



A STUDY ON COOL ROOFS AND COOL ROOF SRI (SOLAR REFLECTANCE INDEX) TILES IN HYDERABAD

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Abstract: With the ever-increasing urbanization and energy demand in the country, there will be a substantial increase in energy consumption of any typology of building and urban heat island effect. In a city like Hyderabad, which has a composite climate, the use of heat mitigation measure like Cool Roofs, not only improves the thermal comfort, but also reduces the cooling demand in the long run. The paper describes about a cool roof, the different types of cool roofing materials and discusses the latest Cool Roof Policy of Telangana state. The paper also includes a market study of Cool Roof tiles in Hyderabad.

Index Terms - Cool roof, Telangana Cool Roof Policy, SRI roof tiles, Market study

1.INTRODUCTION

The definition of cool roofs, according to Energy Conservation Building Code (ECBC) 2017, with amendments upto 2020 is that “Any roof with slope less than 20°, minimum solar reflectance value of 0.70 and minimum emittance value of 0.75 can be referred to as a cool roof”⁽¹²⁾. Cool roofs are a simple and economical method to reduce heat gain from the roof and reduce the energy consumptions, especially during summers.

The roof is an important part of a building envelope and they are a huge contributor to building heat gain. A cool roof comprises of light-coloured materials, mostly white or of pastel shades, with high reflective properties that prevents absorption of heat by reflecting the sun’s heat back into the atmosphere. Cool roofs are capable of reflecting back of around 80% of the sunlight, as compared to 20% of sunlight from the conventional roofs⁽¹²⁾.

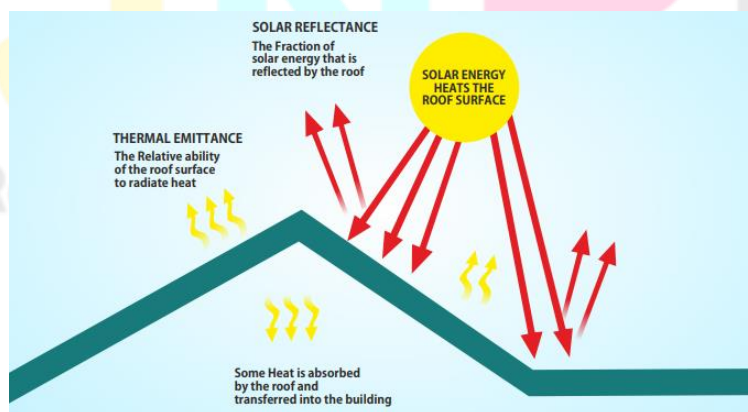


Fig 1: Working principle of cool roof
[Source: Telangana Cool Roof Policy 2023-2028

2. LITERATURE REVIEW

AUTHOR(S)	TOPIC	PUBLICATION	OBJECTIVES	INFERENCES
Mohan Rawat & R N Singh	Energy Saving Opportunities in Buildings using Cool Roofs for India: A Review	AIP Conference Proceedings, vol. 2358, no. 1, July - 2021	1. To understand the concept of cool roofs and its energy-efficient opportunities for residential buildings in different climatic zones of India using comparative analysis.	1. The energy savings due to the cool roofs are in the range of 8.4% to 30.4%, and indoor temperature variation is between 2.0° C to 7.0° C for different Indian climatic zones.
Hema Sree Rallapalli & Dr Janmejoy Gupta	Cool Roof initiatives in India: An evaluation of the existing conditions and lessons to be learnt from global best practices.	Aegaeum Journal, vol. 8, no. 7, pp. 1421-1430, 2020	1. To review and analyse the efficiency of cool roofs and its existing government policies, regulations and practices followed in India. 2. To study the various best practices implemented across the world and to suggest measures that can implemented in India taking reference from the global examples.	1. Cool roofs are a cost-efficient and smart solution that help in managing indoor room temperatures, especially in peak summers and aid in reduced heat gain from the roof. 2. The policy makers should consider socio-economic and environmental factors while drafting the policies, regulations and incentives. 3. Certification of products with appropriate and stringent technical standards will aid in maintaining the standard of the products.
Vishal G, Rajashree K, Jayant S, Hema R, Nilesh K, Niranjana R, Prabhakara R & Ashok S	Assessment of the Impact of Cool Roofs in Rural Buildings in India	Energy & Buildings, vol. 114, pp. 156-163, Feb 2016	1. To analyse the impact of cool roofs on unconditioned school buildings in Hyderabad & Nagpur.	1. The average and peak reductions in indoor air, roof underdeck, and roof over deck surface temperatures are 2.1°C, 5.0°C, and 12.3°C, and 4.3°C, 10.0°C, and 26.3°C, respectively, for the room with white roof as opposed to gray roof in ZPH School, and 1.5°C, 4.0°C, and 9.5°C, and 3.3°C, 4.2°C, and 25.2°C in VNHM School.
Rathish Sathyabama A, Vishal G., V. Vinayaka Ram & Aviruch B.	Optimizing roof insulation for roofs with high albedo coating and radiant barriers in India	Journal of Building Engineering, vol. 2, pp. 52-58, June 2015	1. To perform energy simulation of a daytime operational office building using various roof combinations in different climatic zones of India. 2. To identify a suitable roof insulation by conducting an IRR analysis.	1. The optimum roof R-value in hot and dry and composite climates is 0.49 m ² K/W, while in hot and humid and temperate, the value is 0.31 m ² K/W and in cold climates, the optimum R-value is 1.02 m ² K/W. 2. The economic analysis proves that the roof insulation greater than 25mm is not economically feasible.
Mohan R & R.N. Singh	A study on the comparative review of cool roof thermal	Energy and Built Environment, vol. 3, no. 3, pp. 327-347, July 2022	1. To review the thermal performance of cool roofs, for different roof surfaces in different climatic zones of India.	1. The average % of energy savings achieved using cool roofs are 32.8% for temperate, 35.7% for tropical, 15.0% for hot-dry and 25.01% for composite climate.

	performance in various regions		2. To study and analyse the various benefits, limitations of cool roofs and to suggest recommendations.	2. For temperate, tropical, hot-dry, and composite climatic zones, the average reductions in roof surface temperature are 4.7 °C, 2.4 °C, 2.3 °C, and 1.4 °C, respectively.
Selvakumar V, Priya D, Srishti S, LM Sathish, Shyam P and Bijal B.	Combating Climate Change-induced Heat Stress: Assessing Cool Roofs and Its Impact on the Indoor Ambient Temperature of the Households in the Urban Slums of Ahmedabad	Indian Journal of Occupational and Environmental Medicine, vol. 24, no. 1, pp. 25-29, Mar 2020	1. To perform a comparative analysis of a cool roof vis-à-vis conventional roof type. 2. To understand the socio-economic impact of roofing and health.	1. Cool roof materials such as thermocol insulation, white paint with high SRI (Solar Reflectance Index) on external roof surface and ModRoof efficiently aid in reducing indoor room temperatures.
Mohan R & R.N. Singh	Performance evaluation of a cool roof model in composite climate	Materials Today: Proceedings, vol. 44, no.6, pp. 4956-4960, 2021	1. To conduct a comparative analysis of a cool roof vis-à-vis conventional RCC roof, in terms of room temperature, in composite climate of India. 2. To analyse the effect of the cool roof on the indoor room temperature of buildings.	1. The temperature within the chamber decreased by around 2.4 C, while the temperature outside the roof decreased by 9.2 C and 4.1 C, respectively.
Mohan R & R.N. Singh	Techno-economic analysis of cool roof materials in a composite climatic zone	Materials Today: Proceedings, vol. 52, no.3, pp. 1406-1410, Nov 2021	1. To perform a techno-economic analysis of cool roofs using different paint materials. 2. To evaluate the cost-effectiveness of cool roof by calculating Internal Rate of Return (IRR) and payback period.	1. The application of cool paints on the roof surface reduced the cooling demand of the building. 2. Building roofs treated with cool paints had shorter payback periods (2 years) and higher IRR (32.55% to 36.55%). 3. The lifespan of the cool paint coating varied from 5 to 7 years.
Aviruch B, Jyotirmay M, Vishal G & Hashem A.	Determination of Energy Saving of Cool Roof on an Office Building in Hyderabad, India Using Calibrated Simulation	Solar Energy Society of India Journal, vol. 20, no. 1 & 2, 2010	1. To perform energy simulation to estimate the % of energy savings using cool roofs for an office/educational building. 2. To calculate the cost-benefit analysis of the cool roof.	1. The results show that there is 5% overall energy savings and 8.8% energy savings for cooling, when the conventional is replaced with cool roof. 2. The lifespan of the cool roof coating is estimated to be 5 years, with a payback period of 2.4 years.
Vaibhav Rai K, Akash V, & Durva G.	A big picture of urban heat island mitigation strategies and recommendation for India	Urban Climate, vol. 37, no. 10, May 2021	1. To study and review various mitigation strategies of Urban Heat Island effect and analyse their efficiency in the Indian urban context.	Short-term mitigation: 1. Encouraging and implementing cool roof policies in a stringent manner by making it a mandatory clause in ECBC.

			2. To suggest recommendations of mitigation strategies for Urban Heat Island effect at the govt level and highlight the significance of each mitigation strategy.	2. Large and densely populated cities can formulate policies for cool roofs and pavements. Long-term mitigation: 1. Establishing a cool roof rating committee in India to standardize the emissivity and reflectivity of paints and coatings and to monitor roofing products.
Kopal N., Shivraj D, Aviruch B & Vishal G	Cool Roof Implications on Thermal Adaptation in Built Environment	International Symposium to Promote Innovation & Research in Energy Efficiency (Conference: INSPRIRE 2017), Nov 2017	1. To perform an energy simulation to evaluate the thermal performance of cool roofs in different climatic zones of India. 2. To simulate different roof reflectivity values (0.3, 0.45, and 0.8) depending on two thermostat settings: a fixed thermostat value of 24°C and an adaptive thermostat value of 25°C to 26.5°C.	1. The application of cool roofs is found to be the most effective in terms of thermal comfort in the composite climate. 2. When the roof reflectivity of a conditioned building was increased from 0.3 to 0.8, the reduction in overall energy consumption was 26.51% for fixed thermostat operation during the day, 22.41% for fixed thermostat 24-hour operation, 26.74% for adaptive thermostat operation during the day, and 23.16% for adaptive thermostat 24-hour operation.

3. LITERATURE GAP

The gap identified in the literature review was that the research papers did not cover the market study of the materials available for cool roofs in the area where the study was conducted.

4. OBJECTIVES OF THE STUDY

- To study about the cool roofs: definition, working principle, advantages and different cool roofing materials available.
- To study and understand the latest Cool Roof Policy of Telangana.
- To conduct a market study of Cool Roof Tiles and compare & analyse the companies manufacturing this product, based on cost and salient features.

5. LIMITATIONS OF THE STUDY

- The study is predominantly descriptive in nature.
- The market study is restricted to Cool Roof tiles, which is one of the materials used for cool roofs.
- The market study is restricted to the city of Hyderabad.

6. RESEARCH METHODOLOGY

- Study about the cool roofs and the different materials used for the same.
- Study about the latest state level policy of Telangana regarding Cool Roofs.
- Conducting a market study of Cool Roof Tiles and comparing the prices and salient features of different companies manufacturing it.

7. COOL ROOF MATERIALS

A number of factors must be taken into account while selecting a cool roofing material, which includes the existing type of roof, its lifespan and maintenance requirements, availability, cost, installation time, and labour availability. The cool roof techniques are broadly classified into three categories to cater to a variety of contexts.

- **Coated Cool Roofs:** In coated cool roofs, the materials or paints with high SRI value (Solar Reflectance Index) are painted onto an existing or a newly constructed conventional roof. The materials generally used are lime wash, acrylic polymer or

plastic technology which are in liquid form and in white colour. These types of cool roofs are easy to execute and can be used to retrofit existing buildings and can also be used for newly constructed buildings.

- **Membrane Cool Roofs:** In membrane cool roofs, the materials used are the pre-fabricated membranes or sheeting such as PVC (polyvinyl chloride) or bitumen-based. The membranes are installed on an existing roofing system to increase its solar reflectance and reduce heat gain. These types of cool roofs require trained labour for its installation and regular maintenance.
- **Tiled Cool Roofs:** In tiled cool roofs, the tiles used on an existing roof or a new roof have high SRI value (Solar Reflectance Index) and high albedo. The materials used as tiled cool roofs can be ceramic mosaic tiles. These types of cool roofs are easy to execute and can be used to retrofit existing buildings and can also be used for newly constructed buildings.

8. TELANGANA STATE LEVEL POLICY RELATED TO COOL ROOFS

8.1 Telangana Cool Roof Policy 2023-2028

8.1.1 Objectives of the policy

- Awareness programs to adopt to cool roofing strategy for energy savings and improving thermal comfort.
- Creating an institutional framework for city-wide adoption of cool roofs.
- Providing training programmes for cool roof installations.

8.1.2 Targets for Cool roof policy for the state of Telangana

The total area of Hyderabad – including Greater Hyderabad Municipal Corporation (GHMC), HMDA, all Urban Local Bodies (ULBs) & area within Outer Ring Road (ORR) is estimated to be around 7000 sq.km⁽¹³⁾. The targeted roof area for Hyderabad is calculated by assuming a min. of 3% of eligible cool roof area, i.e., 200 sq.km. For the rest of state of Telangana, the achievable cool roof area is assumed to be half of Hyderabad, i.e., 100 sq.km.

Year	Hyderabad Cool Roof Area (sq. kms) Targets for Respective Years	Rest of Telangana Cool Roof Area (sq. kms) Targets for Respective Years	Annual Total Target for Telangana (sq.kms)
2023-24	05	2.5	7.5
2024-25	20	10	30
2025-26	40	20	60
2026-27	60	30	90
2027-28	75	37.5	112.5
Total Aggregated Area by 2028-2029	200	100	300

Table 1: Annual targets of Cool Roofs area for Hyderabad & Rest of Telangana under the Cool Roof Policy [Source: Telangana Cool Roof Policy 2023-2028]

Based on preliminary calculations, the state of Telangana could save upto 600 million units (GWh) of electricity per year after implementation of 300 sq.km area of cool roof.

8.1.3. Implementation Strategy ⁽¹³⁾

8.1.3.A. Mandatory:

- **Government, Non-Residential & Commercial buildings:** Execution of cool roof is mandatory for all the newly constructed Government owned, Commercial and Non-residential buildings, irrespective of site area.
- **Residential buildings:** Execution of cool roof is mandatory for all residential buildings having plot size of 600 sq. yards and above.
- **Government assisted Housing Scheme:** Execution of cool roof is mandatory for Central and State govt. built low-income housing projects and Govt. assisted low-income housing.

8.1.3.B. Optional:

- The cool roof is optional for buildings that already have solar rooftop systems.
- Retrofitting of non-residential buildings.

- The cool roof is optional for all the residential buildings whose plot size is less than 600 sq. yards area.

9. MARKET STUDY

9.1 House of Johnson: Johnson Endura Cool Roof SRI (Solar Reflectance Index) Tiles

- Johnson Endura SRI tiles have SRI value > 90 (White colour) and SRI value > 78 (colour tiles).
- The interior temperatures can be reduced upto 10°-15° C, after application of cool roof tiles.
- The Cool Roof SRI tiles have a matte finish that provide an anti-skid surface, making them safe and practical for areas like Building roofs, Balconies, Exterior facades cladding and Pavements.
- The Johnson Endura Cool Roof SRI Tiles are IGBC (Indian Green Building Council) certified cool roofing tiles.
- The Cool Roof SRI tiles are available in 0.8cm, 1cm and 2cm thickness, out of which 0.8cm thickness is widely used. The different sizes available are 30cm x 30cm and 40cm x 40cm, in which the former is widely used and a minimum order quantity of 15,000-20,000 sq.ft should be placed for the purchase of 40cm x 40cm tiles.
- The Cool Roof SRI tiles are available in 6 colours, namely white, ivory, light grey, pink, almond and sky blue.
- **Prices:** Cool Roof SRI tiles - white colour 30cm x 30cm (8mm): **Rs 68 per sq. ft**
Cool Roof SRI tiles – other colour tiles 30cm x 30cm (8mm): **Rs 75 per sq. ft**
Cool Roof SRI tiles - white colour 30cm x 30cm (10mm): **Rs 73 per sq. ft**
Cool Roof SRI tiles - other colour tiles 30cm x 30cm (10mm): **Rs 80 per sq. ft**



Fig 2 & 3: Images from the market study
[Source: Picture taken by the author]

9.2 Rocotile Roof Cool Tiles (Company outlet at Hayathnagar)

- Rocotile Cool Roof tiles have SRI value – 101 (white colour). They are only available in white colour.
- The interior temperatures can be reduced upto 11°-13° C, after application of cool roof tiles.
- The Cool Roof tiles are ceramic tiles that have a smooth, matt finish and anti-skid surface, making them safe and practical for areas like Building roofs, Balconies, Temple walkways and Pavements.
- The Rocotile Roof Cool Tiles are certified cool roofing tiles, and a certified IGBC (Indian Green Building Council) Member.
- The Cool Roof tiles are available in 1.5cm and 2cm thickness, out of which 2 cm is widely used. The different sizes available are 10”x10” and 12”x12”, in which the latter is widely used.
- **Prices:** Cool Roof tiles - white colour 10”x10” (15mm): Rs 40 per piece (min order qty: 500 no.s)
Cool Roof tiles - white colour 12”x12” (20mm): Rs 50 per piece (min order qty: 100 no.s)



Fig 4: Rocotile Cool Roof tiles
[Source: rocotile.com]

- Laying instructions:
 - 6mm-12mm chips concrete is required to set level for slope.
 - Check if the concrete is cured properly.
 - Use concrete screed mortar in the ratio of 1:6
 - Max. thickness of cement mortar: 25mm.
 - Avoid using steel hammer while laying
 - Use 6-8mm spacers in between the tiles while laying.
 - The joints should be filled with grout and binder mix in 1:1 ratio, waterproofing compounds can be added if necessary.
 - The surface should be cleaned and be left to dry for 8 hours.
 - The tiled area should be cured with water in the morning and evening for 2 days.
- Cost Comparison of Rocotile Roof tile and Ordinary clay tile

Rocotile Vs Ordinary Clay Tile: Cost Comparison (In Rs)		
	Ordinary Clay Tile	Rocotile
Cost of tile	28	42
Grouting compound	3	3
Lime surkhi mortar	32	0
Baby chips slope	0	12
Cement mortar	20	20
Water proofing	10	10
Labour charges	25	25
Total cost per sq. ft.	118	112

Table 2: Cost comparison of Rocotile vs Ordinary clay tile
[Source: rocotile.com]

10. CONCLUSIONS

- From the market study, it can be concluded that the Rocotile Cool Roof tiles are cheaper than Johnson Endura Cool Roof SRI tiles. Also, the former is cost effective when compared to an ordinary clay tile.
- The laying process of the roof tiles is also simple and easy to execute.
- With the implementation of the Cool roof policy and the cost-effectiveness and simple laying process of the roof tiles, there will be an increased usage of this material for reducing indoor temperatures and energy consumptions.

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