

Quality Assessments of Concrete Construction materials.

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ABSTRACT

This research presents the quality assessment of concrete materials to be used in monitoring and accessing construction works, it was performed by studying the 100mm concrete cube mean compressive strengths of 1:2:4 mix with different cement brands/grades, coarse aggregate sources and water-cement ratios using Ajibode river sharp sand in Akinyele local government area, Ibadan. The research was carried out by designing questionnaire and distributing to Consultants, resident Engineers, Contractors, etc to get the sources of fine and coarse aggregates and the available cement grades/brands on which the research was based. Using different brands/grades of cement (Dangote 42.5R, Purechem 32.5N, Lafarge 32.5N and Lafarge 32.5R), and putting coarse aggregates from different sources among those received from the questionnaire into consideration i.e Kopek and Ratcon quarries with different water cement ratios of 0.60, 0.65 and 0.7 shows that each has different effects on the mean compressive strengths being produced with 0.6 water-cement ratio having the highest average compressive strengths when compared with others. Lafarge Superset 32.5R cement produced mean compressive strength of 33.73MPa, Dangote 42.5R produced 28.90MPa, Lafarge 32.5N cement with 24.65MPa while Purechem 32.5N gave 21.8MPa. Also, using the graphs, Kopek quarry coarse aggregates produced the highest average compressive strengths and from the data analysis, the comparisons made among the cement brands and the water/cement ratio with Kopek quarry coarse aggregate concrete in 28 days has the *p-value of 0.001* while Ratcon has the *p-value of 0.037*. Lafarge Superset 32.5R and Purechem 32.5N cements produced the highest and lowest mean compressive strengths respectively while Kopek granites gave the highest mean compressive strengths. Also, 0.4 and 0.5 water-cement ratios were not workable and hereby failed in their compliance.

Keywords: Aggregates sources, Cement brands/grades, Compressive strengths, Quality Assessment, Water- Cement ratios.

1.0 INTRODUCTION

Construction quality assessment involves testing and inspection of materials and works. The process is corruption prone because the cost of material and workmanship is substantial in construction projects. Hence, there is an incentive for unscrupulous contractors to make a wrong choice of materials, cover up substandard materials or works through offering bribes to the site staffs. Common malpractice revealed in past corruption cases includes manipulation in sampling of materials for testing, substitution of test samples, falsification of test reports, and false or selective reporting of field tests.

This calls for the quality assessment of concrete construction materials to monitor the quality of construction materials used for the massive constructions so as to avoid the collapse of structures, loss of lives, properties etc.

Collapse as a whole occurs when part or whole body of a structure fails and suddenly gives way. The structure, as a result of this failure, could not meet the purpose for which it was meant for. Building collapse is an extreme case of building failure. It means the super-structure crashes down totally or partially [4]. Building failure occurs when there is a defect in one or more elements of the building caused by inability of the material making up the components of such building elements to perform its original function effectively, which may finally lead to building collapse. Buildings are meant to provide conveniences and shelter to the people, but the same building has been a danger trap to the same people. Building is expected to meet certain basic requirements such as buildability, design performance, cost effectiveness, quality, safety and timely completion [28]. Generally, buildings are expected to be elegant and functional but many projects are constructed that do not meet any of these basic requirements. The recurring

incidence of building collapse, some of which claimed innocent lives is a consequence of this. Many studies have been carried out and various workshops organized in major cities of the country by various bodies, government agencies and institution in order to look into causes of the incidence of building collapse in Nigeria, but none has been able to come out with how each of the determined factors directly lead to building collapse in the country. There are many factors that cause building collapse in Nigeria and they are; poor structural design and quality management according to [27]. The quality management entails material variability, testing variability, judgment factor, contractors' variability, faulty construction, foundation failure, poorly skilled workmen, unexpected failure modes and unprofessional conduct.

Every production process should follow the proper scientific procedures to get the desired quality concrete products. For this reason, a quality control/ assessment plays significant roles.

2.0 MATERIALS AND METHODOLOGY

2.1 Materials

2.1.1 Cement: Ordinary Portland Cements with grades i.e Lafarge 32.5N, Lafarge Supasets 32.5R, Dangote 42.5R and Purechem 32.5N were used in this research.

2.1.2 Aggregates: Both coarse and fine aggregates were brought from different sources as regard the information gathered from the responses in the questionnaire in Ibadan and environs. The fine aggregate used was Ajibode river sharp sand which is located at Ajibode-Shasha road near Adebayo Akande hall, Akinyele local government in Ibadan while 12.5mm size of coarse aggregates used were obtained from two sources i.e Kopek and Ratcon quarries in order to compare the quality of the concrete compressive strengths produced.

2.1.3 Water: Potable drinking water, free from all possible sources of contamination, obtained from Civil Engineering department, University of Ibadan, Nigeria was used for this work. This water is therefore suitable for concrete work [10].

2.2 Methods

2.2.1 Mixture Proportions: A nominal mix ratio of 1:2:4

(Cement: Fine Aggregate: Coarse Aggregate) was adopted for the purpose of this work and water-cement ratios of 0.6, 0.65 and 0.7 were used after performing the slump test and discovered that 0.4 and 0.5 water-cement ratios were not workable because of the size and dried conditions of the aggregates. The mix matrix is shown in Table 1.0

Table 1.0: Research Mix Matrix for the 100mm concrete cubes

Sand (Constant)	Mix Ratio (Constant)	Water-Cement ratios	Cement brands/grades	Coarse Aggregates quarry sources	Total No of concrete cubes samples with 4 cubes per aggregate source	
Ajibode River Sharp sand	1:2:4	0.60	Dangote 42.5R	Kopek and Ratcon	8	
			Purechem 32.5N	Kopek and Ratcon	8	
			Lafarge 32.5N	Kopek and Ratcon	8	
			Lafarge Supaset 32.5R	Kopek and Ratcon	8	
						Total=32 cubes
	1:2:4	0.65	Dangote 42.5R	Kopek and Ratcon	8	
			Purechem 32.5N	Kopek and Ratcon	8	
			Lafarge 32.5N	Kopek and Ratcon	8	
			Lafarge Supaset 32.5R	Kopek and Ratcon	8	
						Total=32 cubes
	1:2:4	0.70	Dangote 42.5R	Kopek and Ratcon	8	
			Purechem 32.5N	Kopek and Ratcon	8	
Lafarge 32.5N			Kopek and Ratcon	8		
Lafarge Supaset 32.5R			Kopek and Ratcon	8		
					Total=32 cubes	
					Grand total=96	

For 7 and 28 days curing, the total number of concrete cubes cast was 192 i.e (96 x 2).

The required weights of mix ingredient were measured and mixing was done thoroughly to ensure that homogenous mix is obtained. Before casting, the slump of the concrete is measured in accordance to [5]. For each source of coarse aggregate, 4 cubes (100x100x100mm) were cast under each water- cement ratios of 0.6, 0.65 and 0.7, using cement brands/grades i.e Dangote 42.5R, Purechem 32.5N, Lafarge

32.5N and Lafarge Supaset 32.5R in accordance to [8]. After one day of casting, the concrete cubes were removed from the mould and were transferred to a water tank for curing until the time of test. The curing of the cube was done according to [9]. The concretes were tested for compressive strength at 7and 28 days. Four cubes were crushed using the compressive testing machine and the average taken as

the compressive strength of the concrete.

3.0 Measurements of variability

It has been found that the distribution of concrete strengths can best be approximated by the normal or Gaussian distribution. Such a distribution is defined by two parameters; the mean \bar{X} and the standard deviation, S [11]. The average or a mean, for a set of n observation x_1, x_2, \dots, x_n is expressed as:

$$\bar{X} = \frac{\sum_{i=1}^n xi}{N} \dots\dots\dots 2.5$$

And the standard deviation or the root-mean-square deviation, which is the measure of dispersion or variability of the values, is given by

$$s = \frac{\sqrt{\sum_{i=1}^n (x-\bar{x})^2}}{n-1} \dots\dots\dots 2.6$$

Where

S = standard deviation of the set of observations.

X_i – any value in the set of observations.
 \bar{X} = arithmetic mean of the values
 n = total number of observations.

4.0 Results and Discussion

The experimental results are discussed as follows:

4.1 Slump

The result for the slump test of the fresh concrete is shown in Figure 1. The slumps obtained are in the medium range (00- 90mm). The highest slump was obtained with concrete made with 0.7 water-cement ratio, followed by 0.65 and 0.6 water-cement ratio while 0.4 and 0.5 were not workable because of the size and dry condition of the aggregates , which means; as the w/c ratio increases, the slump increases [14] while compressive strength decreases [26] . This aggregate requires less amount of paste to coat its surface and thereby leave more paste for lubrication so that interactions between aggregate particles during mixing is minimized [31].

Table 4.1: Slump test results

Water-Cement Ratios	Slump (cm)	Type of Slump
0.40	0.00	True
0.50	0.50	True
0.60	5.00	True
0.65	6.50	True
0.70	8.50	True

4.1.2 Compressive Strengths Test Results and their Compliance with [3] and [7]

Results of compressive strengths are presented as follows:

Table 4.1: Results of 7 Days Curing Showing the Standard Deviation and Coefficient of Variations of the Mean Strengths Using Kopek Quarry coarse aggregate

Cement Brand/Grades	Water/Cement Ratio	Average Strength Mpa (N/mm ²)	Standard Deviation	Coeff. Of Variation (%)
Dangote 42.5R	0.6	24.40	1.87	7.66
	0.65	20.43	1.06	5.18
	0.7	17.05	1.84	10.7
Purechem 32.5N	0.6	9.38	1.05	11.1
	0.65	7.05	0.17	2.41
	0.7	6.30	0.39	6.19
Lafarge 32.5N	0.6	26.55	1.18	4.44
	0.65	21.90	2.59	11.8
	0.7	12.8	1.42	11
Lafarge Supaset 32.5R	0.6	33.28	4.41	13.2
	0.65	19.15	1.32	6.8
	0.7	15.73	0.43	2.7

Table 4.2: Results of 28 Days Curing Showing the Standard Deviation and Coefficient of Variations of the Mean Strengths Using Kopek Quarry coarse aggregate

Cement Brand/ Grades	Water/ Cement Ratio	Average Strength Mpa (N/mm ²)	Standard Deviation	Coeff. Of variation (%)	Compliance with ACI	Compliance with BS 5328:1990
	0.6	28.90	4.50	15.5	Failed	Complied
Dangote	0.65	25.35	1.99	7.8	Complied	"
42.5R	0.7	22.43	2.52	11.2	Complied	"
	0.6	21.83	2.80	12.8	Complied	Complied
Purechem	0.65	19.93	2.19	10.9	Complied	"
32.5N	0.7	13.8	0.75	5.7	Complied	Failed
	0.6	24.43	3.91	16.1	Complied	Complied
Lafarge	0.65	21.18	2.90	13.6	Complied	"
32.5N	0.7	22.40	1.64	7.3	Complied	"
	0.6	33.73	1.66	4.92	Complied	Complied
Lafarge	0.65	30.18	1.96	6.49	Complied	"
Supaset	0.7	27.30	1.16	4.25	Complied	"
32.5R						

Table 4.3: Results of Seven Days Curing Showing the Standard Deviation and Coefficient of Variations of the Mean Strengths Using Ratcon Quarry coarse aggregate

Cement Brand/Grades	Water/Cement Ratio	Average Strength Mpa (N/mm ²)	Standard Deviation	Coeff.of Variation (%)
Dangote 42.5R	0.6	19.3	2.06	10.6
	0.65	12.68	1.28	10
	0.7	7.95	1.72	21.6
Purechem 32.5N	0.6	17.90	1.68	9.3
	0.65	10.15	0.57	5.6
	0.7	7.93	2.00	25.2
Lafarge 32.5N	0.6	26.15	1.94	7.4
	0.65	23.78	0.52	2.1
	0.7	10.45	0.37	3.5
Lafarge Supaset 32.5R	0.6	22.75	2.58	11.3
	0.65	16.53	1.61	9.7
	0.7	9.63	2.16	22.4

Table 4.4: Results of 28 Days Curing Showing the Standard Deviation and Coefficient of Variations of the Mean Strengths Using Ratcon Quarry coarse aggregate.

Cement Brand/ Grades	Water/ Cement Ratio	Average Strength Mpa (N/mm ²)	Standard Deviation	Coeff. Of Variation (%)	Compliance Using ACI	Compliance with BS 5328:1990
Dangote 42.5R	0.6	22.05	2.47	11.2	Complied	Complied
	0.65	21.70	2.10	9.6	Complied	"
	0.7	13.75	4.34	31.5	Failed	Failed
Purechem 32.5N	0.6	13.98	2.86	20.4	Complied	Failed
	0.65	15.70	0.96	6.11	Complied	"
	0.7	15.58	1.05	6.7	Complied	"
Lafarge 32.5N	0.6	18.88	0.75	3.97	Complied	Complied
	0.65	24.65	2.84	11.52	Complied	"
	0.7	19.53	1.20	6.14	Complied	"
Lafarge Supaset 32.5R	0.6	30.83	5.30	17.19	Failed	Complied
	0.65	26.08	2.51	9.6	Complied	"
	0.7	24.58	1.12	4.5	Complied	"

The standard deviations of the mean compressive strengths of concrete to the individual test results for the general control testing are said to be **Excellently** controlled if it falls below 2.8, **Very good** if within 2.8 to 3.5, **Good** if between 3.5 to 4.2, **Fair** if it's within 4.2 to 4.9 and **Poorly** controlled if above 4.9. While considering the coefficient of variations, under field control testing, the results shown the **Excellently** controlled if it falls below 10%, **Good** if between 10 to 15%, **Fair**, if falls within 15 to 20 % and **Poor** if above 20%.

The summary of these discussions were therefore presented in the tables above as compliance with [3] and [7] which states that the minimum value by which the mean strength of the group of test results of any consecutive four should exceed the grade strength (MPa) is 2 and the maximum value by which any individual test result falls short of the grade strength (MPa) is 2.

5.0 Conclusion and Recommendations

5.1 Conclusion

Kopek quarry coarse aggregates in 28 days has the smallest **mean squared error, "3.315"** (which measures the difference between the estimator and what is estimated due to randomness) hence, proving to be good for the production of concretes with the higher compressive strengths in this research. Lafarge Superset 32.5R cement produced the highest compressive strengths, followed by Dangote 42.5R with higher average compressive strength, followed by Lafarge 32.5N cement while Purechem 32.5N gave the lowest average compressive strength of. 0.6 water-cement ratio has the highest mean compressive strengths when compared with 0.65 and 0.7 water-cement ratios while 0.4 and 0.5 were not workable because of the dry condition of the aggregates after sun-dried so as not to affect the applied water-cement ratios . The statistical analysis of the mean compressive strengths and their compliance with [3] and [7] show the comparisons of different aggregate sources, water-cement ratios and cement brands/grades effects to be used in assessing the quality of concrete construction materials in Nigeria.

5.2 Recommendations

I hereby recommend the use of Lafarge Supaset 32.5R , Dangote 42.5R and Lafarge 32.5N cements for concrete construction purposes when constructing load bearing structures as they give high concrete strengths. Purechem 32.5N cement should be used for non -load bearing concrete structures since it gives lower compressive strengths as compared to other brands/grades of cements and not complied with [7].

Therefore, Nigerians generally and professionals in Nigerian construction industry in particular should adopt the use of this details to access the quality of the different cement brands/grades, aggregates sources, water-cement ratios in monitoring the concrete construction of structures in Nigeria. This will ensure that buildings and other

concrete structures in Nigeria are stronger and reduce the frequency of the incessant collapse of building and other concrete structures in Nigeria.

6.0 REFERENCES

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