Building Envelope for Energy Saving in office Building

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ABSTRACT
The most crucial component in a building's ability to conserve energy is the building envelope. The importance of a building's front increases due to its huge surface area. Because of the low thermal resistance of the facade and high transparency ratio of office buildings, energy consumption is rising. India has a tropical climate, thus heating or cooling is needed all year long to create a comfortable indoor atmosphere. The strain on the mechanical heating and cooling can be decreased by constructing the envelope in accordance with the environment, selecting appropriate materials, and choosing the right fenestration and shading device sizes.

Keywords:-*Building envelope, Office buildings, Energy Saving*

INTRODUCTION

The building envelope plays a critical role in the energy efficiency of commercial buildings, especially office buildings. With rising energy costs and increasing concerns about climate change, there is a growing need to design and construct office buildings that consume less energy and have a smaller environmental footprint. This has led to increased research into building envelope design for energy saving in office buildings [4]

NEED OF STUDY

The building envelope is the bodily separator amid the interior and exterior of a building. It includes the walls, roof, foundation, windows, and doors, and is responsible for keeping the indoor environment separate from the outdoor environment. An energy-efficient building envelope is essential for reducing the energy consumption of a building and reducing its carbon footprint. There are several reasons why studying energy-efficient building envelopes is important:

Energy efficiency: An energy-efficient building envelope can reduce energy consumption by reducing the amount of heat lost or gained through the walls, roof, foundation, windows, and doors.

Cost savings: By reducing energy consumption, an energy-efficient building envelope can also help save on energy costs over the life of the building.

Comfort: An energy-efficient building envelope can help maintain a more consistent indoor temperature, reducing the need for heating or cooling, which can result in a more comfortable indoor environment for occupants.

Sustainability: An energy-efficient building envelope can reduce the carbon footprint of a building, helping to mitigate the effects of climate change.

Regulatory compliance: Many countries and jurisdictions have regulations and building codes that require certain levels of energy efficiency for buildings, making it important for builders and designers to understand how to construct energy-efficient building envelopes.

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AIM:

This study aims to examine the impact of building envelope design on energy consumption and demonstrate the significance of the building envelope in office building energy conservation.

OBJECTIVES:

1. To identify about the various building components which can help to develop energy efficient building envelope.
2. To identify about the various strategies to develop energy efficient facade in different Climate.

METHODOLOGY:

1 • **Introduction, Aim and Objectives:**

2 • **Literature Review:** Literature review to identify the latest research trends, materials, and technologies used for building envelope design for energy saving in office buildings.

3 • **Demand of office Building:** Develop overview of building demand for office building in India

4 • **Energy Saving:** Explore the concept of importance of Building envelope in energy saving.

5 • **Strategies:** Explore the strategies for energy-efficient facade for different Building Components

6 • **Conclusion:** Summarize the research findings and provide recommendations for future design.

LITERATURE REVIEW

Buildings demand for Office in India:

As of June 2022, the six largest cities in India absorbed 30.4 million square feet of office space, a 130% YoY gain, as occupiers' trust in their businesses increased as a result of COVID infections being substantially under control in recent months, according to Savills India. According to a JLL India research, India's office real estate market would likely reach 1.2 billion square feet by 2030 and be valued at $165 billion at present prices. Bengaluru, Delhi-NCR, and Pune were the top three cities, accounting for 66% of leasing activity in the first half of 2022. Bengaluru maintained its position as the market leader with 10.7 million square feet of leasing activity, 110% more than in H1 2021 and accounting for 35% of total gross absorption in H1 2022.

On the other hand, Mumbai's demand has yet to pick up speed as it ranks last among the top 6 in H1 2022. The majority of the city's demand was made up of mid-sized deals and term extensions. However, it should be emphasised that the overall absorption in Mumbai, Pune, Chennai, and Hyderabad is still of a similar size, ranging from 3.3 to 3.7 million square feet per location.[12]

Importance of Building Envelope in Energy Saving:

A building's envelope, which keeps occupants comfortable by acting as a physical barrier between the outside environment and the inside conditioned space, is made up of fenestration (doors and windows), roofs, walls, and insulation. It is one of the main variables affecting a building's energy usage is the building envelope, which divides the conditioned internal area from the unconditioned outer environment.[10,13]

Energy-efficient buildings have building envelopes that do more than just separate the inside from the exterior; they have building systems that actively respond to their surroundings to produce comfortable interiors while drastically reducing energy use.

The majority of commercial structures have energy performance indices (EPI) between 200 and 400 kWh/sq m/yr. In India, it has been demonstrated that energy-conscious building design can lower EPI to 100 to 150 kWh/sq. m. /year. [3][5]

It is pertinent to note that in addition to the energy saving aspects, the fire and life safety should also be considered as the façade plays an important role in vertical spread of fires including the leap-frog phenomenon. Hence the conscious decision should be made during selection the components of the façade specially the cladding materials which are more vulnerable to fire [6,7,8].

***Table 1:**-EPI for Office Building[2]*

Climate Zone	Less than 50% AC	More than 50% AC
EPI (KWh/m^2/year)		
Warm & Humid	101	182
Composite	86	179
Hot & Dry	90	173
Moderate	94	179

If energy efficiency measures are implemented, commercial buildings have the potential to save 40–50% on energy.

Envelopes for buildings that save energy:

• make use of materials with a high level of thermal resistance in the building's facade;

• use vapour barriers and are effective at controlling vapour;

• have effective airflow control to reduce the amount of air that comes in from the outside.

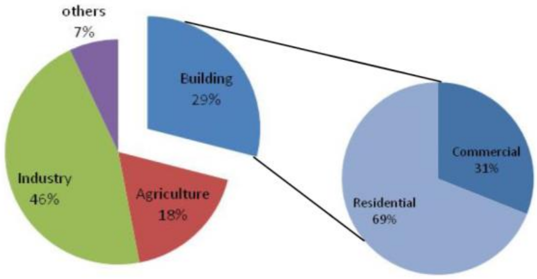

***Fig.1:**-EPI for Office Building [2]*

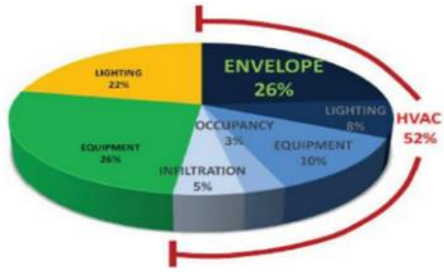

Fig.2:-*EPI for Office Building [2]*

CLIMATIC ZONES IN INDIA:

India has a wide range of climates, from extremely hot desert regions to high altitude locales with severely cold temperatures akin to those in northern Europe.

India may be divided into six main climate-based areas.

Common names for the six climates include hot and Dry, Warm and Humid, Moderate, Cold and Sunny, Cold and Cloudy, and Composite. Any site in India must meet the requirement that the specified conditions last for more than six months in order to be classified as being in one of the top five climatic zones. The climatic zone is known as Composite when none of these categories can be determined for six months or more.[1]

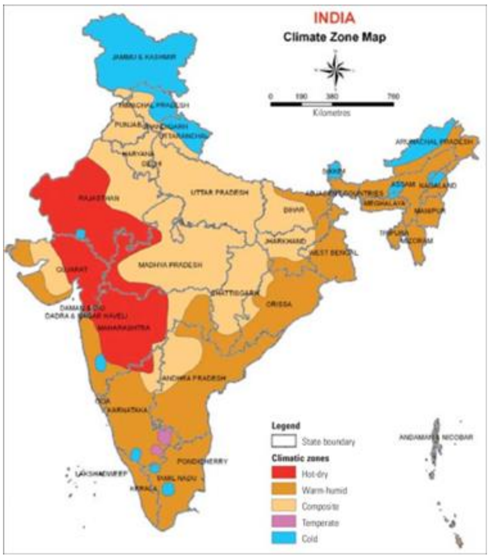

Fig.3:-*Climate Zone map of India [2]*

Table 2:-*Climate Zone in India [2]*

Climate	Mean Monthly temperature (°C)	Relative Humidity
Hot and Dry	>30	<55
Warm and humid	<30	>55
Moderate	25-30	<75
Cold and Cloudy	<25	>55
Cold and sunny	<25	<55

Composite	This applies, when six months or more do not fall within any of the above categories

Table 3:-Building envelope design strategies in Climatic Zone [3]

Climate-specific design of energy efficient envelopes.	
Climate type	**Design strategies for energy-efficient facades**
Heating-dominated	• The building envelope receives solar heating. • Walls can be used as thermal masses for thermal storage. • Better insulation to minimize thermal losses. • Natural daylight is used. Facades have increased glazing areas to allow for natural light; light shelves that redirect light into interior spaces are used.
Cooling-dominated	• Appropriate shading techniques can be employed to protect from direct solar gain. • Use insulation to reduce solar heat gain. **Invalid source specified.** • Design to facilitate natural ventilation (wing walls). • Natural daylight should be used in such a way that solar heat gain is minimized.
Mixed climates	• Use shading devices to protect facade from direct solar radiation during warm days. • Use passive solar design for heating during cold seasons. • Use natural daylight and with increased glazed areas of walls with shading devices.

SURFACE AREA TO VOLUME RATIO(S/V RATIO):
The amount of heat transfer into and out of a building is determined by the surface area to volume ratio (S/V ratio). For lowest heat transfer, a lower S/V ratio is needed.
As it has a low S/V ratio, the aspect ratio should be one to reduce heat transfer.
The guideline for planning office buildings states that because daylight can penetrate interior rooms up to a height of 7 metres, it is important to take appropriate orientation, surface area to volume ratio, and daylight into account. [2]

BUILDING COMPONENTS:
The amount of radiation and wind that enters a building depends on the type of building envelope. It includes the following components:

A. Roof
B. Walls
C. Fenestrations
D. Glazing

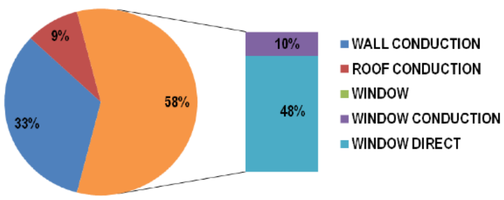

Fig.4:-*Heat Gain through Building Components*

A) Roof: A building's roof absorbs a considerable amount of solar energy. Therefore, the design and construction of it are crucial. Insulating materials can be used either internally or externally to roofs to decrease heat gain through them. On top of the roof, shiny or reflective material may be laid out. [9,11]

B) Walls: A significant portion of the building envelope is made up of walls, which are exposed to a lot of direct sunlight. By increasing the thickness (thermal mass), through cavity walls, by using insulating material, or by painting light-coloured whitewash or distemper on the exposed side of the wall, it is possible to increase the barrier to heat transfer through exposed walls. [9]

C) Fenestration: Fenestration is offered for ventilation, day lighting, and heat gain. Designing apertures and shade structures appropriately can help keep wind and sunlight out of a building or even let them in. Glass is opaque to long wave radiation but transparent to solar radiation. By encouraging heat gain, this property can be exploited to warm a building's interior. Maximum Wall Window Ratio (WWR) less than 60% as per ECBC.[9]

D) Glazing: Use of double or triple glasses with air space in between the direct transmission of solar radiation can be reduced. Reflective Glazing can reduce heat gain without obstructing viewing. They are usually used for windows which cannot be shaded externally.

The U factor and SHGC of Low-E glass is minimum and visible light Transmittance (VT) is also high, hence recommended for office buildings.[9]

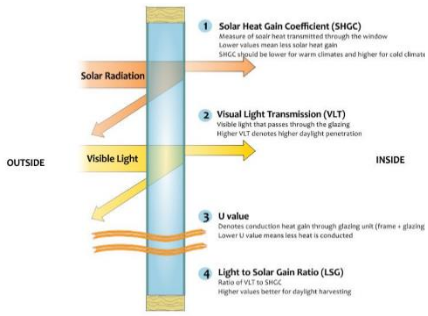

Fig.5:-*Glazing (Nayak & Prajapati, 2006)*

CONCLUSIONS

For office buildings in India, there is a significant opportunity for energy savings through efficient building envelope design. This paper emphasises, how various building envelope elements have different potential for energy savings. To decrease the HVAC load in office buildings, insulation should be installed on the walls and roof for decreasing heat gain. Vertical and horizontal shading devices should be installed on fenestrations, and double-glazed windows with low-e glass should be utilised. The possible energy savings by combining all the criteria could be as high as 17 to 42%.

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