Design of Green Warehouse (10,000 MT capacity) Complex

Executive summary

Central Warehousing Corporation (CWC) is one of the biggest public warehouse operators in the country. CWC is operating 464 Warehouses across the country with a storage capacity of 10.54 million tonnes and providing warehousing services for a wide range of products ranging from agricultural produce to sophisticated industrial products. The purpose of this study is to include sustainability and green design features in the upcoming CWC warehouses. For this study an assessment of a few existing warehouses were carried out. To establish the design of various green features for the upcoming warehouse, a warehouse having a capacity of 10,000 MT was considered. The total site area of the 10000 MT warehouse is 3.19 acres and the total roof area available is around 5730 sq.m. The various aspects which have been looked at for the design of green warehouses were:

- Building design
- Building materials
- Lighting system
- Solar photovoltaic system
- Water management
- Landscape
- Waste management

Building design

To design a solar passive warehouse it is recommended that the longer facades of the building should face North-South. Also the building shall be oriented suitably to take advantage of the prevailing wind direction for natural ventilation (±300 of primary flow direction). For day lighting, skylight-roof-ratio (defined as the ratio of total skylight area of the roof to the gross exterior roof) shall be limited to a maximum of 3% and in the office spaces, the window-wall-ratio (defined as the ratio of window area to the gross exterior wall area) shall be limited to a maximum of 60%. Two skylight layouts were proposed, one for the truss less roof design and another for the pre-engineered structure. In the former, 3 skylights of 3.6 sq.m. (126 m x 21.8 m) along the ridge line were placed with respect to the gangway alignments. For pre-engineered structure, 6 skylights of 1.8 sq.m. area each, 1.2 m offset along the ridge line were placed with respect to the gangway alignments have been proposed. For office spaces, the entire window shall be provided with a shading device calculated from the solar cutoff angles.

Building materials

For sustainable building materials and construction technology, it is recommended to replace cement with fly ash or slag without compromising structural strength in all the reinforced concrete structure such as foundation, columns till plinth level and plinth beams or any other structural member. Also for structural system above plinth level, it is recommended to use pre-engineered building structure (portal frame) made up of recycled steel i.e. recycled MS columns and beams and purlins to support roofing system. It is recommended to use fly-ash bricks with rat trap bond for all the peripheral walls for a height ranging between 0.6 m to 2.4 m with plaster on both the side or use of natural stones for walls if the stones are available locally for the same height. For walls above 2.4 m, it is recommended to use Galvalume sheets. For roofing it is recommended to use Galvalume /aluminium/GI sheets as a roofing material painted

with high SRI (solar reflectance index) paints having SRI value of 78 for low sloped roof on outer side, or use sandwich panels of Galvalume sheets as roofing materials at the ware houses where thermal comfort is of high priority. For the provision of skylight, thermal polycarbonate sheets are recommended to allow daylight inside the warehouses. Also it is recommended to provide plain cement concrete (PCC) flooring, which should have fly-ash or slag as a replacement of cement, without compromising the structural strength of the flooring or it is also recommended to use natural stone as a flooring material if stones are available locally.

Lighting system

For indoor and outdoor lighting, it is recommended to use light emitting diode(LED) lamps. Various benefits of LEDs include but not limited to are better uniformity, more life, and low maintenance. Although energy bills are very low for the warehouse facility but for outdoor facility it can be further optimized through an initial additional expenditure in LED system of only 10% higher from existing cost and with annual energy savings of 16,570 units, further payback can be realized in less than one year.

Solar LED of 30 W at periphery areas and LED of 30 W at the 15 m wide road have been proposed, which would help in achieving better illumination levels. For indoor lighting at warehouse, lighting levels have been increased and almost 40% of the area is getting the desired lighting levels. Although cost of LED is higher as compared to 1x28 W fluorescent lamps (FTL) but benefit of more lamp hours and lesser energy consumption add to the economic viability of LED.

Solar Photovoltaic (SPV) system

For a 10,000 MT warehouse, where the roof area available for solar PV system is 5,544 sq.m., the potential of energy generation through solar photovoltaic system considering 50% of the available roof area will be utilized is around 443,000 kWh/year and the size of SPV system which can be installed is 277 kWp.

Water management

Water is an essential natural resource, which is vital for ecosystem functioning and human well-being. Water scarcity is a recognized global problem, with demand for water projected to exceed supply by 40% by 2030. By the same year, half the world's population will be living in areas of high water stress. To reduce the potable water demand and to manage storm water, low-flow water fixtures and rainwater harvesting scheme have been proposed. Hence it is recommended to replace conventional or inefficient water fixtures with low-flow or water efficient fixtures or in all new upcoming warehouses water efficient fixtures should be provided. To manage storm water runoff, it is recommended to provide rainwater harvesting structure with de-silting chambers and filtration unit (depending on the site and climatic constraints). It was found that on an average the total annual water demand at any warehouse site (site area not more than 13,500 sq.m.) may not exceed 1,200 kilolitres. At the same time for the same site rainwater harvesting potential is 5,450 kilolitres/annum. It means if CWC meets their 100% water demand through harvested rainwater than still there is surplus rainwater which can be used to recharge the ground aquifer.

Landscape

Natural vegetation plays a vital role to maintain the microclimate of the site. Hence it is crucial for a sustainable site that all existing mature trees should be protected and if in case due to design, space and other site constraint, any tree is going to be cut then it should be replanted or compensated by planting new native vegetation. The uniform

spacing (minimum 5 m) should be provided between the trees to maintain the dense cover around the site to minimize the air and noise pollution.

Waste management

Due to an increase in urbanization and scarcity of land, it has become necessary to manage wastes at the source of generation itself. Integrated solid waste management in the warehouses will not only ensure the optimization of the three very important elements in any warehouse such as space, equipment, and personnel, but will also provide the needed assistance for achieving warehouse excellence by the continued elimination of the waste. A well-maintained and orderly warehouse not only looks good, but also helps to protect the stored eatables and other items/goods from damage and loss. It was observed that landscape wastes are generated in huge quantity. Hence to manage it onsite, it is recommended to provide composting pits and a central storage location nearby the composting unit.