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# Optimization of Waste Materials Proportions for Modified AAC Block: A Comparative Study

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**Abstract**: In this study, the development of AAC Block using waste foundry sand, sugarcane bagasse ash, and fly ash was investigated. The objective of this study was to determine the properties of the modifeied AAC blocks and compare them with conventional bricks. The study also aimed to investigate the optimal proportion of waste materials for making blocks. The proportions of SCBA by 0%, 2.5%, 5%, 7.5% & 10%, foundry sand by 0%, 10%, 20%, 30% & 40%, and fly ash were varied, and specimens were cast and cured according to standard procedures. The specimens were then tested for compressive strength, dry weight, and water absorption at 28 days. The results showed that the Modified AAC blocks had satisfactory properties and compared favourably with conventional bricks.

**Keywords:** Baggase ash, Foundry sand, Compression, Water absorption, AAC Block

## I. INTRODUCTION

Bricks are the basic building materials used in construction. Conventional bricks are made from clay, which is a non-renewable resource, and their production has adverse environmental impacts. The use of waste materials in block production is gaining importance due to the potential benefits it offers in terms of cost reduction and environmental sustainability. In this study, the waste foundry sand, sugarcane bagasse ash, and fly ash were used to develop AAC blocks.

## II. OBJECTIVE

1. To identify the Compressive Strength of AAC Block with different proportion of foundry sand & bagasse ash.
2. To identify the water absorption of AAC Block with different proportion of foundry sand & bagasse ash.
3. To determine the Weight of AAC with different proportion of foundry sand & bagasse ash.
4. To compare the production costs between Conventional bricks and AAC blocks.

## III. EXPERIMENTAL WORK

1. Materials used

1.1. Cement - IS mark 53-grade OPC was used in all of the mixes, and the testing was carried out in accordance with IS: 8112-1989. And the physical & chemical characteristics of the Cement are described in the Table 1.
1.2. Foundry sand (FS) is industrial by-products which have been disposed earlier are now being considered for beneficial use. Foundry sand is a discarded material coming from ferrous and nonferrous metal-casting industry. It's a mixture of high-quality size-specific silica sand, few amounts of impurity of ferrous and nonferrous by-products from the metal casting process itself and a variety of binders. And the physical & chemical characteristics of the FS are described in the Table 2.
1.3. Sugarcane bagasse (SCBA) is a fibre derived from the day-old sugar cane, left after extraction of its main ingredient - sugar. It has a potential to partially replace Portland cement. The physical & chemical characteristics of the SCBA are described in the Table 3.
1.4 Fly ash (FA) is a by-product of industry that is used to lower construction costs. Fly ash has a density of 400 to 1800 kg/m3. It offers sound absorption, fire resistance, and thermal insulation. The fly ash used is Class C, has a 20% lime (CaO) content, and has an ignition loss of no more than 6% is used in experiment.
1.5 Limestone includes calcite and aragonite.
1.6 Aluminium is an expansion agent. When the raw material reacts with aluminium powder, air bubble introduced due to reaction between calcium hydroxide, aluminium and water and hydrogen gas is released.

Figure1.1- AAC Block

2. Mix proportion, procedure:-

The SCBA, foundry sand, and fly ash were mixed in varying proportions to determine the optimal proportion of waste materials for making blocks. The proportions of SCBA by 0%, 2.5%, 5%, 7.5% & 10% and foundry sand by 0%, 10%, 20%, 30% & 40%. The specimens were cast in standard sizes of 500x200x100 mm [IS 2185 (Part 3) – 1984] for blocks, respectively. The specimens were cured for 28 days and tested for compressive strength, density, and water absorption. The test results were analysed, and the properties of the developed blocks were compared with those of conventional bricks.These blocks were analysed for both mechanical & durability properties of the concrete blocks. And the mix proportions were shown in the Tables 4 & 5.

Table 1 Properties of Cement

| Sr.no | Property of cement | Result |
|---|---|---|
| 1 | Normal consistency | 28% |
| 2 | Initial setting time | 85 min |
| 3 | Final setting Time | 380Min |
| 4 | Specific gravity | 3.15 |

Table 2 Properties of Foundry Sand FS.

| S. No. | Properties | Value |
|---|---|---|
| 1 | Specific gravity | 2.48 |
| 2 | Bulk relative density kg/m3 | 2489 |
| 3 | Finesses Modulus | 1.94 |
| 4 | Moisture content | 0.10 |

Table 3 Property of Sugar Cane Baggasse ash SCBA.

| S.No. | Properties | Remark |
|---|---|---|
| 1 | Colour | Burnish Black |
| 2 | Specific Gravity | 2.52 |
| 3 | Density | 1.90 $g/cm^3$ |

Table 4 Mix proportions for Baggasse ash

| Mixes Coarse | Cement (gm) | Fly ash (gm) | Gypsum (gm) | Limestone powder (gm) | Aluminium Powder (gm) | Baggasse ash (gm) | Water (ml) |
|---|---|---|---|---|---|---|---|
| 0% | 480 | 2350 | 30 | 240 | 5 | 0 | 1500 |
| 2.5% | 480 | 2292 | 30 | 240 | 5 | 58 | 1500 |
| 5% | 480 | 2233 | 30 | 240 | 5 | 117.9 | 1500 |
| 7.5% | 480 | 2174 | 30 | 240 | 5 | 176 | 1500 |
| 10% | 480 | 2115 | 30 | 240 | 5 | 235 | 1500 |

Table 5 Mix proportions for Foundry sand

| Mixes Coarse | Cement (gm) | Fly ash (gm) | Gypsum (gm) | Limestone powder (gm) | Aluminium Powder (gm) | Foundry sand (gm) | Water (ml) |
|---|---|---|---|---|---|---|---|
| 0% | 480 | 2350 | 30 | 240 | 5 | 0 | 1500 |
| 10% | 456 | 2232.5 | 30 | 240 | 5 | 117.5 | 1500 |
| 20% | 456 | 1997.5 | 30 | 240 | 5 | 352.8 | 1500 |
| 30% | 456 | 1762.5 | 30 | 240 | 5 | 587.5 | 1500 |
| 40% | 456 | 1527.5 | 30 | 240 | 5 | 822.5 | 1500 |

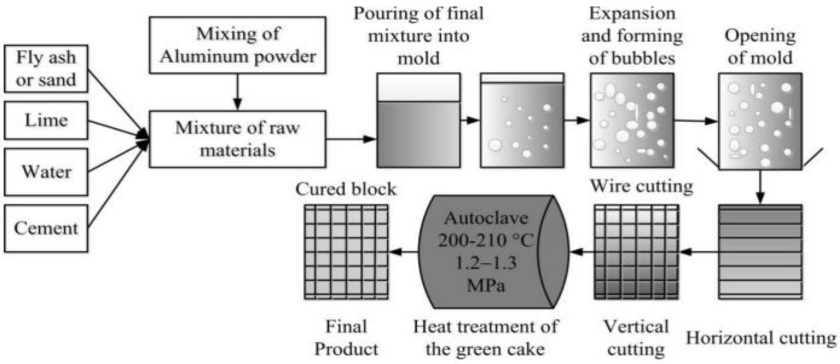



**Figure 1.2** Block diagram representing the manufacturing stages of AAC block

## IV. RESULTS AND DISCUSSION

4.1. Compression strength

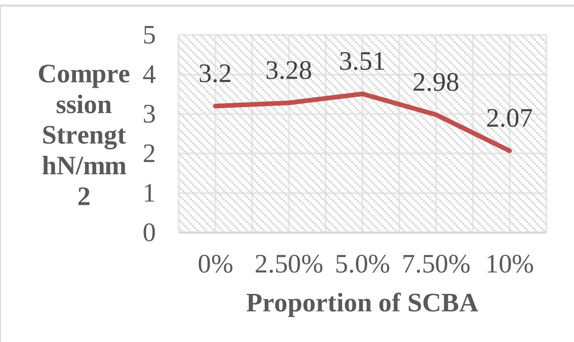
Blocks are moulded with a 500x200x100 mm of size to define the compression strength of blocks. This testing was done for a period of 7 & 28 days as per IS 2185 (Part 3) - 1984. The compressions strength is done for all the specimens for 28 days. Table 5 & 6 shows the compression strength of concrete blocks. The test results showed that the developed blocks had satisfactory properties. The maximum compressive strength of the blocks found 3.32 $N/mm^2$ & 3.93 $N/mm^2$ with use of SCBA and FS respectively. The study also found that the optimal proportions of SCBA & foundry sand for making blocks were 5%, and 40% with use of SCBA and FS respectively.

Table 5 Compression strength test for SCBA Blocks

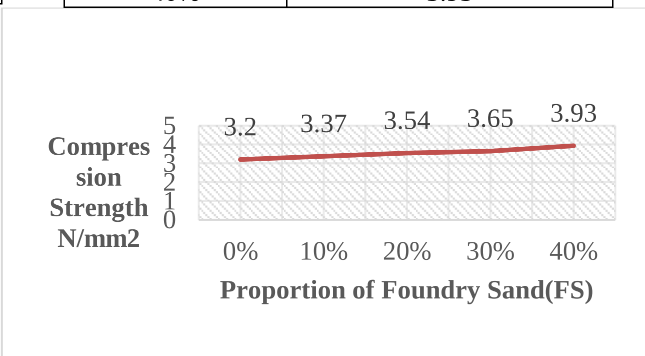
| Mixes of SCBA | Compression strength ($N/mm^2$) at 28 Days |
|---|---|
| 0% | 3.20 |
| 2.5% | 3.28 |
| 5% | 3.32 |
| 7.5% | 2.98 |
| 10% | 2.07 |

Table 6 Compression strength test for FS Blocks

| Mixes of FS | Compression strength ($N/mm^2$) |
|---|---|
| 0% | 3.20 |
| 10% | 3.37 |
| 20% | 3.54 |
| 30% | 3.65 |
| 40% | 3.93 |




Graph No.1 Compression strength of AAC Block with varying % of SCBA




Graph No.2 Compression strength of AAC Block with varying % of FS

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4.2. Water absorption

This test is conducted to determine the capacity of the water absorption of blocks. After the casting work has been done the specimen should be in oven at a constant temperature of 105 $^0$C for 24 hrs and it should be weighted and taken as w1 after that the specimen was taken out and should immersed in the water for 24 h. The specimen should be removed and wiped with dry cloth and weighed and the value should take as W2. And from the formula the percentage of the water absorption will be determined. The water absorption of the blocks ranged from 17.30% to 19.12%.
The formula for finding the percentage of the water absorption,

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

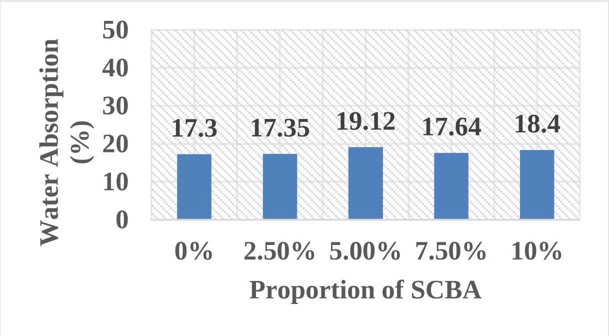
From the different types of mixes of concrete blocks the water absorption test was done and from the results, we observed that water absorption reduced with the increase of fly ash & foundry sand addition. Water absorption continuously decreased with the increase of fly-ash & foundry sand amount as shown in the table7& 8 respectively.

Table 7Water absorption test for SCBA AAC Blocks

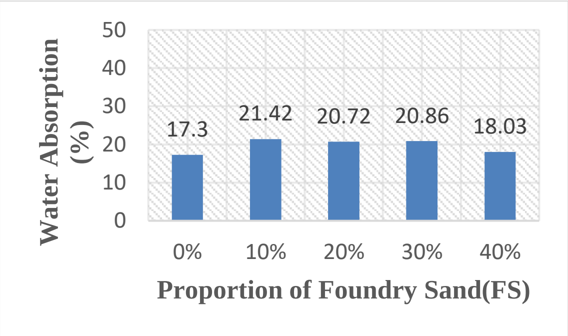
| Mixes of SCBA | Water Absorption (%) |
|---|---|
| 0% | 17.30 |
| 2.5% | 17.35 |
| 5% | 19.12 |
| 7.5% | 17.64 |
| 10% | 18.40 |

Table 8 Water absorption test for FS AAC Blocks

| Mixes of FS | Water Absorption (%) |
|---|---|
| 0% | 17.30 |
| 10% | 21.42 |
| 20% | 20.72 |
| 30% | 20.86 |
| 40% | 18.03 |




Graph No.3 Water Absorption of AAC Block with varying % of SCBA




Graph No.4 Water Absorption of AAC Block with varying % of FS

4.3. Dry Weight-

The dry weight of the blocks ranged from 0.950 to 1.105 kg with use of different % of SCBA while 1.022 to 1.9 kg with use of different % of FS as shown in Table No.09 & 10 respectively.

Table 7 Dry Weight test for SCBA & FS Blocks

| Mixes of SCBA | Dry Density ( kg/$m^3$) |
|---|---|
| 0% | 1022 |
| 2.5% | 1050 |
| 5% | 1078 |
| 7.5% | 1105 |
| 10% | 1145 |

Table 8 Water absorption test for FS Blocks

| Mixes of FS | Dry Density ( kg/$m^3$) |
|---|---|
| 0% | 1022 |
| 10% | 1601 |
| 20% | 1750 |
| 30% | 1810 |
| 40% | 1845 |

4.4 Properties Comparison

| **Properties** | **Traditional Brick** | **AAC Block** | **Modified AAC Block** |
|---|---|---|---|
| Water Absorption | 27.03% | 17.43% | 20.86% |
| Compressive Strength | 2.81 N/$mm^2$ | 3.2 N/$mm2$ | 3.32 N/$mm2$ |
| Dry Density | 1760 kg/$m^3$ | 673 kg/$m3$ | 1078 kg/$m3$ For 5% SCBA and 1845 kg/$m3$ For 40% FS |
| Weight Comparison | 2.71 kg | 0.800 kg | 1.48 kg |
| Cost per piece | Rs. 8 to10 | Rs. 7.95 | Rs.5.55 |

## IV. CONCLUSION

The study showed that waste foundry sand, sugarcane bagasse ash, and fly ash can be used to develop solid AAC blocks with satisfactory properties. The newly developed blocks compared favourably with conventional bricks in terms of compressive strength, density, and water absorption. The optimal proportion of waste materials for making blocks is . The use of waste materials in block production can help reduce the environmental impacts of conventional brick production and provide a cost-effective solution for construction. . The study also found that the optimal proportions of SCBA & foundry sand for making blocks were 5%, 30%, and 40%, respectively.

**Future Scope:**

Further research can be conducted to investigate the effect of varying proportions of waste materials on the properties of bricks and blocks. The use of other waste materials, such as rice husk ash and quarry dust, can also be investigated. The environmental impact of the newly developed bricks and blocks can be assessed through a life cycle analysis. The commercial feasibility of using waste materials in brick and block production can also be investigated.

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