AN EXPERIMENTAL INVESTIGATION ON THE EFFECT OF REPLACEMENT OF FINE AND COARSE AGGREGATE BY SAWDUST IN SOLID CONCRETE BLOCKS FOR DIFFERENT MIX PROPORTIONS

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Abstract:

The need for natural aggregates has intensified in the field of building and construction lately which, by default, is bringing about a tremendous diminution of resources, soaring of prices and simultaneously, the developing nations are perturbed about the management of the wood waste or sawdust.

This paper propounds the salient features of an experimental study based on Timbercrete blocks produced by partial replacement of coarse and fine aggregates with sawdust. Various features like compressive strength, water absorption and density were studied at various replacement percentages. To assess the performance of timbercrete blocks at multiple replacement percentages and experimental study was conducted. Hence, blocks of dimensions 150mm×150mm×150mm were tested, for the aforementioned characteristics, at various replacement percentages of both coarse and fine agglomerates. As a manoeuvre, a concrete assortment of 1:2:4 was used where sawdust was utilised to replace 5%, 10% , 15%, 20% and 25% of the aggregates gradually."Gunny bag curing" was administered as a method of choice for curing. After the experiment was carried out, the compressive strength for 5%, 10% , 15% ,20% and 25% blocks was recorded as 9.87N/mm^2 , 8.48N/mm^2 , 5.2N/mm^2,3.78N/mm^2 and 2.66N/mm^2 respectively after 28 days.

Keywords: Timbercrete, Sawdust, Compressive strength, Density, Water absorption, Gunny bag curing.

Introduction

India being one of the fastest developing countries of the world currently, due to its advancing industrialization and economy, is undergoing a colossal progression in the urbanization.

As a matter of fact, urbanization begets an epic rise in the population density which in turn engenders tonnes of contaminants being released into the natural environment each day and each second. This surge necessitates a crucial requisite of an efficient and economically reasonable housing which is eco-friendly at the same time.

On account of this, the engineers and scholars have been striving to develop a better - rapid, cheaper , more effective and environmental friendly materials and techniques to meet this indispensable demand.

The conventional load bearing structures are supplanted by framed structures where the partition walls act as screens for privacy but not for load endurance excluding their self-weight. Hence, a low density , low strength material can be availed to minimize these dead loads.One such preference - timbercrete might be a breakthrough in this regard.

Mud bricks, which are presently utilised, use fertile soil thus giving heavy self-weight and in addition , requires burning thus creating an ecological hazard. On the contrary , no tree has ever been cut down to produce timbercrete. The sawdust is procured from the sawmills where its a by-product in multiple shapes and sizes. This sawdust , otherwise dumped into the land or burnt deteriorating the environment, is better utilised, which is like harvesting gold from dust.

The coarse and fine aggregates extracted from either stone crushing or from the rivers etc. This however reduces the self-cleaning potential of these rivers.

Sawdust has a density of 400-600 kg/m^3 and can be used to moderately replace these aggregates to produce the

concrete blocks possessing low density , substantial strength at low cost.
IS 2185 (Part 1) 2005 approves an average strength of 3.5N/mm^2 and 2.8N/mm^2 individual unit strength.

Materials used:
For the manufacture of timbercrete , the following materials were utilised:
1) cement (OPC) 43 grade
2) local sand and coarse aggregates (10mm)
3) sawdust mix from a local mill
150 mm×150mm×150mm solid blocks were made in laboratory setting. Mix ratio of 1:2:4 was taken up.The practical procedure followed the hereunder course:

Mixing : The materials were weighed carefully and subsequently mixed in a mixer.

Casting : Compaction was done using an electrically vibrating machine. Moulds of 150mm×150mm×150mm were casted at the enlisted percentages : 5% , 10% , 15% , 20% and 25%.Later, demoulding was done after the next 24hrs and 7 cubes of each mix were casted.

Curing : Gunny bag curing was administered as the method of choice for curing.

Testing : The blocks thus produced were tested for their compressive strength at 7, 14 and 28 days.

Characteristics of materials:

1. Fineness modulus of sawdust : 3.7
2. Fineness modulus of sand : 2.4
3. Moisture content of coarse aggregate : nil
4. Moisture content of fine aggregate : 0.5 %
5. Specific gravity of sand : 2.67
6. Specific gravity of coarse aggregate : 2.71
7. Fineness modulus of coarse aggregate: 6.9
8. Specific gravity of cement: 3.15

Results and discussion:

1.Compressive strength :

The variation of compressive strength with curing age after partial replacement of coarse and fine aggregates with sawdust under gunny bag curing is given here under.

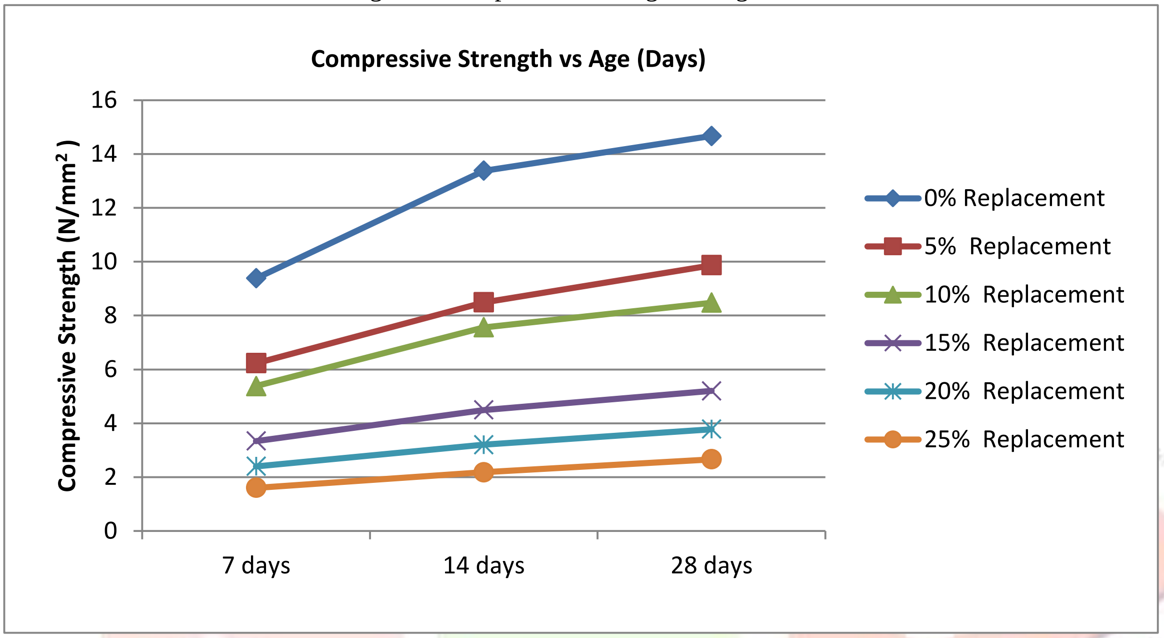
TABLE 1

Compressive Strength of various mix proportions of Cement, Sand, Coarse Aggregates and Sawdust

S.no	Proportions					Compressive strength (N/mm^2)		
	Cement	Sand	Coarse aggregate	Sawdust	Water cement ratio	7 days	14 days	28 days
1	1	2	4	0%	0.50	9.38	13.38	14.67
2	1	1.9	3.8	5%	0.55	6.23	8.49	9.87
3	1	1.8	3.6	10%	0.60	5.38	7.56	8..48

4	1	1.7	3.4	15%	0.65	3.34	4.49	5.2
5	1	1.6	3.2	20%	0.70	2.4	3.2	3.78
6	1	1.5	3.0	25%	0.80	1.6	2.18	2.66

Figure 1 Compressive Strength vs Age



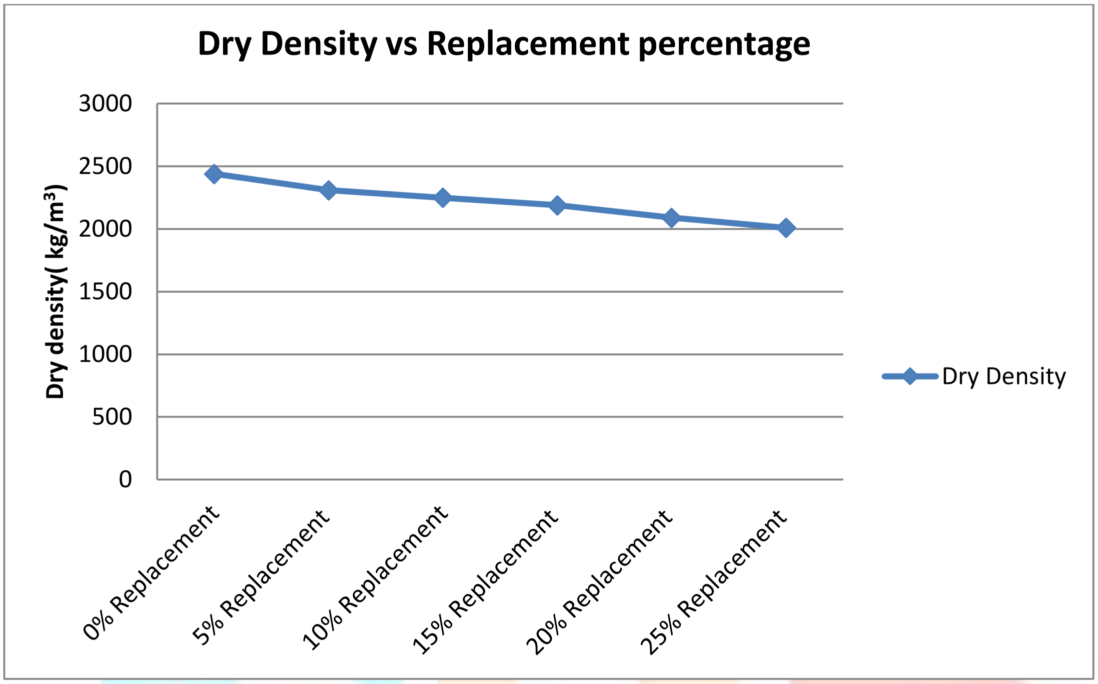
2.Density :

The concrete density relies upon the aggregate and sawdust ratio. It was observed that with the increase in the percentage of sawdust, the density decreases. The change of density with the change in sawdust replacement percentage is depicted in the following table 2

Table 2 Dry Density at various mix proportion

S.no	Proportion				Dry density(kg/m^3)
	Cement	Sand	Coarse aggregate	Sawdust	
1	1	2	4	0%	2440
2	1	1.9	3.8	5%	2310
3	1	1.8	3.6	10%	2250
4	1	1.7	3.4	15%	2190
5	1	1.6	3.2	20%	2090
6	1	1.5	3.0	25%	2010

Figure 2 Dry Density vs Replacement percentage



3. Water absorption:

Sawdust is very much prone to moisture and as a consequence, water absorption enhances with increase in the amount of sawdust. Each block was tested for water absorption on the 28th day of the experiment.

Table 3 Water Absorption Percentage at various mix proportions

S.no	Proportion				Water absorption (%)
	Cement	Sand	Coarse aggregate	Sawdust	
1	1	2	4	0%	0.55
2	1	1.9	3.8	5%	1.38
3	1	1.8	3.6	10%	2.63
4	1	1.7	3.4	15%	3.77
5	1	1.6	3.2	20%	5.5
6	1	1.5	3.0	25%	7.35

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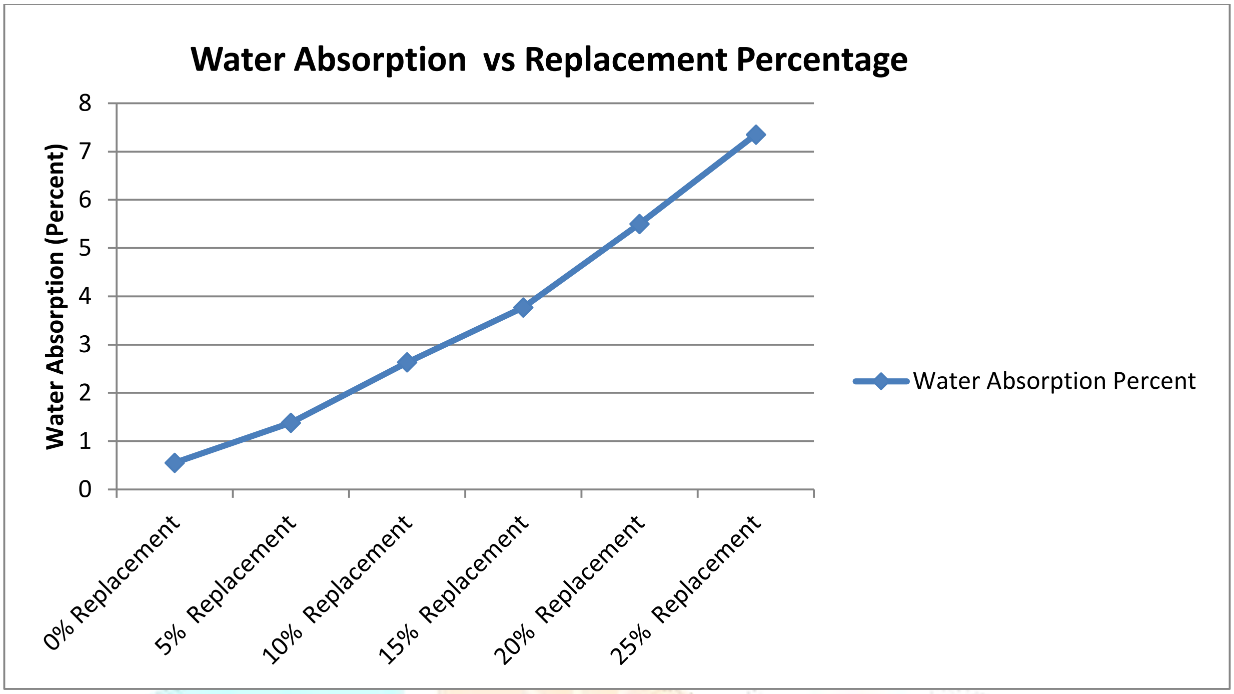
Figure 3 Water Absorption at various mix proportions



Analysis of the result and discussion

To introduce the sawdust usage in timbercrete blocks, an experimental analysis was done. All the analysis and results so obtained have been presented graphically and in the form of table's .The table 1 and the quintessential nature of the graph shown in fig.1 shows that with increase in the percentage of sawdust used compressive strength reduces significantly. Therefore, the partition walls in case of framed structures can be constructed from the timbercrete blocks to minimize the dead load along with cost reduction. The average value for strength needed for the partition walls ranges from 3.2 to 5 and can be achieved appreciably by proper curing to the mix of 1 : 1.7 (0.3) : 3.4 (0.6) or 15% replacement.

On density analysis, it was observed that density reduces with enhance in the percentage of sawdust. The results are depicted in table 2.The density of timbercrete with the mix 1:2:4 and 15% replacement was found to be 2190.

The absorption of water is allowable up to some degree however , excess absorption culminates in leaching of rain water into the blocks , their shrinkage following drying and ultimately , cracking of the blocks .

With increase in the percentage of sawdust there is a remarkable increase in the water absorption too. It is however noted that it's only the percentage of sawdust resulting in the increase of water absorption. For 1:2:6 ratio with 15% replacement factor the water absorption is 3.77% which is permissible.

Timbercrete influences the cost factor also more like other characteristics. The costs can be brought down by about 15% - 20% figure if timbercrete supersedes the conventional blocks.

Conclusion:

The utmost aim of the study was to focus on the role of sawdust in the timbercrete blocks.

1. Compressive strength of the blocks is the kingpin for the construction purposes which are to be kept in mind. The strength of the blocks of mix 1:2:4 and 15% replacement was 5.2 which is both efficient and economical enough to be used in the partition walls of framed structures.
2. Density of the blocks is inversely proportional to the sawdust percentage. A mix of 1:2:6 with 15% replacement is found appreciable for both compressive strength and density factors.
3. Water absorption tendency potential with increase in the percentage of sawdust. Excess water absorption causes decrease in the strength. However, the water absorption can be maintained within a permissible perimeter.
4. Gunny bag curing was opted over Complete submerge curing attributed to the fact that sawdust causes more voids in the blocks hence rejecting cement.

5. Further more research and study is required on the subjects of fire proof and thermal resistance properties, quality of sawdust and their effects on the compressive strength, bending strength, hardness, and shear strength.

The realm of the study can further be widened to encompass the hollow concrete blocks and other blocks.

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