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A Study on the Scope of Use of Wood as a Green Building Material

Ankit Patidar

Bachelor of Engineering, Department of Civil Engineering, Institute of Engineering & Science IPS Academy, Indore(Madhya Pradesh), India
ankitpatidar.civil@gmail.com

Abstract: *The Concrete is the world's most usable construction material. 'Cement' is the main ingredient in it, which is now have become a "gum" with the structure. A structure includes the meshes of "steel" bars as appurtenant to hold the concrete. As the notes, 3% of world's energy goes into the making of the steel & 5% goes into the making of concrete. Reinforced concrete building is actually the true offender – accounting for 47% of CO_2 emissions. The production of CO_2 for the manufacture of 1tonne of structural concrete is estimated at 410kg/m^3.*

This paper is as a signpost to the use of the sustainable wood products compares to as usual materials like steel, concrete, aluminum etc.

The production and processing of wood uses low energy as compare to other building materials. In addition, wood products store carbon that the growing trees have removed from the air. In the process of photosynthesis trees take $CO_2$from atmosphere & store it as carbon form and that carbon remains stored in the wood product even after the trees have stud, 50% of the dry weight of wood is carbon. The right wood is renewable and also forests provide a wide range of other benefits such as further carbon storage, oxygen generation and forest habitat. A timber of 1m^3 can store 1tonne of CO_2. This entire scenario makes the wood most eco-friendly raw material for building construction.

Keywords: *Carbon dioxide, building materials, wood, concrete, forest industry, greenhouse gas balance, wooden skyscrapers.*

1. INTRODUCTION

Wood is one of the oldest materials used by humans for constructional purposes. Despite its complex chemical nature, wood has excellent properties which make it useful for human. It is readily and economically available, easily machinable and amenable to fabrication into an infinite variety of sizes and shapes using simple on-site building techniques, exceptionally strong relative to its weight, a good heat and electrical insulator and of increasing importance. It is a renewable and biodegradable resource. However, it also has some drawbacks of which the user must be aware. It is a "natural" material. The use of wood as raw material in construction is a potential option for reducing net CO_2 emission because relatively low energy is needed for the processing of wood as compare to alternative materials. The use of waste wood as biomass for direct substitution of fossil fuels or fossil fuel-intensive materials is an important means of reducing greenhouse gas emissions as it provides permanent and cumulative reduction in CO_2emission. A sequestration or conservation of carbon is typically limited or temporary. The relation between bio-energy and increased use of construction wood is complex. This analysis is important for the reduction of net CO_2emission by substituting wood in place of other construction materials.

2. CONSTRUCTION MATERIAL& ENVIRONMENTAL IMPACT

Construction is one of the basic needs of infrastructure development. The production of construction materials are the nerve of the various industries, spread inside the countries. Cement and steel are the major materials which are used as building materials. The production process of these materials is main cause of Green House Gases.

2.1 GLOBAL SCENARIO OF ARTIFICIAL CONSTRUCTION MATERIALS

Globally, cement industry generate 5 to 6% of total GHG emission [1].Cement accounts for two-thirds of total energy use in the production of non-metallic minerals. In terms of CO_2emissions, cement production is by far the most important activity in this category. Global cement production grew from 594 Mt in 1970 to 2284 Mt in 2005 to 4180 Mt till 2014with the vast majority of the growth occurring in developing countries, especially in China and India [2].1 tonne cement production generates 0.6 to 1 tonne CO2, Calcination 45 – 50%, Fuel Combustion 40– 45%, Power Generation and Use 10 – 20%.In 2014, the world crude steel production reached 1665 million tonnes (mt) and showed a growth of 1% over 2013. China remained the world's largest crude steel producer in 2014 (823 mt)

followed by Japan (110.7 mt), the USA (88.2 mt) and India (86.5 mt) at the 4th position.[3] On average, 1.8 tonnes of CO2 are emitted for every tone of steel production. The iron and steel industry accounts for approximate 6.7% of total world CO_2 emissions [4].

2.2 INDIAN SCENARIO OF ARTIFICIAL CONSTRUCTION MATERIALS

With nearly 390 million tonnes of cement production capacity, India is the second largest cement producer in the world and accounts for 6.7 per cent of world's cement output. CO_2 emissions from manufacturing industries and construction(% of total fuel combustion) is 24.2 in 2012 in India [5]. The overall domestic demand for cement stood at around 260 million tons in 2012-13 witnessing an increase of around 7.5% over the previous year. Housing construction accounts for as much as 55% of the demand for cement in India and demand from commercial/ industrial sectors stood at 20% [6]. India has become the 3rd largest producer of crude steel with 91.46 million tons till 2015 [7].

3. WOOD AS A BUILDING MATERIAL&IT'S PROPERTIES

3.1 WOOD AND TIMBER

Wood is a commonly used construction material because of its reasonable cost, ease of working, attractive appearance and adequate life if protected from moisture and insects. However, forests are a valuable natural resource that must be conserved, particularly in areas with marginal rainfall. Wood is a product of trees, and sometimes other fibrous plants, used for construction purposes when cut or pressed into lumber and timber, such as boards, planks and similar materials. It is a generic building material and is used in building just about any type of structure in most climates. Wood can be very flexible under loads, keeping strength while bending, and is incredibly strong when compressed vertically. There are many differing qualities to the different types of wood, even among same tree species. This means specific species are better suited for various uses than others."Timber" is the term used for construction purposes. The main problems with timber structures are fire risk and moisture-related problems. Nowadays, softwood is used as a lower-value bulk material, whereas hardwood is usually used for furnishings and furniture.

3.2 FORESTS & WOOD CARBON STORAGE SYSTEM

The sustainable use of wood helps to moderate the rise of CO_2levels in the earth's atmosphere, thus partially mitigating the greenhouse effect. Wood is also renewable.*100 ft^3 of wood contains (absolutely dry) 0.65 tons of carbon, 0.55 tons oxygen, 0.1 tons of hydrogen, minor amounts of other elements*. As long as forests are managed sustainably, trees can be grown, harvested, replenished, and then harvested again and again in an ongoing cycle of harvest, renewal, and growth. Wood, on the other hand, grows by the power of sun, giving off oxygen and storing carbon dioxide. That carbon dioxide is released when the tree falls and decomposes. Forests, and the wood they provide, store carbon for the long term. Trees, the lumber and other wood products made from them, and the wood used in buildings – each provides a carbon storage system.

3.3 PROACTIVE CLIMATE PROTECTION BY USING WOOD AS BUILDING MATERIAL

Increasing the use of wood in commercial/industrial, health care, and government buildings would significantly reduce the climate change impact of building construction and increase carbon storage in the nation's building stock. Individuals and organizations are paying particular attention to evaluating not only the technical suitability of raw materials, but their environmental characteristics as well. The benefits of energy efficient buildings are already well known, including reduced energy consumption and related low costs of operation. However, operational energy-efficiency is not the whole story. In this way, CO_2 emissions can be reduced not only when the buildings are in use, but throughout the life cycle of the buildings and their materials. Figure-1 depicts a Schematic flow chart of wood materials during the building lifecycle.

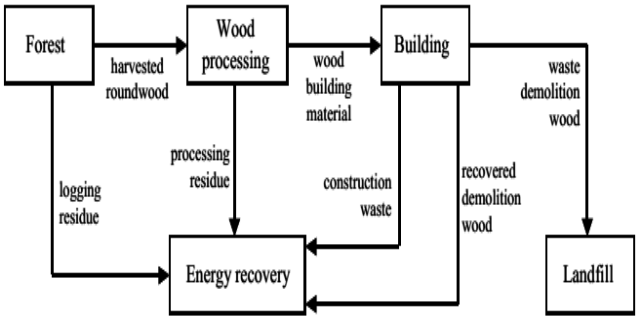

Fig. 1. Schematic flow chart of wood materials during the building lifecycle [8]

4. THE SCOPE OF WOODEN SKYSCRAPERS (TREE HOUSES)

Although it may seem counterintuitive, it would be better if we built buildings from wood than from concrete, brick, aluminium and steel. We use millions of tons of these modern materials every year. They have many valuable properties, but are energy intensive to create, accounting for around 16 percent of the entire planets' fossil fuel production. Instead we could be using wood, which is also strong, renewable and plentiful —we use only a fraction of the world's available forestry resources.

Research undertaken by scientists from the Yale School of Forestry & Environmental Studies and the University of Washington's College of the Environment, published in the Journal of Sustainable Forestry, estimated that the world's forest contain about 385 billion cubic meters of wood, with

an additional 17 billion cubic meters growing each year. A mere 3.4 billion cubic meters is harvested each year, mostly for subsistence fuel burning; the rest rots, burns in fires or adds to forests' density.

Building with wood consumes much less energy than using concrete or steel. For example, a wooden floor beam requires 80 megajoules of energy per square meter of floor space and emits 4 kg CO_2. By comparison, a square meter of floor space supported by a steel beam requires 516 mj and emits 40 kg of CO_2, and a concrete slab floor requires 290 mj and emits 27 kg of CO_2.

If transport and assembly is taken into account, the 16 percent of global fossil fuels used to manufacture steel, concrete and brick is closer to 20 to 30 percent. These potential fuel and carbon emissions savings, already substantial, will become increasingly critical as demand for new buildings, bridges and other infrastructure surges with economic development in Asia, Africa and South America. At the same time, new construction techniques have made wood even more effective as a building material for anything from bridges to mid-rise apartment buildings. The cross laminated timber increasingly used in new buildings, made from alternating layers of perpendicular wood pieces, has strength approaching that of steel.

5. SCOPE OF WOOD AS FUTURE BUILDING MATERIAL

5.1 WORLDWIDE SCOPE

The world's total forest area is just over 4,000 million hectares (ha), 31 percent of the total land area (FAO, 2010). Europe accounts for about 17 percent of global land area but has one quarter of the world's forest resources, approximately 1, 000 million ha, 81% of which is in the Russian Federation.

Sweden's total forest area is 28 million ha, 23 million ha of which is productive forest land. Sweden is to a large part covered with forests (Source: Statistics Sweden). Figure-1 gives the total forest area worldwide.[9]

Region	Total Forest Cover		
	1990	2000	2010
	Million Hectares		
Africa	749	709	674
Asia	576	570	593
Europe	989	998	1,005
North and Central America	708	705	705
Oceania	199	198	191
South America	946	904	864
World	**4,168**	**4,085**	**4,033**

Fig. 2. Trends in Growing stock (forest area) [9] Source; FAO (2010)

5.2 SCOPE IN INDIA

Domestic demand for wood and wood products increases almost 19% annually on average over review period, due to housing and construction boom across India. Value of Indian wood and wood products' imports reaches INR 39.3 billion in 2012, penetration up slightly to almost 5%. Domestic production revenue grows in line with domestic demand, reaching INR1.2 trillion in 2012 (as per Economic Survey, Ministry of Finance, 2012).The Indian forest products industry had total revenue of $65,844.6 million in 2011. Despite increasing operational costs manufacturers' profitability increases eight percentage points over review period to reach 32% in 2012. Although the United Arab Emirates is traditionally India's primary destination for wood and wood products' exports, the US is emerging as a significant trade partner. Production turnover through forecast period expected to see 18% CAGR to reach Rs3.3 trillion in 2018. [10]

Year	Imports		Exports	
	International	National (India)	International	National (India)
2010	226385115	3479703	224014593	571457
2009	191115216	2751696	188514810	390061
2008	242039046	3305937	234786725	444714
2007	230996710	2456089	227745897	277967
2006	201498893	2352598	197594466	280315

Fig. 3. International and National Import and Exports Value (1000 US$) of total Forest Products [11]

The share of American woods in the Indian import market is relatively small, but has grown from 0.4 percent to almost 1 percent ($12.8 million). India's supplies of domestic wood are very limited. Because of this shortage, the import market for raw and semi-processed wood is expected to increase with demand and construction activity over the next few years. Imports constitute 20 percent of total annual consumption of wood in India, while plantations and forestry contribute 58 and 22 percent respectively. Logs account for the largest portion (67 percent) of all wood and wood products imported into India due to relatively lower import tariffs and a local preference for unprocessed wood. Imports of logs have increased by 72 percent to $1.14 billion. India imports logs mostly from Malaysia, Myanmar, Ghana and New Zealand due to a freight advantage and relatively lower prices. The furniture market is the second largest wood processing segment after logs, making India a fast emerging market for high-end, value-added imported products. Imports of fiber and particle board, veneer and sawn lumber have also increased over the last decade, indicating positive demand in the housing, construction, household products, furniture and packaging sectors.

Panel and plywood products are main wood products in India. Product categories include veneer sheets, particle board (composite wood core with plastic laminate finish), panel products (fiber board), plywood made from both hard and softwood (veneered panels and laminated woods), and

medium density fiber board. Indian particle board and plywood industry have large producers who accounts for 15% of the total production, producing some 30 million sqm of plywood and blockboards. The Indian market for particle board and plywood is estimated in value terms, at over Rs 17billion. Of the total market, particle board accounts for over 30% of the market with the rest over 70% accounted by plywood segments. Western India has emerged as the leader in the particle board segment. [12]

In the Plywood segment, Greenply Industries with a market share of 4.1% leads the pack and is closely followed by Century Plywood (3.4%), Kitply Industries(3.2%) and Worthy Plywood(2.3%).Other important players in the segment, though with a very small market share, include Sarda Plywood Industries(1.8%) and Uniply Industries(1.4%). [12]

As in many emerging markets, India is experiencing a rapid phase of urbanization with a change in lifestyles, a growing demand for engineered wood panel products, and a high infrastructure, industry sources expect positive growth for wood products such as plywood, particleboard, medium density fiberboard, oriented-strand board and laminated veneer lumber in near future.

6. CONCLUSIONS

Building with wood is an active form of climate protection. Wood also contains highly-sought-after acoustic properties. It can absorb sound and echoes, and is a favorite material of choice for the construction of structures where proper acoustics is important, such as concert halls. Wood is resistant to electrical currents, making it an optimal material for electrical insulation. Another important characteristic of wood is its tensile strength, which is its ability to bend under pressure without breaking. Wood is the only building material that is renewable, that can be produced using minimal amounts of fossil energy, that stores massive quantities of carbon for long periods of time, and that can be reused again and again before the solar energy stored within it is recovered for energy production. Given the pervasive use of non-renewable and energy-intensive building materials currently used in non-residential construction, there is potential to reduce carbon emissions and increase carbon storage through greater use of wood in commercial/industrial, health care, government, and multifamily buildings as a climate protection solution. A first step toward a climate protection solution is to encourage the use of wood in federal and other public buildings. Public buildings represent one of the most immediate non-residential carbon benefit opportunities. Federal agencies have a goal of reducing emissions by 17 percent by 2020 and the use of greater quantities of wood in federal buildings would contribute to achievement of this goal."

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