COMPARITIVE STUDY ON ENGINEERING PROPOERTIES OF THE AGGREGATES AND COMPRESSIVE STRENGTH OF CONVENTIONAL CONCRETE USING CRUSHED AND RIVER GRAVEL, COARSE AGGREGATES AROUND JIMMA ZONE

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Abstract - Aggregates play a major role in determining the fresh and hardened properties of concrete. Various studies have been conducted on different types of natural coarse aggregate to determine the effectiveness of their use in concrete. Effort toward consuming locally available natural source and to investigate the engineering characteristics of aggregate should be accepted or rejected in accordance to specification and standards has initiated the studies on river gravel as coarse aggregate material for the conventional concrete around the jimma zone.

To achieve the objectives of the study, an extensive research program was planned. The research program was divide into two main phases. In phase one; the aggregate tests were carried out in accordance with the appropriate ASTM, AASHTO, ACI and BS. In this study, a series of two trial sample of aggregate graduations were created for each of the coarse and fine aggregates studied. The result showed that both crushed aggregate, and leg gravel aggregate were within the acceptable limit of ASTM C-33 standards, whereas the river bank gravel aggregate insignificant amount (11.58 percent pass through sieve no 4.75mm) were falling in out in the standards. The other aggregate quality test for bulk density, surface water contents, specific gravity, absorption, aggregate impact value (AIV), aggregate Crushing value (ACV), abrasion and impact in the los Angeles and soundness by sodium were within the stipulated standard and limit.

In phase two, Mix design – the same standards (ACI 211.1-91) was used for all the three mixes and the other ingredients are all the same sources. A result shows that concrete mixes containing river bank gravel aggregate able to increase the workability followed by the leg gravel aggregate and crushed aggregate. While concrete mix containing leg gravel aggregate able to increase the compressive strength followed by the river bank gravel aggregate and crushed aggregate, with the values of 33 Mpa and 30 Mpa respectively.

Key Words: **Conventional concrete, Engineering properties, Crushed aggregate, river aggregate and compressive strengths.**

1. INTRODUCTION

Concrete is a composite material produced by the homogenous mixing of selected proportions of water, cement, fine aggregate and coarse aggregates. Strength is the most desired quality of a good concrete. It should be strong enough, at hardened state, to resist the various stresses to which it would be subjected. Compressive strength of concrete. Therefore, is the value of test strength below which not more than a prescribed percentage of the test result should produce as variety of strength, stiffness, unit weight, porosity and durability properties, yet all concrete contains the same four basic components; Coarse aggregate(gravel), fine aggregate(sand), water and Portland cement.

To predict the behavior of concrete under general loading requires an understanding of the effects of aggregate properties and characteristics. This understanding can only be gained through extensive testing ad observation. It is well recognized that coarse aggregate plays an important role in concrete. Coarse aggregate typically occupies over one-third of the volume of concrete and research indicates that changes in coarse aggregate can change the strength and fracture properties of concrete.

By other hand concrete is one of oldest construction materials in the construction industry and it is widely used throughout the world. It is suitable to almost all types of constructions starting from foundations, road pavement, dams, buildings of various types etc. However, the process involved in the production of concrete requires due care and attention. Comparison of different forms of gravel as aggregate in concrete are investigated sikiru and abdul; thus, they concluded that the gradation of gravel aggregate based on their shapes, workability of fresh concrete produced using these aggregates, density and strength of the hardened concrete has been successfully evaluated. Based on the findings from this research the local populace can be further advised on the best way to use the naturally existing gravel. More importantly, the cost of this naturally occurring gravel is 50% cheaper than crushed granite.

Studies showed that the natural coarse aggregates (uncrushed) were used as a coarse aggregate as an alternative use of crushed one which is fit for conventional concrete. Here in the study area; people try to use those (river gravel aggregate) as aesthetic purpose. The reason for this might be the absence of guidelines and a research study that indicates river gravel aggregate can be used as a coarse aggregate for normal weight. In order to investigate the possibility of using uncrushed coarse aggregates in concrete, it was first necessary to investigate the physical properties of the aggregates themselves, as these properties will affect the properties of fresh and hardened concrete. Three different types of coarse aggregates (Crushed coarse Aggregate, River Bank Gravel Coarse Aggregate and Lag Gravel Coarse Aggregate) were used in this investigation. Hence, this study is carried out to investigate the engineering properties and performance of conventional concrete with three different types of coarse in the Jimma zone.

1.1 Objective

- To determine the Engineering properties of crushed and river gravel coarse aggregate for the requirements of conventional concrete around Jimma zone.
- To compare the Compressive strength and workability of Conventional concrete with crushed and river gravel aggregate.
- To compare test results with standard specifications.

1.2 Scope & Limitation of Study

The focus of the research was the type of aggregate and its needed aggregate characteristic and production of concrete. The types of aggregate, which were to conduct the laboratory test, were crushed aggregate, uncrushed river gravel aggregate and sand sieved gravel aggregate from three sources. The specified grades of the three types of coarse aggregates were 67 with NMAs of 20mm. This study reasoned that there are numerous aggregate characteristic need to be tested and study of all them will provide a total coverage and representation however, time funds as well as the availability of all laboratory test equipment and procedure's that will be generated will be too large and frustrating. To avoid this preliminary survey were conducted and consequently, only few of the aggregate pits sites were selected and sampled from three specific locations and it is expected that the data and information obtained as well as the study findings, suggestions and recommendation will be representative. This is why, out of the whole Jimma zone Woreda, only the three-selected district namely; Deniba, asendabo and Enkulu site respectively are choice for the study.

This research study was studied at the laboratory of ERA/ERCC/ Jimma district. The research study consisted of two main stages. The first stage was the selection of aggregates that are used to this research study and collected from the source in to the laboratory to determine the basic aggregate characteristic. The second stage was, by using the three aggregate types (crushed aggregate, uncrushed river gravel aggregate and sand sieved gravel aggregate) were used to produce normal weight concrete and comparison was made with three different coarse aggregate mix of concrete. The performance of concretes was then assessed in terms of the fresh and hardened properties. After the first & second stages were finished, a statistical analysis was conducted to evaluate the effect of the characteristics of crushed aggregate, uncrushed river gravel aggregate and sand sieved gravel aggregate on the properties of normal concrete.

2. LITERATURE REVIEW

In this review paper is presented to characteristic and effects of coarse and fine aggregate on the concrete properties. Concrete is a heterogeneous mixture of cement, water, fine and coarse aggregate. Many studies have indicated that coarse aggregate normally constitute about 75% of the volume of concrete and therefore have a major influence on the properties of concrete. The strength & durability of concrete is one such property that is mainly controlled by the type and amount of coarse aggregate. In the next section some characteristics of aggregates are described along with a detailed explanation of aggregate and its effects on concrete. The roles of physical, mechanical & chemical aggregates on the behavior and performance of Portland cement concrete are often described in terms of their effects on concrete strength.

2.1 Concrete Constituents Materials

In a concrete mixture the aggregates which are generally graded in size from fine to pebbles or crushed stones, from the inert mineral filler material which the current paste binds together. These aggregates generally occupy 65 – 75 % of the total volume of concrete. Aggregate were first considered to simply be filler for concrete to reduce the amount of cement required. However, it is now know that the type of aggregate used for concrete can have considerable effects on the plastic and hardened state properties of concrete.

Aggregate can be broadly classified into four different categories: these are heavyweight, normal weight, light weight and ultra-light weight aggregates. However in most concrete practices only normal weight and light weight aggregates are used. For this reason, aggregate characteristic, such as size, shape and surface texture influence greatly the properties of a concrete mix.

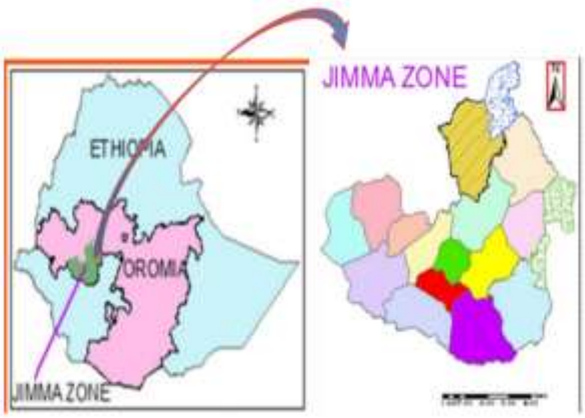
2.2 Research Methodology

To achieve the objectives of this study, an extensive research program was planned. This chapter outlines the experiment program undertaken to determine the engineering properties & characteristic were assessed from the basis of the extent of crushed natural aggregate with river gravel aggregate and its effect on the performance of the normal concrete. A brief introduction of the constituents materials for producing of the normal concrete & an explanation of the test methods are also provided in this chapter.

2.2.1 Study Area

Jimma zone is one of the thirteen zones of Oromia regional, state which geographically lies in south-western art of Ethiopia. Jimma Town is the capital of the zone that is 345 km far away from Addis Ababa, capital of Ethiopia. It covers a total surface area of 19,305.5 km^2. According to the 2007 Population & Housing Census of Ethiopia, the total population of the Jimma Zone was 2,486,155. The zone bordered in Northwest by Illubaboor, by East by Wellega & in West by Shewa zones as well as in the south by southern Nations & Nationalities People's Regional State. In general, the topographical features elevation varies from 1000 to 3360 m above sea level with average maximum & minimum temperatures in the range of 25-30°C. The present study was conducted in three districts of Jimma zone; namely , Deniba 50km from jimma Town, Asendabo 40 km & Enkulu 37 km Jimma town.

There is the reason to choose Jimma Zone as the study area; that this research were conceded to find and gives the alternatives construction material, especially in the case of concrete making ingredients, In these zone the construction a propject has appears fast & actively developing, This study therefore is carried out in Jimma zone and focuses on the use of uncrushed coarse aggregate for the construction projects as conventional concrete materials.



2.2.2 Materials

- WATER
- CEMENT
- COARSE AGGREGATE

Table -2.1: Type & Source of aggregate

No.	Aggregate type	Source
1	Crushed Coarse Aggregate (CCA),	From ERA/ERCC Enkulu crushing site
2	River Bank Gravel Coarse Aggregate (RBGCA)	From Deniba river bed
3	Lag Gravel Coarse Aggregate (LGCA)	From Asendabo sand sieve
4	Fine aggregate (natural sand)	Gambella sand

Fig 2.2 CCA field sample

Fig 2.3 LGCA field sample

Fig 2.4 RBGCA field sample

3. STUDY DESIGN

To investigate the quality & availability of suitable concrete making aggregates in jimma zone, test results of coarse aggregate & fine aggregate samples were collected ERA (ERCC) Materials Testing Laboratories in jimma district. The collected data consists, test results of 3 quintal fine aggregate samples of gambella sand from market and three coarse aggregate with .25 quintals samples from three different sources. The research program was divided into two main phases as outlined below:

In phase I, the aggregate collected from their source (see table 2.1) in the laboratory was tested to determine its physical, chemical & Mechanical Properties. The tests were carried out in accordance with the appropriate ASTM, AASHTO, ACI, ES & BS were applicable (Appendix A). With this understanding the requirements of the properties of the river gravel aggregate for specific application & performance approach to classification of river gravel aggregates & also used for comparison between (crushed natural aggregate, uncrushed river gravel aggregate & uncrushed sand sieved gravel aggregate) with in accordance with the appropriate standards. The properties of natural fine aggregate were also determined in the mix design program.

In phase II, the tree different types of aggregate were used to produce normal weight & also comparison was made with three different coarse aggregate mix of concrete. The research program devised is shown schematically in figure 3.1.

For above two phases were planned & carried out as detailed in the following sections.

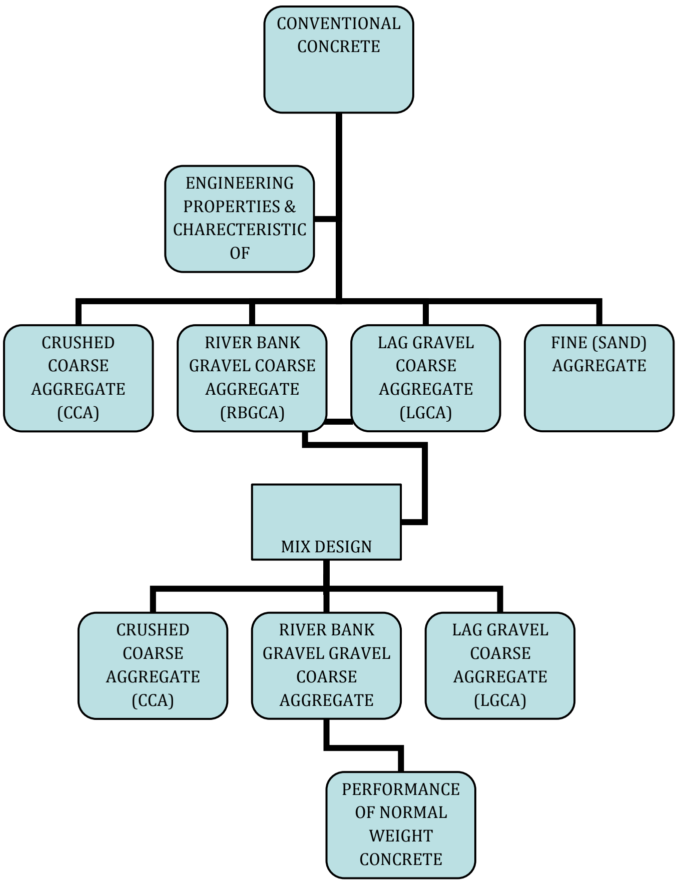


Fig 3.1 Research Program

4. EXPERIMENTAL WORK PROCEDURES OF CONVENTIONAL CONCRETE

4.1. MIX DESIGN

To see the effect of a variety of coarse aggregates, whom maximum size 20mm were prepared mix design for concretes made with aggregates of different properties were used. The coarse aggregate graduations employed are designed as No. 67 in accordance with prevailing specifications by the ASTM C-33.

- Natural (RBGCA) and Crushed aggregate was used, thereby resulting in three mixes, which were designed as follows:
- Mix By Crushed Coarse Aggregate (CCA)
- Mix By River Bank Gravel Coarse Aggregate (RBGCA)
- Mix By Lag Gravel Coarse Aggregate (LGCA)
- Natural sand confirming to specifications by the ASTM C-33 Aggregate for Portland cement concrete: Fine aggregate was used in all mixes the same source.
- Cement: Type I, ASTM C 150, with a relative density of 3.15
- The methods & procedures used in testing these materials, as well as those employed in formulating the mix designs adopted in this study, are then outlined.

Each mix of concrete is composed of crushed or natural coarse aggregate, natural sand, ordinary Portland cement & water.

Mix design were thus created for each three different varieties of coarse aggregates. The summarized mix design & the procedure were presented as follows according to ACI mix design methods;

4.2. MIX DESIGN PROCEDURE USED IN THIS RESEARCH AS PER ACI 211.1-91

Crushed Coarse Aggregate (CCA), River Bank Gravel Coarse Aggregate (RBGCA) & Lag Gravel Coarse Aggregate (LCGA) sample (designation of the samples is given in APPENDIX C-1.1)

Step 1: Slumps

Slump = (25-100 mm) --- (ACI 211.1-91 Table 6.3.1 Appendix C)

Step 2: Maximum size of aggregate

Maximum size is fixed to be 20 mm

Step 3: Target mean strength calculation

f'cr = f'c + 8.5

= 25 + 8.5

= **33.5 Mpa** --- (ACI 318M Table 5.3.2.2 Appendix C)

Step 4: Water / Cement ratio

For 30 Mpa W/C ratio is 0.54 &

For 35 Mpa W/C ratio is 0.47

The W/C ratio can be found by interpolation as follows:

$$\frac{W}{C} = \frac{0.54-0.47}{30-35} * (33.5 - 30) + 0.54$$

= **0.49** --- (ACI 211.1-91 Table 6.3.4 Appendix C)

Step 5: Mixing water amount

For maximum size of aggregate of 20 mm, slump 25 to 100 mm (Minimum range) & Non-air entrained concrete the mixing water requirement according to ACI.211.1-91

Mixing water amount = **190 Kg/m³**

--- (ACI 211.1-91 Table 6.3.4 Appendix C)

Approximate amount of air = **2%**

--- (ACI 211.1-91 Table 6.3.4 Appendix C)

Step 6: Cement Amount

Cement content = Mixing water amount W/C ratio

$$\frac{190}{0.49} = \mathbf{387}\ \text{Kg/m}^3$$

Step 7: Coarse aggregate amount

For maximum size aggregate = 20 mm & fineness modulus of 2.42 & 2.46 i.e

2.40 2.42 2.60

$$X = \frac{(0.66-0.64)}{(2.40-2.60)}(2.42 - 2.40 + 0.66$$

0.66 X 0.64

= **0.658~0.66** --- (ACI 211.1-91 Table 6.3.6 Appendix C)

Step 7.1: for CCA (1475)

Coarse aggregate amount = 0.66*1475 = 974 kg/m³ ;But 1475 kg/m³ is air dry bulk unit weight and it has to be adjusted to air dry condition & back to SSD by dividing by total moisture & multiplying by absorption respectively, i.e.

$$\text{C. A} = \frac{W_{SSD}}{TM} * Absorption$$

$$= [\frac{974}{1+\left(\frac{1.2}{100}\right)}(1 + \left(\frac{1.64}{100}\right))]$$

= **980 Kg/m³**

Step 7.2: for LGCA (1651)

Coarse aggregate amount = 0.66*1651

= 1090 kg/m³ But 1651 kg/m³ is air dry bulk unit weight and it has to be adjusted to air dry condition & back to SSD by dividing by total moisture & multiplying by absorption respectively, i.e.

$$\text{C. A} = \frac{W_{SSD}}{TM} * Absorption$$

$$= [\frac{1090}{1+\left(\frac{1.2}{100}\right)}(1 + \left(\frac{1.52}{100}\right))]$$

= **980 Kg/m³**

Step 7.3: for RBGCA (1621)

Coarse aggregate amount = 0.66*1621

= 1070 kg/m³ But 1621 kg/m³ is air dry bulk unit weight and it has to be adjusted to air dry condition & back to SSD by dividing by total moisture & multiplying by absorption respectively, i.e.

$$\text{C. A} = \frac{W_{SSD}}{TM} * Absorption$$

$$= [\frac{1070}{1+\left(\frac{1.92}{100}\right)}(1 + \left(\frac{1}{100}\right))]$$

= **1080 Kg/m³**

STEP 8: Fine Aggregate Amount

STEP 8.1: For CCA

Fine aggregate amount

$$= 2.63\ [1000 - (190 + \frac{387}{3.15} + \frac{980}{2.59} + 20)]$$

= **774 Kg/m³**

STEP 8.2: For LGCA

Fine aggregate amount

$$= 2.63\ [1000 - (190 + \frac{387}{3.15} + \frac{1095}{2.60} + 20)]$$

= 661 Kg/m³

STEP 8.3: For RBGCA

Fine aggregate amount

$$= 2.63\ [1000 - (190 + \frac{387}{3.15} + \frac{1080}{2.64} + 20)]$$

= 691 Kg/m³

STEP 9: Moisture correction

Table 3.1 Moisture Correction for the Three Types of Aggregates Mix Design

Ingredients	Estimated quantity(Kg)	Absorption (%)	Absorbed water(Kg)	Natural moisture (%)	N.M.C (Kg)	Adjusted quantity (Kg)
Moisture correction for CCA Mix design						
Water	187	_	_	_	_	201
Cement	382	_	_	_	_	382
C. Aggregate	980	1.64	16.01	1.00	9.80	973
Air content	_	_		_	_	_
F. Aggregate	774	1.97	15.20	1	7.74	766
Total	2322					2322
Moisture correction for LGCA Mix design						
Water	187	_	_	_	_	199
Cement	382	_	_	_	_	382
C. Aggregate	1095	1.52	16.63	1.00	10.95	1090
Air content	_	_		_	_	_
F. Aggregate	661	1.97	12.99	1	6.61	654
Total	2325					2325
Moisture correction for RBGCA Mix design						
Water	187	_	_	_	_	184
Cement	382	_	_	_	_	382
C. Aggregate	1080	1.00	10.79	1.92	20.70	1090
Air content	_	_		_	_	_
F. Aggregate	691	1.97	13.57	1	6.91	684
Total	2339					2339

STEP 10: Lab trial batching

Table 3.2 Quantities of Material for Lab Batching for Concrete Mix

Types of aggregate		Water (Kg)	Cement (Kg)	Coarse Aggregate(Kg)	Fine Aggregate(Kg)	Total (Kg)
CCA	quantity (M³)	204	387	974	754	2318
	quantity (Per 9 mold)*	6.18	11.75	29.58	22.89	70.41
LGCA	quantity (M³)	202	387	1090	642	2321
	quantity (Per 9 mold)	6.13	11.75	33.11	19.50	51.00
RBG CA	quantity (M³)	187	387	1070	691	2335
	quantity (Per 9 mold)	5.68	11.75	32.50	20.99	49.94
***=(0.15*0.15*0.15) *9=0.030375**						

5.TESTING ON FRESH CONCRETE & HARDENED CONCRETE

4.3. SLUMP – FRESH CONCRETE

The test was performed by following ASTM C 143/C Standard Test Method for Slump of Hydraulic-Cement. (As shown figure below 5.1)

Fig 5.1 Measuring slump of fresh concrete Mix

4.4. CASTING – FRESH CONCRETE

In order to cast the required number of specimens, 27 cube for each mix was used. (As shown figure below 5.2

Fig 5.2 Typical 150 mm Cube Mould

4.5. COMPRESSIVE STRENGTH OF CONCRETE – HARDENED

Compressive strength tests were performed on 150mm concrete cube specimens at the ages of 7, 14 & 28 days according to BS EN 12390-3:2009. The concrete cube specimens were tested in the 300KN Dension Compression Machine.

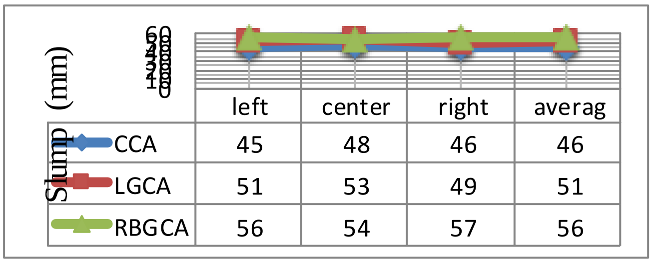
Fig 5.3 Compression Test Machine & Test Sample

5. RESULT & DISCUSSION

This chapter contains tabulations of all data recorded during the tests conducted, a discussion of all quality tests, as well as outlines of the subsequent calculations needed to translate test results into the properties of the aggregates. The average value obtained for each concrete mix on each testing date also presented. Each such mix is assigned a three-character code identifying the type of the coarse aggregate used (CCA, RBGCA & LGCA) and the coarse aggregate gradation number 67.

5.1. Mix design

In this investigation M 25 grade considered and designed using a procedure by (ACI 211.1-91) with water cement ratio of 0.49 (by interpolation). The calculation of quantities of ingredient requires for different concrete mixes are given in appendix C1.2



	left	center	right	averag
CCA	45	48	46	46
LGCA	51	53	49	51
RBGCA	56	54	57	56

Chart -6.1: Slump Test for various Concrete Mixes

The tests were carried in three different mixes with the same W/C, cement type and sand. Also the measure was taken in three different points (right, center & Left side) for each mix sample. Workability of concrete mixes increased with river gravel aggregate followed the sand sieved gravel and the last was crushed coarse aggregate.

From the various results was observed, the workability was good and can be satisfactory handled for all the mixes. There was no problem for the placement and compaction of fresh concrete. But the workability is higher in concrete mixes with river bank gravel coarse aggregate and lag gravel coarse aggregate rather than crushed coarse aggregate because of the round because of the round and smooth surface textures of aggregate.

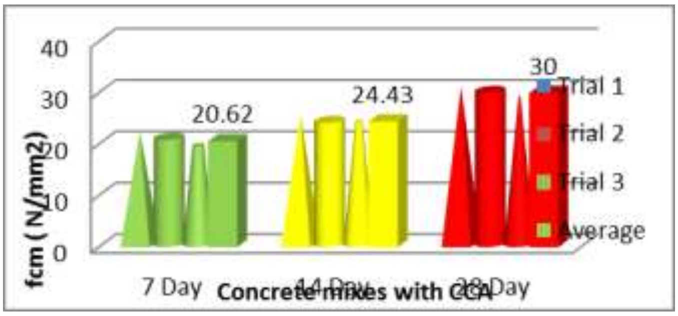


Chart -6.2: Results of Compressive strength for CCA Concrete mixes

Fig 6.2 shows the development of compressive strength of concrete mixes with crushed coarse aggregate, under different types of curing environments for up to a period of 28 days. The maximum 28-days strength of water cure specimen of about 30 MPa was achieved for mix CCA that contained all ranges of particles. The crushed coarse concrete gave compressive strength value of 22.8 N/mm^2 close to the value of 21.7 N/mm^2 obtained for concrete sample CT5 made of angular shape gravel aggregate and the highest among all the gravel aggregate shapes considered.

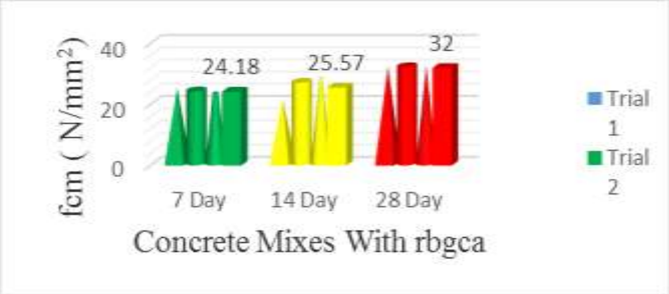


Chart -6.3: Results of Compressive strength for RBGCA Concrete Mixes

Fig 6.3 shows the development of compressive strength of concrete mixes with river bank gravel coarse aggregate (RBGCA) under different types of curing environments for up to a period of 28 days. The maximum 28-days strength of water cured specimen of about 32 MPa was achieved for mix RBGCA that contained all ranges of particles. In all three cases, the mixes containing natural coarse aggregate exhibited higher strength than those with crushed aggregate, contrary to intuitive expectations.

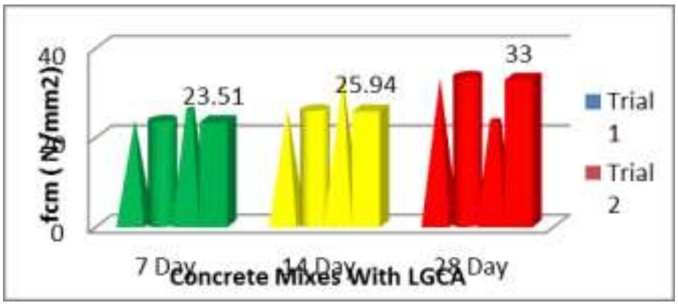


Chart -6.3: Results of Compressive strength for LGGCA Concrete Mixes

Fig 6.4 shows the development of compressive strength of concrete mixes with lag gravel coarse aggregate under different types of curing environments for up to a period of 28 days. The maximum 28-days strength of water cured specimen of about 33 MPa was achieved for mix LGCA that contained all ranges of particles.

The Average values of Compressive strength test results for various concrete mixes are tabulated 6.1, after curing period of 28 days. The value showed that 33.2, 37.6 & 35.6 for, crushed coarse aggregate, river bank gravel coarse aggregate and lag gravel coarse aggregate, respectively for 28 days.

Table 6.1 The Average Compressive Strength Test for Various Concrete Mixes

Mixes IDM	Days	Compressive strength in MPa	Rate of attainment of strength in %
CCA7D	7	20.62	82.48
CCA14D	14	24.43	97.72
CCA28D	28	30	120
RBGCA7D	7	24.18	96.72
RBGCA14D	14	25.57	102.28
RBGCA28D	28	32	128
LGCA7D	7	23.51	94.04
LGCA14D	14	25.94	103.76
LGCA28D	28	33	132

The laboratory test results in compressive strength, seems to indicate that the increase in lag gravel coarse aggregate percentage enhances the mix strength over concrete mixes with CCA. This is due to the fact that both LGCA & RBGCA had denser and more durable and less water absorbing than CCA. Also it shows the comparison between the compressive strength of CCA, RBGCA & LGCA. Comparing the compressive strength of RBGCA & LGCA – M25 grade concrete with concrete made with CCA, its seems the latter is a little lagging behind both concrete mixes with RBGCA & LGCA. But as the design strength of M25 grade concrete is 25 N/mm^2 and the sample gave a value more than that, we believe the concrete can be used in construction work. It is also confirming to the studies from the laboratory test of strength determination it was explored that uncrushed aggregates provide more strength (22% at 28 days) than aggregates for medium grade concrete.

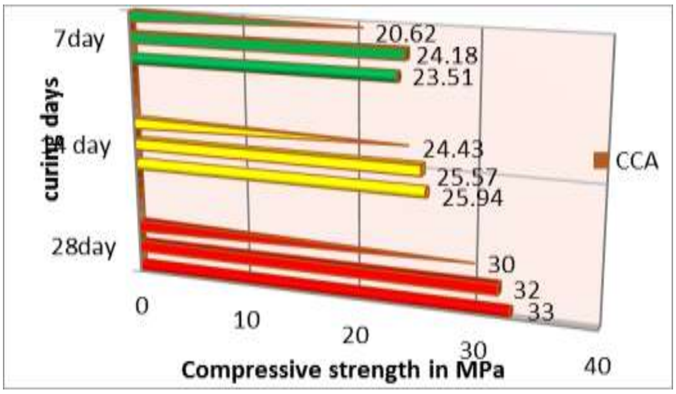


Chart -6.4: Results of Compressive strength for Concrete Mixes

6. CONCLUSIONS & RECOMMENDATIONS

The quality tests of all the three types of coarse aggregate were done with similar standards and procedures. The suitability of any aggregate for a particular purpose depends principally on its physical and mechanical properties. This locally found coarse aggregate has a physical property which meet or are within the standard limiting values as stipulating in ASTM C-33 & BS 812-112:1990 thus making it suitable for the manufacture of concrete and their applications in construction work.

6.1. CONCLUSIONS

Based on the results of this investigation, which have been discussed, the following conclusion are drawn.

The laboratory test results in compressive strength, seems to indicate that the increase in both lag gravel coarse aggregate and river bank gravel coarse aggregate mix strength over the crushed aggregate mix. This due to the fact that uncrushed aggregate has higher in specific gravity and compacted bulk density and lower in absorption than crushed aggregates. For the three types of concrete, it was observed that the compressive strength increases with age at curing. For all the ages at curing, the highest strength was obtained from concrete made with lag gravel, followed by river gravel and the last strength was recorded with concrete containing crushed aggregate. A Previous study has already confirmed similar finding; it is established that lower water content in concrete will result in higher strength. Thus, since lower water content was needed by natural aggregate concrete than crushed rock aggregate concrete, the concrete made by using natural aggregate concrete show higher strength than concrete made by using crushed rock aggregate. This was also confirm and concluded that the natural mixes are stringer than their crushed aggregate counterparts by 31% & 26% respectively. In all three cases, the mixes containing natural coarse aggregate exhibited higher strength than those with crushed aggregate, contrary to intuitive expectations.

6.2. RECOMMENDATIONS

Hence this project was concluded the river gravel aggregates are qualified the engineering characteristics test and recommended based from the combined result of the comparison with crushed coarse aggregates; for the use of conventional concrete in Jimma zone. But some procedure must be needed proper attentions in order to use river gravel as a coarse aggregate; (i.e. manual removals of over graded stone, impurities etc., during extracting the materials from the sources) and here the researcher can say that it can be possible to use this study as a guideline; if the remaining quality tests are completed.

In the meantime, this study was conducted in partial fulfilment of educational requirement. The researcher would like to recommend for important on using the river gravel as a coarse aggregate for the conventional concrete in Jimma zone.

Since it is new ideas using river as a coarse aggregate for the conventional concrete in Jimma Zone. So the first beneficiaries are the community lived around the study area should be aware of the use of those alternative construction materials which is existing naturally and free from any harm. These must need the contributions of concerning bodies (i.e. Local authorities) as well as community participation.

In order to use river gravel as a coarse aggregate, due attentions of procedures and methods of selecting the right aggregate must be identified, prior to the trainings given to professionals who are directly involved as well as the local community until sufficient knowledge about the importance and the use of river gravel as a coarse aggregate is assured.

Although further investigation will be required to study river gravel coarse aggregate technological mechanism in producing aggregate with good engineering characteristics and cost effectiveness achieved in terms of increased strength.

ACKNOWLEDGEMENT

The authors can acknowledge any person/authorities in this section. This is not mandatory.

REFERENCES

[1] Aginam, C. H., Chidolue, C. A., and Nwakire, C. Investigating the Effects of Coarse Aggregate Types on The Compressive Strength of Concrete. International Journal of Engineering Research and Applications. 2013; Vol.3,Issue 4,pp.1140-1144

[2] Anastasios M. Ioannides and Jeff C. Mills. Effect of Larger Sized Coarse Aggregates on Mechanical Properties of Portland cements Concrete Pavements and Structures. 2006; Volume 1 of 2 State Job Number 148030

[3] K. A. Mujedu, I. O. Lamidi, D. O. Ayelabola. An Investigation on the Suitability of the Broken Tiles as Coarse Aggregates in Concrete Production. The International Journal of Engineering and Science. 2014; Volume-3 ,Issue 4,Pages, 35-41

[4] Rozalija Kozul and David Darwin. Effects of aggregate type, size, and content on concrete strength and fracture energy. university of kansas centre for research.1997;

[5] Newman J., and Choo B.S. "Advanced Concrete Technology ", Elsevier Ltd., (2003).

[6] P. Kumar Mehta Paulo J. M. Monteiro Concrete Microstructure, Properties, and Materials Third Edition McGraw-Hill eBook pp. – 273

[7] Michael S. Mamlou k and John P. Zaniewski Materials for Civil and Construction Engineers .Second Edition; Upper Saddle River, NJ 07458 Printed in the United States of America

[8] Rýza Polat, Mehrzad Mohabbi Yadollahi, A Emre Sagsoz and Seracettin Arasa. The correlation between aggregate shape and compressi ve strength of concrete: digital image processing approach. International journal of structural and civil engineering research. 2013; Vol. 2, No. 3,

[9] Denamo Addissie, Handling of Concrete Making Material s in the Ethiopian Construction Industry. Addis Ababa U niversity. 2005;

[10] Shewaferaw Dinku Belay. The Use of Manufactured Sand In Concrete Production: Test Results and Cost Comparison. Addis Ababa University 2006;

[11] Neville A.M. 'Properties of concrete', long man scientific & technical series. 2006

[12] jacob lim lok guan (2011) effects of recycled aggregates on concrete properties national university of Singapore

[13] ACI Education Bulletin E1-99, AGGREGATES FOR CONCRETE Developed by Committee E-701, Materials for Concrete Construction 1999. American Concrete Institute.)

[14] Hannah Nyambara Ngugi1, Raphael Ndisya Mutuku, Zachary Abiero Gariy Effects of Sand Quality on Compressive Strength of Concrete: A Case of Nairobi County and Its Environs, Kenya Open Journal of Civil Engineering, 2014;

[15] OMAR BASHIR SALAH. Investigation on the engineering properties of coarse aggregate locally available in Garissa County. University of Nairobi.2014;

[16] Pedro Nel Quiroga and David W. Fowler. Effects Of Aggregates Characteristics On The Performance Of Portland Cement Concrete. International Centre for Aggregates Research.2004; the University of Texas at Austin.

[17] ACI 223-98 (1998) Standard Practice for the Use of Shrinkage-Compensating Concrete Reported by ACI Committee 223; American Concrete Institute

[18] Troxel, G. E., and Davis, H. E. Composition and Properties of Concrete, MCGRAW - HILL BOOK COMPANY. 1956; INC, New York.)

[19] Building Code Requirements for Structural Concrete (ACI 318M-08) and Commentary An ACI Standard Reported by ACI Committee 318 Deemed to satisfy ISO 19338:2007(E)

[20] BS 812, part 105, Testing aggregates methods for determination of particle shape, 1990

[21] Akçaoğlu, T., Tokyay, M., and Çelik, T. "Effect of Coarse Aggregate Size on Interfacial Cracking Under Uniaxial Compression." Materials Letters, (2002).

[22] Elsharief, A., Cohen, M.D., and Olek, J. "Influence of Aggregate Size, Water Cement Ratio and age on the Microstructure of the Interfacial Transition Zone." Cement and Concrete Research. 2003;

[23] Somayaji, S. Civil Engineering Materials. 2nd edition, Pren tice Hall, Inc., Englewood Cliffs, New Jersey. 2001;

[24] Cramer, S., Hall, M., and Parry, J. "Effect of Optimized Tot al Aggregate Gradation on Portland Cement Concrete for Wisconsin Pavements." Transportation Research Board. 1995; Washington, D.C., pp. 100-106.

[25] Richard E. Weyers, Gregory S. Williamson, David W. Mokarem, Daniel S. Lane and Philip D. Cady. Testing Methods to Determine Long Term Durability of Wisconsin Aggregate. Resources by Wisconsin Highway Research Program. 2005;

[26] Dr. David W. Fowler, Dr. John J. Allen, Alexander Lange, a nd Peter Range. The Prediction of Coarse Aggregate Perf ormance by Micro-Deval and other Aggregate. Aggregates Foundation for Technology, Research and Ed ucation .2006;

[27] S. Zitouni, A. Naceri and M. Influence of the Nature and P article Size Distribution of Rolled and Crushed Coarse Ag gregates on the Physico Mechanical Properties of Concre te. Asian Journal of Civil Engineering. 2015; VOL.17,NO.4(2016) pp;459-478

[28] Gregory S. Williamson. Investigation of Testing Methods to Determine Long Term Durability of Wisconsin Aggreg ate Resources Including Natural Materials, Industrial by Products, and Recycled/Reclaimed Materials. 2005; Blac ksburg, Virginia.

[29] ACI 221R 96; (2001) Guide for Use of Normal Weight an d Heavyweight Aggregates in Concrete Reported by ACI Committee 221: American Concrete Institute.

[30] Malviya, HK, Dhoke, R & Pathak, KK. Effect of aggregate Flakiness on the Compressive strength of Concrete Cubes. Journal on Today's Ideas Tomorrow's Technologies. 2015 Vol. 3, No. 1,pp. 27–40

[31] M Markandeya Raju Ponnada. Combined effect of flaky and elongated aggregates on strength and workability of concrete. International Journal of Civil and structural engineering. 2014; Volume 5, no.4, pp. 314-325,

[32] A Abdullahi. M, The effect of aggregate type on Compressive strength of concrete, International Journal

of Civil and structural engineering, Volume 2, No 3, pp. 791-800, 2012.

[33] Rifath Sharmin, Dr. Mushtaq Ahmed, Mohiuddin Ahmed and Forhat Afja Lubna. Comparison Of Strength Performance Of Concrete With Uncrushed Or Crushed Coarse Aggregates ARPN. Journal of Engineering and Applied Sciences. 2006; VOL.1, NO.2,

[34] Juanyu Liu, Anal K. Mukhopadhyay, Manuel Celaya, Soheil Nazarian, and Dan G. Zollinger. BEST PRACTICES FOR THE USE OF SILICEOUS RIVER GRAVEL IN CONCRETE PAVING December. 2006;

[35] ACI Education Bulletin E1-16 Aggregates for Concrete Prepared under the direction and supervision of ACI Committee E-701, Materials for Concrete Construction

[36] (ACI 211.1-91) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete Reported by ACI Committee 211

[37] ACI 211.2-98 Standard Practice for Selecting Proportions for Structural Lightweight Concrete Reported by ACI Committee 211

[38] Sikiru ORITOLA, Abd. L. SALEH and Abdul R. MOHD SAM . Comparison of different forms of gravel as aggregate in concrete Leonardo Electronic Journal of Practices and T echnologies.2014; ISSN 1583-1078 p. 135-144

[39] Abebe Dinku, Tigist Getaneh. High Strength Concrete Production Using Mugher OPC and PPC. EACE Journal. 2003; Vol.2 - No. 1.

[40] M. B. Haque, I. A. Tuhin and M.S.S. Farid. Effect of Aggregate Size Distribution on Concrete Compressive Strength. 2012;

[41] Chirag Pawar, Palak Sharma and Abhyuday Titiksh. Gradation of Aggregates and its Effects on Properties of Concrete. International Journal of Trend in Research and Development. 2014;Volume 3(2), ISSN: 2394-9333

[42] Nwabueze Michael ANOSIKE. PARAMETERS FOR GOOD SITE CONCRETE PRODUCTION MANAGEMENT PRACTICE IN NIGERIA. 2011;

[43] Zahid Ahmad Chat, Umer Salam and Shahid Bashir. Com pressive Strength Of Concrete Using Natural Aggregates (Gravel) And Crushed Rock Aggregates A Comparative Case Study. International Journal of Civil Engineering and Technology. 2015;Volume 6, pp. 21-26

[44] Chandrashekar. A and Maneeth.P.D. Performance Appraisal of River Stone as a coarse Aggregate in Concrete; Journal of Engineering Research and Applications. 2014;Vol. 4, pp.93-102 ISSN : 2248-9622

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