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Stabilized mud block as a substitute for conventional brick block

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Abstract – The development of many alternative building materials will be of immersive benefit to minimize the impact on the environment pollution. There are few undesirable properties such as loss of strength when saturated with water erosion due to wind or driving rain and poor dimensional stability. Hence a study was conducted to determine the characteristic of stabilized compressed earth block. In this contribution, the stabilized mud block is mixed with 7% of cement 5% cement and 2%. The experiments on the compression and water absorption were made which allow us to determine the characteristics of earth block. Comparisons between the two mixes are discussed. It was found that water absorption is less and dry compressive strength of cement as stabilizer with 7% is higher when compared to cement and lime (5% +2%). Hence the cement with 7% as a stabilizing agent is found to be good compared to other.

Keywords: BBMP solid waste dump yard, ground water quality, mavallipura, physico chemical characteristics.

1. INTRODUCTION

Earth is one of the oldest and the most abundantly available building material and there are many techniques of building with earth such as making masonry blocks out of earth, or making monolith earth walls by ramming. Stabilized Compressed Earth Blocks (SCEB), are an improved version of earth based masonry units. These masonry blocks are made by compressing earth/ soil by simple mechanical means. Although block production is feasible using a wide variety of soils, understanding type of soil available for SCEB is one of the most important aspects – generally sandy clay is the most appropriate. A small percentage of stabilizers – most commonly 5-7% cement is added to the soil mix to increase strength of blocks and their resistance to water.

Several block presses, both manual and mechanized types, have been developed by various institutions and are available to produce blocks of various sizes. The thickness of walls made with SCEB is generally close to 230mm conventional burnt clay masonry. The distinct advantage of these blocks are their uniform sizes and good finish which should be left unflustered externally, provided the building design takes into account basic features of protection from water. This technology is also very amenable to local employment generation through a block production enterprise.

This study aims to make extensive use of raw earth as the main building material, thereby using a local resource, which can help developing technologies that are energy saving, eco-friendly and sustainable. The main research and development id focused on minimizing the use of steel, cement and reinforced cement concrete (RCC). Most of the technologies developed are mastered and the present research is focused on alternative stabilizers to cement and alternative waterproofing with stabilized earth, composed of soil, sand, cement, lime, alum and tannin.

2. OBJECTIVE OF THE PROJECT

To achieve the aim, the following objectives will apply:

- Identify two alternatives to cement for mud brick stabilization. Compare the alternatives to cement for cost, ease of manufacture and embodied energy.
- Summarize whether the SMB is a viable engineering alternative.
- Investigate mud bricks made with the alternative stabilizers and compare them, quantitatively, to cement stabilized bricks for mechanical properties: Compressive strength, absorption.

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3. METHODOLOGY OF PROJECT

The first and the most critical step in Compressed Earth Block (CEB) technology is identification of soil which is suitable for block production and will be available locally in the required quantity.

Soil, consisting of sand, clay and silt is the basic raw material for CEB. In general, soils containing 10-15% clay and 60-75% sand are satisfactory for cement- stabilized CEB. It is preferable that the clay in the soil should be non-expansive, because it is extremely unstable in presence of water, although it can be stabilized in a complicated manner.

If a stabilized CEB is produced using a clayey soil – more than 20% clay and if the cement stabilization is less than 5%, the block is likely to develop cracks during alternate wetting and drying leading to surface cracks or spilling at corners after exposure to weather for 2-3 years. Such problems can be avoided by adding adequate quantity of sand to the soil mix to keep the % of clay below 15%.

Soil suitability can be ascertained by both field and laboratory techniques. Even though the laboratory techniques are always more accurate, field identification is very useful in case where a laboratory analysis cannot be carried out. Field tests can be done on site in a relatively short time and are usually exact enough to ascertain suitability and to help eliminate the unsuitable soil types.

The soil is prepared by sieving it through a 5mm sieve to remove gravel, lumps of clay, roots, etc. If the soil gradation has to be changed by adding sand or quarry dust, it must be done at this stage.

It is very important to achieve uniform mixing of soil for good quality CEB. In manual mixing, the soil must be spread as a thin layer of about 15cm in thickness. The stabilizer is then spread as a thin layer on the soil and then mixed with soil. The entire mix of soil and stabilizer should be turned over completely at least 3 times in the dry state and then again at least 3 times while gradually adding water.

It is very important to maintain the optimum moisture content of the mix – this will need to be arrived at through initial batches of blocks by weighing them and checking the block density. At the optimum moisture content, the blocks will have the maximum density.

At the outset, the amount of water to be added is estimated approximately. A sandy soil will need about 10-12% water for Optimum Moisture Content. Water is added to the soil mix in 2-3 stages. Around half of the water is added to the soil-stabilizer mixture in the first stage and mixed thoroughly by hand. The process is then repeated with the remaining water. The mixing is complete when the mixture has a uniform colour. The cement will begin to act on contact with water, which is why water should be added to the dry mix at the last moment before compaction in order to keep the time before it is used (retention time) to a minimum, as this greatly affects the quality of the blocks.

3.1 Tests on soil

Soil inspection or say geotechnical inspection is very important in understanding the physical properties of soil and the rocks beneath. This is required to ascertain the type of foundation required for the proposed construction. Various tests are done to explore the sub surface and surface characteristics of soil.

Field tests for soil:

1. Visual examination 2. Sedimentation test
3.touch 4.wash test 5. Ribbon test

Lab test on soil

1. Particle size distribution of soil

2. The specific gravity of soil

3. The maximum dry density and the optimum moisture content of soil

3.2 Selection of stabilizing agent

- **Stabilized mud block of cement (7%)**

The mix design for the stabilized mud block of cement (7%) is calculate as given

For casting of one block, the required quantity

- Soil = 1.8 kg
- Quarry dust = 1.8 kg
- Cement =0.252kg
- Water content = 0.648 l

3.3 Stabilized mud block of cement (5%) + lime (2%)

The mix design for the stabilized mud block of cement (5%) +lime (2%) is calculate as given the required quantity

- Soil = 1.8 kg
- Quarry dust = 1.8 kg
- Lime = 0.72kg
- Cement =0.18kg
- Water content = 0.648 l

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3.4 Casting of mud block

The steps for preparing the blocks are as followed below

- Shovel together sand and clay in the pit. These should be mixed according to the amounts you have and your own desires - again, there's really no wrong way.
- Add water - enough to make the mixture "soupy."
- Mix together - the easiest way to do this is to take off your socks and shoes, roll up your pant legs, and jump in with both feet. Mix around until you don't find any dry patches.
- Lay out a tarp and shovel on several shovel loads of the mud. As you scoop out the mud, try to let excess water drain back into the pit. You can also use a 5 gallon bucket to scoop out mud onto the tarp. Cover about a third of the centre of the tarp.
- Stomp on the mixture. The goal is to thoroughly mix the straw and the mud, so stomp around a lot.
- Pick up one side of the tarp so that the mixture falls back onto itself - sort of like kneading dough.
- Grab large handfuls of the mixture and put them into the brick form. Make sure to push the mixture into the corners well, and punch it into the form so it is filled and solid.
- Let the bricks dry in the form for a short while - 15 minutes at least. You can then remove the form and start filling it again.
- Let the bricks sit where they are and dry a while - an hour or so. When they're solid and dry enough to move, stand them up on their sides to dry some more. It may take a week until they're dry enough to build the wall with.

Test conducted on mud block

Checking the strength of bricks is vital in analysing civil engineering design. Engineers have to be very sure about strength and worthiness of basic building unit i.e. Bricks. Following tests are performed to check the quality of bricks.

1. Wet Compressive Strength Test
2. Water Absorption Test
3. Dry Compressive Strength Test

4. RESULTS AND DISCUSSIONS

The experiments conducted at 'Get Sheltered' proved to be less extensive than first hoped. Nevertheless a range of mud brick were constructed using the same method as for those in the main laboratory experiments allowing familiarization with the procedure. Some previously constructed bricks, which had cured for 28 days, were tested for their compressive strength.

These bricks were stabilized with lime or PC and one contained no stabilizer. A fired brick and a regular house brick, as used in masonry construction in the, were also tested Let the bricks dry in the form for a short while - 15 minutes at least. You can then remove the form and start filling it again.

The test results of soil in both laboratory and field is as follows

- The soil consist of sand , silt and clays
- The sand content is assumed to be about 65-70% in the soil sample.
- The silt and clay is about 25-35% in the soil sample.

4.1 Wet compressive strength

Table1: wet compressive strength of stabilized mud block of cement(7%)

SL.NO	Length in mm	Breath in mm	Load in kN	Compressive strength= $\frac{\text{maximum load at failure (N)}}{\text{Average area of bed face mm2}}$	Average
1	223	112	67	2.68	2.67 N/mm^2
2	224	112	66.5	2.65	
3	222	113	69.6	2.70	

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Table2: wet compressive strength of stabilized mud block of cement (5%) +lime(2%)

SL.NO	Length in mm	Breath in mm	Load in kN	Compressive strength= $\frac{\text{maximum load at failure (N)}}{\text{Average area of bed face mm2}}$	Average
1	222	114	69.6	2.75	
2	221	115	70.1	2.76	2.77 N/mm²
3	222	113	70.5	2.81	

Table3: wet compressive strength of brick

SL.NO	Length in mm	Breath in mm	Load in kN	Compressive strength= $\frac{\text{maximum load at failure (N)}}{\text{Average area of bed face mm2}}$	Average
1	222	114	67.6	1.19	
2	221	115	71.1	1.18	1.53 N/mm²
3	222	113	72.5	2.22	

4.2 water absorption

Table4: water absorption of stabilized mud block of cement (7%)

SL No.	dry weight of specimen(m1) in grams	wet weight of specimen(m2) in grams	water absorption in % $W = \frac{M2-M1}{M1} * 100$	Average
1	3.3543	3.4611	2.44	
2	3.416	3.515	2.84	
3	3.402	3.500	2.80	2.69 %

Table5: water absorption of stabilized mud block of cement (5%)+lime(2%)

SL No.	dry weight of specimen(m1) in grams	wet weight of specimen(m2) in grams	water absorption in % $W = \frac{M2-M1}{M1} * 100$	Average
1	3.611	3.750	3.7061	
2	3.5080	3.6100	2.8255	3.22 %
3	3.6500	3.7750	3.1125	

Table6: water absorption ofbrunt brick block

SL No.	dry weight of specimen(m1) in grams	wet weight of specimen(m2) in grams	water absorption in % $W = \frac{M2-M1}{M1} * 100$	Average
1	3.303	3.490	5.6615	
2	3.378	3.600	6.5719	
3	3.5710	3.800	6.4127	6.215%

4.3 dry compressive strength

Table7: dry compressive strength of stabilized mud block of cement(7%)

SL.NO	Length in mm	Breath in mm	Load in kN	Compressive strength= $\frac{\text{maximum load at failure (N)}}{\text{Average area of bed face mm2}}$	Average
1	232	116	86.2	3.24	3.28 N/mm^2
2	229	117	86.77	3.24	
3	234	113	87.0	3.34	

Table 8:dry compressive strength of stabilized mud block of cement (5%)+lime(2%)

SL.NO	Length in mm	Breath in mm	Load in kN	Compressive strength= $\frac{\text{maximum load at failure (N)}}{\text{Average area of bed face mm2}}$	Average
1	230	115	85.1	3.21	3.22 N/mm^2
2	233	116	86.2	3.19	
3	231	117	87.9	3.26	

Table 9: Dry compressive strength for brunt brick block

SL.NO	Length in mm	Breath in mm	Load in kN	Compressive strength= $\frac{\text{maximum load at failure (N)}}{\text{Average area of bed face mm2}}$	Average
1	220	103	74	3.27	3.22 N/mm^2
2	223	104	72	3.1	
3	221	101	70	3.13	

4.4 results of tests conducted on mud block

Table10: conclusion of tests conducted on mud block

Sl no.	Tests	SMB Of 7% Cement	SMB Of 5% Cement & 2% Lime	BBM
1	Wet compression test	2.7 N/mm^2	2.77 N/mm^2	2.0 N/mm^2
2	Water absorption test	2.69%	3.22%	6.215%
3	Dry compression test	3.28 N/mm^2	3.22 N/mm^2	3.22 N/mm^2

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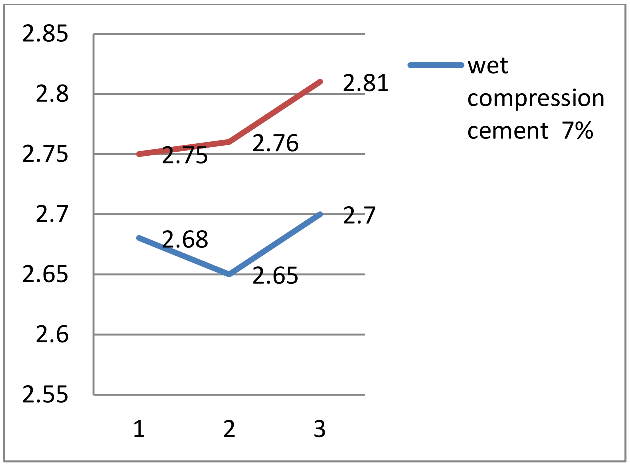
4.5 Comparisons between SMB of 7% cement and SMB of (5% cement & 2% lime)

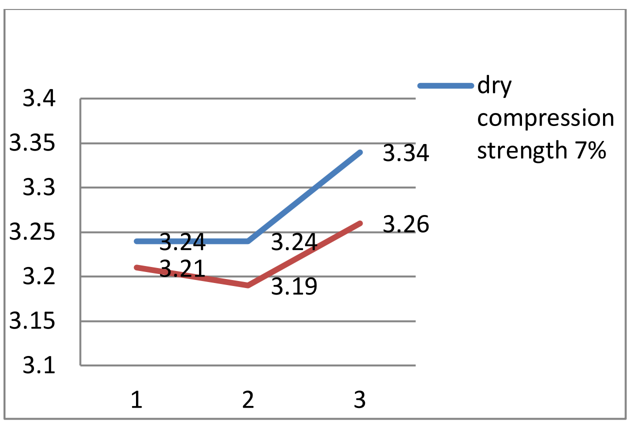
- **Wet compression strength**



Graph 1 : wet compressive strength of two mix

result obtained: SMB of 7% cement has slightly higher wet compressive strength than SMB of 5% cement + 2% lime

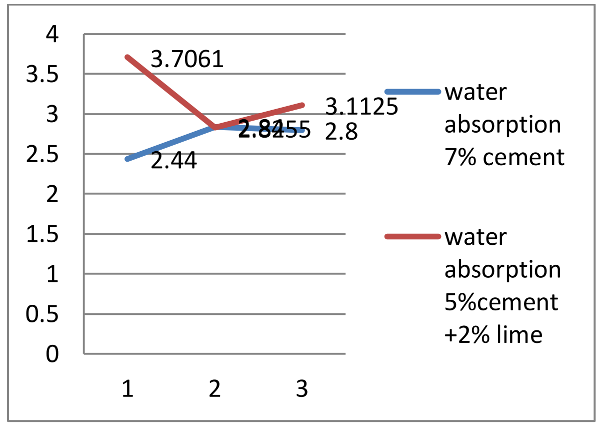
- **Dry compression strength**



Graph 2 : dry compressive strength of two mix

result obtained: SMB of 7% cement has slightly higher Dry compressive strength than SMB of 5% cement + 2% lime

- **Water absorption**

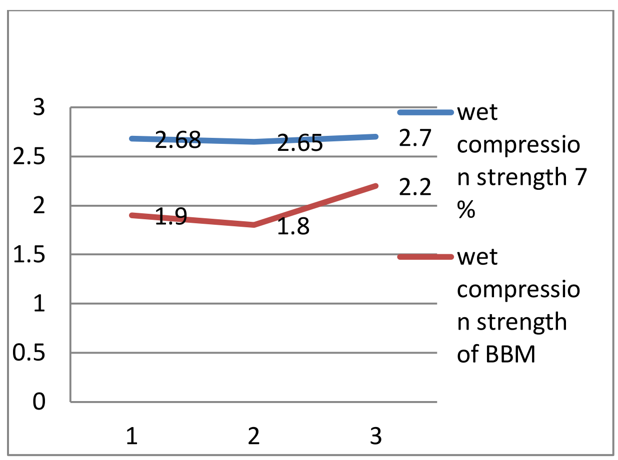


Graph 3 : Water absorption of two mix

result obtained: SMB of 7% cement has slightly lower water absorption than SMB of 5% cement + 2% lime

4.6 comparisons between SMB of 7% cement and BBM

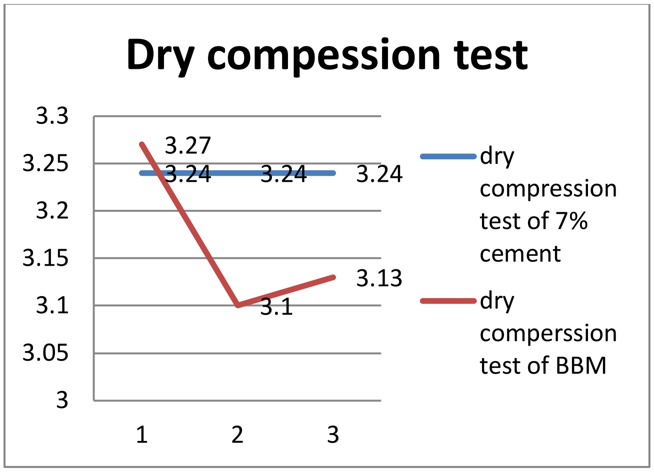
- **wet compression strength**



Graph 4 :wet compressive strength of two mix

result obtained: SMB has slightly higher wet compressive strength than BBM

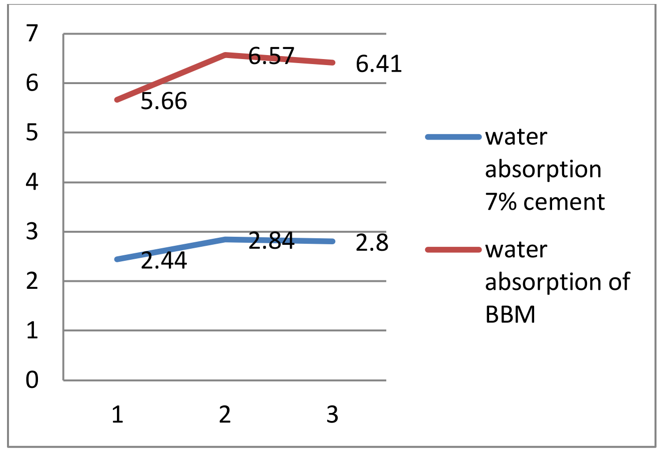
- **Dry compression strength**



Graph 5 : dry compressive strength of two mix

result obtained: SMB has slightly higher dry compressive strength than BBM

- **Water absorption**



Graph 6 : water absorption of two mix

result obtained: SMB has slightly lower dry compressive strength than BBM.

5. CONCLUSIONS

- It was found that wet compressive strength of cement as stabilizer with 7% is lesser when compared to cement & lime (5%+2%) where the value was 2.7 N/mm² & 2.77 N/mm² respectively.
- It was found that water absorption of cement as stabilizer with 7% is higher when compared to cement & lime (5%+2%) where the value was 2.69% &3.22% respectively
- It was found that dry compressive strength of cement as stabilizer with 7% is higher when compared to cement & lime (5%+2%) where the value was 3.28 N/mm² & 3.22 N/mm² respectively.
- It is found that water absorption is less and dry compressive strength is higher in case of the block having (7%) cement as a stabilizing agent. And the wet compressive strength is also almost lesser to block having (5+2%) stabilizer. Hence the cement with 7% as a stabilizing agent is found to be good compared to other.
- It is noted that SMB has more Wet Compressive Strength & Dry Compressive Strength and less Water Absorption characteristics when compared to brick
- Therefore it can be concluded that the SMB can be used as a Load Bearing Wall and as a substitute for conventional brick in strength wise.

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