

Original Article

A Study on Temperature Variation of Roofing System Using Thermochromic Powder

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Abstract: *The increasing impact of heat gain in buildings has led to the need for innovative roofing materials to improve thermal comfort and energy efficiency. This study investigates the temperature variation of roofing systems using thermochromic powder. Thermochromic materials have the ability to change color with temperature, thereby altering their heat absorption and reflection properties. In this research, thermochromic powder was applied to roofing surfaces and compared with conventional roofing materials. Temperature measurements were taken at different times under varying environmental conditions. The results indicate that thermochromic coatings reduce surface temperature during peak heat periods by reflecting solar radiation. This contributes to improved indoor comfort and reduced energy consumption. The study highlights the potential of thermochromic materials as an effective and sustainable solution for temperature regulation in buildings.*

Keywords: *Thermochromic powder, Roofing system, Temperature variation, Heat reduction, Sustainable materials.*

I. INTRODUCTION

Rapid urbanization and climate change have significantly increased ambient temperatures, leading to higher heat absorption in buildings. Roofing systems play a crucial role in regulating indoor temperatures as they are directly exposed to solar radiation. Conventional roofing materials tend to absorb and retain heat, increasing indoor discomfort and energy demand for cooling. Thermochromic materials offer a promising solution due to their ability to change color based on temperature. At lower temperatures, these materials absorb heat, while at higher temperatures, they reflect solar radiation by changing to lighter shades.

This dynamic property helps in reducing heat gain in buildings. The application of thermochromic powder in roofing systems can significantly improve thermal performance. This study focuses on analyzing temperature variations in roofs coated with thermochromic materials and comparing them with conventional roofing systems.

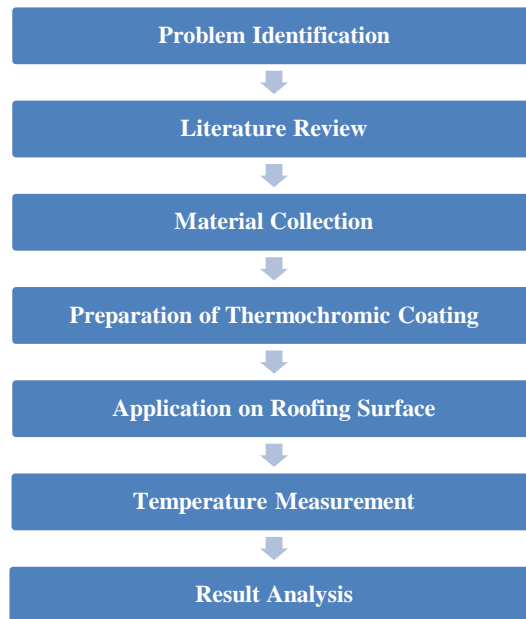
II. LITERATURE REVIEW

According to Sharma et al. (2024), thermochromic coatings effectively reduce surface temperature by reflecting solar radiation at higher temperatures. Kumar et al. (2023) reported improved energy efficiency in buildings using temperature-responsive materials.

Rao et al. (2022) observed that thermochromic materials enhance indoor thermal comfort by minimizing heat gain. However, durability and cost were identified as challenges. Singh et al. (2025) concluded that thermochromic coatings can reduce cooling energy consumption significantly.

Overall, previous studies indicate that thermochromic materials have strong potential in sustainable construction, though further experimental validation is required.

III. METHODOLOGY



IV. MATERIALS USED

A. Thermo-chromic Powder

Thermo-chromic powder is a temperature-sensitive material that changes color when exposed to different temperatures. It was mixed with suitable binders and applied as a coating on roofing surfaces.

B. Roofing Material

The experimental setup utilized concrete slabs as the primary base material for the roofing system. To evaluate thermal performance, two distinct samples were prepared: a conventional roof without any coating and a second roof coated with thermo-chromic powder. The preparation of the thermo-chromic surface involved mixing the powder with binding agents, such as a resin or paint base, and applying the mixture using brushes and various coating tools. Throughout the testing phase, temperature variations were monitored and recorded using specialized measuring devices, including thermometers and infrared sensors.

V. EXPERIMENTAL PROCEDURE

The experiment was conducted by preparing two identical roofing specimens. One specimen was left as a conventional surface, while the other was coated with thermo-chromic powder mixed with a suitable binder. The coated surface was allowed to dry completely under controlled conditions. Both samples were exposed to sunlight for several days. Temperature readings were recorded at regular intervals (morning, afternoon, and evening). Surface temperature and indoor temperature beneath the roofing system were measured using infrared thermometers and digital sensors. The data collected was analyzed to evaluate temperature variations.

VI. RESULT AND DISCUSSION

The experimental results show that thermo-chromic-coated roofing systems significantly reduce surface temperature compared to conventional roofs. During peak afternoon hours, the coated roof exhibited lower temperatures due to its ability to reflect solar radiation after color change. The indoor temperature beneath the coated roof was also comparatively lower, improving thermal comfort. The temperature reduction ranged between 3°C to 7°C depending on environmental conditions. The results confirm that thermo-chromic coatings enhance heat resistance and reduce heat gain.

Table 1: Temperature Comparison of Roofing Systems

Time (min)	Surface Temp A (°C)	Surface Temp B (°C)	Bottom Temp A (°C)	Bottom Temp B (°C)
0	30	30	29	29
10	36	34	32	31
20	42	38	36	34
30	47	42	40	37
40	51	45	43	39
60	55	48	46	41

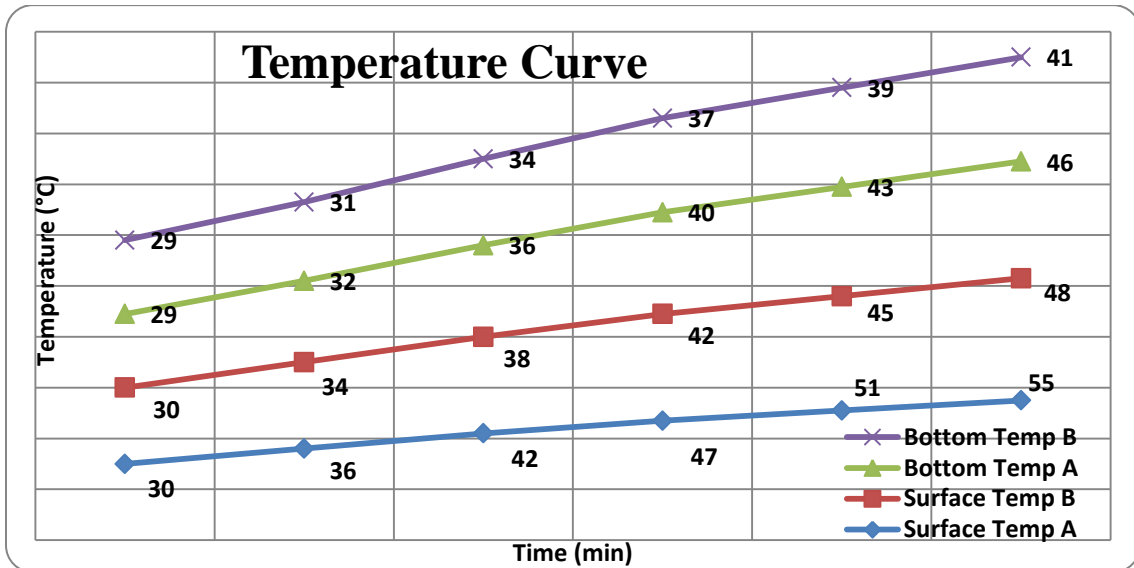


Figure 1: Temperature (°C) vs Time (min)

VII. CONCLUSION

This study demonstrates that thermochromic powder can effectively reduce temperature in roofing systems. The coated roofs showed lower surface and indoor temperatures compared to conventional roofs. The material adapts to temperature changes by reflecting heat during high temperatures, thereby improving energy efficiency and indoor comfort. Thermochromic coatings can be considered a sustainable and innovative solution for modern construction. However, further studies are required to evaluate long-term durability, cost-effectiveness, and large-scale application.

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