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UTILIZATION OF WOOD PRODUCTS IN GREEN BUILDING CONSTRUCTION

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Abstract:

From an ecological point of view, the construction and building industry has a substantial effect on the process of climate change. The construction sector is one of the greatest contributors to the atmospheric emission of gases like CO2 and resultant climate change, mostly due to the manufacturing of traditional building materials like brick, concrete, and steel. These rising ecological concerns have limited our ability to truly modify the method by which we work on the earth. It has been established that the extraction and processing of these materials creates a large quantity of harmful greenhouse gases, and consequently, this business has the potential to mitigate such emissions. Due to the increased carbon footprints of these materials, it is better to employ natural and eco-friendly materials in conjunction with the latest technology to solve such environmental challenges. One solution is to replace the traditional material (non-renewable and emission intensive) with a more eco-friendly alternative, which may aid in decreasing the emission levels and pace of resource depletion. A considerable amount of effort has been accomplished by worldwide research groups in order to provide cost-efficient alternatives as well as sustainable building and construction materials. Embracing green construction materials is a great strategy to achieve such a purpose. Wood is one such material that can be extensively utilised as a building material for any sort of structure. Previous research has shown that wood products emit significantly less greenhouse gas emissions than other building materials over their lifetime. This article will be discussing wood products and their merits as building materials. Several varieties of mass timber panels have been explored in the article.

Keywords: Mass timber, GHG, Cross Laminated Timber, sustainability, carbon emission

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Introduction:

Stakeholders like researchers, architects, builders, industrialists and sustainability advocates are all abuzz over a new construction material they say could significantly mitigate the emission of harmful Green House Gases (GHG) in the construction sector, reduce the wastage and minimal cost associated with construction and helps in creating physically, psychologically and aesthetically healthy built surroundings. The substance is known as wood. Wood is a biological resource and generally acknowledged raw material as a construction element internationally. It offers certain benefits including as high strength to weight ratio, strong insulating capabilities and aesthetic appeal as well. However, its biological nature produces seasoning defects, weathering and biodegradation particularly in outdoor circumstances. For improved performance of timber in service, it is vital to put the moisture content of wood in balance with the surrounding environment. Wood seasoning is removal of excess moisture from wood by drying in regulated settings (Temperature and Relative Humidity) to attain pre-defined moisture content depending upon the ultimate usage of the respective product. It is considered as an important phase in wood processing for ameliorating value of timber. Usually timber with less than 20% moisture content (MC) has little chance of developing defects like stain, rot or mould due to fungal attack on wood. Strength wise, average seasoned lumber is as much as twice as strong as wet timber. It also enhances properties like treatability, Nail and screw holding capacityetc.

However, being a biological resource in nature wood is prone to degradation by species like termites, fungus, ants, borers, beetles and many other organisms when utilised in terrestrial conditions. In marine and aquatic environments bio fouler and borers attack and degrade wood appreciably over a short span. Comparing to other forms of building material, bio deterioration of wood is extremely unwanted. Such deterioration leads to loss of strength in wood buildings and may be disastrous. Although, heartwood of certain tree species demonstrates certain degree of resistance against degrading organisms owing to the presence of secondary metabolites in the form of extractives that inhibit degradation. This intrinsic characteristic of wood is described as natural durability. Generally, sap wood section of timber species is deemed non-durable and hence requires protection from degrading agents and it may be performed by applying certain preservative treatments to wood. Wood preservatives are chemicals which are applied to wood for enhancing its durability.

Wood is a better construction material as long as its generation is traced back to sustainably managed forests. Because timber from natural forest is in short supply due to rigorous forest laws and environmental restrictions, demand is met by fast growing timber species from plantations. However, there is a significant difference in the durability of naturally grown timber and plantation timber, and in order to utilize plantation grown species, their properties and suitability for various end applications must be determined. Substantial researches and documented experiences have enabled us to formulate strategies to use fast growing and low quality wood for high end uses including building and construction purposes.

The present situation necessitates the prudent use of limited wood resources through relevant technical developments. Other sources of lingo cellulosic materials are

also employed in the development of wood substitutes. The development of wood composites has made a substantial contribution in this direction. As alternatives to solid timber panels, wood panel products such as particle board, plywood, fibre board, and block boards have been developed. These panel materials outperform solid wood in terms of different characteristics. They provide more working freedom and may be moulded into desired shapes and forms. In contrast to solid wood, these composites may be created in vast dimensions without the possibility of natural defects such as knots, splits, fractures, and so on. Another benefit of such composites is the ability to utilize tiny pieces and lumbers as raw materials, which would otherwise be burned as fuel.

In any event, a better method of using wood has brought the material back into the limelight. The focus of the attention is on underlying wood, or, as it is more colloquially called, "mass timber" (another way to say "massive timber"). It entails gluing tiny pieces of wood — often conifers like pine, spruce, or fir, but sometimes occasionally deciduous species like birch, ash, and beech — together to form larger sections. Mass timber is a conventional term that envelops results of different sizes and works, similar to glue-laminated (glulam) beams, laminated veneer lumber (LVL), nail-laminated timber (NLT), and dowel laminated timber (DLT). However, the most widely recognized and most familiar type of mass timber, the one that has opened up the most new structural possibilities, is cross-laminated timber (CLT).

Cross Laminated Timber:

Cross Laminated Wood (CLT) is a relatively new and inventive mass timber product that is gaining popularity in the building business. CLT was invented in Europe during the 1990s, and since then, considerable research and development into this item has resulted in its widespread application in construction projects all over the world. The key reason why CLT has received so much attention recently is because its specific capabilities and environmental features contemplate the exploitation of wood in a broader spectrum of purposes than was previously possible. CLT panels are made by stacking layers of timber boards that are orthogonally (at right angles) aligned to one another and bonding them together using a structural glue. The raw material used in the panels is machine stress graded and kiln dried to a moisture content of 12%. After removing any knots or other imperfections, the planks are finger joined to achieve the desired lengths. Under precise pressure, the constructed stack is put in a press and face bonded together.
After that, the stack is placed in a press and face bonded under pressure. When the boards are removed from the press, they are controlled to the desired size and edge profiled using Computer Numerical Control (CNC) machinery and are ready to be transported to the site. These boards are usually made with an odd number of layers, with three, five, and seven being the most common. CLT boards vary in size depending on the manufacturer, but they can be constructed up to 18 m long by 5 m wide with a thickness of up to 500 mm, making them perfect for floor, wall, and roof construction.

Glued Laminated Timber:

Glued Laminated Wood (Glulam) is a mass timber product that may be used in a variety of applications. Beginning in Germany during the 1900s, Glulam was adopted in Australia in the 1950s, although it was not as popular or widely utilised in Europe and

North America. Nonetheless, this item is gaining traction in the building industry due to its appropriate specialised qualities and the rising necessity to work on sustainable methods. Glulam is made up of many layers of dimensional timber with the grain running parallel to the length of the panel. The timber is graded for strength and glued together with a long-lasting, moisture-resistant adhesive. Individual laminates are often finger-jointed to provide longer lengths to meet structural requirements. The size of Glulam members might vary depending on the function and manufacturer.

However, they are normally 180-630 mm thick, 66-200 mm broad, and may be made in lengths of up to 50 m, making them appropriate for use as beams and columns in structural applications. Although varied, the length of the member is often limited by handling, machining, and transportation activities.

One of the most significant advantages of glulam is its ability to be manufactured in massive volumes with complicated shapes that may suit both architectural and structural design requirements. Glulam, like CLT, has outstanding strength and stiffness capabilities with a very high strength to weight ratio, indicating that it is stronger by weight than standard structural steel. Because Glulam is a laminated composite, the strength reducing variables associated with individual wood elements are eliminated, resulting in a composite that is stronger and more reliable than standard solid lumber.

Nail Laminated Timber:

Nail Laminated Timber (NLT) is an engineered wood panel product that was predominantly utilized in the building business over a century ago and is going through a resurgence as part of the cutting-edge trend toward sustainable materials. Although the use of NLT was confined to warehouses and factories, its beauty and favourable performance features allow for the utilization in a broad variety of applications. NLT is made by stacking separate dimensional lumber pieces on edge next to one other and attaching the laminations together with nails. This process of mechanically laminating dimensional timber together produces a solid structural element that may be employed in multi-story structures for floors, walls, roofs, and elevator shafts. Architects have found this sort of composite to be highly beneficial since the monolithic structure of NLT allows for the implementation of unusual shapes and forms like as curves and cantilevers.

The fundamental benefit of this composite is that it does not need specific production facilities or machinery to create panels. Basic carpentry skills are required, and locally available wood species may also be utilised for such panels. NLT also provides a prefabrication scope for bigger and more complicated construction projects. As a result, numerous designers, architects, and engineers have observed that the product is less expensive and has a shorter procurement time than other types of mass wood goods. The general acceptance of product is due to the technical criteria and details, which are fully supported by the majority of building codes and regulations. This may be a considerable benefit over alternative mass timber materials, which are not well established and recognised in building standards and which architects and designers may be hesitant to use during construction.

Figure 1. Different types of mass timber (Gong et al. 2019)

Dowel Laminated Timber:

Dowel Laminated Wood (DLT) is a lesser-known mass timber product that is popular in Europe but is gaining popularity in other areas of the globe. Modern DLT designs were created in Switzerland during the last decade of the twentieth century. It was created as an alternative to mass-produced wood products that use metal fasteners, such as nail laminated wood (NLT).

The DLT is a flexible product that is simple to make while yet meeting structural requirements. DLT is made in the same way as NLT, except instead of nails or screws, wooden dowels are used to attach individual timber pieces. DLT panels are made by placing multiple boards of softwood timber next to one other on one side and friction fitting them together with hardwood dowels. Once inserted into the lumbers, the seasoned (dried) hardwood dowels tend to expand into the surrounding timber socket in order to reach equilibrium moisture content (EMC), resulting in a tight friction fit that improves the panel product's dimensional stability. Production of these goods is typically facilitated by CNC technology, which effectively turns it into an automated process, resulting in a very uniform product that is ultimately safer than traditional manufacturing techniques. The use of fasteners eliminates the need for glue, making it the only mass wood timber product that may provide such benefits by decreasing the usage of chemicals such as adhesives.

Structural Composite Lumber:

Structural Composite Lumber (SCL) is another kind of mass timber that is distinguished by the bonding of tiny pieces of wood to form a stable structural composite. Laminated Veneer Lumber (LVL) and Laminated Strand Lumber (LSL) are the two most common forms of SCL materials used in the building industry (LSL). These materials are often used in construction in North America, while LVL is used in Australia and New Zealand.

LVL was invented in the 1970s and is now one of the most widely utilised SCL products. SCL is made by gluing together precisely graded, thinly cut wood veneers under precise temperature and pressure conditions. The veneers are carefully seasoned before lamination, and the related grains are kept parallel to the length of the product. LSL is a new SCL product that is gaining popularity in the building industry. The key distinction between LSL and LVL is that LSL employs timber strands rather than wood veneers. Both SCL products are ideally suited to residential building construction and may be used in a variety of applications such as beams, joists, studs, rafters, and so on. The main benefit of SCL is that it is far less prone to dimensional changes than normal sawn lumber, which means it is less likely to shrink, split, warp etc. Furthermore, SCL is stronger, more reliable, and better suited to high-load applications than traditional lumber. This product, however, is not often advised for high-rise structures and is most likely best suited for low-rise construction projects.

Figure 2. (A) - Laminated Veneer Lumber (LVL) and (B) - Laminated Strand Lumber (LSL)

Conclusion:

The development of engineered wood panel products has enabled the construction of wooden building structures that are beneficial in a variety of ways, including being energy efficient, having smaller carbon footprints, and being based on renewable resources. Timber buildings are regarded to have the potential, architecturally,

to create more pleasing, relaxed, sociable and creative living experience. The increased awareness of the dangerous environmental implications of traditional construction materials such as concrete and steel is driving the worldwide transition toward mass timber constructions. The availability and renewability of wood as a raw material, as well as the environmental advantages of wood in terms of climate change mitigation, are driving forces in the transition to sustainable and eco-friendly materials. The remarkable thermal insulation of mass wood constructions improves their efficiency. Better thermal insulation allows mass wood product walls to be comparably smaller, yielding more space than other construction technologies. Sustainability in the construction industry is one method to address present concerns connected to climate change as a native American phrase says, we do not inherit the Earth from our ancestors; we borrow it from our children.

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