Solar Decathlon India

SELCO FOUNDATION

Final Design Report – April 2022

Community Resilience Shelter

SYNERGY

Manipal School of Architecture and Planning | SYNERGY

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1. **Executive Summary:**

Team Synergy is a cohesive, passionate team of architecture and engineering students from the Manipal Academy of Higher Education. Their multiple perspectives and experiences in the field have led them to try and solve the challenges provided in the competition to achieve a Net-Zero Water and Energy design for a Community Resilience Shelter. The team has held various systematic meetings and discussions – internally, with industrial partners, and with their project partner, SELCO Foundation, a public charitable trust that aims to provide long-term living solutions for underserved communities. Together, they bring us their design proposal for a community resilience shelter - AHANA.

Nestled in the northern end of the shores of the Bay of Bengal, the site is located within a fisherman community in Puri, Orissa. As we formulated the design for the given space, we visualized a multi-purpose community building that accounts for a community kitchen, Anganwadi, a vocational training center, and other activities. At the same time, it aims at providing community resilience when disaster strikes in the vicinity. And during the times of non-disaster, the space would act as a primary health care center, children learning area, and woman empowerment area. The goal that our team has tried to achieve is not only short-term but also allows the community members to sustain life for a more extended period until their livelihoods are stable again.

We began by analyzing every aspect of the project, including the Energy Performance Index (EPI) goal, an estimate of on-site energy renewal and generation, and other on-site constraints in compliance with our institutional mentors and industry partners. We then studied the site in detail and proposed various aspects and requirements that we must consider making a fully functional working model. Pentakata is a city with a low employability rate. Our project tries to contribute a positive outreach to the town as we address and resolve at least 60% of the challenges provided in the Solar Decathlon Guidelines. Having a warm and humid climate for most of the year, we have targeted an EPI of 53.25 kWh/year. This has been achieved by incorporating innovative strategies like 100% on-site water reusability, automation systems to reduce wastage during the construction, and a sustainable solar passive building design to help achieve our goals. The renewable energy produced is from solar energy and wind energy, which will help provide the energy for the necessary power. Other than that, we have utilised materials that self shade, decreased the ground coverage, increased the FAR, and considered many different aspects to make the building working net-zero energy and net-zero water building.

Our team has put in consistent efforts at achieving the above discussed. Still, they have also tried to offer a viable solution to our challenges without disturbing the balance of the site's visual, thermal, and aesthetic comfort. The team also has worked on Increasing the FAR of the building as the site is small. The design and structural team have worked on making the building more resilient during times of disaster.

2. Team Introduction

2.1 TEAM SYNERGY

Fig 2.1 - Team Members

Team Synergy consists of 13 members: 9 Architecture students and 2 Sustainable Design students from Manipal School of Architecture and Planning, one civil engineering and one construction engineering student from Manipal Institute of Technology, MAHE. Our institutional mentor, Ar. Ratna Sravya is an Assistant Professor at the Manipal School of Architecture and Planning. She has done her Master's in architecture at Deakin University, Melbourne. A culmination of creative minds from the third year to master, each one has a unique talent to bring to the table. Providing a variety of inputs at each stage of the design process has helped us have better open discussions about eliminating maximum possibilities of error and coming up with an efficient design. Each one has taken up different aspects of the Solar Decathlon project as they coordinate and work together into presenting our multi-purpose community resilience shelter - **"AHANA."**

Background of the Lead Institution:

The Manipal School of Architecture and Planning (MSAP) was established in 1978. It aims to foster creative and intellectually vibrant learning with a global outlook on architecture. The schools offer various programs for undergraduates and postgraduates in the same. The school has been producing eminent professionals for more than four decades. Comprehensive knowledge of climate-responsive studies and passive strategies in Bachelor of Architecture has trained them to design energy-efficient buildings. The students pursuing Masters in Sustainable design are trained in energy-efficient modeling through various simulation software. In addition, Manipal Institute of Technology provides multiple courses, among which M.Tech in construction management and B. Tech in civil engineering provide immense knowledge in structural design, construction waste management, water management, and time and material management in construction.

Faculty Advisors:

1. Ratna Sravya, Assistant Professor, MSAP
2. Amarnath Sharma, Assistant Professor-Senior scale, MSAP

3. Naga Venkata Sai Kumar, Assistant Professor, MSAP
4. Vaibhav Jain, Assistant Professor-Senior scale, MSAP

Names of Industry Partners:

TRIOSOLAR - A leading provider of green energy solutions, TRIOSOLAR is a responsible Indian business addressing the key challenges that daunt the world and, more particularly, India today. They provide sustainable, renewable energy at an affordable cost to urban and rural India. They service both industrial and domestic requirements with innovative and affordable solutions.

2.2 Design Management Process

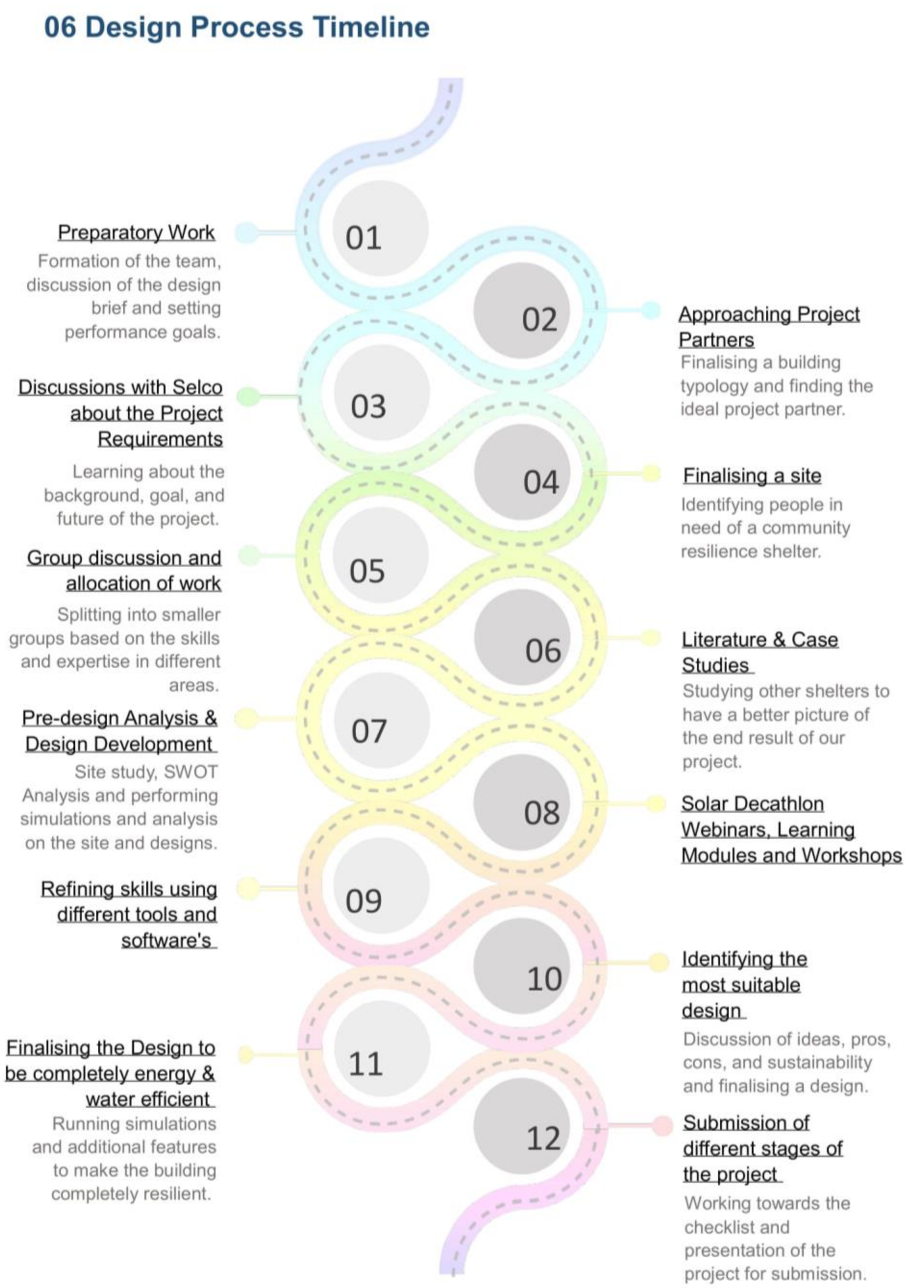


Fig 2.2 – Design Process Timeline

2.3 Challenges Faced and Approach taken to overcome them:

SPACIAL RESTRICTION

Amongst the dense population and closely packed neighborhood, the availability of land is less. The site is only 200 sq m. and needs to provide for all the people in the locality. Thus, the design includes a form that optimizes land use, creating adequate space for all facilities.

CLIMATIC SITUATION AND RESILIENCE STRATEGIES

Pentakota is prone to heavy winds and occasional cyclones and needs a resilient structure to shelter the people. With an integrated structural and architectural team, our group addressed both structural stability and an aerodynamic form to tackle such situations.

COMMUNITY DEVELOPMENT

The community addressed consists of fishers who lie on the weaker side of the economy and require help for growth in their livelihood and support during disaster times. Ahana acts not only as a shelter but also tries to provide facilities to help the community economically, socially, and educationally.

POPULATION CONTROL

A total population of ___ resides in the area under cyclone threat and requires immediate support. Thus, making this project inevitable. Proper spatial planning and accommodation facilities accommodation for all the people.

CURRENT LAND USE OF SITE

The land is currently used as a dump yard, and thus before commencing the design, a site analysis was required to understand the soil condition.

POWER SITUATION

Due to storms and cyclones, there is occasional power cut experienced. To reduce the problems of same, renewable power sources, generators, and inverters to ensure continuous power supply is used in the design.

SANITATION AND HEALTH

A mandatory goal is to ensure mental and physical health, for which sanitation is a significant influence. A clean and green environment, proper maintenance, and hygienic surrounding are thus an essential part of the project.

2.4 Software Used:

Fig 2.3 – Software Used

3. Project Background:

a. Project Name: Project Ahana, Community Centre for Disaster Resilience: Cyclones

Case of the Fishermen Community in Pentakatha, Puri, Odisha

b. Project Partner: SELCO Foundation

SELCO Foundation, an NGO, was established to achieve rural development and conservation of the environment by promoting the use of sustainable energy. The Foundation has been working for the past 11 years on field-based R&D work. It has developed various models and processes in primary energy access, health, education, livelihoods, financial inclusion, and the built environment. This can be replicated and scaled up to bring social inclusivity and equity to the nation.

Key Individual: Prajna Aigal – Analyst (Built Environment), Nirmita - Program Manager (Built Environment Team)

c. Brief description of project and site:

Project Location: Pentakatha, Puri, Odisha.
Climate zone: Warm and Humid (According to ECBC)
Stage of the Project: proposed now, unconstructed, barren land with little vegetation.
Hours of operation: 8 hours during regular days and 24 hours during pandemic or disaster times.

Purpose: Build-Own-Operate

Pentakatha, Puri, Odisha is located on India's east coast, vulnerable to tropical storms originating in the Bay of Bengal. The current location is divided into four municipal wards. The current population in this area is between 40000 and 50000 people, with 12000 households primarily habituated by migrants from Andhra Pradesh. The residential spaces are 300-500 meters from the high tide zones. They are kutcha and pukka houses made of bamboo and mud, with the majority of them being thatched. The project is about solving fundamental needs, mainly for women and children. By creating several community resilience shelters for the community during disasters when they may have to stay for additional days in community shelters after the storm has struck for the time required to reconstruct their house and move back to their regular life.

d. Special requirements from project partner: Cyclone resilience, affordable, small footprint, and easily replicable among other coastal communities. Post completion, it'll be for the community to use.

e. Total built-up area (m2)

Site area(m2)	1560 m2
Permissible built-up area(m2)	2500 m2
Permissible ground coverage(m2)	707m2
Proposed/ estimated built-up area(m2)	2316 m2

Table: 3.1 – Total built-up area

f. Construction budget (INR/m2) from project partner: INR 3000 per sq ft (approx INR 32,000 per sqm) higher costs considered due to cyclone resilience.

4.Performance Specifications: -

a. Climate Analysis:

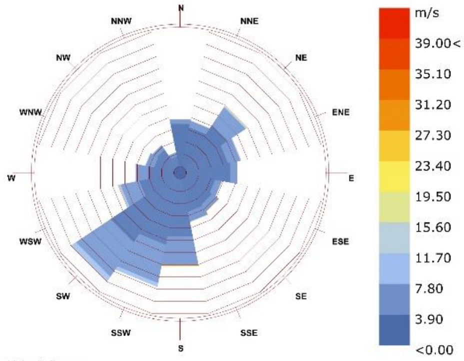


Fig 4.1 - Windrose

Latitude – 19° 28'N to 26° 35'N
Longitude – 84° 29'E to 86° 26'E
Average rainfall – 1392.5 mm with 62 days of rain
Average max temp – 30.22° C
Average min temp – 23.68° C
Monsoon – July-September (S-W)
Summer – March-June
Peak Temperature37.2° C
Winter – October-February
Min Temperature - 20°C

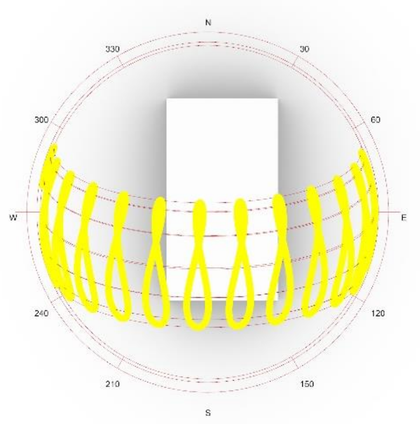


Fig 4.2 – Sun path

Microclimate Analysis

- Warm-humid climate has no heating requirements.
- Excess sun and heat gain should be avoided for thermal comfort via passing cooling techniques.
- East and West facades receive uniform and intense solar radiation throughout the year.
- Glare-free light is primarily available in the north while south requires shading from harsh sun.
- Predominant winds are from southwest-northeast direction.
- July-August are the wettest months while Dec-Jan is the driest.
- Months with most sunshine are Dec-May with average sunshine hours of 8h.
- The months with least sunshine are July and August with average sunshine hours of 4h.

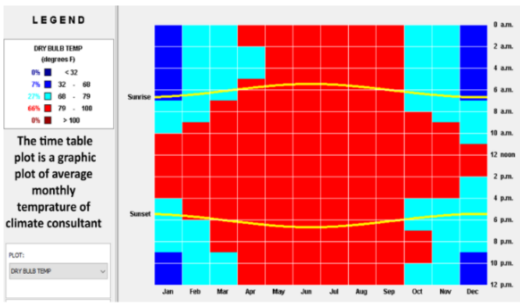


Fig 4.3 – Average Monthly Temperature

Energy-efficient buildings are only effective when the occupants of the buildings are comfortable. To reduce the impacts on settlements and infrastructure, it is critical to develop appropriate mitigation and adaption responses. Climate responsive buildings have minimal adverse impacts on the natural environment and seek to maximize opportunities for indoor environmental quality and performance, saving money. Th red area particularly from April to September should be treated either passively or actively to achieve thermal comfort.

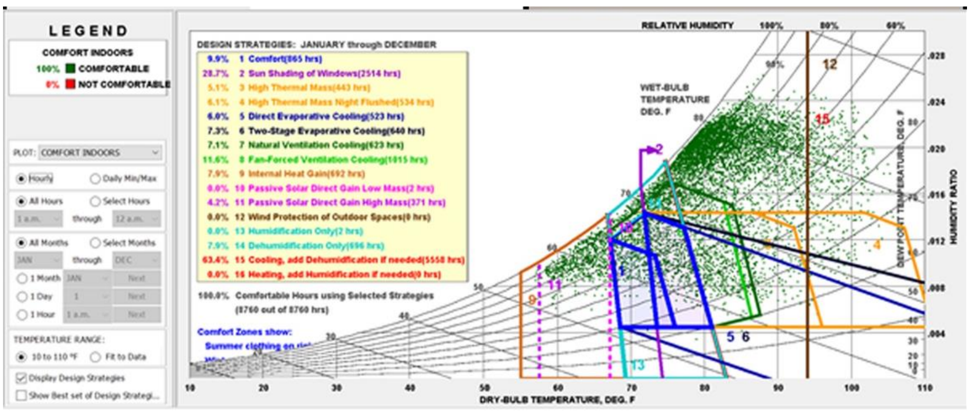


Fig 4.4 – Psychrometric Chart

b. Perfomance Specification:

Input Parameters	Units	Base model design Value (ecbc)	Proposed Design Value (ecbc super)
General			
Building Area	m^2	2316 m^2	2316 m^2
Conditioned Area	m^2	960 m^2	960 m^2
Electricity Rate	INR/kWh	4.3	4.3
Natural Gas rate	INR/G	926	926
Building Occupancy Hours	hr	9AM to 4PM (NonPandamic)	9AM to 4PM (NonPandamic)
Average Occupant Density	m^2/person	0.52	0.52
Interior Average Lighting Power Density	W/m^2	4 to 5	4 to 5
List of Lighting Controls	nos	Occupancy sensors	Occupancy sensors
Average Equipment Power Density	W/m^2	10	8
Minimum OA Ventilation(avg)	l/sec. m^2	0.5	0.3
Envelope			
Roof assembly U value	W/m^2.K	0.3	0.20 W/m^2.K
Roof Assembly SRI		0.3	30
Average Wall Assembly U value	W/m^2.K	0.5	0.22 W/m^2.K
Window to wall Area Ratio	%	N-40%	N – 40%, E W S – 20%
Windows SHGC		0.27	0.25
Windows U value	W/m^2.K	3	2.2 W/m^2.K
Windows VLT	%	5	4
Infiltration	ac/h	2.20	2.20
HVAC System type and description		Split AC	Split AC
Describe mixed mode strategy in operation / controls of AC		Mixed mode	Windows will be open in winter and only in summertime AC is used
Heating source		No heating	No heating
Proposed EPI(Total)	kWh/m^2/ yr		54 kWh/m^2/ yr
Cooling source		electric	electric
Heating setpoint	kWh/m^2/ yr	15	15
Cooling COP	kWh/m^2/ yr	1	3.2
Cooling setpoint		28	26

Table 4.1 – Performance Specification

5. Goals:

GOALS		
RESILIENCE	**SUSTAINABLE CITIES AND COMMUNITIES**	• Inclusive human settlements • Resilient and safe sheltering • Cohousing resilient shelter plan: facilitate community interaction • Built up space reduced through multiplicity
CLIMATE	COMFORT AND **CLIMATE ACTION**	• Integration of renewable energy from natural sources like solar and wind • **Responsible consumption & production** • Maximize thermal comfort level • Reduce impact of building on envr.
BUILDING	SUSTAINABLE ARCHITECTURAL DESIGNING	• Integrate environmental planning of water, energy and waste cycle • Design to accommodate shelter during disaster times
	ENGINEERING AND OPERATION	• Resilient structure: Design to withstand cyclones and floods • Through technology and automation system, reduce construction waste
ENERGY	NET ZERO ENERGY PERFORMANCE	• Minimize operational energy through building design, form and layout • Produce energy that is equals to consumed energy • **Affordable clean energy sources**
PRODUCTION	AFFORDABILITY	• Reducing construction cost using local materials • Reducing operation costs through simulation, planning and commissioning
	SCALABILITY AND MARKETTING	• Prototype designing • Modular for that is reusable • Can be used in other areas which also have similar conditions and requirement
	INDUSTRY, INNOVATION AND INFRASTRUCTURE	• Use of low-embodied energy materials • Cradle-to-cradle construction technique • Smart building automation • Ease of construction with maximum comfort
WATER	WATER PERFORMANCE	• 80% rainwater harvesting, 80% black water recycling on site • 50% reduction in landscaping demand • Fixtures with low water flush/flow • **Clean water and sanitation**
END SERVICE	ALTERNATIVE USE	• Alternative use to boost community and economy during non-disaster times • Disaster times- accommodation for village and around • **Decent work and economic growth**
	ENHANCEMENT OF LIVELIHOOD	• **Good health and well-being** target • Socialization and community growth • Good indoor air quality and comfort • Healthcare provisions • **Life on land**

Table- Project goals, including SDGs (highlighted)

Table 5.1 - Goals

6. Design Documentation

Our design project focuses on designing a community resilience shelter for the people of Pentakhata, Puri, Odisha. The site is a fishing village cyclone-prone area located on the shores of the Bay of Bengal. It is a congested slum settlement with a pattern housing of 50,000 people with thatched roof houses.

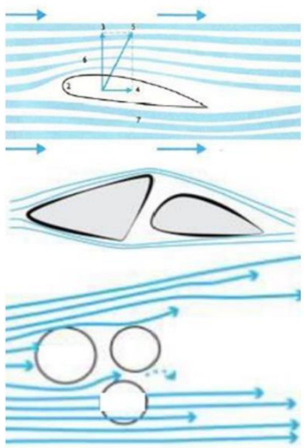
Fig 6.1 – Site Details

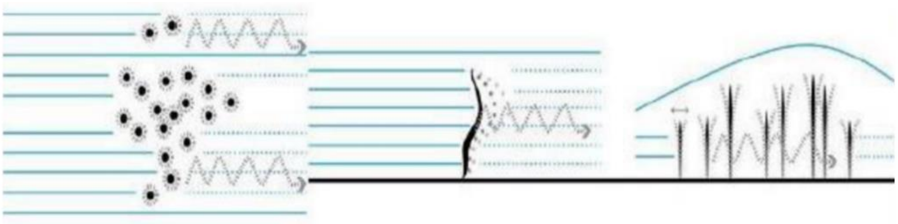
Spatial Requirements of Project:

- The building area should be at least 200 m2 which will be 1 m2 per person.
- At least 70% of the building program should be dedicated to residential spaces, which could be of multi-purpose type.
- The design should meet the thermal comfort and indoor air quality standards as mentioned in the Green Rating Assessment systems.
- Additional facilities can be added through energy and water performance calculations to be restricted to the residential spaces.

Concept Development:

Airfoil is the shape based on which airplane wings are designed. They are the optimum aerodynamic curve that allows less air resistance. The only issue in this shape, aerodynamically, is that it is designed in such a way that causes the rear, tapered end to move upward. The form is thus modified to suit a building in a cyclone-prone area. This concept is used along with materialization. It is a specific arrangement of buildings on a site, allowing the wind passing through to be diffused or redirected around the entire area.





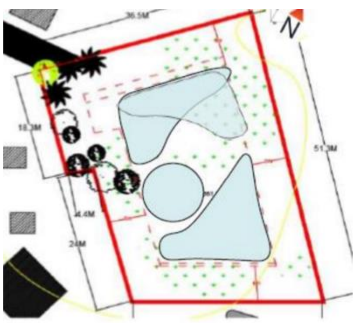


Fig 6.2 - Concept

This concept is used in arranging buildings on the site, as shown in the figure. Though this arrangement does not directly reflect in the plan, it was used to come up with zoning and form that has been incorporated along with the proximity and activity studies done on the usage of spaces that go into the community resilience shelter.

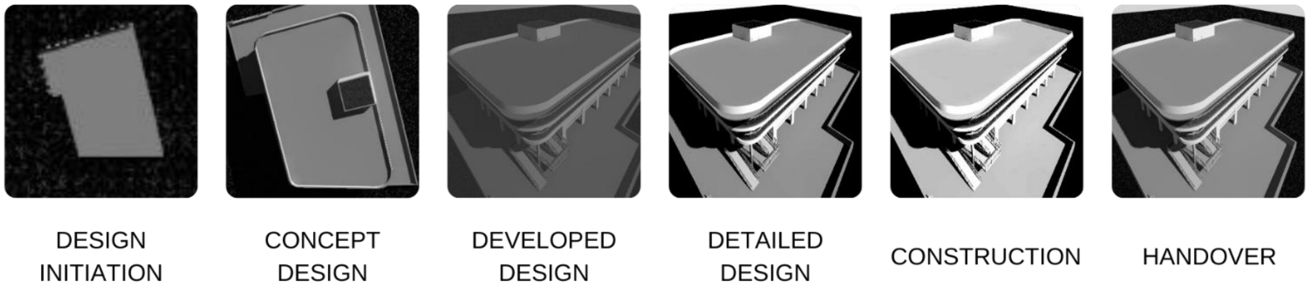
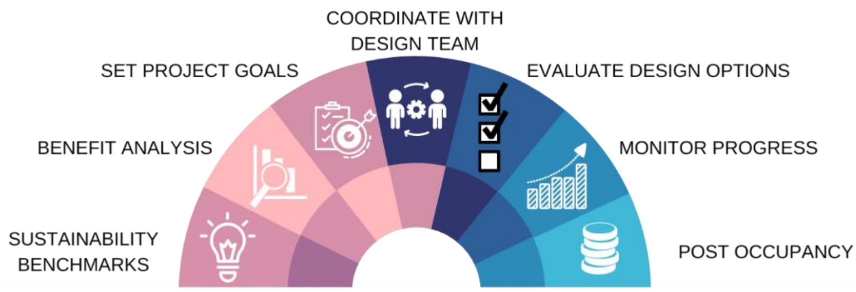


Fig 6.3 – Design Process

The architectural team started with design initiation, where the energy and structural team helped along—followed by conceptual design by the architectural team. Then the design was developed involving the preliminary outputs given by the ECMs from the energy management team and basic structural design from the structural team. Then the design was further detailed to make it net-zero energy and net-zero water building. After that providing the plan to the SELCO team will initiate construction and proceed with the resilience of the community people.



Initially, the team set its benchmarks. For the base case, the values are taken from ECBC. Then the project's benefits were analyzed, and the goals were established—the design team coordinated with the design and structural team to come up with solutions and evaluate them.

The energy and the water are calculated from the initial stage to the final design process stage and estimated at the site, building, zone, and material level. All possibilities of passive strategies are analyzed, and in case of adversities where passive systems do not achieve thermal comfort, minimal active methods are provided

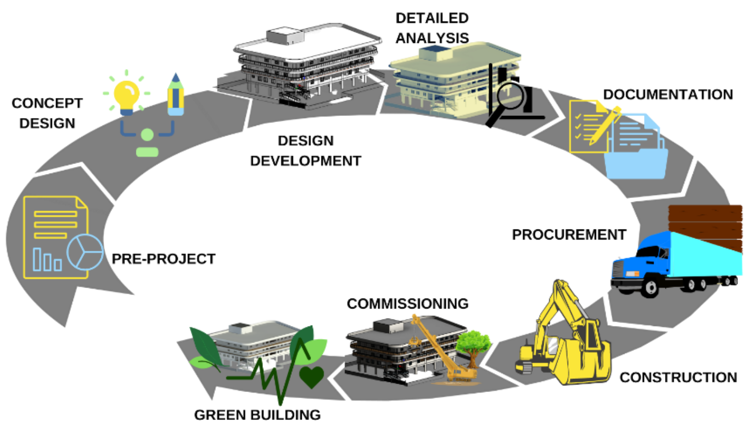


Fig 6.4 – Design Management Process

6.1. Energy Performance

Renewable Energy
If we are considering our site, there are mainly two sources of renewable energy that can be produced (i) Wind Energy (ii) Solar Energy
Considering an entire year, four months (July-October) is monsoon season, and the other months are normal summer condition. With this Existing renewable energy's also, it has its own problems. During the monsoon period, the solar panels won't be efficient to meet the Energy requirement, so wind energy is utilized.
Vertical windmills are used instead of upright windmills because on upright windmills, the direction of wind always must be the same (in our case, it changes day and night considering the breeze). So, the required cut in wind velocity to activate the windmills is 9km/hr (on-site avg. wind velocity is 14 km/hr).

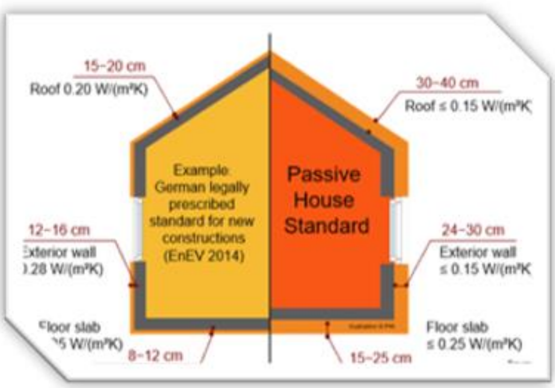
Fig 6.1.1 – Solar Energy

Fig 6.1.2 – Wind Energy

SOLAR ENERGY
Roof Area: 610 Sq.m
Solar PV type: Fixed System Tilt of 23-degree towards south
Number of Solar Modules: 300 units
Energy Production: 900 kWh/kWp/Yr
Company: TATA

WIND ENERGY
Type of wind turbine: H series
Energy Production: 5000w
Number of Wind Turbines: 3nos
Material: Glassfiber
Company: Balaji Systems

The overall EPI of the design is 53 kWh/Yr, which is 53000w per year. Within which 26500w is powered by wind energy and the rest with solar energy.

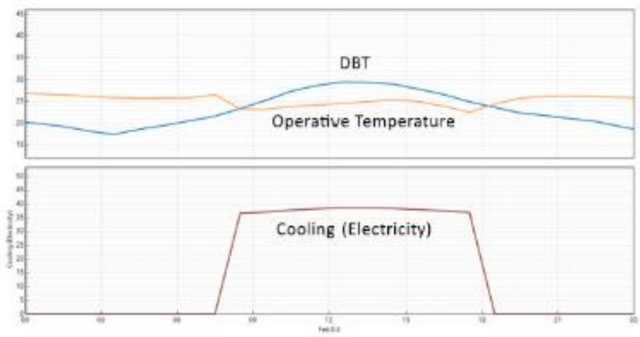


Considering most of the materials used in the building itself follow the standard of Super ECBC to reduce the overall energy requirement

ROOF- **0.20 W/m². K,**
WALLS- **0.22 W/m². K,**
WINDOWS- **2.2 W/m². K**

Fig 6.1.3 Example figure showing the insulation on floor, wall, roof helping in reduction of heat gain

BASE CASE MODEL



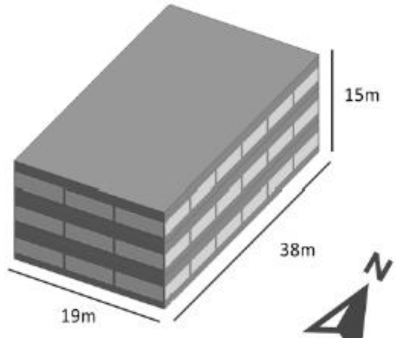


Fig 6.1.3 – Base Case Model

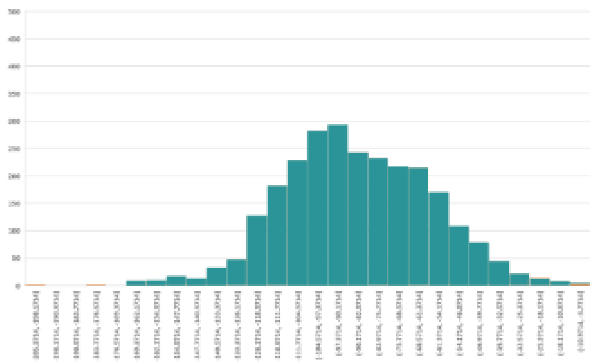


Fig 6.1.4 Cooling Load

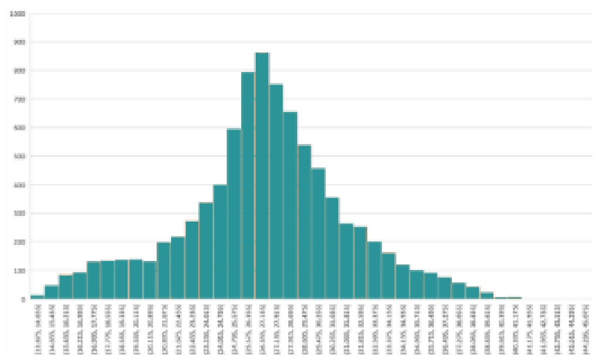


Fig 6.1.5 Dry Bulb Temperature

Dimensions - 19mx358m, height 15m. Based on the chart, it's proved that the base case model is working. During the working hours of the building in February, the operative temperature is lower than the outside Dry Bulb Temperature. Similarly, the Cooling (Electricity) graph goes high during the same period.

The same from the previous line chart is proved in the histogram, which is from the heat map of hourly chart data got from Design-Builder. The Cooling Load increases with an increase in Dry Bulb Temperature during the working hours of the building.

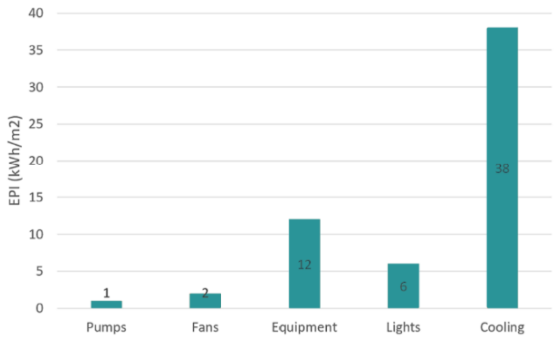


Fig 6.1.6 Target Breakdown

Daylight Requirement	
WWR	40
Surface Type	Reflectance
Wall or Vertical Internal Surfaces	0.5
Ceiling	0.7
Floor	0.2
Furniture (permanent)	0.5
Material	U-Factor
Roof	0.33
Opaque External Wall	0.4
Vertical Fenestration	3
Lighting Zones	LPD (W/m2)
PHC	9.7
Workshop	13.8
Dormitory	9.1
Community Dining and Kitchen	10.9
Restroom	7.7
Stairway	5.5
Occupancy Sensor	10
HVAC-COP	1

Table 6.1.1- Base Case Inputs

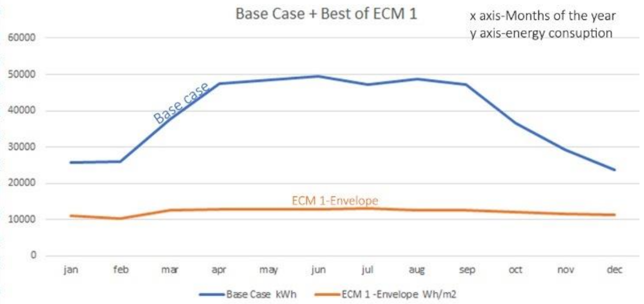
Energy Conservation Measures 1- Envelope Systems

Envelope conduction through
Walls,
roofs and
windows
to reduce the Sensible heat - Envelope Loads

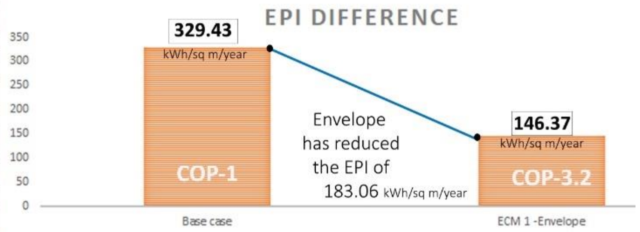
Heat transfer through the Envelope is important to consider while designing the building through Design decisions.

Envelope loads will impact the difference in Temprature (delta T). The conduction through Roofs ,Walls and Window has been reduced by choosing the best u- value and thickness of the material.

Heat transfer can heatup the roofs and walls way above the outside Ambient tempature.So we need to account the address as well and for that Building envelope is considered has one of the 1 st ECMs

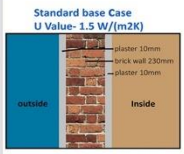


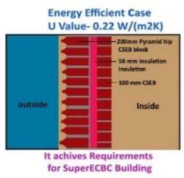
Envelope + COP of AC has reduced the EPI of 183.06



WALL

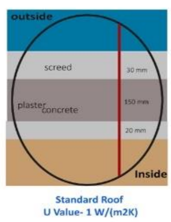
	Case 1 Base case – Brick Wall	Case 2 Base case – Brick Wall	Case 3 Base case – Brick Wall	Case 4 Best case - CSEB
Thickness	230mm Brick wall 10mm plaster both the sides	300mm Cavity Brick wall 10mm plaster both the sides	190 mm Pe cast concrete Cavity wall with 100 mm rock wool	**200mm Pyramid hip CSEB block + 50 mm Insulation+ 100 mm CSEB**
U-Valve W/m2K	0.40	1	0.31	0.22

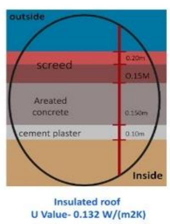




ROOF

	Case 1 – base case	Case 2	Case 3	Case 4 – Best case
Thickness	50 mm Screed on 150mm Cast concrete + Glass wool	150mm Cast concrete + Rock wool 20mm + 12 mm corkboard	150mm Cast concrete + plaster with 10 mm + XPS insulation	over deck insulated+ 15 mm Screed + 150 mm concrete + 10 mm plaster inside
U-Valve W/m2K	0.33	0.35	0.6	0.132





WINDOW

Types of glass	Case 1 – Single Clear Glazing-Base Case	Case 2 – Extra Clear Glazing	Case 3-Cool lite single Glazed with dew drop shade	Case 4-Double Glazing Clear
Thickness	6mm	6mm	6mm	6mm/6mm air filled
Total SHGC	0.719	0.89	0.58	0.154
Light Transmission	0.89	0.911	0.72	0.073
U-Value W/m2K	3.128	5.88	5.6	2.761

Single Clear Glazing

Thickness 6mm
Total SHGC 0.719
Light Transmission 0.89
U-Value W/m2K 3.128

Total SHGC 0.154
Light Transmission 0.073
U-Value W/m2K 2.7

Double Glazing Low E

Table 6.1.2 - Materials

Energy Conservation Measures 2- Orientation

ECM 1(Envelope) + ECM 2(Orientation)

Case 1 EPI-155

Case 2 EPI-148.99

Case 3 EPI-146

Case 4 EPI-145.82

Case 5 EPI-141

Base case EPI-146.67

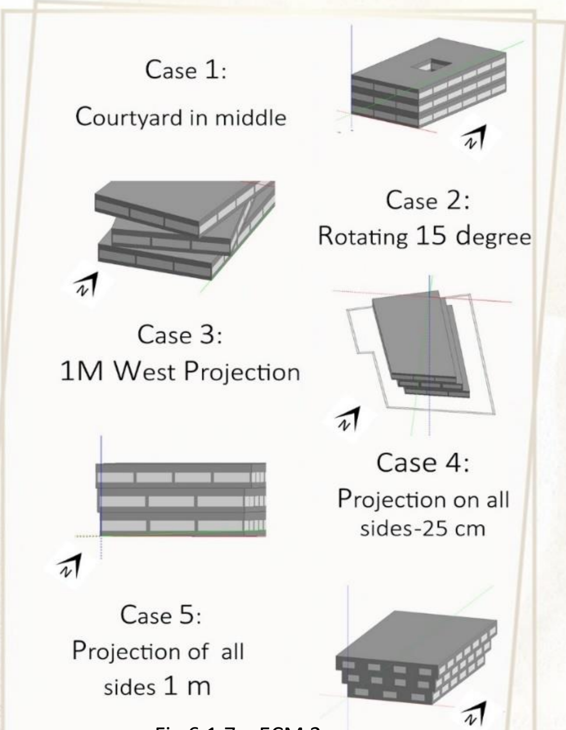


Fig 6.1.7 – ECM 2

ECM 1(Envelope) + ECM 2(Orientation)

Date/Time	Electricity
	Wh/m2
01-01-2021	11097.77
01-02-2021	10453.87
01-03-2021	12741.22
01-04-2021	12954.62
01-05-2021	12952.73
01-06-2021	12890.27
01-07-2021	13029.45
01-08-2021	12719.51
01-09-2021	12656.46
01-10-2021	12124.97
01-11-2021	11636.76
01-12-2021	11476.34
WEST PROJECTION	
EPI	146

Date/Time	Electricity
	Wh/m2
01-01-2021	11785.67
01-02-2021	11079.24
01-03-2021	13487.61
01-04-2021	13723.86
01-05-2021	13730.62
01-06-2021	13651.51
01-07-2021	13786.21
01-08-2021	13459.57
01-09-2021	13389.5
01-10-2021	12823.59
01-11-2021	12298.04
01-12-2021	12185.07
COURTYARD IN MIDDLE	
epi	155

Date/Time	Electricity
	Wh/m2
01-01-2021	11022.76
01-02-2021	10385.51
01-03-2021	12661.68
01-04-2021	12876.84
01-05-2021	12874.54
01-06-2021	12813.05
01-07-2021	12951.76
01-08-2021	12643.42
01-09-2021	12580.92
01-10-2021	12052.24
01-11-2021	11564.44
01-12-2021	11397.12
PROJ ON ALL THE SIDE	
EPI	145.82

Date/Time	Electricity
	Wh/m2
01-01-2021	11282.84
01-02-2021	10614.91
01-03-2021	12927.51
01-04-2021	13154.67
01-05-2021	13157.66
01-06-2021	13087.71
01-07-2021	13227.97
01-08-2021	12915.1
01-09-2021	12848.84
01-10-2021	12302.95
01-11-2021	11804.19
01-12-2021	11669.08
ROTATING 15 DEGREE	
epi	148.99

Date/Time	Electricity
	Wh/m2
01-01-2021	10667.45
01-02-2021	10051.87
01-03-2021	12256.75
01-04-2021	12470.35
01-05-2021	12469.56
01-06-2021	12410.16
01-07-2021	12545.09
01-08-2021	12246.15
01-09-2021	12185.05
01-10-2021	11671.63
01-11-2021	11197.94
01-12-2021	11028.6
1M PROJECTION ON ALL	
EPI	141

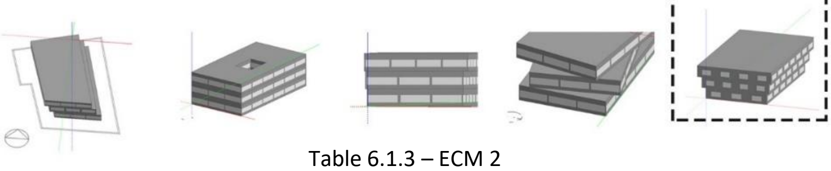
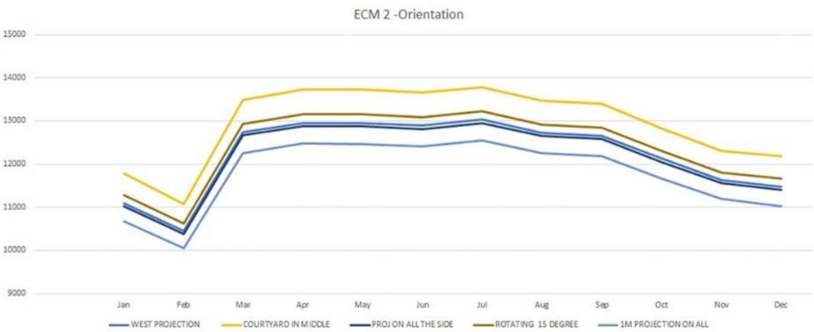


Table 6.1.3 – ECM 2

Best of ECM 2-Orientation



1 m projection on all the sides has the best results

The orientation of the building is considered as one of the Energy Conservation Measure. Five types of orientation are considered wih courtyard in middle, with rotating each floor to 15 degrees, 1m projection on the west side, 25cm projection on all sides and 1m projections on ll sides.

Running a simulation with each of these cases in design builder has resulted with all side projection of 1 m with the least EPI.

And this also helps in increasing the FAR of the building. As the site area is less, the area of the ground coverage is minimal. But this 1m projection on all side would help in increasing the FAR of the building.

Energy Conservation Measures 3- Window Wall Ratio

The window dimensions were evaluated in terms of the ratio between the glazed surface and the gross façade area, which is referred to as window to wall ratio (WWR)

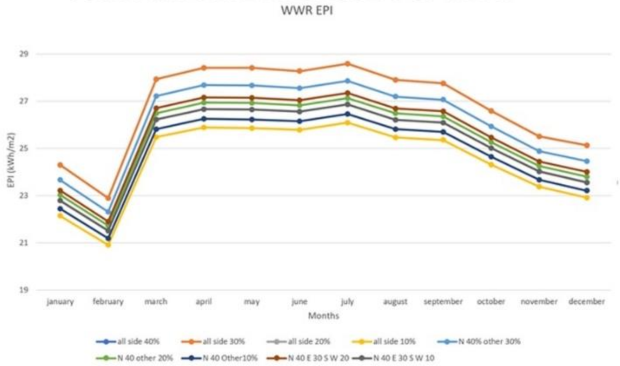
Cases that are considered for this Design

All 40%
All 30%
All 20%
All 10%

North 40% constant
South, East, West-30%
South, East, West-20%
South, East, West-10%

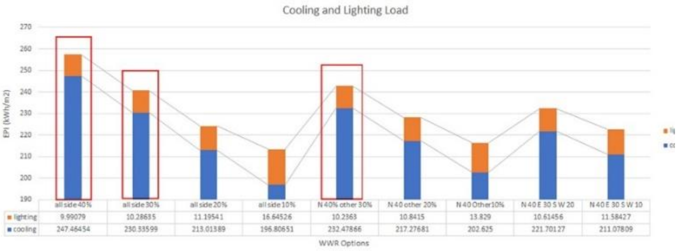
North 40%, East 30% constant
South, East – 20%
South, East – 10%

COMPARING ALL THE RESULTS OF WWR



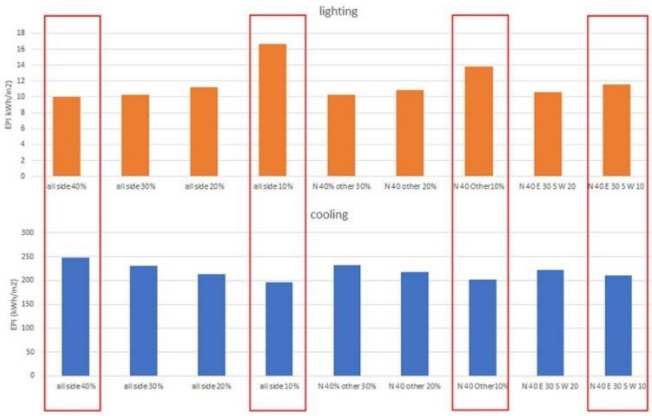
As the EPI of 10% WWR is the lowest as expected, this has been neglected

Comparison of Cooling and Lighting Load



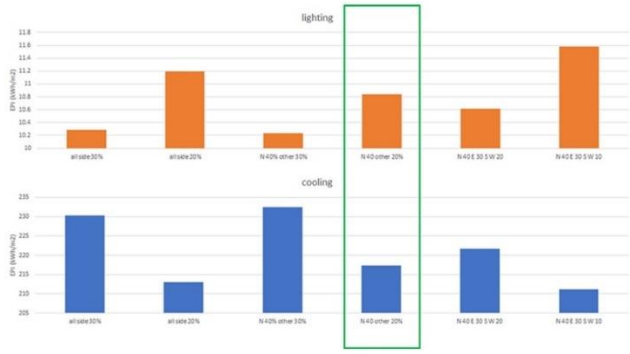
So, cooling load and lighting load of each option is considered to get the best result.

As all side 40%, N40% other side 30% and all side 30% are having a high load they are being neglected in this case.



From this all sides 40%,all sides 10%. north 40% other side 10,N-40% E-30 and S & W-10 percent is neglected

Further Comparison for WWR



Considering only the EPI for each case of WWR, as expected the EPI of 10% WWR came as the least and best value, which when applied will not give best results overall.

So again the EPI of cooling load and lighting load of the building for each case is compared to obtain the best result.

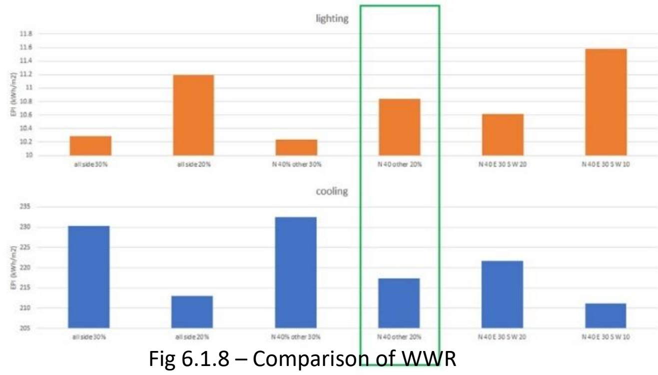
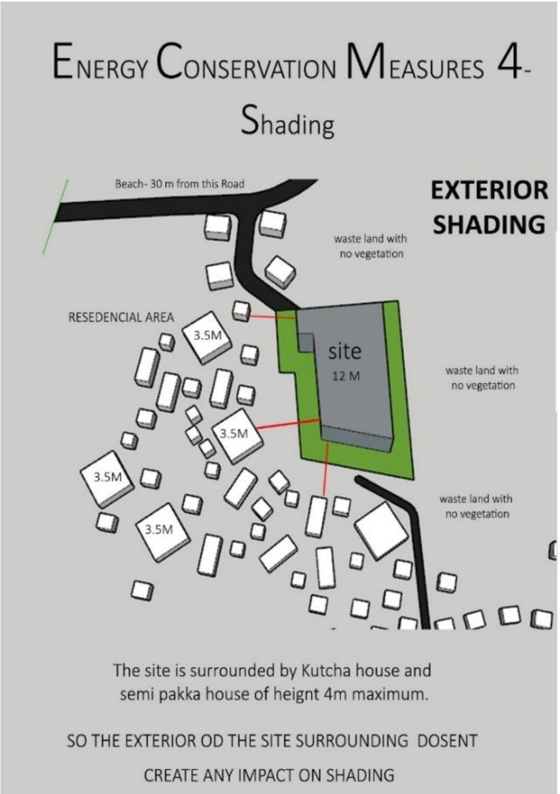


Fig 6.1.8 – Comparison of WWR

In the first stage, all side 40%, all side 10%, North 40% with other sides 30% and North 40% East 30% and other sides 10% are eliminated as their cooling load is high which is not a best solution for a NZEB.

With further comparision it was observed that North 40% and every other side 20% would be an vest option.



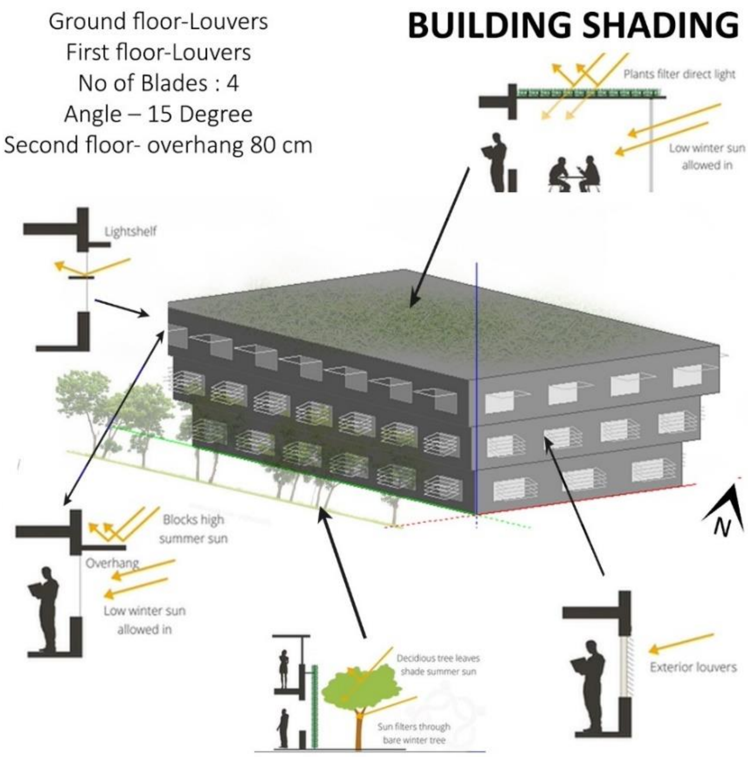
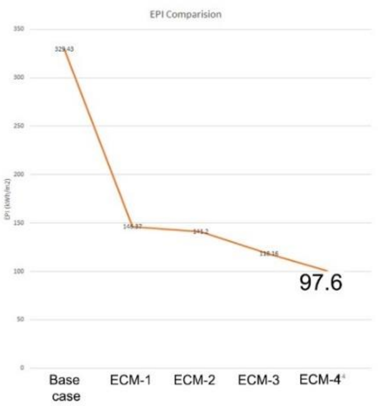
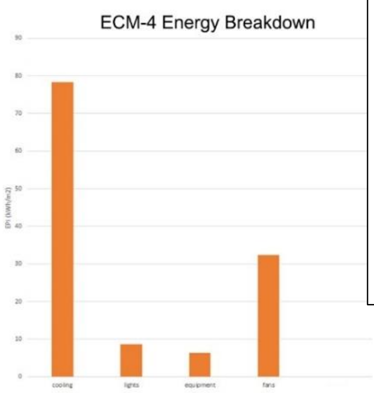


Fig 6.1.9 - Shading

ECM 1+ECM 2+ECM 3+ECM 4- Shading GRAPH





4 Star rated HVAC systems and efficient light fixtures reduced th operational cost Reducing the operating cost and energy consumption. Also Mixed-mode ventilation approach used in the building because with self shading material usage has significantly reduced the cooling load. By integrating both natural ventilation and mechanical cooling strategies, mixed-mode building operation is able to achieve comfortable indoor environments whilst minimising reliance on energy intensive HVAC systems.

Shading Details

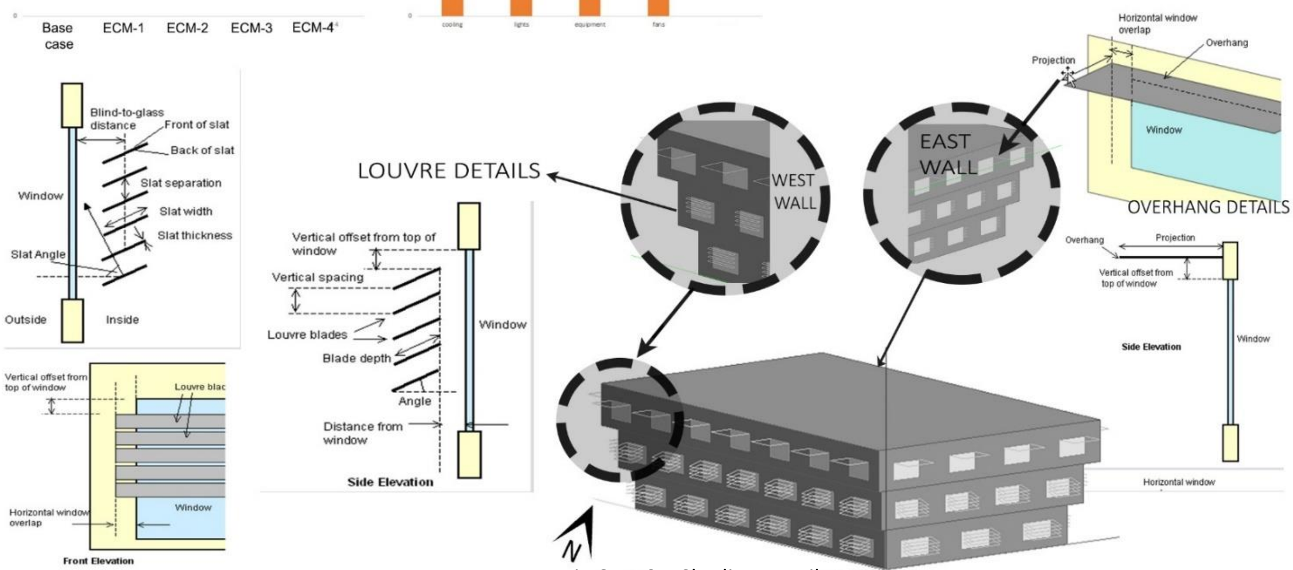
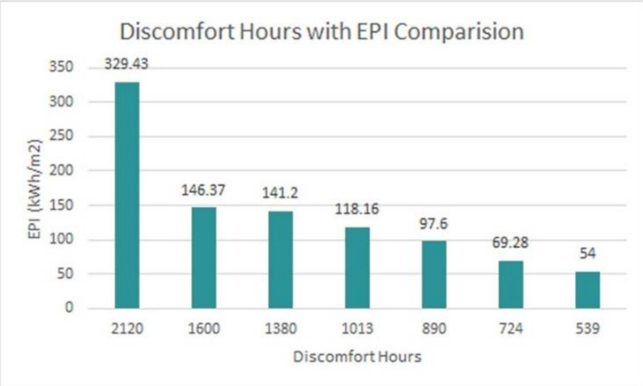


Fig 6.1.10 – Shading Details

EPI



	Base Case	ECM 1	ECM 2	ECM 3	ECM 4	Efficient structure	Design propsed	Target
Cooling	465.015	101	96	77.5	68.5	46	37	38
Lights	59.155	12	11.5	10.4	6.5	6	5.5	6
Equipment	123.262	19	18.2	17.2	15.4	14	13	12
Fans	0	10	10	8.6	5.4	2	2	2
Pumps	0	5	5	2	1	1	1	1

Table 6.1.4 – Energy Breakdown

The discomfort hours will be further reduced below 300 hours with the use of mechanical ventilation. And the EPI will be further reduced and become a net zero building with the use of Renewable Energy Sources. Net Zero Energy Building is the target of this building proposed model. The workflow includes making a building as a energy simulation model in Design Builder Software. From the base case with further addition of ECM (Energy Conservation Measures) has helped in reducing 83% of EPI (Energy Perfomance Index).

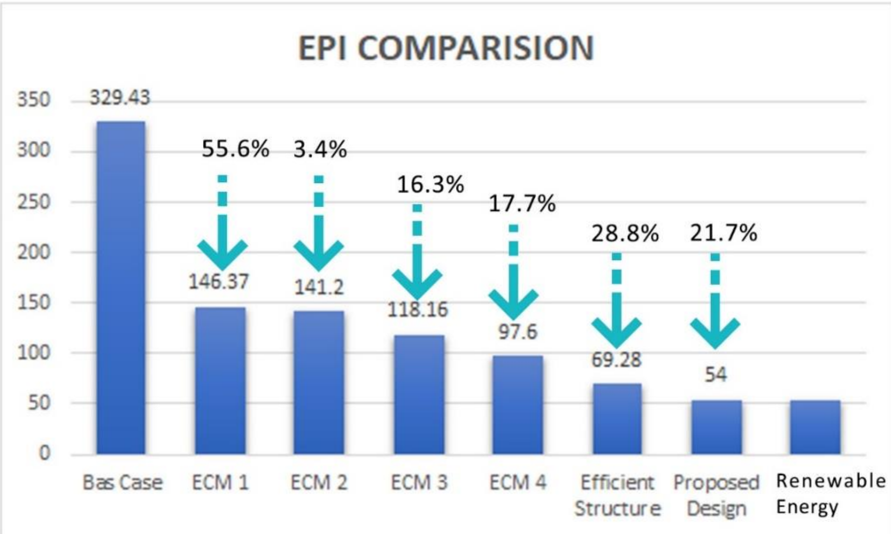


Fig 6.1.11 Optimzation of the proposed design

83 % reducion of EPI by using Energy Conservation Measures from the base case which includes values from ECBC.

6.2.Water Performance

Water performance was one of our biggest concerns for this particular project. Even though our annual rainfall ranges from nearly 1300 mm per year, our occupancy load was lightly compared to the building footprint. Despite these challenges, we still achieved a net positive water cycle.

Rainwater harvesting surfaces	Area m^2	Runoff co-efficient	Effective catchment area m^2
Roof Surfaces	880	0.85	748
Hardscape areas	353	0.80	282.4
Softscape areas	150	0.20	30
	Total Effective catchment area		1060.4

Table 6.2.1 – Catchment Area

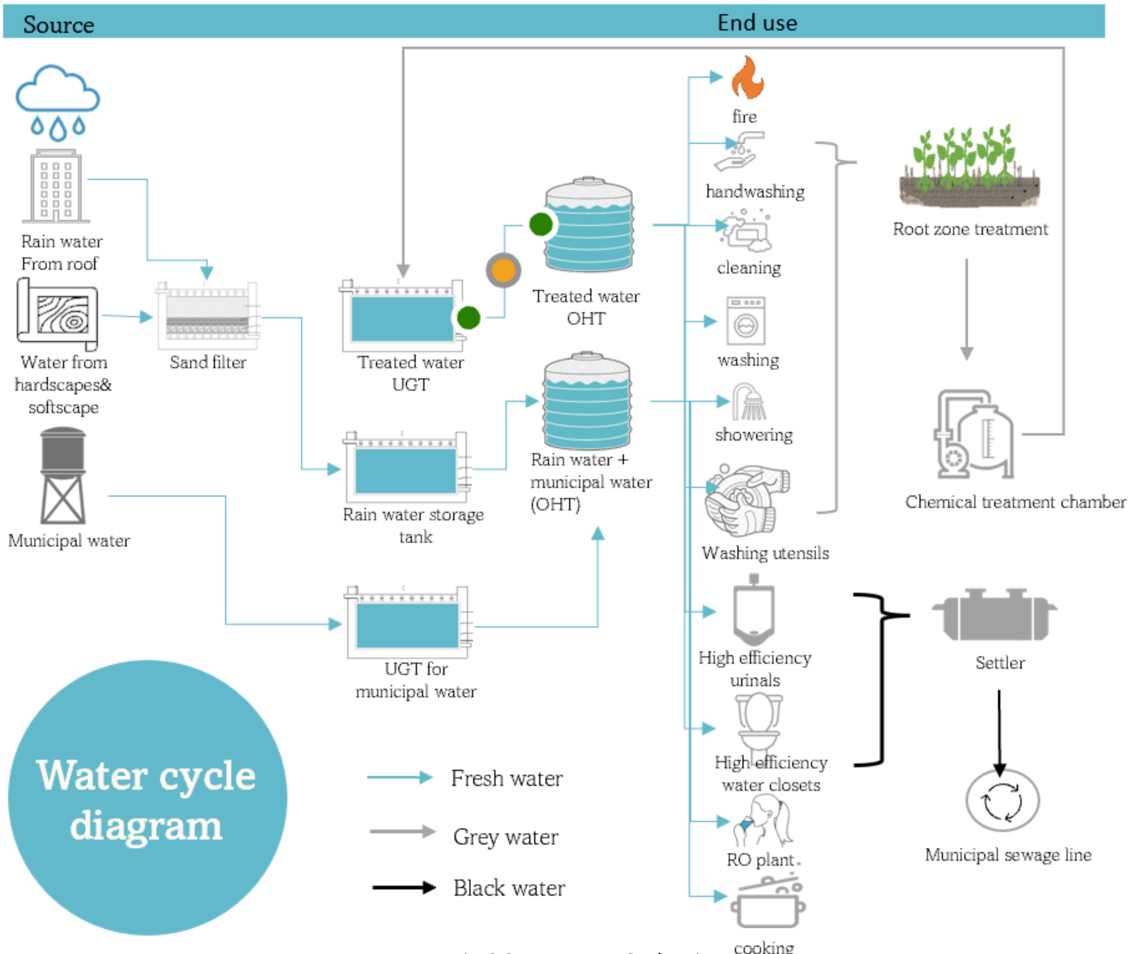


Fig 6.2.1 – Water Cycle Diagram

Strategies used for efficient water performance:

- By considering efficient fixtures, we have brought down the water demand from 135lpcd to 90lpcd
- By recycling the on-site generated greywater to an efficiency of 75%.

  Treatment procedure: The plant canna indica is used for root zone treatment. Then the water passes through a chemical chamber that uses flocculent and disinfectant to make the water reuse at a standard quality. In this project, we are not treating the black water, so the black water is sent to the settler and then to the municipal sewage line

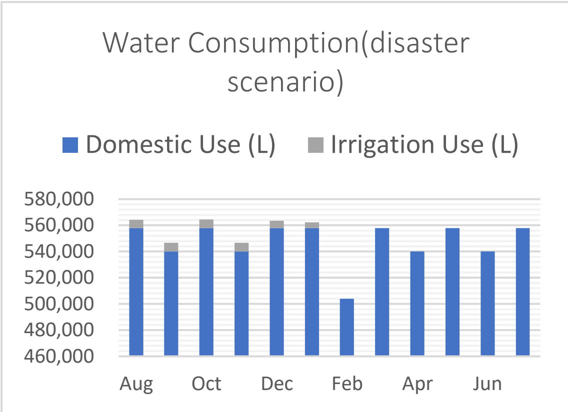
Net Zero Water Cycle

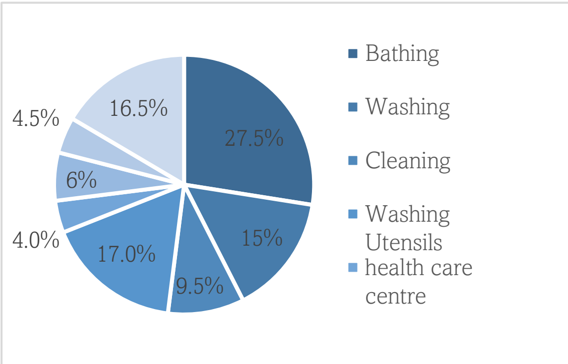
Water calculation during disaster scenario

Water consumption point	Quantity	Litres/day
Occupants : {People x l/person}	200	90
Irrigation (max) : {m^2 x l/m^2}	150	1.5

Municipality water supply (l/day)	10,000

End Use	Percent use	Use in LPD	Greywater in LPD	Blackwater in LPD
Bathing	27.5%	4950	4,950	
Washing	15%	2700	2,700	
Cleaning	9.5%	1710	1,710	
Washing Utensils	17.0%	3060	3060	
health care centre	4.0%	720		
Drinking	6%	1080		1,080
Cooking	4.5%	810		810
Toilet Flushing	16.5%	2970		2,970
Total		18000	12420	4,860





				CONSUMPTION				WATER SOURCES					
Month	Days in month	rain fall in month	effective rainfall	Domestic Use (L)	Irrigation Use %	Irrigation Use (L)	Total Consumption (L)	Municipal Water (L)	Rainwater	Greywater (L)	reusable grey water 75%	Blackwater (L)	Total Stored
Aug	31	347	342	5,58,000	5%	349	5,58,349	3,10,000	362975	3,85,020	2,88,765	1,50,660	403391
Sep	30	230	225	5,40,000	20%	1,350	5,41,350	3,00,000	238060	3,72,600	2,79,450	1,45,800	772701
Oct	31	147	142	5,58,000	35%	2,441	5,60,441	3,10,000	150365	3,85,020	2,88,765	1,50,660	1057644
Nov	30	50	45	5,40,000	30%	2,025	5,42,025	3,00,000	47930	3,72,600	2,79,450	1,45,800	1236150
Dec	31	7	2	5,58,000	60%	4,185	5,62,185	3,10,000	1591	3,85,020	2,88,765	1,50,660	1370575
Jan	31	10	5	5,58,000	100%	6,975	5,64,975	3,10,000	4984	3,85,020	2,88,765	1,50,660	1505604
Feb	28	23	18	5,04,000	100%	6,300	5,10,300	2,80,000	18875	3,47,760	2,60,820	1,36,080	1641939
Mar	31	16	11	5,58,000	95%	6,626	5,64,626	3,10,000	11983	3,85,020	2,88,765	1,50,660	1784315
Apr	30	22	17	5,40,000	97%	6,548	5,46,548	3,00,000	17709	3,72,600	2,79,450	1,45,800	1928077
May	31	72	67	5,58,000	95%	6,626	5,64,626	3,10,000	70623	3,85,020	2,88,765	1,50,660	2129093
Jun	30	156	151	5,40,000	80%	5,400	5,45,400	3,00,000	160332	3,72,600	2,79,450	1,45,800	2416625
Jul	31	282	277	5,58,000	60%	4,185	5,62,185	3,10,000	293413	3,85,020	2,88,765	1,50,660	2842873
Total				65,70,000		53,010	66,23,010	36,50,000	13,78,838	45,33,300	33,99,975	17,73,900	(18,44,197)

Table 6.2.2 – Water Calculation during Disaster

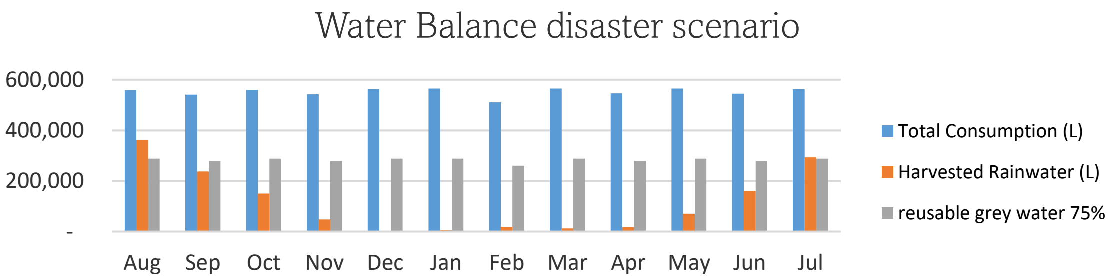
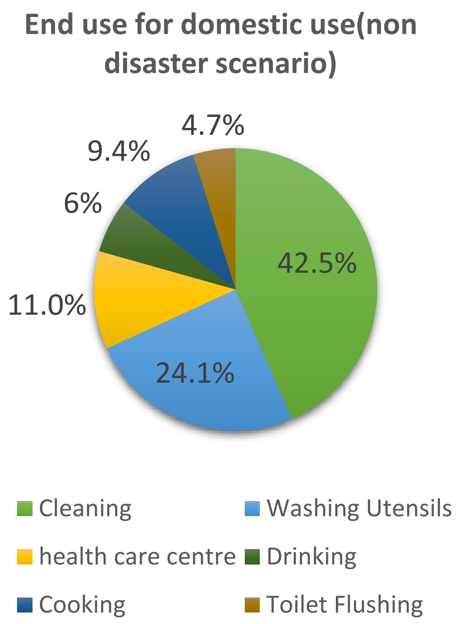


Fig 6.2.2 – Water Balance Disaster Scenario

Water Balance during the non-disaster scenario

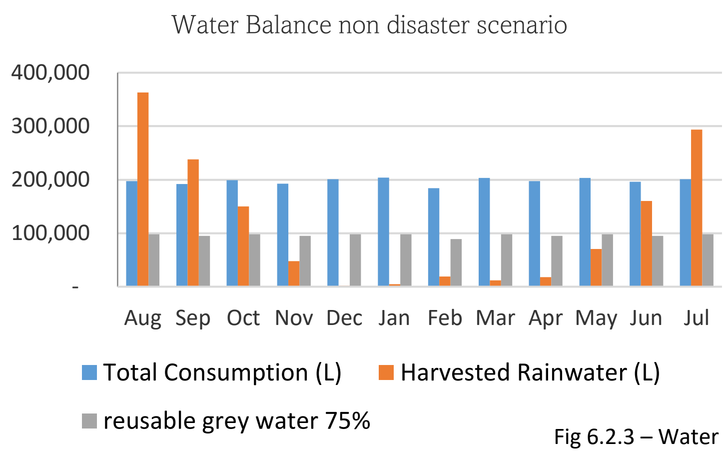
Water consumption point	Quantity	Liters/day
Occupants : {People x l/person}	100	63.5
Irrigation (max) : {m^2 x l/m^2}	150	1.5
Municipality water supply (l/day)	1000	

End Use	Percent use	Use in LPD	Greywater in LPD	Blackwater in LPD
Cleaning	42.5%	2700	2,700	
Washing Utensils	24.1%	1530	1530	
health care centre	11.0%	720		
Drinking	6%	600		600
Cooking	9.4%	500		500
Toilet Flushing	4.7%	300		300
Total		6350	4230	1,400



				CONSUMPTION				WATER SOURCES					
Month	Days in month	rain fall in month	effective rainfall	Domestic Use (L)	Irrigation Use %	Irrigation Use (L)	Total Consumption (L)	Municipal Water (L)	Rainwater	Greywater (L)	reusable grey water 75%	Blackwater (L)	Total Stored
Aug	31	347	342	1,96,850	5%	349	1,97,199	31,000	362975	1,31,091	98,318	39,567	295095
Sep	30	230	225	1,90,500	20%	1,350	1,91,850	30,000	238060	1,26,863	95,147	38,291	498167
Oct	31	147	142	1,96,850	35%	2,441	1,99,291	31,000	150365	1,31,091	98,318	39,567	611332
Nov	30	50	45	1,90,500	30%	2,025	1,92,525	30,000	47930	1,26,863	95,147	38,291	623599
Dec	31	7	2	1,96,850	60%	4,185	2,01,035	31,000	1591	1,31,091	98,318	39,567	586246
Jan	31	10	5	1,96,850	100%	6,975	2,03,825	31,000	4984	1,31,091	98,318	39,567	549496
Feb	28	23	18	1,77,800	100%	6,300	1,84,100	28,000	18875	1,18,405	88,804	35,738	530676
Mar	31	16	11	1,96,850	95%	6,626	2,03,476	31,000	11983	1,31,091	98,318	39,567	501274
Apr	30	22	17	1,90,500	97%	6,548	1,97,048	30,000	17709	1,26,863	95,147	38,291	478798
May	31	72	67	1,96,850	95%	6,626	2,03,476	31,000	70623	1,31,091	98,318	39,567	508035
Jun	30	156	151	1,90,500	80%	5,400	1,95,900	30,000	160332	1,26,863	95,147	38,291	629330
Jul	31	282	277	1,96,850	60%	4,185	2,01,035	31,000	293413	1,31,091	98,318	39,567	883799
Total				23,17,750		53,010	23,70,760	3,65,000	13,78,838	15,43,494	11,57,620	4,65,868	1,65,698

Table 6.2.3 – Water Calculation during non-disaster



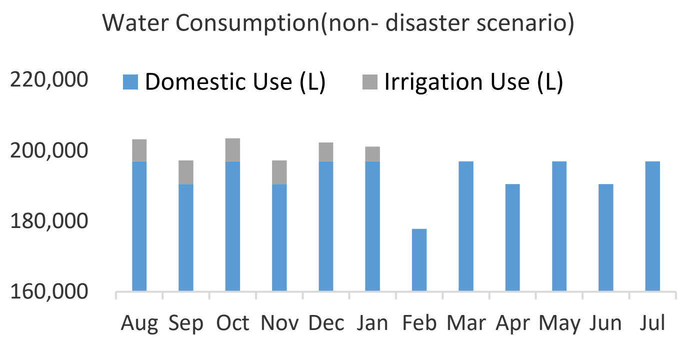


Fig 6.2.3 – Water Balance and consumption Non-Disaster

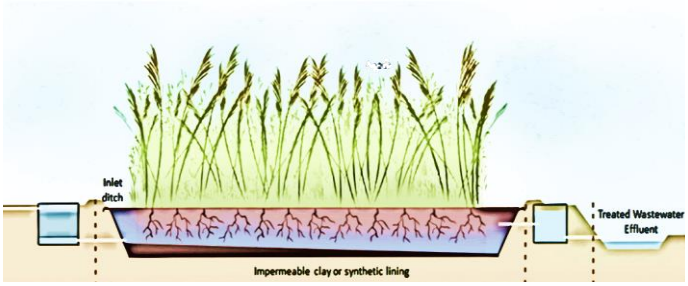


Fig 6.2.4 – Root zone treatment using Canna Indica

Treatment procedure :The plant canna indica is used for root zone treatment. Then the water passes through chemical chamber which uses flocculent and disinfectant to make the water to reuse at a standard quality .In this project we are not treating the black water so the black water sent to the settler and then to the municipal sewage line

All the storage tank calculations are considered for the best constraints that is during disaster scenario.

Total consumption during peak month (Jan) =564975/31
=18225 l/day
Max water storage =2842873/31
=91703l/day
total water stored approximately =90000l/day

Storage tank size
Municipal storage tank (UGT) = 10000l capacity
Rain water storage tank(UGT) =30000l capacity
Treated grey water storage tank(UGT) = 30000l capacity
Treated grey water storage tank(OHT) =10000l capacity
Rain water+ municipal water storage tank(OHT)= 10000l capacity

6.3.Resilience

Due to the storm surge in Phailin Cyclone, large areas were inundated in the affected districts. Flash floods were reported even in the interior districts due to the heavy cyclonic rain. Some other communities also suffered damage to houses and crops due to wind and heavy rainfall due to the cyclone. More than 13,200,000 people in 18,374 villages were affected by the hurricane. Standing crops over a vast area of 6.71 lakh hectares were damaged. Artisans lost their looms, equipment, and raw materials. More than 11,000 sericulture farmers were affected, and fishers were also severely affected due to damage to their boats and fishing nets. Over 8,000 boats and 31,000 fishing nets were damaged.

KEY LEARNINGS

1. Minimize loss of life and hardship through timely early warning, planning, and preparedness.
2. Use multiple channels to disseminate information
3. Enable access to the Internet
4. Build institutions and train disaster management team (DMT) members
5. Link with institutions and further professionalize activities
6. Ensure optimal utilization of resources through effective government - NGO coordination
7. Strengthen the India Disaster Resource Network (IDRN)

8. Ensure continuous training and capacity building
9. Engage with communities and government over a sustained period
10. Address the needs of the most vulnerable

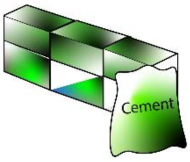
Problems	Strategies
Lightweight roofs are more susceptible to damage due to high wind speed.	To lessen the effect of the uplifting forces on the roof, the roof Pitch should not be less than 22º.
The Foundation, too small for a lightweight building, can be entirely pulled out of the ground.	In contrast to designing for gravity loads, the lighter the building, the larger (or heavier) the Foundation needs to be in cyclone-resistant design.
Wind forces on the walls of the house may produce failure. Wind striking a building creates pressure which pushes against the building on the windward side, and suction which pulls the building on the leeward side and the roof.	High winds in cyclone-prone areas make it necessary to reinforce the walls utilizing reinforced concrete bands and vertical reinforcing bars.
The ridge can fall apart if the rafters are not secure when strong wind passes over the roof.	The ridge can be secured by using: - COLLAR TIES (ii) GUSSETS (iii)METAL STRAPS
Damages can occur to improperly attached windows or window frames.	Detailing of windows will allow for a flexible use where the solid wooden shutters of the windows act as Chajjas.
Trees can disrupt transportation, relief supply missions, and even electrical line damage (if the electrical line is nearer to a tree) if it gets uprooted.	The structure should be placed at a distance equivalent to the tree's height to avoid damage.
Piped water supply systems and bore wells could be damaged during cyclones.	Providing an underground piped water supply would avoid damage or disruption of the water supply.
There will be a risk to the health and safety of the community during or post-disaster.	Health centers should be provided for post-disaster diseases and other health issues.
There are chances of losing communication and connections to outdoor places for resources and emergency calls.	Satellite navigation phones should be available in those areas for communication.
The supply of food or the emergency services could be interrupted.	There should be sufficient food storage and medical facilities or sanitary services during disasters.
There would be a requirement to boost the immune system and be self-sufficient in food for the pandemic.	This is achieved by making the setback into a cultivable area for food and medicinal crops. The cultivated food would be stored in storage for usage during the pandemic. The crops grown are native to the site, as mentioned in State Plants Board

Table 6.3.1 – Resilience

6.4.Affordability

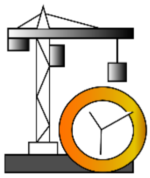
1. MATERIAL AND LOCAL RESOURCES

   Strategic selection of readily available material, available within 200 miles of the site. The use of regional materials ensures the engagement of
   local people and reduces transportation.



2. EASY CONSTRUCTION AND REDUCES TIME

   With the help of local participation and simple column and beam the structural system with brick cladding the construction can be scheduled in shorter time duration.



3. ENERGY EFFICIENCY

   Using efficient passive and active strategies, the energy requirement and consumptions are both reduced, which leads to lower energy costs.

4. INVESTMENT FOR FUTURE FLOURISHMENT

   Including programs to develop the community can help create future opportunity in business and develop a self-sustainable society.

5. MULTI-PURPOSE SPACES

   Optimizing space utilization with the incorporation of multi-purpose spaces, while creating facilities for cyclone shelter and non-cyclone conditions.

6. MINIMIZING CIRCULATION AREA

   With the help of efficient area planning and built-up area, reducing circulation and facilitating more space for activities.

7. MODULAR AND PROTOTYPE FORM

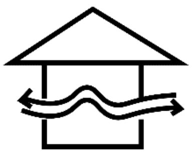
   A prototype design that can be used in other situations, with a modular form and adaptable facilities.

8. VEGETATION AND KITCHEN GARDEN

   Incorporating native vegetation and gardens that can be used to produce herbs and vegetables for the kitchen, creating a self-sustainable program.

9. ROBUST NATURAL VENTILATION

   to support the design of more powerful systems by developing efficient multi-fidelity modeling frameworks to predict the performance of natural ventilation systems with quantified confidence intervals.



6.5.Innovation

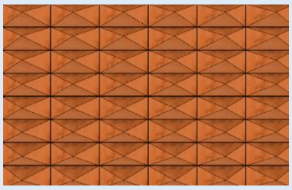
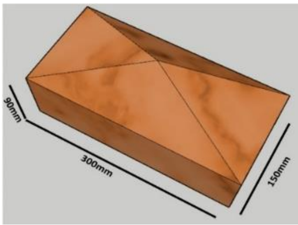
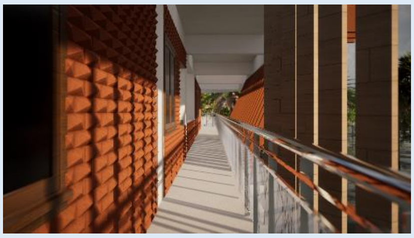
	Compressed stabilized earth block – CSEB is used as the building material, also locally available. It would be a regular material known to the users, which creates a sensation of their daily living life instead of a new space.
	The brick form is with a pyramid hip projection on the outer façade of the building, which will act as a self-shading by itself and reduce the solar heat gain inside the building throughout the year. This would help in maintaining the thermal comfort of the building.
	Most of the color preferred in inside space has been recommended as neutral brown and a mix of white, which create ease of mind for user psychologically during the times of disaster. The space's color makes a significant difference in occupant mindset, particularly in resilience shelters during the pandemic.
	The site is small and has a 6m setback as per municipal guidelines, further reducing the built-up area. So the team has come up with an innovative solution of extending the floor area on the upper floors - first and second floor by 1m and 2m on all sides, respectively. This increases the space and acts as a self-shading element helping reduce the EPI as we are using light materials such as 4mm fiberglass, which doesn't impact the structure.
	Using passive strategies helps reduce the heating and cooling load, the primary energy costs source. The only wind turbine providing the renewable energy for the whole sire costs Rs. 95000. The primary requirement for energy is during the monsoon period when solar panels won't be efficient. So wind turbine helps in producing the required amount of energy.

Fig 6.5.1 - Innovation

6.6.Health and Wellbeing

Considering the health and well-being of users' major adaptations have been taken care of. We have implemented Natural ventilation has the potential to reduce energy consumption in buildings significantly but designing natural ventilation systems is a challenging task because of the many uncertainties in the building's design and operating parameters. Our goal is to support the design of more robust systems, especially the site in the coastal region, by developing efficient multi-fidelity modeling frameworks to predict the performance of natural ventilation systems.

In HVAC, the Scheduled native is enabled. When:

1. The operation Schedule in ON

2. The zone temperature is > natvent set point

3.The inside-Outside delta T is < natvent Delta T

The temperature which has been selected for the users is 28 c for the cooling setback and 12 c for the heating setback, and the model Infiltration rate is set as 50Pa(m3/h/m2) – 25, and outdoor Air (ac/h) is 10. we came up with this value because the primary users, the fishers community, live their livelihood in kaccha houses made of mud, so the temperature achieved inside is above 26°C, which creates a sensation of living in their own home itself.

The HVAC system is set up so that once the occupied space is achieved, the optimal temperature of 26°C. The system is turned off automatically, and no heating requirement for the building. The discomfort hours will be further reduced below 300 hours using mechanical ventilation.

The measurement of carbon dioxide inside a conditioned area indicates IAQ. Odor criteria are likely to satisfy if ventilation rates are set that 1000 ppm CO2 is not exceeded.

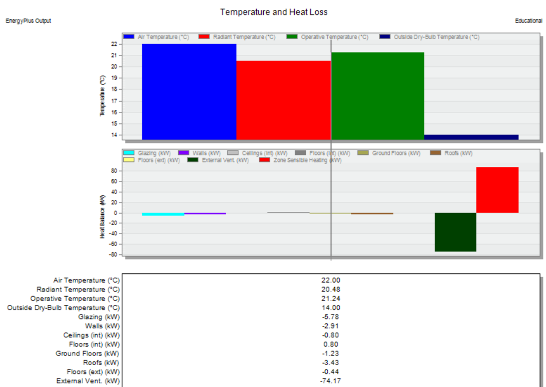


Fig 6.6.1 – Air Temperature

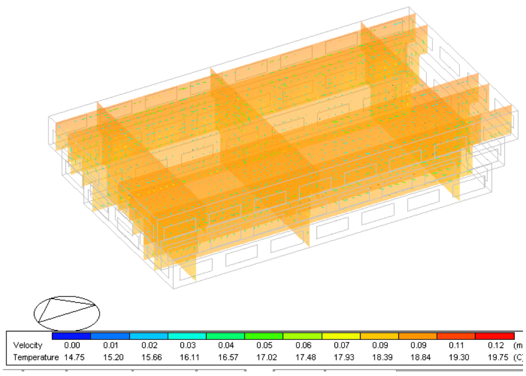


Fig 6.6.2 - CFD

6.7.Engineering and Operations

Plan: The community resilience shelter consists of 3 levels -stilt level, first floor and second floor. The plan for the different floors with beam and column layout is as shown below.

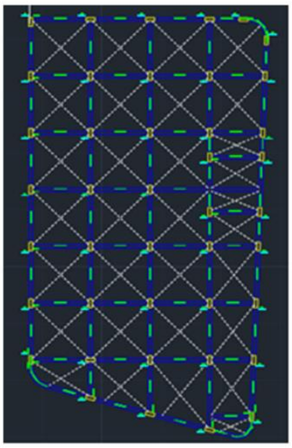


Fig 6.7.1 – Stilt Level Plan

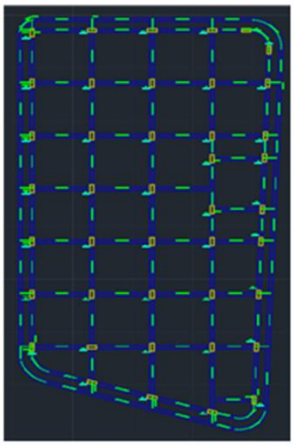


Fig 6.7.2 – First Level Plan

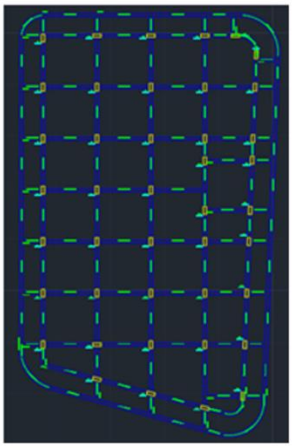


Fig 6.7.3 – Second Level Plan

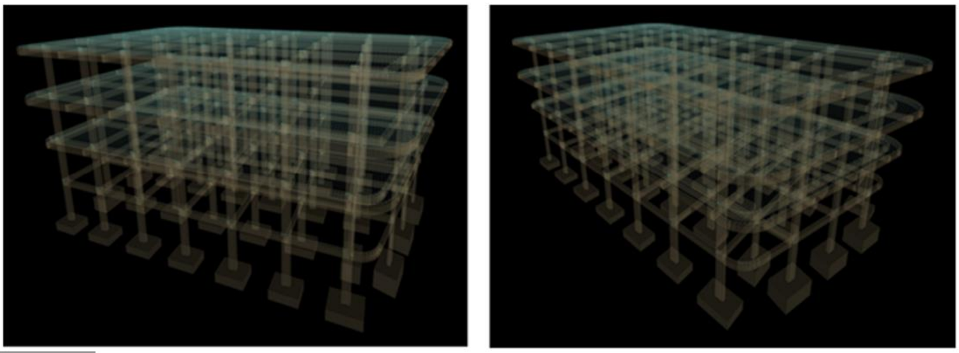


Fig 6.7.4 Model View of the Structure

Deflection: As shown in fig 6.7.5, the structure is safe in deflection throughout the span and has a minimal deflection at the curve edges of the structure due to cantilever deflection.

Foundation: As shown in Fig 6.7.6, the structure consists of 35 rectangular isolated footings and three combined rectangular footings.

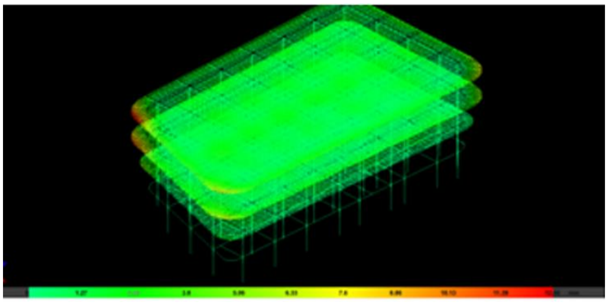


Fig 6.7.5 Overall Deflection in the Structure

As our building height is less than 15 m as per codal provisions, the wind load acting on the building will be negligible. But during the cyclone effect, we have to ensure that the doors and windows are closed tight to avoid the wind entering the building envelope, as wind entering the envelope can cause the uplifting of the structure. As our buliding is made up of RCC compared to the other materials like wood, it has high strength to withstand water forces. Moreover, the building has a basement at the height of 3m above ground, so water entering during floods is eliminated.

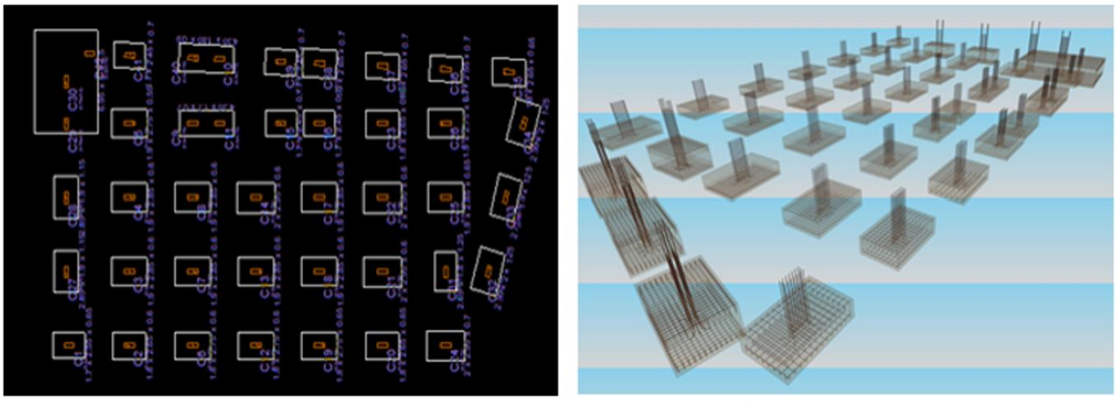
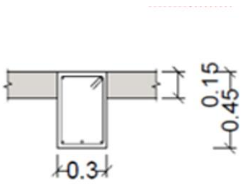


Fig 6.7.6 Footing Details

Beams and Columns: The beams in the structure have a width of 300mm and a depth of 450mm, including the slab depth, i.e., 150mm. The cross-section details of the beam are shown below. Columns are of size 300mm x 750mm. The column details are as shown below.



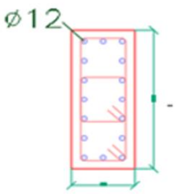


Fig 6.7.7 Beam Details

Fig 6.7.8 Column Details

Fig 6.7.9 Stirrups Detail

Overall Quantity of Structural Components:

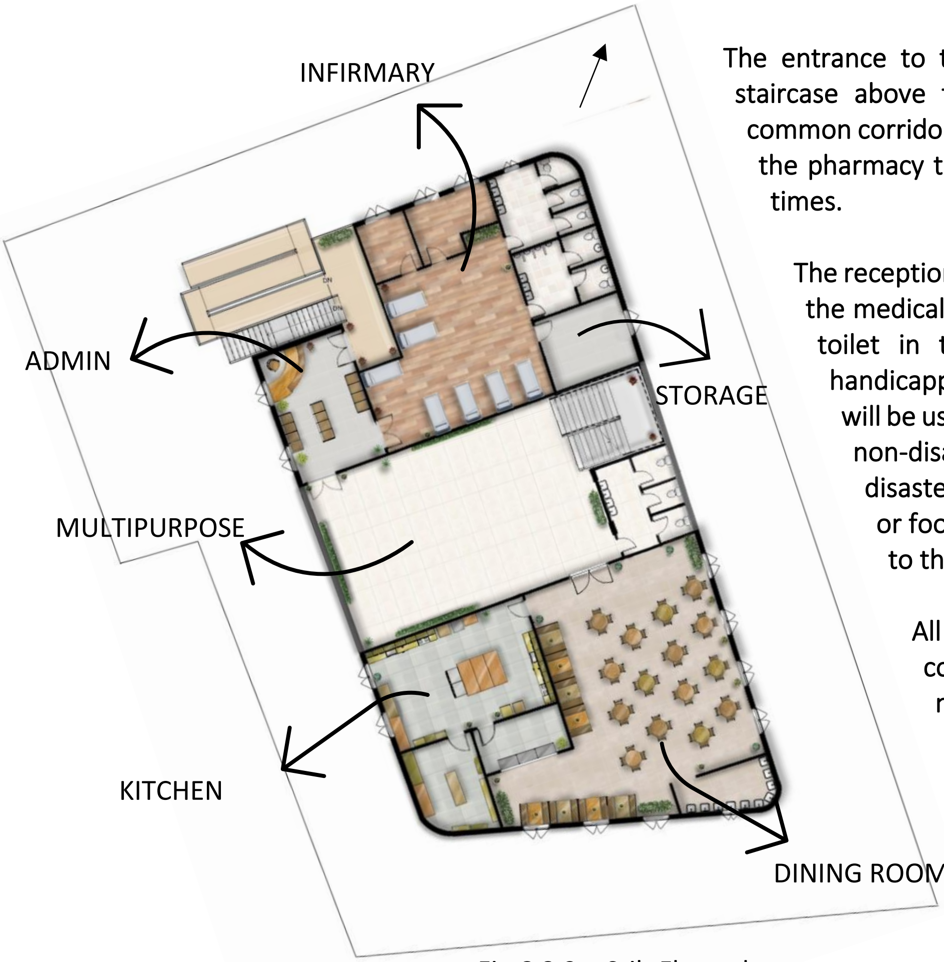
Element	Formwork	Surface	Volume	Bars
	(m2)	(m2)	(m3)	(kg)
Flat Slabs	-	758.15	113.72	10083
Beams	288.69	135.9	66.41	4545
Columns	242.76	-	25.99	3222
Total	-	**894.05**	**206.12**	**17850**
Index (per m2)	-	-	**0.228**	**19.76**
Total Surface: 903.50 m2				
Job Total				
Element	**Formwork**	**Volume**	**Bars**	
	(m2)	(m3)	(kg)	
Pad Footings	294.13	197.49	6977	
Total	-	**197.49**	**6977**	
Element	**Formwork**	**Surface**	**Volume**	**Bars**
	(m2)	(m2)	(m3)	(kg)
Flat Slabs	-	2167.1	325.06	34665
Beams	1116.05	486.87	241.05	18214
Columns	971.04	-	103.97	16547
Total	-	**2653.97**	**670.08**	**69426**
Index (per m2)	-	-	**0.249**	**25.79**
Total Surface: 2691.77 m2				

Table 6.7.1 – Overall Quantity of Structural Components

6.8 Architectural Design:

Fig 6.8.1 – Site plan

The setback in the site is used as a softscape to grow native medicianal and vegetational plants that can b stored for the use during pandemic times. This will help not only bein resilient but also would provide people with job during non-disastrous times. The native plants in the site would also provide shade which would help achive minimal thrmal comfort inside th building.



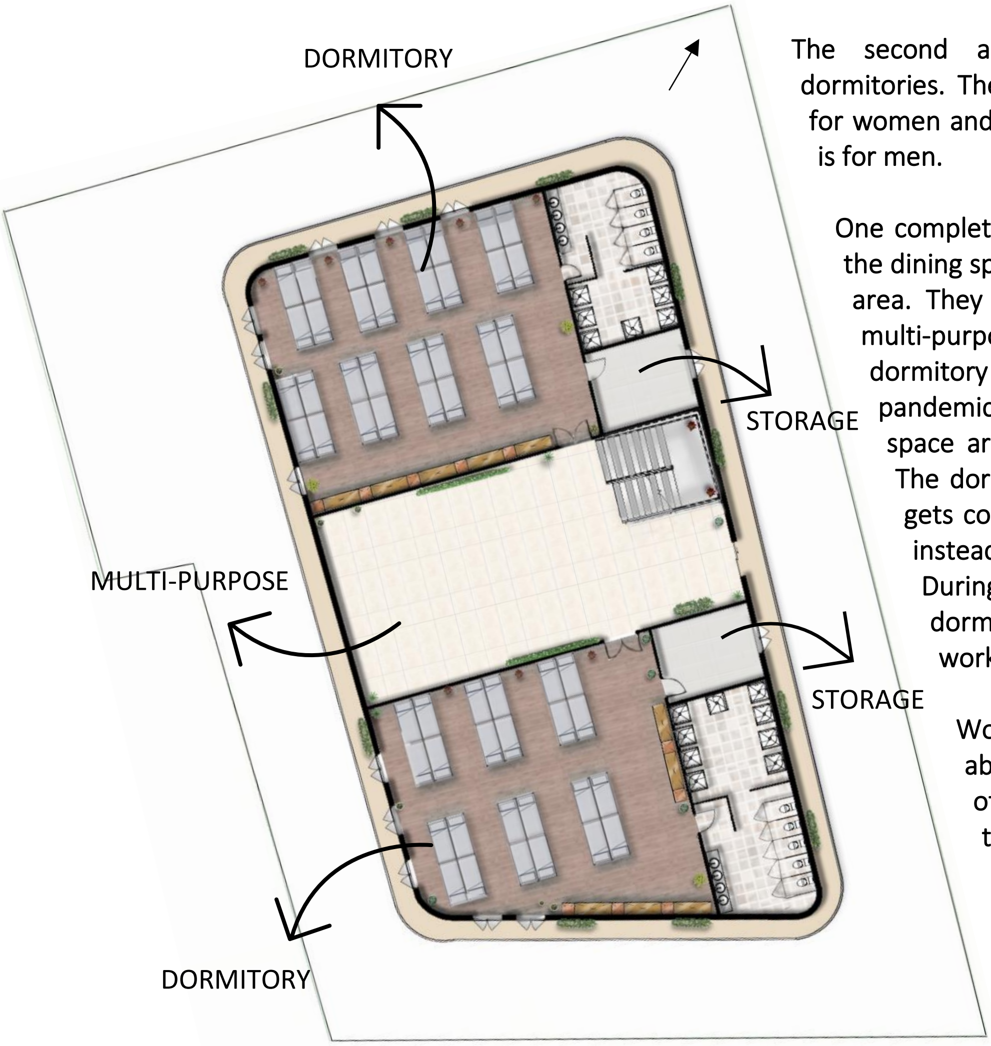
The entrance to the building is via a ramp and staircase above the stilt level leading up to a common corridor. It accesses the admin and then the pharmacy that remains during non-disaster times.

The reception has a seating area and accesses the medical area and the shared space. The toilet in the multi-purpose hall is also handicapped-friendly. The common space will be used as a multi-purpose hall during non-disaster times. During the post-disaster time, it is used as a health care or food distribution center connecting to the dining and kitchen area.

All spaces in this floor layout continue the same function during non-disaster times except for the multi-purpose hall during the post-disaster times.

Fig 6.8.2 – Stilt Floor plan

Fig 6.8.3 – Section



The second and third floor consists of dormitories. The second-floor dormitories are for women and children while the above floor is for men.

One completely accessible dormitory above the dining space and one above the medical area. They are connected by a common multi-purpose space that doubles as a dormitory if required during the pandemic. The beds and furniture for the space are stored in the storage room. The dormitory above the medical area gets converted into an isolation space instead of the recent pandemic. During the pre-disaster time, the dormitory could b used as a women's workshop and Anganwadi.

Workshop – Teaches women about tailoring and sewing and other technologies that can help them earn their expenses and support their families during adversities.

Anganwadi – For kids to learn and understand life and provide nutrition for them.

Fig 6.8.4 – Typical floor plan of second and third floor

The facade fin wall is made of fiber cement boards with an exterior laminate finish.

The letter blocks are made of steel with a layer of chrome finishing for durability and corrosion resistance, adding a shine to the wooden finish fin wall background.

Fig 6.8.5 – 3D Model

6.9Scalability and Market Potential

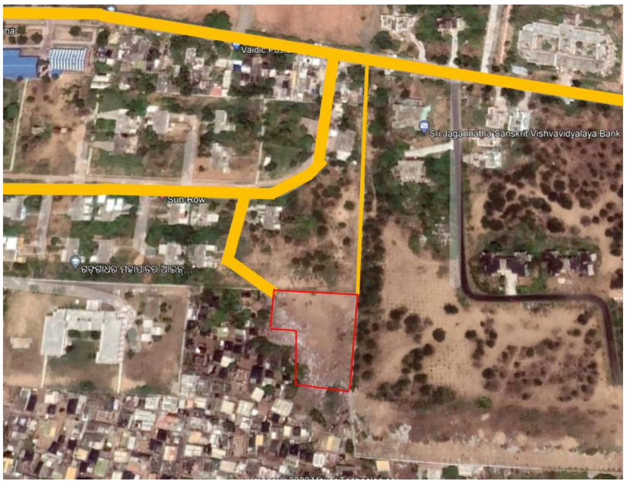


Fig 6.9.1 Site

Scalability is the possibility of expanding or replicating a project that works theoretically. With our project name, Ahana, w came up with the scalability plan by understanding the government guidelines for expansion.

With our prototype, we focused on the following details:
City-level expansion based on the guidelines
1. City level expansion based on the guidelines
2. Identification of skilled/unskilled labor
3. Technologies and resources available
4. Rescue operations

- The city-level expansion - Based on the "Guidelines for Design and Construction of Cyclones/Tsunami shelters" by the Ministry of Home Affairs, we discovered that the shelters need to be placed strategically on a grid-like format to ensure no one affected has to travel more than 2.5 km to reach a shelter. Using that to create a grind based on the population, we can build multiple MPCSs throughout the area.
- Identification of the Site - Availability of land and the land from the government is chosen, which is located in the community itself. The lack of elevation can create problems concerning the guidelines for MPCSs, which have been tackled by providing columns and starting with the stilt floor.

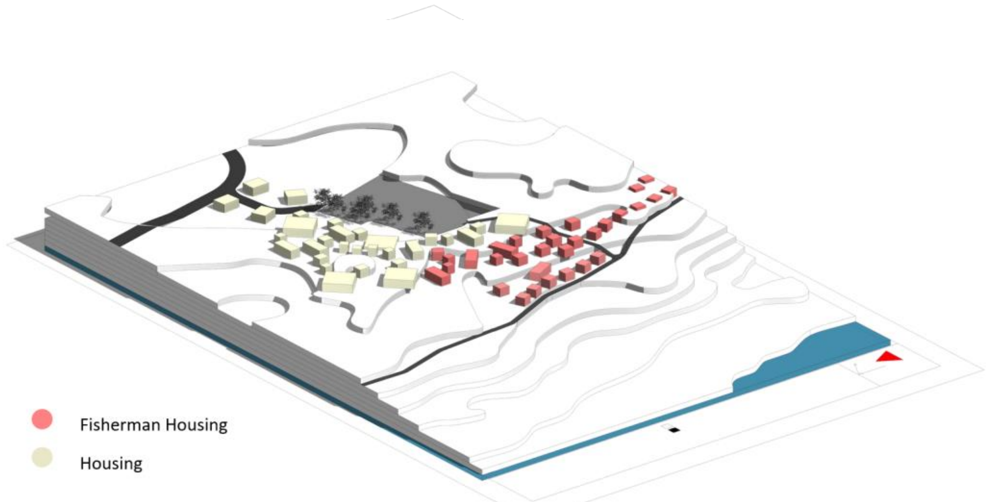


Fig 6.9.2 – Site and Surrounding

- Availability of Labour - As it's a fisherman locality and community, finding skilled labour proves to be a challenge when working with complicated materials and machinery. However unskilled labour is highly available around Penthakata, and this makes it a highly valuable resource during construction.
- Technologies and Resources available -Orissa has high availability of basic construction materials including but not limited to concrete, sand, cement, brick (fly ash/ refractory/building), steel and wood reducing material transport costs and further boosting potential for market reducing the cost impact.
- Rescue operations and connectivity – Rescue operations make or break the effectiveness of MPCSs. For our site in Penthakata region, the Puri helipad (Talabania Helipad) is located ata a distance of 1.9 km making swift SAR operations a possibility and even be used to deploy medical assistance and aid.

6.10 COMMUNITY BENEFITS

Alternative use:

The functions of the building can be divided in three phases: pre-disaster, disaster and post-disaster. During normal period the main functions include education programmes and workshops to collect revenue. Disaster phase will see a transformation to sheltering and providing places for the villagers to stay safe. After disaster these spaces can be developed to help the affected people, by giving free health check-ups, food and clothes distributions. This diversity in functioning will ensure the continuous use of the resilience shelter and help in self maintenance.

Health and welfare:
Attending people during the disaster times and providing affordable healthcare provisions for the surrounding village, thus becoming a primary healthcare facility.

Community benefits:

- Providing educational opportunity for women and children of the village by incorporating anganwaris and workshops
- A shelter for the affected villagers during and after any disasters. This not helps in saving lives but also ensures fast recovery to normal conditions
- Workshops can help the community to grow economically and keep everyone social and develop communication
- Women empowerment is encouraged, by giving the women a safe community to stay and work
- Self help Group spaces can be incorporated with the affiliation of Odisha Government and launching disaster programmes

Achievements:

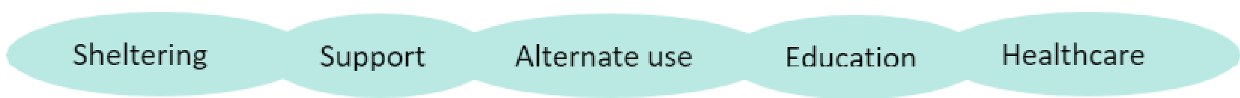
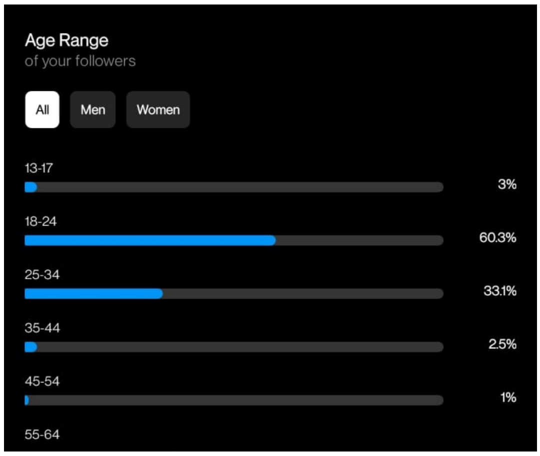
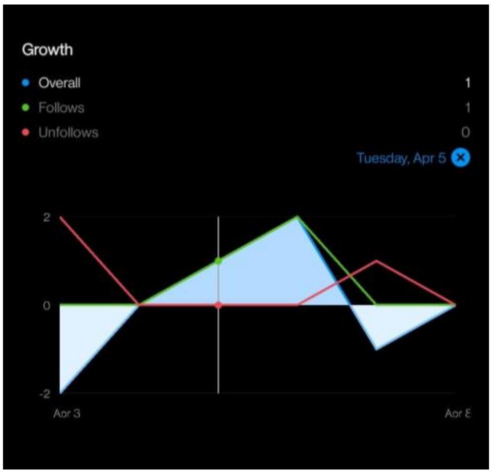


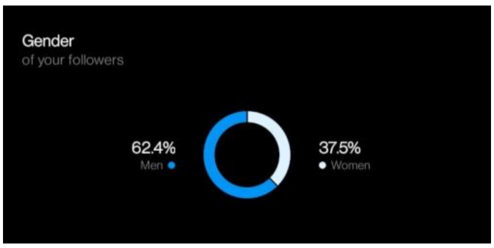
Fig 6.10.1 - Achievements

6.11 Communication

Synergy.solardecathlon is the official Instagram page of Team SYNERGY. With 247 followers and increasing the main aim of our team is to spread awareness about climate change and bring sustainability into the spot light for social masses. We majorly concentrated on the upcoming society of students as India is called an young nation for a reason. Our major audience are people from the age group of 18 to 24 years who are mostly from India. The followers are 62.4% men and 37.5% women.







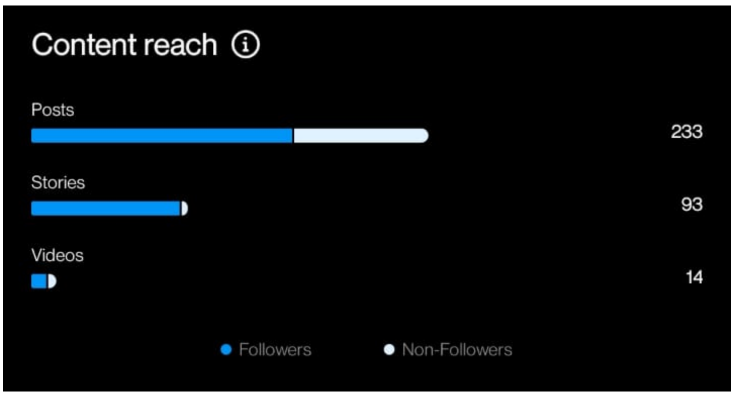


Fig 6.11.1 – Instagram Overview