Finishes protect the cross-laminated timber (CLT) at the DPR Construction headquarters in Sacramento, the first CLT structure in the city.

Photo courtesy of Sansin Corporation.
Architect: SmithGroup.

COATINGS & ENGINEERED WOOD

A Necessity or a Luxury?

By Sjoerd Bos, Managing Director, Sansin Corporation

As wood buildings rise ever taller, we are reminded how flexible, strong and beautiful wood is as a building material. For architects, wood presents the opportunity to get creative with buildings in ways that aren't possible with steel or concrete.

According to ResearchAndMarkets.com, the global cross-laminated timber (CLT) market was valued at $664M (USD) in 2018 and is projected to reach $1.4M (USD) by 2024. Overall, tall timber construction is gaining in popularity for several reasons, ranging from economic and aesthetic to environmental.

Tall timber structures offer strong seismic and wind performance, and wood's natural properties—combined with the sheer size of the wood—lead to fire resistance. This is especially true for mass timbers due to charring and the fact that wood actually gets stronger as it dries from heat.

From an economic standpoint, mass timber allows for pre-fabrication, leading to shorter construction schedules and reduced costs. Environmentally, wood is the only building material that has the ability to remove carbon from the atmosphere throughout its lifecycle, even after disposal when wood fiber is recycled.

Another encouraging development is that the building code is lining up to support more mass timber construction. Starting in 2021, the International Building Code will allow for buildings between nine and 18 stories, depending on the exposure and fire-resistance of the wood.

Aside from structural advantages, wood is simply beautiful. If it were not for rain, wind, sun or snow, we would all let wood just weather naturally. However, architects and building owners want the wood to look beautiful over the life of the building. This is where a coating system plays an important role from construction to the grand opening and beyond.

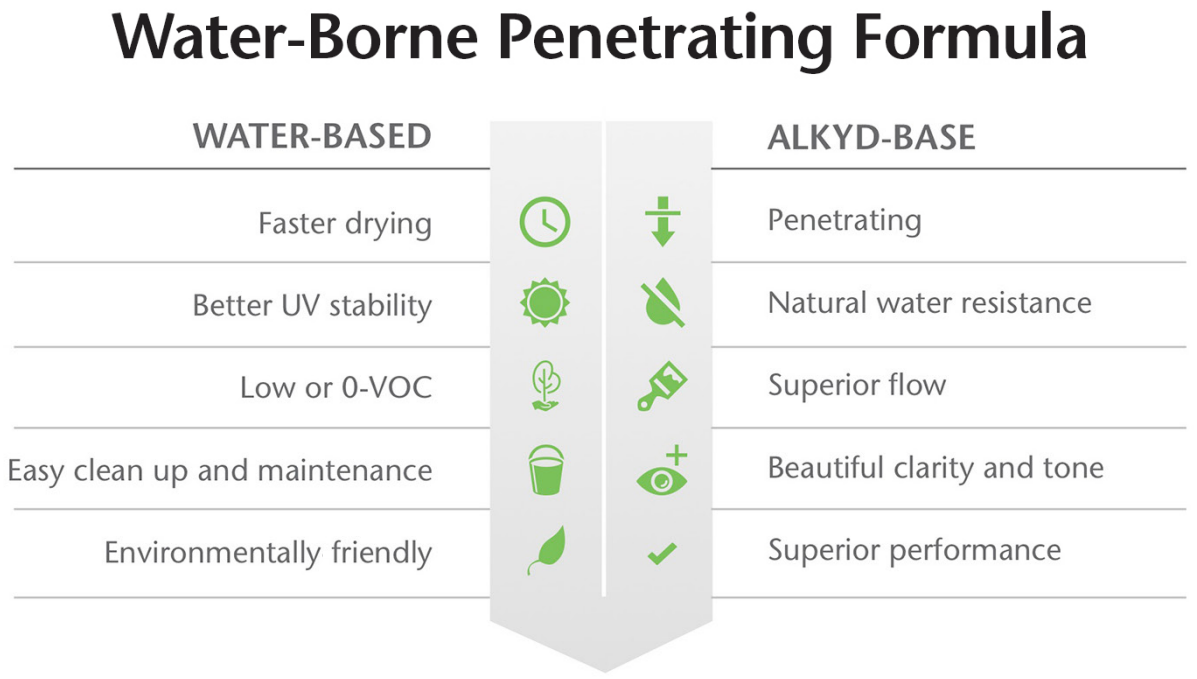
DEVELOPMENT OF WATER-BORNE COATINGS

History indicates that builders have been treating wood for almost as long as they have used it as a building material. Wood tar – the resin that results from heating wood – has been traced back to the Iron Age in Scandinavia, and the Romans used tar to protect the wooden hulls of their ships. Linseed oil, also known as flaxseed oil, has been used for hundreds of years to protect and maintain wood.

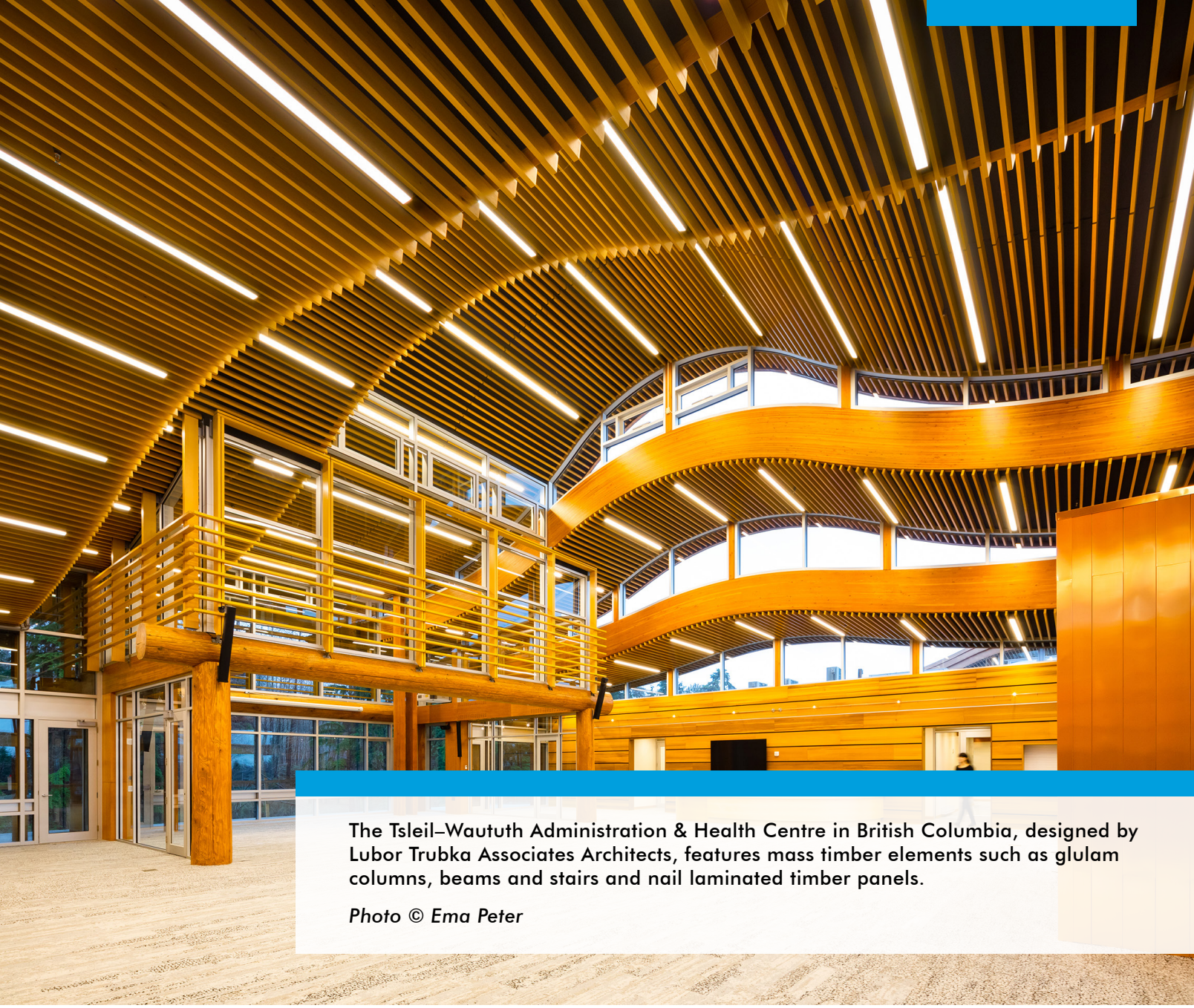
However, some of the more traditional oils, like linseed oil, lack UV protection, create a golden hue that is sometimes undesirable and can even support the growth of mildew. Furthermore, linseed oil is high in volatile organic compounds (VOCs), which contribute to smog and ozone depletion. Petroleum-derived solvents are even more environmentally detrimental, requiring large amounts of energy to extract and ship the petroleum and then to process it into solvents.

Over the last several decades, the industry wanted – and consumers and regulators were increasingly demanding – coatings that reduced the impact on the environment while also allowing for easy clean up and maintenance, along with improved productivity. The 1990 New Clean Air Act by the Environmental Protection Agency (EPA) required manufacturers to decrease the number of VOCs in their finishes.

Initially, water-based stains entered the market but became unpopular as they did not have the clarity, flow, penetration, water repellency or performance that users expected from an oil-based finishing product. Ultimately, water-based coatings let finishers down, and some coaters insisted on using oil-based stains, despite the higher toxicity.



Water-borne wood finishes combine the benefits of water- and alkyd-based coatings.



The Tsleil–Waututh Administration & Health Centre in British Columbia, designed by Lubor Trubka Associates Architects, features mass timber elements such as glulam columns, beams and stairs and nail laminated timber panels.

Photo © Ema Peter

Eventually, newer water-borne technology was developed that utilized modified natural resins but used water to carry the finish into the wood. In this way, water-borne finishes were now able to deliver on the performance and beauty of traditional oil-based products while living up to their environmental promises. In addition to reducing environmental toxins, water-borne finishes offer UV stability and are a more user-friendly option with easy clean-up and maintenance.

It is important to note that the terms "water-borne" and "water-based" are often incorrectly used interchangeably. In truth, the technologies are very different. For this reason, applicators and contractors – especially those who have a history with the troublesome water-based finishes – need to understand the differences. In short, it is no longer necessary to use traditional oils and solvents to achieve the desired look and protection, especially if the project has an environmental scope in terms of toxicity, VOCs and the health of applicators and customers.

Designed by Perkins & Will, the gravity-defying staircase at University of British Columbia (UBC) Earth Systems Sciences Building is constructed of more than 1,300 tons of BC-sourced CLT.

Photo © Michael Elkan Photography
Architect: Perkins+Will

BEAUTY & PROTECTION – A FINE BALANCE

Architects design a building focused on the look, shape and beauty of the wood; they are not necessarily thinking about protection of the wood related to UV exposure, moderating the wood moisture content or dimensional stability. But it is important to consider a coating system and schedule that looks at the wood's journey to the construction site and the elements and conditions at the building site related to exposure and climate. Undercoats applied at the factory provide a way for CLT, glulam and other mass timber to repel the elements while allowing the wood to breathe and lose moisture at a controlled rate to reduce checking.

From an aesthetic standpoint, the substrate itself will be telling in terms of color, texture and species-specific features that can be highlighted. With architects, we go even a step further. Do we want a natural look for the grain of the wood to shine through, or is an opaque finish preferred? Do we want to see a natural matte finish or a fuller, richer result? The general rule of thumb with coatings is the darker the color, the greater the UV protection. So there is a trade-off between protection, beauty and the quest for a natural-looking finish.

PROTECTING MASS TIMBER IN THE FACTORY & ON THE JOB SITE

How and when to apply the finish is a decision that sometimes rests with the OEM or wood manufacturer. Several manufacturers have machines to prepare and apply one or more finish coats and a quality control system designed to ensure the product is applied in accordance with the coating manufacturer's published preparation and application procedures.

Due to potential exposure to UV and moisture during storage, transit and construction, manufacturers need a plan to minimize timber discoloration, mold and UV degradation, all of which can impact aesthetics and the ability of the subsequent coats to be applied properly.

Increasingly, mass timber manufacturers are choosing to apply all coats of the finish system in a factory setting, which yields many benefits. From a financial perspective, coating the wood before it leaves the wood manufacturer's warehouse is a revenue-generator that creates a new line of business and an added value to offer customers. Additionally, from a pragmatic standpoint, applying primers (i.e., undercoats) and topcoats in a factory ensures temperature, humidity, dust, lighting (for color match) and product mil thickness are controlled. Commercial sanders, sprayers or flood coaters, racks and packaging stations are also available, and a factory setting enables proper data recording and record-keeping. By delivering pre-finished product to the job site, the wood is protected in transit and in situ.

Another option is to apply just the undercoat in the factory to all six sides and then add the finish coats later at the construction site. For this to be effective and efficient, care must be taken to apply a penetrating undercoat, or sealer, that can also be utilized as the first coat of the complete finish system. A penetrating, breathable undercoat helps ensure the stability of the wood and protects it from moisture intrusion and UV damage in transit or at the construction site. This is especially important at the end grain, which is particularly susceptible to moisture intrusion issues. Additionally, the proper undercoat increases topcoat performance, especially when designed into a specific coating schedule.

Glulam panels are coated in the controlled environment of a factory setting.
Photo courtesy of Sansin Corporation

It is also important for jobsite managers to insist that engineered wood be stored and handled with the same care as millwork material. The best storage plan is to minimize storage altogether with deliveries coordinated between the fabricator and the contractor to coincide with erection timelines. When that is not possible, minimize inventory at the construction site and store the mass timber products in a covered area. Other best practices include preventing contact with wet ground, keeping the packaging intact so water can't get inside and carefully handling the engineered wood panels to prevent damage.

APPLICATION BEST PRACTICES

When coating all mass timber at the construction site, keep in mind that surface preparation is the best predictor of finish performance.

Proper sanding is a critical first step. Sand the surface with an appropriate machine capable of sanding efficiently to an appropriate texture, and then clean using compressed air or a vacuum. When coating large-surface engineered wood, well-stirred product is key (and continue doing so throughout the application process). Test on an inconspicuous area to ensure proper color and penetration.

Apply the finish in as close to ideal temperatures as possible (70 degrees F/20 degrees C) and with humidity levels at 50 percent. Application on mass timber is best with a flood coater-type applicator, such as an HVLP airless applicator or a Juice Box sprayer. With sanding and flood coating, water-borne, penetrating finishes will dive into the wood for better and longer protection. Under-application of product only leads to later disappointment in performance.

When applying in controlled factory conditions, drying times should be dependable, based on the manufacturer's product data sheet. Utilizing drying racks and Infra-Red heat or ovens can speed up that process.

It is a good idea to take wet mil measurements to ensure the product is applied per the product data sheet and matches expected coverage. Also, retain control samples for later assessment, if needed.

Sanding, correct dosage, even application of the product to all sides and proper drying and storage are the fundamentals of wood finishing for long-term success.

THE VALUE PROPOSITION FOR COATINGS

Making the proper decisions about architectural finishes for mass timber projects is a necessity, not a luxury. Starting with maintenance in mind during the design phase of a project helps ensure the enduring beauty and protection of an engineered wood structure. Making the right coating decisions at the design phase – and having a quality-control-driven plan on how to apply and protect the wood – will also protect the owner's investment in the structure and help keep the building looking as it did on day one.

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