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Environmental impacts of bamboo as a substitute constructional material in Nigeria

J. Atanda

Department of Architecture, Cyprus International University, Nicosia, Cyprus

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ABSTRACT

The environment in Nigeria is exceptionally exposed to diverse natural hazards. Due to this factor, this paper investigates a material which can be substituted for wood or steel in construction. Bamboo, a natural raw material, is one of the fastest growing plants on earth. Bamboo use in construction is not new; it has been regularly utilized for building mud houses and small huts in villages for centuries. Bamboo is a durable and exceptionally flexible building material. It has been utilized for flooring, walls, roofing, concrete reinforcement, and scaffolding, is light in weight and easily transported. This paper will examine bamboo and its environmental benefits, its properties and qualities. In Nigeria, the rate of bamboo use is low; therefore, this paper will investigate bamboo and its uses in Nigeria, conceivable uses that can be embraced demonstrating its accessibility and impacts on the environment in Nigeria.

1. Environmental impacts of bamboo as a substitute constructional material in Nigeria

Bamboo as a natural raw material existed together in the world since the days of man on earth. In the construction sector of Nigeria, wood and steel have been the major materials used in the production. With the forest been reaped down year in year out for logs of timber for construction, experimental researches (Andam, 1995; Youssef, 1976; Liese, 1986) are being discovered to state the fact that bamboo has a natural raw material and a strong capability to that of wood, bricks, also as strong as steel, and it is environmental friendly, cheap, locally accessible, which can be readily used as a substitute material for flooring, roofing, and reinforcement in place of steel in buildings.

Bamboo a composite material is readily accessible in Nigeria and has not been properly utilized. From researches conducted by scholars (Cleaver, 1993; American Bamboo Society, 2002; Anon., 1987), bamboo possesses a vast advantageous usage scheme which is environmental friendly, in respect to trees (wood) which are gathered within 10–30 years, bamboo can be collected within 3–5 years, likewise a 10–30% of biomass contrasted with 2–5% of bamboo (American Bamboo Society, 2014). With the high rate of wood exploitation in Nigeria forest, it will be necessary to provide an alternative means/sources of raw materials for construction. The aim of this paper is to investigate the information about bamboo as a raw material, which can be utilized in the constructional sector in Nigeria, revealing its potential and ecological profits and disservices. With findings gathered this paper will provide a formidable platform, to be considered if bamboo can reduce the environmental defects in the construction sector in Nigeria. The objectives of this paper are: to identify the strength and capability of bamboo for constructional purpose, to identify its present use in

E-mail address: jatanda@ciu.edu.tr (J. Atanda).

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Nigeria and explore further possible usage, to examine the effects depends upon the environment in Nigeria. The article is based on bamboo use, characteristics and properties, data will be collected from literature sources: journals, books, magazines, etc. In this paper, a qualitative research approach will be adopted. Data collected will be examined with references related to previous researches done by scholars and scientist in regards to bamboo. The study will cover bamboo, its characteristics, properties and use in Nigeria. The investigation of bamboo in this paper will be restricted to the ones found in the Nigeria. This paper will only cover the use of bamboo in construction, other aspects like medicinal attribute, industrial use; will not be discussed.

2. Bamboo: characteristics, properties, usage

Bamboo is the fastest developing plant on the plane (Alfonso, 1987); there are more than 70 genera and in excess of 1000 species which have been proposed in botanical literature, (Anon., 1988). They grow in sub-tropical and calm zones, primarily on sandy topsoil to loamy mud soils. It is an adaptable plant with a short development life cycle. The growth of bamboo culms is exceptionally quick, around 70 mm everyday and can be as much as 350–450 mm everyday. The development of its culms is completed within 4–6 months, stated by Wong (1995) their culms take 2–6 years to mature depending on the species. Bamboo culms are generally cylindrical and smooth, with a diameter ranging from 29 to 300 mm, 60–70% of bamboo wood comprises of fiber, and the fiber substance is more prominent in the outskirts than inside. The average height of bamboo is around 100 times its diameter.

Bamboo development pattern is a particular blend of grass, leaf-bearing tree, and palm. They are like leaf bearing tree; they also have tubular blades, lanced shaped cover leaves and peculiar flowers like grasses. They build their crown consistently furthermore shed their leaf yearly, bamboo has a strong rootstock.

3. Properties

Properties of bamboo change because of an extensive variety of genera families and species. Besides, imperative species of bamboo properties will be mentioned as: 1. Tensile and compressive strength, 2. Shrinkage, 3. Resistibility and 4. Elasticity. Fibers in bamboo run axial; hence the tensile strength of bamboo is in their outer zones which are profoundly versatile vascular bundle, their strength varies along with culm height, the compressive strength increases with height while bending strength has opposite pattern. Bamboo shrinks more than wood when it loses water. It shrinks in the cross sections ca. 10–16%, in the wall thickness, ca. 15–17%. Bamboo has an abnormal state of flame resistibility due to its high substance of silicate acid. Bamboo has an enormous elasticity which makes it a good building material which is environmental friendly for areas with earthquake. Lastly bamboo has a relatively low weight and can be transported easily and utilized (Klaus, 2002).

4. Usage

The utilization of bamboo can be grouped into six major aspects as follows: 1. Construction, 2. Furniture production, 3. Paper making, 4. Textile, 5. Pharmaceutical usage and 6. Household-items. In the constructional aspect, bamboo is used as a building material for decoration and as a structural member of a house. Bamboo has been utilized by the local populace for housings years back, being used as poles, purlins, trusses, rafter, mats, flooring (Fig. 1), ceiling, roof, wall (Fig. 2), window and door frames, foot bridges and fence posts. They are additionally used in modern-day as scaffolds to support slabs while constructing. Bamboo production is now common to the world and has been developed in China, India, Vietnam and Thailand where bamboo mat boards are manufactured. With studies observed, in Asian countries bamboo can be a valuable sustainable natural resource (Naxium, 2001a).

Bamboo has been utilized in furniture production and pulp and paper making, as a fuel (charcoal, oil, gas produced through pyrolysis), and the fibers are used for textile making, and other ranges of products like chopsticks and table wears, also to medicinal health care products (Xaing, 2010). Bamboo has been chosen to be used as a raw material in construction due to its environmental friendly attributes and readily availability (Yu et al., 2011). Nutritional active minerals such as vitamins, amino acids, steroids are also extracted from bamboo culm, shoot and leaves. Bamboo can also be processed into beverages, medicines, pesticides and household items e.g., toothpaste, soap, etc. (Naxium, 2001b).

5. Bamboo in Nigeria: source and availability

According to RMRDC, (2004a), bamboo is widely distributed in Nigeria. Fig. 3 demonstrates the level of bamboo occurrence in Nigeria. However, RMRDC, (2004a) indicates that bamboo is widely distributed in the south and middle belt regions of Nigeria. In reference to this report the states in which the bamboo is not less than 10% of their natural vegetation are: Ogun, Oyo, Osun, Ondo, Edo, Delta, Rivers, Akwa-Ibom, Cross-River, Abia, Ebonyi, Enugu, Anambra and Imo states. While states like, Ekiti, Bayelsa, Lagos, Kogi, Kwara, Benue, and Nassarawa have not less than 6.0–9.0% of their natural vegetation occupied by bamboo. Pocket of bamboo clumps is found in Niger, Taraba, Plateau and Abuja, in these states however the availability of bamboo is short of what 3.0–5.9% of natural vegetation. In Adamawa, Bauchi, Borno, Gombe,

Fig. 1. Bamboo flooring (Anon., 2015a).

Kano, Kaduna, Katsina, Kebbi, Sokoto, Jigawa, Yobe and Zamfara states, they have less than 3% of their natural vegetation dominated by bamboo (Fig. 3).

The average diameter of bamboo culms varies from 3.2 to 9.1 cm while the average height varied from 2.7 to 4.4 cm. The largest size bamboo occurred in the South–South while the smallest size occurred in the North–East. The shortest is found in the South–South while the tallest was found in North–Central zone. This demonstrated that the bamboos in the Southern part are basically thick and short while those in the Northern part are tall and thin (RMRDC, 2004a). The distribution pattern indicated that bamboo adapts particularly to the rainforest regions where it is found in plenitude because of high mean yearly rainfall and length of the rainy season (Fig. 3).

Fig. 2. Bamboo wall (Anon., 2015g).

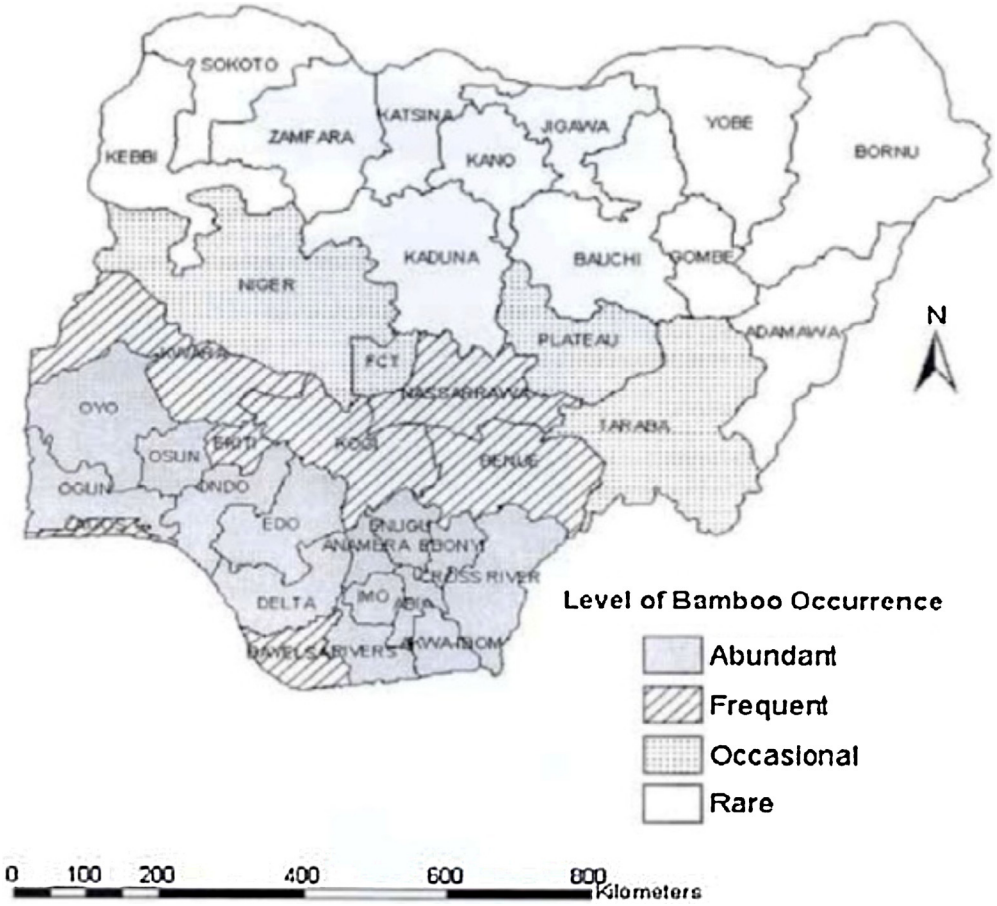

Fig. 3. Source and availability of bamboo in Nigerian states (Anon., 2015d).

6. Constructional usage of bamboo in Nigeria

The constructional utilization of bamboo in Nigeria includes fencing, scaffolding which is the major use (Fig. 4).

Bamboo culms are used as supporting pillars to provide temporary support for decking. In rural area where bamboo is mostly used especially in Cross River and Akwa Ibom states, bamboo is used to construct mud house, where the bamboo culms are used as frames to provide skeleton for the building (RMRDC, 2004b) (Fig. 5).

7. Bamboo as a substitute material for constructional purpose

The utilization of bamboo has a substitute material for development and has been contemplated in different ways by different researchers (Youssef, 1976). Bamboo can be utilized as a substitute for steel reinforcement; studies have demonstrated that natural fiber reinforcement concrete is stronger, stiffer and more pliable contrasted with the conventional concrete or a steel reinforced concrete when subjected to irregular cyclic loads (Lakshmipathy and Sanathakumar, 1980). The average strength of bamboo was determined to be between 204 N/mm^2 and 250 N/mm^2 (Alade and Olutoge, 2004) this result is comparable to mild steel. Tensile strength is also influenced by the diameter of the reinforcement; comparable impacts do not exist in the case of conventional steel reinforcement. The tensile strength of bamboo which is 28,000 per square inch contrasted with steel 23,000 makes them fundamental material for quake structural engineering (Andam, 1995). Bamboo can also be used in foundations, where the bamboo poles will be treated against fungi and rots and are directly driven into the soil. Bamboo can also be used for flooring and walling. Bamboos are already in the rural areas as skeleton for their buildings can be treated properly to last longer when used for walling. On the account of flooring, bamboo is one of the trending flooring industry materials, with its exceptional qualities, and its high yielding renewable and natural resource has an environmental advantage over finite raw materials and long cycle renewable resources extraction. Bamboo flooring can reduce the consumption demand for forest hardwood cultivation and helps to prevent the forest from deforestation. With various tests it has been observed that bamboo flooring is one of the most popular covering and it is significantly important while developing a sustainable green design project. Bamboo can also be

Fig. 4. Used as a roofing element and structural base in mud house (Anon., 2015b).

Fig. 5. Bamboo used for scaffolding (Anon., 2015f).

used for roofs and trusses; bamboo has a high strength/weight ratio and hence it is a good substitutes/alternative for roofing framing and for spanning larger distances (Oyejobi and Jimoh, 2009).

8. Environmental impacts of bamboo

Bamboo plays an important role in the environment. Bamboo helps lower the light intensity and protects against ultraviolet rays. Deforestation rate is also been reduced, with the trees chop down year in year out, this will however decrease the rate of timber consumption. Bamboo development reduces pollution; its plants reduce up to 35% carbon dioxide in the climate and deliver more oxygen. Bamboo roots help control erosion as it makes a water barrier; developed countries use bamboo as a defensive component for their crops and villages from washing ceaselessly. Bamboo devours high amounts of nitrogen and this helps decrease water pollution. Bamboo can be harvested and replenished without destroying the natural forest (Anon., 2015e).

Bamboo is a highly-yield renewable resource: bamboo chipboard, agro-based medium density fiberboards and flake board used in engineering and construction; ply bamboo used for wall paneling, floor tile, bamboo pulp for paper making, briquettes for fuel, bamboo fibers used for making composite thermoplastic reinforcement which are used to make roofs, etc. These diversities make bamboo environmental friendly and easily adaptable. They can be harvested within 3–5 years unlike most softwood 10–20 years, and also they have biomass of 2–5% unlike wood 10–30% (Anon., 2015c).

9. Environmental impacts of bamboo use in construction

Environmentally bamboo reduces the use of timber consumption in construction as expressed prior, it naturally has a waxy surface which does not oblige paint and this makes it free from health hazards brought about by paints. Because of its quality and strong ability studies have demonstrated that bamboo can be utilized as reinforcement for concrete, and these will diminish the pollution waste of steel factories in Nigeria. Likewise, bamboo can serve as a light structural component of building, which can be restricted in height, serve to bring down the seismic effect connected with dead load structures during seismic occasions. "In 1992, Cost Rica was hit by an earthquake which registered 7.5 in magnitude on the Ritcher scale. The only buildings which survived were homes built of bamboo construction . . . " (Russell, 2015). However, with all these environmental benefits bamboo has on construction, bamboo is sliced into piece and glued together while working with. A serious health and safety issue surrounds the handling and the application of gluing them together. Presently no specific standard is stated for its construction or gluing together, and glue contains formaldehyde which can be harmful to the environment (Kennan, 2015).

10. Conclusions

To conclude the use of bamboo as a substitute material for construction in Nigeria will be a bold step toward building a sustainable environment. With the abundance of bamboo in Nigeria, further research should be conducted to find out detailed characteristic and properties of the species in Nigeria and their various attributes. Due to the great advantages bamboo yield to the environment bamboo can be a substituted material for wood in construction, thereby reducing the rate of deforestation and promoting rehabilitation of wood based panel industries. With adequate government input into policy measure, bamboo can be a very resourceful material in Nigeria, thereby contributing highly to mitigate the negative impacts of soil erosion, militate against climate change, protect the biodiversity and promote sustainable construction development. Also, the government should encourage the use of bamboo in construction such as low-income housing scheme, furniture making, finishing materials and also partner with governing bodies such as NIA, ARCON and also building industries. The lack of knowledge in the construction sector should be adequately addressed.

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