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REVIEW ARTICLE **OPEN ACCESS**

Light in Architecture

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INTRODUCTION

The perceived beauty by eyes is arising from the light, otherwise within darken, there would be no beauty. Actual beauty can be perceived by the light of wisdom and physical beauty can be perceived through our most precious sense, namely sense of sight. Light either physically or mystic causes that the beauty would be perceived and the color and other beauties of object can be manifested [1]. Therefore discussion on light within aesthetic and art context is of high value. Among sciences and arts within which one can address the role of light, it is architecture art that is characterized by detailed discussion with regard to processes of using natural light. Lighting tools as means to supply artificial light are matter of interest. Within art of architecture, light is one of components discussed along with other concepts such as structure, spatial order, material and color and so on and it should fulfill its role as an independent element. One of critical features of natural light is its sequence and changeover daytime which gives rise to movement and state alteration over different hours. Over history of painting, at impressionists era, attention to light can be perceived when painters left their studios and set about painting under sunlight. Among features of this style, one can note attention to color and light over different daytime hours and reflection of colors of different objects in each other and impact of surrounding colors and using special and unique colors. This paper aims to examine the role of light in architecture as well as internal architecture as a vital component which engenders concept. It is expected that hopefully in the future we would be able to see buildings in which natural light is used as a quite effective element as our ancestors used it.

Light and human being

Since prehistoric era, shining objects which used to associate a vivid thing in the mind were always praised and respected by human being and they eagerly celebrated for it, or they worshiped it. This great attention to light phenomena can be found within most of primary human cultures and within societies with different traditions and beliefs over any time. Some societies used sunlight in their religious ceremonies and some others considered the shining of glowing objects as factor of generating mysterious processes for accessing to extraterrestrial domains [2]. Even today in many eastern schools in which yoga is taught, for establishing concentration, some shining objects are used such as lamp, sun, moon, crystal or firelight. Light is symbol of divine wisdom and origin of all purities and goodness, similarly getting out from darkness of ignorance and shining the light of wisdom within its soul always has been a final objective. Due to glowing of divine light into material body, i.e. holder of human soul, man can achieve to growth and spiritual excellence, as a result, for manifesting this metaphor in architecture, one usually uses light in the architecture of religious buildings as obvious element and independent from other concepts used in the building so that light beams can be seen distinctly within material and dark physique of the volume. Deep and dark spaces of middle age churches or Islamic mosques adorned by light element effective can convey a spiritual and divine sense. Within this place lit up with a weak light, by observing ambiguous shades of objects, one attempt to complete the picture in its own mind and so he or she comes to an ecstasy, consequently a feeling of approaching to the source of existence and being would be awaken within him or her [3].

Psychological effects of light:

Ambient lighting has a full bearing on mental and psychological modes, that is, as eye sees the light, its effect would be reflected throughout one's being and brings about variety of modes. Extent of its watt, intensity, weakness and variety of colors all affect human being mood. A good lighting brings about sense of tranquility and security and prevents developing excessive tiredness. Sometime we complicate the discussion on light by no reason and we lose the point that most reliable tool for us for determining effect of light is nothing but our eyes [4]. Differentiation between good and bad light and sufficient or deficient light can be obtained by merely looking at it. In other word, when one is found in an environment, he or she better and further understand the flaws of lighting. Modality of lighting of an environment has a deep influence on one's moods and temper just as moods are different at an autumn weather or in a sunny day in summer or a pleasant day of spring, or as a European's mood is different from a man of Arabia desert due to difference in climate, in the same way, either suitable or inappropriate lighting have different effects on one's mood [3].

An appropriate lighting meets human needs and reliefs his mind, brings about sense of tranquility and peace, it establishes proportion with background space and grants a beautiful hint to texture, color and form of furniture, in contrast, an inappropriate lighting can brings about an annoying feeling in people, it can fill the space by an unpleasant atmosphere and residents consider it as an anxious and nervous environment so that they feel that there is something wrong there. Poor light causes eye tiredness, anxiety and headache [5].

It is worthy to bear in mind that the system you select for your house would form a part of mode and form of your house. Fluorescent lamps has a good shining, however, coarseness of unpleasantness of its light represents a big flaw so that for lighting up the house, using yellow lamps are more pleasant and appropriate. Now, one may raise this question that which source may be more appropriate for lighting up the house or any other space, and this question is strongly dependent to state and mode of that space and that how do you want to deploy it. For this purpose, you can use a variety of lamps such as gas lamp, compact fluorescent lamp, and incandescent lamp and so on with your color taste.

Living room is a place used for eating food, or hosting intimate guests, watching television and so on over daytime. The modality of lighting induces sense of peace or reversely lack of peace, delight or dullness to inhabitants. An important method for lighting of a room is using indirect light that doesn't produce sharp shadows on the face of people and objects directly. Thus, using mild shadows, a special warmness and intimacy would rule the space. For making lighting more beautiful and for completing it in the room, in addition to ceiling chandeliers and lamps, one may use small ornamental lights for adorning corner and edge of room with mild light [6].

Art of Lighting:

The most critical factor for designing lighting within space is considering its type of usage. Then determining its natural light sources at next step, and subsequently determining objects and elements of space internal arrangement. Bear in mind that the best kind of light would shine from ceiling downward. From other side, dark colors in room ceiling cause the room to appear lower. A room with dark color walls would increase the depth of room. A room with dark color in the end wall would make the walls to appear shorter again. Therefore the way in which coloring of rooms has been done has great influence on its depth and largeness. Sometimes owing to the fact that we fail to change the color of place for any reason, an appropriate lighting can moderate the state of colors. Light can divide the space. Sometimes we want to separate two spaces for viewer. For example we decide to make a p art as information room and another place is assigned as client room. Another class of lights is used for inducing a specific sense to the viewer. Using filters, one can change the lights, and a classical area can turn into a romantic space [6].

Light receiving elements in traditional architecture

These elements are studied within Iranian traditional architect for two purposes, first group serve as controller of light such as awnings and second group are skylights. First group serve as adjusting the light inletting into building and are divided in two classes: first class are those belonging to the building such as porch, and second class are those that can be added to the building and usually they are ornamental usage such as curtain. Elements served as skylight are called differently, yet all of them are still skylight such as: aperture, shabak, reticulated door and window, glasshouse, dome skylight, sash window, roshandan, Feriz and Khavun, goljam, net aperture, Fanzar, Pachang and Tehrani. These are contrasted with porch, curtain, awnings, large tent, vault which serve as controlling and adjusting inletting light into the building [7].

Light controllers

Porch (Ravaq): it is a space consisted of ceiling and columns that is closed at least in one side and protects human from exposure to raining and shining of sunlight and within regions with high sun light and heat admits appropriate and moderate light inside and thus the lighting would be indirect.

Edge awning (Tabeshband): it is a strip 6 to 18 cm in width and sometimes its height reached to around 5 meters and it was made of plaster and reed. One usually installed a rafter tie on the door and window which served as horizontal edge awning and was called top-awning (Sarsayeh) and shining of sunlight into inside was controlled by it.

Awnings: developing shadow on the windows would prevent the direct sunlight from entering and as a result the produced heat emanating from sunlight would be significantly mitigated. Awnings may have different effects such as control of direct sunlight inward, controlling natural light and ventilation. Awning efficiency is varying and depends to color and place of its installation with respect to the window as well as conditions of natural ventilation in the building. Awnings are divided into various types, namely fixed, moving as well as natural overhangs such as trees.

Large tent (Saradaq): an awning with shadow on the building which its tent is tightly stretched on a truss set up above building, in this manner, it prevent the sunlight entering inside.

Vault alley (Sabat): it is a covered alley that can be found either in tropical or in cold regions. In tropical cities they had to build the alley narrowly with high walls and for making shadow, they would construct vault alley.

Curtain: using thick curtains for preventing and adjusting sunlight from entering into building was common since Safavid era; similarly it has been used over Qajar era. These curtains are usually made of canvas or silk and were either one-layered or two layered and was usually installed in the front of porches or windows or sash windows. Drawing up the curtain carried out by pulley and ropes which used to draw it in a coordinated manner all its parts, because these curtains were thick and heavy and otherwise one failed to draw it up (Ibid).

Skylights

Reticular windows (Shabak): Iran varying climate, bright and fierce sunlight, wind and raining, storm and hurricane and national and religious beliefs necessitate that in addition to door and window, a building would have a curtain or net for protecting inside of building. Inside of building is projected by apertures, wooden or plaster windows and curtain and the outside part was covered by clay or tile nets, these nets mitigate the light intensity and admit a weaker light through it. Deviation of light beams due to encounter with net carved edges would give rise to dissipating the light and contributed in uniformity and distribution of light. Meanwhile, despite all outside space could be seen from inward, however from outside there was no sight inwardly [8].

Reticula doors and windows

Window usually serves as receiving light, air circulation and sight of outside perspectives without disturbing the privacy of household. In regions with intense sunlight, the window should be made appropriate with intensity of light. Reticular windows bring about a balance between external and internal light, a balance that when it is seen from inside, it prevents from fierce sunlight and from tiredness of eyes against that fierce sunlight. Designs used in making net windows are often so as to adjust room internal lighting. Net windows dissipate external intense light and moderate it. When the outside light is not intense, it admits that entire to inside. Sometimes one uses glass for net doors and windows as well (Reticular doors are referred to as door-window). Wooden, clay and plaster net doors and window and apertures was closed by oiled paper and reopened in the summer (Ibid).

Aperture

Aperture and window cannot be separated from each other. In fact aperture serves as a small window embedded above or on both side of a door and used for receiving light and supplying fresh air for closed spaces. In other word, aperture is referred to as some holes embedded above or above vaults. Aperture is made of either wood or sometimes of clay and plaster and usually it has been fixed. Within buildings with central and introverted texture with possibility of receiving enough light from vestibule ceiling or another point, one embeds an aperture above entrance door (Ibid).

Sash window

Sash is a reticulated window that instead of opening on the vertical hinge, it opens upwards and would be placed in the case considered for it. Sash usually can be found in the floor of pavilions, veranda and porches of cold region buildings. Net sashes serve usually as window or wooden apertures.

Glasshouse (Jamkhaneh)

At the top of domes and small domes of bathhouse and bondman-house (Ghulamkhaneh) of ribats and streets and bazars, there are still some apertures which are shaped into bulging cupolas by some clay rings. Clay rings are laid beside each other in this place, and during winter, some glass bowls like bottom

of glass jars are placed in rings, however, during summer, one or all of them are removed. Also today, for lighting of covered spaces in which due to climate of season it should be warm or cold, it can serve as the best tool and continued to be placed on the roof of bathrooms.

Dome skylight (hournu)

It is referred to as the skylight at the ceiling. Due to fact that near tip of the dome, it is not possible to build like other parts, therefore one doesn't feel around the tip, so that the tip of vault would serve as skylight. For example in roof of bazars, the hole of dome skylight is usually open so as to allow the lighting and ventilation take place. Within buildings with no possibility of using window within walls, such as bazars or other public buildings, architectures would make some apertures within "karbandi sun" so as to allow the appropriate ventilation in the best way possible and it was called as Roshandan. Roshandan is usually in the shape of pavilion and is made perpendicular on Karbandi sun part and some of them were with glass, some of them had polygonal background, like Roshandan of Isfahan Hasht Behesht palace spring-house.

Fariz and Khavun in the building

Khavun was an ornamental design made of carved brick pieces and mosaic, then it is painted in various colors with soil and isinglass of colors solved in the water and was laid in frontal of building, middle of columns and door Fariz. For receiving lighting and ventilation to rooms, clay pipes were pierced and some designed are derived and those pipes were installed above doors and windows.

Karbandi and Muqarnas

Within spaces in which lighting and receiving sunlight is carried out through ceiling, the light is admitted into space directly and it illuminates only a part of it. Apart than beauty aspect, karbandi and muqarnas are used for drawing on sunlight as much as possible. Thus, it causes that light deviates in different directions and illuminates it in a distributed and dispersed manner, in this way, it provides in the internal space a uniform and distributed lighting spanning larger area.

Role of vestibule in lighting of building

Following entering the building, and due to intensity of light outside, light should be broken to not have an undesirable condition from view of someone who just enters it. One of most important factors in architecture as for division and breaking of light intensity is entrance vestibule with round or polygonal shape. There is a skylight above a vestibule which admits a moderate concentrated light within various hours of daytime, using this method for adjusting and moderating light and heat is among features of traditional architecture, especially at the rim of deserts.

Variety of vaults, arches and squinch also effectively contribute in manner of light receiving in building inside. Presence of squinch results in developing three distinct regions under dome area. The third region is the main dome which in its axes sometimes some small windows may be embedded and contributes in building light receiving. Innovation of ribbed vault method caused that the ceiling load directly applies on walls and so the walls and vaults have been made lighter and one would be able to embed window within these light walls and so abundant and indirect lighting can be provided. Annular barrel vaults also have lateral windows and or some small domes with window are embedded above them. In four-parted dome also that is resulted from intersection of two annular barrel vaults with same height and width, many apertures can be provided. Wagon vault also allows architect to embed a window between two arches and develop the natural light of building inside. Light receiving process takes place differently in different building, for example in bathhouses, the light receiving takes place through numerous apertures or Jamkhanehs based on being introverted or extroverted.

Although sunlight is always necessary for providing natural lighting in a building, however, since this light finally turns into heat, it is needed to provide the degree of necessary light for any building with regard to type of building and its climate circumstances. As the importance of sunlight depends to type of region climate and different seasons, in cold weather, upmost sun energy is required and building should be directed in such manner that receive most level of sunlight, by contrast, when it is warm, direction of building should be so that sunlight intensity would be minimized and similarly it should be no possibility for direct sunlight to enter internal space. For this reason, lighting of building varies across different climates from hot and arid and rim of desert to warm and humid climate to cold region and each one calls for their specific lighting and light design based on their special climate.

Lighting tool

When daylight comes to an end, people also needs light in the darkness of night, therefore after settling down in a fixed place and establishing cities and constructing residential houses, one felt to need a tool as an artificial light factor with ability to be moved from a place to another or to be used in anyplace at building. Therefore since this time, providing artificial light has begun with tools named luminous factors

and human being turned toward creating various tools in this area. These tools has been called lighting tools in general, and aimed at providing artificial light for illuminating the space at darkness time. These tools were: fat-burning, candleholders, lampstands, lamp bases, lamps, lanterns, torches, candles and oil lamps [9].

Following images are related to Sheikh Lotfollah mosque that is one of the architectural masterpieces of Safavid era. In this mosque, light enters through small apertures on the top of dome which brings about changing mode over daytime. Since due to turning sunlight, sunshine takes place over day only on some of these apertures, internal space of mosque at every hour of day light has its own unique temperament.

Examining adoption of natural light within some samples of western buildings over different eras

At first, we address the modality of using natural light in gothic church. The main idea of gothic style as building a part of heaven on the earth called for an immaterial space. Two factors contributed in solving this problem. First factor was displacing the load-bearing structure of building to outside, another was appropriate lighting. Dimensions of structural components can be reduced in the inside area to as much as possible, thus they could use very large windows in a freed areas. The light shined inwardly from upper part of middle vault walls is so intense that in this place no part remains dark. The viewer really thinks that the middle ceiling above him or her is suspended. Reversely, below part of middle vault is half dark. As for two side vaults with required dimensions for structural components at the bottom part, their walls fails to provide the possibility for such lighting. One feels that is situated at a half dark space with terrestrial nature, and when he or she looks up can see a bright sky, the place of divine beings. Church ceiling should associate the high and suspended ceiling of sky.

At baroque style, space is full of contradictions and it lures the senses. Here also lighting is of high importance, alternative sequence of bright and dark sides brings about a fostered imagination of depth. Viewer thinks that the space is extended to infinity. Structure of building with appropriate lighting represents as unreadable and entire building has an imaginative mode. Within this special era, in buildings of end of baroque era, use of indirect light was widespread. In these buildings, viewer often used to fail to see the windows and lighting of internal space was provided by reflection of light on the walls.

Due to his sensitivity to value of light in designing building, Louis Kahn has been known as poet of lighting and Kimbell art museum designed by him is abstract of all good lighting designs with daylight. This building should be placed within classics of all times.

Since long time ago, lighting of art museums was coupled with uncertainty, because ultraviolet light of daytime can be destructive effect especially on paintings. Kahn has selected most moderate level of daylight for space lighting in Kimbell museum, by considering that there is no or minimum level of destructive impact. He expected to satisfy biological needs by daylight and brings about sense of peace through awareness to time, and provided many other modes and feelings. This museum is constructed of a series of round vaults connected to each other 30 m in length and 7 m in width with a ceiling skylight along ridge of each vault. Daylight is returned back by suspended natural light fixtures situated beneath ceiling skylight and thereby would be refined. Natural light fixtures are consisted of a frame to which a metal plate is connected and has tiny holes that admit some amount of daylight so as to moderate any possible intense contrast between bottom part of fixtures and its surroundings. Following images demonstrate some part of art museum.

Among other buildings in which daylight is used in most effective and beautiful manner, one can mention Hong Kong and Shanghai Bank by Norman Foster. One has attempted to illuminate the entrance hall in this building by a gigantesque concave mirror situated in the building with a height more than 30 m. using a mirror located outside of building, at first the light is reflected inside the building and then it redirect 90 degrees by second mirror and is reflected from up toward building inside.

CONCLUSION

Light is most immaterial and tangible element of nature and always has been presented in Iranian architecture, in fact it represents sublime world and spiritual space. At traditional architecture era, the attitude toward light was soared to its highest level under influence of Islamic doctrine and has been recognized as symbol of sacredness and spiritual realm. Iranian architectures seeks truth, truth in architecture is excellence and excellence belongs to Almighty God and anything can be found in this architecture is one of its member that is inseparable and is directed toward truth. Light is a symbol of moving toward truth with no physical and material nature and this, along with other factors such as climate and situation of placing of a building, and the way in which the light is used are matter of interest, while this case in Western architecture is in a different manner. Rules governing modern architecture are something other than truth. Modern architecture is inclined toward simplicity and purity and seeks to reach its excellence through formal elements and it is other than spiritual purity. With this attitude, light has direct presence in the architecture, while in Iranian architecture light always has been received in a moderated manner, and this is realized, as it has been mention earlier, through architectural components such as apertures, skylights, Goljam, colorful glasses, sash windows. It should be noted that though the building in western architecture is completely expanded before light shining, or light direct annoyances are wholly eliminated, however one can compensate it through artificial lighting and this quite acceptable and appealing with regard to their own attitude in this respect.

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