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Cross-laminated Timber: An Innovative Building Material Takes Hold in Oregon

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An innovative building material takes hold in Oregon

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Figure 1: Albina Yard, a 16,000 sq. ft. creative office building currently under construction in North Portland's vibrant Mississippi District, is being constructed with CLT. Courtesy of LEVER Architecture

In a rapidly urbanizing world fueled by the enormous demand to house and shelter billions of people in the upcoming decades, building materials must be utilized that have a lighter climate impact than today's commonly used energy-intensive building materials.

Is there an alternative to the energy-intensive concrete jungle that is both sustainable and financially viable? How can our built environment enhance, rather than destroy, the natural environment? Part of the solution lies in a recent innovation that uses one of the world's oldest building materials, wood, with a modern twist: cross-laminated timber, often abbreviated as CLT. These wood-based structures can create an integration between the urban built environment and the natural world.

Cross-laminated timber is a wood panel consisting of multiple layers of lumber oriented at right angles to one another and then bonded together

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with glue adhesives to a solid, straight rectangular panel. Structurally, this is a much stronger material than conventional wood structures that consist of smaller components such as two-by-fours tied together by plywood and plaster board. The Portland region has become a national leader in promoting this material, fostering research, production, and innovation in constructing buildings that utilize CLT. The region is such a focal point for CLT research that the 2016 International Mass Timber Conference was held in Portland, and is scheduled to occur again in Portland in 2017. This conference attracts the world's leading industry professionals in research, production, design and construction of mass timber products. In addition to being a leader in CLT research, the Portland region is one of the first American cities to support the construction of all- wood mid-rise buildings.

Portland's position as a hub of CLT production, research and design is important because local leaders are increasingly concerned about addressing pent-up demand for building construction while ensuring that these buildings are constructed with materials that have a lighter climate impact than energy-intensive materials such as steel or concrete.

Construction and operation of buildings are responsible for up to 40 percent of global energy use, and at least one third of the anthropogenic greenhouse gas (GHG) emissions. This is primarily due to fossil fuel consumption in building operations such as heating, cooling, and lighting. Thus, the large carbon footprint of buildings must be reduced for the world to address climate change. Concrete and steel, which are the primary building materials for commercial structures, have a large carbon footprint and use highly energy-intensive foundation materials. Carbon dioxide is the world's dominant greenhouse gas, and concrete production is responsible for eight percent of CO2 emissions.

Trees foster carbon sequestration by utilizing the sun's energy to convert carbon dioxide to oxygen while storing the carbon. The reduction in carbon emissions occurs when the trees are sustainably harvested to be used as wood products. After a tree has been harvested, 50 percent of the weight of the wood is carbon. The wood stores carbon until it begins to decompose, meaning the more structures built out of wood, the more carbon is stored, which in turn reduces the greenhouse gases in the atmosphere.

Engineered wood is becoming an increasingly viable sustainable alternative to typical steel or concrete structural systems needed to support dense, urban buildings. Imagine a future city where the forest is sustainably reproduced in an urban cityscape of timber skyscrapers; the concrete jungle is replaced with an ecological urbanism consisting of wooden structures woven together with landscaping and green infrastructure.

Numerous local and national grant programs have incentivized the advancement of CLT research and production. Oregon BEST, which funds and supports Oregon cleantech startups, and a newly established collaboration between Oregon State University and the University of Oregon called the Center for Advanced Wood Products Manufacturing and Design are working to

CLT was originally created in Europe in the early 1990s. It consists of panels with multiple layers of wood oriented crosswise that are bonded with structural adhesives, and pressed to form a solid, straight, rectangular panel. Finished CLT panels are typically from two to ten feet wide, with lengths up to sixty feet and thickness up to twenty inches. This allows it to be used for long spans in floors, walls, or roofing. The prefabricated nature of CLT panels makes them fast and easy to install, generating almost no waste on the job site. CLT panels are prefabricated with pre-cut openings for doors, windows, stairs, service channels, and ducts, and shipped directly from the manufacturer where they can be quickly and efficiently lifted into place. The panels are shipped with preinstalled lifting straps to effectively utilize the just-in-time construction method and provide substantial savings on construction timelines, creating financial viability for the innovative building material. The strength of the material supports a taller, mid-rise building typology compared to the four or five story maximum height supported by traditional wood construction.

Figure 2: CLT wood panel. Photo courtesy of ReTHINK Wood

support expansion of Oregon's capacity to manufacture CLT.

Framework, a twelve-story wood building scheduled to open in Portland's Pearl District at Northwest Tenth Avenue and Northwest Glisan Street in early 2018, was one of two projects to win a $1.5 million prize at the U.S. Tall Wood Building Prize Competition, a contest sponsored by the U.S. Department of Agriculture, the Softwood Lumber Board, and the Binational Softwood Lumber Council. Framework's design is intended to showcase the nature of an innovative mass timber structure at both the street level and on the city skyline. The building mass is split around a central vertical core and lifted at the north street corner to create a double height daylight community space that showcases the building structure and brings together the main entrances into the retail, housing, and office spaces.

The project architects, LEVER Architecture, articulates a vision of utilizing CLT as part of a symbiotic cycle between natural resources and the rural industries that rely on these resources. Principal architect Thomas Robinson says, "Oregon produces an incredible amount of wood, and most of it is exported overseas. CLT provides an opportunity to leverage the value produced from rural communities into a sustainable building model in urban areas. This relationship completes and perpetuates a sustainable lifecycle."

LEVER Architecture also designed the Albina Yard building, which is a 16,000-square-foot office building in North Portland on North Albina Avenue. The building is the first to use American-produced CLT as a building-

Figure 3: Framework building rendering, Portland OR. Courtesy of LEVER Architecture

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wide structural system. The wood materials create a building that exudes a natural, vibrant aura. "People like to be in wood buildings," says Robinson. "They have character, and create healthy environments since fewer chemicals such as paint go into these types of buildings."

Forest policy advocates based in Portland believe that CLT can provide a sustainable building material while reinvigorating rural forest production. Timm Locke of the Oregon Forest Resources Institute has long advocated for the sustainable environmental impacts of wood construction. He says that the net carbon emissions associated with producing a ton of softwood lumber is 33 kg carbon per metric ton. For comparison, a ton of recycled steel results in 220 kg carbon per metric ton and poured concrete is 265 kg carbon per metric ton. "Because of this huge discrepancy in embodied energy, the carbon savings from simply using wood instead of concrete as your primary building material can offset decades of emissions associated with the building's operation," says Locke.

In addition to the carbon-sink function that wood buildings provide, the material can have a positive impact on proper

Figure 4: Albina Yard, Portland OR. Courtesy of LEVER Architecture

utilization of forest resources. Modern, scientific forestry is sustainable and subject to regulatory rigor. Harvested trees in the Pacific Northwest are required to be replanted, which increases the vitality of the forest.

CLT will play an important role in sustainable forest management because it can be manufactured using limited-value trees with diameters as small as four inches, including many dead trees. National forests on either side of the Cascades are filled with thin thickets of Western hemlock, Douglas fir and other trees that are conducive to wildfires and pest outbreaks. Harvesting thin trees is not normally economically feasible because they have so little value, and federal and state forest managers don't have the budget to clear them. These lower-grade trees can be incorporated into CLT panels giving economic viability to at-risk forest materials. The composite nature of CLT panels provides an important outlet for these diseased or damaged lower-quality trees that otherwise present substantial forest fire risks.

D.R. Johnson Wood Innovations located in Riddle, Oregon, recently became the first manufacturer in the United States to receive certification from the American Plywood Association (APA) to produce cross-laminated timber. Instead of Oregon lumber being exported,

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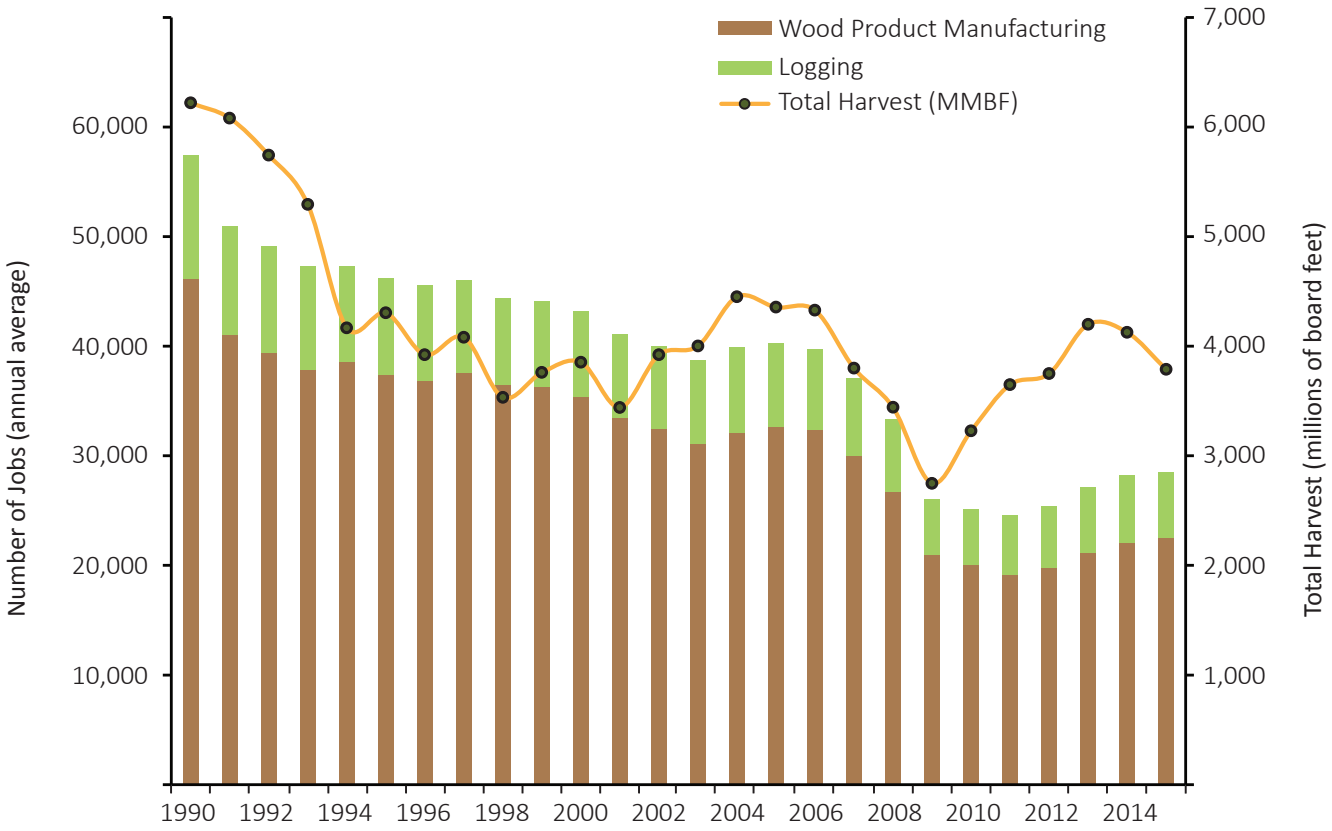
CLT constructed buildings can help keep materials in the local life cycle and decrease shipping costs.

Post-tensioned concrete is the most common structural system currently used for mid-rise commercial construction between approximately six and twelve stories tall. CLT construction is specialized and as a result requires primarily crane operators and carpenters, while post-tensioned concrete requires an array of workers to set the structural framework, lay the rebar and tensioning cables, and to pour the concrete. The CLT construction process is efficient due to the prefabricated timber panels, allowing a simpler, more efficient construction timeline. This will help alleviate a difficult labor issue commonly reported among developers in the Portland market: an increasingly limited supply of available construction workers to meet high construction demand in a booming development cycle. This highlights a labor mismatch in Oregon: while development firms in the Portland area struggle to fill construction jobs, rural Oregon continues to experience economic stagnation and high unemployment despite the overall thriving Oregon economy. CLT could potentially transfer the labor demand from the labor-constrained Portland market to desperately needed rural timber production jobs. Figure 5 shows that employment in logging and wood

Figure 5: Employment and timber harvest levels, Oregon, 1990-2015



Sources: Oregon Current Employment Statistics; Oregon Department of Forestry

product manufacturing in Oregon is not keeping pace with the increase in timber harvests.

The carbon sequestration potential of CLT has led to unprecedented collaboration in the Pacific Northwest between architects, conservationists, forest managers, and rural communities. For example, the Washington environmental group Forterra has created a coalition that hosts leadership summits focused on advancing CLT and other similar heavy timber product usage in the Pacific Northwest. This coalition building will be important in promoting collaboration between sustainability advocates, the forest industry, and the development field. Forterra's government affairs director Leda Chahim describes the impetus for this urban and rural coalition: "If rural timber communities are to flourish in the future, they need opportunities to rebuild robust economies resilient to economic and political change. Promoting CLT can create a linkage that addresses the growth in urban cities in a sustainable manner while reinvigorating rural areas with needed timber production jobs."

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Cross-laminated timber presents a triple net solution to urban design, environmental, and housing affordability challenges. The planet benefits from the carbon sink of wood buildings while also promoting sustainable forest management. CLT also presents a social opportunity by promoting desperately needed rural timber production jobs. Finally, the pre-fabricated material addresses the needed profit margin in a capitalist real estate development industry by providing financial savings from reduced construction times. By merging the forest with the city, cross-laminated timber will play a key role in a sustainable, financially viable, and high-quality future built environment.

Figure 6: A logging truck near Brightenbush, Oregon. Courtesy of Wonderlane / Flickr