STRENGTH AND WATER ABSORPTION CHARACTERISTICS OF BAMBOO LEAF ASH BLENDED CEMENT CONCRETE

BY

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CERTIFICATION

This is to certify that this research carried out by ONI, YETUNDE OLAPEJU under the supervision of Dr.K.O. Olusola, has been read, approved and adjudged to fulfill in part, the requirements for the degree of Master of Science (M.Sc) in Building Structures of the Obafemi Awolowo University, Ile-Ife, Nigeria.

Supervisor's Signature and Date ---

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Head of Department's Signature and Date ---

Dr. O.O. Aina

DEDICATION

This project is dedicated to the Almighty God, my maker, who has made this work a success, I ascribe all glory honour and adoration unto his holy name. This project is also dedicated to my help meet, Mr Kehinde Oni and my Parents Chief Tunde Olowookere and Mrs. Aduke Olowookere.

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ABSTRACT

The study examined the compressive strength, tensile strength and water absorption of bamboo leaf ash (BLA) blended cement concrete with a view to ascertaining its suitability for structural purposes in building construction. It investigated the chemical composition of BLA calcined at different temperatures of 500°C, 600°C, 700°C, 800°C, 900°C and 1000°C with a view to determining the optimum temperature that will yield the most amorphous BLA; it further determined the physical properties of the most amorphous ash. The study also determined the effects of replacing cement with various percentages of the most amorphous BLA on the strength and water absorption characteristics of BLA blended cement concrete.

Bamboo leaves collected in Obafemi Awolowo University, Ile-Ife were first dried and burned in an open air and later calcined in a furnace to temperatures of 500°C, 600°C, 700°C, 800°C, 900°C and 1000°C. Two factorial experimental arrangements namely 9 × 6 × 2 × 3 and 9 × 3 were used. Two (2) strength tests namely compressive and tensile strength tests were conducted. For these tests, the cement replacement by BLA was at nine (9) levels (0%, 2%, 4%, 6%, 8%, 10%, 15%, 20% and 25%) and curing age at six(6) levels (7, 14, 28, 60, 90 and 120 days). For water absorption test carried out at the end of 28 days curing age, the cement replacement by BLA was also at nine (9) levels, using three (3) replicates in all the tests, a total of 351 cubes were cast and tested. American method of mix design for 28-day target strength of 25 N/mm^2 was adopted and this was taken as control. All specimens were tested using ELE compression testing machine of capacity 2000 kN. Data obtained were analyzed using percentages, mean and analysis of variance (ANOVA).

The result revealed that the chemical property of BLA varies with calcination temperatures, BLA ash obtained at calcined temperatures of 500 ^oC, 600 ^oC, 700 ^oC, 800 ^oC, 900 ^oC and 1000 ^oC had a combined percentage acidic content (SiO_2 + $A1_2O_3$ + Fe_2O_3) of more than 70% (ASTM C618 – 2008).The ash calcined at 1000^0C had the highest combined acidic content of 90.90% and hence is the most amorphous ash. The compressive strength of tested concrete specimen decreased significantly ($p \leq 0.05$, $R^2 = 0.996$) with increase in the BLA content, and BLA content ≤ 8% met the design strength of 25 N/mm^2 at 28 days hydration period; while the tensile splitting strength of BLA blended cement concrete specimen decreased significantly ($p \leq 0.05$, $R^2 = 0.998$) as BLA replacement of cement increased above 10%. The water absorption generally decrease with increase in the BLA content, and increased with high replacement BLA content greater than or equal to 15%. Optimal BLA substitution with respect to water absorption was 10%. Based on the test results the study concluded that between 8% and 10% BLA content would be adequate as cement substitution for structural concrete works.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The generation and disposal of waste is an intrinsic part of any developing or industrial society. Waste, both from domestic and commercial sources, has grown significantly in Nigeria over the past decade (Amu and Babajide, 2011). Wastes either liquid or solid are inevitable products of most of man's activities, whether urban or rural. Their type, amount and composition vary with the type of activity, be it domestic, industrial or agricultural in nature. The waste that comes from agricultural, domestic, commercial, industrial as well as construction activities composed of a wide variety of materials such as food wastes, construction wastes, papers, plastics, metals, garden wastes, factory offsets and process wastes, medical wastes and other discarded and residual items. It is estimated that the production of waste amounts to millions of tons (Amu and Babajide, 2011).

The percent of Nigeria's population living in cities and urban areas has doubled in the last 15 years (Amu and Babajide, 2011); as they areas experience continuous growth which contributes to the generation of solid and liquid waste. The management of waste is a matter of national concern. The volume of waste produced does not actually constitute the problem, but the ability or inability of governments, individuals and waste disposal firms to keep up with the task of managing waste and the environment. There is no doubt that a dirty environment affects the standard of living, aesthetic sensibilities, health of the people and thus the quality of their lives. The corollary is that improper disposal or storage of this waste can constitute hazards to the society through the pollution of air, land and especially water and because of high increasing cost of wastes handling, one of the attractive options of managing such wastes is to look into the possibility of wastes minimization and recovery; hence

The construction industry relies heavily on conventional materials such as cement, granite and sand for the production of concrete; and the high and increasing cost of these materials has greatly hindered the development of shelter and other infrastructural facilities in developing countries. There arises the need for engineering consideration on the use of cheaper and locally available materials and the presumed waste materials which lead to an overall reduction in construction cost for sustainable development (Olutoge, 2010).

Concrete is one of the most versatile construction materials that have been widely used for centuries; the basic ingredients in concrete is cement, fine aggregate and coarse aggregate. Annual global production of cement concrete according to Mehta and Monteiro (2006) is about 11 billion metric tonnes every year. The high demand for concrete in virtually all kinds of construction such as dams, roads, bridges, silos, stadia and buildings has led to shortages and high cost of conventional materials especially Portland Cement used in concrete production. Saiprasad and Jha (2006) stated that long term performance of structures has become vital to the economies of all nations, and that concrete has been the major material for providing stable and reliable infrastructure since the days of the Greek and Roman Civilization. The quality of concrete produced is determined by its constituent materials, while it is expected that concrete produced at any given instance should among other qualities have satisfactory performance in compressive strength requirement. The compressive strength of concrete is considered one of the most important properties in the hardened state and the design of concrete structure is based on the assumption that they resist compressive stresses only. Concrete has relatively high compressive strength, but significantly lower tensile strength, and as such is usually reinforced with materials that are strong in tension (often steel).

Attempts has equally been made by various researchers to reduce the cost of the constituent's material and hence total construction cost by investigating and ascertaining the usefulness of materials generated as agricultural or industrial waste. Some of these wastes include sawdust, pulverized fuel ash, palm kernel shells and fly ash. The use of industrial and agricultural bye – product in cement production is an environmental friendly method of disposal of large quantities of materials that would otherwise pollute land, water and air. Some of the waste products which possess pozzolanic properties and have been studied for use in blended cement are fly ash (Bakker, 1999; Bouzoubaa *et al.* 2001; Siddique, 2004 and Antiohos *et al*. 2005), Silica Fume (Shannag, 2000), Blast furnace Slag (Bakker, 1999), Waste burnt clay (Syagga *et al.* 2001; and Shihembesta and Waswa, 2002), Corn cob ash (Ogunfolaji 1995; and Adesanya, 2001). The two mostly used pozzolan in European Countries are blast furnace slag- a waste product from iron making process, and fly ash – a waste product from electricity production in coal fired electricity plants (Bakker, 1999). The waste product that is of concern in this study is Bamboo leaf ash .

Bamboo is a naturally occurring composite material which grows abundantly in most of the tropical countries; it is considered a composite material because it consists of cellulose fibers imbedded in a lignin matrix. Cellulose fibers are aligned along the length of the bamboo providing maximum tensile flexural strength and rigidity in that direction (Lakkad and Patel, 1981). Over 1200 bamboo species have been identified globally (Wang and Shen, 1987). Bamboo is the common term for members of a particular taxonomic group of large woody grasses; subfamily *bambusoideae* and family *Andropogoneae/Poaceae*(Scurlock J. *et* *al*). The stem of the tree is round, smooth and hollow; the nodes are swollen and it has no branches but the lower portions, that is, three-fourths of the tree, have more spines between each node. It has simple shiny, thin, stiff, smooth and dark green leaves with flowers found in bunch and seeds resemble the corn of wheat in shape.

Recent work by Dwivedi *et al* (2006) incinerated bamboo leaves in an open atmosphere and then heated to a temperature of 600^{o}C for 2 hours in a furnace had discovered that bamboo leaf ash is amorphous in nature with pozzolanic properties. Amu and Babajide