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Topic of Research: **OPTIMIZATION OF BUILDING ENERGY PERFORMANCE**

FINDINGS

In today's world, the rate of population expansion, industrial advancements, and rising social welfare levels have contributed to recent increasing in energy demand. Buildings account for around 40% of global energy consumption and 36% of carbon dioxide emissions.

This study looks at ways to restrain the growth of energy use in the Indian residential sector and methods to save energy by focusing on standard policy and energy-efficient building models. The building is a complex geometry and a combination of many elements. Building walls and envelopes are the two significant elements in the building's energy requirement. A considerable amount of heat is transferred in or out of the buildings through the wall and fenestration. In the present work, Degree Day's method is used to determine the optimum insulation thickness for different insulation materials. Some of the commonly used insulation materials available in the market are considered in the study. Insulation materials used in the study are fiberglass rigid, urethane rigid, fiberglass urethane, perlite, and extruded polystyrene. The Cooling Degree Days were calculated using the base temperature varying from 18ºC to 26ºC for the four major cities, Mumbai, New Delhi, Kolkata, and Chennai of India. The impact of base temperature and Cooling Degree Days on insulation thickness and how annual cooling costs vary with insulation thickness is analyzed. Energy-saving varies with the thickness of the insulating materials applied on the wall. In addition, with the help of insulation, energy can be saved by up to 80%. The optimum insulation thicknesses vary between 1 and 12 cm for the different base temperatures and cities. Annual cooling cost per m^2 is also calculated for the base temperatures 21 ºC and 24 ºC, and the result shows that fiberglass urethane has the lowest annual cooling cost for different cities. Among the five insulation materials, 82.8% of energy savings from insulated walls based on optimum insulation thickness is achieved by applying extruded polystyrene. When the base temperature increases from 18 ºC to 20 ºC, 9.47% of energy can be saved from the wall transfer in or out of the building. Similarly, it increased from 20 ºC to 22 ºC, with 10.57% energy saving, from 22 ºC to 24 ºC, 12.12% energy savings, and from 24 ºC to 26 ºC base temperature 15.07% energy saves.

Fenestrations are also an essential element of the building, which significantly affects the building's energy efficiency. The energy flow inside the building from the glass and windows can be restricted by providing shading on the windows. Provide the shading on the window with the most common type of fixed shade like overhang and fin. Shading devices are beneficial in controlling the sensible heat gain and light transmittance through the fenestrations of the building. Most studies analyze the impact of window wall ratio (WWR), shadings, and sensible heat gain (SHGC) on a building's energy demand but do not consider the combined effect of these parameters. Considering all the building envelope parameters in the analysis, like window-to-wall ratio, orientation, shading devices, projection factor, and type of glass. The residential envelope transmittance value variation with the Window-Wall Ratio, projection factor, and fixed shading devices are analyzed. The energy from building envelope elements in residential buildings is optimized using the Taguchi method. The analysis of transmittance energy through the building envelope is conducted in eight cardinal directions by providing shading with the fin and overhang.

From analyzing the heat transfer from the building envelope and based on the result, the optimum energy saving achieved by selecting the optimum combination of the process parameters, i.e., the window-to-wall ratio of 7%, triple glazing type of glass used, shading with the overhang fin, and orientation in the west direction. WWR contributes 89.55%, type of glass 4.03%, shading 5.26%, and orientation 1.15% in the residential envelope transmittance value of the building. The result shows the most significant factor in the building envelope among the selected parameter is the window-to-wall ratio.

The study analyses whole building energy utilization using simulation by considering passive parameters and appliances to achieve the maximum saving building model. An optimization algorithm evaluates a wide range of combinations of specific energy factors to identify the least expensive way to build new homes. The optimization strategy employs a sequential search of numerous possible option combinations. It employs the most cost-effective solutions to generate the least-cost curve and the least amount of energy required to attain specified home-performance levels. Three building models were analyzed in the study based on energy savings. This study evaluates the least-cost curve, energy consumption, and CO_2 emission and optimizes a combination of building energy performance parameters that maximize annual energy savings and minimize CO_2 emission. Based on the result, energy can be saved up to 10%, 48%, and 52% by selecting the optimum combination of parameters. The difference between source energy savings and total present value for the minimum cost and maximum saving building model is 4.2% and 26.77%.