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Estimation of Cooling Load By Using Different Roof Material

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ABSTRACT

Cooling load calculations are carried out to estimate the required capacity of cooling systems. The purpose of this project is to develop a user-friendly program that can easily calculate space-cooling load of a typical class room taking some of the basic inputs like latitude, longitude time zone, building materials and other metrological data of the location. Our thesis is based on reducing cooling load of room by using recycle plastic as roof material in the place of RCC because thermal conductivity of plastic is less as compare to RCC.Which reduces the cooling load. Cooling load calculations are carried out to estimate the required capacity of cooling systems. The purpose of this project is to develop a user-friendly program that can easily calculate space-cooling load of a typical class room taking some of the basic inputs like latitude, longitude time zone, building materials and other metrological data of the location.

I. INTRODUCTION

Cooling load calculations are carried out to estimate the required capacity of heating and cooling systems, which can maintain the required conditions in the conditioned space. To estimate the required cooling capacity, one has to have information regarding the design indoor and outdoor conditions, specifications of the building, and specifications of the conditioned space (such as the occupancy, activity level, various appliances and equipment used etc.) and any special requirements of the particular application.

For comfort applications, the required indoor conditions are fixed by the criterion of thermal comfort, while for industrial or commercial applications the required indoor conditions are fixed by the particular processes being performed or the products being stored. The design outdoor conditions are chosen based on design dry bulb and coincident wet bulb temperatures for peak summer or winter months for cooling and heating load calculations.

For estimating cooling loads, one has to consider the unsteady state processes, as the peak cooling load occurs during the day time and the outside conditions also vary significantly throughout the day due to solar radiation.

In addition, all internal sources add on to the cooling loads and neglecting them would lead to underestimation of the required cooling capacity and the possibility of not being able to maintain the required indoor conditions. Thus cooling load calculations are inherently more complicated as it involves solving unsteady equations with unsteady boundary conditions and internal heat sources.

The total building cooling load consists of heat transferred through the building envelope (walls, roof, floor, windows, doors etc.) and heat generated by occupants, equipment, and lights. The load due to heat transfer through the envelope is called as external load external load, while all other loads are called as internal loads.

The percentage of external versus internal load varies with building type, site climate, and building design. The total cooling load on any building consists of both sensible as well as latent load components. The sensible load affects dry bulb temperature, while the latent load affects the moisture content of the conditioned space. Buildings may be classified as externally loaded and internally loaded.

In externally loaded buildings the cooling load on the building is mainly due to heat transfer between the surroundings and the internal conditioned space. Since the surrounding conditions are highly variable in any given day, the cooling load of an externally loaded building varies widely.

In internally loaded buildings the cooling load is mainly due to internal heat generating sources such as occupants or appliances or processes. In general the heat generation due to internal heat sources may remain fairly constant, and since the heat transfer from the variable surroundings is much less compared to the internal heat sources, the cooling load of an internally loaded building remains fairly constant. Obviously from energy efficiency and economics points of view, the system design strategy for an externally loaded building should be different from an internally loaded building. Hence, prior knowledge of whether the building is externally loaded or internally loaded is essential for effective system design.

As mentioned before, the total cooling load on a building consists of external as well as internal loads. The external loads consist of heat transfer by conduction through the building walls, roof, floor, doors etc., heat transfer by radiation through fenestration such as windows and skylights. All these are sensible heat transfers.

In addition to these the external load also consists of heat transfer due to infiltration, which consists of both sensible as well as latent components. The heat transfer due to ventilation is not a load on the building but a load on the system. The various internal loads consist of sensible and latent heat transfer due to occupants, products, processes and appliances, sensible heat transfer due to lighting and other equipment. Figure below shows various components that constitute the cooling load on a building. Plastic recycling is the process of recovering waste plastic and reprocessing the material into useful product. Since the vast majority of plastic is non-biodegradable , recycling is the part of global effort to reduce plastic in the waste stream , especially the approx. 8 million metric tons of waste plastic that enter the earth`s ocean every year. This helps to reduce the high rates of plastic pollution.

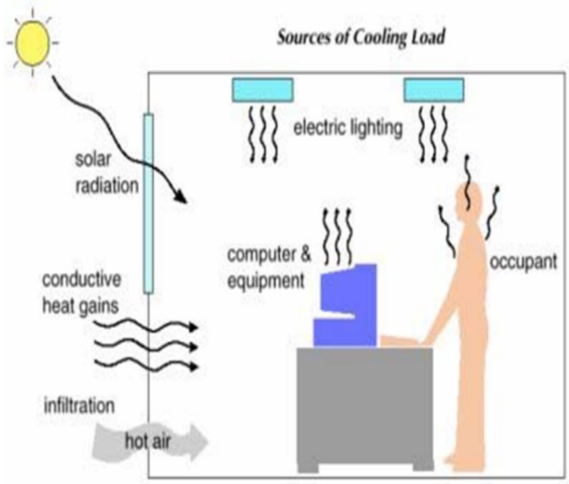

Figure 1. Specifications of the conditioned space

II. REVIEW OF LITERATURE

Wong et al, (2003) conducted a field study in a low rise commercial building in Singapore [4]. In his studies a maximum reduction of surface temperature of 30oC was obtained and the temperature reduction varied on the type of plants and density LAI (Leaf Area Index) of the plants. Thermal performance of green roof installed by the Vicenza Hospital, Italy was studied and analyzed by Lazzarin et al. [5], in 2005. The role of the latent flux of the evapotranspiration was studied and with the soil in almost dry conditions the green roof allows an attenuation of the thermal gain entering the underneath room of about 60% with respect to a traditional roofing with an insulating layer.

An experimental study on the selection of appropriate plants for the green roof was done by Liu et al. (2011).The experiment was done at the top floor of an eight floor building located in Taiwan [10]. The results indicate that the plants from CAM families, Portulacaceae, Crassulaceae and Euphorbiaceae are more droughts tolerant by humans. The results showed that the temperature reduction effects decrease with plant height in the following pattern: 35cm>15cm>10cm. The results also indicate that the plants with green colored leaves are more effective in roof top heat insulation.

A study conducted in University of Lleida, by Gabriel Perez et al. (2011) used recycled rubber from tires as a drainage layer in green roofs instead of porous stone materials [11]. He concluded that the extensive green roofs can be a good tool to save energy during summer in Continental Mediterranean climate, and that the use of rubber crumbs instead of Puzolana as drainage layer material in extensive green roofs is possible, and should not arise any problem for its good operation thereby reducing the consumption of natural materials, which require large amounts of energy in its transformation process to obtain their properties. Moreover it would provide a solution to the problem of waste rubber from the tires.

In **Investigation of cooling potential of an eco-roof on warm days,** we studied that, the thermal benefits of green roofs are unquestionable. The Indoor and roof temperature of a building with green roof experience much lower temperature compared to an exposed bare roof. To analyze the thermal performance, a comparative measurement and experiment were carried out on two symmetrically constructed rooms in Southern part of India. Experimental investigations have been done on these rooms as the objective of this study is to analyze the thermal impacts of green roofs in Indian climate.

COOLING LOAD CALCULATION AND PRINCIPLES, from this we studied that, For estimating cooling loads, one has to consider the unsteady state processes, as the peak cooling load occurs during the day time and the outside conditions also vary significantly throughout the day due to solar radiation. In addition, all internal sources add on to the cooling loads and neglecting them would lead to underestimation of the required cooling capacity and the possibility of not being able to maintain the required indoor conditions. Thus cooling load calculations are inherently more complicated.

Typical metabolic rates

Activity	Specifications	Metabolic rate
Resting	Sleeping	0.7 met
	Reclining	0.8 met
	Seated, quite	1.0 met
	Standing, relaxed	1.2 met
Walking	0.89 m/s	2.0 met
	1.79 m/s	3.8 met
Office activity	Typing	1.1 met
Driving	Car	1.0 to 2.0 met
	Heavy vehicles	3.2 met
Domestic activities	Cooking	1.6 to 2.0 met
	Washing dishes	1.6 met
	House cleaning	2.0 to 3.4 met
Dancing	-	2.4 to 4.4 met
Teaching	-	1.6 met
Games and sports	Tennis, singles	3.6 to 4.0 met
	Gymnastics	4.0 met
	Basket ball	5.0 to 7.6 met
	Wrestling	7.0 to 8.7 met

III. CONCLUSIONS

This paper investigates the thermal behaviour of an extensive green roof on mild warm climate of India. It is convincingly demonstrated that the green roofs can greatly affect the room air temperature and interior and exterior surface temperature of the roofs on warm days. Temperatures in the two rooms are shown to be different by a large margin. Compared to a bare roof, the room air temperature of a green roof was reduced by a maximum of 4.4oC and the roof surface temperature was reduced by a maximum of 22%. A maximum heating gain of 6.1oC has been observed for the conventional roofs over the green roofs. The heat flux studies show that the heat transfer is reduced to a large extent (by 50%) on an average for experimental data. The heat flow swings are also considerably dampened and smoothed out. A thermal lag of 2 to 3 hours has been observed. The thermal performance of green roof model is presented with extensive set of validation with experimental data for room air temperature and plant canopy temperature. Parametric study shows that, to be effective, the soil depth needs to be more than 10 cm. In the study, it was found that the 20 cm, 30 cm, and 40cm (soil depth) roofs were all successful in bringing down the temperature of the room to more or less the same extent. It could be inferred that in hot climate (like the southern part of India), green roofs are a welcome relief from scorching solar radiation by contributing to human comfort as well as minimizing air conditioning expenses.