International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 13 Issue: 04 | Apr 2026 www.irjet.net p-ISSN: 2395-0072

Sustainable Concrete with Partial Replacement of Fine Aggregate by Burnt Brick Debris

M. Gowri[1], B. Srikanth[2], K. Sandhya[3], P. Uday Kiran[4], R. Naveen [5]

[1]*Assistant Professor, Department of Civil Engineering, Sanketika Vidya Parishad Engineering College, Andhra Pradesh, India*

[2,3,4,5]*B. Tech Students, Department of Civil Engineering, Sanketika Vidya Parishad Engineering College, Andhra Pradesh, India*

Abstract - *This study investigates the use of burnt brick debris as a partial replacement for fine aggregate in concrete. Due to the depletion of natural sand and increasing construction waste, alternative materials are required. Concrete mixes were prepared with 0%, 10%, 20%, and 30% replacement levels. Tests such as slump, compressive strength, density, and water absorption were conducted. Results show that workability decreases with increase in brick content, while compressive strength improves up to an optimum level and then decreases. The study concludes that burnt brick debris can be used as a sustainable material in concrete.*

***Key Words*: Sustainable Concrete, Burnt Brick Debris, Fine Aggregate Replacement, Workability, Compressive Strength, Density, Water Absorption, Construction Waste Utilization, Eco-Friendly Materials, M25 Concrete.**

1. INTRODUCTION

Concrete is a widely used construction material made of cement, fine aggregate, coarse aggregate, and water. Natural river sand is commonly used as fine aggregate, but its excessive use has led to scarcity and environmental issues such as riverbed degradation. At the same time, large quantities of burnt brick debris are generated from construction activities and are To determine the compressive strength of concrete at 7, 14, 21, and 28 days.

To study the density and water absorption of hardened concrete. often disposed of as waste.

Burnt brick debris has good bonding properties due to its rough texture, but its porous nature and higher water absorption may influence the performance of concrete. Hence, it is necessary to evaluate its suitability as a partial replacement for sand.

This study aims to use burnt brick debris as a partial replacement of fine aggregate in concrete to promote sustainable construction and reduce the use of natural resources.

1.1 Scope of the Project

- This study focuses on using burnt brick debris as a partial replacement for fine aggregate in concrete.
- The replacement levels considered are 0%, 10%, 20%, and 30%.
- Cement, coarse aggregate, and water content are kept constant for all mixes.
- Burnt brick debris is crushed and sieved to pass through a 4.75 mm sieve.
- The study is carried out under controlled laboratory conditions.
- Workability of fresh concrete is evaluated using the slump test.
- Compressive strength is tested at 7, 14, 21, and 28 days.
- Density and water absorption of hardened concrete are also analyzed.
- The project aims to determine the optimum replacement percentage of burnt brick debris.
- Durability and long-term performance studies are not included in this project.

1.2 Objectives of the Project

- To study the suitability of burnt brick debris as a partial replacement for fine aggregate in concrete.
- To determine the physical properties of burnt brick debris such as specific gravity, sieve analysis, and water absorption.
- To compare the properties of natural sand and burnt brick debris.
- To prepare concrete mixes with different replacement levels (0%, 10%, 20%, and 30%).
- To evaluate the workability of concrete using the slump test.
- To identify the optimum percentage of burnt brick debris that gives good strength and acceptable workability.
- To promote the use of construction waste and reduce dependence on natural river sand.

2. LITERATURE REVIEW

Keerthi Narayana et al. (2010): Investigated the use of crushed fire bricks as a partial replacement for fine aggregate in concrete. Replacement levels of 20%, 25%, and 30% were considered. The study found that crushed brick particles are rough and angular in shape, which improved bonding between cement paste and aggregates. As a result, tensile and

flexural strength increased up to about 25–30% replacement. The study concluded that crushed fire bricks can effectively replace natural sand up to approximately 25–30% without significant loss in strength.

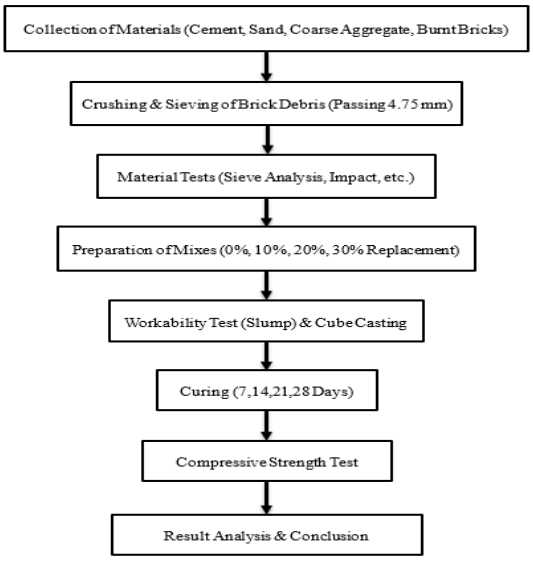
Nishka Devi et al. (2016): Studied brick powder as a fine aggregate replacement at levels of 10%, 15%, 20%, and 25%. The results showed improvement in compressive and split tensile strength up to 20% replacement. Beyond this level, strength decreased due to higher water absorption. The optimum replacement level was found to be approximately 20%.

Siva et al. (2017): Investigated partial replacement of fine aggregate with crushed fire bricks at 10%, 15%, 20%, and 25%. Workability decreased as brick content increased due to its porous nature. Compressive strength increased up to 20% replacement and decreased beyond that. The study concluded that 20% replacement is optimum.

P. Patel (2019): Studied burnt brick debris as a replacement for natural sand at levels of 5%, 10%, 15%, and 20%. The study found that durability properties such as acid resistance improved at moderate replacement levels. The optimum replacement percentage was approximately 15%.

Sriharsha and Murthy (2014): Utilized demolition debris along with blast furnace slag to prepare concrete samples using 53 grade cement. Various mix proportions were tested to evaluate compressive strength and water absorption. The results showed that demolition waste can be effectively used in manufacturing concrete blocks when proper mix design is adopted.

3. METHODOLOGY



Flow Chart -1: Methodology of the Project

3.1 Materials used:

- Cement – Binding material used for strength.
- Fine Aggregate (Sand) – Used as filler; partially replaced.
- Coarse Aggregate – Provides strength and stability (10 mm & 20 mm).
- Burnt Brick Debris – Used as partial replacement for sand.
- Water – Required for mixing and curing.

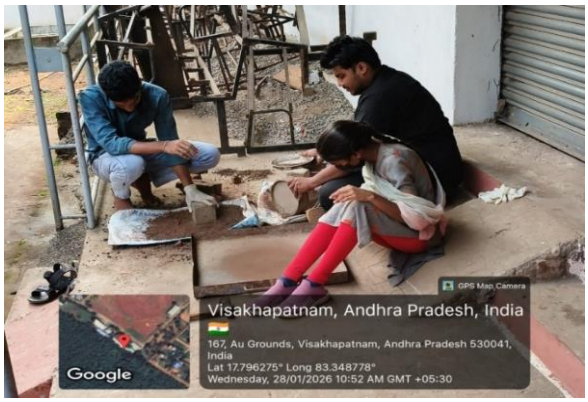


Fig-1: Crushing and Sieving of Burnt Brick Debris

3.2 Tests on Materials:

Cement:
- Fineness Test
- Standard Consistency Test

Fine Aggregate (Sand):
- Specific Gravity Test
- Sieve Analysis
- Moisture Content Test
- Water Absorption Test

Coarse Aggregate:
- Specific Gravity Test
- Sieve Analysis
- Aggregate Impact Value Test

Burnt Brick Debris:
- Specific Gravity Test
- Sieve Analysis
- Water Absorption Test

3.3 Mix Proportion:

Concrete mixes were prepared by partially replacing fine aggregate (sand) with burnt brick debris at different percentages of 0%, 10%, 20%, and 30%. The quantities of cement, coarse aggregate, and water were kept constant for all mixes to ensure proper comparison. Materials were weighed accurately and mixed uniformly before casting concrete specimens.

4. RESULTS

The results of the study are categorized to provide a clear understanding of the performance of concrete with partial replacement of fine aggregate by burnt brick debris. The observations are based on various experimental evaluations

carried out during the study. These results help in analyzing the behavior of concrete in terms of strength, workability, and durability. They also assist in identifying the optimum replacement percentage for effective and sustainable use in construction.

4.1 Tests on Materials:

The material tests were conducted to determine the physical properties of cement, fine aggregate, coarse aggregate, and burnt brick debris before use in concrete. Tests such as fineness and standard consistency for cement, specific gravity and sieve analysis for aggregates, and water absorption for all materials were carried out. These tests help in ensuring that the materials are suitable and meet the required standards for concrete production.

Table -1: Results of Materials Tests

Material	Test Conducted	Result Obtained
Cement	Fineness Test	7%
Cement	Standard Consistency	33%
Fine Aggregate	Specific Gravity	2.69
Fine Aggregate	Water Absorption	1.4%
Fine Aggregate	Moisture Content	4.167%
Fine Aggregate	Sieve Analysis	Zone 2
Coarse Aggregate	Specific Gravity	2.71
Coarse Aggregate	Aggregate Impact Value	11.29%
Coarse Aggregate	Sieve Analysis	20mm Nominal Size Aggregate
Burnt Brick Debris	Specific Gravity	2.014
Burnt Brick Debris	Water Absorption	16%
Burnt Brick Debris	Sieve Analysis	Passing 4.75 mm

4.2 Tests on Fresh Concrete:

Fresh concrete tests were performed to evaluate the workability and consistency of the concrete mixes. The slump test was conducted for different replacement levels to understand the ease of mixing, placing, and compaction of concrete. The results indicate the effect of burnt brick debris on the workability of fresh concrete.

Table -2: Slump Test Results

Slump Test Results Replacement (%)	Slump Value (mm)
Standard (0%)	130
B10 (10%)	105
B20 (20%)	90
B30 (30%)	75

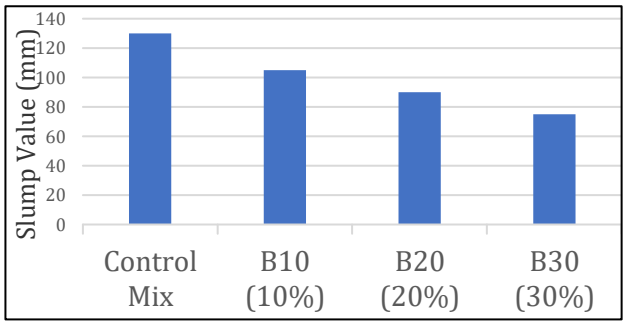


Chart -1: Workability of Concrete Mixes

4.3 Tests on Hardened Concrete:

Hardened concrete tests were carried out to study the strength and performance of concrete after curing. Compressive strength tests were conducted at different curing periods, along with density and water absorption tests. These tests help in evaluating the strength, quality, and durability characteristics of concrete with partial replacement of fine aggregate.

1) Compressive Strength Test:
Hardened concrete tests were carried out to study the strength and performance of concrete after curing. Compressive strength tests were conducted at different curing periods, along with density and water absorption tests. These tests help in evaluating the strength, quality, and durability characteristics of concrete with partial replacement of fine aggregate.

Table -3: Compressive Strength Results

Mix	7 Days (MPa)	14 Days (MPa)	21 Days (MPa)	28 Days (MPa)
Standard (0%)	17.6	22.2	24.6	27.0
B10 (10%)	18.5	23.4	25.8	28.5
B20 (20%)	19.2	24.6	26.9	29.8
B30 (30%)	17.9	22.8	24.7	27.6

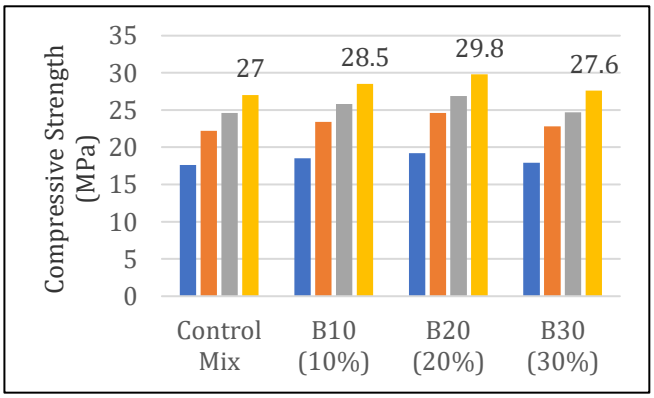


Chart -2: Compressive Strength of Concrete Mixes

2)Density Test:

The density of concrete decreases gradually with an increase in burnt brick debris content. This is because brick debris has lower specific gravity compared to natural sand. However, the density values of all mixes are within acceptable limits for normal concrete.

Table -4: Density Test Results

Replacement (%)	Weight of Cube (kg)	Density (kg/m^3)
Standard (0%)	8.44	2500
B10 (10%)	8.34	2470
B20 (20%)	8.25	2445
B30 (30%)	8.17	2420

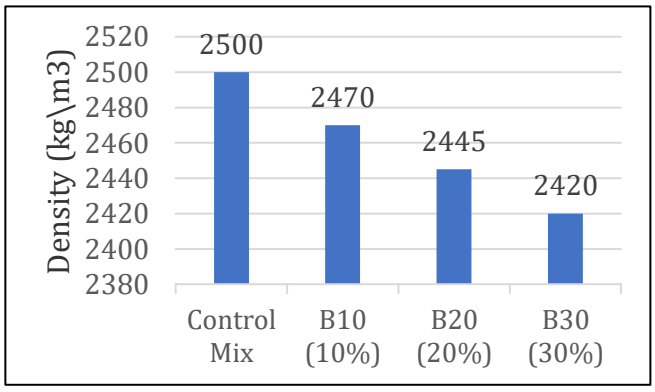


Chart -3: Density of Concrete Mixes

3) Water Absorption Test Results:

The water absorption of concrete increases with higher replacement levels of burnt brick debris. The values increase from 0.43% for the control mix to 0.61% at 30% replacement. This is due to the porous nature and higher water absorption capacity of burnt brick debris.

Table -5: Water Absorption Test Results

Replacement (%)	Dry Weight (g)	Wet Weight (g)	Water Absorption (%)
Standard (0%)	8.200	8.235	0.43
B10 (10%)	8.260	8.300	0.48
B20 (20%)	8.360	8.405	0.54
B30 (30%)	8.150	8.200	0.61

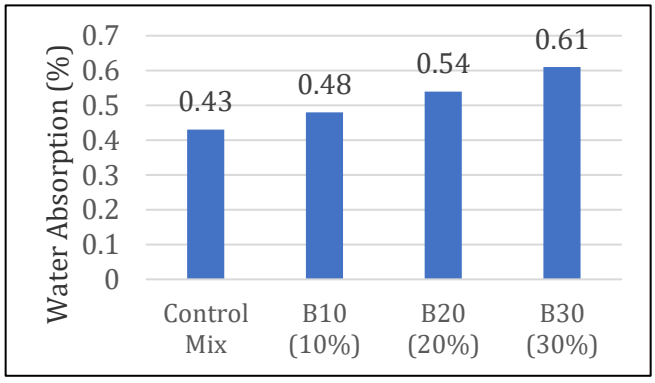


Chart -4: Water Absorption of Concrete Mixes

5. CONCLUSION

From the experimental study, it can be concluded that burnt brick debris can be effectively used as a partial replacement

for fine aggregate in concrete. The workability of concrete decreases with an increase in brick debris due to its higher water absorption. The compressive strength increases up to 20% replacement and then slightly decreases at higher percentages. The density of concrete shows a slight reduction, while water absorption increases with higher replacement levels. The optimum replacement level is found to be 20%, which provides a good balance between strength and workability. Thus, the use of burnt brick debris promotes sustainable construction by reducing waste and conserving natural sand.

6. FUTURE SCOPE

- Further studies can be carried out with higher replacement percentages beyond 30% to determine the maximum usable limit of burnt brick debris.
- Durability tests such as permeability, shrinkage, and long-term strength can be evaluated.
- The study can be extended to high-strength concrete and different mix design methods.
- Combination of burnt brick debris with other waste materials can be explored for better performance.
- The use of brick debris in real construction applications can be studied for practical feasibility.

REFERENCES

1. Keerthi Narayana, K., et al. (2010). Crushed brick as fine aggregate.

2. Neville, A. M. (2011). Properties of Concrete.

3. Tariq Ali (2013). Over-burnt brick in concrete.

4. Sriharsha, K. & Murthy, A. (2014). Demolition waste in concrete.

5. Patil, G. S. & Autade, P. B. (2015). Brick aggregate in concrete.

6. Nishka Devi, et al. (2016). Brick powder as fine aggregate.

7. Siva, A., et al. (2017). Crushed brick replacement study.

8. P. Patel (2019). Brick debris as sand replacement.