WOOD AS A SUSTAINABLE BUILDING MATERIAL IN NIGERIA.

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ABSTRACT

Sustainable development has become a worldwide phenomenon especially in developed economies where it is observed that the green gas emission is critically destroying the ozone layer. A major contributor to this effect is the building construction industry where a lot of energy is expended in the production of building material.

Shelter on the other hand is a basic necessity; however its development should be sustainable and environmentally friendly. Wood as a building material is found to outdo other building materials in terms of its cost effectiveness, sustainability and durability

Wood is a natural material with a minimal impact to the environment when compared to steel, plastic and concrete. It is also beautiful, light, strong, durable, flexible and easy to work with. The tropical regions especially Nigeria has a lot to gain from the effective utilisation of wood as a major component of building. This is attributable to its low heat conduction and therefore will go a long way in energy savings. It is also abundant and can be regenerate through proper afforestation principles.

This paper takes a look at the challenges posed by wood as a major building material and how such challenges can be tackled especially by professionals in the building industry. It also highlighted the enormous benefits derivable from its use, both to man and the environment.

Key words: Construction, Cost, Environment, Sustainable, Wood,

INTRODUCTION

Wood both refined and unrefined has been used as a primary source of building material for ages in construction of buildings and bridges, but the advancement in technology had made its use reduced. Because wood as a building material is seen to have limitations, there was a gradual shift to steel and concrete owing to their plasticity and flexibility in use Andreas (2005) opined that architects are only limited not by the material but by their knowledge of how the material works.

The advancement in technology is supposed to have created more advancement in the utilisation of wood but unfortunately its utilisation as a major component in building in Nigeria is low. The professionals in the building industry shy away from it, despite the inert properties of wood as a building material.

However sustainable development is now the trend worldwide, this is with a view to scale down the negative impact of man's activity on the environment, an example of this impact is the ozone layer depletion and global warming. The key to this problem lies with the choice of construction methods and choice of material. Wood as a building material has been seen to have a minimal impact on the environment.
(Table 1.)

Material	Carbon release (kg/m³)	Carbon stored (kg/m³)
Sawn timber	15	250
Steel	5320	0
Concrete	120	0
aluminium	2200	0

Culled from: National Association Of Forest Industries, 2001,
Timber As An Environmentally Superior Material.

The first criticism that may come up in the mind of an environmentalist is the possibility of deforestation, which is the complete destruction of forest resources, however, it is only wood that has the potential of being regenerated through careful afforestation principles. Stone and clay on the other hand, once removed from its source can never be regenerated.

Wood is the only major building material that does not undergo much refinement. The main process involved in wood production is seasoning which is the controlled removal of water from the timber. The second process is sawing which involves the cutting of logs into various shapes and sizes.

Each building material has an embodied energy, an embodied energy is referred to the amount of energy used to fabricate a particular building material and is calculated in MJ/m^2 (mega joule per meter squared).The studies carried out by NAFL (2001) shows that timber has the lowest embodied energy when compared to steel, bricks and aluminium. On the other hand the carbon emission into the environment showed wood to have the lowest value during the manufacturing process.

The concept of life cycle assessment has been in existence since 1960 but has started receiving more attention now by environmentalist. Joel (1999) here the architect, the developer and the home owner tries to look at the impact of material holistically to see its environmental impact and prefer ability of design alternatives.

SUSTAINABLE DEVELOPMENT

The most widely accepted definition of sustainable development following the world commission on environment declaration as quoted by Khan (1996) defined sustainable development to mean the development that "meets the needs of the present without compromising the needs of future generations to meet their own needs".

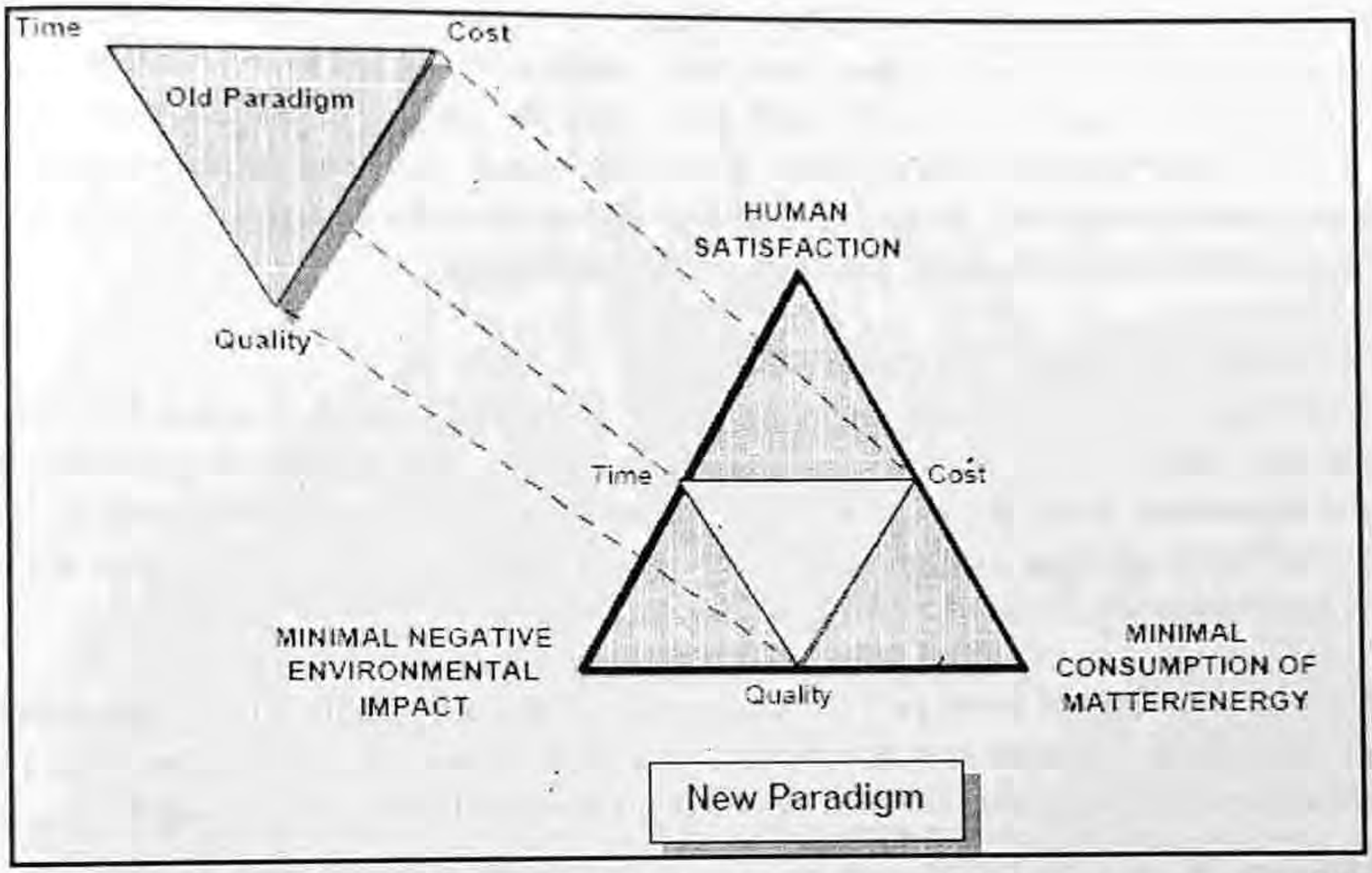


Figure 1: The paradigm of sustainable development culled from Jeorge et-al (2009)

The paradigm of sustainable development has shifted from the old concept of design where, the main consideration has been time, money and quality to also add human satisfaction, minimal negative impact to the environment and minimal consumption of energy.

Jeorge et-al (2009) also stated the key objectives of sustainable development as the minimization of consumption of matter and energy over the whole life cycle of consumption while at the same time satisfying human needs and aspirations with sensitivity to cultural context, and avoiding negative environmental impact.

Wood amongst other material is the only one that has the potentials to be controlled as it literally does grow on trees, with proper sustainable forest management; forests will continue to produce more wood indefinitely. The regeneration of other building materials such as steel and aluminium takes million of years to develop.

Wood serves as an avenue for the absorption of carbon dioxide which is stored indefinitely. It also requires less energy to extract process and transport than steel or concrete. Wood- framed buildings are more energy-efficient, costing less to construct and operate over time. This can be seen to go along with what sustainable development entails.

Bruce (2004) observed that a recent research conducted by the Consortium for Research on Renewable Industrial Materials (CORRIM) which compared steel, concrete and wood in residential home construction, in various cities of America. The study found out that using steel as a wall component generates 33 percent more greenhouse gas emissions than wood and concrete generates 80 percent more. In fact, wood was found to outperformed steel in terms of greenhouse gases, energy use, air and water while the wood wall outperformed concrete in all measures except in water pollution, which showed no difference.

STRUCTURAL CAPABILITIES OF WOOD

It is interesting to note that of all materials timber is the only one that can exhibit different structural capabilities using the same size and type of wood. The structural capability and the beauty are dependent upon how the sawing of the wood is done. The wood sawn along the grain tends to have more structural capability than that sawn across, while the opposite is the case in terms of beauty this was asserted by Andrea (2005).

The clear understanding of these peculiar characteristics will aid specifications especially by the architect since both the size and the cutting style will be specified too. The figure below illustrates a Quarter sawn timber labelled 'A' and plain sawn timber board labelled 'B'

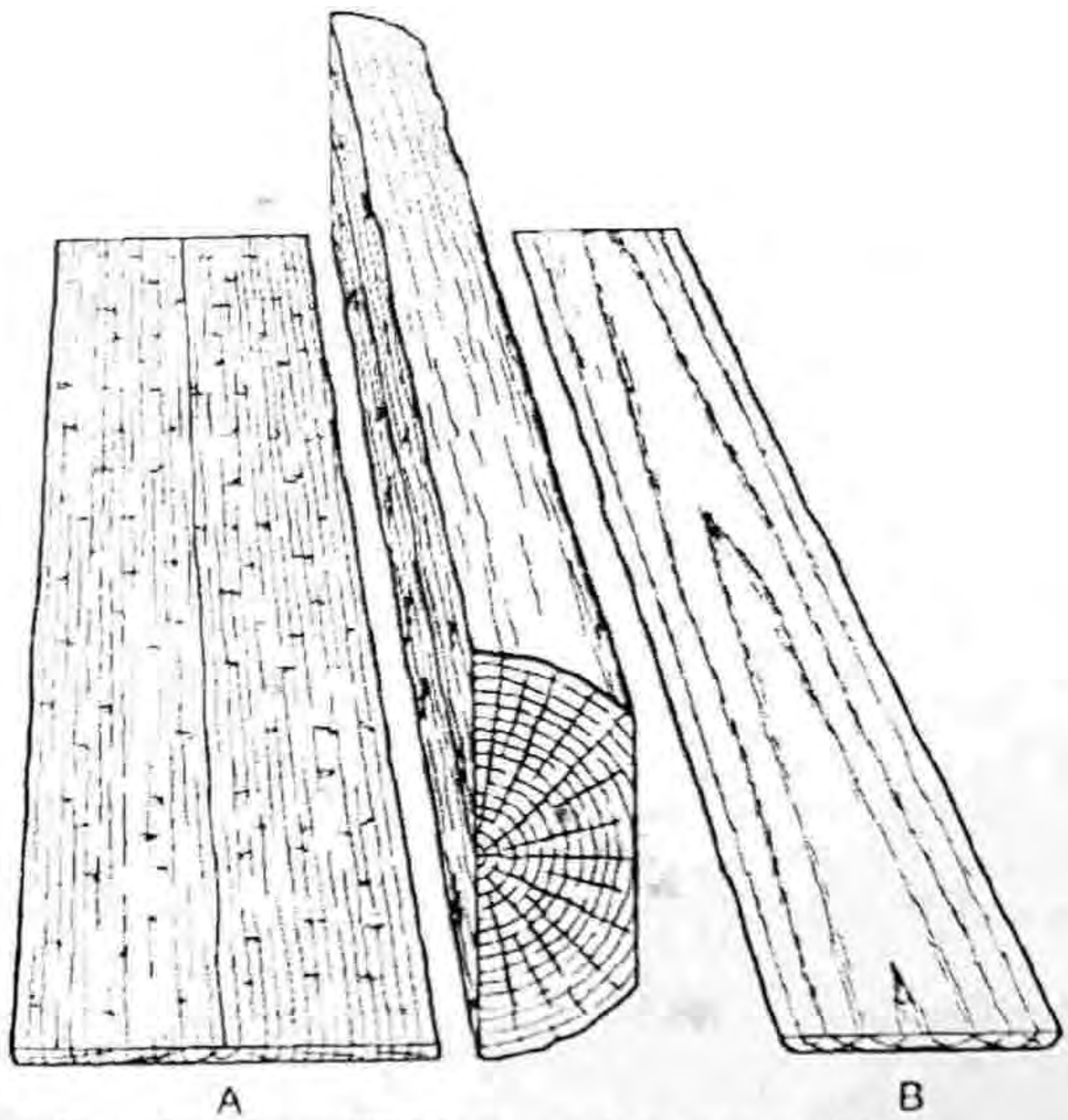


Figure 2: culled from **William and Anton, (1999),**

Table 2. Some advantages of plain sawn and quarter sawn wood

SN	**Plain sawn wood**	**Quarter sawn wood**
1.	Shrinks and swells less in thickness	Shrinks and swells less in width.
2.	It is less susceptible to collapse in draying	Cups, surface checks and splits are less in seasoning and in use.
3.	The surface appearance is less affected by knots found in the joints of timber.	Holds paint better in some species.
4.	Cost less because of its ease of sawing.	Does not allow liquid to pass through in some species.

TABLE 2: culled from William and Anton, (1999),

WOOD AND HEAT CONDUCTION

Wooden buildings require much less insulation to retain their warmth. The greatest challenge of tropical regions is the excessive heat gains in buildings especially those built of concrete and steel. With this in mind it will be of great advantage to explore this potential of timber in other to have energy savings in cooling houses.

Table 3.0. Thermal conductivity of some building material.

SN.	Material	Thermal conductivity k(w/m-k)
1	Fired clay	1.0
2	Cement board	0.6
3	Limestone gravel	0.6
4	Sand and gravel (concrete)	1.4-2.9
5	stone	1.5-3.0
6.	wood	0.05-0.15
7.	steel	19.0-21.0

John (2003) Heat transfer text book.

The analysis shows wood to be 30 times better than stone in terms of resistance to heat flow and the same with concrete, while when compared with steel, it shows it to be 400 times more resistive to heat flow. The resistance of heat flow found in wood can therefore be of great advantage as less energy will be required to cool the interior spaces of the dwellings.

WOOD AND THE ENVIRONMENT

Wood apart from its warmth creates a welcoming environment and also blends naturally with nature while at the same time creating an authentic aesthetic appeal that no other material can produce. Wood is also a natural product that degrades after its life cycle without much impact to the environment.

The strength and durability of wood is evident in many wooden heritage buildings that can be found worldwide. Wooden buildings like Norway's beautiful Stave churches are still structurally sound and are still in use today, centuries after being built.

Timber construction can therefore be seen as agents of green architecture. A green design reduces resource consumption both by ensuring that a structure lasts and that it can be easily adapted if necessary. The 19th century barn at Fallingwater in Pennsylvania is a great example; because even though the use has changed the structure was successfully adapted for the new use with little adjustment.

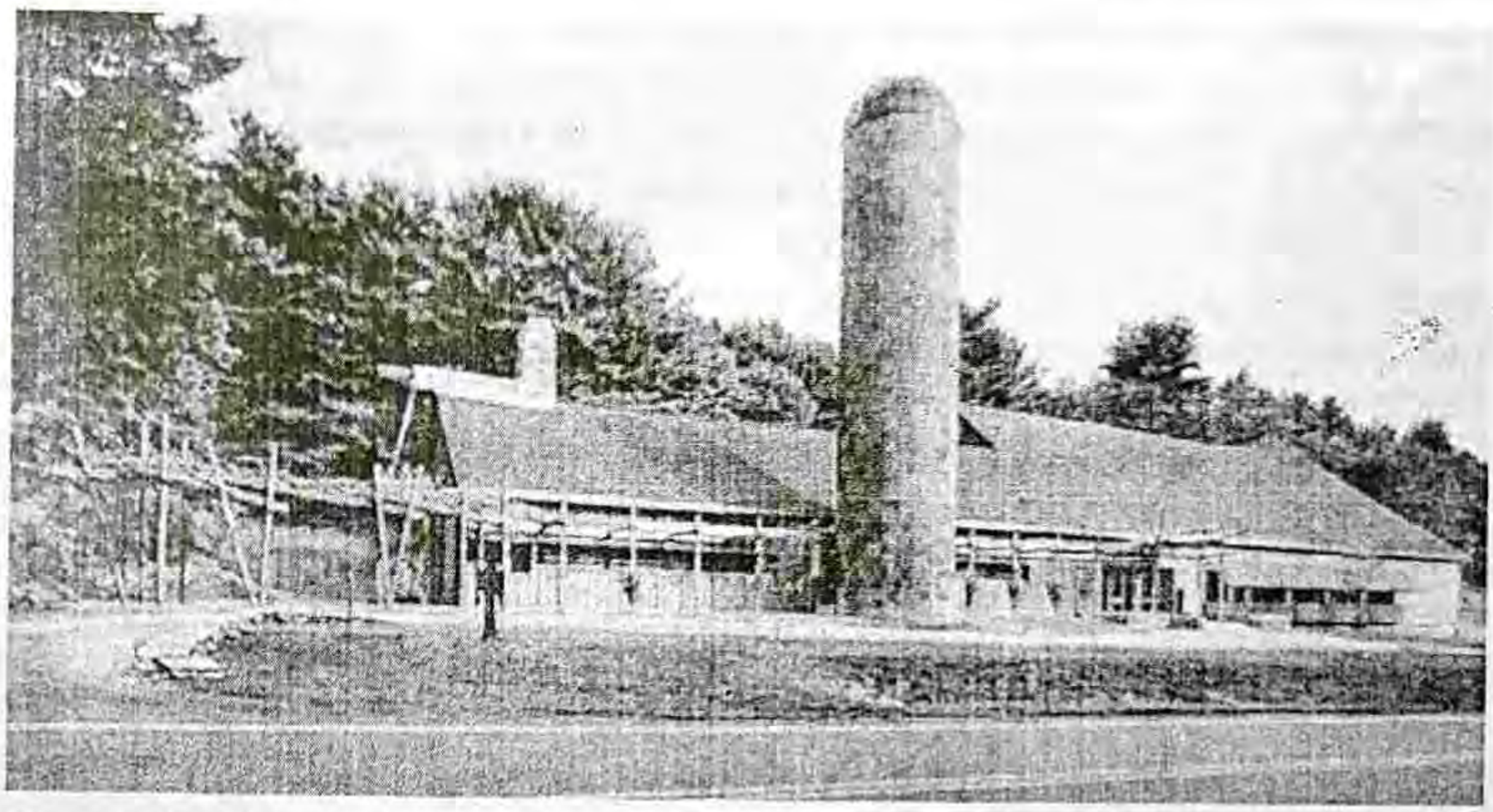


Plate 1.Showing the barn at Pennsylvania built in 1870.Source.
Http://www.fallingwater.org/49/about-the-barn-at-fallingwater.

The result of designing green should be a healthy, high performance environment made with the lowest feasible impact to the planet. Wood structures require less energy to build and to operate, which reduces our reliance on fossil fuels. Wood can be recycled, reused and renewed, again and again.

Wright (2010) Stated thus:

"Wood is universally beautiful to man,
and the most humanly intimate of all
[building] materials."

Few other material can match wood's unique combination of benefits, including strength, affordability, and environmental superiority.

CHALLENGES OF WOOD AS A BUILDING MATERIAL

No building material exists without its challenges; however the limitations these materials pose are restricted to our level of creativity and also the time and patience we have to study such material. And with the advancement in technology the applications that were seen not to be tenable can be explored now.

> *"There is no law, no principle, based on past Practice, which may not be overthrown in a moment, by the arising of a new condition, or the invention of a new material;*
> *(Andreas 2005)*

The challenges associated with the use of wood as a building material includes inflamability under fire, termite infestation and weathering.

1. Fire and wood

The greatest challenge of wood as a structural material has been fire. But studies have shown that wood as a building material is the only material that insulates itself after the initial charring. But after the initial degradation phase the properties of timber keep the burning rate fairly low. Studies have shown that when timber burns it gets momentarily protected by its own charring, which creates an insulating chárcoal layer that reduces the speed of charring. This means that a timber structure, well designed, will remain capable of carrying the load it has been designed for, even when exposed to fire for quite a long time. The charring rate for timber has been estimated to 0.5-1.0 mm per minute, an average of 0.65 mm per minute for deep sections with single-side exposure NAHB (2009).

Thus, wooden buildings do not momentarily give way when exposed to fire rather it gives an ample amount of time for evacuation. However the best control in wooden building as with other buildings is the prevention in the first place and also the use of fire rated wood in places that are susceptible to fire outbreak.

2. Weathering.

Another factor that affects wood is weathering and decay. Wood 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 wood. 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 wood while the second type provides protection through penetration without leaving any coating.

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

3. Termite

Termite's control is of a very high importance, however the likely hood of termite, encroaching on 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 design principles maintenance. Some of the processes involved in controlling termite infestation as enumerated by Canadian wood council (2001) are Suppression, Site Management, Soil Barriers, and choice of foundation.

I. Suppression

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

II. 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 buried or encased in concrete.

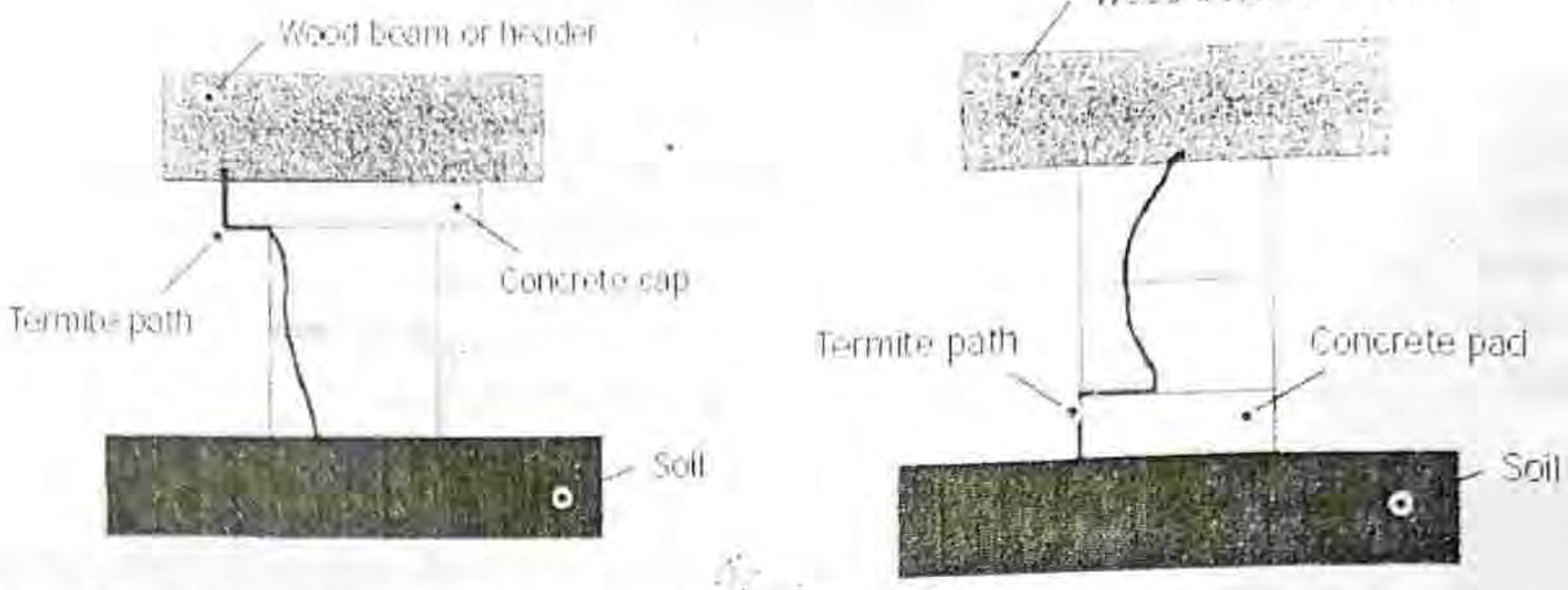
It is also important that the site grading drains water away from the building.

III. Soil or Chemical Barriers

Termite infestation can be controlled by the application environmentally 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 too small for the termites to squeeze through.

IV. Slab and Foundation Details

Foundation walls and slabs can be designed to inhibit the entry of termites into the building, The detailing of the foundation with concrete cap as shown in the figure 3 would force termites to the surface where they can easily be detected. Foundations without the concrete cap allow easy and hidden boring of termites.



Culled from Canadian wood council publication (2007):
termite control and wood frame building

CONCLUSION.

The choice of wood as a major component of building in Nigeria needs to be considered in other to make available to the Nigerian populace a sustainable and affordable housing product. The research showed that wooden structures have survived long period of time and therefore goes a long way to show that they could be used in wholly in buildings.

What is required by the professionals in the building industry especially the Architect is to have a deep knowledge of the various dynamics associated with timber as a construction material

Nigeria is found with a lot of varieties of these natural and sustainable resources that grows on trees. It is the only building material that can be regenerated. On the other hand it is very conducive because of the effective thermal control properties it exhibits. It is also environmentally friendly. It is the hope of this researcher that further studies can be carried out to comprehensively to classify the types of wood according to their structural and aesthetical applications in buildings.

RECOMMENDATIONS.

There would be a need to collate the different types of wood species found in Nigeria and their properties as building components in terms of their structural potentials, aesthetic values, and termite and fire resistance. It is expected that this will go a long way in encouraging its utilisation in both quantitative and qualitative aspects.

REFERENCES

Adam T, Chris K, and Eric H "Communicating the Green Advantages of Wood to Your Customers". Retrieved from http://www.utextension.utk.edu/publications/wfiles on 25th November 2009. 2:30Pm

Andreas E. (2005) Architectural forms of massive timber, 'structural forms and system'. Doctoral thesis presented at the Lulea University of Technology Sweden. (Page v) (27). SP External Scientific Publication

Bruce L. and Jim W (2004) Measures for Renewable Building Materials A publication by *Consortium for Research on Renewable Industrial Materials* (CORRIM) Report on Environmental Performance *retrieved from http://www.corrim.org/factsheets/fs_02/fs_02.pdf on 11th January 2010, 11:15 am*

Falling water about the barn, retrieved from http://www.fallingwater.org/49/about-the-barn-at-fallingwater) on 24 February 2010. 5:12pm.

Joel Ann T. (1999) Environmental life cycle assessment. *Time-Saver Standards: Part I, Architectural Fundamentals (page 185-189* The McGraw-Hill Companies publication.

John H. L. and john H. L. V.2003, A Heat transfer text book, pg 698-703 pub Phlogiston Press Cambridge Massachusetts

Jorge A. V, Jennifer R. D, and Annie R. P., 'Sustainable Technologies for the Building Construction Industry retrieved from http://web.mac.com/urbangenesis/iWeb/Products/Publications files/DGEPaper-CP001.pdf on 5th January 2010, 10:25am.

Model Green Home Building Guidelines (NAHB 2009) retrieved from http://www.cwc.ca/DesignWithWood/Durability/Finishing%20Exterior%20Wood/?Language=EN on 16th December 2009)

Phil T. and Chris W. (2002) Timber as a Building Material -An environmental comparison against synthetic building materials retrieved from
http://www.nafi.com.au/files/issues/TimberLCA.pdf 12th December 2009. 2:16pm

Sustainable landscape design in arid climates conference proceedings Aga Khan Trust for Culture, Held at Dumbarton Oaks on 7 December 1996 published by Aga Khan Trust for Culture

William C. F. (1983) Weathering and Protection of Wood, Feist, William C. Weathering and protection of wood. In: Proceedings, seventy-ninth annual meeting of the American Wood-Preservers' Association; 1983 April 17-20; Kansas City, MO. Stevensville, MD: pg: 195-205

William S. and Anton T,(1999), Physical Properties and Moisture Relations of Wood *an article in*, Wood as an engineering material hand book, Prepared by USA Department of Agriculture, Forest Service, (pg 2). Retrieved from http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr113/ch03.pdf.