PARTIAL REPLACEMENT OF ORDINARY PORT LAND CEMENT WITH GROUND NUT SHELL ASH IN CONCRETE PRODUCTION

BY

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This project is dedicated to Almighty Allah, for his mercy, guidance and protection throughout the period of this course, and to my late senior brother Alhaji Ahmed Dele Yusuf, my brothers and sisters for their support.

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Thank be to Almighty Allah for given me the wisdom and opportunity to undergo this programme.

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Muuideen O. Yusuf

99/2000/86

ABSTRACT

This project work is to evaluate the suitability of using Groundnut Shell Ash (GHA) as a partial replacement for Ordinary Portland Cement (OPC) in concrete production. The main aim is to reduce the exorbitant cost of ordinary portland cement.

In summary out of the 5 different ratio used, it is observed that the 70:30 cement + Ash ratio seems to have a closed value with the control, the 100% cement because the strength test at both 7, 14, 21 and 28 days for the 70:30 cement + Ash given 12.00MN/m^2, 13.50, 14.00 and 16.00MN/m^2 and against OPC 16.40, 12.30,22.00 and 24.30MN/m^2 respectively. Though this result may seems to be low when compared with the strength of OPC concrete.

Statistically the average strength of the various comb, nation are less than that of the control (100:00) cement. The OPC plus GRA ash can be used in area of mass concrete work, light load bearing elements and purely compressive members. Chemical analysis also show that the groundnut shell ash contains elements like Silicon, Aluminum Iron oxide Calcium, Magnessium and other trace elements. The concrete mix design used was 1:2:4.

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CHAPTER ONE

1.1.0: INTRODUCTION

Groundnut Arachis hypogea is a major cash crop in the West Africa Savanna regions, and elsewhere; being an important source of oil, it can be used for a variety of products, magarine, salad oil and cooking oil (Gibbon and Pain). There is a small but important export market in high quality nuts for the Western confectionery trade. The crop is also an important component of the local diet and can be eaten raw, roasted or in stews. Groundnut cake, a by-product of oil crushing and groundnut haulms are useful animal feeds.

Though in some areas, the shell are used for filling used pits, as fill on some local road during rainfall. Therefore it is wise to note that, because of the local use of groundnut shell, in the rural areas for semi technical works, it raises some interest to carry out an investigation on the suitability of the shell (burnt to ashes) as a partial replacement for cement in concrete production. Since very little or nothing is known about the behaviour of this groundnut shell as a material for engineering

CHAPTER ONE

1.1.0: INTRODUCTION

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Concrete is a man-made stone made by mixing sand, broken stones and cement in pre-determined proportions, with sufficient water to enable the setting action of the cement content to take place. Concrete is presently one of the most popular materials for the structural parts of buildings and civil engineering works. When reinforced with steel, it has an almost limitless capacity for carrying loads.

Concrete being such heterogenous materials, the quality of the constituent and proportions in which they are mixed will determined its strength and properties.

Therefore the understanding and behaviour of an type of concrete is found on the adequate knowledge of the engineering properties of the aggregates. The properties of the aggregate actually influenced the properties of the concrete such as workability and strength characteristics.

The main reason of introducing this material is because it is economical. It is cheaper than portland cement. It sometimes exists as natural deposits requiring no or little processing, also because it is a waste or by product from industrial process (eg Blast furnace slag, or

Silica fumes). A further urge to the addition of this supplementary materials in concrete mix was given by the sharp in the cost of energy in Europe and America in the 70s and the cost of energy represents a major proportion of the cost of cement production (Neville 1996).

The cement universally accepted for most purpose is the Portland Composite Cement, Blended Portland Cement (Neville 1996). The European approach of ENV 197- /1992 is to use the term CEM cement which not thought to be clearly expressed. The current American approach is given in ASTMC 1157-194a which covers blended hydraulic cements for both general and special application.

1.1.1: AIMS AND OBJECTIVES

The main aims of this project is to know the suitability of replacing cement partially with groundnut ash, what ratio would be satisfactorily enough and also to find out the effect of such replacement on the strength of the concrete. The objectives is based on the enormous quantity of the groundnut shell being wasted away in our areas and taking into consideration the local use of it as material, also to bring down the exorbitant cost of OPC. It was very necessary to determine and ascertain the strength. The strength depends on types of mixes, compaction, water ratio, curing period (7,14,21,28 days) and crushing strength test if this objective is achieved and found to be economical value, it will enhance the use of groundnut ash (GHA) as a partial replacement for cement as concrete material.

1.1.2: CEMENT

Cement is the binding material in concrete. When water is added to cement, a chemical action takes place resulting in the cement setting hard after wards (Obande 1981). Good concrete therefore depends largely on the quality of the cement being used.

The type of cement used in most laboratory test is the ordinary portland cement (OPC) or the Rapid Hardening Cement (RHC) and they must comply with British Standard Specification BSS 12. There are other types of cements such as – sulphate resistance cement, High Alumina Cement and Blast furnace slag cement used for different jobs depending on their strength and setting time.

In this work Ordinary Portland Cement (OPC) would be used.

1.1.3: WATER

Chemically, water can be defined as a combination of Hydrogen and Oxygen Molecules i.e. $H_2 + O_2 = H_2O$

It is an essential "ingredient in life, for both household and industries. It's main use in concrete construction is to cause the chemical action which results in setting and hardening of cement. It is used for block moulding, concrete mixing and cube curing. It also enables the concrete to be sufficiently plastic for easy placing and compaction.

1.1.4: JUSTIFICATION OF THE PROJECT

If the result from this experiment is successful and a fact is established that if a portion of Ordinary Portland Cement (OPC) is replaced by a certain proportion of Groundnut ash (GRA) without the concrete loosing some of its Engineering properties as well as structural properties such as workability strength and permeability, then this project will be meaningfully justified. In this case many advantages will be benefited from this project work, such as:

1. More income generation for farmers: Farmer's will tends to produce more of groundnut farms and sells the shells to the Industries as by product instead of thrown them away.
2. Instead of thrown away this groundnut shell away any how and allow for indiscriminate burning which leads to air pollution, it can be transported to a particular place for onward process thereby preventing contermination of air and environmental .
3. Production of less quantity of cement: This will save both money and energy because chemical importation will be less and energy will be saved in the Industries because the production of Groundnut ash may not need heat treatment like cement and also less cement will be produced.
4. Cheap Raw Materials: Because this groundnut is produced locally, it would be easier to come by in large quantity especially in the Southern part of the country and in the middle belt during harvesting period.

1.1.5: LIMITATIONS OF THE PROJECT

This project work is limited on the suitability of using a certain percentage of Groundnut Ash as a partial replacement in concrete production. Concrete, as a complex material is affected by many factors such as the quality of cement, the aggregate to be used, compaction and the quality of water to be used as well as the curing period. Most of these factors would have being considered as it affects the strength of the concrete but for the time which will not be enough.

Another limitation is the finance. Most of the tests carried out on concrete would not allowed for repeatation except another cube is moulded and this requires a lot of financial implication. Therefore more research is highly necessary to cover other aspects of this report.

If the justification of this project is successful, I hope most Civil Servants will be a owner of their own house soonest.

The cement type used for this project work would be ordinary portland cement and groundnut ash at different ratio of 70:30, 60:40, 50:50, 40:60, 30:70 and 100% cement as control to test for the strength at 7, 14, 21, and 28 days curing period.

CHAPTER TWO

2.1.0: LITERATURE REVIEW

2.1.1: CONCRETE

Concrete is an artificial substance formed by mixing cement, water and aggregate together in such a fashion that when the mixture is allowed to set it forms a stone-like material (Patrick, 1977). The foundation of the compound is the cement, which when mixed with water forms a paste that bonds the aggregate together. Although many materials have the ability to act as cementing agents, for constructional purposes the terms "Cement" is used to refer to a lime-based compound. The type most commonly used in Britain is portland cement, which is formed by mixing naturally occuring substances containing calcium carbonates (chalk and limestone) with substances containing alumina, silica and iron oxide. There. are many different forms of Portland cement as well as alternative cement type materials, comprehensive coverage, together with details of Portland cement manufacture, is given by (Neville 1968

2.1.2: CONCRETE CONSTITUENTS

2.1.3: CEMENT

The vast majority of the cement used in construction work is described as being a Portland cement and it is with this general type that most of this book is concerned. The other type discussed are high alumina cement and super-sulphated cement (B.W Shacklock, 1974)

All Portland cements have the same chemical constituents and it is the variation in the relative proportions of these chemical which determines the individual type of cement. Most Portland cement used is ordinary Portland cement.

Portland cement are manufactured by mixing calcareous or other lime – containing material with argillaceous or other material containing Silica, alumina or iron oxide, burning them at a high temperature to produce a clinker, and grinding the clinker to a fine powder with a small proportion of ghpsum. The principal chemical constituents formed are tricalcium silicate, dicalcium silicate, tricalcium aluminate and tetra calcium aluminoferrite; often abbreviated to C_3S, C_2S.C_3A and C_4AF

respectively; of these the first two are particularly important because they provide the cementing action – the higher the proportion of C_3S relative to the C_2S, the more quickly strength is gained after mixing.

2.1.4: SAND AND STONE

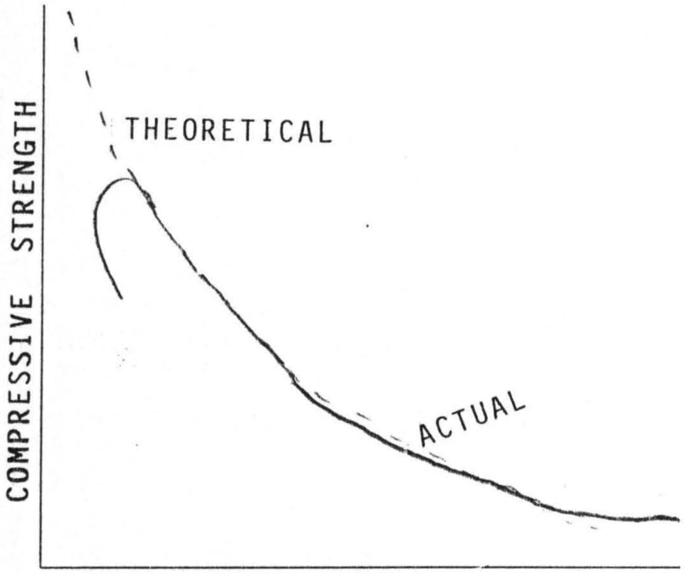
This, known as fine and coarse aggregates respectively, should be clean when they arrive on the site for concrete work. They must be free from lumps of clay, animal and vegetable remains. Where good quality natural sand can be found, it should be used as it is cheaper.

British standards, B. 5882: 1965 or Nigeria Industrial Standards, N.1.5 13 or N. 1.5 16 gives more light on this.

2.1.5: WATER/CEMENT RATIO

Water is an essential ingredient of concrete. It causes the chemical action which results in the setting and hardening of cement to take place and also enable the concrete to be sufficiently plastic for easy placing and compacting.

The degree of workability is largely influenced by the amount of water that is added to the mix in its initial stages. The amount of water to be added to a given mix is specified in term of the water: cement ratio i.e. the weight of water in the concrete divided by the weight of cement. A typical value of the water: cement ratio for a 1:2:4 mix might be in the order of 0.6. Fig. 1.1. shows the variation in strength that occurs with increasing water: cement ratio for a fully compacted concrete.



Water/cement ratio

Fig. 1.1. Influence of water: cement ratio on the compressive strength of concrete.

The theoretical line show a continuing gain in strength with falling water: cement ratios, even at very low ratios (provided that minimum amount of water for the chemical reaction has been added). In practice, however, it is found that full compaction is impossible at very

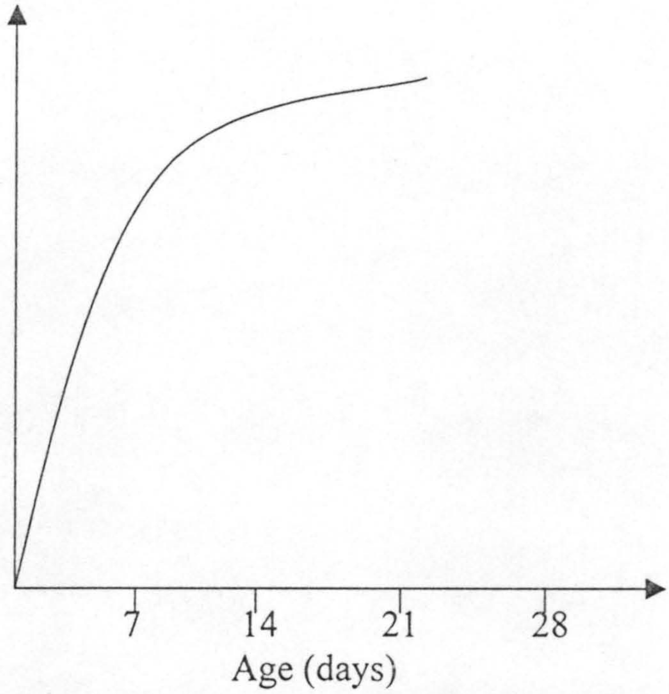


Fig. 1.2 Rate of gain in compressive strength of concrete (Neville and Brook 1987)

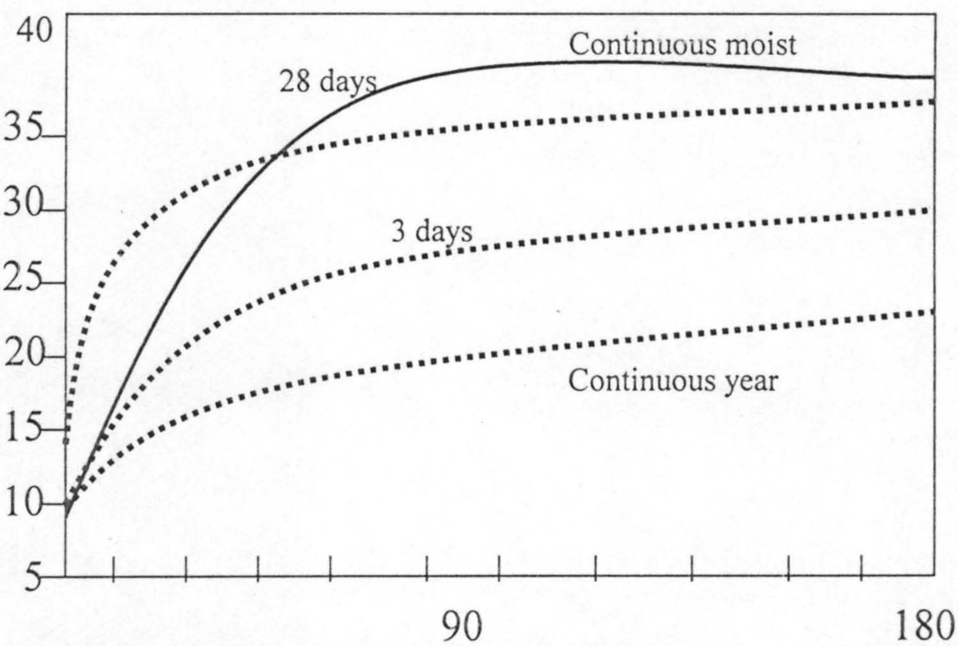


Fig. 1.3: Curing as a factor influencing concrete strength. (Neville and Brook 1987).

low water: cement ratios, so that for practical purposes the strength curve falls away as shown. Figure 1.1 also shows that the fall of strength with increasing water: cement ratio is quite pronounced; it is therefore necessary, whn calculating the amount of tree water that must be added to the mix, to allow for the water that may be contained within the aggregate.

A statement by Gulkey (1974) that "for a given cement and acceptable aggregate, the strength that may be developed by a workable, properly placed mixture of cement aggregate and water (under the same mixing, curing and testing condition) is influenced by

(a) Ratio of cement to water in the mix

(b) Ratio of cement to aggregate

(c) Grading, surface texture, shape, strength and stiffness of aggregate particles.

(d) Maximum size of the aggregates.

2.1.6: <u>STRENGTH OF CONCRETE</u>

Discussion of the strength of concrete introduces the primary deficiency of the material of which every engineer is aware; although having great compressive strength, concrete is very weak in tension it is this lack of tensile strength that lead to the necessity of reinforcement which carries any tensile forces present in the structure. The strength of any concrete presents the overall picture of the quality of the concrete, because strength directly relates to the structure of the hydrated cement paste. Fig. 1.2 illustrates a typical rate of gain of strength of an ordinary Portland cement concrete. As may be seen, the rate of gain of strength is rapid in the early life of the concrete, but decreases as the concrete ages, although some cements continue to gain in strength for many years.

2.1.7: POZZOLANS

As defined by ASTM 618-94, it is a siliceous and aluminous material which in itself posses little or no cementous value but in a finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperature to form compounds possessing cementous property.

According to Brook,(1987) and Neville,(1996) it will be wrong to infer from the previous historical account that this supplementary materials were introduced into concrete solely by the readily availability of this material. This material also bestows various desirable properties on concrete .

According to ASTMC 618-94a, any pozzolana that will be used as a cement blender in concrete requires 70% silica, alumina and ferric oxide and a maximum of SO_3 of 5% also BS 3892 part 1 specifies an SO_3 contents of 2.5%.

(Neville 1984) described Rice Husk Ash (RHA) as pozzolana, also a study carried out by (Okpalla, 1987) shows that at 40% partial replacement of cement with RHA in concrete production, the concrete will have the same strength as plain OPC concrete.

In the light of this, if RHA have produce such a reasonable results, it is necessary to extend the research to other ashes of agric wastes to check its effects on the strength of the concrete so produced from this material, hence the use of Groundnut shell ash (GRA)

2.1.8: GROUNDNUT SHELL ASH (GRA)

Groundnut shell is a waste from groundnut that is usually thrown away after removing the groundnut from the pod. After collecting the shell and Ashed, the chemical analysis shows that if is also a pozzolana because it contain a certain percentage of Silica oxide SiO_2, Alumina oxide Al_2O_3. Iron oxide Fe_2o_3, calcium oxide CaO and Magnessium oxide M_gO in 15.92, 6.73, 1.93, 8.66 and 6.12 respectively. Therefore, using different percentage of the ash in partial replacement with Ordinary Portland Cement (OPC), and testing the strength compared to the standard strength, a good result could be obtained.

2.1.9: CURING CONCRETE

This is a ver important operation if the concrete is to attains its optimum strength and should be taken senously. Curing, according to (Obande, 1981) means keeping the newly laid concrete under uniform conditions of temperature and moisture during the hydration of the cement compounds. Curing makes concrete stronger, more durable, denser and more resistant to abrasion.

The curing procedure being the control of the temperature and moisture movement from and into the concrete. The later not only affects the strength of concrete but also the durability. The influence of most curing on strength can be guagged from fig. 1.3 which was established by price (1951) in his research on factors influencing concrete strength. The graphs a plotted for a concrete of 0.50 moisture content.

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Tensile and compressive strength are affected in a similar manner. The future to gain strength in consequence of adequate curing that is through loss of water by evaporation is more pronounced in thinner elements and in richer mixes but less for light weight aggregate concrete. "If curing is efficient, the strength of the concrete increases with age. This increase is rapid at the early age and then continues more slowly for an indefinite period" cement and concrete Association 1979.

CHAPTER THREE

3.0: EXPERIMENT AND METHOD

3.1.0: In carrying out the laboratory investigation on the partial replacement of ordinary Portland cement with groundnut shell Ash to determine the strength and suitability of it in concrete production, the major materials used in the laboratory were.

- Groundnut Shell Ash (GRA)
- Ordinary Portland Cement
- Sand (fine aggregate)
- Chipping (3/4 aggregate)
- Water
- Mould (size 150 x 150mm)
- Shovels, hand trowels, head pain etc.

When these materials were taken to the laboratory, the various tests, which had to be done started. Most of the materials were bought and taken to the laboratory except the groundnut shells which was get from the farm and water from the school environment.

3.1.1: ASH PRODUCTION

Getting the groundnut shell burnt to ashes seems to be a very tedious work which may be a great set back if the strength test to be carried out is successful. The ash was got by burning the groundnut shell on an iron sheet in an open air with a normal burning temperature. It is important to use ordinary burning method so as to be of benefit to the people at the grass root. The burning in the furnace would not be financially economical and it will consume a lot of time. The burnt ash was sieve through a British standard sieve (75 microns). The portion passing through the sieve will have the required degree of fineness of 0.063mm and below (Okpalla 1987) while the residue was thrown away.

The chemical analysis of this ash was carried out at the Nigerian Mining Corporation, Jos, to determine their silicious, aliminous and other chemical contents of the ash as compare to the ordinary Portland cement and other agricultural wastes to know whether they poccesses a pozzolana characteristics.

3.1.2: CONCRETE PREPATION

The different ratio of concrete mix were prepared using the 1:2:4 mix design which is one part cement, two part fine sand and four part course aggregate. The ratio used for the one part cement and ash were

- 100% cement as control.
- 70:30 cement/Ash
- 60:40 cement/Ash
- 50:50 cement/Ash
- 40:60 cement/Ash
- 30:70 cement/Ash.

The partial replacement of cement with these different ratios groundnut ash was done by volume. For each of the ratio three cubes of concrete were casted to be cured in clean water for the period of 28 days and to be tested at 7, 14, 21, and 28 days respectively. Therefore the total of 72 cubes were produced and tested.

3.1.3: CONCRETE AGGREGATE

According to Barry, (1984), concrete comprises particles of hard materials, the aggregate, bound with cement paste at least three quarters of the volume of the concrete being occupy the aggregate. The wet mix is spread inside the mould and compacted with dense mass. The nature of the aggregate plays a considerable role in the ease with which it can be compacted.

The measure of the ease with which a concrete can be compacted is described as the WORKABILITY of the mix.

3.1.4: <u>WATER CEMENT RATIO</u>

The material used in concrete are mixed with water for two reasons:

(a) To enable chemical reaction with cement which causes setting and hardening to take place

(b) To act as a lubricant to render the mix sufficiently plastic for placing and compaction.

About a half by weight of water to one part by weight of cement is required to make a concrete mix workable.

It was established that the greater the proportion of water to cement used in a concrete mix the weaker will be the ultimate strength of the concrete (Barry, 1984).

The major reason is that "the water in excess of that required to complete the hardening of the cement, evaporates and leaves voids in the concrete which reduces its strength.

$$W/c = \frac{W}{Wc}$$

Where, W/C = water cement ratio

W = weight of water, g

W_c = weight of cement, g.

3.1.5: BULK DENSITY

Bulk density is the weight of aggregate that would fill container of unit volume when the aggregate is batched by volume. The bulk density depends on how densely the aggregate is packed. For this experiment, the weight of cured cubes were taken and the volume of the mould determined.

$$\text{Density} = \frac{\text{mass}}{\text{Volume}}$$

The size of the mould use was (150 x 150mm) or (0.15m x 0.15m) therefore the volume Lxbxh = (0.15 x 0.15 x 0.15)m

$= 0.0034m^3$.

3.1.6: CONCRETING

This is defined as a mass formed by parts growing or sticking together (Chambers 1983): a mixture of sand, gravel, etc and cement used for building. It can also be defined as an artificial substance made from cement, water and aggregate, which when mixed together and allowed to set under normal condition forms a stone like material.

The process of making concrete is concreting. The steps involves are; batching, mixing, compaction and moulding, stripping and curing.

3.1.7: BATCHING

This is the weighing of the materials to be used for concreting. The batching of the concrete materials was done by volume. After weighing the required proportion of cement, Ash, Aggregate, and sand it was properly mixed together and water is added to allow for proper chemical reaction. The mix ratio used for this research work was 1:2:4. This implies cement plus Ash has one part, sand has two parts and aggregate has four parts by volume.

3.1.8: MIXING

It is the process of bringing together the batched materials and mixing them thoroughly together by stirring, to form a uniform mass of the components. In this process water is necessary in order to facilitate the bonding together of the cement which blends the sand, aggregate and cement/Ash together.

Note: After every mixing, the concrete should immediately be placed in the mould to avoid setting and hardening. Also the tools used should be thoroughly washed immediately.

3.1.9: COMPACTION AND MOULDING

The moulds were cleaned with engine oil (to allow for easy stripping). Moulds made with wood were used. The freshly mixed concrete was scoped into the mould; i.e wood moulds with internal area of 150mm x 150mm internal surface area and volume of 150 x 150 x 150mm3. After placing the concrete, then compaction follows. "Compaction is the process of driving out or removing air voids that are trapped in the freshly mixed concrete". This process is achieved by ramming the surface of the concrete so as to dislodge the air and force the particles into a closer configuration. In casting the cubes, the mix was filled in the mould in three layers, each layer rammed 25 times with a tamping rod. After preparing the cubes they were kept in the open air for 24 hours. After the 24 hours, they stripped and place in a fish pond for water curing for 28 days.

The ramming i.e vibration was done uniformly to avoid segregation in some parts while some parts might be under compacted and some over compacted.

3.1.10: STRIPPING AND CURING OF CONCRETE

Stripping is the removal of mould after the concrete is set and strong enough to support its own weight. This was done after about 24 hours of setting under air. It involves careful removal of nails to exposed the set concrete cube.

Curing means keeping the newly laid concrete under uniform conditions of temperature and moisture during the hydration of the cement compound. The method of curing used for this project is water curing.

A clean fish pond of about 1.5m x 1.5m was filled with tap water and the concrete cubes were placed in it. They were kept for twenty-eight days. After which the ratio were tested for strength at 7, 14, 21, and 28 days respectively. It must be ensured that water covers the cubes.

3.1.11: COMPRESSIVE STRENGTH TEST

Compressive strength test is the common and most important because all the needed properties or characteristics of concretes are qualitatively related to its strength. The strength test also determined the quantity and quality of binding material which is cement.

The cubes prepared in moulds of 150 x 150mm was crushed in a compression machine after the specific curing period in the water. Before crushing, the cubes were brought out of the water and kept for sometimes to drip off most of the water in it. They were then weighed on a weighing balance and then taken to the crushing machine. The cubes experienced cracks due to failure in its strength as a result of the load applied by the compression machine. The readings were taken and recorded as shown in the table.

From the result, the compressive strength was calculated by the relationship.

$$\text{Compressive strength} = \frac{\text{load}}{\text{Area}} \,(\text{KN/m})$$

CHAPTER FOUR

4.0 RESULT AND DISCUSSION

4.1. CHEMICAL ANALYSIS

The chemical analysis of the Groundnut Shell Ash (GRA) carried out at the Nigerian Mining Corporation Jos shows that, the groundnut Shell Ash contains the following elements chemically combined together in their various percentage as shown in table 4.1 below.

Table 4.1 Elements contain in the Groundnut ash in various percentage

%$S10_2$	%AL_2O_3	%Fe_2O_3	%C_aO	%M_gO
15.92%	6.73	1.93	8.66	6.12

This result shows that, Groundnut shell Ash contains some elements that are equally found in the ordinary port land cement as shown in table 4.2 below.

Table 4.2 N1S standard of elements contains in the cement in various percentage.

%LSF	Free C_ao%	%$S0_3$	%M_gO	%C_3S	%C_3A
>90%	<3.5%	1.8-2.5%	<40%	>40.0%	>6.0%

Table 4.2 shows the N1S standard of elements contains in the cement in various percentage.

4.2 COMPRESSIVE STRENGHT TEST RESULT

The result of the compressive strength test is as shown in table 4.3 below

Table .3 Result of compressive strength tests

CEM/ASH RATIO	7 DAYS	14 DAYS	21 DAYS	28 DAYS
100.00	16.40 MN/m^2	21.30MN/m^2	22.00MN/m^2	24.30MN/m^2
70.30	12.00 ,,	13.50 ,,	14.00 ,,	16.00 ,,
60 .40	9.33 ,,	11:00 ,,	11.20 ,,	12.00 ,,
50.50	7.00 ,,	8.30 ,,	9.00 ,,	9.00 ,,
40.60	4.22 ,,	5.00 ,,	5.00 ,,	5.00 ,,
30.70	3.00 ,,	3.30 ,,	3.40 ,,	4.00 ,,

4.3 DISCUSSION OF THE RESULTS

The research carried out on this project work and the findings have shown that, Agric. Wastes can be used in a lot of ways instead of throwing them away into the dustbin which later decomposed to form compost manure which is not given require attention of usage by farmers, instead they go for fertilizer.

The only requirement is the technical know-how of how to convert those agric wastes to useful materials. Some of the result got from this finding may not be enough an evidence to prove the suitability of the groundnut ash as a replacement for cement partially, but with continue research improvement, one will surely arrived at a logical conclusion.

Table 4: Crushing Strength of concrete mixed at different ratio at 7 days

RATIO ASH/CM	AGE (7 DAYS)	AVE. DENSITY (Kg/m^3)	CRUSHING LOAD (MN)	CRUSHING STRENGHT AVE (MN/m^2)
100.00	7	2471.00	369.3016.40	16.40
70.30	7	2439.00	263.30	12.00
60.40	7	2400.00	210.00	9.33
50.50	7	2370.00	157.53	7.00
40.60	7	2252.00	95.00	4.22
30.70	7	2202.00	64.00	3.00

Table 5: Crushing Strength of concrete mixed at different ratio at 14 days

RATIO ASH/CEM	AGE (14) DAYS	AVE. DENSITY (Kg.m^3)	AVE. CRUSHING LOAD (MN)	CRUSHING STRENGTH (MN/m^2)
100:00	14	2418.00	479.33	21.30
70:30	14	2409.00	303.00	13.50
60:40	14	2430.00	240.00	11.00
50:50	14	2353.00	187.00	8.33
40: 60	14	2302.00	103.00	5.00
30:70	14	2219.00	73.00	3.30

Table 6: Crushing Strength of concrete mixed at different ratio at 21 days

RATIO ASH/CEM	AGE (21) DAYS	AVE. DENSITY (Kg.m^3)	AVE. CRUSHING LOAD (MN)	CRUSHING STRENGTH (MN/m^2)
100:00	21	2465.00	493.00	22.00
70:30	21	2359.00	311.00	14.00
60:40	21	2359.00	252.00	11.20
50:50	21	2338.00	195.00	9.00
40:60	21	2222.00	111.00	5.00
30:70	21	2133.00	76.00	3.40

Table 7: crushing strength of concrete mixed at different ratio at 28 days

RATIO ASH/CEM	AGE (28) DAYS	AVE. DENSITY (Kg.m^3)	AVE. CRUSHING LOAD (MN)	CRUSHING STRENGTH (MN/m^2)
100.00	28	2353.00	546.00	24.30
70:30	28	2341.00	358.00	16.00
60:40	28	2299.00	261.00	12.00
50:50	28	2225.00	198.00	9.00
40:60	28	2172.00	114.00	5.00
28	2142.00	83.00	4.00	

Table 8: Strength of concrete at 7 days

REPLICATION	TREATRMENT 1	2	3	4	5	6
1	8.40	7.90	8.40	8.00	7.72	7.00
2	8.32	8.46	7.52	8.10	7.48	7.60
3	8.30	8.30	8.48	8.00	7.70	7.50
MEAN TREATMENT	8.340	8.230	8.133	8.030	7.633	7.430

The data table shows that, for the control, the average strength measured 8.340. Variant average strength were observed for the various ratio run gives from 7.36 to 8.230 for T_6 and T_2 respectively. The average strengths of the various combinations are less than that of the control (100:00).

Table 9: Analysis of Variance (ANOVA)

SOURCE OF VARIATION	DEGREE OF FREEEDOM	SUM OF SQUARES	MEAN SQUARE	F RATIOS	F PROB.
Between group	5	2.1397	.4279	5.328	0.0083
Within Group	12	0.9637	0.803		
TOTAL	**17**	**3.1034**			

From the Anova table (9) shows that the difference between the control and the other combination were statistically significant ($P<0.05$). On close observation (separation of means) size difference were observed between control T_1 and group 6 and 5. Group 4,3 and 2 didn't show significant difference with the control (Appendix A).

Table 10: Strength of concrete at 14 days curing

REPLICATION	TREATMENT 1	2	3	4	5	6
1	8.10	8.30	8.22	8.30	8.06	
2	8.18	8.10	8.20	8.04	8.22	7.58
3	8.22	7.98	8.14	7.50	7.09	7.54
MEAN TREATMENT	8.16	8.126	8.186	7.946	7.790	7.35 7.490

The table shows that the control is higher but no significant difference observed between the group $P>0.05$. The separation of means show that size difference were observed between the control T_1 and groups 6.

Table 11: analysis of variance (ANOVA)

SOURCE OF VARIATION	DEGREE OF FREEEDOM	SUM OF SQUARES	MEAN SQUARE	F RATIOS	F PROB.
Between group	5	1.1141	0.2228	2.2771	0.1128
Within Group	12	1.1743	0.0979		
TOTAL	**17**	**2.2884**			

From the ANOVA, Table 11 shows that the difference between the control and the other combinations were not statistically different ($P>0.05$) Appendix B

Table 12: Strength of concrete at 21 days curing

REPLICATION	TREATMENT 1	2	3	4	5	6
1	8.20	8.06	7.78	8.23	8.40	7.48
2	8.45	7.98	8.12	7.96	7.02	7.06
3	8.30	7.84	7.97	7.50	7.20	7.06
MEAN TREATMENT	**8.3167**	**7.9600**	**7.9507**	**7.8967**	**7.4800**	**7.200**

Table 12 show that the strength average for the control (T_1) is higher than that of other combination. It is also observed that there is size difference between the control and groups 6 and 5.

Table 13: Analysis of Variance (ANOVA)

SOURCE OF VARIATION	DEGREE OF FREEEDOM	SUM OF SQUARES	MEAN SQUARE	F RATIOS	F PROB.
Between group	5	2.3665	0.4733	3.2011	0.0458
Within Group	12	1.7742	0.1479		
TOTAL	**17**	**4.1407**			

The Anova table shows that there is significant difference between the control and the groups ($p<0.05$).Appendix C.

Table 14: Strength of concrete at 28 day curing

REPLICATION	TREATMENT 1	2	3	4	5	6
1	8.00	7.98	7.80	8.15	7.90	7.02
2	7.96	7.90	7.78	7.39	7.00	7.70
3	7.86	7.84	7.70	7.00	7.10	7.00
MEAN TREATMENT	**7.9400**	**7.9067**	**7.7600**	**7.5133**	**7.333**	**7.2400**

The table shows that control is higher and no significant different observe among the group. The pair comparison show significant different between control and group 6.

Table 15: Analysis of Variance (ANOVA)

SOURCE OF VARIATION	DEGREE OF FREEEDOM	SUM OF SQUARES	MEAN SQUARE	F RATIOS	F PROB.
Between group	5	1.3260	0.2652	2.1018	.1354
Within Group	12	1.5142	0.1262		
TOTAL	**17**	**2.8402**			

The ANOVA Table shows that there is no significant different between the control and other combination P>0.05 Appendix D

.3.1 CHEMICAL ANALYSIS

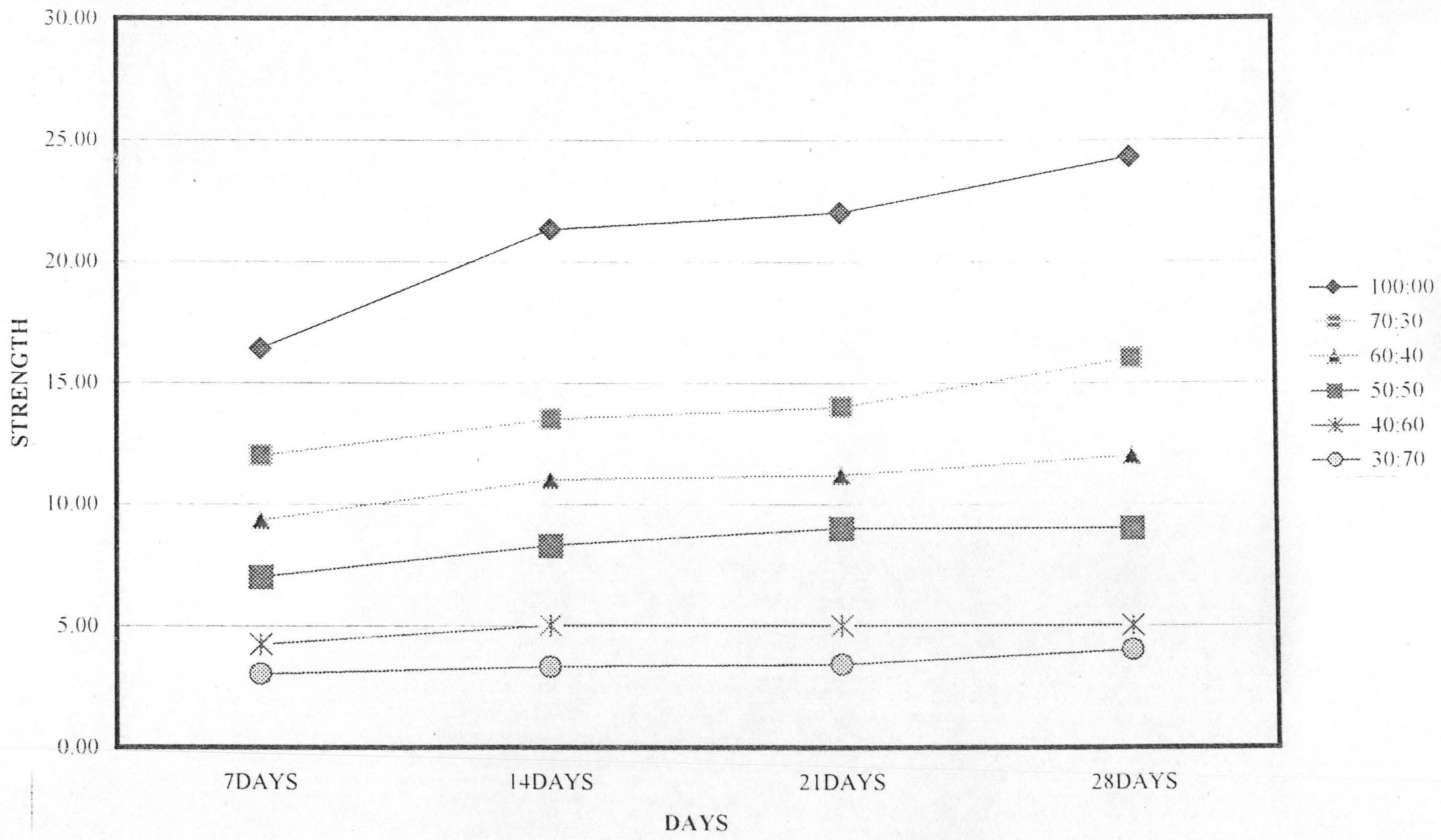
From the chemical analysis (table 4.1), it shows that groundnut Ash contain some chemical compound as it is found in ordinary Portland cement table 4.2, but in less or more of the recommended quality. If the groundnut Ash can be blended with other compound that possess cementous property, it will go along way in reducing the cost of buying purely ordinary Port Land Cement. Such compound like fly Ash, especially the one from bituminous coal which is mainly siliceous and is known as fly ash. This blend well with cement to produce the best of ash plus cement concrete.

4.3.2 STRENGTH TEST RESULT

Being the most important test in concrete production. The research study was carried out so as to see that this important property (strength) is enhanced in the OPC + ASH Concrete.

Looking at table 4.3, the 100% cement concrete increases in strength with age, the likewise other ratios used. But of all the experiments carried out, the 7th and 21st day wet curing shows that there is a closed relationship between the two compares to 14th and 28th days.

Fig.4 Graph showing compressive stregth against time of different mixed ratios.



Also from the table 4.3, it could also be noted that at 70:30 Cement/Ash ratio, the highest of 16.00MN/m^2 at 28 days curing period, which is less than the value got from 100% cement at the same 28 days wet curing. Therefore it would be necessary to blend the groundnut ash with some cementous material.

From the graph fig. 4.1 the 70.30 and 60:40 Cement/Ash ratio follows the same pattern or similar pattern of increment as compared to the 100% cement while 50:50, 40:60 Cement/Ash ratio seems not to have much changes in the value got from the strength test as they seems to assumed the same value or uniform value after 7 days curing.

It should be cleared in our mind that by partially replacing cement in concrete by this groundnut ash, we are not and cannot do away with cement but trying to reduce its cost in the total construction cost and to reduce the adverse effect caused to the entire environment by the production of this cement. Also to reduce the environmental pollution of these agric wastes by converting it to useful materials for building houses and other construction works.

Though the 16.00.MN/m^2 highest obtained for the 70:30 Cement + Ash ratio is less compared to the 24.30 MN/m^2 of the 100% cement. If this mix ratio cannot withstand flexural loading, it can be used in mass concrete work, light load bearing elements and purely compressive member work thereby bring about high saving in terms of cost of construction.

To make the usefulness of the OPC + GRA Ash concrete a reality, further studies nust be carried out in relation to bonding between this concrete and any reinforcement, ;o adequate check must be carried out to see if this is the case with OPC + GRA Ash :oncrete.

Also from the statistical analysis carried out, it would be required that blending of this groundnut ash is very necessary so as to improve the strength and other needed properties of the concrete.

Another important check to be carried out is the durability of this OPC + ASH Concrete. This may involve test for resistance to wearing off or scrapping and how long it takes for the concrete to start disintegrating. This will enable the structural engineers to be precise in predicting the life span of any constructed structure using OPC + GRA Ash concrete.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The result obtained from the compressive strength test at 70:30 cement + GRA Ash shows that groundnut ash at low percentage can replace cement partially and if the research is improved upon, more of the Ash percentage can be used.

The chemical analysis also show that groundnut Ash also contains some elements as it is present in ordinary Portland Cement though some in traces, but if improved upon or blended can measure up to or near the standard range.

5.2 RECOMMENDATION

Looking at the utmost importance of this research work and the little effort made to arrived at this result, I am therefore recommending that:

(1) This research work should be given adequate attention and should be further as quickly as possible so that production of blended cement with this ash (GRA) will be a reality.

(2) For this research to be very successful, there should be standard equipment to be used, such as the standard mould, curing tank instead of using wood mould

etc.

(3) Because of the enormous gain that would be got from this research, like slump test, porosity and workability of cement, concrete should be test for which may not be in this write up to ascertain the usefulness of OPC + GRA Ash in concreting.

(4) This finding should be send to research institute so that they can carried out the same experiment and then compares the findings and arrived at a logical conclusion.

(5) A prototype building should be put in place using this OPC + Ash as building materials.

(6) The Nigeria Institute of Agric Engineers must be ready to establish a national standard code guiding the use of Agricultural Wastes Ash as blended cement in Construction Industry.

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APPENDIX A

----- O N E W A Y -----

Variable T7 7 Days
By Variable TREAT

Source	D.F.	Analysis of Variance Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	5	2.1397	.4279	5.3284	.0083
Within Groups	12	.9637	.0803		
Total	17	3.1034			

----- O N E W A Y -----

Variable T7 7 Days
By Variable TREAT

Multiple Range Tests: Duncan test with significance level .05

The difference between two means is significant if
MEAN(J)-MEAN(I) >= .2004 * RANGE * SQRT(1/N(I) + 1/N(J))
with the following value(s) for RANGE:

Step	2	3	4	5	6
RANGE	3.08	3.22	3.32	3.37	3.41

(*) Indicates significant differences which are shown in the lower triangle

Mean	TREAT	Grp 6	Grp 5	Grp 4	Grp 3	Grp 2	Grp 1
7.3667	Grp 6						
7.6333	Grp 5						
8.0333	Grp 4	*					
8.1333	Grp 3	*					
8.2333	Grp 2	*	*				
8.3400	Grp 1	*	*				

Homogeneous Subsets (highest and lowest means are not significantly different)

Subset 1

Group	Grp 6	Grp 5
Mean	7.3667	7.6333

Subset 2

Group	Grp 5	Grp 4	Grp 3
Mean	7.6333	8.0333	8.1333

Subset 3

Group	Grp 4	Grp 3	Grp 2	Grp 1
Mean	8.0333	8.1333	8.2333	8.3400

APPENDIX B

- - - - - O N E W A Y - - - - -

Variable T14 14 Days
By Variable TREAT

Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	5	1.1141	.2228	2.2771	.1128
Within Groups	12	1.1743	.0979		
Total	17	2.2884			

- - - - - O N E W A Y - - - - -

Variable T14 14 Days
By Variable TREAT

Multiple Range Tests: Duncan test with significance level .05

The difference between two means is significant if
MEAN(J)-MEAN(I) >= .2212 * RANGE * SQRT(1/N(I) + 1/N(J))
with the following value(s) for RANGE:

Step	2	3	4	5	6
RANGE	3.08	3.22	3.32	3.37	3.41

(*) Indicates significant differences which are shown in the lower triangle

Mean	TREAT	Grp 6	Grp 5	Grp 4	Grp 2	Grp 1	Grp 3
7.4900	Grp 6						
7.7900	Grp 5						
7.9467	Grp 4						
8.1267	Grp 2	*					
8.1667	Grp 1	*					
8.1867	Grp 3	*					

Homogeneous Subsets (highest and lowest means are not significantly different)

Subset 1

Group	Grp 6	Grp 5	Grp 4
Mean	7.4900	7.7900	7.9467

Subset 2

Group	Grp 5	Grp 4	Grp 2	Grp 1	Grp 3
Mean	7.7900	7.9467	8.1267	8.1667	8.1867

APPENDIX C

----- O N E W A Y -----

Variable T21 21 Days
By Variable TREAT

Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	5	2.3665	.4733	3.2011	.0458
Within Groups	12	1.7742	.1479		
Total	17	4.1407			

----- O N E W A Y -----

Variable T21 21 Days
By Variable TREAT

Multiple Range Tests: Duncan test with significance level .05

The difference between two means is significant if
MEAN(J)-MEAN(I) >= .2719 * RANGE * SQRT(1/N(I) + 1/N(J))
with the following value(s) for RANGE:

Step	2	3	4	5	6
RANGE	3.08	3.22	3.32	3.37	3.41

(*) Indicates significant differences which are shown in the lower triangle

Mean	TREAT	Grp 6	Grp 5	Grp 4	Grp 3	Grp 2	Grp 1
7.2000	Grp 6						
7.4800	Grp 5						
7.8967	Grp 4						
7.9567	Grp 3	*					
7.9600	Grp 2	*					
8.3167	Grp 1	*	*				

Homogeneous Subsets (highest and lowest means are not significantly different)

Subset 1

Group	Grp 6	Grp 5	Grp 4
Mean	7.2000	7.4800	7.8967

Subset 2

Group	Grp 5	Grp 4	Grp 3	Grp 2
Mean	7.4800	7.8967	7.9567	7.9600

Subset 3

Group	Grp 4	Grp 3	Grp 2	Grp 1
Mean	7.8967	7.9567	7.9600	8.3167

APPENDIX D

\- - - - - O N E W A Y - - - - -

Variable T28 28 Days
By Variable TREAT

Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	5	1.3260	.2652	2.1018	.1354
Within Groups	12	1.5142	.1262		
Total	17	2.8402			

\- - - - - O N E W A Y - - - - -

Variable T28 28 Days
By Variable TREAT

Multiple Range Tests: Duncan test with significance level .05

The difference between two means is significant if
MEAN(J)-MEAN(I) >= .2512 * RANGE * SQRT(1/N(I) + 1/N(J))
with the following value(s) for RANGE:

Step	2	3	4	5	6
RANGE	3.08	3.22	3.32	3.37	3.41

(*) Indicates significant differences which are shown in the lower triangle

Mean	TREAT	Grp 6	Grp 5	Grp 4	Grp 3	Grp 2	Grp 1
7.2400	Grp 6						
7.3333	Grp 5						
7.5133	Grp 4						
7.7600	Grp 3						
7.9067	Grp 2						
7.9400	Grp 1	*					

Homogeneous Subsets (highest and lowest means are not significantly different)

Subset 1

Group	Grp 6	Grp 5	Grp 4	Grp 3	Grp 2
Mean	7.2400	7.3333	7.5133	7.7600	7.9067

Subset 2

Group	Grp 5	Grp 4	Grp 3	Grp 2	Grp 1
Mean	7.3333	7.5133	7.7600	7.9067	7.9400