ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 3, September 2014

Comparism of the Compressive Strength of Concrete Made with Different Brands of Ordinary Portland cement

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Abstract: ***The compressive strength of concrete is one of the most useful properties of concrete in most structural applications. In cases where strength in tension or in shear is of primary importance, the compressive strength is frequently used as a measure of these properties. Therefore the concrete making properties of various ingredients of mix are usually measured in terms of the compressive strength. Cements are hydraulic binders which react exothermically with water to form hard strong masses with extremely low solubility; they consist of chemical compounds such as calcium silicate and calcium aluminates. The Ordinary Portland cement (OPC) used is Eagle cement, Ibeto Cement, Unicem and Dangote Cement. The concrete mix design of 1:2:4 with water/cement ratio of 0.5 was used. 150mm×150mm×150mm metal moulds was used for casting the concrete specimen after obtaining a uniform and consistent mixture for each brand of Cement. The average compressive strength of concrete made with Eagle cement, Unicem, Dangote and Ibeto cement were found to be 48.74N/mm^2, 46.34N/mm^2, 44.35N/mm^2 and 44.96N/mm^2 respectively after 28 days curing. Compressive strength of 30N/mm^2 was targeted for the cubes. It was observed that there is a slight difference between the compressive strengths of the concrete cubes made with four brands of OPC used. This can be due to the difference in quality of the cement produced by these companies. Results obtained clearly show that Eagle cement has the highest compressive strength.***

Keywords: **Binders, Cements, Compressive Strength, Concrete, Mould.**

I. INTRODUCTION

There are two commonly used structural materials which include concrete and steel in the construction of buildings, bridges, highways or dams etc. They sometimes complement one another, and sometimes compete with one another; so that many structures of similar type and function can be built using either of these materials [1]. Concrete as the most widely used man-made construction materials is second only to water as the most utilized substance on the planet [2]. It is obtained by mixing cementitious materials, water and aggregate (and sometimes admixtures) in required proportion. The mixture when placed in form and allowed to cure hardens into rock-like mass known as concrete. In it harden state, concrete should have the following properties; strength, durability, impermeability, and it should have minimum dimensional changes. The strength, durability, and other characteristics of concrete depends upon the properties of its ingredients, on the proportion of mix, the method of compaction and other controls during placing, compaction and curing [2]. Among the various properties of the concrete, its compressive strength is considered to be the most important and it is taken as an index of its overall quality. Portland cement is the most common type of cement used in general construction purpose; it is the basic ingredient of concrete mortal and plaster.

A. COMPRESSIVE STRENGTH

The compressive strength of concrete is one of the most useful properties of concrete. In most structural applications, concrete is employed primarily to resist compressive strength stresses. In case where strength in tension or in shear is of primary importance, the compressive strength is frequently used as a measure of these properties. Therefore the concrete making properties of various ingredients of mix are usually measured in terms of the compressive strength. Compressive strength is also used in a qualitative measure for other properties of a hardened concrete. The compressive strength is determined by testing cubes or cylinders in the laboratory. The strength of a concrete is it resistance to rupture. It can be measured in a number of ways: strength compression in tension, in shear or in flexures. The cohesion and internal friction developed by concrete in resisting failure is related to the water-cement ratio, the design constituents, the mixing, placement and curing methods employed.

B. CURING

Curing is the process of maintaining satisfactorily moisture content and a favourable temperature in the concrete during the period immediately after casting, so that hydration of cement may continue until the desired properties are developed to a sufficient degree to meet the requirement of service. Concrete derives its strength by the hydration of cement particles. The hydration of cement is of momentary action but a process continuing for a long time. The rate of hydration is fast to start with but continues over a long time at a decreasing rate. Curing is usually requires for at least 7 days after the day the concrete is placed, this may vary in certain special circumstances [3].

C. CEMENT

According to [3], cements are hydraulic binders which react exothermically with water to form hard strong masses with extremely low solubility. They consist of

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ISO 9001:2008 Certified
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chemical compounds such as calcium silicate and calcium aluminates. Hydraulic cements are of four types: Portland cement, Blended Portland Cement, and Portland cement with addictives and High Alumina Cement. Cement varying chemical composition and physical characteristics exhibit different properties on hydration. The cement of desired properties can be produced by selecting suitable mixture of raw materials. The various types of Portland cement used in the construction industry are: Ordinary Portland Cement(OPC), Rapid Hardening Portland Cement(RHPC), Sulphate resisting Portland Cement(SRPC), Low Heat Portland Cement(LHPC), Blast Furnace Portland Cement(BFPC), Portland Pozzolana Cement(PPC), Modified Portland Slag Cement(MPC) etc.

Table I Chemical Composition of Portland cement [4].

Name of compounds	Oxide composition	Abbreviation
Tricalcium silicate	$3CaOSiO_2$	C_3S
Dicalcium silicate	$2CaOSiO_2$	C_2S
Tricalcium aluminate	$3CaOAl_2O_3$	C_3A
Tetracalciumaluminoferrite	$4CaOAl_2O_3Fe_2O_3$	C_4AF

II. MATERIALS AND METHODS

Materials used in this research work were acquired from tipper pack market Wethedral junction Owerri, Imo State; they include

A. CEMENT

Cement type was ordinary Portland cement that includes Eagle cement, Ibeto Cement, Unicem and Dangote Cement.

B. AGGREGATE

Aggregate used are classified as fine and coarse aggregate. The fine aggregate are those that pass through the 4.75mm BS (British Standard) test sieve, while those that are retained on the 4.75mm BS sieve are referred to as coarse aggregate.

C. WATER

Portable drinking water was used for mixing and curing the concrete specimens. The experiment was carried out at the Civil Engineering Concrete laboratory of the Federal Polytechnic Nekede, Owerri, Imo State.

D. PREPARATION OF SAMPLES

For this research concrete mix design of 1:2:4 with water/cement ratio of 0.5 was used. The materials used were batched by weight and mixing was carried out manually and separately for each of the Ordinary Portland Cement (OPC) under laboratory conditions. 150mm×150mm×150mm metallic moulds with oil smeared on the inside of the mould to avoiding sticking was used for casting the concrete specimen after obtaining a uniform and consistent mixture. Vibration to remove entrapped voids was done manually and the concrete specimens were left in the mould for 24hours after casting before they were removed from the mould.

III. RESULTS AND DISCUSSION

Table II.Result of slump test of the various brands of Portland cement

Cement brand	Height of slump cone (mm)	Height of collapse (mm)	Slump (mm)
Eagle	300.00	275.00	25.00
Ibeto	300.00	265.00	35.00
dangote	300.00	270.00	30.00
Unicem	300.00	280.00	20.00

Calculations:

$$\text{Density of concrete} = \frac{\text{mass of concrete}}{\text{volume of concrete}}$$

$$\text{Compressive strength} = \frac{\text{Crushing Load}}{\text{Area of cube}}$$

Table III Results of compressive strength of concrete made with Eagle Cement.

Date of Curing	Age of concrete (Days)	Mass of Concrete (kg)	Density of Concrete (kg/m^3)	Crushing Load (KN)	Compressive Strength (N/mm^2)
17/7/12	7	8.550	2533.33	686.00	30.49
17/7/12	7	8.660	2548.15	694.00	30.84
17/7/12	7	8.870	2628.15	790.00	35.11
17/7/12	14	8.972	2658.00	1035.00	46.00
17/7/12	14	8.532	2528.00	1020.00	45.33
17/7/12	14	8.620	2554.10	944.00	44.18
17/7/12	21	8.700	2577.78	1020.00	45.33

Table IIIb Results of compressive strength of concrete made with Eagle Cement.

Date of Curing	Age of concrete (Days)	Mass of Concrete (kg)	Density of Concrete (kg/m^3)	Crushing Load (KN)	Compressive Strength (N/mm^2)
17/7/12	21	8.850	2622.20	988.00	43.91
17/7/12	21	9.000	2666.70	1040.00	46.22
17/7/12	28	9.200	2725.93	1060.00	47.11

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17/7/12	28	8.980	2660.70	1100.00	48.89
17/7/12	28	8.826	2615.11	1130.00	50.22

Table IV. Results of compressive strength of concrete made with Ibeto Cement.

Date of Curing	Age of Concrete (Days)	Mass of Concrete (Kg)	Density of Concrete (Kg/m^3)	Crushing Load(KN)	Compressive Strength(N/mm^2)
17/7/12	7	8.466	2508.44	680.00	30.22
17/7/12	7	8.550	2533.33	694.00	30.84
17/7/12	7	8.625	2555.56	740.00	32.89
17/7/12	14	8.700	2577.78	780.00	34.66
17/7/12	14	8.350	2474.07	920.00	40.88
17/7/12	14	8.810	2610.37	875.00	38.88
17/7/12	21	8.350	2474.07	960.00	42.67
17/7/12	21	8.700	2577.78	996.00	44.27
17/7/12	21	8.250	2444.44	875.00	38.80
17/7/12	28	8.350	2474.07	975.00	43.33
17/7/12	28	9.400	2785.18	1040.00	46.22
17/7/12	28	8.600	2548.45	1020.00	45.33

Table V Results of compressive strength of concrete made with Dangote Cement.

Date of curing	Age of concrete (Days)	Mass of Concrete (Kg)	Density of Concrete Kg/m^3	Crushing load(KN)	Compressive strength N/mm^2
17/7/12	7	8.670	2569.48	750.00	33.33
17/7/12	7	8.670	2669.48	750.00	33.33
17/7/12	7	8.220	2435.36	675.00	32.80
17/7/12	14	8.830	2616.29	920.00	40.89
17/7/12	14	8.861	2625.48	880.00	39.00
17/7/12	14	8.769	2650.96	864.00	40.89
17/7/12	21	9.000	2666.67	945.00	39.11
17/7/12	21	8.941	2649.19	938.00	38.40
17/7/12	21	9.280	2749.63	970.00	42.00
17/7/12	28	9.000	2666.67	1007.00	41.69
17/7/12	28	9.220	2731.85	1020.00	45.30
17/7/12	28	8.980	2660.74	970.00	43.00

Table VI Results of the compressive strength of concrete made with Unicem Cement.

Date of Curing	Age of Concrete (Days)	Mass of Concrete (Kg)	Density of Concrete (Kg/m 3)	Crushing Load (KN)	Compressive strength(N/mm^2)
17/7/12	7	8.200	2429.62	630.00	28.00
17/7/12	7	8.150	2414.81	595.00	26.53
17/7/12	7	8.000	2370.37	495.00	22.00
17/7/12	14	8.350	2474.10	910.00	40.44
17/7/12	14	8.200	2474.10	890.00	39.56
17/7/12	14	8.570	2539.26	1004.00	44.62
17/7/12	21	8.836	2615.11	996.00	44.26
17/7/12	21	8.488	2500.74	990.00	44.00
17/7/12	21	8.350	2472.10	1020.00	45.33
17/7/12	28	9.430	2794.10	1118.00	49.69
17/7/12	28	8.910	2640.00	1020.00	45.33
17/7/12	28	8.760	2595.56	999.00	44.00

Table VII. Result of mean compressive strength of the various brands of Ordinary Portland cement used.

Curing Days / Brand Of Cement	7	14	21	28
	Compressive strength (N/mm^2)			
Ibeto	31.32	38.14	41.91	44.96
Eagle	32.15	45.17	45.15	48.74
Dangote	33.15	39.47	42.23	44.35
Unicem	25.51	41.54	44.53	46.34

The compressive strength of concrete made with Eagle, Unicem, Dangote and Ibeto Ordinary Portland cement, cured in portable water for the period of 28 days is presented in table II, IIIa, IIIb, IV, V, and VI. It is further analyzed and summarized in table VII. Compressive strength of 30N/mm^2 was targeted for the cubes. It was observed from the test that there is a slight difference between the compressive strengths of the concrete cubes made from the four brands of OPC used. This can be due

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ISO 9001:2008 Certified
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to the difference in quality of the cement produced by these companies. From the above results, it was clearly observed that at alleges concretes and brands of cement used, Eagle cement has the highest compressive strength followed by Unicem, Dangote and lastly Ibeto cement.

IV. RECOMMENDATION

In pre-cast and pre-stressed concrete production, emergency concrete structure, and in construction where the construction load is large, there is a demand for high early strength concrete. Long span concrete structures and high rise building construction are among constructions that demand for high strength concrete. Hence, in the production of such concretes, Eagle OPC in particular is recommended.

V. ACKNOWLEDGMENT

The authors want to acknowledge the contribution and cooperation of members of the Civil Engineering Concrete laboratory of the Federal Polytechnic Nekede, Owerri, and Imo State.

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