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EXPERIMENTAL ANALYSIS OF THE MECHANICAL PERFORMANCE OF AAC BLOCK

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Abstract. Flyash blocks made of autoclaved aerated concrete (AAC) are lightweight employed quickly in high-rise structures. One of the sustainable materials is the AAC Block, which is made from fly ash from industrial waste. AAC block masonry in fills contribute to a structure's low weight, thermal conductivity, and speed of construction. To increase the effectiveness of the AAC block masonry, material level research is required. The literatures lack a awareness of the material level of behaviour of AAC block construction. In order to comprehend the compressive stress-strain behaviour of AAC Block masonry and its components, experimental study is described in this work. Compression testing is used to determine how well AAC block masonry responds to weak and strong mortar.
Keywords: Compressive strength, masonry prisms, and AAC block

INTRODUCTION

The behaviour of masonry infills and their impact on structural performance have varied greatly throughout India as a result of recent advancements in the materials used to build them. The infill walls used in building construction are only built for aesthetic reasons. The infills are regarded as non-structural components and are not taken into consideration while designing the structure's seismic response. Infill walls often take up a significant amount of space in RC frames. In the current study, infill is made of block masonry made of autoclaved aerated concrete. these have extra benefits that make them more comfortable for the inhabitants and are superior to red clay bricks that have been burned. Therefore, AAC infills are employed as the best substitute for clay brick infills in the majority of modern constructions. Air pollution is produced when clay brick kilns are heated; instead, the autoclave is used in the manufacturing of AAC. Additionally, one of the primary raw materials utilised in the production of AAC is flyash. AAC is a sustainable building material as a result. Compared to other construction materials, these blocks' low weight minimises the dead load on the structures. Compared to traditional clay bricks, construction with these blocks is quicker and more affordable. Infills made of AAC blocks have an impact on the stiffness and performance overall. As a result, the behaviour of AAC masonry infill as well as its prepeak and postpeak behaviour must be examined.

EXPERIMENTAL PROGRAM

Based on the numerous test processes utilised in the laboratory, the characterisation of the materials used in the masonry is described in this experimental programme. Standard codal references are used to describe the casting and testing process. The testing equipment is discussed, and the results of the experiments are compiled. AAC Brick, Mortar, and Masonry.

MORTAR CUBES PREPARATION

The mortar specimens are manufactured with Ordinary Portland Cement (OPC) of Grade 53 in two strengths, strong and weak mortar M1(1:2) and M2 (1:5).the 50mm cube moulds are used to create the mortar specimens in accordance with clause 5.3 of IS 4031 PART 7 [5]. An edge length of 50 mm is used to calculate the compressive strength of mortar cubes. For mortar ratios M1 and M2, the W/C ratio was set at 0.5. To gauge the mortar's tensile strength, ten cubes for each ratio are made. Article 9.1 states that cubes must be dried by being submerged in clean water for 28 days. Gypsum is placed to the top and bottom surfaces of mortar cubes after curing and before testing in order to smooth out any uneven surfaces and ensure that the load is distributed evenly when the mortar cube is tested. Gypsum is placed to the top and bottom surfaces of mortar cubes after curing and before testing in order to smooth out any uneven surfaces.

Figure 1 Mortar cubes

Figure 2 Gypsum applied on cubes

AAC CUBE SPECIMEN PREPARATION

Autoclaved aerated concrete blocks come in three distinct sizes for construction: The dimensions are 100x200x600mm, 150x200x600mm, and 200x200x600mm. A 150x200x600m.In accordance with IS 6441 (PART 5) 1972 [6] clause 2.1, the test specimen is made by cutting a cube with spinning blades to a 150mm edge length. Three cubes are chosen from a single AAC block using clause 2.2 as a guide: one from the upper third, one from the centre, and one from the lower quarter.Gypsum is added to the top and bottom surfaces of AAC cubes prior to testing to smooth out any uneven surfaces and provide a consistent weight distribution.

Figure 3 Gypsum applied in both surfaces

MASONRY PREPARATION PRISMS

To build the masonry prism, the AAC blocks are chopped into 200x100x70 mm pieces, the same size as a clay brick. The AAC brick masonry prisms were constructed using two cement sand proportions, or strong and weak mortars, one brick for each width brick, and five bricks for each height brick. A brickwork prism has a mortar thickness of 10 mm. A wooden frame with a 10 mm thickness, 200 mm length, and 70 mm breadth is intended to be used comfortably when creating a masonry prism in order to maintain a 10 mm uniform thickness. Appendix B of IS 1905 [3] specifies a height to thickness (h/t) or aspect ratio between 2 and 5, as well as a minimum height of 40 cm . In the current research, The aspect ratio is retained at 3.9, and IS 1905 [3] table 12 offers a correction factor for converting prism strength to brickwork. The brick prism's top and bottom sides were gypsum-coated as well. Two pieces of plywood are inserted between the top and bottom bricks during testing. Each weak and strong mortar cube has six masonry prisms. When utilising sealed gunny bags, the cure time is 28 days. On the top and bottom sides of the AAC bricks, gypsum and masonry prism were coated.

Figure 4 Masonry prism

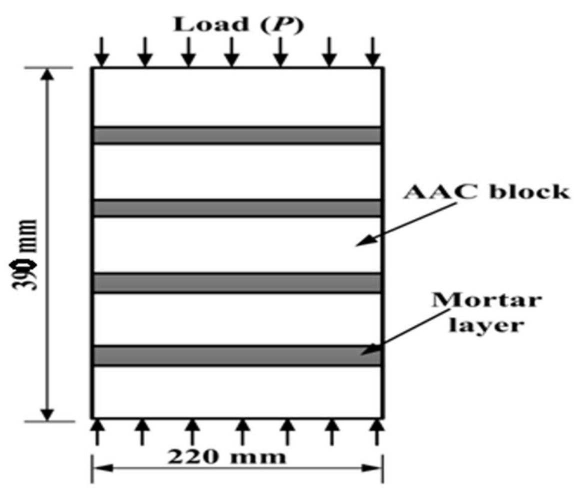

Figure 5 Drawing of AAC masonry Prism

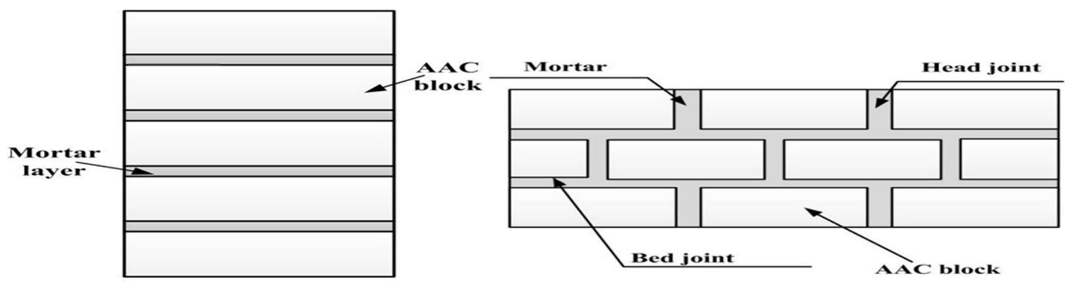

Figure 6. AAC masonry compression test schematic illustration

COMPRESSION TESTS CONDUCTED

Weak and Strong Mortar Cubes and AAC Block are tested for compressive strength utilising a Computerized Hydraulic operated Compression Testing Machine (CTM). to provide a graphical representation of the specimen load response, CTM can automatically record load and displacement data. It can also retain all the outcomes. CTM has a sensitivity of 0.8%.

AAC Masonry prisms' compressive response is tested utilising a hydraulic jack with a 1000 kN load cell and displacement control on a four-post loading frame. The steps and test outcomes are displayed.

Figure 7. CTM

Figure 8 AAC Block in CTM

COMPRESSIVE STRENGTH TEST OF AAC BLOCK

The specimen should have an edge length of 150 mm in order to measure the compressive strength of AAC blocks. According to IS 6441 (PART 5) 1972. AAC block testing is carried out at UTM. The usual AAC block graph is displayed after evaluating six samples.

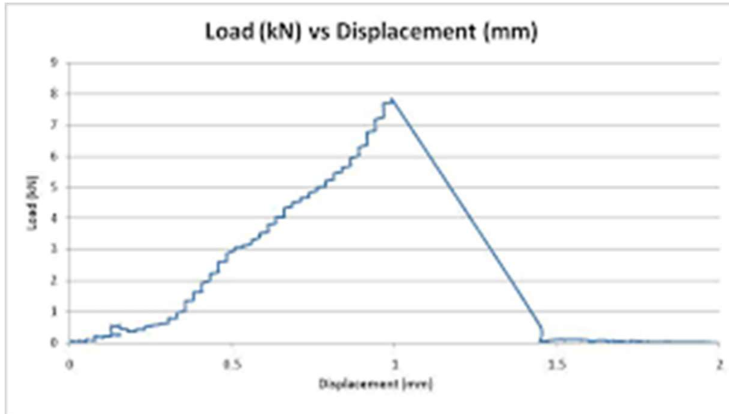

Figure 9. AAC Block Load vs. Displacement

Table-1 AAC cube outcomes

Samples	**Load (kN)**	**Strength (MPa)**
Sample 1	58.2	2.4
Sample 2	96.2	4.4
Sample 3	102.5	4.8
Sample 4	93.2	4.6

MORTAR CUBES COMPRESSIVE STRENGTH TEST

In the current investigation, a 50mm cube is tested to assess mortar's compressive strength in line with IS 4031 PART 7 [5]. It is calculated the strength of strong and weak mortar cubes. Figure 10 depicts the load response of weak and powerful mortar cubes, and Table 2 summarises the findings.

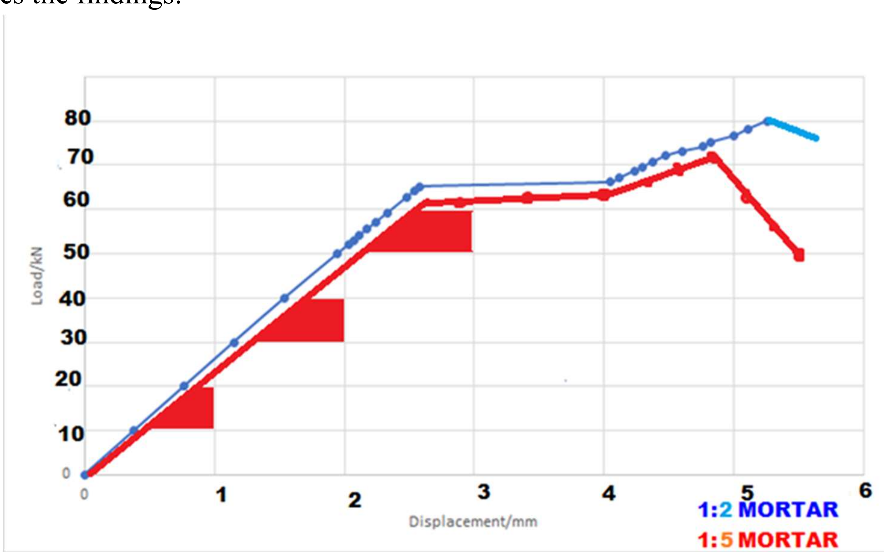

Figure 10 (50mm Mortar cube typical load response (1:2) and (1:5) by volume)

Table.2. Mortar cube results of 1:2 and 1:5

	Mortar cubes 1:2	Mortar cubes 1:5

Samples	Compressive Load (kN)	Compressive strength (MPa)	Compressive Load (kN)	Compressive strength (MPa)
Sample 1	52.99	20.95	29.34	11.98
Sample 2	53.22	20.44	20.99	7.99
Sample 3	48	18.9	27.99	10.85
Avg	51.40	20.09	26.10	10.27

MASONRY PRISM COMPRESSION TEST

Masonry prisms are produced and displacement measurements are made using AAC bricks and mortar ratios of 1:5 and 1:2.Controlled compression testing was performed using a hydraulic jack and a load cell with a capacity of 1000kN mounted on a four-post loading frame.Two LVDTs with a combined maximum displacement of 100 mm and five millimeter strain gauges are employed as measuring devices.

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Figure 11. Configuration in the loading frame

DISCUSSION AND RESULTS

AAC MASONRY PRISM COMPRESSION TEST

After 28 days of curing, an AAC masonry prism is evaluated in a loading frame with continuous displacement. A crack is visible at 210 kN for 1:5 Masonry Prism, but a crack is shown at 270 kN for strong mortar 1:2.Masonry Prism. Poor mortar produced an early masonry prism fracture. Figure 12 depicts the usual stress-strain response of the masonry prism with strong and weak mortar strengths. The compression test strengths of strong and weak mortar masonry prisms are summarised in Table 3. To avoid testing errors, the specimen with the greatest strength is not taken into account while averaging. Table 4 shows the masonry strengths after applying the correction factor to the masonry prism. The strengths of the two prisms are not dramatically different, but the failure in 1:5 has shown a difference.

Table.3. AAC masonry prism strength and E modulus

	1: 3 Masonry		1:6 Masonry	
Samples	THE PRISM STRENGTH (MPa)	The modulus E (MPa)	THE PRISM STRENGTH (MPa)	The modulus E (MPa)
Sample 1	11.99	962	10.9	199
Sample 2	12.492	888	11.3	910
Sample 3	9.7	999.5	9.45	621
AVG	11.394	949.83	10.55	576.6

Table.4. The table of Masonry Strengths was created by adding a correction factor to a prism.

	strength of Prism (MPa)	IS 1905 correction values	Strength of Masonry (MPa)	The modulus E (MPa)
1:6	10.55	0.942	10.34	576.6
1:3	11.394	0.942	10.87	949.83

MASONRY FAILURE:

The fracture in both of the masonry prisms started at the mortar joint and spread through the brick, causing the specimen to collapse. Masonry prism 1:5 collapsed due to spalling. The fracture going through the brick and forming a single, large crack caused the failure of the masonry prism 1:5 seen in Fig. 13. the 1:2 masonry prism fails because only one fracture develops. Because the distance between the nonlinearity point and the ultimate load is so small in 1:2 the fracture spreads exceedingly fast, and the specimen exhibited brittle failure.

(a) (b)

Figure 13. (a) 1:6 masonry specimen with spalling and numerous cracks and (b) Failure resulted from a single crack in 1:3)masonry specimens.

CONCLUSION:

- According to compression test findings, AAC brick has a strength of 4.2 MPa, which is lower than that of normal clay bricks stated in IS1905.
- When compared to comparable brick unit materials, the observed elastic modulus of 340 MPa suggests a very soft material.
- The mortar strengths for 1:2 and 1:5 are 20.09 MPa and 10.27 MPa, respectively, when compared to the strength of AAC brick.
- The compressive strength for a 1:2 masonry prism is 11.394 MPa, and the elastic modulus is 949.83 MPa. For a 1:5, the compressive strength is 10.55 MPa, and the elastic modulus is 576.6 MPa. Despite varying mortar strengths and elastic modulus, the strengths are essentially equivalent.
- The Stress-Strain response for masonry prisms built of 1:2 and 1:5 AAC blocks revealed nearly earlier nonlinearity in the latter than the former.
- Multiple cracking and AAC brick spalling are detected in the 1:5 masonry prism failure pattern, but just one crack is seen in the 1:2 masonry prism.
- The mortar joint and the AAC brick are both where the masonry prism 1:5 fails.
- The fracture propagation in the 1:2 masonry prism is fairly quick, indicating brittle collapse. The cracking load approaches the ultimate load.
- Numerous cracking and spalling have been seen in a 1:5 masonry prism up until the ultimate load, indicating some lagging between the cracking load and the ultimate load.

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