International Journal of
Sustainable Building Technology

ISSN: 2583-3278
Volume 8, Issue 1, 2025
January-June
DOI (Journal): 10.37628/IJSBT

https://journalspub.com/journal/ijsbt/

Research IJSBT

Glass Façades in Mumbai: Its Environmental Impacts

Adithi Sivaprasad[1,*], Debashis Sanyal[2]

Abstract

In the past few years, the erection of high-rise buildings, or rather skyscrapers, with the extensive use of glass façades can be seen a lot. This paper mainly includes a study on the environmental impacts caused due to the increase of glass façades used in the city of Mumbai. Glass as a material does look pleasing but with the torrid temperatures we experience in Mumbai and the high amount of glass used, then is glass a better alternative to thick masonry? Is it necessary to know the cause of how it affects the environment and find out possible solutions for the same? Based upon the case studies of Mumbai, the heat island effect and high energy consumption are the major problems caused due to the extreme use of glass façades. To overcome such issues, it is mandatory to incorporate sustainable glass façades into our design to minimize the environmental impact. The use of photovoltaic glass, low emissivity coatings, and double or triple glazing, can be a few of the methods that can be followed.

Keywords: Heat Island effect, green façade, energy-efficient building, photovoltaic glass

INTRODUCTION

This paper focuses on a case study run on the city of Mumbai, which is the most populated city located on the west coast of India. To cater to the urban population growth, Mumbai is rapidly expanding to meet housing needs. As a result, the land cover, urban fabric, and urban geometry have changed significantly, which led to an increase in solar energy absorption [1]. Mumbai's 2024 population is now estimated at 21,673,100. In 1950, the population of Mumbai was 3,088,810. Mumbai has grown by 376,600 in the last year, which represents a 1.77% annual change [2]. The total surface area that the city of Mumbai covers comes to 603 kilometres squared, thus, to come to a conclusion the population ratio is more than double to what it should be.

Due to the increasing demand for housing units and work areas, Mumbai had to go forward with high-rise structures. In the past few years, there has been an erection of skyscrapers on a very large scale. These high-rise buildings provide multiple surfaces for the reflection and absorption of sunlight, increasing the efficiency with which the city area is heated [1]. This itself has impacted highly on the global warming issues of the city. Additionally, the use of glass façades has worsened it even more. This paper thus is a study on how glass façades have an impact on the environment, does it affects thermal comfort both internally as well as externally, and what alternative measures could be taken to lessen the environmental damages.

***Author for Correspondence**
Adithi Sivaprasad
E-mail: adithisivaprasad26@gmail.com

[1]Student, Department of Architecture and Planning, National Institute of Technology, Raipur, Chhattisgarh, India
[2]Professor, Department of Architecture and Planning, National Institute of Technology, Raipur, Chhattisgarh, India

Received Date: October 10, 2024
Accepted Date: November 06, 2024
Published Date: January 30, 2025

Citation: Adithi Sivaprasad, Debashis Sanyal. Glass Façades in Mumbai: Its Environmental Impacts. International Journal of Sustainable Building Technology. 2025; 8(1): 79–84p.

GLASS FAÇADES

Glass façades, also known as curtain walls in some cases, are the terms used for the complete glass wall that is used in the exteriors. In this modern era, seeking inspiration from European countries, even in the Indian context has started to be widely used and that too at a very high extent. Indeed, glass does allow sunlight to profusely enter the building, but apart from this generosity, this material also plays a big role in controlling the changes in the surrounding environment, be it interior or exterior. Glass also has a significant

impact on the building's energy efficiency rating. This includes cooling and heating of the interior, the comfort provided to the occupants, and the adverse effects and consequences caused in the exteriors due to the reflected sun rays.

In a city like Mumbai, where the climate is mostly hot and humid, the city's population is extremely high compared to its capacity, which increases the demands on its resources. The pollution levels in this city are very high. Starting with high-rise buildings, these buildings themselves affect the amount of sunlight that reaches the interiors. These skyscrapers block sunlight, casting shadows on the surrounding areas, and most of the sunlight is absorbed or reflected by the buildings themselves and some sunlight may still reach surrounding areas. Coming to the next point, the use of glass as the main material, impacts the microclimate, intensifying the heat island effect and compromising the building's sustainability goals of that region, and intensifies the heat-island effect thus putting the sustainability factor of that building into a risky position. In Mumbai, many buildings are skyscrapers due to the city's high population demand and limited land availability, driving up demand for vertical development. The sun's reflection on these glass buildings contributes to increased temperature and affects the thermal performance of the building, potentially leading to higher cooling demands and higher energy consumption.

GLASS AND ITS TYPES

Just like how the design of the façade plays an important role in the effects caused on the environment, the type of glass used is also equally important (Table 1). Climate analysis must be conducted, and based on its results, the type of glass used should be found out. Mumbai in general has a hot and humid climate, but even in different parts of Mumbai, one can experience varied temperatures. Similarly, there are various other factors that get affected namely: visual, thermal, and environmental comfort which are all interrelated and influential in shaping the architectural identity of the building. However, when properly used in conjunction with the proper type of glass, the interface with the effective solution will reduce energy consumption.

Table 1. Properties of glass [3].

		Annealed Glass	**Toughened Glass**
1.	Strength	59–150 N/mm^2	7–28 N/mm^2
2.	Young's modulus	70 kN/mm^2	70 kN/mm^2
3.	Density	2.4 kg/m^3	2.4 kg/m^3
4.	Thermal coefficient of expansion	$8.8 * 10^{-6} K^{-1}$	$8.8 * 10^{-6} K^{-1}$
5.	Poisson's ratio	0.22	0.22

Table 2. Types of glass in terms of thermal performance [3].

Glass Type	
Laminated glass	A transparent sheet of polymer is sandwiched between two or more layers of glass to protect from ultraviolet rays and reduce noise vibrations.
Insulating glass	Glass layers are separated by sealed dry air or gas space for thermal insulation and condensation control.
Coated glass	Covered with low-emissive coatings that reflect radiation.
Tinted glass	Composed of minerals that color the glass to absorb radiation.
Wire glass	A wire mesh is inserted between glass plates to enable the glass to stick together during a crack.
Smart glazing	A unique solution in space management by way of instantaneous control of opalescence and dynamic retro projection of videos and images. It is an active glass that under the effect of an electric current switches from translucent to transparent glass with no alteration of light transmission.

CLIMATE ANALYSIS

The city of Mumbai is situated in the coastal border of India (Table 2). It thus has a tropical climate which is extremely hot and humid. Due to its proximity to the equator, it's quite challenging to precisely delineate summers here [4]. On average, this city experiences a total of 3520 hours of sunshine, the monthly average is approximately 115 hours [3–5].

Climate analysis is a crucial step in understanding the environmental impact of glass façades in Mumbai. The city's tropical climate, with high temperatures and humidity, escalates the heat island effect and energy consumption. Climate analysis helps architects and designers determine the optimal building orientation, position of glass façade, and type of glass used, which can significantly reduce the environmental impact [6].

Climate analysis is a crucial step in understanding the environmental impact (Figure 1) of glass façades in Mumbai. By considering factors, such as temperature, humidity, solar radiation, wind speed and direction, and precipitation, architects can optimize building design, reducing energy consumption, improving thermal comfort, mitigating the heat island effect, and promoting sustainable design.

1. *Temperature:* Mumbai's high temperatures, especially during summer, increase the heat island effect and energy consumption.
2. *Humidity:* The city's high humidity levels exacerbate the heat island effect and reduce the effectiveness of cooling systems.
3. *Solar Radiation:* Mumbai receives high levels of solar radiation, which increases the heat gain through glass façades.
4. *Wind Speed and Direction:* Wind speed and its direction affect the dispersion of heat and pollutants in the city.
5. *Precipitation:* Mumbai's high rainfall during monsoons affects the cooling demands and energy consumption.

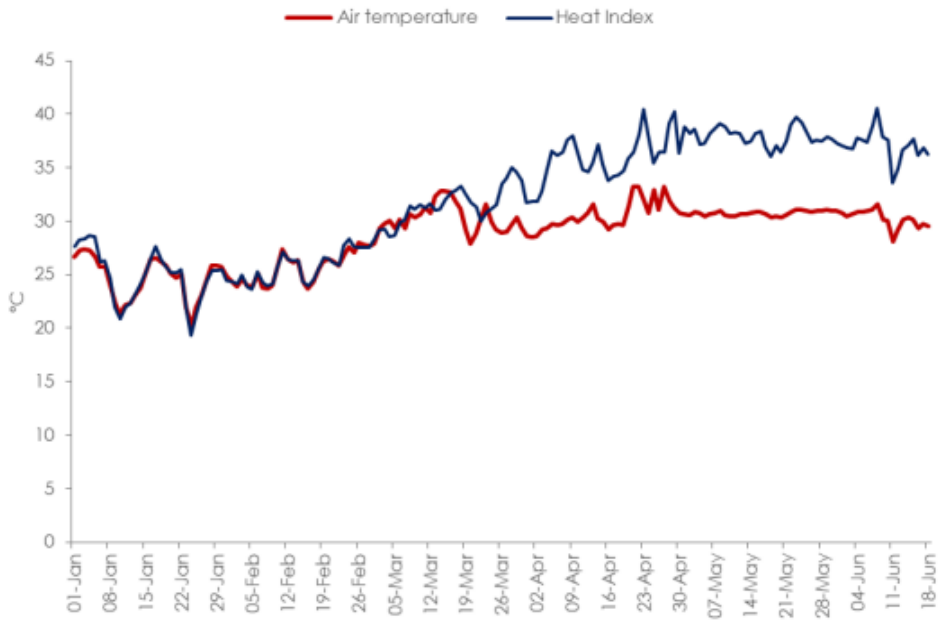

Figure 1. The buildup of heat in Mumbai air temperature vs. heat index [4].

EFFECTS ON THE ENVIRONMENT

Heat Island Effect

At the urban scale, the microclimate is influenced by the heat island phenomenon (Urban Heat Island, UHI), which has a direct impact on the thermal comfort in the building, as well as on the energy demand [5]. The urban heat island effect is defined as higher air temperature in an urban area compared to a

rural area in the same region (Figures 2 and 3). The urban heat island effect is influenced by meteorological factors, such as wind speed, direction, and solar radiation [7, 8]. Glass absorbs some of the heat, but more than that it reflects the heat back to the surroundings. This is a serious point to be considered as, once the sun's rays are emitted back into the surroundings, it increases the heat of that area. This can cause the land surrounding the building to heat up. At external conditions, one common accident that takes place is, the roads heating up causing the tires to melt. This also causes the green patches nearby, to catch fire due to the extreme heat rise. Thus, leading to wildfires [9, 10].

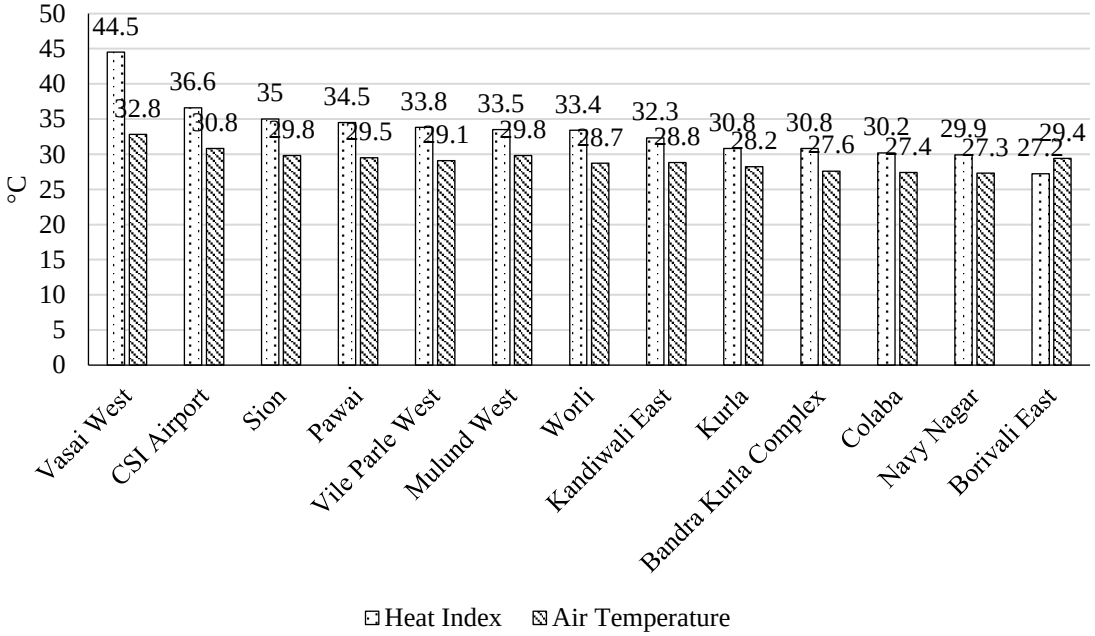

Figure 2. Distribution of pre-monsoon heat within Mumbai air temperature vs. heat index [4].

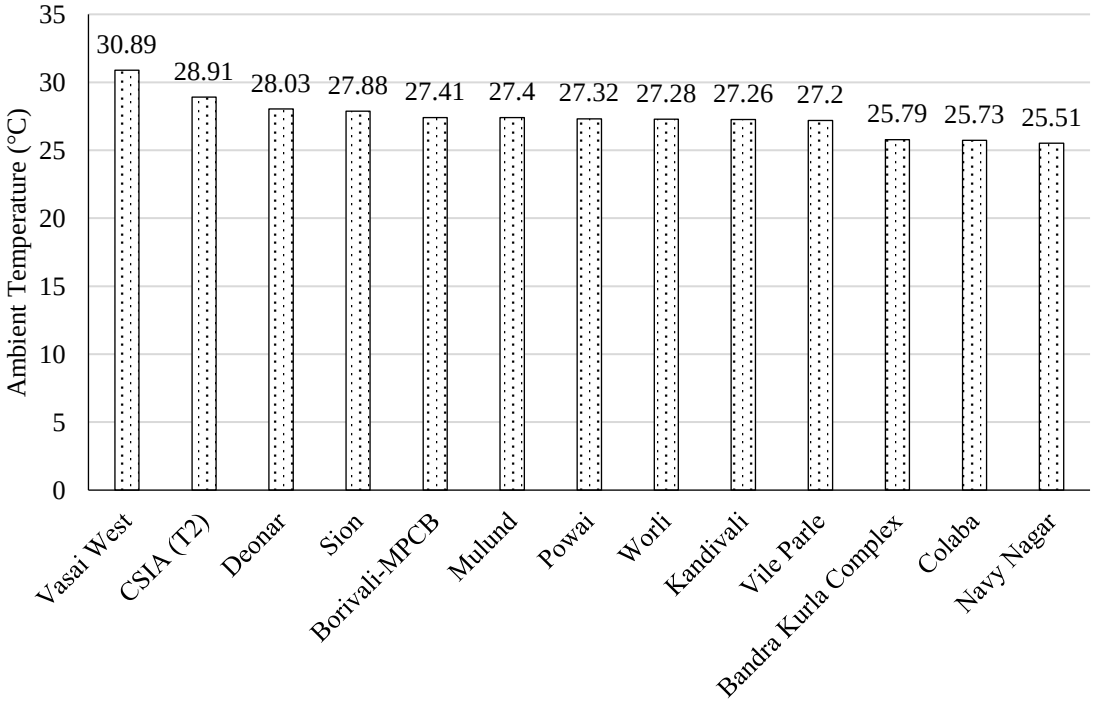

Figure 3. Daily average air temperatures in different areas of Mumbai [4].

In the interior level, the demand for cooling increases due to the high amount of heat absorbed by the glass. Glass has high thermal mass and hence takes time to release it from within the space. This also leads to trapping and restricting the airflow. All these problems sum up to global warming.

Energy Consumption

The use of glass façades increases the temperature in the interiors and thus means of mechanical ventilation like HVAC, must be provided. The use of such mechanical instruments has increased the electricity consumption of the city. These glass facades increase energy consumption on a huge level due to an increase in heat, leading to higher cooling costs and greenhouse gas emissions. Hence the energy consumed in such cases is more. Thus, the overall energy generated by a building exceeds the limit, which isn't a sustainable option for the long term. These problems have already crossed the limit of risk and have become a big threat [10, 11]. The Brihanmumbai Municipal Corporation in 2022, came up with a climate action plan which showed the need for sustainable options and solar-based technologies to reduce the impact on the environment.

CONCLUSIONS

According to the research, it clearly states that glass façades pose a significant environmental threat to the city of Mumbai. The extensive use of glass in high-rise buildings increases the urban heat island effect, increases energy consumption, and contributes to global warming at large. As the years fly by, the number of skyscrapers built and the amount of glass used is just increasing, and so is the effect on the environment. Strict action must be taken before this gets out of control. To mitigate these issues, architects and designers must adopt sustainable design strategies, such as selecting high-performance glasses, incorporating green façades, and utilizing energy-efficient materials. Furthermore, this research highlights the need for a revolutionary change in building design, prioritizing environmental sustainability and energy efficiency. By adopting innovative materials and design approaches, we can reduce the environmental effect caused due to glass façades and create more sustainable and liveable cities for future generations. This can only be done with the cooperation of the city residents, the local level body, and the other governing bodies.

Indeed, glass does give a good aesthetic look, but it affects the environment on a major basis. Factors like R-value and U-value are extremely affected in such areas, thus causing a change in both interior as well as exterior temperatures. In the interiors, mostly the temperature rises even more when the climate of Mumbai is already hot and humid. In cases of the exterior, the sunlight coming gets reflected and thus bounces back to the environment. This increases the temperature outside, which may cause many problems like trees getting burnt and the roads getting heated up. All these are a part of the Urban Heat Island phenomenon. To overcome the effects of glass façades, it is essential to incorporate sustainable glass façades into building design, minimizing environmental impact. The use of photovoltaic glass, low emissivity coatings, double or triple glazing, and green façades can significantly reduce energy consumption and mitigate the heat island effect. Moreover, architects and designers must adopt sustainable design strategies, prioritizing environmental sustainability and energy efficiency.

This research further shows that the type of glass used, building orientation, and position of glass façade play a crucial role in determining the environmental impact of glass façades. Climate analysis has revealed that Mumbai's tropical climate, with high temperatures and humidity, further escalates the heat island effect and energy consumption. The Brihanmumbai Municipal Corporation's Climate Action Plan (2022) emphasizes the need for sustainable options and solar-based technologies to reduce environmental impact. Such initiatives must be highlighted so that the urgency of adopting sustainable design strategies and materials in building construction comes forward.

There can't be a perfect solution and substitute for glass, but one can use the perfect type of glass based upon the area they're working with and the glass type that will cause lesser impact. Ultimately, this research paper serves as a call to action, urging architects, designers, and stakeholders to rethink

their approach to building design, prioritizing environmental sustainability and energy efficiency. By working together, we can create a more sustainable built environment, reducing the environmental impact of buildings and promoting a healthier, more sustainable future for all.

REFERENCES

1. World Population Review. (2023). Mumbai population 2023 [Online]. Available from: https://worldpopulationreview.com/cities/india/mumbai.
2. Centre for Science and Environment (CSE). (2025). Urban heat stress: Mapping of vulnerability in Mumbai [Oline]. New Delhi: Centre for Science and Environment. Available from: https://www.cseindia.org/urban-heat-stress-Mumbai.pdf.
3. Mumbai Climate Action Plan. Mumbai: Municipal Corporation of Greater Mumbai. 2022. Available from: https://www.mcgm.gov.in
4. Savić J, Đurić-Mijović D, Bogdanović V. Architectural glass: Types, performance and legislation. Facta Univ Ser Archit Civ Eng. 2013;11(1):35–45.
5. Mehaoued K, Lartigue B. Influence of a reflective glass façade on surrounding microclimate and building cooling load: Case of an office building in Algiers. Sustain Cities Soc. 2019;46:101443.
6. Tabatabaei SS, Fayaz R. The effect of facade materials and coatings on urban heat island mitigation and outdoor thermal comfort in hot semi-arid climate. Build Environ. 2023;243:110701.
7. Hannoudi L, Saleeb N, Dafoulas G. The impact of glass properties on the energy efficiency and embodied carbon of multi-angled façade systems. J Clean Prod. 2024;437:140725.
8. Shastri H, Ghosh S, Paul S, Shafizadeh-Moghadam H, Helbich M, Karmakar S. Future urban rainfall projections considering the impacts of climate change and urbanization with statistical–dynamical integrated approach. Clim Dyn. 2019;52:6033–6051.
9. Maral SG, Mukhopadhyay T. Signal of urban heat island (UHI) effect: a case study of Mumbai metropolitan region. Mausam. 2015;66(4):729–740.
10. Salsabila ND, Usman IM, Abd Malek MI, Ibrahim NL, Utaberta N. Analyzing the effects of high-rise buildings with glass façades on outdoor human comfort in the Jakarta metropolitan area. J Adv Res Appl Sci Eng Technol. 2023;29(2):91–104.
11. Dwivedi A. Macro-and micro-level studies using Urban Heat Islands to simulate effects of greening, building materials and other mitigating factors in Mumbai city. Archit Sci Rev. 2019;62(2):126–144.

