NAME OF INSTITUTE- SMEF'S BRICK GROUP OF INSTITUTES

NAME OF THE TEAM- TEAM ALPHA

COMPETITION DIVISION- COMMUNITY RESILIENT SHELTER

NAME OF THE PROJECT PARTNER- SUSTAINABILITY INITIATIVES

FINAL DESIGN REPORT – APRIL 2021

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EXECUTIVE SUMMARY

Team Alpha from Brick School of Architecture, India, designs the Community Resilience Centre. The goal of the project is to design a Net Zero Energy Centre that is affordable for the targeted market. A community resilience shelter is used for emergency evacuation during extreme weather events like cyclones, floods, and earthquakes. These can be continued to shelter people affected from disaster until they rebuild their homes and livelihoods. Such a building is also expected to house community service activities such as education, health training, and income-generating social functions. To achieve this we as a team of 7 people aim to work and took consideration of everyone's strength and skills and started working. Daily brainstorming was done and we took meetings for reviewing our stage-wise work. We also took guidance from our faculty members. As step by step, we distributed ourselves into an integrated approach of three major terms 'Design – Simulation – Calculation' which helped us to get close to our goals.

As Pune is not much vulnerable to disaster we decided it will be perfect to take a city that can help people affected by disaster to start their livelihood. Rapid urbanization in Pune has meant that structural inequalities and systemic vulnerabilities of individuals, institutions, ecosystems, and city development processes have surfaced; necessitating strategic engagement to make city systems more resilient. With the motivation to address these challenges, Pune was selected in 2016 to join the 100 Resilient Cities (100RC) Network, pioneered by the Rockefeller Foundation. Fundamental to 100RC's philosophy on resilience is not only preparing cities for disasters but also, working with different socio-economic groups and a wide range of stakeholders to prepare for economic, social, and physical stresses and shocks. According to 100RC, "resilience is the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kind of chronic stresses and acute shocks they experience."

Disaster can strike anytime. So we can come up with a temporary structure that can be built in a very short span of time and doesn't require skilled laborers. This temporary structure will only be built post-disaster and will be available to all groups of people irrespective of their caste., religion, sex, class, etc. the disaster. People who are majorly affected by the disaster. Last year 4000 people were affected in Pune due to flash floods in Pune. So maybe we can divide the community resilient shelters into different parts of Pune which can accommodate people post-disaster. Total accommodation- 4000 people (In Pune). To help these people reorganize and get back to a familiar way of life we can design temporary structures using local materials "to make a house that can be built quickly, lightweight and compactly, durably and economically."

The aim was to not only reduce energy consumption but also address to challenges of affordability and people's lifestyle, market forces, and people's upgrading lifestyle. With careful consideration to all the building science

TEAM INTRODUCTION

TEAM NAME
Team Alpha

INSTITUTIONS NAME
1.SMEF'S Brick Group of Institutes
2. MIT-WPU College

OUR TEAM(ALPHA)
Team Alpha consists of a total of 7 students from SMEF'S Brick school of architecture and MIT-WPU College, Pune, India enrolled in architecture planning and engineering programs. The team is versatile with design expertise in Civil ,Architecture and Planning.

Name	Qualification	Role
1.Nishad Ghodke	BArch(4th year)	Simulation
2.Amruta Shah	BArch(4th year)	Design
3.Atharva Ghawalkar	BArch(4th year)	Simulation
4.Jaidev kshirsagar	BArch(4th year)	Design
5.Moin Siddiqui	Construction engineering and management(Masters)	Calculation

APPROACH
1. Our team has been divided into three working groups 1.Design 2 . Calculation and 3.Simulation .This will lead to division of work helping the members to focus on their own subjects.
2. Meetings and discussions would be conducted amongst team , with faculty advisor and mentors every week on different platforms.

ABOUT THE INSTITUTE
SMEF'S Brick school of architecture was established in 2013, education isn't confined to classrooms, textbooks and exams. It goes beyond conventional learning and teaching techniques to encompass a global approach.The Institute provides 2 courses which are:**1.Bachelor of Architecture**(5 years degree course affilated to Savitribai Phule Pune University),**2. Interior Design**(Diploma course, Institute of Indian Interior Designers accredited).

OUR FACULTY

Faculty lead-
Divya mallavarapu

Designation - **Asst. Professor**
Bio- Ar. Divya Mallavarapu has done her M.Arch in Environmental Architecture, Post-professional Certificate in Project Management (University of California, Berkeley, USA).Her expertise is sustainable design and energy efficiency

Faculty Advisor:
Poorva keskar

Designation – **Principal (BSOA)**
Bio- Dr. Poorva Keskar is an architect, PhD in indoor environmental quality, LEED AP, ECBC master trainer, environment designer ,academician since 24 years, sustainability expert and has published numerous articles and papers.

INDUSTRIAL PARTNER
Sustainability Makes Business Sense!
Industry Partner-VK:e Environmental ,Pune
This firm is formed by Ar. Vishwas Kulkarni, which believes in passionately promoting sustainability.We at VK:e help you in transforming projects to environmentally responsible ones. We offer customised solutions while working with you on the CAPEX, OPEX and sustainability goals of your project through an Integrative Process.

PROJECT BACKGROUND

PROJECT NAME

Beyond Disasters

PROJECT PARTNER:

Project partner- Sustainability initiatives

Sustainability initiatives is not for profit organisation based in Pune. It is formed by a group of like-minded professionals in the field of urban and environmental planning, architecture, environmental science, geography and energy. It is formed with the objective of creating a network of researchers academics and professionals who will develop core research in the area of environment and energy.

Figure 1- Sustainability initiatives

COMMUNITY RESILIENCE SHELTER :

The community resilient shelter would help in disasters like cyclone, flood, pandemic and would be available for people affected by it.The shelter may continue to accommodate disaster-affected people until they rebuild their homes and livelihoods. The primary purpose of shelter is to provide lodging, institution etc for people.Such a building is also expected to house community serviceactivities such as education, health training, and income-generating social functions.

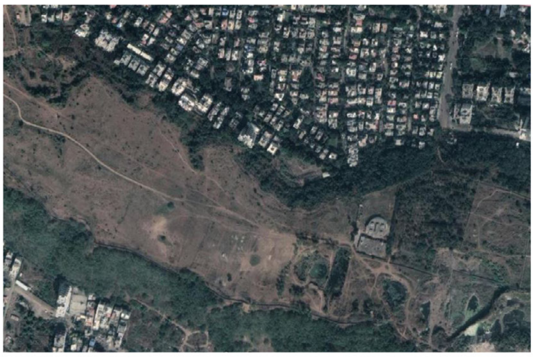


Figure 2-Site location-karve road

LOCATION :

Karve road, PUNE, INDIA

The site is connected to the main city by Warje Road towards West side and by Karve Road towards East side. The area selected have very low chances of getting affected by flash flood, earthquake etc

CLIMATE-Pune has a **composite climate.**

CONTEXT AND MARKET ANALYSIS

1. The city of Pune has been affected by disasters like Dam Burst, Flash Floods, pandemics, epidemics.During times of a disaster people lose their only shelter and due to the economic conditions it is difficult for them to find another living space immediately. A disaster shelter for these people is an important part of a resilient community.
2. Pune being rich cultural heritage, many people travel here for pilgrimage. Many of these people come from a weak economic background so they cannot afford to stay in hotels because which they are forced to reside on road sides and footpaths. A lodging place with minimal expenditure can be proposed.The population which will be targeted are the people mainly the orange ration card holders who are affected by natural calamities.

SPECIAL REQUIREMENTS OF THE PROJECT PARTNER

1. The primary purpose of the building is to provide a secure shelter for low income group of people at the time of disaster.
2. In case of emergency the project should be able to self-sustain in terms of water and energy.
3. At disaster free times the structure should be able to have a secondary purpose such as motels, training center, etc.

PROJECT BACKGROUND

DETAILED BUILDING AREA PROGRAM -

SPACE	AREA	UNIT	TOTAL	NOTES
Admin/Reception				
Reception/Waiting	50	1	50	
Admin	25	1	25	
Washroom				
Male		2-Wc,3 urninal		
Female		3 Wc		
Storage	10	1	10	
Community and Public space				
Workshops	100	2	200	Training ward
Education space and Library	100	1	100	
Multi-Functional Hall	150	1	150	
Market Square	100	1	100	shops for rent for people staying near community
Washroom				
Male		6 urinals,3 wc		1 urinal per 50 people and 1 wc per 200 people
Female		6 wc		2 wc per 100 people
Medical facilities				
Health care center	70	1	70	10 beds
Medical store	10	1	10	
Store room	15	1	15	
Treatment room	5	1	5	
Washroom				
Male		1WC, 1 Urinal		
Female		2 WC		
Staff and nurse quarter		2		1 male 1 female
Community Dining				
Dining area	125	1	125	
Kitchen and storage	50	1	50	40% of dining area
washroom and wash basin		4		2 for male 2 for female
for staff		2		1 for male 1 for female
Services				
Pump room	25	1	25	
Water treatment plant	15	1	15	
Electrical room	25	1	25	
Incineration Chamber	25	1	25	
Biogas Plant				
Residential				
Family accommodation	26	30	780	5 people per unit
(1 bedroom , kitchen , toilet)				
Group accom/ Dorm	70	10	700	10 people per unit
Open Spaces				
Park/ Garden				
Amphitheatre				
Compost pit				
		TOTAL	**2480**	
		Passages	**300**	12% of Total Area
		TOTAL AREA	**2780**	`

Table 1 -Summary of Site area, Landscape area, Total Built-up Area, etc with a breakup of spaces with their areas. Identify conditioned,

PERFORMANCE SPECIFICATIONS

CLIMATIC ZONE

Composite climatic zone

PERFORMANCE SPECIFICATIONS-

1. ENVELOPE

ENERGY ANALYSIS		
Energy conservation measures	**Description**	**Measure levels(Uvalue)**
1. Walls		
	12.5 mm cement plaster + 230Mm brick + 12.5 mm cement plaster	U-Value = 2.13 W/m2K
	12.5 mm cement plaster + 75 mm brick + 50 mm air gap + 75 mm brick + 12.5 mm cement plaster	U-Value = 1.80 W/m2K
Material used	**1.25 cm cement plaster + 20 cm AAC Block + 1.25 cm cement plaster**	**U-Value = 0.78 W/m2K**
2. Roof		
	100 mm RCC + 50 mm foam concrete + waterproofing	U-Value = 1.08 W/m2K
Material used	**Reinforced cement concrete-5 inch. thick with plaster on both sides, polyurethane spray foam insulation 4 inch. on exterior and Extruded polystyrene insulation 0.75 inch on interior**	**U-Value = 0.16 W/m2K**
3. Glass		
	6mm clear glass	SHGC = 0.51 U Value = 3.30 W/m2K
Material used	**Sain-gobbain -tMint GreenMint Green (PLT TG)**	**SHGC = 0.25 U Value = 1.8 W/m2K**

Table 2- Building materials used.

2. LIGHTING

LED lights have been used to reduce the consumption of electricity.

3.ELECTRICAL

To reduce the plug loads 4-5 star rated appliances were used.High efficiency led lights are used which reduce the consumption of electricity upto 75% as compared to other tranditional lightings.Main line is connected to Transformer and is supplied to electrical room which is ahead connected to the shelter.

4.RENEWABLE ENERGY SYSTEMS

Figure 3- Solar panel used

Solar Panel	Shark 440W Super High Efficiency Module
Space required	300 sq.ft.
1 Panel dimension	Length – 6.2 feet, width – 3.2 feet
1 panel weight	25 kg
Total panels	10 Nos. (Shark 440 watt each)

GOALS

ENERGY PERFORMANCE

Improved energy performance of the resilient center without compromising the comfort of the occupants.

RAIN-WATER HARVESTING

To design a water efficient system in the building and on the site for building water usage and landscape water usage.
2) Use of waste water by treating the water on site.
3) Exploring other sources like rain water harvesting.

ARCHITECTURE

1)Provide community interaction spaces for activities to improve livability.
2)Provide 100% Day-lit spaces and enhance visual connection from indoor to outdoors
3)Achieve Core to Built Up Area ratio to be less than 15% and Carpet to Built Up ratio to be greater than 80%

AFFORDABILITY

Use durable construction technologies.
Design strategies to optimise energy performance and taking minimum use of grid energy.

DESIGN STRATEGIES-
(1)Modular housing., (2)Wet areas clubbed together to reduce the cost of construction.

COMFORT & ENVIRONMENTAL QUALITY:

Achieving maximum of comfortable hours without using mechanical system and maintain acceptable indoor air quality.

DESIGN STRATEGIES-
COURTYARD-
1)Where children can play, (2)Daylight(Ensured to all units)
3)Therapeutic Benefits(Landscape view), (4)Passive cooling and cross-ventilation(Ensured to all units)

ADAPTABILITY:

Flexible design to accommodate diferent needs of occupants.

DESIGN STRATEGIES USED-
1. Partition walls-1)Use of partition wall to segregate spaces insead of using permenant walls .This reduces the cost of construction and helps in making the project affordable.
2. Foldable furniture-Folding furniture in apartments so that the living area can be lived with great flexibility and change its appearance during the day and by the uses.

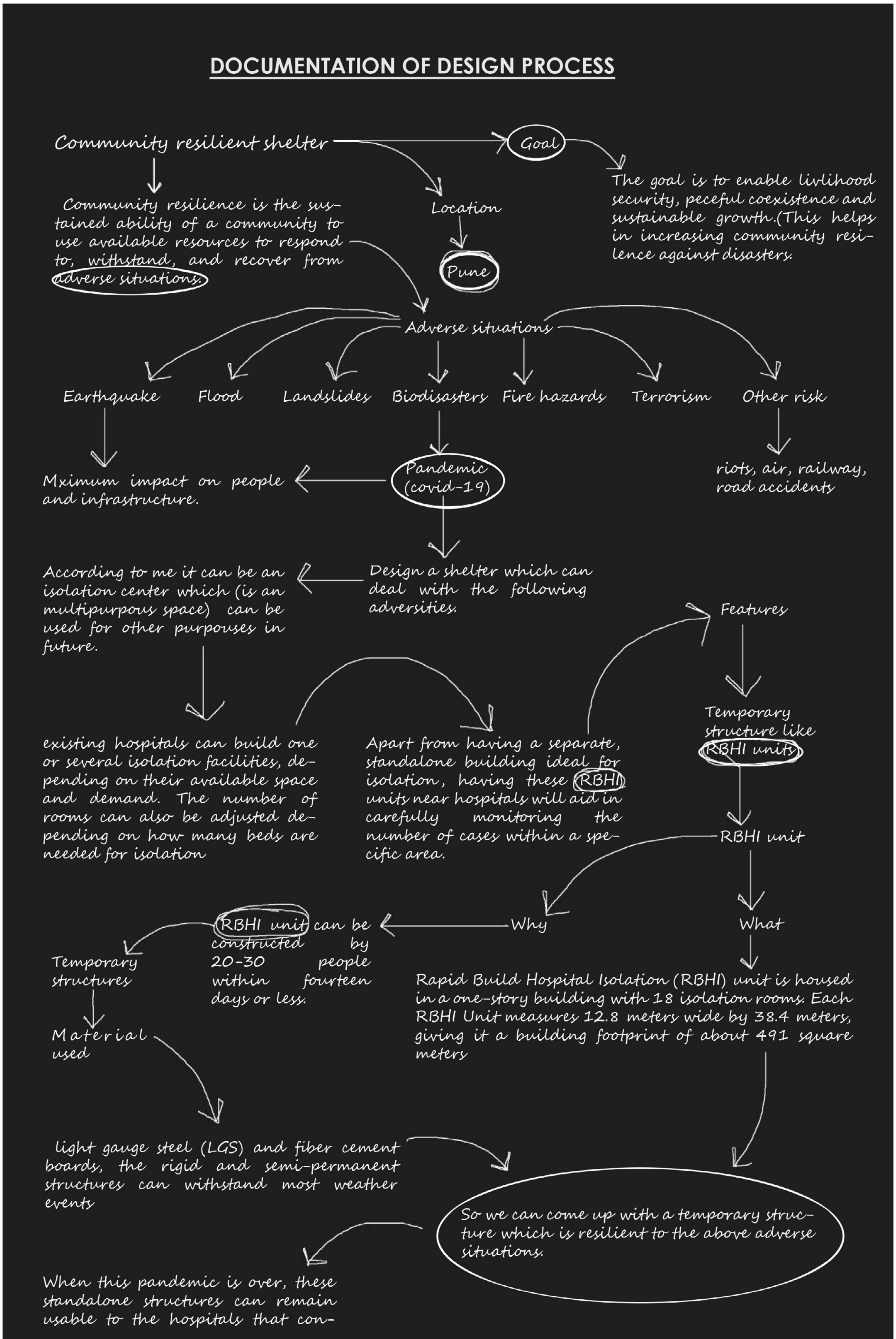


Figure 4- design esquisse

DOCUMENTATION OF DESIGN PROCESS

Community resilient shelter → Isolation center → Spaces

Spaces → Sanitation center; isolation chambers with seperate toilets

Community resilient shelter → Objective

Objective → At the same time the structure should be sustainable and should conserve energy.

Objective → To built a structure that shows resilience against adverse situations like earthquake, floods, biodisasters etc

Features → Net- zero structure → Solar panels can be used

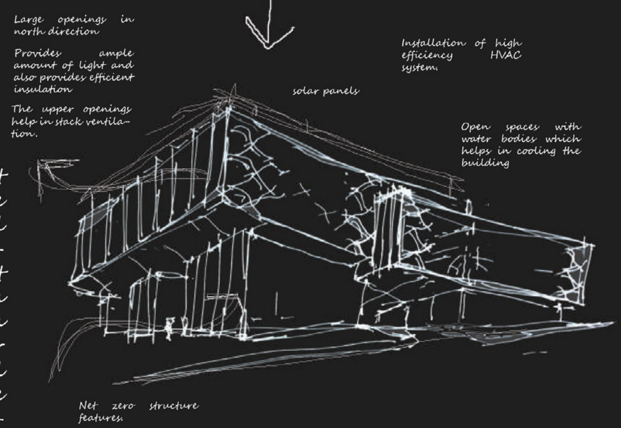
Features → Materials used → light steel gauge → Earthquake resistance → Reasons

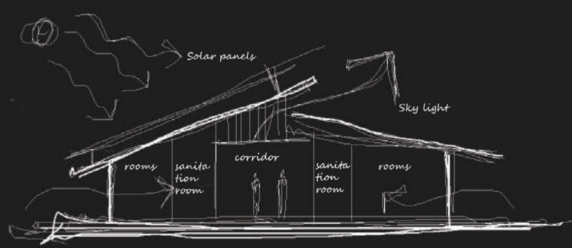
Reasons → Add bracing

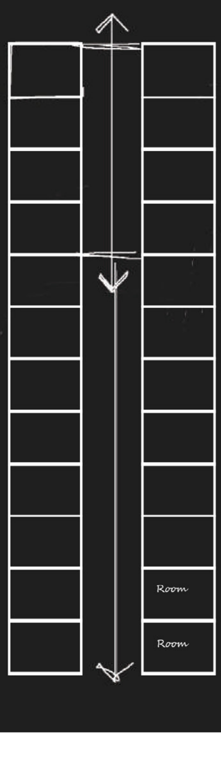
Reasons → Providing open spaces

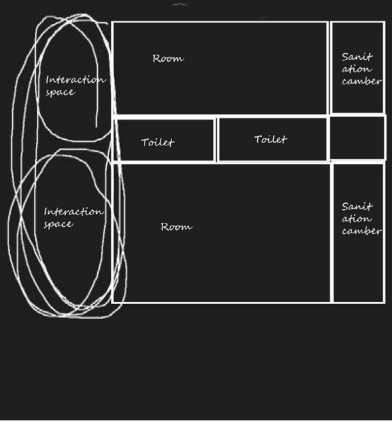
Reasons → Steel structures are earthquake proof as they are made of steel components that come in a variety of shapes, such as angles, plates, and beams.

Reasons → Steel offers the highest ductility and allows the resistant building steel structures to bend considerably without breaking. When you have steel structures, you can be assured that your resistant building steel structures will behave well during an earth-









Other features

One coridor connected to all rooms

We can provide skylights right above the corridor

The main door is air-locked, and two fire exits are stationed at both ends

PPE kit racks provided

Hand washing stations are placed every two rooms for easy access throughout the entire unit.

Figure 5- design esquisse

DOCUMENTATION OF DESIGN PROCESS

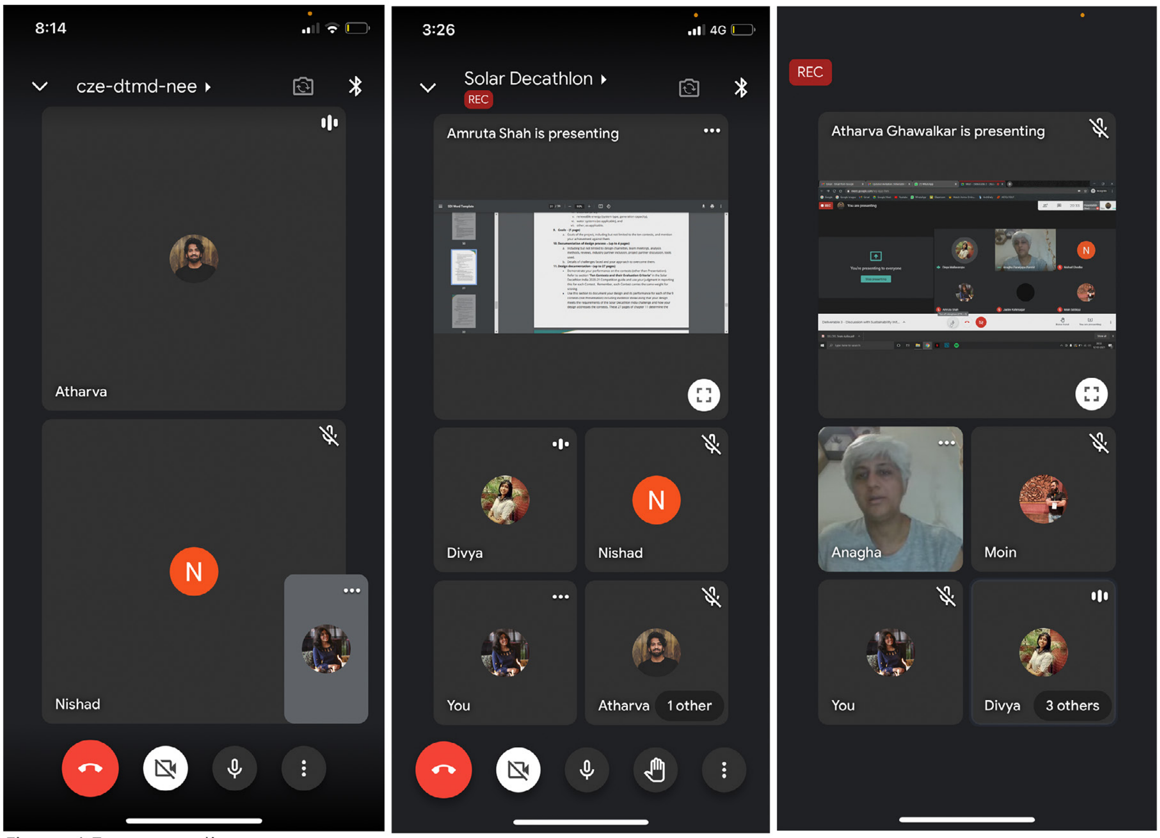


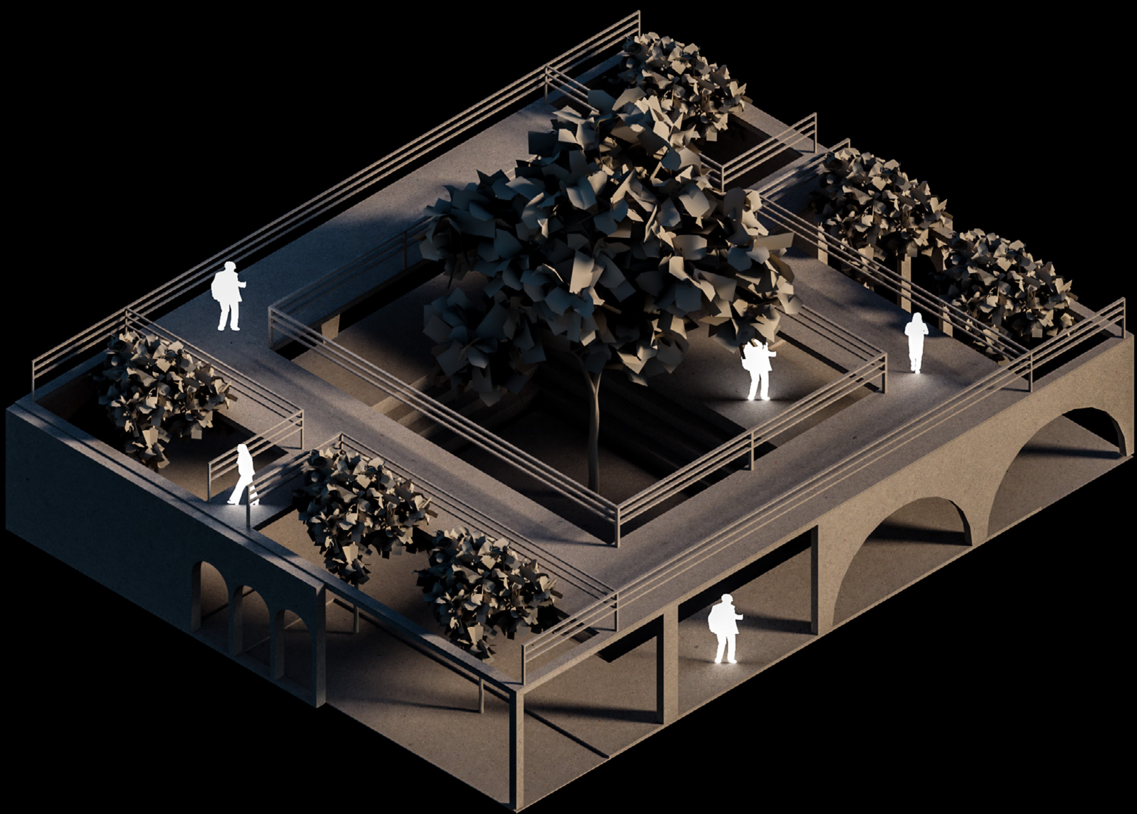
Figure 6-Team meetings

DOCUMENTATION

In the initial stage we started our project by doing research and different case studies on community resilient centre. As the research was going we also had discussion on what is net zero and how the building acts sustainable. As our design charrettes we were given an assignment of mind mapping on what is our understanding on resilience . We also made stage wise presentations and had a debut sessions with our mates on how the people are affected and which cities are more prone for disaster. For our preliminary calculation we also had sessions and tasks for doing simulations and calculations on Revit and Sefira. Some interventions were also done with NGO's regarding the net zero and resilience. According to our project 'community resilient centre' we selected the cities and areas which can be useful for people who are affected by disaster. After the research we made the teams. Our medium for all discussions was google meet and tools used were Revit , Sefira, Design builder , Autocad , Sketch-up, Photoshop , excel etc.

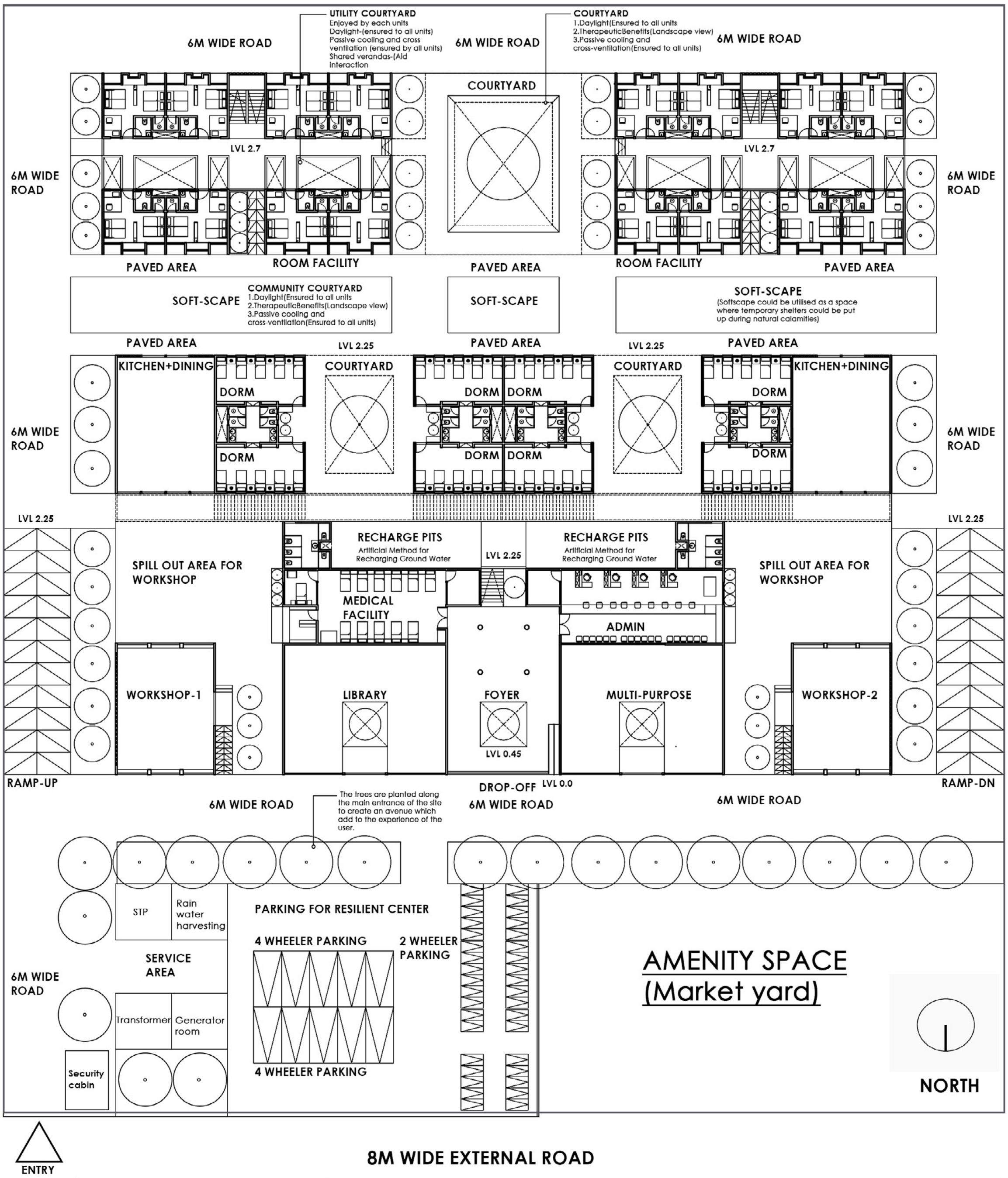
DESIGN DOCUMENTATION

COMMUNITY RESILIENT CENTER



THE COURT

SITE PLAN



PROJECT BRIEF

PROJECT-Resilient center

LOCATION-Karve road, Pune

CLIMATE-Composite climate. The maximum temperature reaches up to 43 degree Celsius in May and the minimum temperature reaches below 9 degree Celsius in December and January.

SPACE REQUIREMENT

1. Foyer
2. Multi-purpose
3. Library
4. Workshop 1
5. Workshop 2
6. Medical -facility
7. Admin
8. Dormitory
9. Kitchen+Dining
10. Rooms
11. Transformer
12. Generator room
13. STP(Sewage treatment plant)
14. Rain water harvesting
15. Market square
16. on- site energy generation
17. Parking

2020
SOLAR DECATHLON INDIA

1. ENERGY PERFORMANCE

SOLAR PASSIVE STRATEGIES REDUCE ENERGY CONSUMPTION-

ORIENTATION-

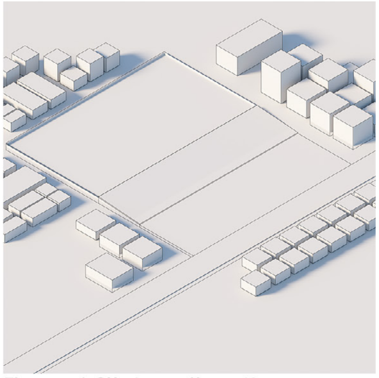


Figure 6-SiteLocation- Karve Road, Pune.
Site area-7984 sqm

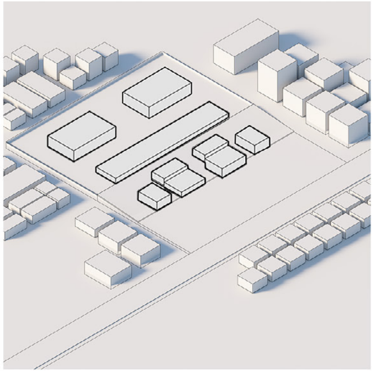


Figure 7-Structure with longer side oriented towards N-S direction to reduce the heat gain from the direct sun from east and west.

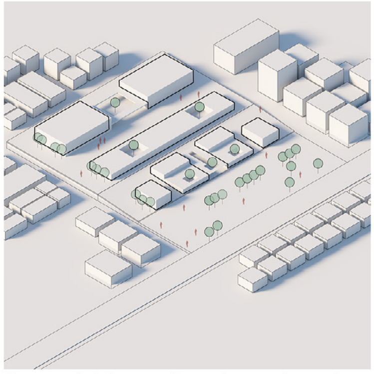


Figure 8-Hierarchy of courtyards and plantation provided for day light entry and ventilation.

The best orientation from a solar point of view requires that the building as a whole should receive the maximum solar radiation in Winter and the minimum in summer. For practical evaluation, it is necessary to know the duration of sunshine and hourly solar intensity on the various external surfaces on representative days of the seasons.

Inference from Table

North-Receive 2102W/m2/day of solar radiation in Summer and 840W/m2/day in Winter.

East and West -Receive 3475W/m2/day solar radiation in summer and 2525 W/m2/day in winters; the value of solar radiation is higher in both summers and winters.

Orientation		Latitude of Pune city
Direction	**Season**	(18.5°)
North	Summer	2102
	Winter	840
North-East	Summer	3144
	Winter	1068
East	Summer	3475
	Winter	2525
South-East	Summer	2393
	Winter	3980
South	Summer	1035
	Winter	4958
South-West	Summer	2393
	Winter	3980
West	Summer	3474
	Winter	2525
North-West	Summer	3144
	Winter	1068

Table 1- Total Solar Radiation (Direct plus Diffused) Incident on Various Surfaces of Buildings in W/m2/day for Summer and Winter Seasons(NBC-2016)

South: Receive 1035W/m2/day of solar radiation in Summer and 4958W/m2/day in Winter.

To minimize the exposure of spaces to direct sunlight, The structure was orientated in such a way the more extended facade of the building oriented north-south direction with dead walls provided on east and west (reduce the heat gain from direct sun).

WINDOW WITH SHADING DEVICE-

Double heighted openings and more window area are provided on the northern side to allow greater amount of diffused north light to enter the units.Whereas on the southern side-

1.LOUVRED WINDOW-To cut the glare from the south side and to provided good ventiltion through louvers.

2.JALI WALL-Jali wall acts as an architectural element and helps cut glare from the south side and take wind inside;

3.LESS WINDOW AREA are provided inorder to reduce the heat gain from direct sun

1. ENERGY PERFORMANCE

SELECTION OF BUILDING MATERIAL FOR REDUCING HEAT GAIN-

ENERGY ANALYSIS		
Energy conservation measures	**Description**	**Measure levels(Uvalue)**
1. Walls		
	12.5 mm cement plaster + 230Mm brick + 12.5 mm cement plaster	U-Value = 2.13 W/m2K
	12.5 mm cement plaster + 75 mm brick + 50 mm air gap + 75 mm brick + 12.5 mm cement plaster	U-Value = 1.80 W/m2K
Material used	**1.25 cm cement plaster + 20 cm AAC Block + 1.25 cm cement plaster**	**U-Value = 0.78 W/m2K**
2. Roof		
	100 mm RCC + 50 mm foam concrete + waterproofing	U-Value = 1.08 W/m2K
Material used	**Reinforced cement concrete-5 inch. thick with plaster on both sides, polyurethane spray foam insulation 4 inch. on exterior and Extruded polystyrene insulation 0.75 inch on interior**	**U-Value = 0.16 W/m2K**
3. Glass		
	6mm clear glass	SHGC = 0.51 U Value = 3.30 W/m2K
Material used	**Sain-gobbain -tMint GreenMint Green (PLT TG)**	**SHGC =** 0.4 **U Value = 1.8 W/m2K**

Table 4 -Performance comparison of different materials used in building construction in Pune city.

Our intent while selecting the Building material was to minimize energy consumption by implementing materials with lesser U-value without compromising the occupants' comfort. The above table compares the performance of different materials used in building construction in Pune city.

USE OF ENERGY EFFICIENT LIGHTING FIXTURES-

Lighting is an essential criterion that has to be considered while designing a zero-energy building. It can contribute to the reduction of energy consumption by the use of energy-efficient fixtures.
LED and CFL as technologies do not have a difference in brightness intrinsically. Brightness is determined by lumens. Lumens is

Figure 8-Comparison of different ligthing

best described as the measurement of light. A single CFL and LED bulb might have the same lumen (brightness) output but vary greatly in the amount energy needed to generate that level of brightness.

PERFORMANCE-The design goal is to reduce lighting energy requirements.The use of LED fixtures reduces the energy consumption by 55 percent.

COST EFFECTIVE-The cost factor is also one of the key drivers for lighting selection.LEDs have a greater life span as compared to other lighting technology.

ENERGY PERFORMANCE

PLUG LOADS-

The BEE labels and rates the appliance after inspection according to their performance. The appliances are rated from 1 to 5 stars, 1 being the least energy-efficient and five being the most energy-efficient. The BEE star rating is mandated only for certain appliances, including air conditioners, tube lights, washing machines, refrigerators, ceiling fans, televisions, etc.To reduce the plug loads appliances with a rating of 4-5 were used.

RENEWABLE ENERGY SYSTEM

GRID DEPENDENCY AND INDEPENDENCY

The energy system used on site is an 'On-Grid Photovoltaic System.' During regular times the energy requirements will be fulfilled by the primary electricity grid and Photovoltaic system. With a net metering system, any surplus energy produced is fed back to the grid for credits.

The system can also work independently during an emergency. If the primary grid is offline, the Photovoltaic system will provide the energy required through On-site generation and backup batteries which have stored energy produced by the Photovoltaic system during peak hours.

PAY BACK PERIOD FOR PV INVESTMENT

Energy Consumption for the Centre for a year - 60576.05 kWh/Year
The monthly Energy Consumption - 5048 kWh
1 unit – 1kWh usage
Electricity Bill – ₹ 60,576
Yearly charges - ₹ 7,20,912
Energy Regeneration required – 41.5 kWh
Cost of 1 kWh PV panel - ₹1,00,000 (Inclusive of all connection)
Total Cost of PV System – ₹41,50,000
The payback period for the PV system will be completed in approx. 6 years

ENERGY EFFICIENT WATER PUMPS

Colour	Multicolour
Material	Metal
Item Dimensions LxWxH	20 x 22 x 22 Centimeter
Power Source	Corded Electric
Item Weight	8 Kilograms

About this item

- Material:Metal, Color:Multicolour
- Package Contents:1 Water Pump , Total Head : 3 to 54 meters , capacity : upto 5200 LPH
- 1 year on product.
- Pipe size (mm x mm): 25 x 25, hp: 1.00, kw: 0.75, rpm (syn): 3000, head range (metres): 6-34, discharge range (LPH): 2700-500
- Self priming upto 8.0 metres at mean sea level
- Unique motor design-capacitor start and run (psc) type eliminating centrifugal switch
- Aluminium pressure die cast / aluminium extruded motor body
- Brass impeller
- Fitted with thermal overload protector
- Applications: water supply to bungalows, garages, flats, laundries, clubs, gardening and lawn sprinklers, booster applications. Country of Origin: India

Figure 9- Specification of water pump used

1.ENERGY PERFORMANCE

1.ENERGY PERFORMANCE INDEX

Energy Performance Index(EPI) is the key metric used for bechmarking energy usage in commercial building. EPI is the energy used per unit area measured as KWh/m2/year or KWh/person/year.
The benchmark for Community Resilience Center is 58 kwh/sqm/yer.
By following different strategies and methods the EPI for the project was lowered to around 20 KWh/sq.m/year.Some of the strategies include using efficient lighting system such as LED battens and bulbs. Using power saving electrical appliances.Using passive strategies in design to have visual and thermal comfort in structure which reduce the load on the energy consumption.

	Sr.No	Type	Wattage (Watts/Hour)	Specifications	Units	Usage per day (Hours)	No. of Days	Total Hours	Total Consumption Watts	Company
1	1	LED Batten	**15**	1200 lm	96	5	365	175200	**2628000**	Philips
	2	LED Batten	**20**	2000 lm	32	5	365	58400	**1168000**	Philips
	3	LED Batten	**34**	4100 lm	34	9	365	111690	**3797460**	Philips
	4	LED Batten	**43**	5200 lm	10	12	365	43800	**1883400**	Philips
	5	LED Batten	**59**	8000 lm	8	5	200	8000	**472000**	Philips
	6	LED Bulb	**7**	630 lm	150	1	365	54750	**383250**	Philips
	7	Considering 35% of total use for external lighting					365		**3616239**	Philips
	8	Considering Passage and stairwell area as 18.5% (458.3 Sq.m	**800**	37500 lm		8	365	2920	**2336000**	Philips
2	1	Fan	**28**	900mm	72	12	150	129600	**3628800**	Atomberg
	2	Fan	**32**	1200mm	47	12	150	84600	**2707200**	Atomberg
3	1	Induction Cooktop	**1300**		32	0.25	100	800	**1040000**	Philips
4	1	Refrigerator	**750**	500 lts	2	24	365	17520	**13140000**	Bluestar
5	1	Exhauts Fan	**18**	200mm	60	1	365	21900	**394200**	Atomberg
6	1	Exhaust Chimney	**300**		2	6	365	4380	**1314000**	Energystar
7	1	Computer	**100**		5	5	300	7500	**750000**	HP
8	1	Printer	**30**		1	0.5	100	50	**1500**	HP Inkjet
9	1	Mixer	**600**		4	1	365	1460	**876000**	Usha
10	1	Medical Cold Storage	**1000**		1	24	365	8760	**8760000**	
11	1	Pump	**1000**	1 BHP	4	8	365	11680	**11680000**	Crompton
					Total Energy Consumption (watts) :				**60576049**	

Table 5- Total energy consumption

ENERGY PERFORMANCE INDEX

Energy Performance Index		
Description	**Total**	**Units**
Total Energy Consumption	**60576049**	Wh/year
Peak Energy Consumption in kWh	**60576.049**	kWh/year
Building Area	**2939**	Sq.m
Energy Performance Index	**21**	kWh/Sq.m/year

Table 6- Energy Performance Index

1.ENERGY PERFORMANCE

ON SITE ENERGY GENERATION

Energy performance would be to be self-sufficient so that when disaster strikes, the building can function.

1.Solar Pv are provided on the roof tops of the structures and are used to generate energy during the time of disaster

2.Help to do all activities even though the state electricity gets disturbed and electric poles fall and there is no electricity supply to your building in times of disaster.

3.Each building unit is provided with PV systems on terrace.

4.The generated renewable energy is consumed at the building level, and the additional generation is fed to the grid. At the time of disasters, the additional energy generated will be stored in batteries and used if the grid is down.

5.At the block level, PV panels are placed in series – which are connected to an inverter.The additional energy generated is fed to the grid using a one way feed meter.

Solar Energy Potential (On grid photovoltaic system with battery backup)			
Area for generating 1 kWh		10	Sq.m
Energy Generated in 1 year		1500	kWh
Area available for generation	Considering 50% of roof area	770	Sq.m
On site generation	1 kWh per 10 Sq.m	77	wKh
Energy generation per year		1,15,500	kWh

Solar Energy requirement (On grid photovoltaic system with battery backup)			
Area for generating 1 kWh		10	Sq.m
Energy Generated in 1 year		1500	kWh
Total energy Consumption	(1 year)	60576	kWh
PV System Requirement	Considering 1 unit producing 1500kwh of electricity in a year	40.384	kWH
Total Area for PV System	Considering 25% extra	415	Sq.m

Table 7- On-site renewable energy generation potential.

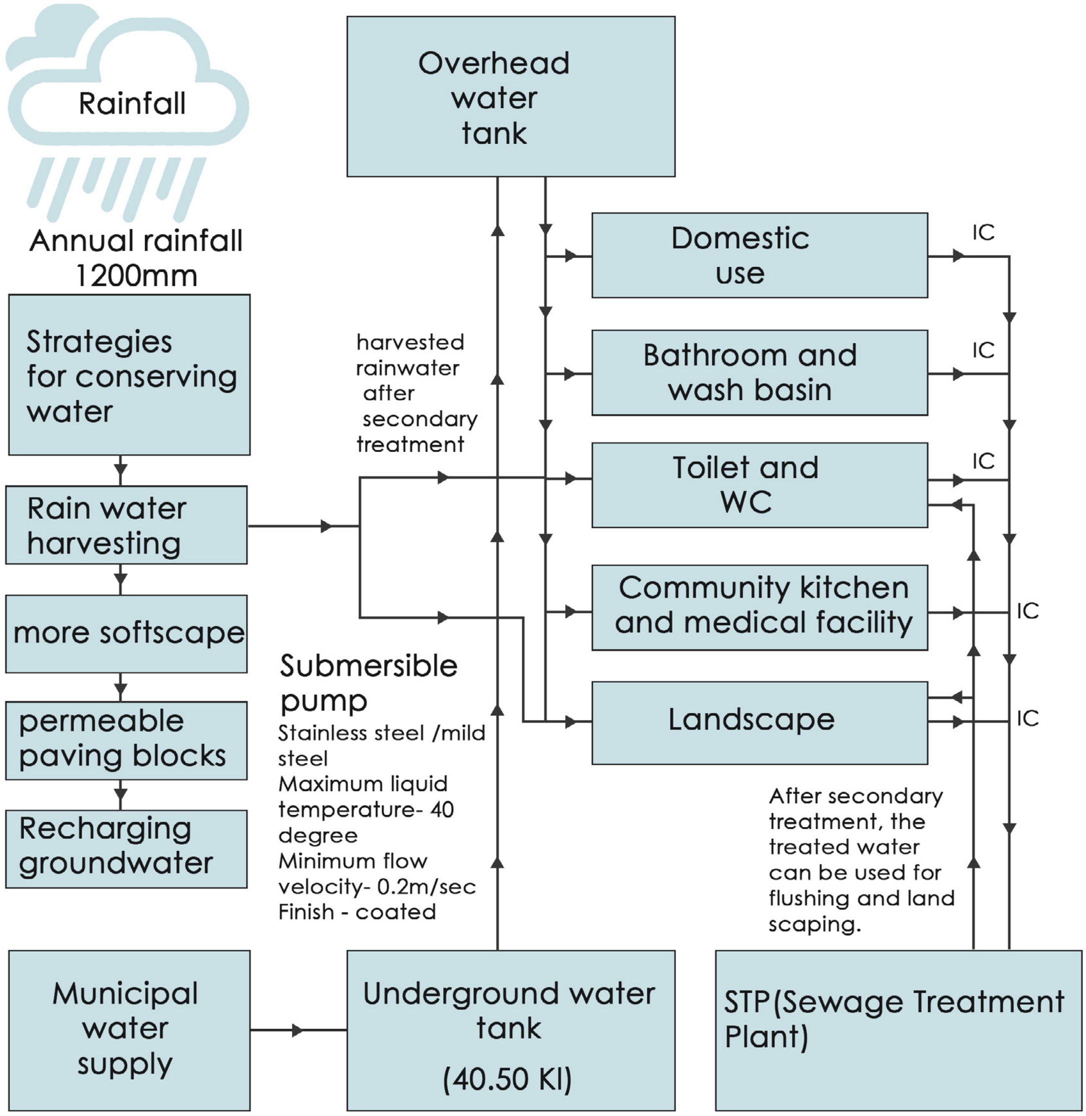
Solar Panel System	Block Level	Site Level	
Area for genertaing 1kWh	10 Sq.m		
Energy generated in 1 year	1500 kWh		
Area available	269	770 (50 % roof area)	Sq.M
PV Generator potential	26.9	77	kWh
Energy Generation per year	40,350	1,15,500	kWh
Total Energy consumption (1 year)	60576.05 kWh		
PV system requirement	41.5kWh		
PV system requirement	15	26.5	kWh

Table 8-Solar PV system at block and site level.

2. WATER PERFORMANCE

WATER CYCLE DIAGRAM

Figure 10



NOTE

Considering 135 litres of water per capita for 300 person = 40500 litres of water per day, Calculation for toilet purpose of 17% = 6885 litres, and having a efficiency of 75% for the treatment of waste water the plant after treatment will give 5164 litres of water per day. 11% of the treated water will be used for landscaping (510litrs) and 89% of water will be used for flushing in toilets (4654 litres).

STRATEGIES USED FOR CONSERVING WATER-

The strategies used to achieve net zero in water include -1) Rain water harvesting, the harvested water after treatment would be stored and used during the disaster times.2) Larger area of softscape and permeable paving blocks have been provided for percolation of water, 3) Efficient water fixtures used to reduce the water usage.

2. WATER PERFORMANCE

ANNUAL WATER CALCULATIONS

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)	Cooling tower Ussage factor (%)	Cooling tower water demand (l)	Total fresh water demand (l)	Storage (l)
July	31	211	206	872348.2	1255500	1255500	627750	20%	18265.82	0	609484.18	0%	0	1255500	250000
August	31	128	123	520868.1	1255500	1255500	627750	20%	18265.82	0	609484.18	0%	0	1255500	250000
September	30	132	127	537806.9	1215000	1215000	607500	20%	17676.6	0	589823.4	0%	0	1215000	250000
October	31	82	77	326071.9	1255500	1255500	627750	50%	45664.55	0	582085.45	0%	0	1255500	250000
November	30	26	21	88928.7	1215000	1215000	607500	50%	44191.5	0	563308.5	0%	0	1215000	250000
December	31	5	0	0	1255500	1255500	627750	50%	45664.55	0	582085.45	0%	0	1255500	250000
January	31	0	0	0	1255500	1255500	627750	100%	91329.1	0	536420.9	0%	0	1255500	250000
February	28.25	1	0	0	1144125	1144125	572062.5	100%	83227.325	0	488835.175	0%	0	1144125	250000
March	31	2	0	0	1255500	1255500	627750	100%	91329.1	0	536420.9	50%	54703.84	1310203.84	195296.16
April	30	13	8	33877.6	1215000	1215000	607500	100%	88383	0	519117	100%	105878.4	1320878.4	123295.36
May	31	41	36	152449.2	1255500	1255500	627750	50%	45664.55	0	582085.45	100%	109407.68	1364907.68	166336.88
June	30	122	117	495459.9	1215000	1215000	607500	50%	44191.5	0	563308.5	50%	52939.2	1267939.2	250000

Table 9 -Detailed water calculation for demand and storage(Source - Indian Meteorological Department) Pune Municipal Corporation

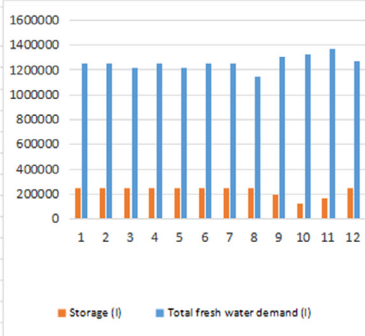


Figure 11- annual water calculation

NOTES-

1. As residential spaces will be occupied at time od disaster only, Hence the use of water or bathing is reduced and have been added to Medical facility.
2. In months of rainy season(June-November) water collected from rain water will be used and for remining months water will be taken from Pune Municipal corporation.

End Use	Percent use	Use in LPD	Greywater in LPD	Blackwater in LPD
Bathing	30%	12150	12,150	
Washing	20%	8100	8,100	
Cleaning house	8%	3240	3,240	
Washing Utensils	16%	6480	6,480	
Others	2%	810	405	405
Drinking	4%	1620		1,620
Cooking	3%	1215		1,215
Toilet Flushing	17%	6885		6,885
Total		**40500**	**30,375**	**10,125**

Table 10 -Water balance table(Source - Indian Meteorological Department)

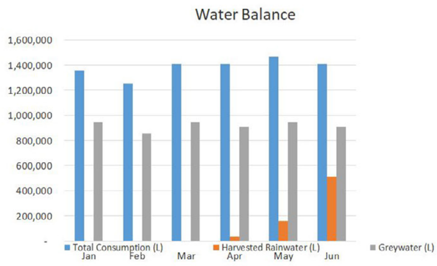
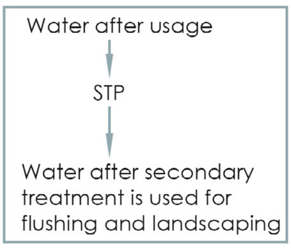


Figure12 -Water balance table

		CONSUMPTION						WATER SOURCES			
Month	Days in month	Domestic Use (L)	Cooling Use %	Cooling Use (L)	Irrigation Use %	Irrigation Use (L)	Total Consumption (L)	Municipal Water (L)	Rainwater	Greywater (L)	Blackwater (L)
Jul	31	12,55,500	90%	98,483	5%	5,471	13,59,454		906215	9,41,625	3,13,875
Aug	31	12,55,500	80%	87,540	5%	5,471	13,48,512		541089	9,41,625	3,13,875
Sep	30	12,15,000	50%	52,948	50%	52,948	13,20,896		558686	9,11,250	3,03,750
Oct	31	12,55,500	75%	82,069	30%	32,828	13,70,397		338731	9,41,625	3,13,875
Nov	30	12,15,000	20%	21,179	90%	95,306	13,31,485		92381	9,11,250	3,03,750
Dec	31	12,55,500	0%	-	90%	98,483	13,53,983		0	9,41,625	3,13,875
Jan	31	12,55,500	0%	-	90%	98,483	13,53,983	20,000	0	9,41,625	3,13,875
Feb	28	11,44,125	20%	19,944	90%	89,747	12,53,815	20,000	0	8,58,094	2,86,031
Mar	31	12,55,500	50%	54,713	90%	98,483	14,08,696	20,000	0	9,41,625	3,13,875
Apr	30	12,15,000	90%	95,306	90%	95,306	14,05,612	20,000	35193	9,11,250	3,03,750
May	31	12,55,500	100%	1,09,426	90%	98,483	14,63,409	20,000	158368	9,41,625	3,13,875
Jun	30	12,15,000	90%	95,306	90%	95,306	14,05,612	10,000	514695	9,11,250	3,03,750
Total							**82,91,127**	**1,10,000**	**7,08,255**	**55,05,469**	

Table 11 -Water consumption table(Source - Indian Meteorological Department) Pune Municipal Corporation



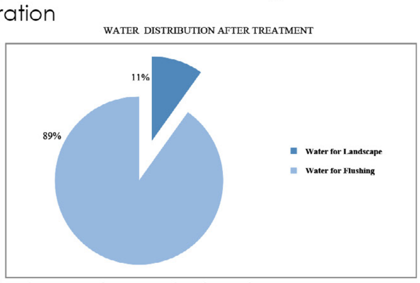


Figure 13 -Treated water usage

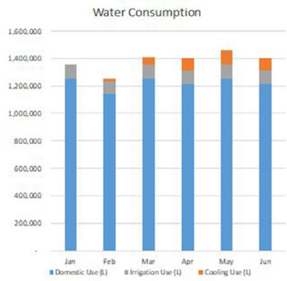


Figure 14 -Water consumption

ANNUAL WATER CALCULATIONS

Month	Days in month	Occupant demand	Irrigation seasonal factor (%)	Irrigation demand	Cooling tower Usage factor (%)	Cooling tower water demand (l)	Total water demand (l)
July	31	1255500	20%	14817.132	0%	0	1270317
August	31	1255500	20%	14817.132	0%	0	1270317
September	30	1215000	20%	14339.16	0%	0	1229339
October	31	1255500	50%	37042.83	0%	0	1292543
November	30	1215000	50%	35847.9	0%	0	1250848
December	31	1255500	50%	37042.83	0%	0	1292543
January	31	1255500	100%	74085.66	0%	0	1329586
February	28	1144125	100%	67513.545	0%	0	1211639
March	31	1255500	100%	74085.66	50%	54713	1384298
April	30	1215000	100%	71695.8	100%	105896	1392591
May	31	1255500	50%	37042.83	100%	109426	1401968
June	30	1215000	50%	35847.9	50%	52948	1303796

Table 12 -Water demand for irrigation and cooling tower

STRATEGIES FOR MINIMIZING AND REUSING WATER-

1. Use of Aerator valves as per pressure required. (Suggested by TERI in WSDS-2020)
2. Use of insulated pipes for hot water supply
3. Use of Bio Digester toilets
4. Borewells and rainwater harvesting

WATER COLLECTION STATRGIES-

1. Rainwater harvesting
2. use of softscape and recharge pits for percolation of water

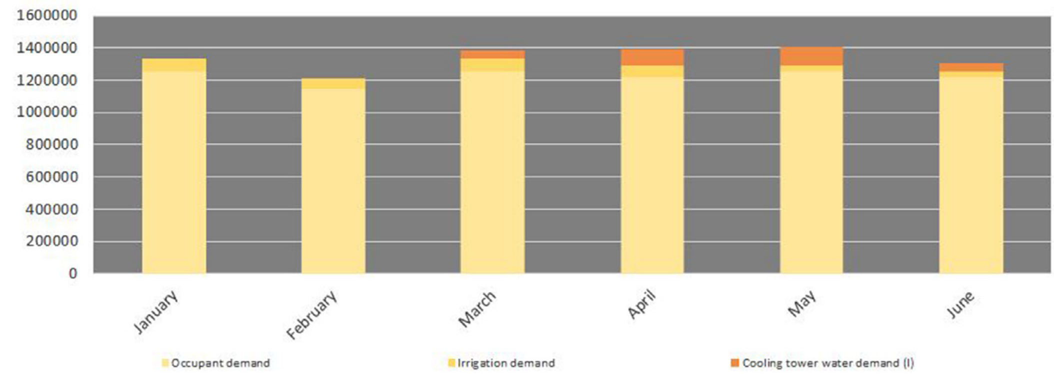


Figure 15 -Water demand for irrigation and cooling tower

Month	Days in month	Generated black water	Generated Grey water	Filtered grey water
Jul	31	318897	936603	702452.25
Aug	31	318897	936603	702452.25
Sep	30	308610	906390	679792.5
Oct	31	318897	936603	702452.25
Nov	30	308610	906390	679792.5
Dec	31	318897	936603	702452.25
Jan	31	318897	936603	702452.25
Feb	28	290608	853517	640137.9375
Mar	31	318897	936603	702452.25
Apr	30	308610	906390	679792.5
May	31	318897	936603	702452.25
Jun	30	308610	906390	679792.5

Table 13-Showing the amount of generated greywater in eve ry month.

Months	Rainfall (mm)	Effective rain (mm)	Harvested rainwater (l)
July	211	206	906215
August	128	123	541089
September	132	127	558686
October	82	77	338731
November	26	21	92381
December	5	0	0
January	0	0	0
February	1	0	0
March	2	0	0
April	13	8	35193
May	41	36	158368
June	122	117	514695

Table 14-showing amount of rain water harvested every month

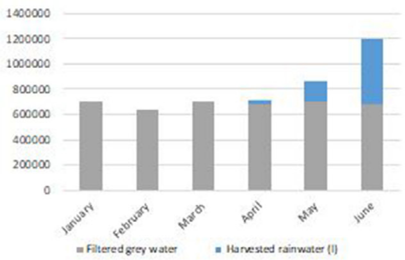


Figure 16 Filtered grey water

Occupant's Activity	Percent usage	Quantity	Grey water	black water
Bathing	29.0%	11745	100%	0%
Washing	19.6%	7938	100%	0%
Drinking	4%	1579.5	0%	100%
Cooking	3%	1174.5	0%	100%
Toilet	17.0%	6885	0%	100%
Cleaning house	8.0%	3240	100%	0%
Washing Utensils	16.4%	6642	100%	0%
Others	3.20%	1296	50%	50%

Table 15- Domestic water usage for ocupants

As the rain water harvested is 8 percent it could also be used for drinking by tertiary water tretment of chemical by chlorinization and ozonization.

3. RESILIENCE

1. ADAPTABILITY

1. Pune is vulnerable in varying degrees to a large number of natural as well as man-made disasters— Pune has a large percent of the landmass prone to earthquakes of moderate to very high intensity; over 12 percent of the land is prone to floods and river erosion; 68 percent of the cultivable area is vulnerable to drought and the hilly regions are at risk from landslides and avalanches. Further, the vulnerability to Nuclear, Biological, and Chemical (NBC) disasters and terrorism has also increased manifold.

2. During times of a disaster people lose their only shelter and due to the economic conditions it is difficult for them to find another living space immediately. A disaster shelter for these people is an important part of a resilient community.

3. Pune being rich cultural heritage, many people travel here for pilgrimage. Many of these people come from a weak economic background so they cannot afford to stay in hotels because which they are forced to reside on road sides and footpaths. A lodging place with minimal expenditure is proposed in the resilient center

4.The lodging facility will also be available to the student who migrates to Pune from smaller villages. The facility will provide them with a stay at a minimal price.

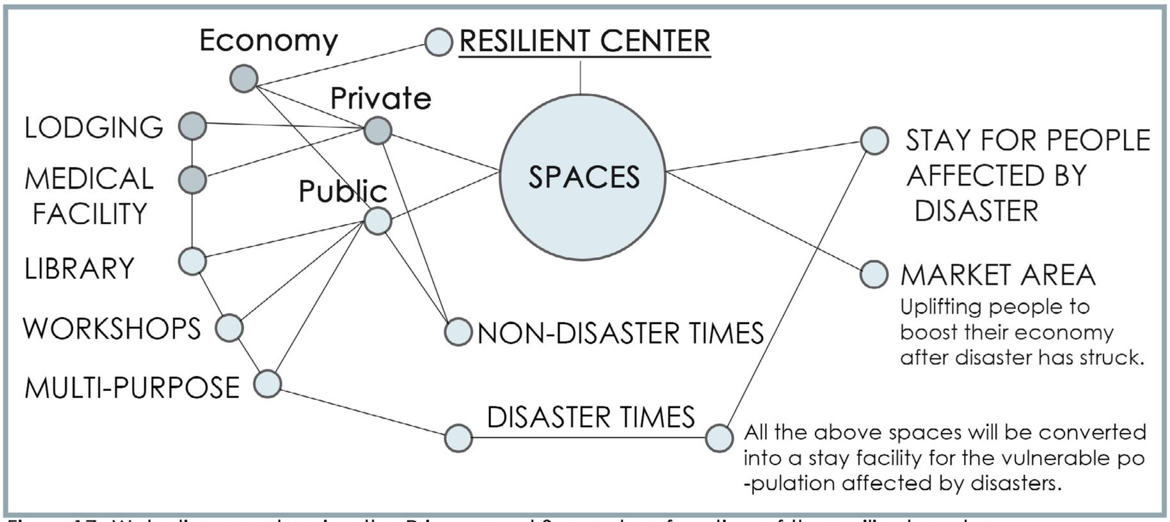
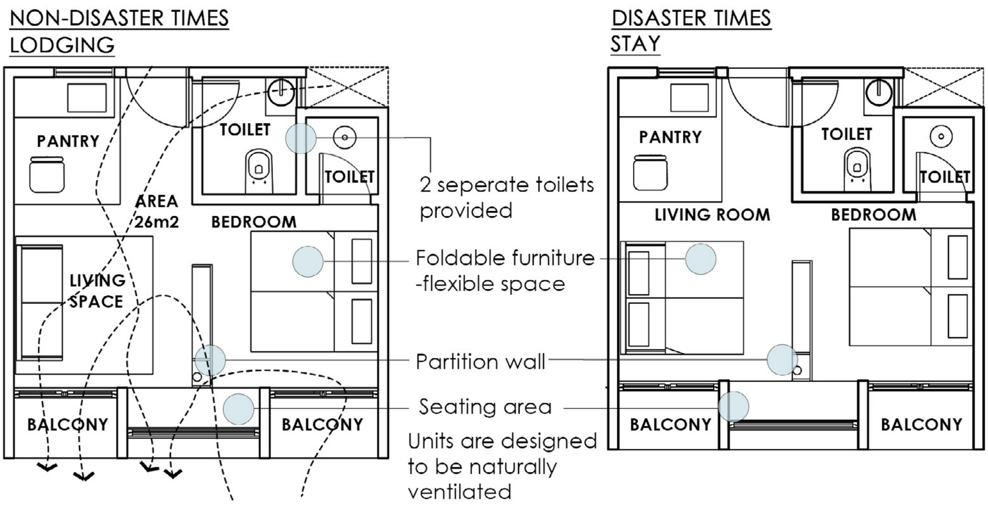


Figure17 -Web diagram showing the Primary and Secondary function of the resilient center.



The foldable furniture provided so that the space can be lived with great flexibility and change its appearance during the disaster times.

3. RESILIENCE

RESILIENCE IN ENERGY PERFORMANCE

Resilience in Energy performance would be to be self sufficient so that when disaster strikes the building is able to function.

1.SOLAR PV are provided on the roof tops of the structures and are used to generate energy during the time of disaster

2.Help to do all activities even though the state electricity gets disturbed and electric poles fall and there is no electricity supply to your building in times of disaster.

3.Each building unit is provided with PV systems on terrace.

4.The generated renewable energy is consumed at the building level, and the additional generation is fed to the grid. At the time of disasters, the additional energy generated will be stored in batteries and used if the grid is down.

5.The solar panels will be housed on the roof of the building which will protect it from floods and other disasters such as storms etc.

(Note-Pune city has never experienced storm)

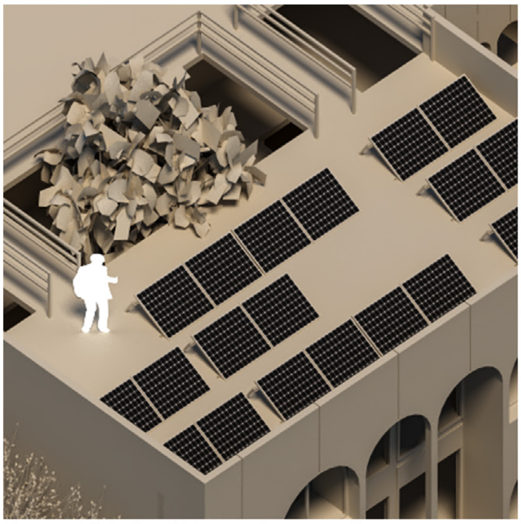


Figure 18-Solar PV panels on roof

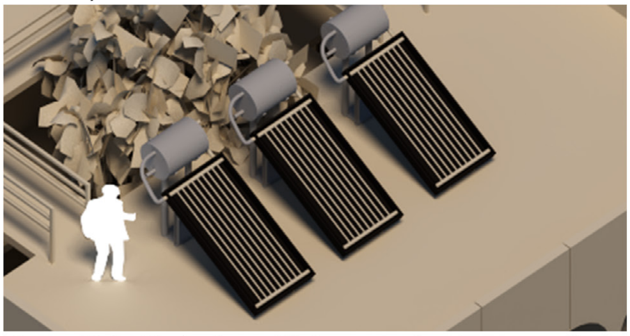


Figure 19-3d illustration of Solar water heater on rooftop

RAINWATER HARVESTING-

Rainwater harvesting is a method used for collecting, storing, and using rainwater for various purposes, for example, for landscape irrigation. This technique collects rainwater from different hard surfaces like rooftops and other manmade hard surfaces above the ground.

The roof catchment systems channelize the rainwater that falls on the roof into a tank through gutters and pipes. Using rainwater for laundry, garden use and for flushing the toilets can reduce 70% of the consumption of main water by a household.

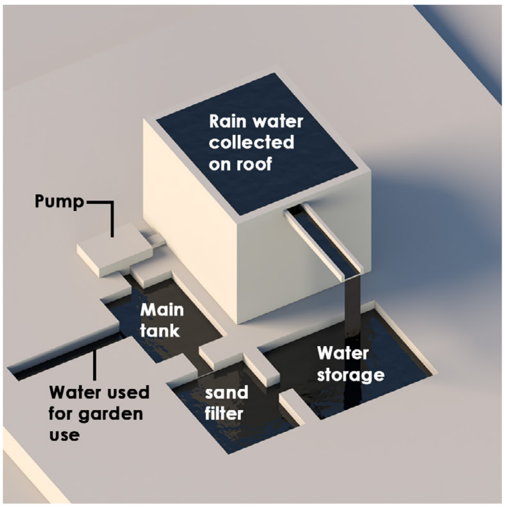


Figure 20-Conceptual diagram showing the process of rainwater harvesting.

3. RESILIENCE

3. BIO-DIGESTER TOILETS

The Bio-Digester Technology Toilets are toilets in which human waste (faecal matter) is treated.

The BIO-DIGESTER TOILET SYSTEM has two key components which perform the task of treating the human waste matter and converting it to **s**afe water fit for irrigation / gardening.

Anaerobic Microbial Inoculum (commonly called as the AMI - Anaerobic Microbial Inoculum) and sometimes referred to as DRDO Bacteria. This is a non hazardous solution which is poured into the Bio-Digester Tank and works round the clock to treat the human faecal matter and converts it to water, carbon di oxide and methane.

A specially designed tank known as the Bio-Digester Tank which contains the AMI and into which flows the Black Water (toilet discharge). This tank can be installed over or under the ground as per the site requirements. It is delivered factory assembled and only the inlet and outlet connections have to be made at the site.

The water consumption for bio-toilets- 0.5 liter (min.) to 0.8 liter(max.) water per flush} for l00% cleaning of the commode or pan. Whereas for a Conventional toilet-water consumption is 6-10 liters per flush.

The other strategies to achieve net zero water usuage include-use of efficient water fixtures,large area of softscape, water permeable paving The use of rain water harvesting and bio-toilets in resilience building helps in achieving the goal towards net zero water usage.

ECONOMIC UPLIFTMENT

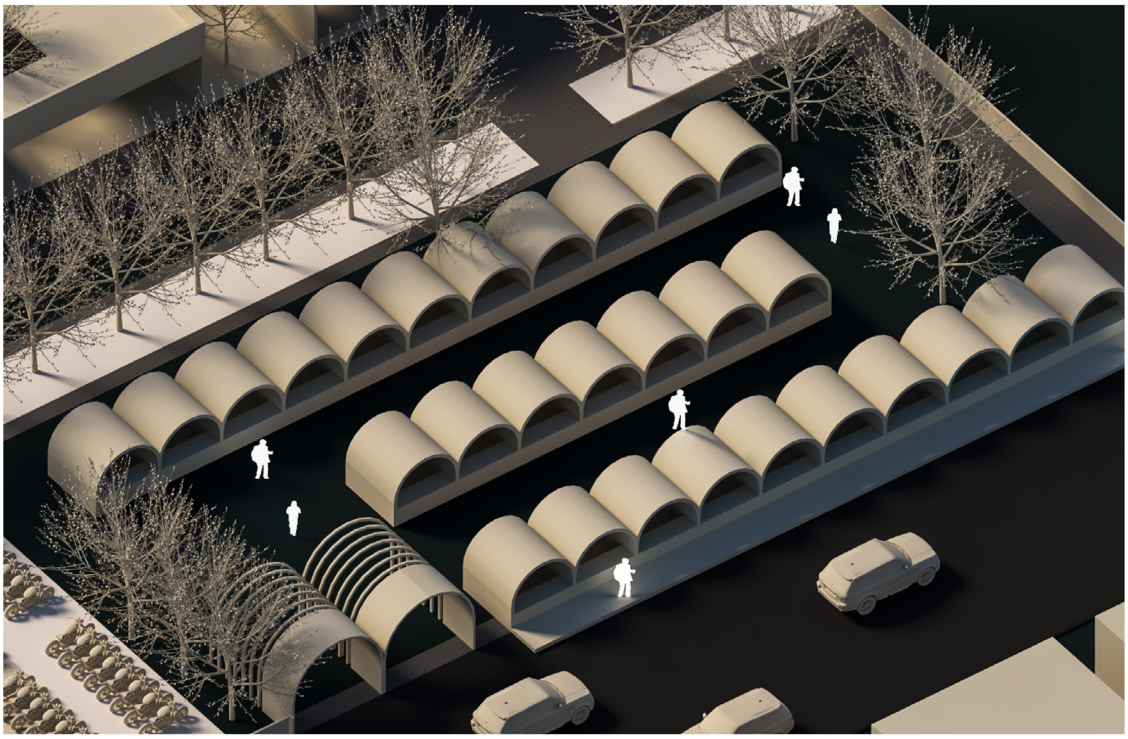
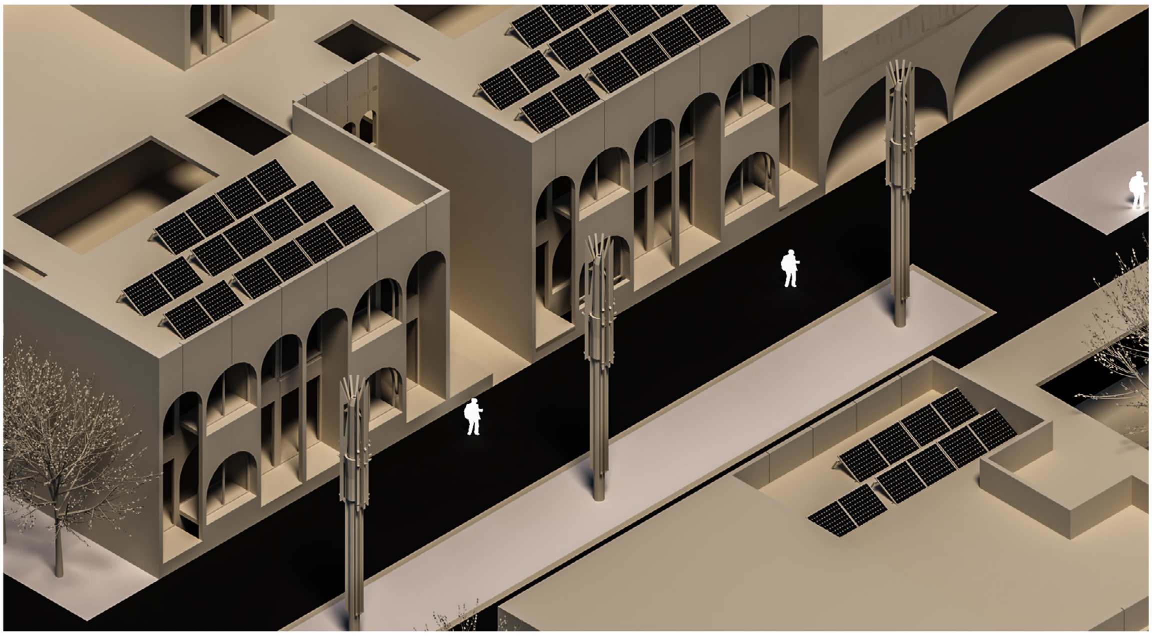


Figure 21- The Community Resilience Centre will aid the affected people to rebuild their economy by starting a small venture in the market space provided at the front.It will also provide them with shelter until they are ecomonically stable enough to support their families.This space would be used as multipurpose spaces during non disaster times.

3. RESILIENCE

MODULAR SHELTER

temporary shelters which would be set up, if the rooms are over occupied during disaster times.These shelter also comprises of umbrella roofing system which helps in ground water percolation.



During non-disaster times the umbrella roof will be closed and would be used as an interaction space,

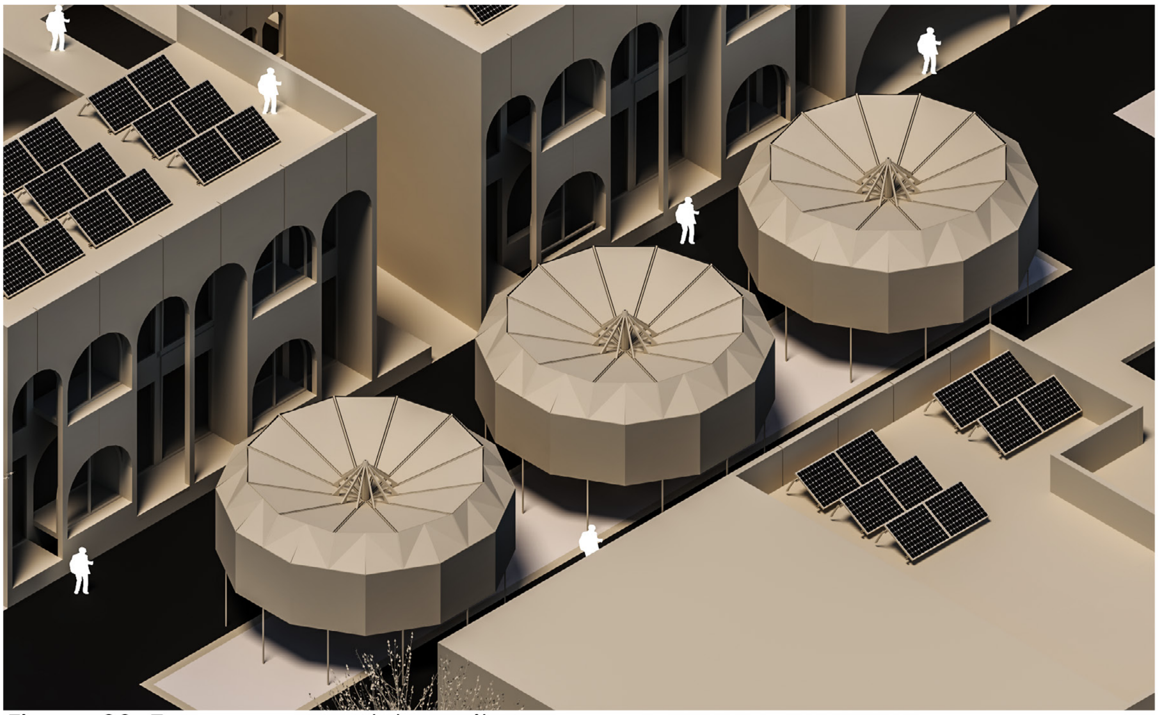


Figure 22- Temporary modular units

Providing temporary modular housing units in our site's open spaces will provide shelter in **emergency situations** if the rooms are **over-occupied**.

4. AFFORDABILITY

DESIGN STRATEGIES FOR RIGHTSIZING AND OPTIMIZATION TO CONTROL CONSTRUCTION COSTS.

Low-Cost Construction is a new concept that deals with effective budgeting and following techniques that help reduce the cost of Construction through the use of locally available materials and improved skills and technology without sacrificing the strength, performance, and life of the structure.

DESIGN STRATEGIES FOR REDUCING CONSTRUCTION COST-

MODULAR DESIGN-1. Allows a more efficient and sustainable construction.
2. The entire design of the resilient center is done in a rigid grid.
3. Repetitive modules of the same dimensions have been used and repeated in the resilient center's design.

ADVANTAGES MODULAR DESIGN

1. SHORTER CONSTRUCTION TIME-Modular building projects can be completed 30-50% quicker than traditional construction methods.
2. ENVIRONMENTALLY FRIENDLY: The amount of waste generated by traditional construction methods has always been an environmental challenge for project managers and stakeholders. Modular construction generates less waste than conventional construction

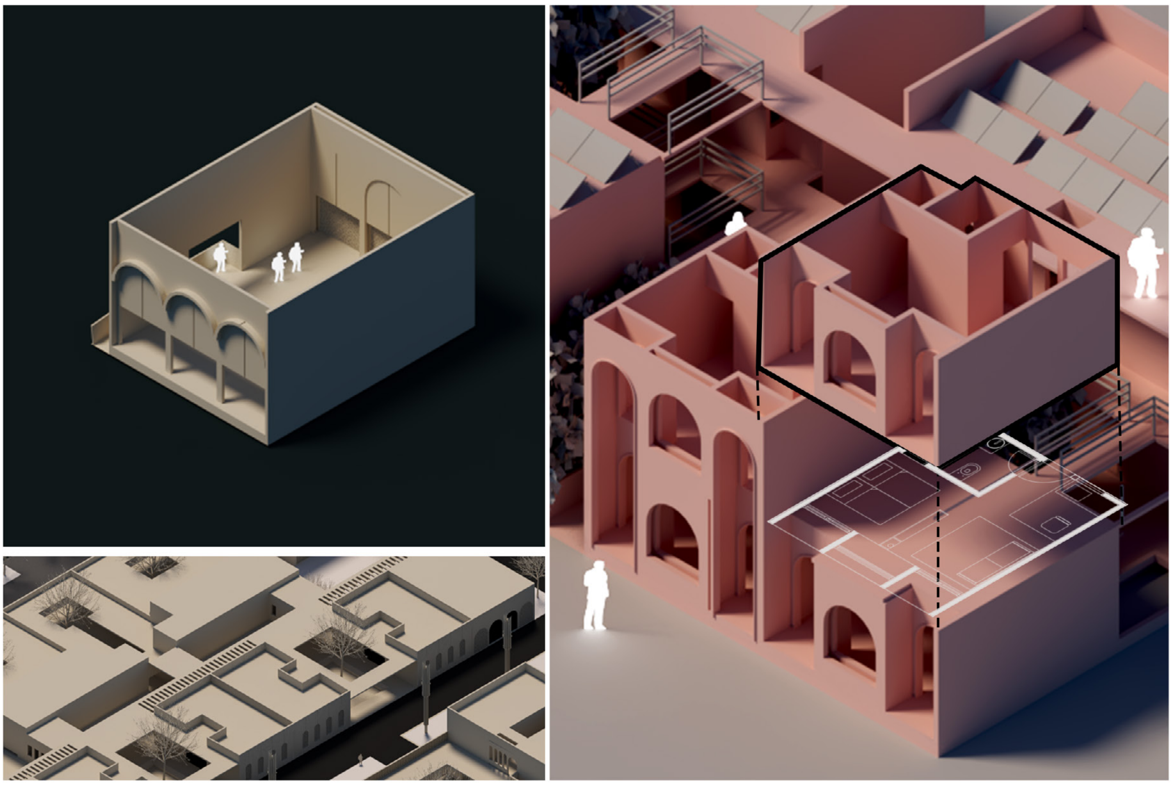


Figure 23- Modules

3. COST-EFFECTIVE-Modular design considerably reduces the construction and labor cost as repetitive modules are used. Modular building projects are 33% cheaper as compared to traditional construction.

4. AFFORDABILITY

CONSTRUCTION MATERIALS USED-

1. AUTOCLAVED AERATED CONCRETE

A. Eco-friendly: AAC helps to reduce at least 30% of environmental waste as compared to traditional concrete. There is a decrease of 50% of greenhouse gas emissions.
B. Lightweight: It is 3-4 times lighter than traditional bricks and, therefore, more accessible and cheaper to transport.
C. Energy Saver: It has an excellent property that makes it an excellent insulator. Great Acoustics: AAC has excellent acoustic performance. It can be used as a very effective sound barrier.
D. Fire Resistant: Just like the regular concrete, ACC is fire resistant. This material is entirely inorganic and not combustible.
E. Low Maintenance: AAC reduces the operating cost by 30% to 40%. It also reduces overall construction cost by 2.5% as it requires less jointing and reduces the quantity of cement and steel.
F. Faster Construction: It reduces construction time by 20%. As these blocks are lighter, it makes construction more accessible and quicker.

TAKEAWAYS-

The compressive strength of AAC blocks is comparatively more than traditional clay brick. These are suitable for walls in RCC framed building. The utilization of fly ash leads to the reduction in cement consumption in the product, which results in the removal of greenhouse gases. The AAC block density is 1/3 that of traditional clay brick, and there is no more change in wet conditions. It helps in reducing the dead load of the structure. Cost of construction reduces by maximum up to 20 % as reduction of a dead load of wall on beam makes comparatively lighter members. As both sides face the AAC block wall are plane, the thickness of plaster is significantly less, so there is a substantial reduction of up to 50% in the requirement of cement and sand for plasterwork. The energy consumed in the production process emits no pollutants and creates no by-products or toxic waste products

GFRP BARS-

1. GFRP bars are a mixture of e-glass fiber made of e glass polymers having tensile strength of more than 1200 n/mm2 with a density 1900kg/m3 and almost nine times lighter than steel
2. 40% cheaper than conventional steel

GFRP				STEEL TMT			
Dia.	Bars Per ton	Weight per bar (Kg)	Price per 12m bar (Rs.)	Dia.	Bar Per ton	Weight per bar	Price per 12m bar(Rs.)
6	1667	0.6	103				
7	1068	0.936	133				
8	833	1.2	170	8	210.9704641	4.74	209.508
10	625	1.6	236	10	135.1351351	7.4	322.64
12	403	2	361	12	93.89671362	10.65	464.34
16	205	4.87	703	16	52.8262018	18.93	825.348
20	124	8.08	1132	20	33.8066261	29.58	1289.688

Table 16-Price comparison between GFRP and Steel TMT

INNOVATION

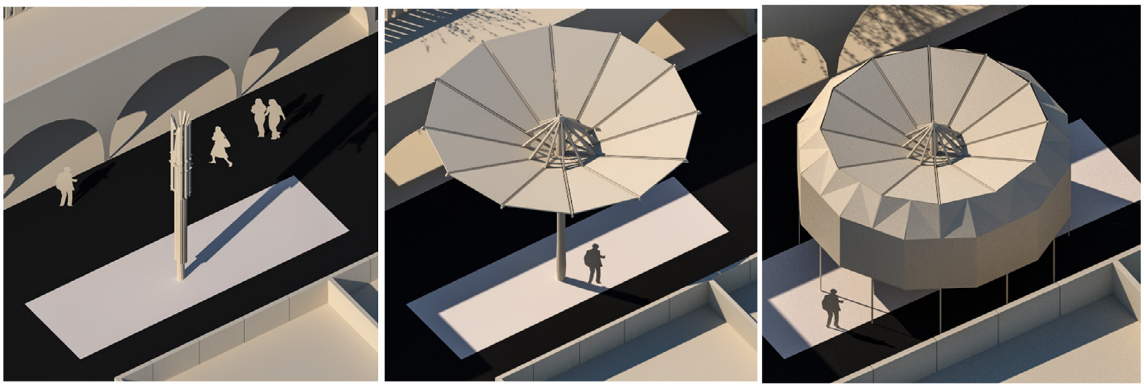
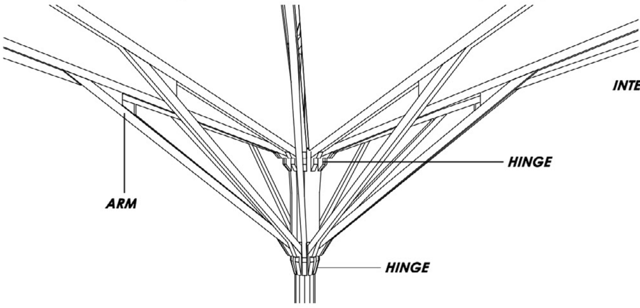
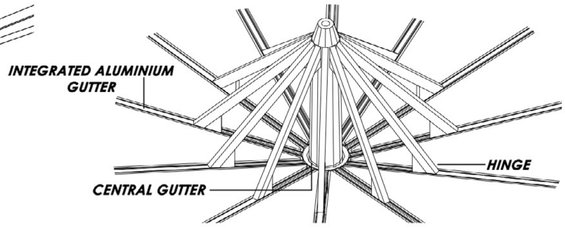
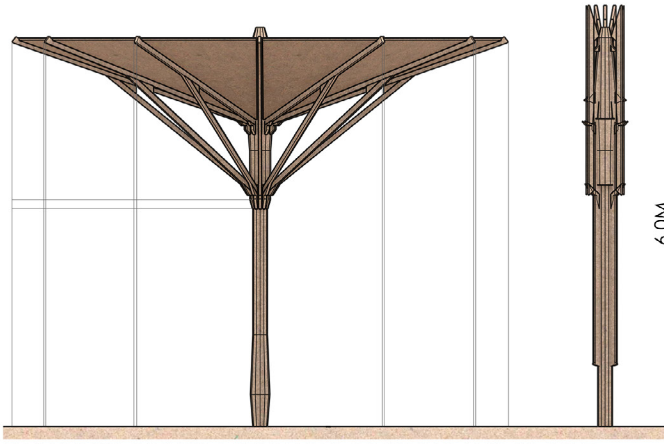


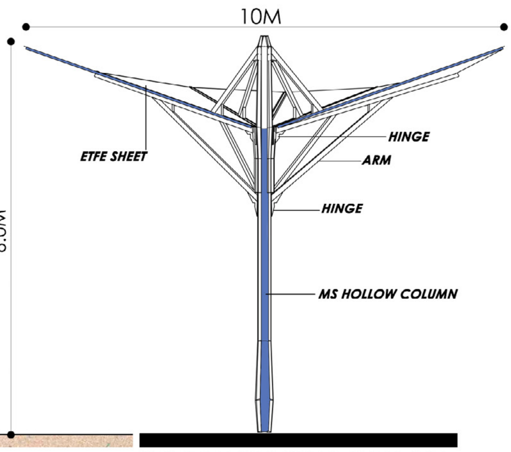
FIGURE 24-UMBRELLA ROOFING
Umrella roofing which converts into a temporary shelter to accomodate people during disasters.





DETAIL SHOWING GUTTER CHANNELS





ELEVATION OF RETRACTABLE ROOF (OPEN AND CLOSED)

SECTION SHOWING HOLLOW CORE

RAIN WATER HARVESTING WITH THE HELP OF UMBRELLA ROOFING

The umbrella system also allows change in experience when the system is open and closed.The central hollow MS column act as a rainwater gutter and facilitates for rainwater harvesting.The arms of umbrella have rainwater channels which col lects and give direction to flow of water.

MATERIALS-

ETFE-Highly tensile material
MS SECTION-for arms of umbrell.
INTEGRATED ALUMINUM GUTTER- For water drainage from the roof to the hollow column.
MS HOLLOW COLUMN-Here holow column is used to be able to collect the rainwater drainage from umbrella.
MS HINGES-Hinges are used to assist the folding of the umbrella.
Tensile fabri

6 SCALABILITY AND MARKET POTENTIAL

TARGET MARKET

After thorough research, the target market selected for this project was people affected by disasters such as earthquakes, flash floods, pandemics, and epidemics. The economically weaker section and the orange ration cardholder are the ones who are most vulnerable during the time of a disaster. As they belong to an economically weaker section, it is difficult for them to find another shelter at such times.

A community resilience center has been proposed to provide shelter to vulnerable citizens at the time of disasters in Karve Road, Pune. At non-disaster times the shelter acts as a self-sustaining model to generate economy by providing spaces for lodging, library, skill development workshops, and multi facilitated activities.

India has been hit with more than 300 natural disasters in 20 years, with around 100 crore people affected. The majority percentage of the people involved are those in poverty. High causalities tend to be centered in the low to the lower-middle-income group.

This Community Resilient center is designed in such a way that it could be replicated in different regions of India because of its modularity and climate responsiveness.

RESPONSE OF THE DESIGN SOLUTION TO THIS STATED TARGET MARKET

The Community Resilience Centre will aid the affected people to rebuild their economy by starting a small venture in the market space provided at the front.It will also provide them with shelter until they are ecomonically stable enough to support their families.

Figure25-Temporary units which can be set up in the market place.

Figure25 -Multiplication of the temporary units.

Each person who wants to rebuild his/her economy can build this temporary unit which can be set up within a few hours and start his small ve nture in the market place provided upfront.

Each of the temporary units are modular units of the same shape and dimension and can be duplicated on any given peice of land.

The repetitive modules saves time of construction.

TEMPORARY UNIT

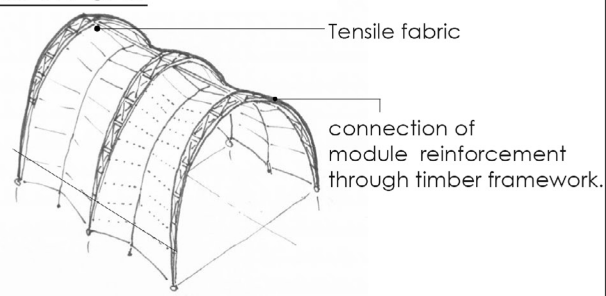


Figure 25

AREA OF 1 UNIT-8 SQM

6 SCALABILITY AND MARKET POTENTIAL

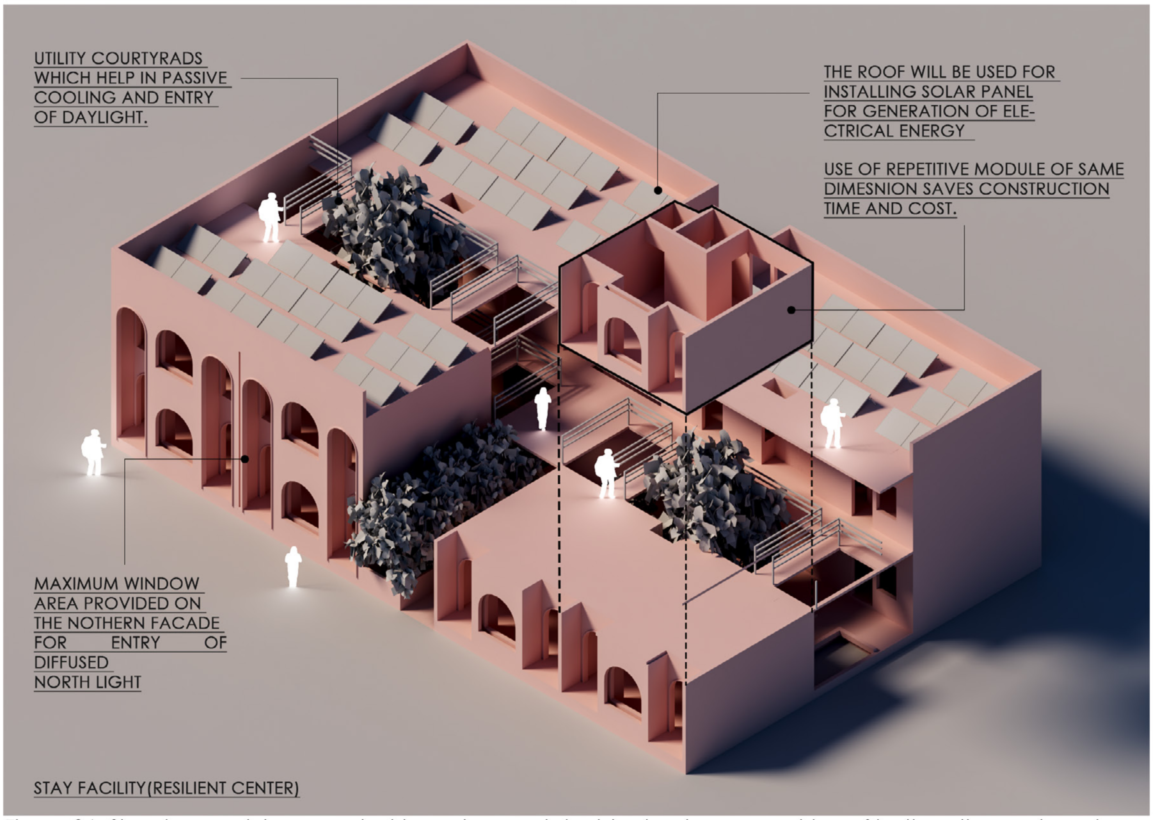


Figure 26- Showing modules repeated to make a sustainable structure comprising of both active and passive design strategies to reduce the energy consumed by the structure.

STRATEGIES FOR REDUCING CONSTRUCTION TIME AND IMPROVING QUALITY

1.MODULAR DESIGN-1. A modular designing concept has been used for effective and sustainable construction., 2. Each of the modules can be repeated to make a sustainable structure housing all the passive strategies(Figure), 3. The use of different repetitive modules of similar dimensions saves construction time and cost.These modules can be easily repeated in different cities of India.Modular building projects are 33% cheaper as compared to traditional construction.

2. USE OF AAC BLOCKS AND GFRP BARS AS CONSTRUCTION MATERIALS.

1. The use of these building material decrease the cost tremendously. thus making it feasible for construction., 2. AAC blocks-t reduces construction time by 20%. As these blocks are lighter, it make construction easier and faster.
3. Availability of ACC blocks and GFRP in India- ●●●●○

STRATEGIES FOR REPLICATION OR LARGE-SCALE IMPLEMENTATION

RESILIENT CENTER

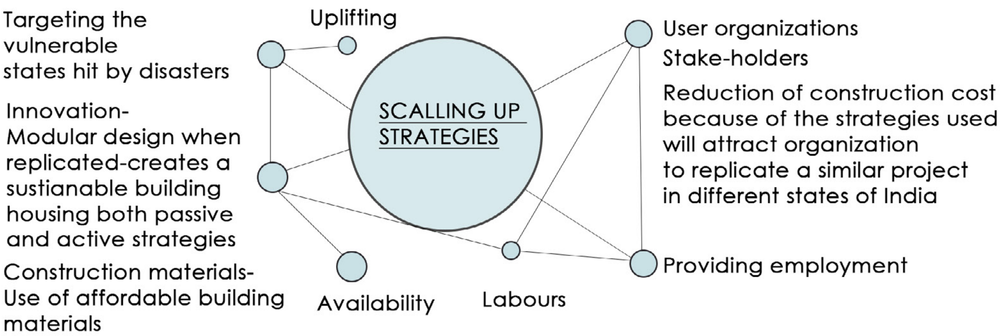
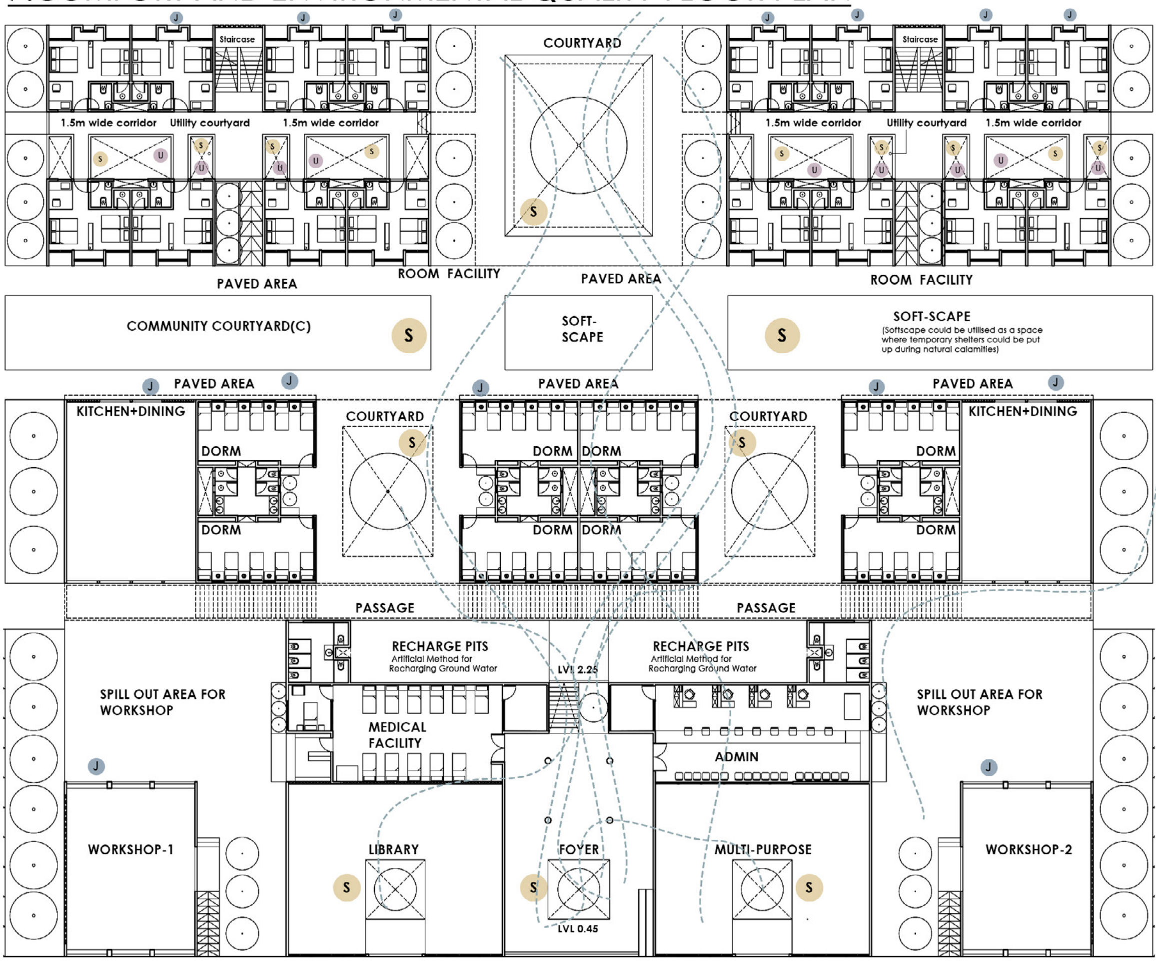


Figure 27- Strategies for replication or large scale implementation.

7.COMFORT AND ENVIRONMENTAL QUALITY-FLOOR PLAN



NORTH

DESIGN STRATEGIES

BUILDING FORM

1. The structure is placed in such a way the the longer facade of the buildind orientes **north-south direction.** 2.The resilient center is divided into three structures which are connected through semi- open spaces.

DEAD WALLS

1. The North-south orientation gives an opportunity for providing dead walls at east and west side, thus r**educing heat gain from direct sun**

UTILITY COURTYARD(U)

1. Enjoyed by each units
2. Daylight-(ensured to all units)
3. Passive cooling and cross ventilation (ensured by all units)
4. Shared verandas-(Aid interaction Also gives opportunity for planters.

COMMUNITY COURTYARD(C)

1. Daylight(Ensured to all units
2. TherapeuticBenefits(Landscape view)
3. Passive cooling and cross-ventilation(Ensured to all units)

OTHER STRATEGIES

1. Buffer between different spaces have been provided
2. The transition from the enclosed space to open space can happen through semi-open space
3. Wet ones clubbed together to reduce the cost of construction.

DAYLIGHT ENTRY

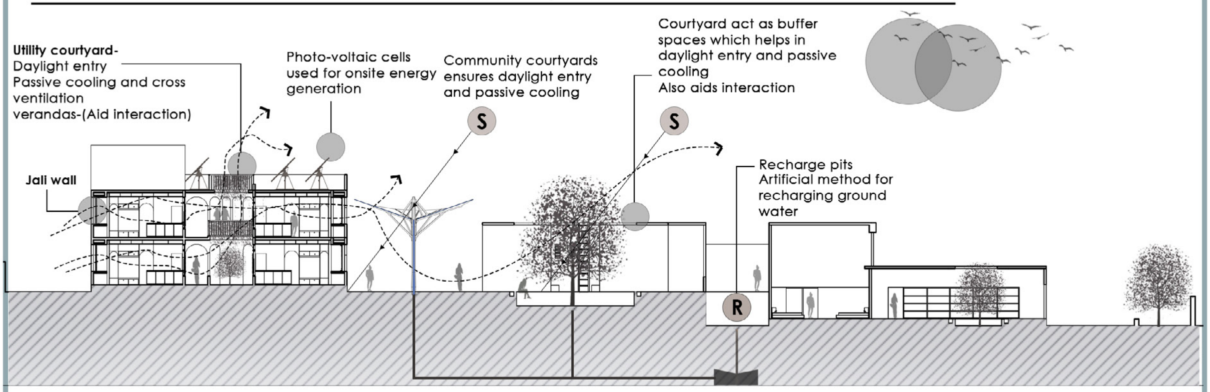
Northern facade-Double heighted openings and **more window area** are provided on the northern side to allow greater amount of diffused north light to enter the units.

Southern facade-1.Single heighted openings 2. **Jali walls and louvered windows** provided on the **southern façade** to **block** the harsh southern light and allow entry of **S-W breeze.** 3.Less window area provided on Southern side because of the harsh southern light.

PLUG LOADS

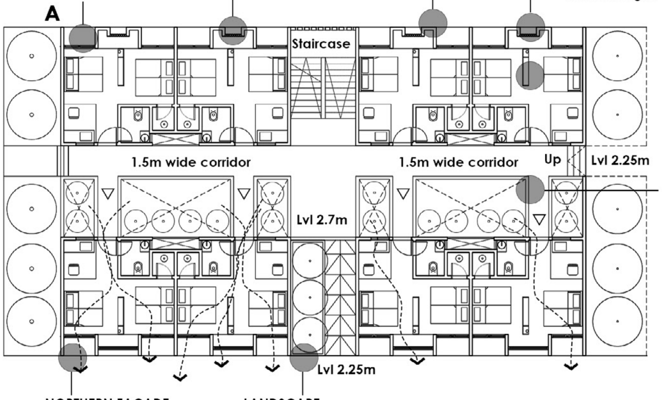
Use of **4-5 star rated** appliances

COMFORT AND ENVIRONMENTAL QUALITY-DESIGN STRATEGIES



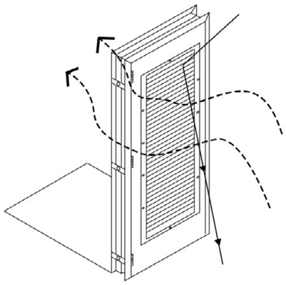
SECTION AA'

FLOOR PLAN(ROOM FACILITY)



DETAIL FLOOR PLAN SHOWING DESIGN STRATEGIES FOR IMPROVING THERMAL COMFORT.

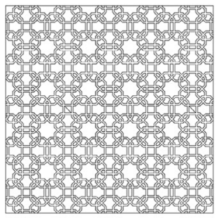
Figure 28



ISOMETRIC DETAIL AT A

LOUVERED WINDOW

To cut the glare from the south side and take the wind inside through the louvers.

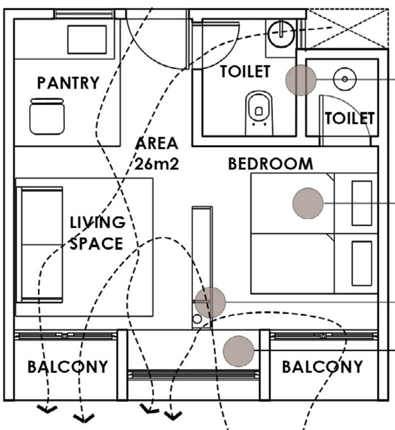


DETAIL AT B

JALI WALL

Jali wall act as an architectural elements and helps in cutting glare from south side and take wind inside

DESIGN STRATEGIES USED AT UNIT PLAN(ROOM FACILITY)



THERMAL COMFORT

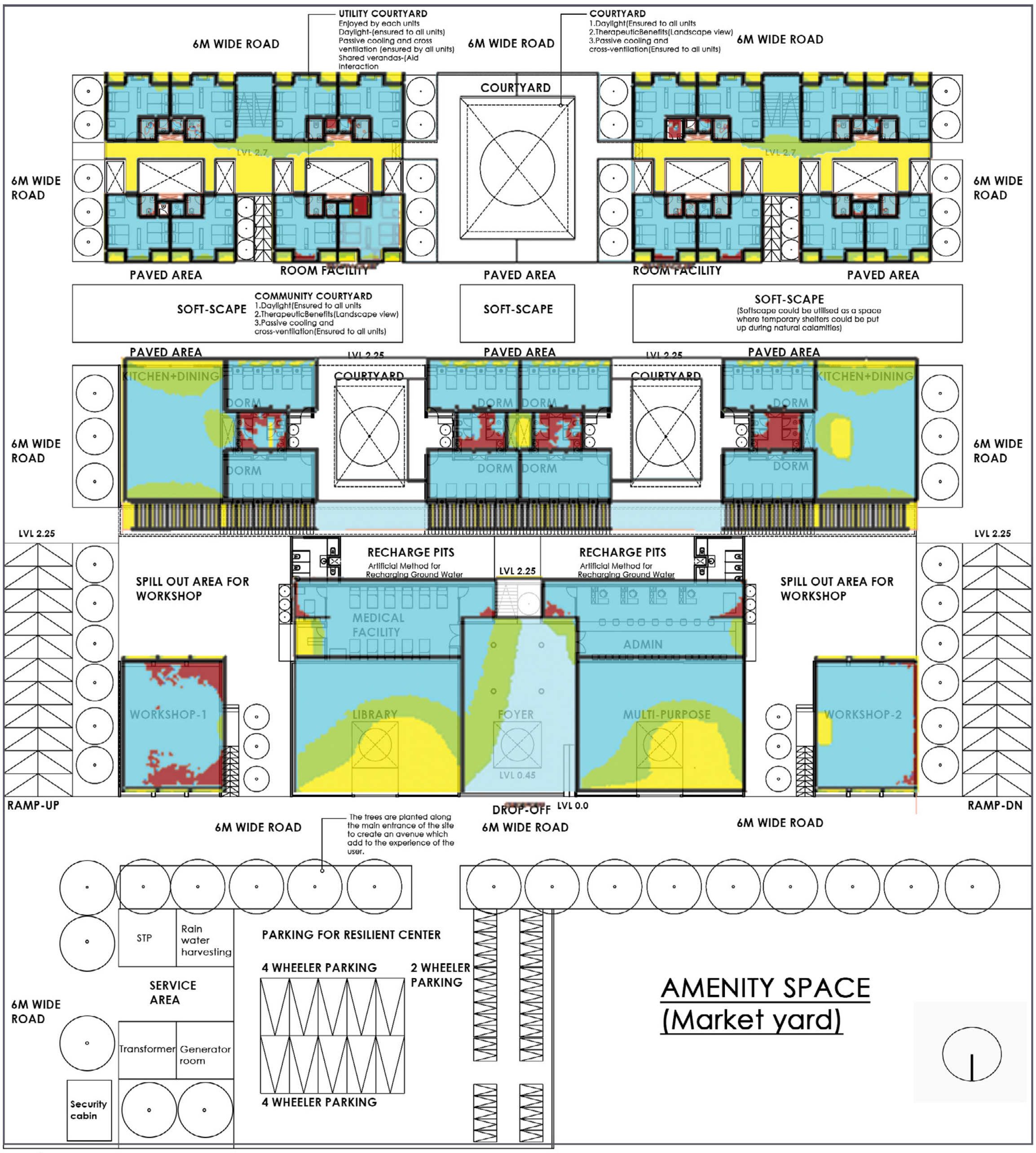
PASSIVE STRATEGIES -

1. N-S orientation.
2.Dead wall on E-W facade tp reduc-e heat gain.
3.Use of jali walls and lovered window on southern facade.
4. maimum window area on Northern facade
5.Vertical plantation in corridor(refer section AA') and Providing courtyards

ACTIVE STRATEGIES -

1. Use of mechanical ventilation wh-erever required, use of 4-5 star rated appliances and use of HVAC system in medical facility

DAYLIGHT ANALYSIS

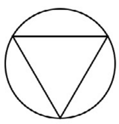


ENTRY

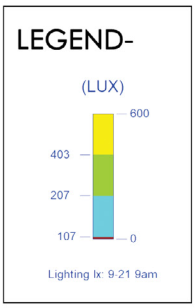
8M WIDE EXTERNAL ROAD

ANALYSIS DONE ON REVIT INSIGHT

ENTRY



N



INFERENCES-

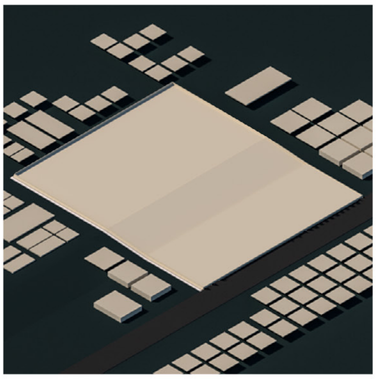
1)Most of the spaces like admin,medical facility, storage rooms, stay etc are well lit with a level of 200-300 lux level

2)There are a few areas where the lux levels have gone beyond 207lux(Fenestrations and sun breakers are provided to reduce the glare.

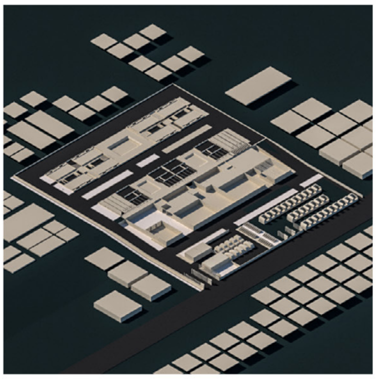
2020
SOLAR DECATHLON INDIA

8. ARCHITECTURAL DESIGN

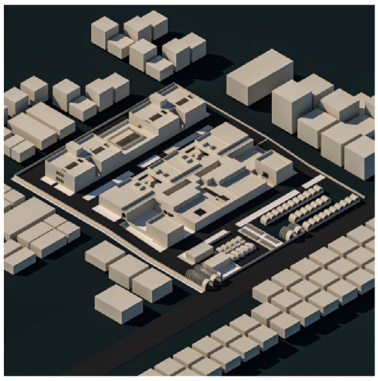
FIGURE 29-FORM EVOLUTION



Site-**Karve road.**
The site comprises gradual existing contours with no existing trees. The site was chosen after studying the hazard map of Pune. Karve road site lies in areas that have a meager chance of getting struck by hazards



Building form-The structure is placed in such a way the more extended facade of the building oriented north-south direction.
The North-south orientation allows providing dead walls on the east and west side, thus reducing heat gain from direct sun.



Spaces-The resilient center is divided into three structures that are connec -ted through semi-open spaces.
Public spaces(Multi-purpose,worksh -ops, Library) are provided in the front for suitable accessibility.Whereas Private areas (dorms, rooms,dining, kitchen) are provided in the back.

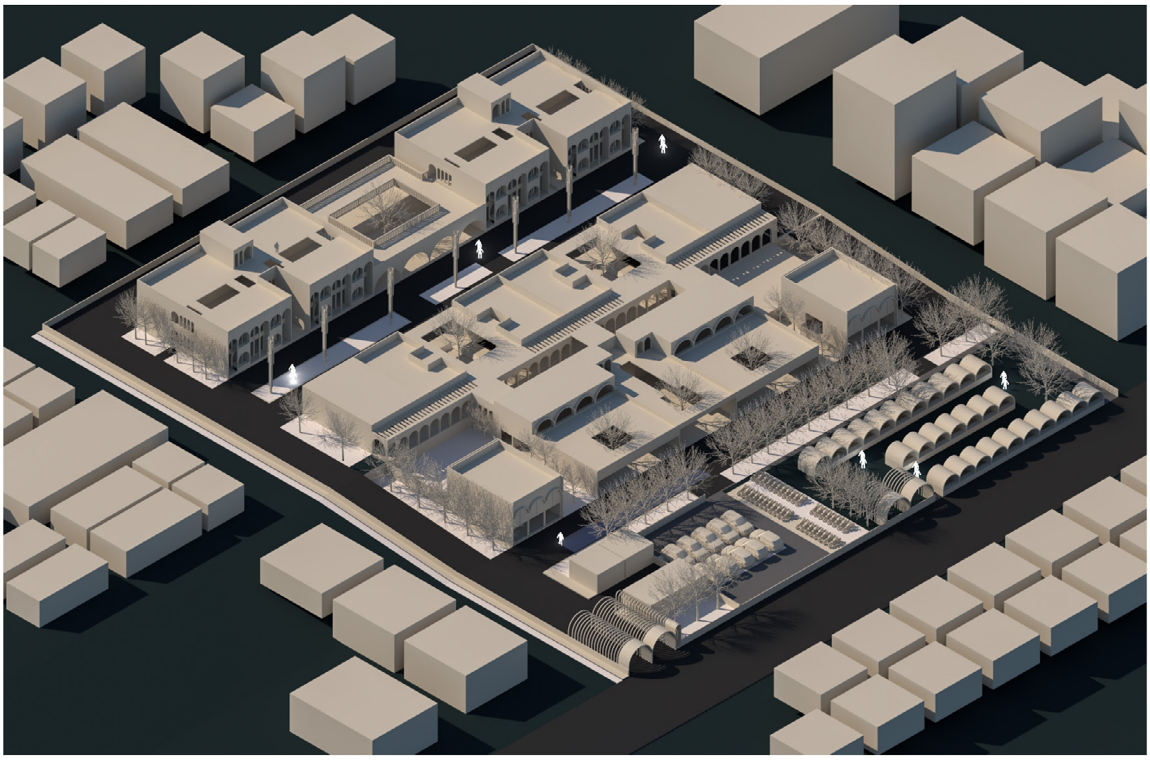


FIGURE 29-3D REPRESENTATION OF RESILIENT CENTER

Integration of building form and function, including exterior and interior architect- -ure aesthetics with respect to the target market.

Building function concerning target market-The primary purpose of the structure is to give lodging for people. During times of disaster, the building will work as a resilient center to shelter people affected by it. It will be a 24 hours operational building. The structure also comprises of Library, multi-purpose, and workshops for both public and private use

Building form-The structure is placed with the longer facade of the building orienting **north-south direction with dead walls provided on the east and west facade.**

ARCHITECTURAL FEATURES-

The resilient center is divided into three structures which are connected through semi- open spaces.Public spaces(**Multi-purpose,workshops, Library**) are provided in the front for suitable accessibility whereas private spaces(**dorms,rooms,dining, kitchen**)are provided in the back.

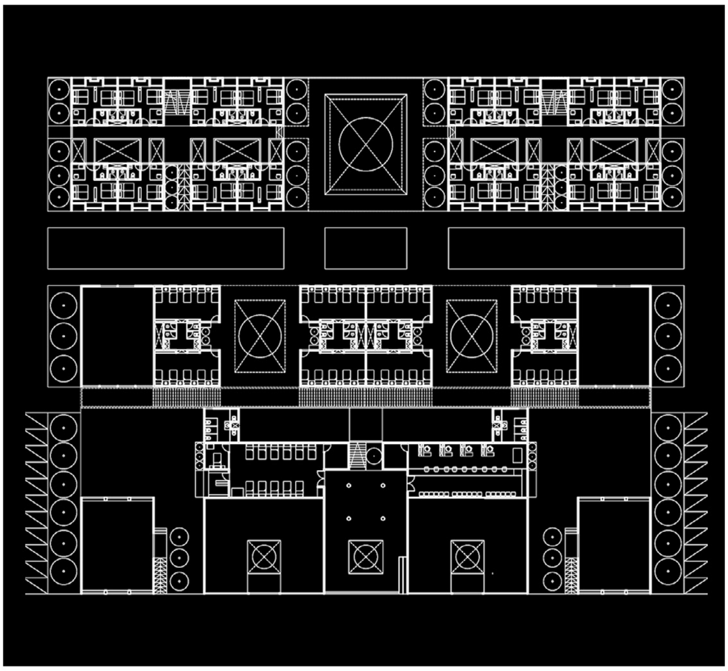


FIGURE 30-HIERARCHY OF COURTYARDS

Courtyards-

Hierarchy of courtyards have been provided which are inspired by the courtyards found in the traditional wadas of Pune city.

This use of this vernacular design strategies help in-

1.Entry of daylight and ventilation.

2.The courtyards also act as a therapeutic landscape for the people affected by the disasters.

3.Act as a community space that aids interaction.

4.Act as soft scape for percolation of rainwater which helps in recharging ground water.

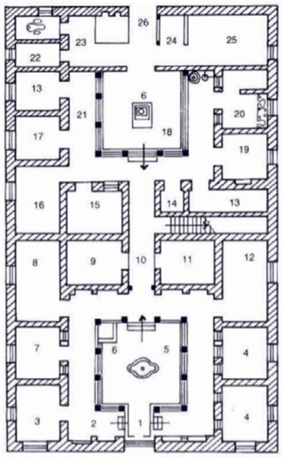


FIGURE 31-TRADITIONAL PLAN OF A WADA IN PUNE

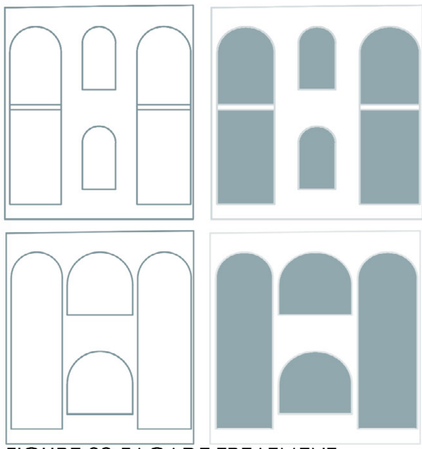


FIGURE 32-FACADE TREATMENT

Northern facade has higher window area as compared to the southern facade.

FACADE TREATMENT

As dead walls are provided on E-W facade prevents no fenestration is required. This reduces the cost of fenestration

Northern facade-**Double heighted openings** and **more window area** are provided on the northern side to allow greater amount of diffused north light to enter the units.

Southern facade-1.Single heighted openings 2. **Jali walls and louvered windows** provided on the **southern façade** to **block** the harsh southern light and allow entry of **S-W breeze.** 3.Less window area provided on Southern side because of the harsh southern light.

Other design strategies used - 1. The transition from the enclosed space to open space can happen through semi-open space(Passages), 3. **Wet areas clubbed together** to reduce the cost of construction.

9. ENGINEERING DESIGN AND OPERATION

3D REPRESENTATION OF STURUCTURAL

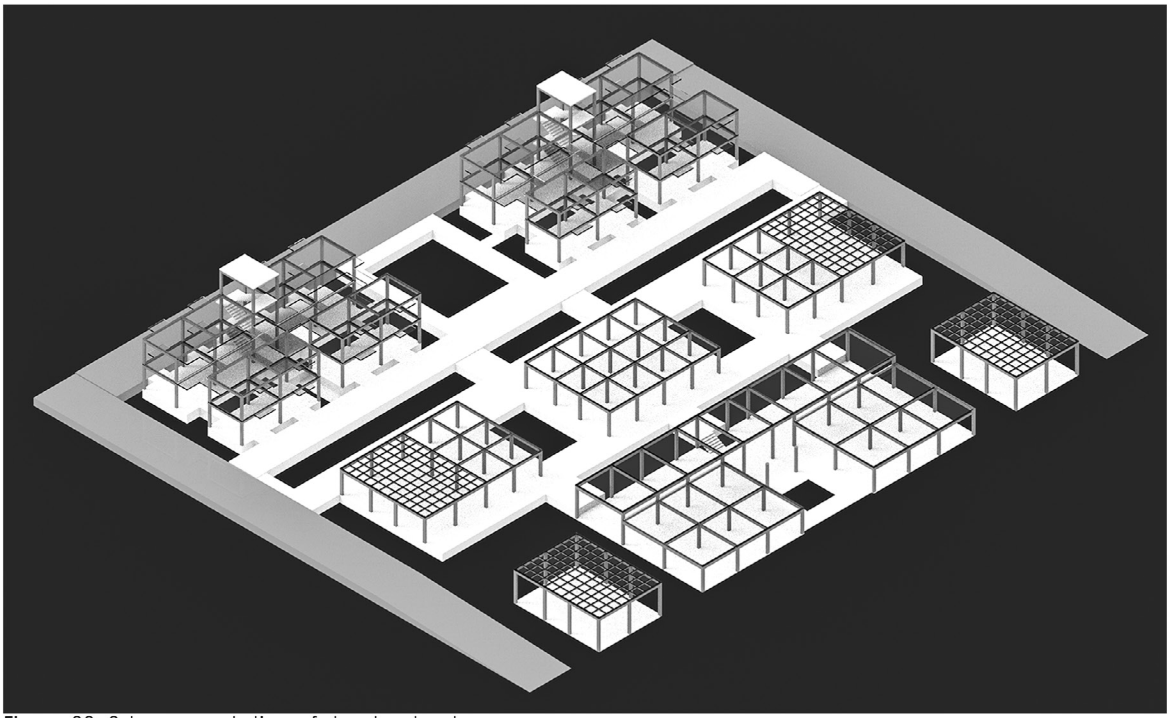


Figure 33- 3d representation of structural system

1)A rigid grid has been followed while designing the resilient center

2)The use of rigid grid system helps in decreasing the cost and time of construction.

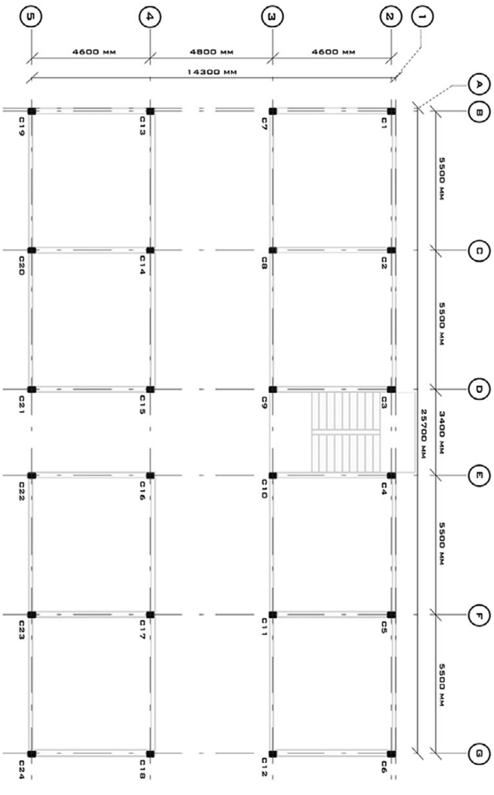


Figure 34- Grid system(Structural plan of stay unit)

ENGINEERING DETAILS

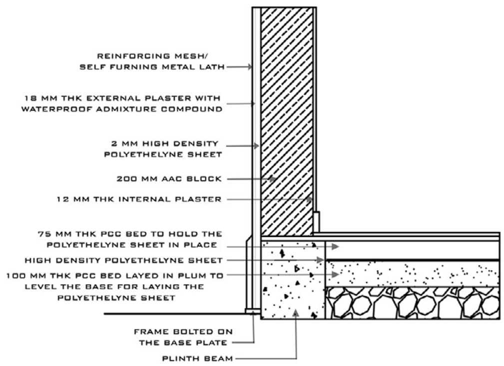


Figure35 -Section of wall

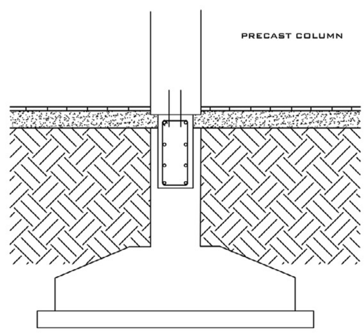
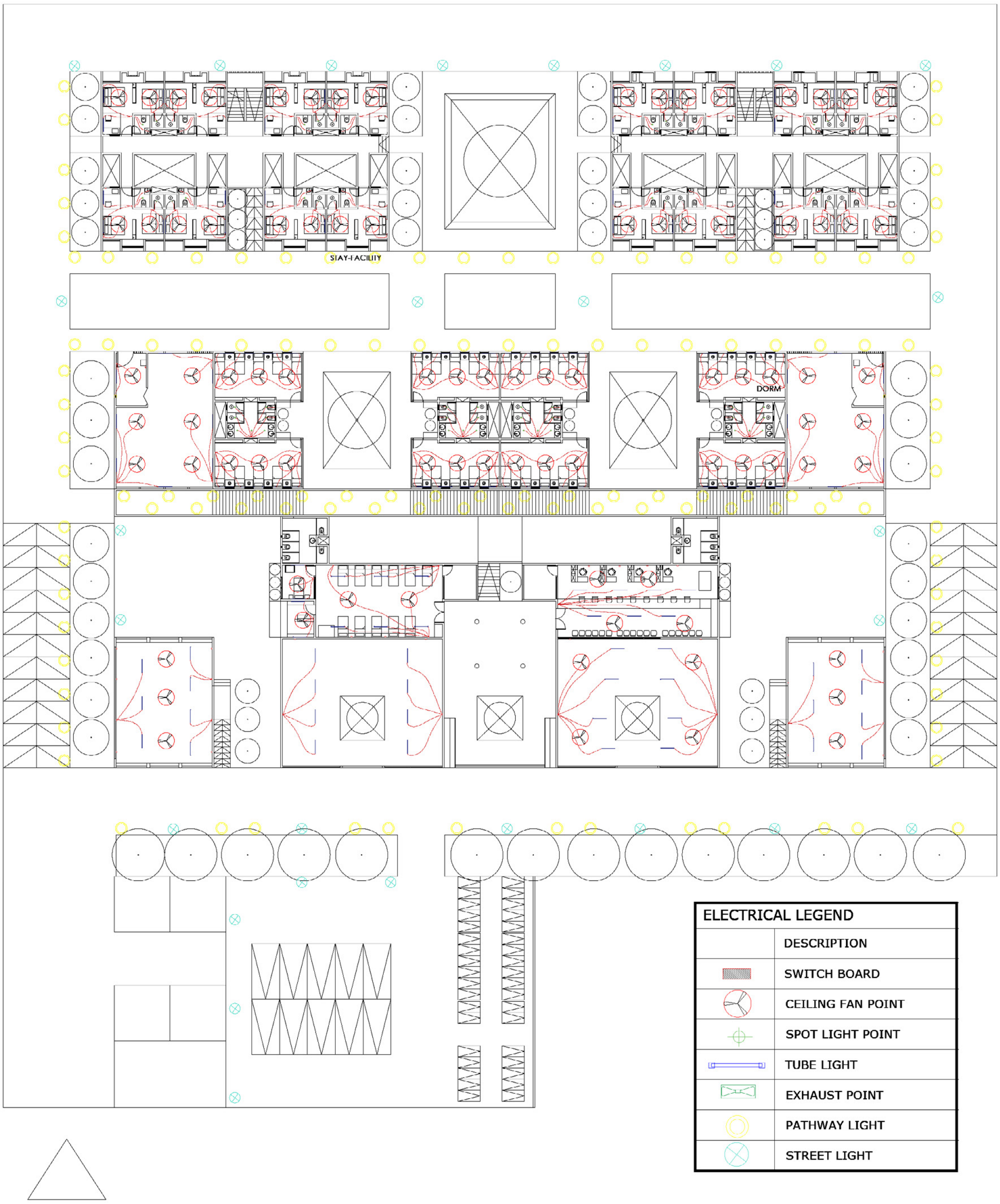


Figure36 -Column plinth details

9. ENGINEERING DESIGN AND OPERATION

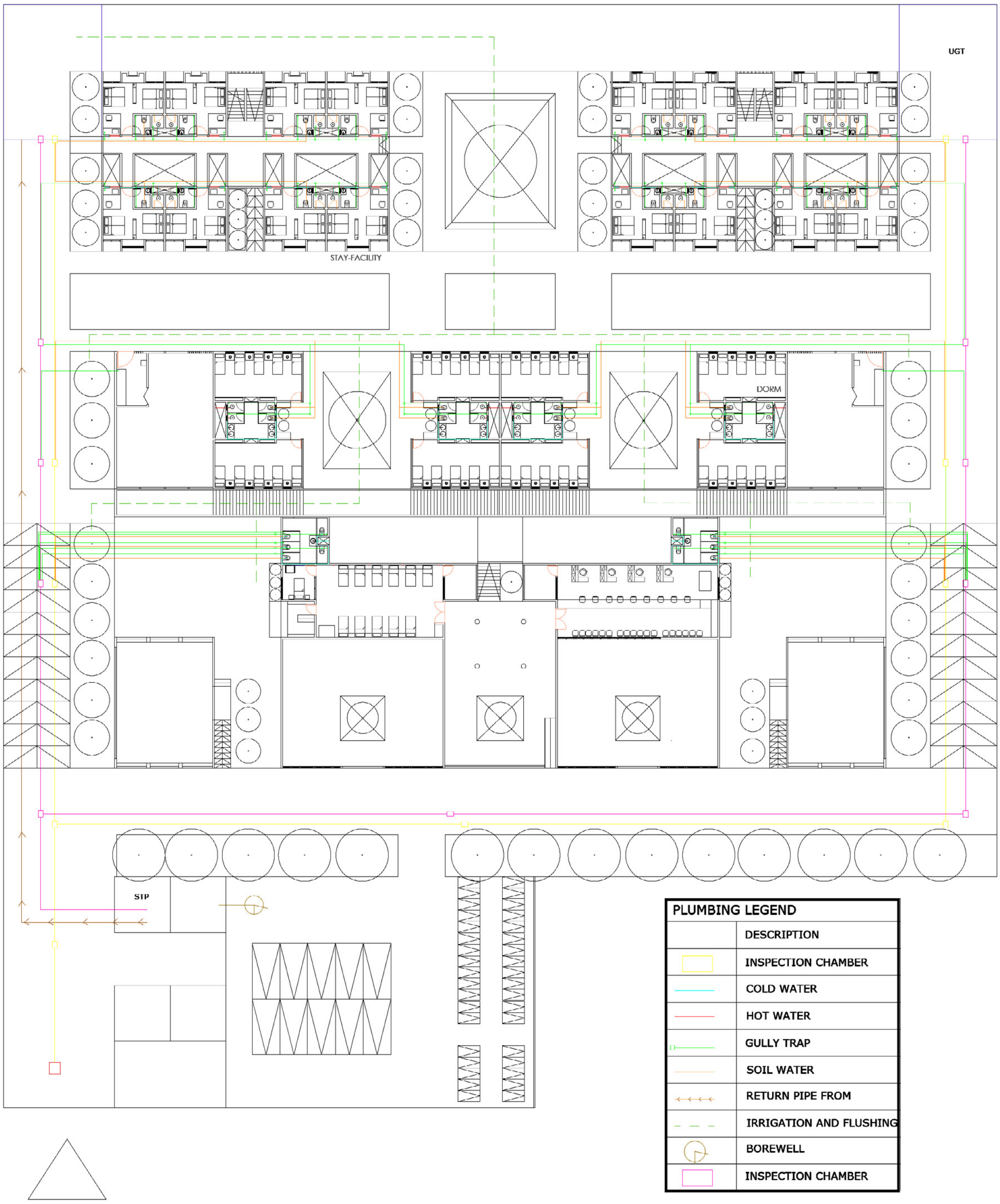
ELECTRICAL LAYOUT



NOTE:
To reduce the plug loads 4-5 star rated appliances were used.
High efficiency led lights are used which reduce the consumption of electricity upto 75% as compared to other tranditional lightings.
Main line is connected to Transformer and is supplied to electrical room which is ahead connected to the shelter.

2. WATER PERFORMANCE

PLUMBING LAYOUT



NOTE:
Grey water is circulated to sewage treatment plant located on site to be treated which is then further used for irrigation and flushing purpose.
As bio-digester toilets have been used extensively water requirement for flushing is reduced upto 75%
Water being the by-product of bio-digester toilet this water is filtered and stored for further use.

REFERENCES

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2. Indian Meteorological Department

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4. Indian Green Building Council

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6. Atomberg. (n.d.). Atomberg: Buy Energy Efficient Ceiling, Pedestal, Wall and Exhaust Fan. [online] Available at: https://atomberg.com [Accessed 13 Apr. 2021].

7. Crompton. (n.d.). Pumps (पंप) - Different Types of Pumps Online in India. [online] Available at: https://www.crompton.co.in/product-category/consumer-pumps [Accessed 13 Apr. 2021].