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Article

Lighting design proposal for the facade of an historic art building

Propuesta de diseño lumínico para la fachada de un edificio de arte histórico

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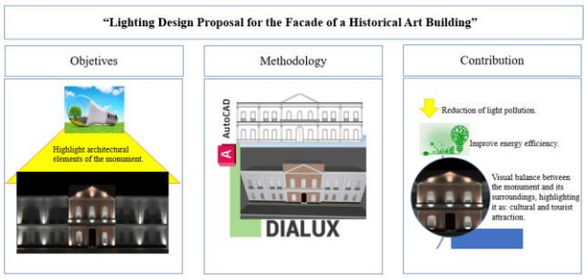
Abstract

This article details a lighting proposal for a historic monument, which includes two main systems: one focused on the building's façade and another on the sidewalk surrounding it. The aim is to highlight the most emblematic architectural elements through a uniform design that avoids visual distortions and minimizes the impact on the structure, using sustainable technologies to reduce light pollution and ensure the preservation of the building. Likewise, the sidewalk lighting is designed to improve the safety and comfort of pedestrians, integrating harmoniously with the façade design. This system seeks to maintain a visual balance between the monument and its urban environment, promoting its perception as a point of cultural and tourist interest.



Lighting, historic monument, architectural conservation

Resumen

El presente artículo detalla una propuesta de iluminación para un monumento histórico, que incluye dos sistemas principales: uno enfocado en la fachada del edificio y otro en la banqueta que lo rodea. Con el objetivo de resaltar los elementos arquitectónicos más emblemáticos mediante un diseño uniforme que evite distorsiones visuales y minimice el impacto en la estructura, utilizando tecnologías sostenibles para reducir la contaminación lumínica y garantizar la preservación del inmueble. Así mismo la iluminación de la banqueta se diseña para mejorar la seguridad y comodidad de los peatones, integrándose armónicamente con el diseño de la fachada. Sistema que busca mantener un equilibrio visual entre el monumento y su entorno urbano, fomentando su percepción como un punto de interés cultural y turístico.

Iluminación, monumento histórico, conservacion arquitectónica

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Introduction

Façades define the character of the building and fulfil various functions, whether formal, aesthetic or symbolic, thus reflecting the social and economic needs of the context in which they are located. Their surface as well as their design are influenced by the function of the building, the materials used, the location, the climate, the prevailing historical or artistic movements, as well as the sensibility of the owner or architect.

Lighting today plays an essential role in the plastic arts and, specifically, the lighting of façades and monuments makes it possible to recreate their architecture at night and achieve results of great beauty which may even be superior to those achieved with daylight, but which, in any case, if the lighting harmonises with their forms and atmosphere, will provide the delicate pleasure of discovering a new and surprising beauty, different from that obtained under sunlight, but no less interesting. This is why man has sought to illuminate his architectural works to enhance and magnify them (Casal, 1967), creating art.

Correct lighting can save at least 40 per cent of a building's total energy use, while bad practices can increase it by up to 90 per cent (CONUEE). The Taxco Charter, which regulates lighting in historic buildings, is a regulation to regulate proposals on night-time lighting of monuments and historic centres with the aim of contributing to the conservation, safeguarding and enhancement of cultural heritage from different approaches.

2. Theoretical framework

El Cuartel del Arte is an art gallery located in the historic centre of Pachuca de Soto, in the state of Hidalgo, Mexico. It is dedicated to presenting exhibitions on painting and sculpture by national and international artists.

In 1861, due to the Reform Laws, the religious ceased to occupy the Convent of San Francisco and from then on, it was given different uses: Practical School of Mines and general headquarters (today Art Headquarters), general state prison and municipal prison (today INAH Hidalgo Centre), and civil hospital (today Hidalgo Centre for the Arts).

In 1861, the Practical School of Mines was established in the building, which ceased to function during the French intervention. It was later put to various uses until, at the time of the Mexican Revolution, it was used as barracks and military offices for the garrison troops. On 18 September 1929, by presidential decree, it passed to the Secretariat of War, and on 17 October of the same year it was handed over to the Chief of Military Operations by the Federal Treasury Office. It became known as the 'Gabriel Hernández' Barracks. In 1984 the Regional Museum of History was inaugurated, this museum had three rooms. In the first one 'Raúl Guerrero G' there were fossil remains and prehistoric objects; this section showed the area of dominion that the Huastec and Aztec cultures had, as well as the archaeological discoveries in the area of Tula.

The second room 'Roberto Weitlaner', showed the colonial period, here the places of the catholic evangelization and artistic pieces of that historical period were observed. In the last room 'César Lizardi', wood carvings, wrought iron utensils, silver religious objects and oil paintings, among other artistic representations of the New Spain, were exhibited. In 2001, the Cuartel del Arte was created by the State Council for Culture and the Arts.

In 2010, the State Council for Culture and the Arts (CECULTAH), and the Support Programme for Cultural Infrastructure of the States (PAICE), remodelled the interior of the venue. In March 2018, work began on the refurbishment of the building, mainly on the façade, reopening on 13 March 2019.

In the need for cultural spaces and artistic expression to be projected to students, academics and alumni, the Ministry of Culture of the state decided to open the Cuartel del Arte for the first time, to exhibit the work of the creators from Hidalgo who study or who have graduated from the Institute of Arts (IA) of the Autonomous University of the State of Hidalgo (UAEH). Architecture The site on which the building stands has the shape of a rectangle and its main façade faces west. The main façade is covered with carved pink and white quarry stone and is formed by a door with a semicircular enclosure between two low windows with a very low arch. Three balconies on the first floor, preceded by a common quarry stone balustrade, correspond to its axes.

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On each side, on both floors, there are four windows, and the gable is crowned by a continuous parapet interrupted in the centre by a triangular pediment the length of the balustrade. The rear façade has large stone walls, in the centre a square bay, with two columns with a quadrangular base and capital; in this bay is the access door with a semicircular doorway; in the centre a balcony, and on each side two windows at the bottom and at the top.

2.1 General Requirements for the Lighting of Historic Monuments

Lighting projects for historic monuments should address the following key issues:

1. Research

It is essential to gather historical, graphic, photographic and documentary information about the building and its surroundings. This will require the consultation of specialised bibliography, as well as access to historical, photographic and cartographic archives to provide a comprehensive context.

2. Conceptual proposal for the intervention

It should include a detailed description of the characteristics of the property or historic area, including the movable assets, outstanding architectural or natural elements, and their stylistic, formal, urban and architectural particularities. It should also analyse their interaction with natural lighting, both indoors and outdoors, and their relationship with the immediate surroundings.

For public spaces, it is necessary to study the type and location of the main and secondary light sources, as well as the orientation and solar incidence. In addition, it is essential to define the objective of the intervention, specifying:

- Function and type of lighting.
- Levels and contrasts of light required.
- Technical means to be used.
- Characteristics and fixing systems of the luminaires.
- Location of the lighting points and the electrical distribution network, guaranteeing their safety.

Finally, a detailed analysis of the environmental impact of the proposal must be included.

3. Development of the proposal

Lighting tests will be carried out to verify the feasibility of the proposed design. These tests must have the prior authorisation of the competent bodies, ensuring that the integrity of the monument and its surroundings is respected.

2.2 Exterior Lighting

For the design and execution of the exterior lighting of a historic building, the following essential points should be considered:

1. Identification of the building and its surroundings

The characteristics of the historic building and its relationship to its immediate surroundings must be analysed to ensure a coherent design.

2. Uniform lighting

The project must ensure homogeneous lighting that allows the building to be appreciated as a complete unit, avoiding distortions or visual divisions.

3. Relationship with the surroundings

The proposal should highlight the monument without generating excessive contrasts that would cause lighting competition with the surroundings or ‘brightness creep’.

4. Independent lighting system

The lighting design should dispense with elements that require direct integration into the structure of the historic building.

5. Fixing and location of luminaires:

- It is prohibited to install luminaires on the façade that require drilling or boring into stone, wood or other materials of the property.
- Luminaires and wiring on rooftops, decks or towers shall be installed using non-invasive methods of attachment that do not affect the structure or ornamental elements.

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– Under no circumstances may ornamental areas (reliefs, sculptures, wall paintings, altarpieces, coffered ceilings) or structural elements with conservation problems be perforated.

6. Avoid visual distortions

No lamps should be placed on the floor, as they alter the perception of natural shadows and generate glare for pedestrians.

7. Detailed technical documentation

All fixing methods, wiring and equipment locations must be specified in drawings and diagrams included in the project. In addition, these must be supervised by a qualified technician and approved by the competent authorities.

8. Light pollution

The project must minimise the emission of light into the night sky to avoid light pollution.

9. Design for maintenance

The installation should provide easy access to all components for maintenance tasks, such as lamp replacement and equipment cleaning.

10. Maintenance manual

The project must include a manual detailing the scheduled maintenance tasks according to the lifetime of the lamps, together with specific instructions for handling and replacement, ensuring the correct operation of the system.

11. Regulatory compliance

The lighting system and its electrical installation must strictly comply with official safety regulations for electrical installations.

3. Methodology

1. Site reconnaissance and identification of construction materials.
2. Architectural survey in AutoCAD.
3. Modelling in DIALux software.

3.1. Site recognition and identification of building materials

Identification of the current construction, materials and lighting. Fig,1,2, 3 and 4. Façades of the Cuartel del Arte and current lighting.

Box 1

Figure 1

Cuartel del Arte, main façade. Extracted on 27/09/2023.*https://es.m.wikipedia.org/wiki/Archivo:Cuartel_del_Arte_en_Pachuca,_Hidalgo_10.jp.*

Box 2

Figure 2

Art Barracks, rear façade. Extracted on 27/09/2023 *https://es.wikipedia.org/wiki/Cuartel_del_Arte#/media/Archivo:Cuartel_del_Arte_en_Pachuca,_Hidalgo_07.jpg*

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Box 3

Figure 3

Current lighting of the Cuartel del Arte

Own Elaboration

Analysis of the materials used in the construction of the main façade to obtain their reflection coefficients, Table 1. Materials used in the construction of the main façade of the Cuartel del Arte. As can be seen, the building has white and pink quarry stone envelopes, wooden windows and doors.

Box 4

Table 1

Construction materials of main façade Art Barracks

Surface area of the Art Barracks.	
Materials	Reflection Coefficient %.
White in 60 x 30 cm blocks	Blank colour:70- 85. From the stone: .30
Wooden door	0.10 – 0.25
Stainless steel ironwork	0.5
Glass	1.50 – 1.66
Pink in 60 x 30 cm blocks	Pink colour 70 – 50. From the stone: 0.30

Own elaboration

3.2. Architectural Survey in AutoCAD

An analysis of the dimensions of the building was carried out, making an architectural survey to determine the necessary measurements for the lighting design. These measurements are represented using the AutoCAD programme, creating the elevation of the main façade, which is the part that is intended to provide better lighting.

Box 5

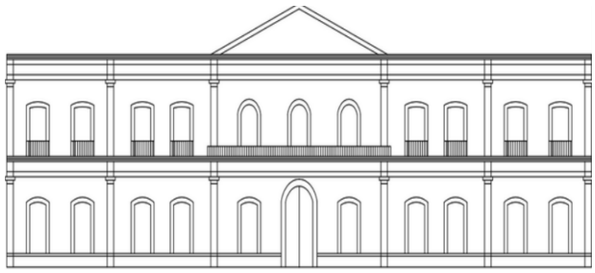

Figure 3

Elevation of the main façade of El Cuartel del Arte *Own Elaboration*

Box 6

Figure 5

Architectural plan of the main façade of El Cuartel del Arte *Own Elaboration*

Box 7

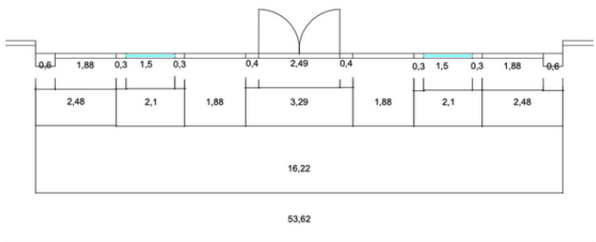

Figure 6

Architectural plan of the main façade with measurements of the El Cuartel del Arte

Own Elaboration

Box 8

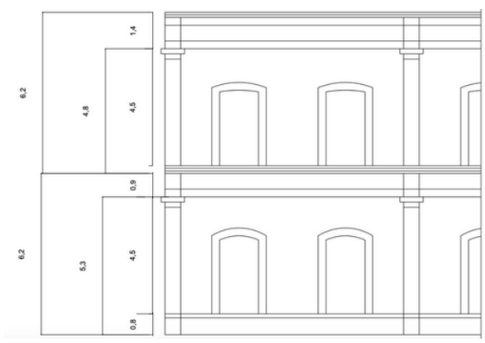

Figure 7

Elevation of the main façade with measurements of the El Cuartel del Arte.

Own Elaboration

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Box 9

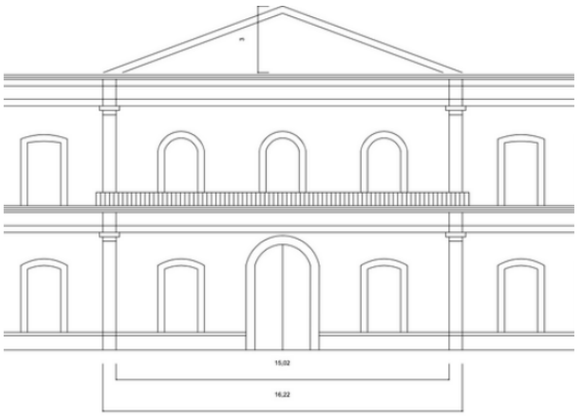

Figure 8

Elevation of the main façade (with measurements) of El Cuartel del Arte

Own Elaboration

3.3. Modelling in DIALux software

The DIAlux evo11 program is a software that allows the lighting design of any building and external areas. In the analysis only the lighting proposal for the façade is made, which is considered as a monument with the aim of showing off the façade and creating a different visualisation of what the building is on its own with natural light.

The lighting is diffuse, focused, framed, indirect or direct, with the aim of highlighting specific areas of the monument in this case, as well as its ornamentation, columns, bell towers, stained glass windows, among others. For this project, the pavement will be illuminated, which is the area where people go to the main entrance, arriving at it obliquely from the sides. The intention is to illuminate to cause impact from the approach to the construction, so a lighting design is made in this part of the Art Barracks in Pachuca de Soto, Hidalgo.

The DWG file is imported into the DIALux program, in which the proportion of the building can be seen, as well as the façade and the pavement, which is the part analysed for the lighting design, Fig. 9. DWG file in the DIALux program. Where the modelling begins and later the appropriate lighting fixtures will be installed according to the analysis that was made

Box 10

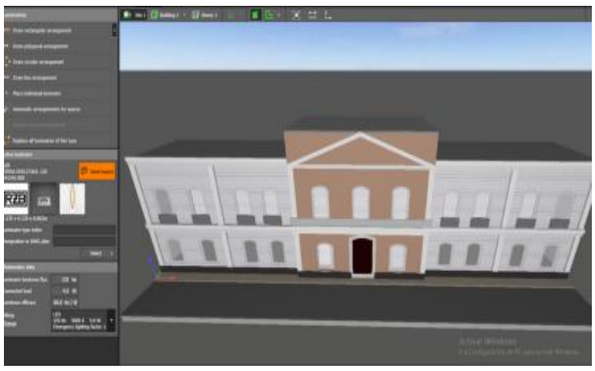

Figure 9

DWG file in the DIALux program

Own Elaboration

4. Proposal for the placement of luminaires according to the construction

The proposal is to illuminate the façade with lighting: diffuse, focused, framed, indirect or direct, in order to enhance specific areas of the monument in this case, as well as its ornamentation, columns, among others. The DIALux evo 11 programme has a system that registers the amount of luxes in the building, however, for the proposal, it will only focus on the exterior zone, which is the façade, Figure 10. The façade is considered to be a monument, since it does not require an exact amount of lighting, but rather a design that highlights certain areas or elements of the building, and with regard to the pavement, a minimum of 20 lux is required in accordance with the lighting standard.

Box 11

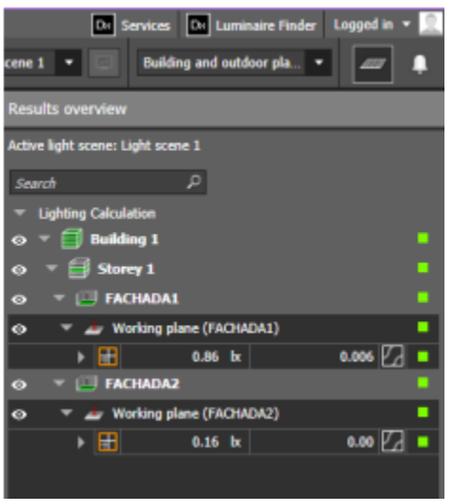

Figure 10

Results of the lux calculation on the façade

Own Elaboration

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5. Result

An analysis is made of the proposed solution to the lighting of El Cuartel Del arte to boost the city, enhancing the building through its illumination, resulting in a new perspective of the gallery, and creating a better view, enhancing the columns, the pediment and the main windows that are in the central façade. Figure 11 and 12 Rendering of the façade lighting design of El Cuartel del Arte.

Box 12

Figure 10

Rendering of the façade lighting design for El Cuartel del Arte *Own Elaboration*

Box 13

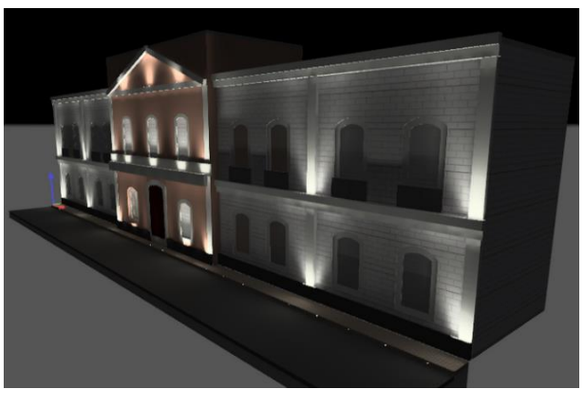


Figure 11

Lateral rendering of the façade lighting design of El Cuartel del Arte *Own Elaboration*

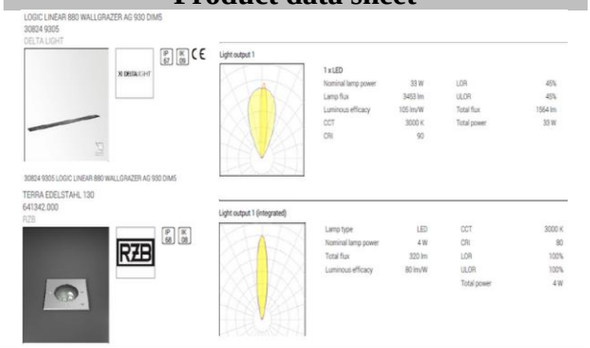
Luminaires used in the project: it is intended to use 2 types of luminaire for the lighting design of El Cuartel del Arte, 1 for the façade and 1 for the pavement, determining that they are suitable for the project. According to the description in Table 2 Description of the luminaires to be used and Table 3.

Box 14

Table 2

Images with description of the luminaire to be used in the project. Created with the DIALux programme

Product data sheet



Own Elaboration

Box 15

Table 2

Results DIALux evo11, façade luminaires. Developed with DIALux software

Luminaire list

Φ_{total}	P_{total}	Luminous efficacy
40781 lm	793.0 W	51.4 lm/W

pcs.	Manufacturer	Article No.	Article name	P	Φ	Luminous efficacy
21	Delta Light	30824 9305	LOGIC LINEAR 880 WALLGRAZER AG 930 DIM5	33.0 W	1561 lm	47.3 lm/W
25	RZB	641342.00 0	TERRA EDELSTAHL 130	4.0 W	320 lm	80.0 lm/W

Own Elaboration

Figures 12 and 13 show the 3D modelling of false colours in DUALux. The false colours work like a thermal camera, it tells you 100° red colour 50° orange colour, in blue colour 0, the false colours work similar but instead of telling you the level of heat they tell you the level of illumination, you can see the amount of luxes according to the lower bar in the following image and you can see how only some areas of the monument are highlighted and as in the access there is more light, the maximum required for the entrance is 20lux and you can see that it complies with what has been proposed.

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Box 16

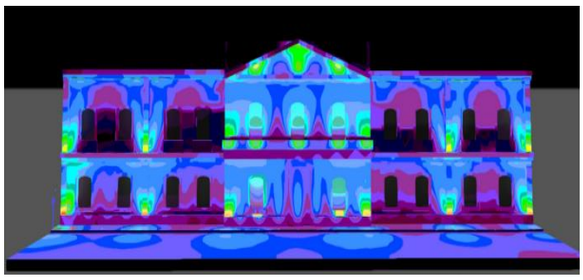

Figure 12

3D modelling of "El Cuartel del Arte", showing the false colours, made with the DIALux programme

Own Elaboration

Box 17

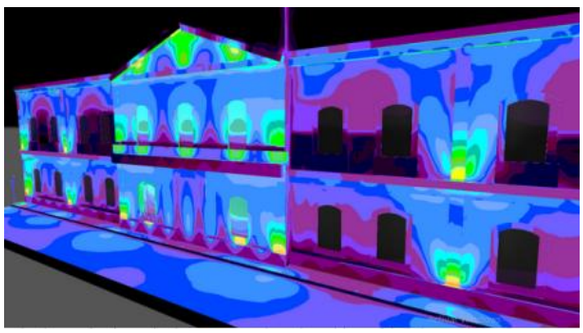

Figure 13

3D modelling side view of "El Cuartel del Arte", showing the false colours, produced with the DIALux programme

Own Elaboration

For the façade, the lighting that is functional and required is 20luxes minimum, for the preservation of the envelope, the lighting should not affect the material and its surroundings.

6. Conclusions

The lighting proposal presented seeks to highlight the architectural and cultural value of the historic monument, highlighting its most emblematic elements in a way that is harmonious and respectful of its surroundings. By employing a carefully planned lighting design that avoids invasive interventions and minimises light pollution, the conservation of the building and its proper integration into the urban landscape at night is guaranteed.

This approach not only promotes appreciation of the cultural heritage, but also enhances its tourist appeal, consolidating the monument as a symbol of identity and pride for the community.

The envelope of the historic monument plays an essential role in ensuring its protection from environmental conditions and preserving its architectural value. A well-planned lighting design not only enhances the conservation of the property, but also enhances its aesthetic appeal, integrating it harmoniously into the urban landscape at night.

The integration of energy-efficient LED luminaire technology was achieved and the spaces to be illuminated were optimised to showcase a historic building, highlighting its finishes and design.

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