

Partial Replacement of Coarse Aggregate by Jhama Class Brick in Concrete

Prof. Mhaske Akansha A.¹, Komakul Shrivani², Bhosale Nikita³, Kotkar Tushar⁴, Bhapkar Vishwajit⁵

¹ Guide, HOD of Department of Civil Engineering Sau Sundarbai Manik Adsul Polytechnic, Chas, Ahilyanagar, India

² Students, Department of Civil Engineering Sau Sundarbai Manik Adsul Polytechnic, Chas, Ahilyanagar, India

³ Students, Department of Civil Engineering Sau Sundarbai Manik Adsul Polytechnic, Chas, Ahilyanagar, India

⁴ Students, Department of Civil Engineering Sau Sundarbai Manik Adsul Polytechnic, Chas, Ahilyanagar, India

⁵ Students, Department of Civil Engineering Sau Sundarbai Manik Adsul Polytechnic, Chas, Ahilyanagar, India

Abstract

The use of concrete is truly large and day by day the cost of the conventional material cost is also rising. So, it is beneficial to use the optional materials for making concrete. The project focuses on coarse aggregate in concrete. In this project work, the study has been done on the replacement of coarse aggregate with demolished brick aggregate known as jhama bricks. The optional source is jhama brick as a coarse aggregate. The jhama brick is available from brick manufacturing area. This would not only make good use of the otherwise material but would also help alleviate disposal problems. The research was conducted to study the suitability of crushed over burnt brick as alternative coarse aggregate for concrete production. The concrete cube of M-25 grade was thrown in this trail explore work and try to analyze different properties of concrete with crushed over burnt bricks as an alternative material. The physical properties like compressive strength & workability with alternative material were used with a dosage of 0%, 10%, 20% & 30% in concrete with the age of 7 and 28 days of curing.

In recent years, the construction industry has been growing rapidly, which has increased the demand for natural aggregates. At the same time, large amounts of waste materials are generated from brick kilns and construction activities. Jhama bricks, also known as over-burnt bricks, are one such waste material. These bricks are rejected because of their irregular shape but they have good strength. Instead of disposing them as waste, they can be crushed and used as coarse aggregate in concrete.

This paper reviews various research studies related to the partial replacement of natural coarse aggregate with Jhama brick aggregate. The effects on workability, compressive strength, tensile strength, flexural strength, density, and durability are discussed. From the reviewed studies, it is observed that up to 20–25% replacement can be used without major loss in strength. Hence, Jhama brick aggregate can be considered as a sustainable and economical alternative material for concrete.

Keyword

Jhama Brick, Workability, Compressive Strength, Water Absorption test, Flexural Strength.

Introduction

Concrete is one of the main Material in construction industries the main ingredient of which is cement, sand, coarse aggregate and water. Now a days this natural material can be replaced with other materials like waste or manufactured materials, making significant changes in performance as well as cost. A major part of concrete is filled with coarse aggregate. The construction industry is revolutionizing in two major ways. One way is the development of construction techniques, such as using automated tools in construction. The other is the advancement in high-performance construction materials, such as the introduction of high strength concrete. Concrete is one of the most extensively used construction materials in ultramodern days. The raw materials from which it's prepared; cement and aggregates, affect both the quality and cost of construction. Aggregates are generally cheaper than cement and constitute over 70% of the volume of concrete.

Concrete is the most widely used construction material, and coarse aggregate constitutes a major portion of it. Due to rapid urbanization, the availability of natural aggregates is decreasing. Jhama bricks, which are over-burnt and rejected during manufacturing, possess high strength and irregular shapes, making them suitable for use as coarse aggregate.

On the other hand, brick kilns produce a large number of over-burnt bricks known as Jhama bricks. These bricks are over-heated during manufacturing and become distorted in shape. Because of this, they cannot be used in masonry work. However, these bricks have good hardness and compressive strength. If they are crushed properly, they can be used as coarse aggregate in concrete.

Using Jhama brick aggregate can reduce environmental pollution, save natural resources, and lower construction cost. Many researchers have studied its effect on concrete properties. This paper presents a review of those studies.

Literature Review

Many researchers have carried out experiments to study the performance of concrete using Jhama brick aggregate. Some important studies are discussed below.

3.1 Patil and Autade (2015) Patil and Autade studied concrete by replacing coarse aggregate with over-burnt brick aggregate at 0%, 10%, 20%, 30%, and 40%. They observed that compressive strength increased slightly at 10% and 20% replacement. After 30%, strength started decreasing. They concluded that 20% replacement gives better results without affecting strength significantly.

3.2 Sonu Kumar Gupta et al. (2018) This study mainly focused on workability and compressive strength. It was found that slump value decreases as the percentage of Jhama brick aggregate increases. This happens because brick aggregates absorb more water. However, up to 15–20% replacement, compressive strength was almost equal to normal concrete. Pre-soaking of aggregates was suggested to improve workability.

3.3 Azeezullah Khan et al. (2019) In this research, compressive strength, split tensile strength, and flexural strength were tested. Results showed that up to 25% replacement, the strength values were within acceptable limits. Beyond that, strength decreased due to increased porosity and weak bonding

3.4 IJSRD (2020)

A study published in IJSRD examined M20 grade concrete with different replacement levels. It was observed that 15% replacement showed slightly better compressive strength than conventional concrete. Density of concrete reduced as the percentage of brick aggregate increased, making it lighter.

3.5 Sharma and Verma (2021)

This study investigated reinforced concrete beams made with Jhama brick aggregate concrete. The flexural performance at 20% replacement was similar to control beams. The study suggested that it can be used in moderate structural applications.

Several researchers have investigated the use of Jhama class brick (over-burnt brick) as a partial replacement for coarse aggregate in concrete to promote sustainability and reduce construction costs.

A study published in the Journal of Mechanical and Construction Engineering analyzed the feasibility of replacing natural aggregates with Jhama brick aggregates. The research highlighted that Jhama bricks, being waste materials, can significantly reduce environmental impact while maintaining acceptable mechanical and durability properties of concrete.

Another review study explored the combined use of Jhama bricks and fly ash in concrete. The findings indicated that replacing coarse aggregate with Jhama brick (10–40%) reduces the weight and cost of concrete while still achieving adequate strength. The study also emphasized the importance of proper mix design due to higher water absorption of brick aggregates.

An experimental investigation on over-burnt brick aggregates showed that compressive strength, split tensile strength, and flexural strength can be maintained or even improved at certain replacement levels. The study concluded that using Jhama brick aggregates can reduce overall construction cost by up to 30% while maintaining structural performance.

Research conducted on M35 grade concrete

revealed that partial replacement of coarse aggregate with Jhama brick (around 20%) provides optimum results in terms of strength and economy. Beyond this level, a gradual reduction in strength was observed due to the porous nature of brick aggregates.

Another experimental study reported that Jhama bricks possess adequate compressive strength (120–150 kg/cm²) and can be effectively used at replacement levels of 15–25% in M25 concrete. The study confirmed that such replacement enhances sustainability while maintaining acceptable mechanical properties.

Recent research on brick aggregate concrete also indicates that crushed brick aggregates can reduce structural weight and are especially useful in regions where natural aggregates are scarce. However, their higher porosity affects water absorption and requires adjustments in mix design.

Overall, literature suggests that Jhama brick aggregates are a viable alternative material, with most studies recommending an optimum replacement range of 20–30% to balance strength, cost, and sustainability.

Problem Statement

1. Depletion of natural coarse aggregates.
2. Environmental impact due to excessive quarrying.
3. Disposal problem of Jhama (waste) bricks.
4. Need for sustainable and economical construction material.

Objective

1. To study the properties of Jhama class brick aggregates.
2. To determine the optimum percentage replacement of coarse aggregate.
3. To evaluate compressive strength and workability.

4. To promote use of waste materials in construction.

Material Used

1. Cement (OPC 43/53 grade)
2. Fine Aggregate (Sand)
3. Natural Coarse Aggregate
4. Jhama Class Brick (crushed form)
5. Water

Scope of the Project

The scope of this project focuses on evaluating the feasibility of using Jhama class brick aggregates as a partial replacement for natural coarse aggregates in concrete production. The study is limited to laboratory-scale experimentation and analysis of mechanical properties.

The project includes the preparation of concrete mixes with varying percentages of Jhama brick aggregate (such as 0%, 10%, 20%, 30%, and 40%) and comparison with conventional concrete. The scope covers testing key properties like workability (slump test) and compressive strength at different curing periods (7, 14, and 28 days).

This work primarily aims to determine the optimum replacement level at which acceptable strength and performance can be achieved. It also evaluates the effect of Jhama brick's porosity and water absorption on concrete behaviour.

The study is confined to:

- Use of standard grade concrete (e.g., M20/M25)
- Laboratory casting and testing of concrete cubes
- Basic mechanical properties (mainly compressive strength)

Overall, the scope emphasizes sustainable construction practices by utilizing waste materials while maintaining structural performance within acceptable limits.

Material Properties

A) Cement: -

Ordinary Portland Cement of Ultra-tech of 43 Grade was used and it was conforming to IS 12269:1987 properties of cement. The cement and water form a paste that bind the other material together and make concrete hardens. In this project we used ordinary Portland cement. Which specifications are as follow:

Sr. No	Properties	Result
1	Fineness	94% Passing
2	Normal consistency	33
3	Initial setting time	47 Min
4	Final setting time	239 Min
5	Specific gravity	3.10

Table 1. Specifications of Cement

B) Fine Aggregate (Sand): -

Sand is normally comprised of well divided rock and mineral materials. In concrete, sand is normally work as fine aggregate. The sand is first sieved with 4.75mm sieve to remove the any particles greater than 4.75mm.

C) Natural Coarse Aggregate: -

The broken stone is normally used as a coarse aggregate in concrete. The nature of work Decides the maximum size of aggregate being used. Natural coarse aggregate used in this work was locally procured, with maximum size of 20mm. The aggregate was washed to remove the dust and dirt and then dry it before use.

D) Jhama Class Brick (crushed form)

Over burnt brick used in this research were obtained from local manufacturing kiln located in Gida

(Gorakhpur). First, we crushed the brick in small form in average size. After crushing over burnt brick the resulting material was sieved through a set of sieves. Particles which size was less than 4.75mm were used as coarse aggregate replacement. These over burnt bricks are also known as jham brick because size and shape of this brick are also different from standee bricks. The bricks are burnt up to temperature of 800-900C in the brick kiln. If the temperature in the brick kiln is uncontrolled then the bricks are burnt excessively up to the temperature 1100-1200C. Due to this the bricks are sold at cheaper rate as they become out of shape. Therefore, this type of brick is known as over burnt brick.



Figure 1. Jhama Class Bricks

Methodology

The methodology adopted in this study involves systematic steps to evaluate the performance of concrete with partial replacement of coarse aggregate by Jhama class brick.

A. Material Collection and Preparation

- **Cement:** Ordinary Portland Cement (OPC 43/53 grade)
- **Fine Aggregate:** Clean river sand (Zone II)
- **Coarse Aggregate:** Crushed stone (20 mm size)
- **Jhama Brick Aggregate:** Over-burnt bricks collected, cleaned, and crushed to 20 mm size
- **Water:** Potable water
Jhama bricks are crushed and sieved to

obtain required aggregate size and then pre-soaked to reduce water absorption.

B. Mix Design

- Concrete mix designed as per IS 10262 (e.g., M20/M25 grade)
- Replacement levels of coarse aggregate:
 1. 0% (Control Mix)
 2. 10%
 3. 20%
 4. 30%
 5. 40%

Batching and Mixing

- Materials are batched by weight.
- Dry mixing of cement, sand, and aggregates.
- Gradual addition of water.
- Proper mixing until uniform consistency is achieved.

D. Casting of Specimens

- Concrete is poured into cube molds (150 mm × 150 mm × 150 mm)
- Compaction using tamping rod or vibration machine
- Surface finished smoothly

E. Curing Process

- Specimens are demolded after 24 hours
- Cured in water tank for:
 1. 7 days
 2. 14 days
 3. 28 days

Result And Discussion

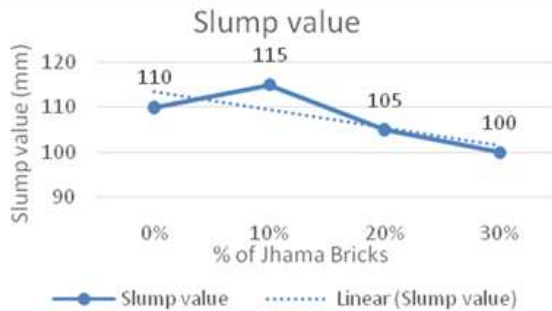
A) Workability Test

The Workability of M25 grade of concrete is measured by a widely used empirical test i.e. Slump Test with W/C ratio 0.45 for addition of

different percentage Jhama Brick.

Sr. No	% of Jhama Bricks	Slump Value (MM)
1	0%	110
2	10%	115
3	20%	105
4	30%	100

Table 2. Table Slump values



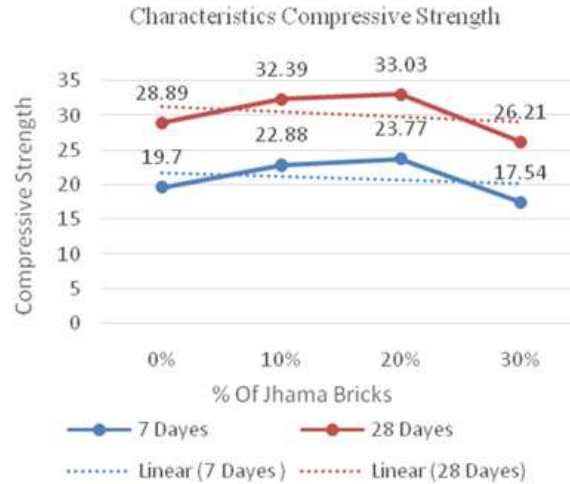
Graph 1. Slump Value Vs % of Jhama Bricks

B) Compressive Strength Test

The Result of compressive strength after 7 days & 28 days are recorded Result indicate that as we increase percentage of Jhama Brick from 0%, 10% & 20% its compressive strength increases after further increment in percentage of Jhama brick there is loss in compressive strength. That means we can replace up to 20% natural coarse aggregate by Jhama Brick.

Sr. No	Replacement in %	Characteristic Compressive Strength in N/mm ²	
		7 Days	28 Days
1	0	19.70	28.89
2	10	22.88	32.39
3	20	23.77	33.03
4	30	17.54	26.21

Table 2. Characteristics Compressive Strength Test



Graph 2. Characteristics Compressive Strength Test

Conclusion

This study investigated the feasibility of partially replacing natural coarse aggregate with Jhama class brick aggregate in concrete. Based on experimental observations and analysis, it can be concluded that Jhama brick aggregate is a viable alternative material for sustainable construction.

The results indicate that as the percentage of Jhama brick aggregate increases, the workability of concrete decreases due to its higher water absorption capacity. Similarly, a gradual reduction in compressive strength is observed at higher replacement levels. However, up to a certain limit, the strength remains within acceptable ranges for practical applications.

An optimum replacement level of approximately 20–30% was found to provide a good balance between strength, workability, and economy. Within this range, concrete exhibits satisfactory performance without significant compromise in structural integrity.

The use of Jhama class brick not only helps in reducing construction cost but also promotes eco-friendly practices by utilizing waste materials and conserving natural resources. Therefore, it can be effectively used in non-load bearing structures, low-

cost housing, and lightweight construction.

In conclusion, partial replacement of coarse aggregate with Jhama class brick is a sustainable, economical, and practical solution for modern construction, especially in areas where natural aggregates are scarce.

On the basis of the result obtained during the experimental investigation, following conclusions were drawn:

- 1) The compaction factor decreased as the percentage of Jhama class brick increases and increased in comparison with the conventional concrete.
- 2) It is to be feasible in mass concrete filling area.
- 3) Use of Jhama Brick helps to preserve natural aggregates source.

Future Scope

The present study demonstrates the feasibility of using Jhama class brick as a partial replacement for coarse aggregate; however, there are several areas where further research can be carried out to enhance its application and performance in the construction industry.

Future work can focus on detailed durability **studies**, including resistance to chemical attack, sulfate attack, and long-term environmental exposure. Investigation of freeze-thaw **resistance** and permeability characteristics can also provide better insight into the long-term behavior of Jhama brick concrete.

Further research may explore the use of Jhama brick aggregate in high-strength concrete and reinforced concrete structures, assessing its performance under different loading conditions. The combination of Jhama brick with other supplementary materials such as fly ash, silica fume, and slag can also be studied to improve strength and durability.

Optimization of mix design techniques considering the high-water absorption of Jhama brick aggregates is another important area. Advanced methods such as the use of chemical

admixtures (superplasticizers) can be investigated to improve workability.

Large-scale field studies and real-time applications can be conducted to evaluate the practical feasibility, economic benefits, and long-term performance in actual construction projects.

Additionally, research can be extended towards developing lightweight and eco-friendly concrete products such as blocks, panels, and precast elements using Jhama brick aggregates.

Overall, future studies can help in expanding the use of Jhama brick aggregate from laboratory-scale experiments to commercial and structural applications, contributing significantly to sustainable construction practices

References

- [1], "Effect of Partial Replacement of Coarse Aggregate by Jhama bricks Class Bricks In and General Science Volume 3, Issues 4, Part-2 July-August 2015.
- [2] Nilesh Kumar, Anil Kumar Saxena, Gourav Soni (2017) [2], "Analysis on concrete made from over burned bricks" International journal of advance research ideas and innovation in technology" Volume 3, Issue 6.
- [3] Vikash Kumar Gautam (2018) [3], "Use of over burn crushed brick as coarse aggregate in concrete mix" International Journal for Research in Engineering Application and Management, ISSN: 2454-9150 Vol-04 Issue-02, May 2018. [4] Bidve Ganesh Shivkanth (2019)
- [4], "Experimental study on effect of partial replacement of coarse aggregate by over burnt brick bats" International Journal for Research in Engineering Application and Management, Volume-2, Issue -4, April-2019. [5] Rakesh Kumar Jena, Partap Kumar Pani, Sundeep Kumar Singh, prasant Kumar Nayak (2019)

[5], “Workability and strength analysis of concrete with brick ballast as coarse aggregate”, IJEAT, ISSN: 2249-8958, Volume-9, Issue-1, October 2019.

[6] CH. Lakshmi Gayathri, M. D hana Lakshmi, N. Nageswar Rao, Shaik Sadik, Y. Gopi Krishna (2021) [6], “The international journal of analytical and Experimental modal analysis”, ISSN No. 0886-9367 Volume xiii, Issue ix, September- 2021.

[7] Arun R, Dhamayanthi Malathi A, Manikandan K C, Vinothkumar P (2021) [7], “Experimental study on effect of partial replacement of jhama brick as coarse aggregate in concrete”, ISSN:2321-0613. IJSRD Volume-9, Issue-3, 2021, [8] Ravi Sharma (2021)

[8], “A Study of effect on Mechanical properties of standard concrete by using jhama brick coarse aggregate”, World journal of research and review, ISSN: 2455-3956, Volume-2, February 2021.

[9] Akash Vijay Kumar Kankal (2022) [9], “Experimental Study On effect of partial Replacement of Coarse Aggregate by over burnt brick bats” Journal of Architecture and Civil Engineering Volume 7 ~Issue 7 (2022) pp:35-41.

[10] Akshay Takle, Priyanshu Kawade, Shubham Mhasade, Aditiya Bahikar (2022) [10], “Analysis on Partial Replacement of Coarse Aggregate by Jhama Bricks in concrete”, JETIR, May 2022, Volume 9, Issue 5.

[11] Md. Aadil (2022) [11], “Experimental study on partial replacement of coarse aggregate by over burn brick with addition of crimped steel fibers”, International journal of research publication and reviews, ISSN 2582-7421, Volume 3, no 9, pp 161-169, September 2022.

[12] Md. Emran Ali, Moustakem Khondaker Moin, Shakil Bin Aziz (2022) [12], “Performance Evaluation of Structural Lightweight concrete using jhama brick as a partially replacement of coarse aggregate”, journal of Cement based composites 2 (2022) 5676.

[13] Gowsik Rajan S, Jayasurya M, Jasin Mursith K, Kamalesh B (2023) [13], “Experimental study on concrete as partial replacement of coarse aggregate and fine aggregate by jhama brick and marble powder”, International journal of engineering technology and management sciences, Issue 3, Volume no. 7, May – June -2023, ISSN: 2581-46