GREEN STRATEGIES FOR BUILDING DESIGN (ARC61804)

Assignment 1: Passive Green Building Case Studies Poster & Booklet

GROUP 15
AR. AXXU

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INTRODUCTION

Pearl Academy Jaipur

Architecture firm: Morphogenesis

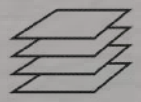
Location: India

Geographical coordinates: 13.065, 80.241

Area: 11745 m^2

Completion: 2008

Occupation: Academic



Number of floors: 3

The design of the Pearl Academy of Fashion, Jaipur, aims to establish an environmentally responsive passive habitat. The campus features interactive spaces facilitating the creative student body to engage in multifunctional zones that seamlessly integrate indoor and outdoor environments. The institute's innovative architecture results from the fusion of traditional building knowledge and cutting-edge contemporary design.

ACCOLADES:

2016
Silver Award under 'Fashion' category
Bronze Award under 'Emerging Design' School for Mumbai
Ranked no. 3 and Jaipur no.4 under top 10 fashion colleges in India

2017
Pearl Academy awarded as "Best Vocational Education Institute of the year - Interior Design"

2019
Accorded Educational Partnership of World Design Organization

2021
Awarded by World Leadership Congress in association with ET for the Best Design Institute in India
Awarded for Excellence in Creative Arts by FICCI 2021

Library of Birmingham

Palazzos Centenary Square, situated in the heart of Birmingham, currently lacks a cohesive identity or atmosphere. Mecanoo's design seeks to reenvision the square by introducing three distinct realms: monumental, cultural, and entertainment. These palazzos contribute to an urban narrative representing key historical periods in the city's history, including The Repertory Theatre (REP), a 1960s concrete building; the Library of Birmingham, designed in 2009; and Baskerville House, a listed sandstone building from 1936.

ACCOLADES:

2012
Building In The Community - Game Changer Award
BITC Social Impact - Big Tick
Guardian 2012 - Social Impact
Carillion S Factor Awards - Winner

2013
Built in Quality - Major Developments West Midlands 2013
West Midlands Property awards - Project of The Year 2013
Considerate Constructors 2013 - Gold Award
Library success in RIBA regional awards
BREEAM Excellent 2013

2014
Constructing Excellence awards 2014 (West Midlands)
Construction News awards 2014
CITB awards
National Constructing Excellence awards 201

Architecture firm: AR Francine Houben and Mecanoo

Location: United Kingdom

Geographical coordinates: 52.479, -1.9085

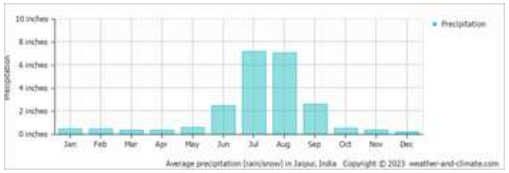
Area: 35000 m^2

Completion: 2013

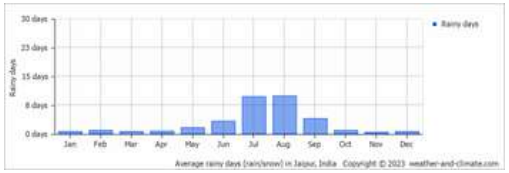
Occupation: Public library

Number of floors: 9

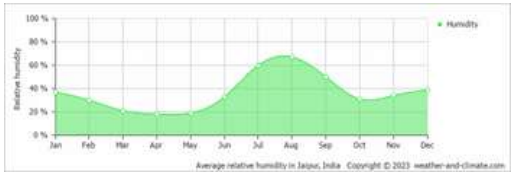
01
SITE PLANNING



summer



winter

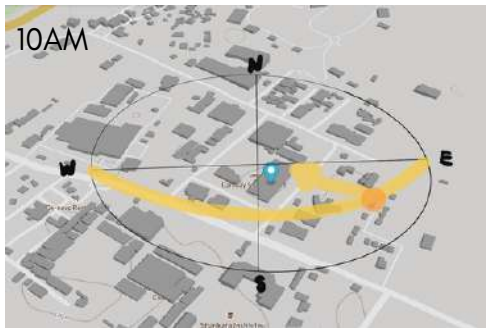
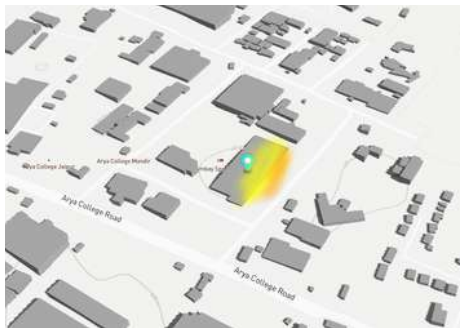
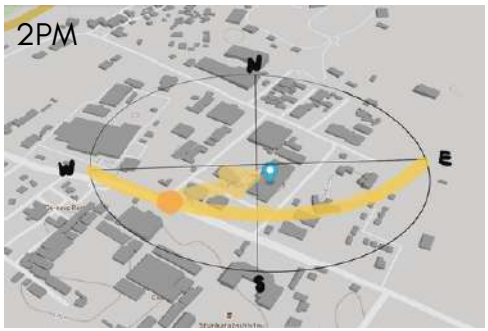
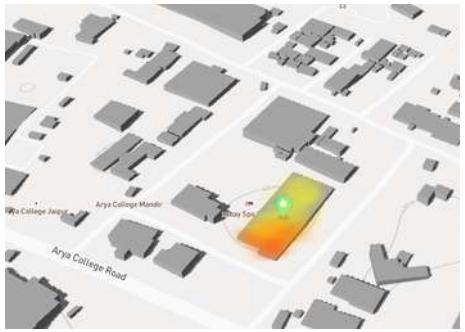
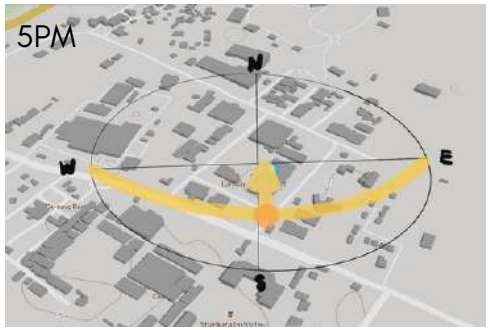


Design Response

The building design prioritizes passive environmental responsiveness due to the challenging climate, minimizing reliance on resource-intensive mechanical controls.

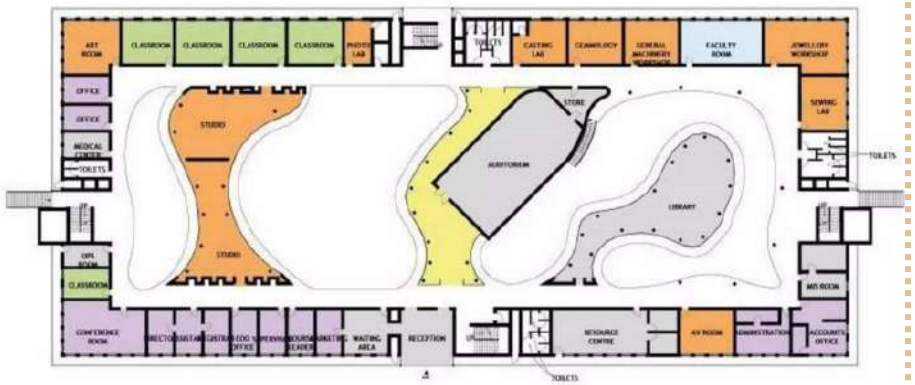
City of Jaipur

Jaipur is the capital of the indian state of Rajasthan and surrounded by Nahargarh Hills in the north and Jhalana in the east which is part of the Aravalli range. Jaipur has typical hot desert climate and has a moonson influesnced hot semi-arid climate with long, extremely hot summer and short, mild to warm winters.

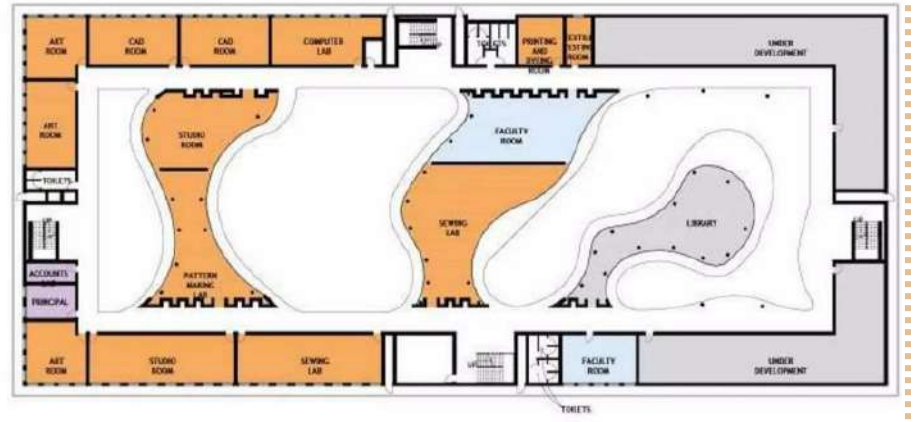
Shadow Casting	Sun Glare Exposure	Design Response
		The morning sun casts a short shadow on the west side. The surrounding buildings aren't tall enough to cast a shadow. A double skin facade wraps the building to filter the harsh sun glare and create thermal buffer space.
		During the afternoon, a slight shadow casted on the east side but those do not affect the site. In the evening, this gently sun glare cast long shadow on the east side that create shade into the interior.
		The intense sun glare during afternoon will lead to hot temperature and to response for that having a courtyard and open concept will allow the process of air transition.

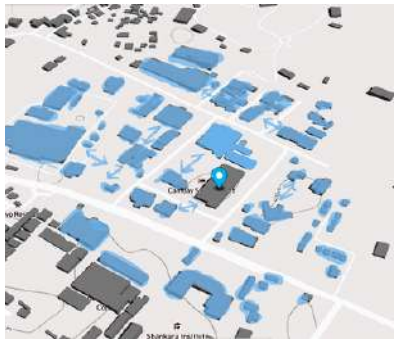
Orientation analysis

GROUND FLOOR PLAN

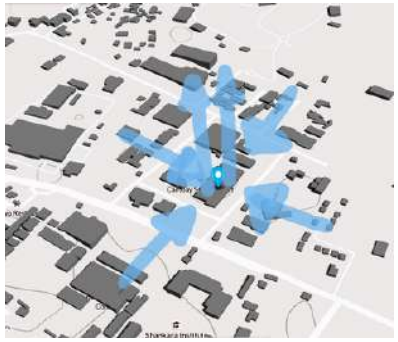


FIRST FLOOR PLAN



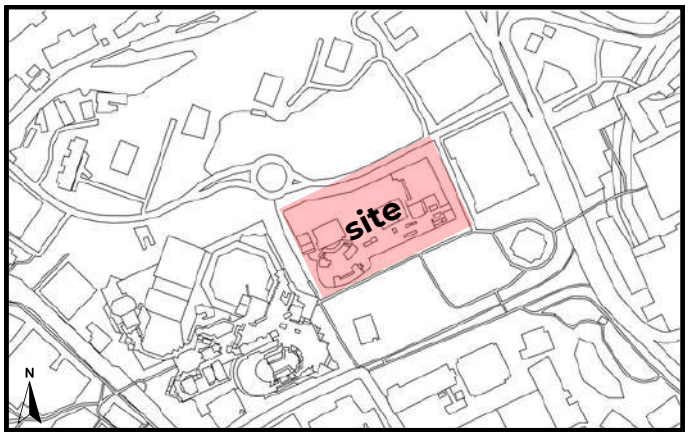


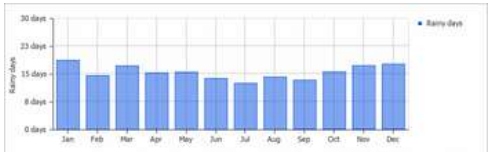
Since the surrounding building dont have the height that can provide shade and located at open land subsequently lead to raising of hot air, it rely on the passive cross ventilation.



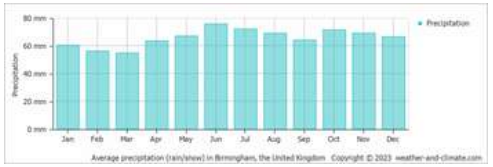
In Jaipur's hot desert climate with long summers, water features act as both decoration and water waste treatment. This aids in the evaporation process, transitioning hot air effectively.

The building independently responds to harsh sunlight, using sun shading and reflective materials in the facades to filter and minimize the impact of intense natural light on the interior.

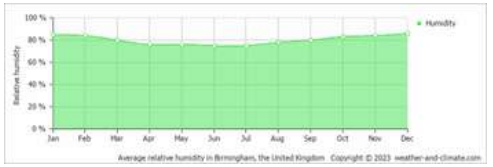




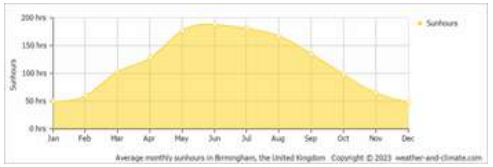
summer



winter



spring



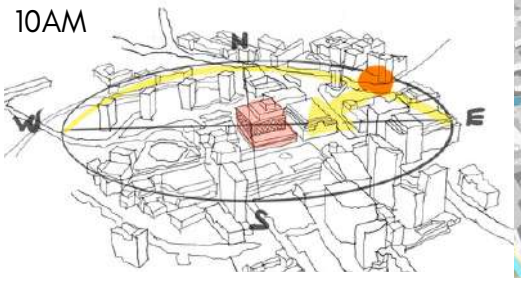
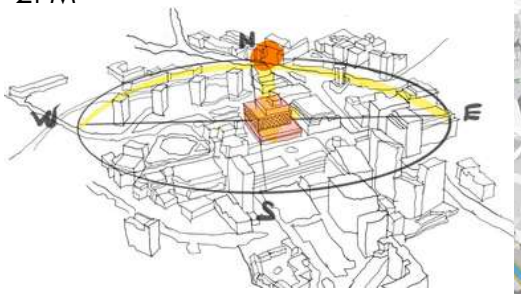
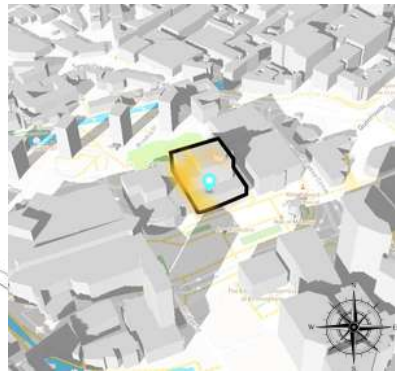
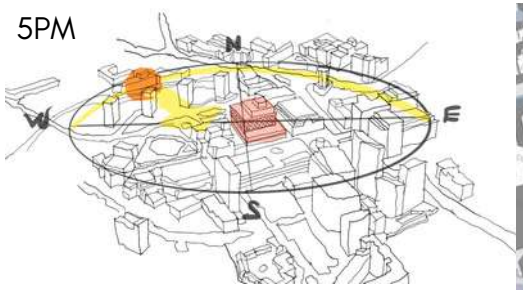
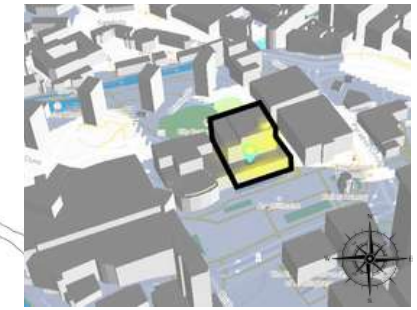
Autumn

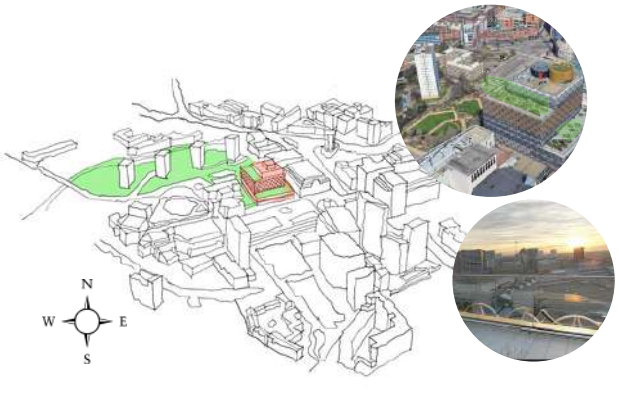
Design Response

Taking the advantage of the frequently rain by applying the rainwater harvesting and heat pump as to cooldown the building during the sunny day

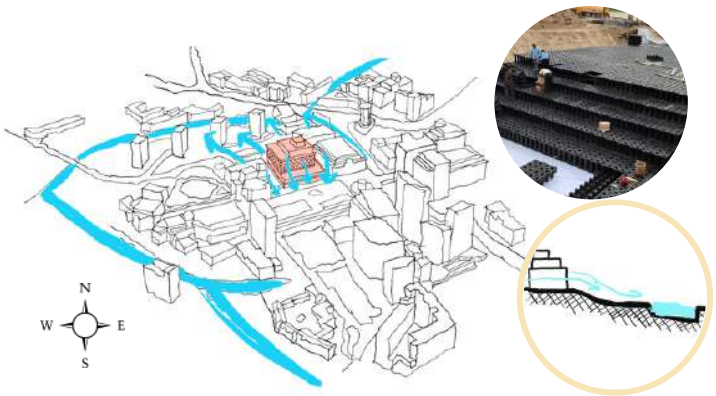
City of Birmingham

The weather in Birmingham is mild and marine. This city experiances a significant urban heat island effect like the majority of other big sities. Due to itsinland location and relatively high elevation, Birmingham has more snow than other major UK conurbation. The hottest temperature is 37°C during the summer.

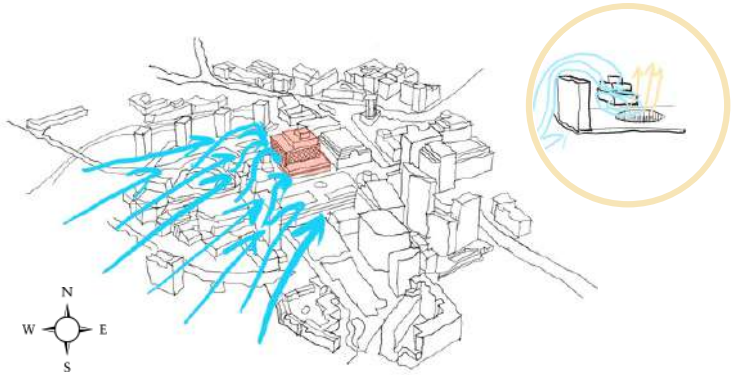
Shadow Casting	Sun Glare Exposure	Design Response
10AM 		The morning sun casts a long shadow on the west. The sun directly glares to the front facade and the rotundas which give a sense of welcoming to the visitors.
2PM 		The sun is blocked in the afternoon by sun shading and reflective materials used in the facades, while natural light diffuses to the interior. There are no long cast shadows as there aren't any tall neighbouring buildings.
5PM 		The evening sun casts a long shadow on the neighbouring buildings to provide shade for the lower levels and along with the aluminium panels and curtain walls they provide a sense of tranquility



These two roof garden incoorperating with shrub and perennials would give a breathing space for the visitors and attract the wildlife as well as improving biodiversity. utilzing the open garden view at the back of the building as well as to reduce urban heat affect



The site have a gently sloping hill which allow the rainwater to flow into the river. To slow down the rainwater flow, the stormwater attenuation is applied to the building construction.



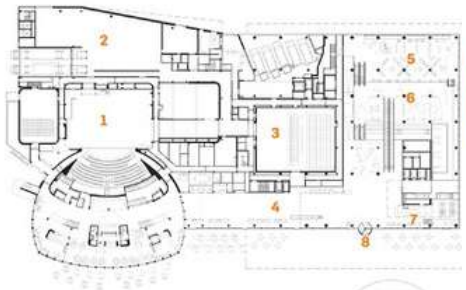
The higher building act as the wind turbulance and would create air pressure that would speed up the wind movement, thus it would trigger the process of the changes of the hot air.

LOWER GROUND FLOOR

1 Children's performance space
2 Children's library
3 Music library
4 Amphitheatre
5 Music performance space

This amphitheatre is an open space as it create visual link as well as providing natural daylighting

GROUND FLOOR



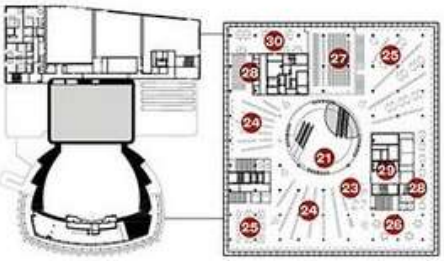
1 REP Theatre main auditorium stage
2 Workshop area
3 Shared studio theatre
4 Shared foyer
5 Upper lending terrace
6 Lower lending terrace
7 Café
8 Entrance

FIRST FLOOR

1 Recording studio
2 Training suite
3 Group study area
4 Meeting rooms
5 Staff area

17 Youth space
18 Amphitheatre to Centenary Square
19 Changing area
20 Staff zone
21 Reader services
22 Book rotunda
23 Level 2 lounge
24 Open access books
25 Quiet study area
26 Group study area
27 Closed access books
28 Toilets
29 Lifts
30 Staff area
31 Reader services

2nd Floor

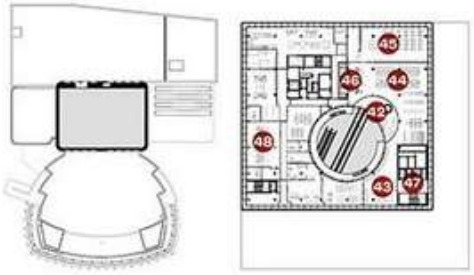


THIRD FLOOR

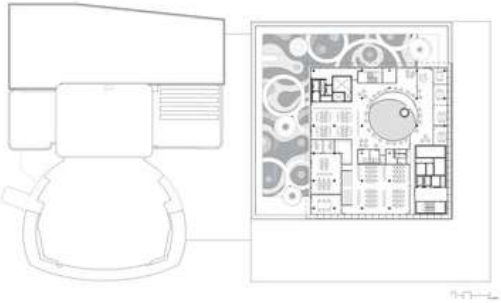
1 British Film Institute mediatheque
2 Gallery
3 Group study area
4 Lounge
5 Garden terrace

43 Learning space
44 Archive and Heritage
45 Archive and Heritage search area
46 WCs
47 Lifts
48 Staff area/services

4th Floor



7th Floor



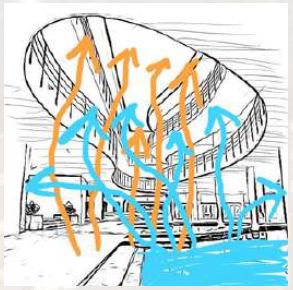
Comparison

Pearl Academy Jaipur

Climate

- located at the typical hot dessert
- relying on the passive ventilation
- relying on self shading device sliver court to control temperature

The thermally banked underbelly, enclosed on all sides, acts as a significant student recreation and exhibition area, serving as the project's anchor.



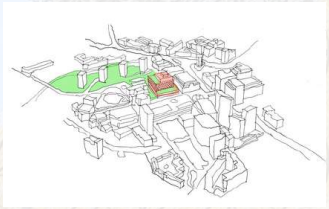
In Jaipur's hot, dry climate, water features cool and treat waste water, aiding the evaporation process to counter the heat.

Due to the lack of taller surrounding buildings for shade and the open land causing the rise of hot air, the building relies on passive cross ventilation.

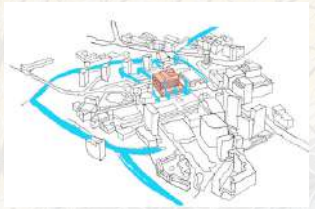
Library of Birmingham

Climate

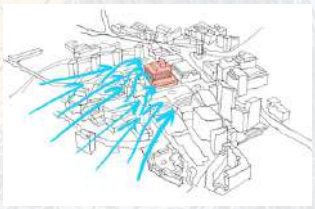
- located at mild and marine wheather
- using with reflected aluminum panel to control light penetration and ventilation.
- rooftop garden on East & West to reduce GHG emissions and heat gain.



Two roof gardens with shrubs and perennials offer a breathing space, attract wildlife, and enhance biodiversity while reducing urban heat effects.



The gently sloping hill directs rainwater into the river. Stormwater attenuation in the building construction slows down the rainwater flow.



Tall buildings create wind turbulence, increasing air pressure and accelerating wind movement, triggering the change in hot air.

CONCLUSION

PEARL ACADEMY JAIPUR

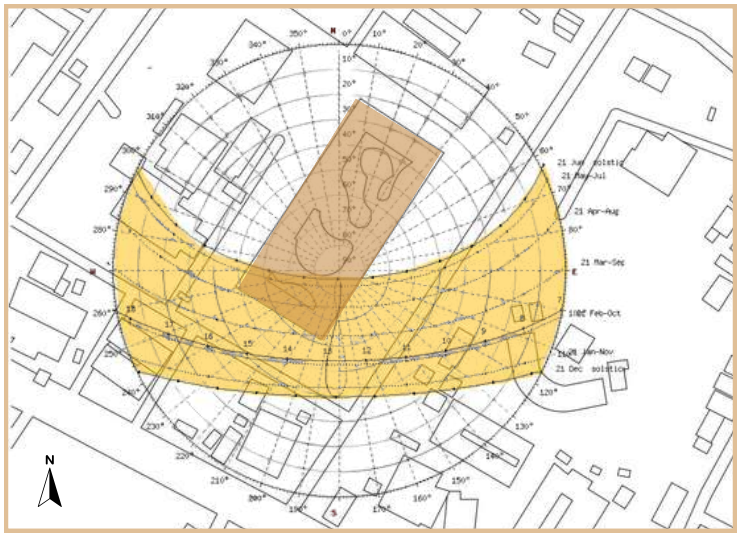
Maximizing passive cooling in a challenging climate requires various methods for microclimate control, reducing reliance on resource-intensive mechanical measures.

LIBRARY OF BIRMINGHAM

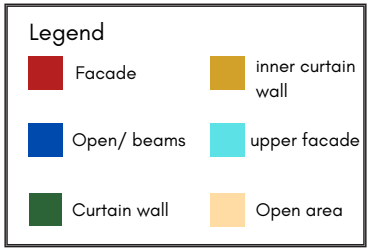
Emphasis on the prevention of heat loss and heat gain as it has 4 seasons. Utilizing the rainwater harvesting system to maximize use of the frequently rain wheather.

02
DAYLIGHTING

Building orientation



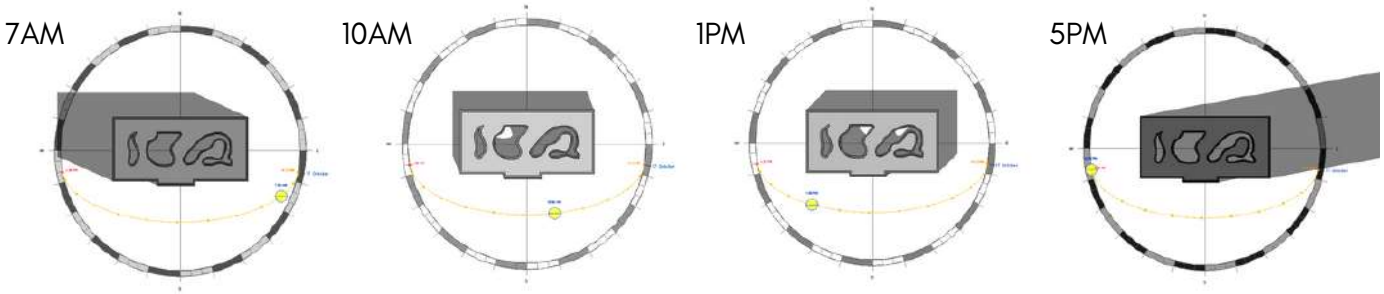
Building perimeters

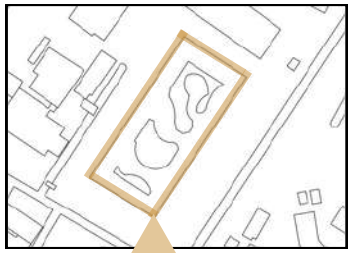


- Large open courtyard allow natural sunlight to **illuminate** the ground floor
- Curtain walls in the inside gives off the **views** of the open space as well as letting natural sunlight in.
- Facade called "jaali" **surrounding** the entire building helps **minimize** the amount of sunlight passing through the building.

The building is facing east to minimize the amount of sunlight into the building keeping the optimal temperature

Shadow cast





Daylight design considerations

Shading Device

Facade that surrounds the entire building in Jaali pattern helps to **diffuse sunlight** from every direction.

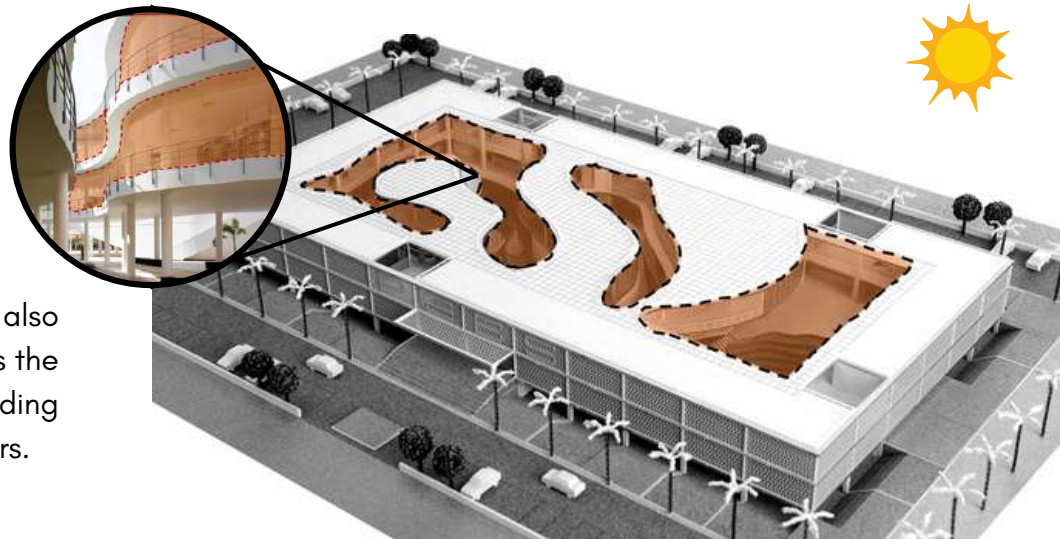
Open Ceiling System

The indoor courtyard has openings in the ceiling platforms that allow sunlight to **penetrate** through to the lowest floor.

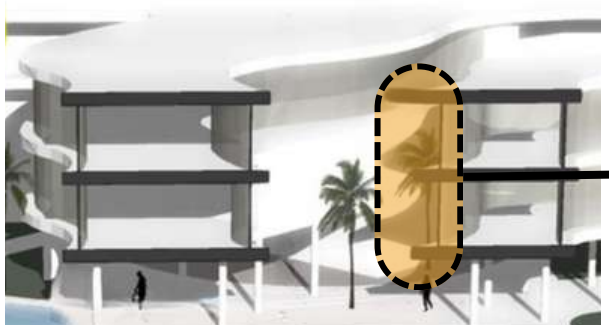
Open courtyard

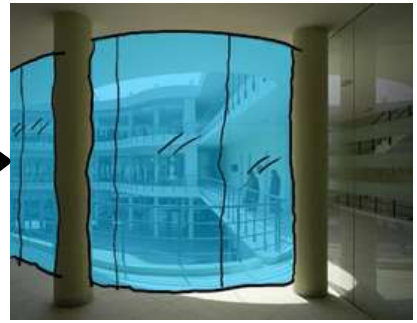
The courtyard helps gets **indirect sunlight** into the the classrooms and corridors via the **curtain wall.**

It allows sunlight in but also at an **optimal level**, thus the temperature in the building is at **comfort** for the users.



Curtain Wall



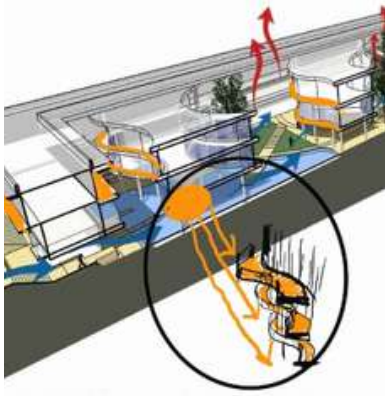


The transparent glass at the classroom area promote the **passive natural light** as to prevent from relying on the mechanical lighting, most of them are located at the 1st floor of the building.

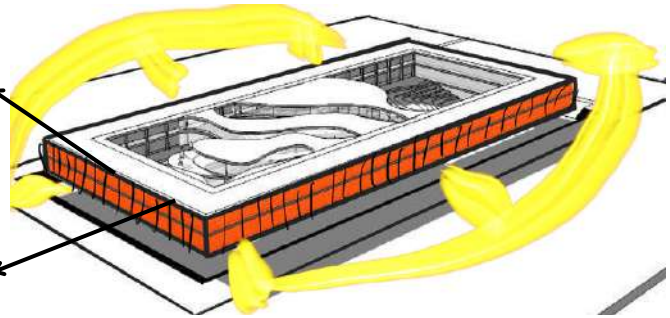
The five-footway gradually widens with each ascending floor, creating a visually appealing, spacious pathway that provides both **aesthetic charm** and **shelter from the sun's rays.**

Silver courts

Relies on self shading sliver courts to control the **temperatures** of internal spaces and open stepped wells while allowing for **sufficient day lighting** inside studios and class rooms.



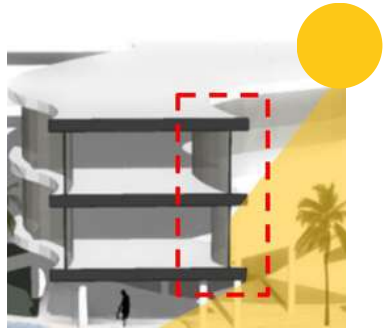
Facade



The building is wraped by the **double skin facade** to filter the harsh sunlight to create shade into the classroom area as

Overhanging floor

Constructed around the building over hanging floors help provide shade as well as **restraining the heat** from the sun to reduce heat emission providing a **cooler interior.**



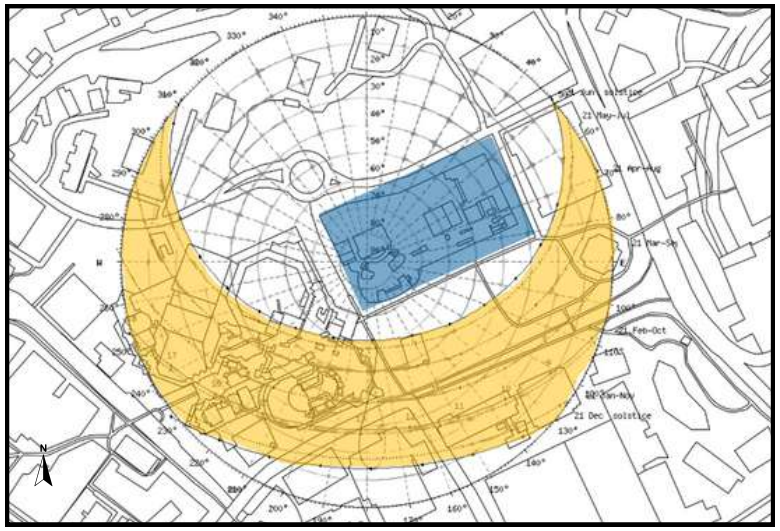
Spatial Experiences

By having multiple courtyard within the building it allows more sunlight into the surroundings, this **decreases** the need of using **artificial light** during the day.

The facades not only helps diffuses sunlight but also gives of as a **warm welcome**.

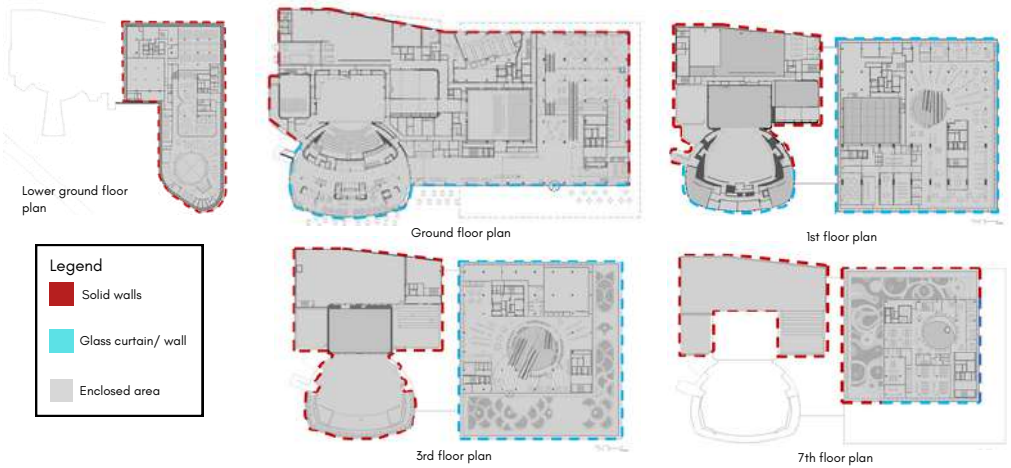
Classrooms are fitted with curtain walls, this increases the amount of n**atural daylighting and eye comfort.**

Building orientation



Positioning the building diagonally while facing both North-West and East directions allows for a **minimal diffusion** of daylight, with the South facade especially optimized to receive an **optimal level** of natural light.

Building perimeters

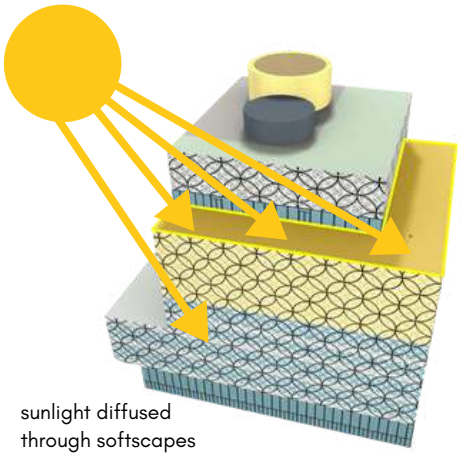


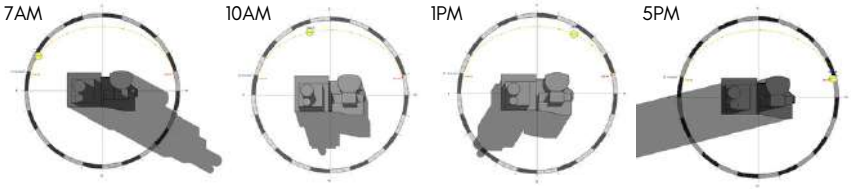
Solid concrete walls are employed to **minimize excessive exposure** to daylight from the West

Use of glass or a curtain wall can **optimize** the level of **illumination** from the South-Eastern sun

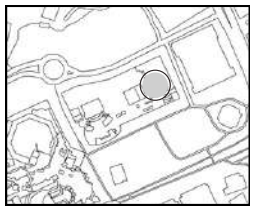
Expansive enclosed areas enable the interior to be brightened by natural sunlight streaming in **through the rotunda**

Shadow cast

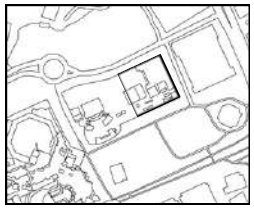




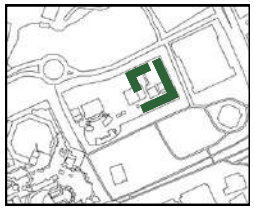
Daylight design considerations



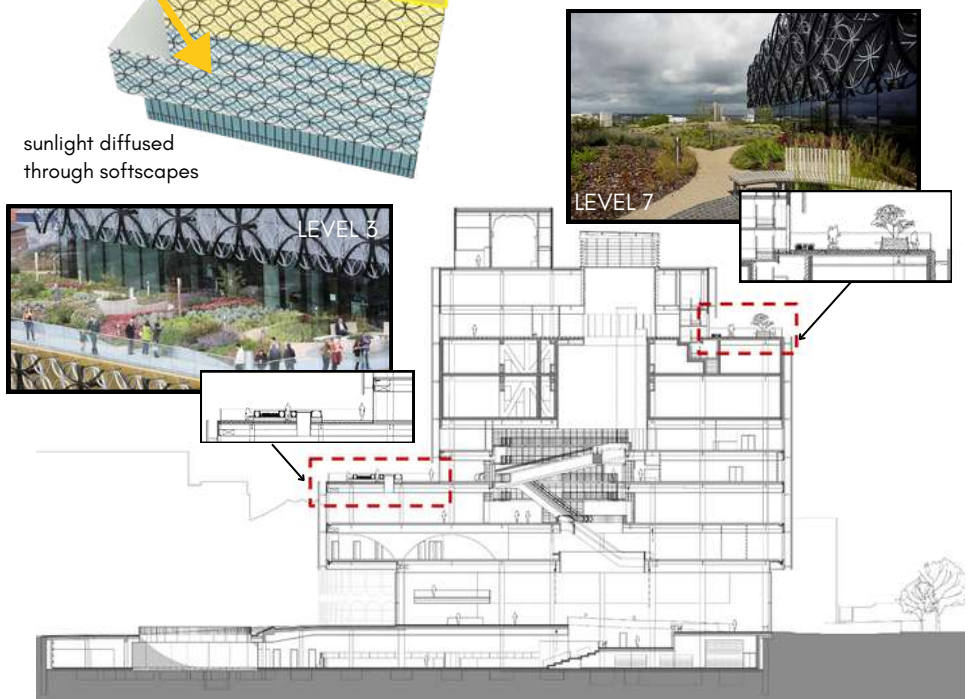
A sizable circular rotunda situated at the top of the building **offers both natural light and ventilation.**



Decorative metal rings with intricate patterns in golden, silver, and glass **façade** act as filters for incoming daylight, **enhancing aesthetics.**



Rooftop gardens on both the western and eastern corners serve as platforms for **implementing temperature regulation** strategies.



Rooftop Garden

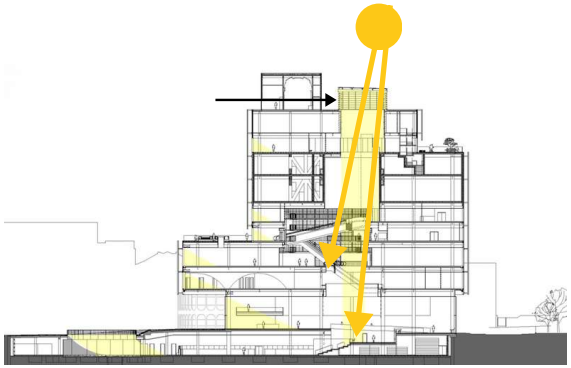
The rooftop gardens are placed on the **3rd** and **7th** floor of the library.

Includes diverse plants and lush ground cover.

Has the capability to **scatter** incoming **sunlight**, preventing it from spreading and reflecting into interior spaces.

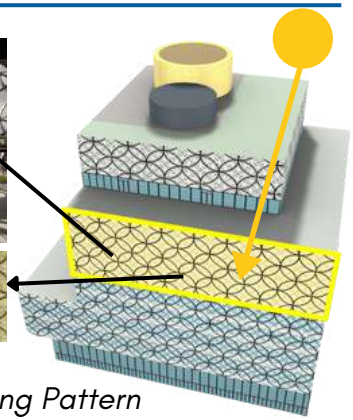
They can influence both external and internal daylight within the building through attenuating, scattering and transmitting light.

The Oculus



- Constructed on the **uppermost floor** of the structure.
- Permits the **ingress** of **natural sunlight** from the roof to reach the children's library located in the building's basement.
- Capable of **dispersing** incoming sunlight into regions that seldom receive **adequate illumination**.

Glazing Window

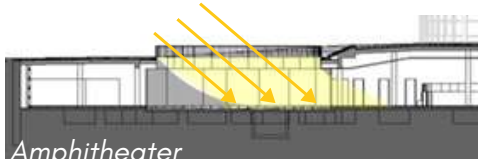


Gothic Filigree Ring Pattern

• Sizeable metal rings organized in this distinctive arrangement assist in diffusing incoming sunlight within indoor spaces.

• The resulting shadows create a **highly symbolic appearance.**

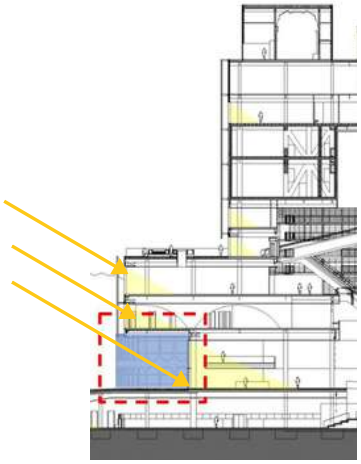
Canopy



Amphitheater

- Offers both overhead and ground-level covering, forming a **communal urban promenade** for the viewers.
- Incorporates **natural daylight** and an outdoor event space.

Cantilever Balcony



The third-floor balcony, aligned with the rooftop garden, not only offers **unobstructed vistas** but also facilitates air circulation. Additionally, it serves the purpose of providing substantial shading beneath the entrance-adjacent balcony. The entrance features double-glazed E glass as external glazing, effectively dispersing incoming sunlight for **optimal energy** efficiency.

Spatial Experience

By maximizing the use of natural light, the middle oculus creates an ever-**evolving ambiance** with the artificial lighting.

With that being said, the library hall is surrounded by large **curtain walls**, which ensures maximised daylight penetration into the building. Adjacent to the hallway on the left, users have the option to finely **regulate** the amount of incoming daylight with the **available blinds**.

Comparison

Pearl Academy Jaipur

Designed to utilize shading devices and the concept of **solid and void** that are capable to reduce the cooling load, while allowing the d**iffused natural daylight** to distribute into the building.

SHADING DEVICES

Facade

Rooftop

Silver courts

Curtain walls

Overhanging floors

Library of Birmingham

Designed to **maximize the amount of daylighting** throughout the whole building w**ithout requiring vast artificial lighting** or mechanical systems to be used.

SHADING DEVICES

Canopy

Cantilever

Rooftop Garden

Oculus

Glazing Window

PEARL ACADEMY JAIPUR

Pearl Acaademy Jaipur tends to use its open and void spaces in the courtyard to **attract more light distribution** from the roof. It also uses its **facade** around the building to allow diffused light into the structure.

CONCLUSION

Although both buildings are in different locations that faces different climate conditions, they have similar orientation locating on the **West and East axis while facing South**. These two buildings also use maximum daylighting intake to **enlighten** their **spatial quality** and improve the work environment for users alike.

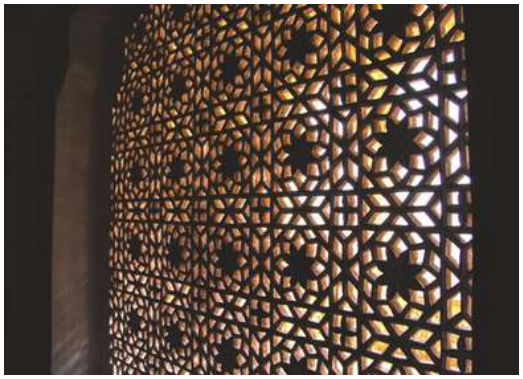
LIBRARY OF BIRMINGHAM

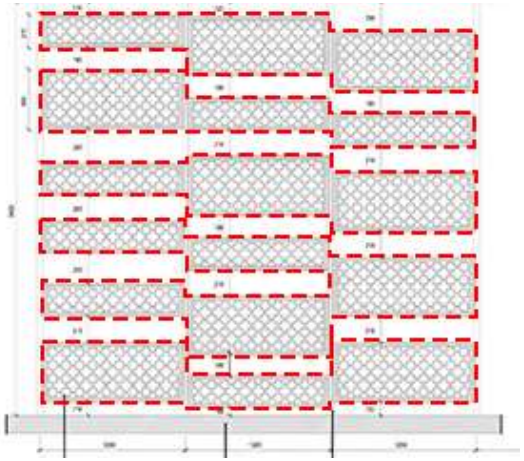
Library of Birmingham focuses on natural sunlight **entering deeper** within the building with its **oculus** and **rotundas** in the centre of the entire structure.

03
FACADE

Jaalis (perforated stone screen)

The building is protected from the environment by a **double skin** which is derived from a **traditional** building element called the 'Jaali' which is prevalent in **Rajasthani** architecture.

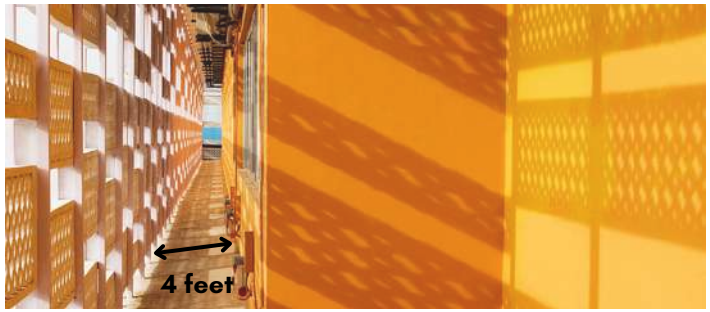




All floors are covered with the perforated stone screen jaali facade in accordance to shadow analysis.

The outer skin sits **4 feet away** from the building and reduces the direct heat gain through **fenestrations**. Drip channels running along the inner face of the Jaali allow for **passive downdraft evaporative cooling**, thus **reducing** the incident **wind temperature.**

Exterior



Interior

The **double skin acts** as a **thermal buffer** between the building and the surroundings. The density of the perforated outer skin has been derived using computational shadow analysis based on orientation of the façades.

The **materials** used for construction are a mix of local **stone (1), steel (2), glass (3),** and **concrete (4)** chosen keeping in mind the **climatic needs** of the region while retaining the **progressive** design intent.

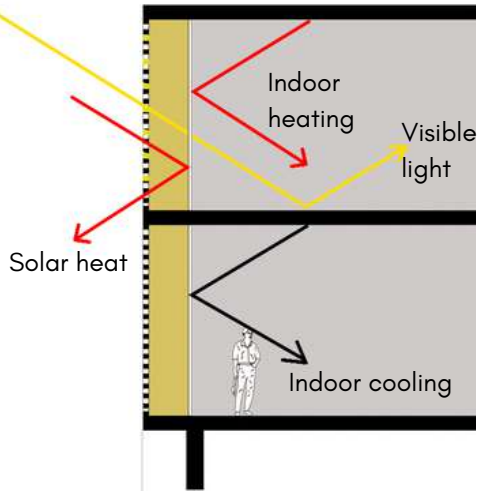
Doubled glazed low-E curtain wall

The facade utilizes Low-emissivity (Low-E) double-glazed windows for energy efficiency, optimizing natural **light** while minimizing **heat** transfer, contributing to a **sustainable** and comfortable interior environment.

Open ground floor

An open ground floor serves as an **inviting facade** choice by fostering **visual continuity,** promoting natural ventilation, and creating an **inclusive** and accessible entrance, all contributing to a dynamic and engaging architectural presence. This also creates more of an **emphasis** on the **jaali facade** allocated on the upper floors of the academy.

-Improved Energy Efficiency
-Daylighting
-Solar Heat Control
-UV Protection
-Sound Insulation
-Condensation Control
-Aesthetic Benefits
-Environmental Considerations

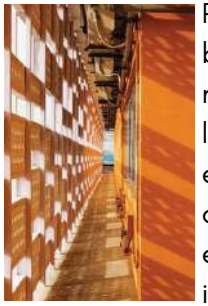


Alongside the entirely open ground floor, there are multiple **water features** which contribute to a cooling effect and create a more comfortable microclimate along the building's exterior thus transforming the **facade** into a **social space.**

SPACIAL EXPERIENCE

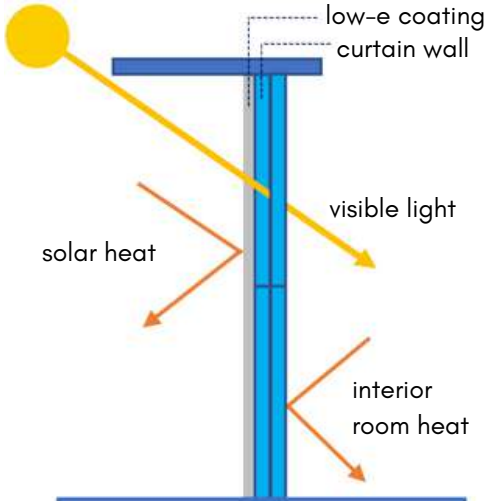
Jaipur's Pearl Academy's Jaali facade uniquely blends **traditional craftsmanship** with modern design, transforming natural light and creating a **dynamic spatial experience.**

Pearl Academy of Fashion creates a **good space** for the occupants in the building, even if the building is surrounded with **industrial zone.** It is certified as a PLEA project



Pearl Academy's Jaali facade blends tradition with modernity, transforming natural light for a dynamic spatial experience. Additionally, PLEA certification ensures energy efficiency and comfort in an industrial context.

Low-E Double Glazing Curtain Wall



U Value = 1.67 ..... Excellent 2 way insulation
Solar Heat Gain Coefficient =0.38 ..... Durable
Shading Reflectance 0.15 ..... Energy efficient
Visual Transmittance = 0.74 ..... Cost effective

Low-E glass is conventional glass that features a pyrolytic or a thin metal coating on one side serving to **minimize** heat **gain** during the **summer** and heat **loss** during the **winter**.

Curtain walling

FW 60+
.Burglar resistance tested to RC3
.Glazing up to 82mm

Windows

AWS 75.SI
.High water and air resistance
.Glazing up to 61mm

Metal Filigree

1st - 8th floors are wrapped with an intricate aluminum façade

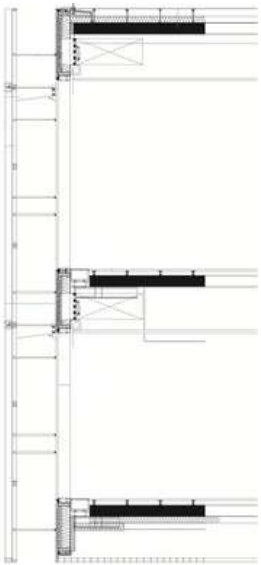
This facade is inspired by the **artisan tradition** of this once industrial city. It serves more of an **aesthetic** purpose than a **functional** one, however, it can also be used to respond to external conditions and **openings** will allow **fresh air** intake and outflow.

1.8 m ∅
Silver circles

5.4 m ∅
Black circles

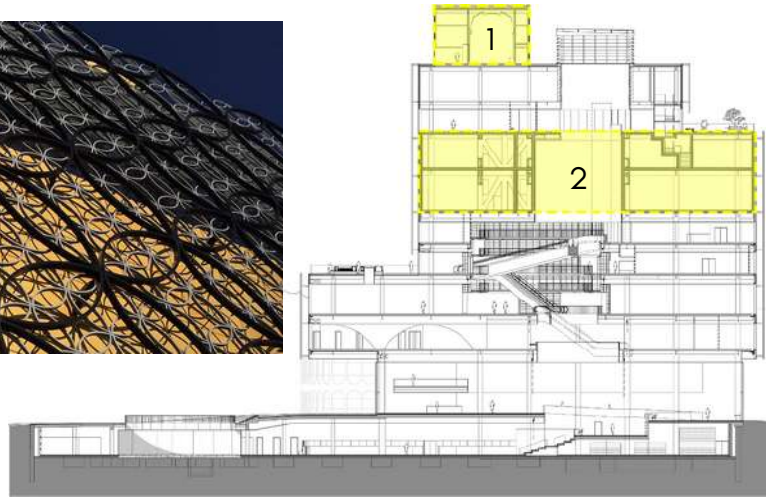
The curtain wall is supported by the reinforced concrete columns.

Each section of the cladding is formed of **5.4m** diameter black rings, with silver circles of **1.8m** diameter.



Facade-detail section

Aluminum Panels



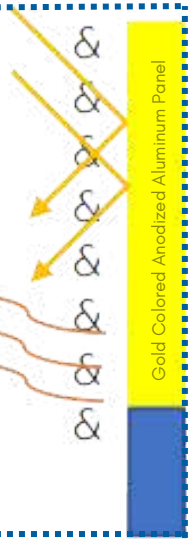
1: Shakespeare Memorial Room: The gold signifies the position of the archive's treasures and thus serves as a declaration of civic significance and approachability.

2: Golden box: The 7th & 8th floors contains the city's collection of archives, photography and rare books will be stored.

Interior

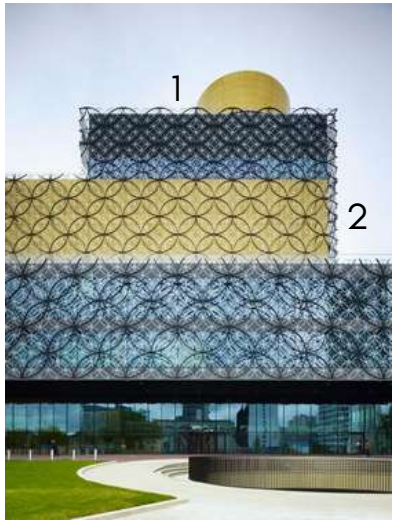
Exterior

Sun **shading** and **reflective** materials within the facades **block** the harsh **rays** of the sun during the height of afternoon while allowing **natural daylight** into the **interiors**.

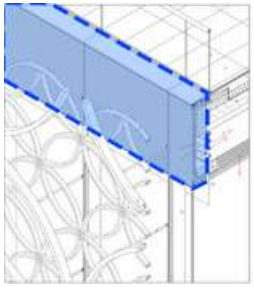


Gold Colored Anodized Aluminum Panel

- A1 fire rating
- Durable
- Primary Reduction
- Lightweight
- 60% lighter than other competing metals like stainless steel and copper.

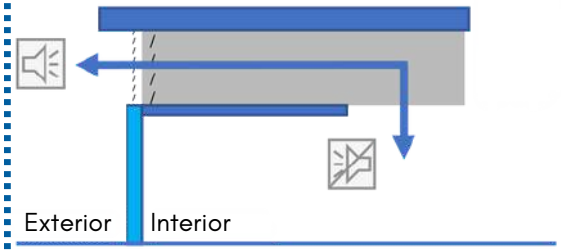


Aluminum louvers



-Regulates light penetration
-Regulates airflow and ventilation
-Reduces noise pollution

SM-5 automatic smoke curtains and FM1 automatic fire curtains.



It has **sound absorbing insulation** that contains millions of tiny air pockets that **absorb** the sound waves and energy as they pass through the attenuator, **reducing** the **noise**.

SPACIAL EXPERIENCE

Before entering, visitors will notice the prominent golden aluminum panels and intricate metal filigree wrapping, setting the library apart as a standout **landmark** in the area.

A sense of rhythmic continuity and architectural harmony is achieved as the exterior design seamlessly extends into the interior spaces, maintaining a circular facade style throughout the building.

The glazed curtain wall allows for ample natural light to enter the library while mitigating solar heat, creating a well-illuminated and inviting environment for users to enjoy reading in comfort.

Comparison

Pearl Academy Jaipur

Mainly focuses on 4 materials, with facade being made of local stone that emphasizes on passive cooling and shading the building.


Making the facade a complex double skin one with 4 feet separation between each skin and utilizing local materials emphasizes on sustainability and human comfort


The building's fully open ground floor is crucial for ventilation as well as a humanized design with visual continuity from upper floors.


Library of Birmingham

Mainly focuses on 2 materials, aluminum panels and low e double glazed window, in respond to the weather and the poetic idea of the building. The building's façade emphasis on shading and reducing solar heat gain.


The building receive most sunlight from all direction and ventilation system are installed on the façade for ventilation during the winter and summer.


Oculus and rotunda are the main light source for the internal spaces with decrease the energy consumption.


CONCLUSION

Both buildings implemented ways to passively cool the building though their orientation and usage of materials where both use Low E double glazed window to maximizes the energy efficiency and initiatives to prevent solar heat gain despite having weather differences, both buildings to enhance and improve the spatial quality for users

P.A.J uses 4 main materials in response to sun shading & passive cooling

Spatial Qualities: Use of local stone shows the priority towards sustainability

L.O.B uses 2 main material as a respond to sun shading and solar heat gain

Spatial Qualities: Through materiality, each spaces are properly lit to maximize human comfort

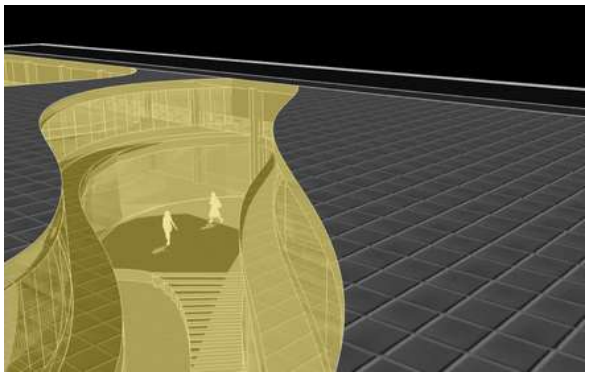
04
NATURAL VENTILATION

Building Orientation

0 - 5 km/h **6 - 12 km/h** **13 - 27 km/h** **> 28 km/h**

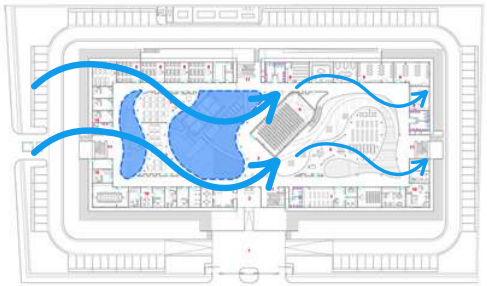
Major Wind Direction: North-West, West, West South-West.

Natural wind **enters through the facade** of the building and makes its way to the courtyard of the structure. The **waterscapes** inside the courtyard allow the wind to cool and creates a **cool natural ventilation** throughout the courtyard and the rest of the building. The warmer air **escapes through the air-wells** in between the courtyards.

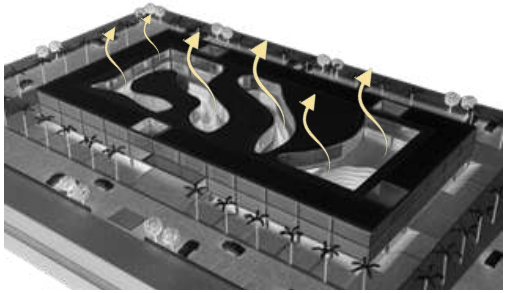


Mass & Void

Solid and voids within the structure allows continuous airflow circulation throughout all the spaces, which naturally ventilates the building.



Cross ventilation occurs when wind enters through one space and leaves the space through voids and openings. Natural breezes get cooled by the waterscapes within the building.



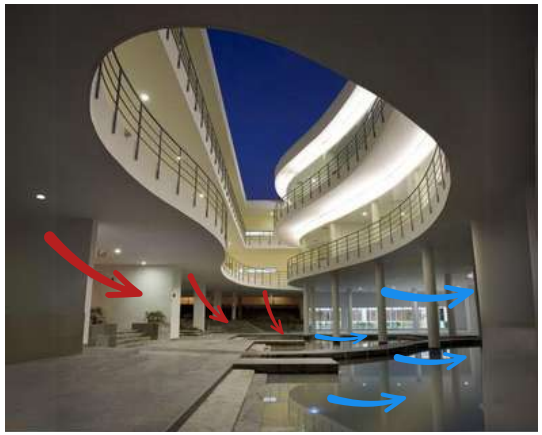
Stack ventilation occurs through the courtyard. Hot air inside rises and escapes through the roof, while cooler air from outside enters through the lower openings, thus called *thermal buoyancy*.

LEGEND

Cross Ventilation

Stack Ventilation

Ventilation Strategies



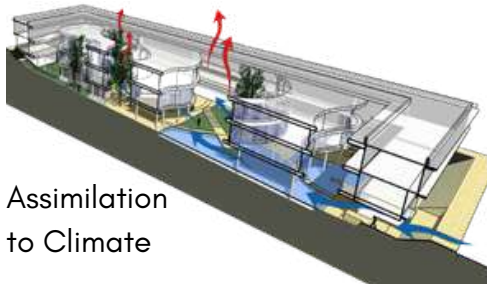
The **water body** which is fed by the recycled water from the sewage treatment plant helps in the creation of a microclimate through **evaporative cooling**.

Shaded Courtyards

The scheme relies on self shading sliver courts to control the temperatures of internal spaces and open stepped wells while allowing for sufficient day lighting inside studios and class rooms.

Raised Building

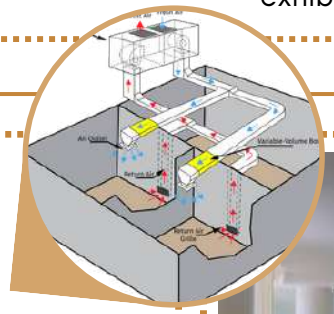
The entire building is raised above the ground and a scooped out under belly forms a natural thermal sink which is cooled by water bodies through evaporative cooling. This under belly which is thermally banked on all sides serves as a large student recreation and exhibition zone.



Assimilation to Climate

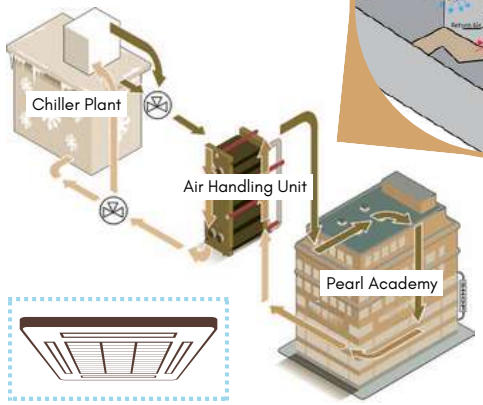
During the night when the desert temperature drops this floor slowly dissipates the heat to the surroundings keeping the area thermally comfortable. This time lag suits the staggered functioning of the institute.

District Cooling System



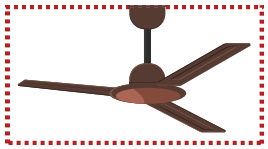
Air Handling Units

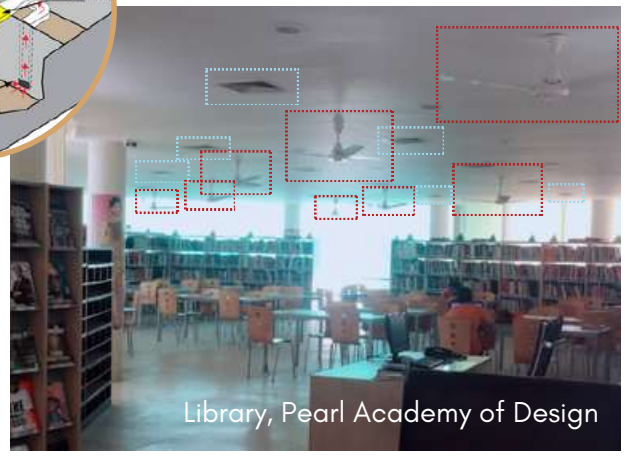
Produced chilled water will be delivered to the building through a pipeline underground to the air handling unit (AHU), which wil then transfer the air-conditioned air to the rooms and cool any heated air.



Ceiling Fans

Provides a mechanical ventilation to allow airflow for thermal equillibrium in the room.



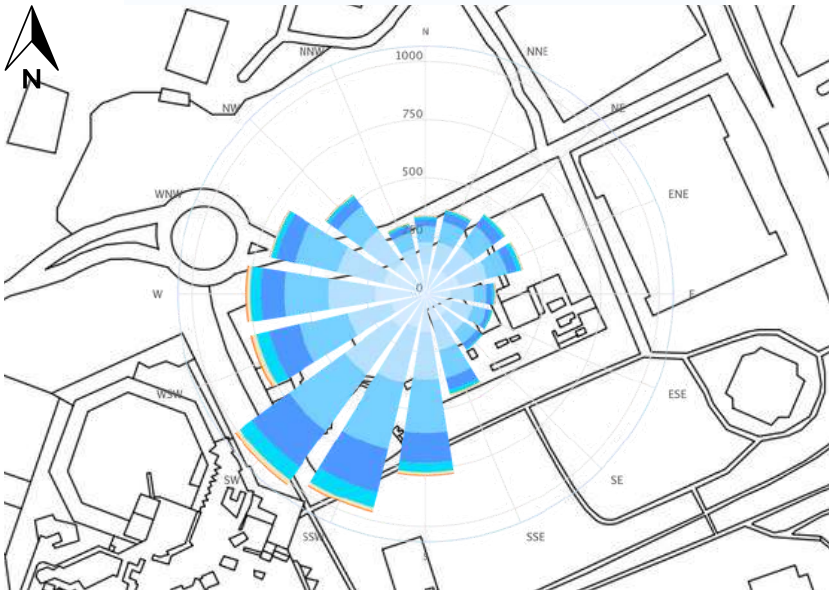


For **80%** of the total operational hours, the temperature of the campus is as per the comfort of the users.

SPACIAL EXPERIENCE

Pearl Academy's open yet shaded courtyards provide a great airwell that allows warm air to escape freely and provide a cooling temperature for users in a desert climate.

Building Orientation

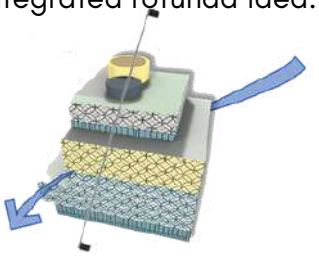


0 - 10 km/h **11 - 30 km/h** **31 - 50 km/h** **> 50 km/h**

Major Wind Direction: West, West South-West, South-West, South South-West, South.

The building is **oriented more towards the west-east** and has maximum surface exposure due to the lack of high-rise structures that would impede wind flow. Thus, the **predominant wind from the south-west** is pulled in with the passive design of the building façade.

Four different geometrical volumes are stacked on each other to produce different canopies and terraces throughout the structure. The building makes use of natural ventilation strategies, such as cross ventilation through façade apertures and stack effect in the courtyard/ atrium, thanks to the integrated rotunda idea.



LEGEND

Cross Ventilation

Stack Ventilation

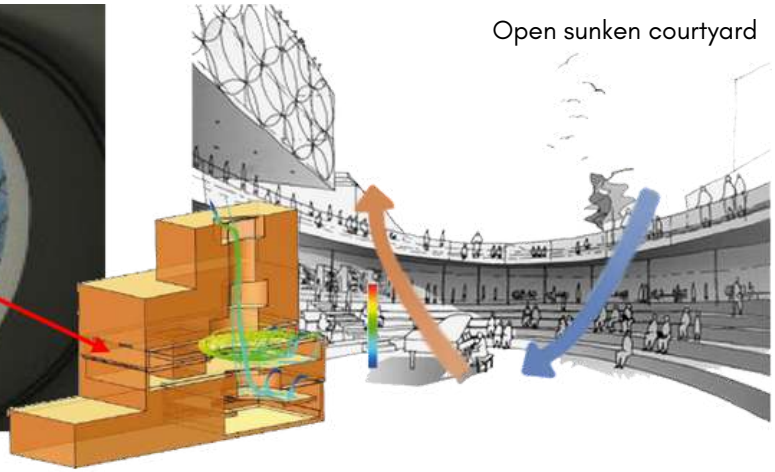
Stack Ventilation

Stack ventilation occurs in the central space of the structure, which is the courtyard.

Cross Ventilation

Cross ventilation is guided throught the fluid yet geometrical site.

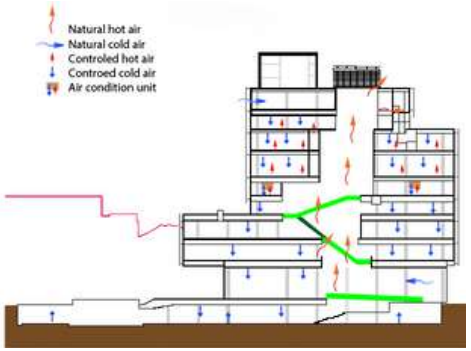
Ventilation Strategies

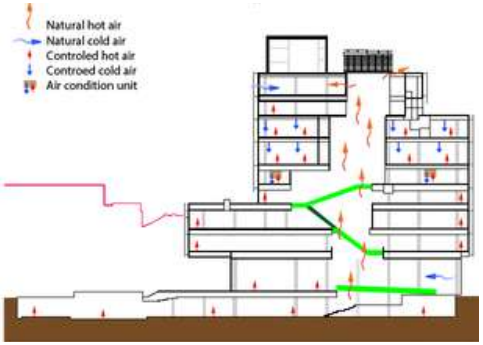


The **circular atrium** and **sunken courtyard** in the building utilize **stack** effect ventilation. Stale air exits through ceiling grilles in the atrium, while the open sunken courtyard facilitates airflow, naturally ventilating the underground spaces.

Summer strategy

The space is supplied with mechanical ventilation for fresh air (controlled on C02 level) which helps cool the building. The warm air is discharged naturally through atrium and from the roof.

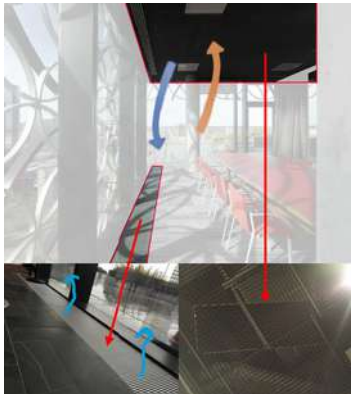




Winter strategy

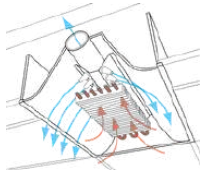
Controlled ventilation and underfloor heating warm the building. Trench heaters in open spaces maintain warmth and mechanical ventilation recovers heat from the top.

Diffusion Ventilation (F-T-F)



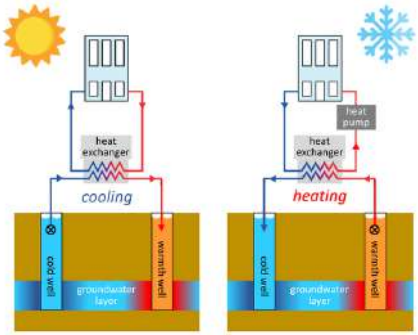
Ventilation grilles are strategically placed on both **ceilings** and **floors** throughout the building, enabling **stack** effect ventilation. Hot, stale air rises to the upper floors and escapes through ceiling openings aided by exhaust fans. Simultaneously, cooler air enters through openings, replacing the expelled air. This **constant circulation** ensures natural and effective ventilation for all interior spaces.

Mechanical Devices Implemented



Passive Chilled Beam

Round Variable Air Volume



Geothermal Aquifer: During summer, extracted groundwater cools the building via a heat exchanger, and the heated groundwater is reinjected into storage, reversing during winter.

SPACIAL EXPERIENCE

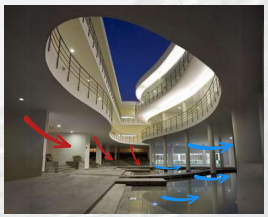
While numerous escalators are dynamically constructed on various floors, a spiraling arrangement of offset cylindrical courts can offer optimal natural ventilation.

Comparison

Pearl Academy Jaipur

The **passive design strategy** of Pearl Academy Jaipur is to utilize natural ventilation strategy: **cross ventilation** & **stack effect ventilation** in a dry tropical climate.

NATURAL VENTILATION METHODS



Waterbody in Structure

Open and Shaded Courtyard

Raised Building

The usage of natural ventilation tactics and mechanical ventilation allows the building to provide excellent internal comfort to users.

MECHANICAL VENTILATION METHODS

Chilled air process

Air Handling Units (AHU)

Ceiling Fans

Library of Birmingham

The **passive design strategy** of Library of Birmingham is to utilize natural ventilation strategy: **cross ventilation** & **stack effect ventilation** in a cool oceanic climate.

NATURAL VENTILATION METHODS

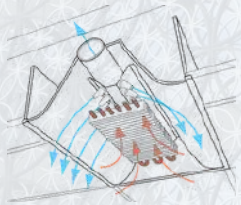
Wide Indoor Reading Spaces

Sunken Outdoor Courtyard

Rooftop Garden

With the combination energy-efficient mechanical ventilation system and natural ventilation strategies, the building was constantly well- ventilated throughout all four seasons.

MECHANICAL VENTILATION METHODS



Passive Chilled Beam

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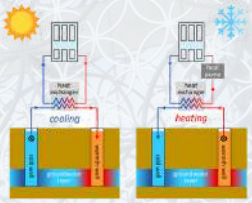


Geothermal Aquifer

PEARL ACADEMY JAIPUR

Strong emphasis on **maximizing the use of passive design**. Given the hot and dry climate conditions, maintaining a favorable microclimate within the project is difficult. Hence, the design implements multiple passive climate control methods, thus **aims to reduce the reliance on mechanical environmental control measures**.

CONCLUSION

Both buildings have similar building orientation which is oriented at west-east axis in order to take advantage prevailing wind path for natural ventilation purposes.

LIBRARY OF BIRMINGHAM

Strong emphasis on **the prevention of heat loss and heat gain** as it has 4 seasons. Heat should be displaced from the building during summer and be maintained within the building during winter. The library also **utilises the rainwater harvesting system** to maximize use of the frequently rainy weather.

05
STRATEGIC LANDSCAPE

Soft scape

Foxtail palm (Wodyetia bifurcata)

Hard scape

- Water body
- Pillar
- Railings
- Pavement

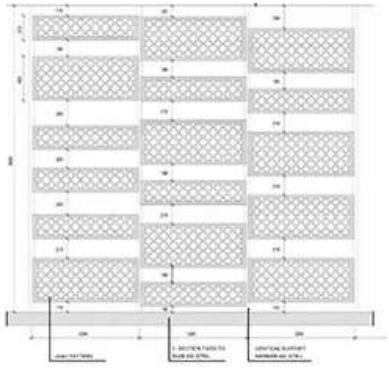
Date palm (Phoenix dactylifera)

Grass trim

Spatial Experience

- User productivity improves due to the cool air quality created within the building.
- The water body at the underbelly of the building provides a space for users to relax.

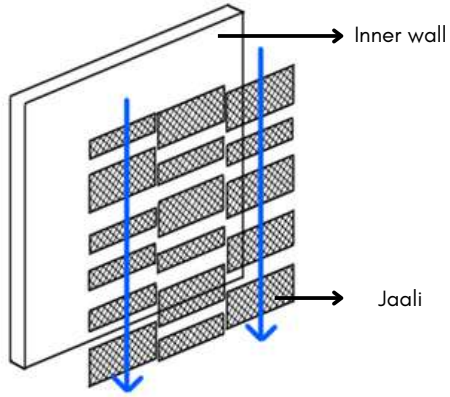
Evaporative Cooling



Jaali common pattern around the building

Jaali

The building is protected from the environment by a double skin - Jaali - which is a prevalent Rajasthani architecture.
The outer skin sits 4 feet away from the building to reduce direct heat gain from fenestration.
The are drip channels running along the inner face of the Jaali that allows the **passive downdraft evaporative cooling**, thus reducing the incident wind temperature.

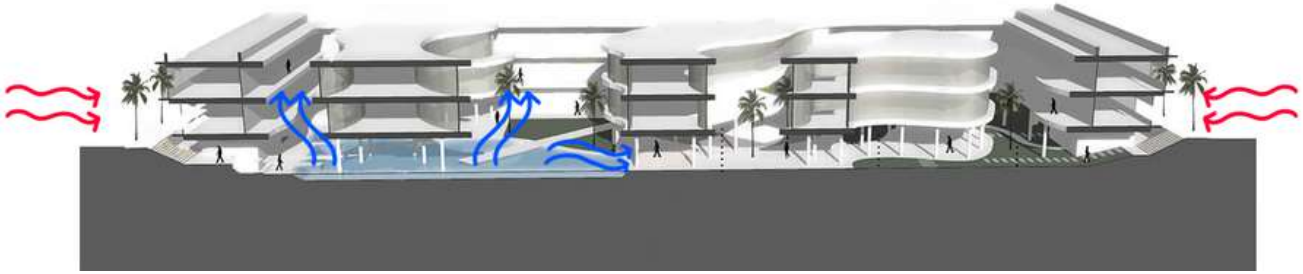


Drip channels

Evaporative Cooling

Building raised above the ground by pilotis

Water Body



Daytime

The water body which is fed by the recycled water from the sewage treatment plant helps in the creation microclimate through evaporative cooling. Green spaces and water bodies are designed as per orientation to be in shaded areas in order to aid evaporative cooling.

Nighttime

During the night, when the temperature of the desert drops the floor slowly dissipates heat to the surroundings and makes a thermally comfortable environment.

Rainwater harvesting and Wastewater recycling

The storage for rainwater reserves and wastewater are built under the building, and the purpose of these two systems are for supplying the water body that aids in evaporative cooling, as well as supplying water to faucets in the building.

Soft scape

Rooftop gardens were built in Level 3 and Level 7 on the library's rooftop to incorporate nature in the building, since there isn't much vegetation within the area of the library. This helps in attracting wildlife and improve biodiversity.

Level 3

Level 7

Hard scape

There are many hardscape elements found in the building, such as ;

Walkways

Benches

Flowerbed

Pavement

SPATIAL EXPERIENCE

- The availability of nature promotes the improvement of the user's well-being.
- Engagement through learning about plants
- Allows users to relax by being surrounded with nature

Level 3 flowers

Geum Mrs J. Bradshaw

Bearded iris

Erysimum Bowles Mauve

Lilacs

Level 7 flowers

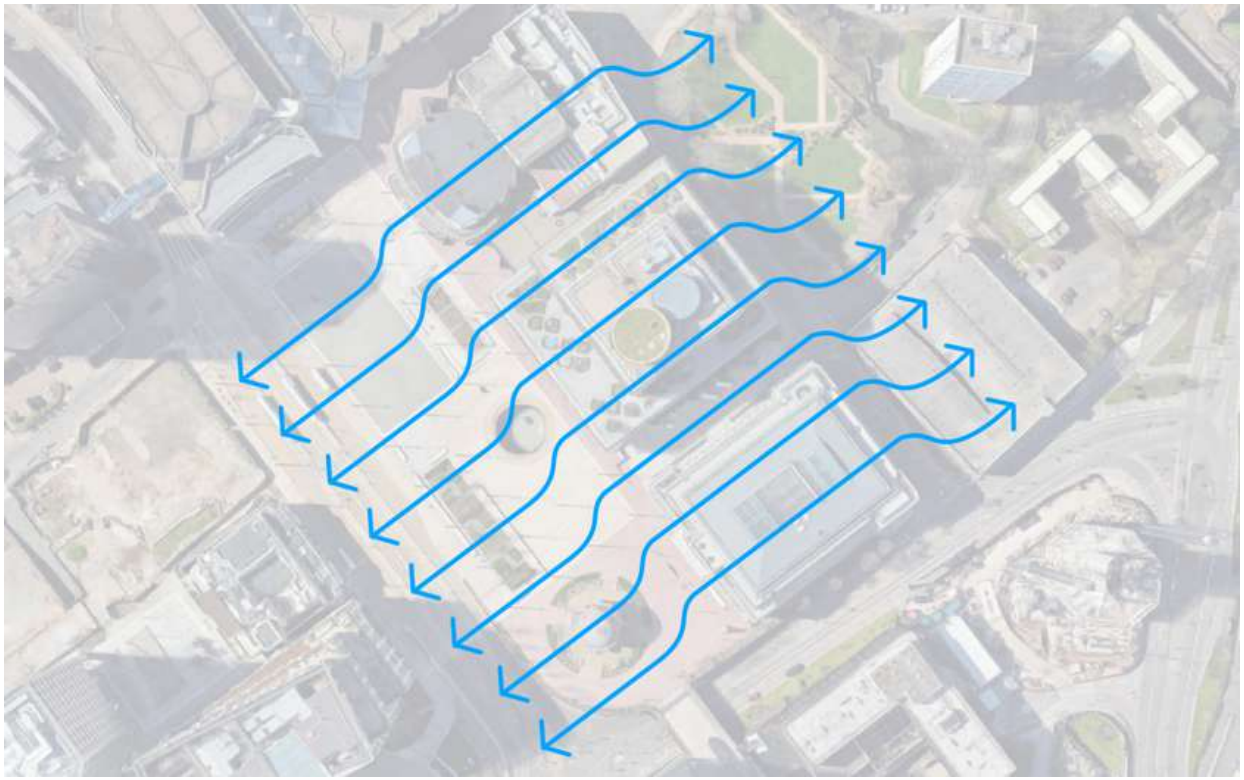
Eupatorium cannabinum

Lavender

Chrysocephalum semipapposum

Traunsteinera globosa

Grey Water System



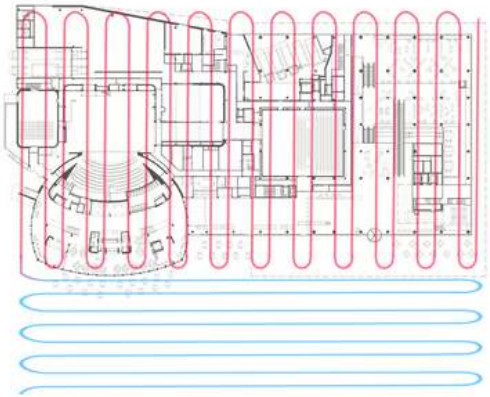
The building has grey water harvesting system installed that reuses water from taps for toilet flushing and along with low water sanitary fittings, will lead to savings in the potable water consumption.

The drainage of grey water in the building goes towards the streets or train tracks as the sewers are underground and underneath the sidewalk.

Ground Source Heat Pump

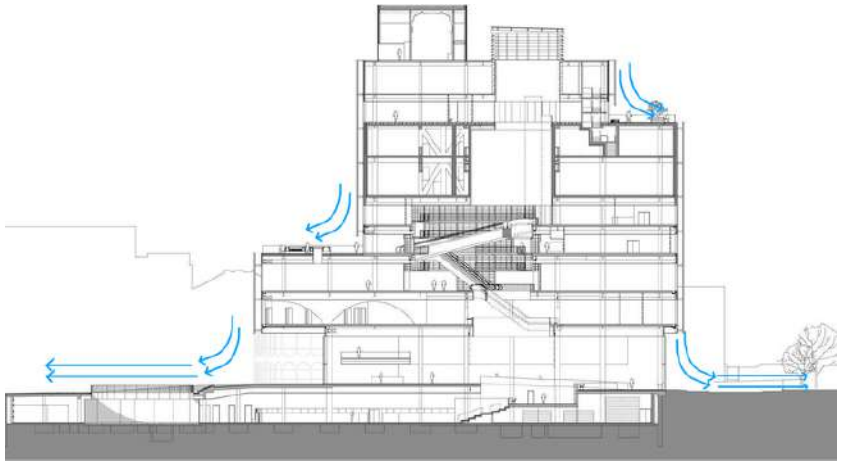
The building implements the heat pump system to as a underfloor heating for winter season.

A thermal transfer fluid (TTF) which consists of water and antifreeze goes through pipes in a loop and the heat from underground will be absorbed by the fluid, then raises the temperature by passing through a heat exchanger to the heat pump.



Rainwater Harvesting System

The library has a rainwater harvesting system built in its design to manage peak flow rates in storms by attenuating excess flow on site for the duration of the storm and the releasing it at a specified reduced flow rate after the storm.



Comparison

Pearl Academy Jaipur

Designed to create an environmentally responsive passive habitat and interactive spaces and a comfortable space for student body creativity which blends indoors and outdoors seamlessly.

The building response to the environment is by building a pond to place a water body for user comfortability.

Open spaces that are well shaded is carefully planned for comfortability, with the balconies in every floor being visually accessible for users for interactivity and creativity.

Library of Birmingham

Designed to address the cityscape by implementing softscape within the building for experiential and educational purposes.

The building has rooftop garden which allows improvement in user's well-being as they can be close to nature.

Summer / Spring

Winter / Fall

The building planted flower gardens which responds to the four seasons of their location to educate the users.

CONCLUSION

Both buildings are designed in response to their respective climate condition by using unique landscaping design strategies.

P.A.J use the climate condition as an advantage to design and implement passive cooling strategies to create a cool space for the users.

Spatial Qualities: The air quality and spatial comfortability has improved.

L.O.B adds softscapes to balance out the hardscapes in the building and the surrounding that improves the landscape and responses well to the four seasons.

Spatial Qualities: The space is used for natural exposure for visual interactivity.

Conclusion

Deduction:
Pearl Academy in Jaipur and the Library of Birmingham showcase a commitment to addressing diverse climates, each responding thoughtfully to their respective settings. Despite distinct geographical locations, both structures prioritize greenspaces and natural elements in their design, contributing to a harmonious integration with their surroundings.

Future Considerations:
A comparative analysis suggests potential areas for mutual improvement. While Pearl Academy adeptly addresses its climatic context, further refinement could involve tailoring landscaping approaches to different seasons, providing users with a nuanced understanding of varied spatial experiences. The Library of Birmingham, in turn, could benefit from insights into effective strategies employed by Pearl Academy in responding to its unique climate. This exchange of ideas could enhance both structures' ability to adapt and optimize their passive design methods.

Final Verdict:
Both Pearl Academy and the Library of Birmingham, with their adept use of passive design, provide lasting, cost-effective solutions, ensuring user comfort amid their surroundings and reinforcing their commitment to sustainability in educational spaces.

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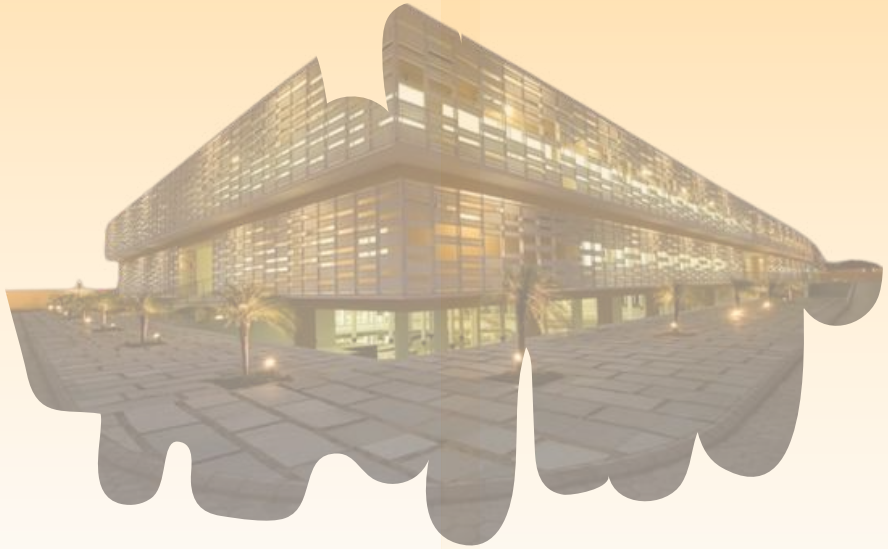

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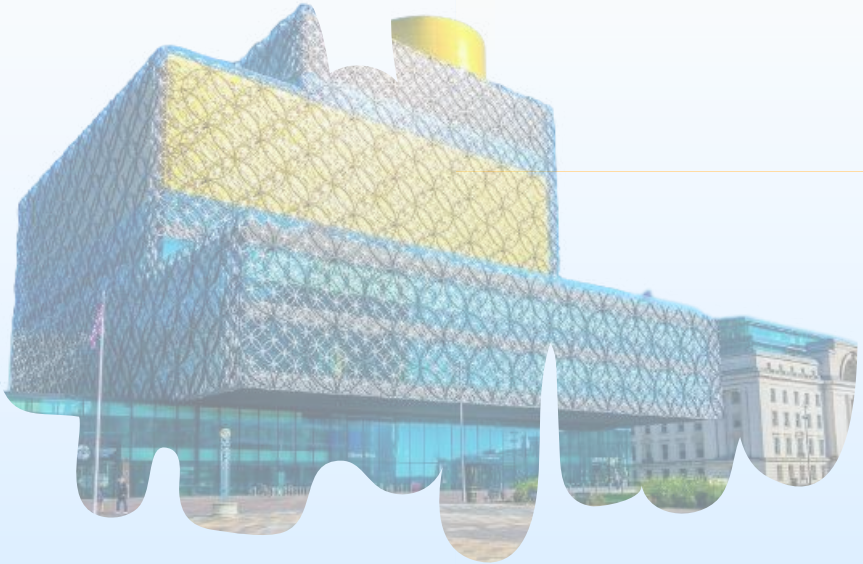

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