Analysis of optimal selection of energy efficient roofing material – A compartive study

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ABSTRACT

This paper presents the results of an experimental, analytical, and simulation results of an innovative cool roof system on thermal behavior and energy performance of a building. An experimental monitoring has been carried out during the year 2015 to assess both indoor and outdoor thermal conditions of the building. In Chennai which has a tropical wet and dry climate, temperature is always at a higher level except two to three months and finding out a cost effective and energy efficient roofing material is the need of the hour not only to tackle heat but to abate pollution as well. A cool roof is energy efficient roof that strongly reflects sunlight and also cools itself by efficiently emitting radiation to its surroundings. This is also known as passive cooling technique. The term 'cool roof' encompasses an extensive array of roof types, colors, textures, paints, coatings, and slope applications. In this study experiments are conducted on four different building models with different types of roofing materials and cooling load for each model was found analytically. A simulation model using the selected material is done in revit Architecture. From the study it is found that white coat roofing material is best out of the materials tested.

KEY WORDS: Cool Roof, Energy Efficient, Solar Reflectance, Thermal Performance.

1. INTRODUCTION

As the demand for energy is increasing day by day and building sector is one of the major consumers of energy, energy conservation in buildings deserve importance. Many modern buildings in India are constructed of concrete or cinder blocks and are topped with flat, tar covered roofing. Such surfaces absorb the incident sunlight, transferring it to the interiors of the building during night. Thus the hot ceiling continues to heat up the space during the day and night making the spaces unbearably hot throughout the summer season and extended to two to three winter months also. In Chennai, temperature is always at a higher level except two to three months and finding out a cost effective and energy efficient roofing material is the need of the hour not only to tackle heat but to abate pollution as well and hence this study.

A cool roof or energy efficient roof is one that strongly reflects sunlight and also cools itself by efficiently emitting radiation to its surroundings. This roof literally stays cooler and reduces the amount of heat conducted to the building below. The term, 'cool roof' refers to the outer layer or exterior surface of the roof which acts as the key reflective surface. These roofs have higher solar reflectance than an ordinary roof surface. Cool roof' encompasses an extensive array of roof types, colors, textures, paints, coatings, and slope applications. A white coloured roof strongly reflects both visible and near infrared sunlight, a white roof will typically be cooler than a colored cool roof. Thus the two basic characteristics that determine the "coolness" of a roof are Solar Reflectance (SR) and Thermal Emittance (TE). Solar reflectance is the ratio of solar energy that is reflected by a surface to the total incident solar radiation on that surface. Thermal emittance is the relative ability of a material to re-radiate the absorbed heat as invisible infrared radiation. One of the test cases involved both an increase in solar reflectance and infrared emittance (Anna Laura Pisello, 2014).

Researchers have studied the ways of reducing cooling and heating loads in a building by means of adopting cool roof concept. Synnefa (2007), studied the impact from using cool roof coatings on the cooling and heating loads and the indoor thermal comfort conditions of residential buildings for various climatic conditions. Anna Laura Pisello, Franco Cotana (2014), studied the possibility of applying an innovative "cool roof" solution, consisting of a prototyped cool clay tile, on a traditional residential building in central Italy to improve the thermal conditions of the indoor environment that is adjacent to the roof. Hashem Akbari (1997), monitored the effects of cool roofs on energy use and environmental parameters in six California buildings at three different sites. Haberl and Cho (2004), in their literature review about cool roof impact on building cooling requirement (Akbari, 1997), found that cool roof technology is able to save about 20% of cooling requirement in residential and commercial buildings. Kolokotroni (2011), found that this strategy should be included as an effective building passive retrofit solution also in temperate climates where the optimum reflectance value is around 0.6-0.7, the effect of application of cool roof paint in a naturally ventilated office building in London. Simulations of annuals building energy demand have shown that the cool roof technology has a positive impact for low insulated buildings in various climates as it reduces indoor air temperature during summer. In fact, several numerical and experimental researches showed important benefits in terms of energy saving for cooling in case of different buildings' uses, e.g. residential buildings. Their results showed that installing a cool roof reduced the daily peak roof surface temperature of each building by 33–42 K.

In this paper, performance of different energy efficient roofing materials were done and compared using analytical, experimental and simulation methods. Experiments were conducted on four physical models of 15 Sq.ft.