Introduction

- Tall buildings emerged in the late 19th century in U.S.A. to meet the growing demand for inner city office space and today they have become a world-wide phenomenon.

- Tall buildings were made possible by such innovations as the electric elevator, advances in structural steel making, and advances in heating, ventilation, air conditioning and electrical systems.
The earlier view of tall buildings as large scale energy consumers with little regard for sustainable architecture is now changing.

The new generation tall buildings are being designed with energy conservation and sustainability as their principal criteria.

Paradigm Shift in Tall Building Thought

- Unusual configurations
- Innovative structural systems
- High performance materials
- Energy Efficiency and Dematerialization
- Reduction in Embodied Energy of materials
- Disaster mitigation measures
- Building Management Systems
- Smart, Nano and Green Technologies

Emerging Trends in Tall Building Design
**Advantages of Enhanced Environmental Performance**

The advantages of a low energy / enhanced environmental performance are:

- Mitigation of environmental damage and reduction in building’s reliance on fossil fuels.
- Financial incentives for the building owner with reduced energy bills.
- Better image of the building.
- Availability of grants for energy saving devices.

**The Bioclimatic Skyscraper**

- The Menara Mesiniaga designed by Ar. Ken Yeang is the epitome of building design that reflects climate characteristics specific to the location of the building.
- The building design reduces long-term maintenance costs and lowers energy use.
- The trussed steel + aluminum sunroof also incorporates solar panels that power the building.
- Some other features include the skycourt, vertical landscaping, and naturally ventilated core.
The Bahrain World Trade Centre (BWTC) has been named the best tall building in the Middle East and Africa region for 2008 by the Council on Tall Buildings and Urban Habitat (CTBUH).

- Designed and engineered by Atkins, the BWTC is the world’s first commercial building to harness wind power for energy with the incorporation of large-scale wind turbines.

- Three, 29-metre diameter wind turbines will generate up to 15 percent of the two towers’ electrical requirements.
Chad Oppenheim, Buro Happold, and Ysreal Seinuk teamed up to create a high-rise in Miami whose exterior structure includes wind turbines, photovoltaic panels, and solar hot water generation.

Renewable energy solutions in Tall Buildings

Diagrid Structures

- Hearst Tower, New York, designed by Sir Norman Foster is 46 stories.
- The tower’s most prominent feature is the geometric pattern of its glass and steel, which the architect calls a “diagrid”: a diagonal grid of supporting trusses, covering the façade with a series of four-story-high triangles.
- The pattern uses twenty per cent less steel than a conventional skyscraper frame would require.
Sustainability Features

- The Hearst Tower became New York City's first skyscraper to achieve LEED Gold accreditation from the USGBC.
- 80% of the steel used was recycled.
- On the inside, the floors and ceiling tiles are made from recycled materials.
- Rainwater is collected on the roof and is funneled into a 14,000-gallon tank in the basement.
- The Hearst gathers enough water from the sky to account for 50% of the tower's usage.
- This water is pumped into the cooling system, used for irrigating plants and for the innovative water sculpture in the main lobby.

Tall Building Aerodynamics

- Source: Penwarden and Wise (1975)
Swiss Re
- Architect Sir Norman Foster

- Windows in the light wells open automatically to augment the air conditioning system with natural ventilation resulting in energy savings of up to 40%

- The steel spiral diagrid structure creates an aerodynamic form that provides the lowest resistance to wind and diminishes the danger of strong downward winds in the area around the building.

Pearl River Tower, a green skyscraper, under construction which is designed to harness winds at lofty heights will use internal wind turbines to keep the lights on.

- Fashioned like a giant wing, the tower pushes air through wind tunnels on two of the building's 71 stories.
- This building will also employ geothermal heat sinks, ventilated facades, waterless urinals, integrated photovoltaics and daylight responsive controls when it opens in late 2009.
Carbon Tower

• Peter Testa, an architect in Santa Monica, Calif., has designed a 40-story skyscraper that would do away with steel for the structure.
• Instead, Mr. Testa's "woven building," would be held up by a crosshatched lattice made of carbon fiber, which is several times stronger than steel.

Role of Nano-materials

In the 40 Bond Street in New York--designed by Herzog & de Meuron, the green glass mullion caps feature a self-cleaning hydrophobic nanocoating that repels water and dirt.
Role of Nano-materials

- Tall buildings with Nanopaint can act as air purifiers.
- Nanopaint on the face of tall buildings could reduce pollution.
- When exposed to ultraviolet light, titanium dioxide (TiO2) nanoparticles in paint break down organic and inorganic pollutants that wash off in the rain and decompose air pollution particles like formaldehyde.

Solar Nanotechnology

- Ultra-thin, amorphous silicon, organic and inorganic solar cells derived from nano-crystals can convert sunlight into electricity at a fraction of the cost of silicon based solar cells.
- With nanotechnology, tiny solar cells can be printed onto flexible, very thin light retaining materials, by passing the cost of silicon.
Torre Mayor is a 57-story office tower built in Mexico City, Mexico.

This $250-million project reaches a height of 225m above ground and is the tallest building in Latin America.

The seismic design approach utilized in this project offers an innovative concept in absorption of seismic energy for tall buildings.

Steel, reinforced concrete and an innovative system of 98 dampers bordering the building make Torre Mayor resilient to tremors.

The skyscraper is structurally dependable in earthquakes measuring up to 8.5 on the Richter scale.
India Tower

- The 300 m high India Tower, designed by New York based FXFOWLE architects currently under construction in Mumbai.
- India's tallest building is going to be one of its greenest and will have:
  - A solar chimney to generate electricity
  - On-site waste water reclamation
  - Daylighting
  - Solar shading, natural ventilation and rainwater harvesting.

Retrofitting of Existing Tall Buildings for Energy Efficiency

- The 102 story Art Deco skyscraper, the Empire State Building, once the world's tallest building is now set for a $100 million 'green renovation.'
- The Clinton Climate Initiative, Johnson Controls Inc., Jones Lang LaSalle and the Rocky Mountain Institute partnered to come up with a plan to reduce the building's energy consumption by 38 percent, or $4.4 million, annually.
- Promoters hope that this iconic skyscraper can become an efficiency model for buildings worldwide.
Retrofit Measures for Energy Conservation

The conservation measures at the Empire State building include:

- Filling the existing windows with an energy saving gas and adding an additional plastic pane.
- Upgrading the building's cooling system.
- Using computerized "smart" energy management technology that can adjust temperatures floor by floor.
- Provide tenants with detailed energy use in their space.
- Shut off lights in unused areas.
- Much of the interior lighting is also being replaced with more efficient fluorescent bulbs.

Retrofitting of Sears Tower

- The Sears Tower was built in 1973 when energy efficiency was not a key building strategy.
- Its claim to fame was that it was the tallest building in the world.
- Today under the joint partnership of the Clinton Climate Initiative and the City of Chicago plans are afoot to retrofit the 1450 feet tall building for making it green.
Retrofit Measures for Energy Conservation

Preliminary plans call for:
- Letting in more light.
- Installing solar panels and wind turbines.
- Planting gardens on the building’s small balconies.
- The owners may decide to change the black exterior to reflect heat and cut down on air conditioning.

Source: CNN

Retrofitting of United Nations Headquarters, New York

- The 554 ft. tall UN building was designed by an international group of architects led by Wallace K. Harrison, Oscar Niemeyer and Le Corbusier in 1951.
- This building will be undergoing extensive renovations that will transform the building into a model of energy efficiency for all to follow.
Retrofit Measures for Energy Conservation

- The main goal behind the renovation is energy efficiency, with the project aiming at a 30% reduction in energy consumption.
- The entire lighting system will be retrofitted with energy-efficient light bulbs, room sensors and solar panel technology.
- Other considerations include the removal of the extremely hazardous asbestos within the original insulation, and the replacement of the window seals, to prevent the cold, or hot air, from leaving the building.
- The architects in charge of the project hope to obtain a LEED silver rating from the Green Building Council.

Conclusion

- Increased emphasis on the use of green and sustainable building materials and technologies is creating a paradigm shift in the way the new generation tall buildings are being designed.
- Energy efficiency has become the core issue for the acceptance of any design solution that advocates long-term economy.
- Many iconic tall buildings across the world are being retrofitted for energy efficiency and they should serve as role models for tall buildings across the world.
- The application of green technologies in tall buildings can accelerate our march towards sustainability.
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Thank You