

ECOSUSTAINABLE HIGH-RISE

The Environmentally Conscious Architecture of Skyscraper

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ABSTRACT

The term “*green architecture*” is related to evolving architecture which is sensitive to the environment and emerges from the environmental awareness due to the effects of destruction of air, water, energy and earth. It is characterized by improving energy efficiency, sustainability concept and holistic approach of the entire building enterprise, where all of the environmental factors are regarded as an objective.

Although there are many of environmentally conscious architectural works today, but most of the building designers prefer to deal primarily with small-scale buildings (low to medium rise) and often only in greenfield, rural or suburban sites. All those large scale, high-rise or tall buildings located in dense urban areas are regarded as avoidable objects that consumes a lot of energy, uses huge amounts of materials, and produces massive volumes of waste discharge into the environment. These intensive buildings deserve greater attention and should be designed by greater part of our expertise and effort to ecologically design than the smaller buildings with fewer problems.

The paper discusses “green” dimensions applied to tall buildings/high-rise buildings with their innovative approach that leads to *ecosustainable tall buildings*.

Keywords: Tall Buildings/High-rise buildings/Skyscraper; Green Architecture.

DEFINITION OF “GREEN BUILDING”

This paper describes what is meant by “green buildings” from some points of view. Yeang¹ defines “green building” as “*building with minimal environmental impacts, and where possible, buildings with positive, reparative and productive consequences for the natural environment, while at the same time integrating the built structure with all aspects of the ecological systems of the biosphere over its entire life cycle.*”

Another reputable institution, The American Society for Testing and Materials (ASTM) also defines green building as : “*structures, including all types of residential, industrial and commercial, that are designed, constructed, renovated and demolished in an environmentally sensitive and responsible manner.*”

Green buildings exhibit a high level of environmental, economic and engineering performance in the framework of “Sustainable Development”. CIB [2], as the leading international organization for research collaboration in building and construction, constitutes the definition of “Sustainable development” as “*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*” (Brundtland Report, 1987).

The process of examining the environmental impact of a building from design to demolition is called *sustainable design*. Architects and engineers practicing sustainable design seek to achieve maximum building efficiency while making minimum use of natural resources.

Therefore, the term “Green Architecture” refers to [3]: *environmentally conscious architecture that incorporates not only the ordinary values of architecture (strength, functionality, comfort, cost, aesthetic) but also the environmental dimensions of green buildings (energy efficient, sustainability concept, holistic approach).*

THE PLACE FOR “GREEN BUILDING”

Green building takes place every where in the building and property enterprise when *there is a commitment to meet the ecological objectives*. The areas of importance of green buildings include [4]: energy conservation and efficiency, indoor air quality, with resource and materials efficiency within the building. Green buildings concepts are applicable throughout the entire life-cycle of a structure, including design, site work, construction, operation and demolition.

THE TALL BUILDINGS SHOULD BE “GREEN”!

The technical term “tall building”, as official definition formalized by The Council on Tall Buildings and Urban Habitat [5], is *a building in which “tallness” strongly influences planning, design, construction and use. It is a building whose height creates conditions different from those that exist in common buildings.* High-rise building or skyscraper is a tall building with a small footprint and small roof area with tall facades. It can be of commercial, residential, hotel or mixed use tower.

To a certain extent, the issue of the environmental awareness is related to designing tall building in an ecologically responsible way based on some considerations as follows:

1. *Tall building accommodates thousands of people in a single building only.*

The explosive population growth throughout the world, particularly in developing nations, coupled with dramatic changes in technology and energy-intensive growth in the developed countries, increases the possibility of permanent damage to the global environment. Architectural design of tall buildings that accommodate thousands of people in building within a city must account for such concern.

2. *Tall building is more sustainable than other low rise buildings.*

It's tallness makes it difficult to demolish. Encouraging sustainability is the only way to survive within current conditions and circumstances.

3. *Tall building consumes large volumes of energy and materials.*

It's massive scale and volume demands huge quantity of energy and material from the construction stage to operational phase during it's life-cycle.

4. *Tall building requires special expertise to be involved.*

It's high-rise built form needs special engineering systems because of its height, and this claims particular or greater attention to design and to operate it.

5. *Tall building exists in all major cities in the world.*

Whether we like it or not, tall building emerges as a building type to be everywhere at the same point in time. The tall building will continue to be built in large numbers into the first quarter of the millennium since it is

predicted that by the year 2006, there will be half a billion people inhabiting one percent of the earth's land surface (Fazal,1995).

6. *Tall building contributes the problem of environment pollutant.*

Due to its high density of people, tall building produces massive volume of waste discharge into the natural environment that needs to be anticipated by expertise with regard to creating ecologically healthy and responsible design.

THE PARTIES INVOLVE IN THE DESIGN OF “GREEN TALL BUILDING”

The successful design of green tall building relies on *the cooperation of the owner/developer and the multidisciplinary building professionals (architect -structure/mechanical/electrical engineers- interior designer – environmental expert)* that are participated together in a *collaborative teamwork* where each “player” must have a *strong commitment* to pursue the environmental goals that has been established in advance.

“GREEN PRINCIPLES” APPLIED TO TALL BUILDINGS [6, 7, 8, 9]

During the World Congress of Architects (United International of Architects-UIA and American Institute of Architects-AIA) meeting in June 1993, the *Declaration of Interdependence for a Sustainable Future* was drafted. This declaration affirms *energy efficiency, sustainability concept, and holistic approach* related to the natural, artificial, and social environments. In accordance with this declaration, International Council for Building Research and Innovation in Building and Construction (CIB W082) advocates new paradigm in a global context that can be interpreted as key issues using the key verbs: *reduce, conserve and maintain.*

Based on the above declaration, green principles (environmental parameters) for tall buildings can be established as follows:

1. *Embodied Energy.*

The green tall building makes efficient use of raw materials (environment-friendly materials).

The energy consumed in the process of manufacturing construction materials, elements and components is called the embodied energy. This energy content of material should include all stages from their extraction to their being installed on site and should also include the energy consumed in transportation to the building site.

2. Energy Efficiency.

The green tall building consumes a minimum amount of energy and over its life span..

Energy efficiency means minimizing energy consumption (energy requirement to heat-cool-ventilate, to light and to power all machines in the building) without sacrificing either the comfort or productivity of the occupants through the entire life of the tall building. Significant effort in building technology must be sought in improving building services and envelope systems to address this issue. It is worth to note that the operational energy is significantly greater than the embodied energy.

3. Bioclimatic Approach.

The green tall building optimizes the meteorological data of the climate to achieve comfort.

The climatically responsive tall building works with climate to encourage the use of passive techniques and low energy system to pursue comfort for the occupant within the building.

4. Recyclability.

The green tall building minimizes new resources and generates a minimum amount of waste and pollution over its life span.

Reducing the usage of non-renewable energy sources, mineral resources, water resources through reuse, recycle, regeneration, and promoting the use of renewable resources (solar energy, wind energy, biomass energy).

5. Flexibility and Adaptability.

The green tall building respects for its users and meets their needs now and in the future.

Due to its tallness, the tall building determines human's degree of freedom and flexibility to a certain extent for up to 100 years after construction. The design for

future reuse enables the structure adaptable to other uses. Mixed-use building can be better solution to anticipate the future needs for spaces.

6. Toxicity.

The green tall building creates a healthy indoor environment.

Maintaining comfort and healthy indoor air quality means avoiding the polluting effect of a material or system. Pay attention to formaldehyde emissions from many interior finishes and furnishings and sick building syndrome as an elevated incidence of illness among building's occupant caused by insufficient fresh air circulation and by excessively low humidity resulting in increased respiratory sensitivity to germs and toxins.

7. Site Quality.

The green tall building uses a minimum amount of land and integrates well with the adjacent built environment.

Although most of tall buildings were built in a urban fabric, the placing of tall building in an urban site (called zero culture ecosystem) must consider an effect on the groundwater and other surface/subsurface features of the urban locality through its foundation, possible shadowing to other landsites or neighborhood, the increasing traffic volume, the enhancement of heat-island effect, and the generation of uncomfortable wind around the tall building. The green tall building recognizes such environmental impacts and establishes a comprehensive technical solutions to minimize the problem.

8. Comprehensiveness.

The green tall building demonstrates a holistic approach to address the interdependency of the building and the environment.

The tall building as a system exists in relationships with the natural environment which take place over time. The building acts as a living organism, it needs energy and materials as inputs, it utilizes energy and material in a continuing process during its operation, and also produces outputs into its environment. The interactions occur between

the building with its environment can be visualized as a set of interactions consists of :

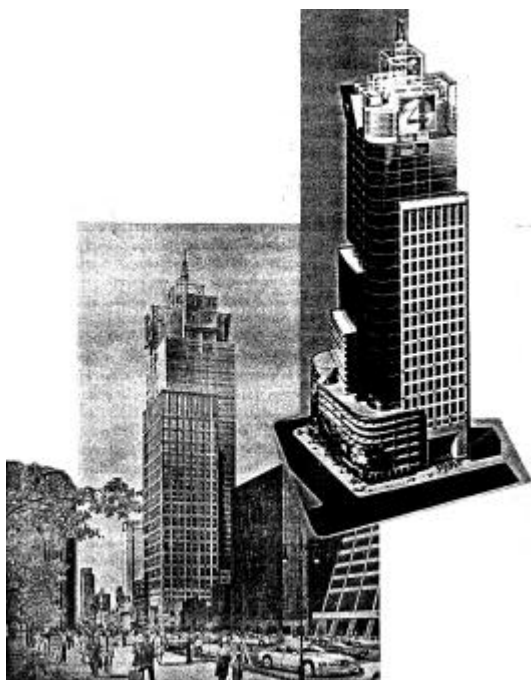
- External Interdependencies : the processes and activities that take place in the environment of the building
- Internal Interdependencies : the processes and activities that take place within the building
- External to Internal Exchanges : the exchanges of energy and matter from the natural environment into the built environment (the building)
- Internal to External Exchange : the exchange of energy and matter from the built environment (the building) into the natural environment.

The green tall building synthesizes all the interactions to a balanced ecosystem as the most effective way of designing an ecologically responsive built environment.

GOING GREEN THROUGH ARCHITECTURE OF TALL BUILDINGS [10, 11, 12]

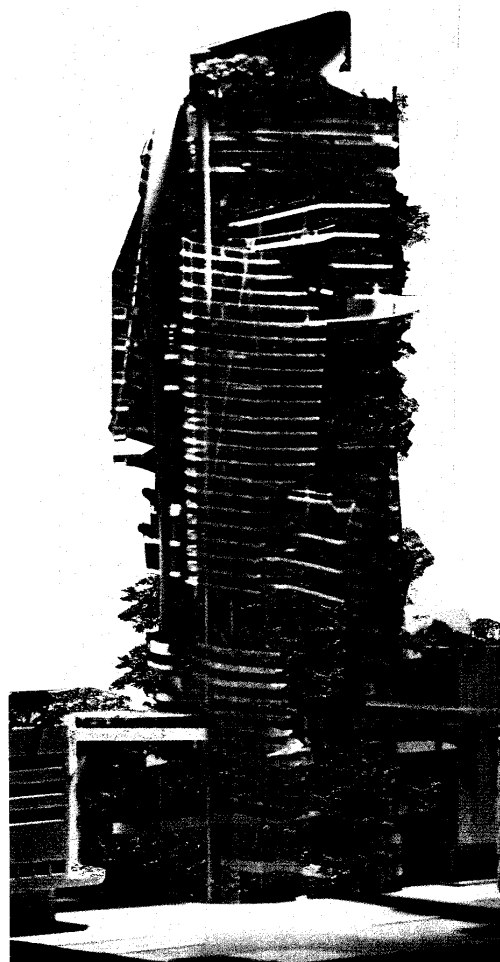
The next architectural works exemplifies the attempts of the collaborative architect to propose a new paradigm dealing with the eco agenda of tall building.

1. *4 Times Square, New York City, 1999* *Architect : Fox & Fowle Architects*



This 48-storey tower, 1,600,000 sq.ft mixed-use area, located in the heart of the fabled Times Square, is significant because it is the first ever in the city of New York to incorporate a significant number of environmentally friendly features. The tower demonstrates a veritable catalogue of “sustainable technologies”, ranging in their aims from the early stages of material production (low embodied energy), through the construction stages on site, the operation of the facility (energy efficiency and low toxicity) to the eventual demise and/or renewal of the building (recyclability). The tower represents a magnificent achievement on eco-agenda.

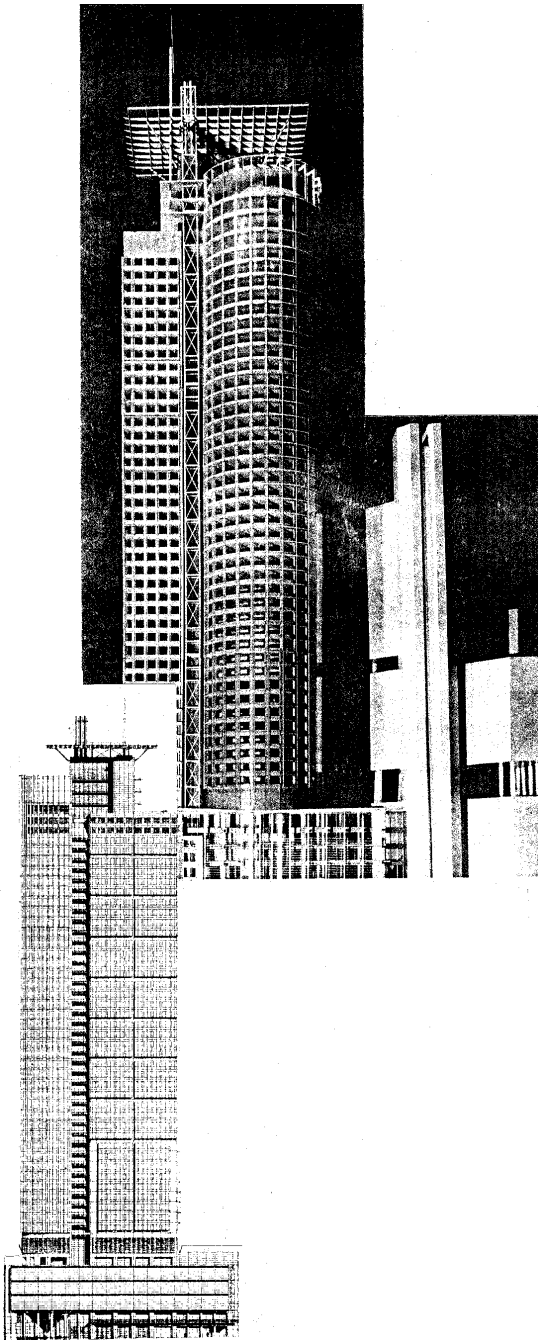
2. *EDITT Tower, Singapore, 1998* *Architect : T.R. Hamzah & Yeang*



The proposed 26-storey, 6,033 M2 area EDITT Tower is designed as a multi-use high-rise building, initially conceived as an exhibition building incorporating exhibition spaces, auditorium, retail and office use, with

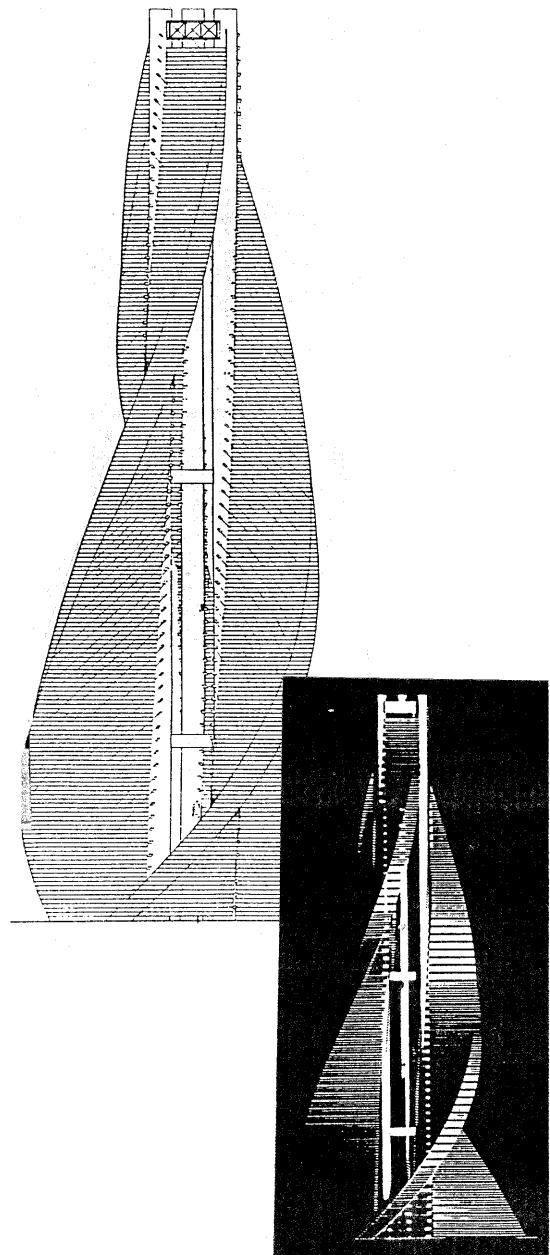
the potential to metamorphosis later in its 100-150 year design life into a full office tower or apartment building. The design concept brings together a range of issues-ecological response to site, deconstruction and recyclability, waste recycling, on-site energy production, embodied energy and the result is a visually stunning architecture that presents environmentally conscious design and energy performance.

3. Skyscraper Project, Frankfurt, 1997
Architect : Prof. Schweger & Partners



This 52-storey skyscraper (200 M high), planned as a naturally ventilated building, consists of a square and a cylindrical tower; both building sections are linked by a transitional zone with elevator core and traffic areas. The office areas are naturally ventilated directly from the outside in without any constructional elements. The façades fulfill the task of natural ventilation with optimum shading and glare protection at minimum cost.

4. The Helicoidal Skyscraper, 1999
Architect : Prof. Manfredi Nicoletti



The 565 M-high ecological skyscraper integrates the unique structural concept with the environmental criteria through utilizing the principle of aerodynamic. Its form derives from organic principles and innovative integration of specific structural and aerodynamic concepts aiming to minimize the structure's weight and volumes, to maximize the ratio between gross and useful floor space. Generally, tall buildings have the effect of bending the flow of wind down to street level, creating an unpleasant micro-climate and increasing pollution in the lower strata of the urban atmosphere. The Helicoidal Skyscraper, describing a logarithmic spiral in space, instead, reacts to the wind with a vertical force which conducts the air upwards taking pollution out of the air in the streets. The "chimney effect" is increased by the convection currents created by the thermal distribution of solar heat on the external surfaces of the tower (studied in a thermo graphic analysis, New York University).

Recent developments in public awareness have shifted the "green" issues from a peripheral concern to a global agenda. Although the effects of global warming, ozone depletion, acid rain, and deforestation have not been assessed, it is clear that these issues are already impacting the design and construction of tall buildings and the urban development. A new generation of architects must be trained to become aware of these concerns.

For tall buildings, research must address the urban and economic impact of high-rise buildings on the environment and the urban context. The green principles must be addressed as well as development of innovative structural systems to assist creating tall buildings more efficient in term of energy and material. The previously tall building design examples demonstrate that green criteria is not a brake for architectural creativity, rather, it should encourage to stimulate further creative investigation and innovative integration to achieve **ecosustainability in architecture**. This is particularly true for tall buildings which very often demand structural performances pushed to the extreme and the most positive integration between aesthetic and structural needs to pursue the ecological balance and minimum energy toward ecological building as a new movement in contemporary architecture.

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