JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

THE STRUCTURAL USE OF TIMBER IN CONSTRUCTION. A REVIEW

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ABSTRACT
Timber is one of the construction materials which when properly used, can have positive impact to both human beings and the entire ecosystem. This study therefore examines the performance, challenges and prospects of timber as a material for use in construction works. The study also highlights the sustainability benefits that are attached to the use of timber in the building system; the different types of timber used in construction; the properties of timber and the various applications of timber. From this study, it was noted that timber can be used for all types of structures if certain precautions can be observed. Some of the issues that lead to poor performance of timber in construction are; poor seasoning of wood; untreated and non-preserved wood; poor coating and technology which if can be done correctly can see timber being used for a long time. The other issues range from approval from the necessary government regulatory agencies and acceptability. Contemporary construction of tall buildings from timber, in whole or in part, suggests a growing interest in the potential for building with wood at a scale not previously seen before. As wood is the only significant building material that is grown, we have a natural inclination that building in wood is good for the environment. Building with wood does not pollute the environment. The environmental benefits of using timber are straightforward and enormous.

Key Words: Contemporary Construction, Seasoning of wood, Coating, Technology, non-preserved.

1.0 Introduction

1.1 Background Information.

Timber construction has experienced a remarkable resurgence in recent years. This is fueled by its unique combination of elegance, warmth and sustainability. As the world looks for green solutions, timber which is a natural and renewable material has become the most popular choice among architects, engineers and home owners. Timber has become a key element in contemporary architecture.

Advances in construction technology and wood treatment have allowed use of timber in larger projects, including multi storey buildings. The combination of wood and other materials like glass and steel has resulted into modern designs that have captured the attention of everyone. Recent studies show that there is significant and growing interest in using timber. This interest came up partly as a result of the development of new engineered timber products and the potential economic benefits that can be obtained from prefabricated timber elements and composite building systems. The primary motivation for architects and engineers understands the potential sustainability benefits of timber and its role in green and sustainable architecture. One of the main reasons for the shift towards timber is the environmental impact of traditional construction materials like concrete. Concrete production is responsible for 8% of global carbon dioxide emissions and its usage needs to be controlled. Timber is a renewable construction material that is available worldwide and has a lower carbon foot print than materials that require fossil energy like cement or lime concrete. Timber is also cost-effective and requires less time for assembly than traditional materials. In addition the use of per-fabricated timber components can speed up the construction process as they can easily be transported and assembled on the construction site.

Ramage et al,(2017),in their research in renewable and sustainable energy, stated that, there is sufficient timber supply for the foreseeable future for any type of timber construction. Timber has a high strength to weight ratio and it is used most efficiently in structures where it is carrying a lot of its weight. Timber for construction is one of the many forest products used around the world. It is used for construction of both large and small buildings. There is ample global supply for the foreseeable future. Timber is natural and renewable. It has a high strength to weight ratio and is easy to work with, making it especially useful even where only basic technology and procedures are available (Apu, 2003). According to Douglas (1995) timber remained the most predominant building material until the last half of 19th century. Today, proponents of timber as a building material perceive it as an attractive building material while its opponents opine that it is unreliable for construction. However, Andreas (2005) asserted that architects are only limited not by the material but their knowledge of how the material works.

1.2 Statement of Problem.

With recent observations and studies of various building materials, it has been observed that timber is one of the low-cost materials. This is to imply that timber is one of the cheapest, yet underutilized material in the building industry. This is true when timber is compared with other building materials like aggregates, sand, cement, reinforcement bars and roofing sheets.

Cost comparisons are difficult to make between timber frame and other construction materials. This study focused on the suitability of timber and its usefulness as a building material for application in civil engineering structures.

Generally, despite the numerous contributions of timber to the construction, there still exists lots of challenges associated with the use of timber in civil engineering works .Some of these challenges include lack of knowledge in timber use, treatment

methods and non-availability of standard timber connectors.

2.0 Sources of Timber as Building Materials.

Timber is obtained from trees. The trees are generally categorized as hardwoods and softwoods. Hardwood trees around sixty years and more to grow. Hardwoods include ash, balsa, beech, mahogany and oak trees. Softwood trees take around half the time that hardwoods take to mature. This could be twenty five to thirty years. They include trees like larch, pine ,confers and spruce. Timber as one of the few natural building materials can boast of a whole lot of advantages generally ranging from being safe to handle, not leaking chemical vapors (Ramage,et al 2017).Once a tree has been chopped down, the branches are removed so that the trunk of the tree remains for processing. The tree trunks are transported to the sawmill where they are converted into usable planks.

2.2 Reasons for use of Timber in Construction Works;

Below are some of the reasons for using timber in civil engineering works (Atlantic Cladding,2018)

i. Ecology and Sustainability; Timber is easily replaced because of the standing policy of replanting new trees once any timber has been harvested thus ensuring continual availability of timber.
ii. Low production energy .It takes very little energy to convert trees into timber for construction and this means there is less energy consumed when using timber for construction.
iii. Offers great insulation properties; Timber offers very desirable insulation properties compared to brick and concrete materials.
iv. Easy to work; Timber is a very versatile material and can be used in various ways and is very easy to install.
v. No limit to design
vi. Durable, easy to maintain and quick to build with when timber is treated.
vii. Fire retardant; some types of treated timber are fire retardant and hence prolongs te time it takes to catch fire and hence slowing down the burning process.

The qualities of timber as a building material include availability, physical and aesthetic qualities, work ability and versatility, environmental sustainability, flexibility of space arrangement, dry construction, industrial production and comparative cost effectiveness (Gregory, 1984; Nolan, 1994 and Whitelaw, 1990).

i. Availability and Acceptability

Timber is locally available in Kenya. It can be purchased from local suppliers and transported to site using even small vehicles. Timber is accepted as an attractive building material in most cultures.

ii. Physical and Aesthetic Qualities

Timber has a high strength to weight ratio making it an attractive framing material. Some species are highly resistant to rot. Timber withstands humidity with less structural change than other building materials. It is very durable and there are numerous finishes available to protect and enhance the natural beauty of the material. These sealants and protective finishes promote its durability. If well protected and well installed, timber can last for centuries with minimum maintenance (Sturges,

1991). Timber is more fire resistant than bare steel, as charring forms an insulating layer that protects the inner core of the material. Heavy timber construction is less prone to damage by short-term high temperatures allowing for a longer period for evacuation in case of fire.

iii. Work ability and Versatility

Timber can easily be shaped by simple hand tools. It can be cut, planed and chiseled. There are many ways to connect timber to timber or to other materials since timber can easily be secured or fastened with nail, screws, bolts and other connectors. There are many design options possible with wood that are not practical with inorganic materials such as concrete or steel. The design performance required by a particular building application can be more flexibly matched by selecting timber of the appropriate density, compressive and tensile strength, colour, texture and fire resistance (Anderson, 1970).

iv. Environmental Sustainability

Environmental sustainability recognizes that human activity over time and the health of the environment are interdependent and that environmental health has necessary social, political and economic determinants. Probably the most significant environmental benefit of timber is its renew ability and biodegradability (Resource Assessment Commission, RAC, 1991). It has low manufacturing process energy and benign air emissions (Townsend and Wagner, 2000). Timber is an excellent insulator against hot or cold weather. The old ‘’log-house’’ remains a model for minimum energy consumption in buildings (Ogunsote, 1993).

v. Flexibility of Space Arrangement

Partitions made from timber can easily be moved around to change layout in response to new functional requirements.

vi. Dry Construction

Unlike concrete floors, timber floors do not require a curing period before achieving maximum strength. Construction is therefore faster. Finishing is also faster, since timber walls can be painted immediately, unlike plastered walls which require several days to dry.

Industrial Production

Timber is especially well suited for mass production. Standard components such as doors, windows, boards for walling construction, floor, ceiling and roof tiles as well as skirting can be purchased in standard sizes.

vii. Comparative Cost Effectiveness

The local availability of high quality wood and the abundance of local millers make timber production less dependent on imports. Prices are relatively stable, since they are less influenced by the volatile foreign currency exchange market. This gives timber a cost-comparative advantage over other materials that have high import content.

3.0 Properties of Timber

3.1 Physical Properties;

3.1.1 Density and specific weight; all the mechanical properties of clear wood are related to its density which varies with the apparent specific gravity. The true specific gravity of wood is approximately equal for all species of wood and averages 1.54, whereas the specific weight and apparent specific gravity vary with density of wood.

3.1.2 Bulk density; this depends on the volume of pores and moisture content of the wood. For most wood species, the bulk density is less than density. Bulk density value is used to determine the quality factor which is the ratio of compressive strength to the bulk density. It is 0.6 for pine and 0.57 for oak.

3.1.3 Moisture Movement Water is found in three portions of wood; It constitutes over 90 per cent of the protoplasm in the living cells; It saturates the cell walls; It fills ,more or less completely, the pores of the life less cells. Timber may shrink or swell depending on the movement of moisture.

3.1.4 Tensile Strength Wood is very strong to tensile forces acting parallel to grains but very weak when these forces are made to act parallel to the grain. Thus ,the tensile strength of some woods ranges from 500-2000 kg/cm2 parallel to the grain whereas same values lie between 10-100kg/cm2 for the same varieties when tested perpendicular to the grain.

3.1.5 Compressive Strength; Timber from most of the trees is amazingly strong under compressive loads of 500kg/cm2 to 700 kg/cm2.The compressive strength parallel to grains is always less than that determined at right angles to the grain in the same type of wood.

3.1.6 Transverse or Bending Strength. The most important use of timber as beams is based on the fact that wood has very high bending strength. It may vary from 300 to 900 km/cm2 or more.

4.0 CHALLENGES OF TIMBER AS A CONSTRUCTION MATERIAL

i. Fire

The greatest challenge of wood as a structural material has been fire. Studies have shown that wood as a building material is the only material that insulates itself after the initial charring.

Studies have shown that when timber burns, it gets momentarily protected by its own charring,

Which creates an insulating charcoal layer that reduces the speed of spread of fire. This means that a timber structure, if well designed, will remain capable of carrying the load it has been designed for, even when exposed to fire for a reasonable time for evacuation. However, the best control in timber building as with other buildings is prevention in the first place and the use of fire rated timber in places that are susceptible to fire outbreak.

ii. Weathering and Decay

Another factor that affects timber is weathering and decay. Timber decay arises from fungal attack in combination with excessive moisture, while weathering occurs as a result of chemical and light reactions (William, 1983).These effects of weathering can be prevented through the application of coatings on the surface of the timber. The choice of coating is dependent upon what is expected to be achieved. Coatings are classified into two; there are those that form a thin layer or coating on the surface of the timber while the second type provides protection through penetration without leaving any coating. However,

the protective benefits of all coatings also depend on proper maintenance of the coating. No coating will last indefinitely and all need to be periodically reapplied.

iii. Termite Infestation

Termite control is of very high importance; however, the likelihood of termite encroaching into a dwelling is not dependent upon the type of frame used in construction. All that needs to be done is a simple adherence to some basic principles of maintenance. Some of the processes involved in controlling termite infestation are Suppression, Site Management, Soil Barriers and choice of foundation.

a) Suppression

This involves the systematic location and destruction of colonies, the inspection of timber products to treat an infested area, the burning of infested lumber and heat treatment of reclaimed lumber.

b) Site Management

Site management is another avenue where termite infestation can be controlled. This can be achieved through the proper disposal of construction debris, pegs and concrete form works rather than burying them.

c) Chemical and Soil Barriers

Termite infestation can be controlled by the application of environmental friendly chemicals. Sharp sand laid along the foundation footing has been found to be a very strong barrier because they are too heavy for the termites to move and the spacing between them is too small for the termites to squeeze through.

d) Slab and Foundation Details

Foundation walls and slabs can be designed to inhibit their entering into the building. The detailing of the foundation with concrete cap will force termites to the surface where they can easily be detected. Foundations without the concrete cap allow easy and hidden boring of termites.

3.0 TIMBER AS A SUSTAINABLE BUILDING MATERIAL

In 2015, The UN established the 17 Sustainable Development Goals (SDGs),nine of which are directly related to construction. According to Okereke (2006), a sustainable material should possess the following characteristics:

- Easily available and affordable, preferably locally;
- Meets with the requirements as specified in National Standards; in terms of durability and maintainability;
- Should be environmental friendly and should not constitute any health hazard;
- Should be versatile in usage, that is, it could be used for different purposes (as walling materials, flooring, etc).Timber is a natural material and renewable resource. With proper planning, trees can form inexhaustible source of construction materials.

4.0 Conclusion

From the above analyses, it can be concluded that timber as a construction material has lots of sustainable benefits to the construction industry. The benefits cannot be considered purely in terms of environmental impacts, i.e., reducing the carbon footprint, but also in social and economic terms. In general, the cost of timber solutions tends to be slightly higher than other common systems such as concrete, bricks or steel.

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