ANALYSIS BY INSULATION OF BUILDING FOR REDUCING ENERGY CONSUMPTION IN GWALIOR

Prof. Y. P. Singh
Director, Amity School of Architecture and Planning,
Gwalior, Madhya Pradesh, India

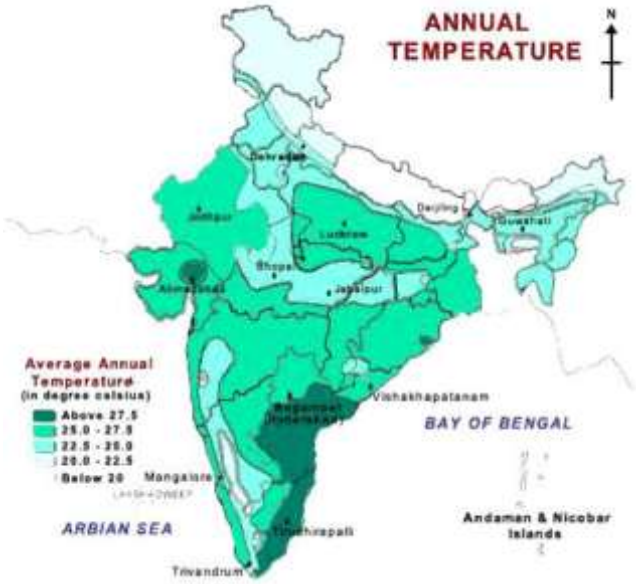
Abstract : ***With resources of energy diminishing day by day, local and international targets of reduction of greenhouse gasses, the performance of building may take a greater significance in near future.***
For India, annual cooling degree days are 3120 and annual heating degree days are 80. In this paper, the average cooling degree days and heating degree days of Gwalior, a city in Madhya Pradesh are studied and heat loss per unit area of building wall is estimated with and without the insulation. For calculating the heat loss, average U value of building walls was considered. The base temperate was considered to be 22 degrees Celsius.
The results are compared between the best and worst U values of the buildings.
The results indicate that insulation has a quick payback period of around 1-2 years and saves the lost energy through building walls by up to 80%.

IndexTerms – Energy efficiency

Introduction
The value of degree-days is a measure used to indicate the demand for energy to heat or cool buildings. The monthly and/or annual cooling and heating requirements of specific buildings in different locations can be estimated by means of the degree-days concept. The method assumes that the Energy needs for a building are proportional to the difference between the mean daily temperature and a base temperature. The base temperature is the outdoor temperature below or above which heating or cooling is needed.
Insulation helps maintain comfort temperature by reducing leakages. With the advent of green technologies and practices, today the potential to save energy by design can be as high as 40-50%.Insulation in buildings is assuming tremendous importance and has a potential to reduce energy consumption to an extent of 5-8%.

I.GWALIOR
Gwalior district is located at the northern part of Madhya Pradesh, a central state of India. Figure 1.shows the average temperature of various parts of India. The figure clearly shows that Gwalior lies in moderate temperature zone. Thus, there is a requirement of heating and cooling both at different times in a year.

II.CONCEPT OF HEATING AND COOLING DEGREE DAYS
A "degree day" is a measure of the average temperature's departure from a human comfort level of 22°C. The concept of degree days is used primarily to evaluate energy demand for heating and cooling services. Using a base temperature of 22°C, heating degree days (HDDs) are defined as 22 – T, where T is the average temperature of a given day. Cooling degree days (CDDs) are calculated in a similar fashion. Cooling degree days are defined as T – 22, where T is the average temperature.



***III DATABASE* FOR TEMPERATURE**
Accurate and reliable weather data are crucial for building energy simulations and analyses. The weather data being used in energy analysis determines the accuracy and characteristics of the results. Therefore, the database used in an energy analysis should cover a long period and

depend on recent values .In this study, daily minimum and maximum outdoor dry-bulb temperatures of recent years were used. The data obtained during at least 5 years were used in the calculations. Daily mean temperatures were obtained by averaging the minimum and the maximum temperatures.

COOLING DEGREE DAYS OF GWALIOR

Celsius based 5 years average (2010-2014) cooling degree days for a base temperature of 22°C are as shown below in table 1.

MONTH	CDD	%ESTIM.
Jan	4	4
Feb	24	4
Mar	127	5
Apr	246	4
May	386	4
Jun	366	7
Jul	256	4
Aug	214	4
Sep	202	4
Oct	137	4
Nov	54	4
Dec	16	4
Total	2032	4

Table 1: Cooling degree days of Gwalior

Here, %ESTIM. Shows how much the given data is estimated to account for the missing data.

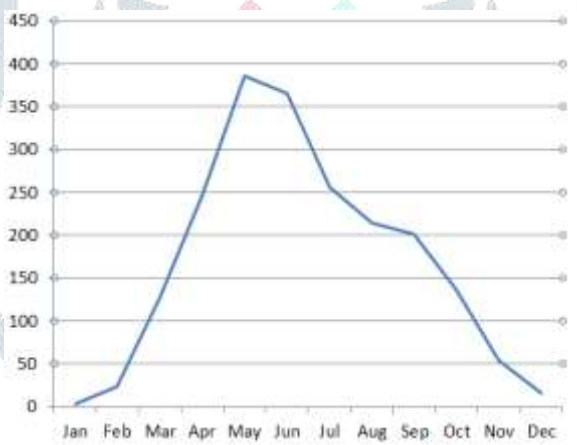


Figure 2: variation of CDD with months

HEATING DEGREE DAYS OF GWALIOR

Celsius based 5 years average (2010-2014) heating degree days for a base temperature of 22°Care as shown below in table 2.

MONTH	HDD	%ESTIM.
Jan	278	4
Feb	143	4
Mar	49	5
Apr	4	4
May	0	4
Jun	0	7
Jul	0	4
Aug	0	4
Sep	0	4
Oct	20	4
Nov	107	4
Dec	230	4
Total	831	4

Table 2: heating degree days of Gwalior

Here, %ESTIM. Shows how much the given data is estimated to account for the missing data.

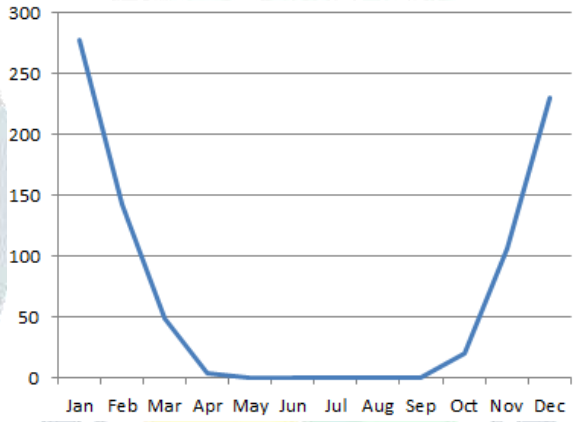


Figure 3: variation of HDD with months

ENERGY LOSS

The U-value of a material or structure is the rate at which heat will pass through a given area for a given temperature difference. It is a property of the material in a structure and is usually measured in watts per square meter per degree Celsius (W/m2 /0C).

Cooling Energy Lost =(U*Annual CDD*24)/1000 kWh/year/m2

Similarly,

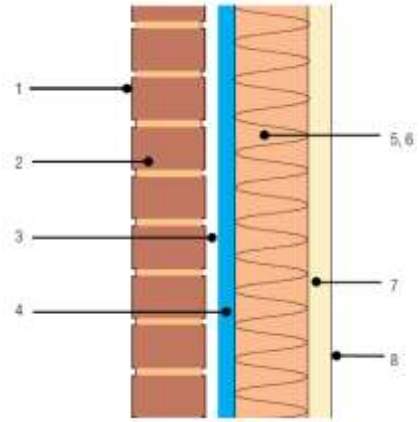
Heating energy lost = (U*Annual HDD*24)/1000 kWh/year/m2

Insulation assumed

For the purpose of study, the insulation assumed is one of the most common insulation nowadays, i.e. fiberglass insulation of R value 2.5.

U value of a typical wall

R value of a typical brick wall due to the insulating effect of various components is as shown below:



No.	Element description	R value
1.	Outdoor air film	0.040
2.	110mm brickwork	0.180
3.	Unventilated air space	0.200
4.	Reflective insulation	0.000
5.	Unventilated air space	N.A.
6.	Bulk insulation wall batt	2.5
7.	10mm plasterboard	0.059
8.	Indoor air film	0.12
	Total R value	**3.1**

Table 3: calculation of R- value of a wall

So, R value with insulation=3.1
And, R value without insulation=0.5
Thus, U value with insulation=**0.322**.
And, U value without insulation= **2**.

Energy loss calculations

We can calculate the energy lost though a typical wall in a year during cooling and heating days individually by using the formula given above as shown:

	Annual degree days	Lost energy without insulation	lost energy with insulation	Saved energy per year
CDD	2032	97.5 kWh/year/ m2	15.6 kWh/year/ m2	81.9 kWh/year/ m2
HDD	831	39.9 kWh/year/ m2	6.4 kWh/year/ m2	33.5 kWh/year/ m2

Table 4: energy loss calculations with and without insulation

From the above table, we see that,
Total energy saved by insulation = 115.4kWh/year/m2. And,
Total energy lost without insulation= 137.4kWh/year/m2.
Percentage of energy saved by insulation=83.9%.

Payback period

Years to payback is the time required for the insulation to save enough money to pay for itself. A simple payback is the initial investment divided by annual savings after taxes.

Payback period = installation cost/savings per year

For calculating payback, we assume COP of air conditioner to be 3 and COP of heat pump to be 4.
The installation cost of insulation per m2= Rs.260 per m2
The cost of electricity in Gwalior per kWh is taken as Rs. 6.

Money saved annually

It is as shown in table:

	Energy saved annually per m2	Electricity saved annually per m2	Money saved annually per m2
Cooling days	81.9 kWh	27.3 kWh	Rs.163.8
Heating days	33.5 kWh	8.37 kWh	Rs.50.2

Table 5: savings per m2 annually

Total savings from the insulation per m2 =Rs.214
So, payback period for the insulation under study = 260/214 = **1.21 years**

CONCLUSION

The impact of wall insulation on annual savings and payback period was investigated in this study. It was found that insulation leads to a large reduction in heat loss through the building walls, thereby increasing the efficiency of the system and reducing electricity consumption in HVAC systems of buildings. Insulation also has a quick payback period of around 1 to 2 years. Thus, insulation can be considered as a prime component of an efficient green building.

REFERENCES

[1] ICANZ insulation handbook, edition November 2010
[2] ASHARE Hand book, Fundamentals(SI)
[3] http://www.degreedays.net
[4] S.Shanmuga Priya,analysis of cooling degree days for tiruchirappalli – a district in India.
[5]http://www.wikipedia.org/
[6]Subhash Mishra, Energy Saving Analysis In Building Walls Through Thermal Insulation System
[7] http://www.designingbuildings.co.uk/
[8] BUILDING INSULATIONFrom Indian Green Building Council, CII-Sohrabji Godrej Green Business Centre, Hyderabad