

Low Energy Building In Green Architecture

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LOW ENERGY BUILDING IN GREEN ARCHITECTURE CONTEXT: Paradigm and Manifesto for Sustainable Future

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ABSTRACT

Low energy building was given due attention since the issue of energy crisis in the early 1970's. Although the issue has been discussed in many academic symposiums, however the subject tends to prolong until today. Architecture as a leading physical development disciplines plays a significant role in reducing resources depletion and adverse environmental impact and at the same time it placed the quality of environment along the aesthetic of the building design paralleled to the prevalent critical global issues. The integration of building features for the purpose of saving energy has become the top priority in building maintenance and procurement. With such issues the trend in building design is moving towards a new paradigm shift along the line of global warming and sustainable development. In this paper, the low energy building will be discussed at various levels, ranging from the early concern of builders during the pre-industrial era until the present dilemma in the global issues. In a standard procedure of design it is the responsibility of the architect to take into consideration of the building materials, design elements and micro-climate that may became the most important factors in low energy building approach. Hence, such approaches have to be holistic instead of focusing on the building per se. This paper will also elaborate on the topic of green architecture which is envisaged as the design alternative for saving energy in the residential and office environments.

Keywords: Low energy building, green architecture, environmental issues

ARCHITECTURE AND ENERGY IN HISTORICAL PERSPECTIVE

Energy efficiency is not a new criterion in architectural design. Since the dawn of the century the building of dwellings was responsive to the elements required by the climatic conditions. The application of the local building materials available in the region and the understanding of the underlying purpose of the building in tandem to the cultural activities is a good example of this task. During this time the climate and the availability of natural resources are the basic factors in the production of art and architecture. Time and again the production of buildings is a reflection of the builder's responsibility to the environments. Even in the extreme climatic

conditions the designer attempt to explore and produce an extraordinary architectural design with respect to the situation and the capability of the populace. Hence, the energy related context in architectural evolution can be classified into several periods as follows:-

A. Architecture in a Pre-Industrial era (before 1800):

Abundance of natural resources and the limitation of technology were the main characteristic of this period. The structural systems as the mainstay dictate by the limited technological advancement. Such a significant influence on the characteristics of the buildings was evident in the load-bearing wall system and short span structures which influenced the space and size of opening in the building. Bricks and timber were the main building materials. Likewise, the environmental control inside the building were also depending on the building envelope (wall and roof) which is employed by the prevalent technological know how of that particular time. The protection from the cold weather is only provided by the hearth which is located at the centre of the building, while illumination inside the building is relying on the very narrow windows or supplemented by candles, torches and oil lamps. However, several architectural styles were developed during these periods such as Gothic, Renaissance, and Romanesque as well as traditional architecture inherited by the locals.

B. Architecture in the Industrial Era (1800-1900):

The innovation in technology and abundance of natural resources also influenced the characteristic of architecture during this period. The development of rigid frame structural system through the application of steel and reinforced concrete construction technique were employed by the builder. The span of the column and internal spatial distribution and structural module were inflicted by these elements. The application of glass as a building envelope system became a new technology in building construction together with the invention of lightweight brickworks. The development of technology also pursues the eases for environmental control inside the building such as: light bulbs, "Freon" for refrigeration in air conditioning system, elevators, mechanical and electrical equipments available during this period. Hence, this situation influences the outlook of architectural design and style in the modern time. The mass production of the building materials and the availability of good transport system help to market the building materials worldwide. As a result, the industrial building system produced the building materials in mass quantity and not limited to one area. The application of such materials had resulted in the internationalization of ideas in design and construction techniques without considering the climatic characteristic and local culture. The buildings are monumental and the designer was idolized as hero. However, the architectural works were often required huge energy to consume, even during the construction phase, needless to say its operation.

C. Post-Industrial Architecture (after 1900):

Characteristic of this period is the lack of natural resources and the developing of advance technology. Structural system which developed in this period is a multi-system, steel construction, pre-cast concrete, metal, hybrid, wide and flexible structural module. This condition enriched by the advancement of building materials and techniques in constructions which produce new high quality materials such as: glass, plastic, textile, and fiberglass and fibre-optic.

Environmental control was taken in through the integration between artificial and natural illumination system with application of illumination technology, implementation of energy-efficient technology for air conditioning system, the usage of energy-efficient materials, building automation system equipment and digital simulation equipment to predict energy consumption along the year.

Architectural appearance was pioneered through the progress of post-modernism which accommodates the local climate and the cultural aspects of the people. In addition, the post-modernism has a specific characteristic which fit the local context as well as re-conceptualization in the meaning of architecture. The issues on global environment, energy conscious design influenced the designer with respect to the energy-efficient issues which is becoming a major criterion in architectural design.

BUILDING OPERATIONAL SYSTEM

To achieve the desired thermal comfort and internal environmental living conditions (such as temperature, humidity and illumination) the building can be adjusted with or without non-renewable energy. According to Worthington, 1997 in Yeang, 1999, there are several levels in the operational system which is used in the building.

1. Passive mode:

Low level of energy consumption and minimal usage of mechanical and electrical equipments which generated from a non-renewable energy.

2. Mixed mode:

Some system depends on the energy and the usage of mechanical/electrical appliances.

3. Active mode/Full mode:

The whole system used mechanical and electrical equipments with its base on non-renewable energy.

4. Productive mode:

All the systems produce energy in situ (on-site energy) from renewable resources, such as photovoltaic system.

ENERGY-EFFICIENT ARCHITECTURE AS A MANIFESTO OF ENERGY CONSCIOUS DESIGN

Basically, the influence of energy context in architecture has been understood by modern masters since the beginning of the 20th century. Bauhaus argued that architectural works during this period is the final works resulted from a rational analysis as expressed through formal expression in a new process and new construction's material. The works of Walter Gropius with sun-tempered home, Keck Brothers with Crystal House, Le Corbusier with his proposal for the Mediterranean House to name a few are the examples of the early contribution in the energy conscious design. Design with Climate, gave a justification for the contribution of architect on the energy-efficient design although they are intimidated by euphoria of industrial revolution and international movement.

Oil embargo in 1973 was an awakening moment in the building energy conscious; the escalating of fuels price has changed the lifestyle of the people in the developed country who had enjoyed the cheap petrol for leisure. The crisis clearly implicated a new architectural development by applying an alternative solution for energy conscious design which is based on its paradigm as classified as follows:

1. Bioclimatic Architecture/Low Energy Architecture:

The concept is based on a passive design approach and low energy by catching natural local energy to create comfort condition for the user. Several effort are taking place, such as: configuration of the building mass, site planning, building orientation, façade design, mechanical instrument and optimizing of natural lighting, determining the color of building envelope, horizontal and vertical landscape, natural ventilation. There are several noted architect who pioneered in bioclimatic design such as: Ken Yeang, Norman Foster, Kenzo Piano, Thomas Herzog, Donald Watson, Jeffry Cook to name a few.

2. Energy-Efficient Architecture

This concept attempt 'to minimize the usage of energy without limiting or change the building function, comfort reason even the productivity of its user', by using science and the current technology. Optimization of air conditioning system, lighting, integration between natural and air condition system and the synergy between passive and active method are taking place in this application. The principles of form follow function are moving out into form follows energy which is based on energy conservation principle. Such architects who pioneered in this approach are Norman Foster, Jean Nouvel and Ingenhoven & partners.

3. Solar Architecture

Is the architectural concept which use solar energy in direct manner (light radiation and thermal) or indirect manner (wind energy) into the building. The elements of space in architecture (floor, wall and roof) integrative function as active solar system or passive solar system. Solar architecture basically comes up from energy diversification by exploring the renewable resources.

GREEN ARCHITECTURE AND ENERGY EFFICIENCY

The declaration of the scientific explanation about destructions phenomena of the earth and earth's atmosphere in the 1980-1990 marked the historical point of the degradation of the earth surface. Scientific journal in 1985 reported that the ozone depletion phenomenon started to show on the earth atmosphere. This phenomenon was resulted by the concentration of CFC's (Chlorofluorocarbon) gases in the atmosphere. In 1988 the climatologist agree and stated that serious problem in the earth was occurred. Another incident of the volcanic measurement in Hawaii showed the rising of earth temperature which triggered global warming. Both destructions are caused by the accumulation of air pollution which came from industrial manufacturing, transportation, building and the usage of the huge energy by human needs and lifestyle. This situation trigger a new thinking in architectural design and the approach to green architecture is born.

1. Green Architecture

The concept of green architecture is concerned with the environment and based on the attention given to the natural environment conservation. Energy efficiency, sustainability and holistic approach are noted and adopted in these approaches. Several forms of resources saving practice are integrated in the process such as: recycle, reuse, reconfigure. The green architectural works noted are as follows: NMB Bank (architect: Ton AlbertsAmsterdam), Four Times Square (Fox & Fowle architects), The Helicoidal Skyscraper (proposal Prof. Manfredi Nicoletti), Frankfurt 'Max' Tower, Nagoya 2005 Tower, Bishopsgate Tower, Elephant and Castle Tower (T.R. Hamzah & Yeang), Glasshouse (LOG ID/Dieter Schempp,Fred Mollring) Germany, 17-18 Apartments, Les Garennes,France (L. Bouat et al), Audubon House, New York City (Croxtan Collaborative Architects).



CHURCH OF THE HOLY APOSTLES-GREECE
Pre Industrial Architecture



CIVIC CENTER, CHICAGO (SOM)
Industrial Architecture



MENARA MESINIAGA, MALAYSIA (Ken Yeang)
(Bioclimatic Architecture)



INSTITUT DU MONDE ARABE, FRANCE (J. Nouvel)
(Energy-efficient Architecture)
Post Industrial Architecture



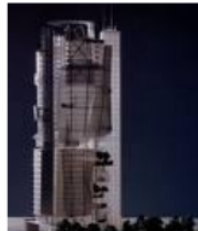
THE BRITISH PAVILION, SEVILLE (N. Grimshaw)
(Solar Architecture)



NMB BANK, AMSTERDAM (Ton Alberts)



4 TIMES SQUARE, NEW YORK
(Fox & Fowle Architects)



SHANGHAI ARMOURY TOWER, CHINA (K. Yeang)
(Green Architecture)



2. ENERGY EFFICIENT ARCHITECTURE'S FACADE

There is a kind of agreement among designers to agree upon the reduction of glare and excessive sun rays from the glass facades. To gather the energy efficiency, Indonesia and other ASEAN countries has determined a criterion on energy conservation for façade, technically referred as 'Overall Thermal Transfer Value (OTTV)'. There are several values which determine the design criterion for limiting heat factor because of solar radiation through building façade. In Indonesia the criteria are formulated in Standard National Indonesia 2000 (Indonesian National Standard 2000) which gives standard in energy conservation on building facade.

CONCLUSIONS

The above examples are part and parcel of the architectural conscious design approaches in determining the low energy design in buildings leading to sustainable development. As Papanek (1985) described: " *In this age of mass production when everything must be planned and designed, design has become the most powerful tool with which man shapes his tools and environments. This demands high social and moral responsibility from the designer* ". His ideas is supported by Gentle (1984) where he said that: "... if ever we *needed great designers, it is now! The environmental architecture of America is almost without exception depressingly ugly...*"

Bioclimatic and ecological design usually implemented without integrating the architectural style. However the best chances to optimize environmental cycle in the building context are in the design process. In the past, during the design process, an architect examined the proportion and architectural style of the classical temple. Paradoxically, today our earth is the temple where the rule is that human lives is determine by the limiting of the balance of world natural resources. The glory days of architectural style were history such that the Post-modern style was a reaction to the international style (modern architecture), this style declared the re-born of ornamentation, colour and the characteristic of space organization from the previous era. Post-modern discourage an enrichment and variation in the awakening of energy efficiency. Post-modern's wall exterior ornament can be a building envelope which is sensitive to the local climate. Contextual response can appear the new aesthetic value which contributed from compatible new material.

It is necessary to make several actions to implement the agenda's of energy conservation in architecture. From technical aspects, it is easier to use the reduction of the energy criterion. On the institutional side, it is necessary to facilitate the fundamental pattern of the usage of energy in the built environment, through upgrading the building design and integrating with the transportation

system. The difficult phase is to maintain the conservation ethic in the soul and lifestyle to use energy in the wise manner and committed to do it. Energy-efficient architecture pragmatically can be applied if the designer understands the behavior of climate. Hence energy-efficient architecture can contribute to enhance the low energy consumption through energy conscious design, as concluded by Hayes (1997)

¹²
“...Fifteen years ago, companies competed on price. Today it is on quality.
Tomorrow, it is design....”

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