PARTIAL REPLACEMENT OF ORDINARY PORTLAND CEMENT WITH BAMBARANUT SHELL ASH IN CEMENT BASED CONCRETE

BY

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PGD/ARG ENG/2000/2001/144

A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR AWARD OF POST GRADUTE DIPLOMA IN AGRICULTURAL ENGINEERING (SOIL AND WATER ENGINEERING OPTION)

IN THE DEPARTMENT OF AGRICULTURAL ENGINEERING SCHOOL OF EGINEERING AND ENGINEERINGTECHNOLOGY FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE.

DECLARATION

I, Zakariya Muhammed, hereby declare that this project is my original work and that it has not been presented elsewhere for the award of degree.

Zakariya Mohammed.

CERTIFICATEION

This is to certify this project was carried out by Zakariya Mohammed for the partial fulfillment of the award of Post Graduate Diploma in Agricultural Engineering (Soil and water Engineering option).

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ENGR. B. A. ALABADAN Date

Project Supervisor

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Head of Department

DEDICATION

This work is dedicated to my late father, Hassan, Noma B/Yauri and my mother, Hauwa Hassan B/Yauri.

AKNOWLEDGEMENT

Generally, academic research of this nature is not an undertaken that can start and finish single handedly by the candidate. External aids either morally or financially are required so as to achieve completion and result.

It is on based on this assistance render to me during this project that I wish to express my gratitude to my H.O.D DR D. ADGIDZI, My supervisor Engr. B.A. ALABADAN who made the work successful, all staff of the Agric. Engineering Department F.U.T. Minna. My gratitude also goes to Engr. M.A. Olutoye from Chemical Engineering Department F.U.T. Minna. My thanks also goes to Chief Technologist Civil Engineering Department Mallam Dauda Dada and his laboratory technician Mallam Umoru for their co-operation.

Similarly, I wish to thank my Uncle Dr. U.Abubakar B/Yauri who gave me moral and financial support.

My thanks goes to my Director Engr. Lawal Magaji, Brothers Noah Dauda and Aliyu and good friends, Engr. Nasiru Abdullahi illo, Aliyu A.B.M., jibrin Mohammed fire, Shiekh H. yakubu, Ismaila Abdullahi, Abdul Karim Musa and Yakubu Ibrahim magent. May God reward you Amen.

CHAPTER ONE

INTRODUCTION

1.1 GENERAL INTRODUCTION

Bambara (Voandzeia subterrenea) groundnut grow wild in West and dry region of Africa. The dried seeds contain about 20 percent protein and useful amount of calcium and iron which made it good for human consumption Zedan et tal., (1988). This groundnut takes its name from Bambara in Mali. The Bambara groundnut does well on poor soil in hot dry region which makes it available in northern part of Nigeria such as Sokoto, Kebbi, Zamfara and Borno State. However, apart from its use as manure and for animal consumption, no industrial or significant use has not been discovered for the seed shell.

Since most agricultural waste are left behind on the farm as organic manure, recent research was developed to investigate of what benefit it could further put to.

Various research had worked on agric waste such as rice husk (Okpala, 1987), (Mbachu and kolawole, 1998), maize cob, Bean Thresh, Guinea corn thresh (Ipia,2000).

This research work is on the use of Bambara groundnut shell ash a partial replacement of cement in concrete.

1.2 JUSTIFICATION OF WORK

Concrete is the major construction material. An essential part of it is made from cement.

The high cost of cement and low purchasing power of the Naira has made it almost impossible for many Nigerians to own their house. The devaluation of the Naira also makes construction jobs very exhorbilant and a percentage of the budget goes in yearly for construction, making the idea of housing for all year 2000" an unrealistic dream.

For the poverty alleviation programme that caters for shelters to be appreciated, the cost of building must be as cheap as possible without altering its quality.

The proximity of Bambaa groundnut to some Nigeria's cement industry brought about the possible of this research and since rice husk ash was successful, there was little doubt that B/nut will not be.

The Bambara groundnut ash is agricultural waste product which has little or no use. This research helps to promote waste management at little cost.

1.3 THE OBJECTIVEOF THE PROJECT

The objective of this work is to ascertain the suitability of Bambara groundnut shell ash as partial replacement in cement based concerte.

1.4 SCOPE OF THE WORK

The scope of this research are preparation of the ash

(1) BY burning Bambara groundnut shell to ash a temperature between 300°c – 500°c. This temperature was best in this work, since a lower temperature yield incomplete ashing and ashing at higher temperature depreciated the material with the ash.

(2) The ash's composition was deduced by gravimetry analysis, flame analyzer and atomic absorption spectrophotometer.

(3) The ash was then mixed at varying proportions (10/90, 20/80, 30/70. 40/60, 50/50 and 0%) with constituent and its various strength was determined by the E.L.E. Crushing machine.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 DEFINATION OF CONCRETE AND ITS PROPERTIES

Concrete is made by mixing together stone chips (coarse aggregate) sand (fine aggregate), cement (the binder) and water (the medium) of mixing the above ingredients into a unifies plastic mass Aguwa,(1998). It is the water that sets off the chemical process of hydration of cement. Unlike steel, concrete can be made locally almost anywhere as long as cement is available. It is the best construction materials used in most of the poorer countries.

Some important properties of concrete include workability, durability, strength, permeability, and resistance to compressive stress and ability to protect steel. The inert aggregate occupied large proportion in volume concrete.

The study of concrete mix and its properties is so vast that no one researcher can cover all the necessary areas that need attention. So many authors have worked on different topic as part study on concrete mix some of them are mention below.

Feret, (1986) discovered that the presences of air viods in concrete mix causes a reduction in the compressive strength and hence adequate workability for proper compaction during placing is very important.

Following this study, the uses of concrete in large scale works was made possible by the development of power driven mixer and aided by the discovery of vibration machine for compaction of concrete.

Abran (1919) studied the relationship between the strength of concrete at a given age and the water/cement ratio. He discovered that, the most important variable affecting the strength of concrete at a given age are the water cement ratio and degree of compaction. He also showed that when concrete is fully compacted its compressive strength was inversely proportional to the water/cement ratio.

Some work had been done on the relationship between cube and cylinder strength of concrete. According to Neville (1981), the ratio of cylinder to cube strength depend primarily on the level of strength and is found to be higher for high strength concrete. According to the British standard BS 1881-1952 and Indian Standard 15:456-1964-66, the cylinder strength may be taken as equal to 75 and 80 percent of the cube strength respectively.

Taylor,(1975) recommended that the ratio of cylinder to cube strength approached almost unity for very high strength concrete having a 20 days strength of 700kg/cm.

The flexural strength of concrete is determined by subjecting a plain concrete been to flexural test under transverse loads. The theoretical maximum tensile stress reached in the bottom fibre of a standard rest beam is referred to as the modulus of rapture. The magnitude of modulus of rapture depends on the dimension of the beam and type of loading.

Neville,(1981) stated that during curing of concrete, temperature also controlled the rate of progress of the reaction of hydration and consequently effect the development of strength of concrete.

The studies above showed that the strength of concrete depends on both age and temperature of weather. It was discovered that the strength maturity relation depend on the properties of the cement and on the general quality of the concrete the concrete and it is valid only within a range of temperatures.

2.3 MATERIALS OF CONCRETE

The materials that are mainly used for the formation of concrete include:-

i. Cement
ii. Water
iii. Fine aggregate
iv. Coarse aggregate
v. Admixture (necessary in specially case). examples, hydrated lime, calcium chloride, kaolin, linseed, soybean and tungoil

2.3:1 CEMENT

Cement is the binder in concrete structure Aguwa,(1998). The ability of certain limes to harden under water, it is stated dependent on their day contents. The first artificial cement was introduced by the English mason and building contractor Joseph Arpdin, Shirley,(1975). He patented the process of production of materials in December 15, 1824.

Modern pertland cement are made from one raw material rich in calcium and another rich insolicon. These materials are, respective chalk or limestone and clay or shale. Clay and shale usually contain significant qualities of compound of aluminum and iron. It is the iron. It is the iron that imparts the characteristic gray colour to ordinary Portland cement.

2.3:2 WATER

Water is the medium of mixing the whole constituent materials of concrete into unified plastic mass. The materials used for making concrete is mixed with water for two reasons Aguwa,(1998). First to cause the reaction between cement and water which result in cement activity as binding agent and secondly to make materials of concrete sufficiently plastic to be place in position. The water used for mixing concrete most be drinkable. It should not contain sugar or salt in significant quantities.

2.3:3 AGGREGATE

Aggregate form more than three quarters of the volume of concrete, selection and proportion of coarse and fine aggregate greatly influence the properties of both fresh and hardened concrete Jackson,(1991). The choice of grading maximum aggregate size and aggregate cement ratio are subjected to concrete mix design.

Broadly, aggregate can be classified according to density as normal light weight and heavy weight aggregate Jackson,(1991).

2.2:3:1 NORMAL AGGREGATE

These usually consist of natural materials, hard crushed rock or natural gravel and sand, but artificially materials like crushed bricks and blast furnace slag can also be used. The specific gravity of these materials, usually lies between 2.6-2.7 ACI manual of concrete part 1(1981). Because satisfactory concrete can be made with a very wide range of aggregate, local sources of supply usually determine which aggregate will be used. Where very high strength resistance skidding, good appearance other special properties are required, appropriate aggregate will have to be selected preferably basis of pervious experience Jackson,(1991).

2.3.2:2 LIGHT WEIGHT AGGREGATE

These consist of various artificial and natural materials with specific gravities of between 0.1 and 1.2-ACI manual of concrete part 1(1981). They are used to make high weight concrete for the structural and insulating applications. In general, concrete made with high weight aggregate has better fire resistance than dense concrete, but greater shrinkage and moisture movement. Jackson,(1991).

2.3:3 HEAVY AGGREGATE

These consist of natural and artificial materials with specific gravities of four (4) or more. They are use to make high density concrete for radiation shielding. Example of heavy weight aggregate are barite which according to (ACLmanual of concrete practice part 1, (1981) is naturally accruing rock consist of 95% Barium Sulphate (S.G about 4.1). Satisfactory concrete of good structural strength can be made, especially if prepared by a method such as pre packed to avoid segregation Jackson,(1991).

2.2:4 ADMIXTURE

As a general rule, admixture as it is noted can only affected concrete strength by changing the hydration process and air content of the mix and or by enabling changed to be made to mix proportion, most importantly to the water-cement ratio Jackson,(1991). Accelerating and admixture increase the rate of hydration there by providing and increasing only strength with little or internal cracking in which case a lower strength will result. In contrast, with retarding admixture the early strength of concrete is reduce owing to the delay in setting time Jackson,(1991). Provided no air is entrained, the concrete strength will approximately to the same as that of the control mix within a few days. Air entrainment in concrete will cause a reduction in strength at all ages and to achieve a required strength the mix, content has to be increased. Jackson,(1991).

It should be noted that the effect of particular admixtures in concrete depends on the precise nature of the admixture themselves, the constituent materials and proportions of the mix and the ambient conditions (particularly temperature) Jackson,(1991).

2.2 CONCRETE MIX DESIGN

Concrete mix design can be defined as the procedure by which, for any given set of condition the proportion of the constitution materials are chosen so as to produce a concrete with all the required properties for the minimum cost. Required concrete properties are durability, strength, workability, and permeability Jackson,(1991).

Several methods of mix design are used. The main factors employed in the design include the following among others. Aguwa,(1998).

1. Curves giving compressive strength versus water to cement ratio for various types of cement and ages of harding are available. The water to cement ratio is selected to give required strength.
2. Minimum cement content and maximum free water to cement ratio are specified in BS 8110. Part 1 Table 3.4 to meet requirement. The maximum cement content is also limited to avoid cracking due mainly to shrinkage.
3. Table giving proportion of aggregate to cement to give a specified workability are available, for example Table 1 in BS5328 given the mass of any aggregate to be used with 100kg of cement for a given grade and workability. Table 2 in the same code given the mass of fine aggregate to total aggregate in design of normal concrete mixes, the selection of

the aggregate to cement ratio depends on the grading curve for the aggregate.

2.3 CONCRETE STRENGTH/PROPERTIES OF CONCRETE

The concrete distanced may be so stiff that it can not be canpacted. If too much water is used the concrete usually do not develop full strength Aguwa,(1998). The amount of water needed to make concrete sufficiently plastic depends on the position in which it is to be placed. Aguwa,(1998).

The extreme examples of these are concrete for large foundation which are usually mixed with relatively little water and concrete to be placed for narrow reinforce concrete beams where the proportion of cement to aggregate can be as low as for instance one part of cement to nine of aggregate. Aguwa,(1998). In the second example where a lot of water has to be used the proportion could be one part of cement to four and half of aggregate. As cement in expensive compared to aggregate, it is usual to used little water and therefore cement and the necessary plasticity of the concrete would allow. The following are mixes of concrete Jackson,(1990).

- One part of cement to nine part of all in aggregate for mass concrete foundation. 1:9
- One part of cement to two part of sands and four parts of coarse aggregate, for lintel and concrete floor –1:2:4.
- One part of cement to one and half part of sand and three parts of coarse aggregate for narrow reinforced concrete beams and columns 1:1.5:3.

2.5:1 COMPRESSIVE STRENGTH

The compressive strength of high weight aggregate is usually related to cement content at a given slump rather than water ratio. Water reducing or plastisizing admixture are frequently used with high weight concrete to increased workability and facilitate placing and finishing Shirley,(1975).

2.5 MODULUS OF ELASTICITY

The short-term stress strain curve of concrete in compression a shown inn Fig. 1 below. The slope of initial tangent modulus at any point P. the slope of line joining P to the origin is the secant modulus. The values of the secant modulus depend on the rate of the application of the load.

The dynamic modulus is determined by subjecting a beam specimen to longitudinal vibration Maocginley and Choo (1990). The values obtained in unaffected by tangent modulus in Fig. 1 below the secant modulus can be calculated from dynamic modulus.

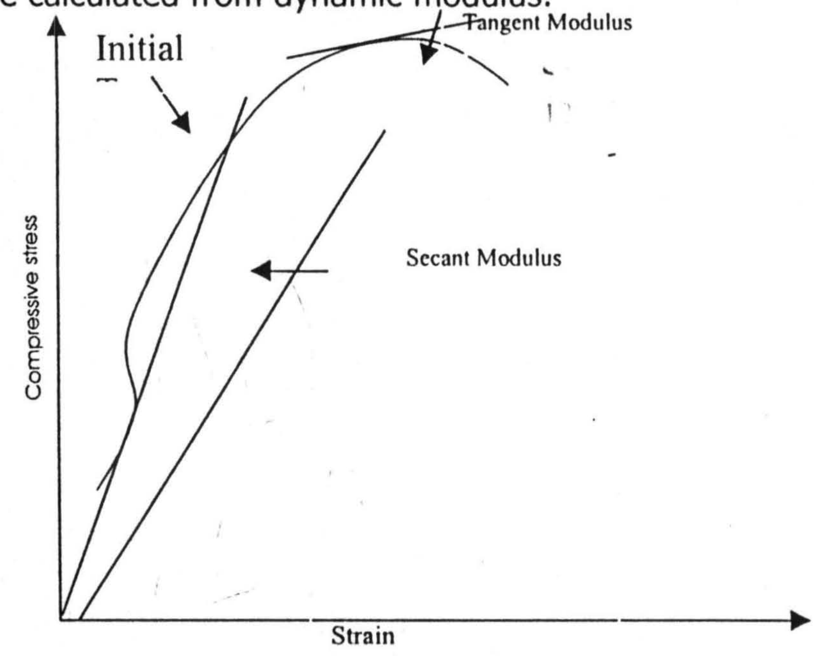

FIG. 1.0 STRESS – STRAIN CURVE.

2.5:3 CREEP

Creep in concrete in gradual in increase in strain with time. In a member subjected to prolonged stress the creep in much long than elasticity strain loading. If the spacemen is unloaded there is an immediate elastic recovery and slower recovery in strain due to creep Neville (1981).

The main factor affecting creep strains are the concrete mix and strength, the type of aggregate, curving, ambient relative humidity and the magnitude and duration of sustained loading. Maocginley and Choo (1990) specified that the creep strain EEC is calculated from the creep co-efficeint by equation.

$$EEC = \frac{Stress}{E} \times Q$$

When E is the modulus elasticity of the concrete at the age of loading. The creep co-efficient Q depends on the effective section thickness. The age of loading and relative ambient humidity values Q can be taken from BS8100 part 2 Maocgginley and Choo (1990).

2.5 SHRINKAGE

Shrinkage or drying shrinkage is the contraction that occurs in concrete when it dries and hardens. Drying shrinkage is irreversible but alternate welting drying and dry cause expansion and contraction of concrete Neville, (1981).

The aggregate types of content are the most important factors influencing shrinkage. The larger the size of the aggregate, the lower the workability of concrete with a large shrinkage strain. On the other hand, non-shrinkage aggregate such as granite gives lower shrinkage Aguwa (1998). A decrease in the ambient relative humidity also increase shrinkage Aguwa (1998).

2.6 MEASUREMENT OF WORKABILITY

a. Slump Test

The fresh concrete is tamped into a standard cone, which is lifted off after filling and slump is measured. The slump is 25.50mm low workability and 100-175mm high workability Maocgiley and Choo (1990).

b. COMPACTION FACTOR TEST.

The degree of compaction achieved by a standard amount of work can be measured. The apparatus consist of two conical hoppers placed over another and over a cylinder. The upper hopper is placed over one another and over a cylinder. The upper hopper is filled with fresh concrete, which, is then dropped into the second hopper and into the cylinder Shirley, (1975). The compacting factor is the ration of the weight concrete in the cylinder to the weight of an equal volume of fully compacted concrete. The compacting factor for concrete of medium workability is about 0.9 Shirley (1975).

2.7 TEST OF HARDENED CONCRETE

2.7.1 COMPRESSION TEST

There are three types of specimen used for compression test. They include:

i. Cubes

ii. Cylider

iii. Square prism. Jackson, (1991)

Each shape gives strength result and furthermore for a given shape the strength also varied size.

Jackson, (1991) and BS 1881: Part 116 specified the used of concrete cubes for determining compression strength; 150mm cube are widely used for quality control purposes.

However, cored cylindrical specimens are used for measuring the compressive strength of concrete. In situ and precast members (BS 1881 part 120). And Jackson, (1991) for the purpose of this work the cube is considered.

2.7.2 CUBE TEST

It is referred that the mould and base be changed together during casting in this reduce leakage of water.

Studies were shown that before assembling the mould, its making surface should be covered with mineral oil and then layer or similar oil must be applied to the inside of the mould in order to prevent the development of the bond before the mould and the concrete Neville, (1981).

BS 1981 part 3 (1970) prescribed that the mould be filled in three layers. Each layer of concrete is compacted by not less than 25 stroke of 22mm square rammer. Ramming should continue until sufficient compaction has been achieved. For it is essential that the concrete in the cube be fully compacted if the compressive test is to be representative of the property of the fully compacted concrete. The mould is filled to over flowing and after compaction excess is remove by dawning motion of a steel wire.

After top of the cube have been furnished by means of trowel, the cube is stored undisturbed for twenty-four (24) hours at a

The ash from wood or similar plant material generally consists principally of sodium carbonate and potassium carbonate. Though, the ash content of the wood or plant material varied considerably. For instance, the ash content of dry-wood varies for 2 per cent by weight for balsa to 0.2 per cent for redwood (sequoia).

All the inorganic constituents of food are referred to collectively as ah although some of them can actually be volatize by burning the food. Such ash contain materials like chlorine, iodine, phosphorus, potassium, sodium and sulphur.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 ASH PRODUCTION

The ash was produced by burning the residue (shell) of Bambara groundnut until it got burnt completely to ash. This was done at a temperature between 300°c – 500°c. This temperature was best since lower temperature yield incomplete ashing, and ashing at higher temperature depreciated the nutrient within the ash. However ashing can be done in an open environment, which is more economical considering the energy wasted and time taken in a control environment (Laboratory)

3.2 DETERMINATION OF ASH COMPOSITION

The ash was analyzed to determine the chemical compound that are present that will enhance cementutios properties. The following are the equipment and procedures used.

3.2:1 Equipment and Materials

i. 10g of Ash
ii. 400ml of Distilled water
iii. 2 beakers and conical flask
iv. one 2ml volumetric flask
v. one buckner funnel and filter paper
vi. two clamp stand
vii. one burret
viii. one crucible
ix. One laboratory furnace
x. One hot plate
xi. Phenolphthalein

temperature of 18^0c to 22^0c and relative humidity of not less than 90 percent. At the end of this period, the mould is stripped and the cube is further cured in water at 18^0c to 21^0c Neville, (1981).

Standard cubes are tested at prescribe ages, generally 28 days with additional test often at three to seven days. In this compression test, the cube is normally place with the cast faces in concrete with the palastrans of testing machine i.e. the positive of the cube when tested is at right angle to that as cast.

According to BS 1881, part 4 (1970) the load on the cube should be applied at constant rate of stress equal to $15N/mm^2$ Neville, (1981). As a result of the non-linearity of the stress strain relation concrete at high stress, it is noted that the rate of increase progressively as failure is approached and speed of the movement of head of testing machine be increase only with hydraulically operated machine.

2.8 ASH

Ash is a solid residue of combustions, if combustions has been completed the ash will be inorganic. In the production of ash, the materials used will normally be ignited and gradual burning with time allowed until the materials is totally combusted and what is remained is termed as ash.

2.8.1 TYPES OF ASH AND OTHER COMBUSTIONS

There are various types of ash, which are brought about by the various type or original material that is burnt.

3.1.2 SAMPLE PREPARATION

The 10g of ash was measured and placed in a beaker. 100ml of distilled water were added to the beaker. The mixture was placed on a hot plate boil for five minutes. This was for the water to properly digest the ash. After the solution had boiled for five minutes, it was removed from the hot plate to cool. When cooling had occurred, the solution was then filtered with the use of a buckner filter paper that was claped to 250ml volumetric flask. After filtration, the filtrate in the 200ml volumetric flask was topped to the 250ml line with distilled water.

The residue on the filter was kept in a crucible for further use where as, the solution in the volumetric flask now use for further analysis.

3.1.3 DETERMINATION LIMEOXIDE (CaO)

1.5g of Na_2Co_3 was weight to fused with 0.5g of sample inside the Murphy furnace after proper mixing at 950^{o}c for about 30 minutes. The content were then cooled. This was later dissolved with 10ml of conc. HCL was poured into porcelain evaporating dish. This was baked on sand bath to dryness. The dried content dish was dissolved with hot dilute Hcl and the contents were filtered into a 500ml volumetric flask and the porcelain was washed with hot distilled water. 25ml of the filtrate was pipelted into a 250ml beaker and the solution was made up to 100ml. Using distilled water. The 250ml beaker and its contents were placed on magnetic striver during filtration 20 draps of triethanolamine with 15ml of KOH and caleine indicator was added. The colour of the contents in beaker changed to green and the content were titrated with EDTA to get purple colour. The lime content was then obtained.

3.1.4 DETERMINATION OF MgO

25ml of the filtrated obtained in experiment A was pipelted into a 250ml beaker and the contents were made up to 100ml using distilled water. 20 drops of triethernolamine and using ammonia solution the P.H of the content was controlled to 11 using Whitman P.H test paper indicator. Small quantity (about 0.5ml) of KCN was added and the solution was titrated which drop of EDTA. Erichrome black, T indicator was added and finally the solution was titrated with EDTA until a reddish colour was obtained and the volume of MgO present was determined.

3.1.5 DETERMINATION OF Fe0

100ml of the filtrate in experiment A was pipetted into a beaker and 1-3mls of ammonia thriocycnate was added. The colour changes to pink red. Filtration was then carried out with EDTA until the colourless solution was obtained and the amount of FeO present was determined.

3.1.6 DETERMINATION OF $AL_2 0_3$

To the content of the beaker in experiment C 15ml of Ammonia acetate was added and it was heated on a hot plate to boiling. One drop of $CuS0_4$ and 8 drops of PAN indicator, which change the colour

iii. Mould oil
iv. 1 tapping bar
v. Wire brush
vi. Curing tank
vii. Steel tank
viii. Set upper racks
ix. Set lower racks
x. Vibrating table
xi. Multi-flower mixer
xii. Tipper sand
xiii. Cement
xiv. Water
xv. Weighing scale pan
xvi. Compression strength machine
xvii. Aggregate gravel

3.2.1 CONCRETE PREPARATION AND TESTING

The Bambara groundnut shell was obtained from farmers within my locality without spending a kobo to buy. Threshing machine was used to separate the shell from the nut. 10kg of the shell was obtained and burnt until it got burnt to ash completely at 500^0c (temperature). The other materials were obtained and brought to the workshop.

The materials are mixed in the following proportions 0% ash: 100% cement, 10% ash: 90% cement, 20% ash: 80% cement, 30% ash: 70% cement, 40 ash: 60% cement and 50% ash: 50% cement at a ratio of 1:2:4. After separate mixing, the concrete were cast in different steel or cast iron moulds generally 150mm^2 cubes, which conformed to the cubical shape recommended. Source Jackson (1991). The mould and base were clamped together during casting.

In the clamping of the mould and the base, the mating surface were covered with mineral oil and the base too. Each layer of concrete was compacted by not less than 25 strokes of a steel bar, which is 380mm long with weight of 1.8kg and cross section of 25mm square. Ramming continued until sufficient compaction was achieved this is essential because the content in cube should be fully compacted if the compressive test is to be the representative of fully compacted concrete. The mould was filted to cover flowing and after the compaction, excess concrete was remove by dowing motion of a steel rule. After the cube has been furnished, they were kept undisturbed for period of 24 hours at a temperature of 18^{0}c to 22^{0}c and not less than 90 per cent relative humidity. At the end of the period the cubes were stopped off and mark for later identification. The identification of the concrete cubes were as follows:-

1. 16 cubes of 100% cement 0% ash – 100
2. 16 cubes of 90% cement 10 ash – 90
3. 16 cubes 0f 80% cement 20 ash – 80
4. 16 cube of 70% cement 30 ash – 70
5. 16 cube of 60% cement 40 ash – 60
6. 16 cubed of 50% cement 50 ash – 50

After the identification mark the cubes were immediately submerged in a curing tank until it was time for testing. They were tested at 7, 14, 21 and 28 days.

In compression test cubes were placed with last faces in contact with platens of testing machine i.e. the positive of each cube when tested was at right angle to the cast. The load on the cube was applied at a constant rate of stress. The increase in strain was increased progressively when approaching the failure.

This experiment was replaced with particle substitution of the cement used with Bambara groundnut shell ash at 0%, 10%, 20%, 30%, 40% and 50% substitution of cement. The values of the strength of these percentage substitutions were also recorded accordingly.

3.2.2 DETERMINATION OF THE SLUMP

This measurement of workability of fresh concrete after mixing at the concrete. To achieve this the following materials needed.

a. cone
b. tamping rod
c. damp cloth
d. ruler

3.2.3 SLUMP TEST PREPARATION

After the provision of materials mentioned above, the internal face of the cone was cleaned thoroughly and force from superfluous moisture. The mixed for concrete cubes were used. The cone was on a smooth horizontal, rigid and non-absorbent surface, the cone was held firmly in place while it is being filled in order not to shift position. The cone was filled in three layer each approximately one third of the height of mould.

Each layer was tamped with 25 strokes were distributed in uniform manner over the cross section of the cone. For the second and subsequent layers the tamping rod penetrated into the underlying layer. The bottom layer was tamped throughout its depth.

After the layer has been tamped, the surplus concrete was strike off from the top of the cone with a sawing or rolling motion of the rod. The damped cloth was used to wipe the base plate and outside of the cone clean. The cone was removed from the concrete by raising it slowly and carefully in vertical direction. This operation was carried out six minutes after the mixing water has been added to the mix. This allowed concrete to slip.

Then the cone was place upside down and placed it on the base plate next to the slumped concrete. Tamping rod was placed on top of the cone projecting over the highest point of the concrete. The distance was measured from the top of the slumped concrete to the underside of the rod to the nearest 5mm, and the result was recorded according to the cement/Ash percentage. This was repeated with 10%, 20%, 30%, 40%, and 50% ash substitutions.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 ASH COMPSITION RESULITS

After using all the various analytical methods mentioned in chapter three, the various compound and their percentage composition as present in the Bambara nut shell ash is shown below.

Compound	Percentage composition (%)
Ca O	0.51
Mg O	4.72
$AL_2 O_3$	1.72
Fe O	2.16
SiO_2	3.16

4.2 COMPRESSIVE STRENGTH RESULTS

The compressive test result happens to be the easiest result that tells at a glance the performance of concrete. After, the experiment was carried out, the average result of the concrete with varying ash and cement percentage by mass is showned in the table below with the age of the concrete and the time of testing.

4.1:1 DISCUSSION OF RESULT

From the various analyses, it is of a great importance to know their significance and discussion whether the works aim was achieved.

4.1:2 ASH COMPOUND COMPOSITION

The tests carried out on ash showed us the various compound (relative to cement performance) present and their percentage proportion. The compound essential for the binding property of cement is $Ca0$ and $Si0_2$. Their presence signifies the ash's contribution to binding in concrete.

The percentage of $Fe0$ and Al_20_3 shows their amount present in the compound and whether ash and cement are mixed, their contribution to the formation of tetracalcium Aluminoferrite (C_4AF) compound, which in response for less heat of hydration in cement and the dark colour of the cement.

4.1:3 COMPRESSIVE STRENGTH

The compressive strength was test on concrete of varying ash-cement composition of seven and twenty-eight days of age. The seven days strength test was use to determine early strength development while the twenty-eight days was use to determine the later strength development.

As the ash percentage was increased relative to that of cement, the various were decreasing with the exception of that of 10% ash to 90% cement. The decrease in age volume could be attributed to low

CaO contribution from the ash since it is CaO and SiO_2 compound that gives cement its binding effect.

It is also observed from the result obtained, showed that at crushing failure of all cubes produce from cement-Ash are normal which showed that the cube are casted and cured. It also show that the ash-cement presence in concrete should not exceed 10-90%.

Again, the compressive strength result shows the possibility of using concrete with ash by construction industries.

4.1:4 SLUMP TEST

The Slump test helps to determine the workability of a named concrete, this showed that, 100% cement to 0% had firmly with only 3mm difference. The difference increase with increases in ash percentage. The 50% ash has a wide difference but was able to stand without collapsing of shear.

CHAPETR FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 CONLUSION

An investigation into the possibility of substituting Bambara groundnut shell ash has been conducted. From the analyses carried out, it could be seen that is was possible for partial replacement of cement with Bambara nut shell ash in concrete. It could be seen that there is generally reduction in the weight of the concrete obtained from ash mixed when compared to that of normal concrete.

Also, the fact that waste is being economized and manage through this research is a welcome development as there is guarantee that it is environment friendly and poses no hazard to human health and existence.

In addition it will be best if the substitution did not go beyond 10% replacement.

6.1 RECOMMENDATIONS

Base on the result of this work, it can be recommended that:-

1. The concrete with the ash should be exposed to industrial effluents and wastewater and tested to see if it can withstand such industrial hazards to concrete.
2. Some other mixing ratio such as 2:3:6 or 1:3:6 may obtained a good result.
3. The percentage of ash should not exceeds 10%ash: 90% cement replacement.

4. Instead of using only Bambara nut shell ash, other agricultural by-products, should be use as replacement of cement in concrete making.