



Comparative Evaluation of the Effectiveness of Cool Roofs in the Hot and Dry Climate of Iran

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ABSTRACT: Escalating urban heat island effects and rising energy demands in Iran's hot, dry climate pose a serious challenge for educational buildings, where high occupant density intensifies cooling needs and operational costs. This research addresses the urgency of adopting cool roof technologies—such as reflective coatings, green roofs, high-albedo materials, and radiative cooling roofs—to mitigate extreme indoor temperatures, reduce carbon footprints, and enhance student and staff well-being. Drawing on empirical data, simulation models, and a comprehensive literature review, we employ a weighted-scoring framework that evaluates each technology's thermal performance, energy savings, cost factors, durability, and environmental impact. Findings reveal that while radiative cooling roofs offer the greatest potential for reducing cooling loads (up to 30–40%) and maintaining comfortable indoor temperatures, they demand more advanced materials and higher initial investment. Green roofs yield substantial insulation and environmental benefits, but are limited by water scarcity and elevated setup costs. Conversely, reflective coatings and high-albedo materials strike a balance between effectiveness and affordability, making them viable for retrofits in budget-constrained educational facilities. The results underscore the need for context-specific solutions that consider local climate, water resources, building typology, and policy incentives. By clarifying the strengths and trade-offs of each cool roof approach, this study provides actionable guidance for architects, policymakers, and school administrators seeking sustainable and cost-effective interventions. Future research should focus on long-term performance monitoring, integrating complementary passive strategies (e.g., shading, natural ventilation), and developing localized materials tailored to resource-limited contexts.

KEYWORDS: Cool roofs, Hot and dry climates, educational buildings, Sustainability, Passive cooling strategies, Energy efficiency, Thermal comfort.

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