DOMUS SEKHMET

"THE HOSPITAL IS A HUMAN INVENTION AND AS SUCH CAN BE REINVENTED AT ANY TIME"

- LELAND R. KAISER

ENVISIONING A HOSPITAL REDESIGN PROPOSAL FOR AN OFFICE BUILDING INCLUDING SUSTAINABLE MEASURES, STRATEGIES AND LOW CARBON FOOTPRINT.

BUILDING, CONSTRUCTION AND INFRASTRUCTURE SOLUTIONS ARE CONSIDERED TO ENHANCE ENERGY AND WATER PERFORMANCE.

GRIHA Trophy 2022-23
CLIMATE ANALYSIS

28.5013° N, 77.4111° E

CLIMATE TYPOLOGY - COMPOSITE CLIMATE

ANNUAL RAINFALL - 65.71 MM

AIR QUALITY INDEX - 265 AQI - POOR

SUITABLE TO HARVEST SOLAR ENERGY DUE TO SUFFICIENT SOLAR RADIATION

NOT SUITABLE TO HARVEST WIND ENERGY DUE TO LOW WIND SPEED

SUN PATH DIAGRAM

SUMMER SOLSTICE

WINTER SOLSTICE

SUN SHADING CHART

Sun shading is required for all months except from December to February. Windows are effectively shaded between sunrise till noon for these months. Windows are required to be shaded for the rest of the hours.

DRY BULB TEMPERATURE CHART

A major part of the working hours are depicted as uncomfortable by the dry bulb temperature graph. The months from December to February have the most uncomfortable temperatures during working hours.

PSYCHOMETRIC CHART

By sun shading and addition of cooling and dehumidification systems, up to 67.7% of comfortable hours can be achieved. Active and passive design strategies are added to majorly address these requirements in the design.

WIND ROSE DIAGRAM

The prevalent wind direction during working hours (from 10 am to 6 pm), annually is from the North-West direction. The secondary wind direction is considered to be in the South-East direction.

RADIATION ANALYSIS

- Climatic Insolation: 1,274.0686 kWh
- Solar Gain: 1,99,255 m² selected

Depicts the annual solar radiation to analyse the sides of the building that majorly contribute to heat gain within the building.

From this, the facades that contribute to heat gain and need treatment have been observed and treated as per requirements.

Active and passive design strategies have been adopted to reduce the observed radiation values.

SOLAR PV ANALYSIS

- PV Energy Production: 11,855.74 kWh/Year
- Building Energy Offset: 42,420 m² PV panel area
- 4.8 years Payback

Depicts the sides of the building that can harvest the maximum amount of solar energy for the building to be fully sustainable.

It shows the best building orientations on which the PV panels can be installed to achieve high energy efficiency.

The panels will be installed only on these facades to cut down on cost and maximize efficiency.

CONCEPTUALIZATION

The main intent that was to be achieved through this proposal was to design a building that "breathes," just like any other living organism.

The approach for this was mainly through the understanding of the climatic advantages and disadvantages, along with the consideration of user comfort.

Prioritization was given towards the understanding of the daily functioning of a hospital - its thermal and energy levels and their impact on occupant functioning and comfort levels.

Designed to ‘envision’ and be resilient for the future - this project is designed to be adaptable to various unpredictable situations that our generation has faced along with the key element that our future generations require - sustainability.

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Registration code: 6SGRIHA - 10
**Construction Management Strategies**

**Wheel washing facilities** are provided at all entrances and exits of the site to ensure that soil pollutants remain within the site boundary.

**Topsoil preservation** is done by introducing porous mats to ensure that the soil remains undisturbed by vehicular and human activity.

All vehicles that carry waste out of the site are covered to prevent further pollution outside of the site boundaries.

**Barricades** up to 3 meters high are provided during the construction phase to prevent air and soil pollution outside the site boundary.

**Water sprinklers** are used over construction material in order to minimize the airborne dust pollution that occurs during construction. The use of non-potable, recycled water ensures sustainability and reduction of water wastage.

Introduction of waste segregation bins during the construction phase will ensure proper wet waste disposal and recycling of building material and dry waste.

Use of gunny bags for curing concrete reduces water demand while assuring efficiency of the curing process.

All vehicular movement on site is restricted to 10 kmph to ensure that surrounding soil and construction debris remains undisturbed and prevents undesired dust. This will reduce both air and soil pollution on site.

Foam Dust Suppressants are used on unpaved pathways to reduce the dust from the construction site that pollutes the surrounding air. It ensures lower water consumption in comparison to the use of water sprinklers.

Using non-potable, recycled grey water for concrete mixing reduces wastage of potable water. Also, addition of water-reducing admixtures in the concrete mixture for construction of additional columns, beams and slabs will reduce water consumption.

**Site Plan and Landscaping**

Light wells are provided on the landscaping areas for light to reach the green spaces present in the basement in order for them to thrive. These light wells are converted into **lily ponds** on the ground level which also reduces the UHI effect and creates a microclimate.

**Xeriscaping** is adopted to landscape the area around the building to ensure low water consumption and promote existing biodiversity.

Trees and plants endemic to Noida have been chosen to nurture the existing ecosystem which will be beneficial for both occupants and other living organisms surrounding the site.

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Registration code: 65GRIHA-10
According to the surrounding data like window location, size and orientation, the facade is designed with openings and orientation with the help of Grasshopper. As the script's value can be altered, this can be used to any location by changing the values which makes it flexible and versatile making the design universal.

Double Skin Facade:

Algae are grown in between the steel structure to help in purifying the air that flows into the building by absorbing the CO₂ gas molecules.

Water is passed through the facade panels which transport the water from the outer to the inner steel structure. The water received is sprinkled onto the algae-grown metal mesh resulting in refurbishment.

Through a period of time when 0.7 kg of algae absorbs up to 1.3 kg of CO₂, it reaches its restraint and dries up.

Bio Reactor:

The dried particles of algae falling into the glass panels are collected and that is treated through the bioreactor and this as a result generates electricity.

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**Dedicated Outdoor Air System**

A **dedicated outdoor air system** is an HVAC unit that is installed outdoors and often used with other HVAC equipment. These units bring fresh outside air into interior spaces independently from heating or cooling systems.

It supplies cooled and dehumidified outside air to a building in the summer and warm outside air during the winter.

**Active-Passive Chilled Beam System**

An active-passive beam system effectively provides cooling to a space **without adding to usage of fan energy** – all while promoting a high level of occupant comfort and energy efficiency.

**Energy Recovery Wheel**

An **energy recovery wheel** consists of a circular matrix of heat-absorbing material, which slowly rotates within the supply and exhaust air streams of an air system.

The wheel transfers energy between two air streams it gains or loses heat to the opposite air stream.

As the wheel rotates into the incoming airstream, energy is released by the wheel to heat and humidify the incoming airstream closer to indoor conditions, reducing unit workload and energy consumed by the heating system.

During summer, heat and humidity are captured from the fresh outdoor air.

**DESSICANT DEHUMIDIFIER WHEEL**

A **desiccant wheel** is a common type of sorption dehumidifier using a solid desiccant. The desiccant material is coated and placed on the supporting rotor structure.

The desiccant wheel is called a passive desiccant wheel as it functions when there is no air heater. It functions as an active desiccant wheel when provided with an air heater.

The wheel is installed with thermal insulation and air-proof material, so no mass and energy exchange takes place with the surroundings.
Air curtains at entrances of spaces that have temperature differences ensure thermal control and reduction of energy consumption. Porous mats with suction technology placed under the air curtains create a system that traps dust and unwanted particles from entering other rooms.

Continuous monitoring of indoor air quality levels through installation of sensors in different parts of the building to ensure health and well-being of occupants.

Air sanitization systems are a crucial requirement in hospitals for the maintenance of a clean air environment for occupants. Energy efficient air sanitization systems are installed throughout the building.

Introduction of indoor plants that purify the air and reduce pollutants in the air create a refreshing environment for the occupants. These plants also ensure that oxygen levels are replenished within the building.

These water-based natural paints (No-VOCs) give off almost no smell. They are made from natural raw ingredients such as water, bees wax, plant oils and resins, plant dyes and essential oils and natural elements such as clay, chalk and talcum.

PUF panels, being good heat insulators, protect the inner environment from the heat and sunlight, thus keeping the structure cool. This saves the costs incurred in indoor cooling. PUF panels can also retain the heat inside the structure to keep it warm and comfortable inside. They also provide acoustical shielding effect and weather resistance.

This material is available locally - at a distance of 12 kilometers from the building site.

Refrigerants used for cooling systems in the building are CFC and HCFC free (compounds that are responsible for depletion of the ozone layer).

Fire extinguishers placed in the building consist of halon-free compounds which are responsible for ozone depletion and other health concerns.

Mirror ducts capture zenith daylight (which is brighter than lateral daylight) through external collectors. The light is channelled into horizontal reflective ducts within the false ceiling. Daylight harvested from mirror ducts is usually glare-free and the technology involves no mechanical parts and requires no power, enabling a considerable energy consumption.

Artificial lighting for the building is designed to meet the recommended lighting level for specified tasks for different spaces. This is done by uniform distribution of light and providing visual comfort by avoiding glare and placing lights in favorable positions throughout a space.

Most of the artificial light requirements are fulfilled with dimmable LEDs, and lamps that provide a high colour rendering index value to ensure better visual quality.

Occupancy sensors ensure efficient use of provided artificial light. It controls the dimmable lights according to occupancy and day-lighting in a space.
WATER DEMAND REDUCTION

Flow rates for the water fixtures in the hospital are maintained as per the required building norms. These are lower than the given GRIHA base case and play an important role in reducing water consumption in the building.

Demand for municipal water has been reduced by re-using the treated grey water waste within the building for non-potable applications such as flushing.

High efficiency fixtures are used to reduce water consumption by 20-30%. Dual flush water closets, low-water consumption urinals, pressure reducing devices, and water conserving shower heads are introduced for the same.

LOW-FLOW FIXTURES

1 LPF
4.5 LPM
4/2 LPF
4 LPM

WASTEWATER TREATMENT

The grey water and black water disposed from the building are collected in separate networks, are sent for treatment and made fit for non-potable uses in the building. This water is re-used for landscaping and flushing.

Overall water discharge of the building is zero, since all the waste water generated is treated and re-used for non-potable applications - that includes landscaping, HVAC systems and flushing.

MOISTURE-NANO TECHNOLOGY IRRIGATION SYSTEM

The piping and connections used in moisture nano technology irrigation systems are similar to those used in drip irrigation however, there is one key distinction; these sensors enable detection of moisture levels and water the soil accordingly. When compared to other approaches, this procedure can cut the amount of water used by 75%.

SOLID WASTE MANAGEMENT

WASTE SEGREGATION BINS

Provision of separate multi-colored garbage bins for different types of solid waste ensures segregation of toxic and non-toxic recyclable materials.

In a healthcare facility, it is key importance to separate the bio-medical, hazardous, electronic, dry and wet waste produced to ensure proper disposal of each waste typology.

AUTOCLAVE SYSTEM

Bio-medical waste must undergo proper treatment before their disposal to prevent further pollution in the environment.

For this purpose, the AUTOCLAVE SYSTEM - a steam-based waste treatment system is introduced in the building to ensure the same.

ORGANIC WASTE TREATMENT

Conversion of organic waste into other usable resources compost, CNG or manure is done on-site by introducing composting bins and an organic waste composter. This compost is then re-used as manure for the landscaping and vegetation present on-site.
Non-Hazardous solid waste resulting from construction and demolition activities are processed and transformed into blocks of the desired size.

Pavers that are environment-friendly for Exterior floorings and allow rainwater to run down underground while laying comprises a layer of solid concrete pavers separated by joints filled with small stones. It's not likely to shift over time with factors.

Steel plants around Noida yield slag that can be used as a substitute for cement. It increases strength, reduces permeability, improves resistance to chemical attack and inhibits corrosion of rebar.

Microalgae are one of the most effective sources of renewable energy production. It can grow at high rates and capable of producing oil along the year. Microalgae biomass was first suggested as a feedstock for biofuel production and received early attention for commercial application.

These panels are efficient and provide long-lasting protection against bacteria therefore they can be used in spaces that require strict sanitary requirements.

Panels made of polyurethane usually sandwiched between two metal sheets helps to retain the heat inside the structure along with providing good acoustical properties resulting in saving energy costs while increasing the performance of a structure.

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**Annual Operative Cost of VRF**

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**Facade**

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**Radiant Cooling**

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LCA

3c. ENVIRONMENTAL IMPACT CATEGORIES:
Potential impacts are reported in kilograms of equivalent relative contribution (EQ) of an emission commonly associated with that form of environmental impact.
- acidification potential (AP) kg SO2EQ
- eutrophication potential (EP) kg NEQ
- global warming potential (GWP) kg CO2EQ
- ozone depletion potential (ODP) kg CFC-11EQ
- smog formation potential (SFP) kg O2EQ
- primary energy (m)
- renewable energy (m)

PRODUCT – A1. extraction.
A2. transport (to factory).
A3. manufacturing

CONSTRUCTION - a4. transport (to the site)
USE - b2. maintenance, b3. repair, b4. replacement, b5. refurbishment

END OF LIFE - c2. transport (to disposal), c3. waste processing, c4. disposal

MODULE D - d. benefits and loads: 1. reuse 2. recycling 3. energy recovery

WATER CALCULATION

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<th>Days in month</th>
<th>Domestic use</th>
<th>Drinking use</th>
<th>Irrigation use</th>
<th>Total consumption</th>
<th>Municipal Water(d)</th>
<th>Domestic wastewater</th>
<th>Blackwater(d)</th>
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Cooling use
- L/Tr: 5.5
- Tr per Day (peak): 150
- Max LPD: 825

Domestic use
- Use LPD/Head: 350
- Number of people: 150
- Total LPD: 52,500

Irrigation Use
- L/m²: 1
- Area m²: 3000
- Max LPD: 3000

LIFE CYCLE INTERPRETATION
- a. the production of building products: (a1-a3) life cycle phases with the dominant impacts.
- b. building operation: (b2 - b5) small yet significant impact on transportation and end of life; (a4, c2 - c4) have negligible environmental impact

MODULE D: (d) has resulted in a reduction of -
- GWP by 30%
- AP by 42% EP by 24% SFP by 31%
- LOWER HEATING VALUE BY 26%

GRIHA Trophy 2022-23
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