Comparison of strength parameters between AAC blocks and clay bricks for building construction using STAAD Pro

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ABSTRACT

Burnt clay brick is a predominant construction material used in construction. The CO₂ emissions in the brick manufacturing process had been acknowledged as a significant factor to global warming. Therefore, now-a-days we should focus more on seeking environmental solutions for the greener environment. To fulfill this objective, new construction materials can be used for construction. One such material i.e., AAC blocks can be used as an alternative material for construction. This work highlights the comparative statistical analysis of the cost-effectiveness of using AAC blocks instead of traditional red bricks. The usage of AAC blocks gives a prospective solution to the construction industry along with environmental preservation.

In this work, an attempt has been made to compare AAC blocks as a replacement material to red bricks. This work shows the analysis and comparison between the G+6 and G+2 building with different material in terms of bricks. The bricks which are taken for first building analysis is burnt clay bricks and for second building analysis is AAC blocks.

This analysis is done by STAAD-Pro software and in result shows the reduction in overall cost of construction by using AAC blocks.

Keywords— Bricks, AAC blocks, Cost-effectiveness, Residential building, Concrete take off, Steel take off, Staad. Pro

1. INTRODUCTION

Autoclaved Aerated Concrete (AAC) is one of the eco-friendly and certified green building materials. AAC is porous, non-toxic, reusable, renewable and recyclable. Autoclaved Aerated Concrete is a lightweight, load-bearing, high insulating, durable building product, which is produced in a wide range of sizes and strengths. The Autoclaved Aerated Concrete material was invented by a Sweden Architect, Johan Axel Eriksson in 1924. It has become one of the most used building materials in Europe and is rapidly growing in many other countries around the world. AAC is produced out of a mix of quartz sand or pulverized fly ash, lime, cement, gypsum/anhydrite, water, and aluminum and is hardened by steam-curing in autoclaves. Due to its excellent properties, AAC is used in many building constructions, such as in residential buildings, commercial and industrial buildings, schools, hospitals, hotels, and many other applications. AAC replaces clay bricks which are environmentally unsustainable. Being aerated, it contains 50 - 60 % of air, leading to lightweight and low thermal conductivity. The characteristic of AAC is helpful in green housings and saves fertile lands and a solution for fly ash disposal.

AAC is produced from the common materials lime, sand, cement and water, and a small amount of rising agent. After mixing and moulding, it is then autoclaved under heat and pressure to create its unique properties. AAC has excellent thermal insulation and acoustic absorption properties. AAC is fire and pest resistant, and is economically and environmentally superior to the more traditional structural building materials such as concrete, wood, brick, and stone.

AAC Blocks is a unique and excellent type of building material due to its superheat, fire and sound resistance, AAC blocks are lightweight and offers ultimate workability, flexibility and durability. The chemical reaction due to the aluminium paste provides AAC its distinct porous structure, lightness, and insulation properties, completely different compared to other lightweight concrete materials.

2. METHODOLOGY

The materials we have used are AAC blocks and burnt clay bricks and compared them throughout in and out. We have structurally designed a building, each time using AAC blocks and clay bricks separately. After the complete analysis, we witnessed various differences.
As a case study for this research work, a typical building plan of the institutional building is considered. To precede the study following work was carried out in sequence.

Firstly we drafted our planning in Staad Pro and then designed beams and columns for clay bricks. Then we similarly designed beams and columns for AAC blocks over Staad Pro. After designing the members, reactions were found out and compared for both of the building materials. After the reactions found out, grouping was done for separate columns and beams depending upon the reactions that came at particular nodes. The footings were also grouped and their areas were found out too which later was compared for both bricks. A detailed estimate was made for the structural members and compared in both the bricks. A detailed estimate was prepared for both above designs. From the data prepared in structural design and estimate, the cost-effectiveness of different items of work was compared.

![Fig. 1: Floor plan of residential building](image)

The building has the following criteria:
1. The building is 6 storey and 3 storey
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:
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 = 10 KN/m², live load = 3 KN/m²)
10. Load combination = 1.5 (DL + LL)
11. Concrete grade: M30
12. All steel grade: Fe 415 grade

![Fig. 2: Skeletal structure of the building](image)

3. COST EFFECTIVE COMPARISION OF ACC BLOCK WITH CLAY BRICK FOR G+6 AND G+2 STOREY BUILDING

3.1 Shear force
The magnitude of shear force for various walls has been plotted in fig. 4, 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. 4: Shear Force Comparison](image)

3.2 Bending moment
The magnitude of bending moment for various walls has been plotted in fig. 5, 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.

3.3 Displacement
The magnitude of maximum displacement for various walls has been plotted in figure number 6, below it is determined that deflection is maximum in clay brick wall whereas minimum in AAC block as compared to other cases.

3.4 Brick work estimation
The brick work estimation is made for an apartment building to obtain the costs that are to be spending in the building blocks.

3.5 Total reaction
The total reaction has been found by Staad. pro using clay bricks, fly ash bricks and AAC block.

3.6 Concrete take off analysis
The frames of the building are modelled and analyzed individually for each blocks using Staad.pro-V8i. The structural members of the frame are optimized for corresponding loadings influenced by the blocks.

3.7 Steel take off in construction work
The magnitude of steel section weight for various blocks has been plotted in fig. 10, 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.
3.8 Cost of blocks in the brickwork of the building

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

![Cost comparison graph](image)

**Fig. 11: Cost comparison (Rs.)**

4. CONCLUSION

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.

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

1. On comparing with clay brick, it shows better results in strength. Cost wise it is best in all cases. But it does not come under lightweight blocks and low thermal efficient. Thus, it is the most economic choice among the building blocks we considered. Hence, it is very suitable for both framed and load-bearing buildings.

2. These blocks come under Light-weight and Thermal efficient blocks. Hence these blocks do not perform load bearing. Cost wise AAC blocks show the 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 raise buildings like apartments (< [G + 4]), individual houses and so on. It shows higher thermal efficiency than other blocks. Hence, better comfort can be felt.

3. The thickness of conventional brick is 230 mm, whereas autoclave aerated concrete (AAC) block having thickness 200 mm, resulting in increased the carpet area.

4. 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.

5. Due to the reduction of concrete consumption and steel consumption carbon footprints are reduced.

6. As the sizes of the members reduce, therefore, the quantity of concrete is reduced to approx. 14.3% of the overall concrete.

7. The size of the members of the structure has been reducing due to use of AAC blocks in comparison of burnt clay bricks.

8. Overall steel for a column by using burnt clay bricks is greater as compared to the fly ash bricks and AAC block. In fly ash bricks and AAC blocks, there will be an approximately 11.38 % and 19.75 % overall steel is reduced as compared to burnt clay bricks.

9. Overall steel for beams by using burnt clay bricks is greater as compared to AAC block.

10. No of clay bricks per floor is greater as compared to the fly ash bricks and AAC block. In fly ash bricks and AAC blocks, there will be an approximately 18.72 % and 58.48 % no. of bricks/ blocks per floor is reduced as compared to burnt clay bricks.

5. REFERENCES


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