

A Study on Manufacturing of Bricks using Black Cotton Soil & Red Soil

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Abstract:-- Over a past few decades, there have been a wide ranges of alternatives available in the field of construction, especially with reference to manufacture of bricks. Further, there are some inventions like fly ash brick, concrete blocks etc. There are also researches using black cotton soil as a raw material in the manufacturing of bricks along with few admixtures 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 additional stabilizer in the brick production as partial replacement of clay in Indian context. The study has revealed that the bricks manufactured using this method have good quality with acceptable strength and further, they can be manufactured in a cost effective manner.

Key Words- Adhesive Material, Brick, Black Cotton Soil, and etc.

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. Asia produces 87% of the total production of bricks. Moreover, 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.

The standard size of brick provided by IS: 2212 (1991) is 19cm × 9cm × 9cm. Bricks are laid in horizontal courses, sometimes dry and sometimes wet mortar. In some instances, such as adobe (a kind of clay used as a building material) 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. 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, though black cotton soil is easily available in Indian context. The black cotton soil is found in major portion of Maharashtra, west M.P., Gujarat, and Tamilnadu. The black cotton soil is easily available in India. The black cotton soil undergoes a volumetric change with the changing in the moisture content, but it provides a good strength with additives.

II. NEED FOR THE STUDY

Black cotton soil has very low bearing capacity, high swelling and shrinkage characteristics due to which in construction site, replacement of the black cotton soil is done with any other soil which has better geotechnical characteristics, hence it is presumed that it can be partially used for manufacturing of bricks process using additive. And ordinary clay is very expensive in local Dharwad area where as black cotton soil is cheaply available.

III. OBJECTIVES

1. To study the Physical and geotechnical properties of black cotton soil, red soil and water as per relevant manuals or IS codes.
2. To manufacture bricks using Black Cotton soil, Red soil and water, after arriving to a proper proportion by trial and error method.
3. To study physical properties of manufactured bricks by conducting various tests as per relevant IS codes.
4. To arrive effective cost per manufactured brick.

IV. METHODOLOGY

- i. The study of properties of raw materials by referring the relevant IS codes and Manuals;
- ii. Comparing and arriving at the proper proportions using the raw materials;
- iii. Manufacturing of bricks by series of trials using various proportions;
- iv. The traditional method shall be followed for manufacturing of bricks which includes the following steps:
 - a. Preparation of clay,
 - b. Moulding and
 - c. Burning.
- v. Conducting tests on manufactured bricks as per relevant IS codes.

V. LIMITATIONS

1. The water which shall be used for manufacture of bricks will be untreated.
2. During manufacture of brick, the burning process adopted will be traditional methods i.e. kiln Process.

VI. MANUFACTURING PROCESS OF BRICKS (As per Methodology)

A. General [2]

The fundamental of bricks manufacturing have not changed over time. However technological advancements have made contemporary brick plants substantially more efficient & have improved overall quality of the products. A more complete knowledge of raw materials and their properties, better control of firing, improved kiln designs and more advanced mechanization have all contributed to advancing the brick industry.

B. Materials

(i) Material allocation for Manufacturing of bricks

Sl. No.	Materials	Acquired from (location)
1	Red Soil	Maillarling Nagar, Hattikolla, Kalghatgi Road, Dharwad
2	Black Cotton Soil	Mehaboob Nagar, Near New Bus Stand, Dharwad
3	Fly Ash	Hanje Hydrotech, Sangli, Maharashtra
4	Water	Nallah, Maillarling Nagar, Hattikolla,

		Kalghatgi Road, Dharwad
5	Kankar	Available on site (the Residue of Over Burnt fragmented Bricks)
6	Coal	Paradise Charcoal Depot, Hyderabad, Telangana
7	Sodium Chloride Solution ^[1]	SDMCET, Dharwad, Civil Dept. Environment Lab.

C. Test Results on Raw Material

(ii) Environmental Tests on water

Sl. No.	Tests	Result	Permissible Range ^[10]
1.	pH Test	7.70	6.50 to 8.50
2.	Turbidity Test	3 NTU	1 to 5 NTU
3.	Alkalinity	259 mg/lit	WHO guidelines*
4.	Chloride Content Test	119.96 mg/lit.	250 to 1000 mg/lit.

(iii) Geotechnical Tests on Black Cotton Soil

Sl. No.	Tests ^{[8][9]}	Result	Permissible Range ^[3]
1.	Liquid Limit Test	26%	25% to 38%
2.	Plastic Limit	15%	--
3.	Plastic Index	11%	7% to 16%
4.	Volumetric Shrinkage Limit Test	26.26%	15% to 25%

D. Procedure for manufacturing Bricks[13]

- i. The Raw materials are initially sieved using 2.36mm sieve. The sieved Black Cotton Soil is soaked in clean water for 3-4 days, later on the supernatant water is bucketed off and top layer slurry is to be taken for manufacturing process.
- ii. The separated slurry is added with Sodium Chloride solution at rate of 0.5% by approximate weight of black cotton soil. (Sodium chloride is added at this stage to prevent lime bursting if any, lime particles is present in clay mass).



Fig. 1. Separating the Black Cotton soil Slurry

iii. The mixture of NaCl Solution and black Cotton Soil is mixed with sieved Red Soil in different proportion as described below:

(iv) Mud Mix Proportion

Trial	Black Cotton Soil Proportion	Red Soil Proportion	NaCl Solution
1	40%	60%	0.5% of total clay mass
2	50%	50%	0.5% of total clay mass
3	60%	40%	0.5% of total clay mass

Later on 10% by total gross weight of mixed clay, fly ash is added to the prepared mixture and allowed to cure for 12 hours to achieve proper consistency.



Fig. 3. Kneading of Mud



Fig. 4. Covering of kneaded mud with fly ash

iv. After 12 hours, the mixture is then moulded and laid over flat dry surface for sun drying for about 5 days.



Fig. 2. Preparation of mud in mud-pool



Fig. 5. Moulding of green Clay Mixture



Fig. 6. Sorting of moulded clay over earthen floor

- v. After 5 days, the dry bricks are transferred towards kiln for burning at range of 1000-1200°C (traditionally) for next 21 days, & then the bricks are ready to use.



Fig. 7. Sun drying of Bricks



Fig. 8. Transferring the Sun dried brick into kiln burning



Fig. 9. Removal of burnt bricks from kiln

E. Test Results on Manufactured Bricks

(v) Physical Tests on Manufactured Bricks

Sl. No.	Tests	Result			Permissible Limit ^[7]
		Trail 1	Trail 2	Trail 3	
1.	Absorption test ^[7]	18.60%	18.96%	19.55%	< 20%
2.	Crushing strength test ^[7]	56.18K g/cm ²	47.91K g/cm ²	41.91K g/cm ²	> 35 Kg/cm ²
3.	Hardness test	No impressions			--
4.	Shape and size	Rectangular cube with sharp edges and corners			--
5.	Colour test	Over Burnt	Copper Red		--
6.	Soundness test	Ringing sound			--
7.	Structure of brick	Homogeneous			--

VII. COST ANALYSIS

Cost analysis is another parameter that we have considered as manufacturer always thinks about his profit. Here we have analysed the cost for normal Red Soil bricks and also for Black Cotton- Red Soil bricks, so that we get clear figure of each brick cost.

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The following tables give the rate analyses of both bricks manufacturing process:

Note: The quantity of each material is considered for 1000 bricks.

(vi) Cost Analysis of Normal Red Soil Brick

Sl. No.	Materials	Qty.	Unit	Rate	Unit	Amount
1	Red Soil	1.05	Tonne	280	Tonne	294
2	Black Cotton Soil	--	--	--	--	--
3	Fly Ash	0.105	Tonne	1900	Tonne	199.5
4	Coal	30	Kgs	12.5	kg	375
5	Kankar Soil*	--	--	--	--	--
6	Sodium Chloride	--	--	--	--	--
	Total cost					868.5
	Water Charges @1.5%					13.03
	Labour Charge **	1000	No.	0.5	Rs.	500.00
	Material Total Cost					1381.53
	Cost of each Brick	1.38	Rs			

(vii) Cost Analysis of Black Cotton-Red Soil Bricks

Sl. No.	Materials	Qty.	Unit	Rate	Unit	Amount
1	Red Soil	0.42	Tonne	280	Tonne	117.6
2	Black Cotton Soil	0.63	Tonne	50	Tonne	31.5
3	Fly Ash	0.105	Tonne	1900	Tonne	199.5
4	Coal	30	Kgs	12.5	kg	375
5	Kankar Soil*	--	--	--	--	--
6	Sodium Chloride	1	Kgs	21	kg	21
	Total cost					744.6
	Water Charges @1.5%					11.17
	Labour Charge **	1000	No.	0.5	Rs.	500.00
	Material Total Cost					1255.77
	Cost of each Brick	1.26	Rs			

* Kankar Soil is freely available, as that is fragments of over burnt Bricks.

**Labour Charge is fixed on Lump sum bases.

comparable results between Normal Red Soil bricks & Black Cotton-Red Soil bricks

VII. RESULTS AND CONCLUSIONS

I. Results

The Project needs control in its work, hence there is a need to compare the manufactured bricks to normal bricks which are generally used in market. The following table gives the

Note: The Trial considered for comparison of Red Soil Normal Bricks and Black cotton Soil Bricks is with respect to Trial 1.

**(viii) Normal Red Soil Brick – Black Cotton Soil Brick
Comparison**

Sl. No.	Parameters	Normal Red Soil Bricks	Black Cotton-Red Soil Bricks
1	Absorption Test	< 20%	< 20%
2	Crushing Strength Test	40.56 Kg/cm ²	56.18 Kg/cm ²
3	Hardness Test	No Impression form	No Impression Form
4	Shape & Size Test	Rectangular cube with Sharp edge and Corners	Rectangular cube with Sharp edge and Corners
5	Colour Test	Copper Red (Uniform)	Dark (Over burnt)
6	Soundness Test	Ringing Sound	Ringing Sound
7	Structure of Brick	Homogenous	Homogeneous
8	Efflorescence Test	Slight	Slight
9	Cost/brick for manufacturer	1.38 rupees	1.26 rupees

II. Conclusion

1. The Physical & Geotechnical properties of Black Cotton Soil, Red Soil & water are within the permissible limits as per relevant IS codes.
2. The Physical Properties of manufactured bricks is better and are suitable for construction of common buildings.
3. All three proportions arrived during manufacturing of bricks are found effective by means of physical properties (as all proportions strength is >35Kg/cm² and other properties are satisfactory) and cost analysis.
4. As per the cost analysis, Black cotton- Red soil bricks are found to be cheaper than Normal Red soil Bricks for manufacturer and leads him towards profit (on bulk sell).

SCOPE

The Manufacturing of bricks using black cotton soil and red soil with addition of NaCl solution to the proper proportion will lead to good quality bricks which can be used for

construction purpose. The manufacturing process is suitable where Black Cotton Soil and Red Soil are locally available. Studies in continuation of this research can be initiated by manufacturing bricks by using steel slag and other additives as an admixtures with proper proportion along with the materials stated above.

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