



THE DESIGN SOLUTIONS TO PROVIDE PASSIVE LIGHT AND VENTILATION FOR LOW-COST HOUSING IN URBAN CONTEXT- CASE OF BENGALURU

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ABSTRACT

The rapid increase in the number of migrants towards the cities seeking for livelihood has paved path for increase in the population of urban poor and sprawling slums in Indian cities. This has brought in lot of livability issues to the compromised built environment not only to the occupants but also in the performance of surrounding built environment themselves. Every citizen has “right to dignity of life” meaning, to have access to natural light; ventilation, sustainability and good sociability as prime priority. A detailed study has been extensively conducted through qualitative methods by observation and stake holder’s interview at every level to understand the workability of the community and bring in sustainable solution for healthy living environment. In this paper the focus is to provide dignity of life by establishing the interaction between built and the un-built through sustainability. The proposal is made prioritizing the Sustainable Goals of Karnataka, and adopting the standards from green building standards prescribed by IGBC, on how the lighting and ventilation impacts the performance of the occupant’s health and well-being, and how good design can improve the indoor & outdoor quality.

Keywords: Built Environment, Natural Light, Sociability, Sustainability, Ventilation

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INTRODUCTION

In Karnataka the slums are maintained and managed by Karnataka slum development board (KSDB). They provide shelter to the slum dwellers. The slums are redeveloped by providing them basic amenities such as sanitary, facilities drinking water, electricity, street lighting, concreted road and paved pavement facilities, a Pakka house permanent shelter, healthy & hygienic environment, safety and security, etc. The Table 1 below represents the statistics data of number of slums in state of Karnataka and Bengaluru city under their responsibility. As per the survey data by KSB, there are around 2804 slums that are 22.56% of urban population. Around 597 slums are found in Bengaluru city alone out of which 387 slums are notified under Karnataka slum areas Improvement and clearance act 1973.

Table 1: Showing the slums in Karnataka & Bengaluru city

Description	State data	Bengaluru city
Total Urban Population (2011 Census) in lakhs	217.97	96.25
Total Slum Identified	2804	597
Total Population in identified Slums(in lakhs)	40.50	5.18
Percentage of Slum Population to total Urban Population.	22.56	18.58%
Total Number of Notified slums(as per Act)	2397	387
Total Number of Non-Notified Slums	407	210

Source: ksdb.karnataka.gov.in

Study Area: There are two sites, Site-1 Lakshmi Devi Nagar which is a rehabilitation quarters G+1 houses 150 units constructed and maintained by KSDB built in 2007, The Structure is now in deterioration state hence KSDB is planned to pull it down and design a stable sustainable structure and also make provision to accommodate more number up to 350 units. They are shifting Site-2 Neelgigi Thopu slum which is situated 2.4KM away from Site - 1. The Site -2 has 55 dwelling units the details of each site is narrated below:

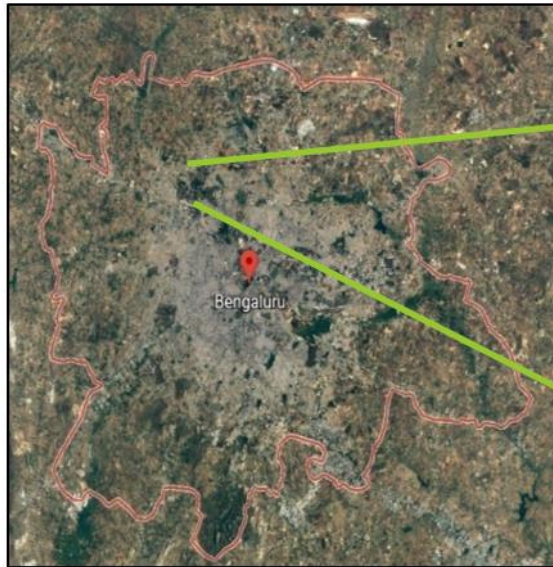


Figure 1. Bengaluru City Map



Figure 2. Lakshmi Devi Nagar, Kaveri Nagar, Bengaluru

Source: Photos Courtesy Author

Site -1 Lakshmi Devi Nagar rehabilitation quarters

The site is situated towards the West of Bangalore, three acres of land at Lakshmi Devi Nagar, Kaveri Nagar, Bengaluru. This project is situated in the industrial suburb of the city towards west of Bengaluru. This project is exclusively built for the slums identified under Slum evacuation & clearance act.

KSDB are also responsible for allotting the dwelling units for the needy and are completely responsible of its maintenance. They make sure the families residing there are currently shelter less/homeless and if somebody evacuates the allotted flat, that flat will be allotted to another homeless family only. As this rehabilitation projects in Bengaluru is being revamped as it is in a very poor state, the building is abandoned and in state of ruins. The construction quality is not up to the standard. Currently it is G+1 Structure, built in brick masonry and accommodates 150 families. In the new proposal, they are planning to enhance the structure by adding two more floors (G+ 3 structures) to accommodate 350 dwelling units, with additional amenities and facilities.

The concept of our proposal is to provide dignity of life to the under privileged by making the built environment livable, to provide natural light and ventilation, encourage sociability, provide sustainable job opportunities, and over all infrastructure and facilities through sustainable concepts.

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Description	Lakshmidewi Nagar
<i>Location</i>	<i>K Block kseb quarters, 2G7G+543, Lakshmi Devi Nagar, Kaveri Nagar, Bengaluru-560058</i>
<i>No. of units</i>	<i>150 units</i>
<i>Types of settlements</i>	<i>Formal housing G+1 structure, constructed and maintained by KSDB</i>
<i>Area</i>	<i>2.49 Acres</i>
<i>Religion</i>	<i>Secular with all religion and castes</i>
<i>Socio-economic statues</i>	<i>Employed at garments factories, printing press, domestic maids, helpers, or self-employed such as barber, tailors, petty grocery shop, street vendors, rickshaw driver, cab drivers, etc.</i>
<i>Water supply</i>	<i>BWSSB</i>
<i>Sanitation</i>	<i>Private bath and toilet facility for each unit</i>
<i>Electricity</i>	<i>No formal/ legal connections BESCOM connections to each unit</i>
<i>Status</i>	<i>Deteriorating building with poor maintenance & construction quality, compromised facilities.</i>
<i>Proposal/Need</i>	<i>KSDB has proposed to demolish this dwelling units and rebuild to accommodate more dwelling units in a G+2 structure with better infrastructure.</i>

Table 2: Showing the data of the rehabilitation for slum dweller building structure to be re designed.

Physical survey data of Slums that are identified to be rehabilitated by KSDB in the Slum dwellers rehabilitation housing quarters. Constructed and maintained by KSDB. Issues Identified with few photos of both the slum: Lakshmidewi nagara existing formal rehabilitation quarters by KSDB.



Figure 3. Photo showing the construction the building.



Figure 4. Photo showing the community gathering quality of on the road with no dedicated interaction space.



Figure 5. Photo showing the openings in the building
Source: Photos courtesy Author



Figure 6. Photo showing the state of the building



Figure 7. Condition of the infrastructure.

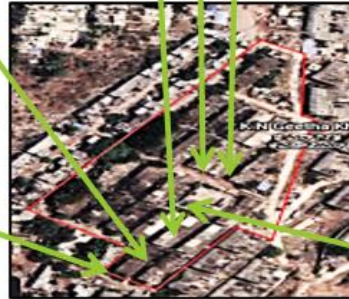


Figure 8. Site Plan of Laxmi Devi Nagar.



Figure 9. Showing narrow lanes.

The Figure 3,4,5,6,7, &8 are showing the current status of the building, this G+1 structure was constructed in 2007 to accommodate around 350 dwellers. The construction quality is very poor hence the building is almost in ruin state, some part of the building like staircase chejja, railings, walls have fallen. The dwellers have evacuated from the building fearing its stability. Not only that, building lacks ventilation and day lighting, the wall to window ratio is disproportionate. All windows are kept towards one face of the building. The building orientation is towards west hence there is lack of thermal comfort in the building. There are no community gathering space, recreation spaces dedicated green open spaces. The main roads are 9 M wide but the interior roads are very narrow only 2M wide. The KSBD has now decided to demolish the entire structure and rebuild the same to accommodate more dwelling units.

Talking about the site context it is situated in the densely populated area with many small-scale industries like garment factories, printing press, etc. are surrounded and this may help these dwellers in getting jobs.

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Site 2: Condition of NeelGiri Thopu Slum. #11th main road Neelagiri thopu slum, Peenya 3rd stage, Bengaluru-560058.

Description	Neelgirithopu Slum
Location	#11 th main road Neelagiri thopu slum, Peenya 3 rd stage, Bengaluru-560058
No. of units	55 thatches' (kaccha houses)
Types of settlements	Informal, self-made haphazardly placed tents
Area	Less than an acer
Religion	Linguistic community mostly from backward class
Socio-economic statues	Un-employed to daily vergers such as masons, maid's
Water supply	No systematic arrangement or accessibility
Sanitation	One toilet core with 5 bathrooms and 5 toilets for all 54 hut dwellers. Maintained by BBMP
Electricity	No formal/ legal connections
Status	Poor living conditions with poor hygiene, no basic amenities
Proposal/Need	This slum is proposed to evacuate and rehabilitated in Lakshmedevi Nagar rehabilitation quarters.

Table 3: Showing the data of the rehabilitation for slum dweller residing at Neelgiri Thopu, Bengaluru.



Figure 9. Neelgiri thopu slum location junction

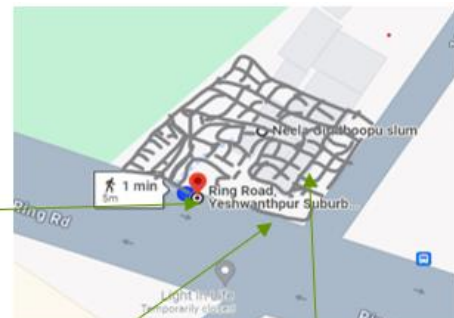


Figure 10. Neelgiri Thopu Slum plan



Figure 11. Condition of the slum Kaccha house, its environment & livability



Figure 12. Showing BBMP sanitation facility.

Source: Photos courtesy Google Maps.

The Figure 9,10,11,12 are showing the existing condition of the slum existence since 15year on the 96 outer ringroad junction, the settelment is inounimous the dwellers are migratores from Andra Pradesh basically job seekers to earn their lively hood. The placement of the huts are very disorganised and lacks basic aminities.The services like electricity water and sanitation has no authorization they are self proclaimed. The KSDB has taken this slum for rehabilitate the dweller to Lakshmi devinagar rehabilitation quarters. The current existing builldgs there are being demolished and a new G+3 structure is coming up in order to accommodate many dwellers.

METHODS

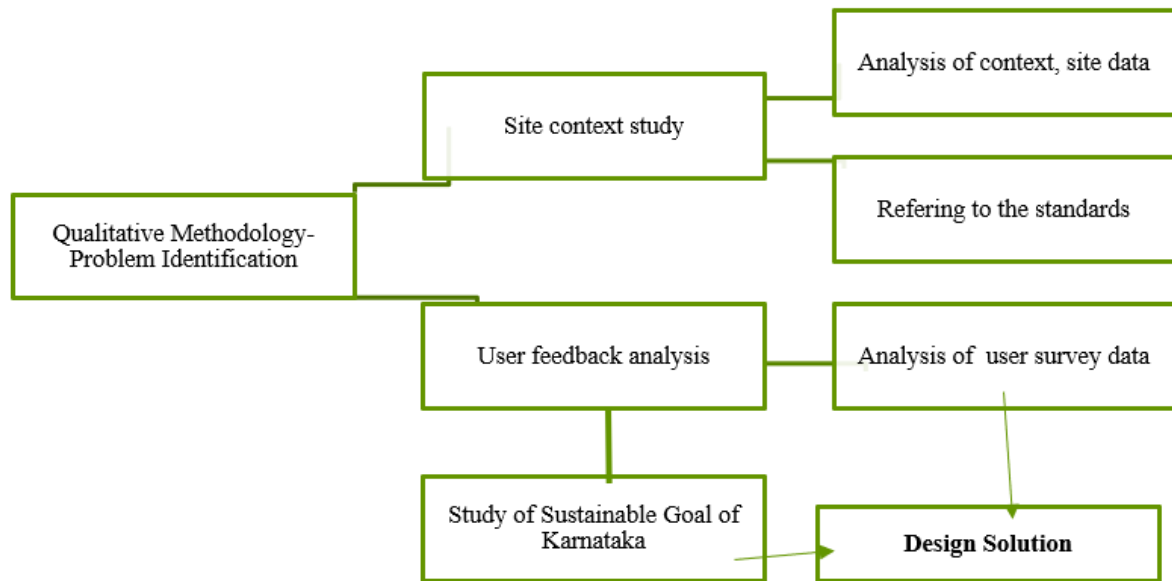


Chart 1. Flow chart showing the methodology adapted to arrive at the design solution.

A detailed study, analysis and survey is conducted to provide a sustainable design and construction technique. The methodology adopted here is qualitative survey with primary and secondary data collection. Interactions were held with the authorities who implemented the project and the beneficiaries. 10% percent sample survey was administered for 15 dwelling units with a random sampling technique.

A systematic interview of all age groups was carried out with a set of standard questionnaires which focused on the particular environment they were living in. For Site 1 Lakshmi Devanagari the question asked were, their origin, what is the skillset they have to earn their livelihood, whether rehabilitation to this quarters has helped them, what difference it has created in their life moving from their origin, how is life in this organized environment, is this well-planned and structured community giving them a better future, what is their expectation, What kind of facilities are they looking for to have stress free livelihood, Are they willing to become “Athma Nirbhar” what type of support, amenities and facilities are they looking at, etc. by talking to the occupants getting their feedback; on these open ended questions were formulated and interviewed, the entire stake holders who were using this space currently. The same set of questions were asked to the Slum dweller at Site-2 Neelgiri Thopu, the people who will be rehabilitated in this built environment in future. How are they feeling to move to a new environment, what were their fear, expectations, what is their needs. What are the pros and cons they predict. Interactions were held with the beneficiaries who implemented the project. Ten percent sample survey was administered for 100 dwelling units with a random sampling technique

FINDINGS AND DISCUSSIONS

The One-on-one interview and site physical survey conducted at: Site-1, the number of Samples: out of 150 Dwellers dwelling units, out of which, 28 Female 20 male dwellers (of all age group from 10yrs to 60+ years of age) were interviewed.

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The outcome of the questionnaire data collected from the dwellers, they were not happy with the location as they were away from the city and it was difficult for them to earn their living, they said there is no community space, they cannot earn their living as there are no job opportunities around as they were moved with the construction, the interiors of house also is very compact it had only two windows and a main door. The chejjas provided did not take care of rain water entering inside. No dedicated community gathering space, no recreation spaces for the dwellers physical and mental well-being. A. Physical Impact The functional space utility of dwelling units and its satisfaction levels has been assessed. The average level of housing satisfaction is 40 per cent. In these existing dwelling units. The Interview at Neelgiri Throup slum 10 male dwellers 15 female dwellers 10 children of age group (10-15yrs) 5 old age people (60+ yrs) they were not willing to move from this settlement as they had sourced their jobs in the near vicinity of 500m and if they are evacuated they will be difficulty in getting their jobs. They were adjusted to this kind of living and not ready to get exposed to the new environment, they were feeling in secured. The physical, social, economic and environmental impact assessments were carried-out.

In order to address all their quarries and give them dignity of life with good health and well-being, a detailed study of SDG -2020 and started analyzing how to adopt the same in this built environment. Along with this a study on green building concepts were studied to adopt green building techniques, the wall window ratio, energy generation, RWH, Open to built area ratio, Natural light, STP's.

PROPOSAL

The ideology is to focus on providing dignity of life for such under privileged urban poor. The aim is to address all the sustainable developmental goals Of GoI, and to adopt green building criteria's & concepts as per IGBC for the rehabilitation proposal. This space had to be transformed completely from what it is now and how we could make it more functional, self-sustainable. The objective is also to achieve cognitive design to enhance mental health and well-being for the occupants.

Under the SDG for Karnataka:

Goal 1: End poverty in all its forms everywhere: Concerned Departments: RDPR, UDD, Education, IT & BT, WCD, Agriculture, Horticulture, Animal Husbandry, Food & Civil Supply, Planning, DES, HFW, Energy, Housing, Finance, Revenue(DMC), Social Welfare. In order to satisfy the

Goal 1: we have proposed urban community garden where in the residents can start irrigation activities and harvest all the vegetables and fruits required for the entire community and also a dedicated market place is proposed to sell it to the neighboring communities. A training center along with anganawadi Kendra is proposed to solve their employment problems and make them Athmanirbhar (Self Sustainable).

Goal 2: End Hunger, Achieve Food Security, Improved Nutrition, and Promote Sustainable Agriculture

This is satisfied by providing open space for developing community garden, concept of organic farming to get good fresh and healthy food. We have provided facilities for collection of roof top and surface rainwater harvesting efficiently, by giving provision for collection, water treatment & storage plant for recycling and reuse of rain water.

Goal 3: Ensure healthy lives and promote wellbeing for all at all ages:

To cater to this goal, each house is designed in such a way that it gets good day-light and ventilation and with reduced air and noise pollution, which is emitted from the industries and factories around the Site. Each dwelling unit is sized 500 Sq ft. with basic facilities like a kitchen, bathroom W.C, utility, Living room and a bedroom.

We have provided pollution free environment with pedestrian friendly circulation paths, restricting the roads with vehicular movements on the periphery of the layout. Intermediate open spaces are provided with walking tracks and pediatric play zones, the trees on each lane are provided to gain fresh air. In this pandemic era, in order to curb the communicable disease, as this is a high rise building the use of common space is kept separately not with a roof covered in order to maintain hygiene and avoid contamination of air. Each house is provided with cross ventilation in order to give good health and well-being.

To contribute to “Atmanirbhar Bharath” to encourage them earn their livelihood, a community training centre is provided in order to develop/ train the residents with certain skill sets to make them earn their lively hood.

Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Goal 5: Achieve gender equality and empower all women and girls.

In order to cater to the SDG goal 4 & 5 a training Centre an anganwadi, community centre is proposed to educate the kids of under the age of 5, night school for elderly to achieve the literacy rate and enable people to gain the wisdom to read and write. One PHC is also proposed in the community. Based on their interest new skill development training is also proposed to be conducted.

Goal 6: Ensure Availability and Sustainable Management of Water and Sanitation for All. Except for the periphery road, this is of white topping, the other services like water supply, electrical services, gas line and networking cables, is taken underground of the pedestrian path in order to avoid road cutting.

The entire site has paved pathways to allow maximum permissible area for rainwater to recharge the ground water. STP is provided to recycle, reuse the water for planting, horticulture and other utility. Roof top Rainwater harvesting Pits are provided to filter rainwater and reuse for domestic purpose.

Goal 7: Ensure Access to Affordable, Reliable, Sustainable and Modern Energy for All:

In order to meet the energy, need and make the environment more sustainable renewable energy is proposed. Solar energy with solar mills is proposed to provide lighting and hot water facilities. With street light also with pv cells/panels. Trees are planted at regular intervals outside the residential units and alongside the amenities to facilitate enough greenery, generate oxygen and combat the air pollution created in the surrounding. The proposal is designed in such a way that it will suffice the SDG 2030 and the house for all schemes under PMYA.

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Figure13. Showing the existing layout of Lakshmi Devi Nagar Site.

- Open pockets is disorganised
- Building orientation and planning of space is not technical
- Space between each building



Window Size and positioning

Figure14. Buildings at Lakshmi Devi Nagar Site

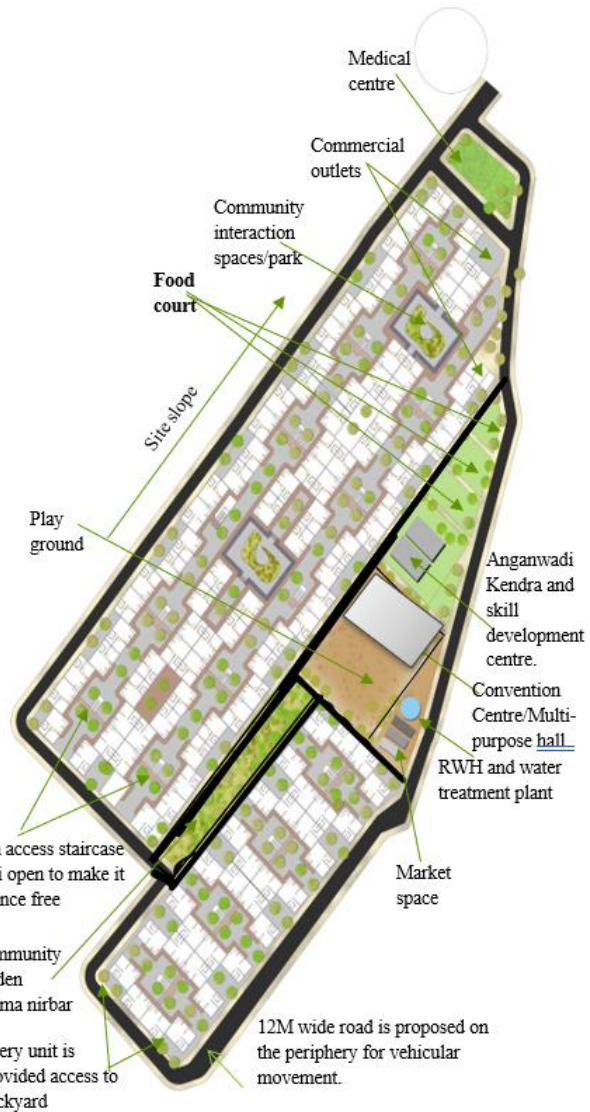


Figure15. Proposed layout for Lakshmi Devi Nagar Site.

Figure 15 showing the Masterplan with implementation of SDG- 1-6 goals in design solution and the user issues are addressed



Figure 16. The energy efficient criteria of green building, roof top proposal showing the solarpannelsand RWHT system. Addressing the SDGoal-7.

Source: Author designed 3d of the building

The site has to be prepared simultaneously to the offsite construction process, and made ready for installation.

This type of house includes roof and flooring thereby reducing the time, cost and labors for construction. Making it more self-sustainable. The concept is to reduce landfill by using construction debris and maintain the environment more sustainable. Each unit is of 25sqm and it is well lit natural light & cross ventilation, and to make it more sustainable and energy efficient roof top solar panels are suggested so that the power for the community can be supplied from harvesting electricity in-situ. Lot of green spaces not only adds to the environmental ecosystem but also adds to a health and well-being of the community. The design is to suite the post pandemic condition to achieve that the common areas are kept open and the individual units are also placed in such a way that the social distancing is maintained. To address the criteria's from IGBC and LEED green concepts, the site is maintained with 40% of lung space with lush greenery, 70% of the interior is lit with day light throughout the day, as the building is designed with offsets the shadow casted by one wall on the other and the green open space with trees will cast shadow on the wall hence reducing the heat gain coefficient inside the building. As the building is surrounded by trees and wall window ratio 1:0.2 is maintained. The interior space, for kitchen glazing is kept two and other rooms it is 1 as per standards. As the structure is G+2 only accessibility and circulation is also addressed.

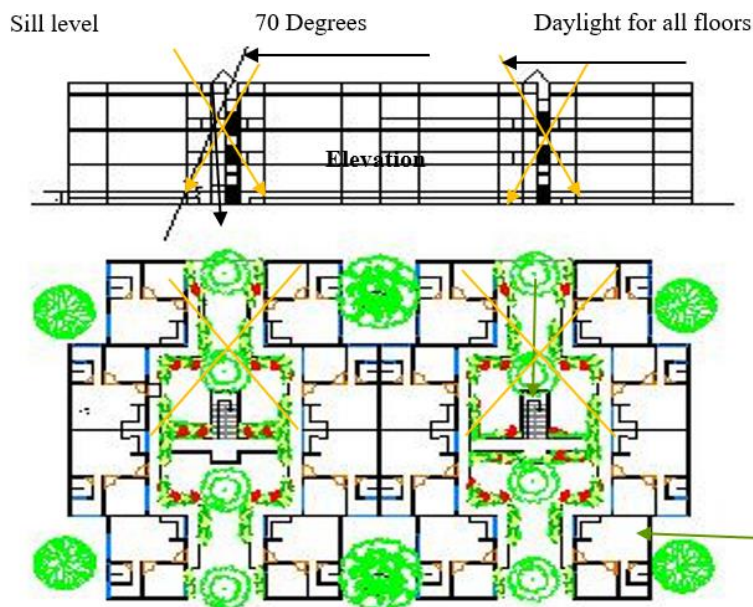


Figure 17. The Plan of two typical unites of the Community showing Day light and air ventilation.



Figure 18. Key plan

Type of Regularly Occupied Spaces	Glazing Factor (GF)*
Living/ Bedroom	1
Study room	1
Kitchen	2

Source: IGBC GREEN HOME RATING SYSTEM VERSION 3.0

Glazing factor can be calculated using the formula given below:

Glazing = Window Area [sq.m] x Actual Visible Transmittance of Glazing x Constant x 100
Factor of Floor Area [sq.m]

$$= 2.4 \times 1.2 \times 0.5 \times 100 = 30/144 = 0.2$$

Constant Values:

Windows on wall: 0.2

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Lighting standard: as per IGBC

In any high raise buildings, the ground floor is quenched with light and ventilation due to closely placed adjacent buildings. According to standards there is a mandatory compliance the building design should meet. The building should meet the 70 degree obstruction angle which is measured by drawing the angle of the building sill to the highest point of the adjacent building. In this project, this criterion is met as the interaction spaces are maintained in between the buildings. Figure 9 showing the natural light and ventilation.

According to IGBC standards, for floor less than 5, the design criteria for operable openings to the exterior such as doors and casement windows should not be less than 25% of the carpeted area of the particular room. This criteria is taken care in this project.

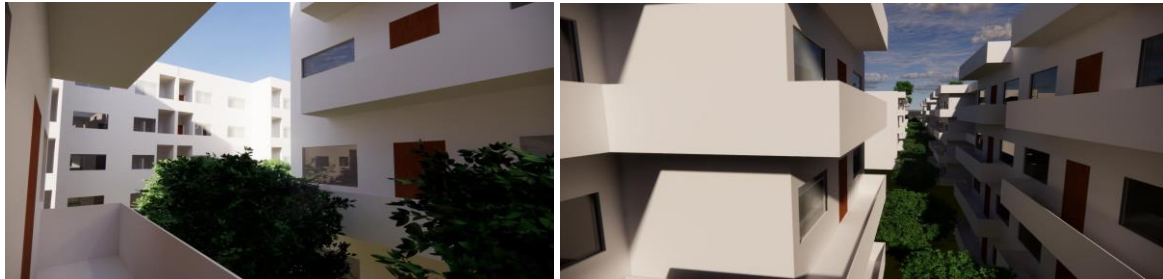


Figure 18 & 19. Community utility like back yard which provides better light and air ventilation

The views in the Figure 18 & 19 are showing the backyard of the utility where the occupants have the privilege of getting natural light and ventilation. The foundation is much simplified to save on the cost and materials but keeping seismic design in consideration. The building thus will stand intact. The precast modular blocks will be faster and easy to erect with simple concept of plug and notch making building net zero. This technique will reduce the landfills in the city. The usage of salvaged door, windows, furniture's, fittings and fixtures from demolition sites will further reduce the wastage of materials and reduces the construction cost drastically. It this building gets dismantled than every part of it can be reused.

Table 5. Showing the Proposed land use.

PROPOSED LAND USE DATA		
Category	Area(m ²)	Percentage (%)
RESIDENTIAL	7035.52	36.44
COMMERCIAL	380.76	1.97
DESIGNATED OPEN SPACES	2648.79	13.72
CIRCULATION OPEN SPACES	4135.54	21.42
SHARED BUILT UP	473.57	2.45
ROADS	4633.44	24
TOTAL	19307.62	100

Points achieved in the proposal

- Rethinking the livability of urban poor under PMYA scheme.
- To provide dignity of life.
- To support and implement the SDG of Karnataka Govt.
- Make the community and built environment self-sustainable & net-zero.
- To provide Sociability, good health and well- being
- To provide Sustainable Site Planning

CONCLUSION

The preliminary result was as we had grouped the house with pockets of utility for group of four houses which is kept open to sky, each house has the privilege of getting cross ventilation into their houses as well as day light. This approach not only met the standards as per NBC, IGBC & LEED but also increased the quality of indoor space. The sizes of the windows the wall-window also plays a major role in trapping good daylight and air circulation inside the building. The materials used in the building also have an impact on the IEQ, the radiation factor should be considered.

To conclude, the shell of the structures keeps the indoor environment cool and comfortable. The materials we choose to use acts as the media between indoor and outdoor. The materials with high reflectance are preferred. Hence not only the wall window ratio but the placement of the window the size, the orientation of the window also matters in bringing thermal and visual comfort for the occupant comfort in a built environment it is also the materials and its usage also place an important role in bringing IEQ. This design is a prototype for moderate climate but is tailor made to suite all 5 climatic zones of India.

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