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Light in Mosque Design

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Abstract— *The topic 'LIGHT IN SACRED ARCHITECTURE' is very complex and it can be approached, with the same rights and competences, by interpreters of religion, philosophers, all artistic expressions, designers (especially lighting designers), people of various practical activities, etc. In this paper on the topic 'LIGHT IN MOSQUE DESIGN' an architect and university professor writes, i.e. a person who educates students of architecture in its various fields and a person who designs himself (who has more than ten architectural realizations of sacred buildings). The paper develops the historical, philosophical, religious, psychological and aesthetic dimensions of the issue of the presence and use of light in sacred architecture. The intangible and ubiquitous phenomenon of light builds architecture and fills its spaces, appealing to our emotions. Thus, both natural light and artificial lighting serve to get to know special places in the architecture, and then give those places a special character. In the detailed descriptions of architectural objects and the circumstances in which these objects are created, we conclude that light is a co-creator of architectural forms and spaces - from the rudimentary way in which it helps to identify space to the sophisticated ways in which it participates in the creation of a transcendental atmosphere.*

Keywords— *Light, Sacred architecture, Islam, Mosque.*

I. INTRODUCTION

With his doctoral dissertation (“Defining architectural space on the example of a town house in Yugoslavia”, 1988), the author laid the foundations of the theory of Architecturally Defined Space (architecture) and opened countless paths of 'searching for architecture'. He presented his search for architecture through a series of published books - university textbooks, scientific books, monographs and travelogues [1].

As the textbooks threatened the curricula of certain subjects, some architectural topics were always left unfinished, that is, some dimensions of architecture were dealt with from the aspect (curriculum) of the specific 'subject' that he taught at the Faculty of Architecture of the University of Sarajevo. For this reason, as an 'extension of the content of university textbooks', he covered certain topics in new books and scientific papers.

Thus, for example, the university textbook “Architectural Physics” (1996, 2010) experienced its extension through a series of books (university textbooks and scientific books) [1]. The same was done with other, fundamental, university textbooks: Constructive systems in architecture, Architectural constructions VI, Bioclimatic architecture, Conceptualization and materialization of the boundaries of Architecturally Defined Space.

'The search for architecture' of the author of this work (from the doctoral dissertation to the present day) symbolically is presented in Figure 1.

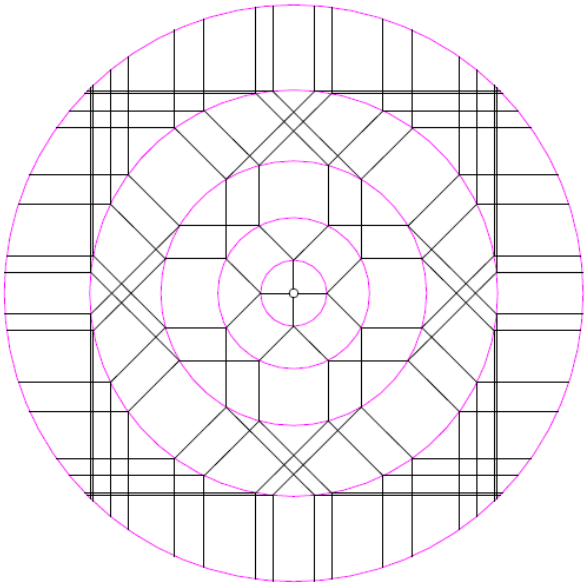

Figure 1. Development of the theory of Architecturally Defined Space through published books
Source: Author (2021)

In the university textbook “Architectural Physics”, the author dealt with light from a purely physical aspect and the relationship between man and light, determining the 'definitional area of human comfort from the aspect of vision conditions':
“Similar to heat and sound, light has its objective dimensions that define it (wavelength, frequency, energy, various types of behavior when spreading through space, etc). From the aspect of Architecturally Defined Space (ADP), light is interesting as a tool that enables not only seeing, that is, collecting information from the environment, but also the mechanism of that seeing, as well as the quality of seeing. This means that man is a special system through which the objective dimensions of light are refracted to form an image of reality, along with a series of subjective dimensions of each individual”. “The concept of illumination has, on the one hand, purely physical dimensions by which light is treated as a special form of energy , and on the other hand, those dimensions that express a person's relationship to the world around him. On the physical plane of consideration, light is treated as part of the spectrum of electromagnetic waves, which is determined by a series of physical quantities: speed of propagation, frequency, wavelength, amount of energy, as well as the lawfulness of their propagation through certain environments. On the subjective plane of consideration, light is treated as a means through which a person acquires information about his environment. From the aspect of

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architectural physics, this second consideration is interesting" [2].

II. LIGHT

From the aspect of architecture, light is interesting as a means that enables not only seeing, that is, collecting information from the environment, but also the mechanism of that seeing, as well as the quality of seeing. This means that man is a special system through which the objective dimensions of light are refracted to form an image of reality, along with a series of subjective dimensions of each individual. An architect must know the mechanism of transformation of the objective dimensions of light into a subjective experience, in order to use the results of this transformation in the creation of architecture in a similar way to the use of building materials, the effects of heating, ventilation, sound systems.

In physics, electromagnetic radiation (EM or EMR) refers to waves (or their quanta, photons) of the electromagnetic field, which spread through the Universe, carrying electromagnetic radiation energy. It includes radio waves, microwaves, infrared, (visible) light, ultraviolet rays, X-rays and gamma rays. All these waves form part of the electromagnetic spectrum.

Classical electromagnetic radiation consists of electromagnetic waves, which are synchronized oscillations of electric and magnetic fields. Electromagnetic radiation or electromagnetic waves are produced due to periodic changes in the electric or magnetic field. Depending on how this periodic change occurs and the power generated, different wavelengths of the electromagnetic spectrum are produced. In a vacuum, electromagnetic waves travel at the speed of light, usually denoted 'c' (c = 300000 km/s). In homogeneous, isotropic media, the oscillations of the two fields are perpendicular to each other and perpendicular to the direction of propagation of energy and waves, forming a transverse wave. The wavefront of electromagnetic waves emitted from a point source (such as a light bulb) is a sphere. The position of an electromagnetic wave within the electromagnetic spectrum can be characterized either by its frequency of oscillation or by its wavelength. Electromagnetic waves of different frequencies are called by different names, because they have different sources and effects on matter. In order of increasing frequency and decreasing wavelength, these are: radio waves, microwave ovens, infrared radiation, visible light, ultraviolet radiation, X-rays and gamma rays (Figure 2).

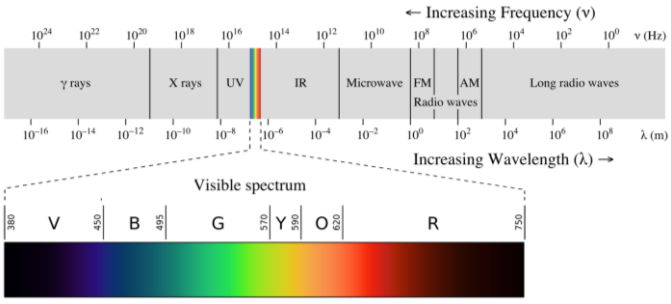

Figure 2. Electromagnetic spectrum with prominent visible light https://www.lumitex.com/blog/visible-light-spectrum, Accessed: 7.6.2022.

The language of light is cross-cultural. More than being used as a way to create a place for enjoyment, light in any religion is a special symbol of divinity. Light in holy places creates a contemplative atmosphere for religious meetings. Whether it's churches, mosques, synagogues or temples, accented light helps focus attention on important things. Until the nineteenth century - the eve of the invention of the light bulb - lighting methods remained more or less unchanged from the earliest antiquity. There were three forms of lighting, ordered by their appearance: torches, lamps, and candles, which used animal fat or, in the case of lamps in the most advanced ancient societies, vegetable oil.

Light in Islam

When he was entrusted to (for the first time) design a mosque (1986), a sacred space, that is, God's house [3], the author of this work had to learn about other dimensions of the light-architecture relationship (especially the light-mosque relationship) and be responsible for ' his vision of the mosque'. With this, he directly studied the Holy Book of the Qur'an, especially those of its fragments (suras) that directly refer to light (Qur'an 24. An-Nur/Light, Qur'an 32 As-Sedzda/Falling on the face, for example):

- Allah is the source of the light of the heavens and the earth! An example of His light is the recess in the wall in which there is a lamp, the lamp is in a lamp, and the lamp is like a shining star that is consumed by the blessed olive tree, both eastern and western, whose oil almost glows when the fire does not touch it; light upon light itself! Allah guides to His light whom He wills. Allah gives examples to people, Allah knows everything well. (Qur'an, An-Nur / Light, 24:35).
- In the mosques that are built by the will of Allah and in which His name is mentioned - they praise Him, morning and evening, ... (Qur'an, An-Nur / Light, 24:36).
- people whose buying and selling do not hinder them from remembering Allah and who perform prayer and give alms, and who fear the Day when hearts and eyes will be disturbed, ... (Qur'an, An-Nur / Light, 24:37).
- that Allah would reward them with a nice reward for their deeds and that He would give them even more of His goodness. And Allah gives to whom He wills, without reckoning. (Qur'an, An-Nur / Light, 24:38.).
- He governs everyone, from heaven to Earth, and then it all returns to Him in a day that, according to your reckoning of time, lasts a thousand years. (Qur'an, Es-Sedzda / Prostrate, 32: 5) [4].

In addition to being a spiritual and mystical symbol, light is also considered a decoration in the mosque. The lighting and decoration of mosques, the mind and imagined world and human traces are brought to the light of the world which is the correct expression. The depth and breadth of vision to understand meaning and existence means becoming intuitive. The analysis of light through stained glass is a reminder of the existence of divine light. The dominant color is blue, which suggests the sky. Yellow and green are used less and are therefore more precious. You can see a picture of stars, flowers and pearls.

Light is one of the most powerful form givers available to the designer. Muslims established their first places of worship in open spaces in nature. The first mosque (in 622) was a simple building with a square floor plan. She had a courtyard, shaded by palm trees in the direction of Mecca (Qibla). In order to indicate this direction, a niche called 'mihrab' was built on the wall. Since the mihrab (niche) is placed inside the inner surface of the wall on the longitudinal axis in the direction of the Kaaba ('qibla'), the vicinity of the mihrab is the most important place of the entire space. To the right of the mihrab there is a 'minbar' where the imam delivers a speech. The main hall for men is called 'sahın'. There is a separate area for women to pray called 'mahfil' (usually at the gallery level). Each space requires a different level of lighting. While performing namaz (prayer), the imam's ritual movements should be easy to follow, and while he is reading (reciting) the Qur'an on a low table called a 'qurs', daylight must be sufficient to meet reading standards [5].

Mosques

Islam (Arabic - romanized: Al-Islam = devotion to one God) is a monotheistic religion that appeared on the Arabian Peninsula in the 7th century. Along with Judaism and Christianity, Islam is one of the three Abrahamic (Ibrahimic) religions. Her followers are called Muslims (Arabic – Romanized: Muslim = one who obeys God). In his mission as God's Messenger, Prophet Muhammad s.a.w.s. was forced to escape from his native Mecca in order to save his bare life. This voluntary avoidance is called Hijra, and it happened in September 622 according to the Gregorian calendar. This event is so important for Islam that it was taken as the basis of time calculation in the Islamic world. Arriving in Jesrib (Medina) Prophet Muhammed s.a.w.s. he organizes the life of the new community, while his every move was recorded and remembered. Speeches and practice of Prophet Muhammad s.a.w.s. (sunnah) will become, along with the holy book Qur'an, the foundation of life in Islam.

Already after four days of stay in Jesrib (Medina), collective prayer (jamâat) was established when the Prophet Muhammad, peace be upon him. built the first mosque in history with his friends.

In Bosnia and Herzegovina (as well as in other areas of the former Yugoslavia), the term mosque refers to a building where Muslims pray. This building, as its visible feature, has a minaret (munara), a more or less tall tower from which the call to prayer is called (performs the call to prayer). An object with the same function, but without a minaret, is called a mosque in Bosnia and Herzegovina. However, the original meaning of the term 'mosque' is 'a place that gathers people'. In the physical sense, it is any clean place where an individual and a person with other people, properly prepared in advance, performs prayer. In the act of performing prayer, a person is directed (qibla) towards the holy Kaaba. Similar to temples in other religions, in Islam, the mosque has become its symbol, so its appearance in man's arranged space is of great importance.

A mosque, also called a masjid (in Bosnia and Herzegovina, the term masjid is used for 'a mosque without a minaret') is a place of worship in Islam. Any act of worship (absolute reverence for Allah) that follows the Islamic rules of prayer can be said to create a mosque. Informal open-air places of worship are called musalla, while mosques used for communal Friday prayer are known as jumaʿ-mosques. The standard elements of the main prayer space of the mosque are: the mihrab (decorative niche), the place of the imam who leads the prayer (it is placed in the wall that shows the direction of Mecca (qibla); facilities for prayer washing (ablution); the minaret from which the call to prayer is issued (adhan); a pulpit (minbar) from which a sermon (khutba) is delivered. Mosques, for the most part, have separate spaces for men and women. This basic structure of the organization took different forms, depending on the region and time period [5].

Mosques serve as places for prayer, Ramadan vigils, funeral services, Sufi ceremonies, marriage and business contracts, collection and distribution of alms, as well as shelters for the homeless. Historically speaking, mosques were also important centers of basic education and training in religious sciences. In modern times, mosques have preserved their role as places of religious education and discussions.

The word 'mosque' has entered various languages, from the French word mosquée, probably derived from the Italian 'moschea' (a variant of the Italian 'moscheta'), from the Armenian 'მაღიო' ('mzkit'), the medieval Greek 'μασγίδιον' ('masgídion'), from the Spanish 'mezquita', from the Nabatean masgědhā́, from the Arabic 'سَجَدَ' (Romanized: sajada, meaning 'to bow in prayer')...

The first mosques built were the Quba Mosque in the city of Majidža in Hejazi (the first building built by the Prophet Muhammed s.a.w.s. after the exodus (Hijra) from Mecca in 622) and the Companions Mosque in the Eritrean city of Massawa. Some scholars refer to Islamic tradition and passages of the Qur'an which claim that Islam as a religion predates the Prophet Muhammad s.a.w.s., and includes previous prophets such as Ibrahim (Abraham). Ibrahim (Abraham) is credited in Islam with building the Ka'ba ('cube') in Mecca, and thus its sanctuary, Al-Masjid Al-Haram (the Holy Mosque), which Muslims see as the first mosque to exist. A hadith (tradition of the Prophet Muhammad s.a.w.s.) in Sahih al-Bukhari states that the Kaaba shrine was the first mosque on Earth, and the second mosque is the Al-Aqsa mosque in Jerusalem, which is also associated with Ibrahim (Abraham) [5].

Below we provide an overview of the largest and most famous mosques in the world.

Masjid al-Haram, Mecca, Saudi Arabia, was built before 622 (Figure 3). On an area of 356,000 m^2, 4,000,000 people can pray. Masjid al-Haram, also known as the Great Mosque of Mecca, is a mosque surrounding the Kaaba in Mecca, in the Mecca Province of Saudi Arabia. It is the site of the Hajj pilgrimage, which every Muslim must do at least once in his life if he is able, and is also the main stage for the ʿUmrah, the 'lesser pilgrimage' which can be done at any time of the year. The rites of both pilgrimages include circling the Kaaba inside the mosque. The Great Mosque also includes other important landmarks: the Black Stone (Arabic-Romanized: al-Ḥajaru al-Aswad, Bosnian: Crni kamen), Zamzam Well, Maqam

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Ibrahim, and the hills of Safa and Marwa. As of August 2020, the Great Mosque is the largest mosque and the eighth largest building in the world. The Great Mosque has undergone major renovations and expansions over the years. It has passed through the control of various caliphs, sultans and kings, and is now under the control of the King of Saudi Arabia who is called the 'Guardian of the Two Holy Mosques'.

Figure 3. Masjid al-Haram, Mecca, Saudi Arabia
https://www.pinterest.com/pin/656047870688609150/
https://en.wikipedia.org/wiki/Masjid_al-Haram
https://www.win911.com/masjid-alharam-uses-alarm-notificationsoftware/
Accessed: 4.10.2021.

Al-Masjid an-Nabawi (Mosque of the Prophet s.a.w.s), Medina, Saudi Arabia, was founded in 623 (Figure 4). Today's building has an area of 384,000 m^2 where, at the same time, 800,000 people can pray. Al-Masjid an-Nabawi locals call it Al Haram, Al Haram Al Madani and Al Haram Al Nabawi. It was the second mosque that Prophet Muhammad s.a.w.s. built in Medina, after the Masjid of Cuba, and is now one of the largest mosques in the world. It is the second holiest place in Islam, after Masjid al-Haram in Mecca. The land on which El-Masjid an-Nabawi was built belonged to two young orphans, Sahl and Suheil, and when they found out that Prophet Muhammad s.a.w.s. he wants to acquire their land for the purpose of building a mosque, they went to him and offered him the land as a gift; Prophet Muhammad s.a.w.s. insisted on paying the price of the land because they were children without parents. The agreed price was paid by Abu Ayyub al-Ansari, who thus became the provider or donor of Al-Masjid an-Nabawi in the name of, or for the benefit of, Muhammad, may God bless him and grant him peace. Muhammed s.a.v.s. participated in the construction of the mosque. Originally an open-air building, the mosque served as a community center, court, and religious school. There was a raised platform or minbar for the people who were reciting the Qur'an and for the Prophet Muhammad s.a.w.s. to give a sermon on Friday (khutba). Later Islamic rulers greatly expanded and decorated the mosque, naming its walls, doors and minarets after themselves and their ancestors.

After expansion during the reign of the Umayyad Caliph Al-Walid I (668-715), it now includes the final resting place of the Prophet Muhammad. and the first two Rashidun caliphs, Abu Bakr and Umar. One of the most prominent features of the site is the Green Dome in the southeast corner of the mosque, originally Aisha's house, where the tomb of the Prophet Muhamme s.a.w.s is located. Many pilgrims performing the Hajj also go to Medina to visit the Green Dome. In 1909, under the reign of Ottoman Sultan Abdul Hamid II (1842-1918), it became the first place on the Arabian Peninsula equipped with electric lighting. The mosque is under the control of the 'Guardian of the Two Holy Mosques'.

The modern Masjid an-Nabawi is located on a rectangular plot and is two stories high. The Ottoman prayer hall, which is the oldest part of Masjid an-Nabawi, lies towards the south. It has a flat tiled roof with 27 sliding domes on square foundations. Holes drilled into the base of each dome illuminate the interior when the domes are closed. The sliding roof is closed during the afternoon prayer (Zhuhr) to protect visitors. When the domes slide on metal rails to shade areas of the roof, they create 'light wells' for the prayer hall. At that time, the courtyard of the Ottoman Mosque was also shaded by parasols attached to free-standing pillars. The roof is accessed by stairs and escalators. The area around the mosque is also used for prayer, and is equipped with umbrellas/parasols. The sliding domes and retractable umbrella/parasol canopies were designed by the German Muslim architect Mahmoud Bodo Rasch, his company SL Rasch GmbH and Buro Happold.

In the chamber next to the Rawdah are the tombs (graves) of the Prophet Muhammad s.a.w.s. and two of his companions (companions), the caliphs, Abu Bakr and Umar ibn al-Khattab. The fourth grave is reserved for 'Īsā (Isa, Jesus), because Muslims believe he will return and be buried there. The place is covered by the Green Dome. It was built in 1817, during the reign of the Ottoman Sultan Mahmud II (1785-1839), and painted green in 1837.

Figure 4. Al-Masjid an-Nabawi, Medina, Saudi Arabia
https://www.youtube.com/watch?v=zhIdHtUNviU
https://www.trekearth.com/gallery/Middle_East/Saudi_Arabia/West/Al_Madinah/Madinah_Munawarah/photo1007055.htm
Accessed: 4.10.2021.

Imam Ali Mosque, Najaf, Iraq, was built in 900 AD. The prayer area of 800,000 m^2 can accommodate 1,600,000 worshipers in one visit (Figure 5). The Shrine of Imam Ali (Ḥaram al-ʾImām ʿAlī), also known as the Mosque of 'Alī (Masjid ʿAlī), is a mosque in Iraq that Shia Muslims believe contains the tomb of Al'i ibn Abī Tāliba. He was a cousin of the Prophet Muhammad, and later became his son-in-law. Shias consider Ali their first imam, and Sunnis consider him the fourth Sunni Rashid caliph. According to Shiite belief, buried next to Ali inside this mosque are the remains of Adam (Adam) and Noah (Noah). Every year, millions of pilgrims visit the Shrine and pay their respects to Imam Ali. The Abbasid caliph Harun al-Rashid (763-809) built the first building over the tomb of 'Ali in 786, which included a green dome. Khalifa Al-Mutawakkil (822-861) devastated the site in 850, but Abu'l-Hayja, the Hamdanid ruler of Mosul and Aleppo, rebuilt the shrine in 923, which included a large dome. In 979-980, the Shiite ruler of the Buyid dynasty, Adud al-Dawla (936-983), expanded the shrine, which included a cenotaph over the burial site and a new dome. This included hanging textiles and carpets. He also protected Najaf with a wall and a citadel, while he supplied the khanate with water from the Euphrates.

Vizier Shams al-Din Juvayni (reigned 1263-1284) added facilities to serve pilgrims in 1267, and Sultan Ghazan Khan (1271-1304) added the Dar al-Siyad wing for Sayyids in 1303. A fire destroyed the shrine in 1354, but it was rebuilt around 1358 by Jalairid Sultan Shaikh Awais Jalayir (1356-1374). He also buried the remains of his father Hasan Buzurg in the yard. Timur ordered the restoration of the shrine after visiting Najaf. Sultan Suleiman the Magnificent (1494-1566) also offered gifts, which probably helped restore the shrine, after a visit in 1534. The Safavid Shah Ismail (1487-1524) visited (1508) the shrine, but it was Abbas I (1571-1629) who visited Najaf twice and had 500 men rebuild the shrine in 1623. The renovation was completed (in 1632) by his grandson Shah Safi al-Din. This renovation included a new dome, an enlarged courtyard, a hospital, a kitchen and a hospice, to accommodate the many pilgrims. The cenotaph was restored in 1713, and the dome was stabilized in 1716. In 1742, Nader Shah gilded the dome and minaret, and this was recorded by Nasrallah al-Haeri in his famous poem, iḏhā ḍhāmak al-dahra yawman wa jārā. Nader Shah's wife paid for the renovation of the walls and courtyard and the replacement of the Ivan facade. In 1745, ivan was rebuilt as a nine-layer gilded mukarna. In 1791, a raised stone floor covered the tombs in the courtyard, creating a basement space for them.

The Ottoman Sultan Abdülaziz (1830-1876) restored the Portal of Clocks (Bab al-Sa'a) and the Portal of Muslim Ibn 'Akil in 1863, and the former was gilded in 1888 by the Qajar Sultan Naser al-Din Shah Qajar. In 1886, Sultan Naser al-Din also repaired the dome because there were breaks in it due to weather conditions.

Ibn Battuta visited the shrine in 1326, noting that it was "covered with various kinds of carpets made of silk and other materials, and contains candlesticks of gold and silver, large and small". Between the three tombs "there are gold and silver dishes containing rose water, musk and various kinds of perfumes. The visitor dips his hand in this and anoints his face for blessing" [6].

The mosque is known for its large dome. Near its large gate are two minarets. The great dome is covered with 7,777 gold-painted brick panels, and there are also turquoise mosaics covering the side and rear walls.

The sanctuary is entered through three main monumental portals on the east, north and south sides, called the Main or Portal of Clocks, Portal al-Tusi and Portal Qibla. There are two additional monumental portals, the Portal of Muslim Ibn 'Akil, north of the Clock Gate, and the portal of al-'Amara, or al-Faraj, at the southwest corner. The inner sanctuary surrounds the courtyard, while to the west it is connected to the Al-Ra Mosque. The inner sanctuary is a large cube with beveled edges, on top is a bulbous dome 42 m high, and on the sides it is surrounded by double minarets 38 m high.

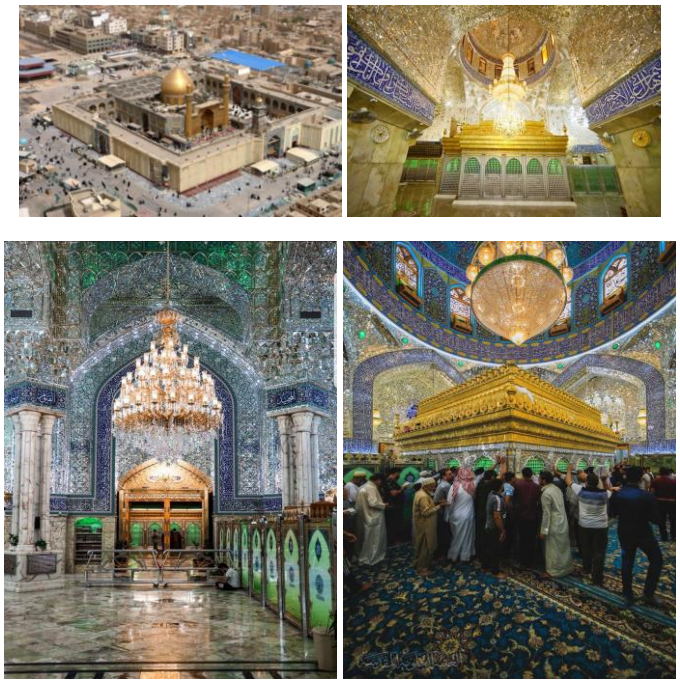

Figure 5. Imam Ali Mosque, Najaf, Iraq
https://www.pinterest.com/pin/2040762320682775/
https://www.islamiclandmarks.com/iraq/shrine-of-hussain-ra
https://twitter.com/visit_iraq/status/1126055864471654400
https://twitter.com/islamicarchit/status/1345771412431245314
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The Faisal Mosque, Islamabad, Pakistan, was built in 1986 (Figure 6). On the prayer area of 130,000 m^2, 300,000 people can pray in one visit. It is the sixth largest mosque in the world and the largest in South Asia, located at the foot of the Margalla Hills in the capital of Pakistan, Islamabad. The mosque has a contemporary design consisting of eight reinforced concrete shells, inspired by the design of a typical Bedouin tent. The construction of the mosque began in 1976 after a donation of 28 million dollars from the Saudi King Faisal, whose name the mosque bears. The unconventional design of the Turkish architect Vedat Dalokay (1927-1991) was selected after an international competition. Without the typical dome, the mosque is in the form of a Bedouin tent, surrounded by four minarets 79 meters high (the contour of the minaret base is 10 × 10 meters).

The combined structure is located on an area of 33 hectares (the mosque itself is 130,000 m^2). It is located at the northern end of Faisal Avenue, at the northernmost end of the city, at the foot of Margalla Hill, the westernmost foothills of the Himalayas. It is located on elevated land against the picturesque backdrop of the national park. The Faisal Mosque was the largest mosque in the world from 1986 to 1993, when it was surpassed by mosques in Saudi Arabia. Faisal Mosque is now the fifth largest mosque in the world in terms of capacity, it can accommodate about 300,000 worshippers.

The main building is the main prayer hall supported by four reinforced concrete supports. Architect Vedat Dalokay believed that the design of this mosque represents the Kaaba in an abstract way. The entrance is from the east, where there is a courtyard with porches in front of the prayer hall. The International Islamic University was located below the main courtyard, but has now moved to a new campus. The mosque still houses a library, lecture halls, a museum and a cafe. The interior of the tent-shaped main hall is covered with white marble and decorated with mosaics and calligraphy by the famous Pakistani artist Syed Sadequain Ahmed Naqvi (1923-1987) and a spectacular Turkish-style chandelier. A mosaic pattern adorns the west wall, and the calligraphy is written in an early Kufic script, repeated in the mirror.

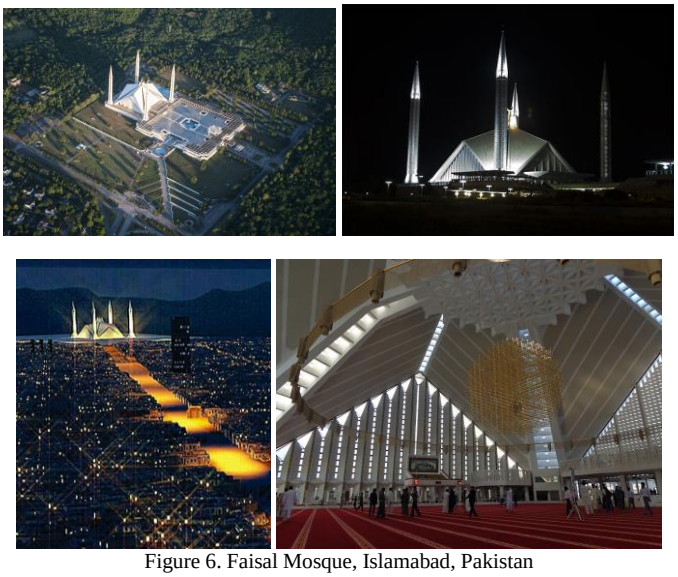


Figure 6. Faisal Mosque, Islamabad, Pakistan
https://www.pinterest.com/pin/435441857703926312/
https://upload.wikimedia.org/wikipedia/commons/9/91/Faisal_Mosque_-_Bird%27s_Eye_View.jpg
Accessed: 4.10.2021.

The Taj-ul-Masajid, Bhopal, India, was built in 1901 (Figure 7). The main concourse area of 23,000 m^2 can accommodate 175,000 worshippers. It is the largest mosque in India and one of the largest mosques in Asia. Construction of the Taj-ul-Masajid was begun by Nawab Shah Jahan Begum (1838-1901) of Bhopal, in the newly built walled suburb of Shahjahanabad. The exact year of the start of construction is not clear (estimated to be 1871). After Shah Jahan Begum died in 1901, the mosque was continued to be built by her daughter Sultan Jahan Begum (1858-1930), until the end of her life. The structure is planned in the middle of three water bodies: Munshi Hussain Talab, Noor Mahal Talab and Motia Talab. The mosque was not completed due to lack of funds, and construction did not resume until 1971. The entrance was renovated with motifs from 13th-century Syrian mosques donated by the Kuwaiti Emir in memory of his deceased wife.

The Taj-ul-Masajid draws a lot of inspiration from Mughal architecture. The mosque has a pink facade topped by two 18-storey octagonal minarets with marble domes, an impressive main hall with attractive pillars and marble floors similar to those of the Jame Masjid in Delhi and the Badshahi Mosque in Lahore. It has a courtyard with a large ablution tank in the center, a two-story entrance with four recessed arches and nine folding openings in the main prayer hall. The mosque also has a zenana (women's gallery), which is rare considering that praying from home was the norm for women at the time the mosque was built.

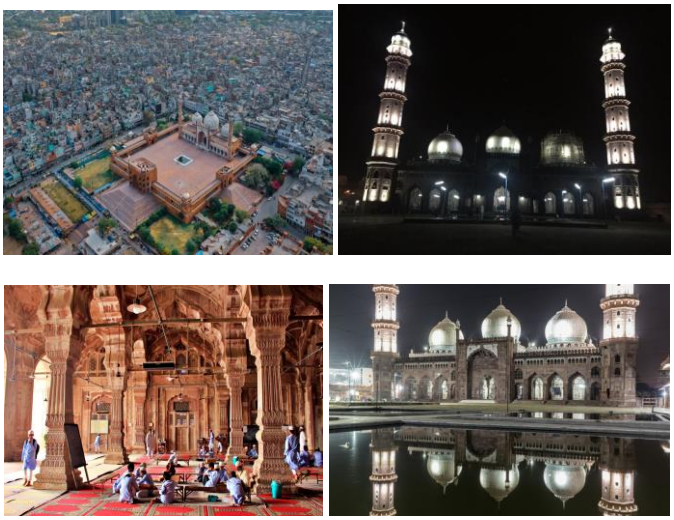


Figure 7. Taj-ul-Masajid, Bhopal, India
https://www.youtube.com/watch?v=hKj_SE-lmec
https://www.tripadvisor.ru/LocationPhotoDirectLink-g319726-d2718605-i163806312-Taj_ul_MasajidBhopal_Bhopal_District_Madhya_Pradesh.html
https://businessmirror.com.ph/2020/11/28/the-mesmerizing-architecture-of-taj-ul-masajid-mosque/
Accessed: 4.10.2021.

Djamaa el Djazaïr, Algeria, was built in 2019 (Figure 8). In its prayer area of 200,000 m^2, 120,000 people can pray at the same time. The mosque has the tallest minaret in the world

and is the third largest mosque in the world after the Great Mosque of Mecca and Al-Masjid an-Nabawi of Medina in Saudi Arabia [7]. The construction of the mosque began in August 2012, after the contract of the Algerian government, for one billion euros, was won by the Chinese state construction engineering corporation. The project was made by German architects KSP Juergen Engel Architekten and engineers Krebs und Kiefer International. The mosque faced construction delays due to budget problems caused by falling oil prices. About 2,300 workers from China, Algeria and other African countries were hired to work on the project. Many considered the construction of the mosque a symbol of the rule (1999-2019) of the long-term president Abdelaziz Bouteflika (1937-).

The mosque is located on a location that covers 400,000 m^2 and overlooks the Mediterranean Sea. The prayer hall has a capacity for 37,000 worshippers, while the structure, including the complex, can accommodate up to 120,000 worshipers and has a parking space for 7,000 cars. The complex also houses a Qur'anic school, a park, a library, staff housing, a fire station, a museum of Islamic art, and a research center for the history of Algeria. The minaret of the mosque is 265 m high, making it the tallest building in Africa. At the top of the minaret is an observation tower, which has 37 floors. The mosque was designed to withstand a magnitude 9.0 earthquake, and the structure was specially treated to resist corrosion. The main prayer hall has 618 load-bearing columns with an octagonal cross-section and 6 km of calligraphic writing engraved with a laser system. The dome of the prayer hall has a diameter of 50 m and rises to a height of 70 m.

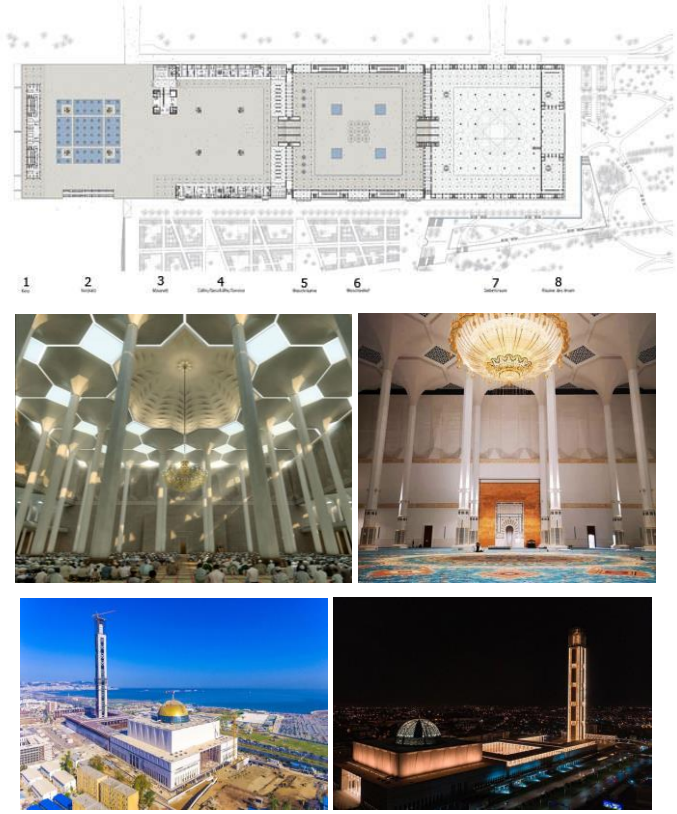


Figure 8. Djamaa el Djazaïr, Algiers, Algeria
https://www.egisgroup.com/action/realisations/greatmosque-algiers-algeria
https://www.wikiwand.com/en/Djamaa_el_Djaza%C3%AFr
https://twitter.com/muslimculture/status/1259913918555869184
Accessed: 8.2.2021.

Artificial lighting of mosques

Lighting describes the way the human eye (man) is exposed to natural or artificial light. Natural light comes from the Sun, stars or fire. The intensity of these sources will depend on the time of day and location. Buildings are often designed to optimize the capture of natural daylight. In contrast, artificial light is man-made and can come from sources including fire, candlelight, gaslight, electric lamps... Today, the term 'artificial lighting' generally refers to lighting generated by electric lamps. The term 'lamp' refers specifically to a light source, which typically consists of a light element housed in an external container (bulb or tube) that emits radiation within the visible spectrum. Artificial light, in general, is easily manipulated to achieve the desired lighting result. Light can be increased or decreased, directed, focused and colored. This allows the lighting to create a series of effects according to the requirements of the space [2].

In recent years, there has been a big shift from traditional incandescent bulbs to energy-efficient alternatives.

Incandescent lamps. A traditional light bulb with an incandescent bulb, which was once often used in residential buildings. They are generally considered to be the least energy efficient choice of electric lights, but they are cheap, turn on instantly and come in a variety of sizes and shapes.

Fluorescent lamps. Compact Fluorescent Lights (CFL) are available in a variety of sizes and fixtures and can be used in place of incandescent bulbs without changing fixtures. They are generally more energy efficient than incandescent bulbs. Some are dimmable and compatible with other lighting controls. CFLs come in rod, spiral and reflector varieties.

Light Emitting Diode (LED). LEDs are a rapidly developing lighting technology and are one of the most energy efficient lamps available. Compared to incandescent bulbs, they can use about 75% less energy and can last 25 times longer, but they are much more expensive. They are generally highly valued due to their comparable or higher quality lighting effect compared to other types of lighting [2].

Types of artificial lighting

Ambient lighting. This is general artificial lighting and overall lighting in the room. It can provide an even spread of light to give most people a comfortable level of illumination and to be able to see reasonably well and move around the room safely. It can usually be delivered using pendants (on walls) or ceiling lights.

Task lighting. This lighting makes it possible to perform tasks such as reading, studying, working on production machines, working on the production line... It is used where the level of light in the environment is insufficient to perform tasks.

Accent lighting. This type of lighting adds drama and character and allows you to highlight certain features that are considered interesting. The idea is to draw the viewer's attention to an illuminated 'point', on a wall, a decorative pool, an expensive vase – for example [2].

An overview of selected examples of light treatment in the design of mosques

The Sheikh Zayed Grand Mosque is located in Abu Dhabi, the capital of the United Arab Emirates (Figure 9). It is the largest mosque in the country, a key place of worship for daily prayers. During Eid, more than 41,000 people visit it. The Grand Mosque was designed by the Syrian architect Yusef Abdelki and was built between 1996 and 2007. The building complex measures approximately 290 x 420 m, covering an area of more than 12 hectares, excluding exterior landscaping and vehicle parking. The main axis of the building is rotated about 11° south of true west, aligning it in the direction of the Kaaba in Mecca, Saudi Arabia. The mosque has 82 domes. The central dome has a base diameter of 32.2 meters and a height of 85 meters. Its four minarets have a height of 107 meters. The project was initiated by the President of the United Arab Emirates (UAE), Sheikh Zayed bin Sultan Al Nahyan (1918-2004), who wanted to establish a structure that would unite the cultural diversity of the Islamic world with the historical and modern values of architecture and art. In 2004, Sheikh Zayed died and was buried in the courtyard of the mosque. The offices of the Sheikh Zayed Grand Mosque Center (Sheikh Zayed Grand Mosque Center, SZGMC) are located in the western minarets. SZGMC manages day-to-day operations and serves as a center of learning and discovery through its educational cultural activities and visitor programs. The library, located on the northeast minaret, serves the community with classic books and publications dealing with a range of Islamic subjects: sciences, civilization, calligraphy, art and money, including some rare publications.

The collection contains materials in a wide range of languages, including Arabic, English, French, Italian, Spanish, German and Korean. The design of the Sheikh Zayed Mosque was inspired by the Persian, Mughal and Alexandrian Abu al-Abbas al-Mursi Mosque in Egypt, and was also directly influenced by Indo-Islamic mosque architecture, particularly the Badshahi Mosque in Lahore, Pakistan. The layout of the dome and the floor plan of the mosque were inspired by the Badshahi Mosque. Its arches are quintessentially Moorish, and its minarets are classically Arabic. Natural materials were chosen for much of her design and construction for their long-lasting qualities, including marble, gold, semi-precious stones, crystals and ceramics. Artisans and materials came from many countries, including India, Italy, Germany, Egypt, Turkey, Morocco, Pakistan, Malaysia, Iran, China, the United Kingdom, New Zealand, North Macedonia and the UAE.

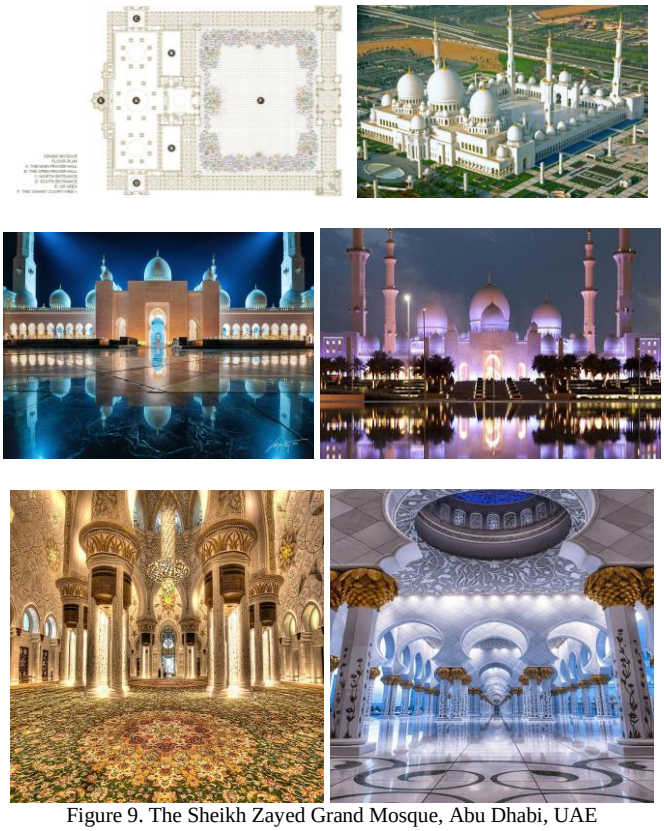
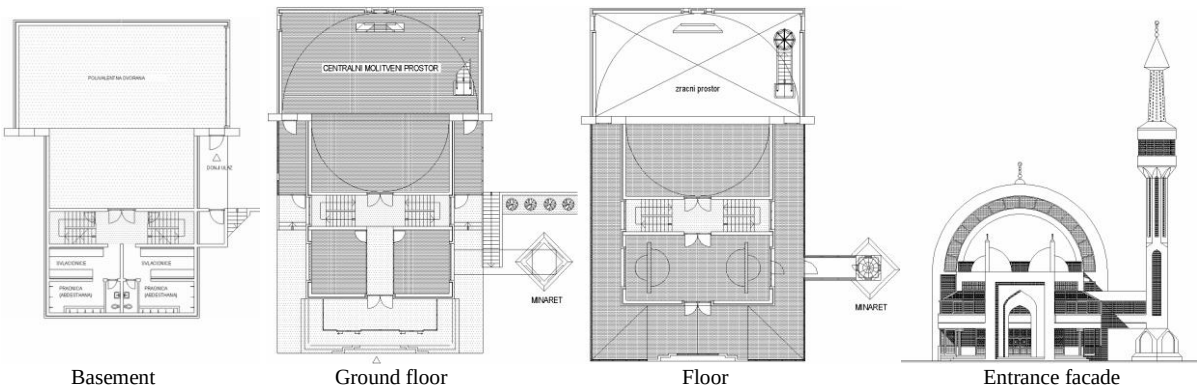


Figure 9. The Sheikh Zayed Grand Mosque, Abu Dhabi, UAE
https://gulfnews.com/uae/government/sheikh-zayed-grand-mosque-centrelaunches-remote-guided-cultural-tours-1.1589133880537
https://www.wallpaperflare.com/grandmosque-sheikh-zayed-abu-dhabi-mainprayer-hall-largest-carpet-in-the-world-5627-m-2-heavy-35-tons-mostly-madeof-wool-wallpaper-bszmx
Accessed: 8.2.2021.

Adil Bey's mosque in Sarajevo (geographic coordinates: 43º53'01.55"N, 18º33'04.76"E). In the design of the central dome, the author, in addition to the necessary attention in terms of its constructive role, gave special attention to the provision of high-quality (uniform) natural lighting and emphasized symbolism: the combination of the larger and smaller segments of the dome resulted in an arc of light that symbolizes the ceremonial entry into Sarajevo with a welcome (Figure 10).



Basement Ground floor Floor Entrance facade

Ahmet Hadrovic, "Light in Mosque Design," *International Journal of Multidisciplinary Research and Publications (IJMRAP)*, Volume 5, Issue 4, pp. 136-146, 2022.

Figure 10. Adil Bey Mosque in Sarajevo (Architect: Prof. Ahmet Hadrovic, PhD, 1999)

Source: Author

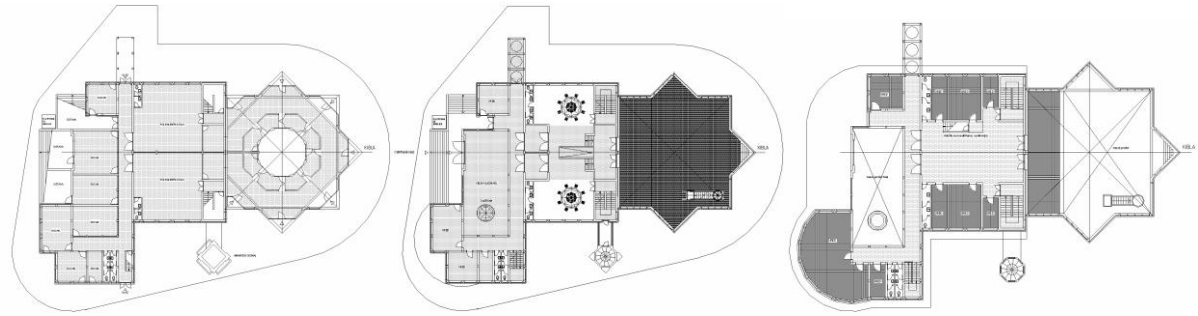
In this, as in all other mosques, the author treated day and night equally, that is, he gave light the importance of building material. During the day, light from the firmament reaches the mosque in a way that its visitor has yet to discover, while at night, light emerges from the mosque as a cheerful and encouraging sign. The terrace at the level of the mahfil is a place for prayer, both in summer and in winter. This motif of a traditional loggia (divanhana) got its modern meaning through the solution of a 'double membrane' architectural object, which ensures internal comfort through the effect of a greenhouse in winter, or intensive natural ventilation in summer.

The minaret is designed as a spatially developed arabesque with a lot of symbolism, in which light effects, according to a special program, suggest the significance of events in the mosque.

Islamic center in Novi Travnik (geographic coordinates: 44º10'03.98"N, 17º39'04.91"E). After the end of the war (1992-1995), the city authorities ordered the project of an Islamic center with a very ambitious project task. In addition to the mosque as a traditional temple in Islam, the project brief also provided for a number of other facilities: mekteb (rooms for conducting elementary religious instruction), a large number of business facilities, a multipurpose hall, offices and a number of service areas that should serve the main facilities of the Islamic center (Figure 11) The Islamic center also includes a kindergarten designed by the Author as a separate building, with special access outside the mosque.

Great attention was paid to the treatment of light in the design of the mosque. Unusually for the tradition of building mosques in Bosnia and Herzegovina, the author designed the envelope of the main prayer hall with a large proportion of transparent surfaces, both for the reason of introducing abundant natural lighting (during the day) and the radiation of rich artificial lighting from the mosque (at night). So the

mosque 'a symbol that radiates light'. At night, the tall minaret becomes a lamp that can be seen (and 'illuminated') from all positions in the city and its surroundings.



ground floor 1st floor 2nd floor

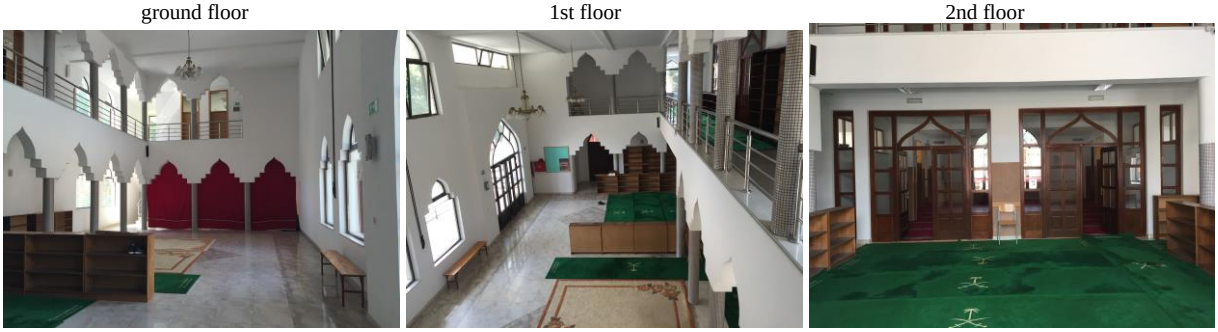


Figure 11. Islamic Center in Novi Travnik (Architect: Prof. Ahmet Hadrovic, PhD, 1998-2015)

Source: Vladimir Obradovic

III. Conclusion

In this work, the phenomenology of light is approached as a physical phenomenon that affects the comfort and practical use of space, and a symbolic phenomenon rich in social and religious meaning. Based on empirical scientific research, the author presents a picture of what today's science could say about this phenomenon. The goal of the author's analysis is basically the formation of a historical and practical basis, on the basis of which it is possible to indicate specific approaches

to the use of light design in different civilizational structures and certain periods of their creation. The points of view of many forms of creation and produced effects are analyzed through the historical conditioning of the generation of light sources, comparing and analyzing solutions, with appropriate classification. The phenomenon of light is approached as a physical phenomenon that affects the comfort and practical use of space, as well as a symbolic phenomenon rich in social and religious meaning. Although spatial comfort can have some subjective parameters that determine it, it certainly includes some general parameters, and one of them is certainly daylight, while the intensity of daylight can play a big role in achieving subjective spatial comfort [8]. Therefore, even today, the concept of good architectural practice is certainly not possible or achievable without a functionally designed lighting concept within a spatial unit and strategically designed units to achieve sufficient optimal amounts of daylight. In architecture in general, light is the starting point, it is not just an opening or a window, i.e. a dome, but an element that is thought about at the very beginning so that all the others make sense at the end. This work suggests the conclusion that the history of architecture is, in fact, a search for light. This is confirmed by the light that dematerializes the surface, becomes more present than the material itself, manipulates vision and ignites the imagination, depending on the transparency of the material, color, texture, orientation towards the light, quality and quantity of light, the overall arrangement of the space and the position of the observer in it. By manipulating natural and artificially generated light sources, architects over the centuries have made architecture more appropriate and reliable. This paper also suggests the conclusion that light is what enables sacred objects to become architecture, a set of values and their relationships conditioned by the time of creation and spiritual needs/identifications, relationships of existence and consciousness. Light is the anchor that additionally keeps us in the sphere of logical and critical thinking, understanding and reasoning, where not only new or old knowledge is systematized, it gives purpose and enables self-esteem. Light understood in this way is – Credo, manifesto and constitution. It could be said that the motif of light in the sacred architecture of all times is an enigma that needs to be solved again and again.

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