INVESTIGATION ON STRENGTH DEVELOPMENT IN CONCRETE USING DIFFERENT MIX RATIO AND BRANDS OF CEMENT

BY

AZEEZ UTHMAN OPEYEMI
ND/23/CEC/FT/0042

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CERTIFICATION

This is to certify that this research study was conducted by AZEEZ, Uthman Opeyemi (ND/23/CEC/FT/0042) and had been read and approved as meeting the requirements for the award of National Diploma (ND) in Civil Engineering of the Department of Civil Engineering, Institute of Technology, Kwara State Polytechnic, Ilorin.

………………………..……. ……………………….

ENGR. DR. E. O. IBIWOYE **DATE**

Project Supervisor

……………………………… ……………………….

ENGR. A. B. NAALLAH **DATE**

Head of Department

…………..…………………………………... ……………………….

ENGR. DR. MUJEDU KASALI ADEBAYO **DATE**

External Examiner

DEDICATION

I dedicate this project to Almighty God, the giver of life for sparing my life who has help me throughout the course of this project and for making it a huge success.

ACKNOWLEDGEMENT

I give thanks to the giver of life, for His profound and boundless grace on my life. He showers His power and grace on me and His thus brought me this far, all honour and glory be to Him.

The conclusion of this project wouldn‟t have been possible if not for the support of my parents and family.

I also wish to commend the effort of my dynamic supervisor, Engr. A. Engr. Dr. E. O Ibiwoye for his dedication and parental care. He who stood by me gallantly with all he has to make this project a successful one.

My gratitude also goes to my parents Mr. and Mrs. Azeez for their support financial, morally and spiritually throughout this program my you live long to eat the fruit of your labour

And also my amiable Head of Department, Engr. B. A. Naallah for his dedication and parental care.

Finally to my friends and relative who has in one way or the other has contributed to this greater achievement may Almighty God be with you all.

ABSTRACT

Investigation on strength development in concrete using different mix ratio and brands of cement. This research assessed the quality of brands of cement produced in Nigeria. Two brands of cement were selected to carry out the research for the compressive strengths and compared with each other. This research determined the cement brands that have the highest compressive strength to enhance the quality and durability of the structure being built in the country. Granite, sharp sand, water, Dangote and Bua brands of Portland cement were used to produce concrete with varying (1:2:4 and 1:3:6) mix ratio for curing dates of 7,14,and 21 days respectively. The tests carried out include slump test at its fresh state while compressive strength was carried out for the hardened concrete, also the vicat test was carried out on the cement brands to determine the setting time. The highest average height of slump is 274mm with mix ratio 1:3:6 using Dangote and 272mm with mix ratio 1:3:6 using Bua cement. Dangote cement shows high compressive strength compeare to Bua cement at all level of mix ratio and curing days. Also, less number of crack developments and crack width. Concrete should be made with Dangote cement during rainy season because of its rapid setting and hardening time. Bua cement also proved greater advantage under hot weather because of its high water absorption rate and thus, reduce number of cracks development which may arise as a result of high evaporation due to heat. Therefore it recommended among others; Mix ratio 1:3:6 may lead to segregation which cause weak concrete. TherefoAre, mix ratio 1:2:4 may provide more strength in concrete because of their less fraction of coarse aggregate in the concrete mix.

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CHAPTER ONE

1.0 INTRODUCTION

Concrete is a versatile construction material that it is readily available, relatively cheap, flexible to handle and it gives shape and any desired form (Joseph and Raymond, 2014). The compressive strength is the most critical property that gives a very good overall idea of the quality of concrete, the tensile strength being negligible in comparison. In the broad sense, concrete is made of a cementitious material (cement, lime, pozolans etc., or any combination of these), aggregates (fine and/or coarse) and water. There may be some additives and/or admixtures added to the basic constituents to vary the properties of the concrete when it is green or hardened (Joseph and Raymond, 2014).

Many researchers have carried out works to predict the strength of concrete at any given age using some developed models. There are many factors that affect the rate at which strength develops in concrete after mixing. Among these factors are the richness of the mix, character and grading of the aggregate, the water content of the mix and the curing conditions [Joseph and Raymond, 2014]. The porosity of concrete, changes with the degree of cement hydration [Joseph and Raymond, 2014]. The degree of cement hydration which is a function of water to cement (w/c) ratio has a direct effect on the porosity and consequently on the strength. As stated earlier, the richness of the mix is one of the factors that affect the rate of strength development in concrete. The richness of a concrete mix is a direct function of the quantity and quality of the cementitious material.

A concrete can be set in that it is no longer fluid, but it may still be very weak, you may not be able to work on it, for example, setting is due to formation of early stage calcium silicate hydrate(www.understanding_cement.com 2005).

There are some distinguished types of concrete which are non-cementitious. This type can be seen in asphalt concrete in which bitumen is used as the binder that is frequently used for road surfaces and polymer concrete that use polymers as the binder.

The generally use 1:2:4 cement-fine aggregate-coarse aggregate mix ratio irrespective of the strength class/grade of the cement as they are unaware of the presence of different grades in Nigeria and their effect on concrete strength (kazeem and wasiu 2015). Famous concrete structures include the Hoover dam, the Panama Canal and the roman pantheon.

Cement is a binder, a substance used for construction that have the ability to sets, hardens and adheres to other materials to bind them together.

Conventionally, cement is the major substance use as binder in concrete. There are different types of cement such as: Portland cement, Ordinary Portland cement, Low heat cement, Pozzalana cement, Rapid hardening Portland cement, Extra Rapid hardening Portland cement, Hydraulic cement e.t.c (kazeem and Wasiu 2015).

Cement varies functionally due to the diversities and the different in the proportion of these constituent. Different factors are put under consideration to determine the best suitable for a certain work.

Mix ratio (in concrete) can be refers to as the proportion of the constituent present in the concrete. Mix ratio is measured using different materials as head pan, wheel barrow e.t.c

Varieties of factors are put under consideration in selecting the mix ratio in concrete production. Commonly used mix ratio are: 1:2:4 and 1:3:6 e.t.c where 1:2:4 implies 1 head pan of cement, 2 head pan of fine aggregate and 3 Head pan of coarse aggregate. The amount of cement required determines the quantity of water required for the mix ratio. This is called water/cement ratio.

1.1 STATEMENT OF PROBLEM

Numerous structures has collapsed or undergone any sort of defect as a result of faulty mix ratio (non-standard mix ratio). The use of cement for concrete without determining the best suitable for a certain construction has contributed greatly to the settlement / displacement of some part of / whole structure (Joseph and Raymond, 2014). Segregation, bleeding, cracks e.t.c are all perceived in some structures due to the adoption of (non-standard) mix proportion.

The choice of cement and mix ratio to be employed is majorly determined by the type of structure to be constructed (Joseph and Raymond, 2014). This serves as rationale for this study.

1.2 AIM AND OBJECTIVES OF THE STUDY

The aim of this research is the investigation of strength development in concrete using different nominal mix ratio and different type of cement.

The objectives are as follows:

- To determine the workability of the material
- To determine the difference in the strength of concrete using different cement
- To determine the difference in the strength of concrete using different mix ratio
- To determine the cement to be used at a particular period of time (weather condition)
- To produce a concrete model using various cement with different mix ratio

1.3 JUSTIFICATION OF THE STUDY

Due to numerous collapse of buildings everywhere, the cost of cement and variation in the strength of concrete, it is necessary to carry out test to determine the best material to be used for concrete and the appropriate mix proportion of each constituent to attain the expected strength.

1.4 SCOPE OF STUDY

The scope of the investigation is limited to the production of concrete cubes by using different cement and different mix ratio. The mix ratio 1:2:4 and 1:3:6 were adopted and cement used for the investigation were Dangote Ordinary Portland Cement and Bua Portland Cement. Cubes were produced and cured after production. The concrete cubes were taken to the laboratory for compressive strength test at different curing periods.

CHAPTER TWO

2.0 LITERATURE REVIEW

The word concrete comes from the latin word “concretus‟‟ (meaning compact or condensed), the perfect passive participle of „‟concrescere‟‟, from „‟con-„‟ (together) and “crescere” (to grow).

Prehistory

Perhaps the earliest known occurrence of cement was twelve million years ago. A deposit of cement was formed after an occurrence of oil shale located adjacent to a bed of limestone burned due to natural causes. These ancient deposits were investigated in the 1960s and 1970s. On a human timescale, small usages of concrete go back for thousands of years. Concrete-like materials were used since 6500 BC by the Nabataea traders or Bedouins who occupied and controlled a series of oases and developed a small empire in the regions of southern Syria and northern Jordan. They discovered the advantages of hydraulic lime, with some self-cementing properties, by 700 BC. They built kilns to supply mortar for the construction of rubble-wall housed, concrete floors, and underground waterproof cisterns. The cisterns were kept secret and were one of the reasons the Nabataea were able to thrive in the desert. Some of these structures survive to this day. (Heinric 1970).

Classical Era

In the ancient Egyptian and later Roman eras, it was re-discovered that adding volcanic ash to the mix allowed it to set underwater. Similarly, the Romans knew that adding horse hair made concrete less liable to crack while it hardened, and adding blood made it more frost resistant. Crystallization of stratlingite and the introduction of pyroclastic clays create further fracture resistance. German archaeologist Heinrich Schliemann found concrete floors, which were made of lime and pebbles, in the royal palace of Tiryns, Greece, which dates roughly to 1200-1400 BC. Lime mortars were used in Greece, Crete, and Cyprus in 800 BC. The Assyrian Jerwan Aqueduct (688 BC) made use of waterproof concrete.

Concrete was used for construction in many ancient structures. The Romans used concrete extensively from 300 BC to 476 AD, a span of more than seven hundred years. During the Roman Empire, Roman concrete (or opus caementicium) was made from quicklime, pozzolana and aggregate of pumice. Its widespread use in many Roman structures, a key event in the history of architecture termed the Roman Architectural Revolution, freed Roman construction from the restrictions of stone and brick material and allowed for revolutionary new designs in terms of both structural complexity and dimension (Roman 1970).

Modern tests show that opus caementicium had as much compressive strength as modern Portland-cement concrete (ca. 200 kg/cm^2(20 MP a; 2,800psi). However, due to the absence of reinforcement, its tensile strength was far lower than modern reinforced concrete, and its mode of application was also different: Smeaton‟s Tower the widespread use of concrete in many Roman structures ensured that many survive to the present day. The Baths of Caracalla in Rome are just on example. Many Roman aqueducts and bridges such as the magnificent Pont du Gard have masonry cladding on a concrete core, as does the dome of the Pantheon. (Heinrich 1970).

Middle Ages

After the Roman Empire, the use of burned lime and pozzolana was greatly reduced until the technique was all but forgotten between 500 and the 14th century. From the 14th century to the mid-18th century, the use of cement gradually returned. The Canal du Midi was built using concrete in 1670. (Heinrich 1970).

Industrial Era

Perhaps the greatest driver behind the modern use of concrete was Smeaton‟s Tower, the third Eddystone Lighthouse in Devon, England. To create this structure between 1756 and 1759. British engineer John Smeaton pioneered the use of hydraulic lime in concrete, using pebbles and powdered brick as aggregate. A method for producing Portland cement was patented by Joseph Aspdin in 1824.

2.1 CEMENT

Cement refers to as a finely powdered manufacture substance which in the presence of water binds together the particles of inert aggregate (like sand and gravel) to form a solid mass and high compressive strength (concrete) with adequate durability. Cement is generally used in building works involving concrete, construction of pavement (rigid pavement) coating of surface to protect from chemical attack uniting the surface of materials such as tiles, pipes, asbestos, and general roofing works and it is used for mortal (cement paste). It was first produced by a mason Joseph Aspdin in England in 1924. He patented it as Portland cement. Source: lecturer note by Fagbenro (2008)

Constituent of Cement

- Calcim
- Gypsm
- Lime
- Magnesin
- Marl
- Sand
- Silica
- Sulphur

2.1.1 Types of Cement

White cement

The cement when made free from coloring oxides of ion, manganese and chromium results into white cement. In the manufacture of this cement, the oil fuel is used instead of coal for burning. White cement is used for the floor finishes, plastering, ornamental works etc. In swimming pools white cement is used to replace glazed tiles.

Coloured cement

The cements of desired colours are produced by intimately mixing pigments with ordinary cement. The chorium oxide gives green colour. Cobalt produce blue colour iron oxide with different proportion produce brown, red or yellow colour. Addition of manganese dioxide gives black or brown coloured cement. These cements are used for giving finishing touches to floors, walls, window sills, roofs etc.

Quick setting cement

Quick setting cement is produced by reducing the percentage of gypsum and adding a small amount of aluminum Sulphate during the manufacture of cement. Finer grinding also adds to quick setting property. This cements starts setting within 5 minutes after adding water and becomes hard mass within 30 minutes. This cement is used to lay concrete under static or slowly running water.

Rapid hardening cement

This cement can be produced by increasing lime content and burning at high temperature while manufacturing cement. Grinding to very fine is also necessary. Though the initial and final setting time of this cement is the same as that of Portland cement, it gains strength in early days. This property helps in earlier removal of form works and speed in construction activity.

Low heat cement

In mass concrete works like construction of dams, heat produced due to hydration of cement will not get dispersed easily. This may give rise to cracks. Hence in such constructions it is preferable to use low heat cement. This cement contains low percentage (5%) of tricalcium aluminate (C3A) and higher percentage (46%) of dicalcium silicate (C2S).

Pozzolana cement

Pozzolana cement is a volcanic power found in Italy. It can be processed from shales and certain types of clay also. In this cement pozzolana material is 10 to 30 per cent. It can resist action of Sulphate. It releases less heat during setting. It imparts higher degree of water tightness. Its tensile strength is high but compressive strength is low.

It is used for mass concrete works. It is also used in sewage line works.

Expanding cement

This cement expands as it sets. This property is achieved by adding expanding medium like Sulphur aluminate and a stabilizing agent to ordinary cement. This is used for filling the cracks in concrete structures.

High alumina cement

It is manufactured by calcining a mixture of lime and bauxite. It is more resistant to Sulphate and acid attack. It develops almost full strength within 24 hours of adding water. It is used for underwater works.

Blast furnace cement

In the manufacture of pig iron, slag comes out as a waste product. By grinding clinkers of cement with about 60 to 65 per cent of slag, this cement is produced. The properties of this cement are more or less same as ordinary cement, but it is cheap, since it utilize waste product. This cement is durable but it gains the strength slowly and hence needs longer period of curing.

Sulphate resistant cement

By keeping the percentage of tricalcium aluminate C3A below five per cent in ordinary cement this cement is produced. It is used in the construction of structures which are likely to be damaged by alkaline conditions. Examples of such structures are canals, culverts etc.

2.1.2 Principal Raw Materials of Cement

The principal raw materials of cement available are:

- Argillaceous e.g. silicates of alumina in the form of clay and shale.
- Calcareous e.g. calcium carbonates in the form of limestone, chalk and mart which is a mixture of clay and carbonate. Sources: CVE 310 lecture note by Fagbenro (2008)

2.2 SAND

This is a naturally occurring granular material composed of finely divided rock and mineral particles, its composition is highly variable depending on the local rock sources and conditions but the most common constituent of sand is Silica (S_1O_2) usually in form of quartz.

In the United States, sand is commonly divided into five (5) sub-categories based on size.

These categories are:

Table 2.1: Classifications of Sand

Classes	Diameters
Very fine sand	$^{1}/_{16}$ - $^{1}/_{8}$mm diameter
Fine sand	$^{1}/_{8}$- $^{1}/_{4}$mm diameter
Medium sand	¼-1mm diameter
Coarse sand	½-2mm diameter
Very coarse sand	1mm-2mm diameter

However, in Nigeria, there are two (2) major classification of sand namely;

- Coarse and
- Soft sand Source: CVE foundation engineering Oyenuga (2000)

2.3 MIXTURE DESIGN

Mixture design does not carry the same degree of certainty as structural design. It is more appropriately defined as a process of selecting the type of mixture constituents and their proportions. The intended properties of the mixture are usually assessed by means of a trial batch, and the mixture proportions adjusted where necessary. This type of mixture is a designed mixture. On the other hand for minor projects or where past experience provides adequate information, mixture proportions may be specified. This type of mixture is a prescribed mixture. In small projects, constituents may even be batch by volume using predetermined sizes of volume boxes. However, in general, batching by mass is the common practice, particularly with ready-mixed concrete supply.

The method of mixture design is seldom of concern to civil engineers as proper selection of materials and mixture proportions relies on past experience with the constituents at hand and their performance in mixtures previously produced. However, it is useful to be familiar with the properties of fresh and hardened concrete commonly required and how the selected mixture proportions influence these properties.

2.3.1 The Purpose of Mix Design

From the above definition given on the mix design, it can be seen that the purpose of designing is two-fold. First; to produce a concrete with all the required properties such as minimum strength and durability and secondly, to produce a standard concrete at a minimum cost.

2.3.2 The Concept of Mix Design

In considering the concept of designed and prescribed mix, it is essential to know that in designed mixes, strength is the specified criterion while in prescribed mixes cement content or mix proportions is the specified criterion.

2.4 WATER CONTENT RATIO IN CONCRETE MIX

Besides water content also largely determine the strength & workability of concrete. Greater the amount of water, higher will be the workability of concrete (more fluid). However it reduces the strength of concrete. But if you keep water too low, workability of water will also reduce. Therefore, it will be difficult to place such concrete in the structure. Amount of water required may vary for same volume of concrete for various grades of concrete. Hence, a balance has to be found in the construction site during concrete mixing.

2.4.1 What is the Right Water-Cement Ratio for Mix Design?

A right water-cement ratio for concrete design will influence the compressive strength, permeability and the overall durability of the concrete structure. The idea of w/c ratio is that more the value, greater is the water content in the concrete and the cement paste becomes more dilute and vice versa.

2.4.2 Water-Cement Ratio and Concrete Strength

The overall concrete strength is reduced with the increase in the water-cement ratio. Addition of more water gives dilute paste that has more pores at the micro level. These make the concrete weak and results in cracks and shrinkage issues.

The aggregates and cement particles take the excess water that is present in concrete. This consumption is uncontrollable if a large excess of water is present in the concrete. Hence, separate water channels are created resulting in bleeding on the surface. This creates weak zones in concrete that are susceptible to cracking under service loads.

Relationship between 28th day compressive strength and Water-Cement Ratio as per BIS and ACI Standards.

A lower water-cement ratio can contribute to a high strength and high-quality concrete. But water-cement ratio alone cannot give a good concrete. A good mix proportion and quality aggregates and binding materials contribute to good mix design. A low water- cement ratio is hence one of the factors influencing good mix design.

2.4.3 Water-Cement Ratio and Permeability

A mix design with a lower water-cement ratio or higher cement content will give low permeability concrete. A high strength concrete tends to give a less pervious concrete. This will increase the durability of the concrete structure.

2.5 GRADES OF CONCRETE

Actually, what do we mean by grade of concrete?

Concrete grades are denoted by M10, M20, M30 according to their compressive strength.

The "M" denotes Mix design of concrete followed by the compressive strength number in N/mm2.

"Mix" is the respective ingredient proportions which are Cement: Sand: Aggregate or

Cement: Fine Aggregate: Coarse Aggregate.

If we mention M10 concrete, it means that the concrete has 10N/mm^2 characteristic compressive strength at 28 days.

NOTE: The Minimum grade of concrete for Plain Cement Concrete (PCC) is M15. The Minimum grade of concrete for Reinforced Cement Concrete (RCC) is M20.

As per IS 456:2000, the grades less than M20 should not be used in RCC works

Table 2.2: Concrete Grade and Mix Ratio

Group	Concrete Grade	Mix Ratio	Characteristic Compressive Strength (N/mm2)
Ordinary Concrete	M5	1 : 5 : 10	5
	M7.5	1 : 4 : 8	7.5
	M10	1 : 3 : 6	10
	M15	1 : 2 : 4	15

As per IS 456:2000, the grades less than M20 should not be used in RCC works

Table 2.3: **Concrete Grade and Mix Ratio**

Group	Concrete Grade	Mix Ratio	Characteristic Compressive Strength (N/mm2)
Standard Concrete	M25	1 : 1 : 2	25
	M30	Design Mix	30
	M35	Design Mix	35
	M40	Design Mix	40

As per IS 456:2000, the grades less than M20 should not be used in RCC works

Table2.4

Group	Concrete Grade	Mix Ratio	Characteristic Compressive Strength (N/mm2)
High Strength Concrete	M55	Design Mix	55
	M60	Design Mix	60
	M65	Design Mix	65
	M70	Design Mix	70

CHAPTER THREE

3.0 METHODOLOGY

A scientific research project needs a systematic sequence in which the research work is done, such sequential methods covers material used, process involved and various test carried out. The brief method of executing this project is as follows;

a. Collection and preparation of materials (cement, sharp sand, granite, concrete cube and water)

b. Mix materials in predetermined mix ratio

c. Casting the concrete cube and curing

d. Carrying out the test according to specification requirement

The method that is used in the execution of this project was the practical approach through the physical sourcing, sieving, oiling, processing, mixing of materials and casting the concrete cube models. The concrete cubes are subjected to workability strength test.

The construction materials required for the experiment work of the project are;

- Dangote cement and Bua cement
- Sharp sand
- ½‘‘‘‘ granite
- Water
- Concrete cubes

The following tools were used during the concrete production stage;

- Head pan
- Hand trowel
- Shovel
- Weighing balance
- Compacting factor apparatus
- Sieve

3.1 SOURCING OF MATERIALS

The material cement was purchased from a commercial dealer. The cement meet the requirement of British Standard (Bs 196) which is the code used here in Nigeria. The granite was purchased from Concrete laboratory, Department of Civil Engineering, IOT chapter, Ilorin, Kwara state. The sharp sand is sourced from a drainage system behind Soil Laboratory, Agricultural Engineering Department, IOT chapter, Ilorin.

3.2 PROCESSING OF MATERIALS

The part that are needed in this project are dangote OPC and bua cement, sharp sand, 1/2" granite, water, concrete cubes, head pan, hand trowel, tamping rod and shovel.

The materials were measured in accordance to the concrete mixes predetermined. Mixing is done and the fresh concrete is ensured to be free of lump and casted into the greasy cubes for easier removal of concrete. Compacting was done in 3 layers and the fresh concrete cubes were kept away from reach of sunlight for 24hours before been immersed into water tank for curing. Curing is done for 7, 14, 21 and 28days with 7days interval after which crushing is done.

3.3 LABORATORY TEST

There were various laboratory test carried out on sharp sand and cement used for the composite concrete mix. The test carried out on the sharp sand includes sieve analysis, specific gravity. The tests that were carried out on cement include specific gravity, fineness, hardening and setting time and water absorption moisture content. For the models produced, it includes water absorption weight by unit volume, compressive strength and slump test.

3.4 DETERMINING THE WEIGHT OF THE CONCRETE COMPOSITE

During the course of performing this experiment "batch by weight "method was incorporated. The procedure used in determining the volume of materials to be used is shown below;

$$\frac{X}{1000} + \frac{CEMENT}{GS} + \frac{2SAND}{GS \times 1000} + \frac{4AGGREGATE}{4AGGREGATE \times 1000} = 1m^3$$

Where X = 0.5

Gc = specific gravity of cement = 3.15 Gs = specific gravity of sand = 2.6

Ga = specific gravity of coarse aggregate = 2.5

If the respective values (representing the varying water – cement ratio) of „x" is substituted into the above equation then the weight of needed cement is gotten. Because 150mm x 150mm cube was to be used. Then the result gotten from here is converted from 1m3 to 0.0003375mm3 equivalents. When the value of the cement has been known, it can be used to get the value (weight) of other composite of the concrete for the particular water – cement ratio. This implies;

X = weight of cement in kg

2 sand = weight of fine aggregates in kg

4 aggregate = weight of coarse aggregate in kg

The respective weights gotten from here are just for the production of one cube of concrete. A total number of 12 cubes are needed for the completion of the project. Then the cumulative weight needed will be multiplied by 12. An allowance of 2% was also added to the cumulative.

Since the test is from the 7^{th} through 14^{th}, 21^{st} and 28^{th} day after been cured in water and 2 cubes are needed to be crushed for each mix ratio, then on computation, the total number of cubes needed per „test-day" per day is 6.

For the total number of cubes crushed for the experiment =12 x 3 36 cubes.

During casting, the use of tamping rod was employed to give the cubes maximum compaction. The standard laid down by BS8110 for the use of 150 x 150 150mm cubes was used, 3 – layers and 35-blows for each layer with tamping rod.

On removal from the curing tank, the concrete cubes are drained of the water on their surfaces and left to dry before being weighed to determine its density(s).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

In this chapter various tests conducted on the specimen will be looked into. The present studies aim is to determine the various means of developing concrete strength using different types of cement and mix ratio under compressive strength. The specimen were cured and tested for 7days interval.

Also, the information may be very useful for future study and future development of building materials.

Table 4.1: Sieve analysis of sand

S/N	Sieve size (mm)	Weight of empty sieve (g)	Weight of sieve sample	Weight of sample retained (g)	% retained	Stimulation % retained	% passing
1.	13.2	519	519	0	0	0	100
2.	2.36	269	286	17	17	4.25	95.75
3.	2.00	316	326	10	27	6.75	93.25
4.	0.85	272	314	42	69	17.25	81.75
5.	710	439	567	128	197	49.25	50.75
6.	600	367	436	69	266	66.50	33.50
7.	500	420	449	29	295	73.75	26.25
8.	425	327	329	2	297	74.25	25.75
9.	350	378	437	59	356	89.00	11.00
10.	200	295	317	22	378	94.5	5.50
11.	150	352	371	19	397	99.25	0.75
12.	75	310	312	2	399	99.75	0.25
13.	Pan	287	288	1	400	100.00	0

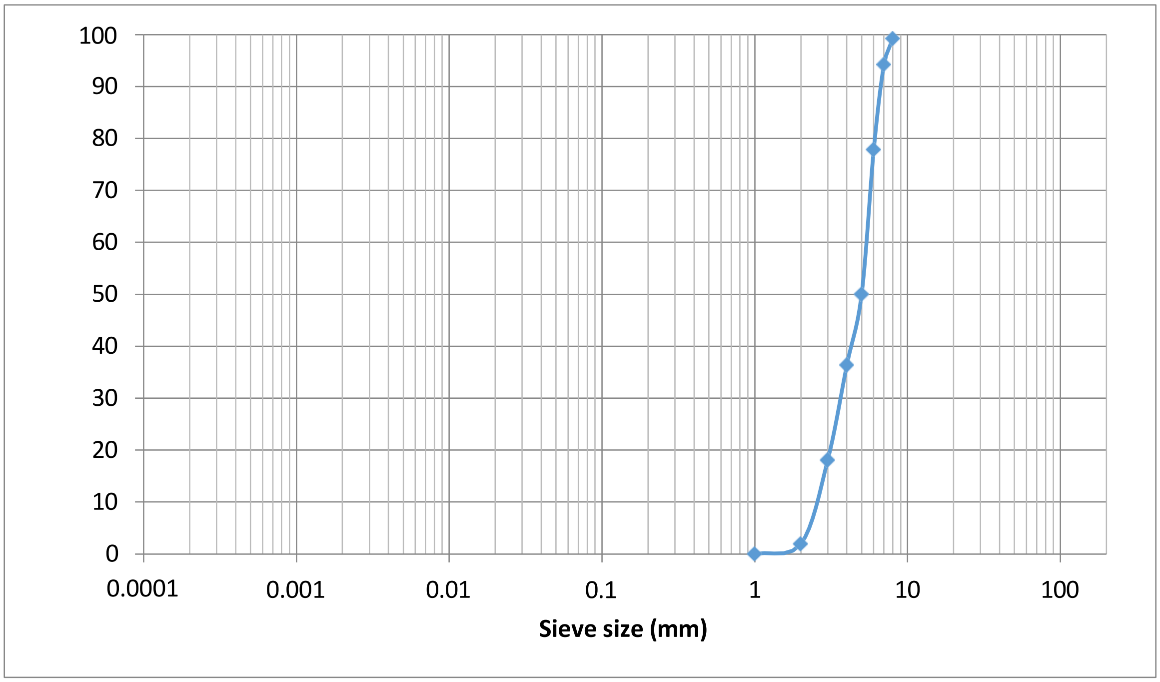

Figure 4.1: Graph of percentage passing against sieve sizes of fine aggregate (sharp sand)

From the graph above it can be deduced that,

Effective size D_{10}=2.7mm

Uniformity Coefficient $C_u=D_{60}\div D_{10}=5.5\div 2.7=2.04$

Coefficient of gradation $C_g= (D_{30})^2 \div (D_{60}xD_{10}) =3.8^2 \div (5.5x2.7) = 0.97$

4.2.1 Specific Gravity of Sand

The average specific gravity of air- dried sample was determined to be 2.54 as detail of result as shown in table 2.2

D = weight of sample

E = weight of cylinder and water fills to certain mark (g)
F = weight of cylinder, sample and water fills to the same level

Table 4.2: Specific gravity of the fine aggregate

Sample	Test 1	Test 2	Test 3	Test 4
		2	3	4
A	130	180	200	100
B	415	354	364	324
C	492	464	485	385
S.G	2.45	2.65	2.53	2.56

$$\text{Average} = \frac{2.45 + 2.65 + 2.53 + 2.56}{4}$$

$$= \frac{10.14}{4}$$

S.G (Average) = 2.54

The sieve analysis of the stone dust used in this project is shown in table 4.2 it conforms to the specification of the ASTM.

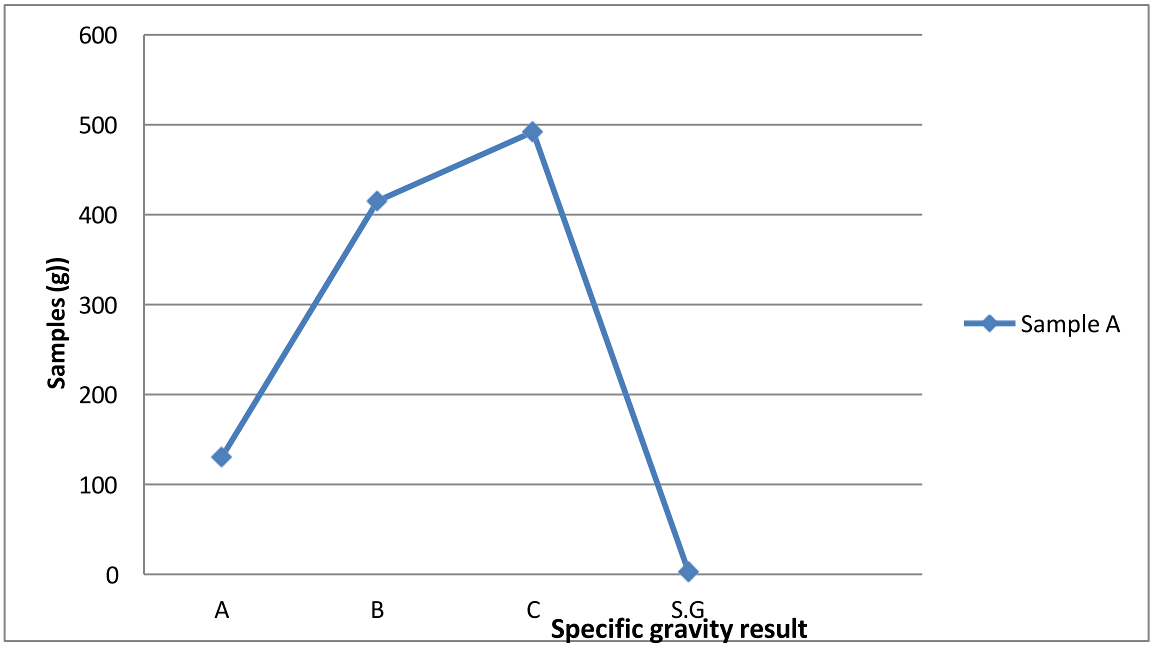

Figure 4.2: Summary of the Specific gravity results of fine aggregate

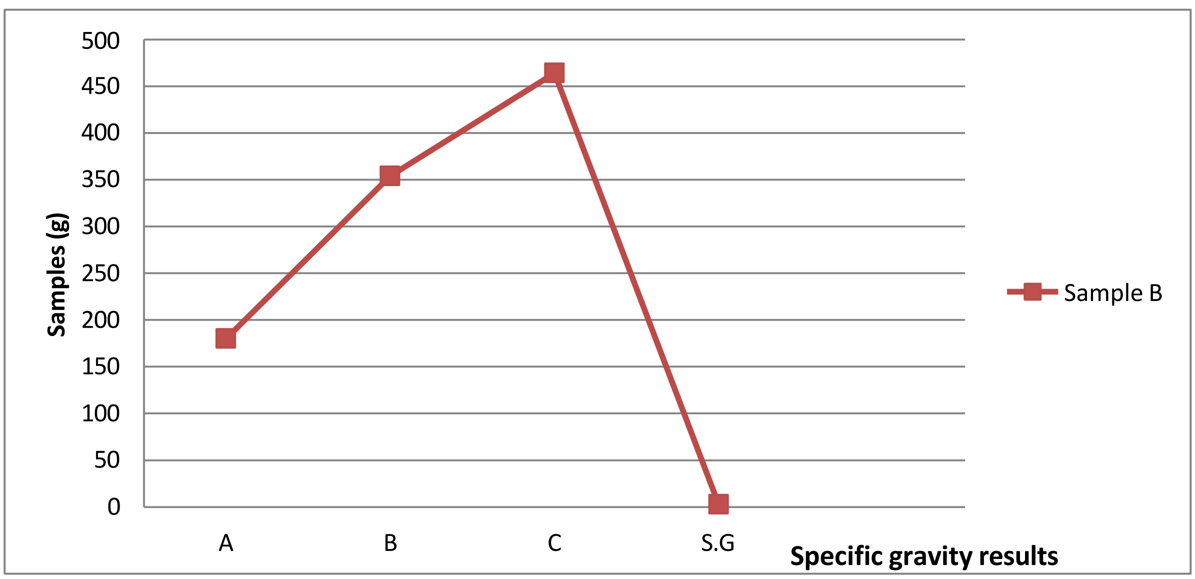

Figure 4.3: Summary of the Specific gravity results of fine aggregate

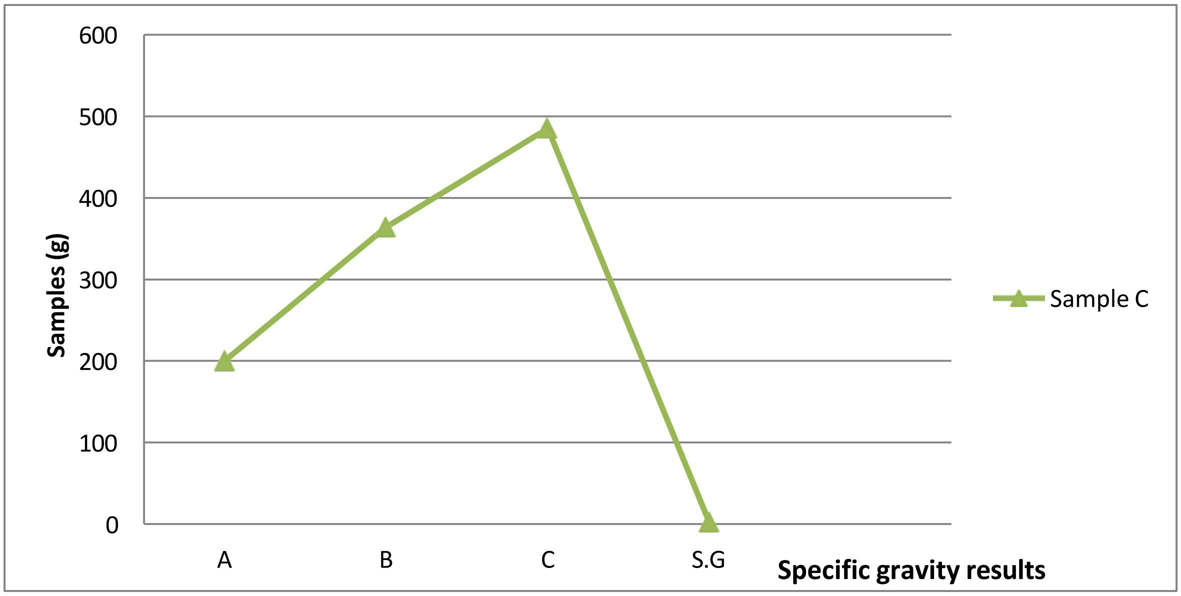

Figure 4.4: Summary of the Specific gravity results of fine aggregate

4.3 GENERAL DISCUSSION

From the table above, it was observed that mix ratio 1:3:6 has the highest average compressive strength 25.0, 25.7, 25.5 and 25.7 respectively for all curing days when Dangote cement was adopted.

Also, from the table above, it was observed that mix ratio 1:3:6 has the highest average compressive strength 20.6, 21.2, 22.6 and 22.6 respectively for all curing days when Bua cement was adopted.

On the other hand, from the slump test table above, the highest average height of slump is 274mm with mix ratio 1:3:6 using Dangote cement.

Also, from the second slump test table, the highest average height of slump is 272mm with mix ratio 1:3:6 using Bua cement.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

It is essential to carry out various test on any materials before making use of its in order to determine its structural properties. This prompted the need to investigate the means of developing strength in concrete by considering cement and the mix proportion.

This project was concluded to develop the strength in concrete with the application of different mix ratio of the concrete composite and different cement.

In all cases, the compressive strength of the concrete increases as the mix proportion increase in the concrete composite.

The two cement at all level of mix ratio maintain economic balance depending on the period under which they are adorpted.

Dangote cement sets and hardened rapidly due to the high quantity of gypsum (a substance which is responsible for the setting and hardening of cement when mixed with water) present in the cement composite.

Dangote cement also shown high compressive strength compare to Bua cement at all level of mix ratio and curing days. Also, less number of crack developments and crack width.

It was observed from the slump test tables that the average height of slump under Dangote cement is low to that of Bua cement at all level of mix proportion.

5.2 RECOMMENDATIONS

Concrete should be made with Dangote cement during rainy season because of its rapid setting and hardening time. Bua cement also proved greater advantage under hot weather because of its high water absorption rate and thus, reduce number of cracks development which may arise as a result of high evaporation due to heat. From the findings in the study, the following are therefore recommended:

i. Nominal mix ratio 1:2:4 provide less compressive strength to that of 1:3:6 and therefore, the later should be used for structure with less imposed loads e.g beams, lintels e t c.

ii. In a mass concrete construction work with few days for construction, Dangote cement with mix ratio 1:3:6 should be used as it set and hardened rapidly to that of Bua cement.

iii. Mix ratio 1:3:6 may lead to segregation which cause weak concrete. Therefore, mix ratio 1:2:4 may provide more strength in concrete because of their less fraction of coarse aggregate in the concrete mix.

Mix ratio 1:2:4 should be used where little or no rendering is planned for because of their less roughage at the outer layer of the concrete.

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