Comparative Study of Physical Properties of Different types of Bricks Used in Construction
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Abstract - In this study, an effort has been made to compare mainly three different types of bricks available in the market. Four physical test are performed on the bricks: compressive strength test, water absorption test and thermal conductivity test. All the three bricks have different dry density. From the dry density, dead load from a wall made of these three bricks are compared. End moments on supporting beam are also compared. Moreover, cost comparison is made for constructing a wall made of these different bricks. Different results and properties are discussed and compared in the discussion section. Other characteristics from visual inspections are also discussed.

Keywords: compressive strength, dry density, water absorption, thermal conductivity.

I. INTRODUCTION

Presently, many different types of bricks are being used for building walls. All the bricks vary in their properties and price. The widely used materials for building walls are burnt clay brick, fly ash brick (FAB) and autoclave aerated concrete (AAC) blocks. It is necessary to find the most suitable brick for the construction purpose.

1.1. Burnt Clay brick

Clay is one of the most abundant natural mineral materials on earth. For brick manufacturing, clay must possess some specific properties and characteristics. It has been established that the use of clay bricks provide a superior and comfortable physical living environment than the use of other materials as far as residential construction is concerned. Despite all initiatives to introduce alternative walling materials like compressed earth block, concrete/stone Crete block and fly-ash brick, it is envisaged that burnt clay bricks would still occupy the dominant position. Fig 1 shows the approximate composition of a burnt clay brick with the proportion of the raw materials.

![Composition of burnt clay bricks](image1)

1.2. Fly Ash Brick

Bureau of Indian standards has issued code IS: 12894-2002 for ash brick. Pulverized fuel ash commonly known as fly ash is a useful by-product from thermal power stations using pulverized coal as fuel and has considerable pozzolanic activity. This national resource has been gainfully utilized for manufacture of FABs a supplement to common burnt clay buildings bricks leading to conservation of natural resources and improvement in environment quality. Fig 2 shows the composition of a FAB with the proportion of the raw materials.

![Shows composition of FAB](image2)

1.3. AACBlocks

![AAC Blocks Composition](image3)
AAC is a steam-cured mix of sand or pulverized fuel ash (PFA), cement, lime, and an aeration agent. The high-pressure steam-curing in autoclaves achieves a physically and chemically stable product with density being one fifth of normal concrete. Fig 3 shows the composition of an AAC block with the proportion of the raw materials. AAC comprises myriads of tiny non-connecting air bubbles which give AAC its incredibly diverse qualities and make it such a terrific insulator. It offers a unique combination of strength, low weight, thermal insulation, sound absorption, unsurpassed fire resistance and unprecedented build ability. AAC is a natural and non-toxic construction material, saves energy, and is friendly to your environment.

II. SCOPE OF THE WORK

The scope of work includes four tests on the three bricks and cost comparison as mentioned below:

A. Determination of compressive strength
   (as per IS:3495:part-1:1992)
B. Determination of water absorption
   (as per IS:3495:part-2:1992)
C. Calculate dry density
D. Determination of thermal conductivity
E. Comparison of end reactions of supporting beam due to dead load of wall
F. Cost comparison

III. METHODOLOGY

3.1. Compressive strength
The test was performed as per the method mentioned in IS:3495:Part-2:1992. 6 specimens of each type of brick were used. The final results were obtained by taking the average value of the 6 results.

3.2. Water Absorption test
The test was performed as per the method mentioned in IS 3495 part 2 1992. 6 specimens of each type of brick were used. The final results were obtained by taking the average value of the 6 results.

3.3. Dry Density test
Dry density was measured by taking the ratio of dry weight and volume of the bricks. Six samples were weighed and the average of six samples was taken as dry density.

3.4. Thermal Conductivity
Tests on thermal conductivity were not performed. The results from published papers were taken directly for the comparison.

3.5. Fire resistance
Tests on fire resistance were not performed. The results from published papers were taken directly for the comparison.

3.6. Sound insulation
Tests on sound insulation were not performed. The results from published papers were taken directly for the comparison.

3.7. Dead load
For dead load comparison a wall 6 m in length, 3 m in height and 0.2 m thick is considered. The supporting beam is considered to be a fixed end beam. The total UDL, and end reactions because of the different bricks are discussed in the results section.

3.8. Cost comparison
The average prices per brick in local market in Surat for each type of bricks are ₹6.5(9x19x9cm), ₹4.5(9x19x9cm) and ₹171(65x24x20cm) for burnt clay brick, FAB and AAC respectively. The cost of masonry taken as 160₹/m². The results are discussed in the results section. The cost of one brick includes the transportation charges and additional taxes. The mortar thickness is considered as 10 mm.

IV. TEST RESULTS

4.1. Compressive strength
Results of the test on water absorption of different bricks are mentioned in figure-4:
4.2. Water Absorption test
Results of the test on water absorption of different bricks are mentioned in figure-5:

4.3. Dry Density test
Results of the test on dry density of different bricks are mentioned in figure-6:

V. Discussion
5.1. Compressive strength
From the data analysis it is obtained that AAC blocks has lowest compressive strength as its 80% of volume is made of air. Whereas burnt clay has high compressive strength as it is highly dense. The highest compressive strength was seen in fly ash bricks as it contains 62% by weight of fly ash materials.
5.2. Water absorption
AAC blocks were found to have highest water absorption as it is highly porous. Whereas fly ash bricks and burnt clay bricks had low water absorption as they are highly dense and least porous.

5.3. Dry Density
Density of burnt brick is highest as it is made of 60% by weight of silica which is heavier than fly ash particles. So Fly ash bricks have lower density then burnt clay bricks as it contains 62% by weight of fly ash and AAC blocks has lowest density as they constitute 80% of air by volume and also 70% by weight of fly ash.

5.4. Thermal Conductivity
As the bulk density of burnt clay bricks is highest, it has the highest thermal conductivity and less for fly ash brick as they are less dense and least for A.A.C blocks as they are least dense.

5.5. Fire resistance
Figure 11. Comparison of Fire Resistance

Table 1. Bending moments in beam supporting wall constructed from different bricks

<table>
<thead>
<tr>
<th>Wall material</th>
<th>Bending Moment at ends KN-m</th>
<th>Bending Moment at centre KN-m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burnt clay bricks</td>
<td>48.24</td>
<td>24.12</td>
</tr>
<tr>
<td>FAB</td>
<td>40.35</td>
<td>20.17</td>
</tr>
<tr>
<td>AAC blocks</td>
<td>14.877</td>
<td>7.43</td>
</tr>
</tbody>
</table>

5.6. Dead load
From the volume of the wall and the dry density of the bricks, UDL on the supporting beam turns out to be 10.72 KN/m, 8.97 KN/m and 3.31 KN/m for the burnt clay bricks, FAB and AAC blocks respectively. The bending moments at ends and at the centre of the beam is mentioned in table-1:

5.7. Cost comparison
The cost comparison of different bricks for constructing a wall of 6 m length, 3 m height and 0.2 m thickness is shown in table-2.

Table 2. Cost comparison for 6x3x0.2 m wall

<table>
<thead>
<tr>
<th>Type of brick</th>
<th>Size HxLxT cm</th>
<th>No of bricks reqd.</th>
<th>Cost Of plaster ₹</th>
<th>Total Cost ₹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burnt Clay Brick</td>
<td>9x19x9</td>
<td>1858</td>
<td>2880</td>
<td>13550</td>
</tr>
<tr>
<td>FAB</td>
<td>9x19x9</td>
<td>1858</td>
<td>2880</td>
<td>11241</td>
</tr>
<tr>
<td>AAC Blocks</td>
<td>65x24x20</td>
<td>112</td>
<td>0</td>
<td>19152</td>
</tr>
</tbody>
</table>

5.8. Other Characteristics
Apart from the tests, other characteristics of the different bricks are mentioned in table-3.

Table 3 other characteristics of different bricks

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Burnt Clay brick</th>
<th>FAB</th>
<th>AAC block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape</td>
<td>Uniform</td>
<td>Rough</td>
<td>5 times more in edge</td>
</tr>
<tr>
<td>Solidity</td>
<td>Excellent</td>
<td>Uniform</td>
<td>Optimum</td>
</tr>
<tr>
<td>Productivity in Construction</td>
<td>Less Compared To AAC</td>
<td>Same as Burnt clay</td>
<td>More Compared To others</td>
</tr>
<tr>
<td>Plaster Finish quality</td>
<td>Excellent</td>
<td>Bad</td>
<td>Good</td>
</tr>
</tbody>
</table>

VI CONCLUSION
From the cost comparison, it is observed that the cost of constructing a wall with Fly ash brick is the least, whereas for autoclaved aerated blocks it is the highest. But at the same time, AAC blocks have smooth finish which does not require plaster. So the cost of plaster can be saved in case of AAC blocks. AAC blocks gives higher rate productivity as they are the lightest. Because of its light nature, shifting of material on site becomes easier. Another advantage of a
wall constructed with AAC blocks is the reduced dead load on the supporting beam. Because of the reduced dead load, the RCC design becomes lighter.

VII. REFERENCES