

Stabilized Earthen Blocks Using Industrial Wastes with Cow Urine

Ajay N Sagar¹,

P.G. Student, Department of Civil Engineering, NMAM Institute Of Technology, Nitte, Karnataka, India¹

ABSTRACT:Image As the construction cost and demand increases the opportunity for making more efficient and cost efficient products also increases. Making of earthen blocks are of very high demand these days. Since many buildings need the blocks just for basic covering, aesthetics, patricians etc. the need for lighter and insulating type of blocks at a reasonable price is very much in need. This experimental study aims to provide a thorough understanding of the properties and the proportion required to have a stabilized earthen blocks. This experimental study revealed that, out of all the samples, blocks which are produced from 25% soil, 40% sand, 15% industrial waste, 7% cement, 2% lime have compressive strength and water absorption values above the limiting value as per IS 1725:1992 and also the blocks with same proportion with 50% cow urine replacement with water tenders good results as per IS 1725:1992.

KEYWORDS: stabilized, industrial

I. INTRODUCTION

As we all know the infrastructure of any developing country is given the most preference. As the rate of construction increases rapidly there will be more and more demand for the construction materials and also for the production of these materials. Increasing number of un-natural blocks such as concrete blocks have increased significantly in terms of production just to meet the daily needs of the demand as well as the exhaustion of naturally available stones are very region specific or it will be costly for the transportation. There are various types of blocks and combinations that already exist in the construction field, but the growing demand keeps us focused or channels us out to keep us inventing more and more or better ways to make these earthen blocks. However not that all blocks made or researched are not having any limitations. Most of the times these blocks are made region specific. Unavailability of natural blocks or buying concrete blocks at a large scale is far too costly means we need to find some other alternative. Usually blocks are made as per the region or economical, i.e. places where there is high humidity or high rainfall or on the other hand were the temperature is very high or very low, there can be a drastic change in the making of these blocks, and of course these blocks are made keeping the eco-friendly factor intact.

II. RELATED WORK

The following are the research analysis made formerly based on the strength parameters and outcomes of earthen blocks and other materials used in this project.

[1] Lambert et.al (2019)In this study they have found the microbial induced calcium carbonate precipitation to grow bio bricks using human urine. The urine collected is fresh and is also stabilised with calcium hydroxide. The bacteria used “*sporosarcina pasteurii*” to help drive the MICP process. The maximum compressive strength obtained in this bio brick was 2.7 MPa. [2] Udawattha et.al (2017)the study was conducted to see the optimal soil percentage to balance the required strength of the concrete and its properties at the same time keeping the blocks way economical than the other type of blocks available in the market. It’s observed that blocks can be made by using soil and fine particles of 5% and 55% out of 65% sand fines and 18% out of 22 % of cement by the respective mass. [3]Papayianni et.al (2017)this article elaborates about earth block houses at the historic centres. The traditional earthen block structure is almost abandoned in the present constructional fields. This article suggests how to repair the already existing structures using locally made or available materials and also how to retrofit the existing structures with the help of present technologies. It also shows the importance of retrofitting some of the most valuable antique structures[4] Periasamy et.al (2016)This study was conducted to know multiple applications of calcium carbonate minerals by bacteria, here various effects of calcium carbonates are mentioned. Effects from various calcium sources and their characteristics are discussed here. [5]Garg et.al (2014)In this study compressed stabilized earthen blocks were made using 5%, 7%, 9%, 10% cement as a stabilizer. Various type of test were done for different proportions of blocks as the compressive strength obtained is to be 3.2 MPa and flexure strength is 1 MPa.



III. METHODOLOGY

In the first phase soil samples were collected from Nirmithi Kendra, Surathkal. The entire sample was properly dried. Sieve analysis was done on the sample to get different fractions of gravel, sand, silt and clay. Only those passing through 4.75mm sieve are used for casting blocks. The industrial waste used in the making of blocks is also made to pass through 4.75mm sieve. The basic tests of the samples were conducted as per the IS code.

In the second phase of study 30 blocks were casted with more varying percentage of the mix proportions. The two proportions with higher 14 days dry compressive strength is selected. Referring to the proportions of higher compressive strength blocks, the combined standard proctor test and unconfined compressive strength test (18 samples) were conducted with less varying percentage of the mix proportions in order to find the optimum mix proportion for the stabilized mud blocks. The percentage of cement, industrial waste and lime were kept constant i.e. 7%, 15% and 2% respectively. The UCC samples were tested for 7 days and two proportions (I & II) with higher strength is selected. The blocks were casted for the obtained mix proportions. Wet mixture of the soil, industrial waste, sand, lime and cement is then pressed into blocks of size 290 X 140 X 90 mm using a manually operated block making machine ensuring zero wastage and gunny bag curing is provided. In the third phase compressive strength and water absorption test results are compared. From the results obtained proportion I (25% soil, 40% sand, 15%DE, 7% cement, 2% lime and 11% optimum moisture content) had higher compressive strength compared to proportion II.

Once the right proportions are found out, replacement of cow urine with water was done for 25%, 50%, 75% and 100 %. The urine sample obtained and collected for 100 blocks at once and stored safely in a shaded area. 50 blocks were casted for various proportions and tested. There were a few obstacles when the blocks were made using only cow urine, i.e. surface cracks were visible compared to the normal blocks which used only water had none. So the proportions were made by adding 50% cow urine and 50% water. Also various others combinations were made to get the best mix. 50% cow urine with 50% water was the most suitable of it. After finding out the right proportions, again bacteria (BACILLUS SUBTILLS) was added, trailed and tested for various proportions. The blocks are cured and kept in shaded area and further tested for various categories.

IV. EXPERIMENTAL RESULTS

After trying out many proportions the following proportions were showing the best results.

| Name | Soil | Sand | Industrial waste | Cement | Lime | Water | Cow-Urine |
|--------------|------|------|------------------|--------|------|-------|-----------|
| Proportion-1 | 25% | 40% | 15% | 7% | 2% | 11% | 0% |
| Proportion-2 | 25% | 40% | 15% | 7% | 2% | 8% | 8% |

Compressive strength results:-

Proportion-1 (290x140x90)

| Dimensions | Days Of Curing | | | | | |
|------------|-------------------------------|------|--------------------------------|------|--------------------------------|-----|
| | 7 Days Average strength (Mpa) | | 14 Days Average strength (Mpa) | | 28 Days Average strength (Mpa) | |
| | Dry | Wet | Dry | Wet | Dry | Wet |
| Horizontal | 4.24 | 3.88 | 4.97 | 3.93 | 8.88 | 5.2 |
| Vertical | 2.95 | 2.33 | 2.97 | 2.84 | 4.11 | 3.6 |

Proportion-2 (290x140x90)

| Dimensions | Days Of Curing | | | |
|------------|-------------------------------|------|--------------------------------|------|
| | 7 Days Average strength (Mpa) | | 14 Days Average strength (Mpa) | |
| | Dry | Wet | Dry | Wet |
| Horizontal | 3.92 | 3.71 | 4.67 | 3.56 |
| Vertical | 2.63 | 2.23 | 2.74 | 2.39 |



Water absorption test:-

Water absorption test on blocks is carried out as per IS 3495 (Part 2): 1992.

| Proportion 1 | | | | |
|--------------|---|--|--|-------------|
| | Wt. of oven dried block(M ₁)g | Wt. of block immersed in water(M ₂)g | Water absorption (%) [(M ₂ - M ₁)/ M ₁] | Average (%) |
| 7 days | 970.6 | 1100.6 | 13.39 | 13.87 |
| | 1325.5 | 1505.5 | 13.60 | |
| | 990.7 | 1135.7 | 14.63 | |
| 14 days | 2200 | 2456.8 | 11.6 | 12.9 |
| | 1700 | 1927.5 | 13.3 | |
| | 1700 | 1934.6 | 13.8 | |
| 28 days | 2008.2 | 2233.8 | 11.23 | 11.37 |
| | 1678.5 | 1855.9 | 10.56 | |
| | 1500.5 | 1685.4 | 12.32 | |

Proportion-2:-

| COWURINE 50% REPLACEMENT WITH WATER | | | | |
|-------------------------------------|---|--|--|-------------|
| | Wt. of oven dried block(M ₁)g | Wt. of block immersed in water(M ₂)g | Water absorption (%) [(M ₂ - M ₁)/ M ₁] | Average (%) |
| 7 days | 960.2 | 1080 | 12.47 | 12.62 |
| | 1223.5 | 1380.5 | 12.83 | |
| | 1234.7 | 1390.2 | 12.58 | |
| 14 days | 2121 | 2378.8 | 12.11 | 11.58 |
| | 1750 | 1960.5 | 12.0 | |
| | 1745 | 1930.6 | 10.63 | |



(a) blocks kept for dry testing, figure (b) blocks tested as per IS 3495 (part1) 1992

V. CONCLUSION

- This study determines various physical properties of stabilized mud blocks (SMBs) with use of industrial waste as one of its compound. The soil used was classified as SC (clayey sand) based on the particle size distribution of the soil. The strength properties of the blocks with varying percentage of soil, sand, lime, industrial waste and cement are studied to optimize the mix proportions for making SMBs.
- Mixed proportion for the optimum ratio was found out by standard proctor test and unconfined compressive strength test results, which shows that proportion-1 (25% soil, 40% sand, 15% DE, 7% cement, 2% lime) was the most stable and the most stabilized one as compared to all the remaining various samples. It was found that 28 days compressive strength of proportion I was 8.88, which is obtained by adding only water for mixing.
- It was found that 14 days compressive strength of proportion I was 3.92, which is obtained by adding 50% cow urine and 50% water. It was found that 14 days compressive strength of proportion I was 4.97, which is slightly higher than the proportion 2.
- However the water absorption of proportion 1 for 14 days is 12.9% as compared to the 11.58% for the proportion 2.
- The average water absorption for proportion 1 blocks was less than 15% satisfying the IS recommendation. From the observed values of engineering properties as listed above, it can be inferred that the Stabilized Earth blocks are a cost effective building material.

REFERENCES

- [1] S E Lambert and D G Randall, "Manufacturing bio-bricks using microbial induced calcium carbonate precipitation and human urine" *Water research*, vol.160, pp.158-166, 2019.
- [2] C Udawatha and R Halwatura, "Character of lime as an alternative stabilizer to improve the long term strength of mud concrete block" *International journal of structural engineering and construction management*, vol.65, pp.122-132, 2017.
- [3] I Papayianni and V Pacht, "Constructional characteristics and restoration aspects of historic earth block structures, *Research on engineering structures & materials*, vol.1, pp.39-51, 2014.
- [4] Periasamy Anbu, Chang-Ho Kang, Yu Jin Shin and Jae-Seong So, "Formations of calcium carbonate minerals by bacteria and its multiple applications", 2016.
- [5] Anil Garg, A Yalawar, A Kamath and J Vinay, "Effect of varying cement proportions on the properties of compressed stabilized earth blocks - A sustainable low-cost housing material"