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Assessment of Quality of Cement Brands Used in the Nigerian Construction Industry

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ABSTRACT

This research work is a cutting edge as an effort and contribution in national development as it concerns Nigerian construction industry. The focus of this work is the investigation of the quality of Portland cement that is most commonly used in the Nigerian construction Industry. Four brands of ordinary Portland cement commonly available in Nigeria were investigated through series of tests such as fineness, workability (slump) and compression and tests conducted to determine their physical, economic and strength characteristics. They were examined to know if there were disparities in the quality of cement that are being used for construction through comparative analysis vis-à-vis the minimum standard as stipulated by the various International and Nigerian standards. The brands of cement considered were labeled as W, X, Y and Z which were assessed using fine aggregates from a river source in Akpugo, Enugu state and coarse aggregates from quarry site in Amofia Ngbo Ebonyi state and portable water from a verified water distribution system. The mean compressive strengths of the four brands for the concrete ages of 7, 14, 21 and 28 days were found to be within the standards. The cement brand Y and W had compressive strengths of 18.84 N/mm^2 and 17.16 N/mm^2 respectively.

***Keywords**: Cement Brands, Construction Industry.*

INTRODUCTION

Makoju (2010) wrote that Nigeria with its population of over 150 million people presents a huge market for any good product, cement inclusive. Considering our level of development, demand for cement has a large potential. These suggest that our absorptive capacity for cement is potentially high if and when the economy is right. The post-civil war reconstruction activities led to an explosion in demand for cement. Government response to this was to embark on massive uncoordinated importation of cement. The problem that arises is how, despite the comparative advantage in the production of cement in Nigeria, these opportunities have failed to transform Nigeria from cement importing country to cement exporting country; a development which has inhibited growth not only of the cement industry but the manufacturing sector in general. However, the overdependence on cement imports seems to have created some problems on the marginal costs and better quality standards for the local cement manufacturers and indeed the Nigerian economy at large. Residential housing is by far the largest segment of cement consumption. The crucial forces on the demand for residential housing are population pressure and the rent level. It is also noted that the pressure from these sources is so critical as to make essential commodity. As such the demand for cement arising from this sector is in turn so critical and it would remain strong even in the face of government policy on population control and austerity (WAPCO, 1990) [1]. It is obvious that recent collapse of structures have been traced back to the poor quality of cement. A government investigation has found poor quality construction materials and building code violations were among the "series of irregularities" that caused the collapse of a building housing garment factories last month in Bangladesh. 5:23 am BST 23 May 2013. The disaster killed more than 1,000 workers and highlighted the hazardous working conditions in Bangladesh's $20 billion garment industry and the lack of safety for millions of workers who are paid as low as $38 a month. The owner used extremely poor quality of iron rods and cement," committee head Khandker Mainuddin Ahmed said one day after submitting its report to the government. "There were a series of irregularities." The report also found that building owner Sohel Rana had permission to build a six-story structure and added two floors illegally so he could rent them out to garment factories. Past statements from authorities said the owner had permission for a five-story structure and added three floors illegally. The report also said the building was not built for industrial use and the weight of the heavy garment factory machinery and their vibrations contributed to the building collapse. Those factors had previously been cited. The committee recommended that Rana and the owners of the garment factories be sentenced to life in jail if they are found guilty of violating building codes [2].

In Civil engineering, cement denotes a substance which can be used to bind together sand and broken stone, or other forms of aggregate into a solid mass, thereby producing materials such as concrete, mortars and various kinds of asbestos cement products. Hence the quality of cement to be used during construction is of utmost importance as failure of concrete structures is usually attributed to incorrect selections of materials amongst other factors. Cement is a binder, a substance used for construction that sets, hardens and adheres to other materials, binding them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement is used with fine aggregate to produce mortar for masonry, or with sand and gravel aggregates to produce concrete.

Cements used in construction are usually inorganic; often lime or calcium silicate based, and can be characterized as being either hydraulic or non-hydraulic, depending upon the ability of the cement to set in the presence of water (see hydraulic and non-hydraulic lime plaster). Non-hydraulic cement will not set in wet conditions or under water; rather, it sets as it dries and reacts with carbon dioxide in the air. It is resistant to attack by chemicals after setting [3].

Hydraulic cements (*e.g.,* Portland cement) set and become adhesive due to a chemical reaction between the dry ingredients and water. The chemical reaction results in mineral hydrates that are not very water-soluble and so are quite durable in water and safe from chemical attack. This allows setting in wet conditions or under water and further protects the hardened material from chemical attack. The chemical process for hydraulic cement found by ancient Romans used volcanic ash (pozzolana) with added lime (calcium oxide). Some of the numerous functions of cement are given below.

1) It is used in mortar for plastering, masonry work, pointing, etc.
2) It is used for making joints for drains and pipes.
3) It is used for water tightness of structure.
4) It is used in concrete for laying floors, roofs and constructing lintels, beams, stairs, pillars etc.

5) It is used where a hard surface is required for the protection of exposed surfaces of structures against the destructive agents of the weather and certain organic or inorganic chemicals.
6) It is used for precast pipes manufacturing, piles, fencing posts etc.
7) It is used in the construction of important engineering structures such as bridges, culverts, dams, tunnels, lighthouses etc.
8) It is used in the preparation of foundations, watertight floors, footpaths etc.
9) It is employed for the construction of wells, water tanks, tennis courts, lamp posts, telephone cabins, roads etc.

Cement is very important building material among other in construction industry. Cement has replaced all other building materials, like clay and lime, which ruled high for hundreds of years, in construction from last century. It has an ability to hold the structure together. At this moment, the cement is extensively used across the planet in the creation of different engineering formations. Cement has shown to be one of the important engineering materials of recent times and has no competitors in construction and implementations. In 1824, was the year in which a little known bricklayer from Leeds in England named, Joseph Aspidin took a patent for the manufacture of the first Portland cement, one of the most vital milestones in concrete histories.(M.S. Shetty, 2003). Since then, there have been many remarkable developments with new structures incorporating reinforced and during the last decade important advances in material technology and high performance of concrete. Over the last century, great rivers have been spanned, huge buildings erected, vast amount of water demand and large networks of roads constructed [4]. Cement is of practical importance to human kind, as it plays a very useful role in binding different piece of materials, bringing to form conceptual ideas as structures. It is directly concerned with cementiceous materials, their compositions and end products on application. Many engineering projects such as tunnels, bridges, highways, reservoirs, construction of dams, drainages etc. require cementiceous advice as concerns binders. This study equips us with firsthand knowledge of the brands of cement suitable for various construction works [5]. The general objective of this study is to investigate the quality of various brands of cement used in the Nigerian construction industry. It is expected that this research will help ascertain if there are disparities in the qualities of cement brands sold in the Nigerian industrial market and its' subsequent application in the construction industry [6].

HISTORICAL DEVELOPMENT OF CEMENT

The Egyptians, Romans and the Indians used different kinds of cementing materials in their ancient construction. The usage of this material differed from these people as they were used based on the availability in their regions. The Egyptians mostly obtain theirs from or by burning a soft white substance called gypsum. While the Greeks and Romans obtained theirs by burning lime stones. The Greek and Roman mortar (mixture of water, fine aggregate and cementiceous material) usage proves to be more efficient and reliable because of its hardness observed in their brick works. The superiority of the Greek and Roman to that of the Egyptians gypsum was noted in their mix design and continued ramming to attain uniformity. (Shetty, 2003). The curiosity of the Greeks and Romans for improvement brought them to the fact adding of certain volcanic ash and tuft in the mixture with lime and sand with fresh or salt water will give a better durability possessing superior strength. The volcanic tuft or ash is siliceous in nature and it was called Pozzolana it was found near Pozzoli a village near Mount Vesuvius in Italy. The Indians finally concurred with the Greeks and Romans mixing of lime and long ramming of mortar superiority over their burning of just gypsum. The Romans went further in the addition of animal blood, lard (white fat from pig) and milk to their mortar and concrete to better its workability while in its free state. Coming to more recent times, in the advancement of knowledge of cement John Smeaton an English scientist was the fore runner to the discoveries and manufacture of all modern cements in 1756 when he was called upon to rebuild the Eddy stone-light house, (Shetty, 2003).

In spite of Smeaton's experiments and findings as to the use of hydraulic lime made little progress, which kept the old practice of mixture of lime and pozzolana for long period of time. In 1976, the hydraulic cement was made by calcining nodules of argillaceous lime stones. Then in 1800 the hydraulic cement was named Roman cement.

As the use of Portland cement increased for the making of concrete, engineers called for a higher standard of the material (Portland cement) for use in major engineering works, which led to the establishment of Association of Engineers, Consumers and Cement manufacturers to set specific standards for cement. The German Standard Specification was drawn in 1877, then followed by the British Standard Specification which was drawn in 1904 thereafter the first ASTM specification was issued in the same year (1904), all for the standard specification of Portland cement. In India, Portland cement was first manufactured in 1904 near Madras, by the south.

India Industrial Ltd and the India Cement Co. Ltd was established in the year 1912-1913 at Porbander (Gujarat), by 1918 three factories were established. During a year plan (1955-1956) there was a tremendous growth of cement production in India. By 1959 the total production of cement in India jumped from 2.69million tonnes to 4.60million tonnes, bringing India to the 9^{th} cement producing country in the world in the leading powers of USA producing 70.5million tonnes and USSR producing 89.4million tonnes.

MANUFACURE OF PORTLAND CEMENT

Portland cement can be made by following two different processes – a dry one and a wet one. The manufacturing process has moved on significantly since bricklayer Joseph Aspdin first made Portland cement in his kitchen stove in England in the 19th century. The basic ingredients of both the dry and wet processes are the same. By mass, lime and silica make up approximately 85% of Portland cement. The materials that are commonly used are limestone, shells, chalk, shale, clay, slate, silica sand, and iron ore. Since limestone is the main component, often cement plants are located near limestone quarries. The first step in both manufacturing processes after quarrying is primary crushing. Crushing reduces the size of the rock to three inches or smaller. Next, the raw materials are combined in the correct amounts and fed into the kiln system. In the dry process, the materials are grounded, mixed, and introduced into the kiln system in a dry state. In the wet process, the raw materials follow all of the steps with water added and are introduced into the kiln system in a slurry state. In the kiln system, the first process is pre-heating. The combined materials are fed through a series of vertical cyclones. As the material moves through these cyclones, it comes into contact with the hot kiln exhaust gases. The exhaust gases pre-heat the material before it enters the main part of the kiln. The pre-heat process allows the chemical reactions that take place in the kiln to happen quicker and more efficiently. In the main kiln, the raw materials are then heated to approximately 2,700 degrees Fareinheit. In the kiln, the initial raw ingredients combine to form clinker. Clinker is mainly made up of tri and di-calcium-silicates which are the main chemicals that bond together when water is added to cement. Unwanted gases, including carbon dioxide, are also emitted from the process. In the next state of the process, clinker is cooled in coolers. The hot air from the coolers is returned to the pre-heater in order to save fuel in the overall process. The clinker is then ground to produce Portland cement. Gypsum is added during the grinding process to control the set rate of the cement. Slag and fly ash can also be added to control other properties of the final product .Both the dry and wet processes are very energy intensive. The wet process, however, uses more energy than the dry process due to the amount of water that must be evaporated before clinker can be produced. The cement industry is constantly looking for ways to make the manufacturing process more efficient. For example, alternative fuel sources are now being used extensively throughout the industry to heat the kilns to reduce the amount of natural resources used in the process.

The manufacture procedures of Portland cement include mixing of raw material, burning, grinding, storage and packaging. The major raw materials used in the manufacture of cement are Calcium, Silicon, Iron and Aluminum. These minerals are used in different form as per the availability of the minerals.

MATERIALS AND METHODS

The laboratory experiment methods carried out in this project works are aimed at analyzing, evaluating and determining the composite properties in the various brand of Portland cement used in the Nigeria, the mechanical or physical processes and calculation of mineral content in respond to laboratory test on four (4) different brands of Portland cement available in Nigeria for construction. The methods used are specified in American Society for Testing and Materials (ASTM 1986 and ASTM 2001), American Association for State Highway and Transportation Officials (AASHTO, T11, T27 2006) And British Standards Institution (BSI 1983, 1985 and BSI 1990), and Indian standard (IS).

Material Collection

The brands of ordinary Portland cement used in the research are labeled W, X, Y and Z. The source of the fine aggregate used is Nyaba River in Akpugo, Enugu state. The source of the coarse aggregate is Mac Daniels Nig. Ltd. Amofia Ngbo, Ohukwu LGA of Ebonyi state.

Methods

[a] Sieve Analysis Of Fine And Coarse Aggregates

This is to determine the grading or the particle size distribution of the aggregates using the sieve analysis, determine the fineness modulus, grading zone of the fine and coarse aggregates and to draw the grading curve of a pile of aggregate and compare with the standard to find out if the aggregates contain the necessary amount of particle sizes needed for the particular purpose.

[b] Fineness of Dry Cement

This is to determine and check the proper grinding of cement by dry sieving. The ability to provide strength for a certain type of cement is checked by finding the fineness of that cement. The fineness of cement is responsible for the rate of hydration and the rate at which cement gain strength and also the rate of evolution of heat. If the cement particles are fine, the greater will be the cohesiveness and strength which are the properties required in concrete. It's noted that cement losses 5-10% of its strength after one month of manufacture dependence on the environment/store.

[c] Slump Test

This is used to measure the amount of slump of freshly mixed concrete. Slump test is used for measuring the consistencies of concrete which can be employed either in the laboratory or at the site where work is in progress. It is used conveniently as a control test and given an indication of the uniformity of concrete from batch to batch by observing the manner in which concrete slumps. Furthermore, some mix design standard procedure specifies requirement for slump which the calculated mix ratio can be used to achieve the slump on site

[d] Compressive Strength Test

The aim is to investigate and determine the relationship between the Water - Cement ratio and comprehensive strength of concrete cubes. Cement paste alone is no used for this because of the unacceptably large variations of strength thus obtained. Standard aggregates are used for making prescribed mortar or concrete cube test mixes to eliminate effects from the measured strength of the cement. The brands of Portland cement grade 32.5 N/mm^2 employed for this project research/test were bought from the depots of the cement manufacturers certified by the Standard Organisation of Nigeria (SON), the agency in charge of standardization in Nigeria. Concrete strength is classified into different grades on the basis of its 28 days compressive strength requirement as background for designing concrete mixes. Hard concrete test were conducted at the age of 7, 21, and 28 days setting interval after curing in untainted water.

RESULT AND DISCUSSIONS

Sieve Analysis

The results of the sieve analysis are shown on Table 3.1

Table 1. The Analysis of the Sieves

Sieve Size (Mm)	Weight of Sieve (G)	Weight of Sieve + Agg.	Weight of Agg. Retained	% Retained	Cumm % By Weight Retained	% Passing
4.75	347.4	348.1	0.7	0.14	0.14	99.86
2.36	361.0	365.7	4.7	0.94	1.08	98.92
1.18	325.0	353.8	28.8	5.76	6.84	93.16
0.6	313.6	459.7	146.1	29.22	36.06	63.94
0.3	310.9	426.4	115.5	23.10	59.16	40.84
0.15	289.3	484.0	194.7	38.94	98.10	1.90
0.075	296.4	304.7	8.3	1.66	99.76	0.24
Pan	245.6	249.5	1.2	0.24	100.0	-----
Summation			500		301.14	

Fineness modulus = {summation of cumm % by weight retained}/100
=301.14/100
= 3.01

AASHTO Designation: M6-93- "Standard specification of fine aggregate for Portland cements concrete" – Indicates that the fineness modulus of sand should not be less than 2.3 and not more than 3.1. The fineness modulus affects the compressive strength of concrete i.e. increase in fineness of sand will cause increase in compressive strength; it also affects density of the concrete.

Table 2. Classification of Sand Based on Fineness Modulus (BS 882: 1973)

Class of Sand	Fineness Modulus
Fine sand	2.2 – 2.6
Medium sand	2.6 – 2.9
Coarse sand	2.9 – 3.2

From the above classification table, the fineness modulus of the fine aggregate is 3.01. Therefore it is coarse sand.

Table 3. Zone Classification of Sand Based on Percentage Passing (IS: 383- 1970)

Sieve size (mm)	Zone I	Zone II	Zone III	Zone IV
10	100	100	100	100
4.75	90 – 100	90 – 100	90 – 100	95 – 100
2.36	60 - 95	75 – 100	85 – 100	95 – 100
1.18	30 – 70	55 – 90	75 – 100	90 – 100
0.6	15 – 34	35 – 59	60 – 79	80 – 100
0.3	5 – 20	8 – 30	12 – 40	15 - 50

From the above zoning table, the fine aggregate falls under Zone III. IS 383:"Specifications for coarse and fine aggregates from natural sources for concrete" stated that Zone I- sand is very coarse and Zone IV- sand is very fine.

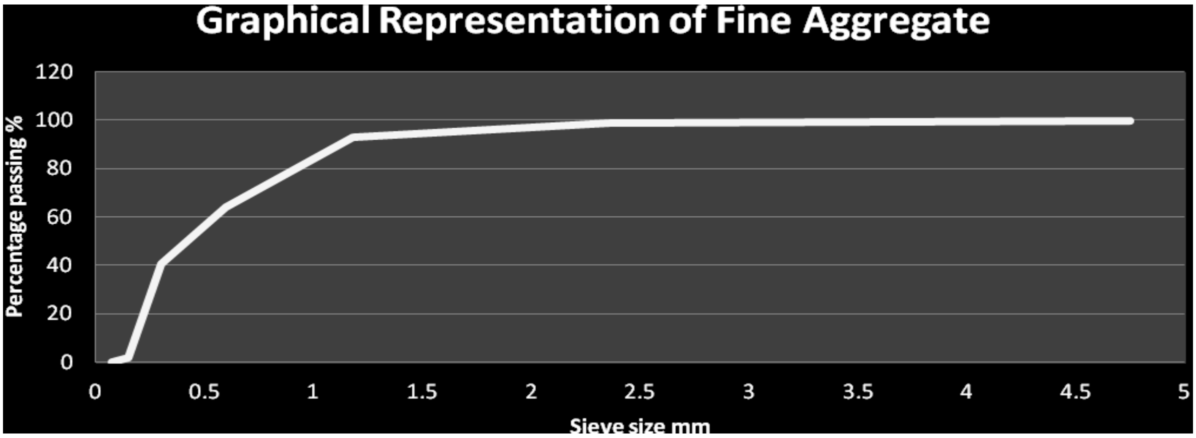

Fig.1. The Grading Curve of Fine Aggregate

Sieve Analysis of Coarse Aggregate

Table 4. The Result of Percentage Retained in the Sieves are Shown

Sieve Size (Mm)	Weight Retained (G)	% Retained	Cu % Retained	% Finer
31.00	0.00	0.00	0.00	0.00
25.00	100.84	10.10	10.10	89.9I6
19.00	518.54	51.854	61.938	38.062
12.50	362.10	36.21	98.148	1.852
9.50	12.10	1.21	99.358	0.642
6.30	4.01	0.40	99.759	0.241
4.75	0.00	0.00	99.759	0.241
Pan	2.41	0.24	100	0
Σ	1000	100		

Fineness of Cement

Table 5. The Results Of Fineness Of Cement

Brand Of Portland Cement	Weight of Cement W3 (G)	Weight Retained W6 = W5 – W4 (G)	% Retained By Weight = [W3 – W6]/W3 X 100 (%)
W	100	566.9 – 560.3 = 6.6	[100 – 6.6]/100 X 100 = 93.4
X	100	564.8 – 560.3 = 4.5	[100 – 4.5]/100 X 100 = 95.5
Y	100	565.6 – 560.3 = 5.3	[100 – 5.3]/100 X 100 = 94.7
Z	100	564.2 – 560.3 = 3.9	[100 – 3.9]/100 X 100 = 96.1

The respective fineness of 6.6%, 4.5%, 5.3%, and 3.9% of W, X, Y, and Z are in conformity with standard according to IS 4031: 1988. Thus cement brand Z with the lowest fineness may be more prone to air set while cement brand W with the highest fineness is least susceptible to air set among other brands.

Slump of Freshly Mixed Concrete

Original height of slump cone = 30cm
Water/cement ratio = 0.5
Mix ratio = 1:2:4:0.5
Total = 1+2+4+0.5 = 7.5
Volume of frustum
$= 1/3 \times h \times \pi \times (R^2 + r^2 + R \times r)$
$= 1/3 \times 0.3 \times \pi \times (0.1^2 + 0.05^2 + 0.1 \times 0.05)$
$= 5.497787144 \times 10^{-3}\ m^3$
Density of concrete = 2400 kg/m^3
Density = Mass/Volume;
Mass = Density x Volume
2400 x 5. 497787144 $\times 10^{-3}$ = 13. 19 kg
Using 10% transfer loss = (10/100 x 13.19) + 13.19 = 14.51 kg
Mass of Cement = 1/7.5 x 14.51 = 1. 93 kg
Mass of Sand = 2/7.5 x 14.51 = 3.87 kg
Mass of Gravel = 4/7.5 x 14.51 = 7.74 kg
Mass of water = 0.5/7.5 x 14.51 = 0.97 kg

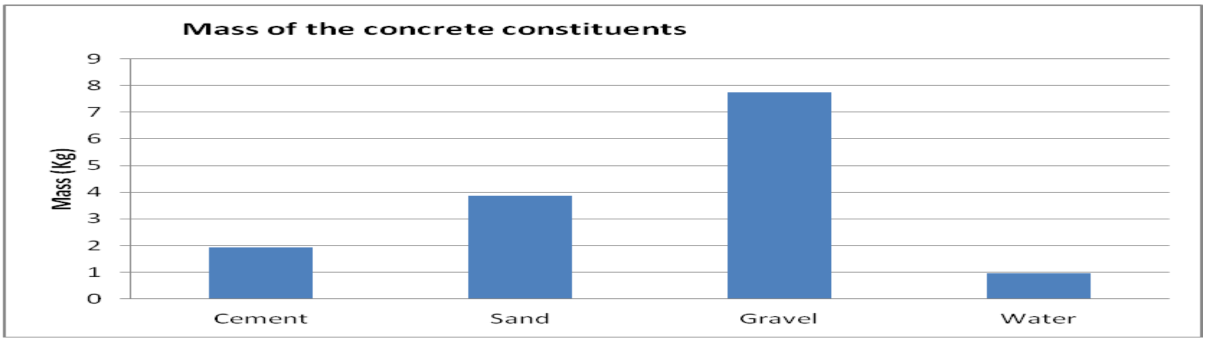

Fig. 2. Bar Chart Showing the Mass of the Different Concrete Constituents

Table 6. Slump Test Result for Different Brands of Cement

Brand Of Portland Cement	Slump (Mm)
W	38
X	32
Y	49
Z	42

All samples of cement under the same mix ratio and water/cement ratio produced a true slump thus the concrete has high workability from the results achieved in the table above.

Y	400	230.5 – 95.5 = 135	35	135/400 X 100 = 33.75
Z	400	230 – 95.5 = 134.5	35	134.5/400 X 100 = 33.6

Compressive Strength Test of Concrete

Table 7. Compression Test Result for Cement Brand W

Dangote					
No. Of Days	**Cube No.**	**Weight Of Cube (Kg)**	**Density (Kg/M^3)**	**Failure Load (Kn)**	**Compressive Strength (N/Mm^2)**
7 Days	Cube 1	8.60	2548.15	410	18.22
	Cube 2	8.50	2518.52	320	14.22
	Cube 3	8.50	2518.52	350	15.56
	Cube 4	8.45	2503.70	360	16.00
	Cube 5	8.35	2474.07	385	17.11
Average			**2512.46**		**16.22**
14 Days	Cube 6	8.30	2459.26	340	15.11
	Cube 7	8.40	2488.89	320	14.22
	Cube 8	8.70	2577.78	380	16.89
	Cube 9	8.40	2488.89	380	16.89
	Cube 10	8.30	2459.26	380	16.89
Average			**2494.82**		**16.00**
21 Days	Cube 11	8.45	2503.70	380	16.89
	Cube 12	8.45	2503.70	380	16.89
	Cube 13	8.30	2459.26	400	17.78
	Cube 14	8.70	2577.78	400	17.78
	Cube 15	8.30	2459.26	460	20.44
Average			**2500.74**		**17.96**
28 Days	Cube 16	8.60	2548.15	350	15.56
	Cube 17	8.70	2577.78	380	16.89
	Cube 18	8.35	2474.07	400	17.78
	Cube 19	8.50	2518.52	420	18.67
	Cube 20	8.50	2518.52	380	16.89
Average			**2527.41**		**17.16**

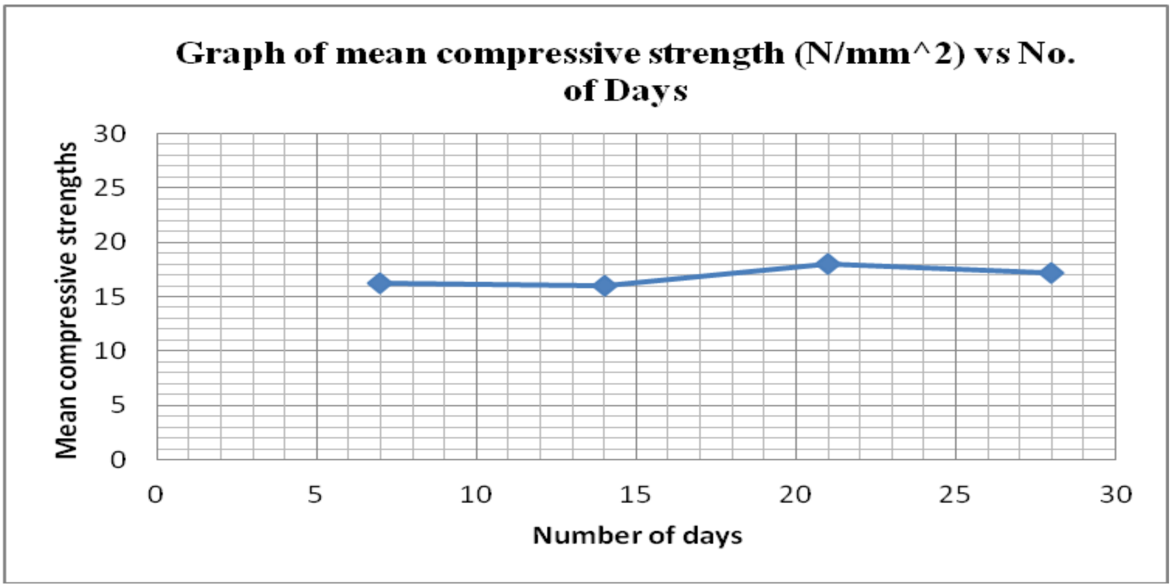

Fig.3. The Rate of Strength Gained by the Concrete Cubes for Cement Brand W

Table 8. Compression Test Result for Cement Brand X

Cement Brand X					
No. Of Days	**Cube No.**	**Weight Of Cube (Kg)**	**Density (Kg/M^3)**	**Failure Load (Kn)**	**Compressive Strength (N/Mm^2)**
7 Days	Cube 1	8.40	2488.89	390	17.33
	Cube 2	8.35	2470.07	400	17.78
	Cube 3	8.60	2548.15	430	19.11
	Cube 4	8.40	2488.89	410	18.22
	Cube 5	8.60	2548.15	400	17.78
Average			**2508.83**		**18.04**
14 Days	Cube 6	8.20	2429.63	380	16.89
	Cube 7	8.50	2518.52	340	15.11
	Cube 8	8.10	2400.00	500	22.22
	Cube 9	8.30	2459.26	480	21.33
	Cube 10	8.45	2503.70	400	17.78
Average			**2462.22**		**18.67**
21 Days	Cube 11	8.50	2518.52	340	15.11
	Cube 12	8.50	2518.52	450	20.00
	Cube 13	8.65	2562.96	480	21.33
	Cube 14	8.50	2518.52	480	21.33
	Cube 15	8.40	2488.89	420	18.67
Average			**2521.48**		**19.29**
28 Days	Cube 16	8.30	2459.26	460	20.44
	Cube 17	8.40	2488.89	460	20.44
	Cube 18	8.50	2518.52	440	19.56
	Cube 19	8.20	2429.63	400	17.78
	Cube 20	8.50	2518.52	460	20.44
Average			**2482.96**		**19.73**

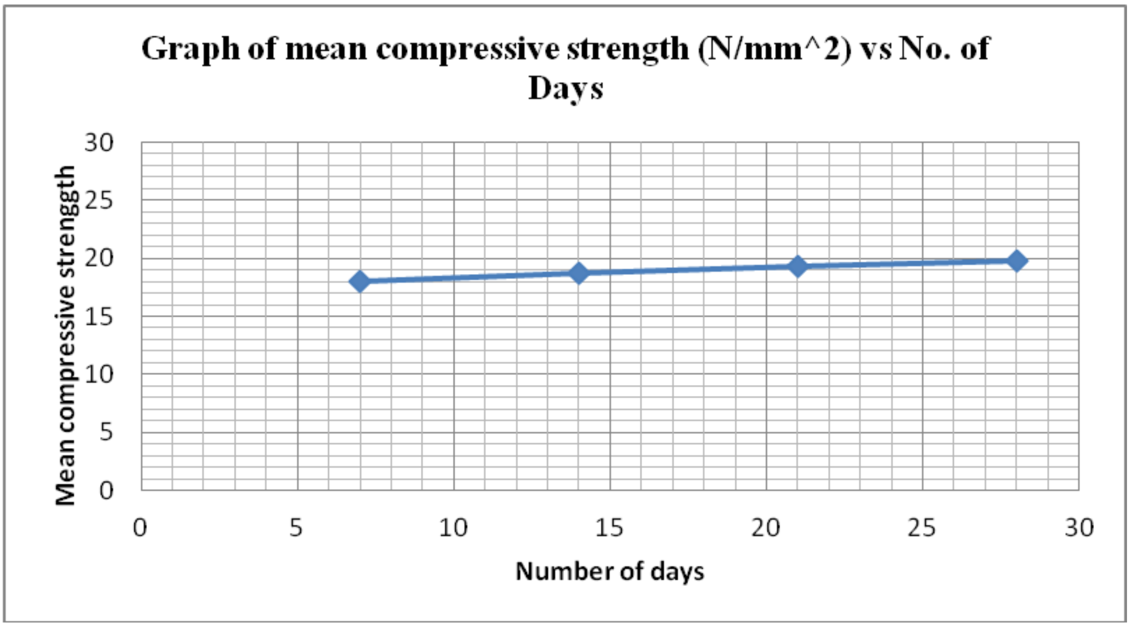

Fig..4. The Rate of Strength Gained by the Concrete Cubes for Cement Brand X

Table 9. Compression Test Result for Cement Brand Y

Cement Brand Y					
No. Of Days	**Cube No.**	**Weight Of Cube (Kg)**	**Density (Kg/M^3)**	**Failure Load (Kn)**	**Compressive Strength (N/Mm^2)**
7 Days	Cube 1	8.30	2459.26	440	19.56
	Cube 2	8.35	2470.07	380	16.89
	Cube 3	8.20	2429.26	380	16.89
	Cube 4	8.30	2459.63	380	16.89
	Cube 5	8.35	2470.07	3.40	15.11
Average			**2457.66**		**17.07**
14 Days	Cube 6	8.00	2370.37	420	18.67
	Cube 7	8.10	2400.00	520	23.11
	Cube 8	8.40	2488.89	360	16.00
	Cube 9	8.20	2429.63	440	19.56
	Cube 10	8.10	2400.00	370	16.44
Average			**2417.78**		**18.76**
21 Days	Cube 11	8.20	2429.63	420	18.67
	Cube 12	8.20	2429.63	420	18.67
	Cube 13	8.40	2488.89	460	20.44
	Cube 14	8.70	2577.78	380	16.89
	Cube 15	8.40	2488.89	280	12.44
Average			**2482.96**		**18.67**
28 Days	Cube 16	8.20	2429.63	400	17.78
	Cube 17	8.40	2488.89	390	17.33
	Cube 18	8.45	2503.70	370	16.44
	Cube 19	8.25	2444.44	480	21.33
	Cube 20	8.45	2503.70	480	21.33
Average			**2474.07**		**18.84**

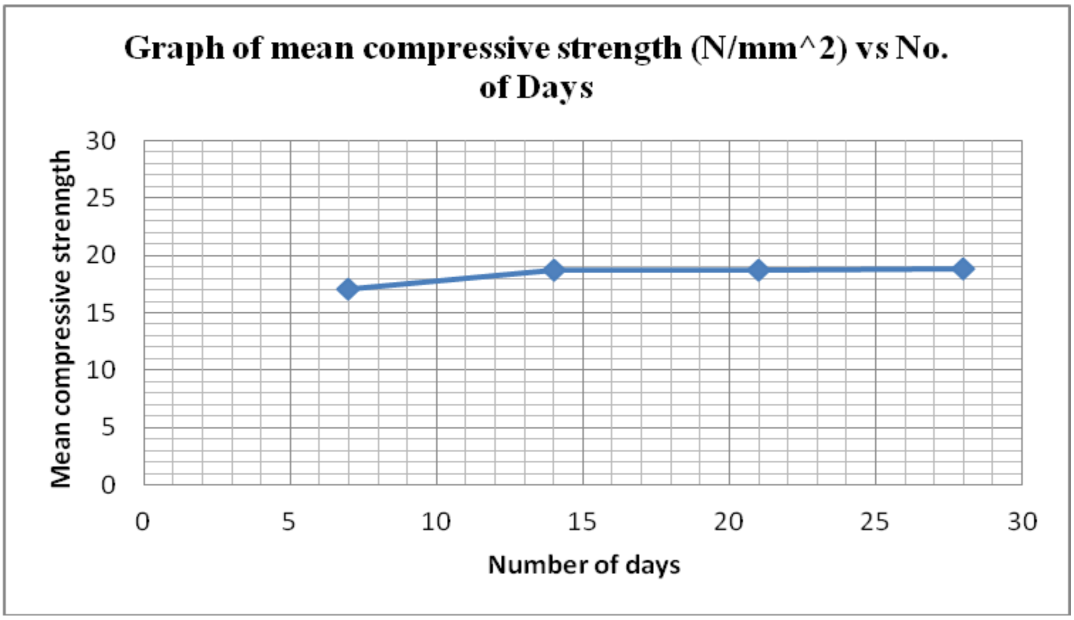

Fig. 5. The Rate of Strength Gained by the Concrete Cubes for Cement Brand Y

Table 10. Compression Test Result for Cement Brand X

Cement Brand X					
No. Of Days	**Cube No.**	**Weight Of Cube (Kg)**	**Density (Kg/M^3)**	**Failure Load (Kn)**	**Compressive Strength (N/Mm^2)**
7 DAYS	Cube 1	8.20	2429.63	310	13.78
	Cube 2	8.60	2548.15	370	16.44
	Cube 3	8.50	2518.52	330	14.67
	Cube 4	8.70	2577.78	320	14.22
	Cube 5	8.50	2518.52	310	13.78
AVERAGE			**2518.52**		**14.58**
14 DAYS	Cube 6	8.70	2577.78	380	16.89
	Cube 7	8.15	2414.81	350	15.56
	Cube 8	8.05	2383.19	320	14.22
	Cube 9	8.30	2459.26	300	13.33
	Cube 10	8.30	2459.26	320	14.22
AVERAGE			**2459.26**		**14.84**
21 DAYS	Cube 11	8.15	2414.81	400	17.78
	Cube 12	8.50	2518.52	400	17.78
	Cube 13	8.30	2459.26	380	16.89
	Cube 14	8.50	2518.52	330	14.67
	Cube 15	8.10	2400.00	360	16.00
AVERAGE			**2462.22**		**16.62**
28 DAYS	Cube 16	8.50	2518.52	360	16.00
	Cube 17	8.35	2474.07	340	15.11
	Cube 18	8.60	2548.15	380	16.89
	Cube 19	8.50	2518.52	280**	12.44**
	Cube 20	8.60	2548.15	380	16.89
AVERAGE			**2521.48**		**16.22**

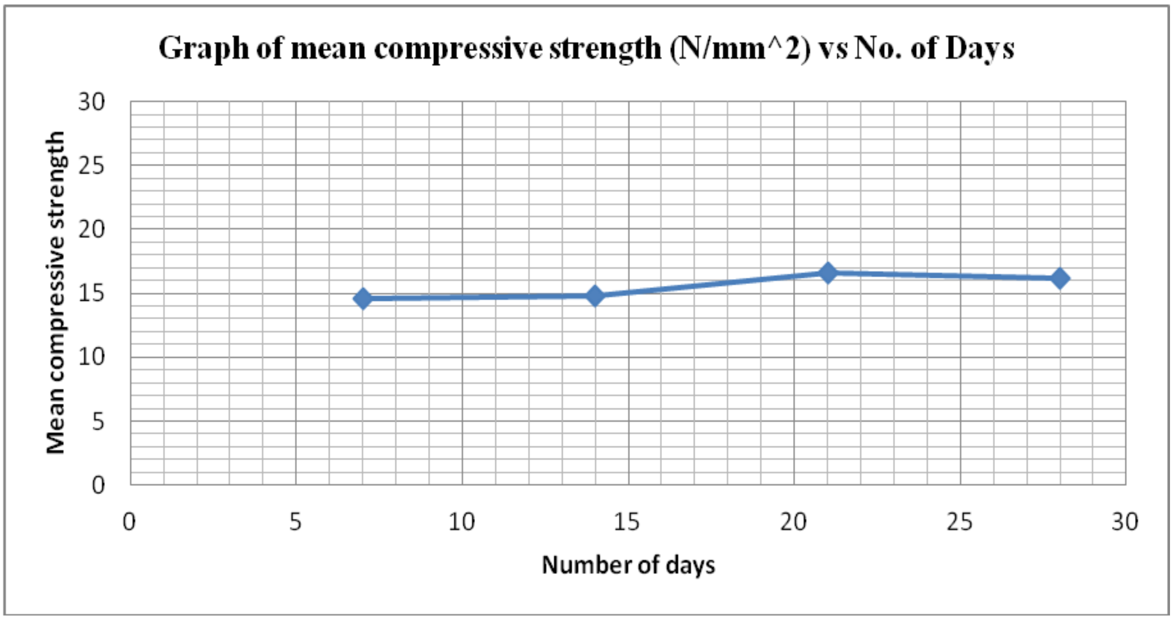

Fig.6. The Rate of Strength Gained by the Concrete Cubes for Cement Brand X.

A total number of 20 cubes were cast and tested and their strengths are shown in the tables above. The various figures attached to each of the table above showed the various rates of concrete strength development of each brand. The cement brands Z and W exhibited initial low strength while that of cement brand X is highest. The M20 concrete (i.e. 1:2:4 mix) indicates that the minimum compressive strength at 7 days is 13.5 N/m^2 while the specified characteristics compressive strength at 28 days should be up to 20 N/mm^2. Under this concrete grade (M20), cement brand X has the highest mean compressive strengths of 18.04 and 19.73 N/mm^2 for 7 and 28 days respectively followed by cement brands Y, W and lastly cement brand Z which has the lowest mean compressive strength.

Figure 7 comparative analysis of the rate of compressive strength gained by the concrete cubes for different brands of cement.

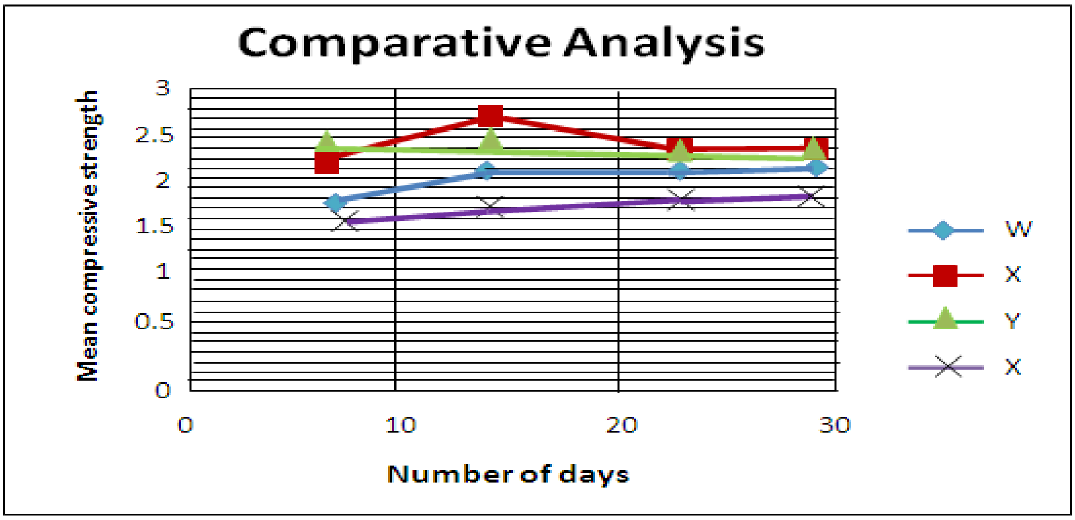

Fig.7. Comparison of Compressive Strength the Four Brands of Cement

The concrete formed with the four brands of cement exhibited compressive strengths that within the accepted ranges.

CONCLUSION

In the current Nigerian market, cement is being graded according to their strength i.e. 32.5N and 42.5N and as such contractors should not be ignorant of the fact that this grading actually affects the strength of the concrete. Using the conventional 1:2:4 mix ratios for both grades as mentioned above, the concrete strength will not be the same hence there is a need for a review of the conventional mix ratio. This work has been able to show the varying qualities and properties of some ordinary Portland cement brands W, X, Y and Z currently available the Nigerian market and used in construction industries. Having conducted the experiments using ASTM, BS and IS methods, the fine aggregate was well graded and confirmed adequate for production of concrete. The workability of the mix was determined through slump test. The relevant strength parameters of the cement brands were determined through compressive results and the result reveals that not all brands of cement assessed are meant to be used for all kinds of projects (construction work). The relationship between both of them is that the main measure of the structural quality of concrete is its compressive strength which is commonly considered in structural design.

The quality of the cement brands have been assessed and found to be satisfactory with the pre-existing quality standards and as a result, hence there is an insignificant disparity in quality of cement produced. The investigation of collapsing structures should be extended to other components that contribute to its construction. Generally, all the brands of cement meet the minimum standard stipulated by the British Standard Institution on Ordinary Portland Cement and any one of the brand available will optimally perform in construction industry.
The contractor must aware of the different grades available in the market and how to use certain mix ratios with the different cement grades to achieve the required concrete strength for the design load of the structure. He must also pay close attention to other components that make up a structure.

REFERENCES

1) Dale P. B., Gaurav, S., and Jason W. (2008) “Early-Age Properties of Cement-Based Materials: Influence of Cement Fineness”. ASCE Journal of Materials in Civil Engineering, 20(7), 502-508.
2) Graeme M. (2003) “Cements, Advanced concrete technology, constituents material”, Edited by John N. and Ban Seng C.Elsevier.
3) Johannes, V. C., Taylor, P. C. and Tennis, P. D. (2005) “Effect of Cement Characteristics on concrete properties”. EB226, Portland cement Association, Skokie, Illinois, USA, 1 – 46.
4) Obi L.E. (2016), “Empirical Investigation of the Effects of Water Quality on the Compressive Strength of Concrete’’ International Journal of Constructive Research in Civil Engineering, vol. 2, Issue 5, pp. 30-55
5) Obi L.E. (2017), Evaluation of the Effects of Coarse Aggregate Sizes on Concrete Quality, European Journal of Engineering Research and Science, vol.2, No. 10, pp. 1-6.
6) Rogers A.R. (2005), Principles of Quality Control. A laboratory manual for West African Portland Cement Plc, Sagamu, Nigeria, 10 – 32Shetty M.S., Concrete Technology, S. Chand & Co., New Delhi, 1982.