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## Cost analysis of building construction by using autoclaved aerated concrete block (AAC), fly ash brick and clay brick as masonry component

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### ABSTRACT

*This research work was done to show comparative study residential building while considering dead and live load using AAC block or fly ash and a clay brick for the G+5 building was done. The use of AAC blocks offers an innovative solution to the construction industry associated with preserving environmental issues. In this work, also an attempt has been made to calculate bricks and blocks quantity per floor. The G+5 building was designed with the help of Staad pro software and the cost calculation for steel take off, cost of structure etc. was carried out. Autoclave aerated concrete (AAC) block has been found to be economical as a construction material replaced by conventional brick. After designing the structure we are found that if we used AAC block in place of conventional brick we are saving almost around 25.08 % of steel in the overall project.*

**Keywords**—Autoclaved aerated concrete (AAC), Lightweight, Conventional brick, Reinforced steel, Save, Reduce

### 1. INTRODUCTION

It is well known as one of the eco-friendly and green building materials. Recyclability, renewability, porosity, non-toxicity, reusability is AAC features. Its features are lightweight, load-bearing, high insulating, and durability, available and produced in different sizes and strengths. Since 1924 it was developed by a Sweden based Architect, J.A Eriksson. It has become one of the most used building materials in Europe and is rapidly growing in many other countries around the world. Today AAC is used for various construction purposes, such as in residential buildings, commercial and industrial buildings, schools, hospitals, hotels and many other applications due to its remarkable property. We can replace clay bricks with AAC block due to its eco-friendly features. Being aerated, having approx. 50 to 60 % of air, offering lightweight and having low thermal conductivity features. AAC feature offers green housings construction and saving in fertile lands and indicate or offer an innovative solution for fly ash disposal issue.

Since AAC is manufactured from the raw materials discussed above with small dosage of the rising agent. After proper mixing and suitable molding, heat and pressure are applied to create its unique properties. Due to its fire and pest resistant property, and also it is economical and environmentally make it more suitability to the other traditional building materials it is used nowadays.

### 2. METHODOLOGY

The building has the following detail:

1. The building is 6 storey (G + 5)
2. The building is framed concrete structure.
3. The building is residential and has the layout as shown above.
4. Floor to floor height: 3 m
5. Type of wall: Brick/ AAC wall
6. Wall thickness: 0.19 m, 0.19 m and 0.2 m
7. Column dimension: 400 x 400 mm
8. Beam dimension: 400 x 300 mm
9. The building is design for static loading or say for gravity load i.e. Dead load & Live load (dead load = 3.75 KN/m<sup>2</sup>, live load = 2 KN/m<sup>2</sup>)
10. Concrete grade: M30
11. All steel grade: Fe 415 grade



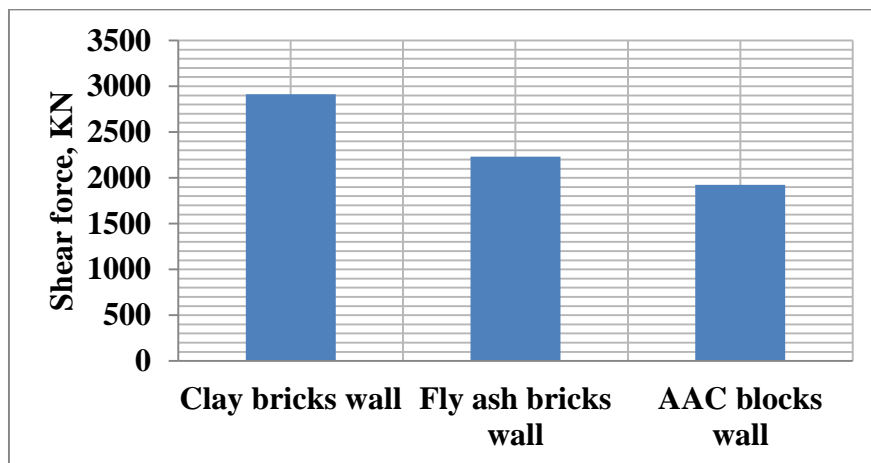
**Fig. 1: Floorplan**

Source: Shri Parasnath builders and developers India Pvt. Ltd

### 3. COST EFFECTIVE COMPARISON OF AAC BLOCK WITH CLAY BRICK AND FLY ASH BRICK

#### 3.1 Shear force

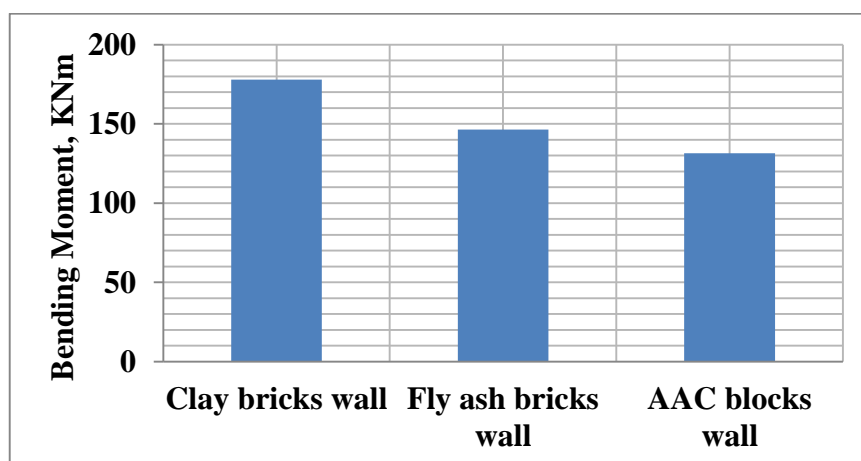
The magnitude of shear force for various walls has been plotted in figure number 5.1, it is determined that in this comparative study maximum shear force is in clay brick wall whereas AAC block wall shows minimum shear force value which results in a balanced structure.



**Fig. 2: Shear force comparison**

#### 3.2 Bending moment

The magnitude of bending moment for various walls has been plotted in figure number 8.2, it is determined that in this comparative study maximum bending moment is in clay brick wall whereas AAC block wall shows minimum shear force value which results in balanced section.



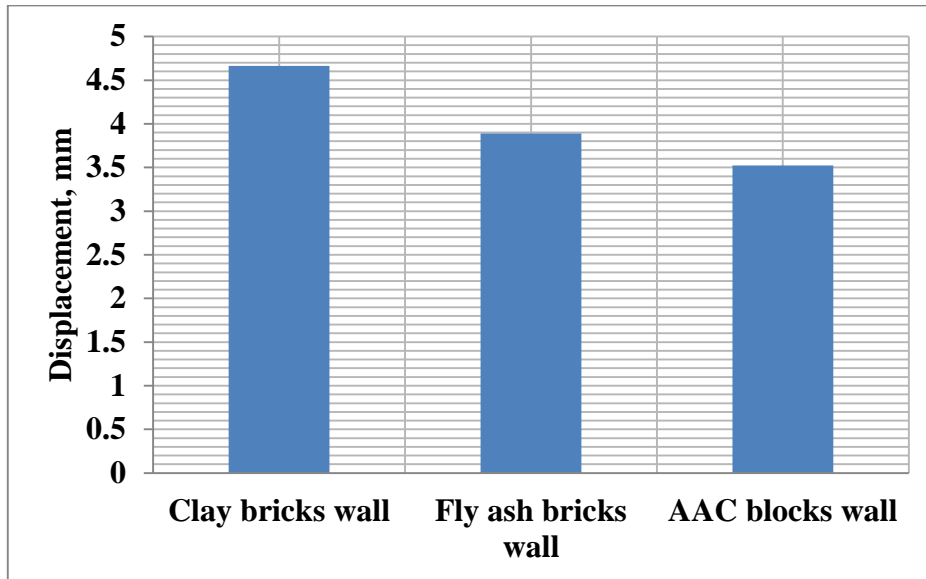
**Fig. 3: Bending moment comparison**

**3.3 Displacement**

The magnitude of maximum displacement for various walls has been plotted in figure number 5.3, below it is determined that deflection is maximum in clay brick wall whereas minimum in AAC block as compared to other cases.

**Table 1: Maximum displacement**

Displacement, mm	Clay bricks wall	Fly ash bricks wall	AAC blocks wall
	4.665 mm	3.889 mm	3.522 mm



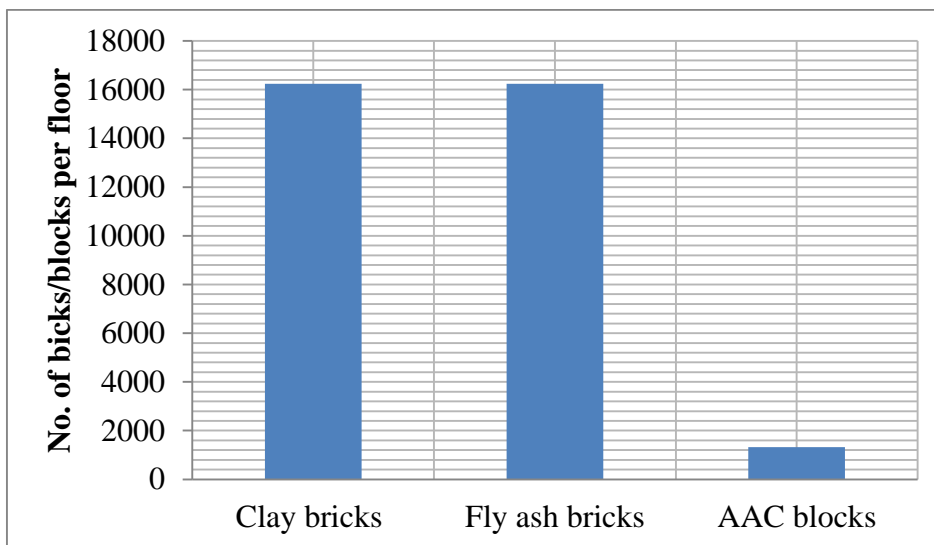
**Fig. 4: Displacement comparison**

**4. OVERALL COMPARISON OF BRICK/ BLOCKWORK IN CONSTRUCTION**

No. of bricks/ blocks per floor which is saved on the project by using clay bricks, fly ash bricks and AAC lightweight concrete blocks is 21791, 15787 and 2685. So the total No. of bricks/ blocks per floor which is saved in the project is 6004 and 13102 by using fly ash bricks and AAC block in the existing structure per floor with red burnt clay bricks. By this, the building can be built in an economical way as compared to the existing structure. From the point of view of total bricks and block required for a construction work is 130746, 94722 and 16110. So the total no. of bricks/ blocks which is saved in the project is 36024 and 78612 by using fly ash bricks and AAC block in the existing structure per floor with red burnt clay bricks

**Table 2: Brickwork comparison**

Type	Clay bricks	Fly ash bricks	AAC blocks
No. of bricks/ blocks Per floor	16235 per floor	16235 per floor	1317 per floor



**Fig. 5: No. of bricks/ blocks per floor**

**5. STEEL TAKE OFF IN CONSTRUCTION WORK**

The magnitude of steel section weight for various blocks has been plotted in figure number 8.7, it is observed that structure with clay brick will be costlier for the same loading as compared to other cases whereas structure with AAC block will be economical in comparison to other cases.

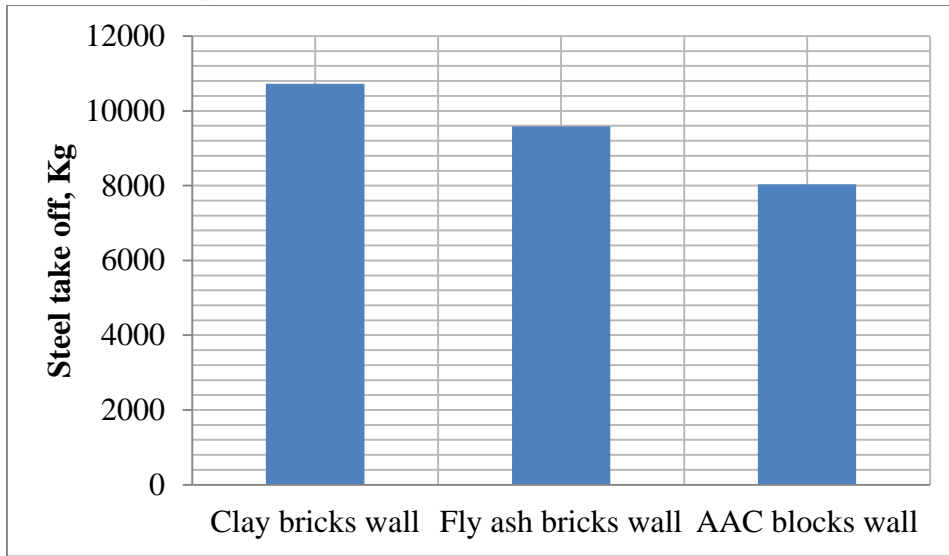


Fig. 6: Steel take off comparison in construction work

### 6. COST OF BRICKS/BLOCKS IN THE BRICKWORK OF THE BUILDING

We have calculated the cost using the standard rate of the blocks in the market.

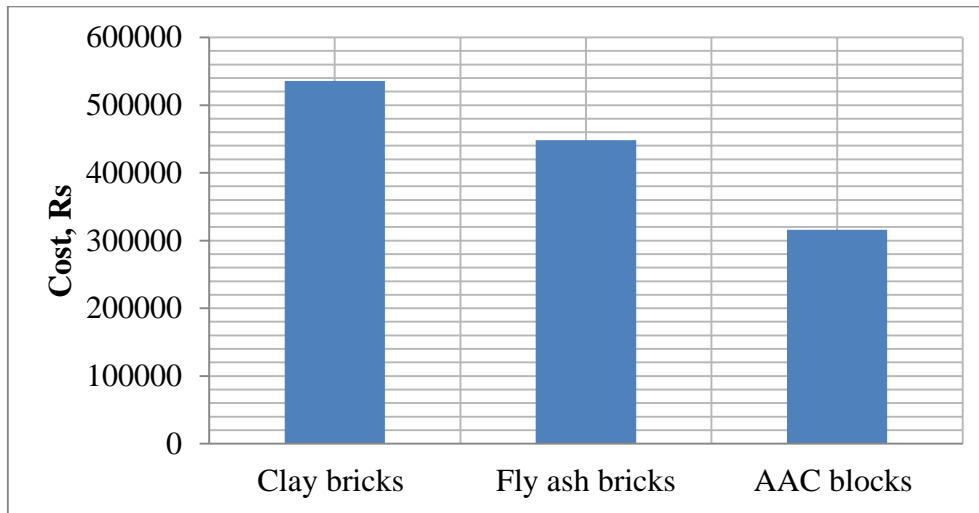


Fig. 7: Cost of bricks/blocks in brickwork

### 7. TOTAL COST COMPARISON OF THE STRUCTURE

The total cost of the superstructure when using burnt clay bricks is Rs 1275281/- the total cost of the superstructure by using fly ash bricks is Rs 1141852/- and the total cost of the superstructure by using AAC block is Rs 936776/-.

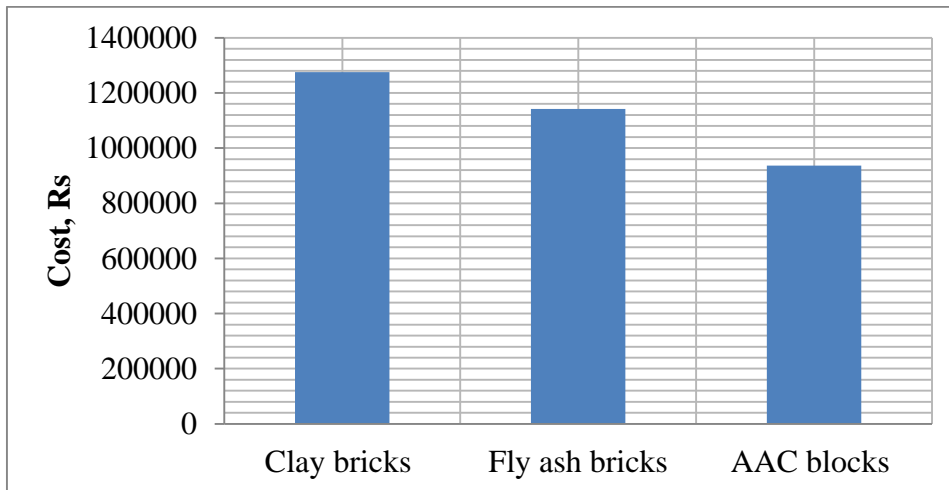
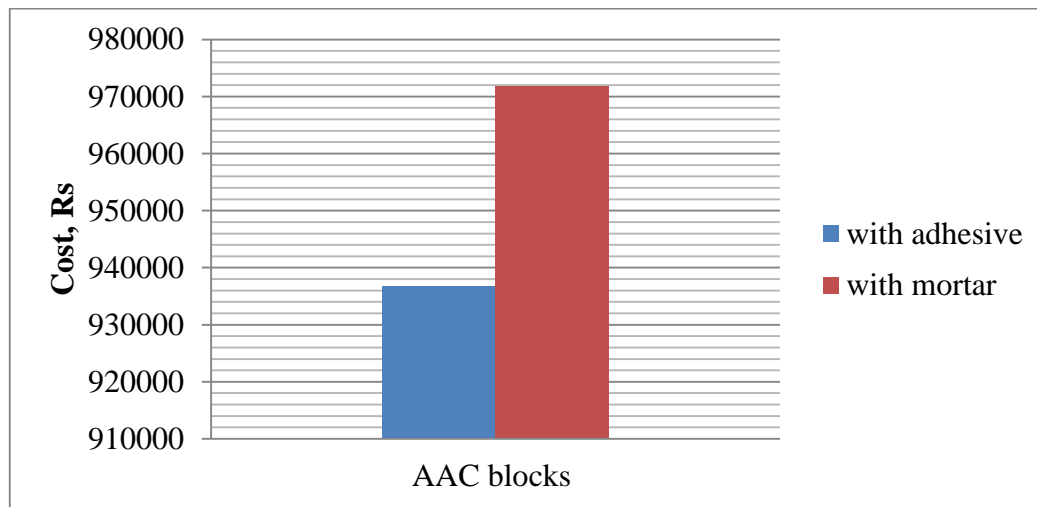


Fig. 8: Cost comparison of the structure

From the above graph following observations has been seen that the overall cost for a building by using burnt clay bricks is greater as compared to the AAC blocks. In AAC block and fly ash brick there will be a 26.54 % and 10.46 % overall cost is reduced as compared to burnt clay bricks in present.

Hence by using AAC block, there will be a less carbon emission in the environment and also by using lightweight block in a construction is economical and time-saving.

Cost of structure using mortar = Rs 936776 /- + 11610/- + 23400/- = Rs. 971786/-



**Fig. 9: Cost comparison of AAC block using adhesive and mortar**

## 8. CONCLUSIONS AND DISCUSSIONS

Through our analysis and comparison, we have managed to find many clear conclusions. Total savings while choosing AAC blocks are as follows:

1. Even though clay bricks are used for so many years even more than a millennium in the construction field, it has its own limitations too. This makes an impact to go for the alternative building blocks in the construction industry.
2. On comparing fly ash brick with clay brick, it shows better results in strength and heating load. Cost wise it is best in all cases. But it does not come under lightweight blocks and thermally efficient. Thus, it is the most economical choice among the building blocks we considered. Hence, it is very suitable for both framed and load-bearing buildings.
3. Cost wise AAC blocks show a higher cost of construction than other blocks. The light-density property of AAC blocks can be effectively utilized only for High-rise buildings and not for any typical structures. Hence it is an uneconomical choice for low rise buildings like apartments (< [G + 4]), individual houses and so on. It shows higher thermal efficiency than other blocks. Hence, better comfort can be felt.
4. This was the only savings which we could clearly see but while using AAC blocks over clay bricks, more savings would be seen in per unit rate of AAC blocks and very less use of plastering and mortar while brickwork, as compared to Clay Bricks. AAC blocks proved to be the best constructional material amidst other bricks having just a much selected few disadvantages.
5. Autoclaved aerated concrete (AAC) block has been found to be economical as a construction material replaced by conventional brick. After designing the structure we are found that if we used AAC block in place of conventional brick we are saving almost around 25.08 % of steel in the overall project.
6. In general structure, the portion of the partition wall is filled with conventional brick masonry, the average density of conventional brick masonry is 19 KN/m<sup>3</sup>. Due to measure loading of infill wall indirectly increases the loading on beam and increases indirectly bending moment on beams also. As compared with conventional brick masonry the density of AAC block is much less i.e. 4.0-7.0 KN/m<sup>3</sup>, resulting in saving steel.
7. By using AAC block we can reduce the project duration, in case of construction with AAC brick masonry the binding agent as mortar is instead of the binding solution, result in decreases the duration of construction.
8. AAC block weights almost around 80% less as compared to the conventional red brick ultimately resulting in great reduction of dead weight. Further, the reduced dead weight results into a reduction of the use of cement and steel which helps greatly in cost savings.
9. Overall cost for a building by using burnt clay bricks is greater as compared to the AAC blocks. In AAC block and fly ash brick there will be a 26.54 % and 10.46 % overall cost is reduced as compared to burnt clay bricks in present. Hence by using AAC block, there will be a less carbon emission in the environment and also by using lightweight block in a construction is economical and time-saving.
10. Steel take off cost for a building by using burnt clay bricks is greater as compared to the fly ash bricks and AAC blocks. In AAC blocks there will be approximately 25.08 % and 10.66 % steel take off cost is reduced as compared to burnt clay bricks.
11. No. of bricks/ blocks per floor which is saved on the project by using clay bricks, fly ash bricks and AAC lightweight concrete blocks is 16235, 16235 and 7902. So the total No. of bricks/ blocks per floor which is saved in the project is 4918 by using fly ash bricks and AAC block in the existing structure per floor with red burnt clay bricks. By this, the building can be built in an economical way as compared to the existing structure.
12. Cost of construction of building using AAC block with mortar shows high cost than with an adhesive.

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