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# Experimental & Analytical Evaluation Of Interlocking Red Mud Block Along With Cementious Admixtures

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**ABSTRACT:** In our earth surfaces totally, 1/3rd of the people's lives under constructed with earthen residential dwellings. Majority of the peoples preferring Burnt Bricks for the constructional purpose which emits nearly about 1 ton of CO<sub>2</sub>. The usage of environmental friendly, structurally sound and inexpensive materials was used in the ancient centuries. The stabilized mud blocks are the one which have a low embodied energy of 0.42 MJ/kg and low carbon foot print. The usage of burnt bricks brings out higher cost and also harmful to the health. It is the time to introduce cost effective, long lasting, user friendly alternative building materials. This study evaluates the strength parameter if mud block under compression, water absorption, and also analytical studies were carried out using Ansys 12.0 to check its performance.

**KEYWORDS:** Red soil, Stabilized Inter locking mud blocks, Compressive strength, water absorption, Modulus of rupture, Ansys 12.0 for its Strength performance.

## I. INTRODUCTION

Human civilization has its origin before 6000 years ago, the mesopotamian Civilization the ancient civilization in the world and they are the first peoples to live in a masonry buildings. Peoples used the locally available material to make the masonry buildings. They used the alluvial soil which was deposited on the banks of river Euphrates and Tigris to dwell on the banks of the rivers. This is the reason why the ancient civilizations were found on the banks of the river. In the case of the rocky and the huge mountains the stones were used as material to build the masonry, the best example is the pyramids build by the Egyptians on the rocky borders of the Nile River. The next great example on the eastern side of our earth is the Great Wall of China which is standing bravely still today. The great structure has a good life because of the usage of the lime as a binding material. The reason for the origin of the civilization on the banks of the river is that the availability of the material easily.

The Harappa and Mohenjo-Daro is one of the civilization which has the utilization of the alluvial and the red soil on the banks of the river Indus and the building made from the red soil and the usage of the lime has its fragments till today, the great bath belonging to the same civilization is the best example for the environmental safety measures did by our ancestors.

The new development of earth construction really started in the nineteenth fifties, with the technology of the Compressed Stabilized Earth Blocks (CSEB): a research programs for affordable houses in Colombia proposed the first manual press – the Cinram. Since 1960 – 1970, Africa has seen the widest world development for CSEB. Social programs and prestige demonstration projects are not computable anymore. India developed CSEB technology only in the nineteen eighty's, but sees today a wider dissemination and development of CSEB.

## II. OBJECTIVE OF THE STUDY

1. To study the Engineering properties of the red mud in Natham, Dindigul district
2. To utilize the red mud in the manufacture of the stabilized mud block along with cementitious admixtures as stabilizers.
3. To promote earth quake resistant structures
4. To promoting earth based inter locking blocks.
5. To study the influence of the admixture in the strength parameter of the blocks.

## III. NEED FOR THE STUDY

- ❖ The world had seen the rise and fall of many civilizations, these civilizations are having a great land mark of huge buildings and monuments these buildings are made up of mud and stones [1]. It was found that nearly one third of the world population live in earthen architecture [2]. Before the usage of natural inorganic binders the lime was used as a binder for the ancient building materials like as mud stones [3]. After the intervention of new building material it is found that the usage of the common clay fired bricks emit about 200kg of Co<sub>2</sub>/ton and the concrete blocks emit 143 kg of Co<sub>2</sub>/ton and the aerated concrete blocks emits about 285-385 kg of Co<sub>2</sub> /ton[4]. Due to the modern construction method the housing in the developing countries had become a tough job to overcome this impact, usage of mud is reintroduced again [5]. The usage of mud had started in the late 18th century; the large scale use of the mud block was used for the construction of Vance our assembly hall in UK [6]. On using the mud blocks the carbon emissions found to be 23kg/ton of the block usage and it is found to be less than the new building materials [7]. The stabilized mud blocks which are the products of the stabilization of the various soils along with the various stabilizers like cement, lime [8]. The use of cement helps in attaining C-S-H gel and it helps in attaining the strength of the block [9]. It was found that the usage of the lime had enhanced the strength of the building and even now we could make the structures alive.

### A. Proposed Study

Our Project aim is utilization of the cementitious materials such as Cement, Micro concrete & Pidi top as stabilizers along with the soil respectively. The blocks were prepared separately with Cement, Micro concrete, Pidi top as stabilizers. Totally, 18 mixes were proposed and they are designated as M<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub>, M<sub>4</sub>, M<sub>5</sub>, M<sub>6</sub> with cement as stabilizers proportion of 5%, 6%, 7%, 8%, 9% & 10% the second six mixes are designed and designated as M<sub>7</sub>, M<sub>8</sub>, M<sub>9</sub>, M<sub>10</sub>, M<sub>11</sub>, M<sub>12</sub> with Micro concrete as the stabilizers in proportion of 5%, 6%, 7%, 8%, 9% & 10%. Similarly, the third mixes designated as M<sub>13</sub>, M<sub>14</sub>, M<sub>15</sub>, M<sub>16</sub>, M<sub>17</sub> and M<sub>18</sub> with Pidi top as the stabilizers in proportion of 5%, 6%, 7%, 8%, 9% & 10% along with soil respectively.

### B. Study Area

Our study area of our project is Located in Natham in Dindigul. The district is located in the south eastern side of the Tamil Nadu. The Dindigul lies in the 10° 3' and 10° 48' north latitude and 77° 15' and 78° 20' east longitude. The Natham village is located in 10° 14' 50'' to 10° 20' 00'' and east longitude from 77° 37' 45'' to 77° 46' 00''.

The selection of soil is based on its abundance and advanced casting facilities like Mechanized Hydro form interlocking blocks which is easily access to casting the mud blocks. The study area is chosen by thorough look over the area and the presence of soil. The soil from the Saranhanghi Village is taken for making the block.

### C. Materials used

- RED SOIL:

The red soil was found in the Saranhanghi plenty in nature. The red soil is rich in the iron content and it is the key factor for enhancing the strength in the block



*Table 1. Engineering properties of soil*

Parameters	Composition
Bulk density	1.18 mg/m <sup>3</sup>
Particle density	2.65 mg/m <sup>3</sup>
Porosity	44.2%
pH	5.9
EC (Soluble salt content)	0.63dSm <sup>-1</sup>
Calcium	0.14%
Magnesium	0.07%
Sulphur	0.07%
Ferric oxides	0.94%
Aluminum	0.11%
Copper	0.06%
Manganese	0.31%
Zinc	0.05%
Silicon	8.2%

(Data received from soil science laboratory,GRI(DU))

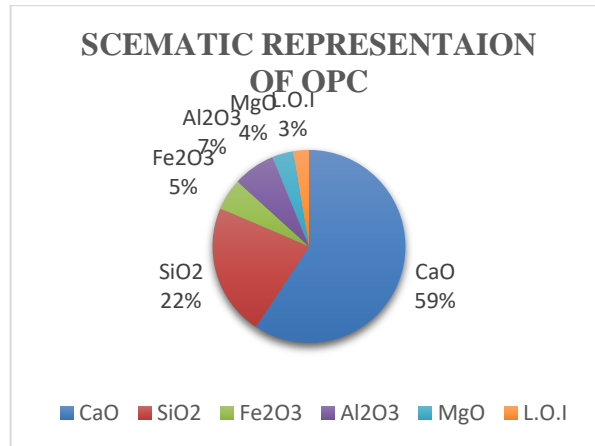
➤ CEMENT:

Ordinary Portland cement of grade 53 used as a stabilizer having specific gravity of 3.2. The cement is mixed with the soil to enhance the process of stabilization.

*Table 2. Chemical composition of cement*

Oxides	% of constituents
CaO	60-67
SiO <sub>2</sub>	17-25
Al <sub>2</sub> O <sub>3</sub>	3-8
Fe <sub>2</sub> O <sub>3</sub>	0.5-6
MgO	0.1-4
L.O.I	1.3-3

(Data received from soil science laboratory,GRI(DU))



➤ MICRO CONCRETE:

The micro concrete contains non-metallic aggregates, or chlorides which prevents the shrinkage in the plastic state. Which does not require elaborate curing? Sprinkling of water for two days is enough, however water curing is advisable for seven days. The specific gravity ranges around 2.85.

*Fig.1. Micro concrete*



*Table 3. Chemical composition of micro concrete*

S.No.	Properties	Value
1	CaO	68%
2	CCE*	189%
3	SiO <sub>2</sub> (Crushed Fine Aggregates)	32%

CCE\* = Calcium Carbonate Equivalent, (Data received from soil science laboratory, GRI(DU))

➤ PIDITOP:

The Piditop is a type of the cementitious admixture which composed of best quality ordinary Portland cement, well graded washed & dried aggregates it having Very low water absorption because it forms dense & low permeability substrate. The specific gravity of 3.56. Equivalent weight of 28 & Molecular weight of 56

Fig.2.Piditop



➤ WATER:

Water used for the soil plays an important part in the strengthening the interlocking mud block. Some specification also accepts water for making blocks pH between 6 and 8 and it is free from organic matter also satisfies I.S. 3025 (pt. 18) [27].

**D. METHODOLOGY**

➤ CASTING THE BLOCKS:

We are using Hyroform as one of the Mechanized Device to casting of Interlocking blocks.

➤ CURING OF THE BLOCKS:

After remaining in their original position for one to seven days. The blocks are cured by sprinkling the water with the help of the flower pot over the tarpaulin or the polythene sheets. And they are kept covered till the day for testing comes. The Blocks made with cementious admixtures such as cement, Micro concrete, Piditop as a stabilizer are tested for 7th, 14th, 28th days of curing.

➤ INTER LOCKING MUD BLOCKS:



*Fig3. Casing of Interlocking Mud Blocks through Hydro form Machine in Field:*



#### IV. RESULTS AND DISCUSSIONS

##### ➤ Compressive Strength Test

The blocks are made and cured for 28 days in the case of cement stabilization, the blocks made with the cement stabilizer are tested for 7th, 14th, 21th day of curing and the blocks are covered with either polythene or tarpaulin sheets and water is sprayed with water being filled in flower pot. The block is taken and they should be dried about one hour. The blocks are tested in Universal Testing machine. The test was conducted and the following are the average compressive strength obtained on the testing.

**Fig.4.Compressive strength for Inter locking mud block**



##### ➤ WATER ABSORPTION TEST:

The block when tested in accordance with the procedure laid down in IS: 3495 (Part II) 1976, after immersion in cold water for 24 hours, an average water absorption shall not be more than 15 percent by weight. It is computed by the formula as designated as below:

$$\text{Water Absorption in (\%)} = \frac{B-A}{A} \times 100$$

Where,

A-Initial weight of the mud block

B-Final weight of the mud block (After immersed into the cold water about 24hrs)

Fig. 4. Water absorption test



**Table 4. Water absorption for Inter locking block for 24hrs Immersed in cold water**

MIX RATIO	DRY WEIGHT in kg (A)	WET WEIGHT in kg(B)	WATER ABSORPTION in %
8% OPC	10.440	11.270	7.95
8% MicroConcrete	10.550	11.400	8.05
8% Pidotop	10.390	11.220	7.98

*(Data received from soil science laboratory, GRI(DU))*

➤ **MODULUS OF RUPTURE TEST:**

Turn the specimen on its side with respect to its molded position (with the original top and bottom surfaces as molded perpendicular to the testing machine bed,) and Centre it on the lower half-round steel supports, which shall have been spaced apart a distance of three times the depth of the beam. Place the load applying block assembly in contact with the upper surface of the beam at the third points between the supports. Carefully align the center of the beam with the Centre of thrust of the spherically seated head block cit. the machine. :\\s this block is brought to bear on the beam-loading assembly, rotate its movable portion gently by hand so that uniform seating is obtained.

Apply the load continuously and without shock. A screw power testing machine, with the moving head operating at approximately 1.2 mm/min when the machine is running idle may be used. With hydraulic machines adjust the loading to such a constant -rate that the extreme fiber stress is within the limits of 7 f O-4 kq'cu>/s/min. Record the total load at failure of the specimen to the nearest 3 kg.



Fig. 5.Modulus of rupture test



CALCULATION:

Calculate The Modulus Of Rupture As Follows:

$$R = 3Pa / bd^2$$

Where,

a = distance between line of fracture and the nearest support,  
Measured along the Centre line of the bottom surface of the beam (as tested).

R = modulus of rupture in kg/cm<sup>2</sup>,

P = maximum applied load in kg,

b = average width of specimen in cm,

d = average depth of specimen in cm.

MIX RATIO (Red soil +8% admixtures)	MAXIMUM APPLIED LOAD in (kg)	MODULUS OF RUPTURE in( kg/cm <sup>2</sup> )
OPC	430	1.712
MICRO CONCRETE	400	2.03
PIDITOP	510	2.05

*(Data received from soil science laboratory,GRI(DU))*

As per IS 4332 part VI, the Modulus of rupture calculated nearest to 0.5 kg/cm<sup>2</sup> for Flexural Strength of soil cement block with three point loading system. We Investigate that the flexural strength of inter locking mud block as higher than the IS codal provision in order to withstanding the flexural stress or bending stress induced in the Inter locking block.

➤ PRISM TEST:

It is the test conducted by arranging the Inter locking mud block one over another consist of three numbers and also five numbers in each test. This test is particularly carried out to find out the compressive nature of the blocks in prism manner.

FORMULA USED:

- Prism strength = Maximum applied load at failure / Cross sectional area
- Efficiency of the Inter locking block = Prism strength / Average compressive strength
- 

**Fig .6. 3 & 5Block Prism test**



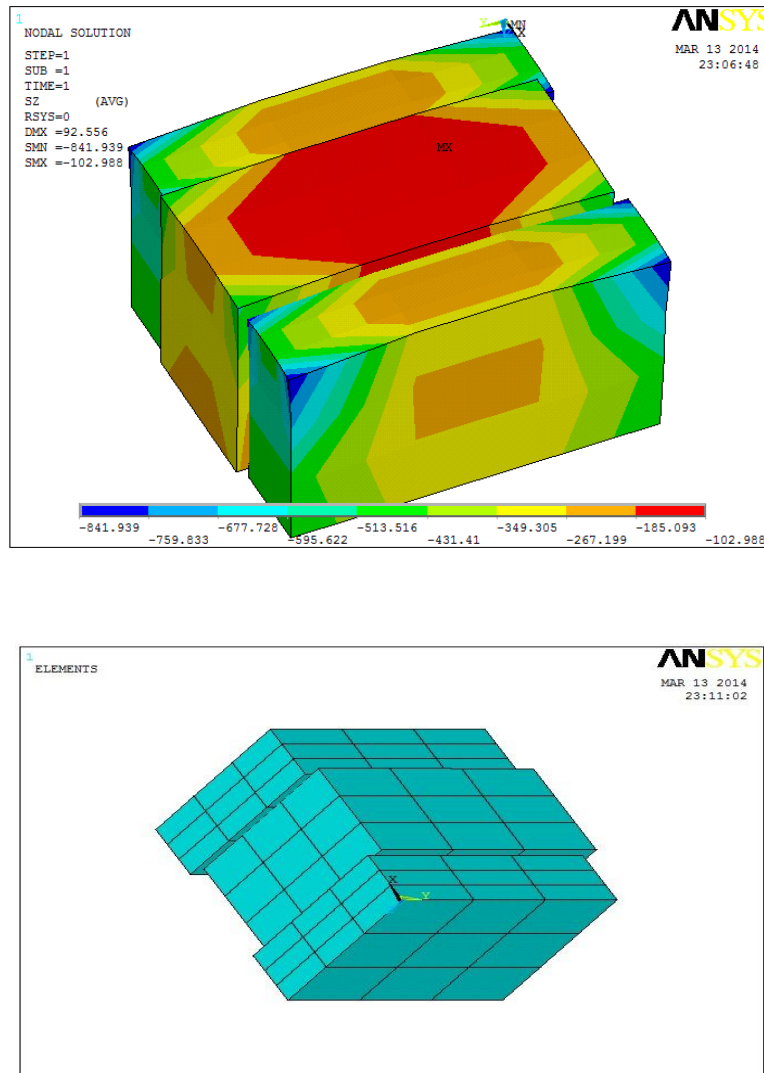
NO OF BLOCKS	AVERAGE COMPRESSIVE STRENGTH @ 8% CEMENTIOUS ADMIXTURES	SIZE OF THE PRISM in (mm)	h/t	PRISM STRENGTH in (N/mm <sup>2</sup> )	BLOCK EFFICIENCY (η)
3 Block prism	6.15 Mpa	230x230x30	3.0	6.01	0.97
5 Block prism	6.15 Mpa	230x230x50	5.0	13.19	2.14

*(Data received from soil science laboratory, GRI(DU))*

➤ Analytical Studies Using ANSYS 12.0:

ANSYS means that the Analytical system software which has been plays the vital role for, the Finite Element Studies gives most precise computation of the results.

Fig 6. Schematic representation of Stress & Meshing of Inter locking mud block



## V. CONCLUSION

- As per IS: 4332(Part V):1970, The minimum average compressive strength of the walling components such as Interlocking block shall not be less than 1.4N/mm<sup>2</sup>.It is suitable for walls with light weight asbestos roof covering .We obtained that the compressive strength of the interlocking blocks as 8.9N/mm<sup>2</sup>.So, the results are satisfies the IS codes . Simultaneously, we could make the structures for long lasting life span of the structures.This study concludes that the use of cementious Admixtures not only improves that the strength performance and also enhances the Engineering properties of the soil at different laboratory test was conducted to it.
- According to Ansys 12.0, there are acceptable variations between analytical & Experimental studies. It is quite common. Because, the Finite Element Studies gives most precise computation of the results.
- As per IS code 3495 (Part II)-1976, the water absorption of the soil based block should not greater than 15%. We attained lesser water absorption that 15%. So, these blocks are having higher durability and it will make the building as strong and durable. So, it is even recommended for higher rainfall areas also.
- As per IS 4332 part VI, the Modulus of rupture calculated nearest to 0.5 kg/cm<sup>2</sup> for Flexural Strength of soil cement block with three point loading system. We acquired that the Average Modulus of rupture i.e., flexural stress as 1.930 kg/cm<sup>2</sup>. We Investigate that the flexural strength of inter locking mud block as higher than the

IS codal provision in order to withstanding the flexural stress or bending stress induced in the Inter locking block.

- According to usage of interlocking blocks, approximately 185 No's of blocks only required for 1m<sup>3</sup> of the masonry wall. Whereas, in case of conventional bricks needs 500 bricks for 1m<sup>3</sup> for walling purpose. So, it helps to avoids mortar consumption for laying of mortar joints. Because, it holds the interlocking block one over the, except pointing purpose.
- We proved that the Average Efficiency of interlocking block as 1.555 from the standard prism block test.

### FURTHER RESEARCH

In the upcoming future, project could be carried on the durability parameter of the red mud block along with various admixtures, additives to improve the life span of the structures. The durability test should even satisfies under the vulnerable conditions such as acid test, weather resistance test i.e., Freezing & thawing effect, water penetration test

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