Bureau of Energy Efficiency

सत्यमेव जयते
Government of India
Ministry of Power

german cooperation
DEUTSCHE ZUSAMMENARBEIT

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THIS PRESENTATION WAS SHARED BY

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Director, VK:e environmental, Pune

FOR THE SESSION:

“Emerging Construction Practices & Technologies”

DURING ANGAN 2019

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Construction Practices &Technologies for Energy Efficiency in buildings

Dr.Poorva Keskar

Director

VK:e environmental

Design Approach

Reduce

Architectural design approach for energy demand reduction through:

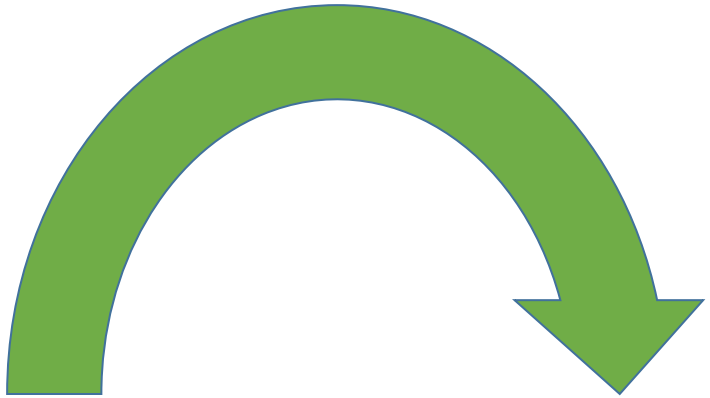
- Orientation
- Spatial planning
- Design for daylighting
- Energy efficient building envelope
- Using appropriate materials

Re-Think

Alternative Active Energy Systems such as

- Geo-thermal Cooling
- Evaporative Cooling

System Efficiencies



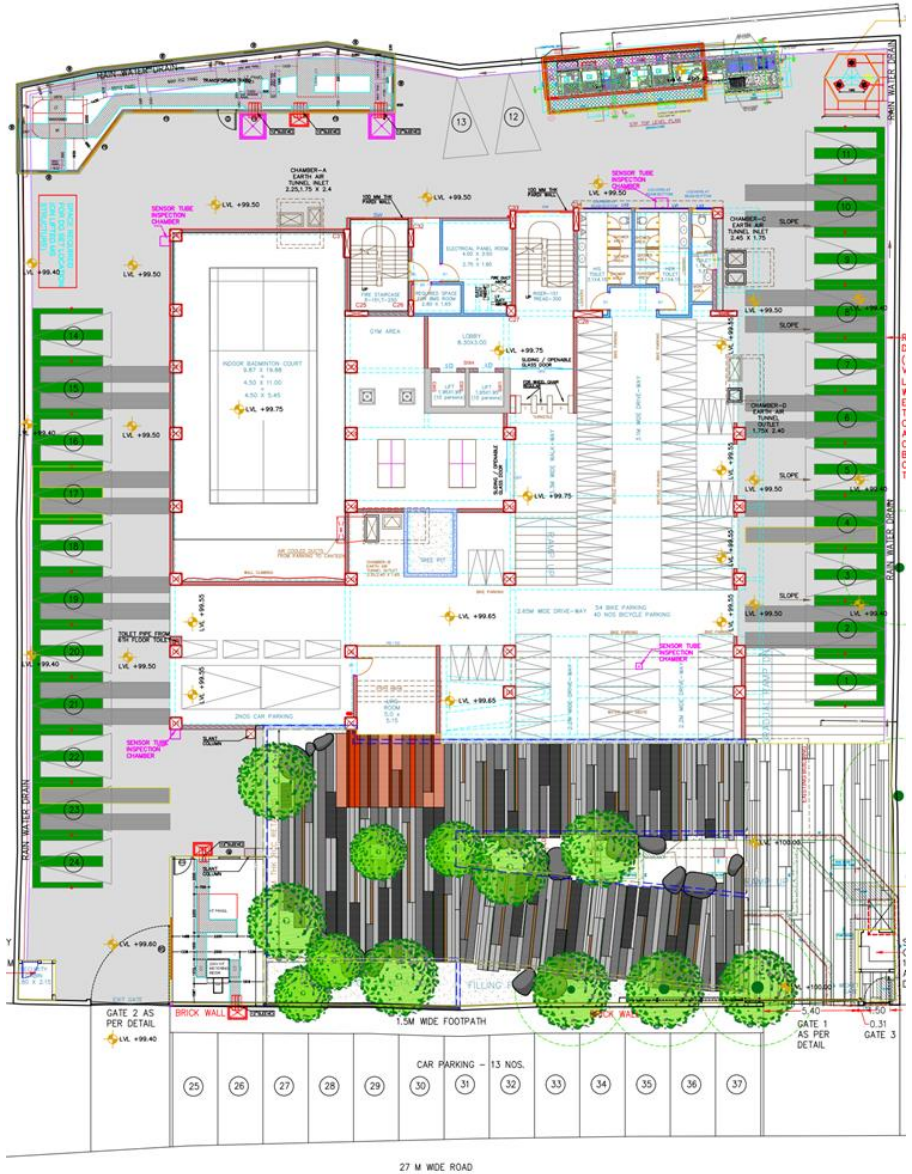
Recycle & Reuse

- ***Recycle and Reuse of construction waste materials***
- ***Recycle and Reuse of treated water***

Re-generate

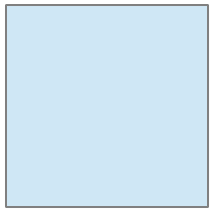
Energy generation through installation of Renewable Energy Systems

The Project

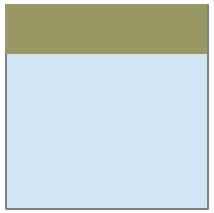


Enpro Headquarters is a proposed office building in Pimpri, Pune having a built up area of around 4700sqm

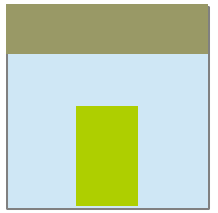
Plan Form



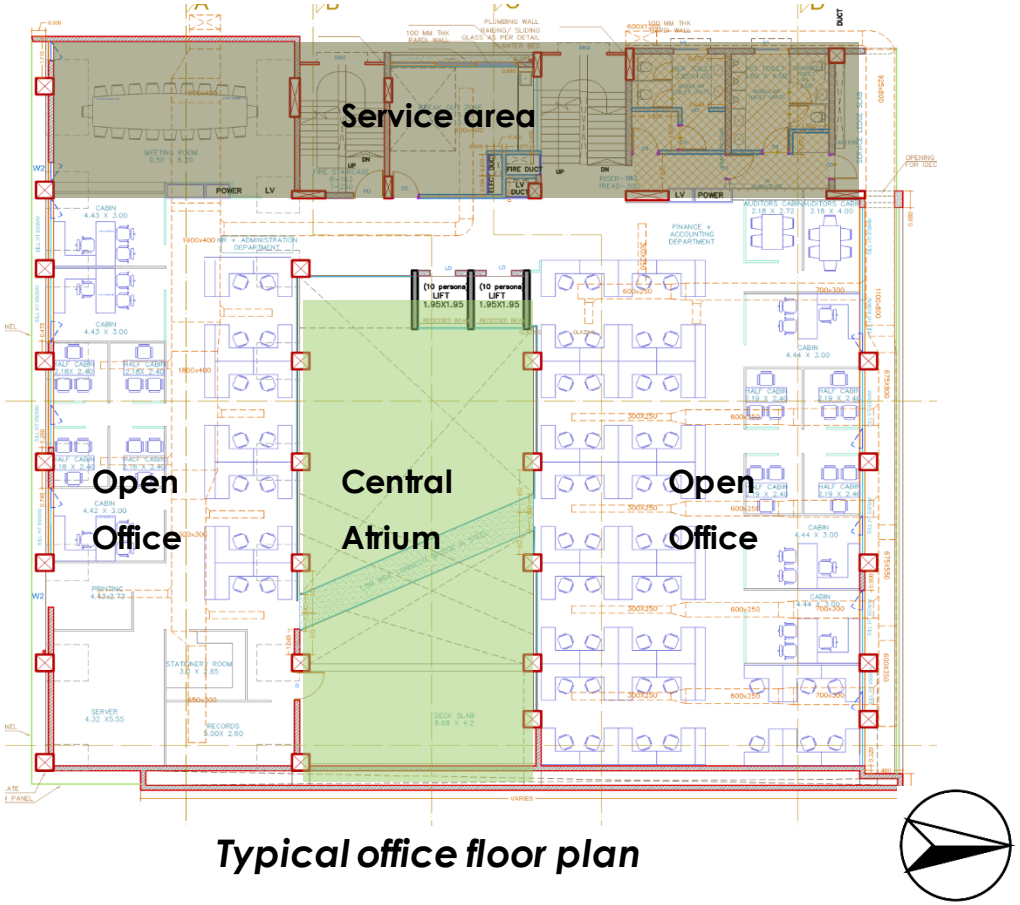
Square plan form : Lower perimeter to area ratio and thus lower conductive heat gain



Service areas planned in the west



Central Atrium to allow ventilation and daylight



Typical office floor plan

SOLAR PASSIVE STRATEGIES

1. Balance between daylight and heat gain due to good fenestration design
2. Atrium for daylight and ventilation
3. Walls with good thermal resistance capacity and cool roof
4. Passive cooling strategies : Earth air tunnel for cooling
5. Evaporative cooling

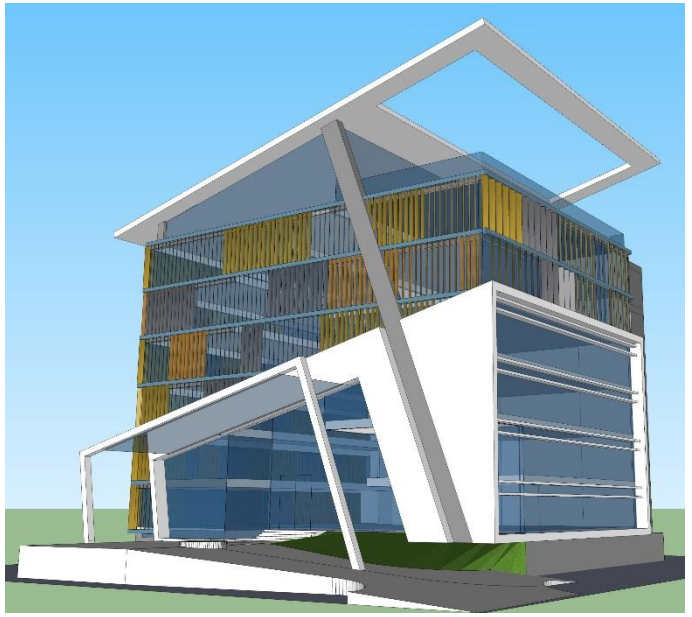
Options for Shading Devices

OPTION 1
Aluminium JALI with full height windows on all sides

Good shading

Obstructed views

Increased costs



OPTION 2
Vertical Fins with full height windows on all sides

Good shading

Obstructed views

Increased costs

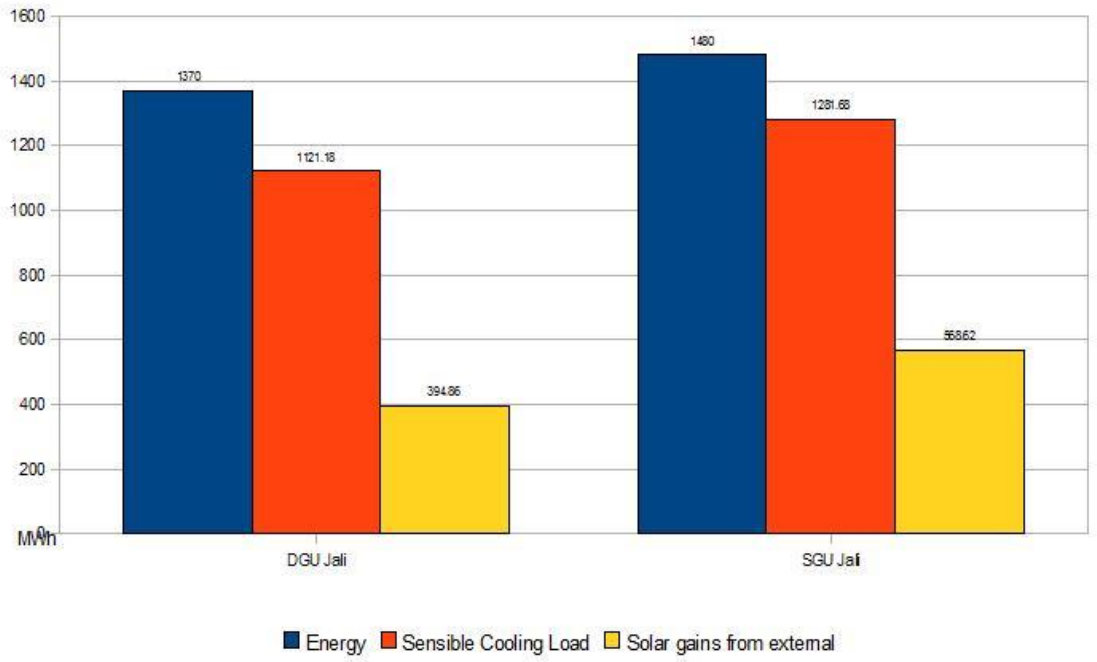
OPTION 3
Optimized WWR with shading devices as per orientation

Good shading

Good Views

Optimized costs due to optimized glazing area and effective shading devices

Selection of appropriate glazing



A representative energy simulation has been conducted to understand the impact of glazing selection along with the proposed Jali on the cooling loads.

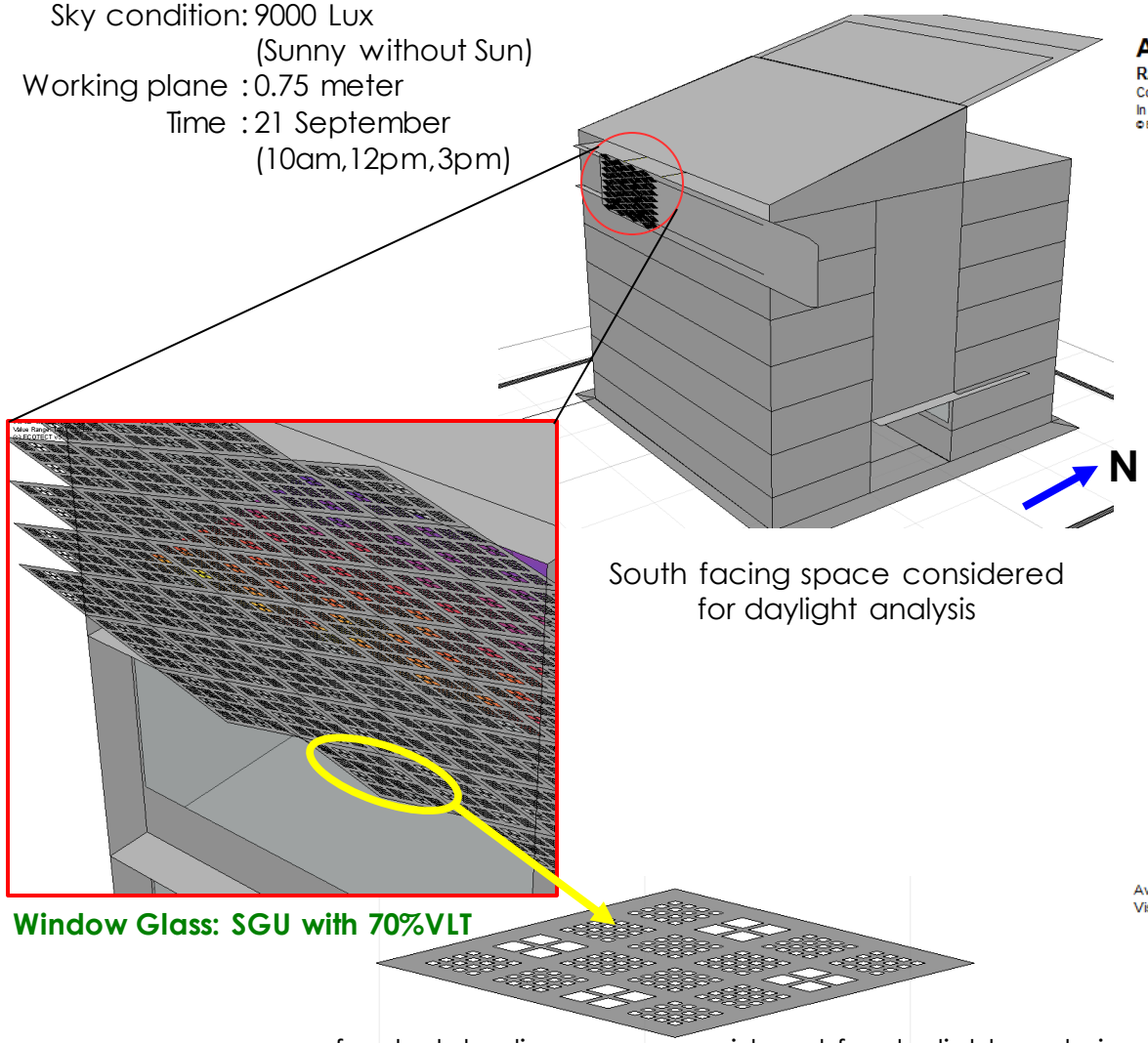
The combination of clear DGU and Jali has reduced the sensible cooling loads by 12% and has reduced the overall energy consumption by 7%

Simultaneously, the daylight availability was checked

DAYLIGHT ANALYSIS

Input Parameters for Simulation:

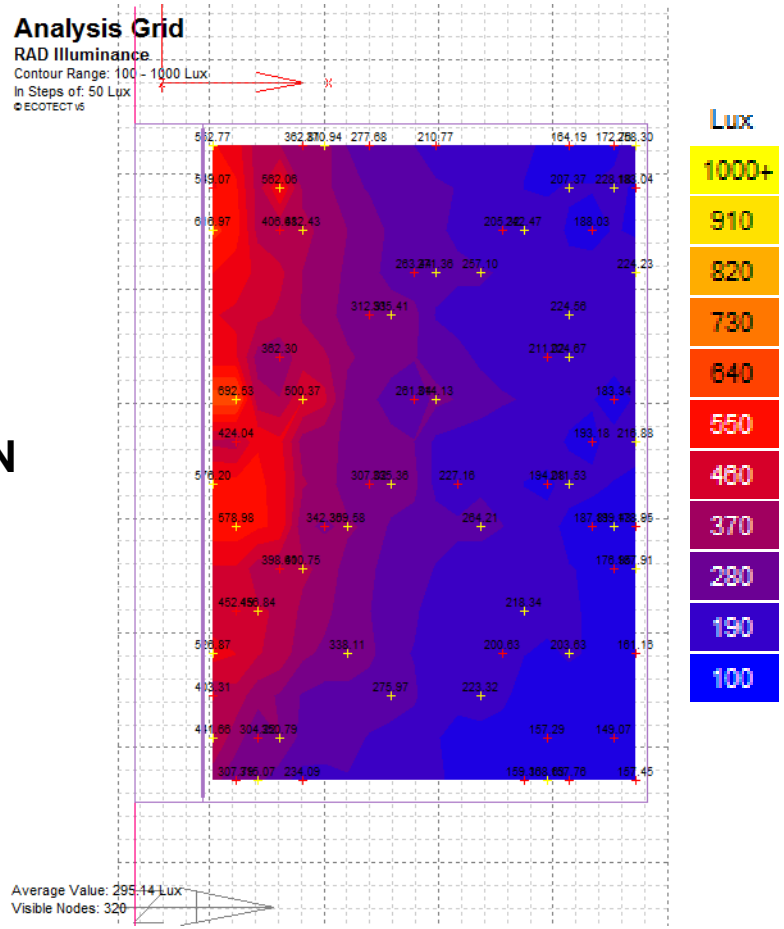
Sky condition: 9000 Lux
(Sunny without Sun)
Working plane : 0.75 meter
Time : 21 September
(10am,12pm,3pm)



South facing space considered for daylight analysis

Window Glass: SGU with 70%VLT

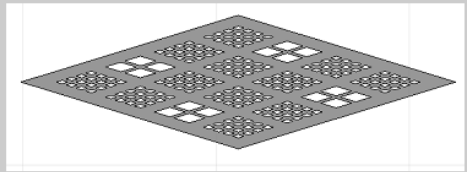
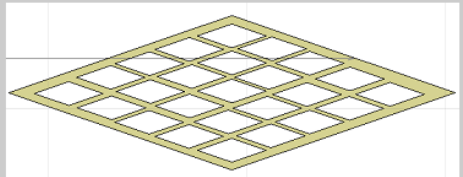
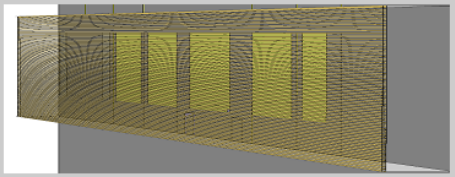
perforated shading pane considered for daylight analysis
percentage of voids for this module is 21.5%



Time of Simulation: 21Sept – **10:00 AM**
Average Value : 295.14 Lux

Difference in Daylight Analysis due to Provision of False Ceiling and Furniture
Option A,L and option 2

Table Showing change in Daylight percentage due to interior objects

17th Sept 9 am			
Type of Option	**Without Ceiling**	**With Ceiling**	**Options**
Option A (22% Voids)	**36.0%**	**45.7%**	
Option L (59.6% Voids)	**74.6%**	**80.09%**	
Option 2 (Louvers)	**66.10%**	**98.60%**	

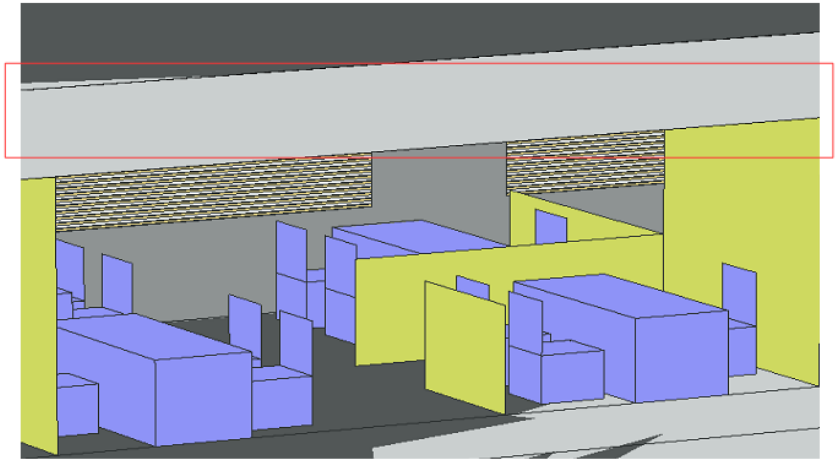
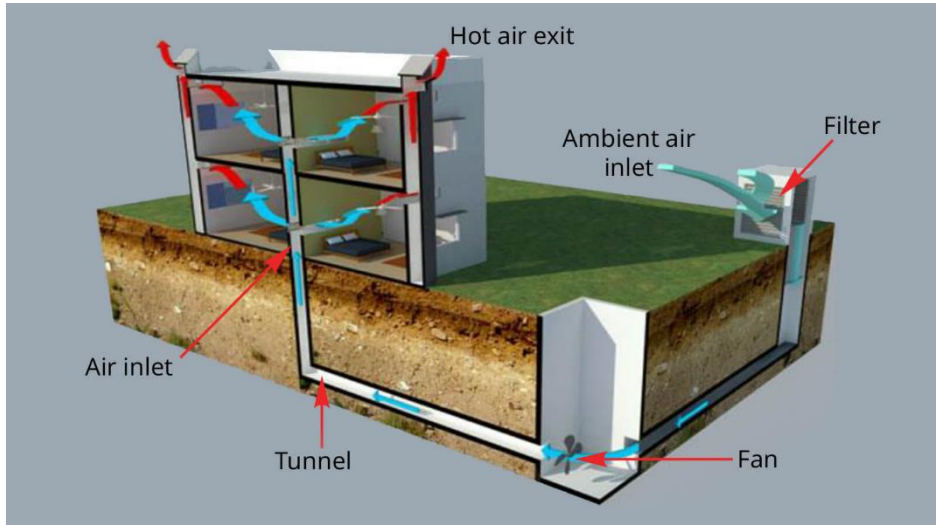


Image showing Ceiling and furniture

In earlier simulations Ceiling was provided at 3.9m above finished floor .
In option 2 it was observed that there is a difference in illumination after providing furniture and ceiling at 3.25m.
Ceiling Reflection 80 % and furniture Reflection 55%

Earth Air Tunnel Cooling



Schematic showing EAT
(Source : BEEP)

Actual Site Photographs

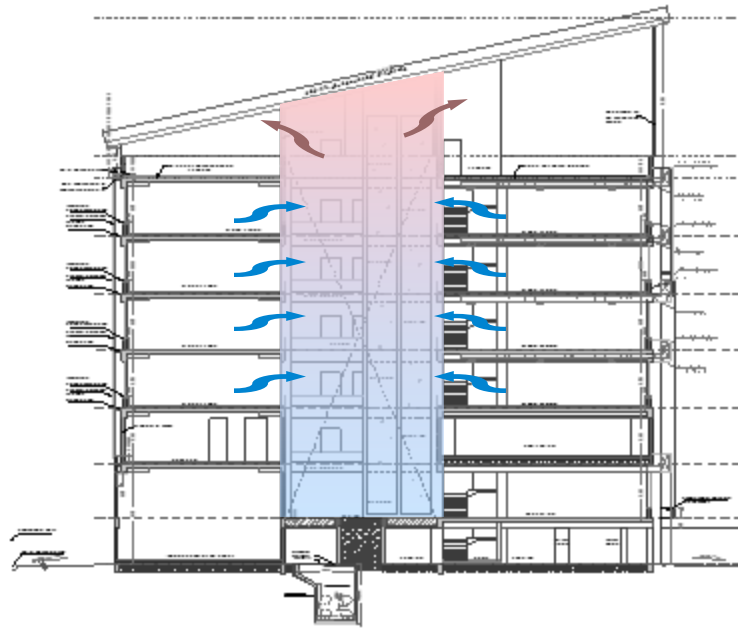
600 mm dia concrete pipes running in two loops.

Loop 1 – 120 meters
Loop 2 – 131 meters

Avg – 4.5 meters depth

An extract fan provides air to Badminton Hall, Reception and Cafeteria.

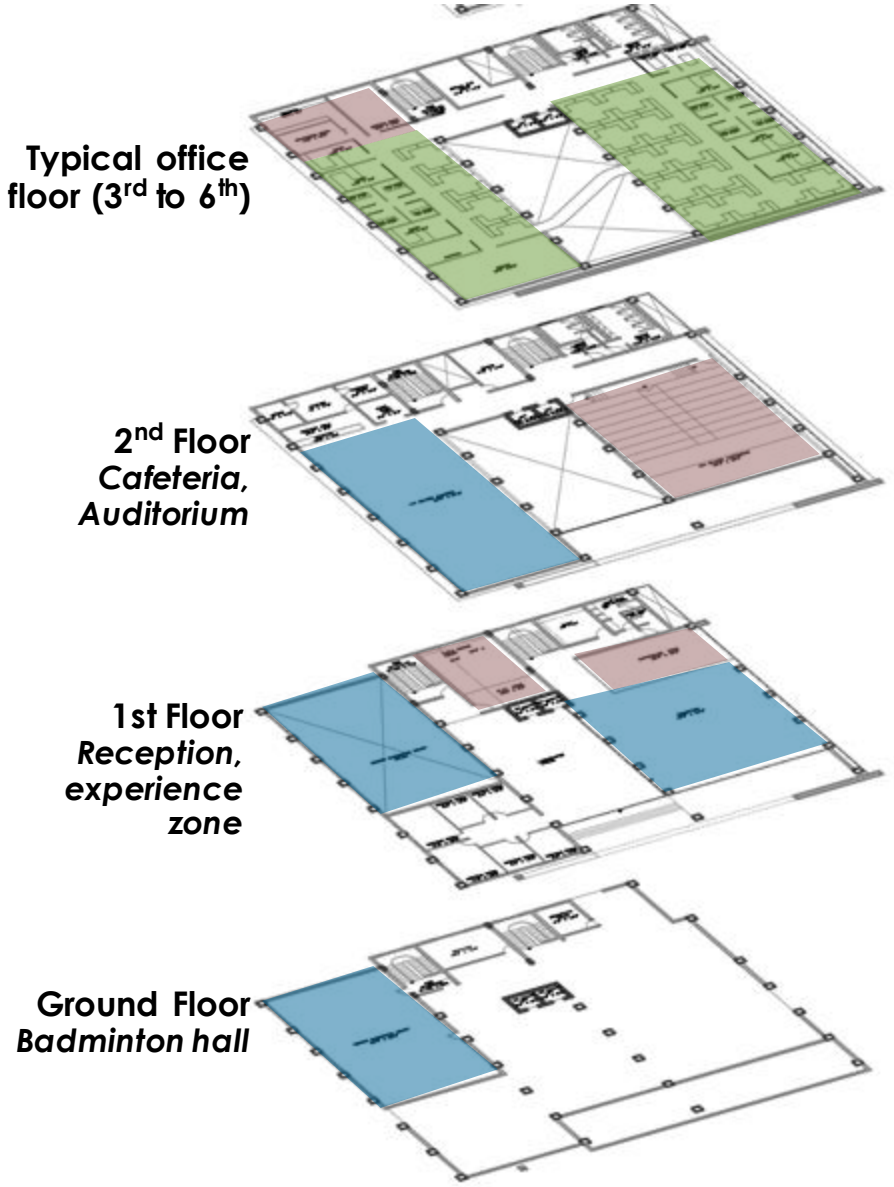
Air Delivery Temperature of 27 to 20 °C is expected



Combination of Active cooling strategies

- **Evaporative cooling** : for all open office areas
- **Earth Air Tunnel** : for Badminton hall, reception and cafeteria
- **Air cooled VRV** : for enclosed spaces such as meeting rooms, cabins, auditorium and experience zone

These strategies have helped in reducing cooling energy demand by more than 50% as compared to conventional central air-conditioning system.

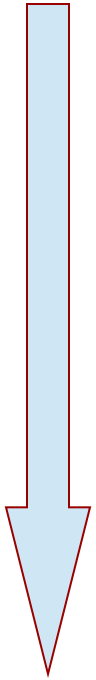


Earth Air tunnel cooling

Evaporative Cooling

Air Cooled VRV

Reduction in EPI with Energy Conservation Measures



Standard EPI
85 kWh/sqm/yr*

With efficient envelope
3%

82.45 kWh/sqm/yr

Efficient envelope
Optimized WWR on all facades, high performance glazing, solar roof, green roof, low thermal conductivity walls

With efficient lighting
4%

79.15 kWh/sqm/yr

Efficient Lighting
Use of high efficacy light fixtures and low LPD

With efficient HVAC
40%

47.49 kWh/sqm/yr

Efficient HVAC
Passive and low-energy intensive cooling techniques.
The proposed VRF system has high efficiency and low auxiliary energy use

Proposed EPI
(excluding equipment)

EPI Ratio = EPI of Proposed Case / EPI of Standard case = 0.56 < 1

Renewable Energy Integration

Solar PV installation of 168KW

Estimated EPI (including equipment) : 65 kWh/sqm/yr

Annual energy consumption : 305,500 kWh/yr

Annual energy generation : 2,57,544 kWh/yr

The energy generation from the solar panels offsets 84% of the total energy consumption of the building, thus the project is a NEAR NET ZERO ENERGY project.

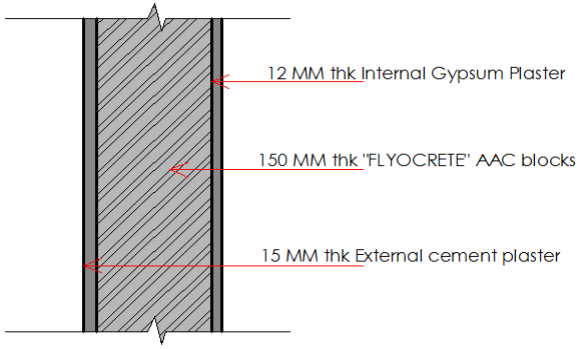
Parksyde Homes - Nasik

Opaque Envelope

Overall Wall Assembly U-value

Flyocrete AAC blocks have been used for wall assembly of the buildings along with external cement plaster and internal gypsum plaster.

The U-value for wall assembly as per IGBC is 1.80 W/m2K and the U-value for the project is 1.12 W/m2K

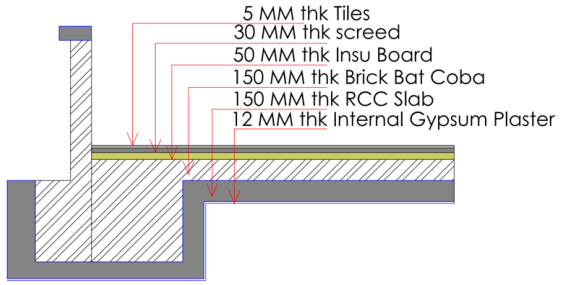


U-Value Calculations				
	Wall Assembly	Thickness	K-Value	R-Value
Layer - 1	External Surfaces (fo)			0.123
Layer - 2	15 mm thk External Plaster	0.015	0.72	0.021
Layer - 3	Flyocrete – AAC Block	0.15	0.24	0.625
Layer - 4	12 mm thk Gypsum internal Plaster	0.012	0.461	0.026
Layer - 5	Internal Surfaces (fi)			0.1
Total Resistance				0.89
U-Value of the proposed Wall Assembly in W/m²K				**1.12**
U value suggested by the IGBC in W/m²K				**1.80**

Overall Roof Assembly U-value

The project has made use of **XPS insulation boards** for the roof in order to avoid excessive heat gain as maximum heat enters the building from the roof area.

Additionally **high SRI tiles** have been laid on the terrace for the cool roof effect.



U-Value Calculations				
	Roof Assembly	Thickness	K-Value	R-Value
Layer - 1	External Surfaces (fo)			0.044
Layer - 1	5mm thick Tiles	0.005	0.18	0.028
Layer – 3	Cement Screed	0.03	0.71	0.042
Layer – 4	Thermal Insulation – XPS	0.05	0.028	1.786
Layer – 4	Brick Bat Coba	0.15	0.81	0.185
Layer – 5	RCC Slab	0.15	1.58	0.095
Layer – 6	12 mm thk Gypsum internal Plaster	0.012	0.461	0.026
Layer – 7	Internal Surfaces (fi)			0.105
Total Resistance				2.31
U-Value of the proposed Roof Assembly in W/m²K				**0.43**
U value suggested by the IGBC in W/m2K				**0.50**

Compliance with ECBC-R

As per ECBC R the Thermal transmittance of roof shall comply with maximum U roof value of 1.2 W/sqmK

For this project the roof thermal transmittance is as follows :

U roof = 1/1470.7 x (0.43 x 1470.7)

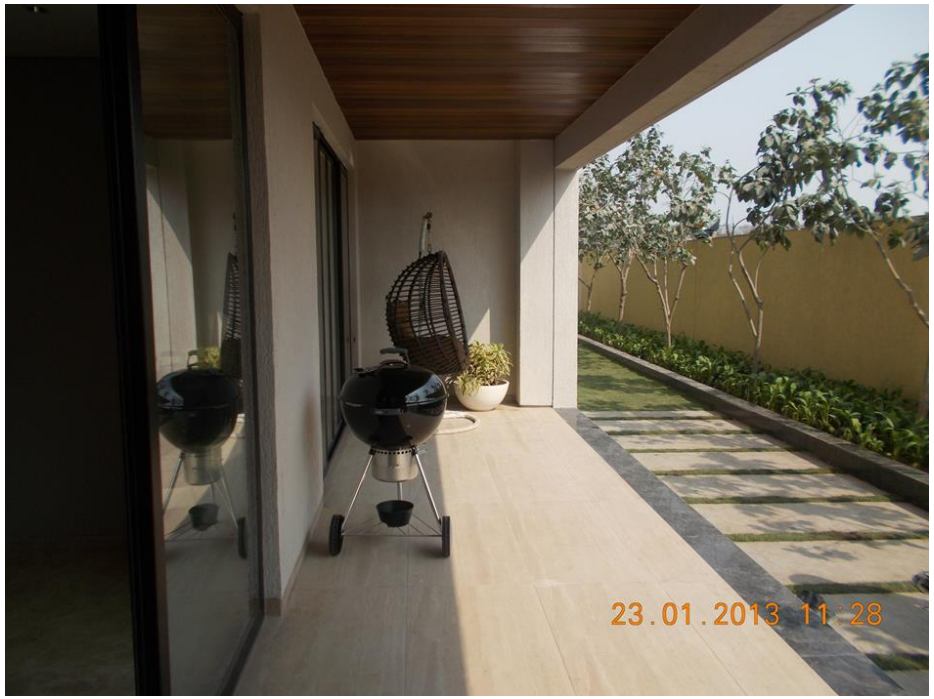
= **0.43 W/sqmK**

Thus the project complies with the thermal transmittance of roof as per R-ECBC

Residential Envelope Transmittance Value (RETV) as per R-ECBC for four climate zone should not be greater than 15W/m2.

Equation 1	**a*Area of opaque*U-value of opaque*w**	**6942.48**
Equation 2	**b*Area of non opaque*U-value of non-opaque*w**	**2358.09**
Equation 3	**c*Area of non opaque*SHGC*w**	**16550.93**
Equation 4	**Eq 1 + Eq 2 + Eq 3**	**25851.50**
RETV =	**(1/Aenvelope)* Eq4**	**13.81**
RETV compliance (15 W/m2)		**YES**

Envelope Design-Fenestrations



Glass Selection and Shading Devices

The project has shown compliance by using a combination of double glazed unit glass and shading devices. The project complies with the requirements of SHGC as per IGBC.

The adjusted SHGC is calculated as per the ECBC methods

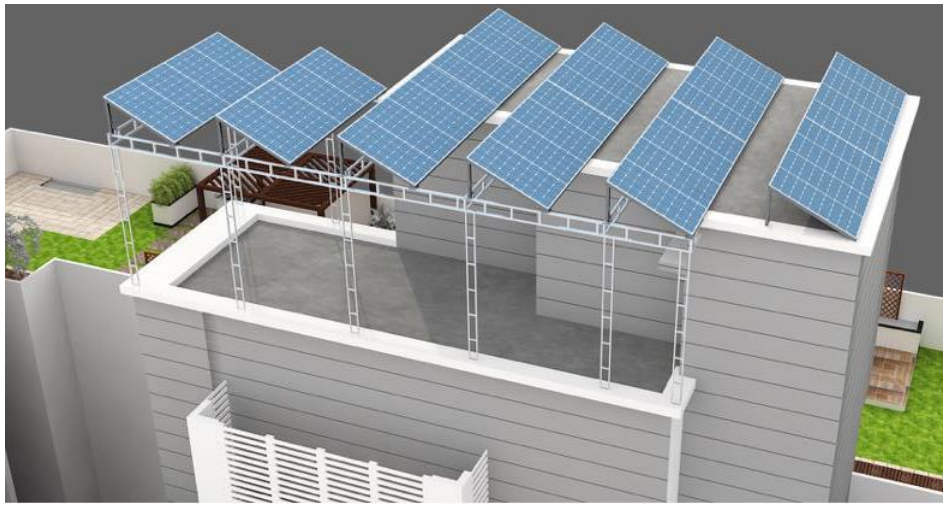
SHGC CALCULATIONS – SUMMARY				
Wing	**Orientation**	**SHGC of Glass**	**Adjusted SHGC**	**SHGC Recommended by IGBC**
WING A & B	East	0.56	0.28	0.32
	West	0.56	0.19	0.32
WING C & D	North	0.56	0.24	0.32
	South	0.56	0.26	0.32
WING E & F	East	0.56	0.24	0.32
	West	0.56	0.19	0.32

Renewable Energy Sources

Solar PV Installation

The project has installed a total of 22 kW of solar photovoltaic cells on the roof tops of all the buildings. The solar photovoltaic cells help to cater to the total annual common area lighting consumption of the project.

Sr No.	Energy Consumption	Value in kWh
1	Total common area lighting consumption	32,844
2	Total generation of installed on-site renewable energy systems	33,726
3	Percentage of power generation using solar PVs	**102.68 %**



Affordability

Thankyou