International Journal of Architecture and Urban Development
Vol. 10, No.3. P 41-46. Summer 2020

E-ISSN 2345-2331
Original Article
DOI: 10.30495/IJAUD.2020.15938

The Role of Daylight within the Vault of Shahrak-e-Gharb Jame Mosque in Tehran

[1]Seyed hesamodin Tabibian, [2]Farah Habib, [3]Seyed Amirhosin Garakani*

[1] *Ph.D., Department of Architecture, Pardis Branch, Islamic Azad University, Pardis, Iran.*
[2*] *Professor, Science and Research Branch, Islamic Azad University, Tehran, Iran.*
[3] *Assistant Professor, Pardis Branch, Islamic Azad University, Pardis, Iran.*

Recieved 22.04.2020; Accepted 25.06.2020

ABSTRACT: Light plays an important role in the valuation of architectural elements, and it is a factor in designing spaces. Elements have no visual identity without light. This paper is intended to analyze the lighting in the vault of Shahrak-e-Gharb Jame Mosque with an emphasis on the role of daylight in order to find out how the designer has viewed the use of daylight in designing this mosque. The main question of this research is, "what is the role of natural daylight within the vault of Shahrak-e-Gharb Jame Mosque?". For this purpose, the light intensity was measured in the Shabestan and the vault of the mosque as an architectural monument using photometric instruments. Then, the trajectory of natural light was simulated using DIALux during a whole year, and the results were analyzed indicating that the role of natural light as an identity element in exhibiting the luminance of the mihrab has been neglected, and the light intensity seems uniform and boring within the vault.

Keywords: *Daylight, Architecture, Jame mosque, Simulation.*

INTRODUCTION

The industrial revolution and successive scientific developments, industrial and technological cycles are increasingly growing the welfare. Along with this phenomenon, exploitation of energy sources resulting from fossil fuel is an important issue the exhaustibility of which is ignored. Consumption of fossil fuels pollutes the environment and endangers the survival of living organisms through hazards such as greenhouse gases, global warming, a melt of polar glaciers, sea-level rise, and water pollution. Thus, focus on the proper design of lighting based on daylight is a solution to reduce the consumption of fossil fuels.

Nowadays, chandeliers as the only source of light, which entered the mosques from Qajar palaces, impeded designing the spaces to gain natural light. Today, a deep and correct understanding of Iranian historical architecture is needed, and forgetfulness of Iranian architectural knowledge has led to a great deal of contemporary architectural troubles. An acquaintance of Iranian architecture and its education can play a great role in reviving current architecture.

Light is found to be the most important metaphysical element of architecture. "Iranian architecture has used the most non-material element (light) for designing to bind its art to heaven, sanctify this art and imply that both frame and content are originated from one source. It has artistically used light as a dual entity (physical and spiritual) to not only reach a spiritual perfection through the universe but to show divine roots of this art" (Najafi, 2014). "Architecture is a subtle flawless magnificent game combining the volumes under the beams of light" (Corbusier, 1946, 108).

Research Background

Currently, international societies of light are conducting research and developing lighting standards for both natural and artificial light. Two International European (CIE[1] and CIBSE[2]) and American (IES[3]) societies developed a manual of standards of illuminating worship places. CIBSE in 13 volumes of lighting guides discusses "Lighting for Places of Worship (LG3, 2014)", which in item 3.3 mentions that some standards were created for mosques by giving details about lighting all of the spaces in mosques in terms of lux and light scattering.

CALI[4] and ISLE[5], and other lighting societies in Canada and Australia are also involved in natural and artificial lighting. IESI[6] started to work on research about lighting since 2010.

*Corresponding Author Email: *f.habib@srbiau.ac.ir*

The top of 5 research studies in the field of daylight are as follows:

The manual of mosque architecture deals with the effects of factors of regulating spaces like mosques including, weather, light, and sounds (Zargar, A., Nadimi, H. & Mokhtarshahi, R., 2008) is a suitable study of the architecture of Mosques.

Qualitative presence of light in Old Iranian architecture expresses the status of light since presence to the reappearance of Imam Mahdi by correlating light and architecture (Mahvash Mohammadi, 2015) discusses the quality of rolling in architecture.

Najamabadi has researched about introduced lighting mechanisms in Sheikh Lotfollah Mosque (Najmabadi Hosein, 2003).

Hoomanirad and Tahbaz have researched about Study of the role of daylight in creating a spiritual space in contemporary mosques (Hoomanirad & Tahbaz, 2011).

The role of natural light in historical mosques of Isfahan assessed the quality of the light needed for building a spiritual space in historical mosques, and its correlation with the quantity is one of good research about the light of the mosques (Hoomanirad, 2017).

Theoretical Basics

'الله نور السماوات و الارض' is verse in An-Nūr Sura in Holy Quran (Holy Quran, Sura Al Nur, Āyah 35). Meaning Allah (God) is the light of the heavens, and the earth implies implying that the entire universe is originated from light, and it is the most important element of the genesis of the universe. The most fundamental reason, why light is positively reflected in mystical thoughts, is the impression of such Quranic verses or words of Prophet Muhammad saying 'اول ما خلق الله نورى' (the first thing God created was my light) (Froozanfar,1982, 48). In Quran, the holy books of Muslims, light is perhaps the most fundamental metaphors (Humphrey & Vitebsky, 1997, 132). There is a key description of the symbolic importance of light in Al-Nur Sura. 'God the light of heaven and earth…...this is a light over light (Portoghesi, 1997).

Islam is a heavenly light that illuminates the universe, which is the divine knowledge. In Islamic traditions, the sun to all seeing and knowing is the eye of God' (Weightman, 1996, 121). Architecture is a beautiful game of light and shadow, and lightness and darkness." When a space covered by absolute lightness or darkness, it can eliminate the meaning of space. Therefore, an intelligent combination of these two gives meaning to the atmosphere and determines its particular use. Light does not shine by itself unless it sits on an object, that is when it can be efficient, involve in creating space and leave new concepts".

Architectural Style of Sharak-e-Gharb Jame Mosque

This mosque was designed by Eng Toosi in 1994. In the physical plan of the project, a commercial complex was planned, as a mortmain property, and religious and commercial uses were fully separated in the general plan. The vast plot opposite the commercial complex has further appeared in the mosque. The complex works as a simple curved wall for the mosque, in which the spaces are: main Shabestan, four meeting halls with a capacity of 100 to 300 persons, seminary, library, and other peripheral spaces. Old architectural characteristics including geometry, rhythm, and hierarchy, as well as Iranian-Islamic symbols, were used in a modern way for designing the mosque, which is also in agreement with the thought of the public.

The dome is made of concrete, which its deflection is relatively low and overlies four translucent panels. There are four other smaller translucent panels at a lower level, increasing illumination of the Shabestan. Despite low deflection of the dome, is can be seen from the main street (Fig. 1 to 4).

MATERIALS AND METHODS

Field studies and light intensity measurements were used by photometric devices. (Table 1)

For field research, Shabestan of the mosque was selected because it is the place of praying and connecting to God. 'This space is the major part of the mosque, which encloses Mihrab and Minbar. (Zargaz, 1999). After field research by DIALUX,

Fig.1: Main view of the Mosque

Fig.2: Shabestan and Mihrab

Fig.3: A close-up of translucent panels in the exterior facade

Fig.4: A bottom view of the dome

Table.1: Measurement devices used in this research

				
LMK camera	Light Meter	Color analyzer	Luminance Meter	Digital multimeter

the output data were analyzed in summer solstice (June 22) and winter solstice (December 22). 'Solstices were selected due to light variation and position of the sun in the longest and shortest day of the year as well as the highest and lowest angle of solar radiation. (Hoomanirad & Tahbaz, 2014).

Lighting variations were simulated three times a day at 9 a.m., 12:00, and 3 p.m. during every month of the year. Light intensities lower than 100 lux (grey to dark green) was low light, between 100 to 300 lux (navy blue to green) were auxiliary light, between 300 to 2000 lux (yellow to orange) was sufficient light and higher than 2000 lux (red to violet) were over light sometimes creating visual discomfort (Mardaljevic, 2010; Nabil & Mardaljevic, 2005).

Based on illumination standards, the average light intensity is 300 lux in the recitation part, 300 lux in the mihrab, and 100 lux in praying hall. Table 2 shows the quality and quantity of light for the interior section of a mosque (Unver & Enarum, 1999) (Table 2).

RESULTS AND DISCUSSION

Analysis and Simulation of Daylight illuminance in Sharak-e-Ghrab Jame Mosque

June 21, 9 a.m.: As shown in Table 3, at this particular data and time luminance of the mihrab and its surrounding wall is 15 Cd/m2 and 50 Cd/m2, respectively. Despite the mihrab is made of glossy stone, due to its cavities and scalariform texture shades form and luminance decreases.

June 21, Noon Prayer Time: Table 3 shows that luminance is 10 to 20 Cd/m2 in the mihrab and 50 Cd/m2 in the surrounding wall. Thus, the latter is more illuminant.

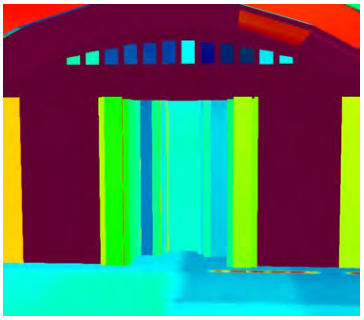
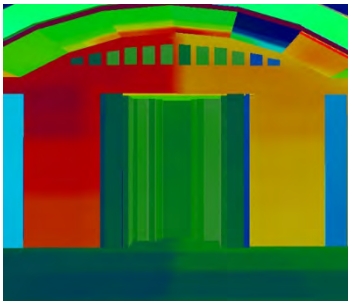
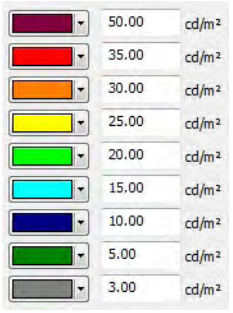
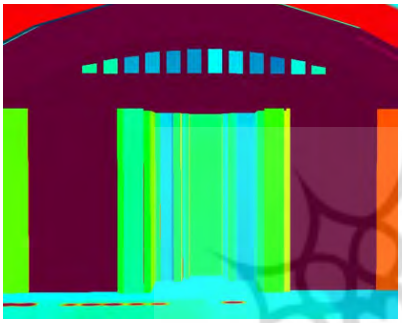
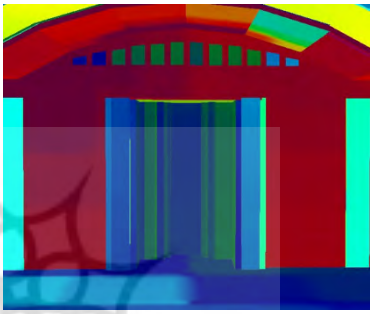
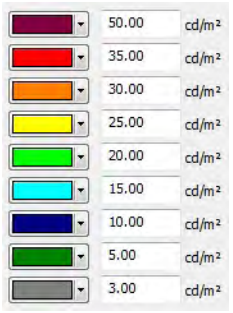
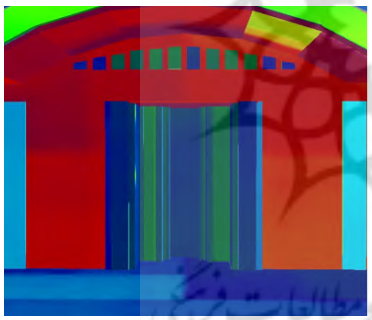
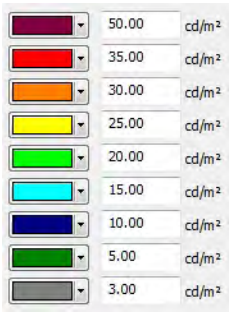
June 21, 3 p.m.: Luminance at this very date and time is slight (3 to 5 Cd/m2). The color of the surrounding wall is red to violet with a luminance of 35 to 50 Cd/m2.

December 21, 9 a.m.: As seen in Table 3, luminance in the mihrab of this mosque is approx. 5 Cd/m2 at 9 a.m. of the shortest day of the year, while it is 30 to 35 Cd/m2 for the surrounding wall. Any particular order is observed in the

Table.2: Quantity and quality of lighting in mosques. (Lighting and spatial structure in religious architecture)

Quality			Quantity		Reaction-Time
Direction-shadows	Light color	Lighting distribution	Aspect	Lighting lm/m²	
low –Dispersed shade	white – warm	vertical – Zonal	Vertical	300	Reading
low –Dispersed shade	white – warm	vertical – Zonal	Horizontal	300	mihrab – Prayer
low –Dispersed shade	white – warm	Vertical	Vertical	100	pray – Prayer

Table.3: Luminance analysis of daylight in Cd/m2 in mihrab and vault of Shahrak-e-Gharb Jame Mosque measured by DIAlux in the height of 140 cm

D / H	21 June	21 December	Cd/m²
9 a.m.			
Summer 12:02 p.m. & Winter 13:O6 p.m.			
3 p.m.			

mihrab and its wall.

December 21, Noon Prayer Time: Luminance of is 10 Cd/m2 in the mihrab and the 50 Cd/m2 on the wall. Also, in this scenario, luminance of the mihrab is very low, and it cannot create a sense of holiness and sufficient the luminance before the worshippers.

December 21, 3 p.m.: the mihrab is grey and its luminance is 3 Cd/m2 while the luminance is maxed.15 Cd/m2. In this case, the luminance of the mihrab is lower than that of the wall.

In all scenarios, luminance of the mihrab is lower than the adjacent surfaces, which is very low. The architect has solved this problem by using artificial light to increase the luminance and lightness of the wall of the mihrab.

Analysis of Daylight in Simulation Models of the Plan of Vault and Mihrab of Shahrak-e-Gharb Jame Mosque

June 21, 9 a.m.: Table 4 shows that within the whole space of the vault luminance is 250 to 300 Cd/m2 in this particular date and time, which is ideal for holding prayer, reciting Quran and reading prayer books.

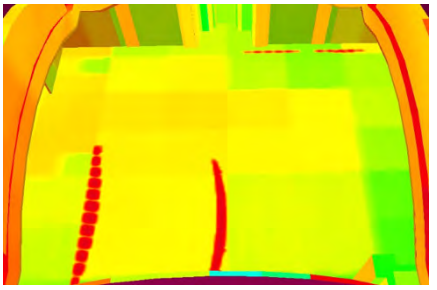
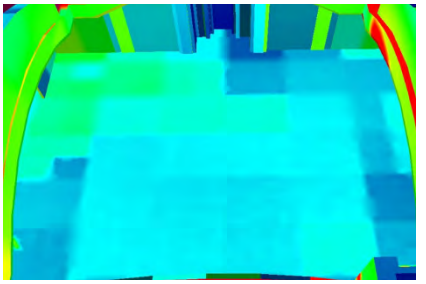
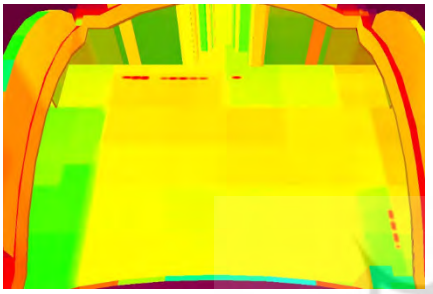
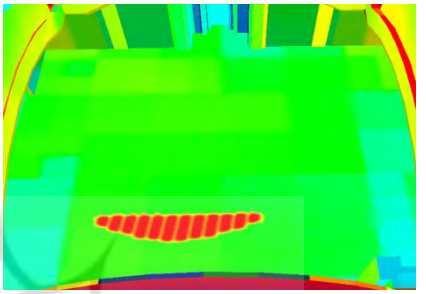
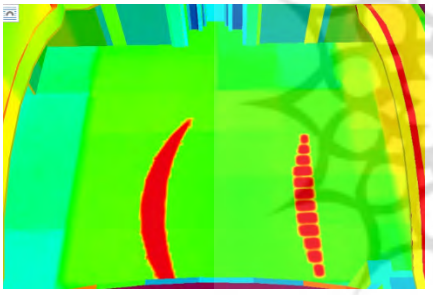
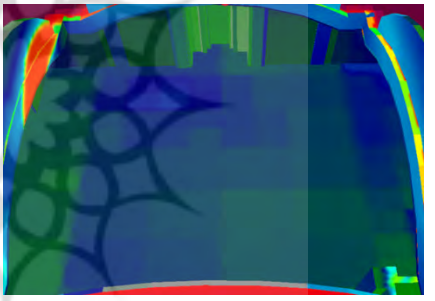
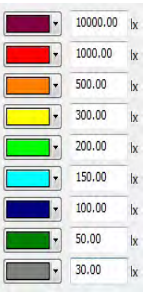
June 21, Noon Prayer Time: in the plan of the mosque, the surface is mostly in yellow (200 lux), while the left side is in green (200 lux), which is ideal for recitation.

June 21, 3 p.m.: As observed, the site in front of the mihrab is in green (200 lux). The left side of the plan is blue (150 lux), and the right side has turned yellow (300 lux). This is the best lighting for recitation. Thus, at this particular date and time, light is best distributed within the mosque, which ideal for holding prayer and other religious practices.

December 21, 9 a.m.: As shown in table 4, Navy blue and pale blue are the colours viewed in most parts of the plan (100 to 150 lux), which hardly illuminates the mihrab, and it is not suitable for Quran recitation or reading prayer books. Under this light, one is only able to say a prayer or connect to God privately. In this case, artificial lighting will be needed.

December 21, Noon Prayer time: At 13:06, when Muslims

Table.4: Analysis of daylight in the plan of Sharak-e-Gharb Jame Mosque (in lux) taken by DIALux

D / H	21 June	21 December	lux
9 a.m.			
Summer 12:02 p.m. & Winter 13:O6 p.m.			
3 p.m.			

are called to prayer at noon, lighting in the mihrab (150 to 200 lux) is inadequate. The vault has the same conditions which are insufficient for recitation or reading prayer books, but it is good for saying a prayer.

December 21, 3 p.m.: At this very date and time, the light intensity in the model of the vault is 50 to 100 lux, which is not even good for holding prayer, and it depends on artificial light. Contemporary architects can easily utilize natural light for designing, but they are accustomed to using artificial lights. “It is a pity that despite rich [Iranian] architecture displaying like a mirror towards the architects, natural lighting of present mosques regardless of their dependence on artificial lights does not follow the meaningful pattern of natural light either.” (Hoomanirad et al., 2018). All qualitative and quantitative properties of light can ideally be used in contemporary designing through perfect translucent panels and meeting its requirements. “Distribution, direction, angle, luminance, and glare of light are quality factors of light in space” (Heidary, 2009, 96).

CONCLUSIONS

Luminance is the mihrab of Shahrak-e-Gharb Jame Mosque is very low, and at the highest levels, it is lower than 20 lux, which is even lower on the surrounding wall. On the contrary, due to the holiness of the mihrab, its luminance must be higher than that of the wall. The architect has tried to solve this problem by using artificial light to increase the luminance and lightness of the wall of the mihrab.

Dark glass has also been used for constructing light wells beneath the vault, which has made the interior space of Shabistan gloomy and monotonous. Analysis of light intensity within the vault suggests that in summer when the light has a vertical direction the light intensity is under ideal conditions, while in winter when the angle of solar radiations is so slanted that suitable lighting is not provided within the Shabistan without artificial light. Although the certain light intensity distribution has created a particular uniformity and simplicity throughout the Shabistan, the light game could have increased the beauty and holiness of this space.

‘Islamic architecture especially, in Iran places significant emphasis on light. Interior space of a mosque is imagined to be

the light, crystalized within material forms, which reminds the believers of the verse of light (Nur) in the Holy Quran. Due to great luminosity of solar beams experienced in the crystalline air of most parts of Iran, and the elevated Iranian plateau, a sense of light and the necessity of living in spaces full of sensitive light has long been an inseparable part of life. Light is the most effective element of Persian architecture, which not only serves as a physical component but as a symbol of divine wisdom. The existence of light is a spiritual presence that penetrates deeply into a material converting it to a novel form for the human spirit to inhabit. A spirit whose essence is rooted in the world of light, which is definitely a spiritual world (Ardalan, 2011, 65).

"In addition to meeting visual needs of perceiving the environment, due to its meaningfulness and symbolic value, light has always strengthened the devotional spirit of the places of worship" (Zargar, 1997, 78). As a matter of fact, the presence of light in the architecture of mosques can be compared to that of God in a place of worship. "No symbol or sight as light can be this close to divine unity. This is why Islamic artists try to make the best possible use of this element" (Memaryan, 2005, 466).

The architects should find a new way for proper use of daylight in order to respond to the qualitative and spiritual aspects of modern mosques by studying and applying previous experiences. Precision in applying quality components of natural light such as luminance, lighting, radiation angle, dimness as well as the selection of suitable construction and texture materials can help design a devotional space. Increasing the use of artificial light has made the architects ignore the capabilities of natural light. In addition to saving fossil fuel energies, modern designers and architects use natural light as an identity element for creating a devotional space with adequate lighting.

ENDNOTES

1. Commission on Illumination.
2. Society of light and lighting.
3. Illuminating Engineering society.
4. Chinese association of lighting industry.
5. The Indian Society of Lighting Engineers.
6. Illuminating Engineering Society of Iranian.

ACKNOWLEDGEMENTS

This paper is taken from the author's Ph.D. thesis entitled "comparative study of the effects of qualitive components of natural light in the vault of Tehran mosques" under supervision of professor Farah Habib and the advice of dr. Seyed Amirhosein Garakani ,it has been done at the Islamic Azad university , Pardis Branch.

The authors are grateful to Noorgostar Company, Eng. Mohammad Farid Hanifi and Eng. Hamid Moslehi, who assisted in field studies and light intensity measurements, and Ms Somayyeh Ebrahimi who helped using DIALux and modelling.

REFERENCES

Froozanfar, B. (1982). "*Ahadith e Mabavi"*, Tehran: Amir Kabir Publications.

Heydari, S. (2009). "*Architecture and illumination"*, Tehran: University Press.

Holy Quran, Sura Al Nur, Āyah 35.

Hoomanirad, M. & Tahbaz, M. (2011). "The study of the role of daylight in creating a spiritual space in contemporary mosques", Journal of Armanshahr, *special Edition on the proceedings of first conference on light and lighting*, 7 (11/1). 11-23.

Hoomanirad, M., Tahbaz, M. & Pourmand, H.A. (2018). "The pattern of natural lighting in the vaults of historical mosques of Isfahan", *The journal of Islamic Architectural Research,* 16 (5) , PP.11-23.

Hoomanirad, M. (2017). *"The role of natural light in historical mosques of Isfahan"*, Isfahan: Isfahan municipality cultural and Entertainment organization publishing.

Humphrey, C., & Vitebsky, P. (1997). *Sacred architecture.* Barnes & Noble.

Corbusier, L. (1946). *"Towards a new architecture", Oewer complete & volumes.* Zurich: less editions d, Architecture, London: the Architectural press.

Mahvash mohammadi, M. (2006). *"Quality presence of light in architecture, Reviving the configurate.space processing with emphasis on Iranian mosques"*, Tehran: Faculty of Fine arts Tehran.

Mardaljevic,J.(2010). *Climate-based Daylight modelling-LESD.* Retrieved in 15 Jan 2014 form: http://climate-based-daylight.com/doku.php ?id=academic:climate-based-daylighting-modelling.

Nabil, a. & Mardaljevic,j .(2005)." Useful daylight Illuminate: A New paradigm for assessing, daylight in buildings". *Journal of Lighting research and technology,* 37 (1), pp 85-92.

Najafi, S. (2014). *"Analysis and study of Iranian traditional architecture and the role of light there in".* The proceedings of Iranian symposium of light and lighting, Tehran.

Najmabadi, M.H. (2003). "*Sheikh lotfollah Mosque and its features"*, Tehran: Nashre faraz publishing.

Portoghesi, P. (1997). The Roman Mosque, Rome, Italy. *Architectural Design*, (126), 70-71.

Unver, R., & Enarun, D. (1999). A comparative investigation of lighting of mosques and churches in Istanbul. *Publications-Commission Internationale De L Eclairage Cie*, 133(1), 288-292.

Weightman, B. (1996). "Sacred Landscapes and the Phenomenon of Light", Geographical Review, 86 (1), pp 59-71.

Zargar, A., Nadimi, H. & Mokhtarshahi, R. (2008). *"Criteria of site selection and designing mosques"*, The project of the School of Education and Research, Faculty of Architecture, Shahid Beheshti University.