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Study of Stabilised Soil Bricks and Its Compressive Strength

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Abstract – This paper presents the study of stabilized soil bricks and the influence of stabilizer on compressive strength of soil bricks. For the study, locally available brown colour soil is used for production of bricks of size 230x110x75mm. This paper discusses the results of test performed on soil like atterberg limit test, grain size analysis, specific gravity test, compaction test etc. This brownish soil contains less than 10% of clay, therefore 5% clay is mixed before using stabilizer. In this study, OPC/PPC cement is used as a stabilizer. 5%, 8% and 10% by weight of soil of OPC/PPC are used as stabilizer. The bricks of stabilized soil is manufactured by hydraulic press at constant pressure. This soil has (79%) sand fraction and (20.9%) slit & clay. The dry compressive strength of bricks were determined for 7days & 28 days.

Keywords- Bricks, Compressive Strength, Stabilizer, Compaction

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INTRODUCTION

Historically, earth has been the most widely known and used building material in construction and probably has been the most important of all building materials (Legget, 1960). Stabilized soil bricks are cost effective and energy efficient alternative materials to the normal burnt clay bricks used for construction of buildings. Actually, most developing countries are facing a real housing deficiency (Harison & Sinha, 1995). Therefore, there is an urgent need to construct and build houses that are more durable at a low cost. A striking contrast between stabilized soil brick and conventional brick is the energy consumed during the production process and carbon emission. Stabilized soil brick creates 22kg co2/tone compare to that of concrete blocks (143kg co2/ton), common fired clay bricks (200kg co2/ton) during production. In average, cement stabilized soil bricks consumed less than 10% of the input energy as used to manufacture similar fired clay and concrete masonry unit. The technique to enhance natural durability and strength of soil defined as soil stabilization. The demand for sustainable building material at low cost is growing as social, economic and environmental issues evolve in today's society. Recent reports indicated that, about half of the words population are still living in earth buildings (mc henry, 1984; EBAA, Australia). From the literature the best soil composition for soil-cement is 75% sand, 25% silt & clay, of which more than 10% is clay.

COMPRESSIVE STRENGTH

Compressive strength is the capacity of a material to withstand axially directed pushing forces. When the limit of compressive strength is reached, materials are crushed.

Compressive strength = max load at failure (N)/avg. area of bed face(mm2)

In general, compressive strength testing procedures for earth bricks follow those developed for fired clay and concrete masonry units.(ASTM,1984; British standards institution 1985; standards Australia 1997). Individual specimens are tested in uniaxial compressive stress in a concrete cube testing machine or similar device. Apply load axially at a uniform rate 14 N/mm2 per minute till failure occurs and note maximum load at failure.

METHODOLOGY

(A) *Material used*

CLAY- Generally, the presence of clay in moderate amount in a soil is desirable. Since clay has cohesive nature, it imparts plasticity to the soil when under moist condition. Thus the clay minerals act as natural binding agents for the cohesion less granular fraction of a soil (gravel, sand and silt). The soils which have

clay content below 30% can be stabilized using cement.

CEMENT- cement can simply be described as being a mixture of lime and clay which is heated to about 1500c, and the resulting clinker has gypsum added and the sum is then ground to very fine powder. Optimum cement content for the stabilization is in the range of 5% to 10% where addition above 10% will affect the strength of the bricks in negative way. Opc is obtained by adding raw materials like calcareous materials and argillaceous materials. Ppc is obtained by adding pozzolonic materials like flyash, pumicites, volcanic ashes, shales, tuffs etc. in ppc waste utilization making it more environmental friendly.

SOIL- soil is a product of nature. It possesses an inherently variable and complex charater. Not every soil is suitable for earth construction. Top soil and organic soil must not be used. Suitability of the soil depends on its constituents: sand, silt and clay proportions.

(B)*TEST PERFORMED*

ATTERBERG LIMIT TEST- The atterberg limits are abasic measure of the nature of a fine grained soil. The atterberg limits can be used to distinguish between silt and clay. **Liquid limit** is the water content at which the soil has such a small shear strength that it flows to close a groove of standard width. **PLASTIC LIMIT** is the water content at which the soil begins to crumble when rolled into threads of specified size. **SHRINKAGE LIMIT** is the max water content at which a reduction in water content will not cause decrease in the volume of the soil mass. The **PLASTICITY INDEX** may be calculated as the difference of liquid limit and plastic limit.

GRAIN SIZE ANALYSIS- a quantitative determination of the particle size distribution in a soil is made by sieve analysis and sedimentation analysis.

HYDROMETER ANALYSIS-this method is used for the grain size analysis of the soil passing through 75 micron I.S. sieve out of the fraction passing 4.75mm I. S. sieve, to determine the percentage of various sized(silt and clay) particles.

SPECIFIC GRAVITY- specific gravity of soil is the ratio of the weight of a given volume of soil particles in air to the weight of an equal volume of distilled water at a temperature of 4*c.

COMPACTION TEST- the purpose of laboratory compaction test is to determine the proper amount of water at which the weight of soil grains in a unit volume of the compacted soil mass is maximum. The amount of water, thus calculated is called the "**optimum moisture content**"(OMC) and the corresponding density is called "**maximum dry density**"(MDD).

Results of test performed on soil sample are given in table1 and the grain size distribution of soil is shown in figure-1.

Table-1

a	Liquid limit	19%
b	Plastic limit	17%
c	Plasticity index	2
d	Shrinkage limit	11%
e	Specific gravity	2.63
f	Optimum moisture content	10%
g	Max dry density	2.05

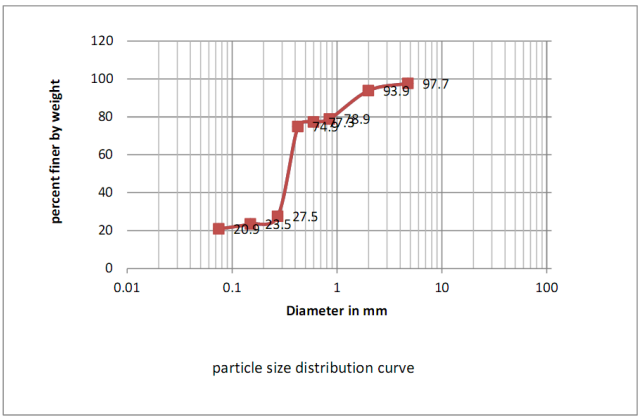

Figure-2

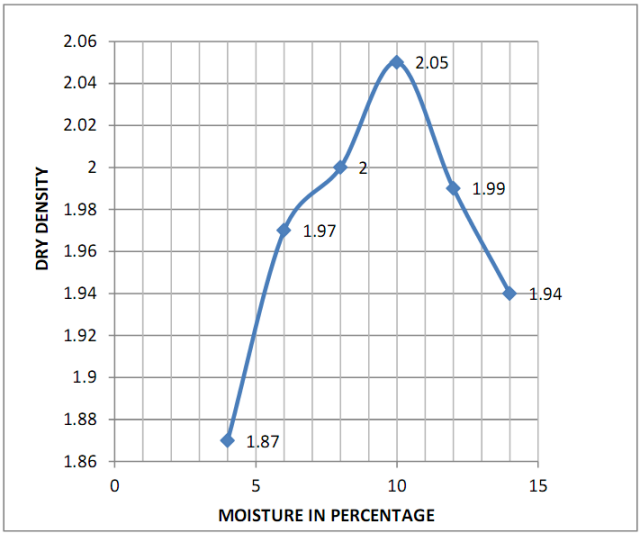

Figure-3

Table-2

Sieve size mm	Weight of soil retained gm	%weight of retained soil	Cumulative % retained	% finer (100-cumulative)
4.75	11	2.3	2.3	97.7
2.00	19	3.8	6.1	93.9
.850	75	15	21.1	78.9
.600	8	1.6	22.7	77.3
.425	12	2.4	25.1	74.9
.272	237	47.4	72.5	27.5
.150	20	4	76.5	23.5
0.075	13	2.6	79.1	20.9

Wet sieve analysis

(C)*PROCEDURE FOR MAKING BRICKS*

The process of manufacture of stabilized soil bricks involves the following five steps:

(1) ANALYSIS OF THE SOIL- soil composition and analysis through comprehensive test in a laboratory is very important. This will be required to estimate amount of cement and other missing native constituents that must be added to the final mix. All soils are made up of three components: sand, silt, clay.

(2) SIFTING OF SOIL- soil should be dried and sieved 9to remove large lumps,stones,leaves,and other impurities) before it can be used properly mixed with cement and compressed into bricks. The soil has the proper moisture content for sifting when 1. A handful can be squeezed without water appearing on its surface 2. The ball of soil disintegrates without lumps as it is released.

(3) PREPARATION OF THE MIX- once soil has been dried and sifted, we can begin to prepare the mix from which bricks will be pressed. The amount of cement to be used will depend on the composition of the soil. More tha 10% by volume is not recommended. Mix thoroughly all the ingredients cement, soil and special additions such as sand or clay that may be needed. After dry mixing of all the ingredients water is added a little at a time until the damp soil-cement reaches the right consistency. A concrete mixer machine is suitable for preparing the mix.

(4) COMPACTION OF THE BRICKS- hydraulic operated machine is proposed for compacting soil-cement into bricks of desired size. The prepared mix can placed into the mould of the machine and pressure is applied and after compaction, the brick formed is ejected from the mould and stacked.

(5) CURING OF THE BRICKS- place the bricks as soon as possible on a flat, non-absorbent surface in a shady environment to cure. Set each brick on edges and space the brick for enough apart so that they do not touch each other. After 24 hours of moulding bricks must be thoroughly sprinkled three times a day with the fine water spray. During the first four days of curing ,bricks be covered with plastic.

(D) ***MIX PROPORTION***

To find the strength of the stabilized soil bricks the soil samples have been mixed in various proportions. Table-3 shows the mix proportion with varying percentage of soil, clay and cement.

TABLE – 3

BRICK NO.	SOIL	OPC	PPC	CLAY
B1	90%	5%	-	5%
B2	87%	8%	-	5%
B3	85%	10%	-	5%
B4	90%	-	5%	5%
B5	87%	-	8%	5%
B6	85%	-	10%	5%

RESULT AND DISCUSSION

Table-4 shows the result of compressive strength of bricks at 7days. And Table-5 shows the result of compressive strength of bricks at 28days.figure-4 shows the graph between compressive strength of bricks at 28 days and cement content with varying proportions, and figure-5 shows the graph between compressive strength of brick at 7 days, 28 days and opc cement content with varying proportions and figure-6 shows the graph between compressive strength of bricks at 7 days,28 days and ppc cement with varying proportions.

- The bricks were unburnt and hydraulically pressed. The soil stabilized bricks was taken for strength determination after 7 and 28 days.
- The maximum strength of brick obtained was 3.873 N/mm2 at 98 KN load, stabilized soil bricks i.e. mixture of [Ppc(10%)+clay(5%)+soil(85%)].
- The minimum strength obtained was 0.632 N/mm2 at 16 KN load,stabilized soil brick i.e. mixture of[Ppc(5%)+clay(5%)+soil(90%)].
- Use of ppc as stabilizer in place of opc gives more strength to the bricks with the same proportions of soil and clay and stabilizer.

- Use of clay with soil at constant proportion increase the strength of the bricks.
- Use of opc cement at constant proportion of clay does not increase the strength of bricks produced by ppc cement at 28 days.

Table-4

MIX PROPORTION	7DAYS STRENGTH N/MM2	LOAD (KN)
Soil(90%)+clay(5%)+OPC (5%)	0.671	17
Soil(87%)+clay(5%)+OPC (8%)	0.948	24
Soil(85%)+clay(5%)+OPC (10%)	1.027	26
PPC (5%)+clay(5%)+soil(90%)	0.632	16
PPC (8%)+clay(5%)+soil(87%)	0.790	20
PPC (10%)+clay(5%)+soil(85%)	1.106	28

Table-5

MIX PROPORTION	28 DAYS STRENGTH N/MM2	LOAD (KN)
Soil(90%)+clay(5%)+opc(5%)	2.292	58
Soil(87%)+clay(5%)+opc(8%)	2.608	66
Soil(85%)+clay(5%)+opc(10%)	3.399	86
Ppc(5%)+clay(5%)+soil(90%)	2.529	64
Ppc(8%)+clay(5%)+soil(87%)	3.003	76
Ppc(10%)+clay(5%)+soil(85%)	3.873	98

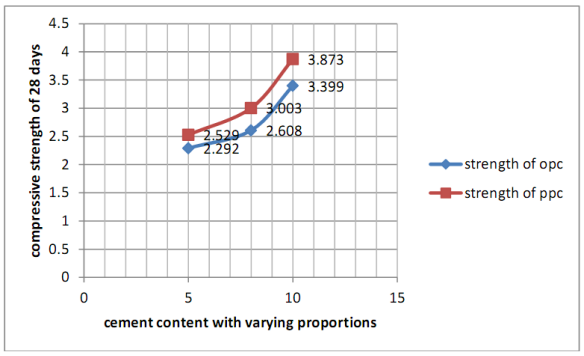

Figure – 4

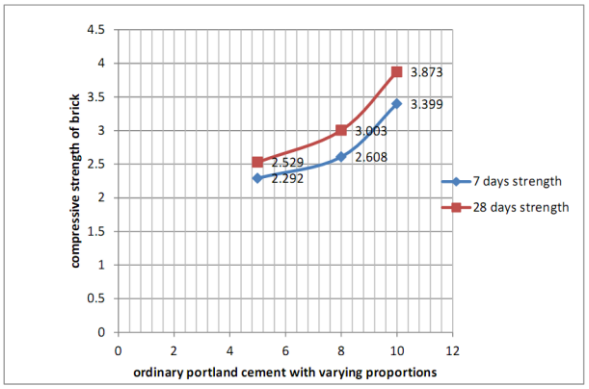

Figure – 5

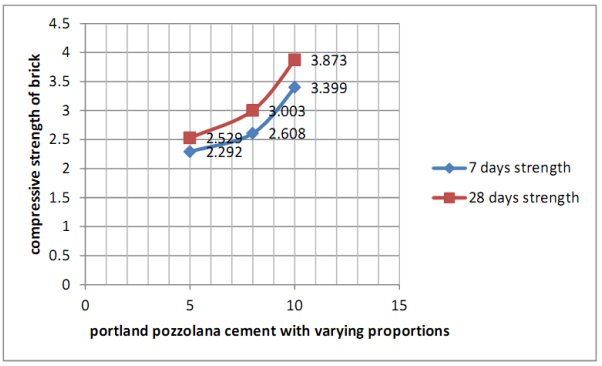

Figure – 6

CONCLUSION

- The influence of stabilizer on compressive strength of bricks is shown in result. In this paper, a brief review on stabilized soil bricks is done.
- Stabilization of soil block using Portland pozzolana cement fulfills a number of objectives that are necessary to achieve a lasting structure from locally available soil. Some of those are: better mechanical characteristics (leading to better compressive strength), better cohesion between particles.
- Increase in cement content results in an increase in the compressive strength value of blocks made at the same constant compaction pressure.
- The result of this paper have revealed that compressed stabilized soil block can be used as an alternative wall making material.
- The amount of water content for the soil-cement mixture needs to be carefully controlled. there needs to be sufficient moisture for the cement to fully hydrate but no excess of water which would reduce the final density, increase porosity and reduce final strength.
- Previous researches showed that stabilized soil bricks demonstrate many advantages compare to conventional fired bricks. This stabilized bricks are environment friendly- no burning of bricks required. It is cost efficient. The utilization of earth in housing construction is one of the oldest and most common methods used by a larger percentage of the developing countries population.

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