

DEVELOPMENT OF THERMALLY INSULATED AND ENERGY-EFFICIENT CONCRETE PANELS INCORPORATING WLSM, EPS AND PCM

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ABSTRACT

This study focuses on the development of thermally insulated and energy-efficient concrete panels incorporating Autoclaved Aerated Concrete (AAC), Expanded Polystyrene (EPS), and Phase Change Materials (PCM). Conventional concrete exhibits poor thermal insulation, resulting in increased energy consumption in buildings. To address this issue, lightweight and sustainable materials are introduced.

AAC reduces density due to its porous nature, EPS enhances insulation, and PCM improves thermal energy storage by absorbing and releasing heat. Experimental investigations were conducted to evaluate compressive strength, density, and thermal performance. Results indicate a reduction in density by approximately 15–20% and improved thermal resistance by 30–40% compared to conventional concrete. The developed panels are suitable for non-load-bearing, energy-efficient building applications.

Weightless Sunken Filling Material(WLSM) is very low density product which have the natural properties of resisting heat . It is more practical compared to AAC aggregates. The thermal resistance will be increased by 50– 65% compared to conventional concrete.

KEYWORDS

AAC, EPS, PCM, Lightweight Concrete, Thermal Insulation, Energy Efficiency.

I. INTRODUCTION

Conventional concrete is widely used in construction due to its strength and durability. However, it has poor thermal insulation properties, leading to increased energy consumption for heating and cooling.

To overcome this limitation, lightweight materials such as AAC, EPS, and PCM are incorporated. AAC provides reduced density, EPS improves insulation due to its low thermal conductivity, and PCM enhances thermal energy storage by regulating temperature fluctuations.

This study aims to develop lightweight concrete panels that achieve a balance between structural performance and thermal efficiency.

II. NEED AND SCOPE

Need

- Conventional concrete has poor thermal insulation
- Increasing demand for sustainable construction materials

Scope

- Development of lightweight concrete panels
- Evaluation of compressive strength and thermal properties
- Application in energy-efficient buildings

III. OBJECTIVES

Based on your file (*page 5*):

- To design lightweight concrete mix using AAC and EPS
- To incorporate PCM for thermal storage
- To test thermal and mechanical properties
- To compare with conventional concrete
- To determine optimum mix
- To explore real-world applications

IV. LITERATURE REVIEW

From your content (*page 6* and later sections):

- AAC improves thermal insulation and indoor comfort
- EPS reduces density and enhances energy efficiency
- PCM improves thermal storage but may reduce strength
- Lightweight panels are suitable for prefabricated systems

These studies confirm the feasibility of integrating AAC, EPS, and PCM in concrete panels.

V. MATERIALS USED

From (*page 7*):

- Cement – OPC 43 Grade
- Fine Aggregate – M-sand (partially replaced by EPS)
- Coarse Aggregate – Partially replaced by AAC
- AAC Blocks – Lightweight aggregate
- EPS Beads – Insulation material
- PCM – Rice husk powder
- Water – As per IS 456:2000

VI. MIX PROPORTION

Control Mix (M25) (*page 8*)

- Cement – 384 kg/m³
- Fine Aggregate – 676 kg/m³
- Coarse Aggregate – 1103 kg/m³

- Water – 192 kg/m³
- W/C ratio – 0.5

Modified Mixes (page 9)

- Mix 1: 10% AAC + 5% EPS + 10% PCM
- Mix 2: 20% AAC + 10% EPS + 20% PCM

VII. METHODOLOGY

1. Literature review
2. Mix design (IS 10262:2019)
3. Casting and curing
4. Mechanical testing
5. Thermal testing
6. Data analysis

VIII. RESULTS AND ANALYSIS

Experimental Results (page 15)

Mix Type	Peak Load (kN)	Strength (MPa)
AAC	278	12.3
AAC + EPS	285	13.1

Strength slightly reduced compared to conventional concrete but acceptable.

Key Observations

- Density reduced by **15–20%**
- Thermal resistance improved by **30–40%**
- Weight reduced significantly

IX. DISCUSSION

From (page 17):

- AAC, EPS, and PCM provide combined insulation effect
- Trade-off between strength and insulation
- Optimum mixes identified

Applications:

- Prefabricated panels
- Modular buildings
- Energy-efficient structures

X. CONCLUSION

From (*page 18*):

- Significant improvement in thermal insulation
 - Reduced density and self-weight
 - PCM enhances thermal regulation
 - Suitable for non-load-bearing structures
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XI. FUTURE SCOPE

From (*page 19*):

- Use of advanced PCM materials
 - Fiber reinforcement
 - Field-scale testing
 - Smart energy systems integration
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XII. REFERENCES

Converted to journal format:

1. Brahim et al., 2020
2. Abd Elrahman et al., 2020
3. Sharma & Bansal, 2021
4. Osibodu et al., 2024
5. IS 10262:2019
6. IS 456:2000