Roumiana Vassileva, Business development Director – EWP, Raute Corporation

With LVL we don't try to predict the future.
WE BUILD IT.

What's driving the move to use more and more engineered wood, such as LVL, in buildings? Taller or low rise structures, residential or commercial, while cost per span effectiveness is usually viewed as the main reason to use LVL in constructions, most building professionals involved in this movement, include the environment, as being part of their inspiration. They are driven by the need to find safe, carbon-neutral, and sustainable alternatives to steel, brick and concrete. LVL allows designers to achieve both of these objectives: higher density at efficient cost and a smaller carbon footprint for their projects.

In addition to environmental sustainability, new thermal regulations in many markets across the world, continue to increasingly favor in construction engineered timber such as LVL, CLT, glulam and I-Beams, compared to bricks, concrete or steel, due to their lower thermal conductivity. LVL-framed timber structures are easier to make more thermally efficient through increased airtightness, adequate U- values and reduced cold bridging. This becomes more and more relevant as the cost of energy has seen double digit price increases by the power companies, pushing many consumers across the world into a fuel poverty.

One of the steppingstone solutions is to decarbonize – build thermal and energy efficient buildings using LVL-frame, reducing energy bills and harmful carbon emissions.

Buildings designed with LVL are significantly lighter and show a similar or even better structural integrity than steel or concrete buildings. Furthermore, LVL allows the pre-fabrication of components and systems, reducing the shipping costs and the assembly time at the construction site, resulting in significant cost and labour savings for the builders.

These are only few of the qualities of LVL, making it one of the fastest growing and trending construction materials in the world. But in order to understand the real intelligence behind this product and where is its development heading, let´s retrace its history.

The past brings lessons, the future brings opportunities. The challenge is finding what brings value.

The technique of gluing veneer sheets, oriented longitudinally in parallel to the processing direction, was not a European invention. In the US, the manufacture of aircraft components by gluing 3.6 mm (1/7") Sitka spruce veneers along the length of the grain began already in 1944. Actually, furniture makers had used glue laminated wood veneers even prior. Notorious piano maker, Steinway and Sons, had used them for the curved sides of pianos since the middle of the 19th century.

The problem however was product scale. No one had been able to put together a manufacturing process of glued laminating veneers, that could result in elements large enough for structural uses. The challenge was solved by US architect and inventor Art Troutner. He gathered a small team and invented machinery that continuously glued and hot-pressed veneers together, producing laminated veneer lumber billets with lengths up to 24m and with impressive properties.

A breakthrough was achieved when a significantly lower-cost thermosetting phenol adhesive and hot pressing were implemented, obtaining a product with very high tensile strength. The glue was up to 2.5 times stronger than lignin (wood's natural binder) so the resulting engineered wood was at least 2.5 times stronger than sawn lumber.

The high characteristic tensile strength, combined with assured quality, were the decisive characteristics that led to the manufacture of a new revolutionary product, Micro-Lam® by Canadian Company Trus Joist in 1971, considered officially the world´s LVL inventor.

LVL development in Europe was led by the Finnish Metsäliitto group. Back in 1974, Metsäliitto evolved from a centralized organization representing forest owners and raw material suppliers, into a forest industry enterprise, involved in mechanical wood processing and pulp and paper manufacture. In order to find alternatives to further investments in new sawmills, the company embraced the idea of pioneering the industrialized production of LVL in Europe, marketed under the Kerto® LVL brand – the first EU manufactured LVL.

After LVL gained popularity in Europe and proved its efficiency as standalone engineered wood product and a system component (floor, wall, roof), the product was positioned in the 90s as a high-end, customized engineered wood product for the Solutions market, with a distinctive value added operational service: adapted connectors, software and design, technical literature, engineering support, job site trouble shooting and supervision. This, coupled with its high structural capability, enabled LVL to capture high sales value down the chain.

What do manufacturers think of the product?

The over 4.8 million m^3 installed certified structural LVL capacity across the world is a testimony to its value. From production point of view, LVL allows for a larger usage of raw material base versus sawn timber or glulam - smaller and larger than the standard diameter logs could be suitable for peeling but not for sawing. In addition to resulting into a strong and stable product, the LVL technology allows for one of the best yields out of a log, which is further maximized by the manufacturer through grading and composing. This way, the partial veneers are composed to full sheets and re-integrated into production, while the lower grade veneers, instead of being discarded are used in the inner plies of the LVL panels or for the manufacturing of non-load bearing / industrial applications, such as joinery and furniture components.

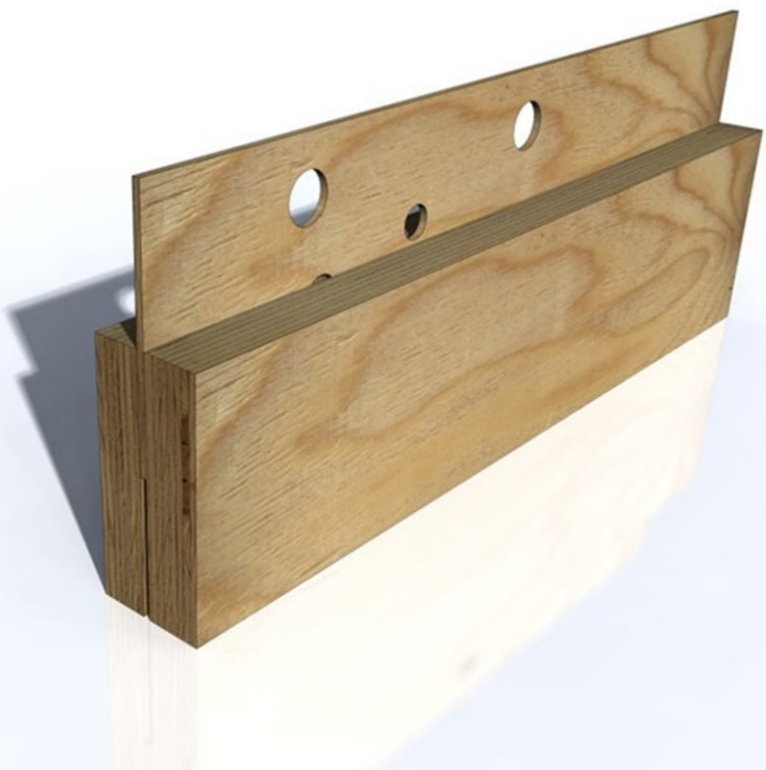
Under the hood of LVL

Based on peeling technology, LVL is one of the highest yields´ product in the current engineered wood products industry.

Typically, softwood logs are soaked or sprinkled with hot water or steam to soften the fiber. The logs are rotary-peeled to 3.3mm thick veneers, which are dried, graded (for strength, moisture content and visual defects), scarfed, overlapped or butt jointed, covered with phenolic glue, laid-up in a continuous manner (all lengths possible, limited by transportation only) and bond together in a hot press under high heat and pressure.

21-90mm thick and 1.2 - 2.5m wide panels are pressed and further machined to the finished dimensions, needed by the customer. Each veneer

Wood defects randomization across veneers in an LVL billet



is thin compared to the thickness of the LVL panel, therefore any natural defect in one veneer doesn´t need to be cut-off (minimum fiber loss) as it has only a marginal effect on the strength of the whole LVL panel. The strength of an LVL beam is engineered through a recipe of various veneer grades and hence is equal to that of a perfect, straight-grained defect-free wood.

Two generic types of LVL are being manufactured: in **Parallel-ply LVL**, all veneers are laid in the same direction, parallel to the panel length for long spans with minimal deflection - particularly suitable for load bearing beams and headers. In **Cross-ply LVL**, approximately 20% of the veneers are laid crossway, perpendicular to the panel length for dimensional stability and high shear and compression strength – distinctly suitable for rim board and self-load bearing floor/roof panels.

LVL – breaking the stereotypes

Engineered wood such as LVL, just as all timber-based products, has been subjected for centuries to the stereotype – “Wood construction is not safe as wood burns!” While there is no denying that wood is combustible, yet, there’s a great deal of evidence to suggest that it is at the same time a fire-safe material, when designed properly. Sometimes safer than steel.

In a fire, a sufficiently thick wooden element will char on the outside, sealing the interior and protecting it from damage. Wood burns slowly at less than 1mm per minute and the char created on the wood surface, helps protect and insulate the unburnt wood below and maintain the structure. This is possible as the build-up carbon on the wooden surface limits the oxygen supply to the wood below and acts as a natural insulator.

A wooden beam supporting two collapsed steel beams after the 1906 San Francisco

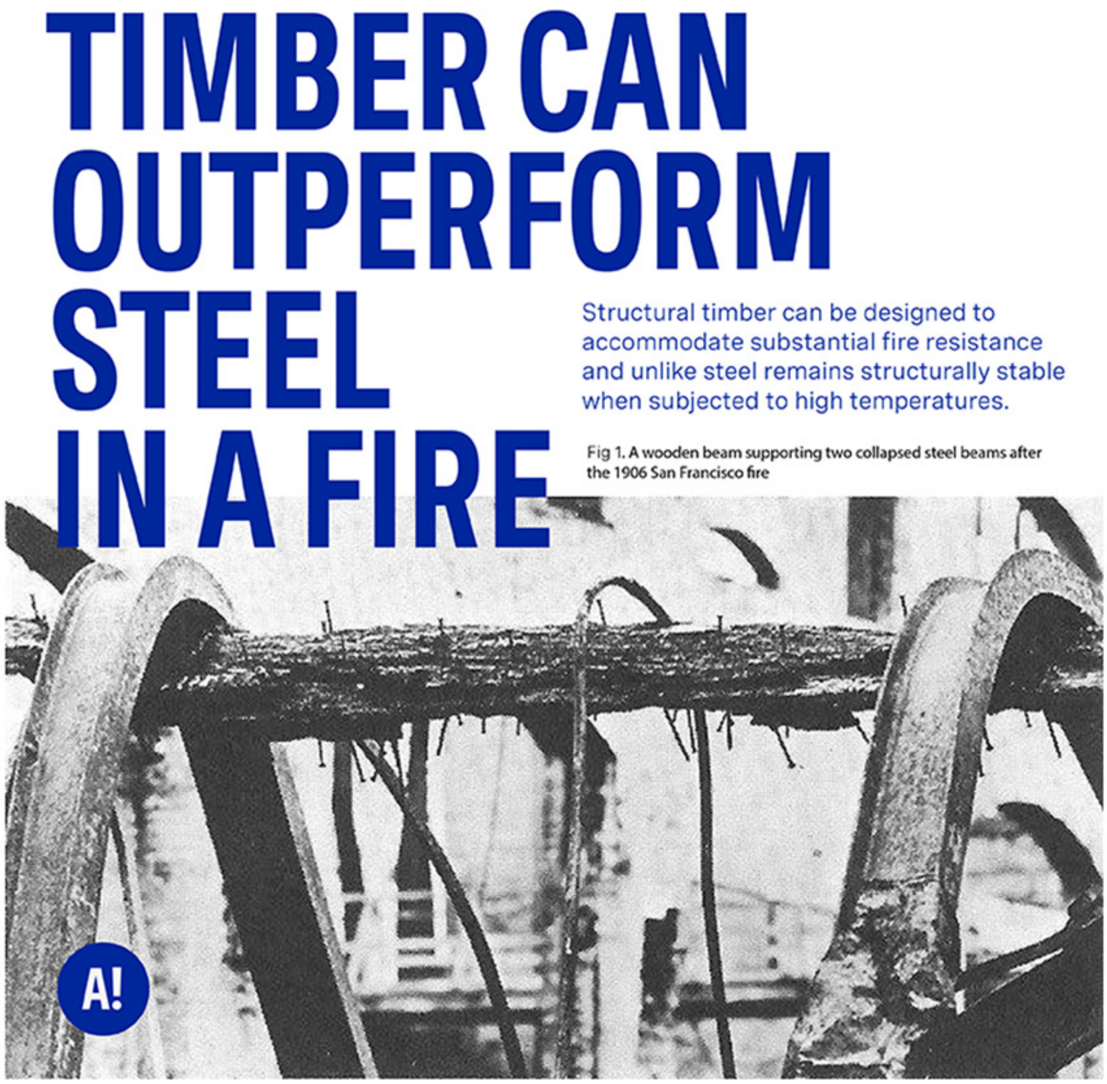


Fig 1. A wooden beam supporting two collapsed steel beams after the 1906 San Francisco fire

Therefore, the wooden structure´s load resistance and liability to collapse in a fire, can be accurately predicted and fire-resistance periods of 30, 60, 90 and 120 minutes can be achieved comparatively easily with structural protective cladding - usually plaster board.

Metal, on the other hand, especially if unprotected, begins to melt when it reaches a critical temperature (around 1300 degrees C) so it can fail catastrophically. Fire experts from APA described steel being "like spaghetti" at this stage.

So, yes, wood burns, but safely!

The rise of the global LVL market

The **global structural LVL consumption** reached 2.64 million m^3 in 2020. Over the past five years, it has grown from 2.22 million m^3 in 2015 to 2.69 million m^3 in 2019, achieving an average annual growth of 5%.

COVID-19 impacted negatively the residential construction in most global markets except for North America. In 2020, several residential projects in global markets, planned with LVL frames, were delayed and pushed back in 2021, resulting in a drop of -2% in global structural LVL consumption in 2020.

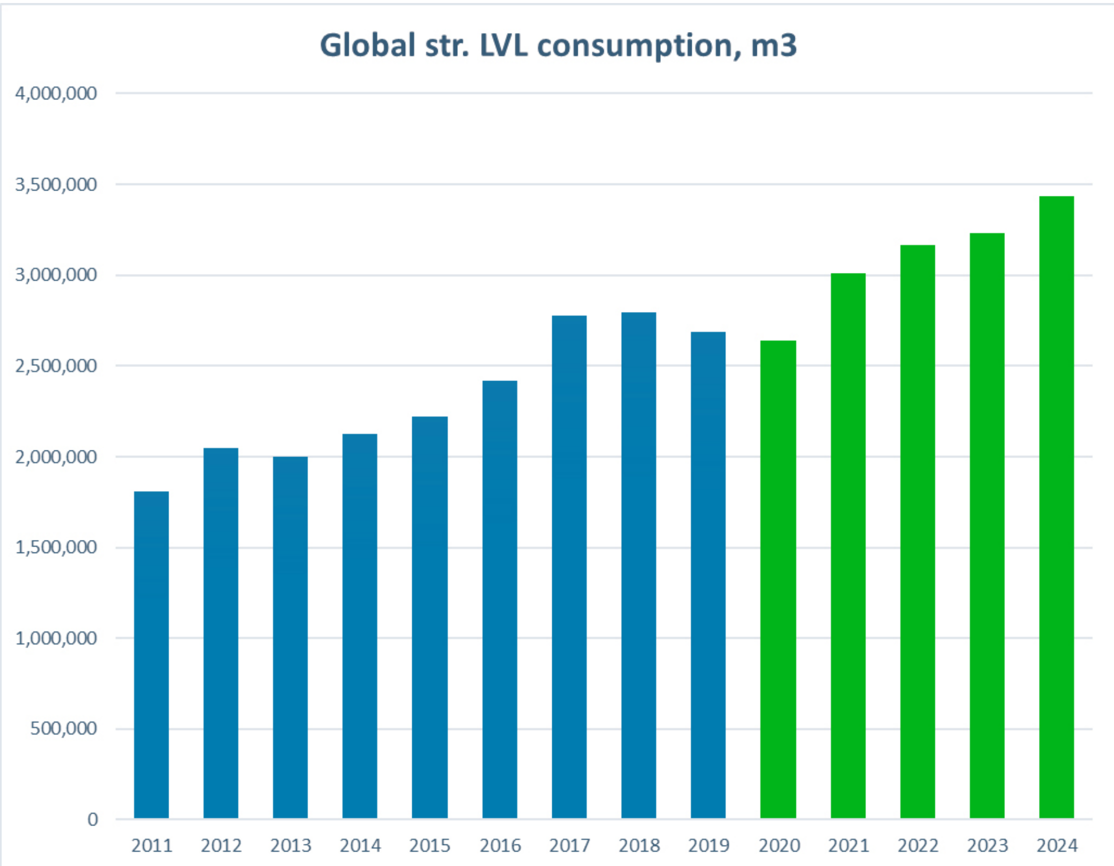
Going forward, and following the fact that most of the LVL-framed building projects have not been cancelled but only delayed, we expect a +14% recovery of global structural LVL demand in 2021 (reaching 3.01 million m^3) and further average annual growth of +4% from 2022-2024, reaching 3.44 million m^3 by 2024.

Global structural LVL capacity has increased by an average annual 4% for the period 2013-2019. Main new capacity additions in that period have taken place in Europe, NA and Japan. Capacity drops have been observed in Australia and New Zealand with the closure of one LVL mill in each of the two markets.

With 2020 global structural LVL capacity of 4.85 million m^3 and global structural LVL production of 2.93 million m^3, average global production per capacity ratio (P/C) was ~61%. It is however forecasted to increase to 71% by 2024, despite planned capacity additions on global level, mainly as global LVL production is expected to grow at a faster pace.

We shape our buildings and then our buildings shape us – the power of biophilia

Biophilia is humankind´s intrinsic connection to nature. It explains why we feel comforted by the crashing of the ocean waves, soothed by the crackling of the fire in the fireplace, relaxed by the rustling of the leaves on a breezy night, or why



Source: Raute, 2021

heights and shadows infuse intrigue and fear.

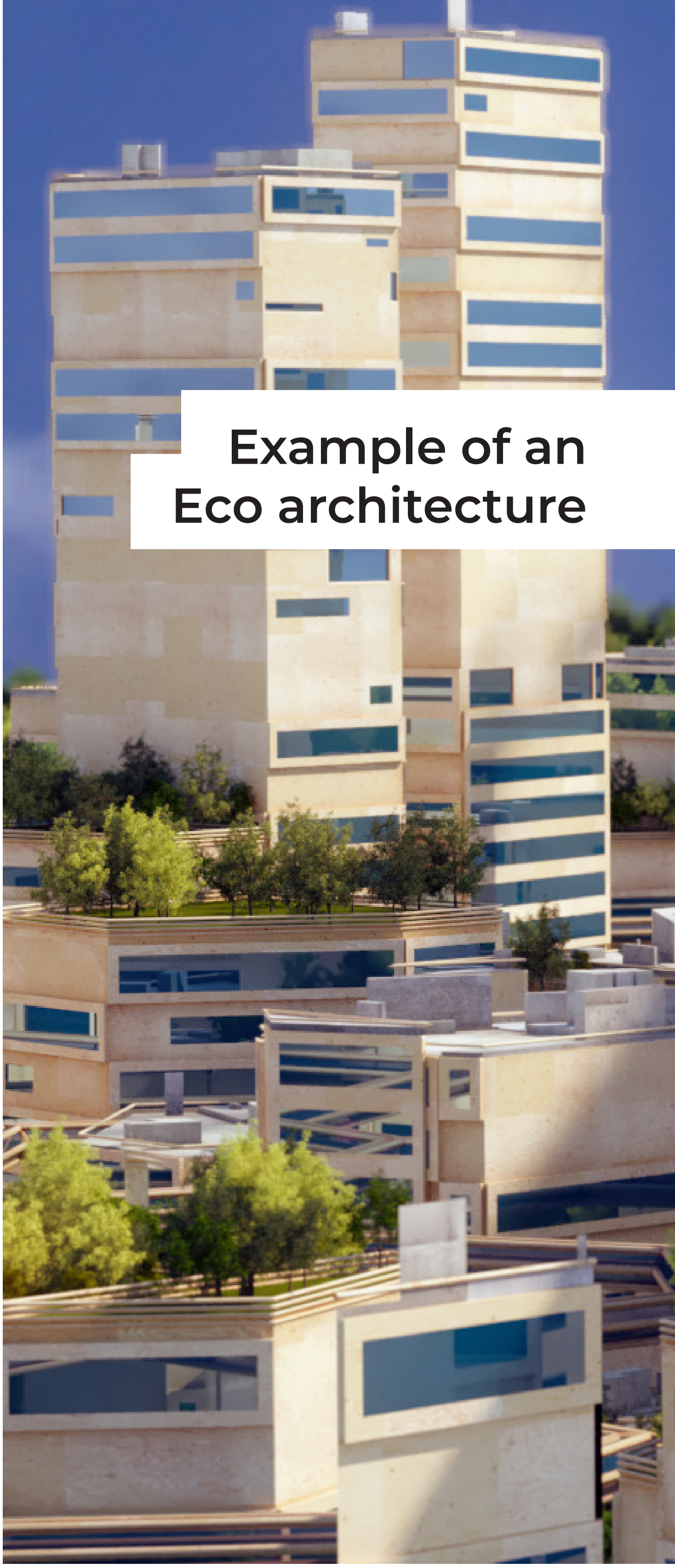
Biophilia in buildings´ design is a powerful argument why some buildings are preferred to others in the current dense, grey and urban jungle. And Laminated Veneer Lumber, like other wooden-based strong and aesthetic construction materials, has indisputable direct and indirect biophilic attributes, making it a natural choice for vanguard thinking architects.

By 2050, the world´s population is expected to reach 9.8 billion, with nearly 70 percent projected to live in urban areas. Can biophilic construction materials help build the cities of tomorrow? We firmly believe that.

The exposed wooden surface in a living environment reminds the inhabitants of nature and has been observed to reduce stress. Wooden based materials are hypoallergenic and promote good air quality. Sound is absorbed by wood through its inherent acoustic properties, contributing to a calm and peaceful environment. Due to wood being a breathing material, it can contribute to a natural regulation of humidity and temperature levels.

There are precedents for tall wooden buildings around the world, resisting the wear and tear of time, even in challenging seismic environments. Japan has 19-story wooden pagodas that have stood for more than 1,400 years – a humbling testimony of the wood craft of our ancestors. The contribution of today are engineered wood products such as Laminated Veneer Lumber, which combined with new design techniques, allow for safe, sustainable and healthy construction.

Using LVL in modern construction is not about doing less harm. It is about doing more good!



Example of an Eco architecture

RAUTE

raute.com

Making wood matter