CHAPTER 7: STUDY OF RAJASTHAN ECO HOMES- CASE STUDIES
CHAPTER 7
CASE STUDY OF VARIOUS ECO BUILDINGS

7.0 INTRODUCTION

Various buildings in India are being rated by LEEDS (India) & GRIHA rating system. Few buildings are being studied for in-depth analysis of various energy efficient features & sustainable building design points.

7.1 CASE STUDY, CENTRAL UNIVERSITY OF RAJASTHAN (CURAJ), KISHANGARH, AJMER, RAJASTHAN

Figure 1: View of The Central University, Rajasthan

The Central University of Rajasthan established in 2009 and is located at Bander Sindri near Kishangarh on Jaipur -Ajmer Road. It’s campus is developed on green concepts particularly focused on water conservation, use of alternative sources of energy, solid waste management, vermin composting, green belt development, sustainable architectural designs of building etc. It has emerged as a model campus.
giving a message that in a water scarce area the problem of water crisis can be handled & mitigating the impacts of regional as well as global environmental challenges to a greater extent.

**Innovation and Design Process**

Central University of Rajasthan (CURAJ) has promoted ecological sustainability & recognized environmental responsibility as a way of life. Efforts to improve environmental sustainability comprise the establishment of the water-shed management, green buildings, sewage treatment plant, rain water harvesting, functional composting system (vermin composting), green belt development, installation of solar panels and solar water heaters etc. These campus sustainability efforts help to maintain the health of the public and surrounding ecosystems.

**Figure 2: Layout Plan of Central University of Rajasthan**
Sustainable Sites

The buildings in CURAJ are designed in such a manner where energy conservation techniques & sustainable building techniques are implemented. Green buildings are necessary since there is a growing awareness on carbon emissions. It doesn’t take much to make a building green: utilize locally available material, make the best use of sunlight and natural air currents, harvest rainwater and recycle water, and manage waste efficiently. This was accomplished with the coordination of different organizations & sustainable techniques. Complying ECBC with cavity walls of 2” thickness having extruded polystyrene insulation + roof slab with 3” polyurethane insulation to reduce heat gain - windows protected from direct solar exposure with the help of horizontal shading devices & precast vertical ‘Jalis’ a vernacular design feature of this region.

Figure 3: Courtyards at Central University of Rajasthan

Essential area of window glass is fitted with high performance glazing. Local stone is used for external cladding. In the master plan, much emphasizes is given on courtyards / enclosed spaces , cutouts in student’s hostels, passive systems like. earth air tunnel, geothermal heat exchange and two stage evaporative cooling. The existing Building Thermal Performance was recorded on 30.05.2013 and was found to be:
### Water Efficiency

**Rain Water Harvesting**: The rain water harvesting is carried out by collecting and storing rain water from roof tops and land surface. The principal components consist of the catchment area, conveyance system and collection device. The quantity of rainfall in Rajasthan being minimal, rainwater pipes for roof drainage are installed in the range of 75mm to 100 mm diameter.

Series of ponds have been constructed under the integrated rain water harvesting scheme. The total area covered is 217 ha. The total catchment is divided into 7 parts having area of 11 ha, 15 ha, 8.5 ha, 2.5 ha, 18 ha, 56 ha, 42 ha and 64 ha. Water gets collected into ponds. There are eight buildings which are equipped with...
water harvesting and sewer re-charge system, provide water into 30 bores raising the groundwater table to support the green cover. Two artificial water bodies on either side of the campus have 20 crore litres of water. Rare birds like egret, black nirds, ibis, heron and lapwing are now regular visitors to these ponds. These surrounding ponds are helping in maintaining the favorable microclimate of the university.

**Energy and Atmosphere**

**Solar Power**: Availability of sunshine for a larger part of the day makes it convenient to use solar energy to meet most of its own & in a first-of-its-kind initiative, meets 60% of its energy needs through solar energy. The university has successfully channelized solar energy to meet its daily requirement. The university campus has four buildings with a monthly requirement of 600 kilowatt electricity (for November 2013), of which 420 KW is generated by solar panels. The energy is used to heat around 80,000 liters’ of water and light up 62 electric poles in the campus. In addition to being eco friendly, the method is also proving to be cost effective for the university. It is now also planning to install four solar units of 30 KW each and one of 1 megawatt in the next year to run 100% on a renewable source of energy.

The university lies in the tropical region and receives enough sunlight to meet 100% energy requirements for eight months barring months of monsoon and winter. Fulfilling its commitment of promoting ‘sustainable development’, the university has installed 62 electric poles of 400 watt each across the university driven by solar panels. These poles automatically become active after sunset and switch off automatically during sunrise. Throughout the day the cells recharge themselves to a level that they could run for 16 hours. Fans, tube lights, computers and other equipments below 9 KW can be operated by solar energy. The production of solar energy in future will attain self reliance in terms of power requirement. In addition to being a renewable source of energy and eco friendly, the method is also proving to be cost effective for the university. University is now planning to install four solar units of 30 KW each and one of 1 MW in order to run 100% on a renewable source of energy.
Sewage Treatment Plant: The sewage treatment plant treats University wastewater. A 120 KLD Sewage Treatment Plant based on Sequential Batch Reactor (SBR) Technology has been installed and the treated water is used for the irrigation of plants with drip technology to reduce water loss. The water is also supplied to the nursery plants. The main benefit of wastewater treatment is maintaining clean water for reuse. Wastewater treatment processes remove potential disease-causing contaminants through a filtering system that blocks their path and further treatment that kills harmful organisms. This keeps potential diseases and bacteria from entering other water sources, or the ground, and harming people as well as plants and animals.
Materials and Resources

Sustainability and environmental considerations have been taken care during construction practices. Few examples are the use of fly ash bricks and smart usage of materials on-site for construction. Energy usage is optimized by keeping the temperature within the buildings at an optimal range by using double layered glass panes for windows, and passive subterranean cooling system coupled with thermal insulation on the roof of the buildings.

The architectural style is a fusion of traditional Rajasthani architectural styles and features and contemporary design elements. The chhatri and jaali are used as prominent design elements in the buildings giving the buildings the look of a unique blend of the traditional and the modern.

Indoor Environmental Quality

Vermin composting: They have established the Solid Waste Management Facility using Vermin-compost technology at its campus to manage the solid waste generated on the campus. The earthworms vermin-compost is proving to be highly...
nutritive ‘organic fertilizer’ and more powerful ‘growth promoter’ over the conventional comports and a ‘protective’ farm input (increasing the physical, chemical & biological properties of soil, restoring & improving its natural fertility) against the ‘destructive’ chemical fertilizers which have destroyed the soil properties and decreased its natural fertility over the years. Vermin-compost is rich in NKP (nitrogen, potassium and phosphorus), micronutrients, and beneficial soil microbes and also contain ‘plant growth hormones and enzymes’. Vermin-compost is produced from waste materials collected in dustbin which is converted into a ‘valuable resource’. More significant is that it is of biological origin i.e. a ‘renewable resource’ and will be readily available to mankind in future.

![Image of Vermin composting](image)

**Figure 7: Vermin composting at Central University, Rajasthan**

**Nursery:** Plants are nature’s one of the most beautiful wonders. A nursery has been created for the students to do the research work and also it greatly reduces the person’s stress levels. Natural aesthetic beauty is soothing to people, and keeping ornamental flowers around the university buildings is an excellent way to reduce levels of stress and anxiety. As a result of the positive energy they derive from the environment, the chances of suffering from stress-related depression will decrease as well.
**Green Transport:** Students of various departments are asked to make use of cycles instead of any other two/three or four wheeler making it a pollution free environment.

### 7.2 CASE STUDY- COMMON WEALTH GAMES VILLAGE HOUSING, NEW DELHI

It was constructed during the Common Wealth Games in the capital city of New Delhi. The games village accommodated the players during the games and is now occupied by individual private homeowners after the games. A 47.3 hectare (118 acre) picturesque site was selected on the banks of holy river Yamuna for the purpose of construction of the games village. The project site is within the immediate vicinity of heritage monuments and historical landmarks, combined with dense green natural covers on the sides.

**Site and landscape**

The development consists of 4000 bedrooms spread across 34 towers varying in heights (such as; 7 storey to 9 storey high). The apartment’s blocks are arranged in a way so as to create visual links with heritage sites in the vicinity. The topsoil of the entire excavated site was collected and stored separately and special measures have been taken for soil stabilization, such as- stockpiling, mulching, and so on. Pervious paving has been provided extensively in the site.

**Health and well-being**

The sanitation/safety facilities are provided as per National Building Code 2005. These include provision of clean and hygienic accommodation, toilet facilities, purified drinking water, commercial spaces, schooling & medical facilities, day care centre etc.. Significant measures are taken to reduce air pollution like enough plantation & open green belt.

**Water**

Water efficient landscaping is being practiced to minimize water usage. This is being done by providing native species, efficient irrigation systems and by limiting lawn areas. The building water consumption also has been reduced by use...
of high efficiency low-flow fixtures. The water management is very efficient in terms of reuse of waste water and less utilization of potable water.

**Building design and energy**

The building design includes the existing site features, such as, the visual linkages with historical monuments, solar geometry, and so on. Due to high density planning requirements, the design did not permit optimum orientation for all apartment blocks. As a result, the apartment blocks have equal exposure towards all cardinal directions. However, the critical facades are shaded and have high performance glazing to negate impact of direct incident radiation. The buildings are fully compliant with the Energy Conservation Building Code 2007. Several energy efficiency measures such as roof insulation, high performance glazing, energy efficient lighting and variable refrigerant volume (VRV) based air conditioning system have been provided to reduce the energy consumption.

**Renewable energy**

Solar photo voltaic system is installed to meet 10% of total energy requirements for internal lighting, & 31% of outdoor lighting. Solar hot water systems are provided to meet part of water heating needs.

**Other features**

Waste water recycling and solid waste management is in operation by Delhi Jal Board at a macro level for the village as well as adjoining areas.

### 7.3 CASE STUDY- SUZLON ONE EARTH, PUNE

One Earth is Suzlon’s corporate headquarters office in Pune, India. The building, showcases itself as a building project with minimal impact on the environment. The complex consists of an office block and a corporate learning centre. The buildings are positioned on a site area of 45 392 sq.m. The total built-up area is 70 865 sq.m. The building is certified green under GRIHA rating system. There are various salient features which enable it to become an iconic green building.
**Architectural aspects:**

The architectural aspects of design are well taken care of in the building. Passive design strategies help in ensuring that visual and thermal comfort is maintained within the building with minimum interventions of technologies. The orientation of the blocks is such that the majority of the building’s facades face north, south, north-west and south-east. This enables adequate day lighting and glare control. Glazing on the first and second floors has been shaded from direct solar radiation using louvers. These also act as important design elements of the building and give it a visual identity. Architectural design of the office block is such that various extrusions on various floors shade portions of the building. Therefore, the building is partly self-shaded. In order to create an interesting office atmosphere, break-out spaces have been created in the form of small terraces which have been interspersed all over the office block. In order to minimize disturbance on site and to ensure easy maintenance, various utility corridors have been provided coupled with the roads and pathways on site. This ensures minimum site disruption post-occupancy.

**Energy conservation:**

High efficiency mechanical systems in the building ensure that the energy consumption of the building is significantly reduced. All desks are equipped with LED lights for task lighting which are governed by motion sensors. So they turn on only when people are seated on their seats. This reduces lighting load to 0.8 W/sq.ft. Extremely high efficiency HVAC systems have been chosen. The HVAC system has various components like pre-cooling of fresh air heat recovery/ exchanger mechanisms to minimize energy consumption in HVAC. Overall, the complex has managed to reduce its energy consumption by 47% below the GRIHA criterion.

**Renewable energy:**

After the reduction of energy performance index of the building, renewable energy systems in the form of solar PV and windmills were installed to generate approximately 250 000 units of electricity through renewable sources annually. The project has an installed 13.44 kWp of solar PV and 18 windmills with power capacity of 4.75 kW each.
Water conservation:

Drastic steps have been taken in order to reduce its water consumption. Use of low flow fixtures throughout the complex ensures that the building requires 65% less water than conventional buildings for sanitary purposes. By planting only native trees and shrubs and using high efficiency sprinkler and drip irrigation systems, the complex has reduced its landscape water requirement by about 50%. Over 55% of the water in the building is recycled and reused within the complex.

Low energy materials:

The intent of making a green building is also reflected in various materials used in the structural systems and in interiors. Use of Post Tension slabs help in reducing concrete requirement in slabs and beams by 37%. Use of PT structural system has helped reduce the requirement of structural steel by almost 50%. Use of Siporex blocks gives the walls of the buildings good insulation while simultaneously using waste material like fly-ash. Majority of the materials used for interior application have high recycled content and are low-energy materials.

Observations:

Overall, the One Earth complex has adopted very high standards for energy and water management. The One Earth complex has taken strong steps to minimize its environmental impact at various levels while simultaneously projecting a very contemporary feel to the buildings and spaces, thereby proving the point that green buildings can be as aesthetically pleasing as any conventional building and yet are able to have minimal negative impact on environment.

7.4 CASE STUDY- CENTRE FOR ENVIRONMENTAL SCIENCE AND ENGINEERING BUILDING (CESE) AT IIT, KANPUR

Centre for Environmental Science and Engineering Building at IIT, Kanpur has been taken as an example to study how the building attempted various GRIHA criteria to make it into a green building.
Sustainable site planning

In order to minimize impact of site development on the environment and surroundings, several best practice guidelines were adopted like demarcation of site for construction, installation dust screen around the disturbed area to prevent air pollution and spillage to undisturbed site area. Top soil was excavated, stored and preserved outside the disturbed construction site. Erosion control systems were adopted and several trees on site were protected. To increase the pervious-ness of site and to reduce heat island effect caused due to hard paving around the building, total paving around the building was restricted to 17%, and more than 50% of the paving is either pervious or shaded by trees.

Water conservation

In this building, reduction in landscape water demand by more than 50% was achieved by use of minimum grass/lawn area, maximum green area under native vegetation and native trees. Low flow plumbing fixtures are used in the building resulting in reduced water consumption from GRIHA’s benchmark in this building by 62%. Waste water is treated and reused for irrigation. Rain water harvesting has been done.

Conservation and efficient utilization of resources: energy

Maximum points /weight age in GRIHA is given for energy conservation. The criteria and commitment for energy conservation could be divided into three parts.

a. Energy: end use
b. Energy: embodied and construction
c. Energy: Renewable energy utilization

Energy: end use

Annual energy consumption of the building has been reduced through following measures:

1. Architectural design optimized as per the climate of Kanpur, sun path analysis, predominant wind direction, and existing vegetation.
2. Optimized building envelope to comply to the Energy Conservation Building Code, to reduce cooling load in the air conditioned spaces and to achieve thermal comfort in the non air conditioned areas.

3. Efficient window design by selecting efficient glazing, external shading to reduce solar heat gain but at the same time achieving glare free natural daylight inside all the laboratory spaces of the building.

4. Roof shaded by bamboo trellis and green cover to reduce external solar heat gains from the roof.

5. Common circulation areas are natural day lit and naturally ventilated through integration of skylights and ventilators.

6. Water cooled chiller selected that complies with the efficiency as per ECBC.

7. Variable Frequency Drive installed in the Air Handling Units (AHUs).

8. Low energy strategies such as replacement of water cooler by water body to cool the condenser water loop, integration of thermal energy storage and earth air tunnels enabled reduction in chiller capacity.

9. Energy efficient lighting design that complies to ECBC.

10. Integration of daylight with artificial lighting.

11. Optimized architectural design and integration of energy efficient fixtures resulted in the reduction of annual energy consumption by 41% from GRIHA’s benchmark.

**Energy: embodied and construction**

GRIHA encourages replacement of high energy intensive materials with low energy intensive materials, to utilize regionally available materials, materials which use low energy in their manufacturing process. Following few were the measures incorporated:

1. Portland pozzolona cement (PPC) with fly-ash content is used in plaster and masonry mortar.

2. Wood for doors is procured from commercially managed forests. Modular furniture made from particle board is used for interiors.
Energy: renewable energy utilization

Following measures incorporated to integrate renewable sources of energy with the building:

1. Renewable energy from photovoltaic panels provide annual energy requirements equivalent to 30% of internal lighting connected load.

2. Hot water demand is met by solar hot water system.