Replacement of Cement by Sugarcane Bagasse Ash and Sawdust in Partial Paver Blocks: A Comparative Study

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ABSTRACT

The use of industrial waste materials as supplementary cementitious materials in construction has gained significant attention due to their potential for sustainable development. Sugarcane bagasse ash (SCBA) and sawdust are two such waste materials that are widely available and have the potential to be utilized as partial replacements for cement in concrete. In this research paper, the effect of partial replacement of cement by SCBA at different percentages (8%, 10%, 12%, and 14%) and replacement of sand by sawdust at 20% on the properties of paver blocks was investigated. Compression strength and water absorption tests were performed on paver blocks at different curing ages (7, 14, and 21 days) with an average of 5 blocks for each proportion to evaluate their mechanical properties and durability.

Keywords: Sugarcane bagasse ash, sawdust, paver blocks, partial replacement, compression strength, water absorption, curing age.

1. INTRODUCTION

Paver blocks are the most widely used material in pavement due to its durability and strength. However, the production of cement, which is a key ingredient in concrete, is associated with significant energy consumption and greenhouse gas emissions. Hence, there is a growing interest in finding alternative materials to replace cement partially in concrete to reduce its environmental impact. Industrial waste materials, such as sugarcane bagasse ash (SCBA) and sawdust, are being explored as potential replacements for cement in concrete due to their availability, cost-effectiveness, and sustainability.

Sugarcane bagasse is a by-product of the sugar industry and is generated in large quantities worldwide. SCBA is a pozzolanic material, meaning it can react with calcium hydroxide to form calcium silicate hydrate, which is responsible for the strength of cementitious materials. Sawdust is a by-product of timber processing and is rich in organic matter. It can be used as a partial replacement for sand in concrete, as it can improve the workability and reduce the density of the concrete.

In this study, the effect of partial replacement of cement by SCBA at different percentages (8%, 10%, 12%, and 14%) and replacement of sand by sawdust at 20% on the properties of paver blocks was investigated. Compression strength and water absorption tests were performed on paver blocks at different curing ages (7, 14, and 21 days) to evaluate their mechanical properties and durability.

2. MATERIALS AND METHODS

Materials:

The materials used in this study were:

Ordinary Portland cement (OPC) of grade 53 conforming to IS 12269:2013.

Sugarcane bagasse ash (SCBA) obtained from a local sugar mill.

Sawdust obtained from a local timber processing unit.

Coarse aggregates of size 20 mm conforming to IS 383:2016.

Fine aggregates (sand) conforming to IS 383:2016.

Water conforming to IS 456:2000.

Mix Proportions:

A total of five mix proportions were prepared by replacing cement with SCBA at different percentages (8%, 10%, 12%, and 14%) and replacing sand with sawdust at 20% by volume. The control mix without any replacement was also prepared for comparison.

Sample Preparation:

Paver blocks of size 200 mm x 100 mm x 60 mm were cast using the prepared mix proportions. The concrete mix was mixed in a mechanical mixer for 5 minutes and then cast into the paver block molds. Total 40 blocks were casted and kept for drying for 24 hours and then were demoulded and cured into the curing tank for 28 days respectively.

3. RESULTS AND DISCUSSION

3.1 SLUMP CONE TEST

This test is performed to check the consistency of freshly made concrete before pouring it into the mould. Consistency is a term which is closely related to workability. It is a term which describes the state of fresh concrete. It also refers to the ease with which the concrete flows. This is used to indicate the degree of wetness. The following concrete was a true slump

Table 1. Results of Slump cone test

SCBA%	Slump 1 (mm)	Slum p2 (mm)	Slump 3(mm)	Average
0	152	156	157	155
8	126	130	132	129.3
10	120	126	124	123.3
12	113	116	115	114.6
14	106	108	106	106.6

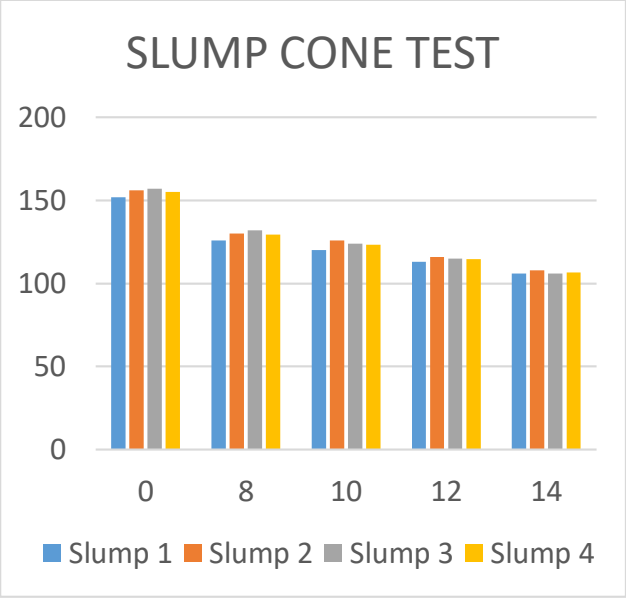

Fig1. Slump cone test results

3.2 COMPRESSION TEST

The compressive testing machine was used to test the entire concrete paver blocks for crushing strength at 7, 14 and 28 days

respectively. The compressive strength for concrete grade M35(1:0.5:1)were investigated for the control mix and while cement was partially replaced by SCBA. The results of compressive strength test at different curing periods are provided in table

TABLE2: Compressive strength results

SCBA %	7Days (N/mm2)	14 Days (N/mm2)	28Days (N/mm2)
0	33.03	41.8	46
8	28.1	36.13	40.52
10	39.4	42.41	48.8
12	38.02	40.43	44.5
14	37.05	40	42.05

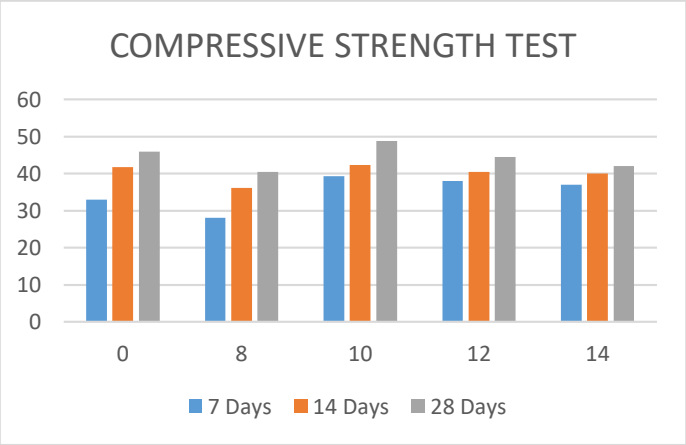

Fig2. Compressive strength of M35 concrete

3.3 WATER ABSORPTION TEST

After the blocks were demoulded, they were kept in water for 7 days, 14 days and 28 days. When they are then weighed, this weight is recorded as the wet weight of the paving blocks. The sample was dried at 110°C until the mass was constant. Weight was recorded as dry weight. Water absorption = [(weight-dry weight)/dry weight].

The water absorption rate will take an average of three units, the water absorption of the paver
blocks should not exceed 6% by mass and the water sample alone should not exceed 7%.

TABLE 3: Water absorption test results

SCBA%	7days	14days	28days
0	3.7	3.1	2.9
8	4.4	3.9	3.6
10	5.8	5.12	4.9
12	8	7.6	7.3
14	8.5	8.0	7.9

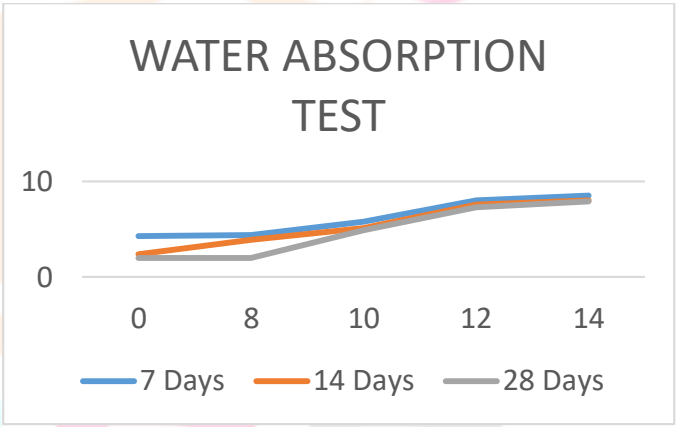

Fig3. Water absorption test

4. CONCLUSION

The study showed that the SCBA can be partially replaced by cement by 10% along with sawdust replaced by 20% of sand. The maximum compressive strength was achieved 48.8 N/mm2 which is 6.2% higher of conventional paver block with water absorption of 4.9%.Overall, the use of SCBA and sawdust as partial replacement of cement and sand, respectively can provide a sustainable solution to reduce the environmental impact of concrete production

and enhance the durability of paver block in high traffic area.

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