Experimental Investigation of New Substitute Brick for Brick Bat Coba

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***Abstract*—**Brick Bat Coba (BBC) is a popular traditional waterproofing method in India, which is mainly employed on flat concrete roofs. The efficacy of the system to a great extent relies on the masonry unit type employed in the system. This study examines the performance of different masonry units that is, Red Burnt Bricks, Fly Ash Bricks, and Autoclaved Aerated Concrete (AAC) Blocks, in BBC applications. By experimental testing and site observation, Red Burnt Bricks were discovered to possess better performance in durability, bonding strength, and water resistance and are very suitable for BBC. AAC Blocks, on the other hand, exhibited high water absorption and unacceptable bonding with mortar, resulting in void occurrence and leakage possibility, which renders them not suitable for waterproofing purposes. Fly Ash Bricks exhibited moderate performance. Cost analysis further showed Red Bricks to be the most affordable choice, with AAC Blocks being much more costly. Further, Thermal analysis indicate that the Fly Ash Brick has optimum thermal resistance with minimum peak temperature and average cooling, making it more appropriate for thermal insulation than Red and ACC Bricks.

***Index Terms*—** Brick back coba, density test, compression test, thermal test

I. INTRODUCTION

Brick bat coba is a commonly practiced waterproofing and thermal insulation method in construction. The conventional bricks, which are of clay material, are employed here due to the available facilities and strength. These conventional bricks, however, suffer from limitations such as high water absorption, heavy weight, and natural clay resource depletion. Because of these problems, there is an increasing demand for alternative materials for successful and sustainable construction.

Some of the studies emphasize the implementation of recycled or green materials as alternatives to conventional bricks. Wang et al. [1] have emphasized the application of fly ash and recycled aggregates in construction products. They are lighter, minimize waste, and are more environmentally friendly than clay bricks. The research established that these alternatives can offer equivalent strength and improved thermal performance. Sharma et al. [2] discussed lightweight concrete blocks as brick alternatives. The outcome revealed enhanced thermal insulation characteristics and reduced weight, which positioned them for applications in buildings.

Thermal insulation properties of building materials are essential to lower the energy consumption in buildings. It has been observed by Garg et al. [3] that the thermal resistance of bricks prepared from sustainable material was higher than that of conventional bricks. It also had lower water absorption, which is a key requirement for waterproofing. Another study by Liu et al. [4] tested polymer-derived bricks. Such bricks were also discovered to have low water absorption and ensured good waterproofing. Such materials did cost a bit more.

American Concrete Institute (ACI) Committee 213 [5], mentioned application of lightweight aggregate in concrete bricks. These materials were found to decrease the total weight of buildings without losing strength. In the study, use of lightweight material for thermal insulation and waterproofing layer was proposed. In a study conducted by Patel et al. [6], expanded clay aggregate application was mentioned to produce lightweight bricks. These bricks were green and yielded superb performance in water resistance tests.

Substituting the conventional clay bricks with substitute materials can minimize environmental degradation. Choudhary et al. [7] investigated that the use of industrial by-products such as fly ash and slag minimizes carbon footprint and saves natural resources. The research also pointed out that waste products could be recycled into valuable building products.

Wang et al. [1] asserted that the substitution can limit soil and energy resources exploitation necessary to manufacture the conventional bricks. This assists in fostering green building practices and minimizing building waste. The IS code test for different bricks are used [8-12].

In the literature, most of the research aims to apply substitutes to general construction but are not aimed at applications such as brick bat coba. In addition, thermal performance has not been researched, limited research on integrating these with cost and environmental analysis for particular use cases such as roof waterproofing exists.

II. Methodology

The research methodology employed here was a methodical analysis of the three commonly employed masonry units, namely Red Burnt Brick, Fly Ash Brick, and Autoclaved Aerated Concrete (AAC) Block, to assess their viability for Brick Bat Coba (BBC) waterproofing systems. The research process started with the procurement of the materials, their physical property evaluation, and cost per unit evaluation to realize their economic viability. Unit water absorption tests were performed, wherein each dry brick sample was weighed and then immersed in water for 24 hours before a reweighing to record the percentage absorbed water. Simulated setups of the BBC were also set up using each of the bricks laid over a concrete foundation with a standard mortar mix, and the setups were cured well to simulate on-site conditions. These arrangements were then observed over time for any obvious signs of bonding failure, void creation, and water leakage.

Further the thermal analysis of Red Burnt Brick, Fly Ash Brick, and AAC Block was carried out in order to compare their heat absorption and heat retention properties. All the brick samples were subjected to outdoor condition, and surface temperature was measured at regular intervals of time using a digital infrared thermometer or thermal sensors. The heating stage lasted until a consistent peak temperature was attained, then a natural cooling stage wherein temperature decline was tracked. Temperature vs. time plots were obtained to assess thermal conductivity, heat storage, and cooling rate for every type of brick. Analysis revealed the thermal response of bricks under controlled environmental conditions.

III. Testing and analysis

The different tests were performed to analyze the physical and mechanical properties of diverse bricks, which are evident from the following figures. Figure 1 depicts the Compression Test, which was performed to ascertain the compressive strength of Red Burnt Brick, Fly Ash Brick, and AAC Block through a compression testing machine. This test enabled us to ascertain the load-carrying capacity of each brick under axial load. The Figure 2 shows the weight measured for thr different bricks.

Fig. 1 Compression Testing

Fig. 2 Weighing machine

The density Test, where the mass and volume of each brick were measured to calculate density, which directly relates to the material's compactness and thermal performance. Figures 3 and 4 show the difference in density between Red Brick, Fly Ash Brick, and AAC Block in their dry and water-absorbed states, respectively. From Figure 1, it can be seen that the dry density of Fly Ash Brick and AAC Block was much greater, at 1540.13 kg/m³ and 1538.91 kg/m³ respectively, than that of Red Brick at a much lower value of 1067.14 kg/m³. This means that Fly Ash and AAC blocks are denser in dry condition. Figure 2 shows the density readings after water absorption, wherein Fly Ash Brick had the maximum reading of 1740.81 kg/m³, then AAC Block at 1538.91 kg/m³, and Red Brick at 1178.97 kg/m³. The obvious increase in density upon submersion indicates the water absorption characteristic of each material. These findings indicate that Fly Ash Bricks not only possess higher initial density but also higher water absorption, affecting their weight and hence perhaps the overall performance in waterproofing systems such as Brick Bat coba.

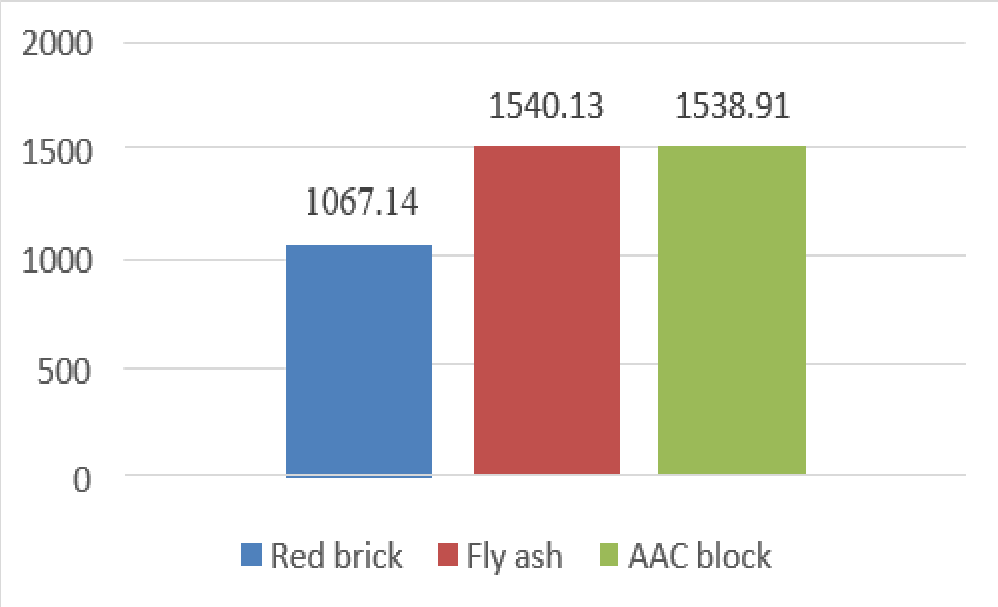

Fig. 3 Density variation for dry bricks

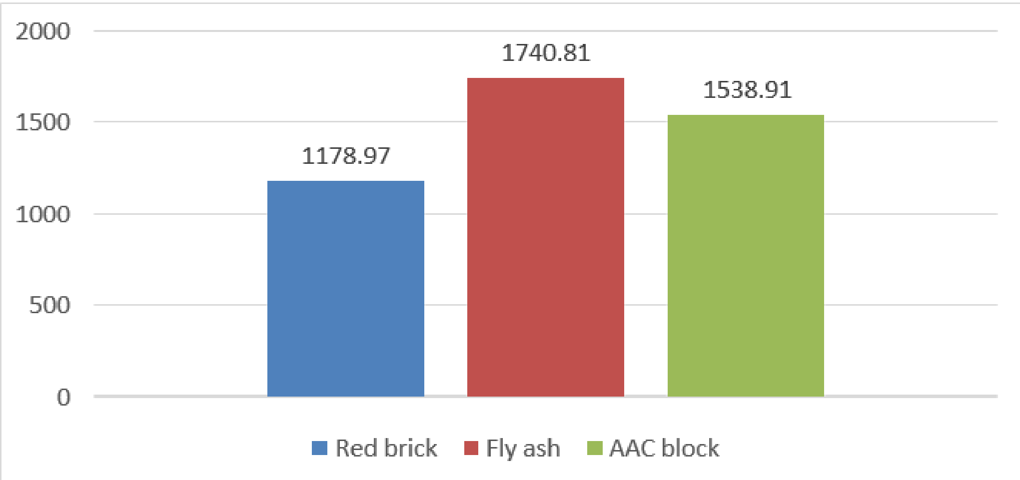

Fig. 4 Density chart of wet bricks

Thermal test

In this test, the experimental thermal test was carried out in the outdoor environment, in order to evaluate heat rejection/absorption for the three bricks. Fig. shows the setup of the experimental test rig. The experimental test rig comprised of 3 types of bricks, thermocouple, and a data storage unit. As shown, the three thermocouples were used to record the temperature of each brick. The k type thermocouple is mounted on the center of every brick and the information is captured by the data acquisition system. The experimental test rig is shown in Fig. 5.

Fig. 5 Experimental test rig

The Figure 6 illustrates the thermal variation of Red Brick, Fly Ash Brick, and ACC Brick with time. All three bricks begin at approximately the same temperature of about 35°C initially. With the progression of time, the ACC Brick experiences the maximum peak temperature of about 45°C, then Red Brick of about 43.5°C, and then Fly Ash Brick at about 43°C, meaning that the ACC Brick is absorbing more heat. At the cooling stage, Red Brick has the quickest rate of cooling, reaching the lowest final temperature of approximately 38.5°C, while Fly Ash Brick and ACC Brick cool at a slower pace to around 39°C and 39.5°C, respectively. Generally, Fly Ash Brick has the most effective thermal resistance with the lowest maximum temperature and average cooling, hence making it more appropriate for thermal insulation than Red and ACC Bricks.

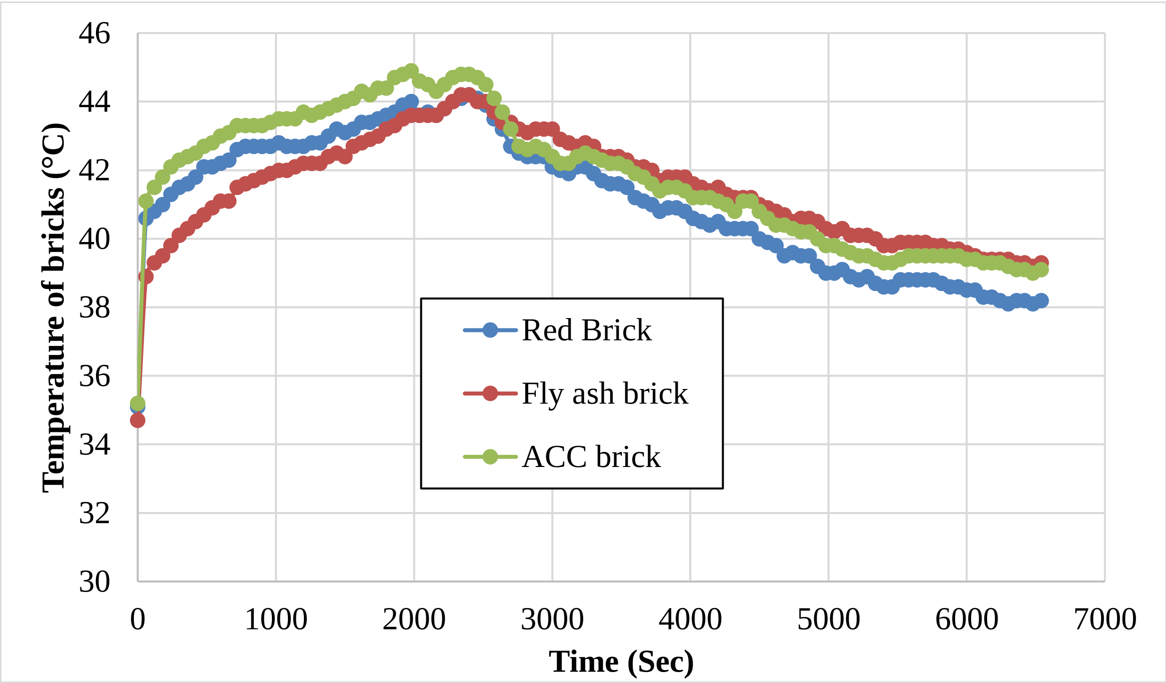

Fig. 6 Variation of temperature for different bricks with time

Conclusion

Based on the experimental investigation of Red Brick, Fly Ash Brick, and AAC Block, it is evident that each material exhibits distinct physical, thermal, and mechanical properties that influence its suitability for Brick Bat Coba waterproofing applications.

- The density analysis showed that Fly Ash Brick has the highest dry and wet density, indicating its compactness and higher water absorption capacity. AAC Block also exhibited relatively high density, whereas Red Brick was found to have the minimum density, making it less heavy and amenable to handle.
- However, thermal performance analysis revealed that Red Brick displayed better cooling characteristics with a faster reduction in surface temperature after heating, which is valuable for reducing thermal stress on roof structures. Fly Ash Brick displayed fair thermal performance, while AAC Block held maximum temperature for a longer period, reflecting poor heat dissipation and increased thermal conductivity.
- Additionally, AAC Block displayed bond failure with mortar due to void creation upon water absorption, which can result in leakage and loss of structural integrity. Given all parameters—density, water absorption, bonding strength, and thermal behavior—Red Brick stands out as the most convenient and long-lasting material for Brick Bat Coba usage.

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