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Investigation of Suitability of Dredged Samples for Production of Bricks

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Abstract: ***This study investigates the suitability of dredged samples for the production of bricks. Some geotechnical properties (moisture content, grain size distribution) of dredged samples were also determined using the British Standard. Bricks were produced using appropriate mixes of two dredged samples. The dredged samples (Oroto dredged samples and Igbokoda dredged samples) have high moisture content of 90.48 % and 37.5 % respectively and both are classified as silty materials. The two dredged samples were mixed in different percentage (1- Oroto dredged sample (DS)85 % and Igbokoda dredged sample (IS)15 %,2-DS 70 % and IS 30 %, 3- DS 55 % and IS 45 %,4-DS 50 % and IS 50 %, 5- DS 45 % and IS 55 %,6-DS 30 % and IS 70 %,7-DS 15 % and IS 85 %, 8- Clay 100%, 9- DS 100%, 10-IS 100%) for the production of bricks and were tested for 7 days, 14 days, 21 days and 28 days. Although, the water absorption level of the bricks produced were high (5.635 to 33.4 %), the compressive strength on the 28th day was within the accepted British Standard. The Igbokoda dredge sample is a good material for the production of bricks when mixed with Oroto Dredged sample because the compressive strength of the material is within the accepted limit.***

Keywords: Dredged samples, Bricks, Moisture Content, Compressive strength; Mixes

1. Introduction

Dredged samples are waste gotten from dredging operations and are disposed off on land, waters and seas. Land filled with waste materials has become a significant source of pollution of air, water, soil, and further, adversely affect the human health, growth of plant and vegetation (Ramachandran, 1995). Inappropriate disposal or treatment of dredged silt may cause secondary pollution resulting in detrimental effects to the environment because it is dense and full of organic matter. Furthermore, the wasted resources can be recycled and reused as construction materials to make up for the shortage of aggregate for manufacturing concrete. Dredged silt was made into lightweight aggregates through high temperature sintering and hydration (Yen, 2003; Hong *et al.*, 2007). Lightweight aggregate concrete made from dredged silt can enhance durability of concrete (Wang and Tsai, 2006; Wang, 2007).

Fired brick and concrete are still the largest amount in wall material. Brick, cement and other Industries have a lot of demand on the clay. Digging clay resources, has seriously affected the quantity and quality of rural land. At the national policy of prohibiting the use of solid bricks, using silt to make sintered bricks instead of clay materials would greatly reduce competition in manufacturing and agricultural industries which is the major way of silt resources utilization. Sludge can also be used to manufacture lightweight aggregate concrete and silicate gel materials. Japan is the most active country to resource recycling of sludge; it was used to produce advanced materials. Silt bricks with light weight, breathable, easy to color processing, suitable for a variety of building decoration. In University of Maryland, a "bio-bricks" was produced using sludge as raw material, and was promoted as advanced technology for sludge resources recycling (Yu Gan, 2007).

In this research, the firing method for production of bricks was not employed because the research is to determine the suitability of the dredged material produced within the rural riverine communities for bricks production. This is because the people of this environment lives majorly in houses made with planks, therefore this research is of two objectives:

1) To turn the dredged samples to wealth by recycling; and
2) To help improve the quality of life of the riverine community people.

2. Methodology

The study areas are located in a dredging site at Ilaje local Government area of Ondo state, Nigeria. The materials used for the production of the bricks are dredged sampless that were collected from the two different locations (Oroto and Igbokoda) in the local government. This research was carried out to investigate the suitability of the dredged samples for the production of bricks.

The two dredged samples were mixed in different percentage (1- Oroto dredged sample (DS) 85 % and Igbokoda dredged sample (IS) 15 %, 2- DS 70 % and IS 30 %, 3- DS 55 % and IS 45 %, 4- DS 50 % and IS 50 %, 5- DS 45 % and IS 55 %, 6- DS 30 % and IS 70 %, 7- DS 15 % and IS 85 %, 8- Clay 100% , 9- DS 100%, 10-IS 100%) for the production of bricks. In total, ten different mixes were madeand tested for 7, 14, 21 and 28 days.

The following geotechnical analysis were carried out on the dredged samples:

Particle size distribution: samples were collectedand prepared by wet sieving. This was done to remove the silt and clay particles and dry sieving of the remaining coarse materials.Using 500g of air dried sample, the grain size distribution was conducted in accordance with BS 1377: 1990.

Particle size distribution-hydrometer method: This method was used for materials passing through the 75 µm sieve in a wet or dry sieving analysis. The particle density of the soil was carried out in accordance with BS 1377: PART 2: 1990.

Water absorption test: Cold immersion and absorption under vacuum for 24 hours was the method used. Water absorption was done according to BS 812 Part 2 1995.

Silt/clay content analysis: The silt /clay content was measured by mixing soil samples with 50 ml water of 1% sodium chloride (NaCl) solution in a cylinder which was filled with water up to the 200 ml.The solution was shaken vigorously and left to settle. The layer of silt that was formed was expressed as a percentage of sand which is in accordance with BS 812: Part16 and 18.

Determination of compressive strength: The compressive strength of each specimen is calculated by dividing the maximum load obtained by the appropriatearea of the bed face. The test is carried out in accordance with BS 3921: 1985 for bricks.

3. Results and Discussion

3.1 Particle size distribution

The result of the particle size distribution testsfor Oroto and Igbokoda dredged samples show that more than 99 % of the aggregate passed through sieve 0.075mm and in ***particle size distribution test if more than 30 % of the sample passes through sieve 0.075mm***, the sample should undergo hydrometer test to know the class which the sample falls in.

Table 1: Particle Size Distribution of OrotoDredged samples

Sieve no (mm)	Weight retained	% retained	% passing
1.8	0	0	100
1.7	0.625	0.125	99.875
0.6	0.525	0.105	99.770
0.5	0.300	0.060	99.710
0.425	0.100	0.020	99.690
0.212	0.090	0.018	99.672
0.15	0.060	0.012	99.660
0.075	0.010	0.002	99.658
Pan	498.290	99.658	0

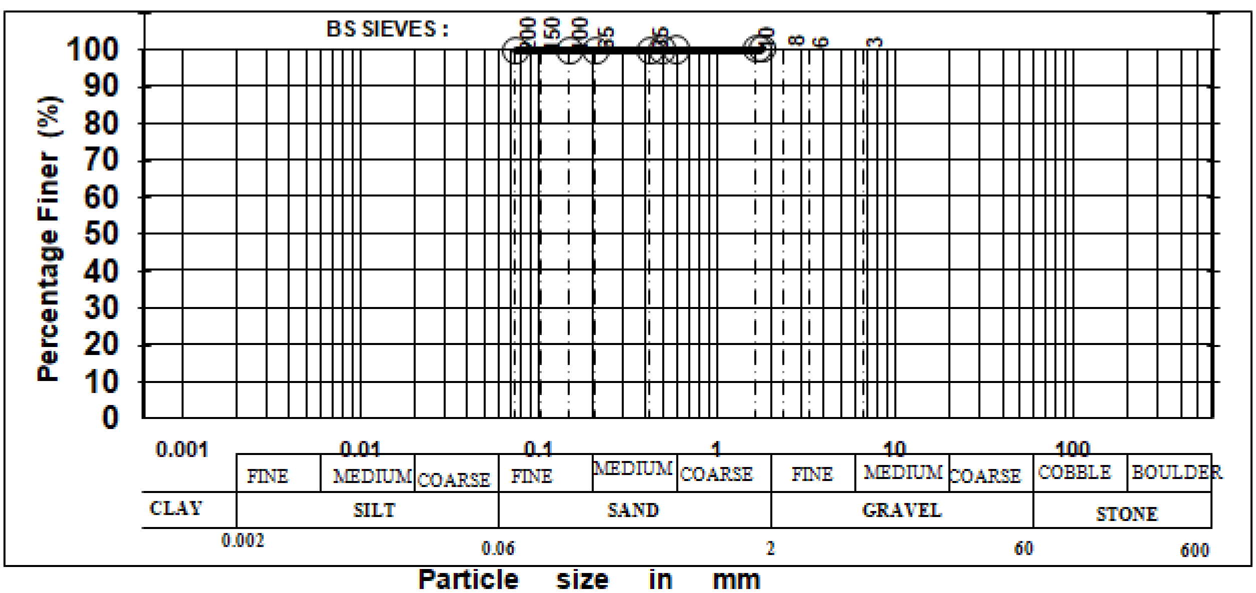

Figure 1: Particle Size Distribution Curve for Oroto Dredged Sample

Table 2: Particle Size Distribution of Igbokoda Dredged samples

Sieve no (mm)	Weight retained	% retained	% passing
1.8	0	0	100
1.7	0.8	0.16	99.840
0.6	0.603	0.121	99.719
0.5	0.5	0.1	99.619
0.425	0.482	0.096	99.523
0.212	0.1	0.02	99.503
0.150	0.025	0.005	99.498
0.075	0.015	0.003	99.495
Pan	497.475	99.495	0

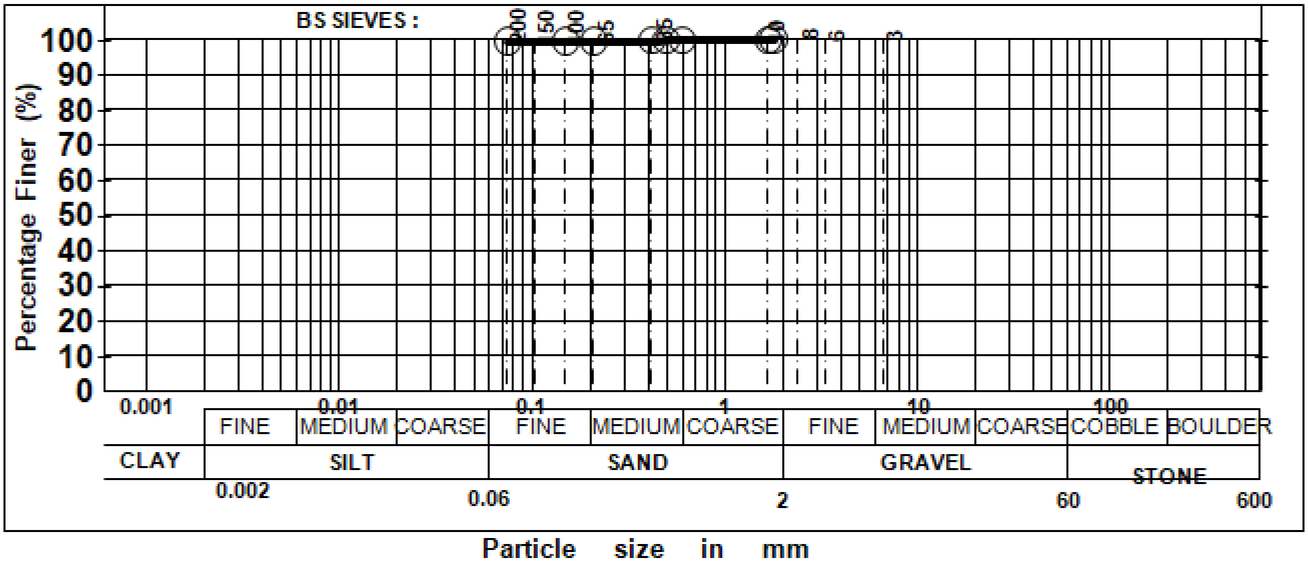

Figure 2: Particle Size Distribution Curve for Igbokoda Dredged Sample

3.2 Hydrometer test

Figures 3 and 4 show Hydrometer analysis for Oroto and Igbokoda dredged sample respectively. The dredged samples were classified as silt materials as presented in Figures 3 and 4. Using the hydrometer graph, the tested material can fall under different categories like, clay silt, sand, gravel and stone, and from the figure, it can be seen that most of the tested samples falls under the silt categories, which classified the dredged samples as silt.

Table 3: Hydrometer Analysis on OrotoDredged samples

Time	R^1	R	Temp.	K	L	D	% passing partial	% passing total
0.5	20	21	26	0.01218	12.9	0.0619	0.3395	33.834
1	18	19	26	0.01218	13.2	0.0443	0.3072	30.615
2	12	13	26	0.01218	14.2	0.0325	0.2102	20.948
5	10	11	26	0.01218	14.5	0.0207	0.1778	17.719
10	9	10	26	0.01218	14.7	0.0148	0.1617	16.115
15	5	6	26	0.01218	15.3	0.0123	0.097	9.667
30	4	5	27	0.01204	15.5	0.0087	0.0808	8.052
60	3.5	4.5	27	0.01204	15.5	0.0061	0.0728	7.255
120	2.5	3.5	27	0.01204	15.6	0.0043	0.0566	5.641
240	2	3	27	0.01204	15.8	0.0031	0.0485	4.833
1440	1	2	24	0.01246	16	0.0013	0.0323	3.219

*A-Correction factor in respect to specific gravity * R^1- Hydrometer reading *R-Hydrometer reading plus control *K – Temperature constant *L - Effective depth *D – Sieve size

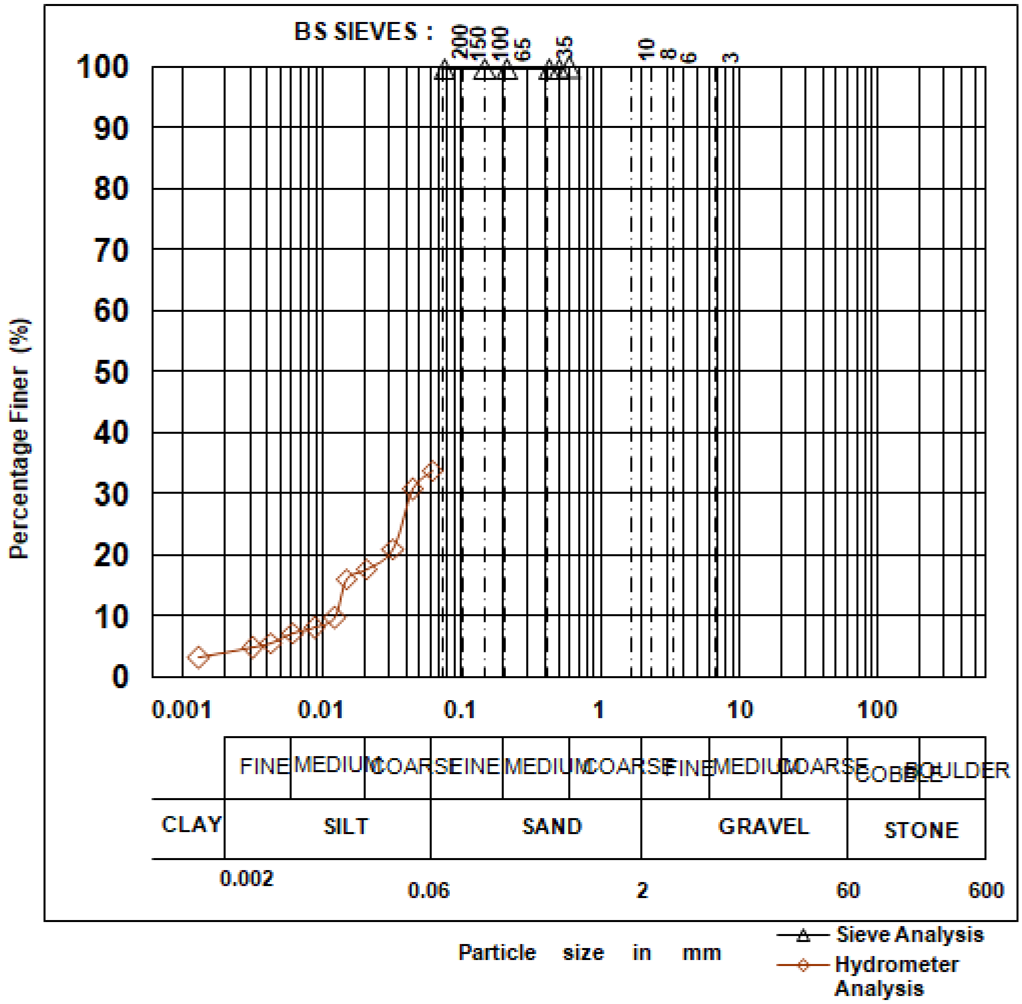

Figure 3: Hydrometer Analysis of Oroto Dredged Sample

Table 4: Hydrometer Analysis on Igbokoda Dredged samples

Time	R^1	R	Temp.	K	L	D	% passing partial	% passing total
0.5	20	21	26	0.01334	12.9	0.0678	0.3605	35.868
1	16	17	26	0.01334	13.5	0.0490	0.2918	29.033
2	15	16	26	0.01334	13.7	0.0349	0.2747	27.331
5	14	15	26	0.01334	13.8	0.0222	0.2575	24.589
10	12	13	26	0.01334	14.2	0.0159	0.2232	22.207
15	10	11	26	0.01334	14.5	0.0131	0.1888	18.785
30	9	10	27	0.01319	14.7	0.0092	0.1717	17.083
60	7	8	27	0.01319	15	0.0066	0.1373	13.661
120	5	6	27	0.01319	15.3	0.0047	0.103	10.248
240	4	5	27	0.01319	15.5	0.0034	0.0858	8.537
1440	3	4	24	0.01365	15.6	0.0014	0.0687	6.835

*A-Correction factor in respect to specific gravity * R^1- Hydrometer reading *R-Hydrometer reading plus control *K – Temperature constant *L - Effective depth *D – Sieve size

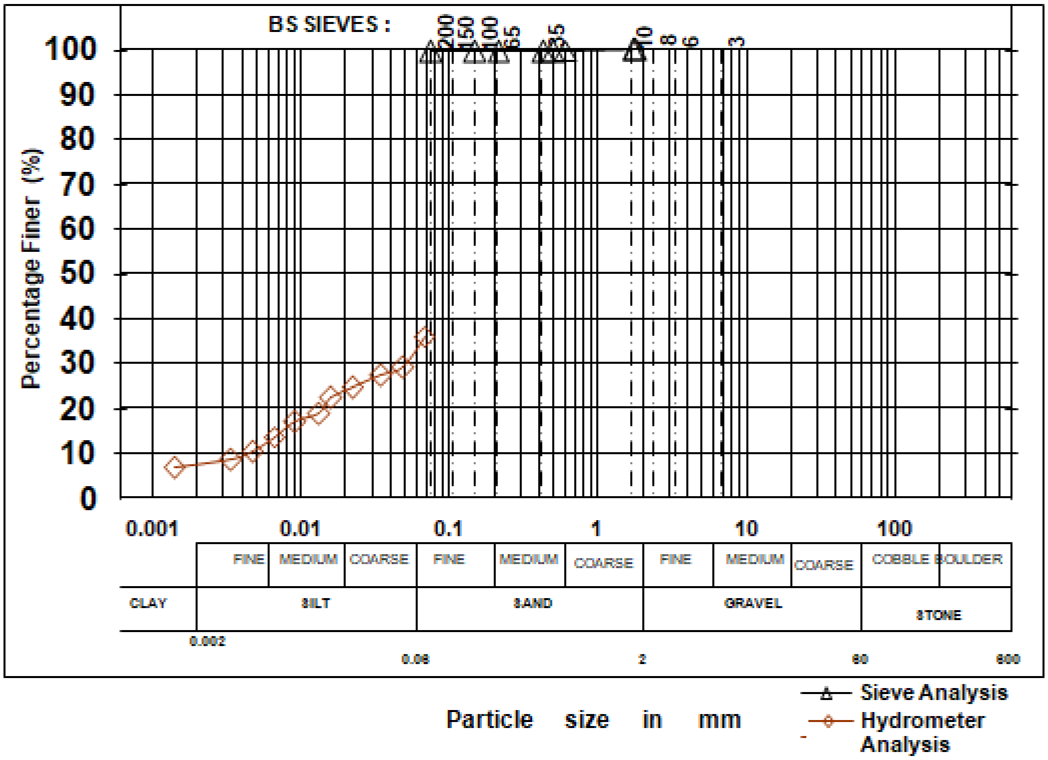

Figure 4: Hydrometer Analysis for Igbokoda Dredged Sample

3.3 Moisture content

Table 1 shows moisture of dredged sample obtained from Oroto and Igbokoda. The results showed that Oroto dredged sample has moisture content of 90.48 % and Igbokoda dredged sample has moisture content of 37.5 %. This shows that the dredged samples has lot of moisture in it.

Table 5: Moisture Content of Various Samples Used

Samples	Igbokoda dredged sample	Oroto dredged sample
Moisture content (%)	37.5	90.48

3.4 Silt/clay content of dredged samples

Table 2 presents the results of silt/clay content for dredged samples. The silt/clay result shows that both dredged samples contains lots of silt/clay.Oroto contains 82.5 % and Igbokoda contains 61.1 % of silt/clay.

Table 6: Silt/Clay Content Analysis

Sample Location	Oroto	Igbokoda
Height of Sample (mm)	183	180
Height of Silt (mm)	151	110
Silt/ Clay Content (%)	82.5	61.1

3.5 Water absorption analysis

The results of water absorption tests for bricks is shown in Figures 5 and 6. This shows that bricks made with pure dredged sample (with cement) has water absorption value of 17.1 %. Comparison was made on the ten (10) mixes, mix 3 has the highest water absorption value, which was 15 %, the mix with the lowest value was mix 9 and the water absorption value was 6.4 % for the 7th day test. For 28th day, mix 3 also had the highest value, which was 33.4 %, and the lowest value was 5.7 %, which was mix 7.

It was noted that the controls that were made did not also satisfy the requirement by the British Standard. The result for the 7th day water absorption test performed on bricks with 100 % clay was 7.6 %, the bricks made with 100 % Oroto dredged sample has 6.4 % and the one of 100 % Igbokoda dredged sample has 7.4 % water absorption and the ones for 28th day did not equally meet the specified standard.

It can be noted from the result in Figure 6, which shows the water absorption value for the 28th day, that mix 1 was missing (mix 1 - Oroto dredged sample (DS) 85 % and Igbokoda dredged sample (IS) 15 %), this is because the mix could not withstand the water absorption test, and was therefore dissolved inside the water. This can be related to the high value of the silt content in the Oroto dredged sample, and from the result of the moisture content, the moisture content of Orotodredged sample is 90.48%, which therefore indicate the high probability of its ability to decompose in water.

According to the BS 3921-1985, the water absorption value is 4.5 % for damp proof course 1 and 7.0 % for damp proof course 2, and the value gotten is above this, implying that the bricks do not satisfy the requirement for damp proof courses. The damp proof course 1 is the value recommended for building and damp proof course 2 is the value recommended for external works.

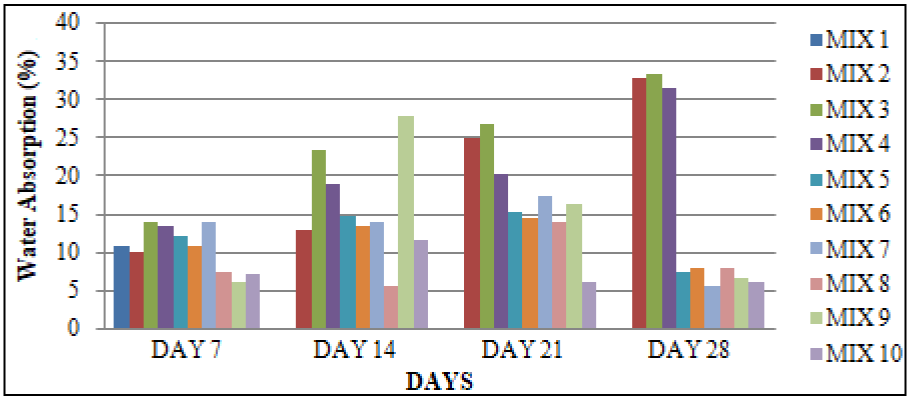

Figure 5: Water Absorption Chart for Bricks (Days 7-28)

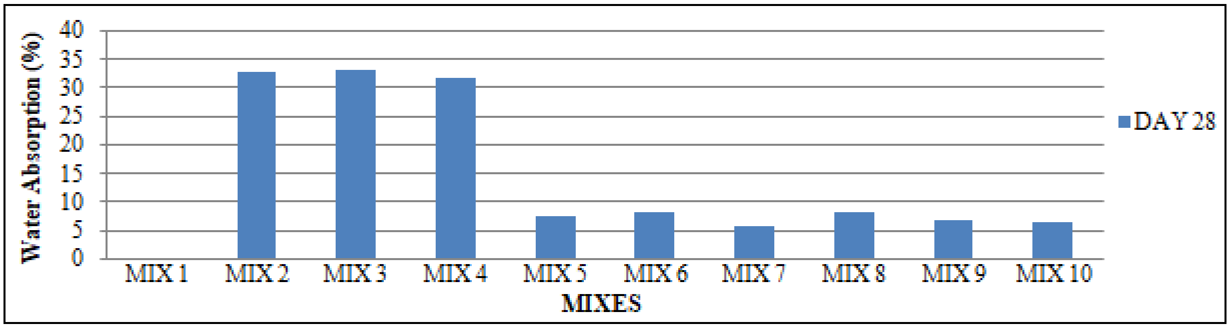

Figure 6: Water Absorption Chart for Bricks (Day 28)

3.6 Compressive strength test analysis

Figures 7 and 8 show the results of the compressive strength analysis of the bricks. These results show that the compressive strength increases with increase in age, and the strength also increased with mix. Loss of compressive strength may be due to many factors one of which is water absorption and it wasseen from the result that the rate of water absorption of the Oroto dredged sample in the mix is higher than the igbokoda dredged sample. In addition, the brick with the lowest strength is the brick of mix 1, which has more of theOroto dredgedsample in it and the highest compressive strength was found in the clay mix. Bricks with different mixes of 28 days have compressive strength of 2.28-7.35 MPa which is within the specified value for British standard because the British standard BS 3921:1985 recommended 7.0 MPa for bricks of which mix 7 had 7.35 MPa on the 28th day, which shows that the sample is good enough for the production of bricks.

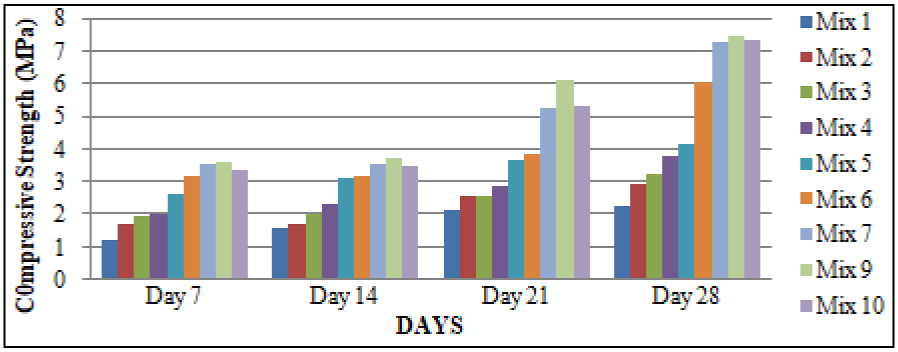

Figure 7: Compressive Strength Chart for Bricks (Day 7-28)

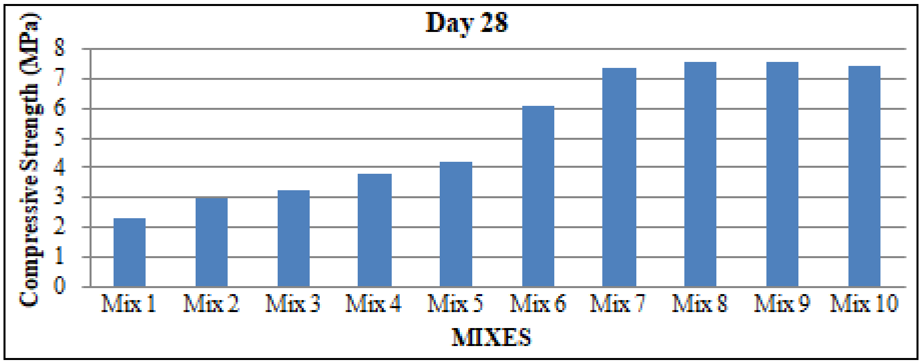

Figure 8: Compressive Strength Chart for Bricks (Day 28)

4. Conclusions

The Oroto dredged sample has higher moisture of 90.48 % while Igbokoda has 37.5 %. In order for these dredged material to be useful for the production of bricks, another material with lower water absorption value has to be mix with it. The Oroto dredged sample contains 82.5 % of silt/clay in comparison to sand; therefore, it will be more useful in the production of bricks than in production of blocks or concretes. Water absorption rate of Oroto dredged sample (6.8 %) is higher than Igbokoda dredged sample, which is 6.4 %. On the 7th day, as percentage of Igbokoda dredged sample increases by 70 % in the production of bricks, the compressive strength increases by 2.31 MPa, and on the 28th day, as percentage of Igbokoda dredged sample increases by 70 %, the compressive strength increases by 5.07 MPa. Hence, Igbokoda dredged sample enhances the compressive strength of the bricks produced on the 28th day.

Igbokoda dredged sample can be managed for the production of bricks, but Oroto dredged sample is not good for brick production. Moreover, considering the high rate of water absorption of these materials, the best option is to fire the bricks, which will result in increase in the cost of production, but will be of good qualities.

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