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Red Mud Brick using Lime and Coir Fibre

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Abstract

In India, about 1 Crore tons of red mud residues are being generated per year, posing serious environmental problems. It is possible to utilize neutralized red mud in construction practice. Coir fiber has tensile strength, ability to resist cracking, spalling and increases the durability. Laterite soil needs minimum stabilization and it is durable, reduces CO2 emission and it is a good thermal insulator. Stabilization of soil becomes essential to attain adequate compression strength. In this research project coir fiber, red mud along with lime is used as stabilizers in laterite soil for improving the strength, durability of brick and thus to provide affordable housing. By implementing this technique in effective manner, bricks can increase the lifetime of structures, reduce moisture and used as an alternative building material.

Keywords; *Stabilizers, Red mud, coir fiber, lime and laterite soil*

I. INTRODUCTION

Human society has been using shelter since the days of Egyptian and Mesopotamian cultures. Before the advent of the commercial period, the invention of mechanical heating and cooling, bio-climatic means were primarily associated with achieving moderately comfortable climates within buildings [17].They have substantially less energy, contribute less CO2 emissions and contribute to the development of local labour and economy. Sand content in a range of 65% to 80% leads to a satisfactory stabilized earth brick. Selection of materials plays a vital role in deciding a building's environmental efficiency. It includes consideration of the resources and energy used during production, as well as the impact on functional factors such as indoor air quality and the building's overall energy efficiency.

Soil is a mixture of stones, gravels, straw and lime. Soil can be made into bricks by mixing with water, placing the mixture into the mould. Straw sometimes used as a binder within the bricks, it will distribute the force throughout the bricks, decreasing the chance of breakage. During the stabilization process, the plasticity of soil is reduced and will be more workable, and its load bearing properties and compressive strength are improved [13].The Red mud generated by this method is extremely alkaline with hydrogen ion concentration usually lies between ten and thirteen. Due to its hazardous corrosive nature, it is posing a really serious environmental problem [18]. For thousands of years, it was common in most parts of the world to build walls using earth bricks. KusumDelval and Kishandarvah suggested that the red mud can be used as a geotechnical material for various purposes (Soil Stabilization and improve the soil properties etc.). One can also use the red mud by stabilizing through adding lime, fly ash, gypsum [6]. From the literature survey, it is observed that red mud can be used by neutralizing it so that toxic can be removed and can increase compression strength. The use of lime reduces moisture and absorb CO2 from atmosphere. The use of coir fiber improves strength and durability. Stabilization of soil becomes

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essential to attain adequate compression strength of bricks.

II. EXTENTION OF THE PROJECT

The project's significance involves supplying low – cost construction materials. Especially in the tropical areas, stabilized earth bricks are a superior alternative considering the cost as a component. Since India is a tropical country, earth brick provides a better social environment; it does not allow too much heat from entering the building. The waste of red mud being disposed in the ground can reduce pollution.

III. OBJECTIVE

- To study about laterite soil and know about the properties.
- To research the effect on the properties and quality of stabilized mud blocks by altering important materials such as red mud, lime and coir fiber content.
- To meet the economic needs of the local situation by increasing dependence on external sources and ensuring low -cost alternatives.

IV. MATERIAL TEST RESULTS

4.1 Red Mud

In the Bayer method of extraction of aluminum oxide from bauxite, the insoluble product generated after bauxite digestion with caustic soda at elevated temperature and pressure is known as red mud [15].

Red mud is principally composed of fine particles of mud. Red mud contains silica, aluminum, iron, calcium, titanium and sodium. The use of the red mud increases the tensile and compressive strength of the bricks. Hydrochloric acid has been used for neutralization process, because it enriches the silicon oxide and aluminum oxide content of red mud eliminates harmful sodium oxide.

Table 1: Physical Properties for Red Mud

S.No	Tests	Values
1	Specific gravity	3
2	Plastic limit	32.3%
3	Liquid limit	45.5%
4	pH	7
5	Plasticity index	10.2%

4.2 Laterite Soil

Laterite has a rich iron, and aluminum. Laterite soil needs minimum stabilization, its durable and reduces CO2 emission. They are the products of intensive and enduring tropical rock, which is intensified by high rainfall.

4.2.1 Sand

Sand is nothing but grains of quartz varying in size from 0.75mm to 2.0 mm. It is hard and chemical inert. Laterite soil has 86% sand.

4.2.2 Clay

Clay particles are finer than 0.002mm.The physical characters of clay are very much dependent on presence of moisture. Laterite soil has 4% clay.

4.2.3 Gravel

Gravel is a loose aggregate of rock fragments. They are classified by particle size of 2 -20mm. Laterite soil has 10% gravel.

Table 2: Physical Properties for Laterite Soil

S.No	Tests	Values
1	Plastic limit	34.77%
2	Liquid limit	46.02%
3	Specific gravity	2.80
4	Plasticity index	11.25%

4.3 Lime

Lime is a cementing material for construction. Lime is formed by burning calcined at 900°c. Lime is used for stabling soil. Lime provides benefits to bricks in both plastic and hardened state. It can be used in building, as they are vapour permeable and hence reduces risk of moisture. They have the property of self-healing if micro cracks develop. Lime absorbs CO2 from atmosphere and plasticity reduction.

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Table 3: Physical Properties for Lime

S.No	Tests	Values
1	Initial setting time	120 minutes
2	Final setting time	24 hours
3	Standard consistency	30%
4	Fineness	10%
5	Specific gravity	2.5

4.4 Coir Fibre

Coir fiber is a natural fiber that is obtained from the coconut husk. It is the fibrous material found between the hard, internal shell and the outer coat of coconut. Coconut fiber has regarding 48thof lignin that adds strength and elasticity to the cellulose primarily based fiber walls. Coconut fiber diameter ranging between 0.29 mm and 0.83mm, length between 6mm and 24mm and approximate mean aspect ratio of 150.

V. TESTING OF BRICKS

5.1 Collection of Samples

Laterite soil was collected from hill region and red mud from aluminium waste. Hydrated lime is used as a binder. The samples were properly dried.

5.2 Mould

Mould was prepared with dimensions 210mm x105mm x 75 mm size by wood.

5.3 Proportions of the Materials

The different ratios of brick stabilizers used are,

Table 4: Material Proportions

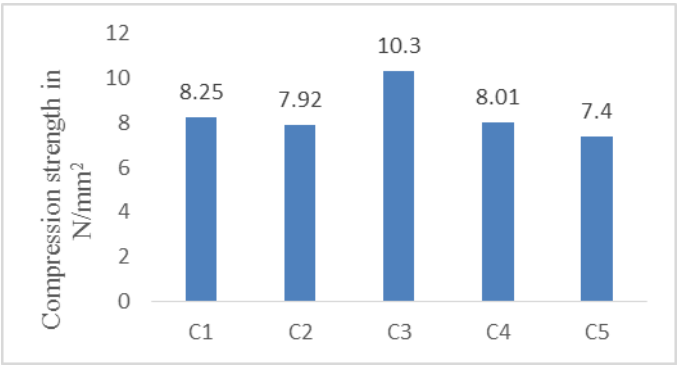
ID	LateriteSoil (%)	Red Mud (%)	Lime (%)	Coir (%)
C1	100	0	0	0
C2	80	8	10	2
C3	80	10	7	3
C4	80	12	4	4
C5	80	14	1	5

5.4Compressive Strength

Compression strength test on the red mud bricks (210x105x75mm) with varying proportions of red mud, coir fiber and lime. Compressive strength of each red mud brick was tested in the compression-testing machine. The maximum compressive strength was obtained by 10.3 N/mm2 for the red mud brick with 10% red mud, lime 7% and 3% coir fiber. Compression test results are shown in Table 5as per IS 1077-1992.

Table 5: Results of Compression Test

S.NO	Identification Mark	Area (mm)	Strength (N/mm^2)	Compressive strength (N/mm^2)
1	C1	210x105	8.5	8.25
		210x105	8.2	
		210x105	8.05	
2	C2	210x105	8.06	7.92
		210x105	7.83	
		210x105	7.87	
3	C3	210x105	10.5	10.3
		210x105	9.4	
		210x105	10.3	
4	C4	210x105	8.1	8.01
		210x105	7.9	
		210x105	8.04	
5	C5	210x105	7.5	7.4
		210x105	6.91	
		210x105	7.8	



Graph 1: Compression Strength

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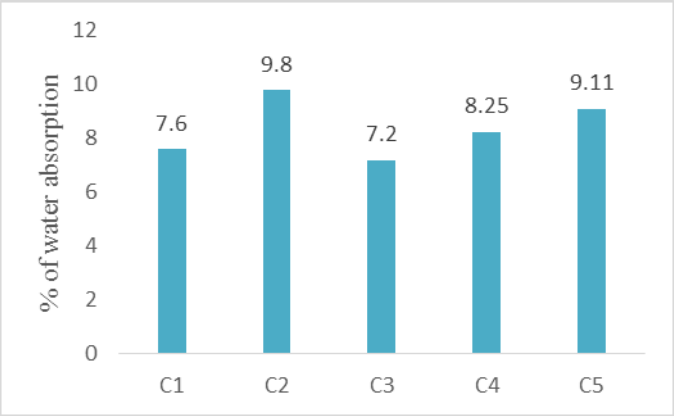
5.5 Water Absorption

As per IS 3495(Part-2)1992 specification the allowable water absorption is 15%. Results of water absorption test are given in the Table 6.Adding 10% red mud satisfies the water absorption criteria. The brick with 10% red mud, 7% lime and 3% coir fiber showed reduced water absorption rate of percentage.

Table 6: Results of Water Absorption Test.

S.NO	ID mark	Weight of dry brick (W_1)	Weight of wet brick (W_2)	Amount of water absorption (%)	Avg (%)
1.	C1	3550	3801	7.2	7.6
		3490	3786	7.95	
2.	C2	3880	4285	10.4	9.8
		3914	4279	9.2	
3.	C3	4000	4300	7.52	7.2
		3950	4220	6.83	
4.	C4	3820	4136	8.27	8.25
		3933	4257	8.23	
5.	C5	3850	4294	8.94	9.11
		3838	4188	8.23	



Graph 2: Water Absorption

5.6 Efflorescence Test of Bricks

The alkalis present in bricks because brick surface efflorescence. For 24 hrs, Brick is immersed in water. It is then removed and dried in the shade. The absence on its surface of white deposits indicates the lack of soluble salts. Observation is performed with naked eyes and classified as slight.

VI. CONCLUSION

The present study on the strength characteristics of red mud brick with lime and coir fiber significantly improved the strength. With 10% red mud, 7% lime and 3% coir fiber the compression strength obtained is 10.3 N/mm2 and the water absorption of 7.2%. Since by adding more offered mud in the bricks the strength of bricks decreases and can be concluded that red mud should not be more than 10%. From the above detailed study on Red mud brick that made can be used for constructions and satisfies the IS criteria.

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