IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 16, Issue 4 Ser. II (Jul. - Aug. 2019), PP 49-52
www.iosrjournals.org

Effect of Concrete Mix Ratios (1:2:4 and 1:1.5:3) on the Compressive Strength of Concrete of 20mm and 25mm Coarse Aggregate Sizes

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Abstract: *This project investigates the effect of mix ratio (1:2:4 and 1:1.5:3) on the compressive strength of concrete of 20mm and 25mm coarse aggregate sizes. Test such as aggregate impact value test, aggregate crushing value test, specific gravity and sieve analysis were carried out on coarse aggregate and fine aggregate. Consistency, setting time and soundness tests were carried out on the cement paste, while compressive strength test was carried out on the concrete cubes measuring 150mmx150x150mm for 7, 14, 21 and 28 days. The specific gravity of fine aggregate was found to be 2.65 while that of the coarse aggregate was 2.78 for both sizes. The results of standard consistency, final and initial setting time tests are 32.5mm, 115mins and 187mins respectively, while that of soundness test is 0.1mm. The result shows an increase in strength as the cement aggregate ratio is increased for 20mm aggregate size. As the size of aggregate is increased, compressive strength also increases for both mix ratios. Therefore 25mm coarse aggregate should be used for construction were high compressive strength is required. More research which include different mix ratios and coarse aggregate sizes should be carried out to see the result across a wider range.*

Date of Submission: 15-07-2019 Date of acceptance: 31-07-2019

I. Introduction

The construction of buildings by incompetent craftsmen and the use of low quality building materials, including low quality concrete have been the major causes of collapse of buildings in Nigeria (Adewale, 2015). The roadside craftsmen/artisans usually construct buildings using 1:2:4 cement-fine aggregate-large aggregate mix ratio irrespective of the size of coarse aggregate. To solve this problem, there is a need to ensure that appropriate mix ratios are used for various construction works. Lives and properties have been lost as a result of collapse of buildings all over the world due to inappropriate use of mix ratios. In this report, investigation is conducted to suggest the appropriate concrete mix ratio required to produce concrete using 20mm and 25mm coarse aggregate sizes for the construction of structural members to reduce the collapse of buildings. The design of concrete mix is the process of selecting ingredients and determining their relative proportion with the objective of producing concrete of having certain minimum workability, strength and durability as economically as possible (Banzal, 2007). The ease of working with the concrete (i.e. workability) depends on the quality and amount of water used. The use of less than the optimum amount of water may make setting difficult and reduce workability. On the other hand, greater shrinkage and a reduction in strength will occur when more water than the optimum amount is used. The best water-cement ratio, therefore, depends on the particular concrete mix (Alawode & Idowu, 2011). The required workability depends on the type of construction, placement method, consolidation method, shape or formwork and structural design (Khayyat, 1999). The strength of concrete is affected partly by the relative proportion of cement and of the fine and coarse aggregates but the water-cement ratio is another important factor. There is an optimum amount of water that will produce a concrete of maximum strength from a particular mix of fine and coarse aggregate and cement (Lafe, 1986). In a research conducted by (Alawode & Idowu, 2011) to determine the effects of water-cement ratios on the compressive strength and workability of concrete and lateritic concrete, it was revealed that the compressive strength of concrete increase with age but decrease as the water-cement ratios increases.

II. Materials And Methods

2.1 Location

This research was carried out at the Department of Civil Engineering, Ahmadu Bello University Zaria. All materials used were obtained in Samaru, Sabongari Local Government Kaduna State.

2.2 Materials

The materials used in this research are: (1) grade 42.5 BUA brand of Ordinary Portland Cement (OPC) obtained from a local outlet. (2) 20mm and 25mm coarse aggregate obtained from a crushing plant located along Sokoto road, opposite Nigerian Collage of Aviation Technology (NCAT) Zaria. (3) Fine aggregate obtained from a river in Zaria. (4) Water which is fit for drinking obtained from ABU Water supply.

2.3 Laboratory test conducted

Laboratory test conducted are: (1) Specific Gravity Test (2) Aggregate Impact Value Test (3) Aggregate Crushing Value Test (4) Consistency, Soundness and Setting Time Test (5) Compressive Strength Test (5) Sieve Analysis.

III. Result And Discussion

3.1 Result of specific gravity

Result shows 2.65 and 2.78 for specific gravity for fine and coarse aggregate respectively, this conforms to ASTM D854-14 which recommends a standard minimum value of 2.6 and maximum value of 2.9 for fine and coarse aggregates respectively. Thus, the aggregates are fit for use in the research.

3.2 Result of aggregate impact value (AIV) and aggregate crushing value (ACV)

The aggregate crushing value (AIV) was found to be 21.5% and 15.5% respectively while that of the aggregate crushing value were 15.5% and 16.15% for the 20mm and 25mm coarse aggregate sizes respectively

Table 3.1: Results of AIV and ACV test conducted on coarse aggregate

Type of Aggregate	AIV (%)	ACV (%)
20mm coarse Aggregate	21.5	19.5
25mm coarse Aggregate	15.5	16.15

3.4 Result of physical properties of BUA brand of OPC

Table 3.2: Physical Properties of BUA brand of OPC

S/No.	Parameters Tested	Test Result	BS EN 197-1 (2000) Requirement
1	Standard Consistency	32.0%	26%-33%
2	Setting Time (minutes) Initial Setting Time Final Setting Time	 115mins 187mins	 ≥ 45mins < 10hours
3	Soundness	0.1mm	≤ 10mm

From Table 3.2 above, it can be clearly seen that the cement has satisfied physical requirements as per BS EN 197-1 (2000), hence it is a sound cement and can be classified as an Ordinary Portland Cement.

3.5 Result of sieve analysis of fine aggregate

Table 3.3 Shows The Grading of Fine Aggregate.

S/NO.	Sieve Sizes (mm)	Mass Retained (g)	Percentage Retained (%)	Percentage Passing (%)
1	4.76	20	2.00	98.00
2	2.36	50	5.00	93.00
3	1.18	69	6.90	86.10
4	0.60	482	48.20	37.90
5	0.30	158	15.80	22.10
6	0.15	205	20.50	1.60
7	Pan	16	1.60	

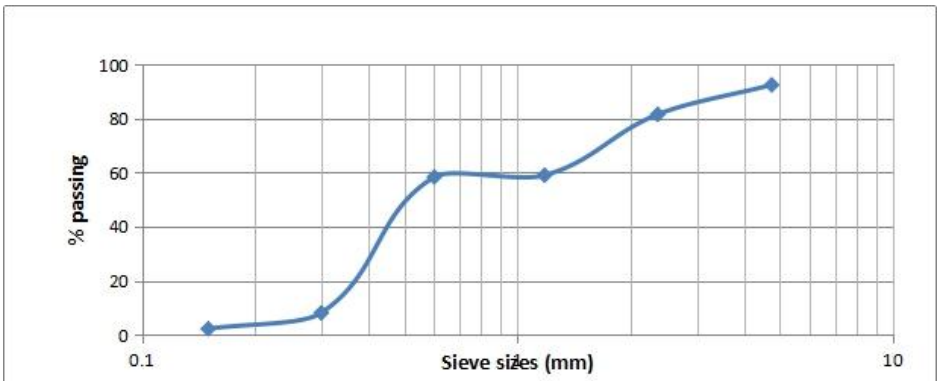

Figure 3.1: Particle size Distribution Curve for Fine Aggregate.

The fine aggregate properties were evaluated and found to be well graded and fall within the allowable limits of BS EN 196-6 (1992).

3.6 Result of compressive strength test

Table 4.4: Average compressive strength for 20mm aggregate

Hydration Period (Days)	Compressive Strength for 1:2:4 (N/mm^2)	Compressive Strength for 1:1.5:3 (N/mm^2)
7	13.33	16.56
14	16.44	17.62
21	17.03	18.62
28	18.55	25.03

Table 3.5: Average Compressive Strength for 25mm Aggregate

Hydration Period (Days)	Compressive Strength for 1:2:4 (N/mm^2)	Compressive Strength for 1:1.5:3 (N/mm^2)
7	16.14	17.48
14	16.73	18.22
21	21.18	21.03
28	25.77	26.51

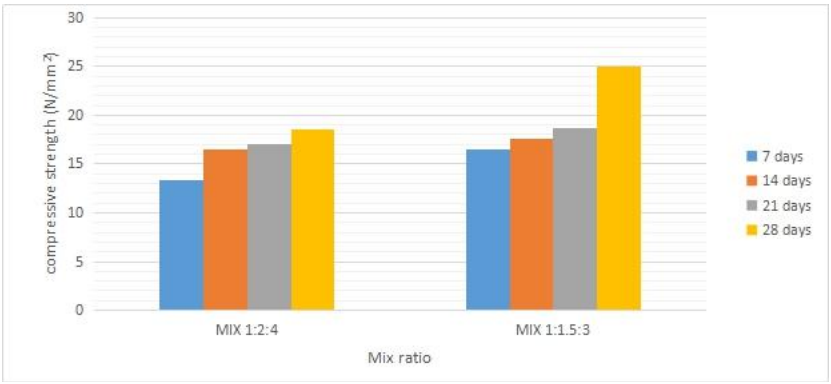

Figure 4.2: *Compressive strength versus mix ratio for 20mm aggregate*.

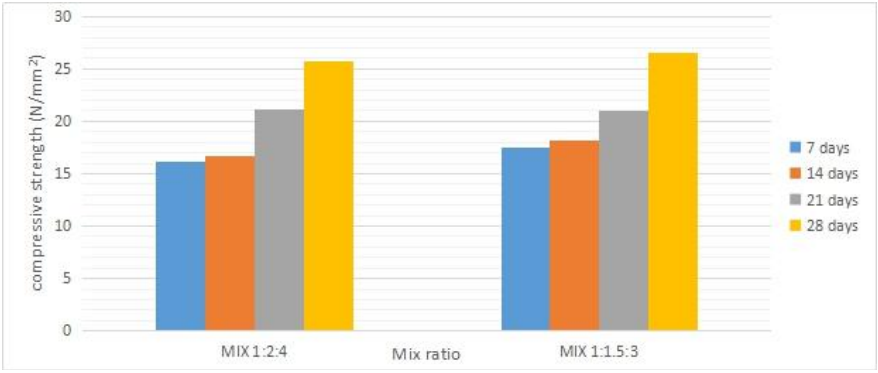

Figure 4.3: Compressive strength versus mix ratio for 25mm aggregate.

From figure 4.2 and 4.3, the compressive strength of concrete increase linearly with age for each coarse aggregate size and mix proportion. There is a significant increase in the 28th day compressive strength for 20mm aggregate as the mix proportion is increased. However, for 25mm aggregate, there is no slight increase in the compressive strength as the mix proportion is increased. According to Neville (1992), concrete attain over 60% of their 28 days strength at the age of 7 days, the results obtained agrees with this finding. Comparing the size of aggregates used in different mix ratio, 20mm aggregates shows that the increase in compressive strength is evident, while for the 25mm aggregate, the increase in compressive strength slightly varies, this shows that the sizes of aggregate have considerable impact on the compressive strength of concrete.

IV. Conclusion

The following conclusions can be drawn from the results of the study:

(i) The compressive strength increases as the cement-aggregate ratio is increased for 20mm coarse aggregate size.
(ii) At a mix ratio of 1:2:3 and 20mm aggregate size, the compressive strength was 18N/mm which does not reach the minimum requirement of 25N/mm.
(iii) Mix ratio has no significant effect on the compressive strength for 25mm coarse aggregate size.
(iv) The compressive strength increases as the aggregate size is increased.
(v) The results of the standard consistency, initial and final setting times of the OPC were 32.5mm, 115mins and 187mins respectively.
(vi) Specific gravity of the fine aggregate was 2.65 while that of the coarse aggregate was 2.78.

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