Chapter 14: SUSTAINABLE ARCHITECTURE

Sustainable development or sustainability, is the foundational principle underlying various efforts to ensure a decent quality of life for future generations. *Our Common Future* (UN WECD, 1987) defined sustainable development as that which "meets the needs of the present without compromising the ability of the future generations to meet their own needs". This classic definition implies that the environment and quality of human life are as important as economic performance and suggests that human, natural, and economic systems are independent. (Kibert C. J, p56)

Sustainable architecture seeks to minimize the negative environmental impact of buildings through improved efficiency and moderation in the use of materials, energy, development space and the ecosystem at large. Sustainable architecture uses a conscious approach to energy and ecological conservation in the design of the built environment.

Energy efficiency over the entire life cycle of a building is the most important goal areas of research and use of sustainable architecture. New concepts in sustainable development are Eco-Efficiency, Biophilia, Biomimicry, ecological economics etc. (Ibid)

The goal with any sustainable building or development is to implement a vast array of practices, techniques and skills to reduce and ultimately eliminate the negative impacts of buildings on the environment and on human health. Different methods employed in Green building i.e. passive and active techniques to reduce the energy needs of buildings and increase their ability to capture or generate their own energy.

To attain energy efficiency in a building one should focus on various aspects such as:

1. Heating, ventilation and cooling system efficiency

   Heating, ventilation and cooling systems are responsible for 39 % of residential and 32% of commercial building energy end use. (Merlino K.R. p59) Passive solar building design could be useful for cost efficiency and well insulation.

2. Renewable energy generation

   Methods of harnessing Renewable resources such as Solar panels, Wind turbines, Solar water heating, Heat pumps etc needs to be used in the buildings.

3. Sustainable building materials

   Using Recycled materials for construction and lower volatile organic compounds can also reduce energy consumption.

Along with these, Sustainable design and planning of the project is very essential for attaining sustainability in building design.[1]

[1] https://en.wikipedia.org/wiki/Sustainable_architecture

Similarly, to attain sustainability The United States Green Building Council (USGBC), a member-based non-profit formed in 1993, created and manages all LEED rating systems. The first LEED rating system was developed in the year 2000. (Schifman M, p9)

(Kibert C.2016) The author describes that Today's Cutting-Edge design is the high-performance green building movement has advanced and where the cutting edge of the field is at the present time. These areas include:

- The development of green building standards
- The net zero built environment concept
- The Living Building Challenge building assessment system
- The emergence of environmental product declarations
- Carbon accounting for the built environment (p531)

Architects and their Works

14.1 SIR NORMAN FOSTER

- Hi- tech Architect
- Follower of modernism
- A sustainable design approach can have a great influence on a building's appearance.
- He thinks of a space in a building as neither finite nor static, being constantly on the move, from inside to outside, from one level to another.
- His style has evolved into a more sharp-edged modernity.

HIS WORKS

- 1979-86: Hongkong and Shanghai Bank, Hong Kong
- 2000-2002: London City Hall, London, England.
- 2003: Swiss Re- the Gherkin- 30 St. Mary Axe, London, England
- 2006, Hearst Tower, New York city
- 2010, Masdar Institute, Masdar City, UAE

SWISS RE- THE GHERKIN- 30 ST. MARY AXE, LONDON, ENGLAND, 2003[2]

- It is 180 m tall exoskeleton skyscraper
- It has a cone-like shape to reduce the wind turbulence around the top.

[2] https://en.wikipedia.org/wiki/30_St_Mary_Axe#/media/File:30_St_Mary_Axe_from_Leadenhall_Street.jpg

- The floor plans are shaped like flowers, with a circular perimeter indented by 6 triangular light courts. The indentations remain a constant size at each level, while the space between them diminishes.
- The floor plan is rotated for each successive floor, creating a series of spiraling 5-storey atria that stretch the full height of the building.
- Despite its overall curved glass shape, there is only one piece of curved glass on the building, the lens-shaped cap at the apex.
- The fully triangulated perimeter structure (Diagrid) makes the building sufficiently stiff without any extra reinforcements.
- This building uses Diagrid system of structure

SUSTAINABILITY FEATURES

- Use of energy-saving methods which allow it to use half the power a similar tower would typically consume.
- Gaps in each floor create six shafts that serve as a natural ventilation system for the entire building, even though required firebreaks on every sixth floor interrupt the "chimney".
- The shafts create a giant double-glazing effect; air is sandwiched between two layers of glazing and insulates the office space inside.
- The shafts pull warm air out of the building during the summer and warm the building in the winter using passive solar heating.
- The shafts also allow sunlight to pass through the building, making the work environment more pleasing, and keeping the lighting costs down.
- Windows in light wells open automatically to augment the air conditioning system with natural ventilation, an occurrence anticipated to save energy for up to 40% of the year.[3]

HEARST TOWER, NEW YORK, 2006

- The building is certified as a LEED gold and became New York City's first green office tower in 2006.
- The building has diagrid system, a series of four storey triangles on the façade, giving distinctive architectural character and also resulted in a savings of 2000 tons facade comprised of triangulated steel frame; which is 20% savings.

[3] https://en.wikipedia.org/wiki/30_St_Mary_Axe

- The building also features extensive use of low-emissivity coated glass that filters out significant amounts of heat or infrared energy from the exterior light while allowing visible light to enter the building.
- It has highly integrated system of lighting sensors installed which comes to use as per human occupancy resulting in 26% reduction in energy consumption.
- It has rainwater harvesting system that collects water in 14000-gallon tank in the basement which helps in air conditioning system and irrigate interior and exterior landscaping. The data indicates that potable water usage has been reduced by 30% annually.
- Heat conductive limestone paves the atrium floor, covering polyethylene tubing that circulates water year-round to help control the ambient temperature of the building.
- It is the first office building in New York to adopt a composting program that processes 100% of its wet food waste. (Kibert C J.2016, p542,543)

HEARST TOWER, NEW YORK, 2006[4]

The Shangai Tower, Shangai ,2015 by Gensler

- The second tallest building of the world, it is essentially a stack of nine cylinders.
- The twisted stack of cylinders comprising the tower has a façade comprised of a double layer of reinforced, insulated glass that promotes daylighting.
- The building has 270 vertical axis wind turbines providing 350,000Kwh of electricity each year. (Kibert C J.2016, p535)

14.2 RENZO PIANO

He was from the Family of builders and thus he studied anatomy of buildings. His designs emphasize – function, framing, structure and site. His styles includes:

High -Tech, eg. Centre Pompidou, France, 1976

- Machine-like buildings with steel, aluminum, and glass
- The support beams, duct work, and other functional elements are placed on the exterior, of the building, interior spaces are open and adaptable for many uses
- Structural expressionism

Postmodernism, eg. Tjibaou Cultural Centre in Nouméa, New Caledonia, 1998

- Combining new ideas with traditional forms

[4] https://en.wikipedia.org/wiki/Hearst_Tower_(Manhattan)#/media/File:Hearstowernyc.JPG

- Familiar shapes and details are used in unexpected ways

Formalism, eg. Congress Center and Offices in Lyon, France, 1996

- Formalism emphasizes form
- Lines and rigid geometric shapes predominate in Formalist architecture

THE SHARD, LONDON, UNITED KINGDOM, 2012

- Glass skyscraper was considered the tallest building in Western Europe. Part of the redevelopment of the London Bridge area.
- Growth of the city from inside: filling the holes, filling the industrial sites, railway sites.
- A Vertical City and has "Lightness" and "Transparency".
- Energy efficient building sheltering 8000 occupants.
- Its shape is the idea of the steeple, a design feature of which London enjoys a rich legacy through its churches
- Glass, steel, aluminum is used.
- The Shard was designed with energy efficiency in mind. It is fitted with a combined heat and power (CHP) plant, operating on natural gas from the National Grid. Fuel is efficiently converted to electricity, and heat is recovered from the engine to provide hot water for the building.[5]

CALIFORNIA ACADEMY OF SCIENCES, 2008

Completely rebuilt in 2008, the building totals 400,000 sq. Ft. (37,000 sq. m) is among the largest museums of natural history in the world. The building emphasizes environmentally friendly design, in keeping with the Academy's focus on ecological concerns and environmental sustainability. It received Platinum certification under the LEED program.

California Academy of Sciences, 2008[6]

[5] https://www.clarke-energy.com/2012/the-shard-combined-heat-and-power-plant/

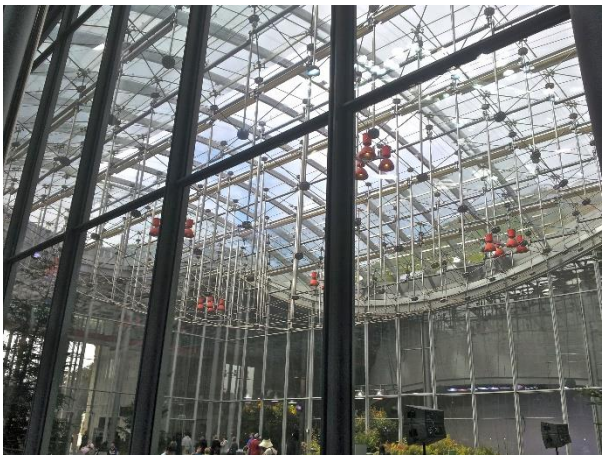
[6] https://en.wikipedia.org/wiki/California_Academy_of_Sciences#/media/File:California_Academy_of_Sciences_pano.jpg

Environmentally friendly features

- Produces 50 percent less waste water than previously
- Recycles rainwater for irrigation
- Uses 60,000 photovoltaic cells
- Supports a **green roof** with an area of (1.0 hectare)
- Uses natural lighting in 90 percent of occupied spaces
- Was constructed of over (15,000 m^3) of recycled concrete
- Construction includes (5,000 t) of recycled steel
- Wall insulation made from scraps of recycled denim

The Green Roof

The California Academy of Science green roof has several environmentally friendly features, as well as sustainable design. Renzo Piano was inspired by seven major hills of San Francisco. The living green roof was planted with 1.7 million California native plants. The museum's central piazza lies beneath a massive glass ceiling in the roof, which opens to allow cool night air to flow into the building below; by using this kind of natural ventilation instead of air conditioning to regulate interior temperature, the building becomes more energy efficient. Renzo Piano and SWA Group won the American Society of Landscape Architects (ASLA) Award in design in 2009.[7]



The piazza inside[8]

Reference Books:

1. Kibert C J.2016. Sustainable Construction, Chapter 16 The Cutting Edge of Sustainable Construction,4th edition, Hoboken, New Jersey: John Wiley & Sons Inc., p (56,531,535,542,543), ISBN: 9781119055174

2. Schifman M R.2018. Building a Sustainable Home, Chapter 2: All about LEED,Skyhorse Publishing, New York, p9, ISBN:978-1-51073-344-2

[7] https://en.wikipedia.org/wiki/California_Academy_of_Sciences

[8] https://en.wikipedia.org/wiki/California_Academy_of_Sciences#/media/File:Piazza_behind_the_Main_Entrance_of_the_California_Academy_of_Sciences.jpg