MITIGATING AIR POLLUTION IN INDIAN CITIESWITHTHEUSEOFBIOFACADES

A DISSERTATION

Submitted in Fulfilment

Of the Requirements for the Degree

Of

MASTER OF ARCHITECTURE

By:

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Enrolment no.1200109010

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BABU BANARASI DAS UNIVERSITY, LUCKNOW

June, 2023

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ABSTRACT

Today, the biggest issues facing the planet are air pollution and, as a result, global warming. These problems may affect the climate. Human health and change. To mitigate air pollution frequently concentrate on reducing the sources of the pollutants. This approach can significantly lower the amount of new air pollutants, but it has little impact on the air's already-existing contaminants. By recognizing the current situation, this study seeks to limit the level of harm to humans by regulating air pollution through municipal engineering, facade structures, and architectural design. The air quality of the urban environment can be significantly influenced by the façades of buildings. The ability of nature to manage air pollution has been used to the realm of architecture. Therefore, this study compares three different forms of bio-façades (namely, Water façade, Green façade, and Microalgae) by utilizing nature's capacity to manage carbon dioxide. These facades do not harm human health and do not require any special technology. . Then, after identifying the aforementioned biological façade kinds, we compared their strength and weaknesses, cost, environmental stability and chose the best one. Which façade system is best according to Delhi and luck now's air pollution condition.

Purpose: The goal of this study is to gain a better understanding of how can we improve air quality and reduce pollutants with the help of bio facade.

Keywords: Air Pollution, Bio Façade, Water Façade, Algae Façade, Green Façade

Chapter 1: Introduction

1.1 Introduction and Background

One of the five things that humans need to survive is air. Each human needs around 15 kilograms of air per day and breaths approximately 22,000 times per day. Humans can typically go without food and drink for 5 weeks and 5 days, but they cannot go without air for even 5 minutes. According to a statistic from the World Health Organization, air pollution claims 2.4 million lives each year. Cities are growing too quickly, which is causing environmental damage and issues like air pollution. The biggest issues facing the planet right now are air pollution and, as a result, global warming.

Air pollution directly impacts air quality. Air pollution is the existence of one or more pollutants in open air with particular features and constancy, enough for jeopardizing the life of humans, plants, and animals or human properties or disrupt the right and desirable process of life in a significant way.

Air pollution directly impacts air quality.As a result, one of the key challenges for countries and governments is dealing with air pollution. This issue is being addressed by numerous institutions and organizations in an effort to find a solution. The final half of the 20th century saw a high in the discussion of environmental issues, even though mankind has long appreciated the value of the environment in their daily life. Environmental issues today provide a serious threat to humanity, endangering not just their comfort and safety but also their very life. The problem of environmental pollution affects the entire world and is not limited to any one nation or region. It is made up of several separate problems, the most significant of which are air and water pollution.

Based on the last report from the World Health Organization, air pollution is one of the main cause of human death. According to 2019 report of India death rate is 1.6 million. A majority of these deaths were caused by particulate matter 2.5 (PM 2.5) pollution, it added. This study looks for solutions to this issue in urban architecture and design. By lowering energy use and air pollution, sustainable architecture aims to improve quality of life.

Paying attention to nature as a model and solution for modifying environmental problems is one of the most crucial methods in architecture and urban engineering. In this study, bio-based facades are presented as a technique to manage and reduce air pollution.

1.2 Need of the study

Currently, during the period from September to April, people around the world can see with their own eyes and feel with their own breath the pollution of the air called smog. The main cause of smog and the source of air pollution are exhaust gases from large factories, burning coal in furnaces, and car exhausts.

Air pollution, known as smog, has increased in recent years. It usually occurs in large cities, where exhaust emissions and energy consumption are very high. Road traffic has a significant impact on the formation of photochemical smog. Often people prefer their own cars to public transport due to convenience or lack of other options. This leads to a high volume of traffic on the roads. This increases the emission of exhaust gases from tailpipes and the escape of dust from worn tires and asphalt into the atmosphere. Passing cars also stir up pollutants lying on the roads. The problem is the condition of the cars. They often do not meet standards. Rapidly developing countries have a big problem with air pollution and thus with the environment as such. This also has a negative impact on human health. Each component of smog has a negative impact on human health, but just as the composition of smog can vary and is constantly changing, so are its effects. The constituents it contains are very dangerous to humans.

One of the most important approaches in architecture and urban design is to consider nature as a model and solution for changing environmental problems. In this study, bio-based facades are presented as a way to control and reduce air pollution.

1.3 Aim of the study

The goal of this study is to gain a better understanding of how can we improve air quality and reduce pollutants with the help of bio facade.

1.4 Objective of the study

- The main objective is reduce the air pollution indoor and outdoor.
- Study the various type of bio façade system and analyze their weakness and strength.

- Study the impact of bio façade system through case studies.
- A study of which facades are productive for controlling air pollution in Indian cities.

1.5 Research Questions

- Do nature and architecture have a role in controlling air pollution discussion?
- What types of bio-facades can reduce the air pollution?
- Which facades are productive for delhi and lucknow among air pollution preventive bio-facades?

1.6 Scope & Limitation

- This study compares bio-facades on a qualitative and quantitative level, examines the advantages and disadvantages of each system, and determines which technology is best for reducing urban air pollution.
- Study will focus on two Indian cities, Lucknow and Delhi.
- The study will only contain information on reducing air pollution.

1.7 Methodology

This study is based on reading accessible references of buildings studies that currently exist since its goal is to show solutions for decreasing the effects of air pollution via bio-based facades. However, this research must be expanded by conducting multidisciplinary research in combination. After introducing the systems and highlighting their strengths and limitations in tables, quantitative data regarding each system's performance was collected. The research was then conducted using a practical approach by contrasting the qualitative and quantitative data for each system.

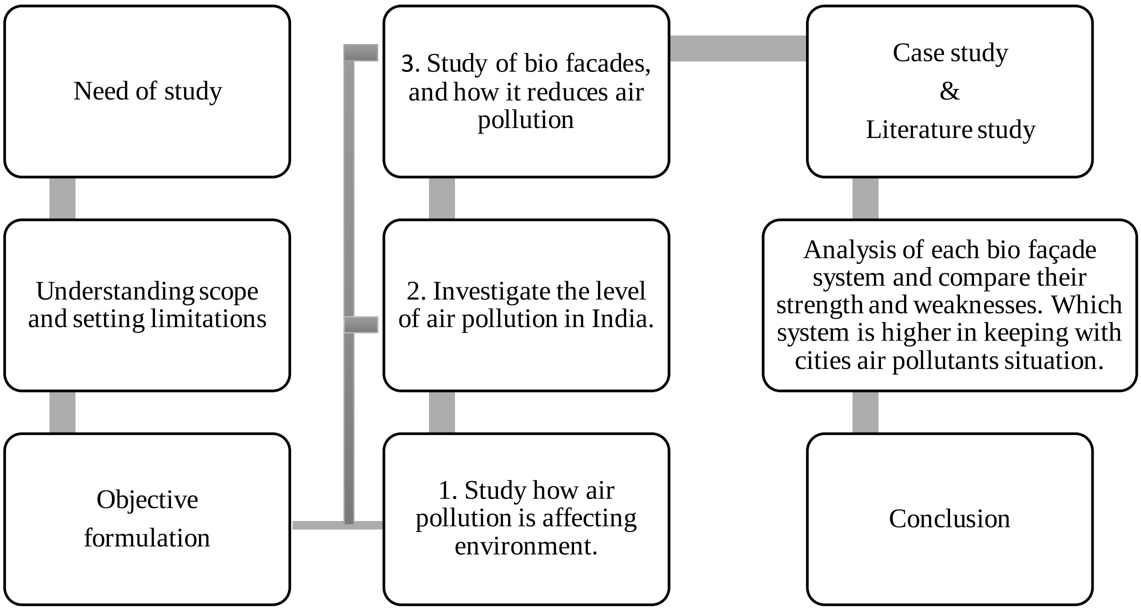


Figure 1: methodology flowchart

Chapter 2: Air pollution

2.1 Definition

Air pollution is the consists of toxic chemicals and other harmful particles that have an adverse effect on human health and other living beings, or cause damage to the eco system. Motor vehicle, industrial facilities, and forest fires are common sources of air pollution.

2.2 Type of air pollution

Air pollution can be summed up in three main types:

2.2.1 Biological pollution: It is pollution resulting from the spread of biological waste material in the air, such as pollen from trees and plants, insects or insect parts, certain fungi, some bacteria and viruses, and even animal hair, animal skin scales.

2.2.2 Chemical pollution:pollution caused by the spread of chemical compounds and elements in the air, such as oil refineries, coal power plants, construction, mining & smelting, transportation, agricultural use of pesticides and insecticides, as well as household activities.

2.2.3 Thermal pollution: is pollution caused by the high temperature of fluids and materials in the air to unusual levels; the heat resulting from energy sources. In addition to dust and soil from the Earth's crust. The previous forms of pollution contribute to the material pollution of the air and the immaterial pollution which is represented by the spread of disturbing noise resulting from the wheels of work and means of transport

2.3 Type of air pollutants:

There are two types of air pollutants:

- Primary pollutants
- Secondary pollutants

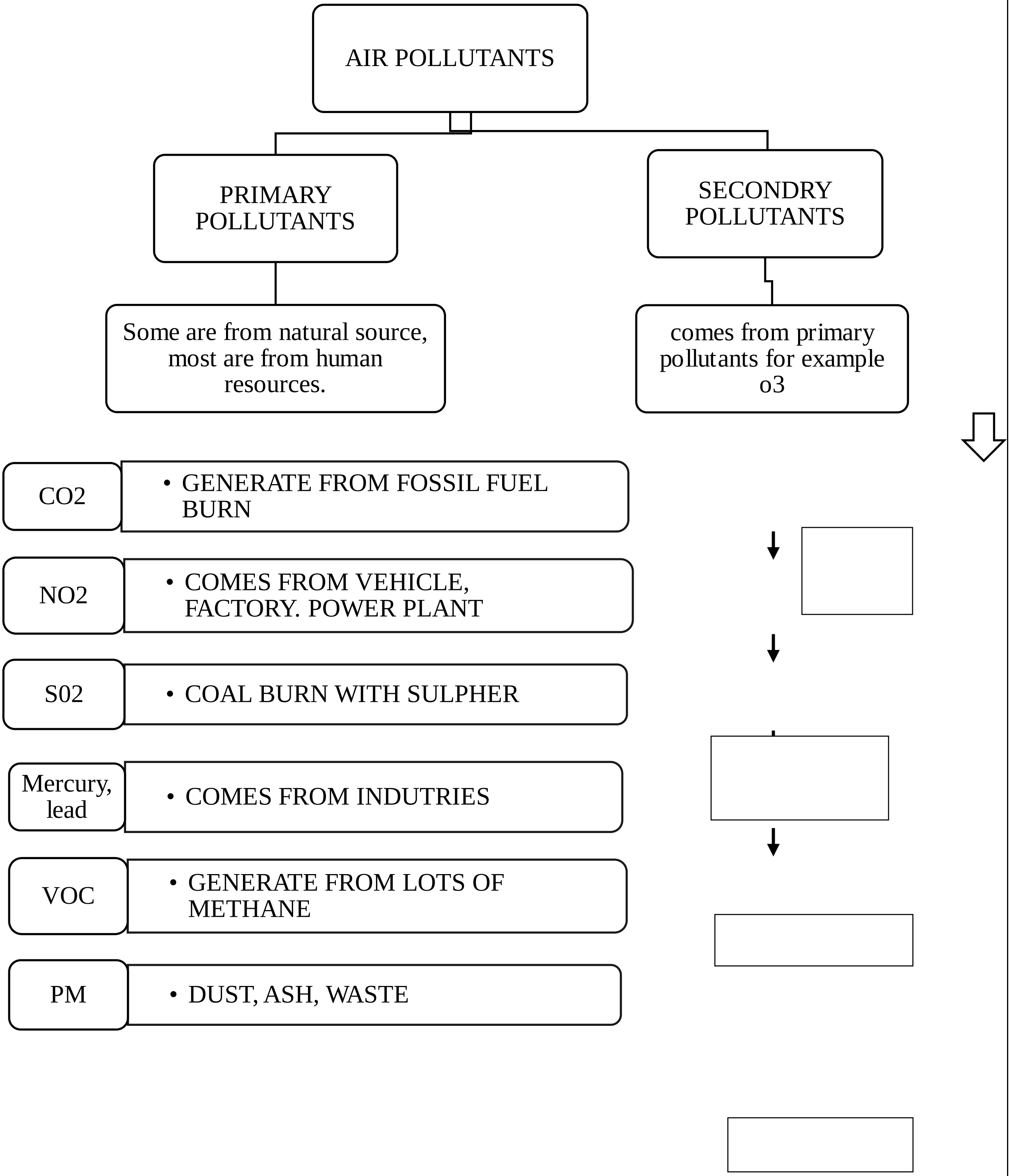


Figure 2 type of air pollution

2.4 Source of Air pollution:

2.4.1 Human-made sources

Vehicle emissions, fuel oils and natural gas to heat homes, by-products of manufacturing and power generation, particularly coal-fueled power plants, and fumes from chemical production are the primary sources of of air pollution.

2.4.2 Natural sources

Dust from natural sources, usually large areas of land with little vegetation or no vegetation & Methane emitted by the digestion of food by animals, for example cattle.

2.5 Air Pollutants and its sources:

2.5.1 Particulate matter (PM)

Particulate matter is a mix of solids and liquids, including carbon, complex organic chemicals, sulphates, nitrates, mineral dust, and water suspended in the air. PM varies in size. Some particles, such as dust, soot, dirt or smoke are large or dark enough to be seen with the naked eye. But the most damaging particles are the smaller particles, known as PM10 and PM2.5. PM10 refers to particles with a diameter smaller than 10 microns (10µm) – that's 100 times smaller than a millimetre. PM2.5 refers to particles with a diameter smaller than 2.5 microns, and these are known as **fine particles**. The smallest fine particles, less than 0.1 micron in diameter, are called **ultrafine particles**.

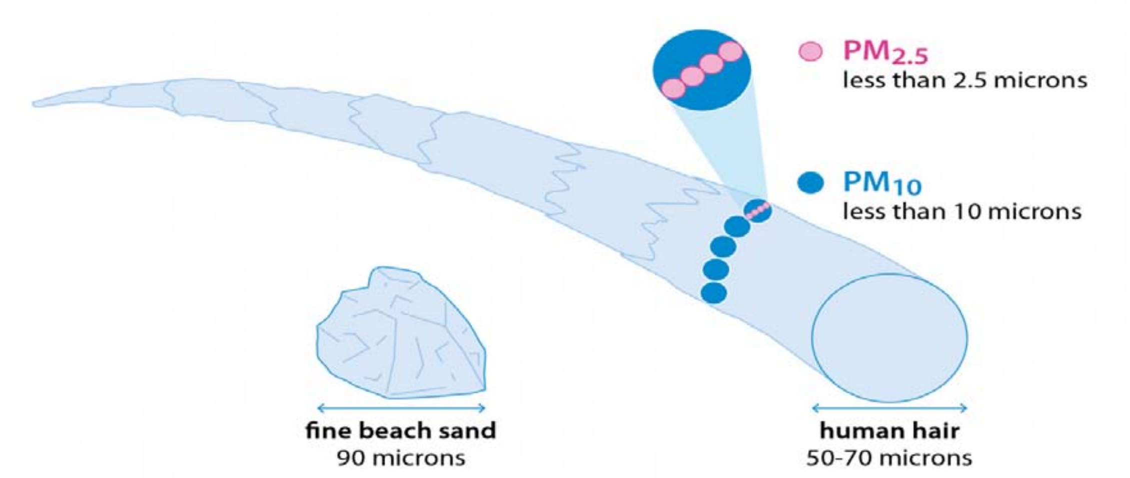


Figure 3:

Where PM does comes from?

Man-made particulate matter mainly comes from industry, building work, diesel and petrol engines, friction from brakes and tyres, and dust from road surfaces. Diesel engines tend to produce much more than equivalent petrol engines.

2.5.2 Nitrogen dioxide (NO2)

Nitrogen dioxide is a gas and is a major component of urban air pollution episodes.

Where does NO2 come from?

Man-made sources of nitrogen oxides, including nitrogen dioxide, are vehicles, power station sand heating. Diesel vehicles are major contributors in urban areas. Roadside levels are highest where traffic is busiest.

2.5.3 Ozone (O3)

Ozone is a gas composed of 3 atoms of oxygen. In the upper level of the Earth's atmosphere, it absorbs harmful ultraviolet radiation.

Where does ozone come from?

Near the ground, ozone is made by a chemical reaction between the sun's rays and organic gases and oxides of nitrogen emitted by cars, power plants, chemical plants and other sources.

2.5.4 Sulphur dioxide (SO2)

Sulphur dioxide is a colourless gas, with a pungent, suffocating smell. It's produced by burning sulphur-containing fuels such as coal and oil. This includes vehicles, power generation and heating.

Where does sulphur dioxide come from?

Most sulphur dioxide comes from electric industries that burn fossil fuels, and also from petrol refineries and cement manufacturing. It can travel over long distances and contributes to the formation of ozone.

2.6 Measurement units

The amount of pollutant present in air is usually expressed as a concentration, measured in either parts-per notation (usually parts per billion, ppb, or parts per million, ppm) or micrograms per cubic meter ($\mu g/m^3$). It's relatively simple to convert one of these units into the other, taking account the different molecular weights of different gases and their temperatures and pressures.

Urban air quality index (AQI) values are computed by combining the concentrations of a "basket" of common air pollutants (typically ozone, carbon monoxide, sulphur dioxide, nitrogen oxides, and both fine and coarse particulates) to produce a single number on an easy-to-understand (and often colour-coded) scale.

2.7 Air Quality Index

Air quality is measured with the Air Quality Index, or AQI. The AQI works like a Air thermometer that runs from 0 to 500 degrees. However, instead of showing changes in thermometer in the temperature, the AQI is a way of showing changes in the amount of pollution in the air.

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201 to 300	Health alert: everyone may experience more serious health effects.
Hazardous	301 to 500	Health warnings of emergency conditions. The entire population is more likely to be affected.

Figure 4

How it works:

Instruments on the ground and satellites orbiting Earth collect information about what is in our air. For example, satellites in NOAA's GOES-R (short for Geostationary Operational Environmental Satellites-R) Series monitor the particle pollution in our atmosphere.

The Joint Polar Satellite System (JPSS) also collects information about particles in our air. These particles include smoke particles from wildfires; airborne dust during dust and sand storms; urban and industrial pollution; and ash from erupting volcanoes. Ground level ozone can also be measured by the JPSS series of satellites.

GOES-R Series satellites can provide particle pollution measurements approximately every five minutes during the day. JPSS satellites can provide a higher resolution measurement of aerosols over the entire planet once a day. JPSS can also observe the movement of aerosols from one side of the planet to the other. JPSS can also measure carbon monoxide which is associated with poor air quality resulting from wildfires.

Chapter 3 Air Pollution in India

The air pollution levels in India worsened in 2021, ending a three-year trend of improving air quality, according to the World Air Quality Report released by IQAir, a Swiss firm on Tuesday (March 22). India is the fifth most polluted country among 117 countries, regions and territories around the world, assessed. The country's annual average PM2.5 levels reached 58.1 micrograms per cubic meter (µg/m3) in 2021, returning to pre-quarantine concentrations measured in 2019. The WHO recommends that average annual readings of small and hazardous airborne particles known as PM2.5 should be no more than 5 micrograms per cubic meter after changing its guidelines in 2021.

3.1No Cities In India Met The WHO Air Quality Guideline:

India was home to 11 of themost polluted cities in Central and South Asia in 2021. No cities in India met the WHO air quality guideline of 5 µg/m3. In fact, in 2021, 48 per cent of India's cities exceeded 50 µg/m3, or more than 10 times the WHO guideline.

In India, if we look at the annual average of PM2.5, all six metro cities except Chennai saw a rise in air pollution levels last year. Delhi was followed by Kolkata, Mumbai, Hyderabad, Bengaluru and Chennai with 63, Indian cities dominate the list of 100 most polluted places. More than half are in Haryana and Uttar Pradesh.

3.2 Air Pollution in NEW DELHI:

The national capital Delhi topped the list of polluted capital cities in the world for the fourth consecutive year. Delhi saw a 14.6 per cent increase in PM2.5 concentrations in 2021 with levels rising to 96.4 µg/m3 from 84 µg/m3 in 2020.

3.2.1 Action taken by Delhi government to reduce air pollution:

- Real time monitoring on construction site.
- Electric vehicle policy.
- PNG based fuel in industries.
- Bio decomposer for parali.
- If construction site area is more than 5000sqm then anti-smog gun is compulsory.
- 13 hotspot point for controlling air pollution.
- Smog tower.

Hotspot point in delhi Alipur, DTU, ITO, Nehru Nagar, Patparganj, Sonia Vihar and Vivek Vihar in Delhi; Sector 1 and 116 in Noida, Loni, Sanjay Vihar and Indirapuram in Ghaziabad; and Knowledge Park V in Greater Noida and Bulandshahr.

3.3 Air Pollution in LUCKNOW:

- The city's air quality has worsened drastically once again and so much so that it has even surpassed the high pollution levels recorded in the pre-Covid times. The hazardous PM 2.5 concentration in the pre-monsoon season has increased by 43. 9% as compared to last year. Moreover, the PM 2.5 concentration levels were 10% more than in 2019.

3.3.1 Action taken by Lucknow government to reduce air pollution:

- Real time monitoring on construction site.
- Electric vehicle policy.
- If construction site area is more than 5000sqm then anti-smog gun is compulsory.
- 4 hotspot point for controlling air pollution.
- Hotspot points are : Lalbagh, Talkatora, Aliganj Central school, gomti nagar

Chapter 4 Bio Façade

A bio façade is an outer enclosure that uses the least amount of energy necessary to maintain a comfortable climate, while encouraging the production of particular materials that have a lower environmental impact. By utilising imaginative architectural elements like green walls, hanging gardens, green roofs, or pergolas, bio-facades can be applied to newly constructed or existing commercial, residential, and public buildings.

4.1 Architectural bio-based facades for controlling air pollution

Architecture may successfully improve air quality and have a favourable or negative impact on a building's energy productivity. This is demonstrated by several studies with various names that have been conducted in various nations. But the study's focus on bio-facades is not the only type of façade that can reduce air pollution; other constructions made of technologically advanced materials also fall under this category. Overall, the study's primary emphasis is on facades inspired by nature.

Bio façades are:

- **Water Façade**
- **Algae façade**
- **Green Facades**

4.2Water Façade: Using Water in the Outer Shell of the Building. The idea of using water to absorb air pollutants comes from the purification of the air by rain. During rain, water droplets purify the air by absorbing air pollutants and fine dust, and by dissolving them in themselves. Apart from the practicality of water walls or curtains, they can contribute to the removal of pollutants and air conditioning. Though this purification system gained popularity for its aesthetics aspect.

Shaocai Yu made the concept that water shooting into the air from tall towers and large structures may be compared to garden irrigation. This strategy was described by Yu in this work, which was published in the Springer environment chemistry magazine, as a novel method for preventing air pollution and heavy dust.

According to Yu, pouring water into the earth's atmosphere can efficiently remove and gather aerosol and gas contaminants by simulating natural rain. Shows that it is dedicated to sustainable development.

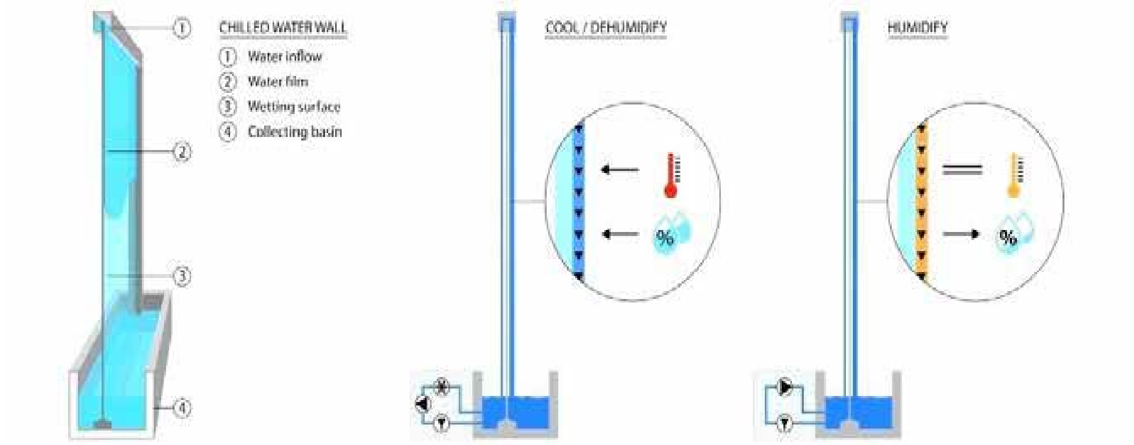


Figure 5A representation of a watery wall details. Source: Fraunhofer Institute, 2018.

4.2.1Strength and weakness of water façade:

	Strength	Weaknesses
Climate aspects	• Creating sub-climates • Reducing the effect of heat islands • Cooling the weather • Increasing humidity	• Impossibility of using it in all climates • Inconsistency and identical function in all seasons • Limited effect radius
Financial aspects	• Reducing the costs resulting from air pollution • Increasing the value in the market • The duration of usage • Easy repair and maintenance	• Increasing the water cost • Increasing the maintenance cost of the main facade
Architecture and structure aspects	• Ameliorating the beauty of the city • Creating lighting effect due to reflection • Not cutting the visual connection of inside and outside • Not applying heavy load on the façade	• It is not a physical barrier per se • Possibility of damage to façade due • To existence of salt.
Environmental aspects	• Ameliorating the air • Improving atmospheric conditions and creating sublimates	• Absorbing insects • Possibility of water freezing in cold seasons

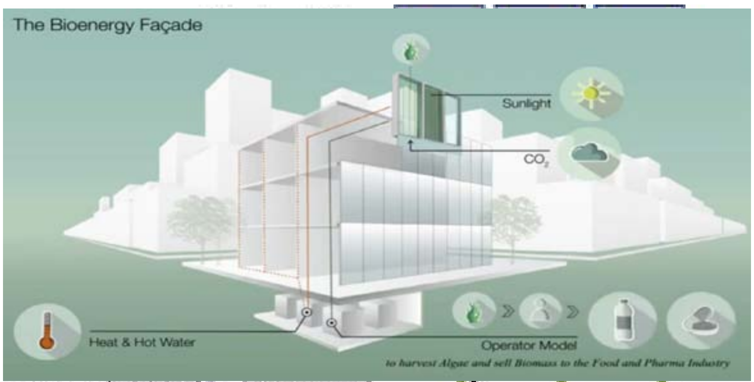
	• Managing rain water	
Stability aspects	• Less energy consumption • Reducing façade temperature • Increasing living space • Increasing life quality	• Increasing water consumption • Need to insulate the main façade • Not controlling the sound

Table 1: Comparison of water facades system's strength and weakness.

4.3 Algae Façade:

The most basic kind of plants are microalgae (without roots, stems, leaves, and other plant organs). The majority of these types of live microorganisms are single-celled. They have a far higher capacity for absorbing and decreasing carbon dioxide than organic plant species because they have a higher surface-to-volume ratio. Through the process of photosynthesis, which involves taking in carbon dioxide from the atmosphere or water, microalgae produce 60 to 75 percent of the oxygen required by people and other creatures (more than all forests and greenies on Earth). Microalgae create a type of green biomass and nourishing protein during the process of absorbing carbon dioxide and producing oxygen. Additionally, microalgae photosynthesize ten times more than adult trees and grass. They need to take in 1.8 kg of carbon dioxide in order to produce 1 kilogramme of microalgae biomass.

These organisms may flourish in any aquatic environment, including saltwater, sewage water, and tap water, and do not require clean water to do so. Because microalgae obtain the majority of their nutrients from sewage, sewage is the



ideal environment in which to grow them. Building façades can be made into biological façades by integrating microalgae, which can transform the walls into surfaces that can produce oxygen. Building walls are made up of vast surfaces that are exposed to polluted air. In this manner, they can improve the structure's passive thermal performance in response to climatic change and turn an ordinary structure into a healthy and energetic structure. It can also transform the structure's walls into a power station. A water storage tank and culture are required to integrate microalgae with the building's façade. Algae are a limitless supply of food, energy, and most importantly, a natural CO2 absorber.

Figure 6 representation of algae facade system

4.3.1 Key benefits

- 5.5 kg yield of biomass(per sqm bioenergy façade per year).
- 38% energy conversion into heat.
- 8% energy conversion into biomass.
- 10kg co2 absorption (per sqm bioenergy façade per year).

4.3.2 Strength and weakness of algae façade:

	Strength	**weakness**
Climate aspects	Creating sub-climates	Lack of suitable functioning in all climates
Financial aspects	Increasing value in the market	• Higher cost of creation (due to lack of technology in the country) • Requiring experts for repair and maintenance
Architecture and structure aspects	• Possibility of using it as loading wall • Beautifying the wall • Creating penumbra effect due to reflection	• Increasing the weight of the building • Obstructing the visual structure
Environmental aspects	• Filtering pollutants • CO2 absorption • Increasing air quality • Managing rain water	
Stability aspects	• Reducing energy consumption • Rapid biomass production Increasing life quality • Sound insulation • Motivating governmental and non-governmental • organizations to conduct studies on algae	• Lack of knowledge about algae facades • Lack of technology availability

Table 2: Comparison of algae facades system's strength and weakness

4.4 Green Façade: The utilisation of plants, both on a small-scale and a large-scale, can significantly reduce air pollution. Because they can be added to existing or under construction buildings and fit in the restricted space, green façades are one of the most well-liked and frequently used methods of absorbing air pollution in cities. Green facades are a useful technology to eliminate pollution from the environment. These walls have the capacity to filter harmful gases, airborne suspended particles, and other impurities. The surfaces of leaves filter harmful gases and absorb pollen and dust. Plants and microbes both function as filters. The concept behind living architecture improves the air quality and regulates the intensity of rain by using plant growth on building surfaces. Vertical green facades are preferable to the more general phrase "green facades." Vertical green systems can be divided into three main groups: live walls, green wall coverings, and green facades.

<table>
<tr><td>Green facades</td><td>Root in the soil:
Here, plants go on the wall naturally without using the supportive structures. In these types of green walls, it usually takes a long time for the plant to cover the whole surface of the wall.
Root in the vase or box:
In this type, plants grow from the vases with a medium size. An irrigation system is always needed for this group, since the root of the plants are not directly in the ground soil.</td><td></td></tr>
<tr><td>Green wall cover</td><td>Green cover with natural growth:
This type is usually seen on old walls, walls of the gardens, and the buildings of historical cities. They grow irregularly without human intervention.
Premade panels with green cover:
The green walls of this group use concrete panels. This is a very recent system. These panels have pores between the pebbles, which are filled with soil and provide the possibility of g</td><td></td></tr>
<tr><td>Living walls</td><td>This system is made up of premade panels or Integrated fabric which are attached to a frame or structural wall. The walls made by this system are able to support a variety of plants. Boxes and geotextile sacks are used in this type. These boxes are attached to a buffer and sometimes can be attached to a wall structure.
In-place living walls:
They are semi-prepared systems, which can be attached to façade. After installing wool layers, plants can be placed in the box. Due to the determined capacity of boxes, plants cannot grow unlimitedly. It should be noted that this system cannot be used for the plants with thick roots.</td><td></td></tr>
</table>

Table 3: types of green facade system.

Tree as dust collectors	
Trees species	**Dust collected gm/sq m of leaf surface**
Tectona grandis (Teak)	5.35
Shorea robusta (Sal)	4.50
Terminalia arjuna (Behera)	4.49

Mangifera indica (Mango)	4.05
Bauhinia purpuria (Kachnar)	3.90
Butea monosperma (Plaw)	3.05
Azadirachta indica (Neem)	2.29
Cassia fistula (Amal tas)	2.24
Tamarindus indica (Imli)	2.08

Table 4: dust collection of trees.

During the current investigation, it was discovered that deciduous trees such as Indian redwood (Caesalpinia sappan), shisham (Dalbergia sissoo), and shirish (Albizia lebbeck) were the most tolerant. Neem (Azadirachta indica), gulmohar (Delonix regia), and guava are semi-deciduous plants that come next (Psidium guajava). The least tolerant trees were discovered to be evergreens like eucalyptus (Eucalyptus citriodora), banyan (Ficus benghalensis), and cassia (Cassia siamea).

4.4.1 Strength and weakness of green façade:

	strength	**weakness**
Climate aspects	• Creating sub-climates • Reducing the heat island effect	• Impossibility of applying it in all • climates • Inconsistency and not functioning in • a similar manner in all seasons Limitations in terms of plant • selection in different climates
Financial aspects	• Reducing the cost of energy for cooling • Reducing the costs resulting from air pollution • Easy repair and maintenance	• Lack of knowledge about the • financial benefits • Higher costs of building • Higher water consumption
Architecture and structure aspects	• Increasing plant coverage in private areas • Efficient use of façade • Ameliorating scenery of the city • Increasing the design of green spaces in the city	• Requiring suitable structural metrics • Requiring structural strengthening to • apply the green wall • Creating visual distraction due to • changing of the colors of plants in • different seasons
Environmental aspects	• Reviving the green space of the city	• Possibility of making bad smell • Possibility of making allergy for

	• Absorption and filtering of the pollutants • Creating wild life in the city • Cleaning the air • Improving atmospheric conditions and increasing the cleanness of air • Purifying the weather and creating sub-climates • Managing rain water	• some people • Absorbing insects
Stability aspects	• Noise reduction • Reducing energy consumption • Reducing façade temperature • Cooperation of citizens in making green spaces • Increasing living area • Improving life quality	• Lack of knowledge on the benefits of • green walls • Possibility of being damaged by • people

Table 5: Comparison of algae facades system's strength and weakness.

4.5 Comparative analysis of each system:

Climatic comparisons			
	Watery façade	**Algae façade**	**Green façade**
Usable climate	Hot and dry	Hot	Hot and dry
Location of the façade	All climate	Sunshiny	Sunshiny

Economic comparison			
	Watery façade	**Algae façade**	**Green façade**
Façade life-time	Unlimited		15-25 years
Building cost	Relatively low	High (due to lack of technology in the country)	High
Utilization period	Low	Moderate	Moderate (dependent on plant type)
Repair and maintenance	Easy – Requiring periodic control	Requiring experts	Requiring periodic control
Increasing value in the market	High	High (Due to innovation in the façade)	High

Architectural and structural comparison			
	Watery façade	**Algae façade**	**Green façade**
Aesthetics	Positive	Relativity positive	Positive
Façade operation (Internal and external obstruction)	Not a physical obstruction per	Yes	Yes (dependent on type of the green wall)
Light passage	Yes	A little	No
Visual connection of the inside and outside	Yes	A little	No
Increasing building weight	A little	Yes	Yes
Load support	No	Yes	No

Environmental comparison			
	Watery façade	**Algae façade**	**Green façade**
Improving air quality inside	Yes	Yes	In some systems
Improving air quality outside	Yes	Yes	Yes
Moisture control	Increasing moisture level (desirable)	Increasing moisture level (Sometimes undesirable)	Increasing moisture (Sometimes undersirable)
Rain water management	Possible	Unpredicted	Possible
Improving public health	Yes	Yes	Yes
Compatible with climatic change	No	No	Yes

Sustainability comparison			
	Watery façade	**Algae façade**	**Green façade**
Heat control	Yes – cooling effect of air	Yes	Yes

Requiring insulation of the façade	If it is in front of main	No	Yes
Noise insulation	Very low	Yes	Yes
Resistance to wind	No	Yes	Yes (relatively)
Urban climate balance	Yes	Yes	Yes

Table 6: comparison between each system.

Chapter 5 Case Study

5.1 BIQ (Bio Intelligent Quotient) House, Hamburg, Germany

The BIQ (Bio Intelligent Quotient) house represents the world's first pilot project for the implementation of a bio-reactive façade in residential buildings. The bio-reactive façade, called Solar Leaf, generates renewable energy from algae biomass and solar thermal heat. In particular, the BIQ house in Hamburg has 200 m2 of algae filled bio-reactive paneling, which supplies the building with all of the energy it needs while reducing carbon dioxide (CO_2) emissions by 6 tons per year.

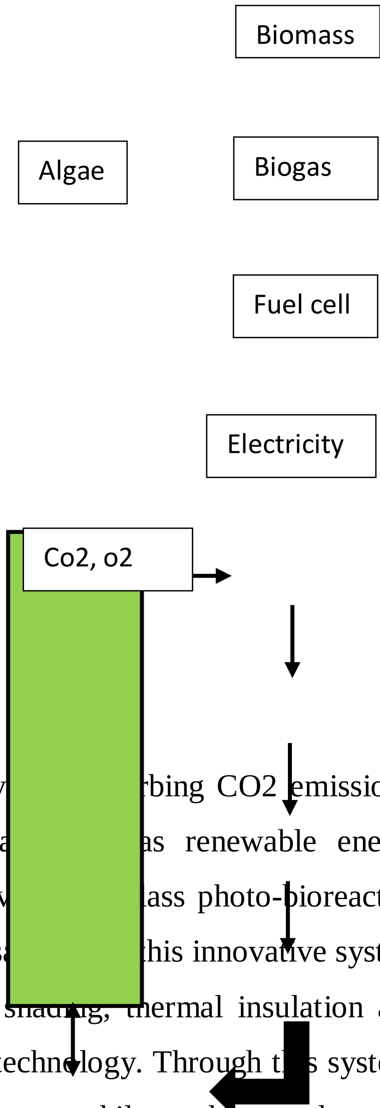


Figure 7 : algae façade working flow chart.

This pilot project exemplifies a building integrated sy[illegible]rbing CO_2 emissions, while cultivating microalgae to generate biomass a[illegible]as renewable energy resources. The environment for photosynthesis is prov[illegible]lass photo-bioreactors installed on the southwest and south-east sides. At the sa[illegible]this innovative system integrates additional functionalities such as dynamic [illegible], thermal insulation and noise abatement, highlighting the full potential of this technology. Through t[illegible]s system, the BIQ house can produce energy in a carbon neutral way while working at the same time as a carbon sink through the use of algae for capturing CO_2.

5.1.1 Calculations of energy production and carbon dioxide reduction:

- The BIQ apartment building has a 200-m2 area of PBRs with each unit 70 cm wide, 270 cm high, and 8 cm thick; 129 modules were installed in the southeast direction and filled with microalgae through photosynthesis. The produced biomass removes CO_2 and generates energy. the electricity consumption is approximately 182,500 kW/h (a summer month bill, for example),
- To measure the energy efficiency of the microalgae facade, the only variable between the original building and the retrofitted building is the building energy

in the window system. The remaining variables such as the specification of the opaque wall, window-to-wall ratio, air infiltration rate, and building operational schedules remain the same between the two scenarios.

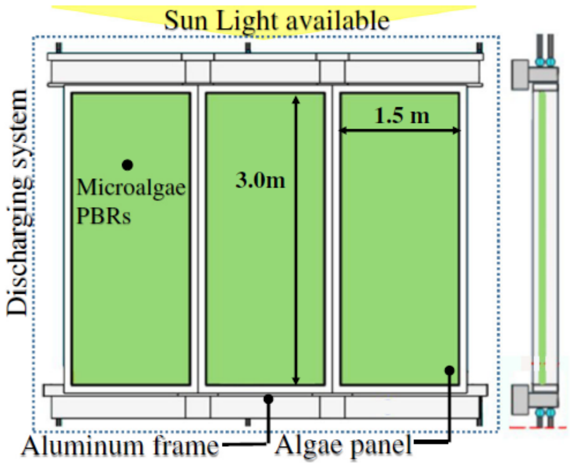
- A total area of 4500 m2 of the northeast and northwest façade and 3800 m2 of PBRs with each unit 140 cm wide, 280 cm high, and 8 cm thick suggest installing and filling with microalgae through photosynthesis.
- From the calculations for the case of Hamburg, being considered the minimum values, the converted electrical energy by the algae facades is approximately 85500 kW/h, which implies 45–50% of the electricity consumption in the building could be saved.
- The algae facades are expected to reduce 100 tons of carbon dioxide emissions per year which is reflected in the internal environment of the building

Photo bioreactor panel energy indicators	Value
Bio methane production	612m^3
Net energy as methane	Approx. 4541 kWh/year
Net energy from heat	Approx. 6,000 kWh/year
Carbon dioxide emission reduction	6 tons/year
Basic data per sqm bioreactor area biomass production	900 kg/year
Energy production from biomass	345ki/m^2/day
Biogas production from biomass	10.20L methane/m^2
• Net annual energy supply	• Approx. 4500 kW/h of electricity
• Note: Indicators for a 200-m^2 bioreactor area with 300 days of production/year. These values are considered minimum because minimum because of the more hours of sunshine in Giza than in Hamburg.	

Table 7: energy saving chart of algae facade system.

- Despite the efficiency of integrating PBR into facades, it only supplies about half of the electricity requirement in the case study building. As a result, additional clean energy technologies, such as photovoltaic, can be combined to maximize efficiency.
- The energy generated, CO2 absorbed, and the cost are all directly proportional tothe area of the algae façade. This technology is costly, which includes the cost of construction, operation, and the high amount of energy required to mix nutrients and maintain algae in suspension. The PBR cost in BIQ is approximately €5 million. However, the technology is cost-effective in the long run due to its benefits.

5.1.2 Conclusion:



The BIQ house plays an important role as a pilot scheme for CO2 reduction and carbon sequestration in the building sector, and in general, as a low-carbon approach for buildings in future urban environments. With a sustainable energy design for energy efficient buildings, it can generate energy through its own envelope, store it, and use it itself. Through the carbon capturing property of algae, the building not only generates clean energy, but also stores carbon emissions and hence removes them in the atmosphere. The project demonstrates the establishment of innovative energy production and air pollution reduction in urban development.

5.2 Bosco Verticale Tower, Milan:

The Bosco Verticale Towers D and E in Milan, designed by the Italian architect Stefan Boeri, provide support for one of the most intense green façades ever made. The combination of its structure, safety, irrigation system and sophisticated selection of plants, with their location in all directions, enables the design of this building to be the most innovative design to date of a high-rise building. It can also be said to have introduced new standards for sustainable housing. The designer's main goal was to counteract the growing air pollution in Milan.

Total no. Of units: 113

Climate : Subtropical humid

Floor Area : 360,000sqm

CO2 Absorption : 19000 kg/year

O2 Production: 18980kg/yea**r**

20,000 sqm of forest

Number of trees: 800

Number os shrubs: 5000

Number of climbers and perennial plants: 15,000

Number of tree spcies: 23

Number of plant and heerbs species: 94

Average greenery for each person living in the towers:

Trees: 2

Shrubs: 8

Plants: 40

Number of inhabitants planned in both toers: 480

Number of bird species with nests in the tower : 20

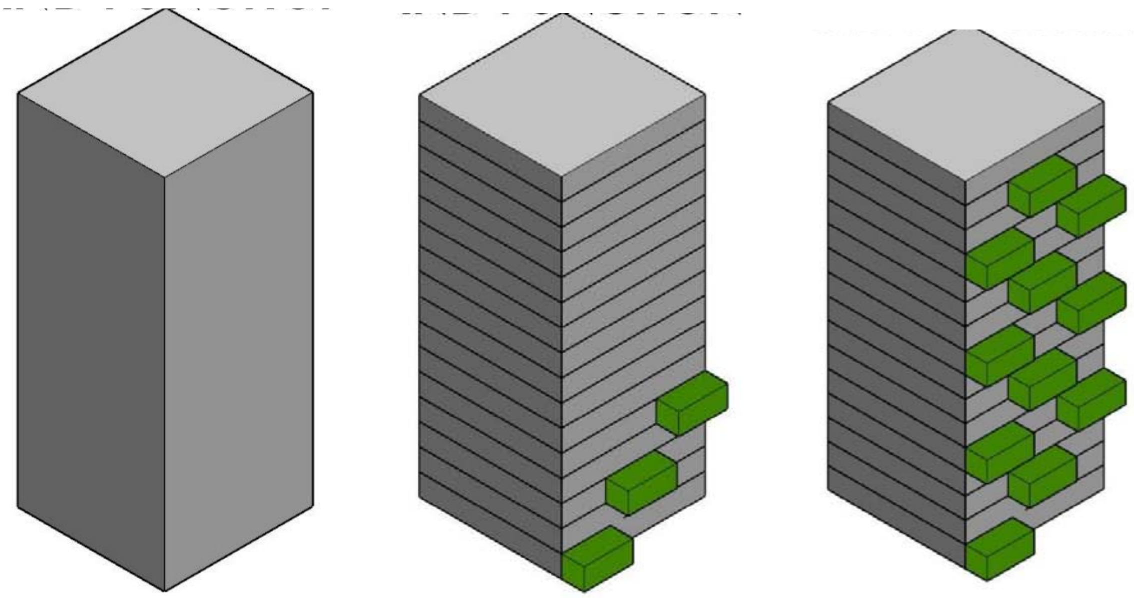
Average construction costs for sqm: 1.950 euro/sqm

Average maintenance costs for sqm: 63 euro/sqm/year

O2 production per day: 52kg/day

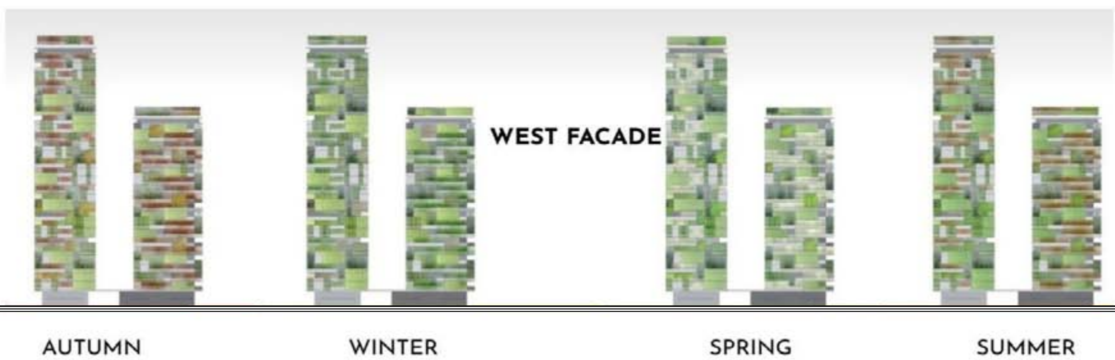
5.2.1 Design Inspiration:

- The design of Bosco Verticale was inspired by the traditional building in Italy that are converted with ivy and replace traditional material on urban surfaces using the changing polychrome of leaves for its walls.
- This idea was multiplied to include buildings surrounded by plants.
- The two residential towers of the projects are 110m and 80m height. They are spread over 27 story with a total built-up area of 40,000sqm.



are ... sta ... esign ... l tu ... allow growth of larger trees without hindrance, even over three floors of building.

- More than just surfaces, the facades can be viewed as three dimensional spaces not only because of the denseness and function of the green curtain but also in aesthetic- temporal terms, due to the multi- colored cyclical and morphological changes in the size of the plants.
- At the same time, the porcelain stoneware finish of the facades incorporates



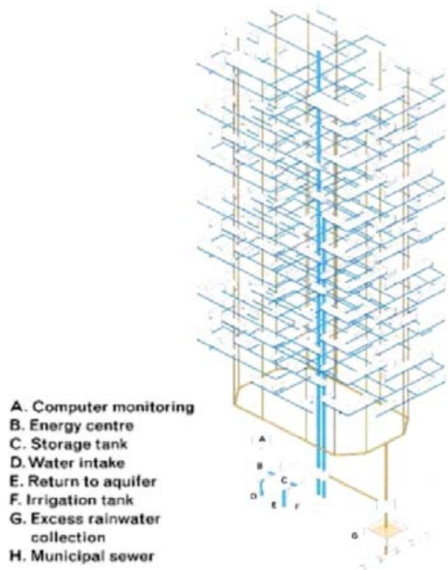
the typical brown color of bark, evoking the image of a pair of gigantic trees in which to live and which are rich in literally and symbolic implications.

Table 8:

The variation in color and shapes of the plants produce a tremendous iridescent landmark in every season and it is highly recognizable even at a distance.

5.2.2 Water supply of plants:

- The plants are watered by drip line. The calculation of the irrigation requirements for the planting was based on climatic conditions of the site and adjust according to the exposure of the facades and the distribution of vegetation.
- The groundwater used for the heating and cooling system is recycled to meet 100% of the irrigation requirements



5.2.3 Engineering of Trees:

- All the trees have elastic temporary bands that connects the root bulb to the steel mesh embedded in soil.
- All the medium and large trees have safety cable to prevent the trees from falling in case the trunk breaks.

- The largest trees in those locations most exposed to wind have a steel cage that restraints the root bulb and prevents it from overturning under major storms.

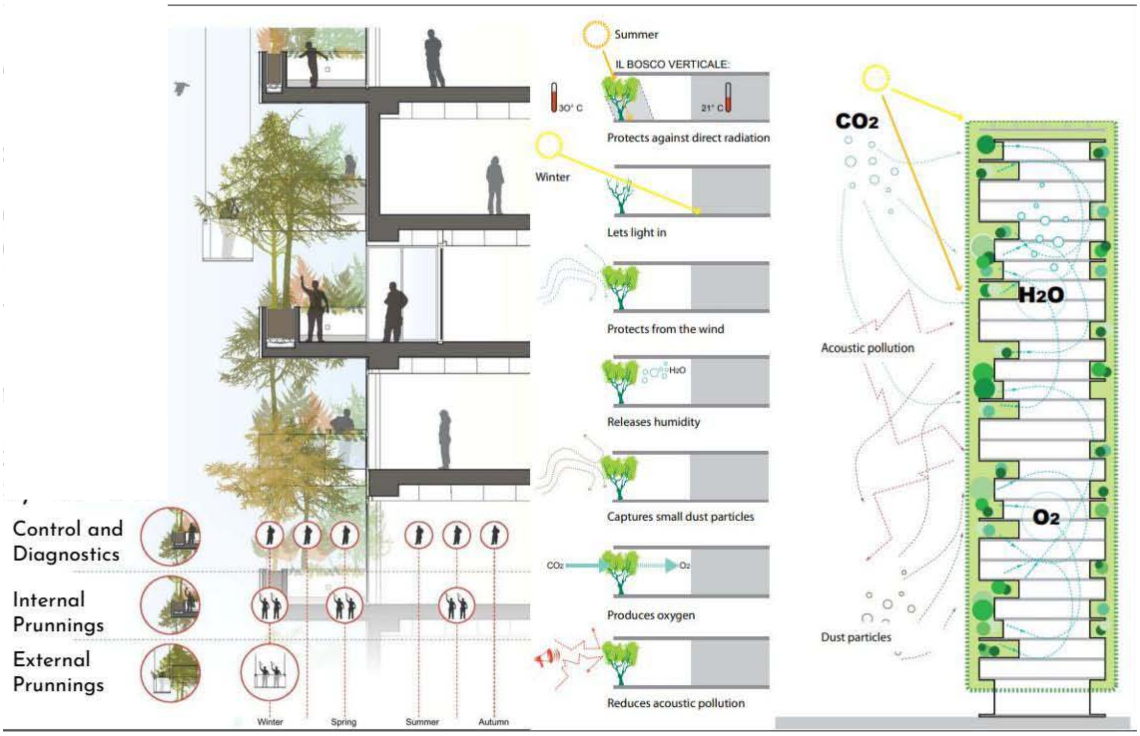


Figure 8

Chapter 6 Literature Study

6.1 Manitoba Hydro Place, Canada

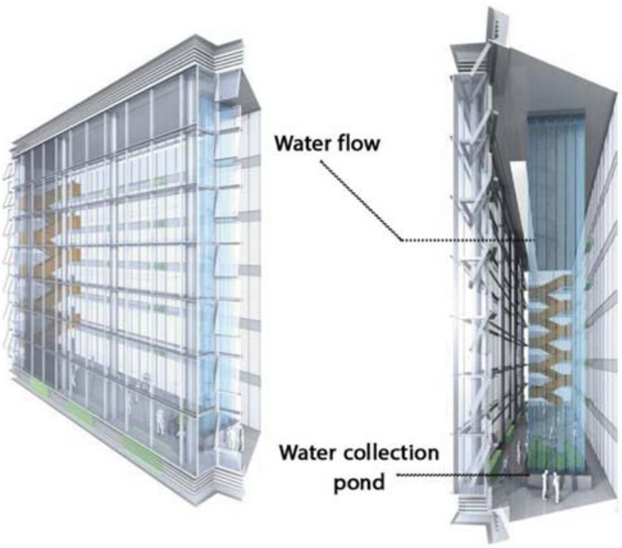
Officially opened: September 29, 2009;

Building size: 64,590 square metres;

Number of storeys: total of 22;

Building height:

- 115 meters to top of solar chimney;
- 88.6 meters to top of building;
- 98.6 meters to top of mechanical penthouse.



Occupant capacity: 2,245;

Green roofs: 3rd floor, east and west sides;

Underground parking: 152 spaces;

Building cost: $283 million.

Energy reduction: 70% less energy than a comparable office building of conventional design.

The Manitoba Hydro Place was designed by KPMB Architects, it is the headquarters of the Manitoba hydro energy utility company.

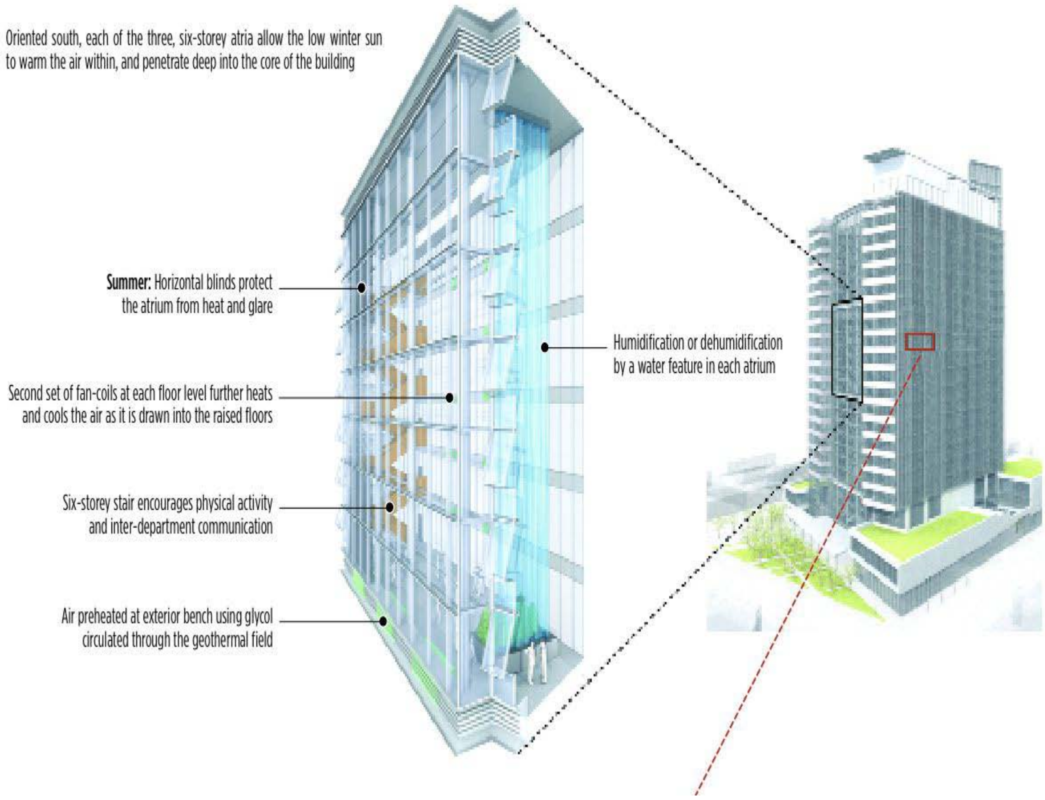
6.1.1 Venting façade:

The double layer curtain wall façade has vent able window which facilitate the introduction of fresh air into the building. The intermediary spaces between the exterior-most wall and the interior wall allow this air to conditioned and distributed throughout building. The interior wall has its own operable windows which allows the occupants to whether they desire the ventilation and air from buffer space.

6.1.2 Dehumidification – humidification:

The building incorporates into the atrium space a water feature that helps control the humidity and also improves the air quality of thebuilding.

- • The Hydro Place building in Manitoba, which holds a LEED certification for Canada, is one example of utilizing watery curtains for the façade. Its notoriety is primarily due to the biological-environmental design and adherence to optimization concepts in this structure. This new structure features an economical design that is efficient and advances energy technology, which the air in Hydro Place's buildings, according to its builders, is 100% fresh and healthy regardless of the air temperature throughout the day, in contrast to regular structures that employ natural air circulation. The lungs of the building are a group of southern apartments, also known as winter gardens, located inside two towers. Adjustable gates built into the floor of balconies allow outside air to be filtered before it enters the building interior. A tall waterfall can be useful for



accessing fresh air from intake air depending on the season by altering humidity.

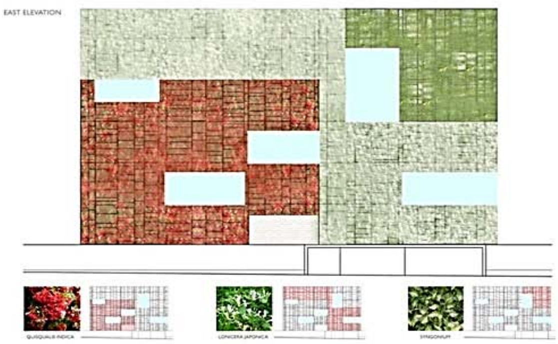
- The major function of the waterfall on the building's façade is to provide access to fresh air. In addition to cleansing the air, it can also modify the humidity of the entering air before it is distributed into the atrium. Each thread of the watery façade is a distinct 4-millimeter strap made of firm, thin polyester that, due to the strap's weight, can lessen the tension on the threads so that the water can manage each one and allow the most airflow possible by entering the watery facades. The building management system modifies the water temperature on the facade in relation to the thermal converter and in accordance with the relative humidity of the inside spaces. The amount of threading and water overflowing in this façade depends on the season and the surrounding environment. The available water in this facade will be retaken by a close system.With the use of a pump sensitive to contaminants, particles will be removed from the water using a reverse filtration system. In addition to being useful for sublimating air and removing pollutants, using watery walls and curtains is created and implemented in many projects by focusing on its aesthetic qualities.

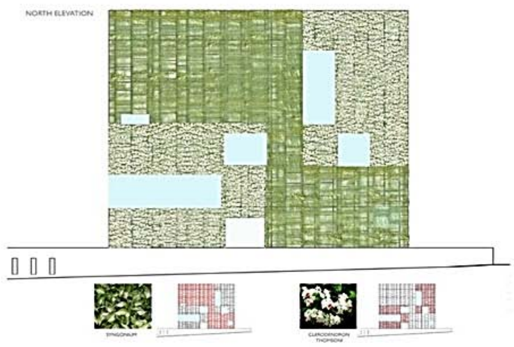
6.2 KMC Corporate building, HyderabadOFFICE BUILDINGS: HYDERABAD, INDIA

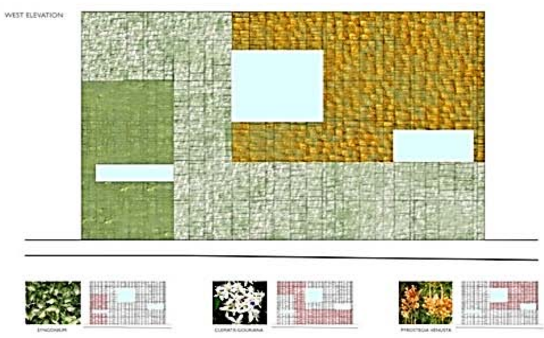
Architects: RMA Architects

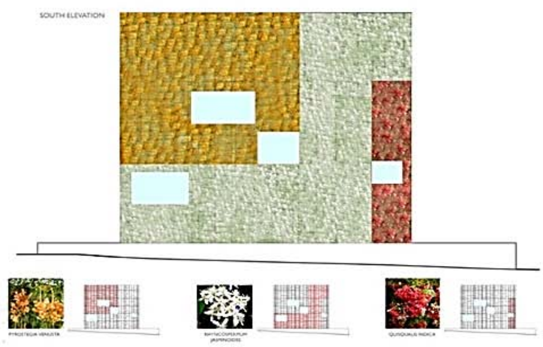
Year: 2012

The corporate buildings,







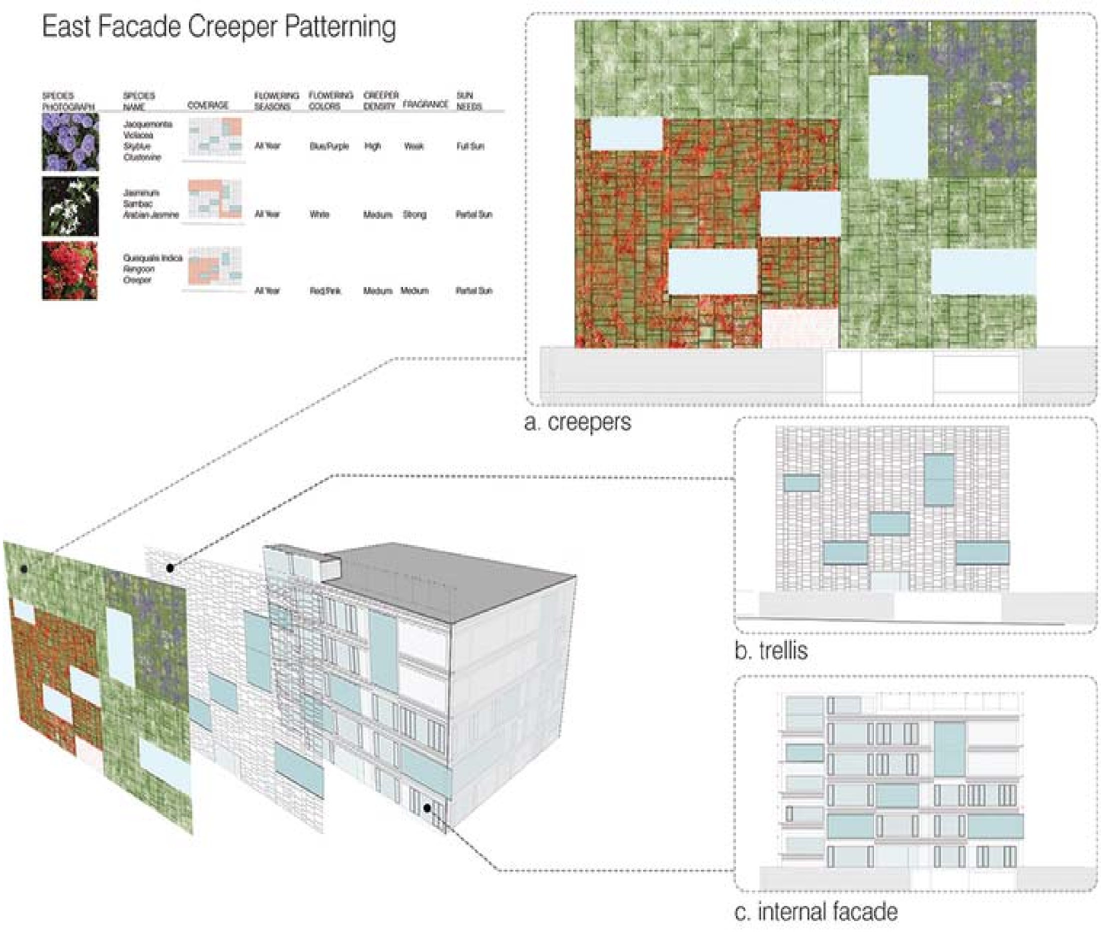


which are in Hyderabad's Cyber City, use the concept of a double skin as an energy-saving and eye-catching design element. Aluminium windows with a reinforced concrete frame make up the building's inner skin.

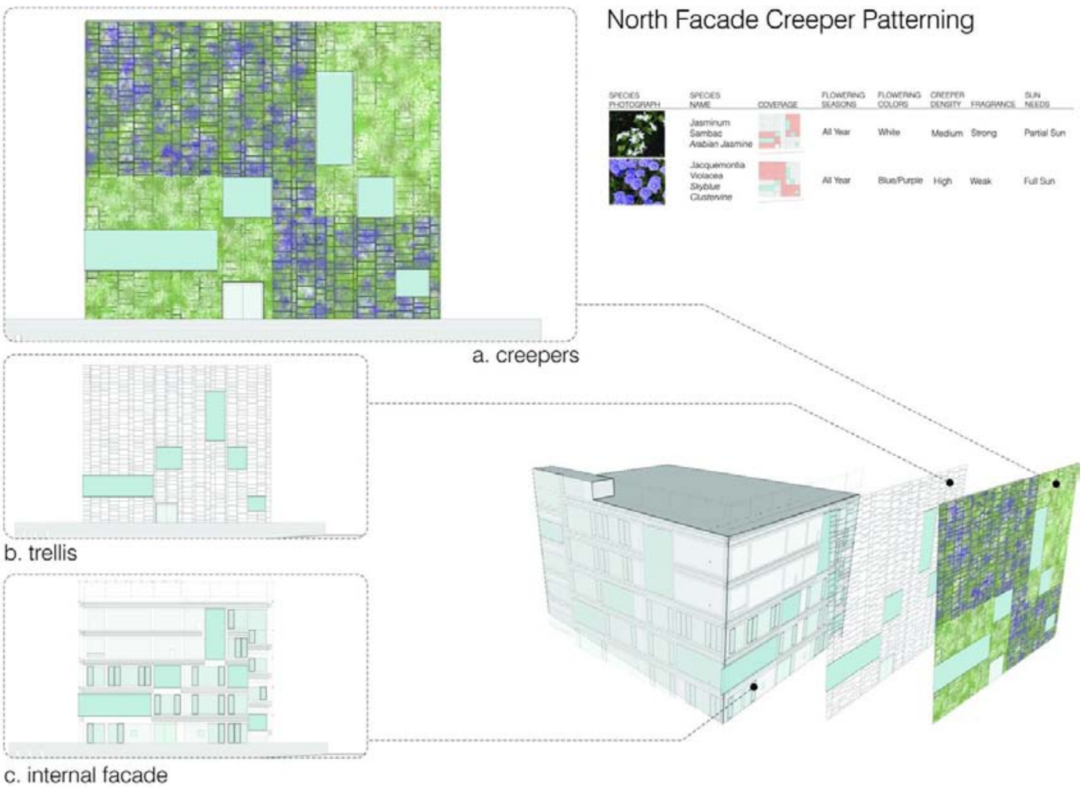
- A specially made cast aluminium trellis with integrated hydroponic trays for cultivating various plant species makes up the exterior façade. The trellis also features an integrated misting system tomanage and regulate the flow of water to the trays and plants.
- The facade's basic design is based on the concept of a double skin that allows light and air to be modulated via the structure.

This is in contrast to the business-as-usual idea of the ‘green wall’, which is a simple application on a surface purely serving an aesthetic, not asper formative function.

- In this project, the screen also takes on an aesthetic function of a dynamic façade where assorted species are organized in a way to create patterns, as well as bloom at various times of the year, bringing attention to different parts of the building façade through the changing seasons.



- But most importantly, the building demonstrates the relevance of traditional cooling systems of humidified surfaces used through time in the hot and dry climates of South Asia.



Chapter 7: Inferences of Case Study & Literature study

Description	Case Study 1	Case Study 2	Literature Study 1	Literature Study 2
Area	8600sqm	360000sqm	16459sqm	-
Co2 absorption	6 ton/year	19000kg/year	Yes	Yes
O2 production	---	18980kg/year	No	Yes
Energy saving	6000kwh/year	---	70%	Yes
Cost	5 million euro	1.950euro/sqm	283 million$	---
Climate	Hot/sunshiny	Hot and dry	Hot and dry	Hot and dry
Lifetime				

Table 9: conclusion of case studies.

Chapter 8. Conclusion

This study's primary goal was to gain a better understanding of how bio-based walls interact with one another to purify the air and improve its quality. But it can be acknowledged that green façade and algal facade can offer the best structure in this regard based on all the measures made in this research and in line with the previous tables.

What matters is finding a useful answer in a timely manner while evaluating each of the bio-based layers in light of the existing circumstances in Delhi and Lucknow.

As per Delhi's air pollution problem we need instant solution with minimum time we can reduce maximum amount of air pollution. Since Microalgae are the organisms that can photosynthesise and quickly absorb significant amounts of air pollution among the suggested biotic techniques. A unique potential for converting walls into photosynthetic surfaces is to integrate them with building façades in enclosures known as bioreactors. Building facades can be converted into photosynthetic surfaces by combining microalgae with them in containers called bioreactors.

These bioreactors that are embedded into the building's façade may adapt to climatic change, enhance the structure's passive thermal performance, transform a standard structure into one that is thriving and healthy, and turn the building's walls into an energy plant. In the end, they will be able to create a power plant within a building. Studies show that even though this technique is still in its infancy and is not cost-effective, its integration with building façades ensures that sustainable energy sources are used nationally, ensures that financial investment supports a clean and healthy climate, and supports societal symbolism values. It is important to highlight that among the bio-façades examined in this study, the microalgae façade achieved the higher scores by applying the AHP approach. We can therefore draw the conclusion that microalgae façades could be employed as an ideal type of bio-façade to help sequester carbon dioxide in urban areas that suffer greatly from the adverse effects of air pollution.

The best option for Lucknow's air pollution issue is a green wall. In Lucknow, the usage of green façade in urban areas can significantly lessen air pollution on a limited scale. Green walls can be one of the most successful methods for enhancing the climate when taking into account the reduction of air pollution in sublimates, the relative reduction of temperature during hot seasons and hours, and the enhancement of the sublimatesurrounding the wall. Being a sustainable choice, green facades are a solution that lowers energy use, lowers consumption prices, produces natural beauty, and enhances climatic quality. Every day, designers are putting new and innovative designs into practise thanks to advancements in green facade technology.

According to research data, green facades and algal façades are the greatest options for reducing air pollution in Lucknow and Delhi.

Design problem

Bio façade housing

Why this project?

Due to increasing problem of air pollution in our cities, we need to provide some designs that helps the environment and also tackle with the increasing problem of air pollution. That's why I choose this project how can we reduce air pollution without harming environment.

Why Housing?

My study shows that in most populated areas there are two types of building commercial and residences. Major part of that area is residences that's why I choose housing project for this.

Bio Façade:

A bio façade is an outer enclosure that uses the least amount of energy necessary to maintain a comfortable climate, while encouraging the production of particular materials that have a lower environmental impact. By utilising imaginative architectural elements like green walls, hanging gardens, green roofs, or pergolas, bio-facades can be applied to newly constructed or existing commercial, residential, and public buildings.

Reference List

- https://swachhindia.ndtv.com/world-air-quality-report-2021-63-indian-cities-in-100-most-polluted-places-on-earth-67358/
- https://www.drishtiias.com/daily-updates/daily-news-analysis/world-air-quality-report-2021
- https://timesofindia.indiatimes.com/city/lucknow/air-pollution-in-lucknow-worse-than-pre-pandemic-levels/articleshow/92012323.cms
- Hume, C. (2009). Canada's Most Important Building. Toronto Star, December 19, 2009. Available from: https://www.thestar.com/news/insight/2009/12/19/hume_canadas_most_important_building.html. (accessed 11 June 2017).
- Kovarik, B. (2018). Environmental history timeline, “Air pollution”. Available from: http://environmentalhistory.org/about/airpollution/. (accessed 11 June 2017).
- Krzyzanowski, M. (2008). WHO Air Quality Guidelines for India
- Hamidreza Rezazadeh (2022). Reduction of carbon dioxide by bio-façades for sustainable development of the environment.
- Batool Moafaq Al-Zaidi 1, Armin Sarkis Markaryan (2020), Eating air pollution using building's façade technology.

PLANS

PROPOSED BIO FACADE HOUSING IN SUSHANT GOLF CITY, LUCKNOW

TOWER A2
3,3.5BHK
GROUND FLOOR PLAN

TOWER A2
3,3.5BHK
13TH FLOOR PLAN PH

TOWER A2
3,3.5BHK
14TH FLOOR PLAN PH

TOWER A2
3,3.5BHK
FIRST FLOOR PLAN

TOWER A2
3,3.5BHK
2ND TO 12TH
FLOOR PLAN

TOWER A1 AREA CHART	
TOTAL NO. OF UNITS IN TOWER	55
NO. OF 3.5BHK UNIT IN TOWER	51
NO. OF PENT HOUSE UNIT IN TOWER	4
AREA OF 3.5BHK UNIT IN TOWER	125SQM
AREA OF PENT HOUSE UNIT IN TOWER	675QM
NO. OF LIFTS	2
FIRE STAIRCASE	1
TOTAL NO. OF TREES IN TOWER	236
NO. OF TREES IN ONE UNIT	4
TOTAL NO. OF PLANTS/SHRUBS IN TOWER	755
TOTAL NO. OF PLANTS/SHRUBS IN UNIT	9

UNIT PLAN FOR 3.5BHK
125SQM

GUIDE: AR. SHAILESH KUMAR YADAV
RASHMI SINGH, M.ARCH (P. T.), 1200109010

PLANS

PROPOSED BIO FACADE HOUSING IN SUSHANT GOLF CITY, LUCKNOW

GROUND AND 1ST FLOOR PLAN
TOWER A5
(2 , 2.5 BHK)

TYPICAL FLOOR PLAN
2ND TO 13TH
TOWER A5
(2 , 2.5 BHK)

UNIT PLAN FOR 2.5 BHK
870SQFT

UNIT PLAN FOR 2BHK
800SQFT

TOWER A4 AREA CHART	
TOTAL NO. OF UNITS IN TOWER	82
NO. OF 2BHK UNIT IN TOWER	40
NO. OF 2.5BHK UNIT IN TOWER	42
AREA OF 2BHK UNIT IN TOWER	80SQM
AREA OF 2.5 BHK UNIT IN TOWER	87SQM
NO. OF LIFTS	2
FIRE STAIRCASE	1
TOTAL NO. OF TREES IN TOWER	300
NO. OF TREES IN ONE UNIT	4
TOTAL NO. OF PLANTS/SHRUBS IN TOWER	410
TOTAL NO. OF PLANTS/SHRUBS IN UNIT	5

GUIDE: AR. SHAILESH KUMAR YADAV
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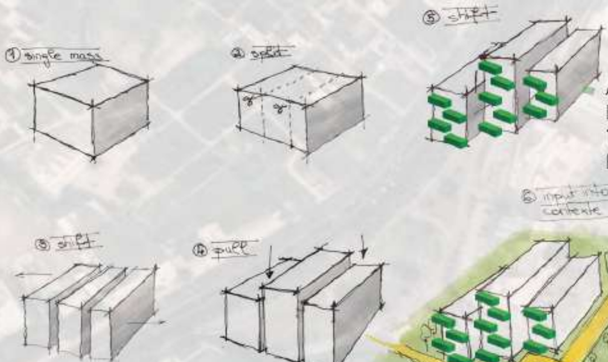
CONCEPT

DESIGN CONCEPT: REDUCING AIR POLLUTION THROUGH SUSTAINABILITY

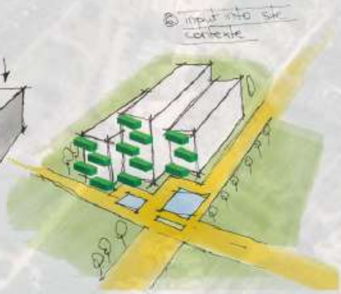
THE MAIN AIM IS TO ACHIEVE A COMFERTABLE ENVIRONMENT THROUGHOUT THE YEAR AND REDUCE AIR POLLUTION ON SITE DUE TO INCREASING POLLUTION PROBLEM IN CITY, WHICH WAS THE MAIN CHALLENGE IN TROPICAL CLIMATE. TO ACHIEVE THAT SUSTAINABILITY AND REDUCE AIR POLLUTION ON SITE SURROUND BUILDING BY PLANTS.

ORIENTATION AND SHAPE OF THE BUILDING : RECTANGLE

ORIENTATION AND SHAPE OF THE BUILDING CAN REDUCE THE ENERGY SIGNIFICANTLY, ROTATION OF THE BUILDING CAN INFLUENCE THE HEAT AND COOLING ENERGY DEMAND.

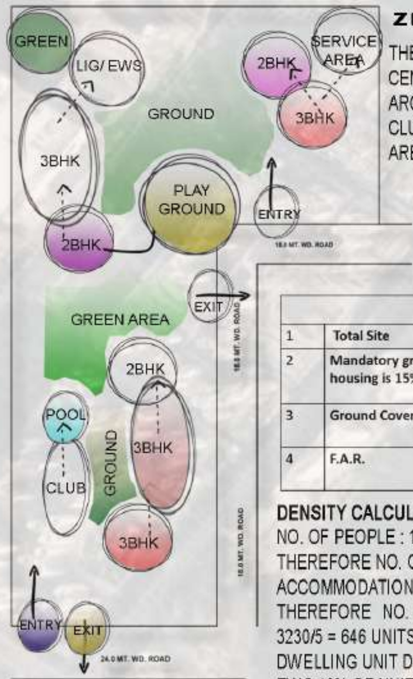


AT EACH EDGE L SHAPE BALCONY IS FORMED AND THE PATTERN OF THE BALCONIES.



THE TOWWERS ARE CHARACTERISED BY LARGE OVERHANGING BALCONIES, DESIGNED TO ACCAMODATE TO LARGE EXTERNAL TUBS FOR VEGETATION AND TO ALLOW THE GROWTH OF LARGER TREES WITHOUT HINDERANCE.

MORE THAN JUST SURFACE THE FACADE CAN BE VIEWED AS THREE DIMENSIONAL NOT ONLY BECUASE OF DENSENESS AND FUNCTION OF GREEN CURTAIN.



ZONING

THERE ARE 2 ENTRIY AND 2 EXIT ON SITE. CENTER PART IS GROUND OF HOUSING AROUND THET BUILDINGS ARE PLACED. CLUB BUILDING IS IN THE FRONT . SERVICE AREA IS IN NE CORNER.

Area Calculation:		
1	Total Site	8 acre = 32368sqm
2	Mandatory green area for housing is 15%	32368x15% = 4855.2sqm
3	Ground Coverage	45% = 14565.6sqm
4	F.A.R.	1.25

DENSITY CALCULATION :

NO. OF PEOPLE : 1000/HECTARE

THEREFORE NO. OF PEOPLE : 3.23X1000 = 3230 PEOPLE

ACCOMMODATION CONSIDERING 5 PEOPLE PER UNIT

THEREFORE NO. OF DWELLING UNITS REQUIRED = 3230/5 = 646 UNITS

DWELLING UNIT DISTRIBUTION:

EWS 10% OF UNITS= 64.6 UNIT

LIG 10% OF UNITS = 64.6 UNIT

HIG 30% OF UNITS = 193.8

MIG 50% OF UNITS = 323 UNITS

WATER CALCULATION :

DOMESTIC WATER REQUIREMENT@135LT/PERSON = 436050 LTR.

FIRE WATER REQUIREMENT 5% OF DOMESTIC = 21802LTR.

SERVICE AREA 10% OF TOTAL SITE= 32368X10% = 32368SQM

REQUIREMENTS:

CLUB BUILDING	SERVICE AREA
GUARD ROOM	2BHK UNITS
SWIMMING POOL	3BHK UNITS
PLAY GROUND	BASEMENT CAR PARKING
BADMINTON COURT	SURFACE PARKING
LIG/EWS UNITS	GREEN AREA

GUIDE: AR. SHAILESH KUMAR YADAV
RASHMI SINGH, M.ARCH (P. T.), 1200109010

SITE ANALYSIS

ABOUT SITE : SITE IS LOCATED IN SUSHANT GOLF CITY, SEC-C POCKET 7 , LUCKNOW U.P.

SITE AREA: 8 ACRE

BYLAWS:

G. C. : 45%

F. A. R. : 1.25

SET BACK : 15M

BIO FAÇADE HOUSING : DUE TO INCREASING POLLUTION RATE IN INDIA BIO FAÇADE HOSING IS A SUSTAINABLE HOUSING OPTION TO DECREASE THE POLLUTION PROBLEM.

SOIL CONDITION

SOIL IS ALLUVIAL WHICH IS VERY PRODUCTIVE AND CONTAINS SAND, SALTS AND SILT PARTICLES

SHAPE

THE SITE IS MORE OVER IN L SHAPE .

EARTHQUAKE FACTOR

LUCKNOW LIES IN SEISMIC ZONE III (EARTHQUAKE MODERATE DAMAGE RISK ZONE III

DISTANCE TO KEY LOCATION

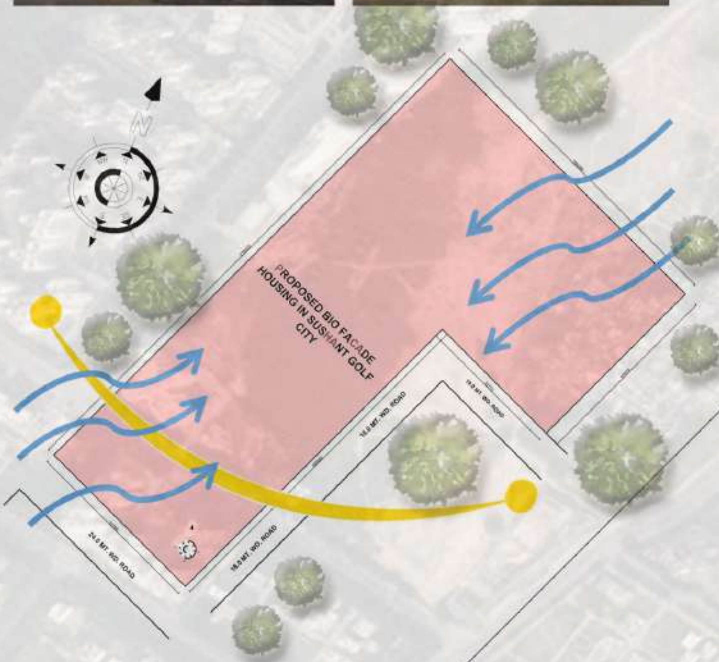
RAILWAY STATION (CHARBAGH) - 10 KM
AIRPORT - 12.3 KM
ISBT (ALAMBAGH) - 15.3 KM
HAZARATGANJ CROSSING - 13.8KM

KEY PLAN

LOCATION PLAN

APPROACH TO THE SITE: THE APPROACH TO THE SITE IS FROM 24 METERS WIDE ROAD WHICH IS CONNECTED TO THE SHAHEED PATH HIGHWAY AND IS GOING PARALLEL TO THE SULTANPUR ROAD.

SITE IS APPROACHED BY A 24M WIDE ROAD AND RIGHT SIDE ROAD IS 18M WIDE. REST SIDES OF THE SITE ARE COVERED BY DIFFERENT ENTITIES.



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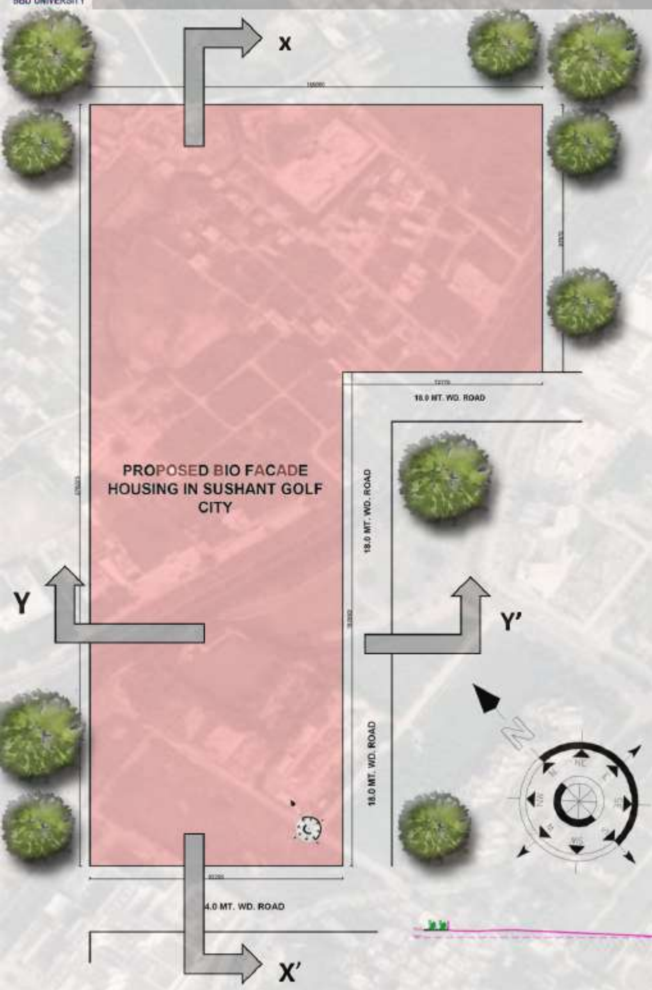
SITE ANALYSIS

PROPOSED BIO FACADE HOUSING IN SUSHANT GOLF CITY, LUCKNOW



CLIMATE-

THE COMPOSITE CLIMATE DISPLAYS THE CHARACTERISTICS OF HOT AND DRY, WARM AND HUMID AS WELL AS COLD CLIMATES. DESIGNS HERE ARE GUIDED BY LONGER PREVAILING CLIMATIC CONDITIONS. THE DURATION OF "UNCOMFORTABLE" PERIODS IN EACH SEASON HAS TO BE COMPARED TO DERIVE AN ORDER OF PRIORITIES.

WIND DIRECTION-

THE WIND MOVEMENT IS PREDOMINANTLY FROM NE-SW.

MAXIMUM WIND SPEED IS 5M/S (GENTLE BREEZE) IN 15 JUNE.

MAXIMUM WIND SPEED IS 2M/S (LIGHT BREEZE) IN 2 NOVEMBER.

TEMPERATURE-

SUMMER- MAX. = 45°C MIN. = 30°C

WINTER - MAX. = 25°C MIN. = 3°C

RAINFALL-

MORE THAN NINE-TENTHS OF THE ANNUAL RAINFALL OCCURS FROM JUNE TO OCTOBER

WHEN THE CITY RECEIVES AN AVERAGE OF 827.2 MILLIMETERS (32.57 IN) FROM THE SOUTHWEST MONSOON WINDS, ALTHOUGH OCCASIONALLY FRONTAL RAINFALL FROM THE NORTHEAST MONSOON WILL OCCUR IN JANUARY.

S.W.O.T. ANALYSIS-

STRENGTH :

BYPASS HIGHWAY NEARBY (SHAHEED PATH), WHICH CONNECT NEARBY CITIES AND CENTRAL LUCKNOW.

WEAKNESS :

THERE IS NO SUCH POTENTIAL WEAKNESS IN TERMS OF LOCATION.

OPPORTUNITIES :

THIS HOUSING IS ONE OF IT'S KIND. IT'S A NEW CONCEPT FOR TACKLE THE PROBLEM OF AIR POLLUTION.

THREATS :

THIS AREA IS DEVELOPING DAY BY DAY WITH MAJOR BUILDINGS ALLOCATING NEARBY , SO HIGH TRAFFIC ZONE CAN BE A PROBLEM IN FUTURE

INFRASTRUCTURE:

SEWAGE SYSTEM – 19 MILD OPEN SEWAGE CHANNEL

D

RAINAGE SYSTEM – PRESENT

ELECTRICITY – PRESENT

WATER SUPPLY – BORE WELLS USED

VEGETATION:

THERE ARE DENSE TREES AT CORNER OF NE & SE DIRECTION OF THE SITE. AND SMALL BUSHES COVER THE SITE APPROXIMATELY AT CENTER AND ITS SIDES.

TOPOGRAPHY & SLOPE:

SITE IS PLAIN IN NATURE WITH NO CONTOURS. OVERALL SITE IS BELOW THE ROAD LEVEL. 8"BELOW TOWARDS EAST, 6"BELOW TOWARDS NORTH,

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SITE PLAN

PROPOSED BIO FACADE HOUSING IN SUSHANT GOLF CITY, LUCKNOW

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PLANS

UNIT PLAN FOR 2.5 BHK
870SQFT

UNIT PLAN FOR 3BHK
112SQM

TOWER A1
GROUND AND 1ST FLOOR
PLAN
(2.5,3BHK)

TOWER A1
TYPICAL FLOOR PLAN
2ND TO 13TH

TOWER A1 AREA CHART	
TOTAL NO. OF UNITS IN TOWER	82
NO. OF 3BHK UNIT IN TOWER	56
NO. OF 2.5BHK UNIT IN TOWER	26
AREA OF 3BHK UNIT IN TOWER	112SQM
AREA OF 2.5 BHK UNIT IN TOWER	87SQM
NO. OF LIFTS	2
FIRE STAIRCASE	1
TOTAL NO. OF TREES IN TOWER	328
NO. OF TREES IN ONE UNIT	4
TOTAL NO. OF PLANTS/SHRUBS IN TOWER	690
TOTAL NO. OF PLANTS/SHRUBS IN UNIT	7

PLANS

PROPOSED BIO FACADE HOUSING IN SUSHANT GOLF CITY, LUCKNOW

GROUND AND 1ST FLOOR PLAN
TOWER A3 (3, 3.5BHK, 2, 2.5 BHK)

TYPICAL FLOOR PLAN
(2NT TO 13TH)
TOWER A3 (3, 3.5BHK, 2, 2.5 BHK)

TOWER A4 AREA CHART	
TOTAL NO. OF UNITS IN TOWER	136
NO. OF 3BHK UNIT IN TOWER	26
NO. OF 3.5BHK UNIT IN TOWER	28
NO. OF 2BHK UNIT IN TOWER	40
NO. OF 2.5BHK UNIT IN TOWER	42
AREA OF 3BHK UNIT IN TOWER	112SQM
AREA OF 3.5 BHK UNIT IN TOWER	125SQM
AREA OF 2BHK UNIT IN TOWER	80SQM
AREA OF 2.5 BHK UNIT IN TOWER	87SQM
NO. OF LIFTS	4
FIRE STAIRCASE	2
TOTAL NO. OF TREES IN TOWER	512
NO. OF TREES IN ONE UNIT	4
TOTAL NO. OF PLANTS/SHRUBS IN TOWER	786
TOTAL NO. OF PLANTS/SHRUBS IN UNIT	9

UNIT PLAN FOR 2.5 BHK
870SQFT

UNIT PLAN FOR 3BHK
112SQM

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