Asian Journal of Engineering and Technology (ISSN: 2321 – 2462)
Volume 03 – Issue 02, April 2015

Effect of Maximum Particles Size on Compressive Strength of Cement Stabilised Compressed Earth Blocks

Olusegun Akintomide Esan*, Nasiru Isaac Demide, Aderibigbe Wasiu Yinka

Building Technology Department, The Federal Polytechnic,
Idah, Nigeria

**Corresponding author's email: oaesan [AT] yahoo.com*

ABSTRACT--- ***This paper reports an experimental investigation into the effects of particles size on the compressive strengths of Cement stabilised Compressed Earth Blocks of mix ratio 8% and 10% , (of cement), using varying soil particle sizes of 2mm, 1.25mm, 0.63mm, and 0.40mm. The compressed bricks were crushed for strength at 7 days, 14 days, and 28 days. The results showed that the compressive strength at 7 days were 1.53 Nmm^{-2} for 2mm; 1.7 Nmm^{-2} for 1.25mm; 1.8Nmm^{-2} for 0.63mm; and 1.94 Nmm^{-2} for 0.40mm. For 14 days, with 2mm, 1.25mm, 0.63mm, and 0.40mm maximum particle sizes the strength were 1.7 Nmm^{-2}, 1.82 Nmm^{-2}, 2.17 Nmm^{-2}, 2.24, Nmm^{-2}. While at 28 days were the strength were 2.34 Nmm^{-2}, 2.83 Nmm^{-2}, 3.49 Nmm^{-2}, and 4.19 Nmm^{-2} for 2mm, 1.25mm, 0.63mm, and 0.40mm respectively. In summary, the result shows increase in strength with decrease in particle size of soil and increase in days of curing.***

Keywortds---- Laterite, Stabilizers, Compressive Strength, Compressed Earth Block, Cement.

---

1. INTRODUCTION

Laterite is a type of soil that is found throughout the tropics. Its colour varies from white grey to dark red depending on the iron content. It consists mainly of fine and coarse sand mixed with clay. It can be used for the purpose of construction of houses and roads. When used for the former, it can either be used in form of blocks as masonry units, as renders on walls and for flooring. Stabilized Laterite bricks are often cheap and very resistant to rain. Laterite is a highly weathered soil which contains large proportion of iron and aluminium oxides as quartz and other minerals. The maximum particle sizes varies from one location to the other, this was investigated to see the effect it may have on the compressive strength of the blocks produced from the laterite.

1.1. Laterite

Laterite is a highly weathered tropical soil containing a varying proportion of iron and aluminium oxides, which are present in soil as clay materials. Its chemical composition and morphological characteristics are influenced to a large extent by the degree of weathering to which parent materials are subjected. The particle distribution recommended for a good Laterite is 45 – 47% sand, 10 – 30% for silt and 15 –30% clay [1] . It is one of the oldest materials used for building construction in rural areas in Nigeria and its advantages as a building material include:

1. It's resistant to fire.
2. It is cheaper than most alternatives wall materials and readily available at most building sites or near to the site.
3. It has very high thermal resistance capacity that enables it to keep the inside of a building cool when the outside is hot and vice versa.
4. It's a good absorbent of noise.
5. It is easy to work using simple tools and skills.

Despite its good qualities, the material has the following weakness as a building material.

- Low water penetration resistance, therefore, readily crumble and fail structurally.
- Low resistance to abrasion and requires frequent maintenance when used in building construction.

However, there are several ways to overcome these weaknesses and make earth suitable a building material for many purposes. [2]. One of such is soil stabilization.

1.2. Soil Stabilization

Soil stabilization is a process directed towards the improvement of stability or load bearing capacity of the soil by the use of controlled compaction, proportioning and/or the addition of suitable admixture or stabilizers. Stabilization is the modification of the appropriate soil-water-air system in order to obtain lasting qualities [3]. This technique is used to produce a strong and more stable composite material. Many types of soil can be improved with the addition of stabilizers [4]. According to [5]Stabilization relies on the direct effect of the interaction of particles, water and air in a soil, and it allows one to achieve permanent properties in order to make a soil suitable for application as building material. With stabilization it is possible to change two of the main characteristics of a soil, its texture and its structure. The changing of these properties is principally intended to:

- Reduce porosity and the tendency of a soil to swell or shrink.
- Achieve better cohesion.
- Improving resistance toerosion and water resistance of a surface.
- Achieve high dry and wet compressive strength, tensile strength and shearing strength.

1.3. Method of Stabilization

The numerous methods by which soil can be stabilized are categoriesed into Chemical and Mechanical Stabilization [6]. The methods of stabilisation commonly used are Cement stabilization, Mechanical Stabilization, Lime Stabilization, asphalt Stabilization, Lime Fly ash Stabilization, Lime Fly ash Bound Macadam [7]. Factors Affecting Mechanical Stabilization are Mechanical Strength of aggregates, Gradation, Properties of the soil, Presence of, Salts, Compaction. A great number of substances may be used for soil stabilization. It is up to the builder to make trail blocks with various kinds and amount of stabilizer [8]. Stabilizers commonly used include Bitumen, Bound Macadam, Sodium silicate (water – glass), Cow dung, Gypsum, Pozzolanas (eg, fly ash, rice husk ash, volcanic cash), Molasses, Resins, Natural fibres (example; grass, straw, sisal, saw dust), clay, Lime, and Portland cement [9]&[10]. In this study Ordinary Portland Cement (OPC) was used for stabilization.

1.4. Stabilization with Cement

Cement is a building material known as matrix in a mortar mix. Generally, the property of cement is covered by BS12 [11]. Naturally, the colour of cement is Gray but other colours are got from the addition of pigments such as carbon black, chromium, ultra – marine blue, cobalt blue and cobalt blue colour of product got are black or dark green blue, blue respectively. Cement is suitable for the stabilization of all types of soils especially for coarse-grind soils. Portland cement is commonly used as soil stabilizer and factors that made it so include:

i. Cement is readily available in most countries.

ii. Use of cement involves less care and control than any other methods of stabilization.

iii. More information is available on cement treated Laterite than other Laterite stabilization.

iv. Almost any soil can be stabilized with Portland Cement if enough quantity is used in combination with the right amount of water, proper compaction and curing.

The exact quality of cement required to produce satisfactory soil cement mixed under a certain set of condition is found out by performing actual laboratory test such as wetting and dry compressive strength test, and freezing and thawing test. Portland cement greatly improves the compressive strength and may also reduce moisture movement especially when used with sandy soils. As a rough guide, sandy soil need 5-10% cement for stabilization, and Compaction when pressing block will greatly influence the result [12]. [13] states that the best results of stabilization are achieved when it is combined with compaction; therefore the two are often treated together. Though stabilization can however be used on un-compacted soil as well.

1.5. Compressed Earth Bricks (C.E.B)

Compacting the soil produces block which is, by virtue of the increased density is stronger and more water resistance. Stabilized Compressed earth bricks, are often used to promote a new contemporary image for building with earth though are more labour intensive to produce compared with mud bricks [14].

Block Dimension: The length, width and depth of blocks varies from one press to the other, however, the approximate dimension of 290mm x 140mm is common. Quite a number of machines can be ordered with different moulds which can be very useful [15].

Uses of Compressed Earth Bricks: Compressed earth bricks are best and the most versatile ways of using earth for construction. They have over the centuries, been used to build almost every type of domestic and public building, such as palaces, tombs and temples, some of which are several years old; a testament to laterite's excellent performance in varied climates [16].

2. OBJECTIVES

To investigate the effect of maximum particle size on the compressive strength of cement stabilized laterite brick.

3. METHODOLOGY

Preparation of Material:Laterite soil from a borrow pit located at Kafin-Tafawa village, Bauchi, Nigeria was gentle broken down into simple particles and made to pass through 2.00mm sieve, to get the sample, this was repeated for 1.25mm, 0.63mm, and 0.40mm sieve sizes.

Mixing Proportion (Method): Each of the and laterite of 2.00mm, 1.25mm, 0.63mm, and 0.40mm maximum sizes got above was batched by weight and mixed in the ratio 8% of Ordinary Portland Cement (OPC) produced by Ashaka Cement Company was used. cement to laterite, and mixed dry before adding water gradually by sprinkling while the thoroughly mixed in order to achieve the consistent mixture.thereafter, the mix was used to press blocks. This was repeated with using mix ratio 10% of cement to laterite.

Compaction and Curing: Hand operated SOBA-RAM press with mould size of 29.7mm x 10.42mm x 10.6mm was used. The inside of the compaction chamber was cleaned and oiled. Soil mix was filled into the compaction chamber and the soil compacted. The brick was ejected and cured using surface covering with an impermeable polythene sheet.

4. RESULT

At the day of testing, the weight and area of each block were taken, thereafter,the load was applied

to determine the crushing load. These were used to calculate the strengths of the blocks. Three blocks of the same cement/laterite mix and the same maximum laterite particle size were tested for strength at 7days, 14days and 28days and the average determined as the strength.

The compressive strength was determined using: Compressive strength **(N/m^2)** = $\frac{\text{Crushing Force}}{\text{Area of brick}}$

Where: Area of brick = 290 x 140 = 40600mm^2

Table 1: Summary of the Compressive Strength of CEB stabilized with cement of 10% & 8% mix ratio at 7, 14 & 28 days of curing.

% of Cement	Compressive Strength (N/m2)											
	7 days				14 days				28 days			
	0.40mm	0.63mm	1.25mm	2mm	0.40mm	0.63mm	1.25mm	2mm	0.40mm	0.63mm	1.25mm	2mm
10%	1.89	1.69	1.60	1.48	2.22	2.09	1.77	1.80	4.06	3.37	2.68	2.26
8%	1.79	1.53	1.50	1.40	2.14	1.95	1.69	1.65	3.77	2.63	2.48	2.19

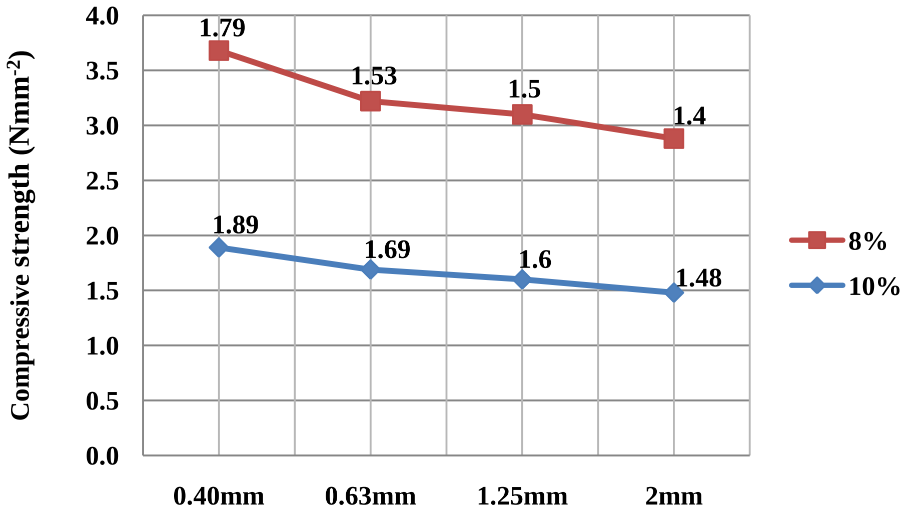

Figure 1 Maximum Particle Size Vs Compressive Strength at 7 days

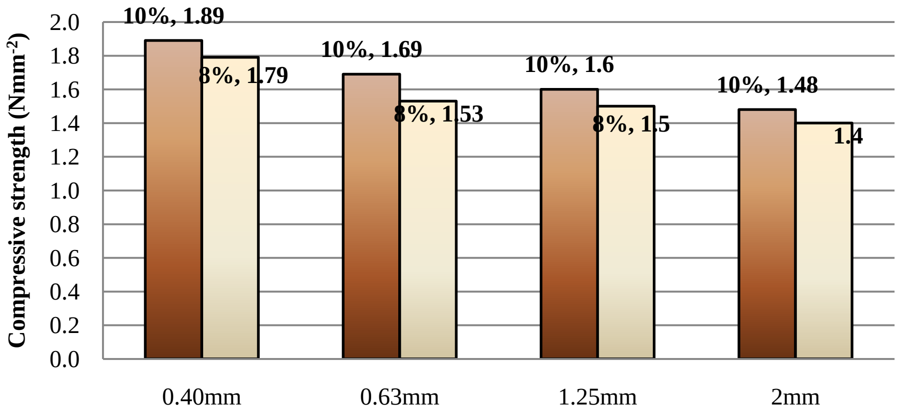

Figure 2 Maximum Particle Size Vs Compressive Strength on 7th day

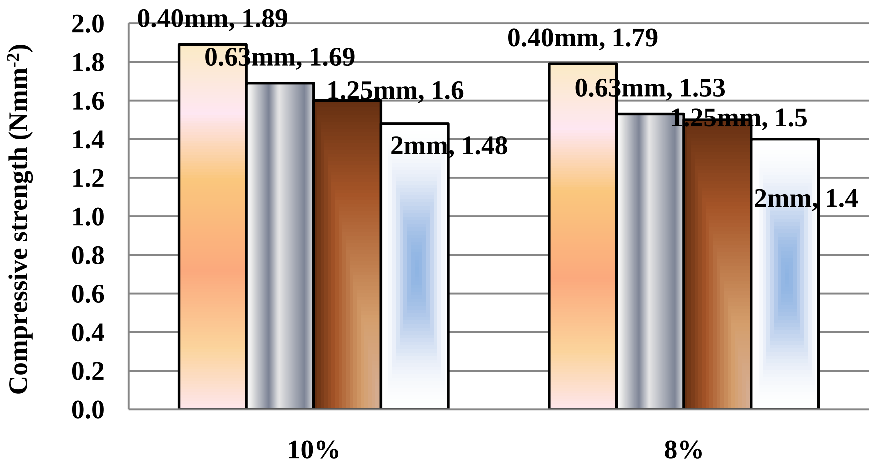

Figure 3   Cement Percentage Content Vs Compressive Strength on 7th day

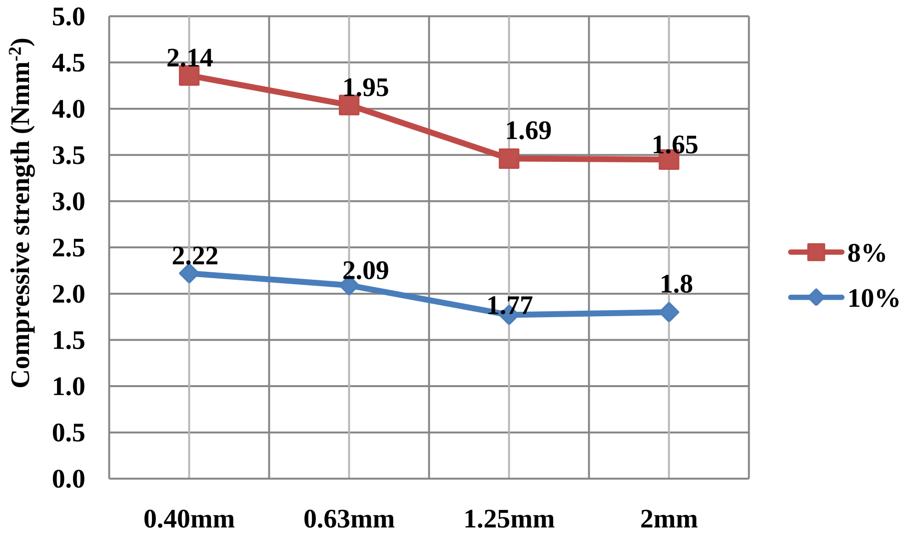

Figure 4 Maximum Particle Size Vs Compressive Strength on 14th day

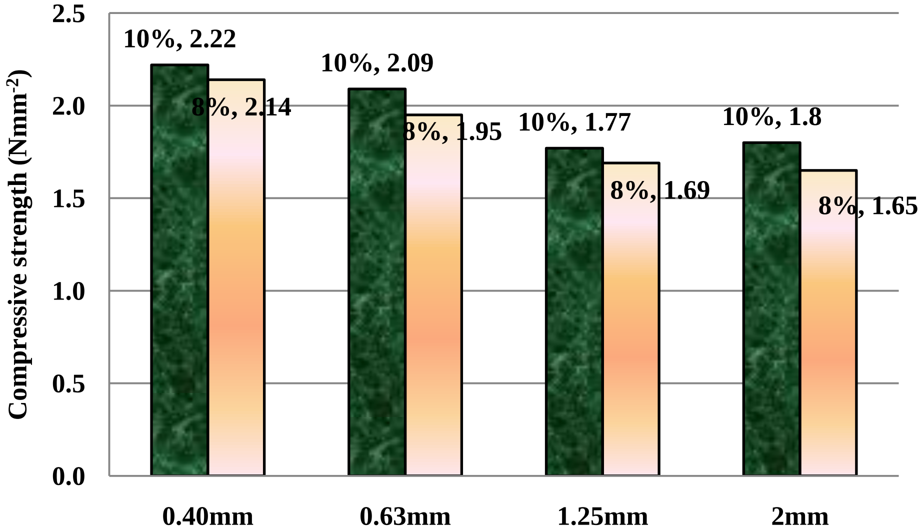

Figure 5 Maximum Particle Size Vs Compressive Strength on 14th day

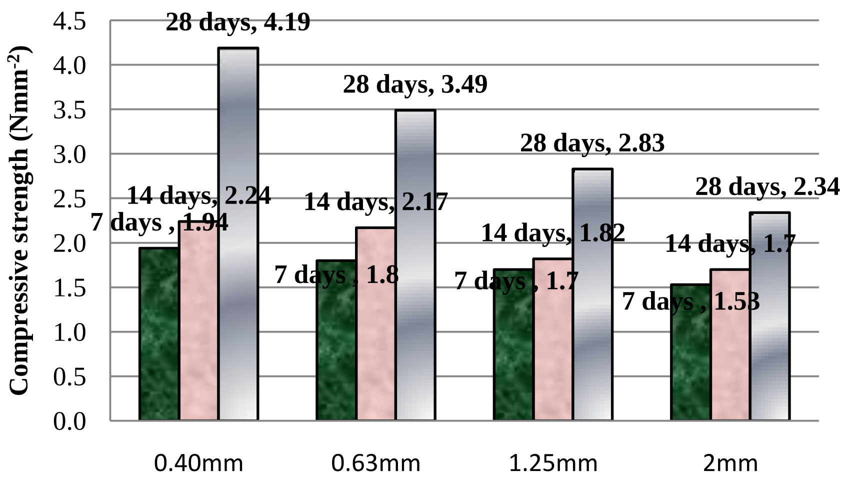

Figure 6 Cement Percentage Content Vs Compressive Strength on 14th day

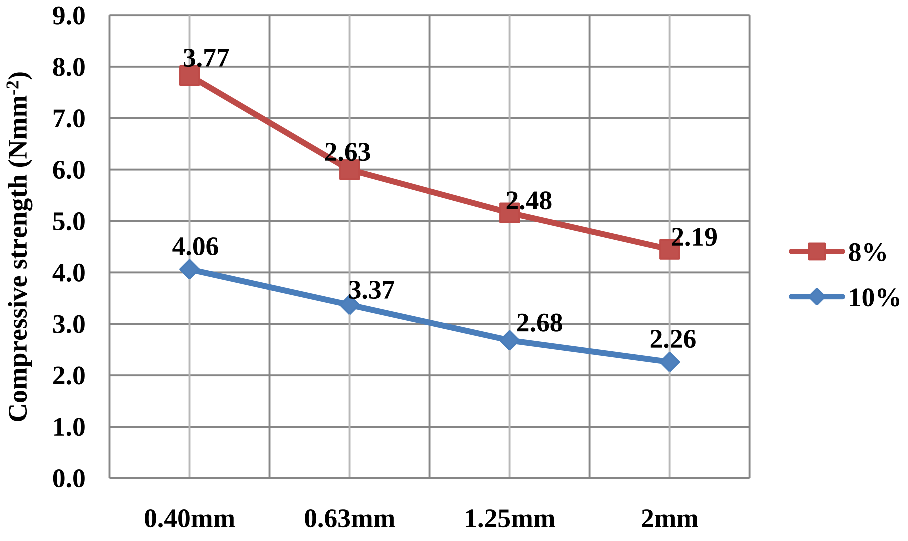

Figure 7 Maximum Particle Size Vs Compressive Strength on 28th day

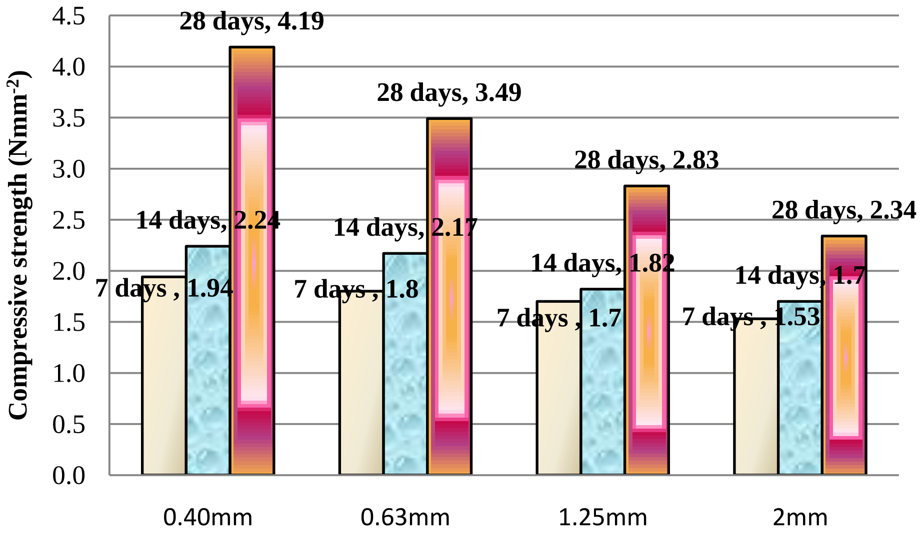

Figure 8 Maximum Particle Size Vs Compressive Strength on 28th day

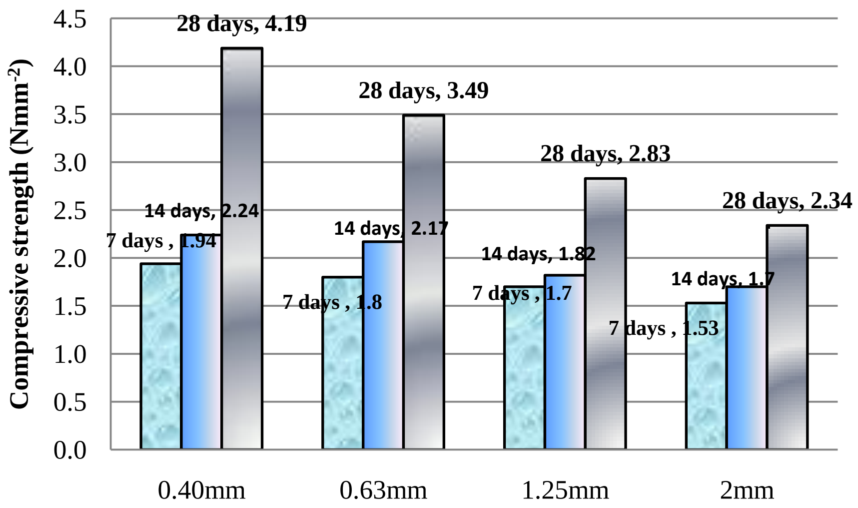

Figure 9 Cement Percentage Content Vs Compressive Strength on 28th day

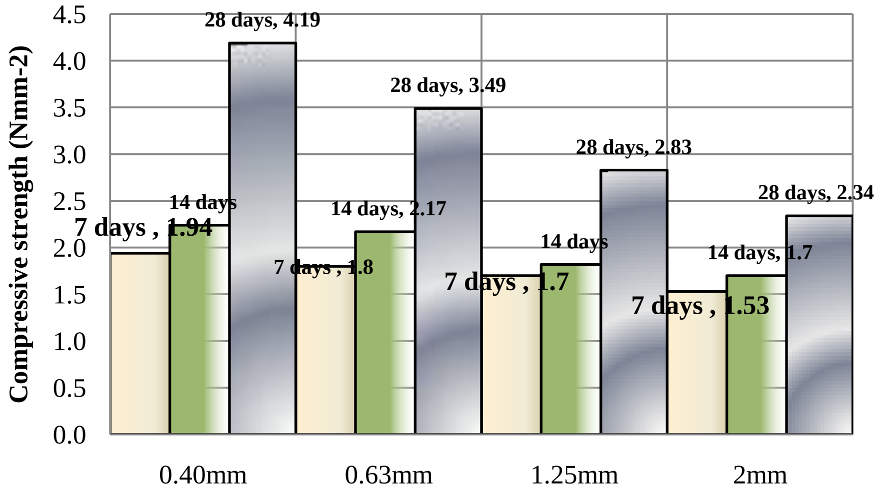

Figure 10 Cement Percentage Content Vs Compressive Strength on 28th day

Generally, from the table and chats above, the compressive strength of the blocks increased with decrease in the size of the maximum particle size, but the compressive strength increased with increase in cement content

Table 2: Summary of the Compressive Strength of CEB stabilized with 10% & 8% cement at 7, 14 & 28 days of curing.

	Compressive Strength (N/mm^2)								
	8% Cement					10% Cement			
	0.40mm	0.63mm	1.25mm	2mm		0.40mm	0.63mm	1.25mm	2mm
7 days	1.79	1.53	1.50	1.40		1.94	1.80	1.70	1.53
14 days	2.14	1.95	1.69	1.65		2.24	2.17	1.82	1.70
28 days	3.77	2.63	2.48	2.19		4.19	3.49	2.83	2.34

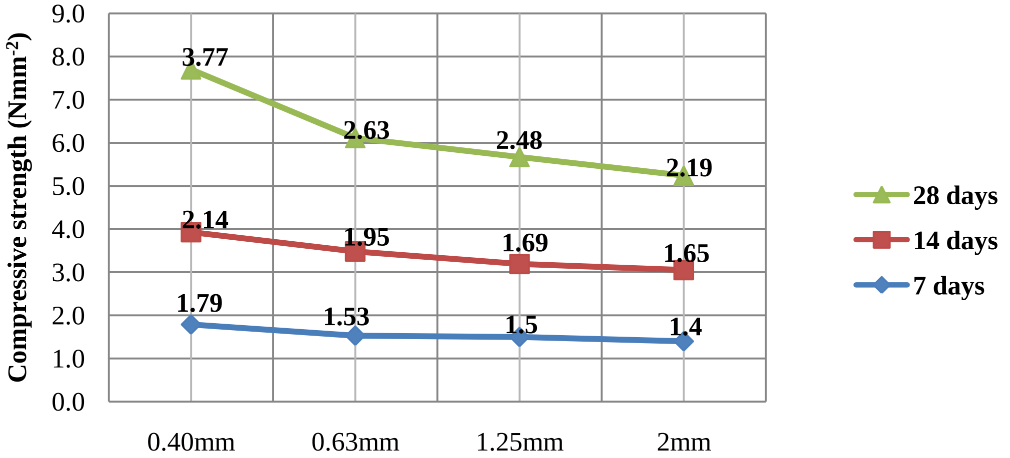

Figure 11 Maximum Particle Size Vs Compressive Strength on at 8% Cement Content

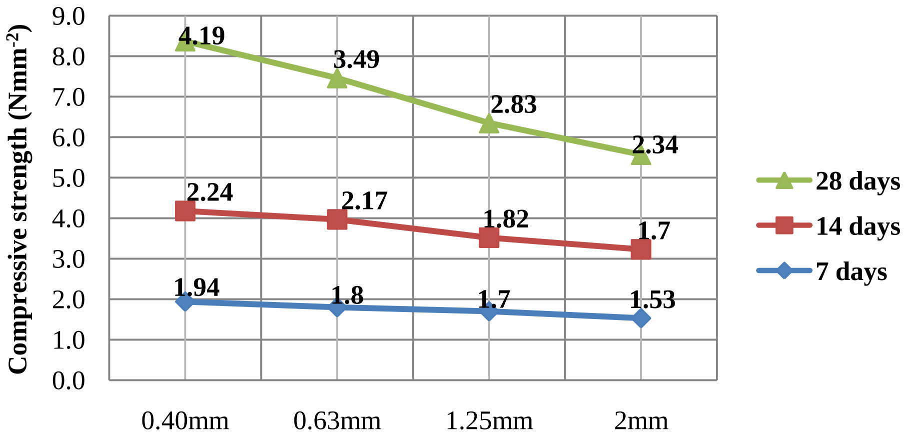

Figure 122 Maximum Particle Size Vs Compressive Strength on at 10% Cement Content

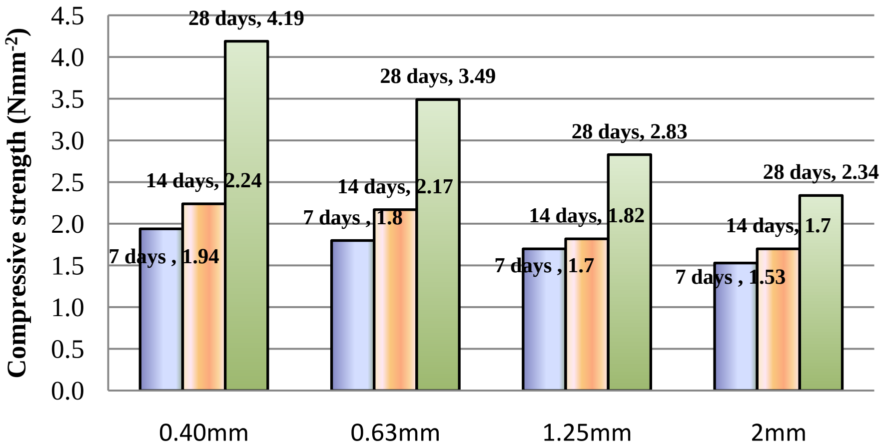

Figure 13 Maximum Particle Size Vs Compressive Strength on at 10% Cement Content

Generally, from the table and charts above, the compressive strength of the block increased with decrease in the maximum maximum particle size, but it increased with increase in days of curing befor test.

5. CONCLUSION AND RECOMMENDATION

The particle size distribution which includes 2.0 mm, 1.25mm, 0.63mm, 0.40mm diameter affects the compressive strength of the brick. The compressive strength values obtained for cement stabilized Laterite blocks are found to be above 1.5Nmm^{-2}. The size of the bigest laterite has effect on the strength of the blocks produced from it using cement as stabilizer. The bigger the maximum laterite particle size, the lower the compressive strength of the blocks produced from it. The block with 0.40mm maximium particle size has a highest compressive strength, while that of 2.00 has the lowest. Therefore, the maximum particle of laterite be kept as low as possible for the production of Compresssed Earth Block is obtained with higher strength as the maximum particle size decreases,. However the maximum particle must not be more than 10mm, as it is a requirement that the particles of laterite for the maximum particle of laterite be kept as low as possible for the production of Compresssed Earth Block production must not be more than 10mm.

It is hereby recommend that the maximum particle of laterite be kept as low as possible for the production of Compresssed Earth Block in order to achieve the maximum compressive strength possible at the particlar instance. Replication of this study but this time with laterite of different particle distribution to see the effect of the soil grading.

6. REFERENCES

[1] Norton, J. (1986). Building with Earth Intermediate Technology, Intermediate Technology.

[2] (Berry & David, 1987)

[3] UNCHS (1992). Report of the executive Director on Building Materials for Housing. http://www.unescap.org/huset/hangzhou/hangzhou_report.htm. 27/11/2007

[4] Peck, P.B. and Tarzaghic, K. (1967). Soil Mechanics in Engineering Practice.

[5] Lassi, F. & Osunade, J.A. (1983). Laterite Soil and Masonry Units Performance Characteristics on Housing. Unpublished Project Seminar on the Use of Clay Bricks and Blocks, ABU, Zaria.

[6] Flaherty C.O. (1974). Soil Stabilization. Highway Engineering Vol. 2. Edward Anold Ltd.

[7] Bot, P.J. (2008). A Study Of Agricultural Wastes Ash As A Stabilizer In Compressed Laterite Bricks. Unpublished Masters of Science Thesis University of Jos

[8] Craig, R. F. (1992). Soil Mechanics. Chapman and Hall. London

[9] Esan, O. A & Esan, B. O. (2010, November). *Effect of Asphalt on Cement Stabilised Compressed Earth Blocks:* Paper Presented at The International Conference on Research and Development.

[10] Amarnath, M.S. (2010). Use of Locally Available Materials and stabilisation Technique. http://elearning.vtu.ac.in/Programme/volvo/SoilStab-Useof New.pptDRMSAEdusat.pptrev.ppt) accessed on 20th September, 2010)

[11] British Standards Institution (1990) BS 1924: Methods of testing for stabilized soils, London, England

[12] www.fao.org/decrep/s 1206/51250-06.htm.

[13] NBTE, (2008). Introduction to Soil Mechanics. ND Building Technology NBTE-TVE Learning Materials

[14] Ola S.A. (1974). *The Case for Soil Stabilization in Nigeria*: Nigerian Journal for Engineering Vol. 1, No. 1 ABU Press, Zaria.

[15] Sho S. P. (2004). Performance Characteristics of Laterite Stabilized with Cement and lime for Low cost Building and Road Pavement. HND II Civil Engr. FPTB.

[16] Ola, S.A. (1985). Strength and Structural Properties of Some Stabilized and Unstabilized Compressed Earth (Kwara) Soil. Proceeding of the Seminar, Clay Bricks and Blocks N.B.R.RI