Solar Decathlon India

SVC CONSTRUCTIONS

IEM
INSTITUTE OF ENGINEERING & MANAGEMENT
Good Education, Good Jobs

AMAR

TEAM AMAR

'Final Design Report – April 2023'

Division:-Multi-family Housing

aspal Ashoka School of Planning and Architecture

CONTENTS

List of Tables

LIST OF FIGURES

Response to reviewer's comments

Summary of reviewers comments

- ❑ The passive design strategies need to be worked out. with this a detailed comparative to be worked out with respect to its workability.
- ➢ Based on the previous review we have worked on the passive energy systems and also worked on renewable energy with more practicality and suitable scenarios.
- ❑ Your need to work on the scope of the project with respect to the users and the number of potential users you intend to target.
- ➢ And this time we have considered all the income groups and the number of people living there.
- ❑ The information about the water cycle that you have mentioned is not necessary. the expected water cycle needs to have the understanding of how you are utilizing water and also the waste water for and on your site/for your project.
- ❑ And how are you reducing the water consumption from 120 LPCD ?
- ➢ We have mentioned how the water consumption is used in the building and how did we reach to net zero water consumption.
- ➢ And we have reduced the water consumption to 90 LPCD by using efficient fixtures.
- ❑ You need to mention the potential hazards or risks for your site and then give an appropriate mitigation plan for the same.
- ➢ Resilience is the ability to avoid severe calamity caused by natural disasters in a building or a surrounding neighborhood. Our goal is to create a resilient design that can withstand these disasters. various terraces and gardens are provided within the site and the buildings, which aid in breaking down the entire typical structure into smaller units. These terraces or open spaces contribute to increased thermal comfort as well as proper air circulation within the site.
- ❑ Try and quantify the systems or even a single innovative system which you are going to propose for the project. Show its workability and sizing for detailed understanding of the same.
- ➢ We have added the innovative systems which are used in this design and their workability.
- ❑ It is good that you mentioned the cost, but how will you prove the affordability? Comparison between materials for better affordability or so could be one such example.
- ➢ We made a base case and proposed case for our estimation.
- ➢ We showed different specifications of materials for EWS &LIG and MIG &HIG [which is in annexure]

- ❑ It is good that you have mentioned about the passive strategies and their impact on health & well being. Though you need to prove it through some thermal comfort models, simulations or calculations. Do ask your TRG and Teachers to help you in this regard
- ➢ As per the review we made the calculations of one base case and proposed case with thermal comfort models
- ➢ We did the calculation by taking ASHRAE-55 as consideration standards

- ❑ You have highlighted things correctly, but narrative between the project partner is missing. This could also be added.

- ➢ We divided the value proposition into two parts: Developer perspective and Client perspective and we mentioned the highlights of our design and showed how our project is different from others

- ❑ Mention the baseline case that is considered for the calculations
- ➢ We mentioned the baseline and proposed values
- ➢ We calculated carbon emission in materials and transportation.

EXECUTIVE SUMMARY

This project focuses on net-zero buildings, which are less common in the construction sector but are the way of the future. SVC Constructions, Architude, and Beardsell are our project partners, aim to provide their clients with affordable and sustainable homes. Commencing the design development with a strong concept and anchoring all decision on sustainability helped address the various contests. Below are some of the key conclusions.

Architectural Design: The inspiration for this project came from "sedimentary and volcanic mountains'" which epitomizes a microcosm which is complete in itself and self-regenerating/ replenishing. Understanding the ecosystem and the numerous traits and aspects of a mountain and then replicating the core values and ideas within the complex was the approach.

Energy : The final base EPI value after calculating is 107.3KWh/ye/m2 and 90.1% is generated on site. base case where as proposed EPI value after adding Passive and active technique if 15KWh/yr/m2

Annual generation from solar panel is 6,59,157 kWh/yr. The site has been introduced by water hydro turbine which generates 7,38,000 KWh/yr annually.

Water calculation: Only around 28% of municipal water (potable) is used annually, and the remaining 72% is satisfied by rainwater and recycled water, according to our calculations. To reduce water usage, we have Low flowrate fixtures. 90 LPCD of water each day is the quantity used in the proposed case.

Embodied Carbon: We have used less carbon-emitting materials in this project. The proposed design has decreased the carbon emissions by 3748 kg, or 24.6%, from the basic emission of 15320 kg. We calculated the carbon emissions from materials used in construction, excavation, manufacturing, and transportation of materials, as well as the carbon emissions from walls, roofs, structures, flooring, and fenestration.

Health and well-being : We performed the calculations and simulation using 'Climate Consultant' and 'CBE' tools to arrive at thermal comfort. Quik build construction technology is used to minimize the internal temperature by 7 degrees Celsius. Through this we were able to obtain a thermal comfort level between -0.5 and +0.5 which is in accordance with ASHRAE-55 requirements by applying passive ventilation techniques. The waste materials are created during building are reused elsewhere, such as tiles being utilized as pavement in public spaces.

Resilience : The main intent of the design was that it is *'safe to fail'* and has a *'no regrets'* plan in place. All the various potential risks are factored for the resilience strategy. The proposal includes the pre-disaster preparedness, designing a resilient strategy and post-disaster recovery plan as well.

Engineering and Operations and Innovation: The proposed design has employed cutting edge technology of using sensors for light, 5 star rated appliances, efficient water fixtures, humidity and moisture sensors for plants to ensure that there is energy and water savings for the project. It has also installed a hydro power generated using the adjacency to the nallah, solar panels/ water heater also for harnessing renewable energy. All this is proposed to be monitored through a smart application such that it ensures that the home owner and the maintenance team are sensitive of all the aspects of operations. Policy inputs for a maintenance manual is also recommended.

Affordability: The overall cost of the proposed case is 3.1% more than base case but this cost is recovered in 5 years. Quik built construction which reduces 10% cost compared to base case has a U value of 0.1 which is much less than base case thereby increasing efficiency both financially and through carbon emissions. 5-star appliances whose initial cost is 12% more than 3 star appliances but reduces energy consumption by 25% and in one year recover the extra cost.

Value Proposition: The ideal compromise between energy performance, thermal comfort, energy efficiency, innovative methodologies and affordability has led to the creation of the final design. In order to increase comfort, we made an effort to incorporate open areas/ terraces that let in natural light and air at various levels of the building. This boosted ventilation, minimized heat gain, improved day lighting and put in beautiful multi-level gardens in all the blocks in addition to serving as a gathering place for residents to socialize, these gardens also serve as a fire rescue zone. Green spaces are used as gathering places for the elderly, children, and others. Alternatively, they can be used as working areas as well.

TEAM SUMMARY:

a. Team Name : "AMAR"
Why Amar :Amar translates as eternal / never dies. It claims that it is constantly changing or getting better.
b. Institution Name : Ashoka School of Planning and Architecture, Hyderabad, Telangana.
c. Division : Multi-family Housing
d. Team members : AMAR is a group of 11 members from the Ashoka School of Planning, Architecture, and Engineering who have collaborated to create affordable and efficient building designs. The roles of our team members have been outlined in

TEAM MEMBERS :

Salman Pasha
Team lead
[Architectural Design]

K.V.K.Sirisha
[Water calculations]

Lokesh .Ellendula
[Innovation & Water calculation]

Mohammad
Energy calculations

Mirza Ali Raza
Affordability and Resilience

P.Abyudha
[Affordability & Value proposition]

Kavya. Devara
Affordability

Pooja .Pydipelli
Engineering & operations

Sahith .J
[Engineering & operations

R.Gopichand
Embodied carbons

Snaini .Joardar
[Engineering]

Supporting members

- Mohammed Khaleed Ahmed
- Mudragadda Karthik
- Navya sree Gubba
- Padamati Sahithi Reddy
- Naresh Konde
- Gowtham Ranadev kumar
- Cherith .Arshanapally
- Varun Heda
- Subhranhil Mukherji
- Soham Kundru

e. Approach :

- There are 10 people in Team AMAR. We come from various backgrounds in order to meet the requirements of the competition.
- We divide the workload among us to make it simpler for us while we compete in this event.
- We have reached out to a number of business partners who will offer their professional advice in order to accomplish our competitive objectives.

f. Background of the lead institution :

ASPA is a prestigious architecture college in Hyderabad that uses the best architectural education procedures to set the standard for architecture education. ASPA is a contemplative space for "Creative Learning." It is a place for students to discover their passion for architecture and to engage in an experimental learning process that will shape them into exceptional architects. The emphasis here is on Design Thinking and Architectural Design. The following is a list of technical classes that are organized.

•Energy Efficiency
•Water Efficiency
•Architectural Design and Development
•Innovation
•Affordability and Materials
•Structures and Building Construction

g. Faculty lead:

Ar. Anju Manikoth is a trained Architect from School of Planning and Architecture, New Delhi. She also has a post graduate diploma in Public Policy and Management from Indian Institute of Management Bangalore and a masters in Urban Management and Development from Erasmus University Rotterdam Netherlands. She has a specialization in Urban Land Governance. She has worked for the private sector and Non-government organizations and has over 13 years' experience.

Faculty Advisors

- Dr. MS. Raghavendra
- Prof. Gunjan , IEM kolkatta
- Prof. Balachandran
- Prof. Major Divya Pillai
- Prof. Kisley
- Prof. Harish Vangara
- Prof. Vinay
- Prof. Chandrakanth
- Asst Prof. Nabaneeta Sharma
- Asst Prof. Mounica Challa

h. Industry Partner :

ARCHITUDE

a) Architude

BEARDSELL

b) Beardsell

Fig.1 Industry Partners

Software's used in this project are:

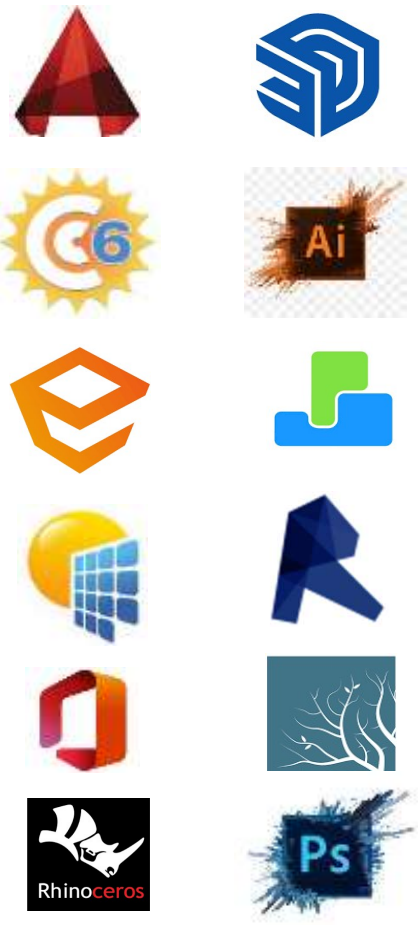


Fig.2 Software's

PROJECT SUMMARY

- Project name:- **Indraprastha**
- Project partner:- **SVC Constructions : Indraprastha** ,Suchitra, Secunderabad, Telangana.
- Site coordinates : 17°30'39.0"N 78°28'00.8"E
- Climate zone : Composite climate/ Warm and Humid
- Status of project: Yet to be completed
- Site area: **15,967 sq.m**
- Permissible ground coverage : **9,929 sq.m (** Setbacks of 7 meters from other sides and 8 m from the front/ road side has been taken as per the building height and the bye laws of the city of Hyderabad)
- Permissible estimated built-up area : **9,929X12=1,19,148 sq.m**
- Goal EPI : **28.6 KWh/year/m^2 - Achieved – 15 KWh/yr/m2**
- Preliminary construction budget : Cr. 130cr-150cr
- Timeline of the project – Three years

SPECIAL REQUIREMENT OF THE PROJECT PARTNER

- In house sewage treatment – Setting up of STP/ Water storage/ Electoral ministration & SWM.
- Water harvesting with zero discharge.
- Reducing carbon footprint- linking green spaces to pedestrian and bicycling networks- Green areas and landscape (at as many locations as possible).

S.NO	Particular	Baseline estimate	Proposed estimate
1	Land	68,00,00,000	[10%] 748,000,000
2	Civil work	[20-40%] 5,000,000,000	5,500,000,000
3	MEP services	[25%] 6,000,000,000	6,600,000,000
4.	Landscape and site development	[50%] 3,000,000,000	3,300,000,000
5.	Consultant [Architect and Engineers]	[6%] 9,00,00,000	[15%] 22,50,00,000

Table 1: Project Estimations

BUILDING AREA PROGRAMME-

Total site area- **15,967sq.m**

Total housing area- **13,967 sq.m**

Club house area- **2,000 sq.m**

Setback from abutting road side- **7.5m**
Setback from remaining **3 sides- 6m**

(Setbacks are taken according to go168 norms based on **building height** which is **36m)**

Total site area after setbacks- **11,165 sq.m**

- Total built up area- **11,165X40%=4,466 sq.m**
- Total landscape area with circulation- **11,165X60%=6,699 sq.m**

Total landscape area-**6,699 sq.m**

- Site circulation area- **6,699X40%=2,679 sq.m**
- Landscape area- **6,699X60%=4,019 sq.m**

Area of a each unit:-

Hig-**162sq.m** **(62** units)

Mig-**120sq.m** **(61** units)

Lig-**100sq.m** **(69** units)

Ews-**74sq.m** **(** 81 units)

$$\frac{\text{Total super built-up area- 30,705}\textbf{sq.m}}{\text{Total ground coverage area- }\textbf{4,466sq.m}} = \textbf{G+12 floors}$$

Condition and non-condition zones in the site-

- Note as it is a non-commercial residential area, we made sure that every space whether it is built up or an open space is well **ventilated and lighted with natural sources without any conditioned cooling.**
- Techniques like **venturi effect** and **wind catchers** are provided to ensure good thermal comfort interesting **mass and void** are to be created for better **lighting and shading**.

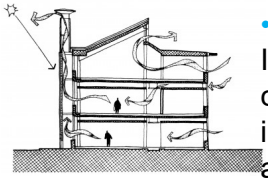
Fig.3 site ground coverage area

Note- the above image is only to understand the proportion of built up area, landscape and setbacks.

GOALS & STRATEGIES

- **Waste management-**

We aim for 70-80% less waste production during the construction stage, as the construction industry accounts for 30% of global waste.

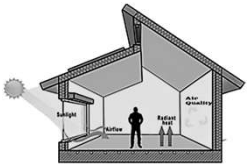


- **Design solution-**

Incorporating passive cooling techniques such as the Venturi effect, wind catching towers, self-shading envelopes, and perforated wall shadings into our design in order to make our building more energy efficient while also creating an interesting form.

- **Technical innovation-**

Reduce the water and electricity consumption/ wastage upto 60% by using sensor based water fixtures motion sensor based lighting fixtures and automated setting mechanism to prevent the unwanted wastage and usage of resources.

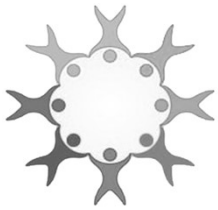


- **Care for user-**

Aiming to create a healthy environment and good thermal comfort to ensure the well-being of the user since most of the multi-family housing dol not have sufficient lighting, open spaces, fresh air flow and good ventilation etc., which leads to excess bacteria and germs which effects the users health.

- **Affordable**

Most of the time we see that in order to make the things affordable we compromise not only on sustainable features but also in aesthetic aspects so our goal is to create a sustainable housing complex while ensuring affordability so that the community is inclusive



- **Community**

An inclusive mixed class community is being proposed and designed to promote inclusivity, vibrancy and social interaction among the many user groups (regionally, religiously, and politically polarized groups). These open areas will be at various scales and levels to encourage activity between and within groups.

- **Landscape**

Utilizing landscape cover's full potential will maximize carbon sequestration, reduce the UHI effect, reduce soil erosion, increase biodiversity, and protect riparian ecosystems while promoting biophilia and emphasizing a diverse plant palette with a focus on native drought-tolerant plants, agroforestry, etc. This will also ensure outdoor thermal comfort, air purification, ground water recharge, human health, and wellbeing.

ENERGY CONSUMPTION OF ALL FLATS

ENERGY PERFORMANCE INDEX (EPI)

The total energy used in a building over the course of a year divided by the total built-up area in kWh/m2/year is known as the energy performance index (EPI). For the block model with orientation, massing, shading, and insulation of the building envelope optimized, a basic case is built in design builder. Since it is a residential building, occupancy is 24 hours a day. This design's basic case achieved an EPI of 241.62 KWh/yr/m^2•

Consumption of BLOCK A

Common Amenities = 3,27,828.9 KWh/ year

Common Equipment(Elevators and pumps):-Elevators=44,500.8KWh/year; Pumps=292 KWh/year

Total Annual consumption of common areas (Block A) = 3,72,621.7 KWh/year

Consumption of BLOCK B

Common Amenities = 4,24,036.5 KWh/year

Common Equipment(Elevators and pumps):-Elevators=66,751.2KWh/year; Pumps=584 KWh/year

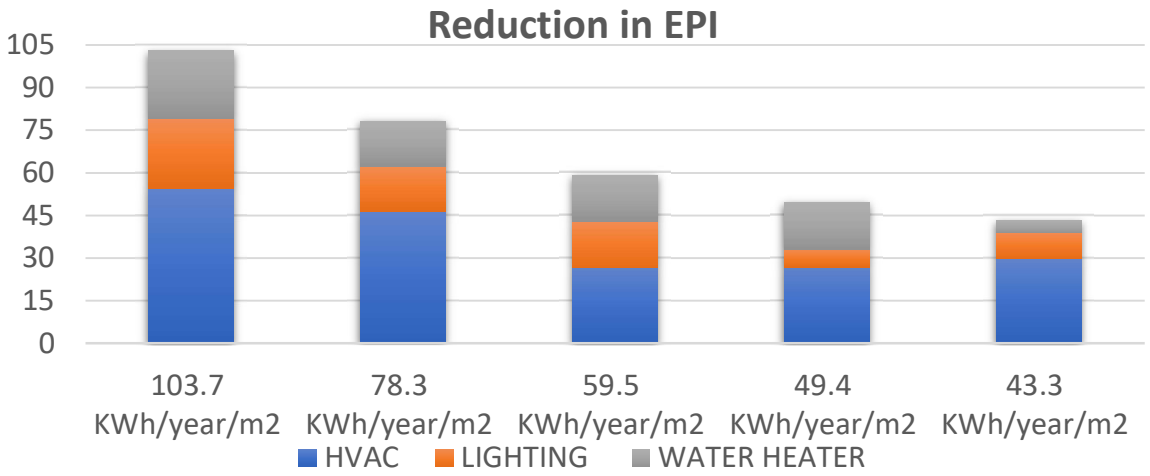
Total Annual consumption of common areas (Block B) = 4,91,371.7 KWh/year

Total annual consumption of common area = 8,63,993.4 KWh/year

EQUIPMENT	POWER INPUT	QUANTITY	RUNNING TIME	DAY CALCULATION	ANNUAL CALCULATION
T.V	80 W/h	305	7hrs	170.8 Kwh	62,342 Kwh
LIGHTS LED-TL	18w/h	1085	5hrs	97.650 Kwh	35,642 Kwh
LED-BULBS	10w/h	657	5hrs	32.850 Kwh	11,990 Kwh
FANS	70w/h	955	12hrs	802.2 Kwh	2,92,803 Kwh
AC	200w/h	330	5hrs	330 Kwh	1,20,450 Kwh
REFRIGERATION	350w/h	275	24hrs	2310 Kwh	8,43,150 Kwh
GYSER	500w/h	405	1hrs	202.5 Kwh	73,912 Kwh
EXHAUST	40w/h	770	5hrs	154 Kwh	56,210 Kwh
PLUG POINT	220w/h	1580	3hrs	1042.8 Kwh	3,80,622 Kwh
RICE COOKER	700w/h	775	1hrs	192.5 Kwh	70,262 Kwh
OVEN	2000w/h	190	0.5hrs	190 Kwh	69,350 Kwh
WASHING MACHING	2000w/h	190	1hr	380 Kwh	1,38,700 Kwh
WIFI MODERM	5w/h	190	24hrs	22.8 Kwh	8,322 Kwh
TV BOX	18w/h	190	6hrs	205.520 Kwh	91,439 Kwh
LAPTOP	90w/h	130	10hrs	117 Kwh	42,705 Kwh
CHIMNEY	150w/h	100	4hrs	60 Kwh	21,900 Kwh
			Total	**10,666.6 Kwh**	**23,20,217 Kwh**

Table 2: Annual consumption.

Tot.al Annual consumption of 12 floors = 23,20,217 KWh/year
Total Annual Energy consumption = Common areas + Housing units = **31,84,210.4 KWh/year Energy**
Performance Index of base case (EPI) = 31,84,210.4 / 30,705=103.7 KWh/year/m^2



Our major objective is to lower the EPI by at least 50%- 70% after obtaining an EPI of **103.7 KWh/year/m^2** for the basic case.
To start with, the common spaces are outfitted with energy-saving equipment that lowers the EPI by 4% which gets it to **99.5 KWh/year/m^2** Next, the HVAC systems were switched to RHEEM by "Sanicon Energy Solutions" 5star, Inverter Split AC from the 3 star AC, which reduced the EPI by 24% which is **75.6 KWh/year/m^2** Next, the use of efficient 5 star equipment and lighting further decreased the EPI by 17% which is **62.7 KWh/year/m^2** Finally, Solar water heaters were installed as a final step in place of the energy-intensive electric geysers, which helped to achieve the final EPI value of **56.6KWh/year/m^2** There is a need for solar water heaters because abundant of thermal energy of sun throughout the year.

DAYLIGHTING

- Using natural light is one of the most effective energy-saving strategies. Daylighting helps to save money by reducing the amount of artificial light required. As a result, optimal daylighting was considered from the start of the building design process.
- The building on simulating, has achieved 22.19 day light factor , which is further reducing the EPI of approx.11 % (**50.3KWh/yr/m^2**)

Note : for any further information please refer to annexure.

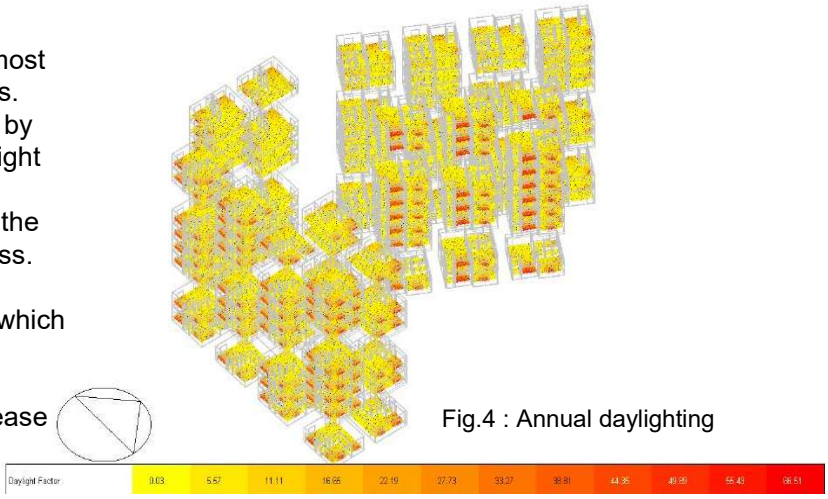


Fig.4 : Annual daylighting

ON-SITE RENEWABLE ENERGY - SOLAR PHOTOVOLTAIC

A solar PV plant is proposed to set up on 70% of roof of the building.
We have calculated the solar generation of the roof top of the building to maintain the our energy saving goal. Here also we take 70% of the area of club house. After calculating all of the parameters we got 42.6% of reduction percentage in energy consumption. The payback period in 6.8 years.
Annual generation of RE = **6,59,157 kWh/yr.**
Reduction of = **42.6%**
Area required for the generation of RE = **3376 M^2**
EPI of the project **= 50.3 KWh/yr/ m^2**
EPI after reduction of 42.6% = **28.8 KWh/yr/m^2**
Note : for any further information please refer to annexure.

Fig.5: Solar panel layout

AMAR

ENERGY CONSUMPTION

GRAVITATIONAL WATER VORTEX MINI HYDRO TURBINE

A gravitational water hydro turbine plant is proposed to set up on the NAALA at south west of the site.

The gravitational water hydro turbine which can generate 410kWh/day are being installed at the edge of the NAALA

6 No. of system is being proposed which can generate up to **7,38,000 kWh/yr.**

The system operate as follows:

Naala water is channeled at the bank of the naala and conveyed to a circulation tank. This circulation tank has a circular orifice at its base. The combination of localized low pressure at the orifice and the induced circulation at the tangential entry influences strong vortex flow.

Potential energy is entirely converted to rotational kinetic energy at the vortex core. This is then extracted by means of a vertical axis turbine.

Water is then returned to the river through the tail race.

Power output and efficiency

Power output and efficiency The maximum hydraulic power output of the turbine is given by:

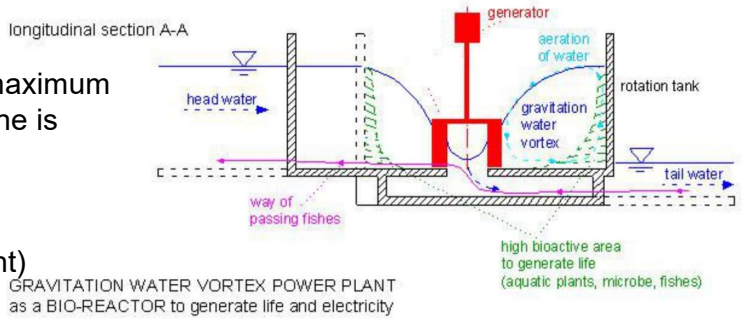
P = r.g.Q.Hv watt

r = 1030 kg/m2 (water density)

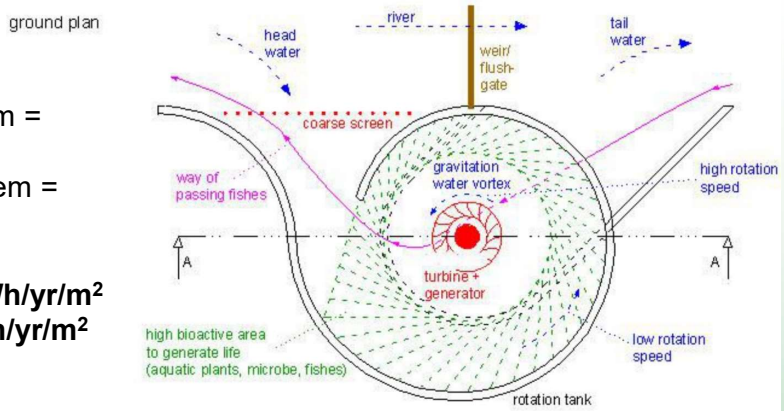
g = 9.8 m/s2 (Gravitational constant)

Q = 1.2 m3/s (water flow rate)

Hv = 1.7 m (hight of the vortex)



GRAVITATION WATER VORTEX POWER PLANT as a BIO-REACTOR to generate life and electricity



P = 20,591.76 W

Annual generation from one system = **1,23,000 kWh/yr.**

Annual generation from 6 no. system = **7,38,000 kWh/yr.**

Reduction of = **47.7%**

Final epi after reduction = 15 KWh/yr/m²

Final EPI of the project = 15 KWh/yr/m²

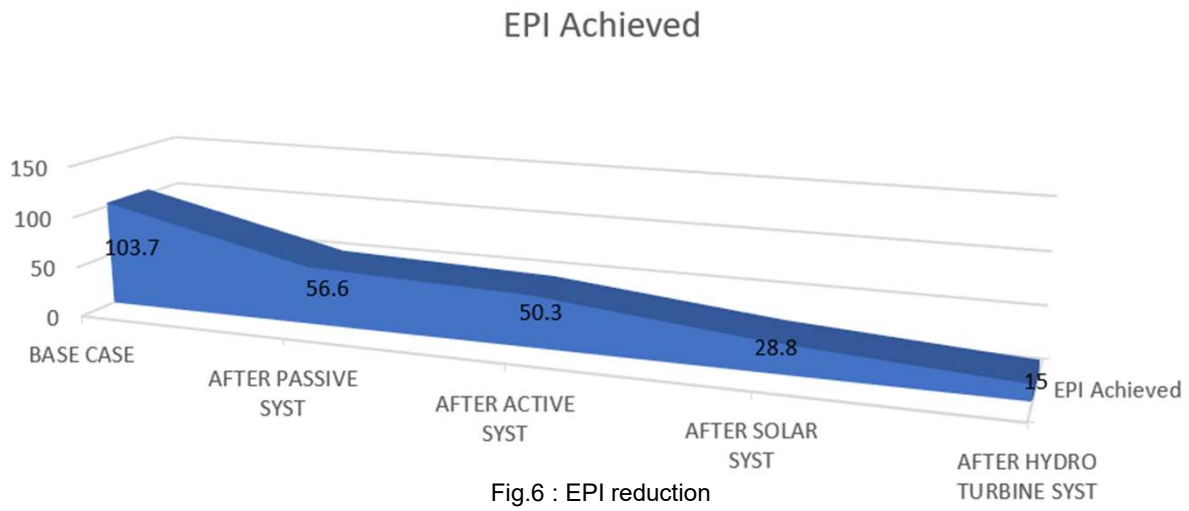


Fig.6 : EPI reduction

ARCHITECTURAL DESIGN

RECREATIONAL SPACES

Architectural Design

Design has the potential to make a good impression by being aesthetically and visually pleasing while also being efficient and sustainable. Good architectural design also has the potential to make a person feel comfortable, at peace and inspired. In recent times, in urban areas, the need/ demand for housing has gone up manifold. Providing a good design solution for housing can significantly improve the quality of lived experience of the residents alongside being safe, resilient and sustainable. Through this project the attempt of the team is to create a design that is aesthetically balanced, green and sustainable. Besides design, another important aspect in this project is that the complex is host to mixed income groups by having housing for economically weaker sections as well as high income groups. Being inclusive and abiding with the idea of 'Right to the city' and providing an inclusive housing solution with good architectural design is at the core of the project.

About the Project

The project is a MULTI-FAMILY HOUSING PROJECT on a site of 4.5 acres near Suchitra, Hyderabad, India. A total of 275 units for mixed income groups are designed which has a composition of 30% HIG 40% MIG 20% LIG and 10% EWS. Besides the housing, a club house for recreational purposes is also provided within the housing complex.

Areas of each unit are as follows

HIG -149.1	81 units	40%
MIG -93.6	110 units	30%
LIG-79.6	56 units	20%
EWS -63	28 units	10%

In Hyderabad, all projects follow the local bye-laws of GO 168. Besides the GO, other standards that were referred are Time saver standards and National Building Code. All standards of setbacks, fire safety norms etc. are taken from the above.

CONCEPT(MOUNTAINS AND THEIR ROLE IN ECOSYSTEM)

The design development of project is anchored on a concept. A concept design provides an overall theme and a direction for each decision that will be taken in the development and construction of the project. A good concept will anchor the design, reduce thinking in the future stages of the development and ensure there is cohesiveness and synergy between the various components of the project. In this project, the inspiration is being derived from **a 'sedimentary and volcanic mountains**'. The core idea is to understand the ecosystem and the myriad aspects/ features of a mountain and thereafter emulate the same within the complex. A mountain is extremely sturdy/ **depicts stability**, have an **independent ecosystem** and **thrives with life** (both flora and fauna) alongside having a huge impact on climate both locally and regionally.

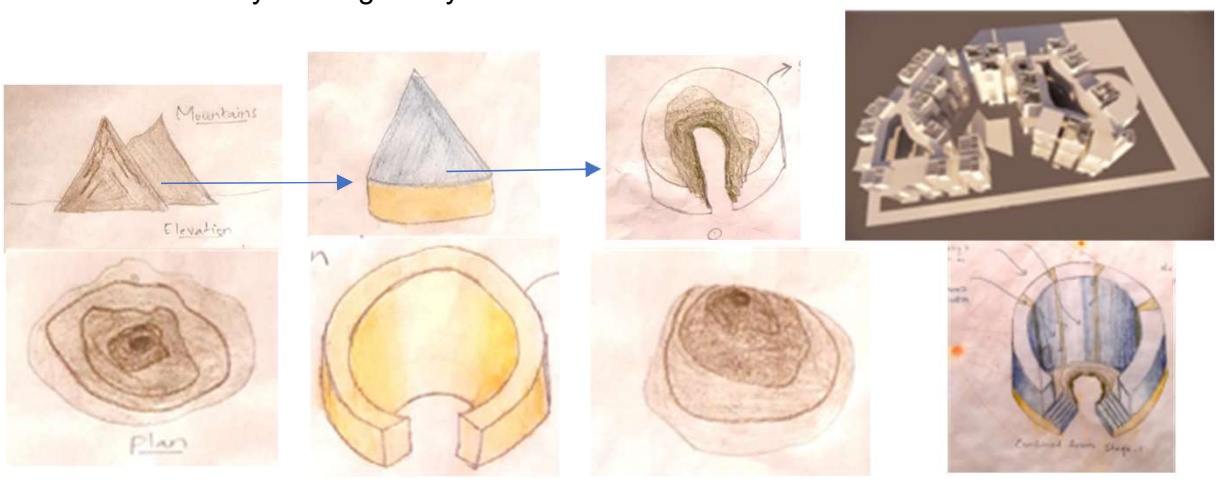


Fig.7 Concept

Having anchored our design on the concept, the team undertook the design development in various stages. While the final output has evolved from the initial idea, the integrity of concept has been maintained. Some of the main aspects that are in line with the main concept are that all the units receive adequate light and ventilation and access to green terraces (for social interaction, space for the elderly to relax and children's play areas) at higher levels. The total built mass is divided into 3-part block A consists of LIG and EWS housing units and block B consists of HIG and MIG units and a clubhouse for both the blocks is included. The rest of the remaining area is maintained as an open lawn for group gathering, events, sports/ playing and other physical activities. The areas of each floor are mentioned below.

Key Design Features –

Fig.8 Site plan

Site Planning: Adequate light and ventilation is paramount for a human being without which there is a possibility of putrefaction. The master planning for the site is undertaken keeping in mind the climatology of the region. The orientation of the blocks and the location of the units is designed to maximize adequate ventilation and minimize the harsh south-south-west sun. Most of the units are oriented in the northwest-southeast direction which brings in the morning sun into the units are minimizes the afternoon sun. This orientation also facilitates in maximizing daylight while minimizing heat gain. Besides the above, through site planning various amenities are also provided for the community and are listed below.

- Play area for kids consists of EPDM flooring, sand pit, half basketball court.
- Outdoor fitness – Open gym and Zen/Taichi/yoga
- Sit outs – open, semi open, closed
- OAT
- Planter boxes with seating and pocket gardens

Terrace gardens: The terraces serve multiple agendas in that it firstly aids in breaking down a typical high-rise structure into smaller units, which in turn creates smaller openings, aiding in proper airflow within the building. Secondly, it is a humanizes the scale for an individual without making them feel small.

•Thirdly, it acts as a leisure space for toddlers, children and elderly alike. The terrace is closer to their housing units and is safer for the young and the elderly to access green spaces at their levels. These areas are used as gathering spots for people to engage and foster a feeling of community.
•Finally, the terrace also acts as a strong building element for passive cooling through cross ventilation alongside creating a micro-climate that is cooler through evapotranspiration.

Fig.9 Landscape views

Inclusive Design: Having an inclusive settlement was central to the design brief. This design solution has allocated one tower to the LIG-EWS category and the other for MIG-HIG category. While the HIG class of people prefer their privacy, they definitely require and access services from the EWS class of people. Therefore, separate blocks ensured that they different class groups are close enough yet have their own private spaces.
Furthermore, the **specifications** of the two blocks are also different and are designed to cater to the price range of each group. Please refer to affordability section to analyze the price variation.
Reduce – recycle – reuse is another important strategy employed in the design development. For instance, the flooring of common areas will be terrazzo flooring using the various waste materials of tiles that have been generated during construction.
Renewable energy: Solar water heaters and solar panels are installed in the roof for harnessing clean energy and will be stored in the batteries as backup. About 6,59,157 KWH is being generated through the panels and will be sent back to the grid. The team explored the possibility of installing micro wind mills on the roof, but unfortunately, the wind speed in the location is only about 8kmph which is insufficient for the operation of the same.
Façade and shading units: To shelter the structure from direct solar radiation and to reduce heat gain during the summer months, each unit has its own tiny terrace garden, which also serves as an aesthetic to the building's elevation. Detailed plans are available in the annexure. The wall- window ratio is about 30% and this also helps in optimizing the heat gain and thermal comfort.

Conclusion: The Architectural design has been undertaken with a strong concept and has addressed all the possible aspects for a comfortable and inspired living. Commencing from a strong architectural language which is anchored in a sustainability as a vital component, the team has attempted to hold the integrity of the concept to the last detail of a planter. Aspects of inclusive community, having open community spaces that are closer to the units, including renewable energy and undertaking reuse- reduce and recycle makes this project cutting edge while being sensitive to the needs of humans and the planet alike.

MIG unit

HIG unit

LIG unit

EWS unit

SECTION

BLOCK-B PLAN

3D VIEW

Fig.10 Drawings

WATER PERFORMANCE

India uses a lot of water, but the amount that is available is getting less and less. According to CPHEEO standards, the per capita demand for this project is 135 LPCD. By using efficient water fixtures, treating the water before reusing it, and even harvesting rainwater, we were able to reduce this demand to 90 LPCD (Annexure number - Chapter 2 (table 2.1)

Housing typology	No of units	People per unit	Total people
1-bhk [ews]	81	3	243
1-bhk [lig]	69	3	207
2-bhk	61	5	305
3-bhk	62	6	372
		Total Occupants	1127

Total Occupants	1127
Full time carer taker	60
Part time care taker	60
Total	120
Grand total	1247

Table 3:Total no.of people

Water	Use	Litres per day	Quantity [L]	Days
Portable water	Drinking	5	5,885	365
	Cooking	5	5,885	365
	Bathing	40	47,080	365
	Washing clothes	20	23,540	365
	Washing utensils	4	4,708	365
Non portable water	Flushing	6	7,062	365

Usage	Block 1	Block 2	Total	Days	Total
Maintenance	5,254	6,912	12,166	365	44,40,590
Landscaping/ gardening	1,706.50	4,991.10	6,697.60	365	24,44,405.00
Total water required					68,84,995

The average per capita consumption per day is 90 L which includes maintenance & landscaping usage of water.

Detailed usage of portable and Non-portable water

Base case -1 (135 LPCD considered)

Types of person	Annual total water need	Daily total water need	Total water need	Potable water	Grey water	Flushing water	Number	Days
Residents	5,55,32,925	1,52,145	135	20	60	55	1127	365
Care taker full time	29,56,500	8,100	135	20	60	55	60	365
Care taker	13,14,000	3,600	60	20	60	55	60	365
Guest	59,13,000	16,200	135	20	60	55	120	365
	6,57,16,425	1,80,045	Total					

Annually		
TP	TG	TF
82,27,100	2,46,81,300	2,26,24,525
4,38,000	13,14,000	12,04,500
4,38,000	13,14,000	12,04,500
8,76,000	26,28,000	24,09,000

Base case -2 (120 LPCD Considered)

Types of person	Annual total water need	Daily total water need	Total water need	Potable water	Grey water	Flushing water	Number	Days
Residents	4,93,62,600	1,35,240	120	7	58	55	1127	365
Care taker full time	26,28,000	7,200	120	7	58	55	60	365
Care taker	6,57,000	1,800	30	7	58	55	60	365
Guest	52,56,000	14,400	120	7	58	55	120	365
	5,79,03,600	1,58,640	Total					

Annually		
TP	TG	TF
28,79,485	2,38,58,590	2,26,24,525
1,53,300	12,70,200	12,04,500
1,53,300	12,70,200	12,04,500
3,06,600	25,40,400	24,09,000
34,92,685	2,89,39,390	2,74,42,525

Design case (90 LPCD Considered

Types of person	Annual total water need	Daily total water need	Total water need	Potable water	Grey water	Flushing water	Number	Days
Residents	3,29,08,400	90,160	80	10	64	6	1127	365
Care taker full time	17,52,000	4,800	80	10	64	6	60	365
Care taker	3,28,500	900	15	10	64	6	60	365
Guest	35,04,000	9,600	80	10	64	6	120	365
	3,84,92,900	1,05,460	Total					

Annually		
TP	TG	TF
41,13,550	2,63,26,720	24,68,130
2,19,000	14,01,600	1,31,400
2,19,000	14,01,600	1,31,400
4,38,000	28,03,200	2,62,800
49,89,550	3,19,33,120	29,93,730

Total water required Annually (liters)	38492900
Maintence and landscaping water required	6884995
Total water required (Annually)	45377895

Table 4 : Total water consumption

Water Efficient Fixtures

We proposed efficient water fixtures and water efficient systems in our project. These fixtures have comparatively less water flow rate than conventional fixtures that allowed us to maintain 80 L as average per capita water consumption per day.

Low Flow Fixtures				Baseline Case		New Case 1 (Waterless Urinals + New Closets (reduced flow rate)		New Case 2 (Waterless Urinals + New Closets (reduced flow rate)		New Case 3 (Waterless Urinals + New Closets (reduced flow rate)	
Fixture Type	Duration per use (in minutes)	Daily uses (per person/ day)	Occupants	Flow Rate / Capacity (in LPF/ LPM)	Daily Water Use (litres)	Flow Rate / Capacity (in LPF/ LPM)	Daily Water Use (litres)	Flow Rate / Capacity (in LPF/ LPM)	Daily Water Use (litres)	Flow Rate / Capacity (in LPF/ LPM)	Daily Water Use (litres)
Water Closets	1 Flush	1	1127	4	4,508	4	4,508	4	4,508	4	4,508
	1 Flush	3	1127	3	3,381	2	2,254	2	2,254	2	2,254
Health Faucet/Bidet, Hand-held spray	0.25	1	1127	4	4,508	6	6,762	3	3,381	1.75	1,972.25
Faucet	0.25	4	1127	4	4,508	6	6,762	3	3,381	1.75	1,972.25
Kitchen Sink	0.25	3	1127	5	5,635	6	6,762	3	3,381	1.9	2,141.30
Showerhead /Hand-held Spray	8	1	1127	10	11,270	8	9,016	8	9,016	4	4,508
Total Daily Volume (litres per day)					33,810		36,064		25,921		17,355.80
Annual Usuage (litres per year)					1,23,40,650		1,31,63,360		94,61,165		63,34,867
Percentage water savings annually (%)							6%		24%		49%

Recycle and Reuse strategies

In this project, we included waste water treatment system of two stage sludge treatment plant to recycle both grey water and black water that is discharged by housing units.

Also, the rain water is collected through Roof catchment, Recharge pits, Rain water gardens, Ditches, French drains etc. and is then treated. This treated water is then reused for different activities like flushing ,car washing, gardening, maintenance, etc. The harvested rain water calculations are mentioned below tables.

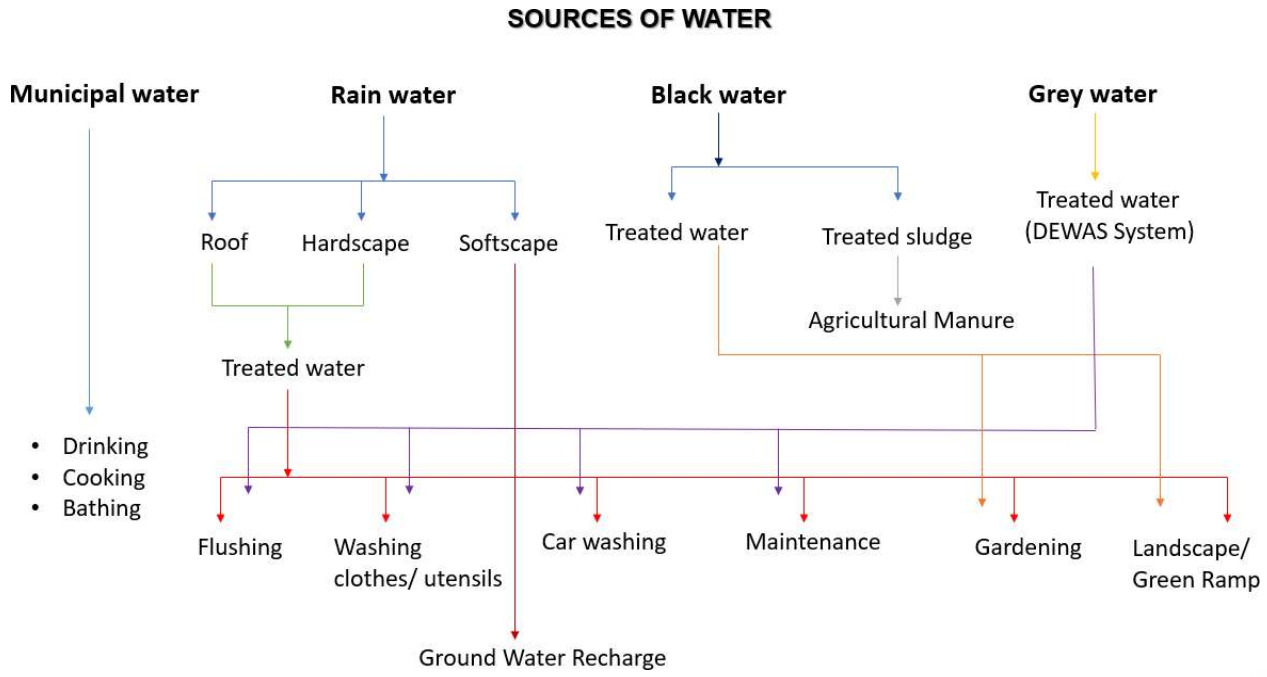
Month	Average rainfall [mm]	Roof catchment (y)	Rainfall on site	Ground water recharge(10%)	Surface runoff [5%] (c)	Treatable water	Total harvested rain water (x+y)
		3 towers] (lpm)	(a)	(b)	(lpm)	(x = a-(b+c)) (lpm)	(lpm)
			(lpm)				
January	10.9	49654.95	174040.3	12438.535	6219.2675	105727.5475	472465.95
February	8.2	37355.1	130929.4	935.743	4678.715	87959.842	355433.1
March	18.9	86098.95	301776.3	2156.735	1078.367	212442.25	819229.952
April	20.9	95209.95	333710.3	23850.035	11925.017	202725.3	905920.952
May	31.6	143953.8	504557.2	36060.34	18030.17	306512.89	1369717.8
June	116.3	529804.65	1856962.1	132715.745	66357.872	1128030.833	5041028.65
July	170.6	777168.3	2723970.2	19468.019	9734.009	1917599.88	7394742.308
August	190.4	867367.2	3040116.8	21727.496	10863.748	2140158.356	8252983.2
September	114.1	519782.55	1821834.7	130205.215	65102.607	1106744.328	4945721.55
October	108.5	494271.75	1732419.5	123814.775	61907.387	1052425.59	4702986.752
November	26.1	118898.55	416738.7	29784.015	14892.007	253164.128	1131317.55
December	5.3	24144.15	84625.1	6048.095	3024.047	51408.808	229731.15
Total annual rain water harvested (liters)							35621278.91

Table 5:Water flow rate per min for conventional and efficient water fixtures

We have a naala on the south side and the flow of it is also not so good enough to use it for a portable water.

WATER BALANCE

Municipal water and the treated waste water are the two sources of consumption water in this project. As per our calculations, only about i.e.45KLD, of total consumed water is taken from the municipal corporation and the rest is fulfilled by rain water and recycled water for this project.



Month	Total Consumed water(lpm) (y)	Municipal water (45klpd) (lpm)	Total Harvested rain water (lpm)	Treated Grey water (lpm)	Treated Black water (lpm)	Alternate water (lpm) (x)	x/y
January	34,79,130	1395000	472465.95	2860618	231942	4960025.95	1.42
February	31,42,440	1260000	355433.1	2583784	209496	4408713.1	1.4
March	34,79,130	1395000	819229.952	2860618	231942	5306789.952	1.52
April	33,66,900	1350000	905920.952	2768340	224460	5248720.952	1.55
May	34,79,130	1395000	1369717.8	2860618	231942	5857277.8	1.68
June	33,66,900	1350000	5041028.65	2768340	224460	9383828.65	2.78
July	34,79,130	1395000	7394742.308	2860618	231942	11882302.31	3.41
August	34,79,130	1395000	8252983.2	2860618	231942	12740543.2	3.66
September	33,66,900	1350000	4945721.55	2768340	224460	9288521.55	2.75
October	34,79,130	1395000	4702986.752	2860618	231942	9190546.752	2.64
November	33,66,900	1350000	1131317.55	2768340	224460	5474117.55	1.62
December	34,79,130	1395000	229731.15	2860618	231942	4717291.15	1.35

Total consumed water is 4,09,63,950 and by using efficient fixtures - 63,34,867 We get 3,46,29,083 which is total consumed water.

Storage

In this project we proposed six different underground tanks for both portable and non-portable water , where all these are placed at different places in the site.

As per our calculation, only about 25% of total consumed water is taken from the municipal corporation and the rest 75% is fulfilled by rain water and recycled water.

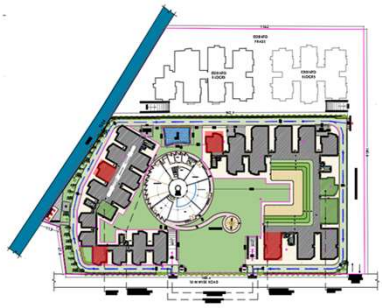
Tank Typology	Area of the tank (cu.m)	Dimensions (m)
Municipal water	45	5x2.5x4
Harvested rain water	29129	40x30x25
Recycle water	4551	10.5x7.5x7.5 (2 nos)
Fire tank	300	8 X 8X 5
Solar water heater	25	

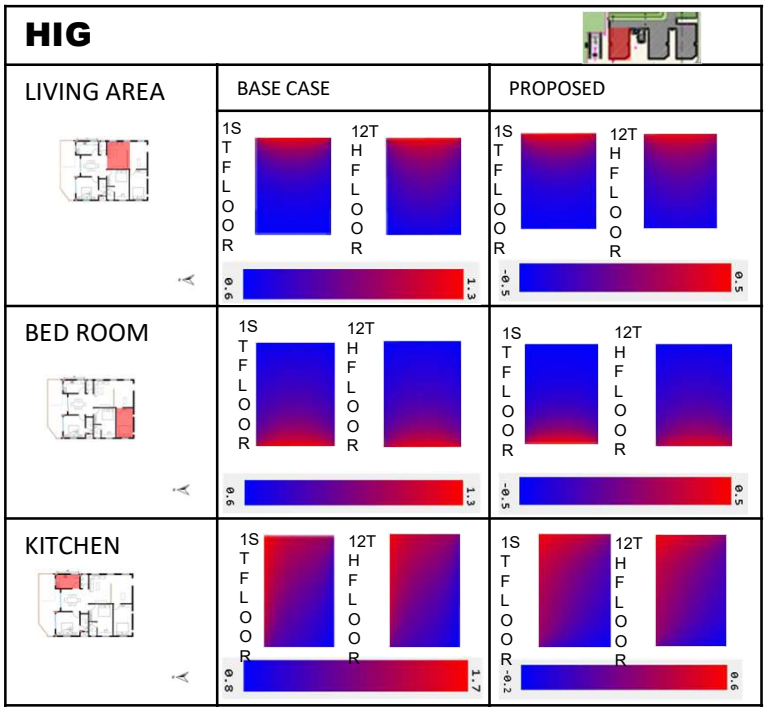
HEALTH AND WELL BEING

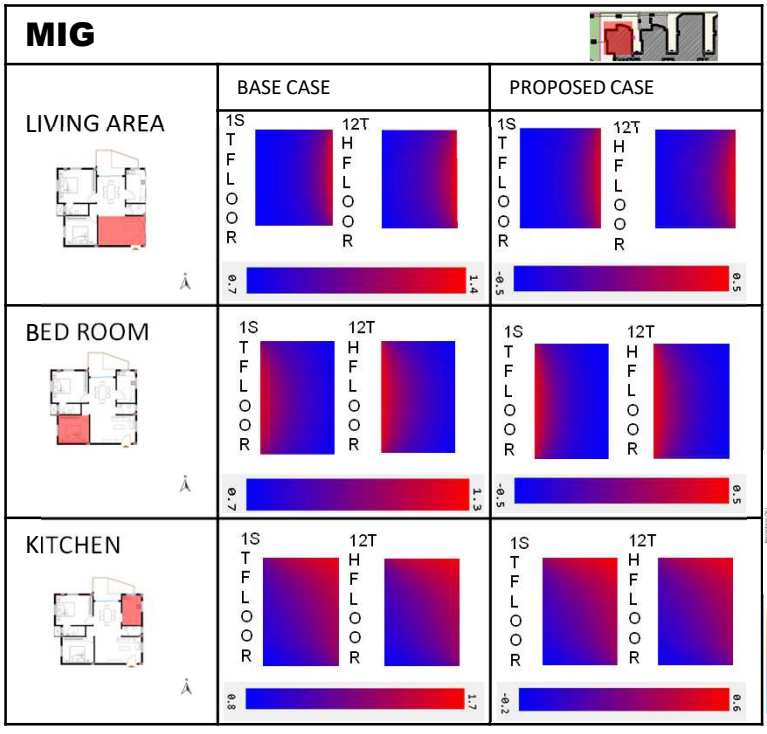
THERMAL COMFORT

ANALYSIS OF THERMAL COMFORT

According to ECBC 2017 ,Hyderabad falls under Climate Zone 2 as per ECBC, which is classified as a warm and humid climate zone. This means that buildings in Hyderabad must comply with the energy efficiency standards set out in the code for this climate zone.

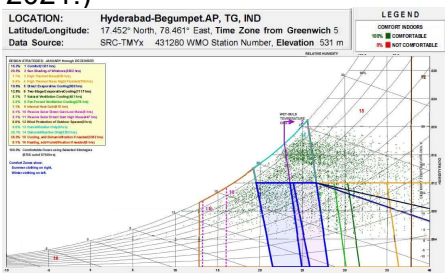




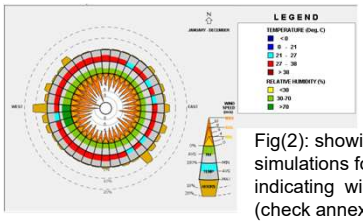


showing simulations of spaces in terms of PMV

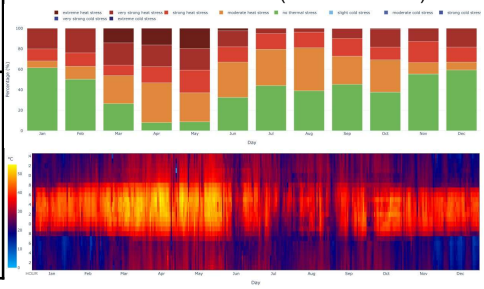
We took the units situated in all the directions so that we could cover all the units in the project and then we calculated the clo and met of the occupant based area specification. To achieve thermal comfort we need to go through researches, data collection and simulations to know the required thermal comfort of that particular area the data collection consists of PMV and PPD analysis ,wind analysis, heat analysis and sun shading chart. The weather data of Hyderabad is taken from EPW file of Hyderabad (IND_TG_Hyderabad-Begumpet.AP.431280_TMYx.2007-2021.)



Fig(1): showing Psychometric chart (check



Fig(2): showing simulations for indicating wind wheel (check annexure)



showing simulations for indicating heat map(check annexure)

AMAR

Slide 23

GU0 General Write up khaleed change it to the goal of choosing the units for simulation, Just the para make it shorter and add some info about clo and met

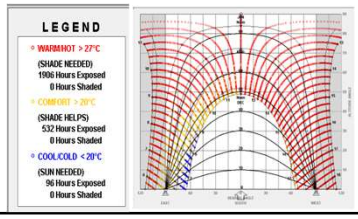
Guest User, 2023-04-23T08:45:44.952

HEALTH AND WELL BEING

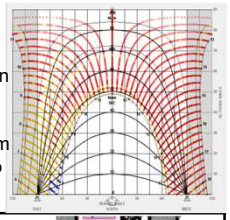
THERMAL COMFORT

ANALYSIS OF THERMAL COMFORT

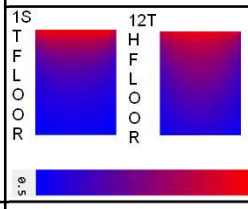
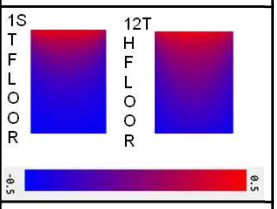
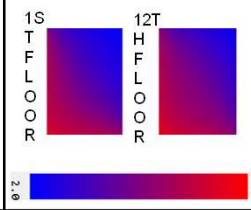
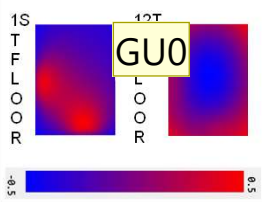
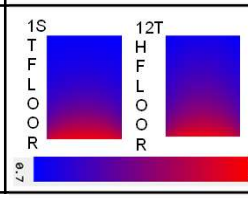
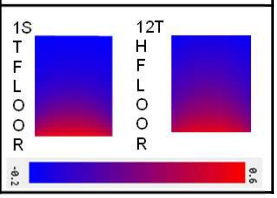
Fig(4a): showing simulation for sun shading chart from dec 21 to Jun 21 (check annexure)



Fig(4b): showing simulations for sun shading chart from Jun 21 to dec 21



LIG

	BASE CASE	PROPOSED CASE
LIVING AREA		
BED ROOM		
KITCHEN		

EWS

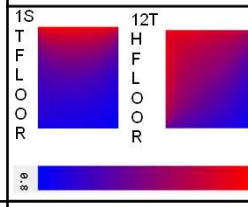
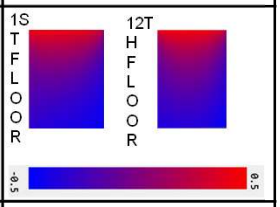
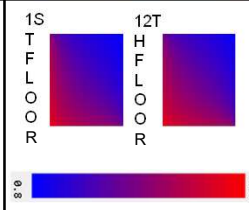
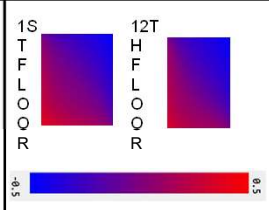
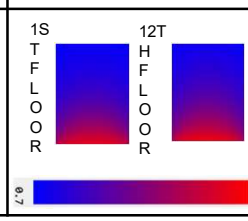
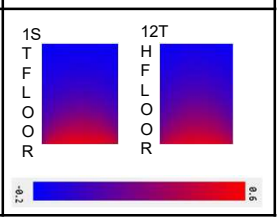
	BASE CASE	PROPOSED CASE
LIVING AREA		
BED ROOM		
KITCHEN		

Table: showing simulations of spaces in terms of PMV

Moving on to the calculation part
We had done all the calculations according to the standard ASHRAE-55
Which gives guidance on the acceptable temperature, humidity, air movement, and radiant temperature for different types of indoor spaces.

Now, in this project we had one base case and one proposed case ,in both cases we took the units where we are more likely to have more radiation of sun compared to other units in all directions.

In base case we were not getting the required thermal comfort level as per ASHREA-55.

Then in proposed case we used a construction technique called **Quik Built,** which is more economical, has more resistance and reaching the required thermal comfort level, by reducing 7degrees of indoor temperature compare to the traditional technique used in construction industry.

Slide 24

GU0 This I feel is correct because Rest sides should be cooler in the room, While the top floor is exposed so the red is equally spread out due to equivalent amount of heating through the mass of the envelope
Guest User, 2023-04-23T08:20:49.170

GU0 0 @Khaleed
Guest User, 2023-04-23T08:21:06.795

GU0 1 Recheck the simulation once if you get out of time let it be...
Guest User, 2023-04-23T08:22:40.845

WASTE MANAGEMENT DURING CONSTRUCTION

As the Construction works generates more than 30 percent of global waste. By using 3R's –REDUCE,RECYCLE AND REUSE options to minimize the waste production in our project.

In our site we designate a specific area to collect and segregate the possible construction waste materials for later reusing in the site. Typical construction debris in dwelling units include bricks, steel bars, broken tiles, glass, wood waste etc.,

• cement mortar waste can be reused for backfill or levelling purpose within the site.

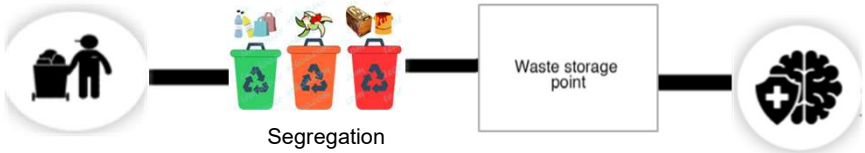
•Steel scrap, broken glass, aluminium waste paint cans is sold to the scrap vendor.so, that vendors will reuse for manufacture purpose.

•Shuttering waste which is used in the project is send to the project partner [svc constructions].

•Tile scrap is used as Chinese mosaic flooring in common areas.

•The approximate quantities of waste we get at the time of construction in each material is given below ;

- Wood – 68.82sq.m
- Glass – 407.2sq.m
- Tiles - 70,630.75sq.m



Solid waste Disposal Diagram

Waste collection and Transportation System

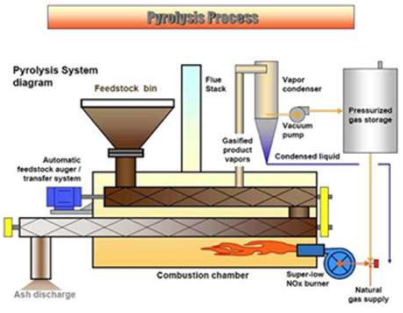
WASTE MANAGEMENT POST CONSTRUCTION

As a residential complex building produces huge amount of solid waste. Which not treated properly can produce a lot of landfills and can indirectly affect the community health.

Waste from dwelling units is segregated in unit level into dry waste ,wet waste, E- waste and toxins waste. All the segregated waste is collected in a dedicated place of 48 sq.m in the site.

Wet waste :

Wet waste from dwelling units and bio-degradable dry waste from landscape is used to make a vermicompost as it is used to make manure which for gardening.



Dry waste and toxic waste :

Collected dry waste and toxin waste is transported to pyrolysis-catalytic dry reforming (PCDR) unit in which all types of dry waste like plastic to tyres. PCDR allows for resource recovery, converting carbon dioxide and waste plastics into synthetic gas.

E – waste : All the E- waste from all the dwelling units will be sold to the scrap vendor .So, that the products will be recycled.

EMBODIED CARBON

Buildings account for at least 39% of energy-related global carbon emissions on an annual basis. At least one-quarter of these emissions result from embodied carbon, or the carbon emissions associated with building materials and construction. Optimizing ready-mix concrete design, choosing finish materials with low-embodied-carbon footprints, and considering low-embodied-carbon or carbon-sequestering insulation options are the most impactful no-cost measures for reducing embodied carbon. Designing for minimal material usage can reduce embodied carbon, lower up-front costs, and maintain a building's sound structure and aesthetics.

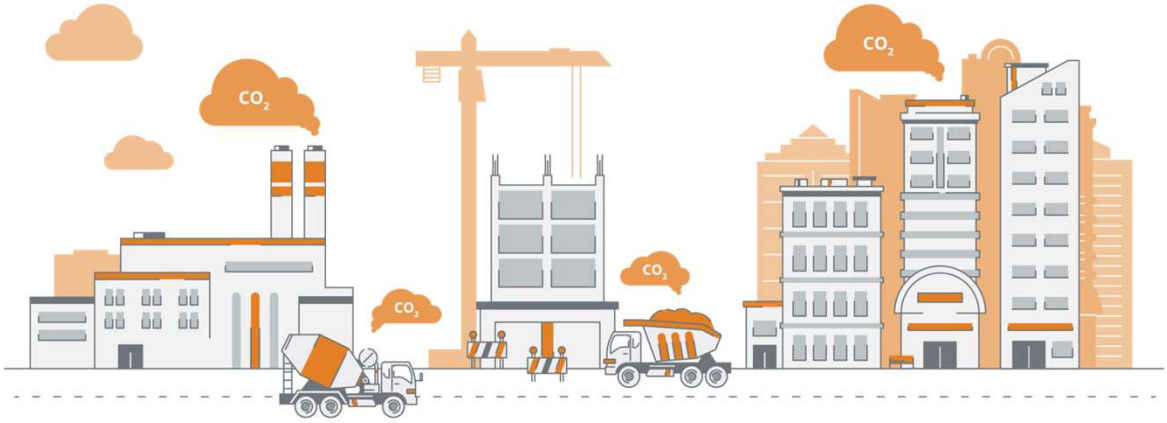


Fig.11 Embodied carbon

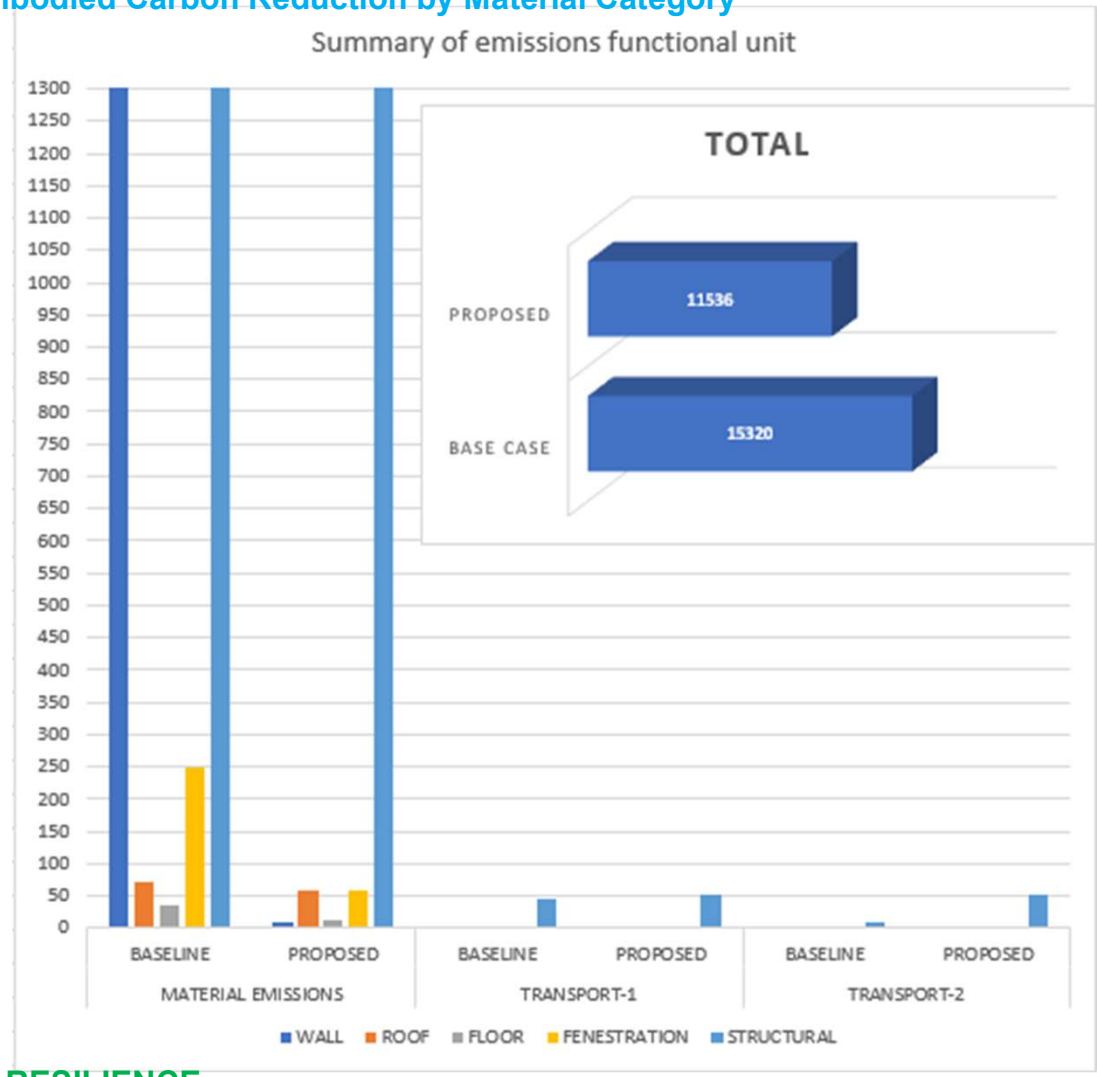
On site Carbon Emission

- For all excavation and Machines used in the site while construction, there is a emission of carbon is 13226.05 kg CO_2
- For Logistics there is consumption fuel and certain amount of carbon was emitted for that we use locally available materials
- 2.7 kgco2 was emitted from 1 liter of diesel.
- Baseline carbon emission is 15320 kg-co2 e
- Proposed carbon emission is 11536 kg-co2 e
- We reduced upto 24.6% of carbon emission.

System Type	Baseline				Proposed			
	Material emissions	Transport 1 (kg-C02 e)	Transport 2 (kg-C0.2 e)	Total (kg-C02 e)	Material emission (kg-C0.2 e)	Transport 1 (kgC02 e)	Transport 2 (kg-C02 e)	Total (kgC02 e)
wall	1875	1	0	1876	8	0	0	8
Roof	71	0	0	71	60	0	0	60
Floor	35	0	0	35	13	0	0	13
Fenestration	250	0	0	250	59	0	0	59
Structural	13034	44	10	13088	11290	53	53	11396
Grand Total emissions per functional unit (kg-C02 e)				15320	Grand Total emissions per functional unit (kg-C02 e)			11536

Table 6: Embodied carbon

Embodied Carbon Reduction by Material Category



RESILIENCE

By definition, this resilience involves creating and building structures that can withstand droughts, extreme heat, storms, earthquakes, floods, and other types of natural disasters and severe weather. Thus, resilient homes are residential buildings that face catastrophes head-on and remain standing afterward.

ITS IMPORTANCE IN PRESENT TIMES:

- Over the past 25 years, disasters caused by natural hazards have claimed 1.3 million lives and resulted in untold damage around the world.
- These disasters are becoming more frequent, damaging, and deadly –particularly for the poor and also the Walls crumble, roofs blow off, and structures collapse.
- These homes are under threat from earthquakes, floods, hurricanes, and other disasters.

IMPORTANCE OF OPEN SPACES OF RESILIENCE:

- The resilient homes will always look for safer and healthiest building. The intention is that the design must be **'safe to fail'** while being **ready to bounce back quickly.** It is critical that there is a 'No Regrets' plan in place for the multi-family housing complex to be resilient. Some of the strategies are listed below:
    - adequate open spaces &
    - Rainwater harvesting/ flood water management/ adequate storm water drain mechanism.
    - Passive and active cooling techniques.
    - Earthquake proof design for construction
    - independent power supply .

PRE-DISASTER STRATEGIES FOR POSSIBLE DISASTERS :

In order to develop a safe-to-fail strategy it is paramount that the design and its development is undertaken keeping in mind the various potential disasters and preparing the built environment to be resilient through passive techniques. While there is a possibility of unexpected and extreme weather events or unpredictable risks and vulnerabilities that are unforeseen, it is essential that the designer/ architect develops a resilient strategy. Below are some stages that cannot be overlooked.

- **Identify Potential Risks:** The first step in pre-disaster preparedness is to identify the potential risks faced by the residential apartment. These risks may include natural disasters such as floods, earthquakes, and storms, as well as human-made disasters such as fires and gas leaks.
- **Develop a Disaster Preparedness Plan:** Once the risks have been identified, it's important to develop a disaster preparedness plan. The plan should include emergency procedures, evacuation routes, and communication protocols. It should also include information on where to find emergency supplies and how to access emergency services
- **Educate Residents:** All residents of the apartment complex should be educated on the disaster preparedness plan. This can be done through meetings, posters, and other educational materials. Residents should be informed of what they need to do in the event of a disaster and how they can help others in the building.
- **Conduct Regular Drills**: Regular drills should be conducted to ensure that everyone knows what to do in the event of a disaster. These drills should include evacuation procedures, communication protocols, and emergency supply distribution.
- **Secure the Building:** The building should be secured to minimize the risk of damage during a disaster. This may include reinforcing windows and doors, installing shutters, and securing loose items.
- **Stock Emergency Supplies**: Emergency supplies should be stocked in the building, including food, water, first aid kits, and flashlights. These supplies should be stored in a secure location and regularly checked and restocked.

PREPAREDNESS STRATEGY FOR DIFFERENT POSSIBLE DISASTERS:

Heat Wave

- Heat waves begin to form when high pressure in the atmosphere sneaks in and pushes warm air towards the ground. The vast majority of the recreational spaces have shade. Because of these heat waves and the buildings' all-day shade, low pressure develops in the planted area. The influence of the urban heat island will gradually be reduced by the area covered by shady plants.
- Resilience is the ability to avoid severe calamity caused by natural disasters in a building or a surrounding neighborhood.
- Our goal is to create a resilient design that can withstand these disasters.
- Green terraces are provided as fire safety locations. Every two or three levels have green terraces that serve a variety of functions, including serving as refuge locations.
- Passive methods are used to the full extent possible to ensure that occupants are comfortable in adverse weather conditions to lessen the load and save money. Numerous methods are utilized in the structure to give users a comfortable visual environment, such as the center courtyard that opens up to the sky and the contrast created by the bricks used in construction. The interiors would be cooler and offer higher thermal comfort as a result of using wall materials with lower U values .

Flood water management:

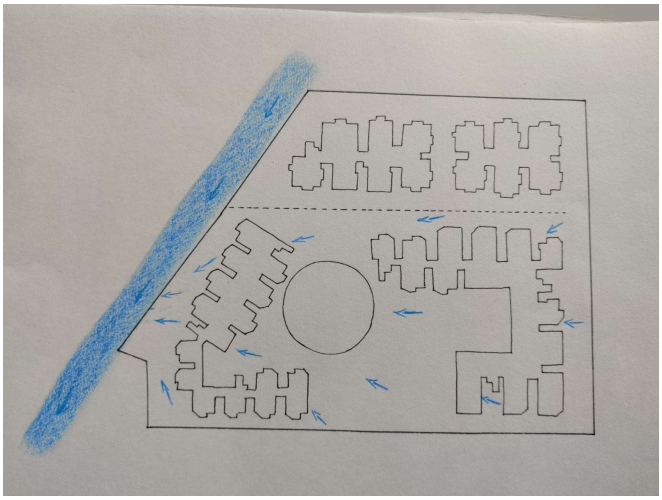
- Off late the frequency of cloud bursts and sudden and short rainfall with high levels of downpour leads to flooding and water logging in several areas. Addressing this is important so that business as usual can be carried out during and after the showers. Some strategies that are being adopted are:

- Since perforated concrete is utilized along the outer wall in places where there may be significant rain and flooding could result, we used sponge technology there. This method increases groundwater levels by allowing 42–45% of water to permeate the soil , **in that the main three methods provided are:**
    - Water harvesting pits are provided at water draining points. By using gutters, we can store rain water and make use of it.
    - underground storage for Rain water harvesting – 1050000litres
    - In case of any emergency sump water can be used Water harvesting pits are provided at water draining points. By using gutters, we can store rain water and make use of it.

The site planning is undertaken such that the slope of the site is towards the nallah. We will be draining the excess water into the nallah next to the site .

Earthquake :

- Hyderabad is located in a plateau region where chances earthquake is very low.
- The main volunteer team will make sure to free up the corridor spaces so that everyone will be safely reaching into that safer space.



Rainfall storage :

- Annual rainfall recorded in Hyderabad = 137.1mm avg
- Sump capacity for storing daily usage water in housing units: 20,000litres (2mx2.5m x4m)
- Total water consumption per person per day = 9,016 LPCD (80 LT/person/day) .

In case of Fire

- According to regulatory requirements, a Multi Detector has been put in every room on the floor. dish bars in kitchens. It consists of a photoelectric smoke detector and a heat detector.
- The automatic sprinkler system is a vital early warning system that can put out a severely destructive fire. Every room has access to them, and a pressurized network of pipes supplies their supply.
- Each fire sprinkler has a glass bulb that acts as a temperature sensor and melts at 68 degrees Celsius. Only the neighboring fire sprinklers will activate when a fire melts the glass bulbs.

Having a power backup during a disaster is extremely important. Here is the strategy that has been employed for ensuring adequate power for several days.

- Backup batteries are being installed to meet the energy needs during a crisis.
- During a power outage or loss, the backup batteries provide the residence with a backup supply of electricity.
- Depending on the model and your requirements, batteries can power your entire house or simply particular appliances such as your refrigerator or sump pump.

Using Backup Batteries While Compare to Generators:

- They are Pollution-free batteries.
- Reduction in reliance on foreign oil and fossil fuels.
- Clean power is available every day of the year; even overcast days provide some power; otherwise, we have power-saving generators on which we may rely.
- Return on investment and Less maintenance.

- Efficient and environmentally friendly.
- Government subsidies, tax breaks, and rebate programs are available to help with the early expenditures of the project, reducing the budget.
- Power generate by one solar panel is 12kWhr/Day

Minimum Power Consumption of Housing Units:

- Total no. Of Solar panels installed is 227 Units {12 x 227 = 2724kWhr/Day} is generated from solar panels.
- Power consumption for housing units is 2320217kWhr/Year = 6356Whr/Day
- Power consumption for common spaces is 863993kWhr/Year = 2367Whr/Day
- Minimum consumption for housing = 1589kWhr/Day
- Minimum Consumption for common spaces = 789kWhr/Day
- In case of any power cut, solar panels will generate 2724kWhr/Day the usage is 2378kWhr/Day .

Early Warning Systems:

- An Early Warning System (EWS) is a system that has a set of capacities needed to generate and disseminate timely and meaningful warning information of the possible extreme events or disasters (e.g., floods, drought, fire, earthquake and tsunamis) that threatens people ‘s lives.

Post Disaster: How Community will be working:

- They can sustain through developed natural techniques in resilient housing buildings.
- By stored rain water, electricity through back batteries, and also getting communities safer and clean environment through volunteers.
- In case of pandemic attacks, the volunteers will provide all food, groceries and basic needs for all communities.
- And also provides the primary clinic in case of health issues and giving them safer environment inside the housing units.
- And also giving the safe and neat environment to senior citizens and also maintain the social distancing inside the building.

Conclusion:

- The resilient designed work has proven that resilient housing initiatives can be transformative and produce permanent change: they can save lives, protect the vulnerable, from natural calamities and provide a cost-effective and long-term solution to the qualitative housing deficit that countries throughout the world are experiencing today.

ENGINEERING AND OPERATIONS

CHOOSING EQUIPMENT:-

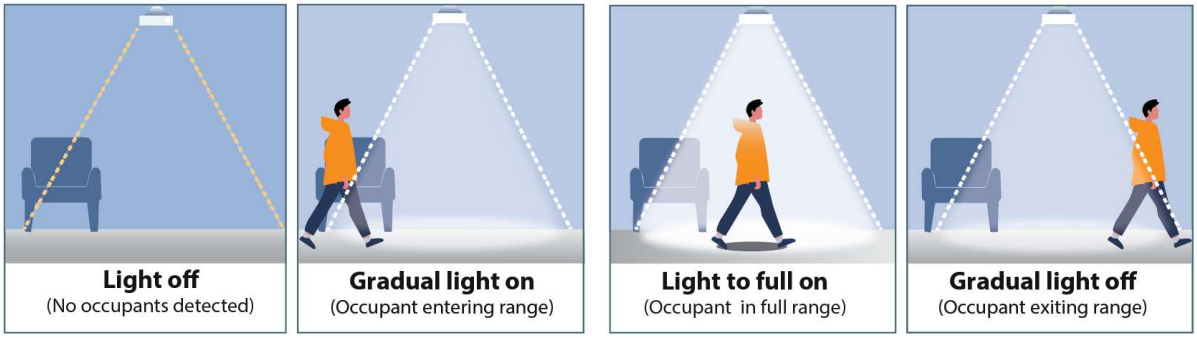
The choice of equipment was chosen in accordance with a survey of the market to identify the wattage of various items utilized in a medium residential unit. Using energy-saving equipment will be promoted because the facility is intended to be net zero.
Going for 5 start rated electrical appliances helps in reducing the consumption of electricity.

		Base w/hr	5 star w/hr
EPD(Equipment Power Density) in W/m2 for 1 unit.	W/hrs EPD(W/m2)	6405 57.5	3211 28.6
LPD(Lighting Power Density) in W/m2 for 1 unit.	W/hrs LPD(W/m2)	220 2.1	130 1.3
Common equipment		1340	1340

Table 7: Engineering and operations.

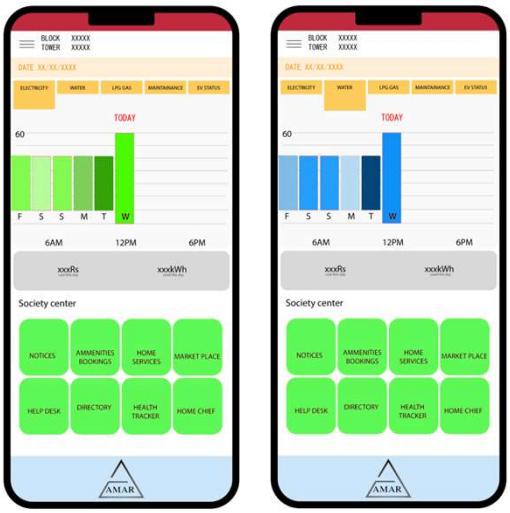
SENSOR LIGHTING:-

- The sensor are a wonderful invention that can help in saving energy. When they detect movement, the lights turn on, and when the movement quits, they switch off.
- Thus, in the effective way, LED lights can result in cost savings. Most motion sensors shut off automatically in 20 or 30 second period. Because it is simple to forget to turn off lights in rooms with low usage.
- Such as bathrooms and storage rooms, motion detector lights are perfect for these types of spaces. When inactive, these fixtures use between 0.1 and 0.3W of energy, while they can help save at least 60% more energy than CFL bulbs.



MONITORING APP:-

Today, almost everyone owns a smartphone. It is advised to create a mobile application that will be handled by the community management. All residents will be expected to download this app, mostly for operational and security reasons. This software will help the occupant get a better understanding of understanding of how his or her actions affect the environment, in order to act more carefully.

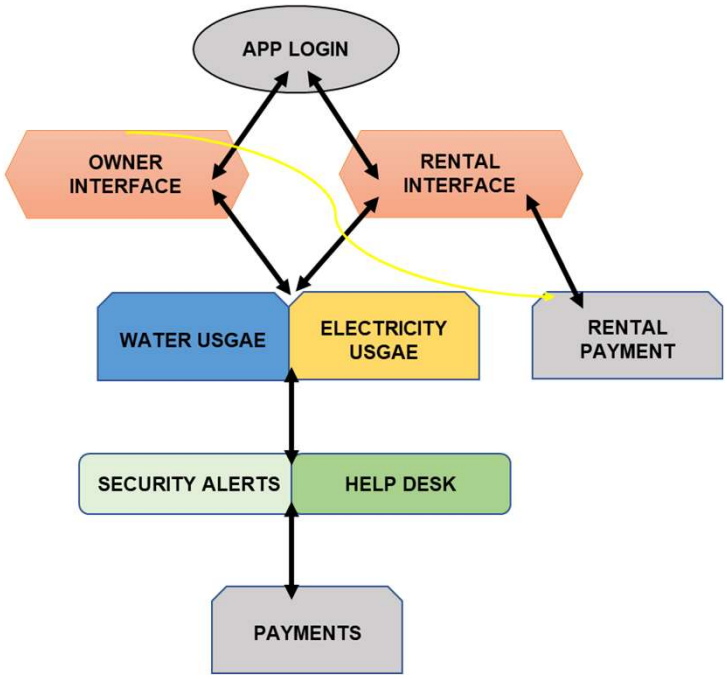


App interface showing electricity and water consumption.

MAINTENANCE

Soil moisture sensors were placed in the soil to calculate the moisture content and to turn on & off the drip irrigation system automatically when it's necessary. 3 liters of water is used in that vertical garden per unit daily. User can operate irrigation system through the app which is mentioned above and a switch is provided to operate it manually

APP ALGORITHM :



login page:-
personal id information- through which unit owner will login to the app.
home page:-
monitoring chat:
real time or before days electricity and water consumption.
operation chat:
in which electronic appliance can be operated.
final monthly report:
in which usage report has to be printed and also emitted carbon in whole month.

Maintenance Manual

- When the user opens the app for the first time, ask for their basic information such as their name, email, and apartment number.
- link the apartment meter details to the app through technology- electricity, water, gas – payment link -
- Provide a dashboard that displays the user's monthly water and electricity consumption in a graphical format. The dashboard should also show the user
- how their consumption compares to other units in the apartment complex. – incentivize the least user in some manner – examples
- Allow the user to set goals for their water and electricity consumption – accordingly show notifications/ alerts to reduce consumption
- provide tips and recommendations for how they can achieve those goals.
- Provide the user with notifications when they exceed their monthly consumption goals or when their consumption is abnormally high. – motivate people to be within a certain range
- Allow the user to report any issues they encounter with the water or electricity supply in their unit, and provide a contact form to get in touch with the appropriate authorities.
- Finally, make sure to include a user-friendly interface and an easy-to-navigate menu to enhance user experience.
- Security management – people coming and going out of the complex
- Personnel management

Value Proposition

Each of the above contests have been elaborated to showcase the methodology and the conclusions of the design strategy. They are tangible in nature and are central to achieving a sustainable design solution for the project. This section summarizes the costs and benefits of all the above contests and specifically responds to the value addition for different stakeholders.

DEVELOPER:

- There are numerous features, such as the use of renewable energy via solar panels, the removal of units and the creation of landscape or open terraces, storm water collecting, and so on. It will be advantageous for the developer to acquire clients.
- Even if the initial cost is higher, they benefit in the long run.
- For example, creating voids between buildings by eliminating units would aid in receiving adequate amount of sunlight and also have good amount of air circulation so there is no need to use artificial light during the morning, which reduces the cost of maintenance.
- And we have employed various approaches or systems such as rain water collecting, STP plant, storm water collection, solar panels, varied sceneries, and so on to attract people.
- Furthermore, by utilizing various landscaping components, the club house improves the beauty of the location, which aids in attracting people.

USER:

- The electricity and water bills will be lower because they have decent air and ventilation and use solar panels. [Lower upkeep]
- In addition, the green space provided between the buildings fosters a sense of connection between nature and the people who live there.
- Good air quality promotes good health and provides thermal comfort.
- Green spaces are used as gathering places for the elderly, children, and others. Alternatively, they can be used as working areas as well.
- Another important aspect in this project is that the complex is host to mixed income groups by having housing for economically weaker sections as well as high income groups. Being inclusive and abiding with the idea of ‘Right to the city’ and providing an inclusive housing solution with good architectural design is at the core of the project.
- Having an inclusive settlement was central to the design brief. This design solution has allocated one tower to the LIG-EWS category and the other for MIG-HIG category. While the HIG class of people prefer their privacy, they definitely require and access services from the EWS class of people. Therefore, separate blocks ensured that they different class groups are close enough yet have their own private spaces.

Club house

Terrace gardens

Open spaces

Corridors & Balconies

- Our project has many open areas on the site that are accessible to both youngsters and seniors, and a community garden is located inside the clubhouse.
- These areas are used as gathering spots for people to engage and foster a feeling of community.

AFFORDABILITY:

- People in metropolitan areas require houses since the population is growing there.
- Thus, we made an effort to design our project in an affordable manner by utilizing various strategies and affordable materials that helped us lower the cost of the construction as well as the cost after the construction. [Even the initial cost is high in further run it helps the people to reduce the cost in other terms]
- In order to keep the cost of our project low, we used a variety of technological and architectural components, such as solar panels, picture wall-style panels, huge apertures, rainwater harvesting pits,STP etc.

SAVING ON CONSTRUCTION :

•We use QUIK build technology for interior and external walls instead of brick wall construction since it provides more thermal comfort .

•It is a eco-friendly construction system that dramatically reduce construction time.

•It is thermally insulated an is aesthetically superior to RCC construction.

- And also it reduces the construction cost, earthquake and corrosion resistance and lighter in weight.The construction period is less than compared to brick work. Which helps in decreasing the labor and material cost.
- The project's base construction time span is **five years**, however we are completing it in the span of **three** because we are adopting new construction techniques.
- The use of leftover materials for corridor flooring will cut costs.

S.No.	Particulars	Definition	Baseline Estimate (Project Partner / SOR basis)			Proposed Design Estimate		
			Amount in Million INR	%	Amount (INR per sqm)	Amount in Million INR	%	Amount (INR per sqm)
1	Land	Cost of land purchased or leased by the Project Partner	127.50	8.5%	3,993	127.50	8.5%	3,993
2	Civil Works	Refer Item A, Civil works in Cost of construction worksheet	1112.17	74.4%	34,827	1111.95	74.4%	34,820
3	Internal Works	Refer Item B, Civil works in Cost of construction worksheet	33.08	2.2%	1,036	32.94	2.2%	1,032
4	MEP Services	Refer Item C, Civil works in Cost of construction worksheet	28.43	1.9%	890	55.78	3.7%	1,747
5	Equipment & Furnishing	Refer Item D, Civil works in Cost of construction worksheet	0.00	0.0%	-	0.00	0.0%	-
6	Landscape & Site Development	Refer Item E, Civil works in Cost of construction worksheet	17.70	1.2%	554	18.50	1.2%	579
7	Contingency	Amount added to the total estimate for incidental and miscellaneous expenses.	59.57	5.0%	1,865	60.96	5.0%	1,909
	TOTAL HARD COST		1378.45	93.2%	43,166	1407.62	95.1%	44,079
8	Pre Operative Expenses	Cost of Permits, Licenses, Market research, Advertising etc	10.00	0.7%	313	10.00	0.7%	313
9	Consultants	Consultant fees on a typical Project	10.00	0.7%	313	10.00	0.7%	313
10	Interest During Construction	Interest paid on loans related to the project during construction	96.35	6.4%	3,017	112.62	7.5%	3,527
	TOTAL SOFT COST		116.35	7.8%	3,643	132.62	8.9%	4,153
	TOTAL PROJECT COST		1494.80	100.0%	46,809	1540.24	103.0%	48,232

CIVIL WORK : We are using QUIK build construction instead of brick work which reduces the construction time and even the cost of the construction.
This also aids in energy saving.

Detailed calculations for the cost estimations is provided in the project sheet that is ttached separately.

The total project cost for the proposed case is 1540.53 million rupees and is 3.1% more than the base case. The per square meter cost is 48,241 Rupees.
Of the total cost, about 7
CIVIL WORK : We are using QUIK build construction instead of brick work which reduces the construction time and even the cost of the construction.
This also aids in energy saving.

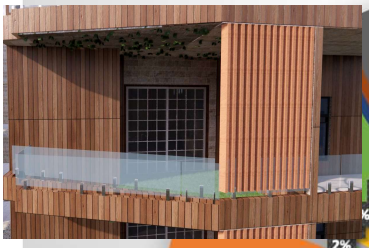
For internal works we are using low carbon emission materials for tiles and others .
We are using construction waste materials which decreases our cost.

MEP services : We are using STP, solar panels , hydro power generator and rain water storage plant which benefits the people in terms of cost and energy in the long run.

LANDSCAPE : We are having roof gardens which are used as refuge areas and gathering spaces for children and elderly people.
And we used drip irrigation for roof gardens and sprinklers .

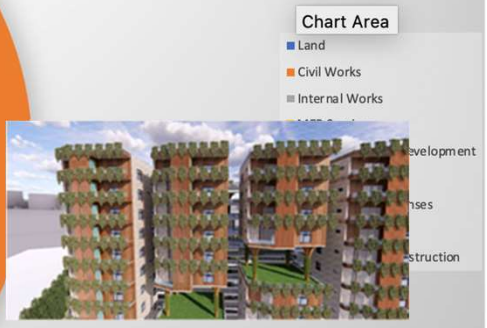
Detailed calculations for the cost estimations is provided in the project sheet that is attached separately.

INNOVATION



SHADING DEVICES

Shading devices are provided on south-west side so that heat gain will be reduced simultaneously electrical consumption is reduced.



NATURAL VERTICAL SHADING

Creepers act as self-shading, through which the building gets natural shading and reduces heat on the building.

USING LESS CARBON EMISSION MATERIALS

AGGREGATE

TATA STEEL

SAIL WOOD

PORCELAIN TILES

ULTRA TECH CEMENT

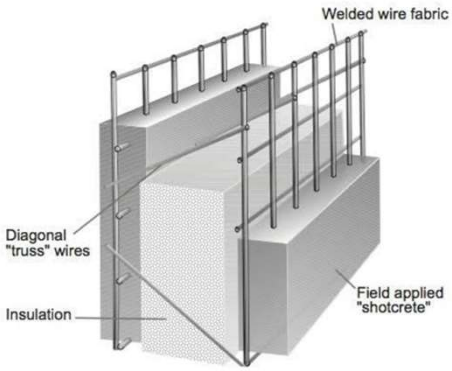
UPVC WINDOWS

SOLAR PANNELS

THERMACOL SHEETS

GI MESH

QUIK BUILT CONSTRUCTION



Quik built construction is used in this design.

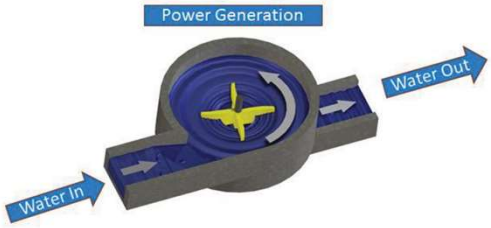
- Makes the building weight light
- Reduces inside temperature up to 7degree Celsius compared to outer temperature.
- Heat intake is very low
- Reduces consumption of electricity by proving good thermal comfort.
- Reduces 15-%20%cost compared to brick or ACC block construction.

Table: 15

POST INSTALLATION MONITERING APP

Proposing an app which helps residents to know how much quantity of water, electricity they are consuming and also carbon emission. Each flat has an account and they can monitor their consumption per day. This app has same interface for tenant and owner, the only difference is tenant can pay their electricity and flat rent through this app itself.

WATER HYDRO TURBINES AND SOLOR PANNELS



SCALABILITY AND MARKET POTENTIAL

- Scale pf the project – EWS,LIG, MIG, HIG
- Scale of the project budget is 1504.53 million

Construction market growth from past 5 years

- Chosen materials are readily available in market.
- They are highly durable
- Materials like cement, aggregate, steel bars, glass, upvc etc. are used and they can be recycled.
- There are resources for speedy adoption in the market.

Slide 37

GU0 Please Improve w\quality of the diagrams, anything you all are pasting please

Guest User, 2023-04-23T15:46:13.164

ANNEXURE

https://drive.google.com/drive/folders/1NDM34NDjS9SAxMEjFVsTds3OHApUXK7f?usp=share_link

SVC CONSTRUCTIONS LLP

Date: 10th Oct 2022

To,

The Director,
Solar Decathlon India

Dear Sir,
This is to inform you that our organization SVC Constructions has provided information about our Indraprastha @Suchitra Circle project to the participating team led by Ashoka School of Planning and Architecture, Hyderabad, so that their team *Team Amar* may use this information for their Solar Decathlon India 2022-23 Challenge entry.

As a Project Partner to this team for the Solar Decathlon India 2022-23 competition, we are interested in seeing the Net-Zero-Energy, Net-Zero-Water, resilient and affordable solution this student team proposes and the innovation that results from this.

We would like to have a representative from our organization attend the Design Challenge Finals event in April/May, if this team is selected for the finals.

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

With warm regards,

Signing on Behalf of Mr. Vishnu Suresh, Director, SVC Constructions
Name of Representative: Swarup Dayal
Designation: Manager, SVC Constructions
Email: swarupdayal@gmail.com
Phone: +91 97031 00788

GSTIN 36AEEFS1747N1ZK
Address: Flat No.205, Lotus Block, Gardenia Towers, Pipe Line Road, Subash Nagar, Jeedimetla, Hyderabad, Telangana-500055.
Phone: +91 92965 04493, +91 63058 62010.
svcconinfo@gmail.com / givcplinfo@gmail.com.

BEARDSELL LIMITED
Plot No. 3, Jyothi Colony, Near AOC,
Lane opp. to Ganshyam Super Market,
Secunderabad - 500 015. Telengana.
Phone : 040-27748160, 27740102.
Tele Fax : +91 40 2774 5799
Email : hyd@beardsell.co.in
CIN No. L65991TN1936PLC001428

19.04.2023

The Director
Solar Decathlon India
New Delhi

Sub.: Ashoka SPA - Team Amar – Beardsell Limited - Industry Partner – Letter

Dear Sir,

Greetings from Beardsell!

We are a nine-decade young public listed company with strong and proven presence in the building industry space through our innovative and sustainable products including QuikBuild, Insulation, and Pre-fabrication materials and technologies.

Our organisation, Beardsell Limited, is collaborating with the participating team, Team Amar, led by Ashoka SPA on their Multi-Family Housing Building project for their Solar Decathlon India 2022-23 competition entry.

The nature of our collaboration will be that of an **Industry Partner**. We shall deploy our innovative building material and construction technology products in the proposed multi-family housing project being designed by TEAM AMAR, ASPA.

We would be able to have a representative from our organization to attend the Design Challenge Finals event in May, if 'Team Amar' is selected for the Finals.

We would like our organisation's logo to be displayed on the Solar Decathlon India website, recognising us as one of the Industry Partners for the 2022-23 competition.

With warm regards,

BEARDSELL LIMITED * HYDERABAD *

Mr/Sri B.Vijaya Bhaskara Rao
General Manager
Beardsell Limited
Plot No. 3
Near AOC
Secunderabad 500015

CC: The Director, Ashoka School of Planning and Architecture, Hyderabad

ARCHITUDE BIM SERVICES PVT LTD
Plot no-36, Koundinya Nagar, Nacharam Main Road, Hyderabad, Telangana 500076.

Date:- 20-04.2023

To
The Director,
Solar Decathlon India
New Delhi

Sub:- Ashoka SPA – Architude BIM services Pvt Ltd., – Industry Partner – Letter.

Dear Sir,

Greetings from Architude BIM Services,

This is to inform you that Our Organization, Architude BIM services Pvt Ltd, is collaborating with the participating team lead by Ashoka School of Planning and Architecture on a Multi-Family Housing project for their Solar Decathlon India 2022-23 competition entry.

The nature of our collaboration will be Virtual design, construction, simulation of green buildings, and we would like to have a representative from our organization attend the Design Challenge Finals event in April/May, if this team is selected for the Finals.

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

With warm regards,

vijayadurga

Name: Vijayadurga Koppisetti
Designation: CEO
Name of the Organization: Architude BIM Services
Email: ceo@architude.org
Phone: 9355115833

ASHOKA Institutions

ASHOKA

School of Planning & Architecture

(Approved by Council of Architecture & Affiliated to JNA & FAU, Hyderabad)
Malkapur (V), Choutuppal (M), Yadadri Bhuvanagiri Dist.-508 252 (TS)

Cell : 91 7207012468

Date:22/02/2023

To,

Solar Decathlon India.

Respected Sir,

This is to certify that the below mentioned students along with the faculty are the regular members Of **ASHOKA School of Planning and Architecture, TELANGANA** forthesession2022-23 and participating in Solar Decathlon India 2022-2023 competition with team identity **AMAR.**

NAME	STREAM	REGISTRATION No.
Prof. Anju Manikoth (Faculty lead)	Dept. of Architecture.	CA/2010/49445
Mohammad Salman Pasha	Architecture	19271AA018
K.V.K.Sirisha	Architecture	19271AA040
R.Gopichand	Architecture	19271AA008
Mohammad	Architecture	19271AA017
Mirza Ali Raza	Architecture	19271AA016
P.Abyudha	Architecture	19271AA001
KavyaDevara	Architecture	19271AA012
Pooja Pydipelli	Architecture	19271AA023
J.Sahith rao	Architecture	19271AA027
E.Lokesh	Architecture	19271AA011

Best regards,

Dr . MS.Raghavendra

Director

ASHOKA School of Planning and Architecture.

Near Ramoji Filmcity, Yadadri, Bhuvangiri Dist. Hyderabad.

Dr. MS. Raghavendra
Director
ASHOKA School of Planning And Architectur
Near Ramoji Film City, Yadadri
Bhuvangiri Dist. Hyderabad.

INSTITUTE
OF ENGINEERING & MANAGEMENT
Salt Lake Electronics Complex, Kolkata-700 091, WB, INDIA

Phone : (033) 2357-2969/2059/2995
(033) 2357-8189/8908/5389
Fax : 91-33-2357-8302
E-mail : director@iemcal.com
Website : www.iem.edu.in

Date: 15/02/2023

To,

Solar Decathlon India

Dear Sir,

This is to certify that the below mentioned students along with the faculty are the regular members **of INSTITUTE OF ENGINEERING & MANAGEMENT, KOLKATA** for the session 2022-23 and participating in Solar Decathlon India 2020-2021 competition with team identity **AMAR.**

NAME	STREAM	REGISTRATION No.
Prof. Gunjan Kumar (Faculty lead)	Dept of Mechanical Engineering	ID No 2132
Subhranil Mukherjee	Electrical Engineering	22020002011013
Snayini Joarder	Electrical Engineering	12018002011075
Sohom Kundu	Mechanical Engineering	22021002007013

Best regards,

Arun Kumar Bar 15/2/2023

Prof. Dr. Arun Kumar Bar,
Principal
Institute of Engineering & Management Kolkata.

Prof. Dr. Arun Kumar Bar
Principal
Institute of Engineering & Management
Sector-V, Salt Lake Electronics Complex
Kolkata-700091

indriyn

19.04.2023

To,

The Director,
Solar Decathlon India
New Delhi

Sub.: SDI 2022-23 – Ashoka SPA – Hyd - Team Amar – Industry Partner – Letter

Dear Sir,

This is to inform you that our organization, **INDRIYIN DATA ANALYTICS PVT. LTD**, is collaborating with the participating team led by **ASHOKA SCHOOL OF PLANNING AND ARCHITECTURE** on their Multi-Family Housing Building project for their Solar Decathlon India 2022-23 competition entry.

The nature of our collaboration will be that of an **Industry Partner**. We shall deploy our products and Apps in the proposed multi-family housing project being developed by TEAM AMAR, ASPA.

We would be able to have a representative from our organisation attend the Design Challenge Finals event in May, if this team (Team Amar) is selected for the Finals.

We would like our organization's logo to be displayed on the Solar Decathlon India website, recognising us as one of the Industry Partners for the 2022-23 competition.

With warm regards,

INDRIYN DATA ANALYTICS PVT. LTD. HYDERABAD

Mr. SIVA PRASAD TEKUMUDI
Founder and CEO
INDRIYN DATA ANALYTICS PVT LTD
CIE, Vindhya C5, IIIT-H, Gachibowli
Hyderabad, INDIA 500032

CC: The Director, Ashoka School of Planning and Architecture, Hyderabad

INDRIYN DATA ANALYTICS PRIVATE LIMITED
Plot No:66, H No 3-147/66, Opp.NRI JUNIOR COLLEGE,
SRINIVASA HOUSING SOCIETY, NIZAMPET, HYDERABAD-500090
CIN: U72501TG2015PTC099961

mail : info@indriyn.com
mobile : 91-8978 767 700
web : www.indriyn.com