UTILIZATION OF BLACK COTTON SOIL IN THE MANUFACTURE OF BRICK

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***Abstract*— Over a past few decades, there are wide ranges of alternatives available in the field of construction with the changing in the raw material for the particulars. As concern with the brick there are some invention like fly ash brick, concrete blocks and brick. Here we are using black cotton soil as a raw material for the bricks and also using some admixture to alter the properties of the black cotton soil. This research study describes the feasibility of using black cotton soil as a raw material with some additional stabilizer in the brick production as partial replacement of clay in Indian context.**

I. INTRODUCTION

A Brick is a block or a single unit of a ceramic material used in a masonry construction. Typically bricks are stacked together or laid as brick work using various kind of mortar to hold the bricks together and make a permanent structure. In the world Asia produces 87% of the total production of the bricks. Moreover, the India and china are the major consumer countries of the bricks. Bricks are typically produced in common or standard sizes in bulk quantities. They have been regarded as one of the longest lasting and strongest building material used in 20th century.

Manufacturing of bricks produces harmful gases which results in substantial air pollution. As per in India produces over 60 billion clay bricks annually resulting in strong impact on soil erosion and unprocessed emissions. Use of traditional technologies in firing the brick resulted in significant local air pollution. The standard size of brick provided by IS: 2212 (1991) is (19cm × 9cm x 9cm). Bricks are laid in horizontal courses, sometimes dry and sometimes wet mortar. In some instances, such as adobe the brick is merely dried.

More usually it is fired in a kiln of some sort to make a true ceramic. Clay bricks are used in a wide range of buildings from housing to factories, and in a construction of a tunnels, waterways, bridges, etc. Their properties vary according to purpose for which they are intended, but clays have provided the basic material of construction for centuries.
The main ingredients of bricks are clay, lime, magnesia, silica, alumina, iron oxide. So, the brick is produced on a larger scale where these ingredients are easily available. The brick production graph continuously decline from last five decades in India because importing the above ingredients from outside which will resulting in higher production cost. In order to satisfy the ever increasing demand for the energy efficient building construction material there is a need to adopt cost effective, environmentally appropriate technologies and upgrade traditional techniques with available local materials. This trend attracts researcher to find probable solution of this problem with using different materials like fly ash, black cotton soil, concrete blocks, agro waste, etc.

Very few researches are on brick made up from black cotton soil among the world, though black cotton soil is easily available in Indian context. The black cotton soil is found in major portion of Karnataka, Maharashtra, west M.P., Gujarat, and Tamilnadu. The black cotton soil is easily available in India. The black cotton soil possesses a volumetric change with the changing in the moisture content, but it provides a good strength with additives.

II.OBJECTIVES

- To make an economical and eco-friendly brick
- To Increase the compressive strength of brick
- To provide the better employment in local areas.
- To use huge availability of black-cotton soil in civil industry

III.MATERIALS USED

- Black cotton soil
- Rise husk
- Coal powder
- Salt

IV.TESTS CONDUCTED ON BLACK COTTON SOIL

- SPECIFIC GRAVITY
- STANDARD PROCTOR COMPACTION TEST
- CALIFORNIA BEARING RATIO TEST
- LIQUID LIMIT TEST AND PLASTIC LIMIT TEST

i. SPECIFIC GRAVITY

Specific gravity of soil solids is defined as the weight of soil solids to weight of equal volume of water.

In effect, it tells how much heavier (or lighter)the material is than water. This test method covers the determination of specific gravity of soil solids.

Its standard value is 2.65.

Equation for specific gravity, G:

G = (W2-W1)/(W2-W1)-(W3-W4)

Table 1 Specific Gravity

TRIAL NO	1	2	3
EMPTY WEIGHT OF PYCNOMETER(W1)g	639	639	639
WEIGHT OF SOIL SAMPLE AND PYCNOMETER(W2)g	959	1006	977
WEIGHT OF SOIL SAMPLE + PYCNOMETER AND WATER(W3)g	1696	1724	1708
WEIGHT OF WATER + PYCNOMETER(W4)g	1516	1516	1516
SPECIFIC GRAVITY(g)		2.31	

ii. STANDARD PROCTOR COMPACTION TEST

Compaction is the application of mechanical energy to a soil so as to rearrange its particles and reduce the void ratio. It is applied to improve the properties of an existing soil or in the process of placing fill such as in the construction of embankments, road bases runways, earth dams and reinforced earth walls.

Observations:

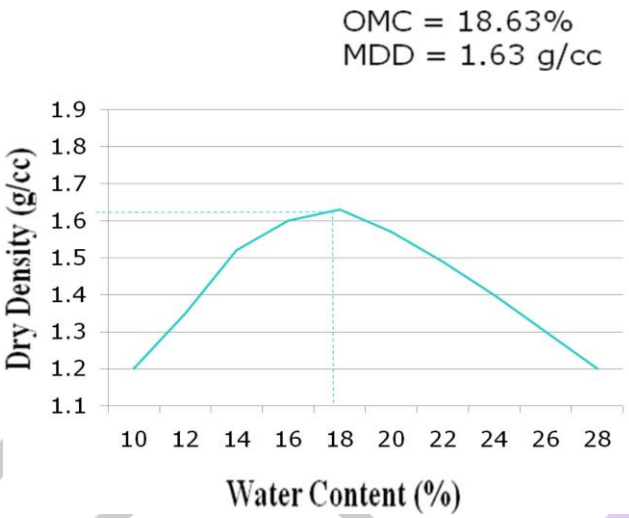
1. Quantity of soil = 3kg.
2. Wt of cylinder = 2008g
3. Diameter of cylinder = 10cm.
4. Volume of cylinder =997.45cc

Table 2.1. Standard proctor compaction test

S.No	WEIGHT OF CYLINDER + COMPACTED SOIL (g)	WEIGHT OF COMPACTED SOIL (g)	AVERAGE MOISTURE CONTENT (%)	WET DENSITY (g/cc)	DRY DENSITY (g/cc)
1	3614	1606	8	1.61	1.27
2	3764	1756	10	1.76	1.54
3	3840	1832	13	1.84	1.56
4	3928	1920	16	1.92	1.61
5	3913	1905	18	1.90	1.56
6	3894	1886	20	1.89	1.52
7	3840	1832	22	1.84	1.51

Table 2.2. Determination of moisture content

S.No	CONTAINER NO	WEIGHT OF CONTAINER + WET SOIL	WEIGHT OF CONTAINER + DRY SOIL	WEIGHT OF CONTAINER ALONE	WEIGHT OF WATER	WEIGHT OF DRY SOIL	PERCENTAGE OF WATER CONTENT
1	2	26.4	25.2	14.5	1.2	10.7	11
2	66	25.4	24.0	14.2	1.4	9.8	14.28
3	32	28.5	26.8	17.2	1.7	9.6	17.7
4	68	23.5	22.0	14.2	1.5	7.8	19.23
5	58	30.5	28.5	19.2	2.0	9.3	21.5
6	91	29.7	27.9	20.6	1.8	7.3	24.6
7	75	25.1	23.5	16.0	1.6	7.5	21.3



iii. CALIFORNIA BEARING RATIO TEST

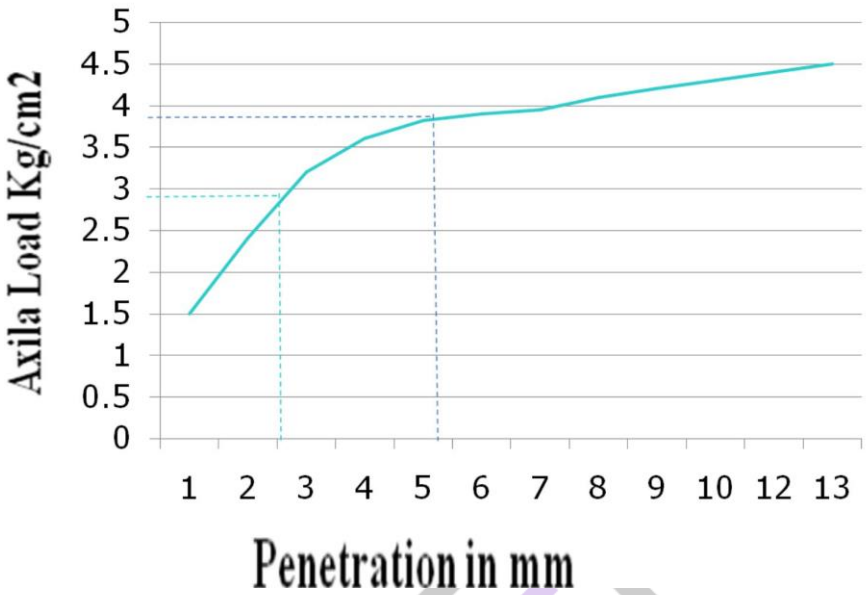
The California bearing ratio test is penetration test meant for the evaluation of subgrade of roads and pavements.
The results obtained by these tests are used with the empirical curves to determine the thickness of the pavement and its component layers. This is most widely used method for the design of flexible pavement.

Observations:

1. Quantity of soil =6kg
2. Optimum moisture content =18.63%
3. Diameter of specimen =15cm
4. Diameter of plunger =5cm
5. Area of plunger =19.63cm^2

Table 3. California bearing ratio test

S.No	PENETRATION (mm)	PROVING RING READING	LOAD IN (kg)	AXIAL LOAD IN (kg/cm^2)
1	0	0	0	0
2	0.5	8	18.19	0.93
3	1.0	13	29.55	1.51
4	1.5	18	40.92	2.08
5	2.0	21	47.74	2.43
6	2.5	25	56.83	2.89
7	3.0	27	61.38	3.13
8	4.0	31	70.47	3.58
9	5.0	33	75.02	3.82
10	7.5	34	77.29	3.94
11	10.0	36	81.84	4.17
12	12.5	37	84.11	4.28



iv. LIQUID LIMIT TEST AND PLASTIC LIMIT TEST

Liquid limit test:

The liquid limit is the moisture content at which the soil passes from the plastic state to the liquid state as determined by the cone liquid limit test.

Plastic limit test:

The plastic limit is the moisture content that defines where the soil changes from a semi-solid state to the plastic state.

It may also be defined as that water content at which soil starts crumbling when rolled into threads of 3mm dia.

Table 4. Liquid limit and Plastic limit test

S.No	PERCENTAGE OF MOISTURE CONTENT (%)	PENETRATION IN (mm)
1	11	27
2	16	51
3	21	63
4	31	80
5	36	106
6	41	150
7	46	206

LIQUID LIMIT = 30%

PLASTIC LIMIT = 46%

V. METHODOLOGY

- The black cotton soil is taken for required amount and extract the impurities like leaves roots etc present in it.
- Blend the lumps of soil completely until it comes to powdered form. After blending, add a 25% water of its total weight and Mix it thoroughly until it becomes a homogenous mix then leave it for 3days. Again after 2 days add 15%water and mix it thoroughly and leave it for 4 days.

- The wetted soil should be dried completely and make it moisture free. Now add 35% of water, 2.5% of rice husk and 2.5% of coal powder [passing through 600 micron] to the dried soil.

- Prepare the clay by adding rice husk and coal powder and mix it homogenously.

- The prepared clay now be rolled on the rice husk and coal powder and poured into the mould
- Prepare the brick by a upward lifiting of the brick mould ,After removing the mould brick can be left for complete dry.Now burn the brick in kiln to complete the brick making process.

WITH OUT USING ADMIXTURES




WITH USING ADMIXTURES

i. CLAY PREPERATION

For the preparation of ordinary black cotton soil was taken from local area of the black cotton soil region. The debris and un necessary particles removed from the soil. Tempering is adding water to the soil in order to make it more workable which takes 5 to 7 days in the case of black cotton soil.
An alternative to tempering is disintegration or weathering, which involves allowing clay to dry in the sun and accept moisture from rain and dew. The repeated drying and moistening of clay will bring clay to a plasticity and workability a proper Crushing will make the mixture more homogeneous. It is noted that at the time of making brick the soil was prepared totally dry by oven drying or sun drying.

ii. MIXING

Mixing is done to make the clay soil homogeneous and smooth. There are different techniques that can be used for mixing, including using animal power or letting humans mix the clay with their feet. Different admixtures such as coal or sawdust were added to the clay for two beneficial reasons:

1) Reduce cracking during drying.

2) Reduce fuel usage during firing.

In addition the rice husk, salt and lime was also added separately as well as combination of any rice husk-lime, salt-lime and salt-rice husk up to 5% of total weight of the soil.

iii. MOULDING

The size of a mould for brick making was selected such that considered shrinkage effect of soil take in mind. Bricks will shrink when drying, so the mould size chose larger than the intended finished brick. The slop moulding technique was adopted for the preparation of the mould. In slop molding, a wet clay mixture is used- the mix is put into a rectangular form without a top or bottom. The mould was selected in size of 190mm x 90mm x 90mm height with a frog 10 to 20 mm deep on one of its flat side. The limitation with this technique is that because the mix is so wet, the brick may deform under its own weight and the surface can be marked easily.

Often this method produces poor quality bricks because of the excess water used both in the mixing of the clay and the wetting of the mould.

The clay mixture becomes so wet and soft that the newly made brick begins to deform under its own weight. Once placed on the ground, it cannot be moved because it is so soft. Often the brick is marked or deformed if accidentally touched or moved before the brick dries properly. The excess water can also cause the brick to crack and break during drying. Slop molded bricks can be imprinted with the brick makers name, called a "frog," on the flat side of the brick. This helps the brick dry and fire better, and is a good form of advertising.

iv. DRYING

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v. FIRING

A clamp is a field kiln built from the green bricks that will be fired. Clamps vary with size and shape and must be oriented with respect to wind direction. Once a clamp is laid ssout and constructed, it must be insulated. Finally, the process of firing the clamp will take place in several steps. First, pre-heating, or water-smoking, will remove the water leftover from the drying process. This process is still physical. The second stage is firing, where the clay bricks will vitrify through a chemical process. The temperature must remain constant at this stage for complete verifications. Finally, for the cooling stage, the temperature must be slow and steady. A clamp may take two weeks to cool.

vi. CURING

The stabilized bricks after moulding are further hardened by curing. The chemical changes occur in the bricks mix contents after moulding and heat of hydration are evolved. The rate of the effect of heat of hydration is mitigated and lowered with sufficient water and alkali solution is provided to accelerate pozzolanic reaction. There are different processes of curing option.

- Steam curing under high pressure
- Steam curing under normal pressure
- Hot water dip curing
- Hot water air curing Water tank curing
- Water curing in the open air

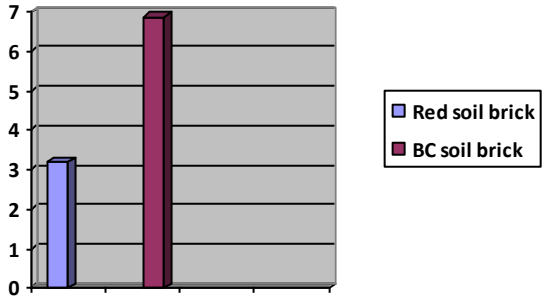
We carried out curing up to 24 hrs by using the technique of water curing in the open air.

VI. EXPERIMENTAL LABORATORY TESTS

1. Compressive strength test as per IS: 3495(Part 1) 1992

For determination of compressive strength of bricks

Compressive strength (N/mm^2) =Maximum load at failure in N/ Avg area of the bed faces in mm^2



Result: The average compressive strength of the black cotton soil brick =6.85N/mm^2

2. Water absorption test as per IS: 3495(Part 2) 1992

To determine the water absorption of black cotton soil bricks used for walls and partitions.

Water absorption =(W2-W1)/(W1)*100

Where W2= Weight of soaked brick

W1= Weight of dry brick

Result: water absorption of black cotton soil brick= 11.45%

3. Efflorescence test as per IS: 3495(Part 3) 1992S

Result : moderate : when there is a heavier deposit then under 'slight' and covering upto 50% of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.

VII. CONCLUSION

The bricks are normally produced using red soil or cementitious materials such as fly ash, GGBS etc. but the researches on production of brick is by black cotton soil is done very rarely the brick which were produced using black cotton soil is highly efficient when compared to red soil bricks. The soil is available abundantly in north Karnataka region. Black cotton soil is that type of soil which is having very good bonding strength when is added with admixture and also having much adhesive property when compared to red soil. The strength of bricks which are produced using black cotton soil are expected to be much greater when compared to the normal bricks as the soil is having good properties such as adhesions , bonding etc.

Since the cost of production in bricks are also very less compared to the other bricks , the bricks can be call as most economical and hence it can be referred for any type of constructions work.

REFERENCES

[1] Muthyalu P. V., Ramu K. et al Study on performance of chemically stabilized expansive soil International Journal of Advances in Engineering &Technology, Jan 2012.

[2] Shakir Alaa A., Naganathan S. and Mustapha K. N. (2013); Development of Brick from Waste material ; International Journal of Engineering And Technology, September-2013.

[3] Subir shri Singh; Build welt with waste ; Envis newsletter feb-2012.

[4] Bogdan, Markovska I., Hristov Y. and Georgiev D. Lightweight Material

[5] Obtained by utilized of Agricultural Waste ; Elsevier-2012.

[6] Giddel M. R. and Jivani A. P.; Waste to Wealth potential of Rice Husk in India a Literature Review ; International Journal of Engineering Research and

[7] Application (IJERA).ISSN:2248-9622, Vol,2, Issue 5, September-October 2011