International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 12 | Dec 2024 www.irjet.net p-ISSN: 2395-0072

Experimental Study of Light Weight Interlocking Brick Based On Material Variation: A Review

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Abstract – *The building infrastructure uses a range of materials. Traditional burned clay bricks are the most basic building materials used in home construction for wall components. However, the modern construction industry's fast expansion has compelled civil engineers to look for a new building technology that can exceed traditional brick in terms of cost, efficiency, and durability. The purpose of this work is to review the literature on the experimental exploration of light weight interlocking bricks using material alterations. The research aims to better understand the behavior of Light Weight Interlocking Brick during casting operations.*

Key Words: **Modern Construction, Cost, Efficiency, and Durability, Light Weight Interlocking Brick**

1. INTRODUCTION

According to the G20 2024 report, India has become the world's fastest expanding major economy. Along with it, India's population is rapidly growing, and it is currently the world's most populated nation. For India's rising economy and population, there is a need to increase governmental infrastructure investment, as well as household investment in real estate and the construction sector.

The construction industry uses a variety of materials. When it comes to wall components, traditional burned clay bricks are the most basic building materials used in home construction. However, the increasing expansion of today's construction sector has compelled civil engineers to look for a new building approach that can result in even higher economy, efficiency, and durability as an alternative to traditional brick. In a tropical nation like India, burned clay brick is the most basic building material used to make dwellings. According to reports, the yearly demand for bricks for construction activities exceeds 140 billion.

1.1 The important of study

Traditional burnt clay bricks are made from clay, which have density of 1800 to 2000 kg/m3 and contributes significantly to the structure's overall weight. The self-weight of the structure represents a very large portion of the design load. Hence by reducing the weight of the brick, the self-weight of the structure can be reduced. This in turn would aid in the reduction of the size of structural members and the resulting use of materials. Furthermore, the reduction in self-weight helps to increase brick sizes within the limit of handling by a single person. This interlocking brick have much advantage such as more economical in transportation, easiness in its on-site and production handling, the requirement of less amount of mortar for the joints and a speedy construction. Therefore it is suitable to have larger light weight cement bricks, but having an interlocking nature to improve the workmanship.

1.2 The aim of study

The aim of this research is to evaluate the literature on the experimental study of light weight interlocking bricks using material variations.

1.3 The object of study

To produce and determine compressive strength, water absorption and density of light weight interlocking brick.

2. LITERATURE REVIEW

Mutune Samson Muinde et.al – 2013 (1) earth has been utilized as a construction material for many years. From ancient times to the present, it has been utilized to construct everything from simple shelters to magnificent temples employing a broad range of techniques. Earthen building has had a rebirth in recent years, owing mostly to economic and environmental considerations. The availability, low cost, and environmentally benign characteristics of soil as a construction material make it an appealing alternative to traditional building methods. The earliest attempts to make compressed earth bricks occurred in Europe in the early nineteenth century. The architect François Cointeraux prefabricated miniature rammed earth bricks and used hand rammers to compress the wet soil into a small wooden mould held with the foot. (The Cinvaram was the world's first steel manual press, developed in the 1950s. It was the outcome of a study conducted for a Colombian social housing project to enhance hand-molded and sun-dried brick (adobe). This press could produce regular bricks in shape and size that were denser, tougher, and more water resistant than conventional adobe. Since then, many additional types of machinery have been developed, and many laboratories have

become specialist and proficient at identifying soils for structures. This method is widely used in many African, South American, Indian, and South Asian nations.

Fajar Putra Mobiliu et.al – 2023 (2) this academic inquiry is to determine the compressive strength and water absorption capacity of interlock bricks made with fly ash. The study includes three separate versions of the combination, explicitly defined by the ratios of Fly Ash: Sand: cement, with combination I (3:3:1) containing 43% fly ash, mixture II (4:3:1) containing 50% fly ash, and mixture III (5:3:1) containing 56% fly ash. The compressive strength values for Interlock bricks made from Fly Ash mixtures were recorded as follows: mixture I had a strength of 16.0 kg/m2 and a water absorption capacity of 20%, mixture II had a strength of 24.7 kg/m2 and a water absorption rate of 17.5%, and mixture III had a strength of 10.3 kg/m2 and a water absorption capacity of 21.8%. The results show that the proportion of Fly Ash in the mixes influences both compressive strength and water absorption capacity. Notably, mixture II, which contains 50% Fly Ash, has a compressive strength that approaches the K25 classification and an absorption capacity that remains below the set barrier, indicating its suitability for use in building projects.

Santosh Bharathy.V et.al – 2018 (3) this paper states that the method for the implementation of interlocking bricks made from Acacia Ash, distinguishing it from traditional clay bricks in terms of its structural integrity and the methodology employed in brick masonry. The Acacia ash, obtained from acacia species, is examined, leading to a partial substitution of cement in the standard mix ratio of fly ash bricks. Three distinct mix ratios are prepared, substituting cement with 2%, 10%, and 15% of Acacia Ash, and the resultant interlocking bricks are produced and tested under various conditions. The results revealed that among the three mixes, the second mixture, featuring a 10% replacement of cement with Acacia Ash, achieved a compressive strength of 7.56 N/mm^2, which is deemed satisfactory.

G. Pavithra et.al -2018 (4) this empirical investigation states that the utilization of lightweight interlocking bricks employing Sewage Sludge and Fly Ash has been undertaken. The disposal of sewage sludge poses a significant threat to both environmental integrity and human health, with treatment expenditures being elevated; consequently, it is imperative to explore alternative applications for sewage sludge. Three distinct mixing ratios have been formulated, incorporating stone dust as a substitute for 10%, 20%, and 30% of sewage sludge, and the resulting interlocking bricks have been synthesized and evaluated under varying conditions to enhance their lightweight properties, reduce costs, and improve performance in adverse environmental conditions. The findings indicated that among the three formulations, the initial mixture, which included a 10% substitution of stone dust with sewage sludge, achieved a compressive strength of 8 N/mm^2, a value that is considered acceptable. Furthermore, the water absorption rate for this particular brick falls within the range of 9 to 12%, thereby conforming to the requisite standards for first-class bricks. This investigation posits that sewage sludge can be efficiently utilized in the production of bricks.

Fatheali A Shilar et.al – 2019 (5) this research paper states that the impact of varying proportions of granite waste powder and lime in fly ash for the production of fly ash-based interlocking bricks, analyzing properties such as compressive strength and water absorption. The granite industry produces significant solid waste, necessitating the utilization of granite waste powder in applications like interlocking bricks to mitigate environmental and health concerns. Three different mix proportions were created: the first with 85-65% fly ash, 5-25% granite waste powder, and 10% lime; the second with 73-65% fly ash, 25% granite waste powder, and 2-10% lime; and the third with 60% fly ash, 10-30% granite waste powder, and 30% lime.The results revealed that the optimal mix for the first proportion is 72% fly ash, 18% granite powder, and 10% lime, yielding maximum compressive strengths of 3.96 N/mm^2 at 7 days and 8.59 N/mm^2 at 21 days across all proportions. Water absorption rates were recorded at 15.20%, 16.10%, and 16.50% for the three mix proportions. The findings suggest that interlocking bricks necessitate less mortar compared to traditional burnt clay bricks. Additionally, the use of interlocking bricks facilitates a more expedited construction process than that of burnt clay bricks.

Amin Al-Fakih et.al – 2018 (6) a comprehensive experimental assessment was undertaken to engineer interlocking lightweight cement bricks utilizing scrap tire rubber. Rubberized interlocking bricks were fabricated by integrating 10% of crumb rubber and 56% by volume to supplant the fine aggregate and cement, respectively. In accordance with ASTM C90 , load bearing concrete masonry units are categorized into three distinct classifications: lightweight, medium weight, and normal weight, with oven-dry weights of less than 1680 kg/m^3, between 1680 kg/m^3 and 2000 kg/m^3, and 2000 kg/m^3 or greater, respectively. The findings indicated that the measured dry density of the concrete brick containing 10% crumb rubber was determined to be 1930 kg/m^3. The density evaluation classifies the rubberized interlocking brick as medium weight concrete. The inclusion of crumb rubber enhanced the rate of water absorption by trapping air around its surface and preventing water penetration.

R. Sayanthan et.al – 2013 (7) a systematic experimental inquiry was conducted to design interlocking lightweight cement bricks aimed at significantly diminishing the dead load, accelerating the construction process, and ultimately leading to a reduction in costs. The incorporation of expanded polystyrene beads was employed to mitigate the self-weight of the bricks. The findings indicate that the optimal mix proportion of the constituent materials to attain the desired strength and density is 1:1:2 for cement, sand, and polystyrene beads, respectively, with a water-cement

ratio of 0.35 for the interlocking hollow bricks, which are dimensionally specified as 600mm x 200mm x 200mm. The mean compressive strength of the bricks was determined to be 4.91 N/mm^2, while the wall panel strength was recorded at 2.13 N/mm^2. Furthermore, the average mass of an individual brick was ascertained to be 20.4 kg, which is deemed a manageable weight for a single individual. This innovation consequently facilitates a reduction in the dimensions of structural components and the associated material usage. A unit compressive strength test and wall panel evaluation demonstrated that a masonry wall of up to five stories can be effectively constructed utilizing these bricks for any designated mortar application, thereby confirming their suitability for load-bearing masonry walls.

L. Arun raja et.al – 2017 (8) this scholarly article states that, the objective of the present investigation is to explore the reproducibility of lightweight bricks utilizing expanded perlite aggregate and lime as the principal raw materials. Expanded perlite aggregate (EPA) has been included into a variety of building materials, including bricks, plaster, pipes, wall components, and floor bricks. EPA serves as an effective thermal and acoustic insulator, as well as a lightweight material, thereby ensuring economic advantages in construction practices. Lime possesses adhesive properties that facilitate bonding with bricks and stones; it is frequently employed as a binding agent in masonry applications. The results indicate that perlite constitutes valuable building materials, such as bricks and floor interlocks, which can significantly diminish the overall self-weight. From the results of compression testing, it is determined that the optimal mixture of expanded perlite material with lime yields a compressive strength of 3.3 N/mm^2. This particular type of brick exhibits buoyancy in water.

Heyder Ahmed et.al – 2021 (9) a study examines the utilization of recycled plastic waste in interlocking brick innovation to enhance building acoustic and thermal performance. Conventional interlock bricks are primarily made from clay, sand, and cement. However, the depletion of these non-renewable resources poses a significant challenge. Consequently, plastic emerges as a viable alternative that can improve buildings' acoustic and thermal characteristics. Plastics possess attributes such as lightweight, durability, corrosion resistance, and weather resilience. Furthermore, leveraging plastic waste eliminates the necessity for producing new plastics, aligning with global sustainability initiatives due to their economic advantages. This investigation involved a comprehensive review of existing literature regarding interlock bricks made from recycled plastic waste. The results aim to elucidate the effective production processes for innovative interlock bricks utilizing plastic waste as a construction material.

S. Kavipriya et.al – 2021 (10) this empirical investigated that, the primary objective of the project is to evaluate the comparative strength and durability of lightweight interlocking bricks in contrast to conventional bricks through the incorporation of wet ash and synthetic vegetable protein as admixtures. The juxtaposition of ordinary interlocking bricks with lightweight interlocking bricks reveals several advantages, including superior compressive strength, enhanced durability, and reduced cost. The empirical test results indicate that the strength of the interlocking bricks is augmented while the weight of the bricks is diminished subsequent to the incorporation of admixtures. The application of wet ash contributes to increased compressive strength, whereas the inclusion of synthetic vegetable protein leads to a reduction in weight when compared to conventional bricks.

R. K. Watile et.al – 2013 (11) this research paper, an empirical analysis has been conducted wherein the compressive strength, water absorption, and density were scrutinized through the application of varying proportions of fly ash, stone dust, sand, and synthetic glass fiber in diverse mix ratios. Glass fiber reinforced polymer (GFRP) is employed as a reinforcement material for the fabrication of interlocking bricks. The findings obtained from this comprehensive examination indicate that the strength of interlocking bricks tends to increase with the age as the percentage of fly ash escalates. The GFRP mix ratio of 1:11 yields a superior compressive strength exceeding 10 N/mm^2. The density of interlocking bricks was found to be 7.5 to 25% higher than that of typical burned clay bricks.The incorporation of the reinforcing agent GFRP enhances the compressive strength of the interlocking bricks, particularly with the maximal application of fly ash over time. Furthermore, the water absorption and density exhibit an upward trend with the increase in fly ash content within the GFRP interlocking bricks. To mitigate the density of the bricks, further experimental investigations are warranted utilizing various waste materials in conjunction with natural reinforcing fibers, thereby promoting economic viability and suitability for multi-storied constructions.

A Hamidi et.al – 2021(12) the objective is to conduct an analysis of the compressive strength of lightweight concrete bricks incorporating solid crude palm oil as an additive. The application of lightweight bricks as wall components in construction represents a viable alternative for mitigating the overall structural weight of edifices. The lightweight bricks investigated comprise a blend of cement, sand, water, and supplementary materials such as solid palm oil, which contributes to the reduction of the brick's mass. The solid palm oil utilized is a byproduct derived from the palm oil manufacturing process. The incorporation of solid palm oil as an additive in the lightweight brick mixture is examined across varying proportions of 0%, 0.5%, 1%, 1.5%, 2%, and 2.5% by weight of cement. The findings from the experimental assessment indicate that the introduction of solid palm oil into the lightweight brick formulation results in an enhancement of compressive strength, with the most favorable outcome occurring at a variation of 1.5%, yielding a

compressive strength of 1.985 MPa. Beyond this optimal threshold, further increases to 2% and 2.5% correspond with a reduction in both weight and compressive strength, with a notable decrease of 40.95%; moreover, the weight reduction of the specimens exhibits a linear correlation with the results obtained from the compressive strength tests.

Meghana A Patankar et.al – 2018 (13) this article conducts a comparative analysis of interlocking brick masonry and traditional brick masonry through various experimental methods. Masonry is the process of constructing buildings from separate parts joined together with mortar. The main masonry units are burnt clay bricks and concrete bricks. Interlocking bricks are an advanced type of structural element allowing for mortar-less construction methods. These bricks can be produced through mechanical or manual means. The adoption of interlocking bricks leads to reduced production costs, lower labor expenses, and the use of readily available materials for infrastructure in both urban and rural areas. The findings reveal that interlocking brick masonry outperforms traditional brick masonry. Interlocking bricks have an average compressive strength of 10.76 MPa, surpassing the 6.65 MPa of conventional bricks. The water absorption rate for interlocking bricks is 7.79%, compared to 10.91% for conventional bricks, indicating lower absorption. Design evaluations confirm that interlocking bricks are safe for structural use in buildings up to five storeys, suitable for load-bearing walls.

3. CONCLUSIONS

Based on numerous researchers' researches on material variation for light weight interlocking brick, the following conclusions were obtained:

1) The physical qualities of light-weight interlocking bricks differ depending on the degree of mixed material design.

2) The light brick interlocking bricks satisfied the minimal criteria and conditions set by Indian Standards. It also confirmed that interlocking bricks may be used as either a load-bearing wall or a non-load-bearing system.

ACKNOWLEDGEMENT

The author sincerely recognizes the contributions of researchers whose papers are acknowledged and referenced in this text. The author expresses gratitude to the authors, editors, and publishers of the publications and papers evaluated in this work.

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