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**Research Article**

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# Evaluation of Water Absorption Rate of Structural Timbers in Normal and Saline Environments

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**Abstract** Timbers are essential material for structural applications owing to their desirable physical and mechanical properties. This study investigates physical properties and solution absorption potential of some timber species that are in commercially use in Nigeria. Four timber species namely Ayin (Anogeissus Laocarpus), Teak (Teetona gradis), Mahogany (khaya ovoriasis) and Iroko (Milicia Excels) were observed to examine their rate of absorption of water in fresh and salty water, respectively. Thus, three different kinds of environment; dry, fresh water and saline (standard solution of inorganic salt, NaCl) were considered and the tests were performed over a varying period of 7, 14, 21 and 28 days. The absorption behavior of each timber species was monitored by the weight of each specimen taken at an interval of 7 days after immersion. The test results revealed the timbers having decreasing order of absorption of Iroko, Teak, Ayin, and Mahogany in terms of weight before immersion in both solutions. Hence, Teak timber absorbed least, followed by Iroko, Ayin and Mahogany, respectively.

**Keywords** Timber species, Absorption rate, Physical properties, Fresh water, Salty water

## Introduction

Timber as a natural and renewable [1], is a natural construction material that comes from trees. It is the oldest natural resources and the diverse ways in which it has been fashioned over the centuries tell the story of civilization better than any other material. It can last for centuries or it can perish in a second in fire. Timber is another name for "wood", whether still standing in form of tree or felled and turned into boards for construction purposes. Some people have been referring to timber since the seventeenth century, although the use of "Lumber" is relatively recent. Timber has always held a significant place in the human economy. It has served man as a structural material for building, furnishings, tools and weapons while other recent discoveries are made on the material. It remains document as versatile raw material especially in construction, refurbishment, and furniture, packaging and temporary works, [2]. In Nigeria, the roof structures and ceiling noggins of most buildings are constructed from timbers using mainly abora, aye and ofara (Tectonis grandis) species because of their workability and durability, [3].

Construction wise, timber is one of the most environmental friendly materials for use. The reason of timber being most popular engineering material is its versatile properties like strength and durability compared to other material in similar approach. Strength as a property, determines the use of timber for structural and building purposes and innumerable other uses. Again, the properties of timber vary widely not only between species but also between pieces of the same species [4]. In case of durability, it is the property of timber to remain in sound condition for long time when exposed to the forces of nature in an exposed or underground condition [5]. According [6], it also has varying degrees of natural durability due to the kind of environment it is exposed to.

Timber can be recycled and when it reaches the end of its life, it can be disposed off with minimal impact to the environment because of its non-toxic nature. Timber is one of the best insulators than concrete, 4000 tones better than steel and 1770 tones better than aluminum, Thomas (2000). That makes it an excellent material for use in construction to reduce energy bills for both household and business. Weight for weight, wood has probably the best engineering properties of any materials. Many of its structural properties result from the microscopic layout of its cells and cells wall.

The common environment where timber generally stays for a longer period of time is air, water and soil. These media contain a huge number of chemical agents some of which are harmful to timber and its product.

Consequently, timber has become one of the widely used materials and it is found in large quantities in Nigeria (Table 1). Many varieties of softwoods and hardwood has allowed for flexible use of timber in building.

**Table 1:** Wood raw material demand and supply in Nigeria

| Raw materials | Demand | Quantity Available | Comment |
|---|---|---|---|
| Log of 30cm diameters ($m^3$) | 76,312,437 | 662,934,500 | Logs were available for adequate supplies to mills. |
| Poles ($m^3$) | 25,625 | 572,261,021 | Enough quantity was available on the plantation. |
| Lumber ($m^3$) | 95, 161 | 271,386,600 | No deficit. |
| Plywood ($m^3$) | 122,109 | 52,372 | Serious deficit. |
| Particle Board ($m^3$) | 35,676 | 76,720 | Sawmills could produce enough wood raw materials |

***Source: Raw material research and Development council, [3]***.

It is thus important to understand the basic properties and their implication in order to have optimal selection and design. Furthermore, since the properties of the timber dictate its applications, it seems to be a logical inference that timber technologist should be in position to investigate the structure of a timber and make a climatic prognostication as to its properties and utilization [3].

Timber as a carbohydrate material is composed principally of carbon, hydrogen and oxygen. The compositions are Carbon - 49%, Hydrogen - 6%, Oxygen - 44%, Nitrogen – slight amount, Ash – 0.1%. These are referred to as element components which later combine to give a large compound called organic compound; cellulose, hemicelluloses and lignin [7]. Furthermore, trees in their natural habitat need to be converted into various forms for subsequent structural applications. Industrial band saw is normally used to fell standing trees, cut into logs of wood and transported to saw mill without delay to a timber merchant, who in turn stacked correctly and seasoned to avoid defects [8]. In plank preparation, sawn wood inevitable has rough surface, because the action of saw-teeth which breaks the fibres of the timber. Hence, further preparation, manually or mechanically are adopted in straightening, cutting, surface smoothening and planning, carving, shaping, moulding and wood turning [8].

**Methodology**

The method involves materials collection, physical observation, sample preparation, laboratory test of strength characteristics of different species of timber. Since the focus is on load bearing property of wood, hardwoods of four varying species were obtained. The selected materials and equipment used include: Teak (Tectona Grandis), Ayin (Anogeissus laocarpus), Iroko (Milicia Excelsa), $H_2O$ (Water), Mahogany (Khaya Ovorinsis), Salt solution (NaCl), Vernier scale, measurement tape, nail, plastic containers, plier, copper wire, wheel borrow and electronic weighing balance.

The timber species used for this study were obtained from Omoniyi Plank Saw mill section, Alaro , Ibadan, Oyo-State, Nigeria. The sizes considered, as seen commonly used in construction works for the compressive strength and tensile strength tests were 50 X 75 X 300 mm and 50 X 75 X 600mm, respectively. Immediately after the compressive strength test, a section of approximately 25mm in length with full cross sectional area was cut off from the test specimen to determine the rate of absorption of the timber. Then the rates of weight of timber before and after immersion in water were taken on periodical basis.

$$\text{Water absorption} = \text{Wt of Soaked} - \text{Wt of Unsoaked}$$


*Plate 1: Cutting and preparation of specimen*

**Sample Preparation**

The obtained samples were prepared, marked and grouped into four batches under different treatment. All samples were weighed before treatment to know their initial values. The samples were later immersed in fresh water and salt solution to determine the rate of water absorption under the two selected environment. The samples were immersed completely in the fresh water and salt solutions, respectively, removed periodically, weighed and recorded accordingly. Some samples were left in open air for control experimentation.


*Plate 2: Preparation of Salt Solution*


*Plate 3: Timber in solution*

**Results and Discussion**

Specimen in open air (control), fresh water and salt solution environments were tested in the laboratory periodically for compressive and tensile strength of the timber material. The results were presented in fig. 1-5.

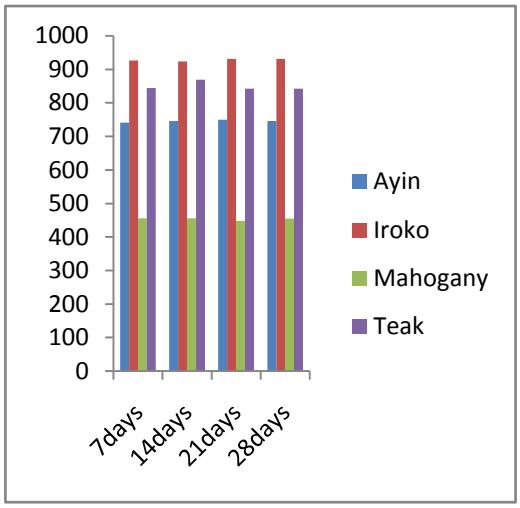



*Figure 1: Weight of Unsoaked timbers (Control)*

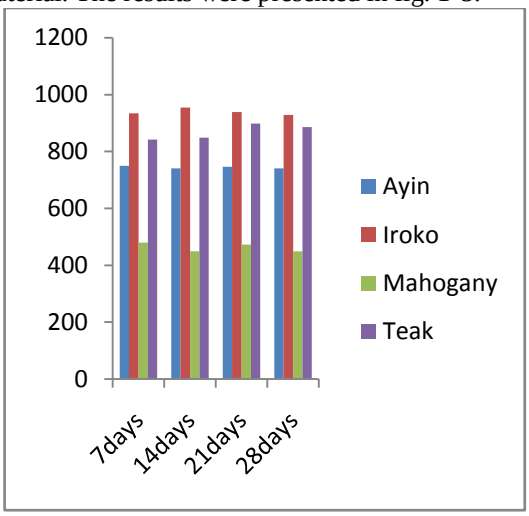
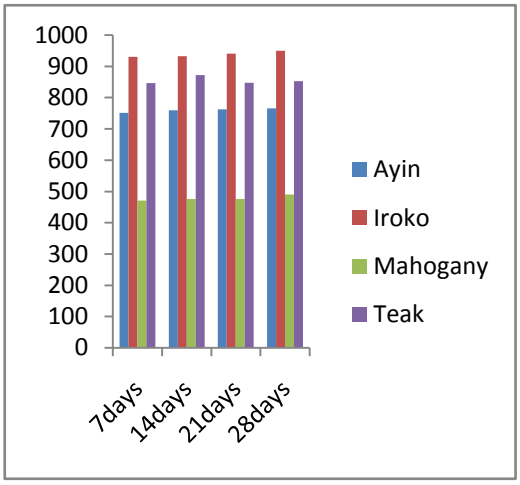



*Fig. 2: Weight of soaked timbers in fresh water*



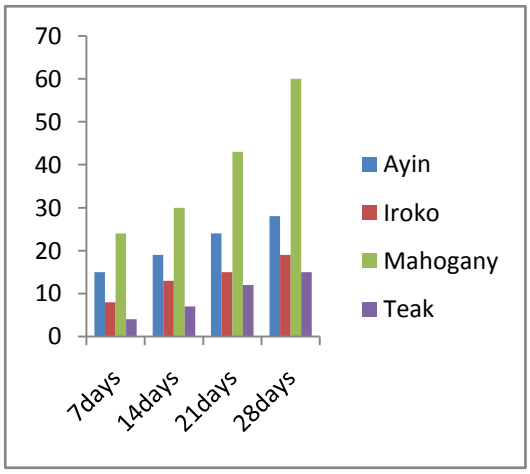



*Figure 3: Weight of soaked timbers in salty water* *Figure 4: Rate of normal water absorption*

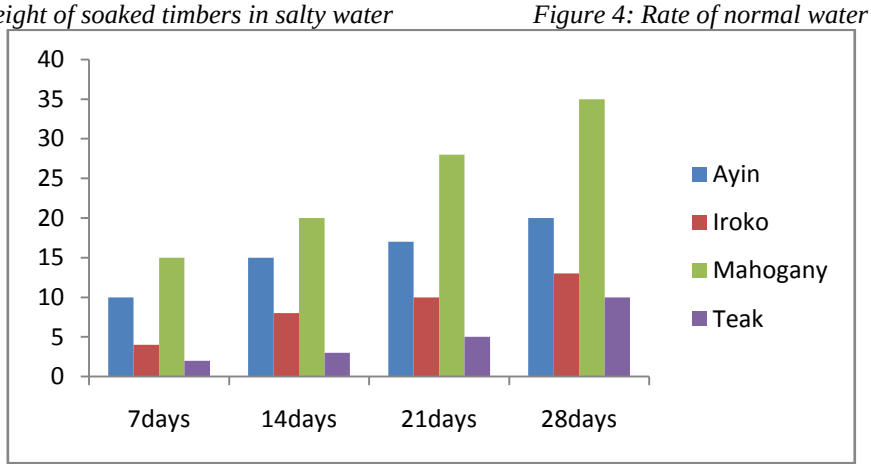



*Figure 5: Rate of salty water absorption*

**Discussion**

The performance of various timber species was evaluated by comparing the percentage of rate of the solution absorption after complete immersion period of 28days in different environments. The absorption behavior of each timber species was monitored by the weight of each specimen taken at an interval of 7days after immersion.

The test results in Fig. 1 – 5 revealed the timbers having decreasing order of Iroko, Teak, Ayin, and Mahogany in terms of weight before immersion in both solutions. Hence, Teak timber absorbs least, followed by Iroko, Ayin and Mahogany respectively.

**Action of the water**

It was revealed that normal water only dissolves the extractive components of wood substances. So, no chemical reaction took place between timber cell-wall component and neutral solvent like water. The water absorption rate of mahogany increased progressively to attained 60g absorption after 28day, followed by Ayin 28g, Iroko 19g and Teak 15g.

**Action of the salt**

For the performance of timber in saline environment, aqueous standard solution chloride (5%) was prepared in the laboratory. Progressive rate of absorption was also observed for the subject timbers at different levels but at reduced rate compared to that in normal water environment. After 28 days of immersion, the rate of salty water absorption of the timbers, found that Mahogany absorbed 35g, Ayin 20g, Iroko 13g and Teak 10g respectively. It was understood that aqueous solution of salt environment is more favourable to timbers than in normal water, a similar observation had been made by Panslin and Zeeuw (1980) who found that the timber treated with low concentration of water soluble salts as protection against biological attacks exhibit little decrease in strength properties under normal condition of service but also always note that not all timber species that showed better performance in water than the salt environment or the amount of rate of water absorption i.e. percentage may be less than that in water.

**Conclusion**

It requires no special knowledge to appreciate that durability of any building materials have an important bearing on its suitability for a specific purpose in a particular environment. In regard to timber, laboratory tests on small clear specimen are of considerable practical behavior of individual species. The rate of solution absorption investigation carried out on four common timber species (hardwood) found in South-West region of Nigeria reveals effects of different environmental exposure on the subject timbers. This will help engineering choice of timber material for construction works in difficult water prone environments. Further investigation therefore required to evaluate structural performance of the materials in such environments.

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