THE EFFECTS OF VARYING FINE-AGGREGATES SOURCES ON WORKABILITY AND STRENGTH OF LOW STRENGTH CONCRETE

BY

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DEDICATION

I dedicate this work to almighty God my creator, the pillar of all knowledge and understanding, for encouraging, leading and inspiring me all through this research work. I also in a special way dedicate this work to my parents, Mr. and Mrs. Waribugo , for their enormous support and assistance all through my research work. Thank you all and God bless you.

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TABLE OF CONTENTS

ABSTRACT

Fine aggregates used in concreting works posses different properties, thus affecting concrete quality and durability.. However, it was observed from previous literatures that these properties variation could adversely affect the performance of freshly mixed and hardened concrete, in terms of workability and strength. The aim of this study was to access the properties of fine-aggregates sold at different locations in the Benin city by investigating their performance on concrete in both the fresh and hardened state.

Concreting materials were procured from four different locations in Edo state namely; Okwae, Okun, Idugbo and Ovia areas of Edo state. Samples are to be labelled according to their locations. Experimental investigations were carried out to approved standards to produce fresh and hardened concrete. Slump and compressive tests was performed on all samples from the four different vendors at the end of 7, 14 and 28days respectively.

Concrete prepared with constituents from the Okwae area, yielded favorable slump of 60.82mm and compressive strength of 13.72N/mm^2 , thus proving its application in lightweight concreting works. However, concreting constituents from the Ovia area yielded slump value of 71mm and compressive strength of 11.92N/mm^2 , proving its viability for use in plain concreting where strength is not the prevailing requirement. Concreting constituents from Idugbo and Okun yielded unfavourable values.

The variations in the properties of concrete for all four vendors has no adverse effects on mix design calculations, only if the concrete would be used in light weight application. To ensure safety and economy in reinforced concrete construction, adequate quality control measures should be applied.

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

RCC……………….. Reinforced concrete cement

VS…………………..Vendor – Sample

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Concrete is a heterogenous mixture of cement, fine aggregates, well-graded coarse aggregates and water. Over the years cement and rock stones have been used in construction of civil structures to meet safety, durability and economy requirements. Concrete may either be in fresh or hardened state, with the latter being more favorable for structural applications. Concrete, on like steel and wood, experiences gradual strength gains on with time ,in presence of water(curing) to prevent excessive evaporation of embedded moisture into the atmosphere in conditions of hot climate. The most widely used material on earth, water, sand, and cement are the ingredients of concrete. Concrete's binding component, cement, provides the material's compressive strength. Tiny angular or spherical silica grains make up the fine aggregate. By plugging gaps in the coarse aggregate, it reduces shrinkage fractures in concrete.

The majority of a concrete mixture is composed of fine and coarse particles. The most common materials used for this are crushed stone, sand, and natural gravel. While a variety of manufactured aggregates, such as air-cooled blast furnace slag and bottom ash, are also allowed, recycled aggregates—derived from construction, demolition, and excavation waste—are increasingly being utilized as partial substitutes for natural aggregates (Crow et al., 2008*)*.The amount of binder needed is determined on the aggregate's size distribution. The largest gaps are seen in aggregate with a relatively equal size distribution; these gaps are often filled by adding aggregate with smaller particles. The binder, which is usually the most expensive component, is required to both paste the aggregate surfaces together and fill the spaces between the aggregate. Consequently, fluctuations in aggregate sizes lowers the price of concrete (Crow and Mitchell, 2008).The use of aggregate does not adversely affect the strength of the concrete because it is almost usually stronger than the binder. Vibration's influence frequently results in non-homogeneity when aggregates are redistributed following compaction. Gradients in strength may result from this(Zongjin , 2011). A decorative "exposed aggregate" finish, which is well-liked by landscape designers, can be achieved by occasionally adding attractive stones to the surface of concrete, such as quartzite, tiny river stones, or crushed glass.

1.2 Statement of the problem

Fine aggregates used in concreting works posses different specific gravity and water absorption property, thus affecting the calculation of concrete mix proportions and concrete quality. Thus, the extent of these variations needs to be measured to obtain tolerable limits and also access the quality of fine aggregates been sold at different locations. However, it has been observed from previous literatures that these properties variation could adversely affect the performance of freshly mixed and hardened concrete, in terms of workability and strength.

1.3 Aim and Objectives

The aim of this study is to access the properties of fine-aggregates sold at different locations in the Benin city by investigating their performance on concrete in both the fresh and hardened state.

The objectives of this study are to;

a. carry out slump test on concrete made with fine aggregates from different locations in Benin city.

b. test the compressive strength of concrete made with fine-aggregates from different locations.

c. obtain the degree of variation in concrete properties using statistical methods and comparig results with standard values

1.4 Scope of the study

This study would be focused on investing the effects of using fine aggregates procured from different Locations in Edo state, namely; Okwae, Okun, Idugbo and Ovia areas of Benin city, Edo state. The effects of this variations on the properties of fresh and hardened concrete of grade 15 would also be accessed. To archive this aim;

a. Investigations of the workability and compressive strength of the concrete that will be carried out.

b. Comparative analysis of test results would be carried out on compressive strength values, slump test values, values obtained from the experiment and compared with those of the British standard.

c. Comparing of result with standard values.

1.5 Justification of the study

As previously stated, this study would better inform the construction industry in Edo state on the effects of varying fine aggregate in concrete production and better suggest suitable locations having fine aggregates that meet standard requirements.

CHAPTER TWO

LITERATURE REVIEW

2.0 Review Of Past Works

2.0.1 Glass powder and Coconut shell concrete

The effects of glass powder and coconut shell on the characteristics of concrete were investigated in this study (Kumar, 2017). The concrete mix utilized was of M25 grade. Glass powder and coconut shell are substituted for the fine aggregate at 0%,5%,10%, and 20% of the original amount. 15 x 15 x 15 cm cubes were utilized to test the sample's compressive strength. The impact of incorporating glass powder and coconut into concrete was examined in accordance with Indian standard specifications, with a focus on the material's workability and strength characteristics. The materials used to prepare the concrete were tested before being used. The writers claim that adding coconut shell to concrete makes it easier to deal with. When using coconut shells as aggregate in the production of concrete, the quantity of cement may exceed that which would occur from using regular aggregate concrete. Because more strength can be obtained with less mixing, it has been found that glass powder and coconut shell can be utilized to create construction blocks more affordably than standard concrete blocks.

2.0.2 Plastic waste concrete

The characteristics of green concrete, which uses plastic waste as aggregate, are the subject of experimental investigation in the paper (Arivalagan,2019). To enhance the mechanical qualities of green concrete, the study focused mainly on recycling discarded metal parts and producing green concrete. With a water-to-cement ratio of 0.45, 10%, 20%, and 30% of the waste were substituted with 10%, 20%, and 30% of coarse aggregate, respectively, to generate green concrete. The concrete samples were contrasted with regular concrete. The results show that adding concrete waste can boost concrete's strength by as much as 20%. It has been concluded as a result that the garbage could be used as an alternative to building materials. In order to receive a workability rating, all Trail mixes are required by IS: 10262:2009 to have a water-to-cement ratio of 0.45. When 20% of the coarse particles in waste concrete are replaced, the compressive strength increases to 18%. The low adhesive strength of plastic garbage is the reason. Trail mixes are required by IS: 10262:2009 to have a water-to-cement ratio of 0.45. When 20% of the coarse particles in waste concrete are replaced, the compressive strength increases to 18%. The low adhesive strength of plastic garbage is the reason.

2.0.3 Babagasse ash concrete

The study looked into the usage of bagasse ash as a partial replacement for fine particles in concrete. In concrete, untreated bagasse ash is generally replaced with fine aggregates in the following volumes: 0%, 10%, 20%, 30%, and 40%. In addition to compressive, tensile, and sorptivity tests on hardened concrete, compaction factor and slump cone tests were performed on fresh concrete (Modania and Vyawah, 2012). Portland cement (grade 53) was used in this experiment. Crushed stone up to 16 mm in size was used to make coarse aggregate, while locally accessible natural sand up to 4.75 mm in size was used to make fine aggregate. Aggregates, both fine and coarse, are authorized in accordance with Indian Standard IS: 3831970. The following findings were observed: 1) There was more compressive strength in comparison to 0% sugarcane bagasse replacement, with 10% substitution. 2) The compressive strength and characteristics of fresh concrete alter as the percentage of sugar cane babasse ash (SCBA) increases. 3) The pozzolanic qualities of SCBA cause the strength of the SCBA combinations to increase more quickly in the days that follow. 4) The tensile strength of mixtures reduced as the SCBA replacement increased, according to an analysis of the tensile strength of concrete. 5) The sorptivity coefficient rises with increasing SCBA percentage and falls with increasing concrete compressive strength. 6) Untreated bagasse ash can effectively replace the fine aggregate percentage (10–20%) without compromising strength or processability. The compressive strength of blends including 10% and 20% gas ash rises later (28 days) than it does after 7 days, which may be related to the pozzolanic qualities of bagasse (reviewed in). Based on these results, the authors concluded that bagasse ash can be used as a component of concrete since it is a good substitute for fine aggregates and cement.

2.0.4 Bottom Ash concrete

The article (Kumar, 2018) discusses an experimental investigation that used bottom ash to partially replace fine particles in cement concrete. Ash is a commonly generated solid waste by power plants, resulting from the combustion of pulverized coal. This study looked into the possibility of using clinker as a substitute for a certain type of fine aggregate. Tests have been conducted to determine whether bottom ash may partially replace fine aggregates in order to alleviate the disposal issue. The samples' compressive, tensile, and flexural strengths were assessed after fine aggregate replaced up to 50% of the bottom ash. The fractional tensile strength of 10% clinker + 90% fine aggregate rose by 9.4% after 7 and 28 days of curing. and 10.5%, in relation to the specified concrete mix, respectively. Good flexural strength is achieved when clinker is used in place of fine aggregate in concrete. In comparison to the nominal concrete mix, the flexural strength of 10% bottom ash concrete increased by 69.2% and 8.2%, respectively, after 7 and 28 days of curing. It has been demonstrated that substantial design blending in concrete can be accomplished by using 10% clinker as a replacement to fine aggregate.

2.0.5 Stone rubble concrete

A thorough analysis of the partial replacement of fine aggregates with stone rubble is presented in article (Kumar and Saravannah, 2018). This study's primary goal is to determine whether stone dust may be utilized in concrete in place of fine aggregates. Five replacement levels were contrasted with the control mixture: 5%, 10%, 15%, and 20%. Throughout the project, Portland cement of grade 53 was utilized plain. The stones were utilized as a fine aggregate in concrete after being pulverized into a coarse powder. The Indian Standard for control concrete (IS 10262: 1982) served as the basis for the proposed concrete mix design. The used grade was M20. Stone powder was used to substitute sand in concrete at ratios of5%,10%,15%, and 20%. The rubble concrete's compressive strength with 5%, 10%, After 7, 14, and 28 days of curing, 15% and 20% substitution of fine aggregate was compared to conventional/natural concrete. The best replacement of fine aggregate with crushed stone rubble was 10% of the fine aggregate, as compared to the corresponding conventional strength of concrete. Because the created product eats the broken bricks, it keeps the debris from stagnating, making it an environmentally friendly concrete. Furthermore, the percentage of cost savings rises with the complexity of the mixture design.

2.0.6 Crushed Claystone aggregates concrete

The study also produces lightweight aggregate concrete with adequate strength by using crushed claystone aggregates (CCB) from broken brick fragments (Noaman et al., 2020). In percentages of 10%, 20%, and 30%, CCB has taken the place of the aggregates. In every mixture, CCB aggregate was utilized in its dry form (prewet). Examinations have been done on workability, density, water absorption, and compressive strength. The following are a few of the observations: 1) It was discovered that the depreciation decreased when CCB was used in place of fine or coarse additives. Red brick aggregate blends provide a higher reduction in sagging when compared to yellow brick aggregate mixes. Because red brick aggregate has a high porosity and water absorption, it uses more SP. 2) include CCB aggregates in every batch of concrete caused the density to decrease. A combined effect was observed when all of the coarse aggregate in the mixes was replaced with fine brick aggregate. Substitution of fine particles at low to moderate ratios has less of an impact than substitution of coarse aggregates. 3) The stone granulates' greater propensity to absorb water was a result of their dry state. The red brick aggregate has a higher potential to absorb water than the yellow brick aggregate. 4) The strength of the concrete is decreased when CCB is added. The compressive strength of aggregate concrete was compared to regular concrete after 28 days. Red brick material was used as fine aggregate in concrete, which further reduced its compressive strength. 5) Creation of a functional, portable, Complete replacement of coarse aggregates may be necessary when using a compression-resistant CCB aggregate mixture for structural constructions.

2.0.7 Demolition debris concrete

Paper discusses the experimental research of high-performance concrete with partial replacement of fine particles by demolition debris (Arasu et al., 2018). Demolition debris is produced during the building, remodeling, repair, and demolition of homes, large buildings, and other structures. The results of the investigation showed that replacing fine aggregate with discarded rubbish increased flexural strength by 6.25%, compressive strength by 5.5%, and flexural strength by 9%. Ordinary Portland cement (grade 53) and single density cement were used to cast each sample. For all samples, fine aggregate that had passed through a 4.75 mm IS sieve and was advised by IS: 3831970 was utilized. According to IS: 3831970, all samples were collected and processed, with coarse aggregates going through a 20 mm sieve and the remainder going through a 12.5 mm sieve. According to Casting and curing of the samples were done using drinking water (IS 456:2000). The writers noted that the trash from construction and demolition (C&D) had strong water absorption qualities and was finely granular. The more C&D waste that is utilized to replace concrete, the less workable it becomes. After some time, the strength values of concrete mixes with up to 20% C and D waste were comparatively near to the crushed concrete (CC) strength value. At 28 days of age, the compressive strength of concrete mixes made from construction and demolition waste and recovered building and demolition waste of 20% and 30% decreased less than that of CC by only 2.03% and 5.7%, respectively. In addition, compared to CC, the inclusion of C&D waste decreased porosity, voids, and water absorption.

2.0.8 Jute Fibre concrete

The article (Viktar et al., 2017) looked at an experimental investigation using jute fiber to determine the best way to substitute natural sand with artificial sand. Around the world, the construction sector uses a lot of concrete. Natural sand, cement, coarse aggregates, and water are the ingredients used to make traditional concrete in India. If concrete has the necessary strength and reinforcement is added with fibers like jute, it will work. Because of its excellent performance, low cost, high availability, and environmental friendliness, jute fiber was utilized in the study's concrete. It was swapped out for 3%, 4%, and 5% of the volume of cement in total. The M30 concrete was ready. Jute fiber was substituted for the extra cementing materials at a ratio of roughly 3%, 4%, and 5%. through cement. Cement was subjected to strength and tightness tests, as well as initial and final set times. Natural black sand that was easily accessible in the area was used for the investigation. Tests for split, flexural, and compression strength were conducted. It has been discovered that the strength of concrete rises with the percentage of fibers in the concrete. After 28 days, the strength of concrete cubes with 5% replacement gradually grew until it reached the allowable limit. At first, the strength exhibited little long-term durability.

2.0.9 Marble powder concrete

A report (Yadav et al., 2015) examined concrete that used *leftover* marble powder to replace some of the sand. Marble waste, also known as marble saw powder, marble slurry, or marble slurry, is a common result of the production of marble. The primary objective of the research was to investigate the possibility of using leftover marble powder in concrete as a partial replacement for fine aggregates. This concrete was made in four different proportions (10%, 20%, 30%, and 40%) with marble powder serving as a partial substitution for fine aggregates (sand). The concrete was then examined after seven, twenty-eight, and ninety days of curing. This study examined the compressive strengths of Portland cement pozzolan (ACC), a type of typical concrete, with a specific gravity of 3.10. To partially swap out the Marble powder was used to create fine particles in the concrete; it has a density of 2.58%. The coarse aggregate, which had gone through a 20 mm filter, was kept on a 10 mm screen with a density of 3.0. As per IS: 383-1970 Zone II, excellent grade river sand with a fineness modulus of 2.72 and a density of 2.64 was utilized as fine aggregate. Through a series of concrete experiments, the strength characteristics of concrete with and without waste marble powder as fine aggregate—which was employed in varied amounts to replace sand—were ascertained. The following conclusions were reached by the authors: When the proportion of waste marble powder was raised to 20%, the concrete's compressive strength increased; nevertheless, when the percentage of waste marble When the powder was added even more, the concrete's compressive strength decreased.

2.1 Gaps to be filled

Lacking from previous literatures are;

a. Accessing the effects of varying fine-aggregates on the workability and strength of concrete.
b. Measuring the degree of variance of strength and slump values of varied fine aggregates concrete using statistical method.

2.2 Concrete

A matrix of cementitious binder (usually Portland cement paste or asphalt) and a dispersed phase or "filler" of aggregate (usually a rocky substance, loose stones, and sand) combine to form concrete, an artificial composite material. To create a synthetic conglomerate, the binder "glues" the filler together (Gagg, 2014). Depending on the binders and aggregate types utilized to meet the engineered material's intended usage, a wide variety of concrete kinds are available. These factors establish the final product's strength, density, and resistance to heat and chemicals. The most common type of concrete binder is cement paste, which is typically composed of Portland cement. When water is added to dry cement powder and aggregate for cementitious binders, a semi-liquid slurry (paste) is created that can be formed; usually, this involves pouring it into a mold. Hydration is the chemical process that gives concrete its hardness and solidification. The cement and water react, binding the other ingredients to form a strong, stone-like substance. Sometimes additional cementitious materials are added to the concrete, either directly as a component or pre-blended with the cement to form the aggregate binder(Gagg, 2014). Examples of these ingredients are fly ash and slag cement.Slag and fly ash can improve the durability and freshness of concrete, among other qualities. As an alternative, various materials can also be utilized as a concrete binder. Asphalt is the most widely used material substitution for asphalt concrete.

2.2.1 Curing

For concrete to cure with the best strength and durability, it must be maintained moist. Hydration happens during curing, which promotes the formation of calcium-silicate hydrate (C-S-H). The final strength of a mix is usually obtained in less than four weeks, with the remaining 10% taking years or even decades to reach(Gagg, 2014). Over several decades, the concrete's calcium hydroxide is transformed into calcium carbonate through the absorption of CO2, strengthening the material and increasing its resistance to damage. However, the cement pore solution's pH is lowered by this carbonation process, which may erode the reinforcing bars. The first three days are crucial for concrete to hydrate and harden. When elements such wind evaporation during placement cause abnormally rapid drying and shrinking, it might result in higher shrinkage cracking due to increasing tensile strains at a period when it hasn't yet developed enough strength. If the concrete is maintained moist during the curing process, its early strength might be boosted. Reducing tension before curing reduces the likelihood of cracking. High-early-strength concrete is made to hydrate more quickly, usually by using more cement, which causes it to shrink and crack more easily. For up to three years, the strength of concrete fluctuates (Gagg, 2014). It is dependent upon both the conditions of structure exploitation and the elements' cross-sectional dimension.(70) Short-cut polymer fibers can be added to ameliorate (lower) curing-induced stresses caused by shrinkage and to increase ultimate and early compression strength. When concrete is properly cured, it becomes stronger, has less permeability, and doesn't crack where the surface dries out too soon. Care needs to also be taken to prevent freezing or overheating because cement sets exothermically. Scaling, decreased strength, poor abrasion resistance, and cracking might result from improper curing(Gagg, 2014).

2.2.2 Curing methods that prevent evaporation of water

Concrete should preferably be kept at a controlled temperature and humidity during the curing time. Concrete slabs are frequently sprayed with "curing compounds" to form a water-retaining layer on top of the concrete and guarantee complete hydration during the curing process. Films often consist of wax or similar hydrophobic substances(Gagg,. 2014). The coating is let to wear away from the concrete with regular use once the concrete has adequately dried. Conventional curing conditions call for ponding or spraying water on the concrete surface. One method to accomplish this is by ponding, which involves immersing setting concrete in To avoid dehydration, cover in plastic and drink water. Wet burlap and covering the fresh concrete with plastic sheets are two more popular curing techniques. Concrete may be treated with rapid curing methods for applications requiring greater strength. One popular method is to use steam to heat the poured concrete; this keeps the concrete moist and increases the temperature, which speeds up and deepens the hydration process(Gagg, 2014).

2.3 Factors affecting the compressive strength of concrete

The water-cementitious ratio (w/cm), the components used in the design, and the techniques used for mixing, placing, and curing all affect the final strength of concrete. Concrete with a lower water-to-cement (cementitious) ratio is stronger than concrete with a higher ratio, all other variables being equal. The overall amount of cementitious ingredients, such as pozzolans, slag cement, and Portland cement, can have an impact on density, abrasion resistance, shrinkage, water demand, and strength. Whether a concrete has enough compressive strength or not, it will all crack. In reality, because of the higher hydration rate, combinations with a high Portland cement concentration may fracture more easily. Concrete shrinks during the process of changing from a plastic to a solid state by hydration. Plastic shrinkage cracks may appear shortly after installation; however, if the rate of evaporation is high, they frequently do in fact happen during finishing procedures, as on a breezy or hot day(ACI , 2008).A summarized list of these factors are:

a) Compaction
b) Curing
c) Water cement ratio
d) Cement types used
e) Aggregate proportion
f) Loading duration
g) Water
h) Aggregate type used
i) Concrete mix
j) Inadequate curing of concrete
k) Moisture content
l) Size of aggregate
m) Temperature
n) Compressive strength
o) Durability of concrete

p) Moisture content during cube tests

q) Relative humidity

r) Age of curing

s) Age of concrete

t) Compression machine and operation factors

u) Degree of lateral restraint

v) Loading direction

w) Moulding temperature

x) Quality of materials

2.4 Workability of fresh concrete

The consistency of freshly mixed concrete is measured using the concrete slump test before it hardens. The purpose of the test is to determine if freshly mixed concrete is workable and, consequently, how easily it flows. It can also serve as a sign that a batch was not properly mixed. The test's popularity can be attributed to its straightforward methodology and basic equipment. Under field conditions, the slump test is used to guarantee homogeneity for various loads of concrete, (Gambhir, 2004).For concrete that is too fluid (non-workable) to be assessed using the usual slump test, an alternative test called the flow table, or slump-flow test, is employed since the concrete will not hold its shape once the cone is withdrawn(Gambhir, 2004).

Fig 2.1 Slump test description(Gambhir, 2004)

The test is conducted using a metal mold that resembles a conical frustum with handles at tached. This type of mold is called an Abrams cone or droop cone and is open at both end s.The tool's standard dimensions are 305 millimeters (12.0 in) in height, 200 millimeters (7.9 in) at the bottom, and 100 millimeters (3.9 in) at the top.On a hard, nonabsorbent sur face, the cone is set.Three steps are involved in filling this cone with new concrete.A 2 ft (600 mm) bulletnosed metal rod with a diameter of 5/8 in (16 mm) is used to tamp each l ayer 25 times.The concrete is struck off flush with the top of the third layer.Upon completion of the third phase, the concrete is removed flush with the top surface of the cone(Gambhir, 2004).

Slumped concrete can take on a variety of forms, and it can be classified as true, shear, or collapse slump depending on its profile. A new sample should be obtained and the test should be performed if a shear or collapse slump is attained. In the test, only a true slump is useful. In general, a collapsing slump indicates that the mix is either excessively moist or highly workable, in which case the slump test is inappropriate. Very dry mixes with slump of 0 to 25 mm are usually used for building roads or pavements; low workability mixes with slump of 10 to 40 mm are usually used for light reinforcing foundations; and medium workability mixes with slump of 50 to 90 mm are usually utilized for regular reinforced concrete that is highly workable and vibrates when laid. When the concrete needs to flow a long way and the reinforcing has tight spacing, it is usually utilized with slump more than 100 mm (Gambhir, 2004).Factors affecting the workability of freshly poured concrete are:

a) Water Content.
b) Mix Proportions.
c) Size of Aggregates.
d) Shape of Aggregates.
e) Grading of Aggregates.
f) Surface Texture of Aggregates.
g) Use of Admixtures.
h) Use of Supplementary Cementitious Materials.

CHAPTER THREE

MATERIALS AND METHODOLOGY

3.0 Materials

Materials used in this investigation include concreting materials e.g Cement, Coarse aggregates (Gravel), Fine aggregates(Sharp sand), and Water.

Cement

Ordinary Portland Cement (OPC) of grade 45 was utilized in this study. The cement was bought at Ring road area in Benin city, Edo state.

Coarse Aggregate (Gravel)

Crushed 10mm gravels was purchased from a building materials vendor in Benin city, Edo state. The aggregates were devoid of clay, loam, mud, and organic matter and was strong, clean, and sharp.

Fine aggregates (Sharp sand)

Fine aggregate was purchased from Okwae, Okun Idugbo and Ovia vendors. To lessen the amount of moisture it contained, it was allowed to air dry for 3 days. Along with being devoid of clay, loam, filth, and organic matter, the sand also met BS EN 12620 (2008) standards for cleanliness and sharpness.

Water

Tap water was used for mixing and curing of the concrete in the civil engineering laboratory, University of Benin. The physical analysis of the water demonstrates that it was pure, devoid of contaminants, and suitable for consumption as advised by the standard. BS EN 1008 (2002).

3.1 Tools and Equipment

During the course of this experiment, the below listed tools and equipment was utilized. Head pans, Shovels, Hand towels, Painting bush, Marine boards e.t.c.

Equipment and machinery to be used in carrying out study are;

1) The digital weighting balance
2) The concrete mixing machine
3) The electronic vibrator
4) The slump test set-up
5) Curing basin
6) Compression testing machine

3.2 Methodology

Experimental research is a research strategy that examines the result of an experiment in conjunction with the expected results and the relationship between the factors compared and contrasted against expected outcomes (Saunders et al. 2007). Experiments to be performed would be targeted measuring the degree of variation between compressive strength values and slump values of concrete made from fine aggregates obtained from different locations.

A brief overview of the experimental procedures to be employed in carrying out this experiment is given below in flow chart form in fig 3.1.

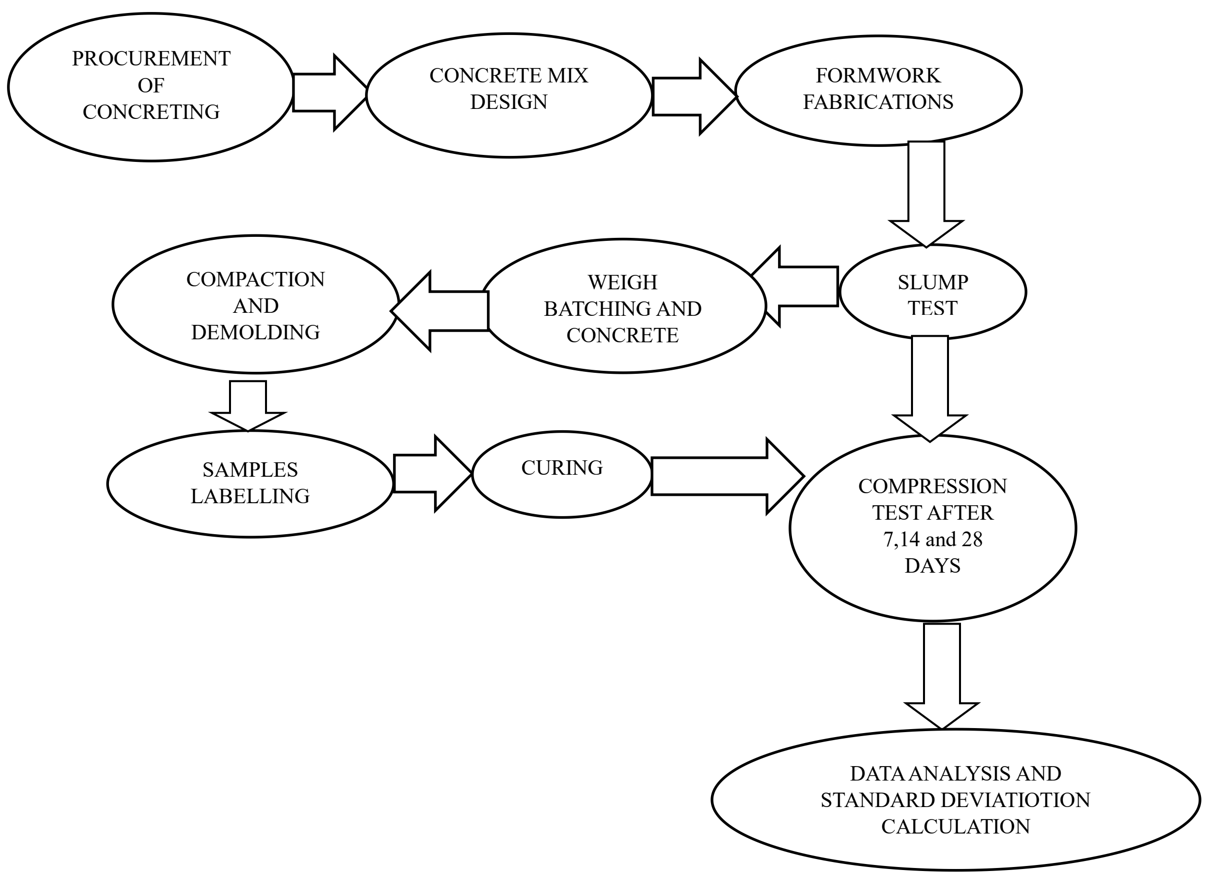


Fig 3.1: Experimental procedures flow chart

As previously displayed on the flow chart of figure 3.1, The steps in executing this experiment are described below;

3.2.1 Procurement Of Concreting And Formwork Materials

Cement, fine aggregates and gravel was purchased from vendors from at Okwae, Ovia, Okun and Idugbo in Benin city, Edo state. Water was gotten from the laboratory. Formwork materials will also be purchased prior to fabrication. Marine board was the best suit to give the cast cubes a smooth surface finish.

3.2.2 Concrete Mix Design

Concrete mix design was done using the traditional method to obtain quantities of concrete constituents. Concrete grade to be used and number of cubes to be cast are to be determined.

3.2.3 Formwork Fabrication And Preparatory Works

Formworks was fabricated to take the shape and size of the concrete cubes to be cast, ensuring vertical and horizontal alignments. Their interior wasl also lubricated to ensure ease of demolding.

3.2.4 Weight Batching Of Concreting Constituents

Accurate quantities of concrete constituents was measured using the digital weighing balance.

3.2.5 Concrete Mixing

The concrete mixer in the laboratory was used to perform dry mixing concrete constituents, while required water quantities was added after achieving a homogeneous mixture. Mixing was done until a uniform texture was observed. However, for slump test , concrete mixing was done on a flat metallic surface.

3.2.6 Slump Test

The consistency of freshly laid concrete can be evaluated using the slump test. In an indirect way, it's utilized to verify that the right amount of water has been added to the mixture. According to BS EN 12350-2, Testing Fresh Concrete, the test is conducted(Concrete Society, 2018). Slump apparatus were prepared on standby prior to concrete mixing. Concrete mixed from fine aggregates gotten from different locations was cast into the slump cone. Slump values were recorded for all concrete samples.

Apparatus

The tools used for carrying out slump test where;

1. The Metal base plate
2. The measuring tape/Meter rule
3. Tamping rod
4. Slump cone

Procedures

1. Oil was applied after cleaning the mold's interior surface.
2. Mold was positioned onto a non-porous, smooth, horizontal base plate.
3. The prepared concrete mix was poured into the mold in four roughly equal thicknesses.
4. Using the rounded end of the tamping rod, uniformly tamp each layer across the mold's cross area with 25 strokes. Tamping was done down till the underlying layer for the layers that follow.

5. Using a trowel, extra concrete was removed and the surface levelled.
6. Excess mortar that may have caused water to seep between the base plate and the mold was removed.
7. Mold was lifted out of the concrete as soon as possible, carefully, and vertically.
8. Slump was calculated by subtracting the mold's height from the concrete fall height.

Casting

Freshly mixed concrete was casted into formworks of size 150mmX150mmX150mm to fill up all cubes.

Compaction

The tamping rod was used to compact the cast concrete 25 times per layer to remove voids and prevent volume shrinkage.

Demolding

The formworks of all concrete samples were removed after 24hours to prepare for labelling and curing.

Labelling Of Samples

All samples was labelled according to their fine aggregates location.

Curing

All concrete samples was immersed into the curing basin at room temperature to prevent water loss due to evaporation which might affect the targeted strength gain. Concrete samples from different locations were kept at different layers in the curing basin for easy identification.

Compression Test

The compression testing machine was used to obtain the compressive strengths of all concrete samples labelled according to their locations at the end of 7,14 and 28 days.

Procedures

1. Concrete samples was removed from the water after required curing time and excess water was cleaned from the concrete top surface.
2. Concrete sample dimensions were measured to the closest 0.2 meters.
3. The testing machine's bearing surface was cleaned.
4. Concrete sample inserted into the machine, while the load was applied to the cube opposite sides.
5. Concrete samples was placed at the center of the machine's base plate.
6. The wheel was gently turned by hand until it makes contact with the concrete sample's top surface.
7. Load was applied steadily and without interruption at a rate of 140 kg/cm2/minute until the concrete cube failed.
8. Maximum load values was noted and any peculiarities in the failure type.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Results

The results from the experimental investigation in both numerical and visual forms are given in this chapter and at the appendix section. Recorded values for both slump and compressive strength are given in tabulated form. Slump values were recorded at the occurrence of fresh concrete collapse for fine aggregates from different vendors. Compressive strength values were recorded at the end of 7, 14 and 28 days for 10 samples each from all four different vendors.

4.0.1 Slump test results

Recorded slump values and their averages are presented in both tabulated form and visual displays. Average slump values and were however calculated at the appendix section. Tables 4.1, 4.2, 4.3, 4.4 shows the results of recorded slump values of all 40 samples (i.e. 10 each for all four vendors). Related parameters also recorded were the cube size, concrete grades, mix ratio, water cement ratio etc. with their respective units.

The pictorial representation of concrete collapse is shown in the appendix section of this work. The tabulated results are shown on the next page.

Table 4.1: Slump test results for first vendor (Okwae)

S/N	Sample	Slump (mm)	Concrete Grade (N/mm^2)	Mix ratio	W/C ratio
1	V1S1	52	15.00	1:2:4	0.6
2	V1S2	73	15.00	1:2:4	0.6
3	V1S3	56.5	15.00	1:2:4	0.6
4	V1S4	67.5	15.00	1:2:4	0.6
5	V1S5	55	15.00	1:2:4	0.6
6	V1S6	65.8	15.00	1:2:4	0.6
7	V1S7	56	15.00	1:2:4	0.6
8	V1S8	46.4	15.00	1:2:4	0.6
9	V1S9	75.2	15.00	1:2:4	0.6
10	V1S10	60.8	15.00	1:2:4	0.6

(Author, 2024)

Average slump value = **60.82mm**

Table 4.1 shows the average slump of freshly mixed concrete for the first vendor at Okwae area, for the same concrete grade, mix ratio and water cement ratio. Samples were labelled V1S1, V1S2, …etc. meaning, vendor 1-sample 1,vendor 2- sample 2, and so on. Values recorded were irregular which may be due to constituent materials variations , room temperatures, water evaporation rate, etc. However, an average slump value of approximately 61mm was obtained.

Table 4.2: Slump test results for second vendor (Ovia)

S/N	Sample	Slump (mm)	Concrete Grade (N/mm^2)	Mix ratio	W/C ratio
1	V2S1	72.5	15.00	1:2:4	0.6
2	V2S2	68.3	15.00	1:2:4	0.6
3	V2S3	66.55	15.00	1:2:4	0.6
4	V2S4	85.5	15.00	1:2:4	0.6
5	V2S5	60.2	15.00	1:2:4	0.6
6	V2S6	87.9	15.00	1:2:4	0.6
7	V2S7	60.87	15.00	1:2:4	0.6
8	V2S8	76.4	15.00	1:2:4	0.6
9	V2S9	73.2	15.00	1:2:4	0.6
10	V2S10	59.3	15.00	1:2:4	0.6

(Author, 2024)

Average slump value = **71.02mm**

Table 4.2 shows values for the second vendor at Ovia , for the same mix ratio, water cement ratio and concrete grade. Samples were labelled V2S1, V2S2, …etc. meaning, vendor 2-sample 1,vendor 2- sample 2, and so on. Slump values however fluctuated as seen earlier in table 4.1. Average slump value was computed as **71mm.**

Table 4.3: Slump test results for third vendor (Okun)

S/N	Sample	Slump (mm)	Concrete Grade (N/mm^2)	Mix ratio	W/C ratio
1	V3S1	78.6	15.00	1:2:4	0.6
2	V3S2	64.5	15.00	1:2:4	0.6
3	V3S3	63	15.00	1:2:4	0.6
4	V3S4	68.3	15.00	1:2:4	0.6
5	V3S5	72.8	15.00	1:2:4	0.6
6	V3S6	85.3	15.00	1:2:4	0.6
7	V3S7	62.5	15.00	1:2:4	0.6
8	V3S8	75.4	15.00	1:2:4	0.6
9	V3S9	73.86	15.00	1:2:4	0.6
10	V3S10	65.9	15.00	1:2:4	0.6

(Author, 2024)

Average slump value = **64.18mm**

Results for slump values in table 4.3 varied constantly with the peak value of 85.3mm, also the mean slump value computed was approximately **64.18mm.** Samples were labelled V3S1, V3S2, …etc. meaning, vendor 3-sample 1,vendor 3- sample 2, and so on **.** These values were for the third vendor at Okun.

Table 4.4: Slump test results for fourth vendor (Idugbo)

S/N	Sample	Slump (mm)	Concrete Grade (N/mm^2)	Mix ratio	W/C ratio
1	V4S1	75.8	15.00	1:2:4	0.6
2	V4S2	62.3	15.00	1:2:4	0.6
3	V4S3	60.7	15.00	1:2:4	0.6
4	V4S4	73.6	15.00	1:2:4	0.6
5	V4S5	88.2	15.00	1:2:4	0.6
6	V4S6	85.8	15.00	1:2:4	0.6
7	V4S7	63.8	15.00	1:2:4	0.6
8	V4S8	61.5	15.00	1:2:4	0.6
9	V4S9	86.8	15.00	1:2:4	0.6
10	V4S10	79.0	15.00	1:2:4	0.6

(Author, 2024)

Average slump value = **73.75mm**

Table 4.4 shows the final set of slump test results for the fourth vendor at Idugbo. Slump values however fluctuated as seen earlier in table 4.1. Average slump value was computed as approximately **73.75mm**.

Table 4.5 : Average slump values for each vendor

S/N	Vendor	Average Slump (mm)
1	Okwae	60.82
2	Ovia	71.00
3	Okun	64.18

4	Idugbo	73.75

(Author, 2024)

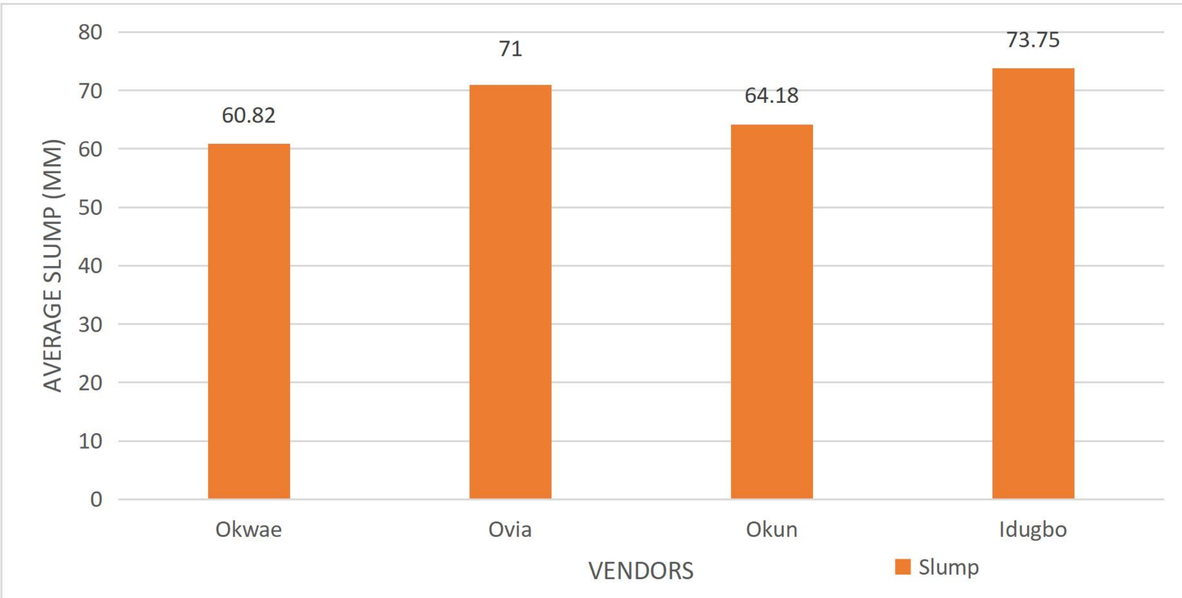


Fig 4.1: Average slump values for all four vendors (Author, 2024)

From the above chart, the Idugbo vendor has the highest average slump value of **73.75mm** , followed by the vendor at Ovia with a slump value of **71mm**, while the vendor at Okun has the least value of **60.82mm.**

4.0.2 Compression test results

Compression test results for all concrete cubes (150x150x150mm) were recorded in tables 4.5, 4.6, 4.7 and 4.8 respectively, at the end of 7, 14 and 28 days for all vendors. Calculations of average strength values and percentage strength gain were done at the appendix section of this text. Five samples were crushed at the end of 7, 14 and 28 days for each vendor. Also included in the tables were related parameters such as the samples ID, concrete grade, water cement ratio etc. with their respective units. The cross-sectional areas for all cubes were constant as 22,500mm^2 .

For first vendor;

Table 4.6: 7 days compression test results for first vendor (Okwae)

S/N	Sample	Concrete Grade (N/mm^2)	Mix ratio	W/C ratio	7 days Compressive strength (N/mm^2)
1	V1S1	15.00	1:2:4	0.6	4.63
2	V1S2	15.00	1:2:4	0.6	3.98
3	V1S3	15.00	1:2:4	0.6	5.36
4	V1S4	15.00	1:2:4	0.6	5;63
5	V1S5	15.00	1:2:4	0.6	4.75

(Author, 2024)

Table 4.7: 14 days compression test results for first vendor (Okwae)

S/N	Sample	Concrete Grade (N/mm^2)	Mix ratio	W/C ratio	14 days Compressive strength (N/mm^2)
1	V1S1	15.00	1:2:4	0.6	8.71
2	V1S2	15.00	1:2:4	0.6	9.53
3	V1S3	15.00	1:2:4	0.6	6.55
4	V1S4	15.00	1:2:4	0.6	10.24
5	V1S5	15.00	1:2:4	0.6	11.23

Table 4.8: 28 days compression test results for first vendor (Okwae)

S/N	Sample	Concrete Grade (N/mm^2)	Mix ratio	W/C ratio	28 days Compressive strength (N/mm^2)
1	V1S6	15.00	1:2:4	0.6	12.7
2	V1S7	15.00	1:2:4	0.6	11.96
3	V1S8	15.00	1:2:4	0.6	13.87
4	V1S9	15.00	1:2:4	0.6	16.87
5	V1S10	15.00	1:2:4	0.6	13.22

(Author, 2024)

From the above tables 4.5 and 4.6, approximately 70% of the target strength was met at the end of 14 days, while roughly 85% was met at the end of 28 days of curing. The average compressive strength for this vendor at the end of 7, 14 and 28 days were 4.87N/mm^2, **9.25N/mm^2** and **13.72 N/mm^2**.

For second vendor;

Table 4.8: 7 days compression test results for the second vendor (Ovia)

S/N	Sample	Concrete Grade (N/mm^2)	Mix ratio	W/C ratio	7 days Compressive strength (N/mm^2)
1	V2S1	15.00	1:2:4	0.6	5.87
2	V2S2	15.00	1:2:4	0.6	4.23
3	V2S3	15.00	1:2:4	0.6	3.75
4	V2S4	15.00	1:2:4	0.6	5.47

5	V2S5	15.00	1:2:4	0.6	4.85

(Author, 2024)

Table 4.9: 14 days compression test results for the second vendor (Ovia)

S/N	Sample	Concrete Grade (N/mm^2)	Mix ratio	W/C ratio	14 days Compressive strength (N/mm^2)
1	V2S1	15.00	1:2:4	0.6	8.78
2	V2S2	15.00	1:2:4	0.6	6.23
3	V2S3	15.00	1:2:4	0.6	6.75
4	V2S4	15.00	1:2:4	0.6	7.47
5	V2S5	15.00	1:2:4	0.6	5.85

Table 4.10: 28 days compression test results for the second vendor (Ovia)

S/N	Sample	Concrete Grade (N/mm^2)	Mix ratio	W/C ratio	28 days Compressive strength (N/mm^2)
1	V2S6	15.00	1:2:4	0.6	11.54
2	V2S7	15.00	1:2:4	0.6	14.58
3	V2S8	15.00	1:2:4	0.6	10.87
4	V2S9	15.00	1:2:4	0.6	12.87
5	V2S10	15.00	1:2:4	0.6	9.76

(Author, 2024)

In tables 4.7 and 4.8, the average compressive strengths at the end of 14 and 28 days were computed as **9.31N/mm²** and **11.92N/mm²**. Thus, having a strength gain of roughly 62% and 79.46% at the end of 14 and 28 days.

For third vendor;

Table 4.11: 7 days compression test results for the third vendor (Okun)

S/N	**Sample**	**Concrete Grade (N/mm^2)**	**Mix ratio**	**W/C ratio**	**7 days Compressive strength (N/mm^2)**
1	V3S1	15.00	1:2:4	0.6	4.75
2	V3S2	15.00	1:2:4	0.6	3.84
3	V3S3	15.00	1:2:4	0.6	5.72
4	V3S4	15.00	1:2:4	0.6	4.87
5	V3S5	15.00	1:2:4	0.6	5.85

Table 4.12: 14 days compression test results for the third vendor (Okun)

S/N	**Sample**	**Concrete Grade (N/mm^2)**	**Mix ratio**	**W/C ratio**	**14 days Compressive strength (N/mm^2)**
1	V3S1	15.00	1:2:4	0.6	6.45
2	V3S2	15.00	1:2:4	0.6	5.77
3	V3S3	15.00	1:2:4	0.6	7.86
4	V3S4	15.00	1:2:4	0.6	8.73
5	V3S5	15.00	1:2:4	0.6	5.98

(Author, 2024)

Table 4.13: 28 days compression test results for the third vendor (Okun)

S/N	Sample	Concrete Grade (N/mm^2)	Mix ratio	W/C ratio	28 days Compressive strength (N/mm^2)
1	V3S6	15.00	1:2:4	0.6	9.32
2	V3S7	15.00	1:2:4	0.6	11.36
3	V3S8	15.00	1:2:4	0.6	14.45
4	V3S9	15.00	1:2:4	0.6	17.65
5	V3S10	15.00	1:2:4	0.6	10.68

(Author, 2024)

From table 4.9 and 4.10, average compressive strength values were calculated **as** **8.69N/mm^2** and **12.69N/mm^2** respectively, thus yielding a 58% and 85% strength gain at the end of 14 and 28 days.

For fourth vendor;

Table 4.14: 7 days compression test results for the third vendor (Okun)

S/N	Sample	Concrete Grade (N/mm^2)	Mix ratio	W/C ratio	7 days Compressive strength (N/mm^2)
1	V3S1	15.00	1:2:4	0.6	4.35
2	V3S2	15.00	1:2:4	0.6	3.74

3	V3S3	15.00	1:2:4	0.6	5.83
4	V3S4	15.00	1:2:4	0.6	4.81
5	V3S5	15.00	1:2:4	0.6	5.87

Table 4.15: 14 days compression test results for the fourth vendor (Idugbo)

S/N	**Sample**	**Concrete Grade (N/mm^2)**	**Mix ratio**	**W/C ratio**	**14 days Compressive strength (N/mm^2)**
1	V4S1	15.00	1:2:4	0.6	7.68
2	V4S2	15.00	1:2:4	0.6	4.77
3	V4S3	15.00	1:2:4	0.6	9.53
4	V4S4	15.00	1:2:4	0.6	7.35
5	V4S5	15.00	1:2:4	0.6	6.35

(Author, 2024)

Table 4.16: 28 days compression test results for fourth vendor (Idugbo)

S/N	**Sample**	**Concrete Grade (N/mm^2)**	**Mix ratio**	**W/C ratio**	**28 days Compressive strength (N/mm^2)**
1	V4S6	15.00	1:2:4	0.6	9.42
2	V4S7	15.00	1:2:4	0.6	12.7
3	V4S8	15.00	1:2:4	0.6	11.23
4	V4S9	15.00	1:2:4	0.6	16.64
5	V4S10	15.00	1:2:4	0.6	14.73

(Author, 2024)

In tables 4.11 and 4.12, the average compressive strengths at the end of 7, 14 and 28 days were computed as 5.63N/mm^2 , 7.13N/mm^2 and 13N/mm^2 respectively, thus, having a strength gain of roughly 62% and 79.46% at the end of 14 and 28 days.

Table 4.14: Average compressive strength values for all vendors at the end of 7, 14 and 28 days.

S/N	Vendors	Concrete Grade (N/mm^2)	Mix ratio	W/C ratio	Avg. 7 days Compressive strength (N/mm^2)	Avg. 14 days Compressive strength (N/mm^2)	Avg. 28 days Compressive strength (N/mm^2)
1	Okwae	15.00	1:2:4	0.6	4.55	9.25	13.72
2	Ovia	15.00	1:2:4	0.6	4.49	9.31	11.92
3	Okun	15.00	1:2:4	0.6	3.95	8.69	12.69
4	Idugbo	15.00	1:2:4	0.6	5.23	7.13	13.00

(Author, 2024)

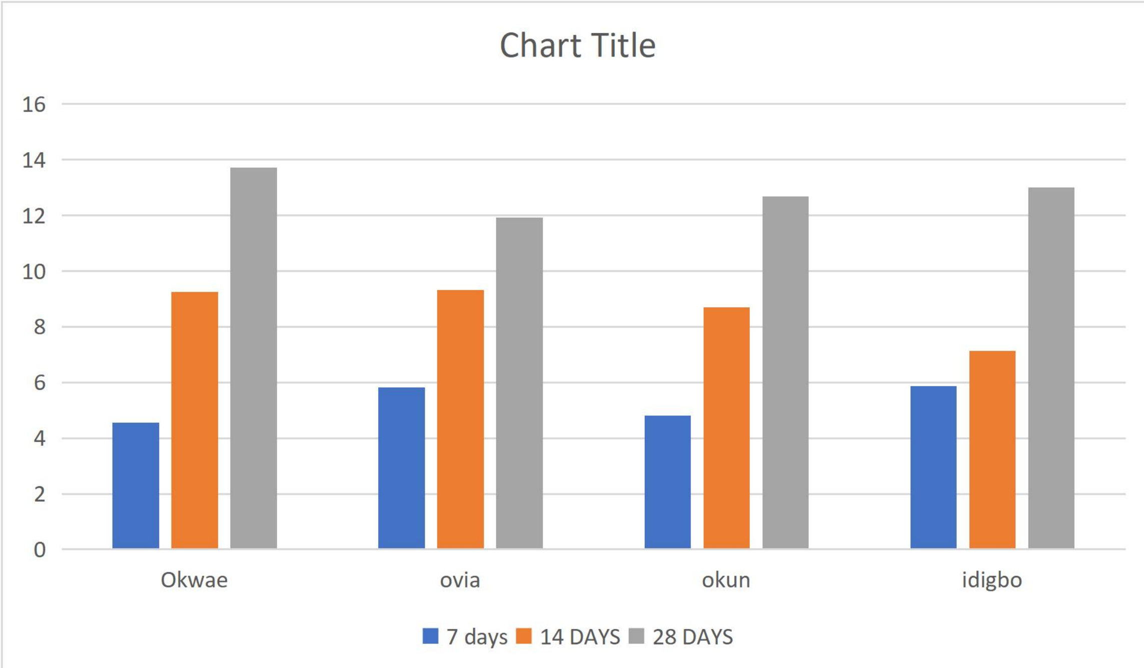
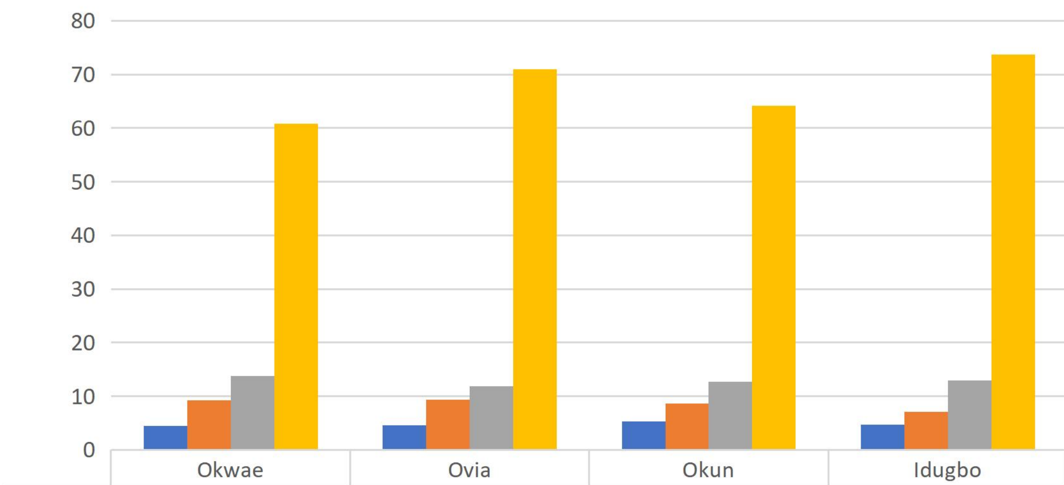


Fig 4.2 : Compressive strengths for various vendors the end of 7, 14 and 28 days (Author, 2024).

Fig 4.2 shows the chart for varying compressive strength values for all four vendors, with the Ovia vendor having highest strength value of **9.31N/mm^2** at the end of 14 days, while the Idugbo vendor has the lowest strength of **7.13N/mm^2** value at the end of 14 days. However, the Okwae vendor has highest strength value of **13.72N/mm^2** at the end of 28 days, while the Ovia vendor has the least value of **11.92N/mm^2** at the end of the same period.



	Okwae	Ovia	Okun	Idugbo
7 days	4.47	4.59	5.26	4.72
14 days	9.25	9.31	8.69	7.13
28 days	13.72	11.92	12.69	13
Slump	60.82	71	64.18	73.75

Fig 4.3: Slump and Compressive strength values for all four vendors (Author,2024)

From the above chart, all measured parameters of this work which includes compressive strength and slump for all vendors have been presented.

CHAPTER FIVE

CONCLUSIONS AND DRECOMMENDATIONS

5.0 Conclusions

The effects of varying fine aggregates used in the concrete preparation on its fresh and hardened properties , has been investigated in this study. Upon completion of the needed experimental procedures, the below listed conclusions have been arrived at;

a) Hardened concrete attains35% and 65-75% of its target strength at the end of 7and 14 days of curing. However, deviations may occur due to material or preparation method constraints.
b) Hardened concrete attains 90-95% of its target strength at the end of 28days of curing. Deviations from expected results may be due to errors in preparation, faulty mix design computations, constituent property variations, etc.
c) Concrete constituents procured from different locations, will yield varying values of slump and strength.
d) Concrete prepared with constituents from the Okwae area, yielded favorable slump of 60.82mm and compressive strength of 13.72N/mm^2 , thus proving its application in lightweight concreting works. However, concreting constituents from the Ovia area yielded slump value of 71mm and compressive strength of 11.92N/mm^2 , proving its viability for use in plain concreting where strength is not the prevailing requirement.
e) The variations in the properties of concrete for all four vendors has no adverse effects on mix design calculations, only if the concrete would be used in light weight application.

5.1 Recommendations

To ensure safety and economy in reinforced concrete construction, adequate quality control measures should be applied in terms of; Ensuring onsite workability test on fresh concrete, concreting constituents testing i.e. specific gravity, water absorption, moisture content, sieve analysis, etc. in case of high strength applications to ensure safety and durability requirements.

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APPENDIX

A1 Slump cone

A2 Digital weighing balance

A3 Concrete mixing and slump testing.

A4 Formworks for concrete cubes(150x150x150)mm

A5 Compression testing machine