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DETERMINATION OF MIX DESIGN OF CONRETE GRADE 30N/MM^2 FOR BORED PILE

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ABSTRACT

The increasing failure of bridges piles and other structures faced by the construction industry in Nigeria due to weak concrete strength has made it necessary to understand the causes of failure of these structures. Research was carried out to study the mix design for concrete grade 30N/mm^2 for bored piles. Tests on aggregates from Kaduna and cement from Dangote were carried out and concrete cubes were cast in order to determine the compressive strength and densities. Three tests were carried out before we could arrive at satisfactory results as specified by the B.S 4450. The compressive strength of the concrete cubes at seven days and twenty eight days were determined. The strengths of the first tests were 18.7 N/mm^2, 20.0 N/mm^2, 19.4 N/mm^2 and 28.9 N/mm^2, 27.6N/mm^2, 26.7N/mm^2 respectively. The second tests were 19.6N/mm^2, 19.1N/mm^2 and 30.2N/mm^2, 29.9N/mm^2, 29.3N/mm^2 respectively. The third test which gave us the desired results were 24.4N/mm^2, 23.9N/mm^2, 24.3N/mm^2 and 32.2N/mm^2, 32.4 N/mm^2, 31.9N/mm^2 respectively. The standard consistency of the cement tested was 28% with initial and final setting time of 2hr. 44 minutes and 5hr. 54minutes respectively. The densities of the cubes at seven days and 28dyas were also determined. The first set were 2.36 g/cm^3, 2.34 g/cm^3 2.32 g/cm^3 and 2.41 g/cm^3, 2.39 g/cm^3, 2.43g/cm^3 respectively. The second set were 2.41 g/cm^3, 2.39g/cm^3, 2.43g/cm^3. And 2.44g/cm^3, 2.46g/cm^3, 2.42g/cm^3 respectively. The third set were 2.39g/cm^3, 2.40 g/cm^3, 2.36 g/cm^3 and 2.41g/cm^3, 2.39g/cm^3, 2.40g/cm^3 respectively.

INTRODUCTION

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required strength, durability and workability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of concrete is governed by the required performance of concrete in two states, namely the plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance, Jackson (1990). The compressive strength of hardened concrete which is generally considered to be an index of its other properties, depends upon many factors, e.g quality and quantity of cement, water and aggregates; batching and mixing, placing, compaction and curing. The cost of concrete is made up of the cost of materials, plant and labour. The variations in the cost of materials arise from the fact that the cement is several times costly than the aggregate, thus the aim is to produce as lean a mix as possible. From technical point of view, the rich mixes may lead to high shrinkage and cracking in the structural concrete and to evolution of high heat of hydration in mass concrete which may cause cracking. The actual cost of concrete is related to the cost of materials required for producing a minimum mean strength that is specified by the designer of the structure. This depends on the quality control measures, but there is no doubt that the quality control adds to the cost of concrete. The extent of quality control is often an economic compromise, and depends on the size and type of job. The cost of labour depends on the workability of mix, e.g a concrete mix of inadequate workability may result in a high cost of labour to obtain a degree of compaction with available equipment, Brook J.J (1990).

Bored pile foundations are the part of a heavy structure used to carry and transfer its load to the bearing ground located at some depth below ground surface. Depending upon various factors like nature of substrata, depth of ground water table, depth of stronger stratum, type and quantum of load to be supported etc., bored piles are designed. Pile testing is considered a fundamental part of pile foundation design. It is one of the most effective means of dealing with uncertainties that inevitably arise during the design and construction of piles. There is much different types of pile in use today, such as timber piles, concrete piles, steel piles, composite piles and others. The choice of pile type for a particular job depends upon the combination of all various soil conditions and the magnitude of the applied load; for example precast concrete piles (spun pile) are usually used in water structure such as jetty and break water, Victor Olusegun Oyenuga (2001).

Limit of the Mix Design

The concrete mix design covers the following:

i. General investigation on all the fine and coarse aggregate used in design.

ii. General investigation on the available water to be used on the mix design.
iii. General investigation on the Portland (Dangote) cement used.
iv. General investigation on the achievable density of $2400kg/cm^3$.
v. General illustration on concrete strength relationship, based on:
a. Types of cement used.
b. Types of achievable concrete design density.

Concrete

Concrete is a composite material obtained by mixing together coarse aggregates (e.g gravel, crushed stone), fine aggregate (e.g sharp sand or stone dust), cement and water in suitable proportion. Sometimes, additional material, known as admixture, is added to modify content of its properties. The selection of the relative proportions of these materials is usually governed by the strength requirement of the concrete. The strength of concrete is commonly considered, it is most valuable property, although, in many practical cases, other characteristic, such as durability, and permeability, may in fact be more important. Nevertheless, strength usually gives an overall, picture of the quality of concrete because strength is directly related to the structure of the hydrated cement paste. Moreover, the concrete is almost a vital element of structural design and is specified for compliance purpose, Jackson (1990). Marconite is one example, Neville A.M (1996)

Composition of Concrete

There are many types of concrete available, created by varying the proportions of the main ingredients below. In this way or by substitution for the cementitiou sand aggregate phases, the finished product can be tailored to its application with varying strength, density or chemical and thermal resistance properties. The mix design depends on the type of structure being built, how the concrete will be mixed and delivered and how it will be placed to form this structure, Neville A.M (1996).

Cement

For this study, ordinary Portland cement (opc) was used. Portland cement is the most common type of cement in general usage. It is a basic ingredient of concrete, mortar and plaster. English masonry worker Joseph Aspdin patented Portland cement in 1824; it was named because of its similarity in colour to Portland limestone quarried from the English Isle of Portland and used extensively in London architecture. It consists of a mixture of oxides of calcium, silicon and aluminum. Portland cement and similar materials are made by heating limestone (a source of calcium) with clay and grinding this product (called clinker) with a source of sulfate (mostly commonly gypsum).

Aggregates

Aggregate are inert, inexpensive material dispersed throughout the cement paste so as to produce a large volume of concrete.Infact aggregate is not truly inert because its physical, thermal and sometimes chemical properties influence the performance of concrete from the economic viewpoint, it is advantageous to use a mix with as much aggregate and as little cement as possible, but the cost benefit has to be balanced against the desired properties of concrete in its fresh and hardened state. Natural aggregates are formed by the process of

Weathering and Abrasion

By artificially crushing a longer parent mass. Thus, many properties of the aggregate depend on the properties of the parent rock, e.g

i. Chemical and mineral composition
ii. Specific gravity
iii. Hardness
iv. Strength
v. Physical and chemical stability
vi. Colour etc.

Water

Water used in concrete work must be free from impurities, water containing chemical solutions such as seawater, should not be used for concrete production. Generally, water that is good enough for drinking is also good enough for concrete production. The quality of water plays a vital influence on the strength of the concrete. Because, impurities in water may interfere with the setting of the cement and may adversely affect the strength of the concrete or cause staining of its surface, and may also lead to corrosion of the reinforcement. For these reasons the suitability of water for mixing and curing purposes should be considered.

Properties of Concrete

Strength and durability are generally considered the most important qualities, include creep and shrinkage characteristics and the elastic modulus, fire resistance, resistances to abrasions and thermal conductivity are sometimes important consideration.

Strength of Concrete

Strength of concrete is commonly considered as its most valuable property, although in many practical cases, other characteristics, such as durability and permeability, mayinfact be more important. Nevertheless, strength usually gives an overall pictures of the quality of concrete because strength is directly related to the structures of the hydrated cement paste. Strength of concrete is almost invariably a vital element of structural design and is specified for compliance purposes. In Engineering practices, the strength of concrete of a given age and cured in water at a prescribed temperature is assumed to depend primarily on two factors only. The water/cement ratio and the degree of compaction. The influence of air voids of strength of concrete greatly reduces its strength. 5 percent of air voids can lower strength by as much as 30 percent, and even 2 percent void can result in a drop of strength of more than 10 percent, these voids are caused due to bubbles of entrapped air or spaces left after excess water has been removed form volume of fresh concrete mix.

When concrete is fully compacted, its strength is taken to be inversely proportional to the water/cement ratio, it may be recalled that the water/cement ratio determines the porosity of the hardened cement paste at any stage of hydration. The water/cement ratio and the degree of compaction both affect the volume of voids in concrete. It seems also that mixes with very low water/ cement and an extremely high cement content (probably above 530kg/m^3) exhibit retrogression of strength when large size aggregate is used. Thus, at later ages, in this type of mix a lower water/cement ratio would not lead to a higher strength. This behaviour may be due to stresses induced by shrinkage, whose restraint by aggregate particles causes cracking of the current paste a loss of the cement aggregate bond. From time to time, the water/.cement ratio rule has been criticized as not being sufficiently fundamental. In practice, the water/cement ratio is the largest single factor in the strength of fully compacted concrete. For a given cement and acceptable aggregate, the strength that may be developed by a workable, properly placed concrete is influenced by the following:

i. Ratio of cement to mixing water.
ii. Ratio of cement to aggregate.
iii. Grading surface texture, shape and softness of aggregate particles.

iv. Maximum size of the aggregate.

Workability

Workability is the process or case at which concrete can be mixed, placed, compacted and finished. Infact workability is rather difficult to define. Precisely, it is intimately related among other to:

Compatibility: Those properties of concrete which determine how easily it can be compacted to remove voids.

Mobility: That property which determines how easily the concrete can flow into the mould and around the reinforcement.

Stability: That property which determines the ability of the concrete to remain a stable and coherent mass during handling and vibration. No single test has yet being devised which satisfactorily measures all the properties associated with workability.

In practice, it is expedient to use some type of consistency measurement as an index to workability, the slump test, the compacting factor test, and the VB consistometer test are among the more common test, F.K Kong and R.H. Evans (1980).

Proportion of Concrete Mix Design

The selection of mix proportion to achieve a desired splitting tension strength, is induced in the British method (B55328: Part 1: 1991). Generally, in British practice, flexural strength is the correct design criterion for some structures e.g highway pavement, the selection of mix proportions on the basis of a direct determination of the flexural strength is rarely practiced.

Although cement, fine aggregate and coarse aggregate are mixed ina definite proportion so as to get a strength, durable, workable and economic mix, but the proportion of the three constituents is governed by the specific requirements of a particular work which the concrete is to be used. mix design method are useful as guides in the initial selection of these proportions but it must be strongly emphasized that the final proportions to be adopted should be established by actual trials and adjustments on site.

Traditional Mix Design Method

For several decades, since the 1940s, mix design in the UK has been much influenced by a paper authored by Dr. A.R. Collins which was published in concrete and constructional engineering in October, 1939 and which later became road note. No.4 according to road note

No. 4 method, a water/cement ratio is first chosen to satisfy there requirements of strength and durability; the aggregate/cement ratio is then chosen to satisfy the workability requirement.

Statistics and Target Mean Strength in Mix Design

Based on several result obtained from analysis from a wide range, the research has demonstrated that the strength of concrete fall into some pattern of the normal frequency distribution curve symmetrical about the average with most of the test finding leading to almost approximated average result. In this case, comparison of the required characteristic strength of concrete with the target mean strength to be used in the mix design is possible the characteristics strength is the cube strength below which not more than 5% of the test result may fall. It is seen that:

Target mean strength = characteristics strength + 1.64 (s) where (s) = is the standard deviation of the strength tests. The quantity 1.64(s) here represents the margin by which target mean strength must exceed the required characteristics, and is called the current margin.

Curing

The word curing can be defined as means of keeping the newly laid concrete under uniform condition or temperature and moisture, during the hydration of the cement compounds so as to achieve maximum compressive strength of concrete. Curing is the last step and an exceedingly important one of the manufacture of concrete. Hydration of cement takes place only in the presence of moisture and at favorable temperatures, this condition must be maintained for a suitable time interval called the curing period.

Curing makes concrete stronger, more durable, denser and more resistant to abrasion. Concrete should not be allowed to dry out too quickly, if not the surface would be weak, cracks may develop and raindrops can eat into it. Direct sunshine and wind should be kept off newly placed wet concrete.

Bored pile

Replacement or bored piles are formed by excavation or boring techniques. When constructed in water bearing soil which is not self-supporting, the pile bore will need to be supported using steel casing, concrete rings or drilling fluids such as bentonite slurry, polymer mud, etc. excavation of the pile bore may also be carried out by hand-digging in the dry; and the technique developed in Hong Kong (Hong Kong Geotechnical Engineering Office, 1996) involving manual excavation is known locally as hand-dug caissons.

Bored Pile Advantages

The main advantage of bored piles over conventional footing or other types of piles are:-

i. Pile of variable lengths can be extended through soft compressible or swelling spoils into suitable bearing materials.
ii. Piles can be extended to depths below frost penetration and seasonal moisture variation.
iii. Large excavations and subsequent backfill are eliminated.
iv. Adjacent soil is not distributed or remolded.
v. Extremely high capacity caissons can be obtained by expanding the base of the shaft diameter, thus eliminating construction of capos over multiple pile groups.
vi. For many design situations bored piles offer higher capacities with potentially better economics than driven pile.

Types of bored pile

Bored piles are classified according to the ways in which they are designed to transfer the structural load to the substratum. The pile can be cased with pipe when required. For such piles, the resistance to the applied load may develop from end bearing and also from side friction at the shaft perimeter and soil interface.

A belled bored pile consists of a straight pile with a bell at the base, which rests on good bearing soil. The bell can be constructed in the shape of the dome or it can be angled. For the majority of bore piles, the entire load-carrying capacity is assigned to the end bearing only. However, under certain circumstances, the end-bearing capacity and the side friction are taken into account, Brook J.J (1990).

Construction Procedures

The most common construction procedure used involves drilling. There are three major types of construction methods; the dry methods, the casing methods and the wet methods.

Dry method

This method is employed in soils and rocks that are above the water table. The soils are normally strong and not easily collapsible when the hole is drilled to its full depth.

Casing method

The casing method is employed in soils and rocks, which are easily caving or collapsible soils when the borehole is excavated. The construction method is almost the same as the dry method but requires an introduction of slurry during drilling when collapsible soils are encountered.
The drilling is continued past the collapsible soil layer into a more stable soil layer. Casing is then introduced into the hole and slurry is pumped out of the hole. A small drill that passes through the casing is then used to drill further into the soil. If there be any need for reinforcement, a rebar cage is introduced to the full length of the pile. Concreting works start and the casing is retrieved for the hole gradually. Concreting is completed when the concrete fill up to the required level.

Wet method

This method is employed in a very soft soil condition. This method is sometimes referred to as slurry displacement method. Slurry is used to keep the borehole open during the entire depth of excavation.
Construction of a bored pile using this method starts with excavation by drilling with the slurry in the hole. The entire depth is drilled with slurry. If needed, reinforcement is introduced in the hole. Concreting starts by placing a tremie pipe to the bottom of the borehole. As concreting progresses, the slurry is slowly displaced to the ground surface where is collected. Concreting completes when the finish level is reached, Augustine Femi Olashinde (1994).

Equipment used

i. Power augers
ii. Casing oscillators
iii. Continuous flight anger drilling rigs.
iv. Kelly.
v. Reverse-circulation drilling rigs.
vi. Tripod rigs.

METHODOLOGY

Methods

Test carried out in the course of this project are:

(a) Tests On Cement

i. Determination of standard consistency of cement.
ii. Initial and final setting time.
iii. Soundness test.

(b) Tests on aggregates

i. Specific gravity of fine and coarse aggregate
ii. Standard flakiness test
iii. Standard elongation test
iv. Determination of Aggregate Impact (AIV)
v. Determination of Aggregate Crushing (ACV)

(c) Compressive Strength test (cube test) .

CONCLUSION

This research is basically meant to **design a specific concrete of grade 30N/mm^2 for bored piles at a depth of 25m minimum, of a slump ranging from 80mm –160mm, which was achieved on concrete mix design test three with strength of 24.2N/mm^2 at 7days of mean strength and 32.2N/mm^2 at 28 days mean strength** as regarded by general specification B.S 1881 of concrete analysis. It is cleared that this procedure should be followed and repeated if another type of crushed coarse aggregate and sand from another zone is to be used. If there is any change of cement, the design should also be repeated. No doubt for the same material and cement at the same location, the above design of concrete mix proportion here has formed the basis of applicable mix design for bored pile.

RECOMMENDATION

Since this research project have proved satisfactory at concrete mix design proportion test three, based on grade 30N/mm^2 of 2400kg/m^{3}density for board pile, using Dangote cement and zone two sand, it is quite recommendable for use at any place in Kaduna metropolis. Care should be taken strictly on weather situation and ratio analysis.

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APPENDIX 1

Table1: Standard Consistency Test of Cement

s/n	Maximum	Brand of cement	Quantity of cement (g)	Quantity of water (ml)	Depth of penetration (mm)	Remark
1	4	Dangote cement	400	120	3	W/C=0.28
2.	2	Dangote cement	400	112	5	

Standard consistency % $\frac{112}{400} \times 100 = 28.0\%$

Table2: Initial and Final Setting Time Results

Mix time (minutes)	Wt of cement (g)	Depth of penetration (mm)	Volume of water (ml)	Setting time	
				Initial	Final
4	400	5	112	11:06am -1:50pm (2hrs: 44mins)	11:06am-43pm (5hrs:57mins)

Table3: Soundness Tests of Cement Result

S/N	Wt of cement	Vol. of water	w/c	Distance b/w pointers b4 heating (L_1) (mm)	Distance b/w pointer after heating (L_2) (mm)	L_2-L_1	Average	Remark
1	400	112	0.28	44.0	44.5	0.5	0.5	
2	400	112	0.28	19.5	20.0	0.5		

$$Average = \frac{0.5 + 0.5}{2} = 0.5mm$$

Table4: Specific Gravity Result

Description: specific gravity of aggregates				
S/NO	Description of sample	0-5"	$^{1}/_{2}$"	¾"
A	Weight of empty bottle (gm)	751	748	751
b.	Weight of bottle + water (gm)	2307	2304	2307
c.	Weight of water (b-a)	1556	1556	1536
d.	Weight of Bottle + sample (gm)	1764	1511	1641
e.	Weight of sample (gm)	1013	763	890
f.	Weight of bottle + sample + water(gm)	2935	2779	2861
g.	Water added (f-d)	1171	1268	1220
h.	Water displaced (c-g)	385	288	336
i.	Temperature of water	20^{0}c	20^{0}c	20^{0}c
	Specific Gravity ($^{e}/_{h}$ x k)	2.631	2.649	2.567
	Average	2.631	2.649	2.567

Relative Density of Water and Conversion Factor "K"

Temperature ^{0}C	Relative Density	Factor "K"
18		1.0004
19	0.9984347	1.0002
20	0.9982343	1.0000
21	0.9980233	0.9998
22	0.9978019	0.9996
23	0.9975705	0.9993
24	0.9973286	0.9991
25	0.997077	0.9989
26	0.9968156	0.9986

Sieve Analysis

Table 5.1Sieve Analysis of Fine Aggregate (River Sand)

Sample no: **Weight of :** **Sample Description:**	**River sand (test 1)** **262g** **Fine aggregate zone 2**				
Sieve No.	Sieve size (mm)	Cumulative % weight retained	Cumulative% retained	Cumulative % weight passing	Specification
1"	25.4m				
¾"	20.0mm				
½"	12.5mm				
3/8"	10.0mm	-	-	100	100
3/16"	5.0mm	12	4.6	95.4	90-100
No.7	2.36mm	31	11.8	83.6	75-100
No.14	1.18mm	37	14.1	69.5	55-90
No. 25	600µm	44	16.8	52.7	35-59
No 36	425 µm	-	-	-	-
No52	300 µm	97	37.0	15.7	8 – 30
No. 100	150 µm	33	12.6	3.1	0-10
No. 200	75 µm				-
Passing 200					-

Table 6: Sieve Analysis of Fine Aggregate (River Sand)

Sample no Weight of Sample Description	River sand (test 2) 261g Fine aggregate zone 2				
Sieve No.	Sieve size (mm)	Weight retained (g)	% retained	% passing	Specification
1"	25.4mm				
¾"	20.0mm				
½"	12.5mm				
$^{3}/_{8}$"	10.0mm	-	-	100	100
$^{3}/_{16}$"	5.0mm	10	3.8	96.2	90-100
No.7	2.36mm	32	12.3	83.9	75-100
No.14	1.18mm	38	14.6	69.3	55-90
No. 25	600μm	44	16.9	52.4	35-59
No 36	425 μm	-	-	-	-
No52	300 μm	100	38.3	14.1	8 – 30
No. 100	150 μm	31	11.9	2.2	0-10
No. 200	75 μm				-
Passing 200					-

Table7: Sieve Analysis of Fine Aggregate (Stone Dust)

Sample no : Weight of Sample: Sample Description:	Stone dust (0-5mm) aggregate (test 1) 359g Fine aggregate zone 1				
Sieve No.	Sieve size (mm)	Weight retained (g)	% retained	% passing	Specification
1"	25.4mm				
¾"	20.0mm				
½"	12.5mm				
$^3/_8$"	10.0mm	-	-	100	100
$^3/_{16}$"	5.0mm	18	5.0	95.0	90-100
No.7	2.36mm	103	28.7	66.3	60-95
No.14	1.18mm	52	14.5	51.8	30-70
No. 25	600μm	77	21.4	30.4	15-34
No 36	425 μm	-	-	-	-
No52	300 μm	64	17.8	12.6	5-20
No. 100	150 μm	30	8.4	4.2	0-10
No. 200	75 μm				-
Passing 200					-

Table 8: Sieve Analysis of Fine Aggregate (Stone Dust)

Sample no :	Stone dust (0-5mm) aggregate (Test 2)				
Weight of Sample:	389g				
Sample Description :	Fine aggregate zone 1				
Sieve No.	Sieve size (mm)	Weight retained (g)	% retained	% passing	Specification
1"	25.4mm				
¾"	20.0mm				
½"	12.5mm				
3/8"	10.0mm	-	-	100	100
3/16"	5.0mm	12	4.2	95.8	90-100
No.7	2.36mm	88	30.4	65.4	60-95
No.14	1.18mm	42	14.2	51.2	30-70
No. 25	600µm	60	20.8	30.4	15-34
No 36	425 µm	-	-	-	-
No52	300 µm	48	16.6	13.8	5-20
No. 100	150 µm	25	8.7	5.1	0-10
No. 200	75 µm				-
Passing 200					-

Table 9: Sieve Analysis for $^1/_2$" Aggregate (test 1)

Sample no :	½" aggregate (Test 1)				
Weight of Sample:	602g				
Sample Description:	12.5mm ($^1/_2$") % b weight Envelope				
Sieve No.	Sieve size (mm)	Weight retained (g)	% retained	% passing	Specific ation
1"	25.4mm				-
¾"	20.0mm				100
½"	12.5mm	-	-	100	85-100
$^3/_8$"	10.0mm	465	77.2	22.8	0-50
$^3/_{16}$"	5.0mm	129	21.4	1.4	0-10
No.7	2.36mm				
No.14	1.18mm				
No. 25	600µm				
No 36	425 µm				
No52	300 µm				
No. 100	150 µm				
No. 200	75 µm				
Passing 200					

Table 10: Sieve Analysis for $^{1}/_{2}$" Aggregate (Test 2)

Sample no	**½" aggregate (Test 2)**				
Weight of	**529g**				
Sample Description	**12.5mm ($^{1}/_{2}$")% by Weight Envelop**				
Sieve No.	Sieve size (mm)	Weight retained (g)	% retained	% passing	Specification
1"	25.4mm				
¾"	20.0mm				100
½"	12.5mm	-	-	100	85-100
$^{3}/_{8}$"	10.0mm	410	77.5	22.5	0-50
$^{3}/_{16}$"	5.0mm	206	20.6	1.9	0-10
No.7	2.36mm				
No.14	1.18mm				
No. 25	600µm				
No 36	425 µm				
No52	300 µm				
No. 100	150 µm				
No. 200	75 µm				
Passing 200					

Table 11: Sieve Analysis for $^3/_4$" Aggregate (Test 1)

Sample no: **Weight of Sample:** **Sample Description:**	$^3/_4$" aggregate (test 1) **603 grms** **20mm(3/4")% by Weight Envelop**				
Sieve No.	Sieve size (mm)	Cummulative Weight retained (g)	Cummulative % retained	Cummulative weight passing	Specification
1$^1/_2$"	37.5mm				100
1"	25.4mm				
¾ "	20.0mm	-	-	100	85-100
½ "	12.5mm	-	-	-	-
3/8	10.0mm	595	98.7	1.3	0-25
3/16"	5.0MM	8	1.3	-	0 – 5
No.7	2.36mm				
No.14	1.18mm				
No. 25	600µm				
No 36	425 µm				
No52	300 µm				
No. 100	150 µm				
No. 200	75 µm				
Passing 200					

Table 12: Sieve Analysis for $^{3}/_{4}$" Aggregate (Test 2)

Sample no:	$^{3}/_{4}$" aggregate (test 1)				
Weight of Sample:	**718 grms**				
Sample Description:	**20mm($^{3}/_{4}$")% by Weight Envelop**				
Sieve No.	Sieve size (mm)	Cummulative Weight retained (g)	Cummulative % retained	Cmmulative weight passing	Specification
1$^{1}/_{2}$"	37.5mm				100
1"	25.4mm				-
¾ "	20.0mm	-	-	100	85-100
½ "	12.5mm	-	-	-	-
3/8	10.0mm	713	99.3	0.7	0-25
3/16"	5.0MM	3	0.4	0.3	0 – 5
No.7	2.36mm				
No.14	1.18mm				
No. 25	600µm				
No 36	425 µm				
No52	300 µm				
No. 100	150 µm				
No. 200	75 µm				
Passing 200					

Table 13: Aggregate Crushing Value

Description of material; retain 10mm sieve	
Weight of material in mould (A)	3387grms
Weight of material passing sieve 2.36mm (B)	915grms
Acv = B/A x 100	27.0
Average	27.0

Table 14: Aggregate Impact Value

Description of material: passing 14mm sieve and retain 10mm sieve			
Sample ref:	A	B	C
Mass of sample before test (A)	725	718	717
Mass of retained on No. 7 Sieve (B)		648	
Mass of sample passing No.7 Sieve (A-B)=C		72	
Impact Value $^C/_A$ x 100%		10%	

Mass passing sieve No. 12.5mm retained 10mm (A) 720

Mass passing sieve No. 7 after crushing (B) 72

Table 15: Determination of Elongation Index

Aggregate size	(mm inch)	Passing	retained	Passing	Retained	Passing	Retained	Total
		¾"	½"	½"	$^3/_8$"	$^3/_8$"	¼"	(g)
Total weight of dry aggregate (g)	W_1	222		50		2		274
Weight of elongated aggregate after passing	W_2	39		9		2		50
Elongation index (%)	$\frac{w_2}{w_1} \times 100$							18.2

Table 16: Determination of Flakiness Index

Aggregate size	(mm inch)	Passing	retained	Passing	Retained	Passing	Retained	Total
		¾"	½"	½"	$^3/_8$"	$^3/_8$"	¼"	(g)
Total weight of dry aggregate (g)	W_1	222		50		2		274
Weight of flakiness aggregate after passing(g)	W_2	34		2		0		36
Flakiness index (%)	$\frac{w_2}{w_1}\times 100$							13.1

Table 17: **CONCRETE DENSITY MIX DESIGN**

Date	APRIL 2012	Operator	
Uses:			Reinforced concrete Structure
The aspire strength required G30			35Nmm^2
The slum (maximum)			(30mm -80mm)
Maximum size of Aggregate ¾ "			19mm
Bulk density of Aggregate			1710Kg/m^3
Specific gravity of Aggregate			2.567
Finess modulus of fine Aggregate			2.705
Specific gravity of Fine Aggregate			2,549
Water Requirements (Table 10.16 (a) and 10.16 (b)) and 10.16 (b)			$\frac{200x92}{100}$ = 184Kg/m^3
Standard Specific gravity of Cement			3.15
The entrapped air content			2%
Water Cement Ratio (Table 10.8 (a))			0.50
Hence, the cement content			$\frac{184}{0.5}$ = 368Kg/m^3
Bulk Volume of Coarse Aggregate per unit volume of concrete (Table 10.17-10.18)			0.63
Hence, the weight of Coarse Aggregate per cubic meter of concrete			1710x0.63 = 1077Kg
The Absolute volume of mix ingredient per cubic meter of concrete are:-			
Cement			$\frac{368}{3.15x1000}$ = 0.117m^3
Water			$\frac{18}{1000}$ = 0.18m^3
Coarse Aggregate			$\frac{1077}{2.567x1000}$ = 0.420m^3
Entrapped Air			0.02 x1 = 0.020m^3
Total Volume			0.741m^3
Hence the volume of Fine Aggregate required			1 – 0.741m^3 = 0259m^3
The corresponding weight			0.259 x 2.259 x 1000 = 660kg
Plastiment BV 40			$\frac{1}{100}$ x $\frac{368}{1}$ = 3.7 = 4Kg
The weight of material per cubic meter of concrete are:			
Cement			368Kg
Water			184Kg
Fine			660Kg
Coarse			1077Kg

In place of chemical, add 107kg of coarse aggregate		107Kg
Total		2396Kg/m^3
Hence, the density of concrete		2400Kg/m^3
Perform and calculated by	Reviewed and checked by	Witness by
Name: Date Signature	Name: Engr. Salihu Andaa Yunusa Date Signature	Name: Date Signature
This section will filled by the lab. Technician	This section will be fill by he Q.C & Lab Chief	This section will be filled by the ER' Staff

Concrete Laboratory Compressive Strength Test

Table18: Concrete Mix Proportions (Test 1)

Date:	24/02/12
Concrete Grade:	30N/mm^2
Slumps:	125mm
Density	2400kg/m3
Cement	Dangote
Mix	1m^3
	Ordinary Mix (kg)
Cement	380
Sand (sharp)	400
Aggregate (4 to 16mm)	380
Aggregate (16 to 20mm)	583
Aggregate (0-5mm)	390
Water	267

Concrete Laboratory Compressive Strength Test (Test 1) (Dangote Cement)

Grade	30 N/mm2	Size of specimen	150mm x 150mm x 150mm					
Slumps	125mm	Curing condition	Immersion in water					
Cube and identification marks	Date of cast	Age of testing (days)	Date tested	Weight of cube (g)	Density of cube (g/cm^3)	Crushing load (KN)	Crushing strength (N/mm^2)	Average
3A	24/02/12	7 days	02/03/12	7970	2.36	420	18.7	19.4N/mm^2
3B	24/02/12	7 days	02/03/12	7890	2.34	450	20.0	
3C	24/02/12	7 days	02/03/12	7840	2.32	436	19.4	
3D	24/02/12	28 days	23/03/12	8140	2.41	650	28.9	27.7N/mm^2
3E	24/02/12	28 days	23/03/12	8050	2.39	622	27.6	
3F	24/02/12	28 days	23/03/12	8210	2.43	600	26.7	

Table4.19: Concrete Mix Proportions (Test 2)

Date:	24/02/12
Concrete Grade:	30N/mm^2
Slumps:	128mm
Density	2400kg/m3
Cement	Dangote
Mix	1m^3
	Ordinary Mix (kg)
Cement	400
Sand (sharp)	400
Aggregate (4 to 16mm)	400
Aggregate (16 to 20mm)	600
Aggregate (0-5mm)	340
Water	260

Concrete Laboratory Compressive Strength Test (test 2) (Dangote Cement)

Grade	30 N/mm2	Size of specimen	150mm x 150mm x 150mm					
Slumps	128mm	Curing condition	Immersion in water					
Cube and identification marks	Date of cast	Age for testing (days)	Date tested	Weight of cube (g)	Density of cube (g/cm^3)	Crushing load (KN)	Crushing strength (N/mm^2	Average
4A	24/02/12	7 days	02/03/12	8120	2.41	440	19.6	19.4N/mm^2
4B	24/02/12	7 days	02/03/12	8040	2.39	440	19.6	
4C	24/02/12	7 days	02/03/12	8215	2.43	430	19.1	
4D	24/02/12	28 days	23/03/12	8220	2.44	680	30.2	29.8N/mm^2
4E	24/02/12	28 days	23/03/12	8310	2.46	672	29.9	
4F	24/02/12	28 days	23/03/12	8160	2.42	660	29.3	

Table 20: Concrete Mix Proportions (Test 3)

Date:	02/03/12
Concrete Grade:	30N/mm^2
Slumps:	110mm
Density	2400kg/m3
Cement	Dangote
Mix	1m^3
	Ordinary Mix (kg)
Cement	420
Sand (sharp)	400
Aggregate (4 to 16mm)	390
Aggregate (16 to 20mm)	600
Aggregate (0-5mm)	340
Water	250

Concrete Laboratory Compressive Strength Test (Test 3) (Dangote Cement)

Grade	30 N/mm2	Size of specimen	150mm x 150mm x 150mm					
Slumps	128mm	Curing condition	Immersion in water					
Cube and identification marks	Date of cast	Age for testing (days)	Date tested	Weight of cube (g)	Density of cube (g/cm^3)	Crushing load (KN)	Crushing strength (N/mm^2)	Average
5A	02/03/12	7 days	09/03/12	8050	2.39	550	24.4	24.2N/mm^2
5B	02/03/12	7 days	09/03/12	8110	2.40	538	23.9	
5C	02/03/12	7 days	09/03/12	7980	2.36	546	24.3	
5D	02/03/12	28 days	30/03/12	8125	2.41	724	32.2	32.2N/mm^2
5E	02/03/12	28 days	30/03/12	8070	2.39	730	32.4	
5F	02/03/12	28 days	30/03/12	8095	2.40	718	31.9	

APPENDIX 2

s/no	Age in days	crushing strength	
1	7	18.7	
2	7	19.4	G30(1)
3	7	20	
4	28	28.7	
5	28	27.6	
6	28	28.9	

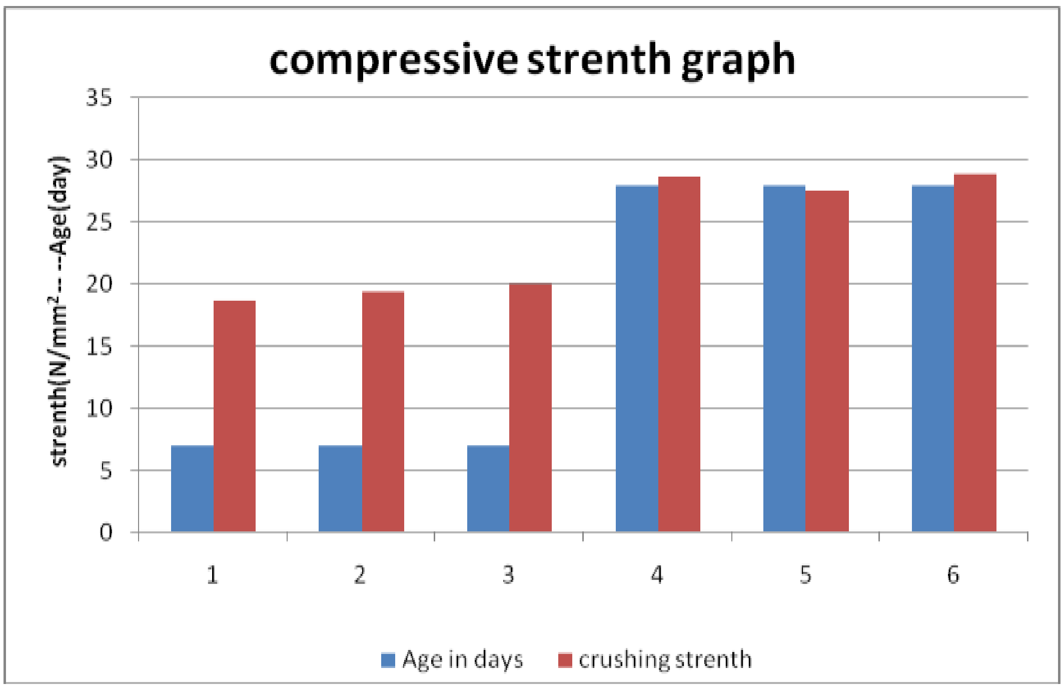

FIG 1

s/no	Age in days	crushing strength	
1	7	19.1	
2	7	19.6	
3	7	19.6	G30(2)
4	28	29.3	
5	28	29.9	
6	28	30.2	

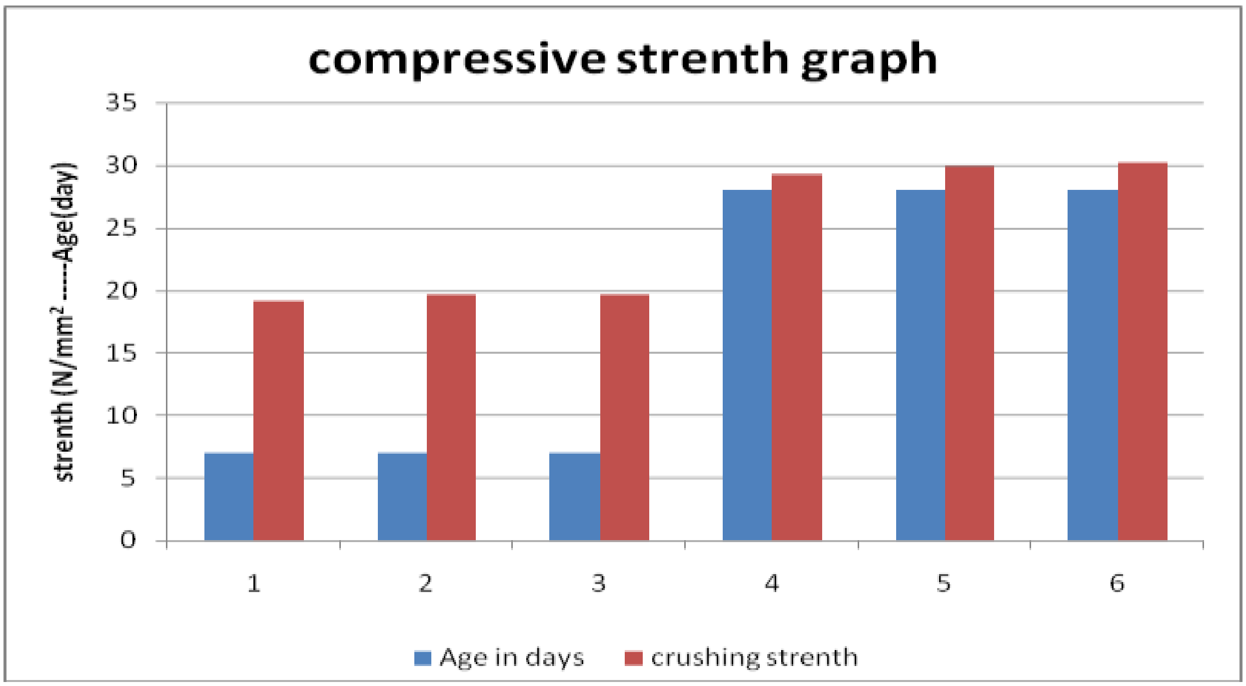

FIG 2

s/no	Age in days	crushing strength N/mm2	
1	7	23.9	
2	7	24.3	
3	7	24.4	G30(3)
4	28	31.9	
5	28	32.2	
6	28	32.4	

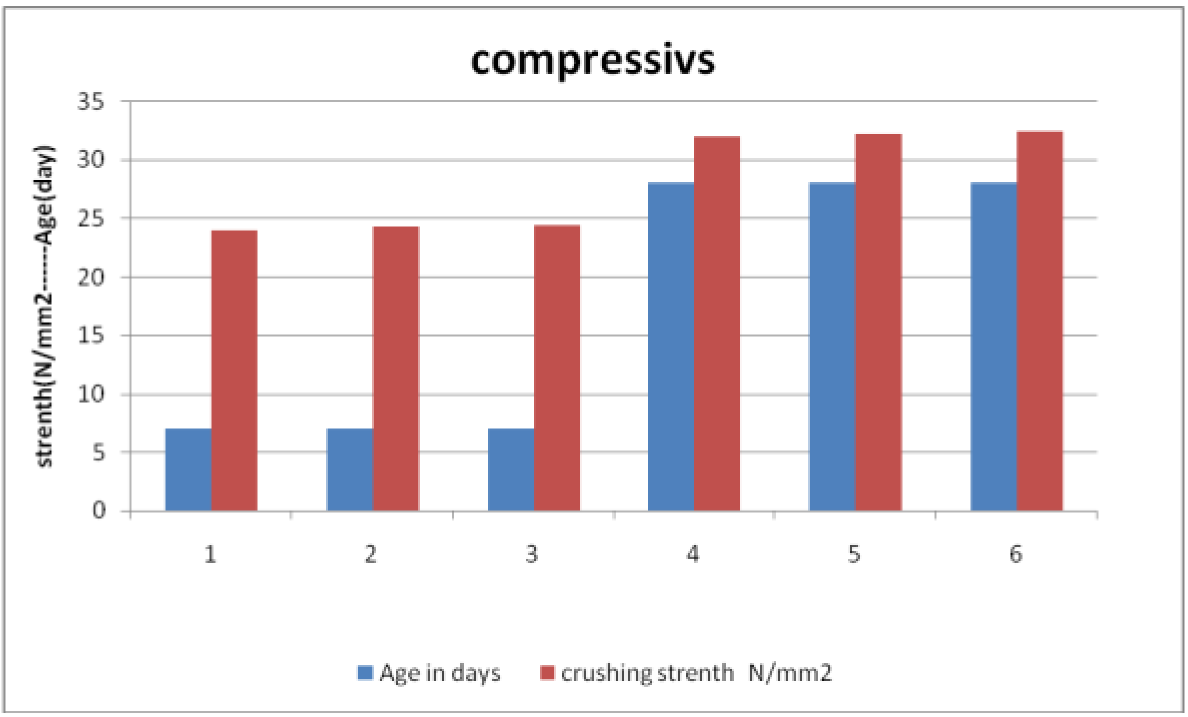

FIG 3

S/No	Age in days	crushing strength	
1	7	19.4	
2	7	19.4	
3	7	24.2	MEAN{G30}
4	28	27.7	
5	28	29.8	
6	28	32.2	

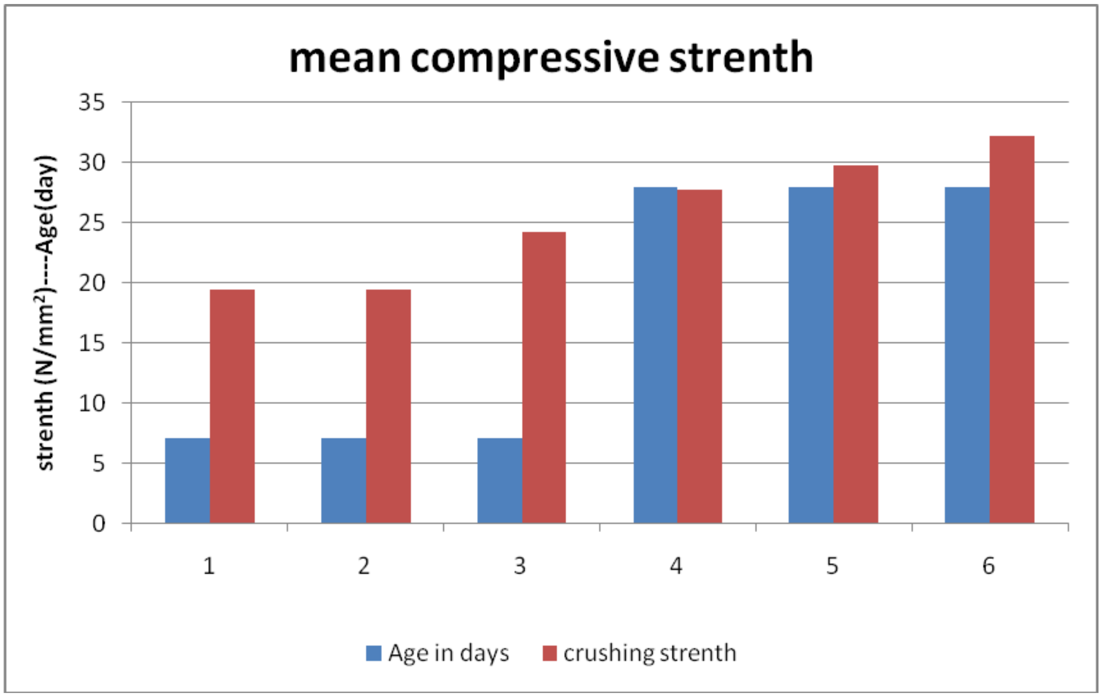

FIG 4

Reference to this paper should be made as follows: *Salihu Andaa Yunusa, et al* (2015), *Determination of Mix Design of Conrete Grade 30n/Mm^2 for Bored Pile. J. of Physical Science and Innovation,* Vol. 7, No. 2, Pp. 14-43.