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INFLUENCE OF BURNT TYPE ON THE COMPRESSIVE STRENGTH AND INITIAL RATE OF ABSORPTION BEHAVIOR OF LOCALLY AVAILABLE BRICKS

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Abstract

The properties of bricks vary according on their geographic location, as well as due to variances in manufacturing processes and burning techniques applied even within the same region. Our research intends how the Initial Rate of Absorption (IRA) influences the compressive strength of three types of locally available burnt bricks and mortar blocks in Gazipur. Based on an investigation of the relationship between IRA and water absorption (WA) with compressive strength, it has been found that IRA is a key factor directly influencing the compressive strength of bricks and blocks, because bricks are exposed to water for a brief duration, and those with higher WA rates have greater IRAs. Additionally, water absorption has a considerable impact on brick strength, the higher IRA and the lower its compressive strength, leading to increased damage and efflorescence. This relationship was observed in ten samples each of coal-burnt, gas-burnt, electric-burnt (auto bricks), and mortar block. In this study, due to coal burning, there are numerous unclosed pores available, and as such, they have the lowest compressive strength at 15.78 MPa, the highest WA at 16.47 % and the highest IRA at 3.8 Kg/m2/min, making them particularly susceptible to water damage. In contrast, Mortar block had the highest compressive strength, at 30.7 MPa, but the lowest WA and IRA values, at 5.5 % and 0.49 Kg/m2/min, indicating a good moisture resistance. These observations imply a clear correlation between compressive strength and water absorption, as well as between compressive strength and initial rate of absorption features.

Keywords: *Initial rate of Absorption, Compressive strength, bricks, Mortar block.*

1. Introduction

Masonry has a rich history and has been used to build some of the most iconic and durable structures in the world. From the Great Wall of China to the pyramids of Egypt, masonry has stood the test of time and continues to be used in construction today. Despite the emergence of other materials such as concrete and steel, masonry still holds a significant place in the construction industry. Masonry has been used as a common construction material worldwide for many centuries. However, the vulnerability of unreinforced masonry systems was highlighted during past and recent earthquakes (K.C Voon and J.M Ingham, 2013). Old masonry buildings are integral and very important part of housing infrastructure in Bangladesh. Old masonry buildings are generally exposed to a very high seismic risk due to high seismic vulnerability inherent in such buildings. For simulation of structural behavior of such buildings, performance of embedded joint is important from the point of view of seismic design. Masonry structures of Bangladesh are mostly designed only for vertical loads. The structural elements such as walls which were designed for vertical loads only, have to carry lateral load as well during an earthquake. Important masonry parameters are compressive strength, flexural strength, initial rate of absorption, shear strength, modulus of elasticity, creep and thermal expansion etc. Compressive strength test of masonry prism is to be conducted according to ASTM C1314. Compressive strength of masonry is dependent on numerous factors such as water absorption, initial rate of absorption, mortar strength, unit, strength, relative value of units and mortar strength, aspect ratio of the units (ratio of height to least horizontal dimension), and orientation of the units in relation to the direction of the applied load. Those factors give indications of the complexity of making an accurate assessment of masonry strength. Initial rate of absorption is greater influence to compressive strength and also it causes for efflorescence and damping. The properties of bricks are influenced by the nature of the clays, methods of molding and the firing. Pure clays are useless for brick making unless they are mixed with a non-plastic material and this

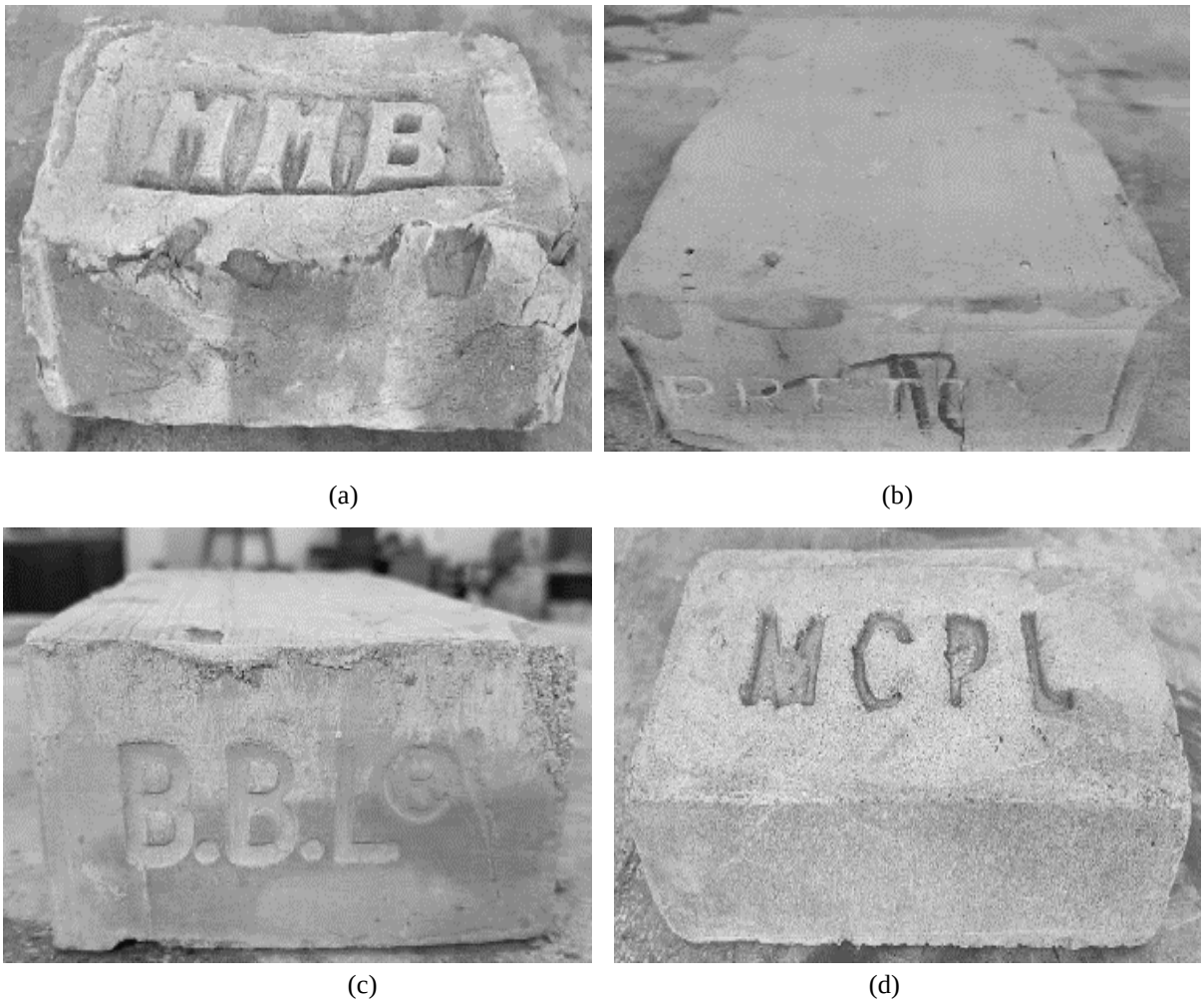
is different for every country or region. As the properties of clays vary throughout the world, it will be apparent that different kinds of bricks predominate in different regions. Our research's main aim is to study the effect of compressive strength and initial rate of absorption due to the changes of burnt types which are locally available in our country.

2. Research significance

In the present day, an array of masonry units is produced using various raw materials and methods of production, including clay, calcium silicate, stone, and concrete. Nonetheless, the rectangular clay brick remains popular due to its ease of handling. This study is focused solely on clay brick as a building material, which is produced by firing clay with or without other components at a sufficiently high temperature to prevent it from disintegrating when exposed to water. Solid and hollow bricks are the two main classifications of bricks. In most building codes, a brick is regarded as solid if its net cross-sectional area in any plane parallel to a bearing surface is 75% or more of its gross cross-sectional area measured in the same plane. Conversely, a brick is defined as hollow if the cores, cells, or empty spaces within the total cross-sectional area exceed 25% of the unit's cross section. Understanding the compressive strength of masonry is crucial in designing safe and reliable masonry structures. Compressive depends on many factors, water absorption and initial rate of absorption are the most important parameter. It is crucial to underscore that the materials chosen for this inquiry have effectively satisfied the quality evaluations according to the predetermined criteria. The strict adherence to pertinent standards has ensured the integration of high-quality materials, thereby enhancing the reliability and precision of the resulting analysis and conclusions.

3. Experimental program

The current study has employed industrial clay bricks that are available both locally and commercially. These

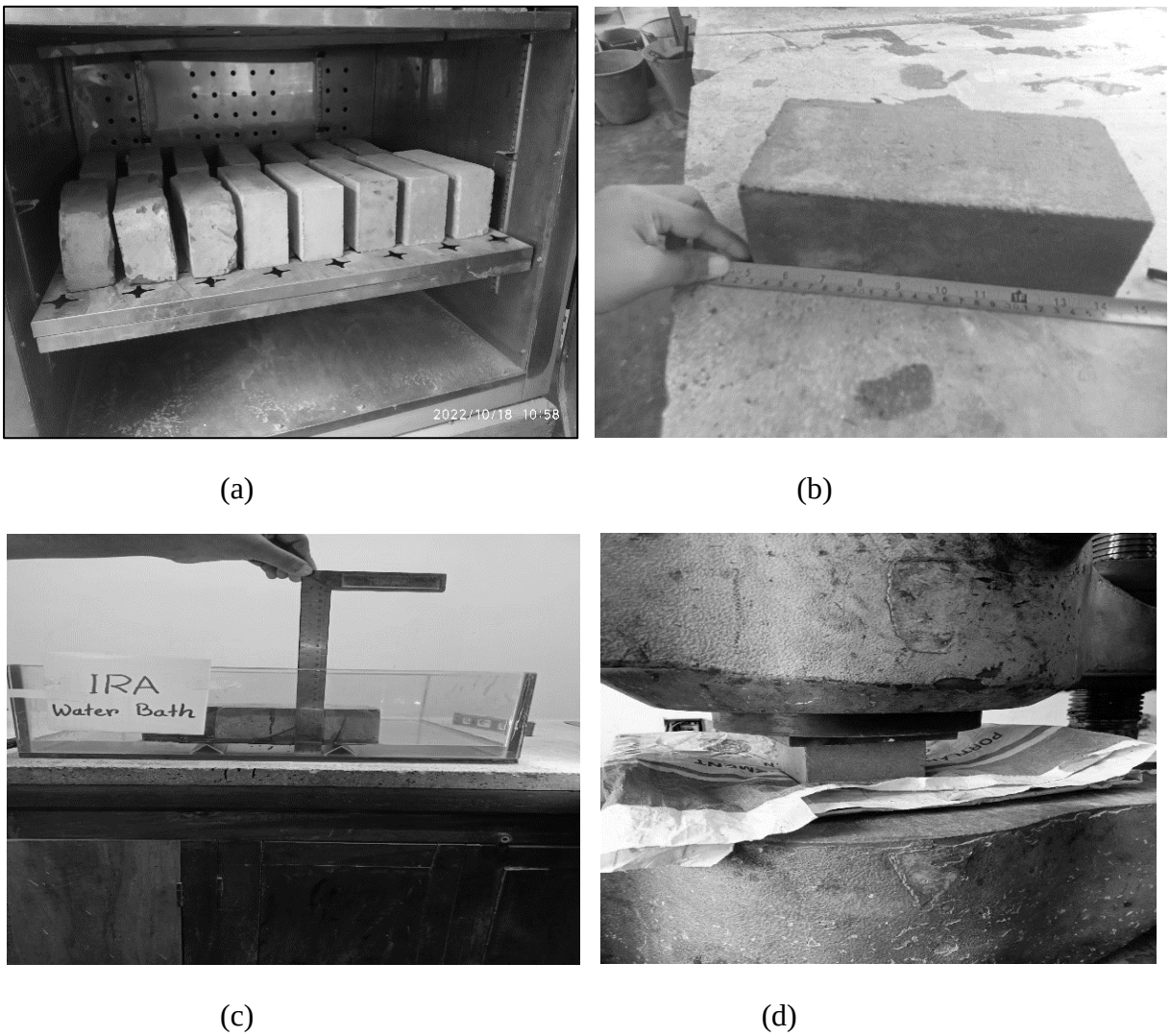


(a) (b)

(c) (d)

Figure 1. Masonry units (a) Coal burnt (b) Auto bricks (c) Gas burnt (d) Cement block [Clockwise]

bricks have dimensions of 9.5 × 4.5 × 2.75 inches. The compressive strength has been evaluated by conducting tests on five sets of half scale bricks, following the guidelines outlined in ASTM C67. The ASTM C67 standard was utilized to evaluate the diverse attributes of the bricks, encompassing their dimensions, density, compressive strength, water absorption capacity, and rate of initial absorption. The investigation focuses on the characterization of four distinct types of bricks, namely coal burnt, gas burnt, auto brick, and cement brick as shown in figure 1. To ensure standardized and reliable results, the testing procedures adhere to established codes and standardsThe bricks are subjected to compression testing, simulating their behavior within a masonry wall. This method involves placing the brick between the platens of a testing machine, replicating the conditions experienced in an actual structural application. The systematic assessment of these brick types serves to enhance our understanding of their mechanical performance, aiding in the development of robust and resilient masonry structures. All test has been conducted in this study following ASTM C67.



(a) (b)

(c) (d)

Figure 2. Photography of (a) Oven dry process (b) Dimension measurement (c) Initial Rate of Absorption test (d) Compressive strength test

4. Result and Discussion

This study examined Gas Burnt Bricks, which are renowned for their uniformity and dimensional reliability. Gas Burnt Bricks have average dimensions of 9.63 x 4.54 x 2.6 inches. The bricks displayed a mean water absorption of 13.84%, accompanied by a standard deviation of 1.99 and a coefficient of variation (COV) of 14%. The mean Initial Rate of Absorption (IRA) was found to be 2.15 kg/m²/min, with a standard deviation of 0.51 and a coefficient of variation (COV) of 24%. Gas Burnt Bricks exhibited a compressive strength of 25.26 MPa, with a standard deviation of 3.50 and a coefficient of variation (COV) of 14%.

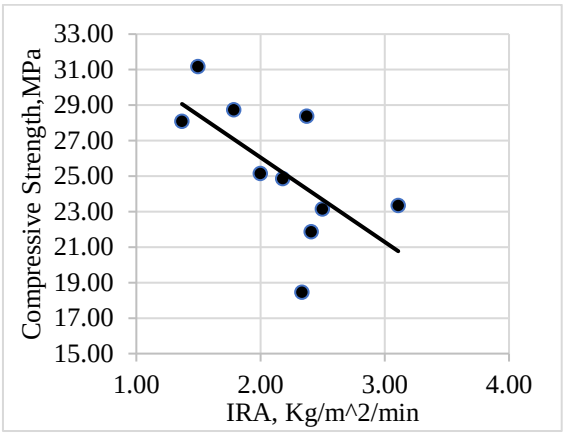


Figure 3. Relation between compressive strength with IRA of gas burnt brick

The suitability of block masonry units for construction applications was also assessed. The mean measurements of Blocks were determined to be 9.5 x 4.76 x 2.79 inches. On average, the Blocks' water absorption was 5.5%, with a standard deviation of 0.64512 and a coefficient of variation (COV) of 11.7192%. The mean IRA of Blocks was 0.49 kg/m²/min, accompanied by a standard deviation of 0.313 and a coefficient of variation (COV) of 63.72%. The study found that the Blocks' compressive strength was 30.78 MPa, with a standard deviation of 3.84 and a COV of 12.5%.

Table 1: Properties of masonry units

Properties	Gas Burnt	Coal Burnt	Auto Bricks	Cement Block	Test Standard
Dimension (in)	9.63 x 4.54 x 2.6	9.34 x 4.4 x 2.7	9.45 x 4.62 x 2.59	9.5 x 4.76 x 2.79	ASTM C67
Water absorption (%)	13.84	16.47	13.06	5.5	ASTM C67
IRA (kg/m²/min)	2.15	3.8	2.9	0.49	ASTM C67
Compressive strength (Mpa)	25.26	15.78	23.49	30.78	ASTM C67

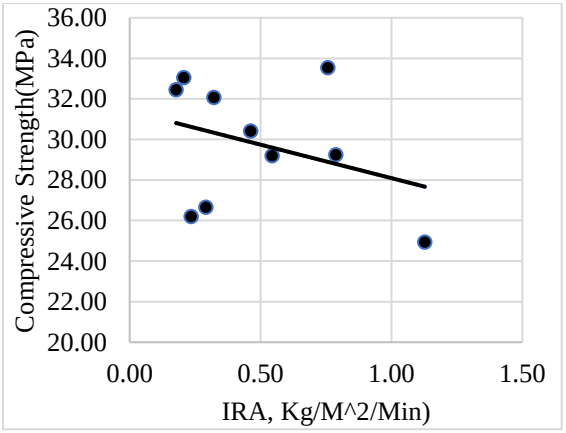


Figure 4. Relation between compressive strength with IRA of cement block

The distinctive characteristics of Coal Burnt Bricks were also examined. The mean measurements of Coal Burnt Bricks were determined to be 9.34 x 4.4 x 2.7 inches. The bricks displayed a mean water absorption of 16.47%, accompanied by a standard deviation of 1.682 and a coefficient of variation (COV) of 10.2%. Coal Burnt Bricks exhibit an average IRA of 3.8 kg/m²/min, accompanied by a standard deviation of 0.619 and a COV of 16%. The Coal Burnt Bricks exhibited a compressive strength of 15.78 MPa, accompanied by a standard deviation of 4.18 and a coefficient of variation (COV) of 27%.

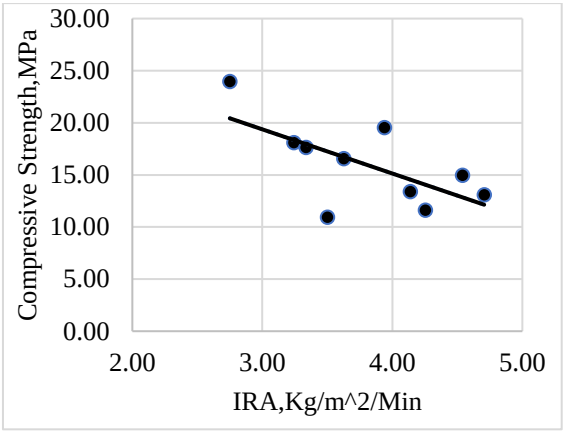


Figure 5. Relation between compressive strength with IRA of coal burnt brick

The study encompassed Auto Bricks, a prevalent masonry component. Auto Bricks exhibit an average size of 9.45 x 4.62 x 2.59 inches. The bricks displayed a mean water absorption of 13.06%, accompanied by a standard deviation of 2.89 and a coefficient of variation (COV) of 22.18%. Auto Bricks' mean IRA was determined to be 2.9 kg/m²/min, with a standard deviation of 0.186 and a COV of 6.94%. Auto Bricks exhibited a compressive strength of 23.49 MPa, with a standard deviation of 2.33 and a coefficient of variation (COV) of 9.95%.
The study summarized the all properties of masonry unit in the following figure 7.

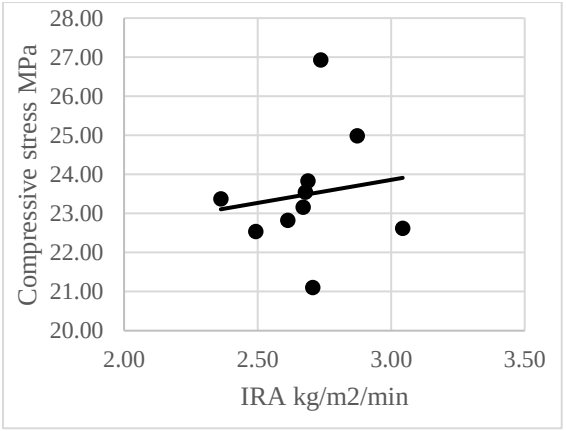


Figure 6. Relation between compressive strength with IRA of auto brick

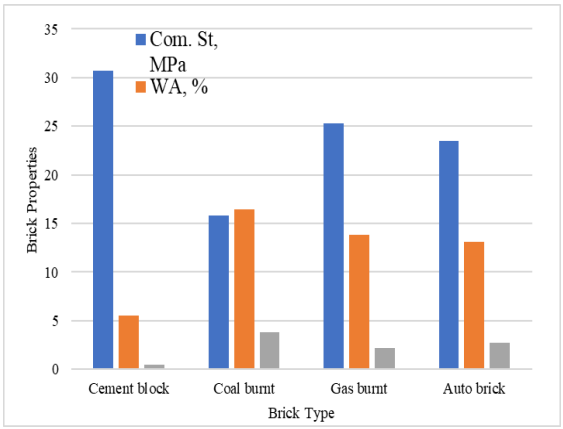


Figure 7. Masonry unit properties

5. Conclusion

This Paper Presents Results of influence of burnt type on the compressive Strength and initial rate of absorption behavior of locally available bricks. Key research findings may be summarized as follows

- Compressive strength of bricks depends on water absorption and initial rate of absorption which are key factors.
- Due to unclosed pores coal burnt takes highest water absorption and lowest compressive strength.
- Now a days available used of cement block has been taken lowest water absorption and initial rate of absorption and greater compressive strength.
- Additionally, water absorption has a considerable impact on brick strength, the higher IRA and the lower its compressive strength, leading to increased damage and efflorescence.

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