

Studying the Application of New Models of Sustainable Architecture for Using the Natural Light and Energy Efficiency

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ABSTRACT

It isn't long decades passing from introduction of sustainable architecture and international communities provided many alternatives to complete and develop it. Architectural designers and professionals may consider the principles of sustainable architecture, i.e. maintaining the natural energies, reduced usage of fossil fuels and environmental and climate coexistence. So contemplating the sustainable architecture and its principles will provide us with native architecture (retroactive) of this territory because architects of this territory in different climates could provide the best coordination with environment and providing the users with the best living conditions using its limitations and possibilities. Iranian architecture is one of the successful examples of architecture mixing with nature with such elegance that seemed it is a part of the bed and natural environment. Such mixture with the bed and considering its capabilities and limitations causes the coordination of native and sustainable architecture to such extent that they can be hardly discriminated.

KEYWORDS: sustainable architecture, natural light, energy efficiency

INTRODUCTION

Sustainable development theory followed by sustainable architecture is the controversial subject in contemporary architecture. It is no question that each building must be able to communicate with natural environment where it built. What is challenging is the type and how this relation is. To answer this question the idea of sustainable architecture has been discussed today [Asadpour, 2006:1]. Dealing with sustainable architecture and ways of forming such approach in architecture designing provided us with native architecture and a sustainable approach comparing to each other to extract its teachings for designing the modern architecture [Armagan, 2009:20]. Considering the sets and units of native architecture, it seems that such sets have good example for sustainability in their own time and place. For making a sustainable and suitable environment, native architecture has been such mixed with nature that attained to some methods not only is harmless for its environment but also promotes and perfects the material. This study aims to initially review the concept of sustainability followed by sustainable architecture and after describing the climate and architecture properties investigates the application of natural light in new architecture and sustainable concepts in the architecture.

Sustainable Development

To better perceive the concept of sustainable architecture, it is necessary to have a clear definition of concept of "Sustainable Development" [Mellatparast, 2009: 122]. Generally sustainable development goes back a very long ago. In 1960s, Walter Izard et al. in Harvard University tried to make a connection between general economic models such as output and input with other categories such as food chains by biologists. Their results caused the publication of a book on 1972 provided new discussion related to analysis of environmental effects. There were conducted many other studies of this case later. However, the concept of sustainable development goes back to the activities of development planners and report of international unions for environmental protection and natural resources. Later on 1987 the report of international environment and development commission report was published. On 1992, the UN conference of environment and development was held in Rio de Janeiro and spread out this concept [Azizi, 2001:20].

Although experts are agree in the regard of "global issues may be resolved by making the policies and plans ended to sustainable development", however, there is no such agreement for definition of "sustainable development", therefore, there are different definitions for concept of sustainable development, and thus, it is felt a risk that this concept is ambiguous and misused. Generally accepted definition of sustainable development is the definitions as indicated in the report of Brontland stating that "sustainable development" is the development meeting

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the needs of current generation with no compromise ignoring the capability of future generation in meeting their needs.” The main objective of sustainable development is meeting the fundamental needs, improving and promoting the living level for all, maintaining and better controlling the ecosystems and safer and more fortune future for them [Mellatparast, 2009: 122].

Sustainable development is defined based on social, economic and environmental development and designing trainings and skills comprise main part of social development that must be related to social values and environmental resources [Hosseini, Mofidi Shemirani, Madi, 2008: 214] and finally it must be said that sustainable development has a general concept and related to all aspects of human life and implementing the models of sustainable development needs fundamental changes in the national and international policies and generally sustainable environment with the objective of environmental protection focuses on:

- Reduced energy waste and distribution environmentally;
- Reduced production influencing on human health;
- Removing the toxins from materials [Mellatparast, 2009: 122].

Sustainable Architecture

Application of sustainable concepts in the architecture opened new discussion called “*Sustainable Architecture*” or “*Ecological Architecture*” or “*Green Architecture*” or “*Environmental Architecture*”, all of them having the same meaning indicating the environmental friendly architecture [Gheyasvand, 2007:4]. With no intermediate, sustainability is the same route that architecture must access to it in the future. This type of architecture must indicate the feeling of man to the nature. How we design our home and select its materials is the most important issue influencing the future of construction [Soflaei, 2004: 63]. All designed conducted with relation of sustainable systems must be able to predict for the future. A building for example must be such designed with the consideration of reusing it and even its components. Such prospective view is also used for meeting the needs of future generation [Soleimani, 2008:2].

Along with what discussed above, one can state more concrete references to design for a sustainable architecture detailed as below, considering all subjects and structures recommended for designing a sustainable architecture:

- Housing+ sunlight and green space;
- Intact walls for an intact housing;
- Recognizing the concept of ill building;
- Ceilings with natural conditioning;
- Rainwater collection and reuse it;
- Improving the sanitary services and installation systems;
- Improving the heating and cooling systems;
- Insulating the building by making layers of hollow air in its walls and ceilings;
- Properly designing and making the door and windows as a linker between in and out;
- How accurate sunlight for living spaces with least wastes from fuels;
- Maximum usage of natural energy sources (sunlight, wind power, etc..);
- Solar heat systems;
- Properly replacing the cooling systems, etc...;
- And finally it must be said that the development is sustainable when it has been considered by public [ShahroozTehrani, 2007:1].

Dimensions of Sustainable Architecture

Dimensions of sustainable architecture detailed as below:

- Saving energy and using renewable and clean sources of energy;
- Saving the new and nonrenewable sources and materials, recycling;
- Respecting the context of plan
- Appropriate usage of climate in any region;
- Using native materials [Nasr, 2010:2].

Principles of Sustainable Architecture

Some buildings come with properties considered as sustainable buildings. The principles must be observed to classify a building as a sustainable architecture includes:

Principle One, Energy Saving: Building must be constructed such that it needs least fossil fuels.

Principle Two, Regional coordination: buildings must be such designed that coordinated with climate and existing energy sources in the place of construction.

Principle Four, Reduced Usage of New Materials: Buildings must be such designed that it could reduce using new materials as far as possible and at the end of their useful life they can be used as new sources.

Principle Five, Coordination with Site: Building must be gently constructed on the land of its site compatible with its surroundings.

Principle Six, Holism: All architectural principles must be considered in a full process resulting in making a safe environment [Gheyasvand, 2006:4].

Reflecting more indicates that the concept of sustainable architecture roots in old customs and old human culture and in traditional living it has been more respected to the nature. Therefore, the activities of last decade of 20th century can be seen as an attempt to revive such old concepts [Mousavi 2004:19]. In sustainable development followed by sustainable architecture it is obvious that any building must interact with its context and surrounding. The controversial and considerable part of this subject is how to interact and type of measures taken. This is the same subject for many years the residents of this territory could enjoy it and used it by implementing special techniques and rules for optimally using the energies and natural resources particularly sun and wind coordinating with climate and region [Zandieh, 2010:2]. In the corners of this wide territory by a civilization with the same variety with its climate variability, we can see the richness of its native architecture relying on its adaptation with variety of whether and environmental conditions. The miracle of traditional architecture for using regional materials and creating specific construction techniques with the best method of meeting the physical and spiritual needs of man is clear for lovers of cultural manifestations of Iran [Khakpour, 2006:46]. Native architecture indicates the human attempt for interacting with environment and nature and is the manifestation of culture, thought, customs and knowledge as well as techniques used by past and present men [Shahroodi, p.37]. native architecture of Mazandaran could be also extremely influenced by nature, region and environment. This kind of architecture has been such mixed with nature that can be called "Nature-Oriented" Architecture [same]. Most principles of sustainable architecture can be seen overtly and covertly in Mazandaran Architecture. More, to make this subject clear, there will be initially discussed the geographical and climate properties of Mazandaran and then its architectural properties.

Light in Architecture

Architecture Art is one of the sciences and arts that light plays role in it with many papers dedicated to how benefiting from natural light. In architecture art, light is one of the components discussed besides other elements and concepts such as structure, spatial order, materials, color,... and it must play its role as a separate element during designing. One of the most important characteristics of natural light is its sequence and transformation during the daytime causing the movement and shift during different hours. In the history of painting, impressionists considered light for their paintings. When painters were leaving their ateliers and begin painting under sunlight with natural light, they found the specifications of this style considering the color and light during different hours of the day and reflecting the colors of different objects in each other and influence of surrounding colors and using special and pure colors.

Light is the first provision for any type of visual perception. In the darkness, we can neither see the space nor the form and color. But light isn't only a physical necessity, but its psychological value is one of the most important factors of human life in all fields. "Men are like mosquito. They rush towards where there is a light without knowing why. We rush towards the light whether we will or not. Light attracts us to itself" says Morris Lapidus. Besides its applied usage, light has always symbolic value. Light is a part of essence of life and in most cultures, light or sun has been valued as a source of light and a divine element.

In ancient Egypt also light was of a special importance. Based on the situation of Egypt, the intensity of light and consequently the contrast between shadow and light (highlight) is very high. Explicit and geometric forms used in the Egyptian architecture with sharp and precise corners under sever light had special effects.

Architecture is accurate and dazzling artistic play of a set of bodies made under the light. Our eyes have been such created to see the forms under the light: "this is these highlights uncovering the forms against our eyes. Cube, cone, sphere, cylinder and pyramid are the first forms shown by light. Their images are pure, sensible and clear. But in Egyptian architecture, the play of light and shade isn't only limited to great initial forms. The surfaces of such volumes have been coated with high reliefs processed and engraved with high elegance on the stones; thus, highlight phenomenon has been also repeated here in a small scale. For Egyptians, man cannot access and or see the essence of God, and then it must be inevitably in the dark. The way of approaching to this God must be ended from light to dark and it could be slightly clear by the help of such light phenomena. By selecting the proper place of building with accurate attention to the route of sunlight, its light was such being used that sun's radius in a given time formed

an axis lightened a specific place and leaving other places in the dark. Jean Louis de Canival describes the lighting of statues of Khafran temple by: "light was shined from small windows between wall and ceiling inward and to individual status and reflected orderly by stones of the floor made out of polished white marble and a fully mate light with no direction was lightened the space and column and walls all of red granite remained in the dark". There are many status of gods and such darkness was more stressing their mysterious world. Only elected persons let to entering this temple and could see such thing that by today's view it couldn't be easily called an art, but it must be called as visual expression of ritual-religious combination. Such light as stated above was used intentionally to service, promote and materialize the main idea.

As stated above, Greece temples were fuller of status with their effect more on free space in front of the Altar. Thus, it isn't surprising that most of such internal spaces had only one opening, i.e. one door to the outside. Most other Greece temples were also being constructed by a method like Blood Temple using a waterfront in the distance between status and entrance door by which they modify the lighting to the status. The light shined in, was reflected by contacting to the water surface and then made the status seeable. In the spaces needing more lighting, Greek people used ceiling light: they were constructing a part of ceiling with more height and used such additional space for lighting in.

Advantages of using Natural Light in the Room

According to experts, sunlight is one of the most important factors to protect human health. In addition to physical health, the cause of some mental disorders such as depression can be due to the lack of sunlight.

Using natural lighting or sunlight has much relation with construction architecture and we may do nothing after that. But, remember that if everyone can only use a half of light of its home by sunlight, it can have positive effect on energy consumption nationally.

Before power supply and invention of light bulbs, the architecture of buildings was such that sunlight was used extremely for lighting it.

One of the masterpieces for supplying internal lighting with sunlight is Carnac temples constructed four thousand years ago in Egypt, such that even by best artificial lighting one cannot supply such suitable lighting.

According to experts, one of the most important factors for protecting human life is sunlight. Besides physical health, the reason for some mental disorders like depression is due to lack of sunlight.

In cold countries with long winters, depression is one of the common disorders among people. Lack of sunlight may result in reduced Vitamin D in the body as well as some hormones related to sunlight.

Studies indicate that people who regularly exposed to fluorescent lamps and CFLs affected by fatigue, depression and malaise.

In addition, sunlight although might make some skin troubles, but it can also treat most other skin diseases.

Using Natural Light in the Home

Most of us were accustomed with artificial light, for this reason, we less use windows and open the blinds and curtains to let sunlight coming in. most of us use the windows of our home when we feel the heaviness in the room or when we will watch out the windows. Most people may be upset if they feel they will be seen by others and this is natural based on out religious culture and views. For this reason, we less open the curtains. But it is better to mention that during the daytime, if you use lace curtains, the internal side of room may not be seen from outside so you can use sunlight by opening thick curtains. Such light, besides supplying enough light may disinfect and dry the moisture of the home and generally protecting your health.

Reflex Glasses, Elegant but Unsuitable

Application of reflex glasses in the windows of residential buildings is one of the common mistakes of current architecture. Using such glasses is a mistake even in office buildings, entered to residential buildings with greater mistake. It isn't proper to use such glasses in fact for windows of places needing suitable light. These glasses prevent entrance of sunlight and they must be only used for places where we won't be seen from outside during daylight but we will see outside.

From Artificial Lighting to Depression

Let light bulbs to be on only at nights. By this, besides saving energy and power as well as reducing your bills, you can protect the life of your family and yourself. Most studies concluded that in working spaces using natural light there was provided considerable improvement in the efficiency of their personnel. Studies indicated that the more usage of y fluorescent light bulbs by people, the more fatigue, depression and restlessness they have. For this

reason, it is recommended to use less artificial lights, particularly at nights in the bed room, turn the lights off and don't sleep under artificial lights.

Fluorescent light bulbs and Migraine

"Migraine Action Association" in UK stated that most patients referring to this institute or are a member of this institute believe that using fluorescent light bulb increased their migraine headache. This association asked UK state to make decision for delay in decision made for extended sales of fluorescent light bulbs and ban of selling regular bulbs. Before this, some other scientific and charity Epilepsy Institutes in UK reported the possibility of increased risk of affecting to this disease because of exposing to fluorescent light bulbs.

Five Main Advantage of using Sunlight

Generally it can be stated that using sunlight instead of artificial light during daytime in the working place or home comes with following advantages:

- 1- **Reduced Energy Consumption:** less dependence to artificial lighting can reduce electricity usage up to 10%;
- 2- **Reduced microbial factors and molds in the building:** most diseases, particularly chronic respiratory problems are mostly made by bacteria and molds formed in wet parts of the building such as undergrounds and bath. Sunlight can reduce production of such harmful organisms and is considered as one of the best disinfectants.
- 3- **Health for Vitamin D:** Plenty of sunlight may prevent lack of vitamins D and B1 causes diseases such as Rickets and Beriberi disease.
- 4- **Improved efficiency of people at work:** most studies concluded that by using sunlight in workplace, it could considerably improve the efficiency of employees.
- 5- **Increased visual attractions in internal design:** natural lighting is yet one of the best types of lighting systems being used in internal design and can be challenging and yet a satisfactory work for structure. In addition, extended natural lighting can have long term advantages affecting on human life.

Effective Usage of Natural Light Energy

The most effective method of using sunlight is supplying the natural light. Even the best filamentous bulbs comparing with sunlight need more electric energy for supplying a given rate of light, producing more heat. Combination of sunlight for lighting the building must be conducted considering reduced absorption of unsuitable heat.

It is possible to have an idea for optimizing the relation between natural shade and light directed into the modern architectural spaces. Concrete precast great spotlight used by Renzopiano in Menil complex in Huston, Texas, is a beautiful example of such new forms.



Figure 1- Concrete spotlights in Menil complex- Renzopiano

Another example is the work of Thomas Hetzrog, the designing center in Linz, Australia. In this project, there has been used a system with ability of reflecting and neutralizing the natural light distribution.

Glass could severely influence on modern architecture. Although using this material in 50s and 60s of 20th century made some problems, but it is yet used as one of the guaranteed materials with very good efficiency in sunlight architecture.

James Carpenter, architect and designer of glass and light in New York, has used the diachromic glass for making light effects.

This idea and its presence are considered as an objective since forming such project. Because this may not necessarily save energy, it is clear that new methods must be found for optimizing the application of glass as a constructional material.



Figure 2- Linz Designing Center, Australia- Thomas Hertzog

Electrochromic glass is an interesting achievement obtained by adding mobile properties to a stable material. By using an electric current for a few seconds, it can be changed to a mate surface. The idea of having a multi-layer all mobile wall, like a chameleons that can react to its surrounding has been followed by Mike Davis from Richard Rojers Co. he is a pioneer character for discovering new fields in technology of glass. Some of his activities include various studies in the field of first samples of multi-skin glazing walls for a researching project called “PROJECT 218”.

Ventilated cavity wall of external part of Loidz building, London, with high thermal efficiency, is another example that uses stylized sunlight optimally for its internal spaces.

One of the suitable fields of study is investigating the possibility of using gases, fluids and even organic materials that could be used between two glass walls or shaping the glass itself as applied in glass cups in Loidz building, London.

The art of using natural light for making performance effects is yet one of the subjects more considered in architecture. For this reason, new technologies provided new possibilities. Richtag building, Berlin is the place of new parliament of Germany implemented by Norman Foster and partners. His innovative idea of this project for energy issue finally resulted in making a structure with external appearance up the building with capability of light conduction. This new interpretation of a dome, that is the place of visitors, reflects the natural light by hundreds of mirrors forming the middle funnel towards lower part of building, i.e. parliament.



Figure 3- Loidz Building, London- Richard Rojas



Figure 4- Skylight dome of Reichstag Parliament, Berlin

One of the main components of Hong Kong Bank is Foster office work, atrium supplying natural light in the building. Light in this building is supplied by reflecting the light from the surface of two large mirrors. Sunlight collecting plate in the external part formed from hundreds of small mirrors following the sunlight route and reflects it to a concave mirror above the atrium. This concave mirror conducts the light into the space and even under the glass floor of the building. The prototype made by Norman Foster indicates by best way how light conducted to the underground.



Figure 5- Conduction of light to lower floors of Hong Kong Bank- Sketch of Norman Foster

Conclusion

Any space comes with two faces with light, day and night that by change in the size of light, both are linked to each other. It is artificial light that during any time has given a special feeling and concept to the architecture and living. We can say that when the fire in the fireplace was holy during Zoroastrian era, similarly light has been also praised. Even in later periods when there was a belief to the sun and its worship, because light is shining the world and showing the route of life was being considered and induced a feel of divine.

Light can be used by different reasons for inducing the concept and an objective; for example, by making an opening and directing the light to a subject we may focus on that subject and or by using soft and mild movements of light, we can give a spiritual feeling to that space such that when entering to such spaces, it make a calm and respectful feeling to the man and man can see himself against the endless greatness by which perceiving his humility. Its effect has been more used for churches and mosques. By heightening the building and lightings on related surfaces one can do this and or by using the widows in the corridors and special lightings, it can be moved though and or paused in the vestibules; this concept can be related to the movement of man in this world and attaining to the resurrection where he must be paused.

Following factors may have minimum thermal loss and maximum efficiency of sunlight when designing the construction architecture:

1- The direction of a building for better collecting the sunlight in the winter is better to be in a greater front. Computer studies indicated that the optimal and economic state for area and direction of a building to receive sunlight is obtained a building with ration of northern to eastern or western ratio of 1.5 to 1.6.

- 2- Materials comprising the external layer of the building must have maximum thermal resistance such as light concretes (floor concrete, gas concrete, and coarse concrete).
- 3- It is necessary to reduce the ratios of external layer area to useful volume and roof area to useable area and the openings area in the external layer (door and widows) to suitable area in the building.
- 4- It is necessary paying attention to reduced air leakage from sutures and openings of external layer.
- 5- Planting the trees in the west side or west southern side of the building is beneficial for reducing the entrance of heat at summers.
- 6- Deciduous trees are also good alternatives and can be used in the southern side of the building, because they have leaves at spring and summer so they reduce sunlight entrance to the building and at winter they have no leave and may not block sunlight.
- 7- Living space more usable must be designed in the southern side.
- 8- Reflecting surfaces must be designed in the floors adjacent to sun windows, porch and greenhouse connected to void spaces.
- 9- It is necessary to make walls with heavy construction materials in the southern façade.
- 10- It is necessary to use materials with suitable thermal insulation during construction.
- 11- It is necessary to consider increased efficiency of sunlight and reduced consumption of electric energy.
- 12- The approximate area for windows for using sunlight must be 5% total area of floor.
- 13- Windows must be put in the southern side of building resulting in reduced fuel consumption at winter and reduced temperature of building on sunny days.
- 14- It is necessary to use blinds to reduce energy consumption for cooling the building on summer.

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