Solar™ Decathlon India

DELIVERABLE 4

FINAL DESIGN REPORT
APRIL 2023

TEAM VINAYA

COMPETITION DIVISION
EDUCATIONAL

UNITED NATIONS academic impact MEMBER Sharing a Culture of Intellectual Social Responsibility

BNCA
MAHARSHI KARVE STREE SHIKSHAN SAMSTHA'S
DR. BHANUBEN NANAVATI
COLLEGE OF ARCHITECTURE
FOR WOMEN

INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY

TEAM SHUNYA
Building a sustainable future

TABLE OF CONTENTS:

LIST OF TABLES:

LIST OF FIGURES :

LIST OF FIGURES :

Response to reviewer's comments:

Reviewers comments to Deliverable 3 – and responses including actions taken.

- **Energy-**

1. More data should be reported supporting the renewable energy calculations.
2. give more information in writing and reduce some of the graphs

Response- Provided detailed renewal energy calculations as well, as solar hot water calculations. We have provided a relevant graphs supporting writeup and narrative to every strategy we used to reduce consumption.

- **Water**-

1. You should optimize your storage so that you are able to use most of your greywater produced.
   Response- we put reduced water demand and done all the water cycle calculations. The grey water will be utilized for landscaping and flushing to meet water demand.. The remaining water will be given to PMC tankers for roadside landscaping enhancement purposes.

- **Embodied Energy-**

1. One Click LCA does not have materials database for Indian conditions. You need to rely on the Embodied Carbon calculation tool

We have recalculated embodied emissions using Embodied Carbon calculation tool.

- **Resilience- (evaluation – good)**
- Make sure you address previous comments on landslides

You have not provided an assessment of potential risks.
Response- We have done environmental impact Assessment of site and analysed risks and formulated mitigation strategies. Addressed landslide risks factor and mitigation measures.

- **Engineering and operations-**
- Good detailing is done for the specially designed aspects of the building.
- Elaborate on all systems, for the next report.

HVAC sizing is needed.
Materials are of high embodied carbon.
Response- We have provided all layouts for HVAC, Water, drainage, starutural etc. and given calculations for HVAC sizing using HVAC sizing tool based on indoor and outdoor consitions in peak summer months.

- **Architectural Design-**

1. There is no indication of how your design integrates HVAC systems, structural and water/ drainage systems

Response- we have provided all layouts in operations section.

Affordability-

1. Try graphically explaining your affordable proposal for this section
2. The construction cost analysis is not robust or adequate

Response- Added graphs for better understanding at a glance. we have done all necessary changes and reduced construction cost.

Innovation-

1. Please limit your narrative to ONE innovation only

Response- we have Focussed on only one innovation.

Health and wellbeing –

1. Orientation of your day light model is unclear
2. Your report did not have provision of desired indoor air quality, and adequate fresh air

Response– We have mentioned orientation and simulation inputs. we have Provided simulation inputs for mechanical ventilation modes of operation along with their operation schedules.

- **Value Proposition**–

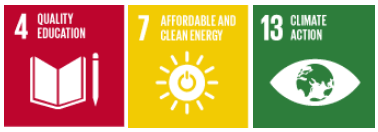
You seem to have included the right elements/ metrics for your value proposition. However, the narrative and its clarity can be improved upon.

Response– We have improved our value proposition with clear statements and quantified every aspect which leads our project towards sustainability.

1. Executive summery

We are the generation most determined to fight injustice and inequalities and the generation that saves the planet from climate change. **TEAM VINAYA,** with a determination to work towards achieving sustainable development proposes a Residential secondary school infrastructure for the new Main branch of Jnana Prabodhini Prashala, Pune.

The proposed infrastructure would support Jnana Prabodhini to achieve sustainable SDG 4 of Quality education, with focus on SDG 7 of Affordable clean Energy and SDG 13 of Climate Action in the process.



Masters in environmental Architecture students and B. Arch students from Dr. B.N. College of Architecture Pune and PhD in Energy science and engineering students from, IIT Bombay make up the multidisciplinary TEAM VINAYA. Experts and consultants from various backgrounds lead our team. Our team has collaborated well, with each member contributing their particular expertise at various stages.

As a team, we started by working on various iterations, which were then combined to produce a single comprehensive design that reflected the viewpoints of each team member. The final version was then improved in accordance with the competition's criteria. Following design completion, team roles were assigned based on the ten SDI contests.

In order to accomplish our sustainable goals, we worked on various aspects each week during the design process. Making our structure towards-net-zero energy, water and waste was our aim. In order to make our building sustainable and adaptable to Pune's warm and humid climate, we started developing the building envelope's specifications while conducting market research and using the ECBC guidelines as a benchmark and developed structural assemblies with lower U values. Our top priority when designing the building was comfort. As a result, we implemented passive techniques like orientation, shading, WWR etc., to help us attain these levels of comfort. To achieve this, we concentrated on proposing energy-efficient fixtures and systems to reduce the building's energy consumption.

Our total calculated energy consumption was 31.1 kWh/sqm/year after running multiple energy simulations on Design-Builder. Our solar energy generation capacity, which generated 46.36 kWh/sqm/year, was able to meet this consumption.

Then for water efficiency, we looked to the NBC to determine the typical water demand for a structure like ours. To achieve our net zero water goal for the building. We used water treatment systems and rainwater harvesting. Annually unused grey water will be sent to PMC to maintain plantation in public spaces.

We have found a solution through this process that not only achieves net-zero, but net-positive energy status.

2. Team Introduction- Team Members

Team Vinaya

Lead Institution- MKSSS's Dr. Bhanuben Nanavati College of Architecture for Women, Pune. (BNCA)

Partner Institution- Indian Institute Of Technology, Bombay

Division- Residential Educational building (campus)

Ar. Anushka Rudrabhate
Team lead -
Building ,Water and Energy Performance, Design modelling and documentation
(2nd yr. M. Arch Env. BNCA)

Ar.Unati Watwani
Structural modelling and Passive Solutions,
(2nd yr. M. Arch Env. BNCA)

Ar. Mrunal Joglekar
Design Presentation and Documentation
(2nd yr M. Arch Env. BNCA)

Prabhat Sharma
Energy Solutions
(2nd yr. PhD Energy science and engineering, IIT Bombay)

Ar. Swapnali Kambale
Resilience management
(2nd yr. M. Arch Env BNCA)

Ar. Suvarna Kulkarni
Resilience management
(2nd yr. M. Arch Env. BNCA)

Trupti Patil
mechanical system.
(4TH yr. B. Arch BNCA)

Ketaki Badhe
Research
(3rd yr. B. Arch BNCA)

Sabhyata Page
Structure design
(3rd yr. B. Arch BNCA)

Sakshi Yerne
Affordability
(4TH yr. B. Arch BNCA)

Akshata Mestry
Water Performance
(4TH yr. B. Arch BNCA)

Darshika Patil
research
(3rd yr. B. Arch BNCA)

Divya Jadhav
Formatting
(3rd yr. B. Arch BNCA)

Aditi Kolhe
Plumbing Analysis
(3rd yr. B. Arch BNCA)

Mrunal Sahaje
Materials analysis
(3rd yr. B. Arch BNCA)

Lead Institute
MKSSS's Dr. Bhanuben Nanavati College of Architecture , Pune
MKSSS's Dr. Bhanuben Nanavati College of Architecture for Women,(BNCA) Pune, popularly known as BNCA offers **B Arch, M Arch** and **PhD** under SPPU with a dedicated Research Center. The institute was established with a futuristic approach and idealism towards architectural education with a quality in imparting education with newest skill set to make their mark on the globe.

Partner Institute
Indian Institute Of Technology, Bombay
The Indian Institute of Technology Bombay (IIT Bombay or IITB) is an internationally acclaimed autonomous public research university and technical institute in Powai, Mumbai, Maharashtra. It is considered as one of the foremost engineering universities in Asia, and as the most reputed and the most competitive institute in India.

Team SHUNYA
IIT Bombay is an interdisciplinary team comprising of faculty members and students specializing in building simulations, solar passive architecture, solar thermal and photovoltaics, and modular pre-fabricated construction technologies.
Mission - To raise awareness in the nation about energy efficiency, responsible energy use and the potential of RE with emphasis on solar energy

The team has been formed by voluntary participation based on the different skills . The team consist masters, PhD and bachelor students from architecture , engineering background also the professionals guiding us through out the competition **Team Vinaya** intends to design a CBSE school with spaces for learning and development in all aspects in a sustainable way keeping in mind the philosophy of our Project Partner- **Jnana Prabodhini** - "Awakener Of Knowledge" - A movement for motivating intelligence towards social change

2.Team Introduction- Team Approach

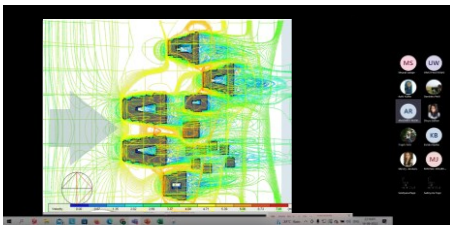
Key Individuals- Faculty Lead and Faculty Advisor-

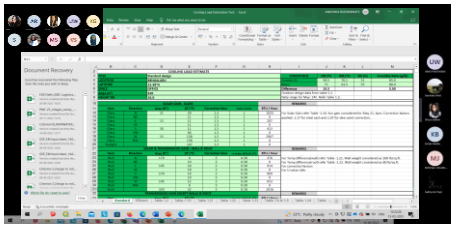
Faculty Advisor-
Dr. Sujata Karve
Professor at Dept. Environmental Architecture, BNCA Pune.

Faculty Lead-
Prof. Prajakta Dalal-Kulkarni.
Associate Professor at Dept. Environmental Architecture, BNCA Pune.

Faculty Advisor-
Prof. Namrata Dhamankar
Assistant Professor at Dept. Environmental Architecture, BNCA Pune.

Work Process:





Team work Approach -online meetings and group discussions

An integrated design strategy was chosen, taking into account the 10 contests of SDI.
To develop a comprehensive framework to address the spatial requirements as well as the net zero design solution anticipated with the future provision, team members from various fields held regular meetings with the project partner, faculty lead, industry partners, and advisors.

1. Project Introduction-	• Meetings with Project Partner, understanding their requirements. • Category- Educational- Secondary residential school
2. Concept Development	• Area program development • Case study analysis • Site analysis
3. Design Iterations	• Zoning • Site suitability and synthesis
4. Online- offline meetings and Simulation webinars	• Towards net zero energy, water and waste approach. • Discussions with guides and partner institute
5. Following Green Building Codes	• To understand base case parameters and designing for efficient case
7. Design Development-	• Simulation approach towards Net zero campus Working on 10 contests of SDI. • Design refinement • Optimization of water, HVAC energy, daylighting, etc.
8. Meetings with guides and project partner for review	• Working with guides to refine concepts and methods allowed us to produce more precise and practical innovations..
9. Design Report – Deliverable 4	• Working on different parameters towards efficient design solutions, the team came up with the D4 report

- **Tools used –**

1. AutoCAD and SketchUp with Lumion were used for 2D and 3D design.
2. software's like Climate consultant, Design Builder, Cove tool, Edge tool, CBE Clima, etc. were used for energy, climate, daylighting and CFD simulations. One click LCA for embodied energy analysis
3. While MS Office, Photoshop were used for estimation, calculations, graphic illustration, report making, etc.

3. Project Introduction-

3.1 Project name:- JNANA PRABODHINI PRASHALA, PUNE

Project partner :- Jnana Prabodhini Prashala, Pune.

अविद्यया मृत्युं तीर्त्वा विद्यया अमृतम् अश्नुते ।
ज्ञान प्रबोधिनी
JÑĀNA PRABODHINĪ

About jnana Prabodhini :-

Jnana Prabodhini – "Awakener of knowledge" – a movement for motivating intelligence towards social change. Knitting an organization of selfless workers, leading the social movements to transform their respective working fields, is the mission of Jnana Prabodhini.
That requires building a multi-dimensional institution with an experimental character in leadership development in all walks of life.

Mastery Learning:
8 Levels are designed for Mathematics and English for the students from 5-8 stds. They are expected to clear at least 7 levels.
CBSE School From 5Th to 12Th std.

The founder of **Jnana Prabodhini**, Late **Shri V.V. alias Appa Pendse** was an Educationist, Social organizer, Patriot and an Active ideologue. Establishment of full-fledged school – 1969
Permeant affiliation granted by CBSE – 1976


Open-shelf library audio-video CDs


Open access laboratories


Activities - Social Sciences


Multimedia facilities /classroom


Dhadpad lab/ Maker's space


Dal:-Evening sports activity

3.2 Site Details-

- **Operate Location**- Bavdhan, Pune
- **Climate zone** – Warm and Humid
- **Building type**: **Residential Educational building.**
- **Project purpose:** Design Build Own
- **Stage of project:** Design phase
- **No. of occupants:** students- 450 staff- 80-85
  Operational hrs.: Student Zone -11AM -5PM; 6 Days/week

Back Office – 10AM-5PM ; 6 Days/week
Library & Computer Centre – 11AM-5PM ; 6 Days/week
(by ECBC 2017)

Description	Area(sq.m)
plot area	56286
Deduct-	
• area under road widening	1170
• 10% open space area	5628.6
• 10% amenity space area	5628.6
• Internal road area	9800
Net plot area	34058.8
Built-up area permissible (1 FSI)	34058.8
proposed built-up area	10985

Table- Site Area Details

3.3 Special requirement of project partner

Since Jnana Prabodhini has a cultural background, client interested in designing Academic buildings with response to the vernacular architecture. using modern technologies- not forgetting the old values.
Special requirement of the client are :-

- To cater to the user group entering the building.
- To enhance the facility for teaching and learning.
- **'Upasana Mandir'** a dedicated prayer hall for daily prayer.

3.4 Energy Performance Index (EPI) Goal-

Benchmark EPI for Educational Building	150 kWh/m2/yr
EPI Base case	89.29 kWh/m2/yr
Targeted EPI for Building (edge tool)	35 kWh/m2/yr
Achieved EPI for Building	31.1 kWh/m2/yr
% reduction from benchmark EPI	76%

Table- EPI Goal

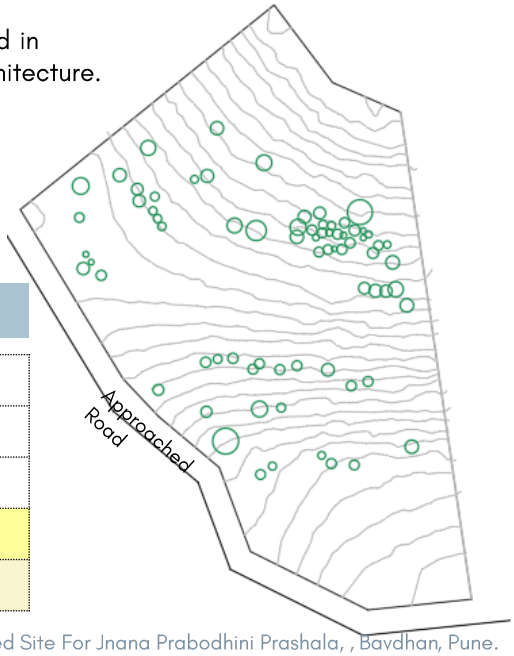
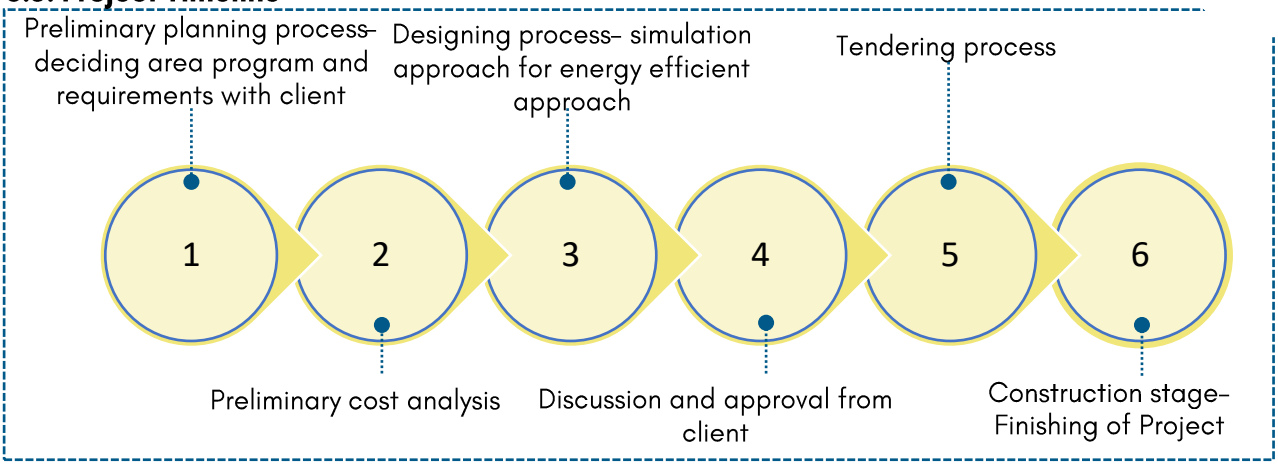


Fig . Proposed Site For Jnana Prabodhini Prashala, , Bavdhan, Pune.

3.5. Project Timeline



- **Project timeline- Stage 1- construction of Academic blocks, Hostel blocks**
  Stage 2- construction of Guest house, sports block
- **Duration**- 4 years
- **Status of the project** : Master planning and designing stage complete.
- **Profile of occupants :**  User age group-
  Students-10 – 18 years old

3.6. Surrounding development type –

Residential, Commercial and Mixed use.

The surrounding areas are well developed with some high end societies on northen side. With some commercial and mixed use spaces.

- **Physical context-**
- Pune has been an example for the blending of the culture and heritage with modernization.
- The cultural capital of the Maharashtra.
- **Occupation-** The Project Partner involvement is the building's self occupation. the entire construction is funded.

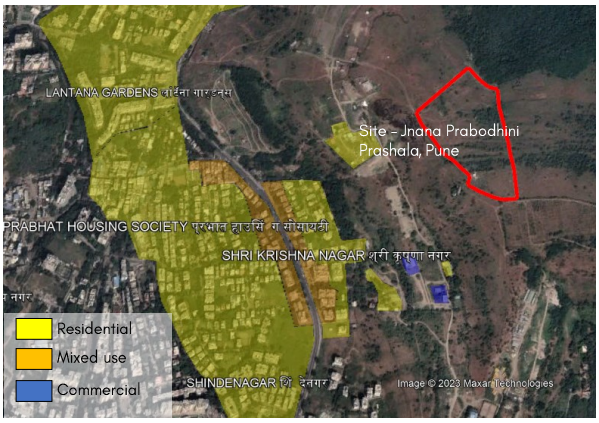


Fig. Surrounding context to site

3.7. Context To study-

- SDG GOAL 4-Better schooling is the foundation of the better future is todays need.
- Net zero construction is typically thought to be a costly investment and has not been widely used in the education sector.
- Hence designing a self sufficient educational campus will revolutionize the perspective of the majority of people while also taking our local environment into consideration.

3.8. End User Schedule

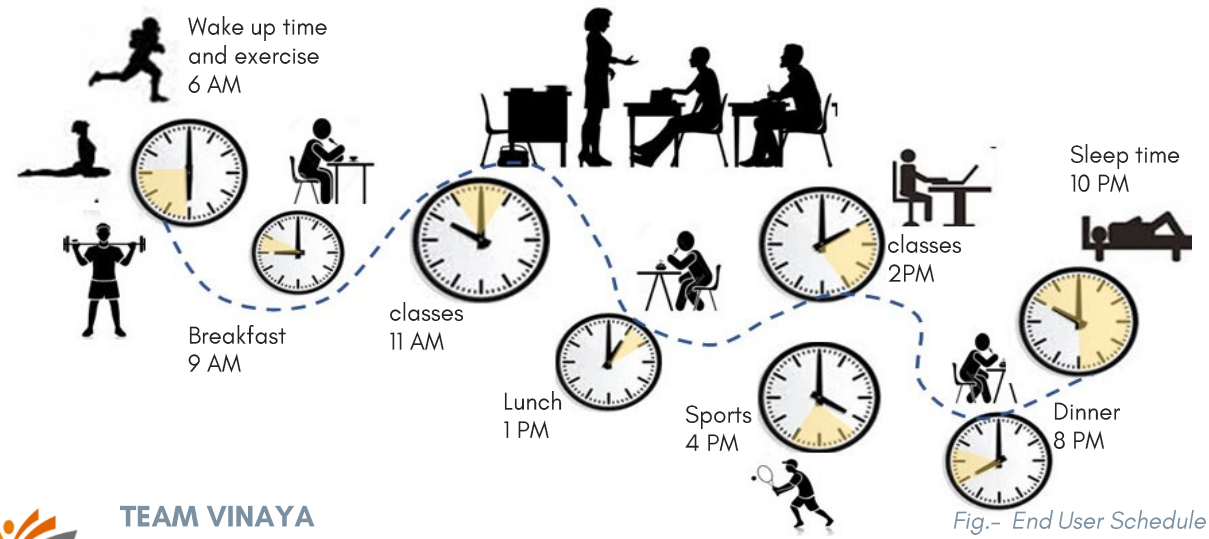


Fig.- End User Schedule

4. Goals and Strategies for the project Towards Green Campus

Context	Goal	Strategies Used	Target Achieved
Integrated Design Approach 	comprehensive holistic approach to design	• providing special designated spaces like **Upasanna Mandir** • Provision of ramps and elevators.	• User cenrtric design approach • Universal design
Independent and self-reliant 	The design solution aims to be net-zero or net positive	creating opportunities to become self-sufficient by acquiring new skills as a part of school's extra curriculum.	• Green education drives and promotion events • Organic farming activity
Energy Performance 	• Net Zero energy design • Targeted (EPI): 35 kWh /m2/yr	• Use of efficient light fixtures and equipments • Use of on site solar power generation	• Achieve **EPI 31. kWh/m2/yr** • Achieved net-positive energy design using PV systems.
Water Performance 	Reduce, Reuse, Recycle	• Use of low flow rate fixtures • Provision of STP • Provision of rainwater harvesting pits	• **50 % water use reduction by** low flow fixtures • 85% use of recycled water from the STP • **30438 KL** RWH on site
Resilience 	Enhancing the building's ability to cater to the climate change	• modern technologies are put up to a resilient campus	• Structural Resilience by using long lasting materials, **Earthquake resistance**. • Affordable construction • Effective waste management. • Energy backup management
Thermal Comfort And Health and Well-being 	improving the overall quality of the space	• Allowing maximum daylight and fresh air ventilation in regularly occupied spaces • **Use of low VOC paints**, dust free interiors, efficient exhaust and regular flush-out systems.	• **More than 95%** of the regularly occupied spaces has sufficient daylight. • All the classrooms have more than 15 % openings for enhanced fresh air ventilation
Waste Minimalization	Reduce, Reuse, Recycle		**100%** of organic waste treated and converted into manure which is used for organic farming and landscaping.
Materials 	use recycled & reused which discourages the use of virgin materials. And reduce Embodied carbon.	• Reuse of old interior materials will reduce furniture cost. • Use of Recycled content building materials	• Reduced **13%** of the overall cost of the materials. • Reuse of old benches and other furniture of existing school • Building construction materials with 30-85% recycled content
Innovation 	Innovation towards sustainable building campus	• Building materials-Carbon tiles • Building management system dashboard	• integrating real-time data, give administrators insights, and involve students in sustainability initiatives

(able- Goals Towards Green Campus.

5. Design documentation

1. Energy Performance

1.1 Climate Analysis and Passive Strategies-

Passive design strategies are the first step towards designing net zero energy buildings. Features that direct a building's form and design and channel the available natural resources to ensure thermal comfort are known as passive design strategies.

Through **proper orientation, external shading, the right amount of glazing, and natural ventilation**, proposed passive design strategies seek to reduce the need for cooling during the summer and heating during the winter.

The early design decisions made regarding the building's shape, orientation, shading, and ventilation have the biggest influence on how much energy the structure uses.

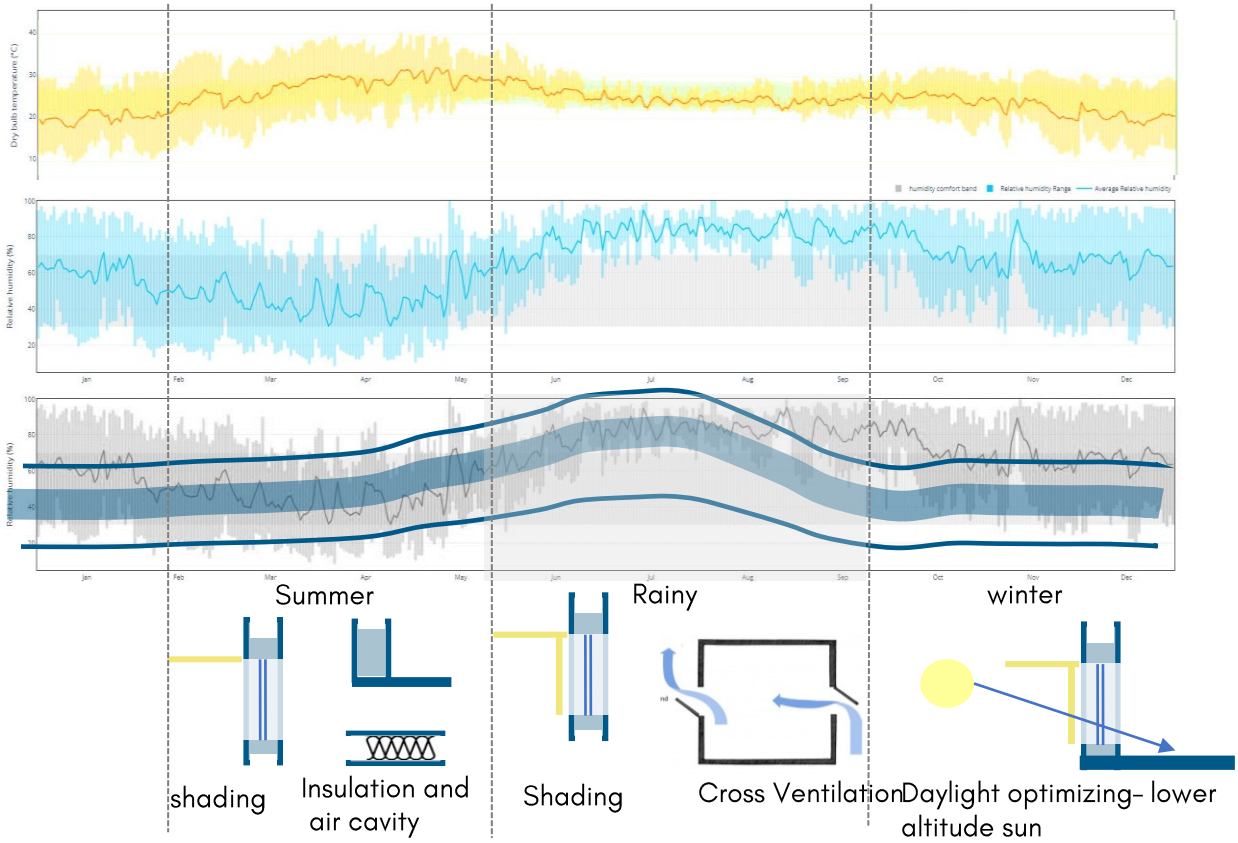


Fig.-passive strategies formulation through study of climate of Pune

1.2. Massing On site

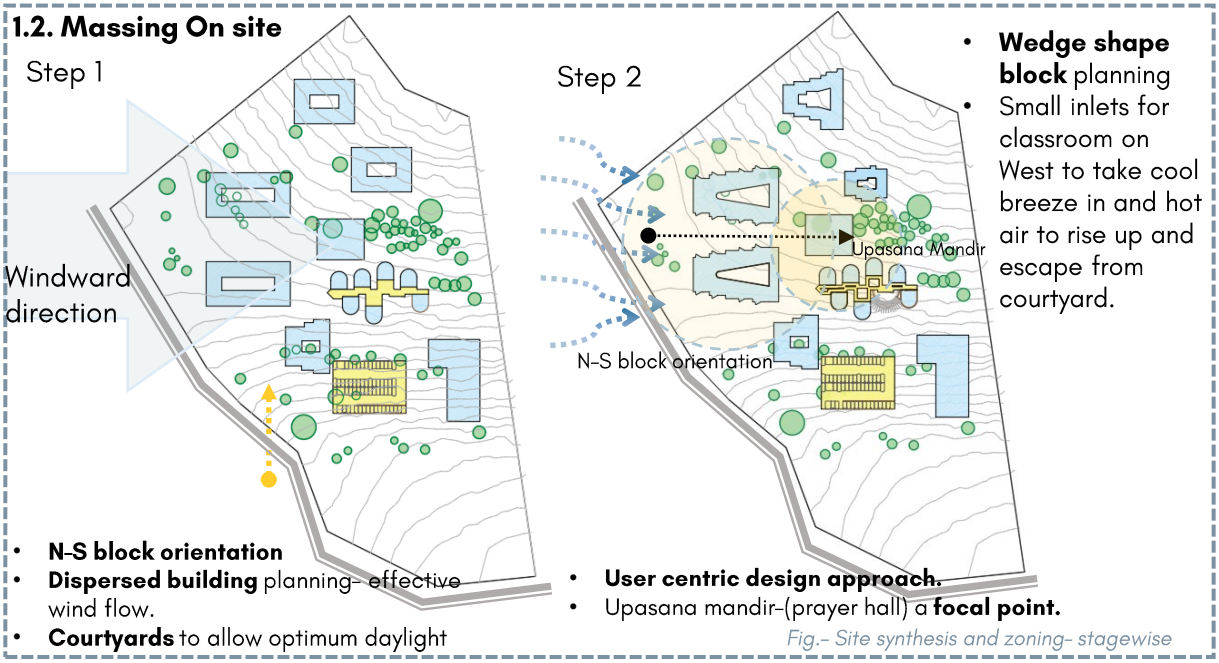


Fig.- Site synthesis and zoning- stagewise

1.3. Daylighting and Shading Design-

We created intricate models and plans in design builder to help us achieve our energy performance goals for the building.
In addition, we improved the envelope to reduce the building's heat loads and boost natural lighting.
In the beginning, we optimised our WWR taking into account the local climate and solar radiation.
In order to minimise our lighting needs without sacrificing thermal comfort, we needed to maximise daylight.

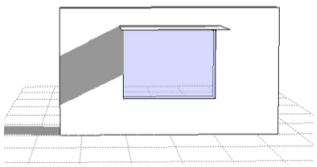
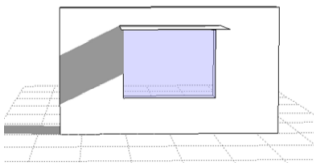
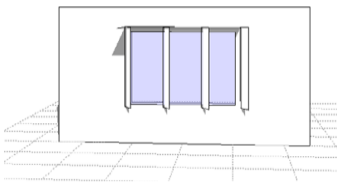
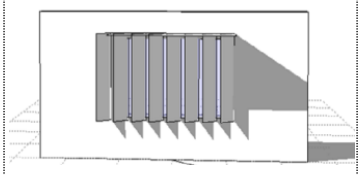
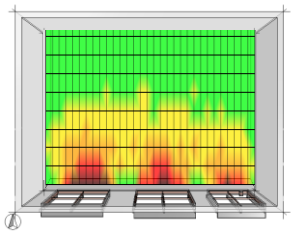
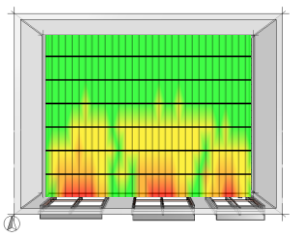
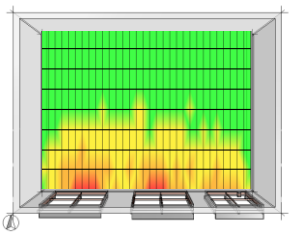
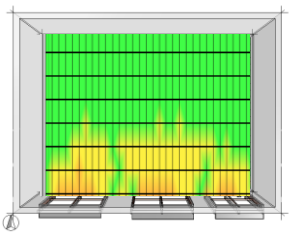
Option 1	Option 2	Option 3	Option 4
			
Overhang-300 mm deep	Overhang-600 mm deep	300 mm Overhang with 4 louvers	300 mm Overhang with 8 louvers
			
Harsh glare- not recommended	uneven light distribution	For school academic block at **south facade**	For admin block at **west facade**
Glass panels With Ventilation mosquito nets- for ventilation WWR- 40%	Glass panels With Ventilation mosquito nets- for ventilation WWR- 35%	Glass panels With Ventilation mosquito nets- for ventilation WWR- 30%	Glass panels With Ventilation mosquito nets- for ventilation WWR- 22%

Table -Design for shading Devices

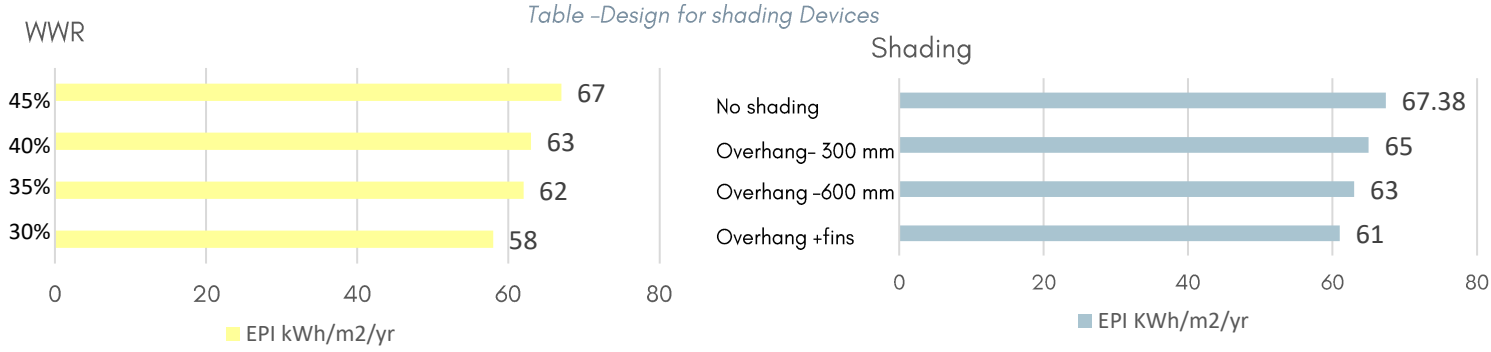


Fig. - Base and Design case inputs For WWR, Shading and their reduction in EPI

The 4 cases were created with different shading options on different facades.
In the first case , 300 mm overhangs provided for southern facade window. The glare percentage was above 60 %
In the second case, the width of overhangs increased to 600 m and WWR Reduced to 35%. After simulation, it is observed that there is uneven lighting distribution.
Hence the placement of windows is changed. To get optimum daylighting at level of 800 mm from ground levels, the lintels raised 750 mm. For shading, The combination of fins and overhangs were designed to reduce glare from high sun angles during winter and allow lower sun during winter. The WWR for designed case at south façade is 30% and on west façade for admin block is 22%

- **Shadow analysis is performed on block model of school block**

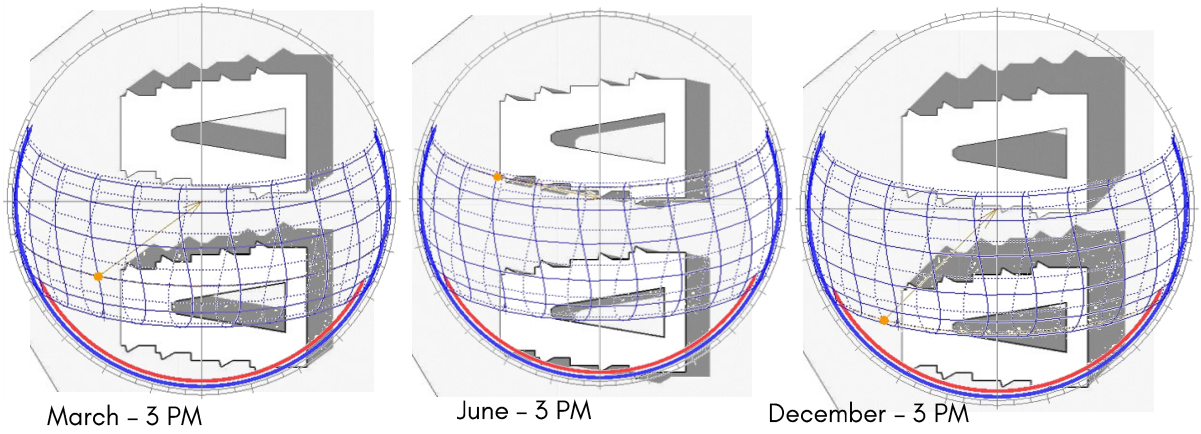


Fig. - Shadow Analysis

Orientation plays an important role in shadow analysis As the orientation is N-S hence shared shades helps to shade entrance pathway and courtyard. The Building Height is 10.8M (G+2 structures.) shadows are in month of March Hence making comfortable transition space.

With the help of Shadow analysis , By identifying areas of the building that will receive the most sunlight, and planned window placement, sizes of the windows, and orientation to optimize natural light and reduce the need for artificial lighting.

During summer season, shading is needed hence all the pathways are shaded with vegetation or by a canopy. This will reduce UHIE. Due to vegetation, the radiation on exposed surfaces will be reduced. The detailed analysis of radiation is explained in section 1.5.

1.4. Building Envelope Optimization- Material assemblies-

- A simulation approach with the potential combinations and its effect on the cooling loads and overall energy use was used to determine the envelope U value.
- The cost implications of the top choices were then examined and BOQ is done based on the material palette.
- By using insulation, the roof's transmittance is decreased to 0.45 W/m2.K.
- By including an air cavity, the transmittance from the walls is decreased to 0.78 W/m2.K.

- the glass selected for proposed case was tinted low E single glazed. Due to shadow analysis and shading devices implementation, instead of DGU, single glazed low E glass with U-Value 1.8 performs well in radiation and shading as well the cost of glazing reduces significantly.

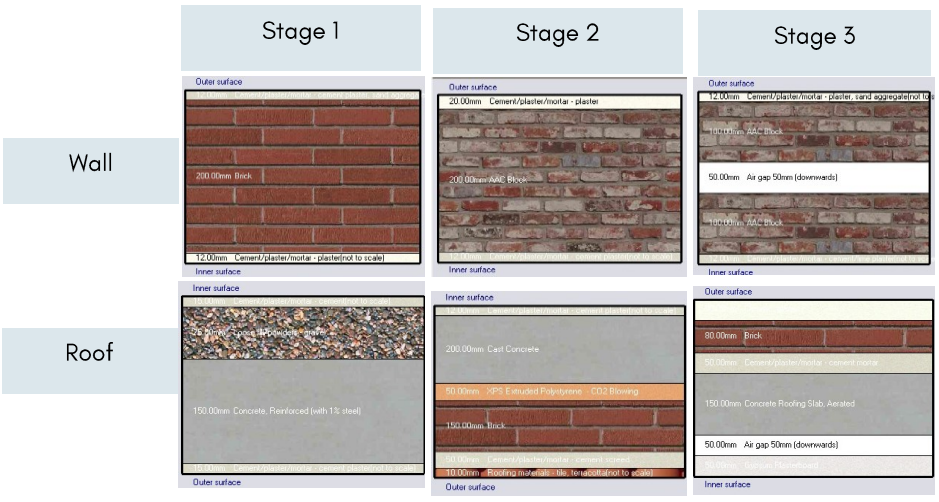


Fig - Material Assemblies For Wall And Roof

- **Material Palette for base case vs. design cases-**

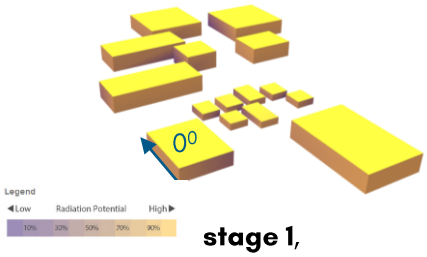
Simulation Parameters for School Block						
Input Parameter		**Baseline**	**Proposed**			**Unit**
			Case-1	**Case-2**	**Case-3**	
Wall material		12mm plaster	12mm Plaster	12mm Plaster	12mm Plaster	
		230mm Fire Dried Brick	200mmAerated brick	200mm AAC Block	100mmAAC Block	
		12mm plaster	12mm Plaster	12mm Plaster	50mm Cavity	
					100mmAAC Block	
					12mm Plaster	
Wall U-value		1.72	1.17	0.69	0.38	(W/m2.K)
Internal Wall material		12mm plaster	12mm Plaster	12mm Plaster	12mm Plaster	
		115mm Fire Dried Brick	100mm Aerated brick	100mm AAC Block	100mmAAC Block	
		12mm plaster	12mm Plaster	12mm Plaster	12mm Plaster	
		1.72	0.78	0.78	0.78	(W/m2.K)
Roof material		External Paint	15 mm plaster	External Paint	China mosaic tile	
		Cement Screed	150mm RCC slab	50mm Cement Screed	50 mm Cement Screed	
		PU Foam	75mm gravel Concrete	Water Proofing	Water Proofing	
		100mm thk RCC Slab	15 mm Bitumen/Asphalt	50mm XPS	50mm XPS	
				200mm RCC Slab	200mm RCC Slab	
				4mm Cement Plaster	4mm Cement Plaster	
Roof U-value		2	0.650	0.470	0.450	(W/m2.K)
Glazing Type		Single Clear/Tint	Single Glazed Unit	Single Glazed low e	Tinted single glazed low E with vertical shading	
Glazing U value		5.4	5.4	3.779	1.8	(W/m2.K)
SHGC		0.64	0.64	0.45	0.25	
Shading Coefficient		0.73	0.73	0.52	0.4	
VLT		65%	65%	65%	45%	
Window Shading		No	Yes	Yes	Yes	
WWR		45%	40%	35%	N, S-30%	
					E- 25%	
					W- 22%	
LPD	Classroom	13.8	By space function method		6.9	W/sq m
	Corridor	7.1			2.3	
	Staircase	5.5			2.7	
	Toilets	7.7			3.8	
	Labs	15.1			7.5	
	Store	6.8			3.4	
	Library	18.3			9.2	
	Reading Room	10			5.7	
Primary HVAC system		Split AC	All spaces-System 6: Packaged VAV with PFP Boxes Variable air Volume with reheat, Fan control- VAV, Cooling Type- Direct expansion, Heating Type- No heating COP as per ASHRAE numbers.			

Table – Simulation Parameters for School Block

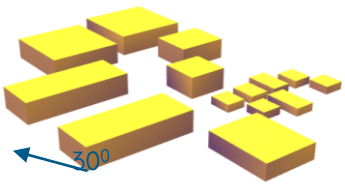
	Strategies	Intend	Compliance	Results
	Passive Design	reduce negative environmental impacts	Thermal Insulation, orientation, Shading, Vegetation,	8-10% savings
	Daylighting and Natural ventilation		Optimizing WWR, Cross Ventilation	
	Energy Efficient Lighting Fixtures	Reduce electricity consumption from the Grid	LPD- Space by space method- Uniformity ratio- 4 Lighting controls for ext. lighting	Up to 50% savings
	Energy Efficient Equipments and HVAC		Min. BEE 3 Star Rated equipments Energy efficient HVAC - VRV System, COP =4 With VFD and Economizers	12-15% savings
	Implementing RE		180 KWH Plant capacity- solar PV	25-30%electricity generation
	Solar water heating	Reduce electricity/gas consumption	100% hot water from Solar (residences)	100% energy savings in DWH
	Energy Metering	Monitoring for improvement in overall energy performance	• Exterior & common area lighting • Municipal water pumping • Ground water pumping • Treated wastewater pumping • Renewable energy generation	

Table - Energy demand reduction strategies

1.5. Annual Solar Radiation and Sun Hours Analysis



stage 1,
90% radiation is seen on the roof while the radiation on the north and south is significantly reduced by elongating the N-S facade.



stage 2,
90% radiation is seen on the roof but due to orienting the blocks at 30° the radiation on southern facade has been increased

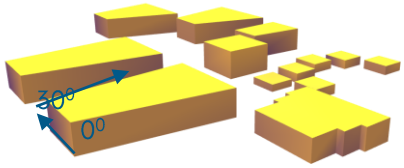
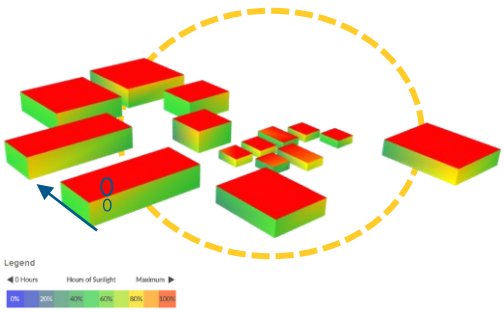
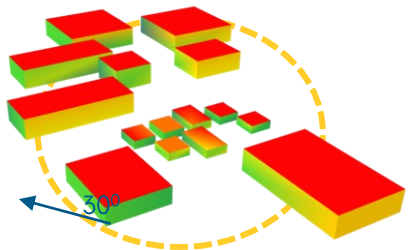


fig.- Radiation Analysis

Stage 3,
90%radiation is seen on the roof but due to orienting the blocks at 30° on both north and south creates a wedge shaped block thus reducing the radiation on the north and south facades.

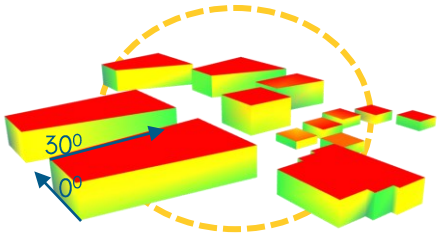


Stage 1
30-70 % solar exposure which is later shaded by landscape and shading devices tackle the extra sun hours in the E-W direction



Annual Radiation

Stage 2
the N-S facade experience the 20-60 % solar exposure which is reduced due to the oblique orientation of 30 °.



Sun Hours Analysis
Analysis done in- Cove tool

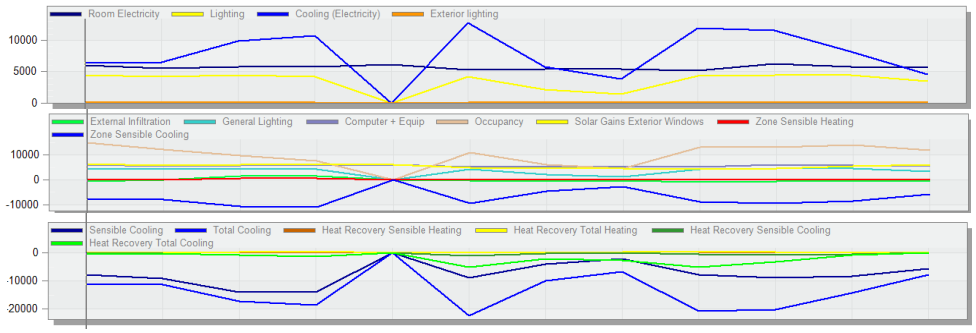
Stage 3
wedged shaped N-S facade experiences 20-70% sun hours whose impact is reduced by landscaping and shading devices while the E-W facades receives 10%-50% solar exposure hence Elongating E-W Facade

The radiation and sun hours are maximum on south west side hence planning of small surface areas with smaller openings on west side will reduce load on active strategies.

1.7. Input Temperatures for effective HVAC design-

the HVAC system was changed from a split system to a shared VRF system with separate indoor units, Based on the Indian Adaptive thermal comfort model (IMAC), For Pune Region

- Cooling setpoint temp. – 25^{0}C
- Cooling Setback- 28 ^{0}C
- Humidity control-
- RH setpoint-50%
- RH Setback- 70%
- Schedules for occupancy, lighting, ext. lighting,
- are set as per requirements



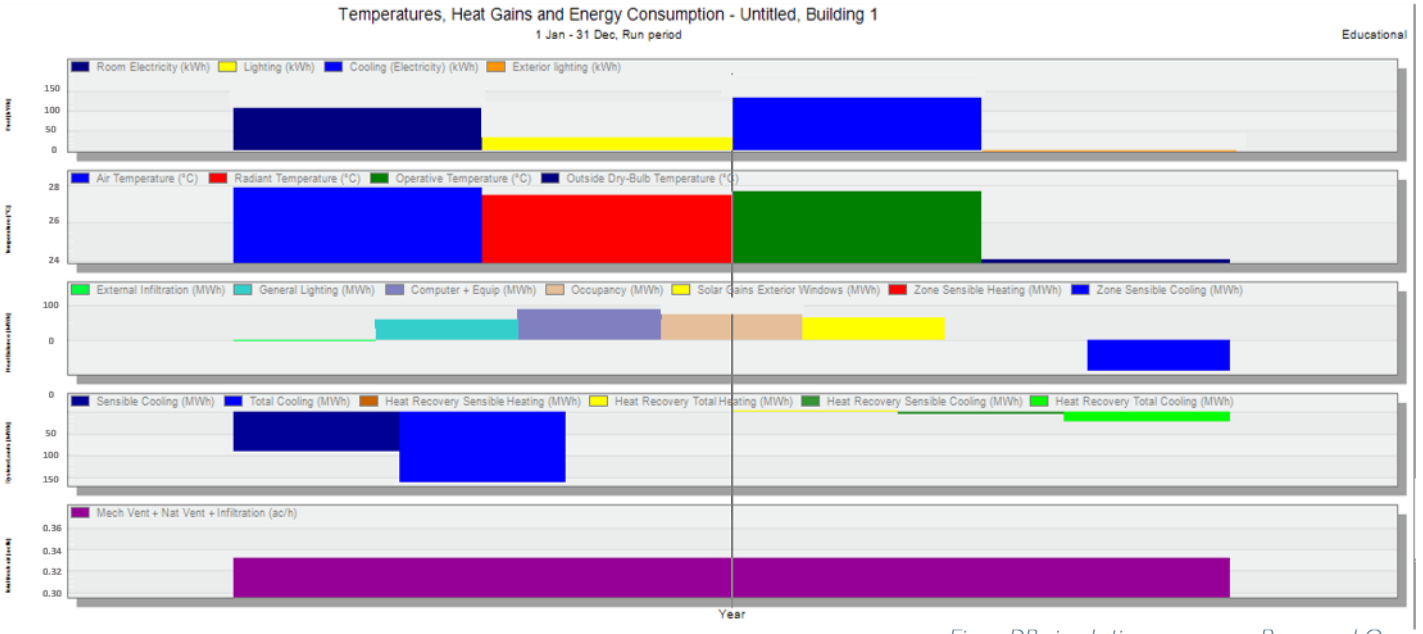


Fig. – DB simulation summery– Proposed Case

For the base case design, the building was designed with no passive strategies, conventional building materials , lighting and HVAC.
The EPI calculated for the base case was **84.29 kwh/m2/yr.**. The design case with appropriate shading, HVAC sizing, passive design strategies for ventilation and daylighting also material choices resulting **EPI 31.82 kwh/m2/yr.**

Energy Performance Index (EPI)
The energy performance index shows how much energy is used annually per square foot of constructed space.
A base case is developed to access the energy used and its reduction on the implementation of energy conservation measures. Schedules for lighting, equipment, and occupancy were created in Design Builder to ensure user uniformity.

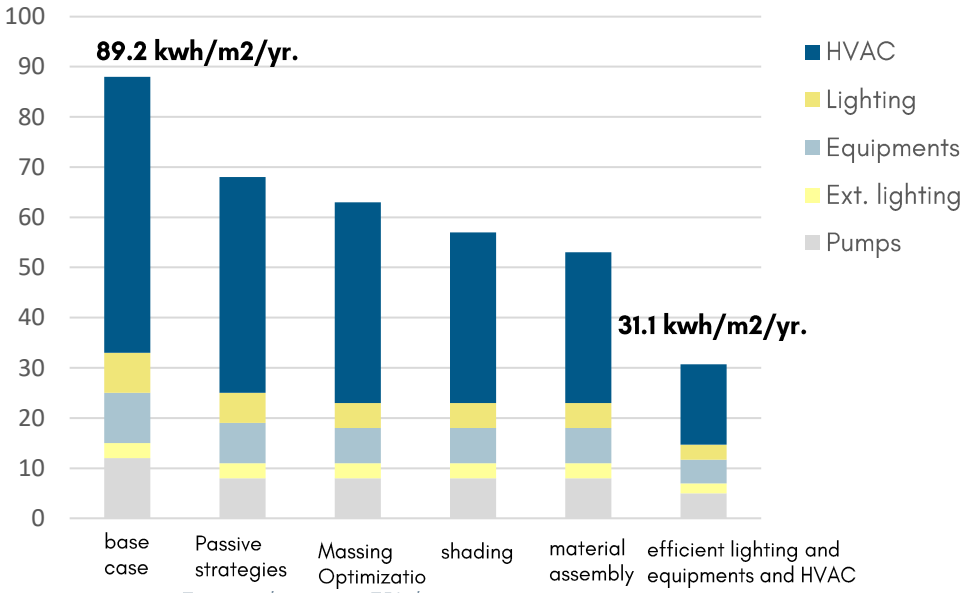


Fig. – reduction in EPI due to energy saving measures

2. WATER PERFORMANCE

2.1. Preliminary Water analysis-

	Strategies	Intend	Compliance	Results
	Rainwater Harvesting System	Enhance Gr. water table ,reduce municipal water demand	Implementing Recharge Pits,	30438 KLD water harvested annually
	water efficient fixtures	minimizing potable water use	WC-2/4LPF, faucets- 3.8LPM, Urinals-1.5LPF, showers- 6LPM	40% savings
	Water efficient irrigation and landscape design	Reduction of water wastage and water demand for landscaping	Drip irrigation, native/ Drought Tolerant species, less Lawn area	62.5% savings
	Wastewater treatment, reuse	treated water use, reducing on Municipal water supply demand	STPs, and grey water treatment system, filtration plant	100% wastewater treated
	Water metering	Monitoring for improvement in overall water performance	At every buildings water line, bores, treated water	

Table - Water demand reduction strategies

Case-specific recommendations and target savings
According to the 2016 National Building Code, the standard case fresh water demand for residential buildings is 135 LPHD (as shown in the appendix).
The proposed case aims to reduce the amount of fresh water needed by 37%, or to 84 LPHD, by implementing strategies like using water-saving plumbing fixtures and behavioural changes.

2.2. Water Balance Calculations for Residential school

Water harvesting Sources	Area	Runoff coeff
Roof Surfaces	4200	0.95
Hardscape areas	9000	0.85
Softscape areas	18160	0.25
grass pavers	3000	0.45
playground	10000	0.4
Effective catchment area	**21530**	

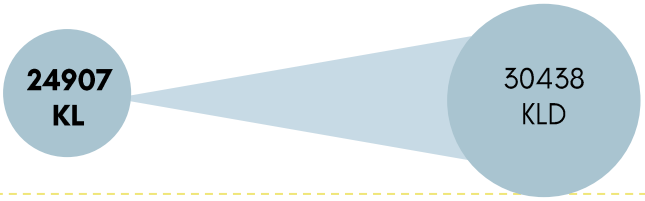
Muncipality water supply (l/day)	46,800	daily freshwater need
Storage size (l)	1,00,000	2 days storage capacity+fire tank

Water consumption point	Quantity	Liters/day
Boarders (demand reduced by LFF)	190	85
day - Boarders (demand reduced by LFF)	470	30
Occupants : {People x l/person}	660	46800
Irrigation (max) : {m^2 x l/m^2}	18160	2

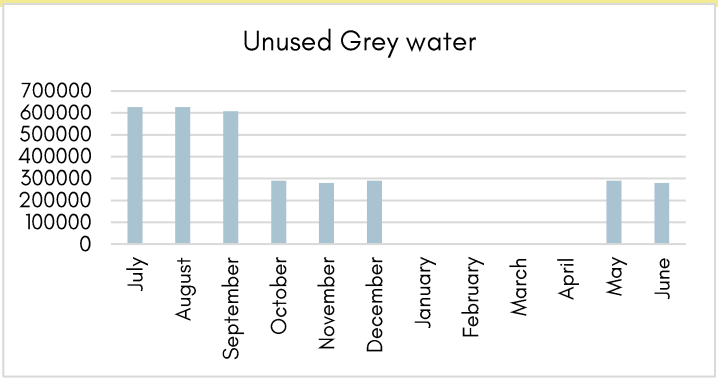
Month	Days in month	Rainfall (mm)	Effective rain (mm)	Harvested water (l)	Muncipality water supply (l)	Primary demand (l)	Grey water generated (l)	Irrigation seasonal factor (%)	Irrigation Water demand (l)	Irrigation fresh water demand (l)	Unused grey water (l)	Total fresh water demand (l)	Storage (l)
July	31	487	482	10373585	1450800	1450800	852491	20%	225184	0	627307.48	1450800	100000
August	31	407	402	8645156	1450800	1450800	852491	20%	225184	0	627307.48	1450800	100000
September	30	195	190	4080366	1404000	1404000	824992	20%	217920	0	607071.75	1404000	100000
October	31	131	126	2702876	1450800	1450800	852491	50%	562960	0	289531.48	1450800	100000
November	30	14	9	190756	1404000	1404000	824992	50%	544800	0	280191.75	1404000	100000
December	31	1	0	0	1450800	1450800	852491	50%	562960	0	289531.48	1450800	100000
January	31	0	0	0	1450800	1450800	852491	100%	1125920	273428.53	0	1724229	-173429
February	28	0	0	0	1322100	1322100	776867	100%	1026040	249172.77	0	1571273	-422601
March	31	2	0	0	1450800	1450800	852491	100%	1125920	273428.53	0	1724229	-696030
April	30	3	0	0	1404000	1404000	824992	100%	1089600	264608.25	0	1668608	-960638
May	31	15	10	221759	1450800	1450800	852491	50%	562960	0	289531.48	1450800	-738879
June	30	201	196	4224186	1404000	1404000	824992	50%	544800	0	280191.75	1404000	100000
				30438683	17093700		10044275			1060638	3290665		

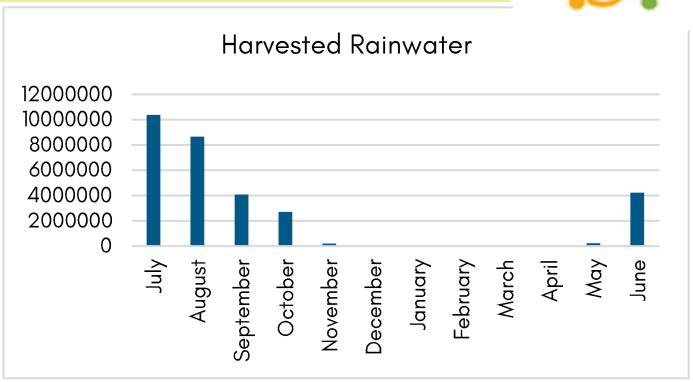
Table - Water cycle calculations

Total Fresh water demand= Occupants +Irrigation



Total water Harvested





The annual fresh water demand for occupants and irrigation is sufficed with the harvested Rainwater (stored and gr. recharged)

2.3. Net Positive Water Cycle Diagram- Annual

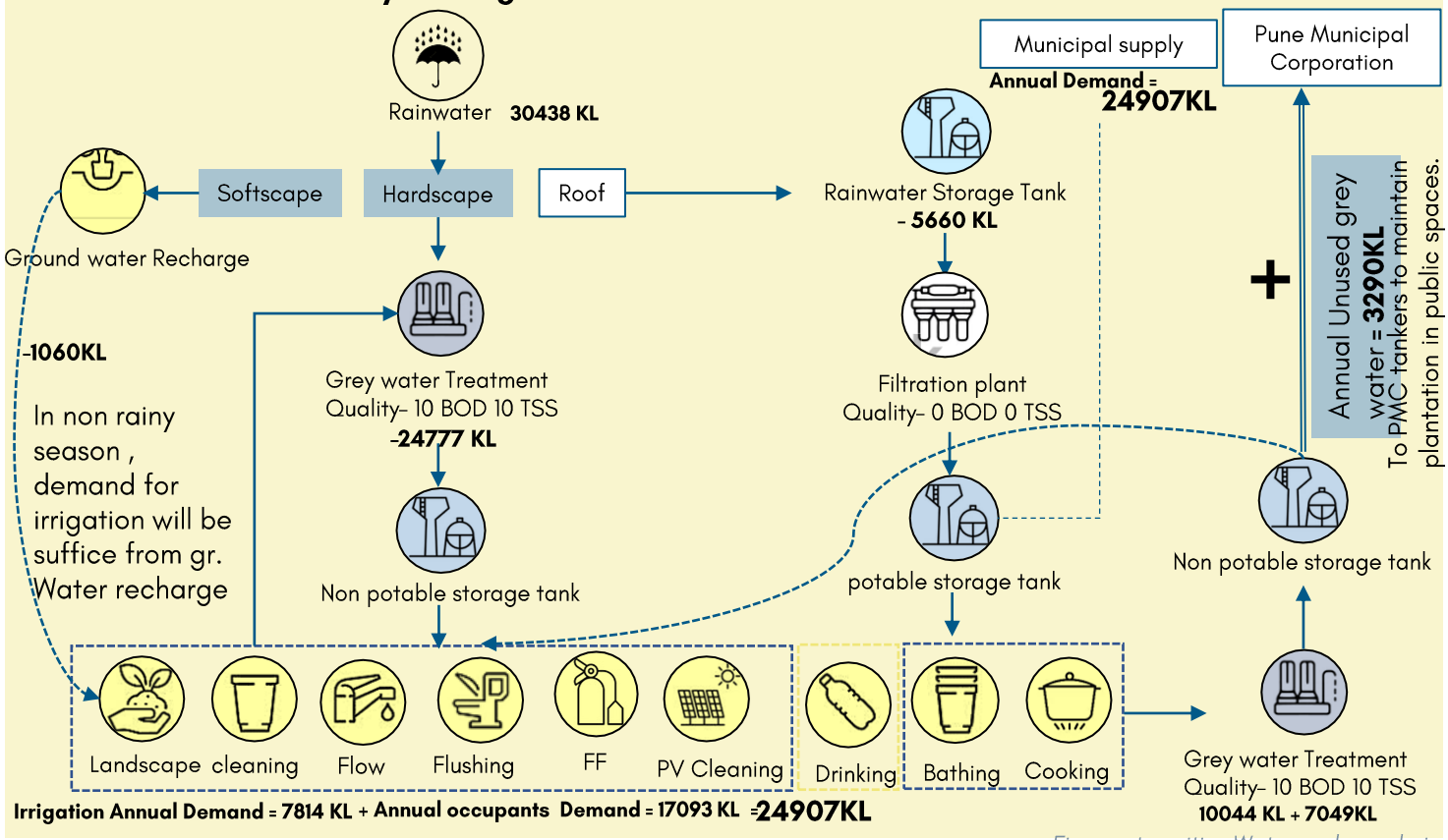


Fig. – net positive Water cycle analysis

2.4. Decentralized waste water treatment plant-

To treat wastewater sources, this system employs physical and biological treatment processes like sedimentation, floatation, aerobic, and anaerobic treatment.
It complies with environmental laws and regulations and is affordable, low maintenance, and made from locally sourced materials.
Potential Plant Capacity- 6 KLD – 3 KLD each.

2.5. Water Performance- By efficient Plumbing Fixtures-

Total Annual Water Reduction (using efficient fixtures) = 40%

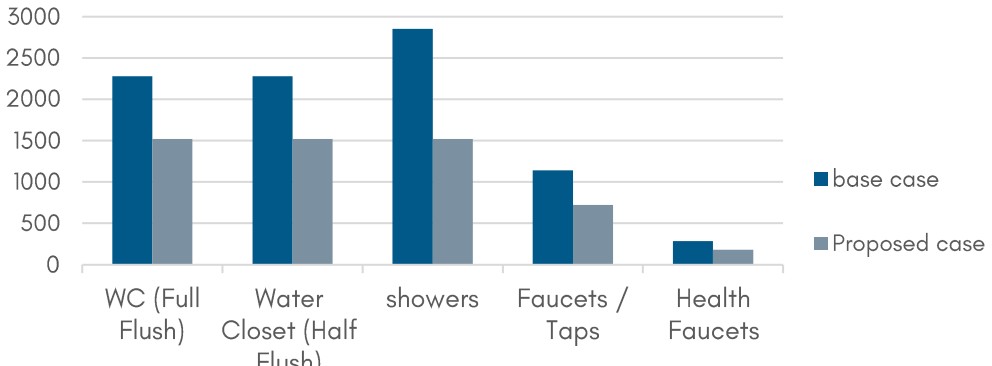


Fig. – water performance by efficient plumbing fixtures

3. Embodied Energy-

Embodied energy is the energy consumed by all the processes comprising the production of a building, from the extraction and processing of natural resources to manufacturing, transport and product delivery

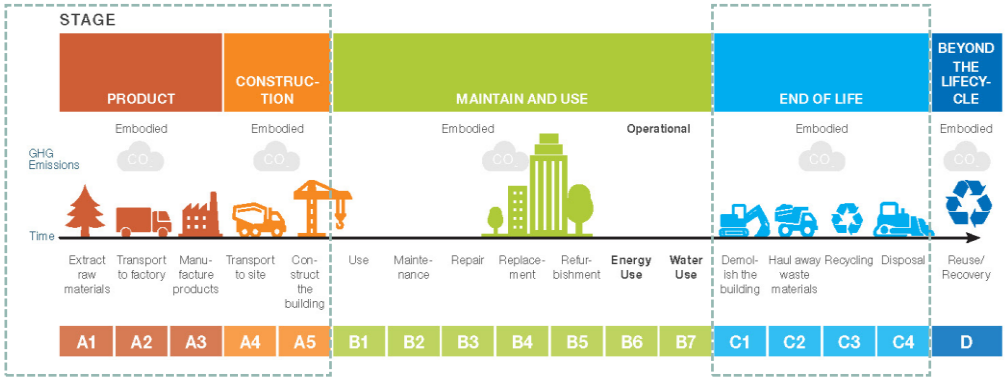


Fig.-embodied energy in building life cycle

For embodied energy calculations, 2 cases were designed in embodied energy calculator provided by SDI for Indian context materials and transportation emission factors.

Base case and proposed case were calculated with simillar material palette considered for energy simulations.
Material quantities for roof, wall, Floor, fenestration, structural assembly, Renewable energy, etc. was referred from BOQ. The average transportation distances from manufacturer and from retailer was calculated with the help of maps.

Reduction in embodied energy is achieved in design case by using **local materials with higher recycled content, lower CO_2 emissions.**

3.1. Project development process to reduce Embodied carbon

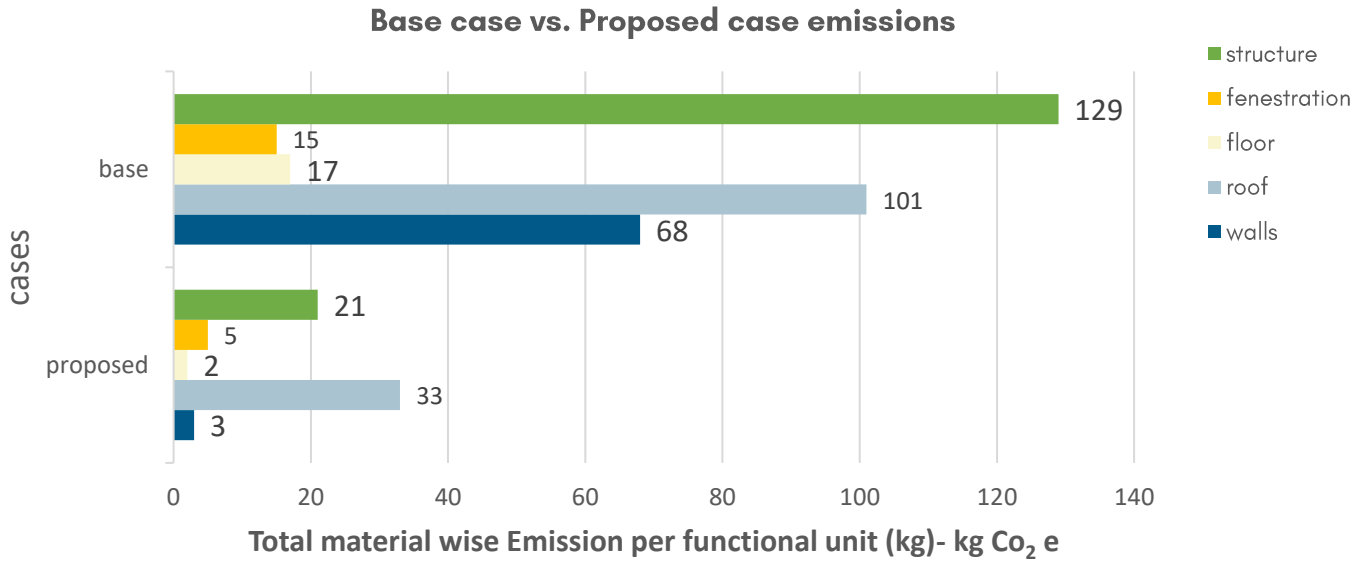


Fig. Base case vs. Proposed case Embodied energy per functional unit kg CO2 e

Material assembly	Base case	Proposed case	% reduction
Structure	129	21	84%
Fenestration	15	5	67%
Floor	17	2	88%
roof	101	33	67%
walls	68	3	96%

Table -Base case vs. Proposed case Embodied energy per functional unit kg CO2 e

Embodied emissions calculations Base case vs.. Proposed case

Base case

			Material manufacturing emissions					
	Material	**Unit**	**Quantity**	**Emissions Factor**	**Material Emissions** *(kg -CO_2 e)*	**Type of Vehicle used**	**Transport Emissions 1** *(kg -CO_2 e)*	**Transport Emissions 2** *(kg -CO_2 e)*
	Brick (common/facing)	kg	2640000	0.39	1029600	HGV Lorry	3124	625
	Cement based plaster	kg	46000	0.44	20240	HGV Lorry	3985	11
wall	Paint	l	99000	0.659	65241	HGV Lorry	234	216
Roof	Cement (OPC)	kg	336800	0.91	306488	HGV Lorry	3985	100
Flooring	Vitrified ceramic floor tiles	kg	139520	0.68	94874	HGV Lorry	4127	52
Glazing	Float glass	kg	6050	1.2	7260	Mini truck	661	17
	Cement (OPC)	kg	418560	0.91	380890	HGV Lorry	2476	248
Structure	Steel reinforcement (steel rebar)	kg	400000	2.6	1040000	HGV Lorry	2367	237

Proposed case

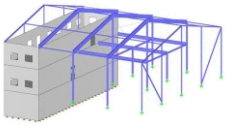
			Material manufacturing emissions					
	Material	**Unit**	**Quantity**	**Emissions factor**	**Material emissions** *(kg -CO_2 e)*	**Type of vehicle used**	**Transport emissions 1** *(kg -CO_2 e)*	**Transport emissions 2** *(kg -CO_2 e)*
	AAC with fly ash content	Kg	2640000	0.39	1029600	HGV lorry	3124	625
	RMC with (30% pozzolana)	Kg	46000	0.084	20240	HGV lorry	3985	11
Wall	Emulsion paint	L	99000	0.659	65241	HGV lorry	234	216
	RMC with fly-ash (30% pozzolana)	Kg	336800	0.084	28291	HGV lorry	3985	3985
	China mosaic	Kg	140350	0.67	94035	HGV lorry	332	332
Roof	XPS	Kg	3408.5	2.9	9885	Mini truck	37	37
Flooring	Carbon tile	Kg	49280	0.056	2760	HGV lorry	146	29
	Stone floor tile	Kg	200445	0.056	11225	HGV lorry	4744	119
Glazing	Float glass	Kg	6050	1.2	7260	Mini truck	661	17
	Cement (OPC)	Kg	418560	0.91	380890	HGV lorry	2476	248
Structure	Steel reinforcement (steel rebar) and steel sections	Kg	400000	2.6	1040000	HGV lorry	2367	237

Table -Base case vs. Proposed case Embodied energy calculations.

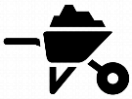
Compared to the base case, the proposed case has **lower emissions and embodied energy**. This is because sourcing locally and using recycled materials reduces the need for energy-intensive production and transportation processes, which has a negative impact on the environment.
Here the transportation emissions are almost similar as the base materials manufacturing are at the range of 500-1000 kms. Where as the distributor to site distances are within 20-100 kms.
The materials impact is significant than transportation.

Embodied carbon reduction strategies-

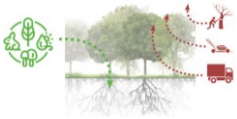
1. **Materials with recycled content:** For proposed case, we suggested recycled content to achieve lower embodied carbon. For instance, steel and concrete with recycled content have lower embodied carbon footprints than conventional steel and concrete.



2. **Utilizing prefabricated parts** for Upasana mandir and sports complex reduce construction waste and a building's carbon footprint. It can be quicker and more environmentally friendly to manufacture these parts off-site and ship them to the construction site for assembly.



3. Using locally available materials can significantly reduce transportation emissions.



4. Using native and adaptive planting palettes to help sequester of the carbon emissions on site.

4. Resilience-

Fire
Risk level- Low risk

Jnana Prabodhini is designed in accordance with the fire safety norms of the NBC.

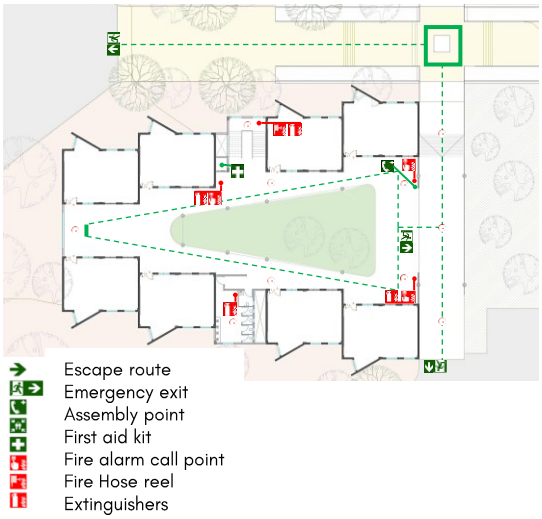


Fig.- Fire safety plan.

Mitigation measures-

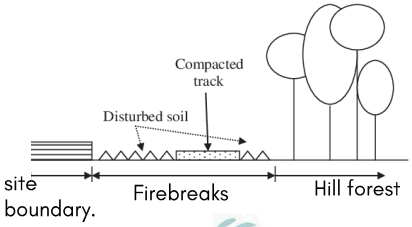
1. **Water sprinklers** have been provided at appropriate distances. All the staircases are compliant to fire safety and the code for egress.
2. **Fire extinguishers** at regular intervals are placed. There is pressurization in the staircase and lift shaft.
3. The basement auditorium has **fire exits** and **sprinkler systems** installed and the fire staircases lead to outside. All the emergency fire equipment such as fire pumps, ventilation and smoke dampers, emergency lighting, fire exit signage etc. are connected with a backup generator and they would function even in case of electrical failure.
4. Emergency evacuation plans would be developed, and the occupants would be trained with the help of mock fire drills.
5. Safety protocols are expected to be followed and will be taught to the students as part of fire safety training.

4. Resilience -

Wildfire-

Risk level- medium risk

The exposure to small scale surface wildfires in summers, which occur on the hills due to dry grass, dry leaves, and twigs. While assessing the site, It was observed that The wildfires occurring on the hills are mostly manmade, due to carelessness or negligence of people/community.



Mitigation measures-

1. The spread of wildfire from the surrounding area to the site can be prevented by creating firebreaks in the shape of small clearings of ditches along the site boundary.

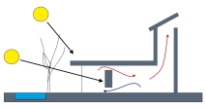
2. Water hydrants would be provided at strategic locations along the boundary for firefighting.

The school has a holiday of around one and a half month in summer so the risk to life of the occupants is very low. Awareness drives in the school as well as in the community around, would be held each year in the beginning of summer season to prevent manmade wildfires.

Heat wave –

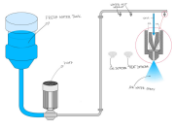
Risk level- medium- high risk

Climate change induced heat waves are becoming a part of summer in Pune and the occupants are at medium risk from the hazard. Although the school is closed for a month and half in summer, adequate measures are taken in the project to protect the

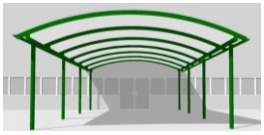


Mitigation measures-

1. Indoor thermal comfort is achieved with passive and active strategies.



2. The water mist systems, provided for firefighting would be used to lower the extreme temperatures in the events of heat waves.



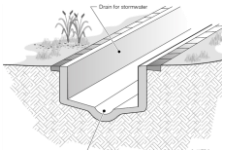
3. The outdoor areas- Are also taken care of with shaded pathways and tree cover in the regularly used areas. Alternatively, the working hours of the school would be changed to minimize the risk of exposing the occupants to the extreme mid-day heat.

4. Measures like grass pavers, reflective paints to roof surfaces, and adequate vegetation are implemented to reduce the heat island effect and offer protection against heat waves.

Extreme rainfall –

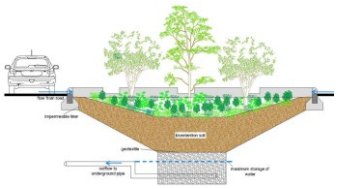
Risk level- medium- High risk

Climate change has altered the rainfall pattern and localized cloudburst like events have started to happen in Pune. The site, being situated on a hill slope has a risk of water flowing from the hilltop areas. The natural water flow pattern would be maintained in the undeveloped part of the site and the landscape design would ensure efficient drainage of the storm water.



Mitigation measures-

1. **Storm water drainage channel** network in the developed area is planned along the roadsides to ensure effective draining off of the storm water away from the buildings.



2. Landscape features like **permeable pavements, bio- retention areas, bio swales** are developed in the site at appropriate locations like near parking areas and hosel block areas to collect excessive stormwater runoff and help to reduce the risk of flooding.

3. **Landscape design with native species** help to absorb more water and prevent soil erosion and provide habitat for pollinators and birds and thus increase the biodiversity of the area making it more resilient to climate change.

Landslides –

Risk level- very low risk

The site although situated on a hill slope is at low risk of landslides as the strata is hard.

Mitigation measures-

1. The site development would be done to ensure retention of the natural terrain wherever possible and minimize cutting and filling in the project area. The buildings are placed in areas with gentle slopes ensuring minimum disturbance to the slopes.
2. Retaining walls constructed using stone recovered from the excavation would ensure stabilising the soil. Plantation of native plant species along the hill slopes would reduce the risk of soil erosion and landslides.

Response to Earthquake-

Risk level- low- medium risk

Pune falls under earthquake zone 3

Mitigation Measures-

1. Damage avoidance structural design design to reduce the amount of structural damage caused by earthquakes. Incorporating open spaces within campus.
2. Steps have been taken to make the building earthquake resistant by designing in compliance with Indian standards of earthquake code.
3. The building frame system used in our design is Reinforced concrete with expansion joints provided at an interval of 30 mts. (IS code 3414 of 1968). The building has been reinforced with shear walls at different places and all columns have reinforcement as per the NBC code for earthquake resilience.

Waste Management-

Risks- Medium risk

The areas of site is large and and without proper waste management and disposal, there is a threat of contamination of groundwater, Due to improper waste handling practices can lead to a health hazard
Due to unpleasant smells and dust can damage. the environmental quality

Mitigation measures-

1. Two phases of waste management are collection and treatment which are predetermined with location of treatment and disposal. Strategies that are included in that are: Reduction strategies, Reuse strategies, Recovery strategies: recycling, composting and energy.

2. The project aims to minimize the waste going in the landfills over the course of the year by reducing, reusing, and recovering waste streams and converting them into valuable resources.

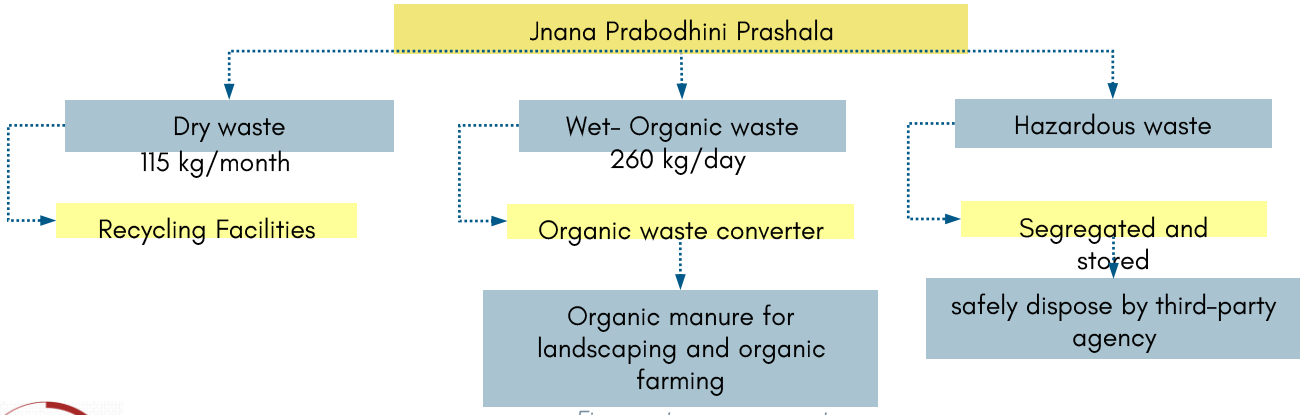


Fig.-waste management

Energy –

Risk level- Low- Medium risk

Mitigation measures-

1. The project has **on-grid PV** solar system to enable import of power from the grid **on overcast days and export in case of excess power generation on site**. There is a provision of biodiesel fueled backup generator of 120 KVA capacity to ensure basic functioning of the institute for at-least 8 hours/day in case of disruption of power supply. Campus is provided with solar streetlights to ensure illumination in the event of power disruption.

2. **A complete emergency lighting installation** will be provided at common areas to allow safe exit from the building(s) in the event of mains power failure.

3. The emergency lighting installation will generally comprise of dedicated luminaires (typically LED types), typically powered by central battery systems with minimum of 90-min ute battery.

Water –

Risk level- Low- Medium risk

The water demand of the project is met with harvested rainwater and recycled wastewater as demonstrated. Solar water pumps would be provided for pumping water from the borewells which would not be affected by disruption in power supply.

Food security –

Risk level- low risk

The on-site fruit trees along with farm produce would help in fulfilling the basic food demand in critical situations. The students will be involved in farming to enhance production and the benefits to be shared with them.

5. Engineering and operations

5.1.Wall Assembly Construction-

To provide thermally comfortable conditions to the occupants, thermal barrier is required to minimize the heat transfer.
After simulating various construction assemblies in design builder designed wall assembly consists of 2 layers of aac block with 50 mm cavity which gives u value of 0.38 W/m2.K. Instead of using layers of insulation, air cavity can be a good thermal barrier with a cost effective solution.

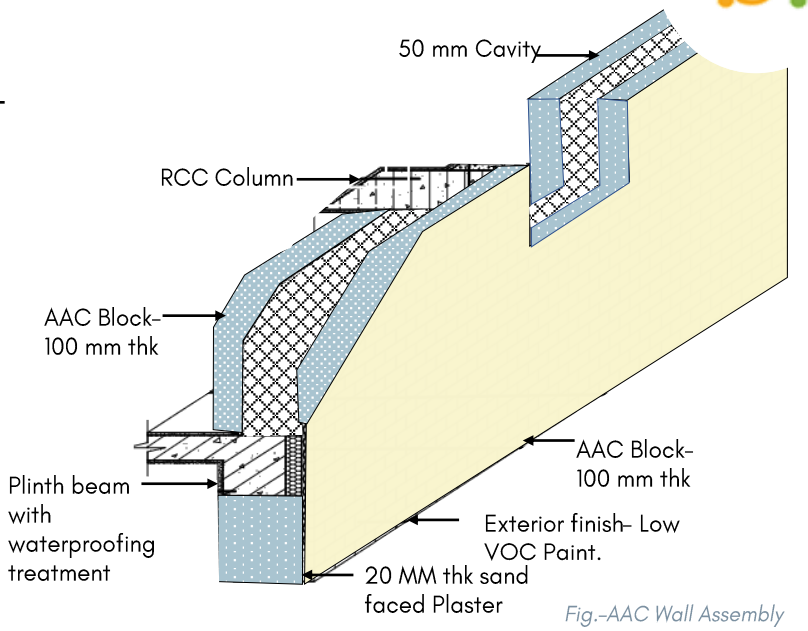


Fig.-AAC Wall Assembly

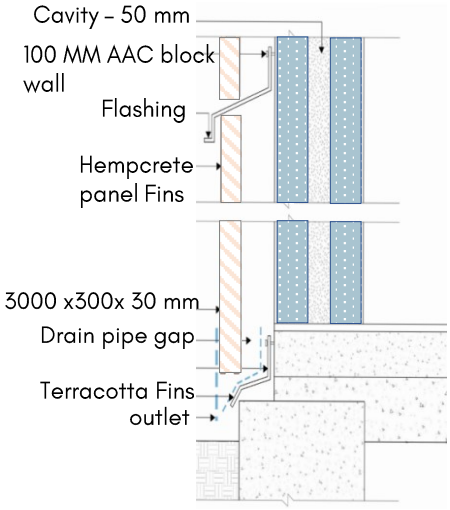


Fig.-AAC Wall with Hempcrete fins

Precast hempcrete panels for fins-
It is light in weight with low embodied carbon content. **Hempcrete** is bio composite material, a mixture of hemp hurds and lime, sand, or pozzolans.
The mix: 2 parts lime binder to 1 part hemp by weight which is used as a material for construction and insulation.
Hempcrete has good thermal and acoustic insulation capabilities.
Product specification-
Full Wall Size: 3000mm (H) x 300mm(W) x 30mm(THK)

Form: Tongue & Groove profile modules
Colour: Light beige natural woody colour exposing hemp raw material.

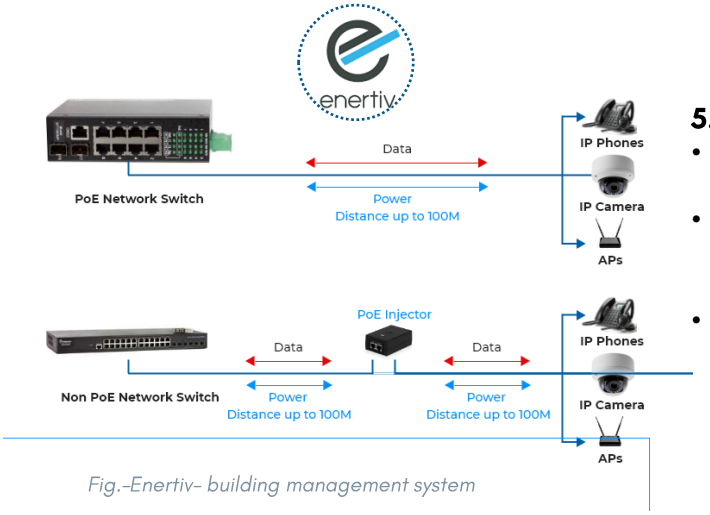


Fig.-Enertiv- building management system

5.3. Enertiv- POE: building management system

- PoE is very helpful in terms of school **safety and security.**
- Multiport switches with PoE-capable ports are a simple and affordable way to solve this problem because they offer great flexibility and reduce installation costs.
- For our project monitoring system will be created using software like Enertiv.

5.4. Use of 5-Star Equipment-

The use of inefficient equipment leads to higher rates of consumption. From the energy model we can observe that energy efficient appliances are critical for achieving net-zero energy use is to purchase of BEE- 5 star rated equipment

Fig.-BEE- 5 star rating

5.5. Renewable Energy generation-

Size of Power Plant	
Feasible Plant size as per your Roof Top Area	340.0kW
Cost of the Plant :	
MNRE current Benchmark Cost (without GST)	Rs. 35886 Rs. / kW
Total Electricity Generation from Solar Plant :	
Annual :	510000kWh
Life-Time (25 years):	12750000kWh
Tariff @ Rs.10.5/ kWh (for top slab of traffic) -	
Monthly :	Rs. 446250
Annually :	Rs. 5355000
Life-Time (25 years) :	Rs. 133875000
Payback Period	3.87 years

Average solar irradiation in MAHARASHTRA state is 1266.52 W / sq.m
1kWp solar rooftop plant will generate on an average over the year 5.0 kWh of electricity per day (considering 5.5 sunshine hours)

16728 Teak trees over the life time.

10455 tonnes CO_2 emissions mitigated

510000kWh
Annual Electricity Generation from Solar Plant

Table- Renewable Energy estimates

The available plant size for solar rooftop is 2000m2
After referring MNRE benchmarks, Average electricity generation is 510000 kWh.

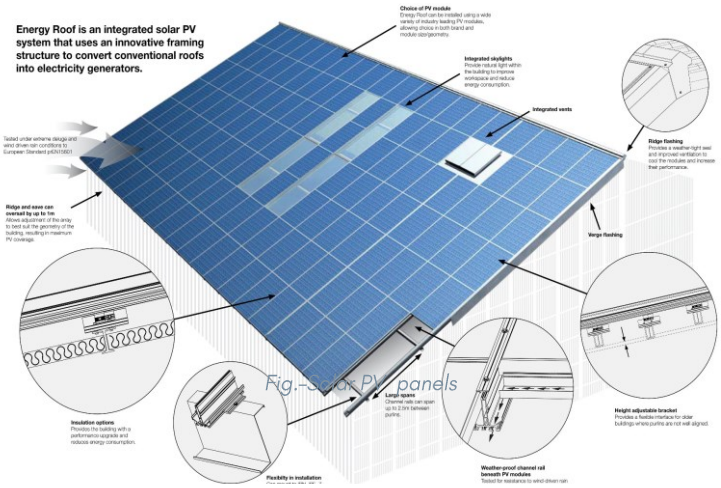


Fig.-Solar PV panels

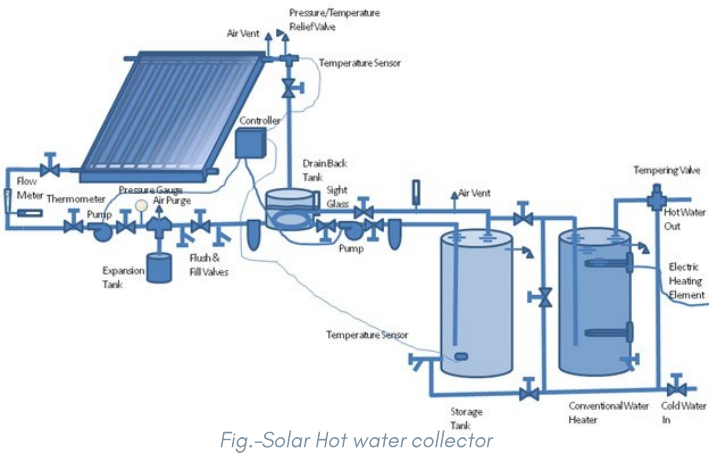


Fig.-Solar Hot water collector

Solar hot water requirement calculations		
No. Of occupants-	190	
Hot water requirement	20	Lit
Total water requirement	3800	Lit
1 solar collector capacity	150	Lit
No. Of collectors	25.3	Nos.
Space requirement for 1 solar collector	30	M2
Total space req.	760	M2
Terrace area available	780	M2
Cost of plant	250	Rs./Lit.
Total plant cost	950000	Rs.
Payback period calculations		
M*cp* ΔT		
M	3800	Lit
Cp	4.186	
Δt= (60-20)	40	
M*cp* ΔT	636272	J
	176.7422	Kwhr.
For 1st year el. Bill	530226.7	Rs.
For 2nd year el. Bill	1060453	Rs.
Payback period= 1.8 years		

Table- Renewable Energy estimates

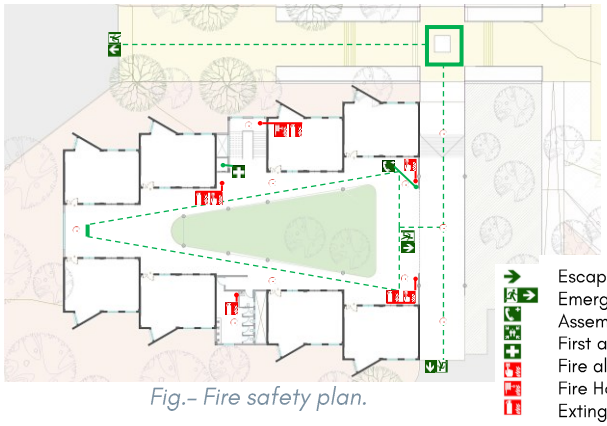


Fig.- Fire safety plan.

5.6. Efficient Fire fighting design-
Smoke Detectors- potentially avoid the risk of a fire and reduce the aftermath and all related expenses.

Carbon Monoxide detector- These detect the presence of carbon monoxide gas (CO) in surrounding air to prevent carbon monoxide poisoning.

5.7. MS Truss roofing-
MS steel truss, with **45% recycled content** one of the most commonly used trusses, offers an effective, flexible, and affordable roofing solution used for roofing of Upasana mandir.
As for Upasana mandir, light weight, long span column less space is needed hence truss design for roofing.

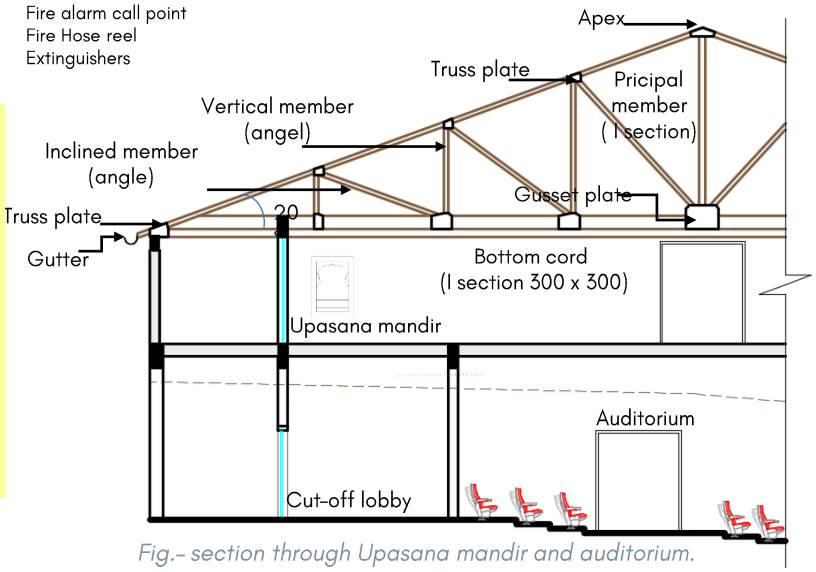


Fig.- section through Upasana mandir and auditorium.

5.7. Structural layout- school Block-

Fig.- Structural Plan- school Block.

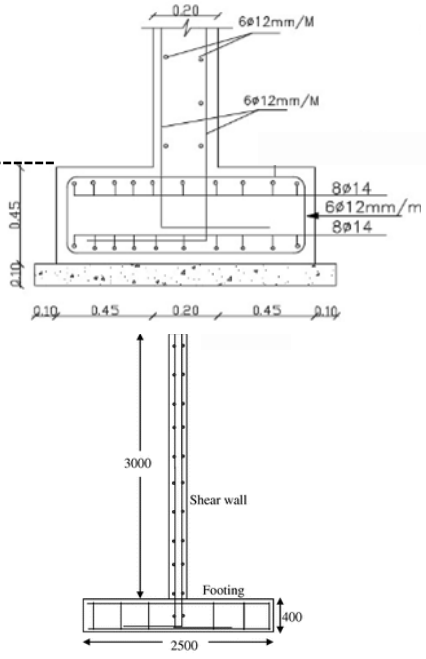


Fig.- Typical column and sheer wall design detail for school Block

The foundation is designed to withstand the ground movements that occur during an earthquake. The foundation is with steel or concrete for strength and stability. MS reinforcement with 85% of recycled content is recommended considering low Embodied emissions.

Sheer walls as lateral load resisting system is used. This system is designed to provide lateral stability to the structure and prevent it from collapsing during an earthquake.

5.8. HVAC Design

Calculations for Base case vs. Proposed case VAV systems Gives reduction in energy of 35%
By applying

- Schedules for HVAC, Adding IMAC temperature range for Pune.
- Temperature controls
- Efficient COP of 4.
- Redesigning building assembly with compliance of ECBC+ U values for walls, roof, glazing, etc.
- Achieving lower lighting consumption by selecting efficient luminaires capacity.
- Efficient equipments for lower sensible heat.
- Adding dehumidification factor for increasing comfort hours according to IMAC 90% acceptability temp. range.
- **Dedicated Outdoor Air System (DOAS)** According to ECBC, Pune comes under Warm and Humid zone ,thus DOAS helps to reduce the humidity.

	Base case		Designed case 1		Proposed case	
Total el. Load generated	**Kwhr**	**Annual kWHr**	**kWhr**	**Annual kWHr**	**kWhr**	**Annual kWHr**
Total lighting load	284.79	149175.06	207.88	108886.90	116.38	60958.33
Total equipments and pumps load	473.58	248064.67	338.27	177189.05	268.27	140522.38
Total HVAC load	1011.00	529573.27	459.55	240715.12	269.55	141191.31
Ext. Lighting load	1.28	670.13	0.98	515.48	0.93	486.10
	1770.65	927483.12	1006.68	527306.55	655.12	343158.12
EPI (kWhr/m2/yr)		84.32		47.94		**31.12**

Table- electric loads and EPI base case vs. Proposed case.

Built-up- 11000 m2

By using design builder, 3 cases were simulated. Due to right sizing and type of HVAC according to space condition, setpoints temperatures and humidity according to seasons (IMAC) and right scheduling, envelope modifications, etc gives **39%** reduction for proposed case. Also we have calculated for peak summer month conditions. use of appropriate lighting and star rated equipments help to achieve EPI less than Targeted EPI. i.e. **31.1 kWhr/m2/yr.**

HVAC Layout for school block- for labs .

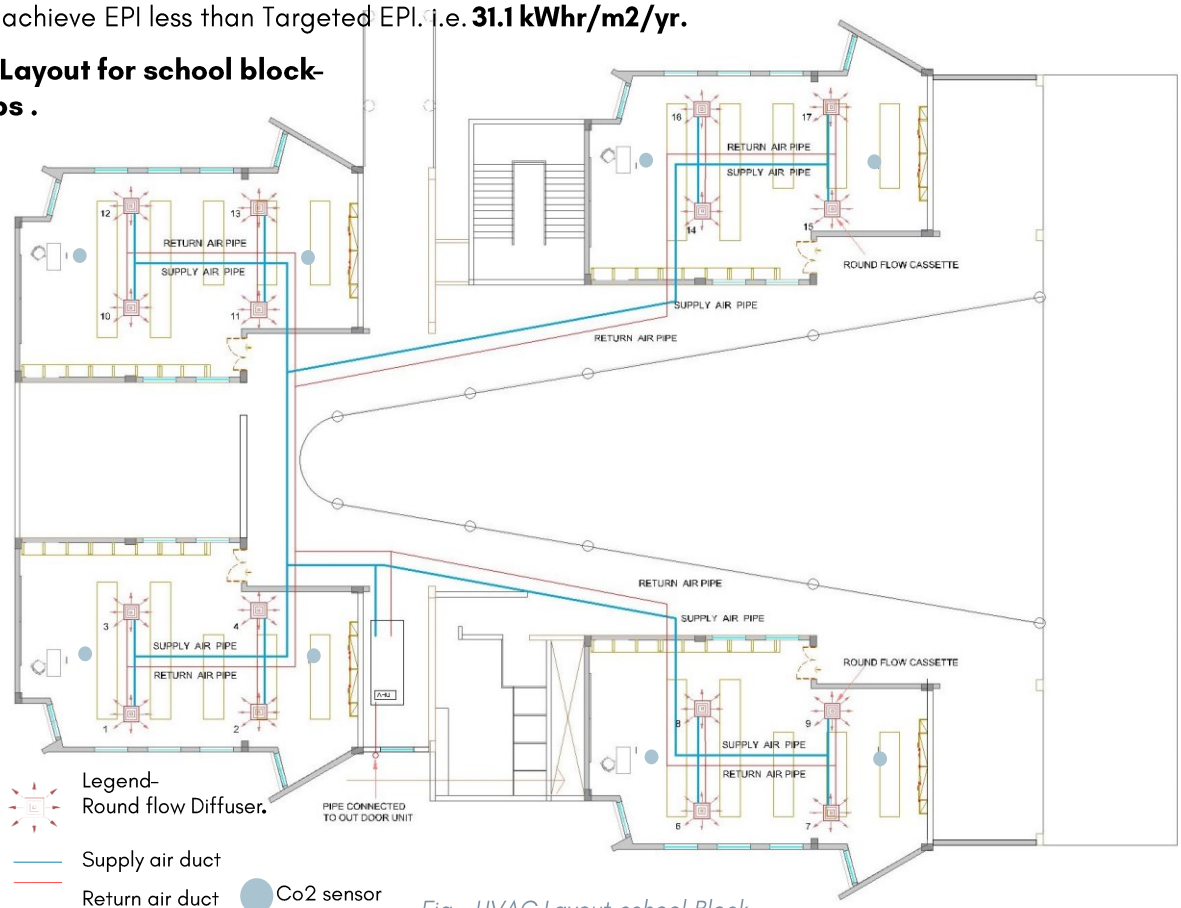
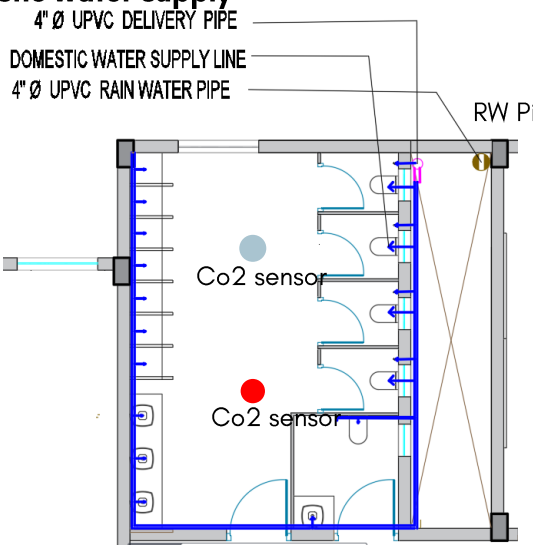


Fig.- HVAC Layout-school Block.

Plumbing Design

Domestic water supply-



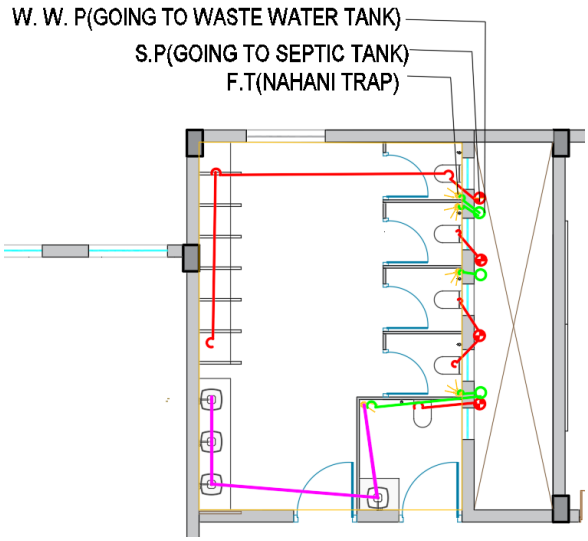
Legend-
4" UPVC delivery pipe
4" UPVC rainwater pipe
Domestic water supply line.

Note-
There is cold water supply from O.H.T
(Domestic water supply line)

Fig.- Water supply layout for toilets- school Block.

Each building's domestic water tank, which is located over the staircase block, will be connected to a water connection line with a metering system.
One-day domestic water storage and a hydro-pneumatic pump that supplies water to each fixture make up the water supply system. Through the domestic water tank, the needs for flushing and domestic water will be met.
By maintaining 1.5 bar of pressure at the fixture outlet, water will be distributed to toilets and wash basins.
The rainwater from roof will be collected through rainwater pipe and send it to filtration tank
The catch basin outside the building's perimeter will be used to connect rainwater collected from the building's roof to the external storm water network.

Drainage water layout-



Legends

Symbol	
F.T	floor trap
W.W.P	4" U.P.V.C waste water pipe
R.W.P	4" U.P.V.C rain water type
S.P	4" U.P.V.C soil pipe

Soil Pipe (going to septic tank)
Floor Trap (Nhani trap)
W.W.P (going to STP tank from drain lines)
Sunk provided for all toilets of depth- 200 mm

Fig.- Drainage layout for toilets- school Block.

The drainage networks will be constructed so that wastewater collection from the toilets will be transferred down to the STP with the intention of reusing as much wastewater as possible.
To collect wastewater from wash basins before dumping it into the manhole or inspection chamber, the drainage system has a trap with a water seal. The waste from soil pipes will be treated separately.
The manhole outlet will be linked to the infrastructure network, transported to the centralized sewage treatment plant (STP), and then used for irrigation and for flushing purpose.

6. Architectural Design-

6.1 Form and Design Evolution

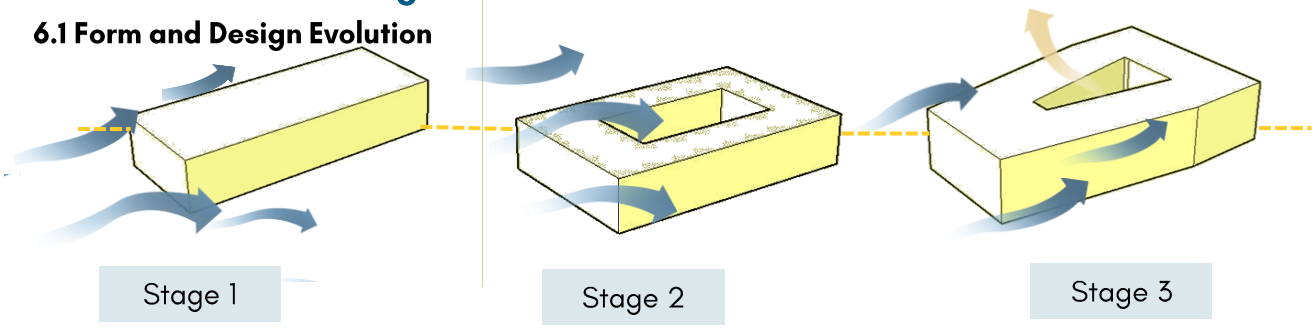


Fig .- Form evolution of school block

6.2 Preliminary energy and thermal analysis of a block model

Methodology: A School Block Model was modelled In **Ecotect** to analyse the Heat gains through the various components of the building envelope.

- Solar radiation on horizontal surfaces are maximum throughout the year.
- Compared to winter Months the radiation is higher on west and south west sides of a building block in month of March hence measures for shading needs to be incorporated(natural/shading devices)

Fig .- Radiation analysis of school block

6.3 Stages of Design Evolution

Stage 1

The buildings are oriented with the longer façade on the N-S direction , with major winds coming from the west.

Stage 2

The buildings are obliqued at 30° oriented for enhanced wind movement and minimum solar gains.

Stage 3

The buildings are obliqued at both north and south at 30° thus forming a wedge shape, which also creates a venturi effect.

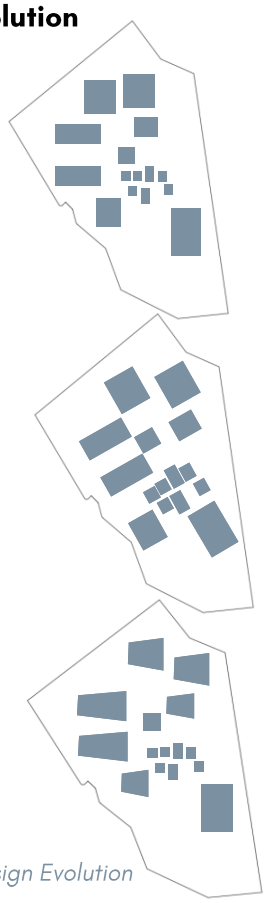


Fig .- Design Evolution

6.4 Computational Fluid Dynamics (CFD) Analysis

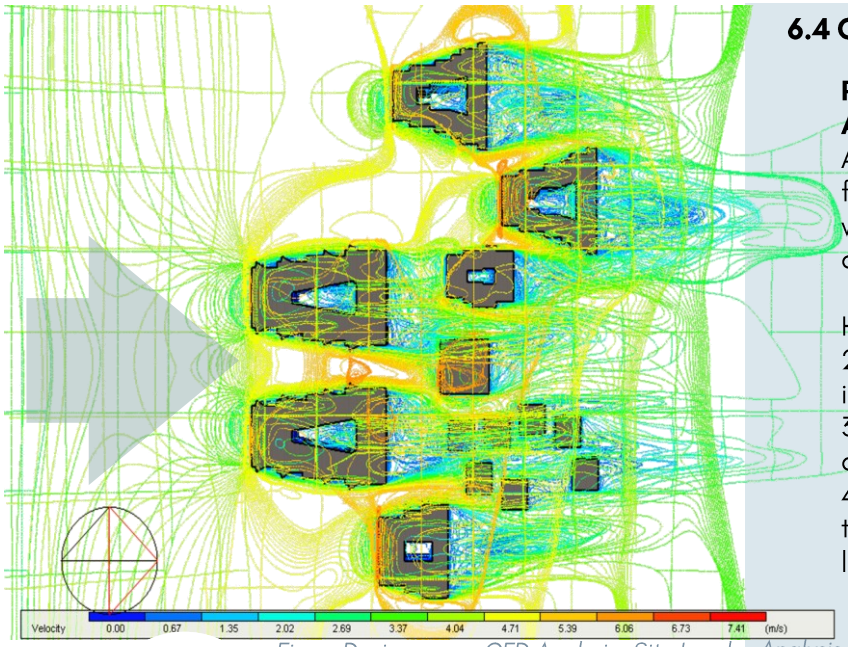


Fig . - Design case- CFD Analysis- Site Level Analysis done in- Design Builder

Prevailing wind direction 270⁰
Avg. Wind velocity- 2m/sec
As the site area is larger as compared to building footprint areas ,hence to there is a need of increase in velocity to reach natural wind to every building in a campus.

Hence 1.staggered arrangements of block is done.
2. Giving smaller openings on west side to get wind inside buildings.
3. Creating wedge form for building blocks will help to divert wind.
4. Distance between 2 buildings according to heights this will help to reach wind to buildings placed in leeward side.

6.5 Stages of Design Evolution

Site Synthesis

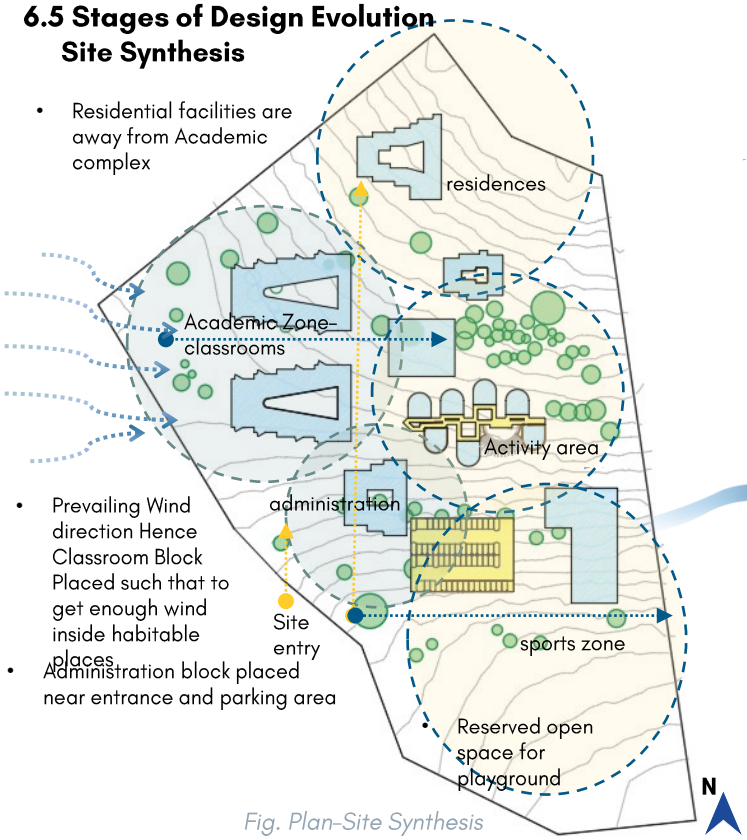


Fig. Plan-Site Synthesis

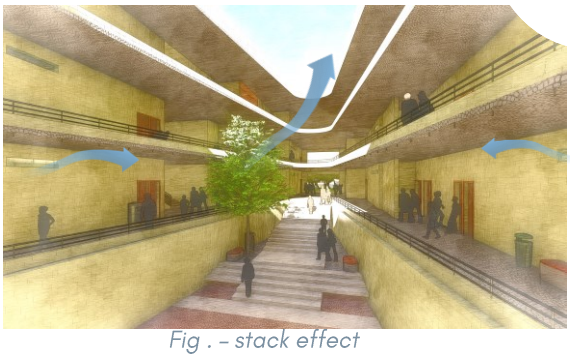


Fig . – stack effect

Fig . – cross ventilation in regularly occupied spaces classroom

The purposeful creation of positive and negative air pressure zones can create an increased air flow through a building or across a surface creating a cooling effect - the forced flow of air through a narrow passage, which can be achieved by creating a pressure difference. The small openings are placed on west side to take fresh air inside and hot air will rise up and escapes through openings on higher height.

All the classrooms are naturally ventilated. The airflow patterns within the building and identify areas of stagnant air or air that is not properly circulating. Were identified and sizing of openings were decided. This will improve the indoor air quality and reduce the risk of airborne contaminants.

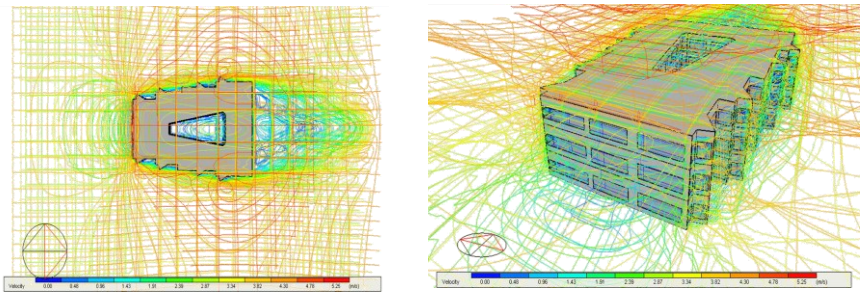


Fig . - CFD Analysis of School Block

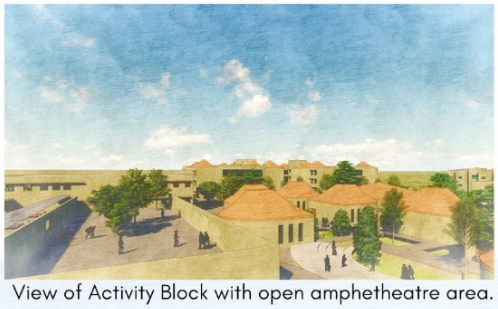
For daylighting ,with glazing of VLT ≥ 0.3, shading PF ≥0.4 shading and light shelves in windows, DEFs for windows in North = 3.5, in South = 3.0, in East = 2.1, and in West = 1.8. Head height is 3.6 m.

Orientation	DEF	Window/ Fenestration Width	X m (distance perpendicular to fenestration)	Y m (distance parallel to fenestration)	(X x Y m²)
North	3.5	12	12.6	14	176.4
South	3	12	10.8	14	151.2
East	2.1				
West	1.8	6			
Total daylight area per floor meeting UDI requirement during 90% of the year					327.6
Total daylight area in meeting UDI requirement during 90% of the year					982.8
Total classroom area per floor					560
Total classroom area					1680
% area daylit					68.5

Table- Window openings for daylighting as per orientation.

View of Administration department and School Block

View of Entrance School Block



View of Activity Block with open amphetheatre area.

Since Jnana Prabodhini has a cultural background, client interested in designing Assembly building with the vernacular architecture design. using modern technologies- not forgetting the old values.
Academic buildings with large central courtyards with smaller inlets on windeard side with sloping roof profile and verhanda style entrance foyer

Special requirement of the client are :-
- To enhance the facility for teaching and learning.
- 'Upasana Mandir' a dedicated prayer hall for daily prayer.

After a thorough analysis passive strategies was created to incorporate strategies at different levels from organization to building elements.
This resulted in a wedge-shaped building form with a courtyard and buffer zones which facilitate cross ventilation.

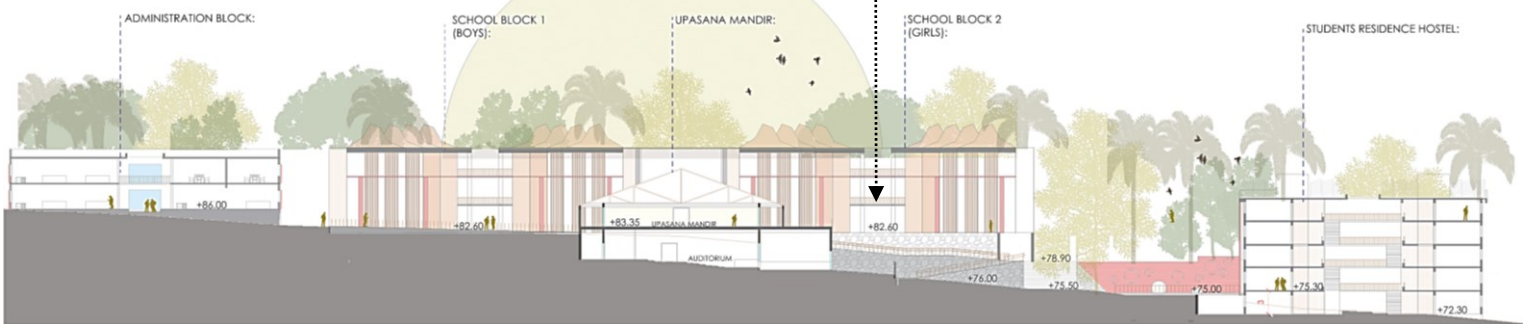
Concept Development-

A campus with building blocks dispersed carefully with series of open, semi covered and covered spaces offers a safe and comfortable outdoor environment.
The focal point of the campus is the prayer hall sitting atop an auditorium which is planned in the ground using natural contours.
Separate academic blocks are proposed for boys and girls in accordance with the requirements of jnan prabodini.
The labs placed on the top floor are connected to both the academic blocks through bridges.
The administrative block is placed at the main entrance to ensure visual connection to academic blocks, activity areas, hostel, and the playground.

Site Plan- Jnana Prabodhini Prashala Pune.

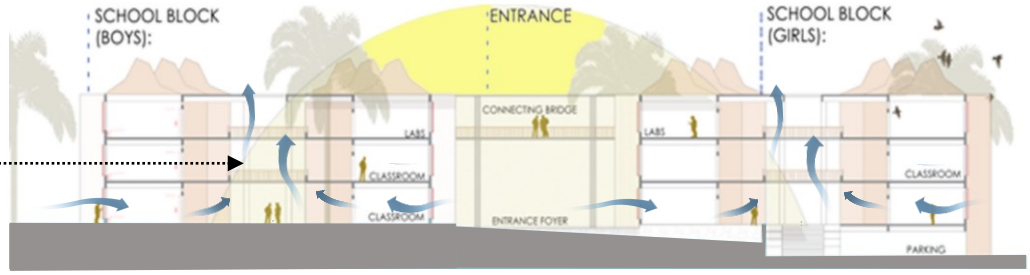
6.6.Architectural Drawings- Site sections

breezy courtyards
Indoor rooms, outdoor rooms and courts used can be designed with shade and partial enclosure that promotes good ventilation.



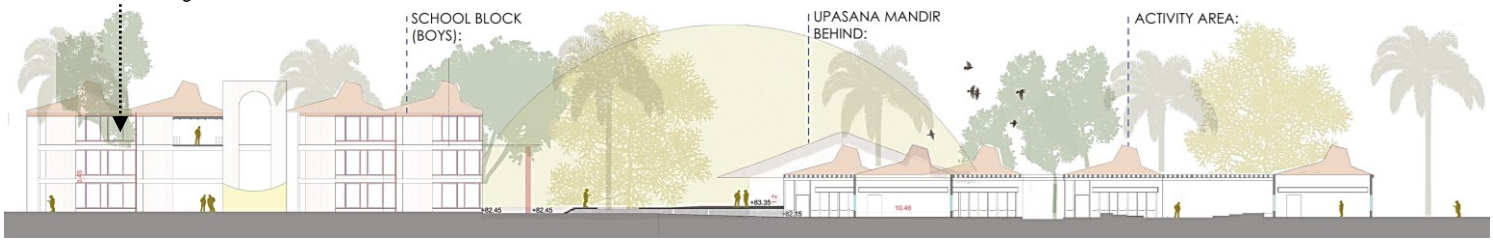
Cross ventilation accelerate wind and enhance natural ventilation

Stack effect uses the differences in air density inside and outside making a space cooler and enhancing natural ventilation



Section B-B

Horizontal Shading devices and overhangs reduce the solar gains and shade the building facade



Section C-C

Fig . - Site sections

Section D-D

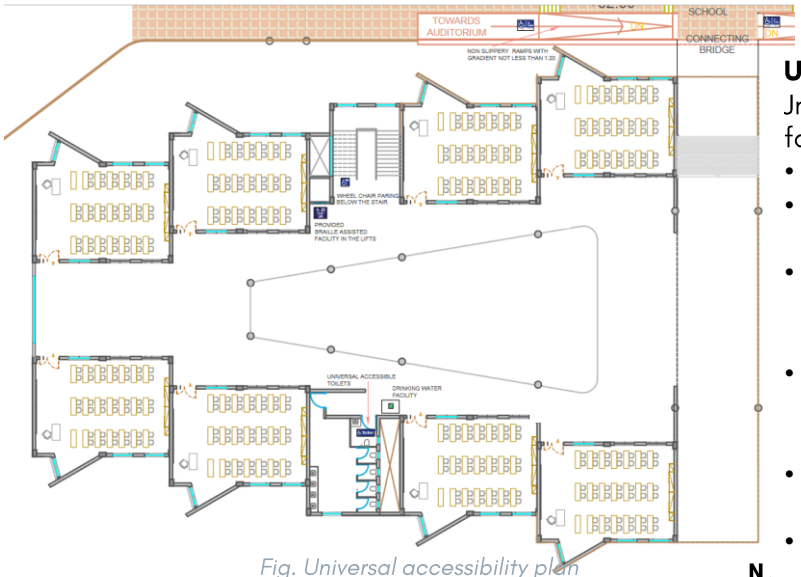


Fig. Universal accessibility plan

Universal Accessibility-

Jnana Prabodhini adopted following measures for occupants health and safety:

- Toilets designated for differently abled.
- Hindrance-free movements in common area (in regard to floor levels).
- Non-slippery ramps with gradient not less than 1:20, at entrance & exit to the building.
- In schools which have multilevel floors, provide lifts or ramps with handrails for movement.
- Provide Braille assisted facility in the lifts.
- Preferred parking for differently abled.

7. Affordability -

7.1 Construction Budget- Base Vs. Proposed (INR/m2)

S.No.	Particulars	Baseline Estimate (Project Partner / SOR basis)			Proposed Design Estimate		
		Amount (Million INR)	**%**	**Amount** (INR per sqm)	**Amount** (Million INR)	**%**	**Amount** (INR per sqm)
1	Land	100.00	11.2%	9,103	100.00	22.6%	9,103
2	Civil Works	159.93	17.9%	14,559	138.64	31.3%	12,621
3	Internal Works	106.32	11.9%	9,678	80.52	11.2%	7,330
4	MEP Services	351.66	39.4%	32,012	332.3	35.3%	30249
5	Equipment & Furnishing	18.58	2.1%	1,691	17.94	2.1%	1,633
6	Landscape & Site Development	79.76	8.9%	7,261	42.82	6.7%	3,898
7	Contingency	35.81	4.0%	3,260	30.61	2.9%	2,787
	TOTAL HARD COST	**852.1**	**95%**	**77,565**	**410.5**	**93%**	**67,372**
8	Pre Operative Expenses	10.00	1.1%	910	10.00	1.1%	910
9	Consultants	10.00	1.1%	910	10.00	1.1%	910
10	Interest During Construction	20.25	2.3%	1,844	11.72	1.3%	1,067
	TOTAL SOFT COST	**40.3**	**5%**	**3,664**	**31.7**	**4%**	**2,888**
	TOTAL PROJECT COST	**892.3**	**100%**	**81,230**	**442.3**	**100%**	**40,260**

Table- Construction Budget- Base Vs. Proposed (INR/m2)

The funds for land allocated for Jnana Prabodhini Prashala were given by the Jnana Prabodhini Trust.
the site area is 56286 Sq. M, hence the total site level development (roads, compound walls, retaining walls, curbs, pathways, landscaping, etc.) shares the major cost of the project along with civil construction work.
Also, the tentative land cost in Bavdhan region of Pune is also higher , as it comes under PMC limits.
Construction cost for proposed case- civil work approx. Rs. 12600 /m2

7.2. strategies that have been employed to reduce building construction materials costs for a proposed case.

- We team Vinaya extensively researched on materials considering its embodied emissions, affordability, life of the product and maintenance factor.
- Sourcing materials locally can significantly reduce transportation costs and the overall cost of materials. In addition, local materials are often more readily available and can be more sustainable.
- Alternative materials such as recycled materials, reclaimed wood, or pre-fabricated components can be less expensive than traditional materials and can provide unique design opportunities.
- Building Information Modeling (BIM) can help reduce the amount of waste and labor needed in construction, ultimately reducing material costs.
- For MEP, we have considered long-term costs materials instead of low quality materials available.
- As it is important Investing in higher-quality materials that require less maintenance can save money in the long run.

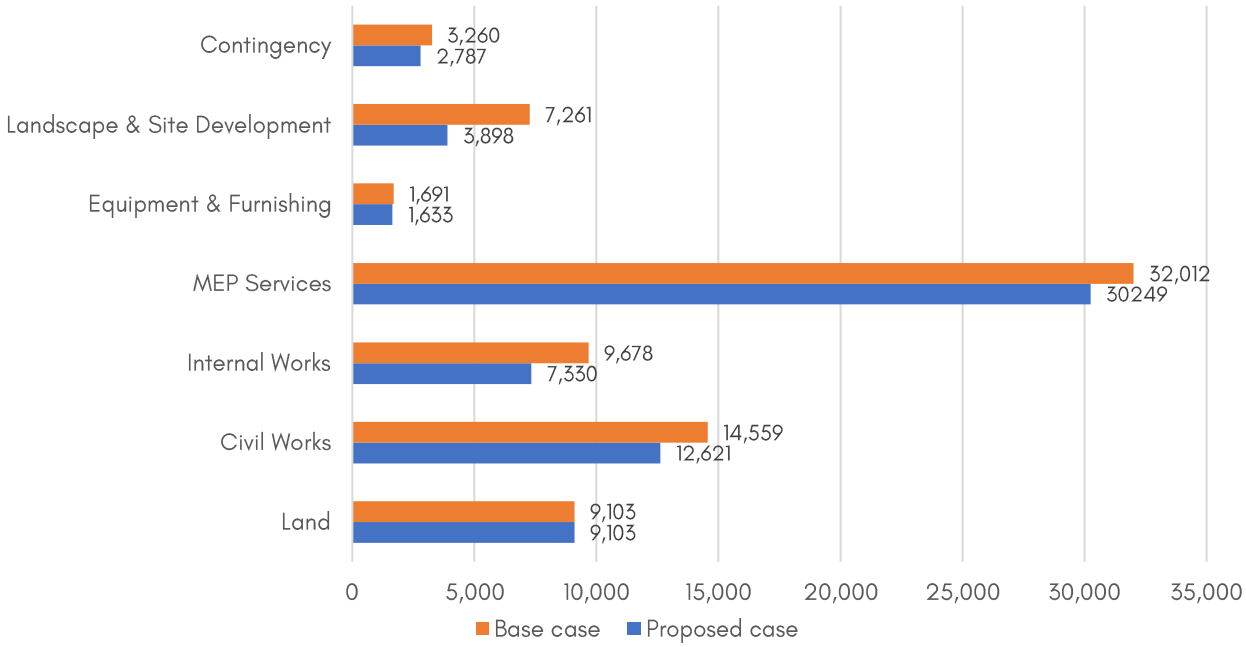


Fig.- Construction Budget according to particulars- Base Vs. Proposed (INR/m2)

7.3. Base case vs. Proposed case

- Resulting in additional cost of installations to reduce the energy bills, such as PV panels, renewable methods, and hybrid construction, the cost of the proposed case is higher in MEP than the baseline estimates.
- The cost of Rainwater harvesting Tank, STP System will increase overall capital cost but its beneficial for long term as it cuts down the operational cost in future after payback period got over.
- For landscape areas, use of native plants, use of grass pavers will reduce the cost for hardscape and landscaping.
- Instead of natural stone flooring and other finishes use of carbon tile will reduce the flooring cost upto 37%.
- improved daylight facility and better indoor environmental quality
  reduces the cooling and lighting loads. Hence, more areas are naturally ventilated and overall HVAC cost also reduces.

- **Locally available Building materials and materials with the percentage of recycled content.**

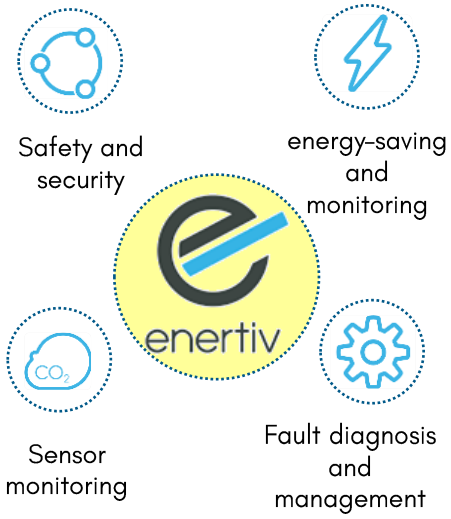
As per BOQ of proposed school project for Jnana Prabodhini, Pune, all the construction and finishing materials are locally available within range of 160 kms.
We suggested Project partner to reuse old benches and furniture which cuts down huge interior cost.

30% of total materials used have recycled content –
(Please refer annexures for BOQ of proposed school project for Jnana Prabodhini, Pune)

7.4. Renewable Energy Generation-

- **As per calculations for renewable energy generation through solar pv (mentioned in Engineering and operation section) For plant size of 345 KW of PV solar power plant, the payback period is 3.87 years.**
- For Hot water requirements, Solar Hot water collectors are used instead of el. or gas geysers. Hence a clean and renewable source of energy
- **Payback Period for solar Hot water collectors for a plant size of 3800 lit. is 1.8 years- 2 years**

8. Innovation



8.1. Campus monitoring system-

For our project monitoring system will be created using software like Enertiv – a building management system that includes a real-time energy dashboard that can be used to monitor energy usage by individual devices.
The app also provides detailed analytics that can help identify opportunities for
1.energy savings and track the effectiveness of energy-saving measures.
2. It also includes a **fault detection and diagnostics** tool that can be used to identify problems with building systems and devices that may be causing energy waste.
Use of the Sensors for the precise monitoring of temperature, air pressure, humidity levels, Fume levels (CO2,CO etc.)

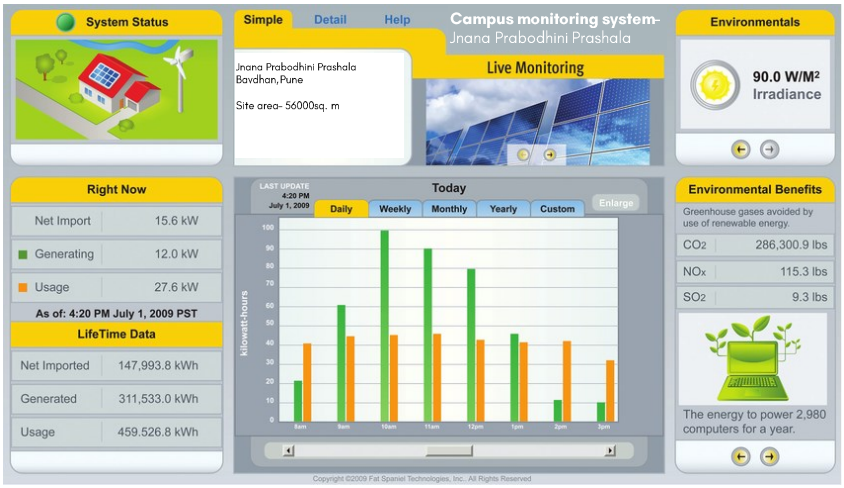


Fig. Campus monitoring system

The following elements could be included in a cutting-edge dashboard system that offers data on waste, water, and energy production in schools as well as management options for sustainable school design.

1.Real-time Monitoring: The dashboard system could make use of smart sensors to keep an eye on how much energy, water, and waste are being used in various parts of the school's campus. The data can then be seen and analyzed by students and school administrators via the dashboard.
The dashboard could also show how far you are from achieving sustainability objectives like maintaining green building certification or cutting energy use by a certain percentage.

2. Data Visualization: To give users a clear understanding of the school's energy, water, and waste performance, the dashboard system can visualise data as graphs, charts, and maps. This can assist both students and school administrators in spotting patterns and trends and making wise decisions.3.Energy and Water Conservation Tips: The dashboard system can provide energy and water conservation tips tailored to different areas of the school campus. For example, the system can suggest turning off lights in unoccupied classrooms or reducing shower time in the locker rooms.

3. Waste Reduction Techniques: The dashboard system can offer waste reduction techniques for various parts of the campus of the school. For instance, the system might advise reducing the amount of paper used in the classroom or using compostable plates and utensils in the cafeteria.

4. Gamification: By gamifying sustainable behaviors, the dashboard system can motivate faculty and staff to take part in sustainability initiatives. For instance, the system may grant badges or points for lowering waste production or energy consumption.

5. Community Engagement: By sharing the school's sustainability performance on social media and inviting students, staff, and parents to take part in sustainability initiatives, the dashboard system can foster community engagement.
1.Overall, the dashboard system can assist schools in implementing sustainable design by offering useful information and encouraging behaviour modification.

Fig. Campus monitoring system- Electricity consumption dashboard

6. Another innovative feature could be interactive elements that engage students in **sustainability efforts.**

For instance, a leaderboard displaying which classrooms or grade levels are using the least energy or creating the least waste could be displayed on the dashboard, fostering healthy competition among students and encouraging sustainable behaviours.
Ultimately, a cutting-edge dashboard system for sustainable school design would integrate real-time data, give administrators insights, and involve students in sustainability initiatives, contributing to the development of a more environmentally conscious and sustainable learning environment.

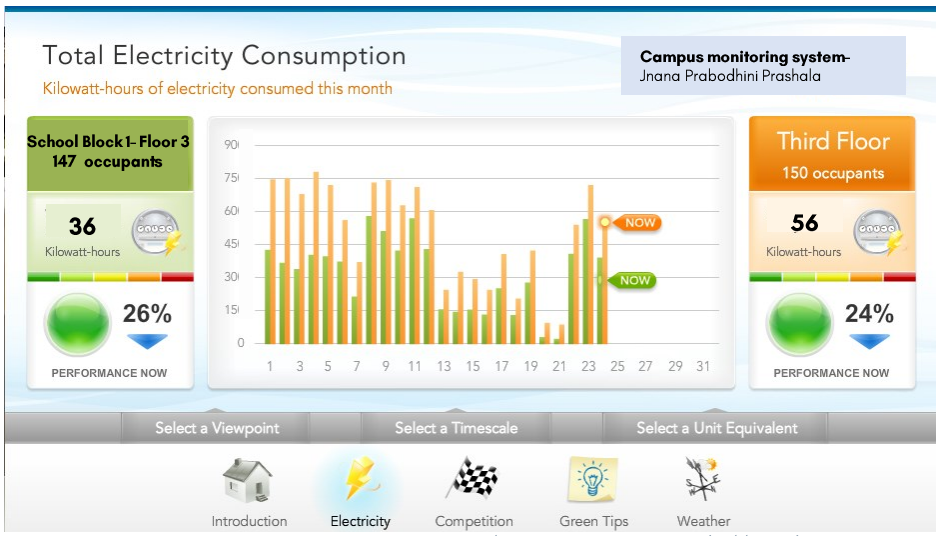


Fig. Campus monitoring system- Electricity consumption dashboard

9. Health and Wellbeing

Indoor Environmental Quality(IEQ) – A quality of indoor environments in relation to health and well being of occupants

9.1. Tobacco Smoke Control –

Jnana Prabodhini commits to the appropriate health and wellbeing of the occupants. For project, there are strict Nonsmoking zones.

Displaying 'no smoking zone' signage boards in all major locations in schoo campus.

- A no smoking signage at the main entrance indicating that smoking is prohibited within 100 meters from the school campus.

Fig.- posters showing No smoking zone

9.2. Daylight-

Designing regularly occupied spaces- At-least 40% of regularly occupied spaces meet the daylight factor. Hence simulations were done on light stanza to meet Prescribed Daylight Factor according to the space.

Daylighting simulations for school block-

Visual task	Prescribed Daylight Factor	Lux levels recommended by NBC	status
Classroomm desk top,	2.5	300	Achieved
Lab	2.5	450	Achieved
Library reading tables	2	500	Achieved

Table.- Daylight factors- benchmark

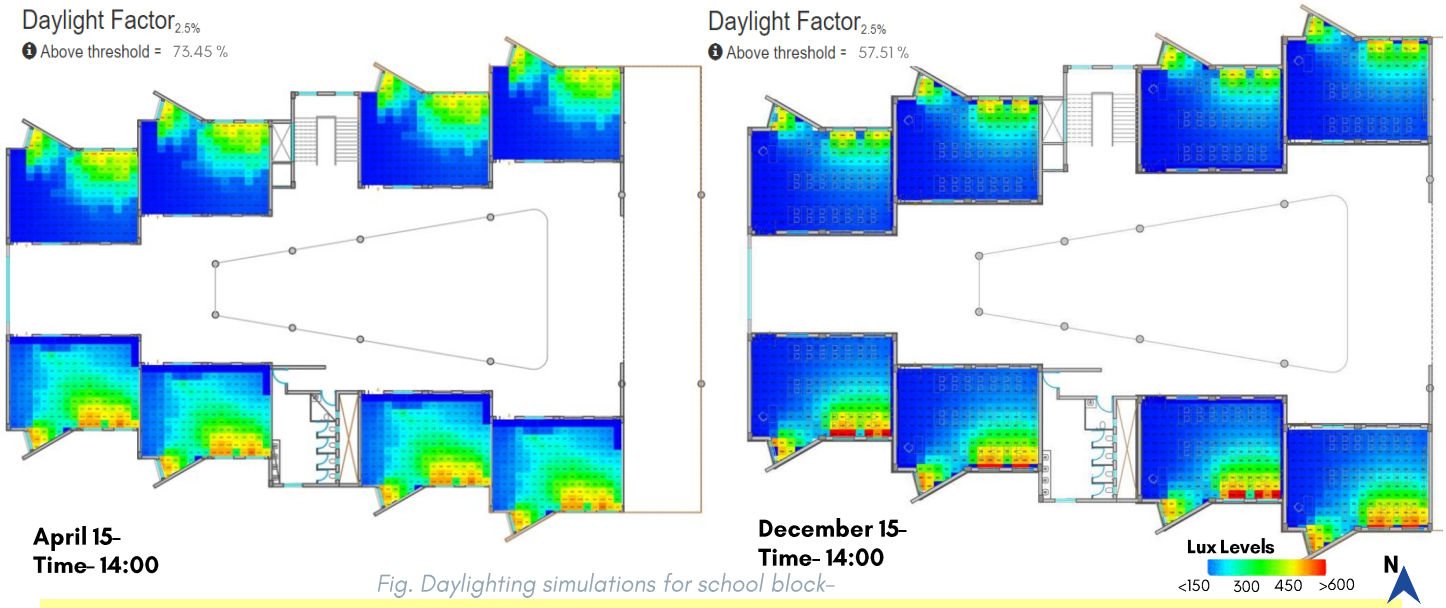


Fig. Daylighting simulations for school block-

For school block, all classrooms were designed **to fit maximum students** of total class strength in a daylit areas for a **productive indoor environment.**
The daylighting model is simulated in LightStanza. considering 800 mm as a working plane

At 2 different seasons- **On April 15**, at 2 PM , as the sun angles are higher, around 70% of the classroom area is above 300 lux levels
On December 15, at 2 PM , as the sun angles are lower, the lux levels near windows are in the range of 600-900. around 57% of the classroom area is above 300 lux levels
For classroom blocks exposed to North façade, direct radiation is less hence openings are wider than southern façade. With an overhang of 600 mm.
At southern facade, 600 mm overhands with fins used as a shading device **to reduce glare** in indoor regularly occupied areas.. The lux levels near windows are in the range of 400-580.

9.3. Fresh Air Ventilation

Naturally Ventilated Schools:

- All multi occupied spaces in the school shall have openings equal to or greater than 8% of the total carpet area.

Space	Carpet area in sqm (a)	Openable area in m2 (b)	Prescribed percentage or openable area	Percentage or openable area (b/a) x 100	Achieved/ Not achieved
School Block					
Classrooms	70	11.7	15%	17	Achieved
Labs	125	34.2	15%	27	Achieved
Admin Block					
Lobby	145.12	22.8	15%	16	Achieved
Office	70	14.4	15%	21	Achieved
Teacher's room	134.15	19.8	15%	15	Achieved
Hostel Block					
Rooms	21.75	4.305	15%	20	Achieved

Table.- Opening areas for naturally ventilated spaces calculations - source- ECBC

Mechanically Ventilated laboratories:

- The fresh air ventilation in all multi occupied areas were simulated with ventilation rate of 0.12 cfm/ sq.ft.
- The zone wise scheduling of HVAC is shown below.
- Dur to zonewise scheduling, The HVAC sizing from base case is significantly reduced from 61-22 tonnage for School block. (the brief calculations are provided in the appendix.)

	Zone Name	Multiplier (ratio)	Cool Design T (°F)	Heat Design T (°F)	Heat Temp Schedule	Cool Temp Schedule	Flow/Area (cfm/ft2)	OA Flow/Person (cfm)
1	GR FWSW Perim ML Zn (ML.V	1	85.0	0.0	n/a	n/a	n/a	n/a
2	GR FSSW Zone (f1.z2)	1	85.0	0.0	n/a	n/a	n/a	n/a
3	GR FE Zone (f1.z3)	1	76.0	0.0	admin temp. annual	S1 Sys1 (PSZ) Cool S	0.50	13.76
4	GR FCor Zone (f1.z4)	1	85.0	0.0	n/a	n/a	n/a	n/a
5	GR FNW Zone (f1.z5)	1	76.0	0.0	admin temp. annual	S1 Sys1 (PSZ) Cool S	0.50	13.76
6	GR FNNW Zone (f1.z6)	1	85.0	0.0	n/a	n/a	n/a	n/a
7	GR FCor Zone (f1.z7)	1	85.0	0.0	n/a	n/a	n/a	n/a
8	ffWSW Perim ML Zn (ML.WS	1	85.0	0.0	n/a	n/a	n/a	n/a
9	ffNW Zone (f1.z1)	1	76.0	0.0	admin temp. annual	S1 Sys1 (PSZ) Cool S	0.50	14.56
10	ffCor Zone (f1.z2)	1	85.0	0.0	n/a	n/a	n/a	n/a
11	ffNNW Zone (f1.z3)	1	85.0	0.0	n/a	n/a	n/a	n/a
12	ffE Zone (f1.z4)	1	76.0	0.0	admin temp. annual	S1 Sys1 (PSZ) Cool S	0.50	14.56
13	ffSSW Zone (f1.z5)	1	85.0	0.0	n/a	n/a	n/a	n/a
14	ffCor Zone (f1.z7)	1	85.0	0.0	n/a	n/a	n/a	n/a

Fig. HVAC mechanical ventilation schedules simulations for school block

System COP

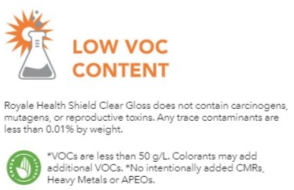
The HVAC system recommended for the project is a **VRV system.**
The system COP is ASHRAE baseline numbers. Incorporating a **VRV systems with a COP of 4 and above will effectively reduce the annual energy consumption and increase the savings.**

2**. Lighting Power Density**- The lighting design is based on space function method. it reduce the LPD of all spaces by 30% to increase the annual energy savings.

3. **Cooling setpoint- consider setpoint of 24 ± 1°C** for circulation spaces like corridors, lobbies etc.
4. **Insulation for roof** and cavity walls - this helps to reduce heat gains benefiecial for indoor thermal comfort during peak summer days.

9.4. Application of NO VOC content paints-

For interiors as well as for exteriors paints and coatings with low or no VOC content for 100% of interior wall and ceiling surface area are used.



10. Value proposition -

An area of the construction industry that has not been extensively researched is **net positive educational projects.**
The Jnana Prabodhini Prashala project in Pune was upgraded to an energy-efficient design by Team Vinaya from BNCA and Team Shoonya from IIT Bombay.
A multidisciplinary team from the building science, architecture, and engineering disciplines developed the design process using integrated design approach with the technical assistance of mentors. The team's intent can be broken down into the following:

• **Net-Zero Energy**: The project's consumption has been reduced from 89.1 to **31.1 kWh/m2 /yr**. This has been made possible by incorporating passive design strategies, offering a reliable HVAC system, and recommending laws that encourage the use of energy-efficient equipments.
Solar PV Panels- After a four-year payback period, the solar PV panels will save **5.3 million Rs. per year.**

NZE balance: For the proposed case, the total calculated annual energy consumption was **31.1 kWh/sqm.**
This consumption will satisfy by a renewable energy generation plant with a capacity of **340 kWh,** which produced 46.36 kWh/sqm/year.
Hence, a design with net positive energy.

• **Net-Positive Water :** Water consumption has been decreased by 40% through strategies such as Low flow fixtures, water harvesting, Water recycling, and occupant behavioral measures. An annual water requirement of **24907Kl** will be catered by RWH of on the other hand, **3290 Kl** of unused treated grey water will be given to PMC tankers for maintaining plantation in public spaces.

• **Net-Zero Waste:** Although effective waste management does not result in immediate financial gains, it actively contribute to a low carbon footprint.
zero solid waste is sent to landfills each year by converting organic waste into manure, reducing, reusing, and recovering dry waste to turn them into useful resources.

•**Green Educational campus Rating:** The three net-zero measures result in 5 star ratings from IGBC Green Schools as well as GRIHA.

7. Appendix-

7.1 Letter of Confirmation from Project Partner.

अविद्यया मृत्युं तीर्त्वा विद्यया अमृतम् अश्नुते ।

JÑĀNA PRABODHINĪ PRASHĀLĀ

ज्ञान प्रबोधिनी प्रशाला

Affiliated to Central Board of Secondary Education, New Delhi
(Vide Letter No. CBSE/AI/69/(G)/12096/Dt. 30/04/69)
School Examination No. - 30008 School Affiliation No. 1130001

ज्ञान प्रबोधिनी प्रशाला, पुणे
१९६९-२०१९
Jñāna Prabōdhinī Prashāla, Pune
1969-2019
॥ राष्ट्रदेवा: भवेम ॥
ज्ञान प्रबोधिनी प्रशाला सुवर्ण महोत्सव
Rashtriya Saka 1891-1941 : A.D. 1969-2019

President	Vice President/s	Chairman	Director	Principal
Dr. Raghunath Mashelkar Former Director General CSIR, New Delhi	**Dr. Vijay Kelkar** Economist **Shri. Anna Hazare** Social Worker	**Shri. S. B./ Ravi Pandit** Industrialist	**Dr. Girish S. Bapat** Secretary **Shri. V. S. Deshpande** Joint Secretary **Shri. V. D. Gurjar**	**Dr. Milind M. Naik**

Date- 06/10/2022

To,
The Director,
Solar Decathlon India

Dear Sir,

This is to inform you that our organization Jnana Prabodhini Prashala, Pune has provided information about our Educational Building (Secondary and Higher secondary school) project to the participating team led by Dr. B.N. College of Architecture, Pune, so that their Team Vinaya may use this information for their Solar Decathlon India 2022-23 Challenge entry.

As a Project Partner to this team for the Solar Decathlon India 2022-23 competition, we are interested in seeing the Net-Zero-Energy, Net-Zero-Water, resilient and affordable solution this student team proposes and the innovation that results from this. We intend to have a representative from our organization attend the Design Challenge Finals event in April, if this team is selected for the finals.

We would like our organization's logo to be displayed on the Solar Decathlon India website, recognizing us as one of the Project Partners for the 2022-23 Challenge.
With warm regards,

(DR. MILIND NAIK)
Principal
milind.naik@prabodhini.org
9422002180
PRINCIPAL
Jnana Prabodhini Prashala
Pune - 411 030

510 Sadashiv Peth, Pune 411 030. INDIA / **Tel.**: 0 (91) (020) 24207000 / 24207121 **Fax** : (91) (020) 24491806
Email : prashala@jnanaprabodhini.org website - prashala.jnanaprabodhini.org

Design Process for the project Towards Green Campus

5.1. Design Process

Project category finalization discussion with guides

Meeting with Project Partner-
Jnana Prabodhini Prashala, Pune
Principal- Dr. Milind Naik.

Project Partner Finalization-
Jnana Prabodhini Prashala, Pune
Understanding Project brief and design requirements.

Team Formation- TEAM VINAYA, BNCA PUNE

Pre design survey-
For understanding Net zero educational campus project

finalization of institute partner.
Meeting with
Mr. Prabhat Sharma -Team Lead
Team Shoonya, IIT Bombay

Partner Institute- IIT Bombay, Team Shoonya

Studying SDI Guidelines

Team meetings and working
Pre- design analysis

Internal review with Team Shoonya
HVAC solutions, Simulations, Energy efficiency

working on project on **10 contests and designing**

Internal review with Guides
Prof. Prajakta Dalal - Kulkarni

Deliverable 1

- **case studies** approach (live and virtual) for climate responsive design ideas.
- **Site visits-** for understanding site conditions and site potentials, understanding microclimate.
- **Site analysis** and suitability – synthesis
- **Site zoning** according to area program
- **Basic estimates formation**
- **Goals formation** towards Net zero project
- **Passive design ideas** for warm and humid climate zone.

Deliverable 2

- Working on comments of D-1
- **Thermal and heat gain analysis.**
- **Simulation approach** for energy efficient design.
- **Redesigning** with alteration of material assembly, systems, etc. for **EPI reduction.**
- **Introduction to RE** to shift from el. grid

Deliverable 3

- **Reworking on estimates and embodied carbon.**
- **Architectural designing options.**
- **Structural designing and detailing.**
- **Calculation** Heat gain, electrical loads, cooling loads, embodied energy, RE Potential, Hot water requirements, waste generation, water management, etc.
- Design Builder simulations for Energy efficiency.

Deliverable 4

5.2 Site Analysis

The site is located in **Bavdhan**, near Pashan lake, Pune.

- **Major Access:** NH 48 , Mumbai - Pune Highway
- **Connecting roads:** Pashan road & Paud Road
- **Site surroundings:**
  - Pashan lake on the north
  - Necklace garden on the north-east
  - Arai hills on the east

Residential development and connecting road- Paud road on the south Chandni chowk on the south-west NH48 Mumbai-Pune Highway along the north, west and north-west.

1.5 km- Bavdhan- pashan road

1.5 km- Shreekrishna nagar

2 km- Kothrud Depot Metro station

Accessible- chandani chowk

Nearby Attractions -

1. Mhatoba hills
2. Neckless Garden
3. Pashan Lake

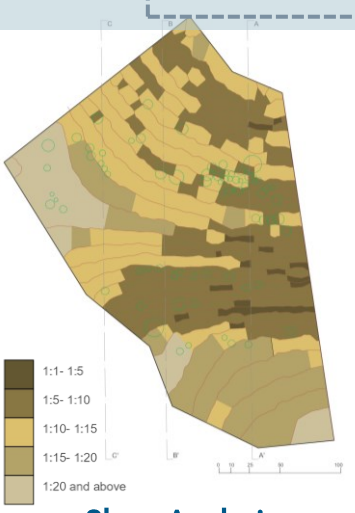
Road Network-

1. Towards Chandani Chawk

The site is bit far away from the dense settlements.

Landuse-

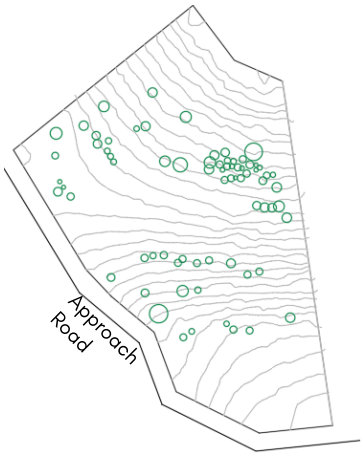
1. The site comes under the hill slopes area with residential and mixed use development nearby



Slope Analysis-

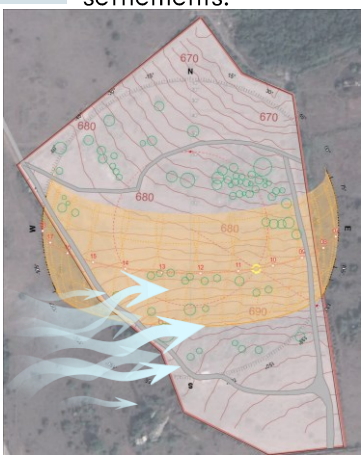
Gives an idea about buildable and non buildable areas- slopes above 1:10 are buildable slopes

Slope from South-North with total drop of 28 m



Existing Vegetation-

Site has some existing vegetated areas with some native plants and fertile soil. This needs to be conserved



Sun path and wind direction

Prevailing wind direction- West.

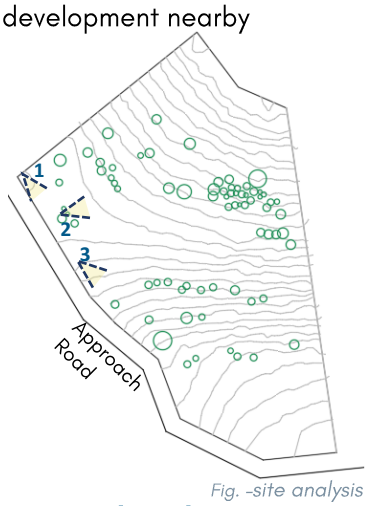


Fig. -site analysis

Visual Analysis-

Site has view of Hills from east and North East Side.

Fig.- Photographs showing Views of site

Fig. -civil aviation map

5.3. Site location and civil aviation-

The site comes under . If the proposed building/structure is falling underN3/N4 zone then for buildings/structures with top elevation higher than 657/ 682 Meters AMSL,

Applications for NOC have been filed with IAF.

5.4. Microclimatic analysis-

Annual ratings for sun, wind and shadow are taken from the extreme months are taken and maximum assigned values are most preferable locations for structures

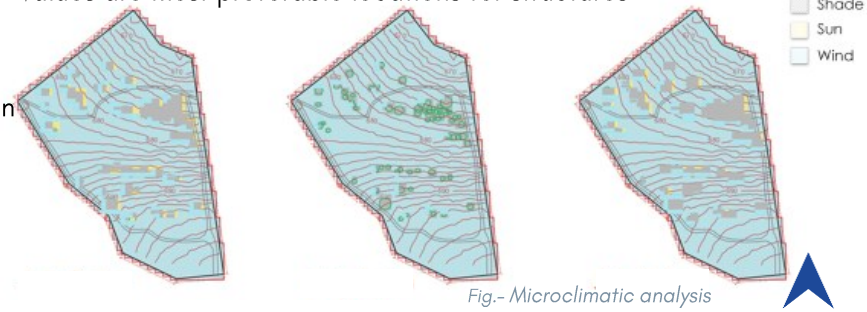


Fig.- Microclimatic analysis

Area Program **Jnana Prabodhini, Pune**

Site area- 56286 M^2 Landscape area- 17666.59 M^2 Total builtup area- 10985 M^2

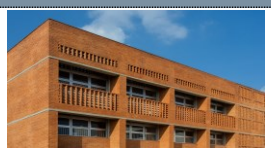
No	Function	Users /unit	Area/unit	No. Of units	Total area	Space type
Academic						
1	Classrooms	40	70	16	1120	Unonditioned
Facility						
1	Library		150	1	150	Conditioned
Laboratories						
1	Physics lab	40	100	1	100	Conditioned
2	Chemistry lab	40	100	1	100	Conditioned
3	Biology lab	40	100	1	100	Conditioned
4	Mathematics lab	40	70	1	70	Conditioned
5	Computer labs	40	100	2	200	Conditioned
Special rooms						
1	Language	40	100	1	100	Conditioned
2	Social sciences	40	100	1	100	Conditioned
3	Activity rooms	40	100	6	600	Conditioned
4	Special purpose group room	40	100	1	100	Conditioned
Administration						
1	Reception counter	2	40	1	40	Unconditioned
2	Office	6	40	1	40	Conditioned
3	Principals room	2	70	1	70	Conditioned
4	Meeting rooms	10	100	2	200	Conditioned
5	Record room	1	20	1	20	Unconditioned
6	Store room	1	40	1	40	Unconditioned
Common facilities						
1	Teachers room	30	150	1	150	Unconditioned
2	Youth wings	80	70	2	140	Unconditioned
3	Prayer hall	300	300	1	300	Unconditioned
4	Auditorium	300	500	1	500	Conditioned
6	Study room		70	1	70	Unconditioned
7	Meditation room		70	1	70	Unconditioned
Residential facility						
1	Guest rooms	4-8	30	4	120	Conditioned
2	Rest room	8	100	1	100	Unconditioned
3	Kitchen	4-5	100	1	100	Unconditioned
4	Dining hall	120	150	1	150	Unconditioned
5	Hostel	160	20	80	1600	Unconditioned
6	Teachers residence	10	50	10	500	Conditioned
Sports indoor						
1	Swimming pool		300	1	300	Unconditioned
2	Gymnasium		200	2	400	Unconditioned
3	Basketball		200	2	400	Unconditioned
4	Badminton		200			Unconditioned
5	Indoor games		200	2	400	Unconditioned
					8450	
	Circulation		20%		1690	
	Toilets		10%		845	
					10985	
	Conditioned spaces				3620	

(Table--Area Program)

7. Appendix -

Case studies -Analysis

The case studies of schools and institutes are given below with inferences and selection was done to understand the climatic segment of hot and humid climate for an integrated application of design strategies.

		International Management Institute, Odisha	Akshar Arbol International School, Chennai	My First School, Tiruvannamalai
Sr. No	**Aspects studied**			
1	**Location**	Bhubaneswar, Odisha	Chennai ,India	Tiruvannamalai, Tamilnadu
2	**Longitude and latitude of the site**	20.2961° N, 85.8245° E	13.0827° N, 80.2707° E	12.2253° N, 79.0747° E
3	**Climate**	Hot & Humid	Hot & Humid	Hot & Humid
4	**User group**	Students, faculties, admins and staff, peons (working staff), visitors	Students, faculties, admins and staff, peons (working staff), visitors	Students, faculties, admins and staff, peons (working staff), visitors
5	**Built up area**	Total area 64,749 sq m (built up 40,410 sq m)	3885 sq.m	31500 sq.m
6	**Building orientation**	Oriented on site to minimize heat gain to reduce electro-mechanical energy in north south direction	North-South	longitudinal side facing towards north- south
7	**Daylight**	The library block with an incline glass box invites natural daylight	Abundantly natural light illuminates the school as it is a purely 'day' building.	Circular openings are provided on top of verandas and at jail openings are provided.
8	**Shading devices and glazing**	The library block has been **strategically placed to cast shadows** **Large overhangs** have been integrated in the design	A **sky-lit activity area** shared by a set of four classrooms Sliding glass partitions to get ample amount of daylighting. **Large horizontal overhangs** on south, west side	**Balconies** are designed with **angled vertical louvers** so as to minimize glare but allow breeze through. West façade windows with **vertical and horizontal shading devices**
9	**Materials**	**solid laterite blocks** & Khondalite	**concrete framed structure** with exposed concrete slabs **CSEB block walls**.	**exposed brick and concrete work**
11	**Thermal comfort measures**	**large overhangs, low VOC paints** are used to improve indoor air quality and the public health. **The water court -leeward side** of the campus	West side is blocked and with minimum openings to avoid glare. Thicker wall section of CSEB to reduce radiation coming in interior spaces	Windows facing the **west and South façade are shaded** with vertical and horizontal shading devices respectively to cut off the heat gain and the glare in the classrooms..
12	**Takeaway**	Building is to be oriented in north-south direction so natural diffused light can be obtained. Large overhangs and different scale of structures can be obtained for shading. Water bodies for natural cooling.	Common interaction spaces between spaces can be obtained due to which visual and physical connections can be obtained.	Semi open spaces help in obtaining natural light using jali. Louvers are provided to shade more glare sun rays side. Locally available materials to be used. Verandas are used to provide proper ventilation

(Table-5 Case studies- Inferences)

7.3 Climate Analysis for PUNE, Maharashtra, India.

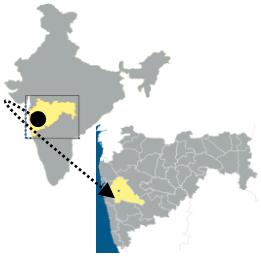


Fig 6.- Location - Pune

Pune, **metropolis** in India, located in the state of Maharashtra.
The **second largest city** in the state
an important city in terms of its **economical and industrial growth.**

Geo. coordinates 18.504° N, 73.8567° E Altitude 80.67 M

Warm and humid climate **722 mm** annual mean rainfall **51** rainy days/year

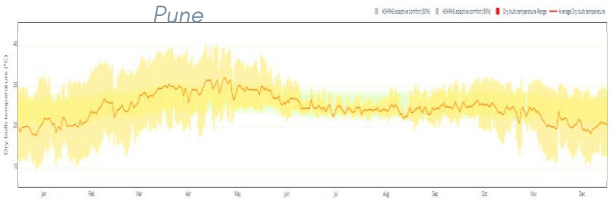


Fig 7 .-Dry Bulb Temperature

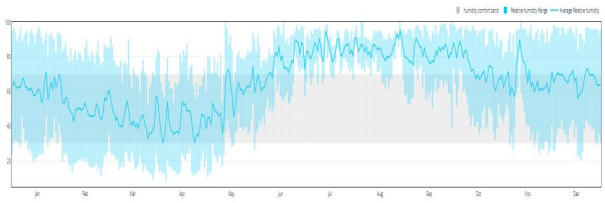


Fig 8.-Relative Humidity

- **Dry Bulb Temperature**

April and May more is the dry bulb temperature as the humidity levels are lower and amount of direct radiation is more. The adaptive comfort band ranges between **20-25⁰C**

- **Relative humidity-**

July-September -more humidity in the air because of cloud cover and lower radiation.
Humidity comfort band ranges between **30%-65%.**
Hence dehumidification is needed in monsoon

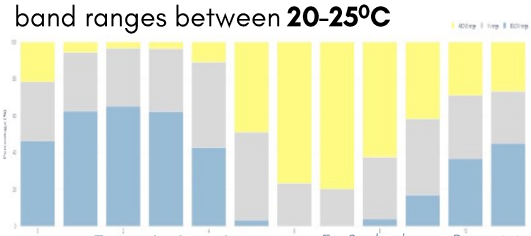


Fig.9 -cloud cover-Precipitation

- **Precipitation-**

March-May the cloud amount is lesser so more clearer skies, July-august, more is the cloud cover as there is more humidity in the air.

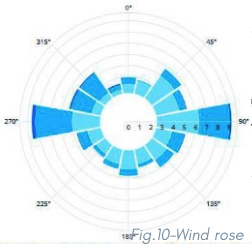


Fig.10-Wind rose

- **Wind Rose Analysis-**

Prevailing wind directions - West. (Throughout the year).

1. Winter winds - east
2. Monsoon , summer winds -west

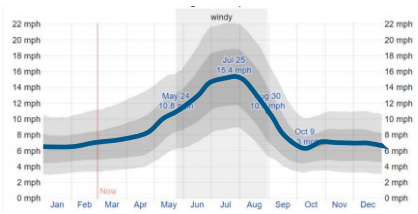


Fig. 11-Wind speed

Wind Speed : The average wind speed is most often in the range of **4-8 KmpH.** Peak Windspeed is in the months of monsoon.

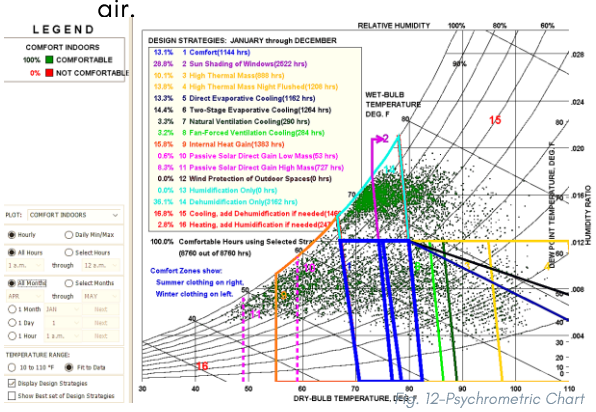


Fig. 12-Psychrometric Chart

- **Psychrometric chart-**

The inverse relationship between Dry bulb temp. Vs. relative humidity and gives strategies according to climate conditions

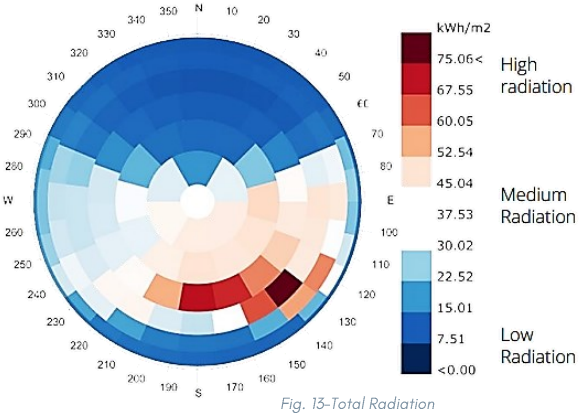


Fig. 13-Total Radiation

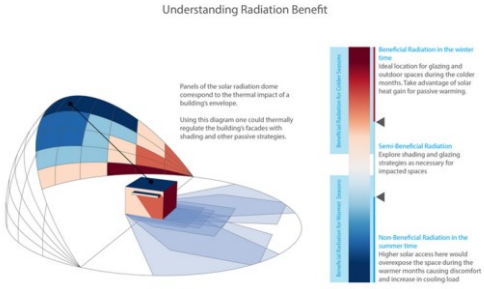


Fig. 14- Radiation benefit

Radiation Analysis- glazing and placement at orientation with Low radiation to reduce energy consumption and to promote Passive design

7.4. water calculations- RWH

Stage 01 - Calculation of Daily Rainfall			
Sr	**Titles**	**UoM**	**Qty (From IMD website)**
1	Average Peak Month Rainfall in July, 2016	mm	445.0
2	Average Peak Month Rainfall in July, 2017	mm	512.0
3	Average Peak Month Rainfall in July, 2018	mm	486.0
4	Average Peak Month Rainfall in July, 2019	mm	770.4
5	Average Peak Month Rainfall in August, 2020	mm	534.6
6	Average Peak Month Rainfall in 5 years	mm	549.6
7	One Day Rainfall (7.5% of Average Peak Month Rainfall) from Table 4	mm	41.22
8	**Average Normal Annual Rainfall**	**m**	**0.04**

YEAR	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEPT		OCT		NOV		DEC	
	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP
2016	0.0	-100	0.2	120	4.4	178	0.5	-94	13.9	-49	77.8	-50	445.8	42	417.6	86	197.1	19	57.6	-34	0.0	-100	0.0	-100
2017	0.0	-100	0.0	-100	0.0	-100	0.0	-100	24.6	-10	289.1	84	512.5	64	290.2	29	211.0	27	116.0	33	13.9	-43	0.7	-88
2018	0.0	-100	0.0	-100	0.7	-58	5.4	-29	6.8	-75	185.6	18	486.6	55	268.9	19	58.7	-65	33.8	-61	20.0	-18	0.0	-100
2019	0.0	-100	0.0	-100	0.0	-100	7.0	14	0.0	-100	193.1	10	770.4	149	521.4	137	318.7	104	209.1	167	32.7	40	0.7	-90
2020	0.0	-100	0.0	-100	5.9	266	0.2	-98	31.2	39	260.4	48	218.8	-29	534.6	143	187.1	20	236.2	201	2.7	-89	4.0	-37

http://hydro.imd.gov.in/hydrometweb/(S(11rnb2uqzhhgkejf3hrwhzqn))/DistrictRaifall.aspx

Fig.- IMD Data for rainfall of Pune

Stage 02 - Calculation of Rainwater Harvesting Potential on site					
Sr	**Title**	**UoM**	**Number**	**run off coefficient**	**Pervious Area**
1	Cemented/ Tiled Roof	sqm	4,200.00	0.95	3990
2	playground	sqm	10000	0.40	4000
2	Vegetation	sqm	17000	0.25	4250
3	Turf	sqm	1160	0.35	406
	grass pavers		3000	0.45	1350
4	hard surfaces(roads, pavements)	sqm	9000	0.95	8550
6	Total Site Area	sqm	**56286**	**Total Pervious Area**	**22546**

	Non roof area (sq.m.)	Capacity (KLD)	Capacity (litres)
60% of runoff volume from non roof surfaces	7924	**327**	326611
45% of runoff volume from roof surfaces	1796	**74**	74011

Stage 03 - Rainwater Harvesting Strategies in the Project			
1	Total rainwater harvesting potential on site from **60% non roof surfaces** and **45% roof surfaces**	KLD	401
2	Total rainwater harvesting potential percolation pits on the site	KLD	40014

Table -RWH Calculations

boarders	Occupant's Activity	Percent usage	Quantity	Grey water	black water	Grey water	black water
	Bathing	29.0%	7438.5	100%	0%	7438.5	0
	Washing	19.6%	5027.4	100%	0%	5027.4	0
	Drinking	4%	1000.35	0%	100%	0	1000.35
	Cooking	3%	743.85	0%	100%	0	743.85
	Toilet	17.0%	4360.5	0%	100%	0	4360.5
	Cleaning house	8.0%	2052	100%	0%	2052	0
	Washing Utensils	16.4%	4206.6	100%	0%	4206.6	0
	Others	3.20%	820.8	50%	50%	410.4	410.4
day-boarders	Occupant's Activity	Percent usage	Quantity	Grey water	black water	Grey water	black water
	Drinking	4%	824.85	0%	100%	0	824.85
	Toilet	17.0%	3595.5	0%	100%	0	3595.5
	Others	79.10%	16729.65	50%	50%	8364.825	8364.825
						27499.73	**19300.275**

7.5 water calculations- Low flow fixtures and waster water treatment and reuse

Water Efficient Plumbing Fixtures- For school								
		Baseline	Design Case	Duration	Daily usage - Men	Daily usage - Women	Baseline Flow	Design Case Flow
Water Closet (Full Flush) -	LPF	6	4	1	1	1	2820	1880
Water Closet (Half Flush) -	LPF	3	2	1	0	2	1410	940
Urinals	LPF	4	1.5	1	2	0	1880	705
Faucets / Taps	LPM	6	3.8	0.25	4	4	2820	1786
Health Faucets	LPM	6	3.8	0.25	1	1	705	447
Total Flow	Litres						**9635**	**5758**
Fixed Occupants	All buildings	440.00						
Visitors	All buildings	30.00						
FTE Calculation		470.00						
Occupants - Male	Numbers	235						
Occupants - Female	Numbers	235						
% savings	**%**	**40**						
Daily Flow								
Flow from flush fixtures (black water)							6815	3972
Flow from fixtures(gray water)							2820	1786
Annual Flow								
Annual Flow from fixtures (black water)							2487475	1191450
Annual Flow from fixtures (grey water)							1029300	535800
Annual flow from fixtures (black & grey water)							3516775	1727250

For Residences-								
		Baseline	Design Case	Duration	Daily usage - Men	Daily usage - Women	Baseline Flow	Design Case Flow
Water Closet (Full Flush)	LPF	6	4	1	2	2	2280	1520
Water Closet (Half Flush)	LPF	3	2	1	4	4	2280	1520
showers	LPF	15	8	1	1	1	2850	1520
Faucets / Taps	LPM	6	3.8	0.25	4	4	1140	722
Health Faucets	LPM	6	3.8	0.25	1	1	285	181
Total Flow	Litres						**8835**	**5463**
Fixed Occupants	All buildings	190.00						
Visitors	All buildings	0.00						
FTE Calculation		190.00						
Occupants - Male	Numbers	95						
Occupants - Female	Numbers	95						
% savings	**%**	**40**						
Daily Flow								
Flow from flush fixtures (black water)							7695	3221
Flow from flow fixtures (gray water)							1140	2242
Annual Flow								
Annual Flow from fixtures (black water)							2808675	966150
Annual Flow from fixtures (gray water)							416100	672600
Annual flow from fixtures (black & gray water)							3224775	1638750

Table 15 - water demand reduction by Low flow fixtures Calculations

Waste water treatment & Reuse		
Total Volume of waste water generated	KLD	5.76
Flow from flush fixtures (black water)	KLD	3.97
Flow from flow fixtures (grey water)	KLD	1.79
Capacity of Sewage Treatment Plant	KLD	(2 Nos X 3).=6
Percentage	**%**	**174**
Efficiency of STP	%	0.85
Volume of treated waste water available daily	**number**	**5.18**
Number of operational days		300
Volume of treated waste water available annually	KL	**1554.53**

Table 16-waster water treatment and reuse

Water Efficient Irrigation System

A drip irrigation system is installed for water efficient irrigation system

- 12 inches apart in sand,
- 18 inches apart in loam,
- 24 inches apart in clay.

SWP Credit 4 Water Efficient Landscaping

Type of vegetation	On Ground (sq.m.)
Turf	1163.87
Native Species	12298.97
Drought tolerant species	2776.05
Other plant species	1421.7
Total	17660.59

Total landscaped area (sq.m)	17660.59
Total area with native/ drought tolerant species (sq.m)	15075.02
Percentage(%) of drought tolerant species	**85.35966239**

landscape area provided with native/ drought tolerant plant species is **85.35%**

Type of vegetation		On Ground (sq.m.)
Turf		1163.87
Area for plantation:		
Native Species		12298.97
Drought tolerant species		2776.05
Other plant species		1421.7
Total		17660.59
Total landscaped area (sq.m)		17660.59
Total Turf area (sq.m)		1163.87
Percentage(%) of turf area		**6.59021018**

landscape area covered with turf **is 6.590%** of total site area.

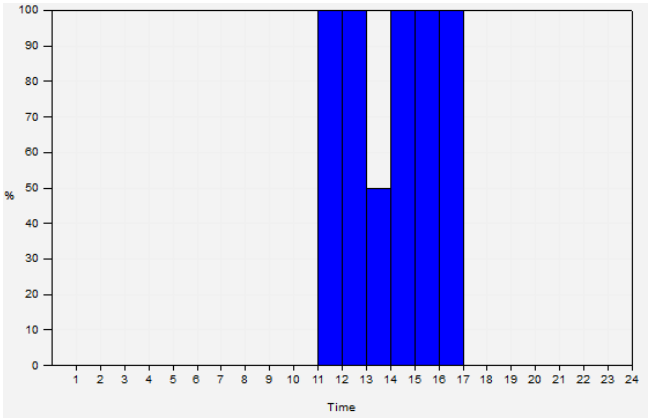
Non-Roof Impervious areas

Site plan highlighting Total non-roof area, area covered with trees (foliage) or open grid pavers.

COOLING LOAD ESTIMATE							
TITLE		Standard design					
LOCATION		PUNE					
LATITUDE		18.31°N					
SPACE		SCHOOL considering lab area of 2 school block only					
AREA (ft^2)		10300					
HEIGHT (ft)		12.0					
SOLAR GAIN - GLASS							
Item	Direction	Area (ft^2)	Area (m^2)	ΔT (°F)	Correction fator	Glass Factor	BTU / Hour
Glass	N	232	22	39	1.3	1	11348
Glass	NE	116	11	11	1.3	1	1600
Glass	E	0	0	11	1.3	1	0
Glass	SE	0	0	11	1.3	1	0
Glass	S	232	22	11	1.3	1	3201
Glass	SW	116	11	66	1.3	1	9602
Glass	W	0	0	158	1.3	1	0
Glass	NW	0	0	158	1.3	1	0
Skylight		0	0	107	1.3	1	0
SOLAR & TRANSMISSION GAIN - WALL & ROOF							
Item	Direction	Area (ft^2)	Area (m^2)	ΔT (°F)	Correction fator	U-value (BTU/h.ft^2)	BTU / Hour
Wall	N	1317	122	4	3	5.40	49823
Wall	NE	488	45	10	3	5.40	34290
Wall	E	1085	101	18	3	5.40	123091
Wall	SE	271	25	18	3	5.40	30773
Wall	S	1317	122	16	3	5.40	135233
Wall	SW	488	45	14	3	5.40	44840
Wall	W	1085	101	12	3	5.40	87922
Wall	NW	271	25	6	3	5.40	13188
Roof		0	0	32	3	6.28	0
TRANSMISSION GAIN EXCEPT WALLS & ROOF							
Item		Area (ft^2)	Area (m^2)	ΔT (°F)		U-value (BTU/h.ft^2)	BTU / Hour
All Glass		697	65	25.8		1.13	20328
Door		258	24	25.8		1.13	7529
Partition				20.8			0
Ceiling				20.8			0
Floor		4304	400	20.8			0
INTERNAL SENSIBLE HEAT							
	Quantity	Unit rates			Conversion fator	Diversity factor	BTU / Hour
People	160	240			1		38400
Equip (W)	4830				3.41	1	16470
Lights (W)	8608				3.41	1	29353
Supply fan gain	5%						32849
INTERNAL LATENT HEAT							
	Quantity	Unit rates					BTU / Hour
People	160	160					25600
OUT SIDE AIR HEAT							
	Flow rate (CFM)	ΔT(°F) & Δg/lb		Convesion factor			BTU / Hour
Sensible	638	25.8		1.08			17777
Latent	638	5.0		0.68			2169
						Total Room Sensible heat	707617
						Total Room Latent heat	27769
						Grand total heat, BTU/hr	735386
						AIR CONDITIONING TONNAGE	61.28

Heat load estimate							
Title		Efficient design					
Location		Pune					
Latitude		18.31°n					
Space		School (residentail)					
AREA - sq.Ft		10300					
HEIGHT - ft		12.0					
Solar gain - glass							
Item	Direction	Area (ft^2)	Area (m^2)	ΔT (°f)	Correction fator	Shgc	BTU / hour
Glass	N	232	22	39	1.3	0.55	6241
Glass	Ne	116	11	11	1.3	0.55	880
Glass	E	0	0	11	1.3	0.55	0
Glass	Se	0	0	11	1.3	0.55	0
Glass	S	232	22	11	1.3	0.55	1760
Glass	Sw	116	11	66	1.3	0.55	5281
Glass	W	0	0	158	1.3	0.55	0
Glass	Nw	0	0	158	1.3	0.55	0
Skylight		0	0	107	1.3	0.55	0
Solar & transmission gain - wall & roof							
Item	Direction	Area (ft^2)	Area (m^2)	ΔT (°f)	Correction fator	U-value	BTU / hour
Wall	N	1317	122	4	3	1.19	11007
Wall	Ne	488	45	10	3	1.19	7576
Wall	E	1085	101	18	3	1.19	27195
Wall	Se	271	25	18	3	1.19	6799
Wall	S	1317	122	16	3	1.19	29877
Wall	Sw	488	45	14	3	1.19	9907
Wall	W	1085	101	12	3	1.19	19425
Wall	Nw	271	25	6	3	1.19	2914
Roof		0	0	32	3	1.48	0
Transmission gain except walls & roof							
Item		Area (ft^2)	Area (m^2)	ΔT (°f)		U-value	BTU / hour
All glass		697	65	25.8		0.54	9714
Door		258	24	25.8		0.54	3598
Partition		0	0	20.8			0
Ceiling		0	0	20.8			0
Floor		4304	400	20.8			0
Internal sensible heat							
	Quantity	Unit rates					BTU / hour
People	160	240					38400
Equip (W)	4830				3.41	1	16470
Lights (W)	6456				3.41	1	22015
Supply air fan gain	5%						10953
Internal latent heat							
	Quantity	Unit rates					BTU / hour
People	160	160					25600
Out side air heat							
	Flow rate (CFM)	ΔT(°F) & Δg/lb		Convesion factor			BTU / hour
Sensible	638	25.8		1.08			17777
Latent	638	5.0		0.68			2169
						Total room sensible heat	247788
						Total room latent heat	27769
						Grand total heat, BTU/hr	275557
						Air conditioning tonnage	22.96

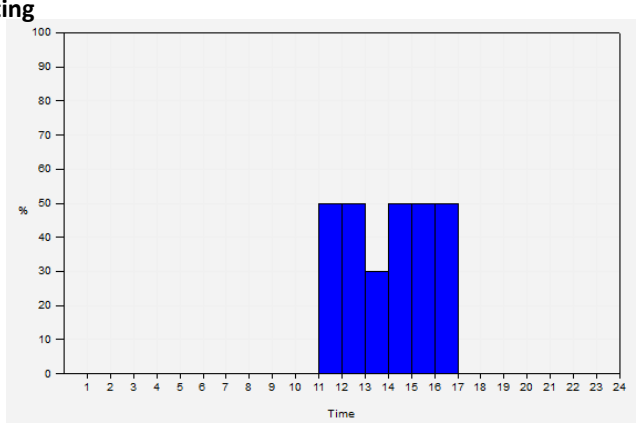
- **Schedules input for Design Builder Simulations-**
- **Occupancy schedule**



Profiles

M...	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Jan	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	Off
Feb	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	Off
Mar	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	Off
Apr	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	Off
May	Off	Off	Off	Off	Off	Off	Off
Jun	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	Off
Jul	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	Off
Aug	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	Off
Sep	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	Off
Oct	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	Off
Nov	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	Off
Dec	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	new occupancy	Off

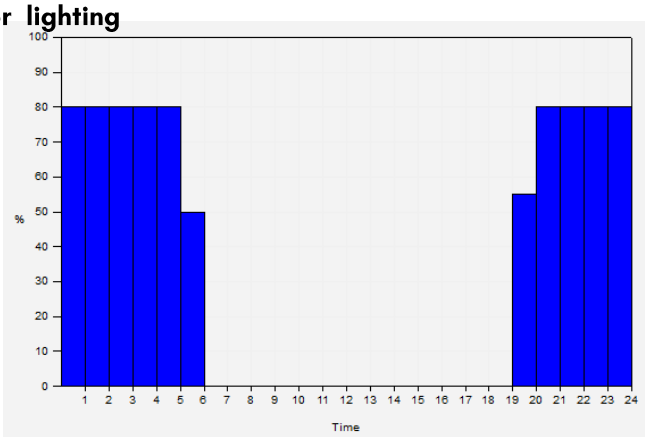
- **Lighting schedule-General lighting**



Profiles

M...	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Jan	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Off
Feb	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Off
Mar	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Off
Apr	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Off
May	Off	Off	Off	Off	Off	Off	Off
Jun	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Off
Jul	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Off
Aug	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Off
Sep	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Off
Oct	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Off
Nov	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Off
Dec	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Copy of case ...	Off

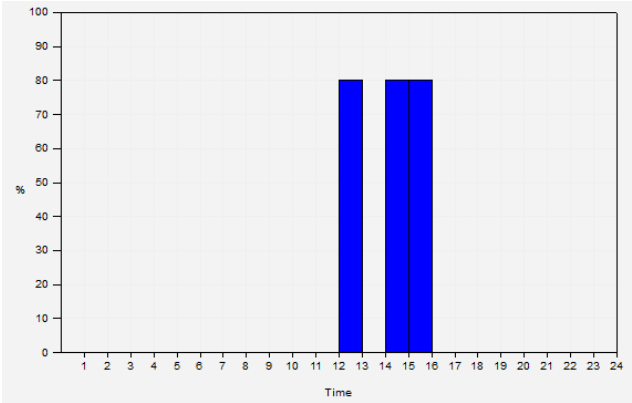
- **Lighting schedule-Exterior lighting**



Profiles

M...	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Jan	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Off
Feb	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Off
Mar	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Off
Apr	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Off
May	Off	Off	Off	Off	Off	Off	Off
Jun	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Off
Jul	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Off
Aug	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Off
Sep	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Off
Oct	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Off
Nov	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Off
Dec	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Copy of Copy ...	Off

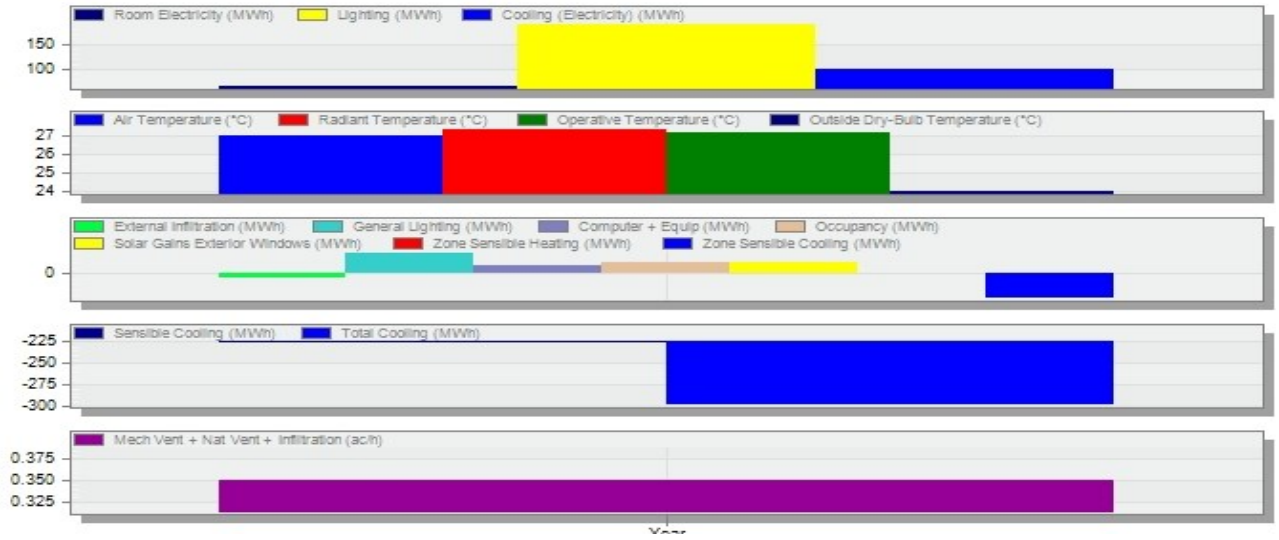
- **HVAC Schedule**



Profiles

M...	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Jan	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	Off
Feb	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	Off
Mar	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	Off
Apr	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	Off
May	Off	Off	Off	Off	Off	Off	Off
Jun	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	Off
Jul	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	Off
Aug	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	Off
Sep	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	Off
Oct	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	Off
Nov	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	Off
Dec	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	case 3 hvac	Off

- **Results for base case and design case 1**



EPI = Total energy consumption(kwh)/built-up(m2)
=(67.81+186.86+99.16+0.20)/4200*1000
= 84.29 kwh/m2/yr.

EPI = Total energy consumption(kwh)/built-up(m2)
=(67.66+41.58+113.22+0.20)/4200*1000
= 53.01 kwh/m2/yr.

Computational Fluid Dynamics (CFD) Analysis - inputs

Prevailing wind direction 270^0
Avg. Wind velocity- 2m/sec
As the site area is larger as compared to building footprint areas ,hence to there is a need of increase in velocity to reach natural wind to every building in a campus.

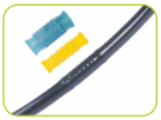
Hence 1. staggered arrangements of block is done.
2. Giving smaller openings on west side to get wind inside buildings.
3. Creating wedge form for building blocks will help to divert wind.
4. Distance between 2 buildings according to heights this will help to reach wind to buildings placed in leeward side.

Product specifications-MEP-Water Efficient Irrigation System

dripindia irrigation pvt. ltd

Regd. Off : 5th floor, Gajanan Avenue, Lane 3, New Pandit Colony, Nashik. 422002 MH.
Factory : Survey No. 273, Pimpalnare Phata, Nashik - Dindori Road, Pimpalnare, Tal. Dindori, Dist. Nashik. 422004 MH. Ph. : +91 2557 255177

1) Emitting Pipe (Integral Drip Line) Hydrogol



Size	Discharge	Thickness	Dripper Spacing
12mm	2 LPH, 4 LPH	0.45mm, 0.65mm	30cm To 120cm
16mm	2 LPH, 4 LPH	0.55mm, 0.80mm	30cm To 120cm
20mm	2 LPH, 4 LPH	0.75mm	30cm To 120cm

2) Emitting Pipe (Integral Drip Line) Flat Drip

Size	Discharge	Thickness	Dripper Spacing
12mm	2 LPH, 4 LPH	0.45mm, 0.65mm	30cm To 120cm
16mm	2 LPH, 4 LPH	0.2mm, 0.25mm, 0.3mm, 0.4mm, 0.55mm, 0.8mm	30cm To 120cm
20mm	2 LPH, 4 LPH	0.75mm	30cm To 120cm

3) LLDPE Plain Lateral

Size	Thickness
12mm	1.0mm
16mm	1.2mm
20mm	1.0mm & 1.3mm
32mm	2.2mm

4) Dripper (Emitter)

Discharge
4 LPH
8 LPH
14 LPH

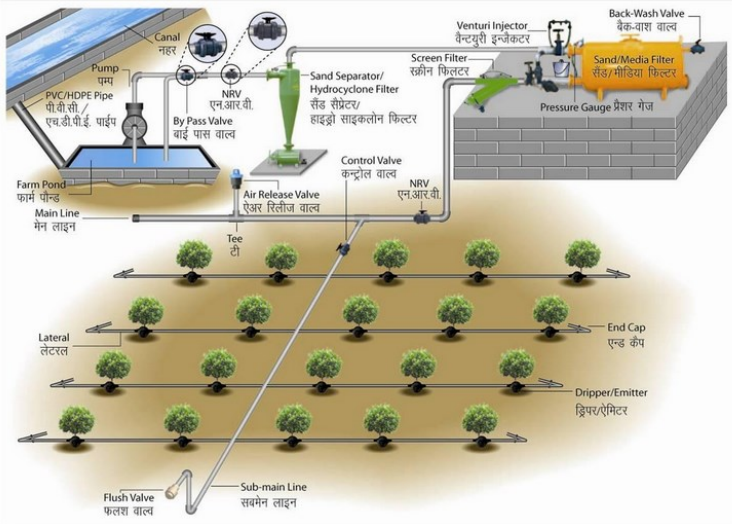
5) Sprinkler Pipes

Type	Size	Thickness
C -Type & L -Type	63 mm	2.2 mm
	75 mm	2.2 mm, 2.7 mm
	90 mm	2.4 mm

6) Sprinkler Accessories

7) Nozzle / Sprinkler

Type	Operating Pressure	Discharge	Radius
Mini Sprinkler Plastic	2 Kg	8.13 LPM	9.0 Mtr
Overhead Sprinkler	2 Kg	34 .50 LPM	12.6 Mtr



PRODUCTS OF DRIP IRRIGATION

EMITTING PIPE (AVAILABLE IN HYDROGOL & SLIM TYPE)	12 / 16 / 20 mm (2 / 4 lph)
LATERAL	12 / 16 / 20 / 32 mm
DRIPPER	4 lph / 8 lph / 14 lph
PVC PIPES	32 to 200 mm
SCREEN FILTERS	63 / 75 / 90 / 110 mm
DISC FILTERS	63 / 75 / 90 / 110 mm
SAND FILTERS	63 / 75 / 90 mm
FERTILIZER TANK	30 / 60 / 90 / 120 ltr.
CONTROL VALVE	63 / 75 / 90 mm
FLUSH VALVE	63 / 75 / 90 mm
VENTURY	1" / 1.5" / 2"
OTHER ACCESSO	

PRODUCTS OF SPRINKLER IRRIGATION

HDPE PIPE	32 / 63 / 75 / 90 mm
METAL SPRINKLER	Radius 12 mtr.
PUMP CONNECTING NIPPLE	63 / 75 / 90 mm
RISER PIPE	length 0.75 & 1 mtr.
ADAPTER	63 / 75 / 90 mm
MINI SPRINKLER	Radius 9 mtr.
MINI SPRINKLER	Part Circle
OTHER ACCESSORIES	
MICRO SPRINKLER	Radius 3 mtr.

Size	Inlet Pressure	Motive Flow L/H	Water Suction L/H
¾"	2	1355	111
1"	2	4290	219
1.5"	2	6590	650
2"	2	6590	670

9) Filter Screen Metal (Also Available in Plastic Body)

Inlet / Outlet	Max. Working Pressure	Range of Flow	Filtration Surface Area
2"	8 Kg/cm²	20m³/hr	492 cm²
2.5"	8 Kg/cm²	30m³/hr	492 cm²
3"	8 Kg/cm²	40m³/hr	1193 cm²

10) Filter Disc Plastic

Inlet / Outlet	Max. Working Pressure	Range of Flow	Filtration Surface Area
2"	8 Kg/cm²	20m³/hr	878 cm²
2.5"	8 Kg/cm²	30m³/hr	878 cm²
3"	8 Kg/cm²	40m³/hr	1193 cm²

11) Sand Separator / Filter

Inlet / Outlet	Range of Flow
2"	20m³/hr
2.5"	30m³/hr
3"	40m³/hr
3"	50m³/hr

12) Emitting Pipe Accessories

Size	12mm, 16mm, 20mm

13) Control Valve

Size
63mm, 75mm, 90mm, 110mm

14) Foggers

Type	4 Way
Pattern	3600
Operating Pressure	4 K.g
Flow Rate (Lph)	30

15) Rain Pipe

Size	Packing	Micron
32 mm	100 meter	300
40 mm	100 meter	300

16) PVC Pipe

	Size	32	40	50	63	75	90	110	125	140	160	180	200
Thickness	4 Kg.	-	-	-	1.7	2.0	2.3	2.7	3.1	3.4	4.0	4.5	4.9
	6 Kg.	-	-	1.8	2.4	2.8	3.4	4.0	4.6	5.1	5.9	6.5	7.2
	10 Kg.	2.0	-	-	-	-	-	-	-	-	-	-	-

17) HDPE Pipe

Size	Pressure Nomination	Grade
32 mm to 110 mm	PN-4	PE-63 & PE - 80
	PN-6	
	PN-10	

18) Mulch Films

Size	Packing	Width
20 Micron	400 Meter	1 Meter & 1.25 Meter
25 Micron	400 Meter	
30 Micron	400 Meter	

19) Spray Pipe

Size (OD)	Packing	Pressure	Colour
16 MM	100 Meter	10 to 14 Kg	Blue
20 MM	100 Meter	10 to 14 Kg	Blue

Products specifications MEP- Water Efficient Plumbing Fixtures

Documents:

1. List of plumbing fixtures with their corresponding flow rates.
2. Manufacturer/ Information brochures of the plumbing fixtures used, indicating the flow rates of fixtures installed.

CERA
Cera Sanitaryware Limited
Mahesana

Water Closet and Urinals

URINAL
5005A Urinal Flat Back with integrated EFS

CALIBRE
2044 EWC Wall Hung Extended P

CNS-WHT-963UFSM
Rimless Wall Hung WC with UF soft close slim seat cover, Hinges, Accessories Set,
Size: 380x515x360 mm **Rs.** 9,750

Flushing system

Control Plate Continental Prime

Range : Flush Plates
Code : JCP-CHR-2415
MRP : ₹ 1,400.00

Metropole Flush Valve Dual Flow 32mm Size (Concealed Body)

Range : Flush Valves
Code : FLV-CHR-1085SQ
Description : Metropole Flush Valve Dual Flow 32mm Size (Concealed Body) with Exposed Shut Off Provision & 100mm Square Plate
MRP : ₹ 3,100.00

Flow Rate

0.5 BAR	1.0 BAR	2.0 BAR	3.0 BAR
3/6	3/6	3/6	3/6

Cat. No. and Name	Star Rating	Flushing efficiency with 6/3 LPF as base	Green Points Rating System				Conforms to UIPC-I (Uniform illustrated Plumbing Code)
			IGBC		LEED		
			Home	Commercial/ Factory	CS3	NC&MR4	
2018 Cruse EWC P or S Concealed	***	3.9 / 2.1	2	4	2	2	Yes
2038 Cruse EWC Wall Hung Extended P	***	3.9 / 2.1	2	4	2	2	Yes
5005A Urinal Flat Back with integrated EFS	***	0.75		4	4	4	Yes
5025 Cicily Lidless Sensor Urinal with integrated EFS	***	0.75		4	4	4	Yes
3141 Campbell One Piece EWC	**	4.2 / 2.2	2	2	-	-	Yes
2098 Campbell EWC S Concealed	**	4.2 / 2.2	2	2	-	-	Yes
3100 Callaghan EWC S Concealed	**	4.3 / 2.2	2	2	-	-	Yes
2004 Calibre EWC P or S	**	4.5 / 2.7	2	2	-	-	Yes
3101 Callaghan EWC Wall Hung Extended P	**	4.2 / 2.2	2	2	-	-	Yes
2044 Calibre EWC Wall Hung Extended P	**	4.5 / 2.7	2	2	-	-	Yes

Faucets /taps

PRS-031L65
Pillar Cock Auto Closing System with 65mm Extension Body
Rs. 3,250

FLOW RATE (Litre Per Minute)			
0.5 BAR	1.0 BAR	2.0 BAR	3.0 BAR
5.87	8.01	11.26	13.74

Overhead showers

Overhead Showers

OHS-1709
Overhead Shower ø105mm Round Shape Single Flow with Air Effect (ABS Body & Face Plate Chrome Plated) with Rubit Cleaning System
Rs. 3,000

FLOW RATE (Litre Per Minute)			
0.5 BAR	1.0 BAR	2.0 BAR	3.0 BAR
4.66	7.09	10.33	12.12

Health faucets/hand shower

ALD-573
Hand Shower (Health Faucet) with 8mm Dia, 1.2 Meter Long Flexible Tube & Wall Hook
Rs. 1,625
Also available
ALD-563
Hand Shower (Health Faucet) with 1.2 Meter Long PVC Tube & Wall Hook
Rs. 1,150
ALD-577
Hand Shower (Health Faucet) with 8mm Dia, 1.2 Meter Long Flexible Tube & Wall Hook with N.R.V (Back Flow Preventer)
Rs. 1,725
ALD-579
Hand Shower (Health Faucet) with 1 Meter Long Easy Flex Tube in Chrome Finish and Wall Hook with N.R.V (Back Flow Preventer)
Rs. 1,350

0.5 BAR	1.0 BAR	2.0 BAR	3.0 BAR
7.00	8.00	10.00	11.20

Products specifications- civil work and finishes-

Grass pavers

VYARA
a block above

Specifications for Ecopave- Grid Paver

Supply and fixing of Grid Paver of VYARA make, in size 600*400*75mm thick in shot blasted finish (Optional) and colours as approved by the architects.

Sr.	Parameters	Minimum Requirements
1.	Size (mm)	600*400*75 Tolerance in size will be ± 2 mm over size declared by the manufacturer.
2.	Tolerance in Thickness of block	75 mm (± 3 mm)
3.	Color / Finish Options	As approved by the architects Finish: Shot-blasted and Sealed
4.	Water absorption:	Class B as per EN 1339:2003 ie. < 8%
5.	Strength Grade	Characteristic Breaking load > 5 kN
6.	Abrasion resistance	Class I as per EN 1339:2003 – ie < 18000mm²/5000mm²
7.	Thickness of wearing layer	Not less than 8mm
8.	Colours	UV Light resistant fast colours from Lanxess only to be used

sr no.	Surface Type	Run-off coefficient	Area(m2)
1	Cemented / Tiled Roof	0.95	7571.5
2	Asphalt/concrete Roads	0.95	9769.63
3	Open-grid Grass Pavement	0.5	2650.13
4	ramps	0.95	435.34
5	Playground	0.35	9015.6

applications-
Green Parking, Pedestrian walkways etc.

- Most Suitable: Open Parking
- Suitable: Foot Traffic
- Somewhat Suitable: Driveway

PUNE

SAI ENTERPRISES

Shop No. 322, Waghere Industries,
Waghere Compound,
Pimpri, Pune – 411 017 Maharashtra

Email

saienterprises29@gmail.com

High SRI Paints for terraces

- 100% of roof will be painted white (with 1 coat, 8 mils)

Technical Information

Physical Appearance	Milky white
Solar Reflective Index (SRI)	122
Coating type	100% pure acrylic base heat insulating paint
Solar Reflectance tested as per ASTM C1549-09	0.95
Thermal Emittance tested as per ASTM C1371-04a	0.91
Volatile Organic Contents (VOC)	Extremely low 1.34 gm/ltr.
Service Temperature	100 °C
Toxicity	Non toxic
Water Absorption :	Water proof coating
High Humidity:	No penetration of water, no loss of adhesion, no blistering, cracking or flaking.
FungusResistance	No fungi development
Impact Resistance	56"/pound
Chemical Resistance	Stable in mild Alkali acid and solvent
Fire resistance	Not flammable
Adhesion Strength :	40pound/square inch
Abrasion Resistance :	0.5gm/1000cycle
Number of coats :	2 coats
Solids by weight	50%
Dry film thickness	55 micron/coat
Dry Touch @ 30°C	60 min
Recoating time @ 30°C	After 4 hour
Curing Mechanism	At ambient temperature paint cures by evaporation of water & coalescence of polymer particles
Viscosity	10 poise
Ph	7 to 8

COOLROOF®
Heat Reflective Paint SRI - 122

GREEN BUILDINGS

APPROVED BY AS PER LEEDS STANDARDS

We take pride is informing that our product COOLROOF® High SRI Paint is one of the very few green building products approved for high albedo/High SRI coatings as per LEEDS standards.

APPROVED BY GREEN BUILDING BODIES

COOLROOF® has been including in GRIHA product catalogue. under criteria 14 and SWA-GRIHA criteria 2and 5 as high albedo coatings. COOLROOF® is also listed in approved product directory of IGBC (India Green Building Council).

COOLROOF® Paint is one of the very few green building products approved by both of green building bodies in India i.e and by IGBC for high albedo coatings.

VOC for our COOLROOF® paint is extremely low.

GRIHA Council

This is to certify that the product

"COOLROOF® HEAT REFLECTIVE PAINT"

has been included in the GRIHA Product Catalogue under the following categories:

High Albedo Paint
GRIHA V.2015 criterion: 8
&
GRIHA V.3 criterion: 14
&
SVAGRIHA criterion: 2 and 5

This products can be used in GRIHA & SVAGRIHA registered projects to meet the GRIHA & SVAGRIHA norms, respectively.
This is valid only for the product which has been mentioned above.

The certificate for the above mentioned product is valid from
11th February 2017 - 10th February 2019

Sanjay Seth
Chief Executive Officer

STP specifications- 5 KLD X 2nos. Will be used on site.

5 KLD Sewage Treatment Plant

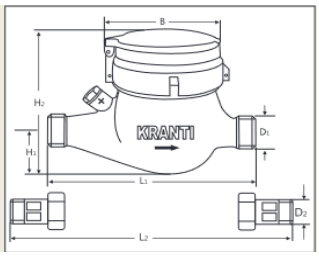
₹ 3.25 Lakh Get Latest Price

Capacity (KLD/MLD)	5 KLD
Feed Flow Rate(m3/day or m3/hr)	5 m3/day
Water Pump Power	1 KW
Application Industry	Residential & Commercial Building
Treatment Technology	Mixed Bed Bio Reactor(MBBR)

Water metering specifications- connected at every building water line to monitor water consumption

DIMENSIONS

Model		BESTO	BESTO	BESTO	BESTO	BESTO
Nominal Size	(mm)	15	20	25	40	50
	(Inches)	1/2	3/4	1	1½	2
D1 - Meter Connection Thread ISO 228/1		G3/4 B	G1 B	G1¼ B	G2 B	G2½ B
D2- Meter Connection Pipe ISO 7/1		R½	R¾	R1	R1½	R2
L1 - Length without Couplings (mm)		165	190	260	300	270/330
L2 - Length with Couplings (mm)		250	290	380	430	470
B - Width (mm) (Max.)		100	130	170	210	270
H1 - Centerline Height (Max.)		50	60	65	75	115
H2 - Overall Height (Max.)		180	240	260	300	300



PERFORMANCE DATA

Nominal Sizes mm	Inches	Metero -logical Class	Qmax Minimum Flow Rate (m^3/h)	Qn Nominal Flow Rate (m^3/h)	Qt Transitional Flow Rate (L/h)	Qmin Minimum Flow Rate (L/h)	Maximum Register Capacity (m^3)	Minimum Register Capacity (L)	Accuracy Between Qmax & Qt	Accuracy Between Qt & Qmin
15	1/2"	Class-B	3	1.5	120	30	99999.9999	0.05	± 2%	± 5%
20	3/4"	Class-B	5	2.5	200	50	99999.9999	0.05		
25	1"	Class-B	7	3.5	280	70	99999.9999	0.05		
40	1½"	Class-B	20	10	800	200	99999.9999	0.05		
50	2"	Class-B	30	15	1200	300	99999.9999	0.05		

Energy metering specifications- connected at every building electrical line to monitor space wise energy consumption

Bentec electronic trivector meters

- Type: PB-12 -3
- Ref. Standard IS 13779/ 1999/ CBIP-88
- Related Voltage; 240X3 V
- Rated Current: 10-40, 10-60, 20-80.
- Power consumption < 8 VA
- Accuracy Class: 1.0

Main Features:

- Measurement of Power
- High Accuracy : Class 1.0
- High Overload Capacity : 6 times of basic current
- SMT & re-flow technology adopted, Immune to various disturbances. EMC can comply with IEC 1036/IS 13779
- Date & Time Display
- Instantaneous KWh Display
- Additional batter backup (Optional)
- Power and different tamper indicator
- Last Six months MD Storage (optional)

UL Listed 42 Bar FK 1230 FIRE SUPPRESSION SYSTEM Halon free

FK-5-1-12

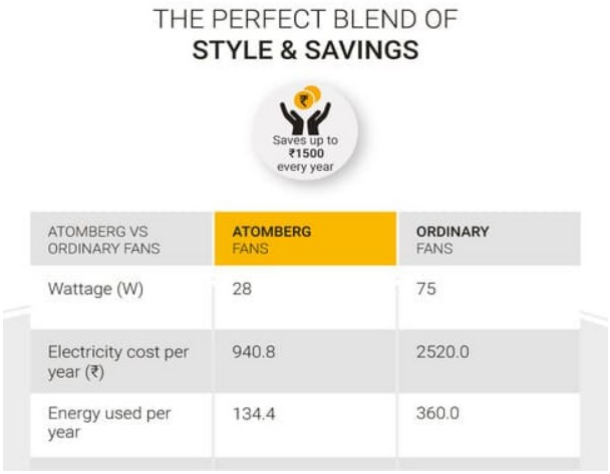
PHYSICAL & CHEMICAL PROPERTIES	
Empirical formulae.	$CF_3CF_2C(O)CF3)_2$
IUPAC Designation	Dodecafiuoro-2-methylpentan-3one
ASHRAE Designation.	FK-5-1-12
Molecular Weight.	316.04
Boiling Point at 1 Atm	49.2 °C (120.6 °F)
Freezing Point	-108.0°C (-162.4°F)
Ozone Depletion Potentia	0
Atmospheric Lifetime	5 days
No Observed Adverse Effect Level	10 %

ENVIRONMENTALLY FRIENDLY

DESCRIPTION	FK-5-1-12 (FK 1230)
OZONE DEPLETION POTENTIAL	0.0
GLOBAL WARMING POTENTIAL	1
ATMOSPHERIC LIFETIME (YEARS)	5 DAYS
SNAP (YES/NO)	YES

Star rated equipments-

Atomberg Renesa Alpha BLDC Motor 3 Blade Ceiling Fan



Fan blade size (mm)	Wattage(w)	Min. air delivery (m3/min.)	Service value	Star rating
1400	28	245	8.85	BEE 5 STAR

Biodiesel generators- 120 KVA X 2 Nos.

GPS GREEN POWER SOLUTIONS

•Considering only 50% lighting, equipments and exterior lighting in case of energy failure. Battery backup till 4 hours
•Considering only 50% lighting Backup till 20 hours

Proposed case				
Total el. Load generated	**W**	**kW**	**kWhr**	**Annual kWHr**
Total lighting load	23276	23.276	116.38	60958.33
Total equipment load	89423.33333	89.4233	268.27	140522.38
Total hvac load	67387.5	67.3875	269.55	141191.31
Ext. Lighting load	116.25	0.11625	0.93	486.10
	180203.0833	**180.2030833**	655.12	343158.12
EPI (kWhr/m2/yr)				**31.12**

Generators - 120kVA to 150kVA

Large, powerful, Biodiesel generators provide reliable power for large work sites, backup supply, festivals, outdoor sporting events and remote broadcast.

Electrical Data		DGK150D	DGK150/01
Rated frequency	Hz	50	60
Rated voltage	V	415	480
Rated output	kVA/kW	120/96	150/120
Rated current	A	167	180
Rated power factor		0.8 (Lagging)	
Winding		3-phase, 4 wire	
Excitation		Self-excitation (brushless)	
Number of poles		4	
Engine			
Model		Isuzu 6HK1TC	
Emissions rating		Tier 3[1]	
Air induction		Turbocharged with Direct injection	
No. of cylinders		6	
Displacement	L	7.790	
Rated output @ 1500 RPM	kW	119	142
Fuel		Diesel / Biodiesel (B20)	
Fuel capacity (Std.)	L	280	
Sound level			
Sound level @ 7 m	dB(A)	53	58
Dimensions and weight[3]			
Dimensions (LxWxH)	mm	3450 x 1240 x 1850	
Dry weight	kg	2950	

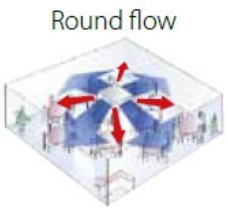
IDU- for HVAC

FXFQ-PVE9 Round Flow Cassette


FXFQ-PV9

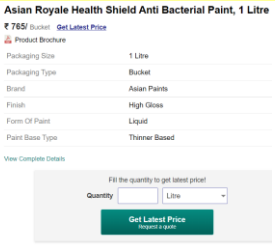

BRC1D52


BRC7F634F/
BRC7F635F



INDOOR UNIT				FXFQ25PVE9	FXFQ32PVE9
Cooling capacity	Nom.		kW	2.8[1]	3.6[1]
Heating capacity	Nom.		kW	3.2[2]	4.0[2]
Power input - 50Hz	Cooling	Nom.	kW	0.033[1]	
	Heating	Nom.	kW	0.027[2]	
Dimensions	Unit	HeightxWidthxDepth	mm		
Weight	Unit		kg		19.
Decoration panel	Model				
	Colour				
	Dimensions	HeightxWidthxDepth	mm		
	Weight		kg		
Fan-Air flow rate - 50Hz	Cooling	Super high/High/Low	m^3/min	13/11.5/10	
Sound pressure level	Cooling	Super high/High/Low	dBA	30.0/28.5/27.0	
Refrigerant	Type				
Piping connections	Liquid/OD/Gas/OD/Drain		mm		6.35/12.7/VP25 (
Power supply	Phase/Frequency/Voltage		Hz/V		
Current - 50Hz	Maximum fuse amps (MFA)		A		

Low VOC paints-


Asian Royale Health Shield Anti Bacterial Paint, 1 Litre

₹ 765/ Bucket Get Latest Price

Product Brochure

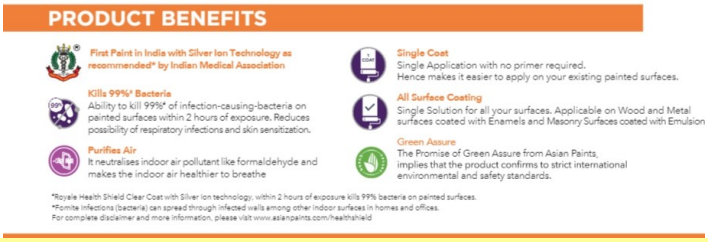
Packaging Size	1 Litre
Packaging Type	Bucket
Brand	Asian Paints
Finish	High Gloss
Form Of Paint	Liquid
Paint Base Type	Thinner Based

View Complete Details

Fill the quantity to get latest price!

Quantity Litre

Get Latest Price


PRODUCT BENEFITS

First Paint in India with Silver Ion Technology as recommended* by Indian Medical Association

Kills 99%* Bacteria
Ability to kill 99%* of infection-causing-bacteria on painted surfaces within 2 hours of exposure. Reduces possibility of respiratory infections and skin sensitization.

Purifies Air
It neutralises indoor air pollutant like formaldehyde and makes the indoor air healthier to breathe

Single Coat
Single Application with no primer required. Hence makes it easier to apply on your existing painted surfaces.

All Surface Coating
Single Solution for all your surfaces. Applicable on Wood and Metal surfaces coated with Enamels and Masonry Surfaces coated with Emulsion

Green Assure
The Promise of Green Assure from Asian Paints, implies that the product confirms to strict international environmental and safety standards.

*Royale Health Shield Clear Coat with Silver Ion technology, within 2 hours of exposure kills 99% bacteria on painted surfaces.
*Fomite infections (bacteria) can spread through infected walls among other indoor surfaces in homes and offices.
For complete disclaimer and more information, please visit www.asianpaints.com/healthshield

CFC-free Refrigerants

Refrigerant	Global Warming Potential	Ozone Depletion Potential
R-22	1810	Medium
R-410A	2088	Zero
R-32	675	Zero
R-134A	1430	Zero
R-290	3	Zero
R-600A	3	Zero

R-32 Properties	
Boiling temperature	-62°F (-52°C)
Critical temperature	172.6°F (78.1°C)
Critical pressure	838.6 PSI (57.8 bar)
Global Warming Potential	675
Ozone Depletion Potential	0
ASHRAE Safety Group	A2L


DAIKIN GLOBAL

Environmental Impact of Air Conditioner Refrigerants and Trends

	Ozone Depletion Potential (ODP)	100 Year Global Warming Potential of Different Refrigerants*1
R12 (CFC)	1.0	10,900
R22 (HCFC)	0.055	1,810
R410A (HFC)	0	2,090
R32 (HFC)	0	675

Pros

The chief benefits of R-32 are its efficiency as well as reduced environmental impact Its performance and operating characteristics are very similar to R-410A, yet with roughly one-third of the Global Warming Potential.

There's very little difference between R-32 and R-410A from a performance standpoint, but R-32 is significantly more efficient.

Native tree species plantation-


Aegle marmelos


Artocarpus heterophyllus


Hardwickia binita


Madhuka longifera

पुणे महानगरपालिका
वृक्ष प्राधिकरण विभाग
स्थानिक जातीचे वृक्षांची यादी

अ.क्र.	वृक्षांचे स्थानिक नाव	वृक्षांचे शास्त्रीय नाव
१)	खैर	*Acacia catechu/Acacia sundra*
२)	हिवर	*Acacia leucophloea*
३)	बाभूळ	*Acacia nilotica*
४)	हळदू	*Adina cordofolia*
५)	बेल	*Aegle marmelos*
१४)	फणस	*Arthocarpus heterophyllus*
१५)	कडूलिंब	*Azadirachta indica*
२८)	कुम्भा	*Careya arborea*
२९)	बहावा	*Cassia fistula*
६३)	वारस पिवळा	*Heterophragma adenophyllum*
६४)	अंजन	*Hardwckia binata*
६५)	पांढरा कुडा	*Holarhhena antidysenterica*
७२)	मोह	*Madhuka longifolia*

ECOBOARD®

•Key Features-
•High structural strength, loadbearing & stability
•High earthquake resistance and durability
•Better water resistance than wood-based
•Superior fire resistance
•Termite prevention
•No Formaldehyde or chemical emissions

ECOBoards are NOT made from WOOD, but use agricultural fibres, residue or by-products from harvests, a product that is usually burned as a waste problem.
Ecoboard uses baggase fibre from crushed sugarcane(Agri residue) This particle board is a good substitute for wood and plywood
ECOBOARDS are best used in the manufacturing of end products, which require a certain degree of structural strength. ECOBoards are a real alternative to concrete, bricks or OSB. Houses built with ECOboards have a lower energy demand and store more CO2 then their own weight..

20% of the total building materials (by cost) used in the building are manufactured locally within a distance of 400 km.

- **List of sheet describing the percentage of recycled content.**

As per BOQ of proposed school project for Jnana Prabodhini, Pune, all the construction and finishing materials are locally available within range of 400 kms and 30% of total materials used have recycled content –
(Please refer annexures for BOQ of proposed school project for Jnana Prabodhini, Pune)

- **List of materials with recycled content**

1. Ferrous material like M.S. Sections, reinforcements with 30% steel binders
2. Non Ferrous Metals like Aluminium for doors and Windows
3. RMC with recycled binders and fly ash contents
4. Plastic-For Plumbing, paving, walling, false ceiling
5. Rubber – For Furniture, Insulation
6. Building and Construction Waste for installation in school premises and pathways

Construction Waste

Salvaged bricks for waterproofing , paving etc.

Doors, Windows

Salvaged floor tiles for China Mosaic For Terrace

Salvaged terracotta roofing tiles

waste management-

The project aims to minimize the waste going in the landfills over the course of the year by reducing, reusing, and recovering waste streams and converting them into valuable resources.

The waste-pickers based collection model as proposed in pune city, is a non-energy intensive and has a low carbon footprint, compared with formal and conventional technological approaches, such as mechanized, centralized waste collection schemes and incineration.10 the different types of waste generated on the site will be treated as follows:

• dry waste, wet waste and hazardous waste will be segregated at the occupant level.

• The organic waste is converted into manure

• Hazardous waste generated on site will be segregated and disposed safely with the help of a third-party agency.

Waste analysis of institute building							
Sr. no	Place- (waste generation sources)	Type of waste- (Organic/Inorganic)	Amount of waste (kg/month)	Issues identified	Treatment/ recycling	Segregation method	Smart strategies /Technique (To overcome issue)
1	Classrooms	Paper waste(organic) & Stationary(Inorganic)	115kg	segregation of paper & plastic.	Paper Recycling.	Physical Segregation.	Reusing papers, Printing double sides, Reduce use of new papers.
2	Admin Department	Stationary Waste(Inorganic)	20kg	No segregation of paper & stationary.	Recycling.	Physical Segregation.	Use of refillable ink catridges for printers, printing double side.
3	I.T. Department	E-waste(Inorganic)	0.3kg	No issues.	E-waste recycling.	Physical Segregation.	Try repairing and maintaining equipments rather than replacing.
4	Canteen	Dry & Wet waste(Organic)	120kg	No issues.	Composting.	Physical Segregation.	Use steel plates instead of disposable.
5	Toilets	Dry municipal waste(Inorganic)	25kg	No segregation of plastic and sanitary napkins.	Landfill.	Physical Segregation.	Use of refillable containers for chemicals that are used for cleaning purposes.
6	Landscape	Gardening waste (Organic)	195kg	No evaluation of waste.	Composting.	Physical Segregation.	

RM CR 4	Organic Waste management, Post Occupancy		
	FOOD WASTE		
1	Number of Occupants	number	200
2	Organic waste generated/person/day (food waste)	kg	0.1
3	**Quantity of organic waste generated in the project per day (food waste)**	**kg**	**20**
4	**95% of food waste**	**kg**	**19**
	GARDEN WASTE		
1	Total landscape area	sq. m	10000.00
2	Organic waste generated/sq.m./day (garden waste)	kg	0.1
3	**Quantity of organic waste generated in the project per day (garden waste)**	**kg**	**1000**
4	**25% of Garden waste**	**kg**	**250**
	VERMICOMPOST PIT		
1	**Total capacity of OWC required to cater to food & garden waste**	**kg**	**269**