). As a result, designers frequently had to account for differential movement, long-term deflection, and other factors in the longevity of each assembly’s long-term integrity. This has also necessitated a multi-scale approach to water control systems: beyond the overall performance of the building, structures must be protected at each connection, joint, and transition. In addition, CLT within this studied context is subject to different construction standards, and industry knowledge management than in its native context within Europe. This departure has introduced a need for innovation within North American mass timber construction. At the project level, innovation on water control solutions in some form, and frequently rely on consultants, research bodies, code officials, and legislators to pioneer mass timber projects using CLT. Though long-term performance monitoring and performance data is not yet available, the design process was consistently informed by consultants from outside the architecture firm. In the most innovative cases of mass timber design (for example, the Glenwood Parking Garage, which is almost completely unenclosed), collaboration with engineers, mass timber product manufacturers, and mass timber research bodies was essential throughout the entire design process. The traditional, sequential model of a design-build approach is not the best option for innovative and effective approaches to moisture management in mass timber structures. A collaborative, design-build approach should be utilized to optimize the durability of the structure.

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