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COMPRESSIVE STRENGTH ANALYSIS OF CONVENTIONAL DESIGN CONCRETE MIX RATIO; 1:2:4 AND NON-CONVENTIONAL CONCETE MIX RATIO; 1:3:3 FOR THE CONSTRUCTION INDUSTRY IN NIGERIA

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ABSTRACT:

The challenge which is very common in Nigeria construction industry is the coarse nature of 1:2:4 conventional mix ratio of green concrete. Most often in Nigeria construction industry, the 1:2:4 conventional mix ratio is often been rationalised and batch to obtain 1:3:3 mix ratio so as to have a workable green concrete. This is often preferable due to the challenge arising from inability of the quarry industry to crush stone 10mm, 12mm, 14mm and 20mm size separately. What is common in many part of this Country is manual crush aggregate, which is hand crush aggregate which are the combination of 10mm, 12mm, 14mm and 20mm, which lead to the difficulty in concrete batching with 1:2:4 mix ratio. This research came from the challenge encountered during the construction of Oba Abegunde Adukanjemeji Monument Dynast, Omu Aran, in getting machine crush aggregate, For the purpose of this research work, the compressive strength of concrete made of conventional mix ratio (1:2:4) and concrete made of non-conventional mix ratio 1:3:3 was investigated. Combination of 10mm, 12mm, 14mm and 20mm size of coarse aggregate was use to cast concrete made of 1:2:4 mix ratio and 1:3:3 mix ratio. The concrete cube of size (150mmx150mmx150mm) made from 1:2:4 mix ratio serve as the control and was cured in a curing tank which was monitored for 7days, 14days and 28days respectively. Also concrete cube made of 1:3:3 mix ratio was also cast and cured for 7days, 14days and 28days respectively.

From the result of the average compressive strength of concrete made of 1:3:3 mix ratio, at twenty eight days of curing gives(16N/mm^2), which shows that, the concrete strength met the minimum required standard for twenty eight days of curing which is (15N/mm^2) while 1:2:4 mix ratio using the same aggregate and curing period gives (17N/mm^2)

Also a statistical test (Analysis of variance, ANOVA) on the data gotten was introduced in which a null hypothesis and alternative hypothesis was proposed, and the null hypothesis was accepted as a result of the asymptotic significance value gotten to be (0.923). This shows that

there is no significant difference between concrete made of 1:2:4 mix ratio and the one made from 1:3:3 mix ratio

Keywords: Coarse Aggregates, Compressive Strength, Concrete, Aggregate Sizes, Fineness Modulus (FM), conventional mix ratio, non-conventional mix ratio and Statistical Test (ANOVA)

1. INTRODUCTION

The drive for optimum safety with the strength of concrete in the mind of engineers has led to the modification of concrete production in construction industry. There are various ways by which concrete has been modified for various purposes without compromising in the strength of concrete, such as coarse aggregate combination, partial replacement of either fine aggregate or coarse aggregate in their research on the comparative analysis of the combination of coarse aggregate size fractions on the compressive strength of concrete concluded that, third test of the combined coarse aggregates which contained 30% 10mm, 20% 14mm and 50% 20mm had the highest compressive strength of 25N/mm^2 . Concrete production can be modified provide the minimum required strength is reached and served the intended purpose. [3, 7]

The challenge which is very common in Nigeria construction industry is the coarse nature of 1:2:4 conventional mix ratio of green concrete. Most often in Nigeria construction industry, the 1:2:4 conventional mix ratios are often been rationalised and batch to obtain 1:3:3 mix ratio so as to have a workable green concrete

This research was undertaken to compare the compressive strength of concrete made of conventional mix ratio (1:2:4) and concrete made of non-conventional mix ratio was investigated. 12mm size of coarse aggregate was use to cast concrete made of 1:2:4 mix ratio and 1:3:3 mix ratio [6]

2. MATERIALS AND METHOD

Commercially available Dangote ordinarily Portland cement was used for this project work. The cement has a specific gravity of 3.15.

12mm sizes of coarse aggregate were used. It was free from clay materials and organic matter. The fine aggregate is normal sand obtained from a burrow pit.

The water used was suitable for drinking. It was obtained from the borehole at the Oba Abegunde Palace, Omu-Aran, Kwara State, Nigeria. This conforms to British standard (BS3148, 1990) specification.

To Mix ratios was used for this research work which are; 1:2:4 (cement, fine and coarse aggregate) and 1:3:3 (cement, fine and coarse aggregate). With water cement ratio of 0.5. The mix composition was done using the absolute volume method shown in equation (1).

Mix Ratio = 1:2:4, 1:3:3

Water cement ratio = 0.5

$$\frac{Fa}{1000_{SG}} + \frac{Ca}{1000_{SG}} + \frac{C}{1000_{SG}} + \frac{0.5C}{1000} + 0.02 = 1m^3 \ of \ concrete \quad (1)$$

Where 0.02 = entrapped air

W = 0.5C

Where W = weight of water

C = weight of cement

$$\frac{Fa}{C} = \frac{Ratio \times Density\ of\ Fine\ Aggregate}{Density\ of\ Cement} \quad (2)$$

$$Fa = \left(\frac{Ratio \times Density\ of\ Fine\ Aggregate}{Density\ of\ Cement}\right)C \quad (3)$$

$$Ca = \left(\frac{Ratio \times Density\ of\ Coarse\ Aggregate}{Density\ of\ Cement}\right)C \quad (4)$$

Where Fa = fine aggregate

Ca = coarse aggregate

Table 1: material used for the control experiment (Mix Ratio 1:2:4);

Materials	Cement
	Water
	Sand
	Granite(12mm)

Table 2: materials for experiment using mix ratio: 1:3:3);

Materials	Cement
	Water
	Sand
	Granite(12mm)

The fine aggregate (sand) and the binder (cement) and coarse aggregates for the control was poured were mixed thoroughly using a concrete mixer. The specified amount of water was then poured into the mixer bucket. It was then mixed thoroughly to ensure suitable consistency for the proportioned coarse aggregate replacement. Water of specified weight was poured and mixed thoroughly to obtain an even and consistent mix. This was done for the two mix ratio to be use in this research work. The concrete mix was then poured into each mould of 150mmx150mmx150mm size for 1:2:4 mix ratio and 1:3:3 mix ratio. The green concrete was then poured into the moulded layer by layer to allow for proper compaction to prevent void on the concrete. The green concrete in the mould was left for 24 hours before it was demoulded and placed in the curing tank. For each mix ratios (i.e.1:2:4 and 1:3:3) concrete cube were cast and cured for 7days, 14days and 28days respectively [1, 2]

A research hypothesis for this research was proposed as follows;

- **Null hypothesis, (H_0):** there was no significant difference in the compressive strength of the concrete made of 1:2:4 mix ratio to compressive strength of concrete made of 1:3:3 mix ratio.
- **Alternative hypothesis, (H_1)**: there was a significant difference in the compressive strength of the concrete made of 1:2:4 mix ratio to compressive strength of concrete made of 1:3:3 mix ratio. [7]

3. RESULT AND DISCUSSION

The results of the sieve analysis test on the aggregate are shown in figure. The fineness modulus (FM) got shows that, the FM gotten is within the FM range of 2.1 to 3.1 as specified in American Society of Testing and Materials (ASTM) C33. Therefore, the fine aggregate is suitable for construction work.

The value of specific gravity of the aggregate are from 2.58 to 2.75

Finess Modulus (FM) = $\frac{0.32+2\ .10+7\ .40+9\ .00+9\ .32}{100} = \frac{294.14}{100} = 2.94$

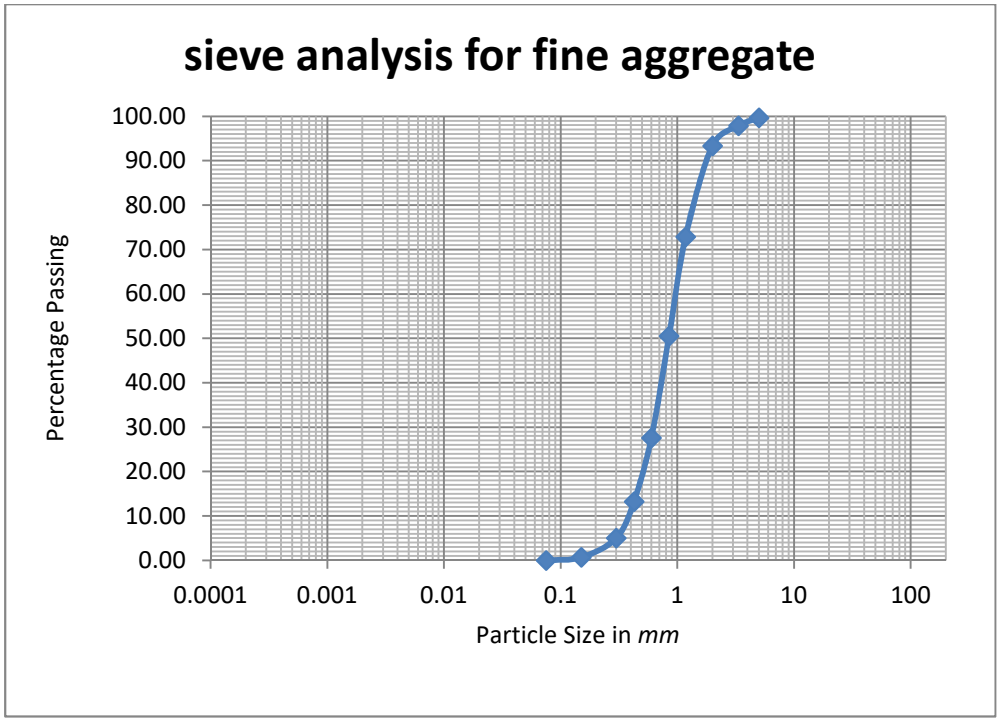

Figure 1: Particle- Size Distribution Curve for Sand

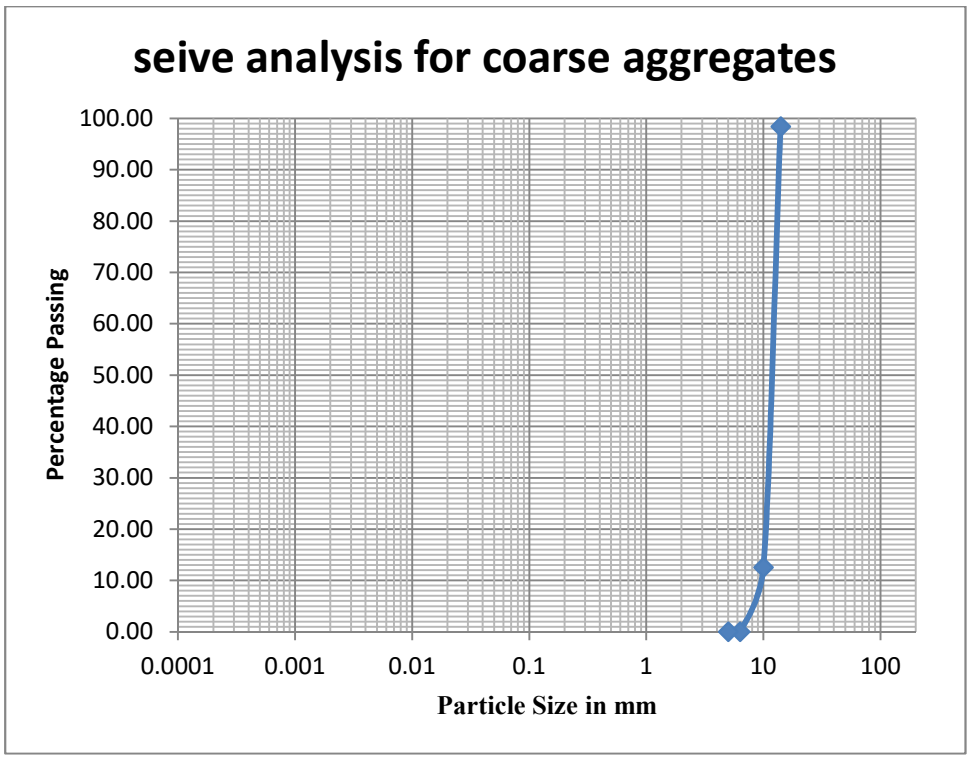

Figure 2: Particle- Size Distribution Curve for Coarse Aggregates (Granite)

Table 3: Crushing strength of concrete made of mix ratio 1:2:4 and 1:3:3

Age of Curing	Mix ratio (1:2:4)Average Crushing strength FCu (N/mm2)	Mix ratio (1:3:3)Average Crushing strength FCu (N/mm2)
7	12	12.67
14	14	14
28	17	16

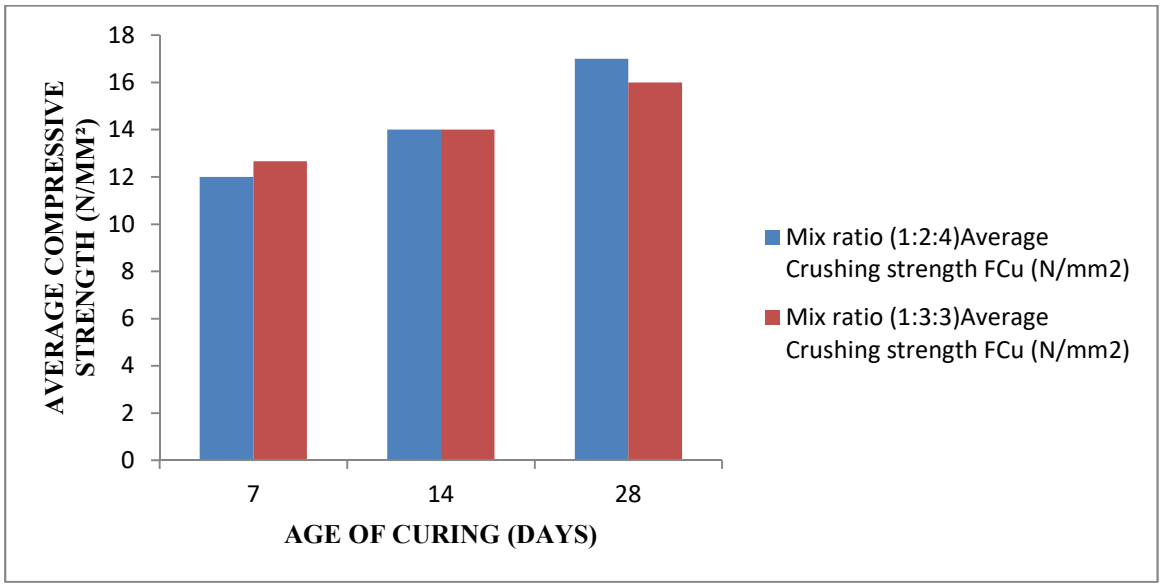

FIGURE 3: Comparative bar chart showing the comparison between concrete made of mix ratio 1:2:4 to concrete made of mix ratio 1:3:3

A statistical ANOVA (Analysis of Variance) test model was also used to compare the compressive strength of the concrete made of 1:2:4 mix ratio with the concrete made of 1:3:3 mix ratio. This ANOVA shows statistically the level of difference between the compressive strength of the concrete made of 1:2:4 mix ratio with the concrete made of 1:3:3 mix ratio, using 0.05 level of significant. [3, 5, 6]

TABLE 3: SHOWING ANOVA TEST MODEL RESULT

ANOVA						
Source of Variation	SS	Df	MS	F	P-value	F crit

Between Groups	0.01815	1	0.01815	0.00397026	0.952782	7.708647
Within Groups	18.285933333	4	4.5714833333			
Total	18.304083333	5				

5% level of significant for P-Value.

DF = degree of freedom.

P – Value = Probability value or asymptotic significance

TABLE 4: SHOWING ANOVA TEST MODEL RESULT

SUMMARY				
Groups	Count	Sum	Average	Variance
Mix ratio (1:2:4)Average Crushing strength FCu (N/mm2)	3	43	14.333333333	6.333333333
Mix ratio (1:3:3)Average Crushing strength FCu (N/mm2)	3	42.67	14.223333333	2.809633333

From the statistical result gotten, the asymptotic significance high, which is 0.953 show that, there is not significance difference between the strength of concrete made of mix ratio 1:2:4 and that made of mix ratio 1:3:3. We therefore accept the null hypothesis.

Also, to elucidate on the above verdict, from the mean of the concrete with mix ratio 1:2:4 and 1:3:3, we can also deduce that there is no significant difference between the strength of concrete made of mix ratio 1:2:4 and that made of mix ratio 1:3:3. [4]

4. CONCLUSION

Based on the result of the research carried out, the following conclusions may be drawn;

- Mix ratio is a factor to be considered when determining the compressive strength of a concrete.
- From the result of the average compressive strength of concrete for seven days of curing (12N/mm^2), for both concrete made of 1:2:4 mix ratio and 1:3:3 mix ratio, we can deduce that, the concrete strength met the minimum required standard for seven days of curing which is 65% of (15N/mm^2 the minimum standard 28days of curing strength).
- From the result of the average compressive strength of concrete for fourteen days of curing (14N/mm^2), for both concrete made of 1:2:4 mix ratio and 1:3:3 mix ratio, we can deduce that, the concrete strength met the required standard for fourteen days of curing which is 90% of (15N/mm^2 the minimum standard 28days of curing strength).
- From the result of the average compressive strength of concrete for twenty eight days of curing (17N/mm^2), for both concrete made of 1:2:4 mix ratio and 1:3:3 mix ratio, we can deduce that, the concrete strength met the minimum required standard for twenty eight days of curing which is (15N/mm^2).
- With the average compressive strength of concrete at 28 days of curing (16N/mm^2), for 1:3:3 mix ratio, we can deduce that 1:3:3 mix ratio can be adopt as a conventional mix design.

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PHOTO SPEAK

Plate I: Compacting of concrete in layers.

Plate II: Compacting of green concrete in layers

Plate III: FULL PROJECT WORK CARREID OUT FOR THIS RESEARCH WORK AT COMPLETION

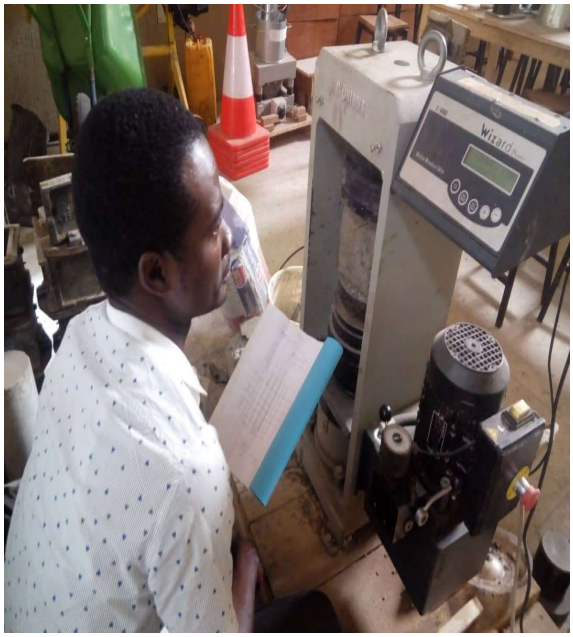

Plate IV: Cube crushing test with a digital crushing machine

Plate V: Cube crushing test with a digital crushing machine

Plate VI: Cube in the curing tank

Plate VII: Cube crushing test with a digital crushing machine