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PASSIVE SOLAR DESIGN FOR ENERGY EFFICIENCY IN BUILDING

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ABSTRACT:

Today, human comfort is the ultimate parameter due to the improvement of the quality of life and the increase of the atmospheric temperature. Electric air conditioners are not recommended for use in large buildings due to their short life and energy consumption. In addition to lower maintenance costs and energy, passive solar energy also offers greater reliability. The efficient design of a passive solar system ensures lower energy consumption, lowers capital costs and helps improve the aesthetics of the building. This paper gives the result of the cooling load estimated by the CLTD method under different climatic conditions. Parameters such as windows, doors, walls and ceiling are studied and presented in this article to determine the heat gain or cooling load of a room. The method for determining the thermal gain is to use the cooling load temperature difference (CLTD) and the cooling load factor (CLF) based on the 1997 ASHRAE Fundamentals Handbook.

INTRODUCTION:

Building and industries have a significant issue of ecological imbalance regarding energy consumption. The energy efficiency of buildings is affected by local climate conditions, as energy use depends on these conditions and the efficiency of HVAC systems varies accordingly. Designing HVAC systems with consideration to the specific climatic conditions is crucial for maximizing efficiency. Around 60% of the energy used in a spacious, air-conditioned building is dedicated to the cooling systems. To reduce energy consumption, it is essential to accurately determine the cooling and heating needs and ensure proper sizing of HVAC systems. External climatic conditions, including outdoor temperature, humidity, and solar radiation, are the main influences on the cooling load.

The energy efficiency of buildings is influenced by local weather conditions. Climate affects the amount of electrical energy used in buildings, and the performance of heating, ventilation and air conditioning (HVAC) systems varies accordingly. It is important to consider the climate when designing HVAC systems for optimal energy efficiency in buildings. This will lead to increased comfort for individuals and improved energy efficiency of buildings. The cooling load, including factors such as human heat gain, lighting, infiltration and ventilation, can be efficiently calculated using MS-Excel.

OBJECTIVES:

1.To study and analysis Passive Solar Design for energy Efficiency in Building.
2.To determine cooling load for a residential building.

LITRTURE REVIEW:

Javad Sadeghsaberi et.al (2013) concentrated on creating a passive solar structure by utilizing the nearby weather conditions. In their research, they examined the different approaches to harnessing heat through the use of passive solar strategies. They observed how the sun's position changes throughout the year and arranged the building's direction accordingly. Considering the site location and specifications, they observed the guidelines that must be adhered to when designing a structure. Particular attention was placed on the different tools and techniques utilized to either retain or repel heat. Factors to take into account include the positioning of windows and the type of glazing, as well as thermal insulation, thermal mass, and shading. Their findings showed that Passive Solar Houses are extremely efficient and highly successful in cutting heating expenses by as much as 50%.

Anil Kumar (2013) concluded that the concept of a solar distribution device using a solar path diagram and various ways of using it in energy-efficient develops possible passive solutions in buildings and construction and also provides an overview of solar-based. Passive solutions and design approaches in potential buildings, especially related to tropical countries. And also answers that the idea of a solar energy distribution machine through the work of the solar path diagram and the various ways it can be used for the clever structures of masculinity and give a high-level perspective of the diffuse orchestration with the roots of the sun and the arrival of radiation into the building are plausible, especially in the case of important tropical nations. So the same can be applied in agricultural countries like India.

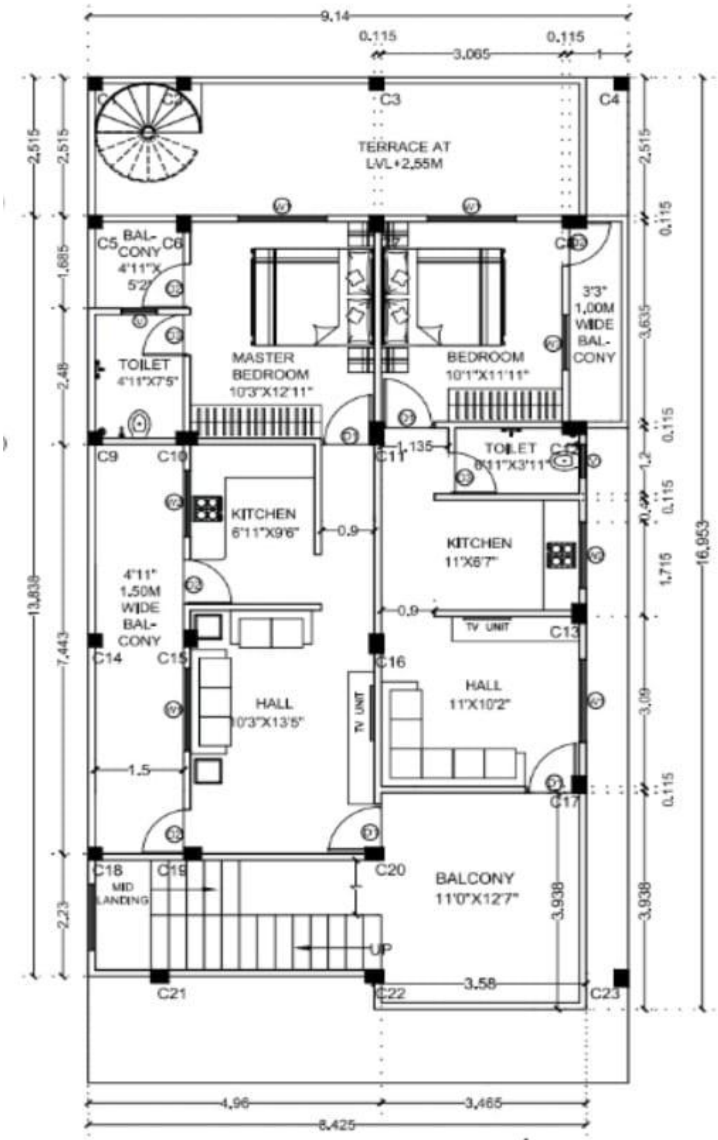
Gupta et. al 1970 he concludes that the variable temperature of non-air-conditioned buildings with partial energy consumption or air conditioning load can be set to a regulated indoor temperature.

AbdolVahidKahoorzadeh et.al (2014) indicates passive solar cells as shading devices. Additional elements keep the interior at a more comfortable and stable temperature. The humidity of the door can be adjusted accordingly. Open the building at night to ventilate and cool the internal thermal mass. Close buildings during the day to keep the heat out. Therefore, the inhabitants of a standard passive solar system feel more comfortable in all conditions, be it cold or hot weather. It also has financial benefits. In fact, buildings require a relatively small cooling or heating system.

METHEDOLOGY:

1. Selection of residential building
2. Identification of parameters
3. Calculation by CLTD method

Building location: the essential building considered in the study is situated in the geographical location of Dhaba, Nagpur district where is from latitude 21.16º and longitude 79.01º E.



FIRST FLOOR PLAN

1. Identification of parameters:

1. **Walls:** In this relationship building walls are made up of brick machinery in (230 mm). This brick machinery, because of its colour, mass and thermal properties, provides thermal storage for the system.
2. **Roofs**: roof receive the majority of the solar radiation delivered to a big solar radiation occurs predominantly through the roof and windows.
3. **Windows:** Sunlight enters directly through outward-facing glass. It moves the massive internal surfaces of the usable space, absorbs and transforms heat.
4. **Shading**: Providing external shading as part of the architectural envelope design is crucial in regulating the entry of sunlight into the interior of buildings.

2. CALCULATION BY CLTD METHOD:

CLTD (Cooling Load Temperature Difference) Method:

The method is employed to determine the heating and cooling requirements of a house. The current CLTD/CLF method, as described in ASHRAE 1979, is founded on the research conducted by Rudoy and Duran in 1975. This technique was created to manually calculate using predetermined CLTD and CLF values. The CLTD and CLF data in the tables were computed using the transfer function approach, which produced the cooling load for standard ambient conditions and zone classification. The designer calculated the cooling load for each hour by normalizing the cooling loads with simple multiplication. The total cooling load for the zone is calculated by summing up the cooling loads of each component.

Walls and Roofs:

A single type of standard zone was utilized. Hourly cooling loads for each hour were transformed into CLTD values by dividing by the roof or wall area and the overall heat transfer coefficient. The cooling load for any wall or roof can be determined using the following equation:

$q = U \times A \times CLTD$…… (1)

Where

q = cooling load, kN,

U = total heat transfer coefficient, kN /m²,

A = area, m²,

CLTD = equivalent temperature difference, ºC.

Fenestration:

In order to calculate the cooling load caused by windows, the heat gain was split into radiant and conductive components. The cooling load from conduction was determined using the equation applied to ceilings and walls (Equation 1). The CLTD for windows is specified for normal conditions, with an adjustment factor provided for temperatures different from 29.44 °C outdoors and 25.56 °C indoors. A cooling load factor is calculated for every hour, allowing the cooling load for each hour to be calculated using a following formula:

$Q = SHGFmax \times SC \times CLF \times A$…… (2)

Where,

Q = cooling load of the reference glazing system, kW,

SHGFmax = Maximum Solar Heating Factor

SC = Reference Glass of Solar Heat Gain System,

A = Cantilever area, (m²)

People, Lights and Equipment

To calculate the cooling load per unit heat gain for various schedules (such as two hours, four hours, etc.) in relation to human lighting and equipment, the weight factor equation was employed. The designer subsequently employs this equation to calculate the hourly cooling load.

$Q = qs \times CLF + q1$…… (3)

Where,

Q = cooling load,

qs = sensible heat,

q1 = latent heat.

VI CALCULATIONS:

In this passive solar design the cooling load for residential building is calculated by taking the peak months such as May in summer, July in monsoon and January in winters.

VI. RESULTS & CONCLUSIONS:

6.1 RESULT: SAMPLE CALCULATION FOR GROUND FLOOR

Load calculation of walls season wise for ground floor			
Ground floor parameters	**Season**		
	Summer	**Winter**	**Monsoon**
North	106.16	-4.10067	36.90
South	74.54	-13	19.80
East	307.40	77.79	163.18
West	373.11	94.42	198.07
Heat gain from people (sensible)	1120.00	1120	1120
Heat gain from people (latent)	640	640	640
Heat gain from lighting	386	386	386
Heat gain from appliances	9752	9752	9752
Total load (W)	12759.21	12053.522	12315.967

Total load calculation	
Ground floor	13333
First floor	10535
Second floor	10648.88
Total load (W)	**34516.69**
Total load (tons)	**9.81**

6.2 CONCLUSION:

1. The energy simulation outcomes for both the house model and the enhanced scenarios are depicted and examined.
2. The CLTD method determined the total cooling load for this residential building to be 9.78 tons.
3. The second floor requires 10.44 kW of cooling, while the first floor needs 10.3 kW and the ground floor requires 13.33 kW.
4. The ground floor requires the maximum amount of cooling while the first floor and the second floor requires minimum the amount of cooling. Because of higher number of Equipments are used in first floor as compared to other two floors.

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