International Journal of Engineering Science Invention
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org Volume 3 Issue 7‖ July 2014 ‖ PP.07-10

Effect of Ngala Clay on the Compressive Strength of Concrete

[1,] Dammo .M. N, [2,]Deborah. J. M , [3],Aghidi. J , [5,] Isa. A Falmata A.K , [6,]Adams. K
Department of Civil Engineering, Ramat Polytehnic Maiduguri, Nigeria.

ABSTRACT :*In the present study, the compressive strength of concrete development incorporating clay is studied. The clay sample was sourced from a location in Borno Sate. Concrete cubes for five different percent of clay, 2, 4, 6, 8,and 10 were added to a mix ratio 1: 2:4 to produce concrete cubes. The compressive strength of concrete incorporating these 2, 4, 6, 8 and 10 % clay for a mix ratio of 1:2:4 for cement sand and aggregate were determined. The results showed increased in strength ranging from (20.8 - 24.9N/mm^2) for 2 and 4% clay, and a decrease in strength for 6, 8 and 10% clay content. This implies that incorporating 2 and 4% clay is highly significant to increase the compressive strength of concrete, than the 6, 8 and10% clay. Thus, indicating the higher the clay content in a concrete mix, the lower the strength and the higher the amount of cement needed to achieve the 20N/mm^2 strength. The compressive strength of concrete obtained at the ages of 3, 7, 14 and 28 days of curing showed increased continuously.*

KEYWORDS: *Clay, Concrete, Sand, Cement compressive strength*

I. INTRODUCTION

The compressive strength of concrete depends on the water to cement ratio, degree of compaction, ratio of cement to aggregate, bond between mortar and aggregate, and grading, shape, strength and size of the aggregate[1,2]. The strength of concrete is controlled by the proportioning of cement, coarse and fine aggregates, water, and various admixtures. The ratio of the water to cement is the chief factor for determining concrete strength and is used as the most basic and important material property when reinforced concrete structures are designed[3,4]. Concrete can be visualized as a multi-phase composite material made up of three phases; namely the mortar, mortar/aggregate interface, and the coarse aggregate phase[5]. Concrete provides wide latitude in surface textures and colours and can be used to construct a wide variety of structures, such as highways and streets, bridges, dams, large buildings, airport runways, irrigation structures, breakwaters, piers and docks, sidewalks, silos and farm buildings, homes, and even barges and ships[3]. Testing method such as Non-destructive method, British Standard and Euro code are used to determine the compressive strength. Each of the method gives the different type of compressive strength value. In most structures, concrete is often subjected to biaxial states of stress, and the behaviour of the material under these types of loadings must be well understood. Concrete is a very important material and widely used in construction industry. It offers stability and design flexibility for the residential marketplace and environmental advantages through every stage of manufacturing and uses [6]. There are many advantages of concrete such as built-in fire resistance, high compressive strength and low maintenance.

Various methods of concrete testing are carried out to ensure that it remains of adequate strength and durability. Concrete is a very variable material, having a wide range of strengths. Concrete generally increases its strength with age [7]. Concrete is an intimate mixture of mineral aggregate and a binding material such as Portland cement. The aggregate should be clean, hard, and durable, graded from coarse to fine materials to increase density by filling voids. It is important that the sand for making concrete should be clean. As a first test, rub a little sand between the palms of your hands. For fine aggregates, pit sand is widely used. One of the major disadvantages of pit sand is that it contains a lot of dirt such as roots, fibres, vegetable growth and impurities such as loam, laterite and clay[8]. Aggregates for concrete are usually specified to comply with the requirements of BS 882 [9], which gives tests for suitable aggregates. The British standard sets out the general requirements for freedom from impurities, permissible limits for only clay and silt, and grading limits for sand and various sizes of coarse aggregates. It is very important to control the quality of the aggregate to be used in concrete making. Most importantly, the effect of the clay content of sand on the compressive strength of concrete must be controlled. This work determines the amount of clay content needed to produce concrete with compressive strength not less than 20N/mm2 for mix 1: 2: 4.

II. MATERIALS AND METHODS

The materials used for this research work are river gravel and pit sand for coarse and fine aggregate respectively, collected from Maiduguri metropolis, Portland cement, vertisol from Ngala and portable water. Different percent of 2, 4 , 6, 8,and 10 Ngala clay (vertisol) were incorporated to examine the effect on concrete strength. The concrete cubes were casted using steel of 150 x 150 x 150cm^3 size. The mix ratio for the concrete was 1:2:4, from which15 cubes were casted, making a total of 75 cubes. The cubes were cured by immersion in water in a curing tank for 3, 7, 14, 21 and 28 days. After which, the concrete cubes were crushed using Universal Testing Machine, which was manually operated. The procedure used in carrying out the test conformed to that of British Standard 1881, parts 108 and 116[10].

III. RESULTS AND DISCUSSION

Table 1 showed the results of the average compressive strength tests for the varying clay content from 0 - 10%. The results showed that compressive strength for 2 and 4% increment of clay increased the compressive strength above 20N/mm^2. It can be seen that for 2 and 4% clay the compressive strength of the concrete is more than 20N/mm^2. While, for 6, 8 and 10% clay content a decreased was observed (Fig 1), similar to Olanitori (2006) observation. The decreased observed implies that more cement increment is needed for 6, 8 and 10% respectively, so that the compressive strength of concrete will not be less than 20N/mm^2. For drying ages the compressive strength of concrete increased consistently with time and not much variation in magnitude of strength was observed (Table 2). Relationship between percentage clay and bulk density showed increased with increase percent clay and decreased with increased as the days of drying increased (Fig 2).

Table1. Compressive strength (N/mm^2) for varying percentage clay and drying days

Clay %	7 days	14 days	21 days	28 days
0	17.2	17.8	20.8	23.3
2	20.8	21.2	21.8	24.4
4	24.9	25.4	26.3	26.8
6	18.4	19.2	20.3	21.8
8	17.2	18.8	19.4	20
10	16.6	17.6	18.8	19.4

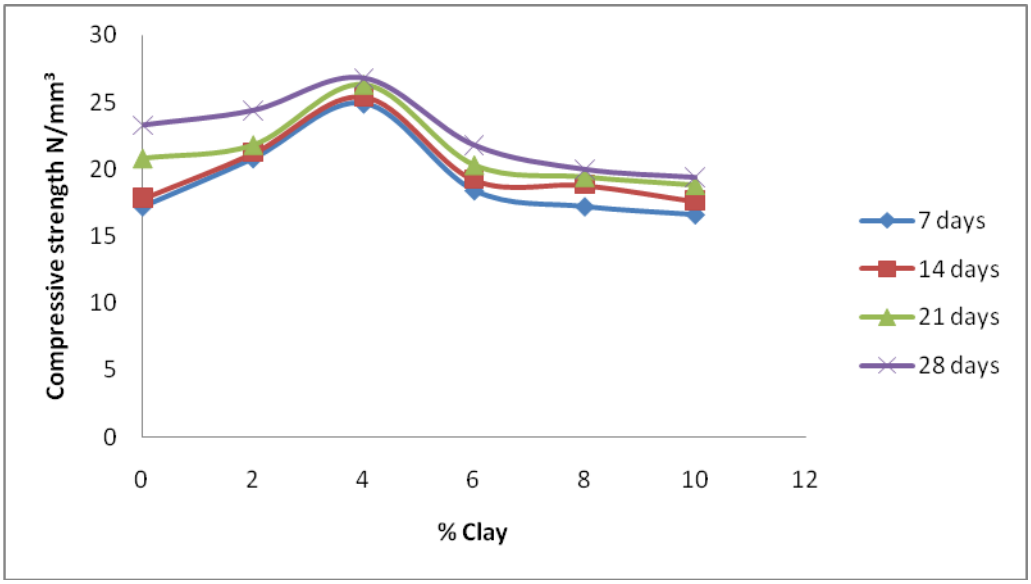

Fig.1: Relation between compressive strength of concrete and percentage clay

Table2. Density (kg/m^3) of concrete for varying percentage clay and drying days

Clay %	Density kg/m3 7 days	Density kg/m3 14 days	Density kg/m3 21 days	Density kg/m3 28 days
0	23.4	22.8	22.6	22.2
2	23.6	23	22.8	22.4
4	24.2	23.8	23.2	22.9
6	25	24.4	24	23.6
8	25.4	24.9	24.2	24
10	25.6	25	24.6	24.2

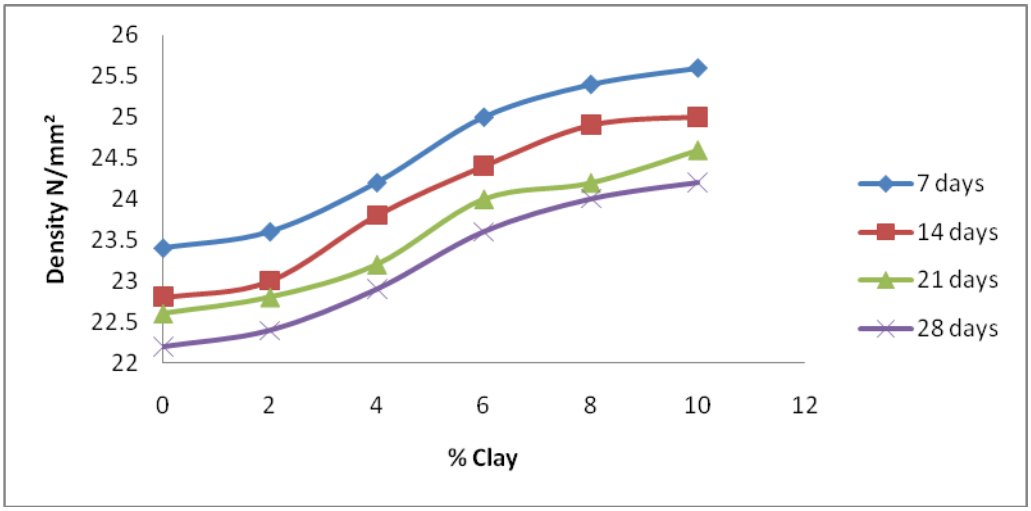

Fig.2: Relationship between Density and percentage clay

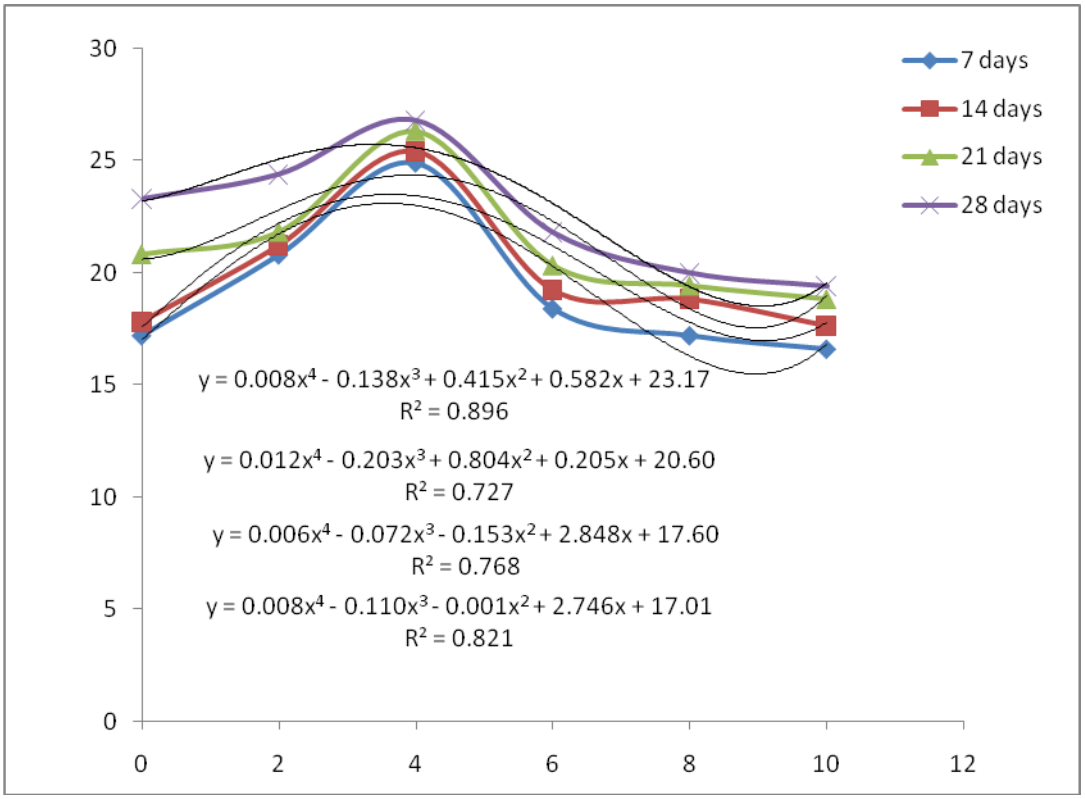

Fig.3: Trend of compressive strength with increase percentage clay

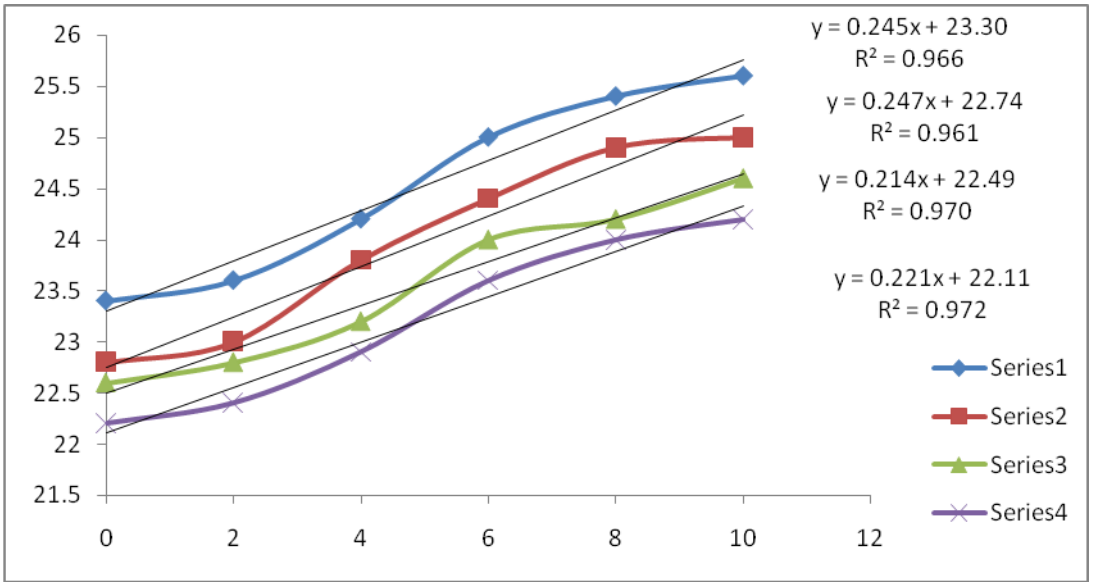

Fig. 4: Trend of density with increase percentage clay and drying days

Fig. 3 shows 2th order polynomial for compressive strength of concrete. The trend is similar for all the percentage, with rising and falling pattern. The compressive strength of concrete decreased at 6% clay content, while 2 - 4% clay content showed increase in compressive strength ranged from 20.8 – 26.8 N/mm^2 for varying days. The 2 – 4% clay content indicated percentage clay required in concrete mix for good strength. Whereas too much clay content in concrete decrease strength and can only be improved by addition of more cement. Whereas fig 4 showed linear relationship with increase bulk density as clay content increased, while decreased with increase drying days.

IV. CONCLUSION AND RECOMMENDATION

From the discussion of results, it can be seen that higher the percentage of clay content in sand, decreased compressive strength of the concrete. It is recommended that comparative cost analysis should be carried out between percentage clay content to cement sand mix ratio so as to maintain 20N/mm^2 compressive strength, and the cost of washing the sand free of clay, so as to determine which one out of the two is cost effective.

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