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# Engineered Wood Products as a Sustainable Construction Material: A Review

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## Abstract

Engineered wood products are considered as best building materials due to environmentally friendly. Huge change to the way in which wood has been utilized in primary application of construction in the course of the most recent 25 years are in light of decreased admittance to high strength timber from growth forests, and the turn of events and creation of various new design of manufactured wood products. Engineered wood products are available in different variety of sizes and measurements like laminated veneer lumber, glued laminated timber, finger jointed lumber, oriental strand board etc. It is utilized for rooftop and floor sheathing, solid structure, beams and the hull of boats. This review objectively explores not only the environmental aspects of the use of different engineered wood composites as a building material, but also their economic aspects, to understand their effect on sustainability.

**Keywords:** engineered wood product, plywood, cross laminated timber, laminated veneer lumber, oriented strand board etc.

## 1. Introduction

Wood is one of the world's most promptly accessible and adaptable building materials, and recent advances in engineered wood products innovation have permitted these to be utilized in a basically load-bearing segment [1, 2]. Wood has assumed a huge part in the existences of people from ancient occasions to the advanced time. It is richly found in an assortment of normal settings and effectively retrievable in its raw form. Wood has been a fundamental component of development for quite a long time, with saved instances of such constructions dated to millennia B.C. Engineered wood products (EWPs) are among the most excellent and harmless to the ecosystem building materials. In manufacture, they are produced efficiently from a renewable resource. In development, the way that engineered wood products is accessible in wide assortment of sizes and measurements [3].

EWPs are chiefly laminated veneer lumber [4], wood I Beam, glued laminated lumber [5], cross laminated timber [6, 7], finger jointed lumber, oriented strand lumber, oriented stranded board [8, 9], medium density fiber board (MDF) and Particle Board (PB). These EWPs are regularly created from the adhesive bonding of wood chips, pieces or veneers, as well as the mechanical securing of timber segments to frame bigger segments, beams, boards or other structural components [10–14].

The advantages of EWPs incorporate upgraded dimensional stability, the development of bigger and more complex structural segments, decreased impact of common imperfections (for example knots), more noteworthy toughness and more homogenous mechanical properties [15, 16]. These properties of wood can be improved through controlled changes, and this is the establishment of designed wood items [17–20]. This builds the overall performance of structural wood composites, prompting a more viable structure material, accordingly growing potential end uses [21–23]. Engineered wood products have permitted wood to be utilized in circumstances where solid timber is incapable, prompting specific items to help a more different exhibit of uses. This has extended market openings prompting the positive financial development of this industry [24].

As well as being utilized as a substitute for more “traditional” engineering materials, engineered wood products have demonstrated to beat conventional sawn lumber in the structural applications for which they are intended for [25, 26]. Extra advantages of working with engineered wood products include: lower building costs with less expensive materials/speedier construction time, lower ozone depleting substance outflows by not utilizing energy escalated materials, unrivaled adaptability under seismic burdens and better energy execution/effectiveness [27].

As per estimates of Forest survey of India (2017), while the annual production from the natural forests is quite low, the production from the tree outside forest is much higher. Most of the Industrial wood in India is produced from outside government forests and agroforestry/ farm forestry in the country. India is one of the emerging markets in Asia pacific engineered wood industry, currently accounting for 10% of the Asia pacific engineered wood market share. Cross laminated timber market is rising construction industry. Laminated veneer lumber is one of the most popular EWPs.

Engineered wood products are making it conceivable to build taller and bigger wood structures, and there is innovative work on this theme. Hence, this review chapter focusses on various engineered wood products, which are more economical. This review chapter of the current writing offers bits of knowledge. This chapter takes a gander at another age of wood products, made from the sustainable structural material. These products can assume an undeniably significant part in a naturally concerned world.

## **2. Types of engineered wood product**

### **2.1 Glued-laminated lumber (glulam)**

Glued laminated lumber, or Glulam, is the most essential and oldest member of the engineered wood products family, which has helped with growing the structural uses of wood and conventional sawn wood development [28, 29]. Solid sawn substantial timber is in restricted accessibly for extremely huge sizes, and is not basically proficient because of deformities like bunches and checking. Glulam has disposed of the limitations of utilization of huge sawn wood concerning size of the stem cross-area, the length of the stem, and the structural deformities present. Production of this product started in Europe at when the new century rolled over, in the U.S. in the 1940's, and in Canada in 1952. Glulam individuals comprise of various wood overlays (or “lams”) that are fortified together using glue [30–34]. The boards are pressed with hydraulic equipment in the process to ensure tight bonds. Dimensional soft-wood lumber is regularly picked for the lamination, and care is taken to guarantee that the grain of the boards runs parallel to the longitudinal axis of glulam member (**Figure 1**). Boards utilized in the lamination process may differ in sizes but do not exceed two inches in thickness. Notwithstanding the benefits related with huge

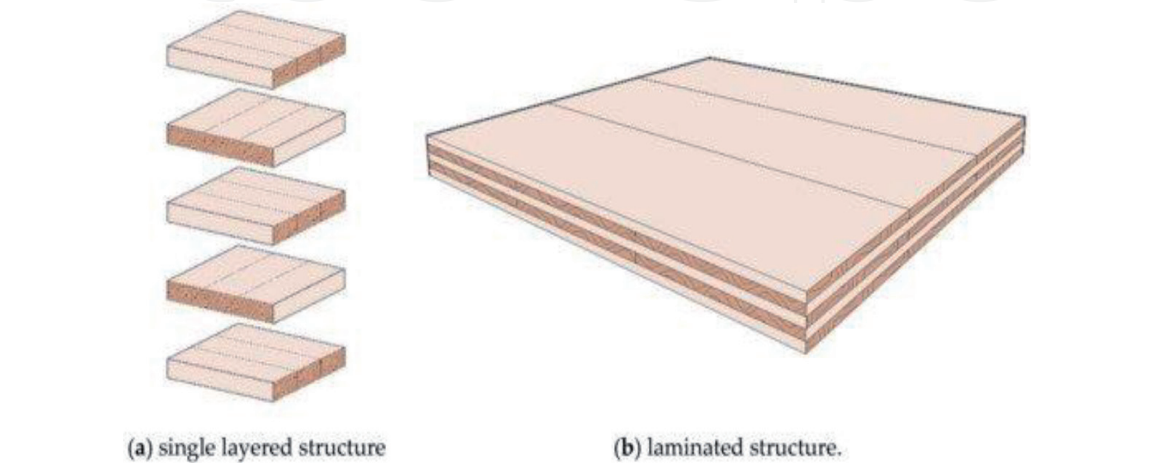


**Figure 1.**  
*Glulam [35].*

cross-sectional zones, lamination boards are regularly joined at the ends to develop glulam individuals that increased the lengths of stock lumber. Recently, fiber-reinforced polymers have been included in the manufacture of some glulam production [36]. This component enhances the tensile performance of the member and is said to offer economic benefit in some applications [37–42]. Glulam is often used as straight beams, including lintels, purlins, ridge beams and floor beams, Columns including round, square and complex section, curved beams and roofs.

**2.2 Cross laminated timber (CLT)**

The construction industry is starting to use new enormous scope engineered wood composites known as mass lumber items. CLT is a moderately new wood product that holds extraordinary potential for significantly expanding the utilization of wood products in construction [43–45]. CLT as enormous boards built through the overlay of various layers of structural grade softwood boards. Each layer of boards is usually oriented perpendicular to adjacent layers and glued on the wide faces of each board, usually in a symmetric way so that the outer layers have the same orientation (**Figure 2**). The products are discovering use in building projects as floor slabs, load bearing wall and shear wall [47–49].



**Figure 2.**  
*Cross-laminated timber [46].*

Being a suitable choice for heavy frameworks manufacturer expanding interest in CLT and giving a green choice to steel and cement. CLT offers high strength and the structural simplicity needed for cost effective buildings, as well as a lighter environmental footprint than concrete or steel. CLT board manufacture considers a wide scope of board sizes and thicknesses. Architect use CLT boards as burden bearing plate components in construction projects, working as floor slabs, rooftops and walls. The substantial idea of CLT and its great strength properties give the likelihood to use in multistory structure. CLT can also be processed as a “ready-made” building material, tailoring its process to the precise required measurement to reduce wastage of building material.

### 2.3 Laminated veneer lumber (LVL)

While glulam and CLT boards are contained wooden boards, various engineered wood products are made with wood veneer. LVL is perhaps the most generally utilized engineered wood products for constructional applications. It is a composite board made from various thin layers of veneers that are lined up with the length of the finished lumber [50–53]. The product was invented in the last part of the 1960's and has gotten grounded as a high strength pillar and header segment in both residential and commercial constructions. Since it is made from veneers, LVL makes up to 35% more powerful utilization of logs than is conceivable with solid lumber. At fabricate, veneers are dried to 8% moisture content, and reviewed for uniform strength and width before lay-up. Adhesive is applied and the board is pressed under heat and consistent pressure until cure (**Figure 3**). Laminated veneer lumber is planned for use as high strength, load carrying beams to help the heaviness of development over window and entryway, and in floor and rooftop frameworks of residential and light commercial wood frame development. It can give the both boards and beam/column components [55].

### 2.4 Laminated strand lumber (LSL)

LSL is usually realized Timber strand. As of now, LSL is being made from excess, over develop aspen trees that normally are not huge, solid, or sufficiently straight to develop conventionally wood products. In this cycle, the debarked logs are utilized to give the material to chipped strands, which can be up to 300 mm long. These strands are then dried, coated with adhesive, and pressed into huge billets by a process which incorporates steam injection (**Figure 4**). The billet might be up to 140 mm thick, 2.4 m wide and 10metres long. Subsequent to sanding, countless sizes are sliced to suit applications like headers, edge joists for floor frameworks,



**Figure 3.**  
*Laminated veneer lumber [54].*





**Figure 4.**  
*Laminated Strand lumber [56].*

columns, joists and studs. It is utilized for a wide scope of millwork, like doors, windows, and practically any item that require high grade lumber. It is additionally utilized for truck decks, fabricated housing, and some structural lumber such as window and door headers [57, 58].

## 2.5 Parallel strand lumber (PSL)

PSL, ordinarily known Parallam, is intended to supplant huge dimension lumber (beams, planks, and posts). Parallel strand lumber was developed in Canada, advanced onto the market in the last part of the 1980's [59]. PSL comes in numerous thicknesses and widths and is fabricated up to 66 feet in length (**Figure 5**). The strands are for the most part taken from veneers peeled from the outermost part of the logs, where more grain is found. Veneers are dried to 11% moisture content and reviewed for strength prior to chopping into strands [61]. They are then adjusted parallel to each other, coated with waterproof glue, then pressed and cured [62, 63]. It is utilized for enormous individuals in residential construction and as middle and huge individuals in commercial building construction.



**Figure 5.**  
*Parallel Strand lumber [60].*

## 2.6 Structural plywood

One of the most important well-known building materials constructed with veneer is plywood. It is handily sourced from everywhere the world and has exhibited fruitful. Plywood is utilized for some light duty building materials. It is likewise utilized for rooftop and floor sheathing, concrete formwork, webs of wood beams, and surprisingly the frames of boats. It very well may be utilized to oppose gravity loads or to oppose horizontal burdens as in plywood diaphragms and shear walls. Plywood is fabricated from stacked veneers which are organized in an odd number of layers, the grain of the face layers arranged to the long dimension of the board (**Figure 6**). The cross-overlaid lay-up of the veneers gives strength, stiffness and dimensional strength [65].

## 2.7 Oriented strand board (OSB)

OSB was first produced in Canada in 1964. Since the mid-1980s, OSB has been one of the most commonly used engineered wood-based panels for structural construction in residential sectors due to excellent properties, especially due to the increasingly competitive price [64, 66]. OSB is an engineered structural panel made from strands of wood sliced from small diameter timber logs and bonded together with an exterior grade adhesive, under heat and pressure [67–70]. OSB is manufactured in various grades with improving resistance to the effects of moisture (**Figure 7**). OSB is extensively used for wall sheathing, floor underlayment, roof cover and I-joist in both commercial and residential building. OSB also is used in furniture, reels, trailer liners and recreational vehicle floors [72–74].

## 2.8 Wood I beam

Wood I beam are engineered wood products which have great strength in respect to its size and weight. Wood I beam is a light beam support assembled by gluing together wooden flanges and fiber board and plywood beams. The flanges of beam made of laminated veneer lumber or finger jointed solid wood lumber. The web of beam made of plywood, laminated veneer lumber or oriented strand board. Wood I beam are available up to 80 feet long (**Figure 8**). It has been used in residential and commercial construction as floor, roof structure of structure and external wall frames. I beam are best for the structure which required rigidity, heat insulation and



**Figure 6.**  
*Structural plywood [64].*



**Figure 7.**  
*Oriented Strand board [71].*



**Figure 8.**  
*Wood I beam [75].*

economy. Nowadays, wood based I beams are becoming popular. Beams allow easy execution of installation penetration. Their 'I' configuration provides high strength and stiffness.

### 3. Advantages of engineered wood products (EWPs)

The term engineered wood products covers a wide cluster of wood-based items produced using veneers or strands peeled, chipped or sliced. These items are appropriate for construction reason as structural materials [76]. EWPs tend to perform better as they have higher load-carrying abilities compared to solid wood of the same dimension. This is because EWPs have more uniform and predictable structural properties, as the usual deficiencies in the wood (like knots and cracks) are either removed or offset by the manufacturing process. The low cost of engineered wood is the most immediate benefits and the reason that it is so widely used.

The utilization of glue laminated timber offers various benefits including structural opportunity, proficient utilization of timberland asset like the utilization of merchantable and non-merchantable wood species and mixed species application. CLT gives various ecological advantages notwithstanding its excellent thermal performance. CLT boards are produced for explicit end use applications, which bring about almost no waste. (CLT's thick cross segment gives significant imperviousness



to fire since boards char gradually [77]. Probably the greatest advantage of utilizing CLT is that the design can be fabricated rapidly and productively. The size of LVL is not restricted by log size, because of its assembling strategy [78]. Since, it is fabricated with homogenous quality that has least number of defects. The advantage of I-joists/beam is they are less likely to bow, crown, twist, up or split as would a dimensional piece of lumber.

Engineered wood product like plywood permits developers to diminish the quantity of trees required for building a home. Plywood sheathing for walls and rooftops definitely diminishes home construction cost compared with utilizing boards of solid wood. Some engineered products, for example, MDF and PB can be produced using sawmill scraps, wood chips and even saw dust reutilizing wood waste.

Engineered wood product is likewise useful in that it assists with cultivating up the interaction of development. Perhaps the most appealing highlights of these engineered components and assemblies are that they can be manufactured to longer lengths than their sawn lumber partners. Additionally, engineered products preserve or extend the use of the forest resource by using a higher percentage of fiber, which previously was burned or left to rot. The use of wood from residual sources, plantations and second-growth forests reduces the pressure to harvest more forest area. Waste timber can be recycled and turned into strands and fibers and reconstituted into engineered wood products.

### **3.1 Comparing material options**

In considering the utilization of engineered wood products for a construction, the manufacturer is given a stable of material choices which permit extensive potential for the declaration of sculptural structure. This opportunity to make a masterpiece, when taken, regularly brings about a wood structure whose elegance and excellence is genuinely a supplement to function. It is significant that the wood industry keeps on advancing the advantages of the unique character and warmth of the uncovered structural products. Engineered wood products can be considered as a reasonable substitute or complement for concrete, steel and brick in large building projects.

Simultaneously, it is similarly imperative to know about the premium related with the stock of regularly elaborate shapes and treatments. These may draw structural components as architectural components in a way that utilizes essentially more material that is needed to help a given burden. To appropriately evaluate the expenses of wood versus steel, one should perceive such contemplations. Really frequently, a wood alternative is saved due to such defective examinations. For instance, a school whose structural framework, in the brain of the designer, will be alright served by a structural steel frame and open web steel joist framework ought not just be assembled that way in light of the fact that a weighty wood post and beams framework is costlier. The Engineered Wood Products explained in this chapter currently permit the wood industry to contend with practically identical items to the steel alternative. Cross laminated lumber is able to replace concrete slabs in the frames of multistory buildings [79]. The weight CLT is about 4 times less than concrete which reduces foundation loads and transportation cost. Glulam is two third the weight of steel and one sixth the weight of concrete. The high strength of laminated timbers enables glulam beams to span large distances without intermediate columns, allowing maximum design flexibility than traditional timber construction.

The different sections of this chapter which describe various EWPs refer to the enhanced utilization of logs due to the use of small sections, in many cases veneers or strands. Engineered wood products bring huge advantages compared to

competing products such as steel, concrete and aluminum in terms of embodied energy, and emissions of carbon dioxide and other pollutants during manufacture and extraction.

## 4. Conclusions

This chapter presents an overview of the EWPs. The advancement of new designs of structural wood products – called EWPs- throughout the most recent 25 years has utilized wood fiber and allowed the wood industry to rival other structure materials in more construction applications. Based on the properties and end uses engineered wood products will see an expanding market share within the wood products manufacturing industry. There are various variables impacting this, for example, the advantages of wood building construction, improved fire execution over dimensional timber products. CLT offers high strength and the structural simplicity needed for cost-effective buildings, as well as a lighter environmental footprint than concrete or steel. Current experience shows that engineered wood products are excellent structural wood building material for future.

## Conflict of interest

The authors declare no conflict of interest.

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