International Refereed Journal of Engineering and Science (IRJES)
ISSN (Online) 2319-183X, (Print) 2319-1821
Volume 5, Issue 4 (April 2016), PP.45-61

Optimization of the Strength of Concrete Made From Nigerian Processed Aggregate

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Abstract:- This paper aims to optimize the strength of concrete produced with concrete made from Nigeria processed aggregate. Coarse Aggregates are the main components of concrete and occupy about 70 – 80% of the total volume of concrete. Their properties have a profound effect on the various properties of concrete when wet as well as after hardening. There are many sources in south-east and south-west Nigeria with abundant supply of crushed stone aggregates. In this paper, comparisons were made of the various properties of concrete made of crushed rock aggregates from six (6) sites in two different locations; three (3) samples each from Abakaliki in Ebonyi state and Auchi in Delta state Nigeria respectively. The properties compared include workability, bulk density, specific gravity and strength to enable the determination and comparison of their compressive strengths. Need was felt for this study as the major private and government constructions that are carried out in these geo-political zones of the quarry sites use any available stone within their reach. Aggregates of 20mm size were employed in the investigation. The mix ratio and water/cement ratio adopted for the study were 1:2:4 and 0.5 respectively. A total of forty-eight(48) concrete cubes (150mm x 150mm x 150mm) were casted of which two (2) cubes were crushed for each sample aggregate at each maturity age namely; 7, 14, 21, and 28 days. All cubes reached the target mean strength after 7 days of curing. The 28 days strengths of the concretes on the average of two locations were 25.67N/mm^2 and 22.07N/mm^2.Consequently, it was concluded that the strength of concrete depends greatly on the specific gravity of crushed stones as well as the weight of concrete.

Keywords:- Aggreates, Concrete, Crushed, Optimization and Strength.

I. INTRODUCTION

Concrete is a composite material which consists of filler and binding materials where the filler materials are fine or coarse aggregate and binding materials are cement paste (Mindess, Young & Darwin, 2003). At the earlier stage of concrete development, it was believed that aggregates were chemically inert and held together by cement. But modern technology proves that aggregates exhibits chemicals bond at the interface of aggregate and paste. Aggregate is such important matter in concrete that maximum properties and workability of concrete are directly changed with the properties of aggregate. Density of concrete is determined by the aggregate density as well as soft with porous concrete produce weak concrete with lower wear resistance. That is why the overall or mechanical properties of concrete depends on the certain properties of aggregate like source of aggregates, normal, light or heavy weight aggregate, size of aggregate, shape of aggregate, crushing type of aggregate, angularity index, surface texture, modulus of elasticity, bulk density, specific gravity, absorption and moisture content, bulking of aggregates, cleanliness, soundness of aggregates, thermal properties and grading of aggregates (Mindess et al., 2003). Moreover, Interfacial Transition Zone (contact surface between aggregate and cement paste) plays an important role in strength and durability of concrete.

Mindess et al., (2003) asserted that aggregates should be clean and free from impurities which are likely to interfere with the process of hydration, prevention of effective bond between the aggregates and matrix and it reduces the durability of concrete. Sometimes excessive silt and clay contained in the fine or coarse aggregate may result in increased shrinkage or increased permeability in addition to poor bond characteristics
According to Orie (2008) optimization of the strength of concrete produced with coarse aggregate involves the adoption of the available resources to meet varying engineering criteria. One of the major goals of optimization of the strength of concrete produced with coarse aggregate is improvement in the compressive strength of concrete.

Previous research has shown that dust-of fracture aggregate can be used as part of the paste volume which is approximately 75um. The degree of packing is expressed in terms of the amount of solid aggregate minerals per unit volume. The mathematical expression is simply "unity minus porosity" (De Larrard, 200); the degree of packing is function of the grading curve and the shape of the particles.

Packaging of an aggregate has an indirect effect on the strength of the concrete made with coarse aggregate. If the packaging is good, the water requirement will be smaller and a lower water-cement ratio may be used to provide a higher strength concrete. For design and research of medium concrete, methods that examine concrete as a collection of bond particles are promising. Those methods can be used for improvement of concrete cost minimization or other optimization problem (De Larrard, 200).

This work describes the evaluation of the optimized strength of concrete produced with coarse aggregate from two different locations (Auchi and Abakaliki) in this work, the coarse aggregate from Auchi was gotten from Setraco quarry site which is located in a village called Imeke along Iyuku-Ijuku after Auchi about 4km from Iyuku and the sample size is 15-22mm. Also the second sample was obtained from BABA Rock quarry which is also located at Iyuku-Imeke Ijattu road near Auchi and the sample size was 15-22mm.

The second locations which it's samples gotten from Abakaliki quarry located at Mgbo village in Ohukwu local government area of Ebonyi State called the Diamond Industrial Quarry and Chigbo Quarry Okposi Umuaghara in Ezza North Local Government Area of Ebonyi State, the sizes rage are also 15-22mm, since the most important property of concrete is its compressive strength, these two samples of different locations are to be used,. The fine aggregate was obtained from River Niger.

Also preliminary laboratory investigations are to be conducted to ascertain the suitability of using the aggregate for construction work. Test which are to be conducted are sieve analysis, moisture content, Bulk density, specific gravity and impact resistance test. The strength of concrete essentially depends on the integrity of the cement paste and the nature of the coarse aggregate.

The purpose of this work is to provide a quantitative method for optimizing concrete strength produced with coarse aggregate from these two locations and also making adjustments during the progress of work even during constructional use of these two locations samples.

1.1 Background of Study: Optimization of the strength of concrete produced with coarse aggregate from Mgbo quarry village in Ohukwu local government area which is known as Diamond industrial quarry and also coarse aggregate from Diamond industrial quarry and alos coarse aggregate from Chigbo quarry, Okposi Umuagbara in Ezza north local government area of Ebonyi State, Abakaliki consist of comparing two concrete strength produced with coarse aggregate from Setraco quarry site in Imeke along Iyuku-Ijattu road and Baba rock quarry site Iyuku-Imeke Ijattu near Abuchi in Edo State.

Since the aggregate has a lot of role to play in concrete strength production, aggregate having a good grading, in the sense that it contains particles of a wide range of size with voids between particles filled by successively smaller particles, would generally have a relatively high packaging density. In order to achieve a better package of aggregate, the coarse aggregate from Auchi and Abakaliki will undergo sieve analysis. The maximum density theory calls for in ideal grading curve, which is parabolic in shape when plotted to a natural scale. However, such an "ideal" grading curve, though capable of minimizing the amount of cement paste needed, produced a harsh concrete mix. In actual practices the addition of more than enough cement paste to fill the voids of the fine aggregate would produce a more workable concrete mix and high compressive strength.

Optimization of concrete strength, consist of selecting the best optimal strength of concrete produced from coarse aggregate of the two locations and different aggregate types which is best suitable for construction work. The properties that should be considered are:

i. The compressive strength
ii. Workability
iii. Durability of the concrete produced from the samples of these locations.

The optimization process must take into account the factors that have a major effect on the strength of concrete. Because of the variability of concrete strength, the mix must be designed to have a considerably higher mean strength than specified in order to choose the best optimal results of the different strength produced by the use of the different types of aggregate in the concrete production. The minimum strength has been replaced in British standard and codes of practice such as BS 5328 and BS 8110, by characteristic strength.

1.2. Statement of Problem: Arising from numerous reported cases of building collapsed Ezeagu et al, (2015) and Ezeagu (2007), aggregate whether local or processed has been found to be one of the contributory factors that affect collapse of structure. This work concentrate on the processed aggregate gotten from areas where several reported cases of collapse has occurrence in south-south and southeastern Nigeria. Abakiliki and Auchi quarry are the major sources of processed aggregate used in Nigeria. And several report cases of collapsed has occurred even with the use of the processed aggregate. Therefore the need for this research necessary in order Optimize the strength of concrete made from Nigeria processed Aggregate.

1.3. Aim and Objective the Study : The aim of this research work is to optimize the strength of concrete produced with concrete made from Nigeria Processed aggregate. The objectives of the study are:

1) To develop a working manual that will guide local concrete users.
2) To compared the obtained results from the two major quarries.
3) To find out its workability, compressive strength, durability and economic aspect of the concrete production
4) To determine the different packaging of the particles of the coarse aggregate of these two locations
5) To forestall possible collapse emanating from the wrong use of these aggregates

6) Also to determine the specific gravity of both samples of coarse aggregate of these two locations to be able to optimize the concrete strength produced from these aggregate.
7) To determine the impact resistance test which will be carried out on the concrete produced with this coarse aggregate type of different locations and also to choose the best optimal strength of concrete produced with these aggregates.
8) To determine the best suitable coarse aggregate of optimal strength for construction work. Prior to this many construction has been carried out without proper investigation and this has led to many failures in some of the structures. Therefore, this project work will provide an opportunity and raise a standard to be followed since there is a direct comparison of two different aggregates that will give a suitable strength for construction

1.4. Significance of the Study : This study gives various insights into the various implications of optimizing the strength of concrete produced with concrete made from Nigeria processed aggregate. The following stakeholder's will benefit from this study; construction companies and builders. The finding from this research would enable them to know the strength of concrete produced with concrete made from Nigeria processed aggregate in order to avoid failure, collapse of buildings and road construction. Most of these failure and collapse is as a result of inadequate investigation, weak concretes and substandard coarse aggregates. The findings from the study will show the importance of optimizing the strength of concrete before use.

1.5.Scope of the Work: The study evaluates the optimization of strength of concrete produced with Nigerian processed aggregates. The coarse aggregate where obtained from Auchi Quarry represent the major source of aggregate from the south-south Nigeria and the Abakeliki quarry represent that for the South East. The fine where obtained from the River Niger sample and this is seen to be one of the major sought after fine aggregate in Nigeria.

a. Sieve analysis
b. Specific gravity
c. Bulk density
d. Aggregate Compaction Value (ACV)
e. Slump test
f. Impact resistance test.

II. LITERATURE REVIEW

The literature review outlined the current state of knowledge on aggregate for concrete, especially on alternative coarse aggregate produced from concrete. Concrete as a construction material has the largest production of all materials used in construction. Concrete required for extensive construction activity can always be made available, since the ingredients of concrete are materials of geological origin.

The rationale for the use of alternative aggregate in concrete technology is examined. It is supported with examples of the successful use of concrete made from coarse aggregate. The literature review also elaborated on compressive strength of concrete made with coarse aggregate. A number of conclusions have been reached based on available literature, discussions and consultations with professionals from relevant engineering, research and scientific disciplines, and the three main issues identified.

Firstly, there is growing evidence of the feasibility of substituting natural aggregate in concrete manufacturing and also an increased use of selected aggregate made from coarse aggregate in concrete production.

Secondly, there is evidence that some properties of aggregate such as porosity, shape and surface texture of the aggregate could have some positive impacts on the mechanical and acoustic properties of concrete made from such aggregate.

And thirdly, the inherent and purposely introduced porosity of concrete leads to increased sound absorption of acoustic barriers made from such concrete. This thesis reports on the comparative investigation of compressive strength of concrete made with coarse aggregate from related literature.

III. Methodology

The materials used in the research were ordinary Portland cement from Dangote Cement Factory, Portable Tap Water, and Crushed Stones from Abakaliki, Ebonyi State and Auchi, Edo State as well as river sand from River Niger, Anambra State.

3.1 Materials Used

The following materials were used for the experiment:

I. **Cement**: Ordinary Portland Cement (OPC) locally available in Nigeria, Dangote Cement brand name in 50kg bag was used for the experiment.

II. **Water**: Portable water from material testing laboratory, Niger Construction Limited was used.
III. **Fine Aggregate**: Naturally occurring river sand was obtained from the banks of River Niger, Anambra State.
IV. **Coarse Aggregate**: Crushed stones were obtained from Crushed Rock Industries quarry in Abakaliki, Ebonyi State and Auchi, Edo State.

3.1.2 ***Equipment Apparatus***

1. Mould 2. Spade 3. Head pan 4. Sieve 5. Electronic weighing machine 6. Taming rod 7. Spanner 8. Manual Compressive Machine 9. Scoop 10. Hand Trowel 11. Hand Brush 12. Gravity bottle 13. Grease 14. Oven

1. Mould

2. Spade

3. Head pan

4. Sieve

5. Electronic weighing machine

6. Spanner

7. Manual Compressive Machine

8. Scoop

9. Hand Trowel

10. Hand Brush

11. Gravity bottle

13. Grease

14. Oven

3.1.3 Uses Of Apparatus

Mould: Four 150 x 150mm cube mould was used for moulding the concrete after mixing
One 150 x 100mm rectangular mould was used for compacted and uncompacted bulk density.
One circular mould was used for aggregate compaction value (ACV).
Spade: The spade is about 1m long and it is used for mixing, turning and transferring mixed concrete to the mould.

Head Pan: This is metallic rectangular pan used to convey materials like cement, aggregate (fine or coarse aggregate) and water from one place to another.
Sieve: This is a metallic plate with holes of certain standard sizes used in separating of aggregate into mean sizes or grades. The sieve have standard number which expressed as or the size of opening in mm, the sieves must conform to the standard of BS 410 of 1969 for test purposes.

Electronic weighing balance: It is rectangular in shape, with four screws stand metal plate at the top where samples are placed, it reads in digital form.
It operates with the help of power (alternated or direct current) used in weighing materials such as cement, aggregate and water, it has the capacity of carrying a maximum weight of 10kg.

Tamping rod: This is about 1m long with round surface bottom; it is used in tamping the concrete in the mould to achieve the desired compaction.

Spanner: This is metal hand tool with jaws opened at both ends, used for tightening over and twisting screwed mould parts.

Hand trowel: It is a tool with a flat blade and a short wooden handle used for spreading of concrete and smoothing of the surface of the molded materials.
Grease: It is a thick oily substance used for lubricating of the mould for easy removal of the cast cube from the mould with it is hardened.

Scoop: It is a bowl-shaped tool with a handle used to lift cement and aggregates from where they are kept to where they are weighed.

Hand brush: It is an implement consisting of multiple more or less flexible bristle or other filaments attached to a handle and used for clearing and greasing the mould.
Gravity bottle: It is a container made of glass and having a tapered neck used for holding both water and aggregate to know its specific gravity.

Manual Compressive Machine: This is a hydraulic machine which consist of a steering like screw that keeps the plate in position with the cube, an iron handle of about 600mm long which is used to generate pressure when stress is applied. It also has a scale which indicates the crushing load of the machine and reads in accuracy of 0-200 tones. This machine is mounted on a rigid platform.

Electric Oven: It is an electric powered chamber used for heating and drying wet samples like aggregates (fine and coarse) before they are used for the test to avoid errors in results.

3.2 Methods
The following tests were carried out
- Sieve Analysis
- Bulk Density
- Specific Gravity
- Impact Resistance Test
- Compressive Strength Test

3.2.1 Sieve Analysis:
Sieve analysis (using BS 410:1986), was carried out on the crushed stones to obtain a uniform grade size of 20mm that was used. The aggregate was washed and oven dried before passing it through the various sieves. The arrangement of sieves was from 50mm on top to 12.5mm at the bottom. It was done manually.

3.2.2 Bulk Density: The test was done in accordance with procedures prescribed in BS 812: Part 2(1975).
3.2.3 Specific Gravity: The apparent specific gravity test was carried out in accordance with the procedures in BS 812: Part 2(1975).

3.24. Specific Gravity Determination
Tables 3.1 and 3.2 give results of specific gravity determination.

$$S.G = \frac{W_2 - W_1}{(W_4 - W_1) - (W_3 - W_2)} \quad \text{……… 3.1}$$

Where
W_1= weight of empty flask
W_2= weight of flask + sample
W_3= weight of flask + sample + water
W_4 = weight of flask + water

Table 3.1: Specific Gravity for Abakaliki Sample

Sample l.D	Specific Gravity	Average S.G
AB 1	2.671	
AB2	2.658	2.674
AB3	2.693	

Table 3.2: Specific Gravity for Auchi Samples

SAMPLE I.D	SPECIFIC GRAVITY	AVERAGE S.G
AU 1	2.638	
AU 2	2.664	2.650
AU 3	2.649	

3.2.5 Impact Resistance Test: The test was performed in accordance with the procedures in BS 812(1975) and BS882 (1983).

3.2.6 Compressive Strength Test: Metal moulds measuring (150mm x 150mm x 150mm) were used to mold the concrete cubes. A total of 48 cubes were prepared with mix ratio of 1:2:4 and w/c ratio of 0.5. The samples were tested at the ages of 7, 14, 21 and 28 days respectively.

3.3 Mixing of Concrete

The batching of concrete was done manually by the use of hands. Different constituent materials were measured and weighed after which the proper mixture took place in the following order.

i. Cement was mixed with fine aggregate on a water tight none absorbent platform until the mixture was thoroughly blended.
ii. Coarse aggregate was added and mixed properly until it was uniformly distributed throughout the batch.
iii. Water was added and mixed until the concrete appears to be homogenous and of the desired consistency.

3.4 Slump Test

The workability of a concrete can be measured by the concrete slump test. A simplistic measure of the plasticity of a fresh batch of concrete following the ASTMC 143 test standards was made.
The slump was measured by filling “ABRAMS Cone” with a sample of fresh batch of concrete. The cone was placed with the wide end down onto a level, non-absorptive surface. It was then filled in three layers of equal volume, with each layer tampered with a steel rod to consolidate the layer in 25 numbers of times. The cone was carefully lifted and the enclosed material slumps a certain amount due to gravity.
The slump was measured with a rule calibrated in cm and values recorded. This was done in accordance to BS 1881: Part 102(1983) and BS 1881: Part 108 (1983).

3.5 Placing of Fresh Concrete in the Mould

Below are the processes that were followed in the filling of the mould with concrete.
a. The mould was cleaned and rubbed with condemned oil.
b. The mould was filled in layers of approximately 50mm thick.
c. Each layer was compacted with 25 blows of tamping rod.
d. The top surface was leveled and smoothened with a trowel.

3.6 Curing:

The test specimens were stored at the damped corner of the laboratory for 24 hours and after this period the specimens were removed from the molds and kept submerged in clear fresh water until taken out prior to test. Curing of the cubes was done according to BS 1881: Part 111 (1983). The concretes were tested for compressive strength at the ages of 7, 14, 21 and 28 days.

3.7 Testing of Concrete Specimens

The testing was done in accordance with BS 1881: Part 116(1983) and BS 1881 : Part 117 (1983). The cube samples after being dried were weighed and placed between hardened steel bearing plates on a universal compression machine. This was used to compute the compressive strength which is the ratio of the failure load to the cross sectional area of the sample expressed in N/mm2. Two(2) samples were used for each test and the average result adopted as the compressive strength.

CHAPTER FOUR
IV. RESULTS

The results of the conducted practical are presented here below as regard their effects on the compressive strength of concrete.

4.1 Calculated Results

Table 4.1: Uncompacted bulk density for Baba Rock Quarry

Sample	1 (kg)	2(kg)	3(kg)
Wt of sample + mould	7.154	7.133	7.128
Wt of mould	1.192	1.192	1.192
Wt of sample	5.962	5.941	5.936
Volume of mould (cm^3)	4050	4050	4050
Bulk density (g/cm^3)	1.472	1.467	1.466
Average bulk density (g/cm^3)	1.468	1.468	1.468

Table 4.2: Compacted bulk density for Baba Rock Quarry.

Sample	1 (kg)	2(kg)	3(kg)
Wt of sample + mould	8.139	8.159	8.211
Wt of mould	1.192	1.192	1.192
Wt of sample	6.947	6.967	7.019
Volume of mould (cm^3)	4050	4050	4050
Bulk density (g/cm^3)	1.715	1.720	1.733
Average bulk density (g/cm^3)	1.723	1.723	1.723

Tabe 4.3 Uncompacted bulk density for Chigbo Quarry.

Sample	1 (kg)	2 (kg)	3(kg)
Wt of sample + mould	7.052	7.060	7.202
Wt of mould	1.192	1.192	1.192
Wt of sample	5.860	5.868	6.010
Volume of mould (cm^3)	4050	4050	4050
Bulk density (g/cm^3)	1.447	1.449	1.484
Average bulk density (g/cm^3)	1.460	1.460	1.460

Table 4.4: Compacted bulk density for Chigbo Quarry

Sample	1 (kg)	2(kg)	3(kg)
Wt of sample + mould	8.412	8.214	7.999
Wt of mould	1.192	1.192	1.192
Wt of sample	7.220	7.022	6.807
Volume of mould (cm^3)	4050	4050	4050
Bulk density (g/cm^3)	1.783	1.734	1.681
Average bulk density (g/cm^3)	1.733	1.733	1.733

Table 4.5: Uncompacted bulk density for Setraco Quarry

Sample	1 (kg)	2 (kg)	3 (kg)
Wt of sample + mould	7.530	7.529	7.572
Wt of mould	1.192	1.192	1.192
Wt of sample	6.330	6.337	6.380
Volume of mould (cm^3)	4050	4050	4050
Bulk density (g/cm^3)	1.563	1.565	1.575
Average bulk density (g/cm^3)	1.568	1.568	1.568

Table 4.6: Compacted bulk density for Setraco Quarry

Sample	1 (kg)	2 (kg)	3 (kg)
Wt of sample + mould	8.346	8.557	8.236
Wt of mould	1.192	1.192	1.192
Wt of sample	7.154	7.365	7.044
Volume of mould (cm^3)	4050	4050	4050
Bulk density (g/cm^3)	1.766	1.819	1.739
Average bulk density (g/cm^3)	1.775	1.755	1.775

Table 4.7: Uncompacted bulk density for fine aggregate from Onitsha

Sample	1 (kg)	2(kg)	3 (kg)
Wt of sample + mould	8.368	8.346	8.355
Wt of mould	1.192	1.192	1.192
Wt of sample	7.176	7.154	7.163
Volume of mould (cm^3)	4050	4050	4050
Bulk density (g/cm^3)	1.772	1.766	1.769
Average bulk density (g/cm^3)	1.769	1.769	1.769

Table 4.8: Compacted bulk density for fine aggregates from river Onitsha

Sample	1 (kg)	2(kg)	3(kg)
Wt of sample + mould	8.973	9.020	8.999
Wt of mould	1.192	1.192	1.192
Wt of sample	7.781	7.828	7.807
Volume of mould (cm^3)	4050	4050	4050
Bulk density (g/cm^3)	1.921	1.933	1.928
Average bulk density (g/cm^3)	1.927	1.927	1.927

Table 4.9: Uncompacted bulk density for Diamond Quarry

Sample	1 (kg)	2 (kg)	3 (kg)
Wt of sample + mould	6.987	7.084	7.031
Wt of mould	1.192	1.192	1.192
Wt of sample	5.795	5.892	5.839
Volume of mould (cm^3)	4050	4050	4050
Bulk density (g/cm^3)	1.431	1.455	1.442
Average bulk density (g/cm^3)	1.443	1.443	1.443

Table 4.10: Compacted bulk density for Diamond Quarry

Sample	1 (kg)	2 (kg)	3 (kg)
Wt of sample + mould	8.241	8.341	7.994
Wt of mould	1.192	1.192	1.192
Wt of sample	7.049	7.149	6.802
Volume of mould (cm^3)	4050	4050	4050
Bulk density (g/cm^3)	1.740	1.765	1.680
Average bulk density (g/cm^3)	1.728	1.728	1.728

Table 4.11: Specific gravity of fine aggregate

Sample	1 (kg)	2 (kg)
W1	0.023	0.23
W2	0.073	0.073
W3	0.062	0.060
W4	0.098	0.096
Specific gravity	2.786%	2.643%

AV.Sp. Gravity = 2.715%

Table 4.12: Specific Gravity of Baba Rock Quarry

Sample	1 (kg)	2 (kg)
W1	0.516	0.516
W2	1.557	1.557
W3	1.039	1.111
W4	1.885	1.928
Specific gravity	2.708%	2.679%

AV. Sp. Gravity = 2.694%

Table 4.13: Specific Gravity of Chigbo Quarry

Sample	1 (kg)	2(kg)
W1	0.516	0.516
W2	1.557	1.557
W3	0.997	1.052
W4	1.860	1.895
Specific gravity	2.702%	2.707%

AV. Sp. Gravity = 2.705%

Table 4.14: Specific gravity of Setraco Quarry

Sample	1 (kg)	2(kg)
W1	0.516	0.516
W2	1.557	1.557
W3	1.097	1.111
W4	1.907	1.928
Specific gravity	2.643%	2.692%

AV. Sp. Gravity = 2.668%

Table 4.15: Specific Gravity of Diamond Quarry

Sample	1 (kg)	2(kg)
W1	0.516	0.516
W2	1.557	1.557
W3	1.142	1.144
W4	1.946	1.944
Specific gravity	2.641%	2.586%

AV. Sp. Gravity = 2.614%

Table 4.16: ACV (Aggregate Compaction Value) Test for Chigbo Quarry

Time: 10 minutes

Sieve size: 3.36mm

Sample Location	**Chigbo Quarry (abakaliki)**
Sample wt	2.000kg
ACV value	294.1995KN
Wt passing	0.562kg
Wt retain	1.432kg
Sample Location	**Chigbo Quarry (Abakaliki)**
Sample wt	2.700kg
ACV value	372.6527KN
Wt passing	0.583kg
Wt retain	2.111kg
Sample Location	**Chigbo Quarry (Abakaliki**)
Sample wt	2.700kg
ACV value	245.16625KN
Wt passing	0.422kg
Wt retain	2.272kg
Sample Location	**Chigbo Quarry (Abakaliki)**
Sample wt	2.700kg
ACV value	294.1995KN
Wt passing	0.959kg
Wt retain	1.728kg

Table 4.17: Mechanical Analysis of Fine Aggregate

TOTAL SAMPLE WEIGTH			GM	FACTOR		TOTAL DRY WEIGT PASSING 3/16 SIEVE DRY WEIGHT OF 3/16 USED		
WEIGHT OF + 3/16” FRACTION			GM	WEIGHT OF DRY SOIL PASSING 3/16 USED				GM
WEIGHT OF – 3/16” FRACTION			GM	WEIGHT OF DRY SOIL + SIEVE				GM
SEIVE SIZE	WEIGHT RETAINED GM	WEIGHT GM	PERCENT %	WEIGHT OF DRY SOIL - SEIVE WEIGHT PASSING				PERCENTAGE OF WHOLE SOIL PASSING %
				SEIVE NO	WEIGHT RETAINED GM	ACTUAL GM	X FACTOR	
3”								
$2^{1/2}$”								
2”				7	13	3.25	3.25	96.75
$1^{1/2}$”				14	38	9.5	6.25	90.5
1				25	36	9	0.5	90.5
¾”				36	174	43.5	34.5	55.5
½”				52	61	15.25	28.25	27.25
3/4”				72	40	10	5.25	22
¼”				100	18	4.5	5.5	16.5
3/16”				200	2	0.5	4	12.5
TOTAL				-75	10	2.5	2	10.5

CLAY %	SILT 3 %	SAND 75%	GRAVEL
COMBINED CLAY & SILT %			

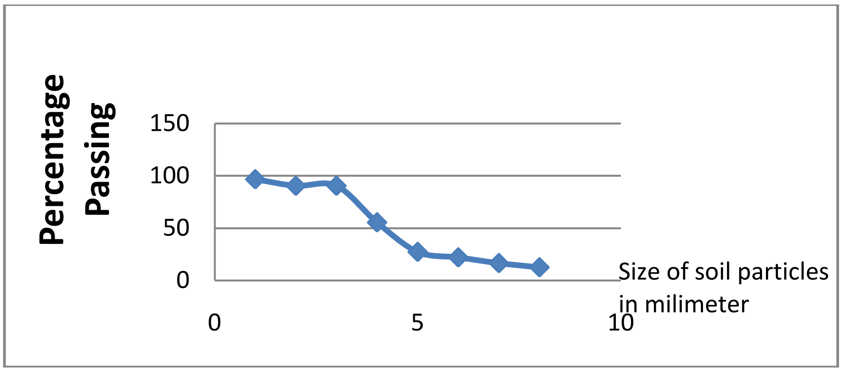

Fig 4.1: Size of soil particles in millimeter for fine aggregate

Table 4.18: Mechanical Analysis of Aggregate from Diamond Quarry

TOTAL SAMPLE WEIGTH			GM		FACTOR		TOTAL DRY WEIGT PASSING 3/16 SIEVE DRY WEIGHT OF 3/16 USED		
WEIGHT OF + 3/16" FRACTION			GM		WEIGHT OF DRY SOIL PASSING 3/16 USED				GM
WEIGHT OF – 3/16" FRACTION			GM		WEIGHT OF DRY SOIL + SIEVE				GM
SEIVE SIZE	WEIGHT RETAINED GM	WEIGHT GM	PERCENT %		WEIGHT OF DRY SOIL - SEIVE WEIGHT PASSING				PERCENTAGE OF WHOLE SOIL PASSING %
					SEIVE NO	WEIGHT RETAINED GM	ACTUAL GM	X FACTOR	
3"									
$2^{1/2}$"									
2"									
$1^{1/2}$"					14				
1					25				
¾"					36				
½"	252	63	37	26	52				
3/4"	132	33	4	29	72				
¼"	11	2.75	1.25	1.55	100				
3/16"	3	0.75	0.5	0.25	200				
TOTAL	0	0	0.5	0.5	-75				

CLAY %	SILT 3 %	SAND 75%	GRAVEL
COMBINED CLAY & SILT %			

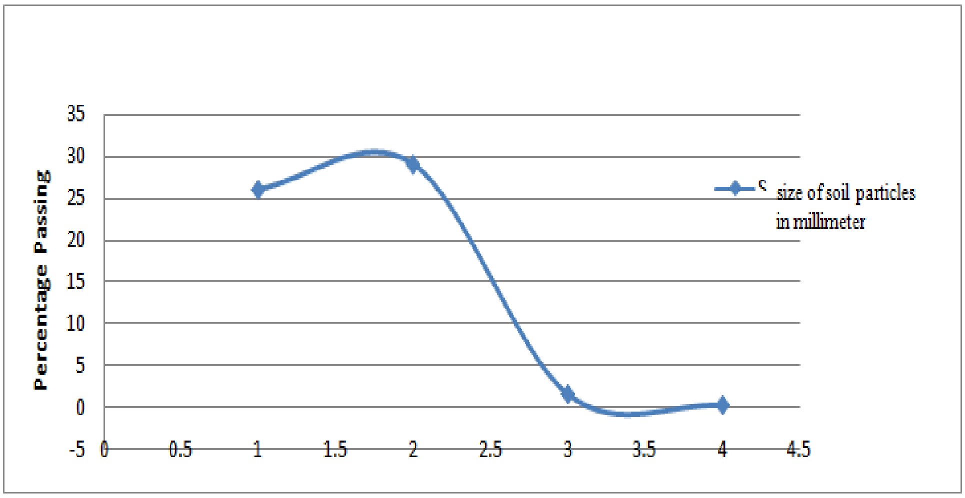

Fig 4.2: Size of soil particles in millimeter for Diamond quarry

Table 4.19: Mechanical Analysis of aggregate from Setraco Quarry

TOTAL SAMPLE WEIGTH			GM		FACTOR		TOTAL DRY WEIGT PASSING 3/16 SIEVE DRY WEIGHT OF 3/16 USED			
WEIGHT OF + 3/16" FRACTION			GM		WEIGHT OF DRY SOIL PASSING 3/16 USED					GM
WEIGHT OF – 3/16" FRACTION			GM		WEIGHT OF DRY SOIL + SIEVE					GM
SEIVE SIZE	WEIGHT RETAINED GM	WEIGHT GM	PERCENT %		WEIGHT OF DRY SOIL - SEIVE WEIGHT PASSING					PERCENTAGE OF WHOLE SOIL PASSING %
					SEIVE NO	WEIGHT RETAINED GM	ACTUAL GM	X FACTOR		
3"										
2 1/2"										
2"					7					
1 1/2"					14					
1					25					
¾"	0	0	100	100	36					
½"	333	83.25	16.78	66	52					
3/4"	41	11.75	5	6.75	72					
¼"	11	4.25	0.75	3.5	100					
3/16"	1	0.25	0.5	0.25	200					
TOTAL	0	0	0.5	0.5	-75					

CLAY %	SILT 3 %	SAND 75%	GRAVEL
COMBINED CLAY & SILT %			

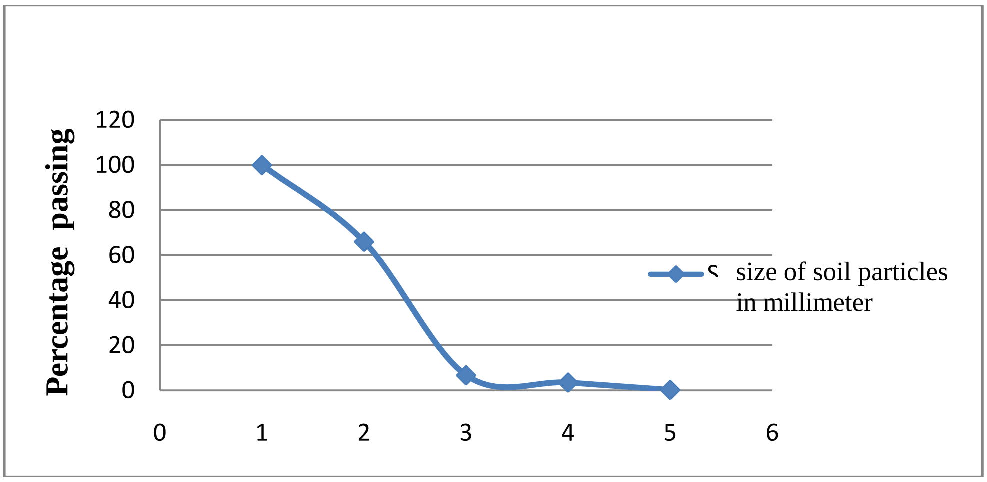

Fig 4.3: Size of soil particles in millimeter for Setraco quarry

Table 4.20: Mechanical Anlysis of aggregate from Baba Rock Quarry

TOTAL SAMPLE WEIGTH			GM		FACTOR		TOTAL DRY WEIGT PASSING 3/16 SIEVE DRY WEIGHT OF 3/16 USED		
WEIGHT OF + 3/16" FRACTION			GM		WEIGHT OF DRY SOIL PASSING 3/16 USED				GM
WEIGHT OF – 3/16" FRACTION			GM		WEIGHT OF DRY SOIL + SIEVE				GM
SEIVE SIZE	WEIGHT RETAINED GM	WEIGHT GM	PERCENT %		WEIGHT OF DRY SOIL - SEIVE WEIGHT PASSING				PERCENTAGE OF WHOLE SOIL PASSING %
					SEIVE NO	WEIGHT RETAINED GM	ACTUAL GM	X FACTOR	
3"									
2 1/2"									
2"					7				
1 1/2"					14				
1					25				
¾"	47	11.75	88.25	76.5	36				
½"	345	86.25	2.00	84.25	52				
3/4"	7	1.75	0.25	1.5	72				

¼"	0	0	0.25	0.25	100				
3/16"	3	0	0.25	0.25	200				
TOTAL	0	0	0.25	0.25	-75				

CLAY %	SILT 3 %	SAND 75%	GRAVEL
COMBINED CLAY & SILT %			

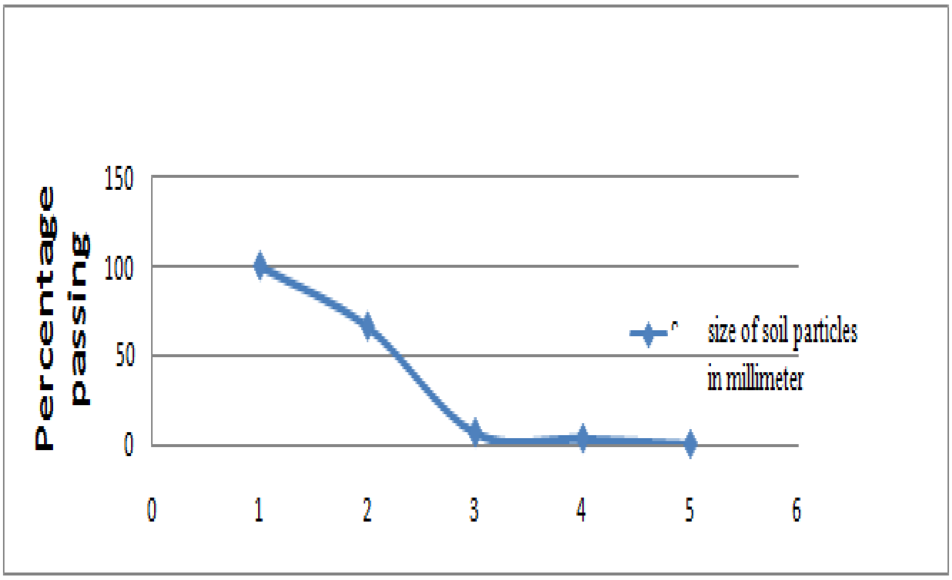

Fig 4.4: Size of soil particles in millimeter for Baba Rock quarry

Table 4. 21: Mechanical Analysis of aggregate from Chigbo Quarry

TOTAL SAMPLE WEIGTH			GM		FACTOR		TOTAL DRY WEIGT PASSING 3/16 SIEVE DRY WEIGHT OF 3/16 USED		
WEIGHT OF + 3/16" FRACTION			GM		WEIGHT OF DRY SOIL PASSING 3/16 USED				GM
WEIGHT OF – 3/16" FRACTION			GM		WEIGHT OF DRY SOIL + SIEVE				GM
SEIVE SIZE	WEIGHT RETAIN ED GM	WEIGHT GM	PERCENT %		WEIGHT OF DRY SOIL - SEIVE WEIGHT PASSING				PERCENTA GE OF WHOLE SOIL PASSING %
					SEIVE NO	WEIGH T RETAIN ED GM	ACTU AL GM	X FACTOR	
3"									
2 1/2"									
2"					7				
1 1/2"					14				
1					25				
¾"	108	27	73	46	36				
½"	215	53.75	19.23	34.52	52				
3/4"	63	15.75	3.5	12.25	72				
¼"	13	3.25	0.25	3	100				
3/16"	0	0	0.25	0.25	200				
TOTAL	0	0	0.25	0.25	-75				

CLAY %	SILT 3 %	SAND 75%	GRAVEL
COMBINED CLAY & SILT %			

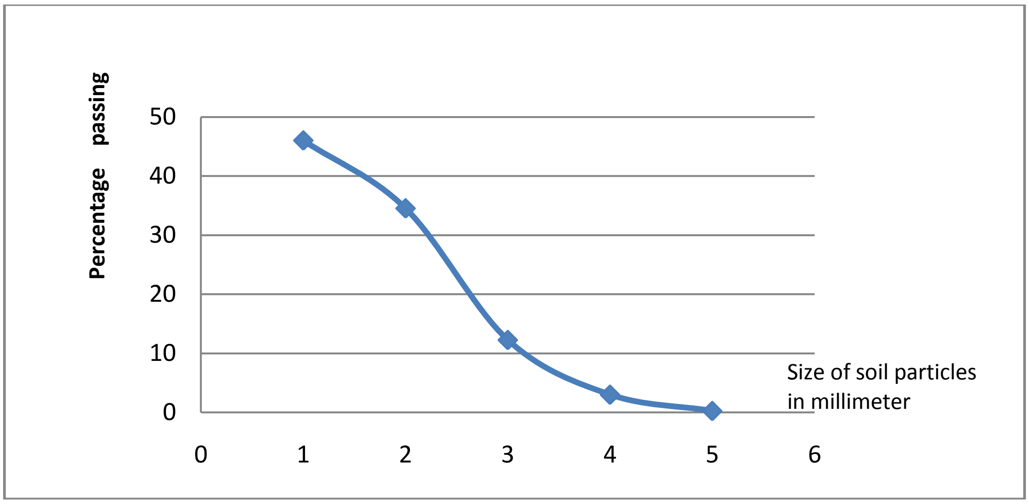

Fig 4.5: Size of soil particles in millimeter

Table 4.22

LABORATORY NO.	CUBE MARK	LOCATION	SIZE OF CUBE(MM)	WEIGHT OF CUBE (g)	CONCRETE DENSITY (g/cm³)	MIX RATIO	WATER CEMENT RATIO	AGE OF CUBE AT DATE OF TESTS	DATE OF CAST	DATEOF TEST	TEST LOAD (KN)	CRUSHING STRENGTH (N/MM²)	REMARKS
		SETRACO											
	A		150 X 150 X 150	7959	2.35	1:2:4	0.50	7 days	14/02/14	21/02/14	310	13.77	
	B		150 x 150 x 150	7992	2.36	1:2:4	0.50	7 days	14/02/14	21/02/14	360	16.00	
										AVE	=	14.89N/mm²	
	A		150 x 150 x 150	8055	2.38	1:2:4	0.50	28 days	14/02/14	14/03/14	470	20.82	
	B		150 x 150 x 150	7959	2.35	1:2:4	0.50	28days	14/02/14	14/03/14	500	22.14	
										AVE	=	21.48N/mm²	

SLUMP 4.8CM

Table 4.23

LABORATORY NO.	CUBE MARK	LOCATION	SIZE OF CUBE(MM)	WEIGHT OF CUBE (g)	CONCRETE DENSITY (g/cm³)	MIX RATIO	WATER CEMENT RATIO	AGE OF CUBE AT DATE OF TESTS	DATE OF CAST	DATEOF TEST	TEST LOAD (KN)	CRUSHING STRENGTH (N/MM²)	REMARKS
		DIAMOND QUARRY											
	A		150 X 150 X 150	8172	2.42	1:2:4	0.50	7 days	13/02/14	20/02/14	270	12.00	
	B		150 x 150 x 150	8432	2.49	1:2:4	0.50	7 days	13/02/14	20/02/14	210	9.33	
										AVE	=	10.60N/mm²	
	A		150 x 150 x 150	8005	2.37	1:2:4	0.50	28 days	13/02/14	13/03/14	430	19.04	
	B		150 x 150 x 150	8444	2.50	1:2:4	0.50	28days	13/02/14	13/03/14	480	21.26	
										AVE	=	20.15N/mm²	

SLUMP 5CM

Table 4.24

LABORATORY NO.	CUBE MARK	LOCATION	SIZE OF CUBE(MM)	WEIGHT OF CUBE (g)	CONCRETE DENSITY (g/cm³)	MIX RATIO	WATER CEMENT RATIO	AGE OF CUBE AT DATE OF TESTS	DATE OF CAST	DATEOF TEST	TEST LOAD (KN)	CRUSHING STRENGTH (N/MM²)	REMARKS
		CHIGBO QUARRY											
	A		150 X 150 X 150	8043	2.38	1:2:4	0.50	7 days	12/02/14	19/02/14	230	10.22	
	B		150 x 150 x 150	8517	2.52	1:2:4	0.50	7 days	12/02/14	19/02/14	260	11.55	
										AVE	=	10.9N/mm²	
	A		150 x 150 x 150	8527	2.53	1:2:4	0.50	28 days	12/02/14	12/03/14	460	20.44	
	B		150 x 150 x 150	7884	2.34	1:2:4	0.50	28days	12/02/14	12/03/14	450	20.00	
										AVE	=	20.15N/mm²	

SLUMP 4.5CM

Table 4.25

LABORATORY NO.	CUBE MARK	LOCATION	SIZE OF CUBE(MM)	WEIGHT OF CUBE (g)	CONCRETE DENSITY (g/cm³)	MIX RATIO	WATER CEMENT RATIO	AGE OF CUBE AT DATE OF TESTS	DATE OF CAST	DATEOF TEST	TEST LOAD (KN)	CRUSHING STRENGTH (N/MM²)	REMARKS
		BABA ROCK QUARRY											
	A		150 X 150 X 150	7853	2.32	1:2:4	0.50	7 days	14/02/14	21/02/14	390	17.3	
	B		150 x 150 x 150	8153	2.42	1:2:4	0.50	7 days	14/02/14	21/02/14	310	13.7	
										AVE	=	15.60N/mm²	
	A		150 x 150 x 150	7705	2.28	1:2:4	0.50	28 days	14/02/14	14/03/14	480	21.26	
	B		150 x 150 x 150	7756	2.35	1:2:4	0.50	28days	14/02/14	14/03/14	540	23.90	
										AVE	=	22.58N/mm²	

SLUMP 5.2CM

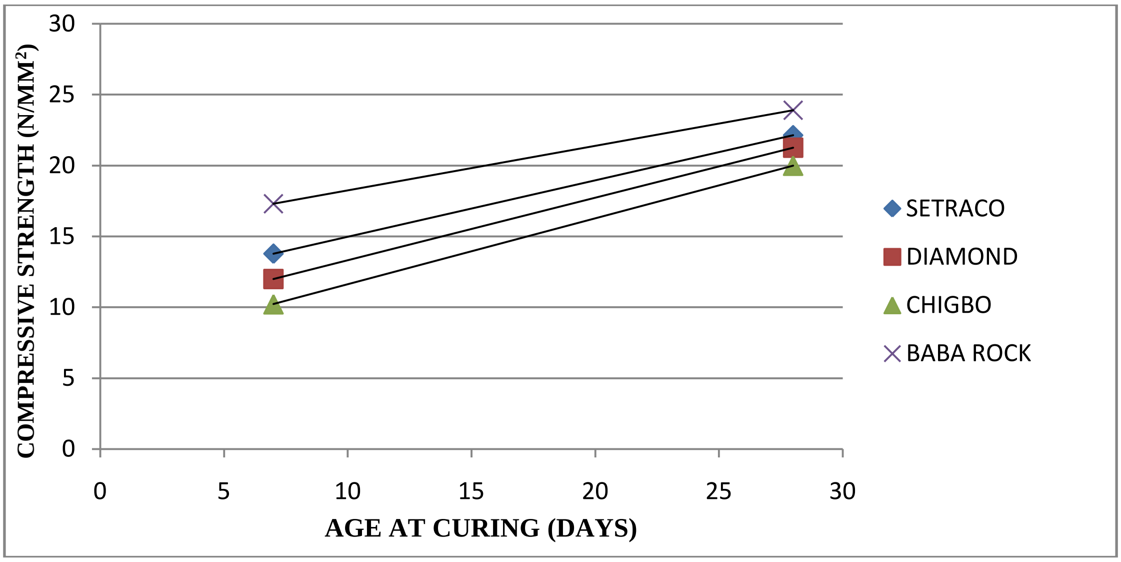

Fig.4.6Compressive strength result of the study areas

V. DISCUSSION: INTERPRETATION OF GRAPHS AND TABLES

5.1 Discussion on Sieve Analysis

The graphs obtained in the sieve analysis for fine aggregate shows that 22% of the River Niger sand used for the purpose of this project work is gravel, and 75% of it, is sand while 3% of the sample is silt. Also the sieve analysis conducted on the coarse aggregate obtained from Chigbo quarry and Diamond quarry all in Abakaliki are 100% gravel from the result and that of Setraco quarry and Baba rock quarry all in Auchi are equally 100% gravel from the sieve analysis result obtained.

5.2 Discussion on Aggregates Compaction Value

The ACV test conducted on the coarse aggregate from Chigbo and Diamond quarry from Abakaliki, also on Setraco and Baba rock quarry from Auchi show that the following result obtained from these coarse aggregate under compaction and passing through sieve size 3.36mm are not the same. From the result obtained after the test it shows that Baba rock quarry in Auchi has a better compaction value due to the mass of sample retained after compacting and passing through the sieve of 3.36mm which is been followed by Diamond quarry in Abakaliki, followed by Setraco quarry in Auchi and lastly is Chigbo quarry in Abakaliki.

5.3 Discussion on Bulk Density for Aggregate

The values obtained in the different bulk density of both fine and coarse aggregates shows that the values obtained from the uncompacted bulk density is lower than the compacted bulk density for both fine and coarse aggregate. After the analysis on average bulk density on all the sample of coarse aggregate from the different quarries and locations the result obtained shows that Setraco quarry has a higher bulk density value for compacted bulk density due to sizes of the coarse aggregate particles. Followed by Chigbo quarry, followed by Diamond quarry and lastly Baba rock quarry. While that of fine aggregate the compacted bulk density has a higher value when compared to the uncompacetd bulk density of the fine aggregate. The uncompaceted bulk density Setraco has the higher bulk density value followed by Baba rock quarry, followed by Chigbo quarry while lastly is Diamond quarry coarse aggregate.

5.4 Discussion on Compressive Strength

The compressive strength result sheet shows the various strength of these concretes at their different ages of curing including their different density and it is observed that concrete gotten from Auchi has higher compressive strength on average with Baba rock aggregates on top followed by Setraco, while the samples from Abakaliki has a minimum considerate values with equal strength at 28 dyas curing, therefore, this goes to show that samples from Auchi at both 7 and 28 days of curing and crushing has a higher compressive strength than those from Diamond and Chigbo (Abakaliki).

5.5 Discussion on Shear Strength of the Concrete

The shear obtained on the concrete cubes after crushing were both vertical, horizontal and diagonal in shape. Tests were carried out in accordance with BS 1881 part 11 and 111 of 1970, with the reading recorded from compressive machine that serves as crushing load of the cubes then the compressive strength were calculated with their relative age and graphically represented above.

5.6 Optimization of the Different Compressive Strength of the Concrete and Age Relationship

Research shows that concrete attains approximately sixty five percent of its 28 days strength in seven days, it was confirmed that the strength of concrete increase with age.

Following the results obtained from this project practical it was observed that the aggregates obtained from Abakaliki did not attain up to 65% of its 28 days strength in 7 days, although this is not a major criteria to judge against its utilization but it serves as one of the factors to be considered when making decisions on which aggregate to be used. It will also be of interest o know that aggregates from Auchi attained more than 65% of its 28 days strength in 7 days, confirming its suitability.

Therefore, when obtaining the strength of concretes for better quality, aggregates from Auchi should be used as the chief samples while the one from Abakaliki could serve as a secondary supplement in situation where every other option are disregarded. Although the discrepancy in the strengths of these concretes collected from Auchi and Abakaliki are quite obvious, this project did not stand to nullify the suitability of samples from Abakaliki since the sample obtained the minimum strength requirement of any aggregate to used for Civil Engineering construction.

VI. CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This project work made use of materials gotten from different locations and at their extraction site, regions effort was put in to ensure precision and avoid numerous errors.

Materials used include two different aggregate samples from Auchi and two different aggregate sample from Abakaliki, River sharp sand (fine aggregate) from River Niger, ordinary Portland cement and a very clean water from ministry of works Enugu State. Series of tests were carried on these samples in conformation to the standard method test of compressive strength of concretes in accordance with BS 1881 part 116. The mix ratio adopted was 1: 2: 4 and the water cement ratio were 0.5, the cube sixe was 150 x 150 x 150 and the cubes were crushed at ages 7 and 28 days.

The results of the test crushing load were recorded and the compressive strengths were calculated and tabulated and graphs plotted, therefore the following observations were made during

1. The compressive strength of concrete increases with age
2. Concrete strength is affected by its mix, degree of workability and curing
3. A suitable concrete is to attain approximately 65% of its 28 days strength in seven days
4. Aggregate type has effect on the compressive strength of normal concrete. The age at curing is adequate to account for the workability in the compressive strength data, it is suggested that samples from Auchi (Baba rock) may be employed for concrete work in places where concrete practitioners have variety of choice available following the fact that sample from Abakaliki shows the least strength development at all ages while the highest compressive strength was achieved from concrete gotten from Baba rock, followed by concrete from Setraco all in Auchi.

6.2 Recommendations

Following the wide spread of collapse of building the following recommendation were postulated:

1) Most of these failure is as a result of weak concretes and substandard coarse aggregates that investigations are not to be made before using any coarse aggregates for construction otherwise aggregates from Auchi are advised since they are better suitable.
2) The investigation should be extended to cover the chemical compositions of crushed stones.
3) Proper compaction of the concretes must be ensured, as compaction is observed to improve the strength of concrete.
4) Crushed stones if sourced with impurities must be washed before use.
5) Further investigations should be made with variation of mix design and water/cement ratio.
6) For reinforced structures where high factor of safety is required, crushed stones from Abakaliki should be used, notwithstanding the cost.

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