The Impact of façade material on office building

Sub theme: **Goal 11 – Sustainable Cities and Communities**

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Abstract

Highlighting the impact of façade materials on office buildings and focusing on the appearance, occupant's comfort and aesthetics. Study of various façade materials and its useability and understanding its impact in the building environment. Studying various materials use of aesthetical appearance of the building façade. Façade materials play a crucial role in maintaining occupant's thermal comfort by shielding them from heat, cold, solar radiations, noise and reducing means of mechanical heating or cooling.

Keywords: Façade materials; comfort; aesthetics; impact

Research Question

What is the impact on façade materials have on the office building?

How do different façade materials impact the performance of the office building?

Aim: Analysing the impact of various façade materials in the office building and variations in façade materials.

Objective:

- Exploring variations in façade materials used in office building in Pune region.
- To analyse the impact of façade materials in office building.

Scope:

Acting as the barrier between the inside and outside of the building and also creating climatic comfort for the users are some of the main purposes of the building façade. The impact of the façade in office building is significant, energy efficient, aesthetic appearance, eco-friendly, sustainable and overall building performance. By focusing on the innovative materials and modern design principles architects and engineers can enhance the functionality and appearance of the building.

Limitations:

- The study will include documentation of specific region with respect to façade materials used only.
- Façade would be analysed in terms of materials specifications only.

1. Introduction

Façade materials serve as a critical interface between the external environment and the internal spaces of office buildings, significantly influencing both aesthetic appeal and occupant comfort. The choice of these materials not only affects the visual identity of a structure but also plays an essential role in regulating thermal comfort and enhancing overall building performance. Facades are the first line of defense against external elements, impacting factors such as temperature control, noise reduction, and energy efficiency. In the contemporary context of sustainable architecture, the usability of various façade materials has garnered increased attention. Innovations in material technology have introduced diverse options that cater to aesthetic preferences while also providing functionality. From traditional brick and stone to modern composites and glass solutions, each material contributes uniquely to the building's thermal envelope. Properly designed facades can minimize reliance on mechanical heating and cooling systems, thus promoting energy efficiency and occupant wellness. Understanding the interplay of façade materials in building design is essential for architects, builders, and designers aiming to create environments that not only resonate with the intended architectural vision but also prioritize the comfort and well-being of occupants. This report will delve into the impact of different façade materials on appearance, occupant comfort, and aesthetic value, highlighting their vital role in building performance and sustainability.

1.1 Methodology

In research methodology following steps are carried out

- **Background study and Introduction**
- **Literature review**
- **Sample study**
- **Comparative Analysis**
- **Findings**

- **Conclusion**
- **Future Scope**
- **References**

1.2 Literature review

This study emphasizes the significant role of facade materials in shaping the energy performance of high-rise buildings. It highlights a shift from traditional materials like stone and bricks to contemporary options such as aluminum and ETFE, which are not only durable but also energy-efficient. [1] This paper discusses how the facade serves as a determinant of a building's thermal and energy performance. It asserts that the choice of facade materials can significantly influence heating, cooling, and lighting requirements, affecting overall energy consumption and indoor thermal comfort.[2]. This review identifies critical materials for facade design, focusing on their energy efficiency, durability, and aesthetic qualities. The study underscores the importance of using materials like insulated glass and aluminum composite panels, which enhance thermal performance and reduce energy use. It points out that the facade is pivotal in achieving sustainable building practices. [3] This research outlines how various facade components directly impact a building's energy performance. It suggests that a well-designed facade can significantly decrease carbon emissions and energy costs during a building's operational phase. The study emphasizes the necessity of using materials that promote energy efficiency to achieve sustainability goals.[4]

1.3 Sample study

1.3.1 Infosys, Pune Phase II

Infosys Pune Phase 2 is a 120-acre campus in Hinjewadi that opened in 2004 and can seat 34,000 employees. It includes office buildings, residential training facilities, food courts, health and exercise facilities, and more.

- Total area: 120-acre campus for 34000 employees.
- Built up area: 150000 sq m (5 storey)
- Façade materials:

The structure is made up of a one-of-a-kind steel skeleton with glass and aluminium coating. The circular interior building structure is a traditional reinforced concrete and masonry structure.

A glass wall with a conical, curved, and sloped surface greets visitors at the main entrance

To improve the visibility of the inner floors to the outside, the cladding incorporates big elliptical cutouts with high performance double glass.

Solar passivation and energy conservation are enhanced by the glass with aluminium coating.

Figure 3.1.1The curve is encircled with steel and Aluminum cladding

Figure 3.1.2 Massive curve structure with glass façade

Sample study: 1.3.2 Collector office, GVFC+9C7, Finance Rd, Agarkar Nagar, Pune.

Collector Office is an administrative headquarters of the district. Collector Office is much an office building, which have efficient public spaces, and a public visitor building to combine both was the major challenge while designing the Collector office.

- Total area: Area: 19797 sq m
- Façade materials:

1. External fins are made of GI Sheet with infill of cellular paper to make it homogenous and light weight

2. Stone wall: The memory of the old Collector Office campus has been retained by using stone from the old buildings to create a strong visual base for the new building.

3. Eco-friendly materials such as AAC blocks, fly ash & adhesives have been used in masonry work which saves on mortar & curing.

4. Project has used efficient DGU glass with SHGC of 0.23 on ground floor and shading devices

Additional features:

- The office buildings have been planned with a courtyard in the Centre, so that every square inch of the building receives ample daylight and cross ventilation.
- Internal courtyards • Only 20% of the building area is mechanically-air-conditioned.
- Facade protected with vertical fins to restrict the solar radiation and allow diffused light providing Thermal and Visual comfort

Figure 3.2.1 The structure showcasing the external façade of the building

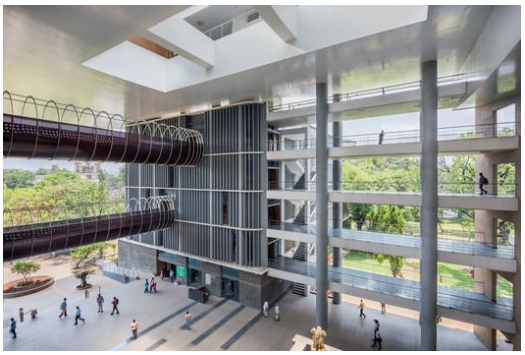

Figure 3.2.2 Internal courtyard

Sample study:1.3.3 KPIT, Hinjewadi phase III, Pune

The KPIT Technologies campus is a result of strong context of hillscape, good understanding of climate and healthy spaces created with pure built form. The built form is mid-rise and narrow to allow natural light and create a sense of healthy working environment. The circulation on site is articulated with vehicles kept at the periphery, thus resulting into pedestrian spaces created within buildings overlooking into green spine.

- Total area: 29 acers
- Built up area: 1250000 sq m (commercial office complex)
- Façade materials:

1. Exposed concrete structure
2. External fins on the sourthen part of the buildings with color gardiations
3. Glass façade
4. RCC structure with light weight blocks 5. Solar panels on the terrace floor

Figure 3.3.1 External Façade showcasing the fins on southern side

Figure 3.3.2 External façade of the office building

India is one of the most significant contributors to carbon emissions in construction, the production of cement which raised up-to 1750 million metric ton in 2020 involves the calcination of limestone, which releases CO2. It is estimated that producing one ton of cement emits approximately 0.7 to 0.99 tons of CO_2.

Sample study: 1.3.4 MEDA's Office Building & Campus Design, Pune

This building has been designed with a strong environmental agenda so that MEDA can have an exemplar building of sustainable design which will give them a stronger identity and advertise their commitment to environmental design.

- Built up area: 8000 sq m • Design decisions informed by highest ratings for GRIHA & ECBC Compliance
- Façade materials:

1. Double glass façade
2. Façade Cladding
3. RCC construction

Features:

- LIGHT SHELVES (SOUTH FACADE) The South and North facades have been designed to allow maximum light penetration because the solar gains are low.
- Slit windows and double wall (east/west)
- Central solar trees provide renewable energy whilst also affording shade to the landscape seats
- The designers have focused on creating visuals to green space from all areas of the building.

Figure 3.4.1 External façade of the office structure

Figure 3.4.2 Provision of living garden with solar energy source

1.4 Comparative Analysis

Sr no.:	Sample study	Façade materials	Inferences
1	Infosys Pune Phase 2, Hinjewadi	Glass and aluminium, traditional reinforced concrete and masonry, façade cladding, high performance double glass with aluminium coating.	The use of high-performance glass and aluminium cladding indicates an emphasis on aesthetics and energy efficiency. The combination of traditional and modern materials provides durability and thermal comfort
2	Collector office, Pune	GI sheets for external fins, AAC blocks, fly ash & adhesives, stone walls, efficient DGU glass with SHGC of 0.23	The choice of materials reflects a focus on sustainability and energy efficiency, with AAC blocks and fly ash indicating the use of ecofriendly materials. The efficient glass with a low SHGC enhances thermal performance.
3	KPIT, phase3, Pune	RCC structure with exposed concrete façade and double-glazing glass, GI sheets for eternal fins with color gradiation	The exposed concrete façade gives a modern industrial look while maintaining strength. The use of double glazing and fins helps in managing heat gain and improving the building's energy performance.
4	MEDA's Office Building & Campus Design, Pune	Double glazing glass façade with cladding, RCC construction. and solar panels for energy conservation.	This design integrates sustainability with aesthetics. The solar panels demonstrate a commitment to renewable energy, while the double glazing and cladding ensure good thermal insulation and energy efficiency.

1.5 Findings

Facade materials play a critical role in various aspects of office buildings, impacting energy efficiency, indoor environmental quality, aesthetic value, maintenance, durability, and construction costs.

- Double-glazed windows are widely acknowledged for their efficiency in maintaining indoor temperatures while minimizing energy consumption.
- Thermal Insulation: The insulating properties of double-glazed windows are enhanced by the air or gas layer between the panes, which minimizes heat transfer.
- Noise Reduction: These windows can reduce external noise by 20 to 65%, significantly improving the indoor acoustic environment.
- Exposed concrete facades offer a range of benefits but also come with maintenance challenges.
- Durability: Concrete is recognized for its strength and longevity, but exposed surfaces can deteriorate due to environmental exposure, leading to issues like cracking.
- Aluminum and glass skeleton facades are becoming increasingly popular in modern office buildings.
- Energy Performance: Using energy-efficient glass can considerably lower heat transfer, improving thermal performance while allowing natural daylight.
- User Comfort: The interplay between thermal comfort, visual comfort, and indoor air quality is essential. Designs should prioritize user satisfaction while optimizing energy efficiency, especially in varying climates.

1.6 Conclusion

Selection of façade materials in office buildings-it-aesthetic decisions in fact is one of the most important parameters determining energy efficiency, quality of life, and impact on the environment. The facade thus well-designed will serve as a dynamic boundary between the inside and the outside, controlling thermal comfort, natural lighting, and even acoustic performance. Secondly, there are advanced facade technologies such as double-skin facades, photovoltaic-integrated facade systems, smart glazing, etc., which are radically transforming the way buildings would behave in relations with nature, whereby they would be less dependent on artificial climate control and, ultimately, their long-term operational costs would be optimized.

Sustainable facade materials also contribute to addressing the global environmental agenda by minimizing carbon footprints and promoting responsible consumption of resources. Such recyclable, locally sourced, and emitting low amounts of pollution materials also enhance green building performance standards (like LEED and BREEAM), leading to responsible construction on the sides of the industry.

Innovation in façades has transformed the existing theatrical spaces of architecture and will always transform the performance level within buildings, ensuring that the buildings provide accommodation for office workers and are not forgotten by climate change. Architects and builders would, therefore, have that holistic approach to aesthetics with performance and sustainability in mind when designing an office building that would be enough to set benchmarks in future developments. Façade design goes beyond its traditional meaning by becoming a part of building energy sensor technology, while it also incorporates itself into a fully human-centric built environment.

1.7 Future Scope

The future of research in facade materials for office buildings will be multifaceted, addressing sustainability technology, climate adaptability, aesthetic integration, and regulatory compliance. By emphasizing these are researchers can contribute to creating more efficient, resilient, and aesthetically pleasing office buildings in changing world. Moreover, the use of novel materials and design strategies will be researched to address the limitations of static facades, promoting the development of facades that can actively respond to environmental conditions. Future studies will also aim to understand

the long-term implications of facade materials on both operational energy consumption and embodied carbon, driving a transition toward more sustainable building practices.

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