COMPARISM OF THE COMPRESSIVE STRENGTH OF RIVER GRAVEL AND GRANITE CONCRETE IN MINNA NIGER STATE.

BY

NISSI HANNAH OLUWAYEMISI

2007/1/27245BT

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION,

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

OCTOBER, 2012.

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UNIVERSITY OF TECHNOLOGY MINNA. RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION, SCHOOL OF SCIENCE AND SCIENCE EDUCATION, FEDERAL

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CERTIFICATION

I Nissi Hannah Oluwayemisi, with Matriculation No. 2007/1/ 27245BT an undergraduate student of the Department of Industrial and Technology Education certify that the work embodied in this project is original and has not been submitted in part or full or any other diploma of degree of this or any other University.

…………………………………. **……………………………..**

Name **Sign-Date**

APPROVAL PAGE

This project has been read and approved as meeting the requirements for the award of B. Tech degree in Building Technology option in Department of Industrial and Technology Education , School of Science and Science Education, Federal University of Technology, Minna, Niger State.

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Supervisor **Signature/Date**

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Head of Department **Signature/Date**

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External Examiner **Signature/Date**

DEDICATION

I hereby dedicate this project to the Almighty God the creator of my life who sustained and preserved my life throughout my under graduate programe and in the writing of this project. And to my entire family.

ACKNOWLEDGEMENTS.

My profound gratitude is first to the ever faithful God for His mercy, grace and divine sustenance throughout the pursuit of this programme, May His name for ever praised.

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TABLE OF CONTENTS

CHAPTER II

REVIEW OF RELATED LITERATURE

CHAPTER III

MATERIALS AND METHODS

CHAPTER IV

PRESENTATION OF DATA AND DATA ANALYSIS

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATION

APPENDICES

LIST OF TABLES

ABSTRACT

This research present the result carried out on comparism of compressive strength of river gravel and granite concrete in Minna Niger state. Tests conducted include sieve analysis, bulk density, and specific gravity. Nominal mix (1:2:4) was adopted for this work and mix compositions were calculated by absolute volume method. For each type of coarse aggregate 12 cubes (150x150mm) were cased to allow the compressive strength to be monitored at 7, 14, 21, and 28 days. Test result shows that the compressive strength of concrete made with river gravel varies from 18.15N/mm^2 at 7days to 23.7N/mm^2 at 14days to 24.00N/mm^2 at 21days and 27.3N/mm^2 at 28days The compressive strength of concrete made with granite also have 21.7N/mm at 7days to 23.78N/mm at 14days to 26.44N/mm at 21days and 28.00N/mm at 28days respectively this indicate that the compressive strength of both aggregates increases with their curing age.

CHAPTER 1

INTRODUCTION

Background of the Study

Comparism is the process of assessing the similarity between two or more things people or event. (Hornby, 2006). When a comparism is being done between people , things or educational programmes, there must be a set down rules and principles to be followed (Okerek 2006). Compressive strength is define as the ratio of the cross sectional load applied to a given area of a concrete block or cubes (John 2009).This type of test is down to determine the load which a given concrete mix can carry after 1day, 3days, 7days, 14days, 21days and 28days respectively based on the number of curing days (Almusallam 2003).

Concrete is a composite construction material composed primarily of aggregates (fine and coarse), cement and water. The use of concrete in building construct is as old as brick and block (Yang E, Sheem 1999). Fine aggregate are aggregate whose size is less than 4.75mm examples are sharp sand and plaster sand. Coarse aggregate is the portion of the aggregate use in concrete that is larger than frac3/16 inch. Examples are granite, river gravel quartzite etc (Bashr 2003). Granite is a coarse-grained igneous rock having an uneven texture, and consisting largely of quartz and feldspar with often small amounts of mica and other materials. Granite is very hard, compact, and takes a fine polish, showing the beauty of the crystals. It is the most important building stone, and is also used as ornamental stone . River gravel is a loss material consisting of rock or mineral fragments. It is produce by the weathering and erosion of rocks. Strong river currents or glaciers often transport gravel great distances before it is being deposited. Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water react with the cement which bonds the components together eventually creating a robust stone – like material (Detroit 1991).

The cement paste glues the aggregates together, fills voids within it and allow it to flow freely. Less water in the cement paste will yield a stronger and more durable concrete while more water gives a freer flowing concrete with a higher slump.(Neville 2006) . Thorough mix is essential for the production of uniform high quality concrete. For this reason equipment and methods should be capable of effective mixing concrete material containing the largest specific aggregate to produce uniform mixture of the lowest slump practical for the work. Separate paste has shown that the mixing of cement and water into a space before combining these materials with aggregates can increase the comprehensive strength of the resulting concrete (Neville AM 1990) Impure water used to make concrete can cause premature failure of the concrete structure. More so, there are factors that can lead to the variation in concrete quality, they includes variation in batching, mixing, quality cement, degree of compaction and variation in curing (Douglas 2001)

The strength and the durability of concrete is determine through proper curing ,which is described as keeping the concrete moist and warm enough so that the hydration of cement can well done More elaborately, it can be described as the process of maintaining a satisfactory moisture content and a favourable temperature in concrete during the mixing and placement so

that hydration of cement may continue until the desired properties are develop to a sufficient degree to meet the requirement of service (Mclntosh JD,2001). During curing more of the cement react with the residual water in hydration. This process develop physical strength, moisture permeability, chemical and volumetric stability. In this process it can further be observed that excessive in the concrete mix will lead to increased bleeding [surface water] and/or segregation of aggregates [when the cement and aggregate start to separate] with the resulting concrete having reduced quality on the other hand (Danunsi 2003) in all but the least critical applications, care need to be taken to properly cure concrete to achieve best strength and harden [this happens after the concrete has been placed] .During this period concrete need to be kept under a controlled temperature and humid condition. If curing is neglected in the early period of hydration the quality of concrete will experience a sort of irreparable loss.

An efficient curing in the early period of hydration can be to a good and wholesome feeding given to a new born baby (Vahid A. 1991] Concrete is the most widely use construction materials, it provides superior fire resistance, compared with wooden construction and gain strength over time, structures made of concrete posses a long service life, concrete due to is widely use as construction material in the word with annual consumption estimated at between 21 and 31 billion tones concrete is use more than any other man made material in the word.

Concrete has relatively high compressive strength but much lower tensile strength, for this reason concrete is usually reinforced with materials that are strong in tension [often steel] the elasticity of concrete is relatively constant at low stress levels but start decreasing at higher stress levels as matrix cracking develops. The strength of a concrete is a major priority in any construction industry, Strength increases with age as long as moisture and a favorable temperature are present for hydration of cement. Hence the reason for curing concrete. Concrete has an environmental impact on a complex mixture of not entirely negative effect; but a major contributor to greenhouse gas emissions, recycling of concrete is increasingly common in structures that have reached the end of their life. As concrete has a high thermal mass and very low permeability, it can make for energy efficient housing.

Statement of the Problem

Despite the abundant resources and 52 years of independence people still finds it difficult to own a home to call their own due to the cost of building materials to carry out the construction work. It is the desire of every individual to own even an estate but the cost has stop people from doing that thereby completely killing the individual's moral towards owning a structure to call their own. According to Okereke (2006), from the research on building material programmes, by extension other sector of building industry, one could without fear of contradiction infer that the building construction industry in Nigeria characterized with low productivity, prolonged project execution of contract awarded cause of lack of fund by the client and lots of projects has also been abandoned in like manner also and lack of improper supervision. (Harbor 2006)

However, building material are very expensive, due to the factor that controls their price, which are not determined here in our country. For instance crushed stone are locally available, but the manual process [man power] which takes several days to be crushed down into pieces. While the mechanical process, involves the use of machines, which is very fast, but these machines are expensive to purchase, that is why the price of building materials are being inflated day in day out. It is in this light of the forgoing that this research is embarked upon to find out the compressive strength of concrete made with river gravel and concrete made with granite. Since river gravel is known to be cheaper compare to granite (Johnson 2000) so as to make it possible for every common man, to actualize his dream of owning a house in Nigeria.

Purpose of the Study

The purpose of this research are;

1. To determine physical properties of concrete made with river gravel and concrete made with granite
2. To determine the compressive strength of concrete made from river gravel and concrete made with granite

3. To determine the difference between the compressive strength of concrete made from river gravel with that of granite.

Significance of the Study

This research will be beneficial to the building industry, especially builders who are directly involved in the construction work. It will be beneficial to common man who have interest of owning a house at hearth as it will reduce building cost. The society will also benefit from the use of river gravel as coarse aggregate for building, if the compressive strength falls within the required standard at 28days. It will also benefit the Federal Government as it will enable them to build more houses for government workers e,g those that willing to buy up a completed house and their by providing more funds to the Governments purse. This process, will also help in identifying other possible building materials that can be put to use in construction industries, which are locally available.

Research Questions

1) What are the physical properties of concrete made with river gravel and concrete made with granite?
2) What is the compressive strength of concrete made from river gravel and concrete made with granite?
3) What is the difference between the compressive strength of concrete made from river gravel with the concrete made from granite?

Scope of the Study

The scope of this study focus on the comparism of the compressive strength of rver gravel and granite concrete in Minna Niger State Due to time limitation, the curing of the concrete cannot be extend beyond 28days. It is therefore, not possible to monitor the strength development of the two aggregates at six months, one year, three years among others.

CHAPTER II

LITERATURE REVIEW

In this chapter, literatures related to this study are reviewed and discussed under the followings:

1. Concrete as a building material
2. Quality requirement of concrete
3. Types of concrete
4. Properties of aggregate

Concrete as a Building Material

Concrete is one of the most widely used structural material in constructions in the world, it is use for massive concreting in huge civil projects like dams, power plants, bridges etc. Concrete is the only major building material that can be delivered to the job site in a plastic state. This unique quality makes concrete desirable as a building material because it can be molded to virtually any form or shape. Concrete provides a wide latitude in surface textures and colors and can be used to construct a wide variety of structures, such as highways and streets, bridges, dams, large buildings, airport runways, irrigation structures, breakwaters, piers and docks, sidewalks, silos and farm buildings, homes, and even barges and ships.

The two major components of concrete are cement paste and inert materials. The cement paste consists of Portland cement, water, and some air either in the form of naturally entrapped air voids or minute, intentionally entrained air bubbles. The inert materials are usually composed of fine aggregate, which is a material such as sand, and coarse aggregate,

When Portland cement is mixed with water, the compounds of the cement react to form a cementing medium. In properly mixed concrete, each particle of sand and coarse aggregate is

completely surrounded and coated by this paste, and all spaces between the particles are filled with it. As the cement paste sets and hardens, it binds the aggregates into a solid mass.
Under normal conditions, concrete grows stronger as it grows older. The chemical reactions between cement and water that cause the paste to harden and bind the aggregates together require time. The reactions take place very rapidly at first and then more slowly over a long period of time.

Cement

Cement is a material that has adhesive and cohesive properties enabling it to bond mineral fragments into a solid mass. Cement consists of silicates and aluminates of lime made from limestone and clay (or shale) which is ground, blended, fused in a kiln and crushed to a powder. Cement chemically combines with water (hydration) to form a hardened mass. The usual hydraulic cement is known as Portland cement because of its resemblance when hardened to Portland stone found near Dorset, England. The name was originated in a patent obtained by Joseph Aspdin of Leeds, England in 1824. Typical Portland cements are mixtures of tricalcium silicate ($3CaO \cdot SiO_2$), tricalcium aluminate ($3CaO \cdot Al_2O_3$), and dicalcium silicate ($2CaO \cdot$

SiO2), in varying proportions, together with small amounts of magnesium and iron compounds. Gypsum is often added to slow the hardening process.

Water

Water has two roles in concrete mixture: First is the chemical composition with cement and perform cement hydration and second is to make the concrete composition fluent and workable. The water which is used to make the concrete must be drinkable water. The impurity of water can have undesirable effect on concrete strength.

Aggregates

Since aggregate usually occupies about 75% of the total volume of concrete, its properties have a definite influence on behavior of hardened concrete. Not only does the strength of the aggregate affect the strength of the concrete, its properties also greatly affect durability (resistance to deterioration under freeze-thaw cycles). Since aggregate is less expensive than cement it is logical to try to use the largest percentage feasible. Hence aggregates are usually graded by size and a proper mix has specified percentages of both fine and coarse aggregates. Fine aggregate (sand) is any material that passes through a No.4 sieve. Coarse aggregate (gravel) is any material of larger size.

Fine aggregate provides the fineness and cohesion of concrete. It is important that fine aggregate should not contain clay or any chemical pollution. Also, fine aggregate has the role of space filling between coarse aggregates. Coarse aggregate includes: fine gravel, gravel and coarse gravel. In fact coarse aggregate comprises the strongest part of the concrete. It also has reverse effect on the concrete fineness. The more coarse aggregate, the higher is the density and the lower is the fineness.

Compressive Strength of Concrete

The strength of concrete is controlled by the proportioning of cement, coarse and fine aggregates, water, and various admixtures. The ratio of the water to cement is the chief factor for determining concrete strength. The lower the water-cement ratio, the higher is the compressive strength. A certain minimum amount of water is necessary for the proper chemical action in the hardening of concrete; extra water increases the workability (how easily the concrete will flow) but reduces strength. A measure of the workability is obtained by a slump test. The strength of concrete is denoted in the United States by fc which is the compressive strength of test cylinder 6 in. in diameter by 12 in. high measured on the 28th day after they are made.

Concrete Sampling

Acceptance of the concrete in the site is performed based on the results of the compressive tests of concrete samples. The concrete samples must be taken from the final consumption place. The purpose of the concrete sampling is to prepare two specimens of concrete which their compressive tests will be performed after 28 days or in any predetermined day.

Concrete Mix Design

Concrete mix design is the process of selecting the suitable ingredients of concrete and determining their most optimum proportion which would produce, as economically as possible, concrete that satisfies a certain compressive strength and desired workability.

The concrete mix design is based on the principles of

- Workability
- Desired strength and durability of hardened concrete
- Conditions in site, which helps in deciding workability, strength and durability requirements

Quality Requirement of Concrete

The concrete mix proportion has an important influence on producing good quality concrete. Typical data of strengths of concrete for different water-cementitious materials ratios with different percentages of fly ash or ground granulated blast furnace slag show that such concretes are comparable made using 43-grade ordinary port-land cement without any fly ash or granulated blast furnace slag. However, when silica fume is used with super plasticiser, the strength of concrete can be increased to 60 to 70MPa, mixed concrete code is a starting point and should be used as a guide to produce and supply good quality concrete for concrete constructions (Murdock 1994). Quality of concrete depends on the constituent materials, their proportions, mixing, transporting, placing, compaction and curing of concrete. The concrete with proper mix

proportion has the needed workability and develops the targeted compressive strength. Efficient concrete mixers are needed to mix the ingredients and to produce a cohesive and workable concrete. Concrete admixtures play an important role in providing the needed workability for transporting and placing the concrete in the formwork. Once the concrete is placed and consolidated by compaction in the formwork, protected and cured properly, it should be a good quality concrete, and is expected to perform satisfactorily in the service life.

Sometimes, a supposed said good quality concrete does not perform satisfactorily in the service life. One of the reasons for such a performance could be the alkaline– aggregate reaction (Yang Sheem 2005). The alkali of cement reacts with the reactive constituents such as reactive silica or reactive carbonate of aggregates in the presence of moisture. This reaction is harmful and eventually the concrete gets distressed and cracked. Corrosion of rebars could be another reason for non- performance. High workability or pumpable concrete is a cohesive concrete mix that does not segregate while transporting and placing. To achieve this, the concrete-making materials should be properly proportioned. The mix proportions are also responsible for providing the desired workability and 28-day compressive strength of concrete. The slump of concrete is kept as long as it is wanted for transporting and placing, using retarding super plasticiser. The grading of coarse and fine aggregates also plays a useful role in producing a cohesive concrete mix. Pumpable high-workability concrete needs more fine aggregates than ordinary concretes

Quality Control Requirements

In order to maintain a high standard of quality, the following should be observed.

Supervision: A competent professional should be employed whose first duty will be to supervise all stages in the preparation and placing of the concrete. All tests on materials, the making and testing of cubes and the maintenance calibration of all mixing and measurement tools should be

carried out under his direct supervision. The requirements of section 2.9.4 of NCP-1: 1973 should be fully complied with.

Mixing and Placing of Concrete

The preparation, handling d curing of concrete should be performed in accordance with the requirement of section 2.9.4 of NCP-1: 1973. Preparation of equipment and place of deposit: Preparation before concrete placement should include the following:

a. All equipment for mixing and transporting concrete should be clean.
b. All debris should be removed from spaces to be occupied by concrete
c. Forms should be properly coated
d. Masonry filter units that will be in contact with contact with concrete should be drenched
e. Reinforcement should be thoroughly clean of all types of deleterious coating
f. Water should be removed from place of deposit before concrete is placed unless otherwise permitted by the supervising officer.

g. All laitance and other unsound materials should be removed before additional concrete is placed against hardened concrete.

Mixing: All concrete should be mixed until there is a uniform distribution of materials, and shall be discharged completely before the mixer is recharged. Concrete should be mixed for four minutes immediately after water is added and should not stay for more than 45 minutes before placement.

Conveying: Concrete should be conveyed from mixer to place of final deposit by methods that will prevent separation or loss of materials. Conveying equipment should be capable of providing a supply of concrete at site of placement without separation of ingredients and without interruptions sufficient to permit loss of plasticity between successive increament.

Depositing: Concrete should be deposited as nearly as practicable in its final position to avoid segregation due to re-handling or flowing. Concrete should be deposited as soon as possible after mixing and without segregation of the materials.

Unacceptable Placement timing: Concrete should be carried on at such a rate that concrete is at all times plastic and flows readily into places between reinforcement.

Concrete: concrete that has partially hardened or been contaminated with foreign materials should not be deposited in the structure

Retampering: Retampering concrete or concrete that has been remixed after initial set should not be used unless approved by the supervising officer.

Continuous Concreting: After concreting is started, it should be carried on as a continuous operation until placing of a panel or section, as defined by its boundaries or predetermined joints, is completed except as permitted or prohibited by the supervising officer.

Placement of walls: Top surfaces of vertically formed lifts should be generally level

Concrete Mix Proportions

Concrete mix proportions have a large influence on the quality of concrete. The water-cement ratio or the water-cementitious materials ratio controls the 28-day compressive strength of concrete. The strength of concrete is also dependent on the strength of cement. The quantity of fly ash or GGBs influences the cohesiveness and quality of fresh and hardened concrete. About 25% fly ash o.45 % GGBs are needed to produce cohesive and workable mix. Naphthalene based super plasticizer (about 1-2% by weight of cement or by weight of cementitious materials) is required with fly ash or GGBs to develop the desired workability and 28-day compressive strength (Joseph Paker 1998). In a normal concrete with 20 or 40 mm maximum size of aggregate the quantity of fine aggregate needed is 30-35% (% by weight of total aggregate). For high workability pumpable concrete, (about 100-150 mm slump) however, about 40% fine

aggregate by weight of total aggregate are needed. RMC units have two options for supplying concrete; designed mixes and prescribed mixes. In case of designed mixes, the producer takes the responsibility for selecting the concrete mix proportions for the needed performance, whereas for the latter, buyer specifies the concrete mix proportions and the supplier of RMC is not responsible for workability and the 28-day compressive strength of concrete. The RMC code IS 4926 provides guidelines for quality control of concrete. The quality control process has been divided into three components, “Forward Control”,

“Immediate control” and “Retrospective control’.

calibration and plant maintenance are required for quality production. Forward Control includes control of purchased material quality, materials storage, mix design and mix design modification, plant maintenance, transfer and weighing equipment and plant mixers and truck mixer. The system is designed to ensure that material and the mix design result in good quality concrete.

Controls over moisture content of the aggregates and grading of aggregates are important to achieve the desired workability and 28-day compressive strength of concrete.

Table 1 .Standard Mixes For Concrete Quality

Specified works cube strength at 7 days	Weight of dry sand per 50kg of cement	Weight of coarse aggregate per 50kg of cement											
Workability slump (mm) compacting factor		10mm maximum size			13mm maximum size			16mm maximum size			38mm maximum size		
		Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
		0-5	5-25	25-50	5-20	20-40	40-100	12-25	25-50	50-125	25-50	50-100	100-175
		80-86	81-93	81-93	81-87	87-93	93-97	82-88	88-94	94-97	82-88	88-94	94-97
N/mm^2	Kg	Kg	Kg	Kg	Kg	Kg	Kg	Kg	Kg	Kg	Kg	Kg	Kg
21	90	145	110	90	165	135	110	190	155	135	225	190	165
25.5	80	125	125	65	145	110	90	165	135	110	200	165	145
30	65	100	-	-	125	90	-	145	110	90	165	135	110

Concrete Types

Plain Concrete: consist solely of cement powder, water and graded coarse and fine aggregates. No reinforcement used and it can be manufactured on the site and can be purchased from a ready mixed concrete company. Used include a sample foundation, garden paths, paving's slabs, and channels.

Reinforced Concrete (R.C): consist of plain concrete reinforced with metal, usually still bars or fabric mesh. It is stronger than plain concrete in both tension and compression and it can be insitu or present. Uses foundation walls, columns, lintels, and beams, floor and roofs.

Precast Concrete: This is usually in form of some kind of units which can be manufactured either on or away from the site, the unit (i.e. precast concrete) is made on some other place than that which is permanently occupy. It can be plain, reinforced or pre-stressed uses includes brick, block, cladding panels, pan stones, copings, windows, still canopies, chimney caps .

Pre-stressed Concrete: High strength concrete can be precast or cast in-situ cast on site or in concrete works. The concrete usually a structural unit is given a very high tension strength by tensioning high-tensile wire or cables while the concrete is either: (a) fresh (this is called pretention concrete). (b) Hardened (this is describe post-tensioned concrete). Used include large pan beams, bridges and elevated motor ways, water retaining structures etc. (Brook 2000)

Strength Properties of Concrete

The main strength properties of mixed concrete are:

Workability It expresses the case of working and closely associated with the uniformity or consistency of the concrete mix. Workability is defined as the amount of useful internal work required for compaction. (Kinniburg 1999)

Uniformity is merely a degree of homogeneity or a state of distribution within the mix (so concrete should be well mixed).Consistency describe the state of wetness of the concrete to the state of firmness of form.

Segregation due to heterogeneity and complex nature of concrete mix, there is often a tendency of the heaviness particles to separate from the lighter ones e.g through gravity during transportation and placing. Thus form of separation which leads a state of non uniformity of the mix is known as segregation.

Bleeding This involves the formation of scum on the surface of the concrete, it happens in very wet mix where there is tendency for the surplus water, this is known as bleeding or water gained

Production of Concrete in Construction Industries.

Concrete production comprises: batching, mix, transportation, placing, compacting and curing the concrete. However, most concrete is now supplied ready-mixed, when it is important to check that the correct material has been delivered to the site and it is placed in its final position in the right condition. Even on small sites, concrete is often pumped from the mixer to

the trenches or formwork and this assists in ensuring that a concrete of suitable consistency has been supplied the production processes are:

Batching Cement needs to be stored in a damp proof and draught proof structured aggregates should stored on clean hard surface. Aggregates may be measured by volume using a timber guage base with its sizes related to the quality of aggregate required to be mixed with a bag of cement.

Mixture Concrete can be mixed by hand or machine on the site or purchased ready-mixed. When it is delivered to the site from a central batching plant in lorries.

Properties of Aggregate

The physical properties of aggregates are those that refer to the physical structure of the particles that make up the aggregate

Absorption, Porosity and Permeability

The internal pore characteristics are very important properties of aggregates. The size, the number, and the continuity of the pores through an aggregate particle may affect the strength of the aggregate, abrasion resistance, surface texture, specific gravity, bonding capabilities, and resistance to freezing and thawing action. Absorption relates to the particle's ability to take in a liquid. Porosity is a ratio of the volume of the pores to the total volume of the particle.

Permeability refers to the particle's ability to allow liquids to pass through. If the rock pores are not connected, a rock may have high porosity and low permeability

Surface Texture

Surface texture is the pattern and the relative roughness or smoothness of the aggregate particle. Surface texture plays a big role in developing the bond between an aggregate particle and a cementing material. A rough surface texture gives the cementing material something to

grip, producing a stronger bond, and thus creating a stronger hot mix asphalt or portland cement concrete.Surface texture also affects the workability of hot mix asphalt, the asphalt requirements of hot mix asphalt, and the water requirements of portland cement concrete.

Some aggregates may initially have good surface texture, but may polish smooth later under traffic. These aggregates are unacceptable for final wearing surfaces. Limestone usually falls into this category. Dolomite does not, in general, when the magnesium content exceeds a minimum quantity of the material

Strength and Elasticity

Strength is a measure of the ability of an aggregate particle to stand up to pulling or crushing forces. Elasticity measures the "stretch" in a particle. High strength and elasticity are desirable in aggregate base and surface courses. These qualities minimize the rate of disintegration and maximize the stability of the compacted material. The best results for portland cement concrete may be obtained by compromising between high and low strength, and elasticity. This permits volumetric changes to take place Pore uniformly throughout the concrete

Density and Specific Gravity

Density is the weight per unit of volume of a substance. Specific gravity is the ratio of the density of the substance to the density of water. The density and the specific gravity of an aggregate particle is dependent upon the density and specific gravity of the minerals making up the particle and upon the porosity of the particle. These may be defined as follows:

1. All of the pore space (bulk density or specific gravity)
2. Some of the pore space (effective density or specific gravity)
3. None of the pore space (apparent density or specific gravity)

Determining the porosity of aggregate is often necessary; however, measuring the volume of pore space is difficult. Correlations may be made between porosity and the bulk, apparent and effective specific gravities of the aggregate. As an example, specific gravity information about a particular aggregate helps in determining the amount of asphalt needed in the hot mix asphalt. If an aggregate is highly absorptive, the aggregate continues to absorb asphalt, after initial mixing at the plant, until the mix cools down completely. This process leaves less asphalt for bonding purposes; therefore, a more porous aggregate requires more asphalt than a less porous aggregate.

The porosity of the aggregate may be taken into consideration in determining the amount of asphalt required by applying the three types of specific gravity measurements.

Aggregate Voids

There are aggregate particle voids, and there are voids between aggregate particles. As solid as aggregate may be to the naked eye, most aggregate particles have voids, which are natural pores that are filled with air or water. These voids or pores influence the specific gravity and absorption of the aggregate materials.

Hardness

The hardness of the minerals that make up the aggregate particles and the firmness with which the individual grains are cemented or interlocked control the resistance of the aggregate to abrasion and degradation. Soft aggregate particles are composed of minerals with a low degree of hardness. Weak particles have poor cementation. Neither type is acceptable. The Hardness Scale is frequently used for determination of mineral hardness.

CHAPTER III

METHODOLOGY

This chapter describe the research design, the area of study, the materials used, the test to be carried out and the procedures adopted for the collection of data for the study.

Research Design

The research design employed in this research is an experimental study. Thus, an experimental study is a study that requires a practical test work to be carried out, which can then be used to collect data, organize data, analyze data and discuss their results to prove something or to find out something.

Area of study

The practical was carried out at Civil Engineering Department Laboratory in Federal University of Technology, Minna, Niger State.

Materials

The materials used for the research work are:

1. Fine aggregate (sand)
2. Coarse aggregate (Granite and River Gravel)
3. Cement.

Fine Aggregate: The fine aggregate used for this work was gotten from sand deposited by water within the Federal University of Technology Minna , Bosso campus and was transported to the civil engineering laboratory The fine aggregate used was in conformity with the BS 882.

Granite : The source of the coarse aggregate (industrial crush granite) was F-Layout along Bosso road in Minna. Granite is a coarse-grained igneous rock having an uneven texture, and consisting largely of quartz and feldspar with often small amount of mica and other materials.

Granite is very hard, compact and takes a fine polish, showing the beauty of the crystals. It is the most important building stone, and is also used as ornamental stones(Brady classer).Granite is usually whitish or grey with a speckled appearance caused by the darker crystal Potash feldspar impart a red or fresh color to the rock. Granite crystallizes from magma that cools slowly, deep below the earth surface. Exceptionally, slow rate of cooling give rise to a very Corse green variety called pegmatite. Granite, along other crystalline rocks, constitute the continental masses, and is the commonest intrusive work exposed at the earth surface(Encarta, 2004).

Cement: this is a fine, soft, powdery –type substance that is made from a mixture of elements such as limestone, clay, sand and /or shale found in natural materials. It is also made of calcium, silicon, aluminum and iron. It basically serves as a binding material. The cement used for this work is Dangote Obajana Portland cement.

River Gravel: At the river bank in river basin, makunkele in Minna Niger state. River gravel is a loose material consisting of rock or mineral fragments. Gravel is produce by the weathering and erosion of rocks. Strong river currents or glaciers often transport gravel great distances before it is been deposited. Rock fragment in gravel that been transported by water are won and rounded, while those carried by ice usually have sharp angular edges the rock fragment in gravel transported by river also vary in size less than those transported by glaciers. Gravel are also found on beaches where there is string wave action; beach gravels are very round and smooth. The properties of river gravel depend on the properties of the parent rock (Encarta, 2004).

Test carried out

The following tests were carried out:

a) Specific gravity
b) Moisture content
c) Bulk density
d) Absorption capacity
e) Sieve analysis
f) Comprehensive strength test via crushing.
g) Slump test.

A. Specific Gravity

According to ASTM 127-84, specific gravity is defined as the ratio of mass (or weight in air) of a unit volume of material to the same volume of water at stated temperature. Specific gravity of material depends on the amount of voids and the specific gravity of the materials of which it is composed .Specific gravity is used in the calculation of quantities of materials

Apparatus

1. Weighing balance
2. Measuring cylinder
3. An airtight container

Sample of Test

A sample of about 1000g of river gravel

Procedure

a) The weight of the cylinder was determined by weighing it, described quantities of river gravel was gently dropped into the cylinder and the cylinder and its' content were weighed and then recorded.

b) The cylinder and its' content was then filled up with water to a specific volume (1000mm).

c) The water content in the cylinder was weighed and the value was recorded.

d)The cylinder was then emptied and cleaned. The cylinder was filled with water, of about 1000mm volume, the cylinder and water in it was weighed and recorded.

e) The weight of sample (dry sample only) is obtained from subtracting the weight of cylinder from the weight of the cylinder plus the sample which is recorded by subtracting the weight of W2 from W3.

B. Moisture Content

Moisture content is the amount of water in excess to the saturated and surface dry condition (that is when the pores in the aggregate are full). Thus the total water content of a moist aggregate is equal to the sum of absorption and moisture content. Aggregate exposed to rain to absorb water in its pores. Further wetting causes it to be surrounded by a film of moisture. The surface or free moisture is very important in the design of concrete mixes. The free moisture tends to offset the workability by altering the water/cement ratio it is therefore necessary to determine content of an aggregate and adequate allowance be made in calculating quantities

Apparatus

Weighing balance

pyrometer

River gravel

Procedure

The moisture content of an aggregate is determined by using pyrometer. The specific gravity of the aggregate is determined by referring to the specific gravity in section 3.1.3.

Then if the weight of the pyrometer full of water = B

The weight with moist sample = C

Weight of pyrometer with moist sample topped with water = A

The specific gravity of the aggregates = p

Then, the moisture content of the aggregates are given by the following;

Express as;

Moisture content = $\left\{ \frac{C}{A} - \frac{B}{p} - \frac{1}{p} \right\} \times 100$

Where;

Air dry weight = (AD)

Oven dry weight = (OD)

Wetted weight = (WW)

Saturated surface dry weight = (SIS)

B. Bulk Density

Bulk density is the actual mass that would fill a container of unit volume and density is used to convert quantities by mass to quantities of volume. The density depends on how densely the aggregate are packed and consequently on the size distribution and shape of the particles for a coarse aggregate of a given specific gravity, the higher bulk density means there are few voids to be filled with sand and cement

Apparatus

a) A metal mould of 150mm x 150mm x 150mm.

b) A scale or balance readable and accurate to 0.5 percent of the weight of sample to be weighed

c) A straight metal tamping rod of circular cross section, long and rounded at both end

Procedure

Loose or uncompacted bulk density: The aggregate are gently lowered into the metal mould to over flowing and then leveled by rolling a rod across the top to level it. Care was taken to present as far as is possible segregation of the particle sizes of which the sample composed. The net

weight of the aggregate in the mould is then used to determine the bulk density in kg/m(3). The bulk density determined by this method is un-compacted bulk density.

Where;

Weight of mould = Wm

Weight of self compacted = WSC

Weight of fully compacted = WFC

Express as;

Bulk density of self compacted = WSC – WM/Vol. of mould

ii) Rodded or compacted bulk density: The metal mould is filled in three layers, each layer was rodded 25 times with a 16mm diameter rod, and weight is then taken. The net weight of the material is divided by its volume, to give the weight of the compacted bulk density. The result obtained for both self and fully compacted bulk density is given in chapter 4

C. Absorption Capacity

Water absorption of an aggregate is very important in determining the water/cement ratio for a given mix. It controls an important property as workability of the mix.

Apparatus

A weight balance

Dry soft absorbent cloth

A shallow tray

Water

Oven thermostatically controlled to maintain a temperature of 100°c

A wide mouthed glass vessel with flat ground lip and a plane ground disc of plate.

Glass to cover it, giving a virtually water-tight fit.

Procedure

The sample were first screened on 3/8 in (10mm) B.S. sieve and thoroughly cleaned to remove fine particles or dust and immersed in water in the glass vessel. The aggregate remained immersed at a temperature of 20°c for 24hours. The aggregate was then placed on dry cloth when the first cloth removes on further moisture. Then the was spread out and left exposed to the atmosphere for 20minutes. The aggregate was turned over once during this period and weighed

After the placement of the aggregate in a shallow tray in the oven at a temperature of 100°c for 24hours after which it was allowed to cool down in the airtight and weighed (w2).

The result is given in chapter 4.

E. Sieve Analysis

Sieve analysis is the separation of an aggregate into fraction. Each fraction consists of particles within specific limit, these being the openings of standard test sieves. The sieves are mounted within specific limit. They are placed in order of size with the largest size at the top and the smallest at the bottom.

The material is placed from the top and the sieve given a vigorous shake manually or mechanically. After shaking, the fraction of coarse aggregate was retain in the sieve above but the finer aggregate was then retain below the sieve. All size above 5mm are coarse aggregate and those smaller than 5mm are fine aggregate.

The grading curves are obtained by plotting the cumulative percentage passing on the ordinate and sieve sizes on the abscissa. A good grading gives a reasonable workability and minimum segregation.

Hence;

Weight retained = Mass retained on each sieves

Weight retained = weight retained/Total weight x 100%

Sieve Analysis for Fine Aggregate: The term fine aggregate means aggregate mainly passing a 4.75 (5.00mm) square mesh. The sieve analysis for the aggregate (sand) was done using mechanical grain analysis (sieve analysis).

Apparatus

Sets of sieve sizes ranging from 2.36mm to 75µm

Electric sieve shaker

Electronic balance

Materials for analysis (100grammes of sand gravel)

Set of brush

Sieve cover and pan at the bottom of sieve and weighing pan.

Procedure

1. The sieve wire meshed were cleaned using iron brush to remove particles that are contained.

2. The sample was then weighed and weight of the sieves was determined individually using electronic balance.

3. They were then arranged in decreasing aperture size (from coarse to fine aggregate) with the pan at the bottom of the last sieve.

4. The sample was then introduced into the arrangement of sieves from the top and was covered securely using the cover.

5. The whole arrangement of the sieves was taken to the sieves shaker. The shaker was on and set to 10minutes. During the shaking, the sieves were firmly held in place using hand. After shaking, the sieve were then weighed again with the weight of the sample retained in each of them was determined by deducting the initial weight from the final weight of sieves plus sample retained on them. The result of sieve analysis for sand is given in chapter 4.

Sieve analysis for coarse aggregate: The term coarse aggregate means an aggregate mainly retained on a 5mm B.S (4.75) square mesh. The aggregate used in this write up is river gravel and granite which is for the production of concrete. The same mechanical analysis employed for aggregate was also used for the coarse aggregate.

Apparatus

Set of sieves ranging from 20.0mm – 2.36

Weighing balance

Sieve shaker

Head pan for weighing the samples

Sieve cover and pan at bottom of the sieve

Material for analysis (1000g of granite)

Procedure

The procedure followed were the same for fine aggregate. The result obtain is recorded in chapter 4.

f. Compressive strength

The compressive strength of concrete was determined, using 150 mm cubes prepared and tested according to BS1881. Three cubes per measurement were cast to determine the compressive strength at the various ages. The compressive strength was taken on three samples and average is reported as a result.

g. Slump

Slump test was performed according to ASTM C 143. The reduction in slump in time was measured which involves measuring the slump of concrete at various time intervals. During the standing time, the concrete was covered to minimize water loss through evaporation

Procedure for determination of batching, mix Design and Concrete mixed

Batching

Before the concrete can be mixed together, the ingredients have to be measured in the correct proportion. The proportioning of the materials used, river gravel, granite, cement and sand including the volume of water used was weighed.

Mix Design

This is the process of selecting suitable ingredients of concrete and determining their relative proportions with the objective of producing concrete of certain minimum strength and design was accepted. The absolute volume method is assumed that the volume of compacted concrete is equal to the sum the absolute volume of all the ingredients.

Using the specific gravity method of batching, a mix ratio of 1:2:4 and water/cement ratio of 0.50 for the casting of 24 cubes for river gravel and for granite in the same proportions. Result in chapter 4.

Cement Mixing

The mixing of concrete could be done by hand when the volume to be used does not warrant the use of mechanical mixing plant, or by mixing plant when the volume is very large. In this research work, the mixing of concrete was done by hand manual method (hand mixing). The materials were measured out by weighing them on a clean mixing surface. The compositions were mixed dried thoroughly before water was added.

Apparatus

Head pan

Shovel

Cement

Weighing balance

Granite

River gravel

Trowel and scoop

Water.

Procedure

The head pan for measuring cement, aggregate and water was weighed and weight was recorded. The weight of the aggregate, cement and water were arrived by weighing each of these materials with the head pan and subtracting the weight of the head pan from the final weight. To arrive at the actual weight of each material. This procedure was carried out for the different types of aggregate with the same mix.

Each of the mix was dried thoroughly before water is being added, the mixes are thoroughly mixed with water using shovel and hand trowel until uniform color and same consistency was obtained.

Casting of cubes

The mould was polished to reduce friction which aid in removing the cubes. They were filled with the mixed sample in layers of three (3) and each layer was tamped 35times. After this process, the mould was then left for about 24hours to allow the cubes to set , before curing of concrete mixes commences. The results obtained are given in chapter 4.

Curing of cubes

The method of curing employed is by immersion in water for 7days, 14days, 21days, and 28days respectively from the day of casting. This was done for the two samples.

Crushing Machine

The cubes were dried in air, weighed and water axially placed the crushing machine with two side of the cubes faces in contact with the platen of the compressive strength crushing

machine**.** The machine was on and operated to crush all the cubes. The crushing strength was determined for 7, 14 , 21 and 28 days respectively. The results obtained are recorded in chapter 4

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

This chapter discuss the presentation and analysis of practical work carried out.

Research Question 1. What are the physical properties of concrete made with river gravel and concrete made with granite?

Table 2: Sieve Analysis for Granite

Sieve size	Weight of sieve (g)	Weight of sieve + sample (g)	Weight of sample retained (g)	Percentage retained (%)	Cumulative percentage passing (%)	Cumulative percentage retained (%)
28mm	1572	1572	-	-	100	-
20mm	1476	1764	288	28.8	71.2	28.8
14mm	1398	1771	373	37.0	33.9	66.1
10mm	1284	1424	140	14	19.9	80.1
6.3mm	1341	1413	72	7.2	12.7	87.3
5mm	1493	1568	75	7.5	5.2	94.8
3.35mm	1265	1289	24	2.4	2.8	9.72
Pan	812	840	28	2.8	-	-
			1000g			454.3

Table 3: Sieve Analysis for River Gravel

Sieve size	Weight of sieve (g)	Weight of sieve + sample (g)	Weight of sample retained (g)	Percentage retained (%)	Cumulative percentage passing (%)	Cumulative percentage retained (%)
20mm	1476	1879.2	403.2	40.32	59.68	40.32
14mm	1398	1875	477	47.7	11.98	88.02
10mm	1284	1391.2	107.2	10.72	1.26	98.74
6.3mm	1341	1352.6	12.6	1.26	-	-
5mm	1493	1493	-	-	-	-
3.5mm	1265	1265	-	-	-	-
Pan	812	812	-	-	-	-
			1000g			227.08

Fineness modulus $\frac{227.08}{100} = 2.27$

Table 4: Sieve Analysis for fine aggregate

Sieve size	Weight of sieve (g)	Weight of sieve + sample (g)	Weight of sample retained (g)	Percentage retained (%)	Cumulative percentage passing (%)	Cumulative percentage retained (%)
5mm	478	478	-	-	100	-
3.35mm	467	471	4	0.8	99.2	0.8
2.0mm	418	435	17	3.4	95.8	4.2
1.18mm	388	423	35	7	88.8	11.2

850µm	356	398	42	8.4	80.4	19.6
600µm	334	432	98	19.6	60.8	39.2
425µm	326	463	137	27.4	33.4	66.4
300µm	316	412	96	19.2	14.2	85.8
150µm	295	359	64	12.8	1.4	98.6
75µm	296	301	5	1	0.4	99.6
Pan	272	274	2	0.4	-	-
			500g	100		425.4

Fineness modulus = $\frac{425.4}{100}$ = 4.25

Table 5: specific gravity for sand

Tray no	1	2
Weight of cylinder (W_1)g	114.4	97.6
Weight of cylinder + sample (W_2	172.0	146.6
	398.2	376.4
Weight of cylinder + water +sample (W_3)g		
Weight of cylinder + water (W_4)	362.5	346.5
	2.63	2.57

Specific gravity = $\frac{W_2 - W_1}{(W_4-W_1) - (W_3-W_2)}$

Average specific gravity = $\frac{2.63 + 2.57}{2}$ = 2.60

Table 6: specific gravity river gravel

Tray no	1	2
Weight of cylinder (W_1)g	131.6	133.9
Weight of cylinder + sample (W_2	230.5	233.9

Weight of cylinder + water +sample (W_3)g	526.0	530.1
Weight of cylinder + water (W_4)	464.1	467.9
	2.67	2.67

$$\text{Specific gravity} = \frac{W_2 - W_1}{(W_4 - W_1) - (W_3 - W_2)}$$

$$\text{Average specific gravity} = \frac{2.67 + 2.67}{2} = 2.67$$

Table 7: specific gravity for granite

Tray no	Test 1	Test 2
Weight of cylinder (W_1)g	552.3	552.3
Weight of cylinder + sample (W_2	529.0	799.1
Weight of cylinder + water +sample (W_3)g	1718.3	1700.1
Weight of cylinder + water (W_4)	1547.0	1547.0
	2.66	2.63

$$\text{Specific gravity} = \frac{W_2 - W_1}{(W_4 - W_1) - (W_3 - W_2)}$$

$$\text{Average specific gravity} = \frac{2.66 + 2.63}{2} = 2.65$$

Table 8: bulk density for sand

Tray no	Compacted	Uncompacted
Weight of empty cylinder (W_1)kg	8.764	8.764
Volume of cylinder (V_0) m^3	0.00256	0.00256
Weight of cylinder + sample (kg)	12.268	11.704

Weight of sample (kg) $(W_2-W_1)= (W_3)$	3.504	2.940
Bulk density $(kg/m^3) = \frac{W_3}{V_0}$	1368.0	1148.4

The ratio of $\frac{\text{loose bulk density}}{\text{Compacted bulk density}} = \frac{1148.4}{1368.0} = 0.84$

Percentage of void $= \frac{\text{density of compacted – density of loose}}{\text{Loose density}} \times \frac{100}{1}$

$= \frac{1368 - 1148.4}{1148.4} \times \frac{100}{1} = 19.12\%$

Table 9: bulk density for granite

Test no	Compacted		Uncompacted	
Weight of empty cylinder (W_1)kg	(1) 1.0739	(2) 1.0739	(1) 1.0739	(2) 1.0739
Volume of cylinder (V_0) 10^{-3}	1.7289	1.7289	1.7289	1.7289
Weight of sample divided +sample (W_2) (kg)	3.993	3.598	3.598	3.590
Weight of sample (kg) $(W_2-W_1)= (W_3)$	2.9191	2.5241	2.5241	2.5161
Bulk density $(kg/m^3) = \frac{W_3}{V_0}$	1688.4	1459.9	1459.9	1455.3
Average	1688		1457.6	

The ratio of $\frac{\text{loose bulk density}}{\text{Compacted bulk density}} = \frac{1457.6}{1688} = 0.86$

Percentage of void $= \frac{\text{density of compacted – density of loose}}{\text{Loose density}} \times \frac{100}{1}$

$= \frac{1688 - 1457.6}{1457.6} \times \frac{100}{1} = 15.81\%$

Table 10: bulk density for river gravel

TEST No	COMPACTED		UNCOMPACTED	
Weight of empty cylinder (W_1)kg	(1)	(2)	(1)	(2)

	1.0739	1.0739	1.0739	1.0739
Volume of cylinder (V_0) 10 $^{-3}$	1.7289	1.7289	1.7289	1.7289
Weight of sample divided +sample (W_2) (kg)	4.120	3.998	3.690	3.660
Weight of sample (kg) (W_2-W_1)= (W_3)	3.0461	2.924	2.616	2.5861
Bulk density (kg/m^3)= $\frac{W_3}{V_0}$	1762	1691	1.513	1.496
Average	1726.5		1504.5	

The ratio of $\frac{\text{loose bulk density}}{\text{Compacted bulk density}} = \frac{1504.5}{1726.5} = 0.87$

Percentage of void = $\frac{\text{density of compacted} - \text{density of loose}}{\text{Loose density}} \times \frac{100}{1}$

$= \frac{1726.5 - 1504.5}{1504.5} \times \frac{100}{1} = 14.76\%$

Table 11: moisture content of sand (fine aggregate)

CAN No	**1**	**2**	**3**
Weight of can (g)	21.3	31.2	25.2
Weight of can + wet sample	55.6	68.30	82.18
Weight of can + dry sample (g)	55.2	67.9	81.56
Weight of moisture (g)	0.4	0.40	0.62
Weight of dry sample (g)	33.9	36.7	56.36
Moisture content	1.18	1.09	1.0
Average moisture content (%)		1.12	

Table 12: moisture content granite

CAN No	**1**	**2**	**3**
Weight of can (g)	24.8	24.9	25.0
Weight of can + wet sample	114.0	10.5	101.9
Weight of can + dry sample (g)	114.0	105.7	101.9
Weight of moisture (g)	0.00	0.00	0.00
Weight of dry sample (g)	89.2	80.8	76.9
Moisture content	0.00	0.00	0.00
Average moisture content (%)	0.00		

Table 13: moisture content for river gravel

Can no	1	2	3
Weight of can (g)	24.9	25.2	24.6
Wt of can+ wet sample (g)	56.3	81.3	89.2

Wt of water + dry sample (g)	56.2	81.3	89.1
Weight of moisture (g)	0.1	0.0	0.1
Weight of dry sample (g)	31.3	56.1	64.5
Moisture content (%)	0.32	0.00	0.16

Average = $\frac{0.48}{2}$ = 0.24

Table 14: water absorption for granite

Trial no	**1**	**2**	**3**
Weight of can (g) W_1	27.7	27.9	19.9
Weight of can + wet sample W_2	91.8	65.8	63.9
Wt of water + dry sample (g) W_3	91.3	65.5	63.6
Weight of dry sample (g) (W_3-W_1)	68.6	37.6	44.0
Increase in mass (g) (W_3-W_2)	0.5	0.3	0.3
Absorption (%)	0.73	0.30	0.68
Average (%)	0.74		

Table 15: water absorption for river gravel

Trial no	1	2	3
Weight of can (g) W_1	129.6	125	123.8
Weight of can + wet sample W_2	214.4	177.9	190.2
Weight of can + dry sample (g) W_3	213.7	177.5	189.7
Weight of dry sample (g) (W_3-W_1)	84.1	52.5	65.9
Increase in mass (g) (W_3-W_2)	0.7	0.4	0.5
Average (%)	0.53		

Table 16: Summary of physical properties of materials

Materials	Sharp sand	River gravel	Granite
Specific gravity	2.60	2.67	2.65
Bulk density (kg/m^3)	1368	1726.5	1688
Moisture content (%)	1.12	0.24	0.00
Water absorption (%)	-	0.53	0.74

Table 17: Summary of Contents Required

	Coarse aggregate (kg)	Fine aggregate (kg)	Cement (kg)	Water (kg)
Design mix for granite	63.04	25.54	13.44	6.72

Design mix for river gravel	63.96	25.34	13.34	6.67

Research Question Two. What is the compressive strength of concrete made from river gravel and granite.

Table 18.compressive strength for concrete made with river gravel.

S/N	Mix proportion	Water cement ratio	Age days	Weight of cube (kg)	Density of cube kg/m^3	Average density (kg/m^3)	Crushing load (KN)	Compressive strength (N/mm^2)	Average compressive strength (N/mm^2)
A1	1:2:4	0.50	7	7.64	2263.7		375	16.67	
A2	1:2:4	0.50	7	7.72	2287.4	2319	420	18.67	18.15
A3	1:2:4	0.50	7	8.72	2405.9		430	19.11	
A1	1:2:4	0.50	14	7.88	2334.8		470	20.89	
A2	1:2:4	0.50	14	8.08	2394.1	2390	600	26.67	23.71
A3	1:2:4	0.50	14	8.24	2441.5		530	23.56	
A1	1:2:4	0.50	21	8.00	2370.4		520	23.11	
A2	1:2:4	0.50	21	8.00	2370.4	2380	575	25.56	24.00
A3	1:2:4	0.50	21	8.10	2400		525	23.33	
A1	1:2:4	0.50	28	8.00	2370.4		620	27.56	
A2	1:2:4	0.50	28	8.02	2376.3	2372	615	27.33	27.33
A3	1:2:4	0.50	28	8.00	2376.3		610	27.11	

Table 19. Compressive strength for concrete made with granite.

S/N	Mix proportion	Water cement ratio	Age (days)	Weight of cube	Density of cube	Average density	Crushing load (KN)	Compressive strength (N/mm^2)	Average compressive strength

				(kg)	(kg/m³)	(kg/m³)			(N/mm²)
B1	1:2:4	0:50	7	7.76	2299.3		420	18.67	
B2	1:2:4	0:50	7	7.50	2222.2	2243	510	22.67	21.19
B3	1:2:4	0:50	7	7.45	2207.4		500	22.22	
B1	1:2:4	0:50	14	7.76	2299.3		550	24.44	
B2	1:2:4	0:50	14	8.00	2370.4	2297	490	21.78	23.78
B3	1:2:4	0:50	14	7.50	2222.2		565	25.11	
B1	1:2:4	0:50	21	7.62	2257.8		600	26.67	
B2	1:2:4	0:50	21	7.37	2183.7	2243	590	26.22	26.44
B3	1:2:4	0:50	21	7.72	2287.4		595	26.44	
B1	1:2:4	0:50	28	7.8	2322.9		630	28.00	
B2	1:2:4	0:50	28	7.92	2346.7	2347	610	27.11	28.00
B3	1:2:4	0:50	28	8.00	2370.4		650	28.89	

Table 20: Compressive Strength at Various Hydration Periods

Materials	Compressive strength N/m² (% strength gained)			
Concrete with granite	7days 21019 (85)	14days 23.78 (95)	21days 26.44 (106)	28days 28.00 (112)
Concrete with river gravel	18.15 (73)	23.71(93)	24.00 (96)	27.33 (109)

Research Question Three: what is the difference between the compressive strength of concrete made from river gravel and concrete made with granite

Table 20

S/N	Age(Days)	River Gravel Compressive Strength N/Mm^2	River Gravel Compressive Strength N/Mm^2	Granite Compressive Strength N/Mm^2	Granite Average Strength N/Mm^2	Differences In Compressive Strength Of River Gravel And Granite
C1	7	16.67	18.15	18.67	21.19	9.11
C2	7	18.67		22.67		
C3	7	19.11		22.22		
C1	14	20.89	23.71	24.44	23.78	0.21
C2	14	26.67		21.78		
C3	14	23.56		25.11		
C1	21	23.11	24.00	26.67	26.44	7.33
C2	21	25.56		26.22		
C3	21	23.33		26.44		
C1	28	27.56	27.33	28.00	28.00	2.00
C2	28	27.33		27.11		
C3	28	27.11		28.89		

Table 21: Compressive Strength at Various Hydration Periods

Materials	Compressive strength N/m^2 (% strength gained)			
Concrete with granite	7days 21019 (85)	14days 23.78 (95)	21days 26.44 (106)	28days 28.00 (112)
Concrete with river gravel	18.15 (73)	23.71(93)	24.00 (96)	27.33 (109)

Workability Test For Concrete Made With Granite

Water cement ratio = 0.50

Weight of cylinder partially compacted sample = 12.6kg

Weight of cylinder + fully compacted sample = 14.16kg

$$\frac{\text{Partially compacted}}{\text{Fully compacted}} = \frac{12.6}{14.16} = 0.89$$

Slump test for granite = 1.8cm = 18m. Gotten from the use of ruler

Workability Test For Concrete Made With River Gravel

Water cement ratio used = 0.50

Weight of cylinder partially compacted sample = 13.22kg

Weight of cylinder + fully compacted sample = 14.11kg

$$\frac{\text{Partially compacted}}{\text{Fully compacted}} = \frac{13.22}{14.11} = 0.94$$

Slump test for granite = 2.22cm = 22.2m. Done with the use of ruler

Findings

This section presents the findings of the study. The presentation of the finding is with regards to the research questions which are as follows:

1**) Physical Properties of Concrete Made With River Gravel And Concrete Made With Granite**

i) The fine aggregate(sand) used has a specified gravity of 2.60 with bulk density of 1368kg/m^3 compacted with an average moisture content of 1.12% and has a finess modulus of 4.25 which falls under the uniform grading according to ASTM grading requirements.

ii) The coarse aggregate (granite) used has a specifies gravity of 2.65 with bulk density of 1.688kg/m^3 compacted with an average moisture content of 1.12% and has a finess modulus of 4.25 which falls under the uniform grading according to ASTM grading requirements.

iii) The coarse aggregate (granite) used has a specific gravity of 2.65 with bulk density of 1688kg/m^3 compacted with an average water absorption of 0.74% and has a finess modulus of 4.54 which falls under the uniform grading according ASTM grading requirements.

iv) The coarse aggregate (gravel) used has a specific gravity of 2.67 with bulk density of 1726.5kg/m^3 compacted with an average moisture content of 0.24% and water absorption of

0.53% and has a fineness modulus of 2.27 which falls under the uniform grading according to ASTM grading requirements.

v) The slump value for the granite concrete mix is 18mm and 22.2 for the river gravel concrete which shows a higher workability is attained when the river gravel is used.These slump values however falls within 0.25mm which is classified by Neivlle as fine slump.

vi) The compaction factor also shows that the river gravel concrete has a higher workability of 0.94 as compacted to the granite concrete which is 0.89 and this means that the granite has a better workability than the river gravel as it falls between the standard required by BS1881: part 103 which is 0.80-0.92.

2) **Compressive Strength of Concrete Made With River Gravel And Concrete Made With Granite**

i) The compressive strength at 7days had an average of 18.15N/mm^2 and 21.19N/mm^2 for the river gravel concrete and granite concrete respectively.

ii) The 14days had an average of 24.00N/mm^2 and 26.44N/mm^2 for the river gravel concrete and granite concrete respectively.

iii) The compressive strength at 28days had an average of 27.33N/mm^2 and 28.00N/mm^2 for river gravel concrete and granite respectively.

iv) The result of the compressive strength shows that concrete made with granite has gained the strength of 26.44N/mm^2 (106%) at 21days while the concrete made with river gravel has a strength of 24N/mm^2 (96%) at 21days.

v) The results of the compressive strength shows a gradual increase in strength as the hydration period increases for both granite and river gravel concrete.

Discussions of Findings

The specific gravity for fine aggregate gotten for fine aggregate shows that the fine aggregate used in this research is of standard with American Standard for Testing and Measurements. The coarse aggregate used (granite) also falls under the ASTM requirement for coarse this indicate it is of standard since it falls within the required range of 2.26. The river gravel used falls under the gradding requirement which is 3.00 while the obtained is 2.27 according to ASTM. The slump test for river gravel shows that river gravel have a higher workability than granite, this means river gravel can be replica to granite. For the compacting factor the result indicates that granite has a better workability than the river gravel and it falls between the standard required by BS 1881:part 103 which is 0.8-0.9.

Table 18-19 shows the compressive strength test of concrete made with river gravel and with granite. The result indicate that the compressive strength of 150x150mm with mix 1:2:4 varies from 18.15N/mm^2 at 7days to 23.71N/mm^2 at 14days to 24.00N/mm^2 at 21days and finally 27.33N/mm^2 at 28days. That of granite also varies with same mix of 1:2:4 having strength of 21.19N/mm^2 at 7days to 23.78N/mm^2 at 14days, 26.44N/mm^2 at 21days and 28.00 at 28days.These results shows that there is continuous increase in the strength of both as their curing age is, while concrete made with granite have the higher compressive strength than that of river gravel.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATION.

This chapter presents a summary, conclusion and recommendation of the research work and data collected.

Summary of The Study

This study investigate the comparism of the compressive strength of river gravel and granite concrete in Minna Niger State. Chapter one clearly articulates concrete as one of the most useful building materials in construction industries and durability. And the use of granite and river gravel as coarse aggregates. The purpose of the study was itemized and significance identified. The three research questions were raised according to the stated purpose of the study.

Chapter II discusses the literature review related to the study under the following headings;

1. Concrete as a building material
2. Quality requirement of concrete
3. Properties of concrete
4. Types of concrete

Chapter III involves research methodology which includes; research design that was employs into this study is an experimental study for the investigation on the comparism of river gravel and granite in Minna on the compressive strength of concrete. The materials used was granite, river gravel, sand, cement and water, while the work shop used was Civil engineering Department Workshop of Federal University of Technology Gidankwano Campus Minna. The procedure for determining physical properties are;

absorption capacity, moisture content, sieve analysis, bulk density, specific gravity of granite and river gravel concrete. Procedures for determining batching mix design, concrete mix. Procedure for determining functional properties of concrete are slump test, curing, and compressive strength.

The results, presentation and analysis of data was made in chapter four, table 2-21, were presented and analyzed and the result was attained, findings were stated and discussion of findings were derived from the study. Finally the study was summarized in chapter five, implication of the study was found and discussed, the study was concluded, recommendations were made and suggestion for further work was stated.

Implication

The findings of this study have far reaching implication on the comparism of the compressive strength of river gravel and granite in Minna Niger State. However, since this study focused on comparing the compressive strength of concrete separately made with two aggregates (river gravel and granite). It will be beneficial to the building industries, especially builders who are directly involve in the construction work. It will also be beneficial to individual whose dream is to own a house or an estate. The society will also benefit from the use of river gravel as building material in the area of high price of nominal building materials such as granite, sand, cement among others. It will also be of benefit to the Federal Governments as they will now spend less in putting up structures.

Conclusion

Based on the research findings, it was concluded that the compressive strength of concrete made with granite is higher than that of concrete made with river gravel after 28days of curing but not withstanding, the compressive strength of concrete made with river gravel was able to attain the required strength according to ASTM (America Standard for Testing and Measurement) standard for concrete strength at 28days of curing. Therefore, river gravel can be used in place of granite where the required compressive strength needed for construction is not more than $25N/mm^2$

Recommendations

Based on the findings of this study, the following recommendations were drawn:

1. Concrete made with river gravel should be highly recommended as replica to granite, where granite is not available for construction work where a compressive strength of $25N/mm^2$ is desired at 28days.
2. River gravel should be use as alternative coarse aggregate material to the conventional granite in concrete production in Nigeria due to its physical and durability properties.
3. River gravel should be use for heavy construction work such as beam, column, retaining of walls among others since it was able to attain the required compressive strength at 28days.

Suggestion For Further Study

1. The behavior of concrete made with river gravel should be further investigated to know the creep properties, thermal shrinkage and young modulus of elasticity.
2. Geographical mapping of the deposit should be carried out to know the distribution and the viability of establishing a production plant for the processing of the aggregate.

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APPENDIX I

Sieve Analysis Process

Bulk Density Process

APPENDIX II

Concrete mixing process

APPENDIX III

Slump test process

Curing process

APPENDIX IV

Putting the casted cube inside the machine for crushing

Taking reading of the crushing load

s

APPENDIX V

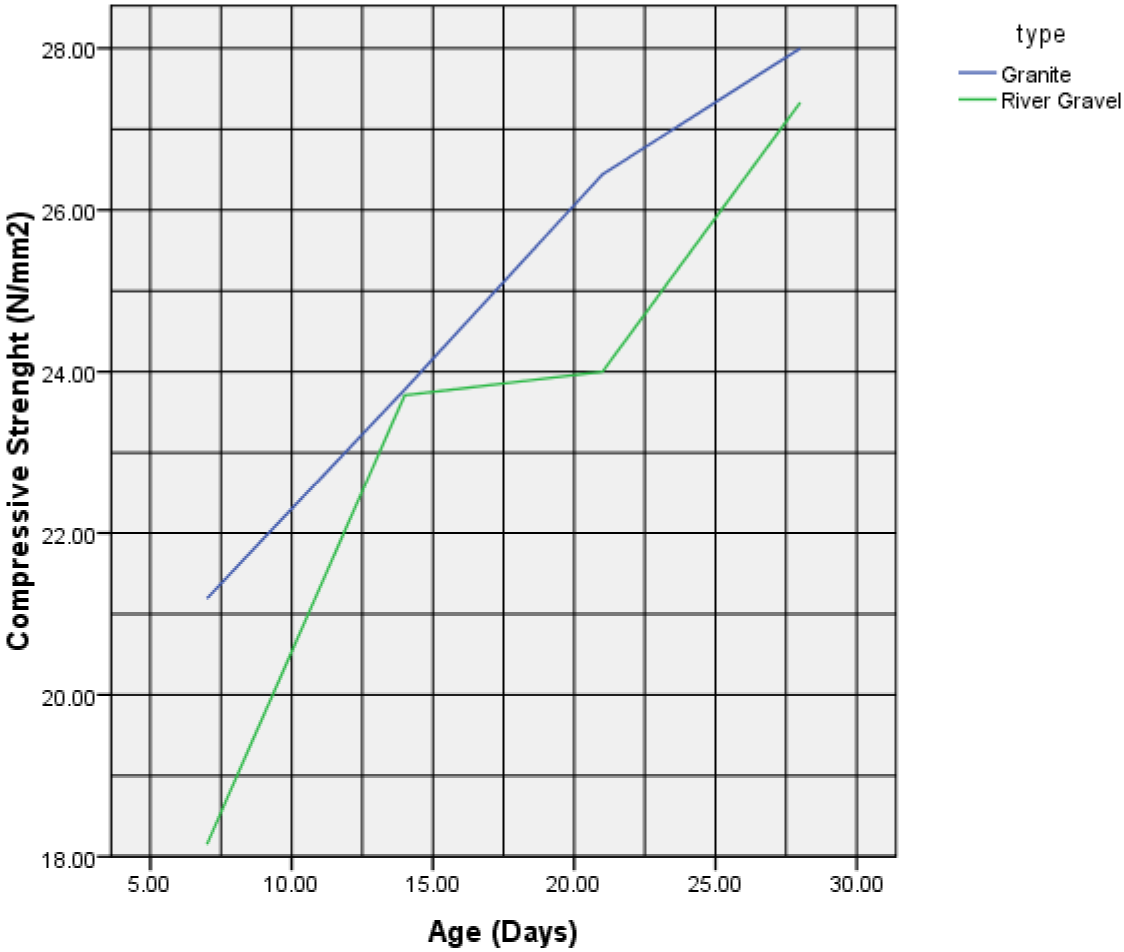
Compressive strength for river gravel

APPENDIX VI

Compressive strength for granite

APPENDIX VII

Strength difference between river gravel and granite



DESIGN MIX FOR GRANITE

Using specific gravity method

Absolute volume for 0.50 water/ cement ratio

Design mix = 1: 2 : 4

Density of granite = $\frac{4 \times \text{compacted bulk density}}{\text{Specific gravity}} = \frac{4 \times 1688}{2.657} = 2547.9 \text{kg/m}^3$

Density of sand = $\frac{2 \times 1368}{2.60} = 1052.3 \text{ kg/ m}^3$

Density of cement = $\underline{1 \times 1440}$ = 457.1 kg/m^3

Density of water = $\frac{0.50 \times 1440}{1}$ = 720 kg/m^3

Total absolute volume = 4777.3

Absolute volume = $\frac{4777.3}{1000}$ = 4.777m^3

Volume of mould = 0.15 × 0.15 × 0.15 = 0.003375

For 12 moulds = 12 × 0.003375m^3 = 0.0405m^3

Add 10 % for waste = $\underline{0.00405\text{m}^3}$

0.0446m^3

Granite = $\frac{4 \times 1688 \times 0.0446}{4.777}$ = 63.04 kg

Sand = $\frac{2 \times 1368 \times 0.0446}{4.777}$ = 25.54kg

Cement = $\frac{1 \times 1440 \times 0.0446}{4.777}$ = 13.44kg

Water = $\frac{0.50 \times 1440 \times 0.0446}{4.777}$ = 6.72kg

DESIGN MIX FOR RIVER GRAVEL

Using specific gravity method

Absolute volume for 0.50 water/ cement ratio

Design mix = 1: 2 : 4

Density of granite = $\frac{4 \times \text{compacted bulk density}}{\text{Specific gravity}}$ = $\frac{4 \times 1726.5}{2.67}$ = 2586.5kg/m^3

Density of sand = $\frac{2 \times 1368}{2.60}$ = 1052.3 kg/ m^3

Density of cement = $\underline{1 \times 1440}$ = 457.1 kg/m^3

Density of water = $\frac{0.50 \times 1440}{1}$ = 720 kg/m^3

Total absolute volume = 4815.9 kg/m^3

Absolute volume = $\frac{4815.9}{1000}$ = 4.816m^3

Volume of mould = 0.15 × 0.15 × 0.15 = 0.003375m^3

For 12 moulds = 12 × 0.003375m^3 = 0.0405m^3

Add 10 % for waste = 0.00405m^3

= 0.0446m^3

Granite = $\frac{4 \times 17265.5 \times 0.0446}{4.816}$ = 63.96 kg

Sand = $\frac{2 \times 1368 \times 0.0446}{4.816}$ = 25.34kg

Cement = $\frac{1 \times 1440 \times 0.0446}{4.816}$ = 13.34kg

Water = $\frac{0.50 \times 1440 \times 0.0446}{4.816}$ = 6.67kg