“Completing the Cycle” with Hardwood CLT: Innovation in material development and utilization

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Abstract

The New River Train Observation Tower design-build project utilizes custom-fabricated hardwood cross-laminated timber to construct an ADA accessible viewing tower in Radford, Virginia. The project showcases hardwood CLT research that positions the engineered biomaterial as a potential key asset for circular carbon economies and low-carbon construction. The study investigated the local sourcing, pressing, CNC fabrication, prefabrication, and exterior utilization of hardwood CLTs made with low-grade, locally-sourced Yellow Poplar. The project is the first example of prefabricated hardwood CLT construction in the United States and serves as an initial full-scale exterior test of fabrication and decay-prevention processes for the building product. Natural preservatives including a pine-tar-linseed-oil mix and wax were used to protect the CLT. BIM technologies such as Revit and Tekla were used to optimize the fabrication, shipment, and on-site assembly processes. The project illustrates that the upcycling and distributed manufacturing of locally-sourced, engineered biomaterials can provide novel architectural opportunities while enhancing local economies.

Keywords: Cross-laminated timber, Low-carbon construction, Design/Build, Materials + Construction Techniques

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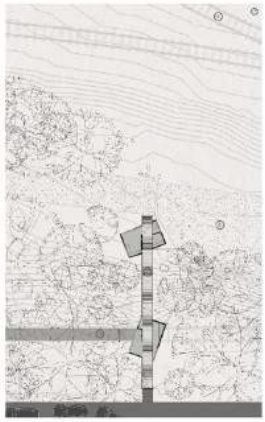

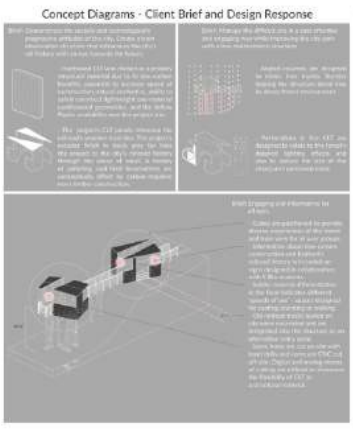

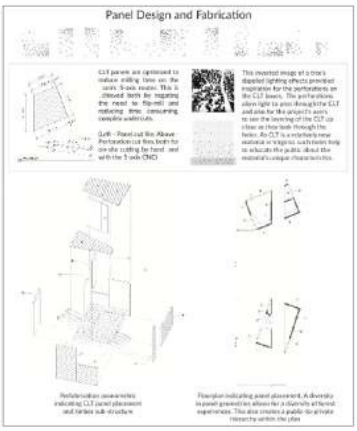

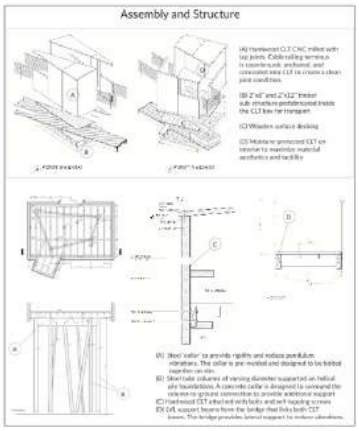

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Innovation in material development and utilization

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A primary benefit of cross-laminated timber (CLT) utilization occurs when low-value, sustainably-harvested timber can be upcycled into CLT – a high-value building product – benefiting rural economic growth while also lowering both construction time and carbon emissions from construction in urban areas. As construction costs in urban areas are lowered through rapid construction with CLT, more of the high-value product is purchased from nearby rural areas. When functioning optimally, this cyclical process of sourcing and utilization has demonstrated that CLT holds the potential to be catalytic to a wide array of associated entities, particularly when all entities are located in the same geographic region.

Considering that only softwood CLT is recognized by code but hardwood forests comprise a significant portion of the US forest stock, how can one 'complete the cycle' locally when code-compliant CLT made with softwoods must often be imported from great distances?

The Radford Train Observation Tower in Radford, Virginia demonstrates that such a "completion of the cycle" can be achieved in locations across the United States through the development of location-specific CLT. For this particular design-build project, locally sourced, locally tested, locally pressed, and locally utilized hardwood CLT panels that meet ANSI certification standards were developed for the project, the client a city attempting to transition their industrial image towards one of low-carbon, clean technologies. In coordination with specialists from wood science, structural engineering, building construction, and sustainable biomaterials, along with CLT pressing and fabrication expertise from the Southern Virginia Higher Education Center, the cross-disciplinary team designed a structure that not only showcases the use of a novel material, but also a structure that displays the first use of modular, prefabricated hardwood CLT construction in the United States, as well as the first use of hardwood CLT as a spatial enclosure system. The CLT was pressed on a custom-modified plywood press with Virginia Tech student's helping to cut the Yellow Poplar lamellae and apply the two-part structurally-rated glue themselves.

The ADA-accessible structure rests on helical pile foundations and is composed of a substructure of 'dancing' steel columns with two 10' x 15' modular, prefabricated hardwood CLT boxes above. The angular columns that appear to be dancing are intended to demeterialize the structure in its forest environment while the CLT boxes – lifted into place and set atop of the steel by crane – are perforated with CNC and hand-cut holes. Such perforations in the CLT allow the public of all ages and heights to playfully peer into the forest beyond. The dual perforation process of machine and hand-cut holes illustrated to the public that CLT is a durable yet malleable material. The structure extends over a steeply sloping site with the furthest horizontal point positioned 28' in the air. During an event in which the local community helped to clean the site, a civil-war era rail line was discovered that has been incorporated into the design as an access path, crushed stone being placed between the parallel rails. Community involvement, a multi-disciplinary project team, the development of a novel building material, and the deployment of unique prefabricated assembly processes comprise a successful attempt to "complete the cycle" in a hardwood-dominated context. The project is expected to be completed in Summer 2019 and has received an AIA design award for both design and material development and utilization.

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