Design of G+5 Green Building

Mr. Viraj Kashikar , Pramod Ubale , Sanyukta Pimpalse , Rohit Kate , Somnath Saptal

Student, D.Y. Patil College of Engineering, Akurdi,Pune,India.

Professor, D.Y. Patil College of Engineering, Akurdi,Pune,India.

ABSTRACT: Designing the G+5 Green Building using modern materials and innovative techniques making it more affordable. For making the structure eco-friendlier. Materials like AAC Blocks, Double Glazing Window glasses, Low VOC Paint, Low flush toilets are use. The orientation plays an important role to maximize the use of natural resources. The structure has basement floor for parking and upper 5 floors each having four, 2BHK flats. For better ventilation and natural light 2 side ducts and 1 circular duct is provided. On grid connected 100kw roof top solar panel, which generates 154550 kwh/Annum. The analysis of risk factor is done by combination of long-term analysis and regular analysis. The results show that Green Building reduces the risk of the occupants and workers. Buildings use 40% of primary energy worldwide so energy conservation is an important aspect. Use of Gravity batteries for storage, use of solar powered street lighting system, 100kw hybrid solar system on roof is done. Water conservation by rainwater harvesting is done considering mean annual rainfall=1000mm and catchment area 541. 62m.sq results in 487458.00 litre per year and designing the underground storage of 600000.00 litre and overhead water storage of 2 days continuous water supply and 1 day for backup. Provision of 500 LPD solar water heater system for supply of hot water.

KEYWORDS: Energy Conservation, Design, Materials, Building Orientation, Rainwater Harvesting.

I. INTRODUCTION

GREEN Building is an age-old Phenomenon which can be practice with very minute changes in the conventional building techniques and materials, which will lead to sustainable development and conservation of environment. It can be defined as the journey to maintainability. Green Buildings will help countries to meet their commitments under Paris Agreement on Climate Change. Various projects like Suzlon energy Limited-Pune, Bio-diversity Conservation India-Bangalore are done under the initiative of Smart Cities Mission, Pradhan Mantri Awas Yojana (PMAY) and AMRUT. The design of G+5 Green building is done by considering the region of Maharashtra, India. The shape, design and orientation of the building plays an important role to utilize natural resources like light. By analysing the risk management, consumption of power, water while construction and during the life cycle of the building, Green Buildings are made eco-friendlier and more economic. Non-toxic materials are used to reduce the risk of health of workers and occupants which leads to outcome of healthy lifestyle. Solar powered streetlights are used so we don’t have to provide electricity from outer source, 100kw solar panels are also install on terrace for other needs and solar water heating systems for hot water. Use of Double-Glazing windows, LED bulbs, Gravity Batteries is done. Green buildings play an important role in reduction of Carbon footprint and emission of toxins. This Green Buildings are approved by organizations like GRIHA, LEED, IGBC which sets benchmark for green initiatives.

II. LITERATURE REVIEW

Green building can provide an important contribution to sustainability, for example, by improving energy efficiency, by improving indoor air quality, and by effective waste treatment. Green development is undeniable that it can reduce environmental impact compared to conventional development methods that use materials that can endanger the environment. Use of AAC blocks, low VOC paints, low flush toilets make the green building more remarkable.

III. METHODOLOGY

- Adoption of following methods helps to build the effective green building-
- Use of solar panels for energy production.
- Construction of ground water tanks to collect rainwater.
- Installation of gravity batteries to store electricity.
- Adequate provision of vents for air and light circulation.
- Use of eco-friendly material.
- Installation of sensors for automatic operations that can save energy.
- Greenery in building area through tree plantation.

IV. DESIGN OF STRUCTURE

4.1 SOFTWARE DESIGN-

SHAPE, DIMENSION & ORIENTATION

- For our project, we are designing G + 5 structures, which have basement floor for parking & upper 5 floors are for residential purpose.
- On each floor, we have four 2bhk flats.
- Our building has 1 passenger lift, 1 staircase way for emergency exit.
- We are providing 1 centrally located circular duct of size 3.000m in diameter for better air circulation & natural light.
- We are also providing 2 side ducts of size 5.250m * 3.000m for better ventilation & sunlight.
- Providing ground water tanks to collect rainwater.
- Space for installation of two gravity batteries.

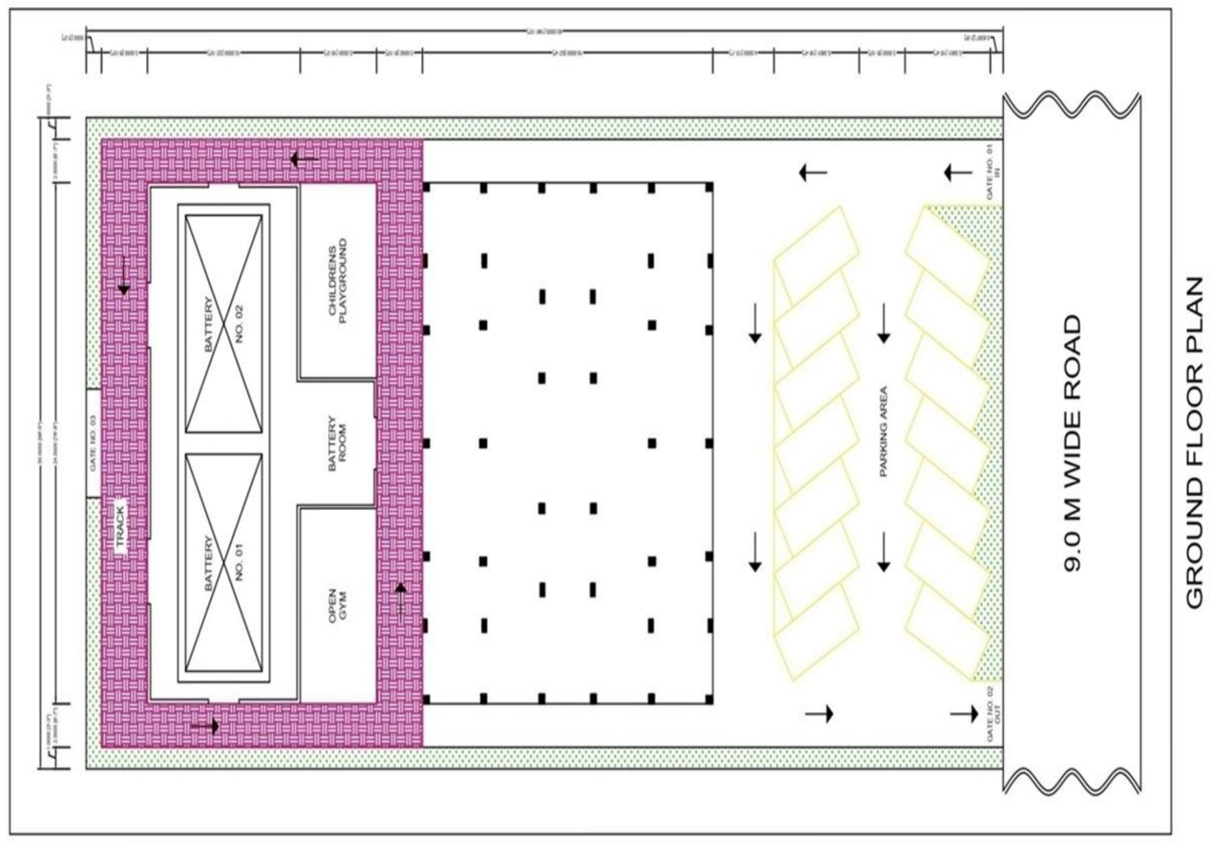

Fig 4.1.1 Ground Floor Plan

Each flat consists of following areas,

- **Shoe Area** = **1.500 * 1.300,**
- **Temple** = **1.500 * 1.500,**
- **Living Room &Dining Area** = **5.175 * 3.700,**
- **Balcony** = **5.325 * 1.150,**
- **Kitchen** = **3.975 * 2.500,**
- **Utility Area** = **1.500 * 2.500,**
- **Children Room** = **3.150 * 3.900,**
- **Master Bedroom** = **3.150 * 3.900,**
- **Master Toilet** = **1.500 * 3.650,**
- **Common Toilet** = **1.500 * 2.500,**

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 05 | May - 2022 Impact Factor: 7.185 ISSN: 2582-3930

- **Balcony (Master Bedroom) = 3.450 * 3.900**

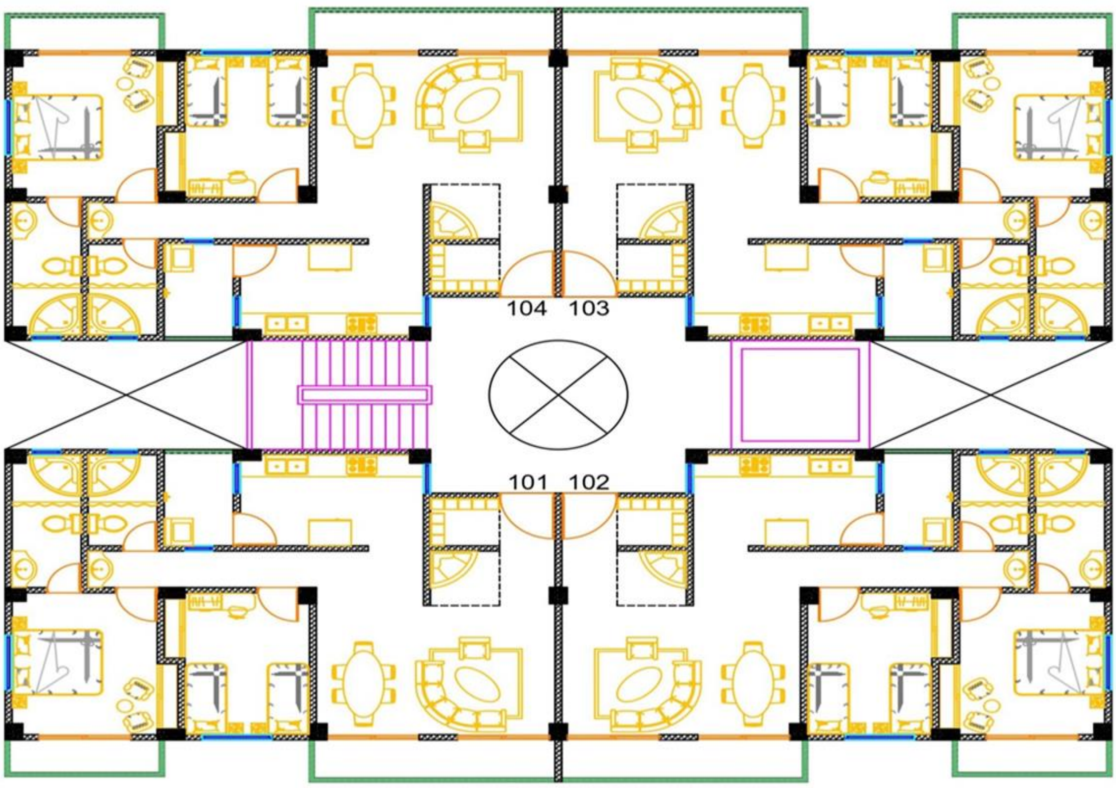

Fig 4.1.2 Floor Plan of First Floor

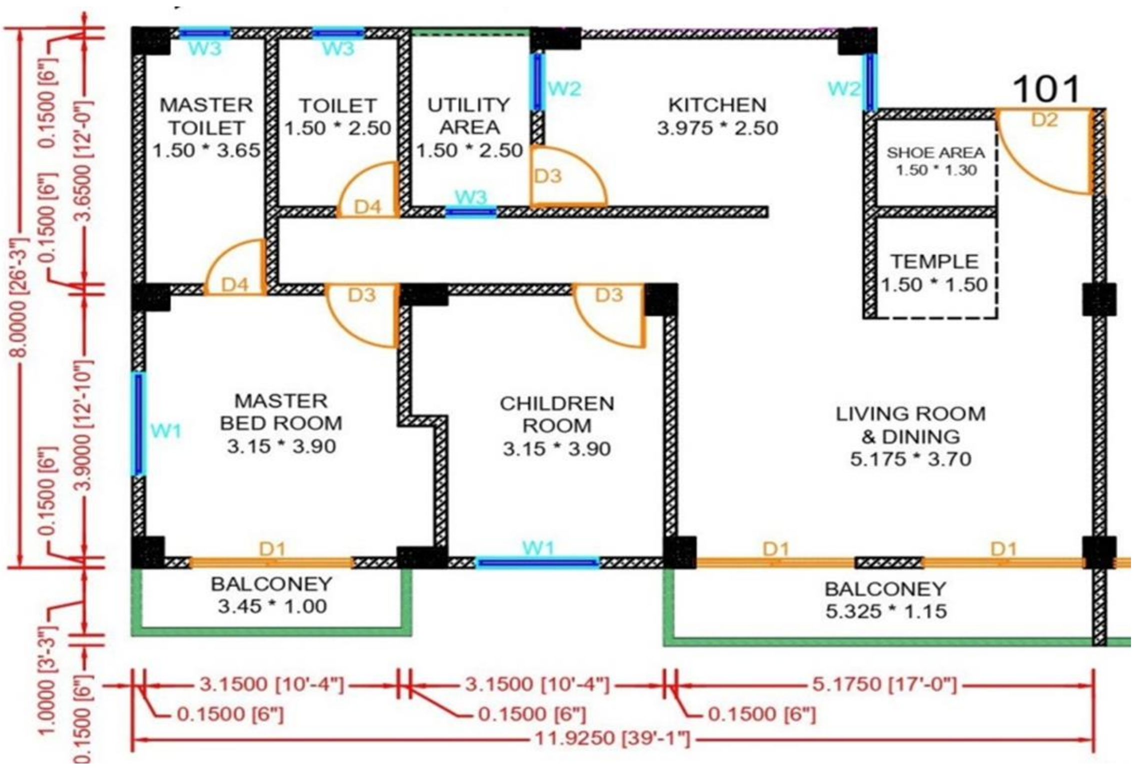

Fig 4.1.3 Detail Plan of Flat

Also, we are taking some considerations for our design are as follows: -

- Number of flats on 1 floor = 4,
- Total number of floors (Residential) = 5,
- Total number of flats in building = 4 * 5 = 20,
- Family members in each flat = 5/6
- Total occupants = 20 * 5 =100
- Number of vehicles in each family,
  - ✓ Car = 1,
  - ✓ Bike = 2,
  - ✓ Cycle = 2.

4.2 MATERIALS-

4.2.1 AAC BLOCKS- Autoclaved aerated concrete (AAC) is a lightweight, precast, foam concrete building material suitable for producing concrete masonry unit (CMU) like blocks. Composed of quartz sand, calcined gypsum, lime, cement, water & aluminum powder, AAC products are cured under heat and pressure in an autoclave. These types of blocks provide thermal efficiency & reduces the dead load of the structure.

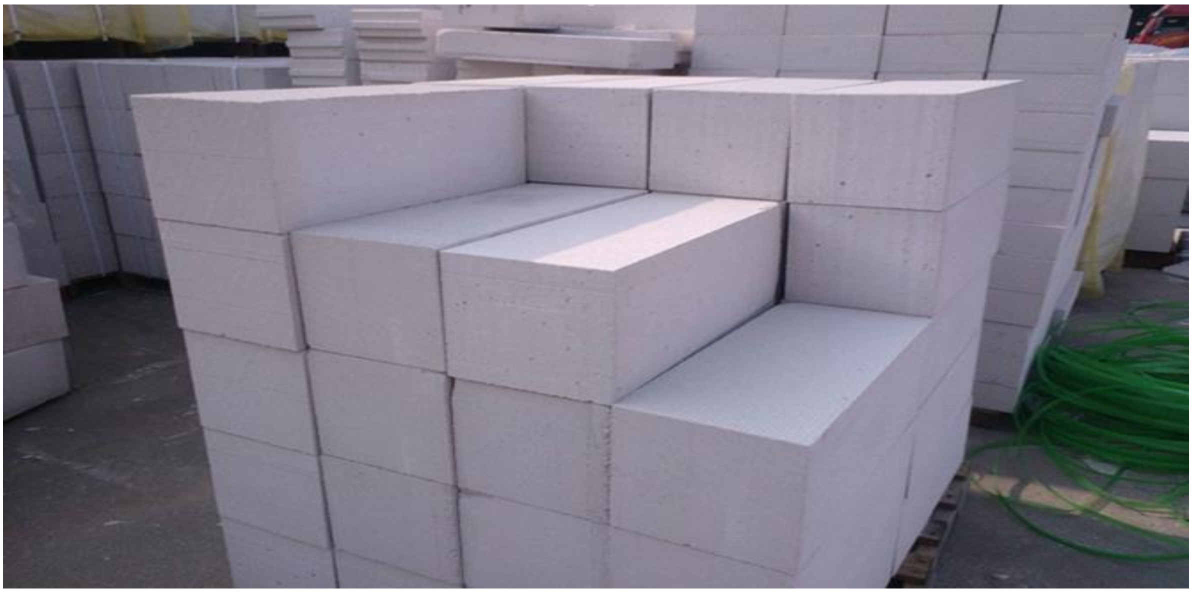

Fig 4.2.1 AAC Blocks

4.2.2 DOUBLE GLAZING WINDOW GLASS: - Double glazing window provides a layer of air or argon gas trapped between two panes of glass. Because air or argon gas is a very poor conductor of heat, so the trapped layer sets up a blanket of protection between cold air on one side and warm on the other. Hence, much less heat is lost through the window. If the inside of one sheet has Low E coating, even less heat is lost because the coating reflects heat back into the room. These type of windows are thermally efficient.

Fig 4.2.2 Double Glazing Window Glass

4.2.3 LOW VOC PAINTS: -VOCs (volatile organic compounds) are ingredients in paint and other products that easily evaporate into the air at low temperatures. This paint makes buildings and their occupants healthier. These paints also cut down on the "paint smell" that permeates a room or building for several days after painting. Without these added chemicals, paint products are better for the environment & better for the occupants living in the buildings where they are used.
SUPPLIERS: Asian Paint, Berger Paint, Dulux India, Kansai Nerolac, etc.

4.2.4 LOW FLUSH TOILETS : -A low-flush or low-flow toilet is a flush toilet that is adapted in order to use significantly less water than a full-flush toilet. Low-flush toilets use a special design of the cistern and the siphon in order to allow the removal of faeces and excreta with less water. Most often, they also include a dual flush system, with one flush being designed for urine only, using even less water than the other designed for faeces. Low-flush toilets work with a very small amount of water. The exact amount of water varies between less than liters (for urine only) up to 6 or 8 liters. These toilets can operate by gravity or vacuum.

4.2.5 SOLAR PANELS-

Fig 4.2.3 Solar Panel

The sun is an unlimited resource that can used to generate power throughout the world. It can be much beneficial to green building to utilize maximum solar energy through solar panels. In our structural design we have planned installation of panels on the roof for hot water as well as for electricity generation. Also, the installation of solar panel's is planned for streetlights in building area.

V. ANALYSIS

5.1 ELECTRICITY ANALYSIS

5.1.1 ELECTRICITY CONSUMPTION-

APPLIANCE	WATTS	NUMBERS	USAGE (In Hours)	TOTAL UNITS CONSUMED PER DAY
LED/CFL LIGHTS	20	3	8	0.480
FAN	30 (36 Inches)	2	10	0.600
IRON	550	1	0.5	0.275
REFRIGERATOR	200 (155 Liters)	1	10	2.000

Hence Total electricity consumed by = 5.500-unit for 1 family per day. Total electricity consumed by = 5.500 * 20 for all 20 families per day. = 110 units **Hence, electricity consumption by all families per day is 110 units.**

5.1.2 ELECTRICITY GENERATION-

Our building requires totally 320 units of electricity per day. For to fulfill that demand we have to install 100 kw solar power plant on the roof of the building. (Rooftop solar system). A 100-kw solar power plant produces nearly 380 – 420 units of electricity per day. For our project, we use hybrid solar system which combines both on grid & off grid systems. Hybrid systems can provide the flexibility of being able to store the energy we generate during the day instead of feeding it back into the grid - typically at a low feed-in tariff. This energy can then be used in the evening instead of buying power back at a higher price.

Hence, we must install 100 kw hybrid solar system on the roof of our building.

5.1.3 ELECTRICITY STORAGE-

Our solar power plant produces nearly 400 units of energy per day. So out of those 400 units, we must store 300 units of energy for our nighttime electricity consumption. So, we designed 2 batteries of 160 unit's capacities, from those batteries we roughly get 300 units of electricity storage. (Neglecting other factors, efficiency, etc.) For those batteries, we excavated a big rectangular area of 22m * 6 m up to a required depth. Also, this excavated area is also acts as a well aquifer, which provides us water.

5.2 WATER ANALYSIS

5.2.1 WATER CONSUMPTION-

As per Ministry of Housing and Urban Affairs, 135 LITRE PER CAPITA PER DAY (LPCD) has been suggested as the benchmark. (Source: NBC 2016, BIS). For rural areas, a minimum service delivery of 55 liter per capita per day (lpcd) has been fixed under Jal Jeevan Mission, which may be enhanced to higher level by states. or urban water supply. So, for our Further calculations (& simplicity), we take 135 lpcd as an average water consumption value by per person per day.

These 135 lpcd is distributed as: -

- Drinking = 05 lpcd
- Cooking = 05 lpcd
- Bathing (hot & cold water) = 55 lpcd
- Washing of clothes = 20 lpcd
- Washing utensils = 10 lpcd
- Washing & cleaning of house = 10 lpcd
- Flushing of water closets, etc. = 30 lpcd.

Now, in our project, No. of Families = 20

No. of person in each Family = 5 / 6

Water consumption by each person = 135 Lit/Day

Hence,

Water consumption = 20 * 5 * 135 Lit

= 13,500 Lit/Day

These is community type system supplying water to various flats. So, we must increase demand by 25%.

Total requirement = 13,500 + 13,500*25/100

Total water consumption = 16,875 lit/day.

5.2.2 HOT WATER CONSUMPTION-

Generally, there are two systems of supplying water from water tanks to apartments: **Individual System-**In general, it could be 100 liters per flat for two bedrooms, in case individual systems are installed for each apartment.

Community System: - In case of a community system supplying hot water to various apartments, requirement is increased to about 25% of individual system requirement. Community system is preferred if hot water is to be provided to all the apartments and the building is of more than three storey's. In our project, we divide our flats in 4 wings.

- Wing A = Flat Nos. 101, 201, 301, 401.
- Wing B = Flat Nos. 102, 202, 302, 402.
- Wing C = Flat Nos. 103, 203, 303, 403.
- Wing D = Flat Nos. 104, 204, 304, 404.

Now, for wing A,

- Total number of flats = 4,
- Family members in each flat = 5 /6 persons,
- Hot water required per person= 20 lpcd.

Hence, Hot water required for wing A is,

- Hot Water for wing A = 4 * 5 * 20

=400 Lit/Day. These is community type system supplying hot water to various flats. So, we have to increase demand by 25%. Hence, Total requirement = 400 + 400 *25 / 10= 500 Lit/Day So, we have to place 500LPD solar water heater for wing A. Similarly, we must place 500LPD Solar water heater for each wing B, C & D. **Finally, we are at the conclusion of that we required FOUR 500 LPD solar water heater system.**

5.2.3 WATER COLLECTION

5.2.3.1 RAINWATER HARVESTING-

The Annual Rainfall of Maharashtra is 1000mm/year. So, for our Further calculations (& simplicity), we take 1000mm/year as a Average Rainfall value for Maharashtra. Also, the calculated catchment area is 541.62m2. (With the help of AutoCAD software catchment area is calculated.) For rainfall calculation we take the following formula: Water collected = mean annual rainfall in m2 x area in m2 x runoff factor Mean annual rainfall = 1000 mm
Catchment area = 541.62 m2 Runoff factor = 0.9 Hence, Water Collected = 1000 * 541.62 *0.9 = 4,87,458.00 liters. **Hence, total amount of water collected by harvesting the rainwater is 4,87,458.00 liters per year.**

5.2.3.2 WELL-

The traditional and still most common method of obtaining water from groundwater sources in rural areas of the developing world is by means of hand-dug wells. In wells inflowing groundwater is collected and can be extracted with the help of pumps or buckets. For gravity batteries, we have excavated a big rectangular area of 22m * 6 m up to 50 m depth. That dogged well is also used for water collection. (We don't need to dig another special well) Wells with a large diameter and depth expose a greater area for infiltration, and therefore provide fast recharge. **Hence, the remaining amount of water is collected from well aquifer.**

5.2.4 WATER STORAGE

5.2.4.1 UNDER GROUND WATER STORAGE-

We have 2 water collection sources, i.e., Harvested rainwater & well. As we know, we don't need any special type of storage tank for to store water pumped from well. We can directly store/provide that water to our overhead tank. But we need to make a special storage tank for to store the water which is collected from the rainwater. Since the total amount of water collected by harvesting the rainwater is 4,87,458.00 liters per year. Since this is very big amount of water hence, we are adding 20% extra storage because of fluctuations in rainfall. **So, finally we are designing our storage tank for nearly 6,00,000.00 liters of water. Since this is large amount of storage, hence we make this tank under the ground**
This tank is constructed below the parking area. Dimensions for 6,00,000.00 liters of water storage tank are:

- **Length = 20 m,**
- **Breadth = 10 m,**
- **Height/Depth = 03 m.**

5.2.4.2 OVER HEAD WATER STORAGE-

Our building requires, 16,875 liters nearly 17,000 liters of water for daily routine. So, we have to design the overhead tank which provide minimum amount of water for 1 day for occupants. For this purpose, we are designed 2 over head tank above the staircase room & lift room. **These tanks are having the dimensions**

- **Length** = **3.5 m,**
- **Breadth** = **3.0 m,**
- **Height / Depth** = **3.0 m.**

Volume of these tanks are

Volume = 3.5 * 3.0 * 3.0 * 2

= 63.0 m3

Conversion from m3 to liter:

1 m3	=	1000 Liter
63.0 m3	=	63,000 Liter

These tanks provide 2 days of continue water supply & 1 day for backup water supply.

- 2 days' Supply = 34,000 Liters,
- 1 day backup supply = 17,000 Liters,
- Fire Safety = 12,000 Liters.

VI. RESULT

- On site solar power plant produces energy which is used by occupant which results to reduce the carbon footprint.
- By providing the Gravity battery we reduced the load on power connectivity systems (MSEB), which also results to do not form the duck curve.
- By implementing gravity battery on a larger scale, we decrease the need for fossil fuels, significantly cutting down CO_2 emissions
- On site water harvesting system provides water to occupant which reduces the load on water management department & increases the water efficiency.
- By using the recycled material, we minimize the environmental impact.
- By using the AAC blocks we reduced the dead load of the building, which results to minimize the use of concrete & reinforcement provided to the building.
- Separate plumbing system achieves the water efficiency by recycling and reusing the water for flushers, gardening, etc.
- By using water recycling system, we reduce the load on the waste streams, which reduces the water pollution.
- By using the low VOC paints, we are increase the indoor environmental air quality which results to improve the healthier space to the occupant.
- Use of electric vehicles, results to minimize the CO_2 emission.

- Overall, by using all techniques, we improve the quality of life & also conserve & restore the natural resources.

VII. CONCLUSION

- This project identified the exciting developments taking place on the technology front and analyzes their implications for intelligent and green buildings, highlighting examples of "best in class" buildings employing green and intelligent technologies.
- Use of low emitting vehicles like battery charged vehicles, CNG cars etc. helps in reducing indoor air pollution.
- Wastewater collected must be recycled and reused for flushers, gardening, thereby we can use water efficiently.

- This project provided documented evidence to educate and influence end-users, building owners, architects, and contractors that a "greener building" can be achieved using intelligent technology and that this "greening" will provide a tangible and significant return on investment.

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