Ministry of Education and Science of Ukraine
Ternopil Ivan Puluj National Technical University

Faculty of Applied Information Technology and Electrical Engineering
(full name of faculty)
Electrical Engineering Department
(full name of department)

QUALIFYING PAPER

For the degree of

Bachelor
(degree name)

topic: ***Development of a system of the building facade external illumination***

Submitted by: fourth year student, group IEE-42
specialty 141 Electrical Power Engineering, Electrical Engineering and Electromechanics
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2021

SUMMARY

This qualifying paper includes: 72 pages, 37 references, 42 figures and 20 tables.

The purpose of this bachelor's qualification work is to analyze the current state of external building illumination, to design and calculate lighting installations for the Development of a system of a building facade for external illumination and as well as goals and objectives of external architectural lighting, methods and creative means of architectural lighting.

To achieve this purpose, we need to go through the following problems:

- to analyze international requirements for external architectural lighting;
- to offer lighting schemes for development of a system of the building façade for external illumination, methods and creative means of external architectural lighting are analyzed. The principles of lighting objects of different shapes are established;
- Criteria for selection of architectural lighting objects for the development of a system of the building facade for external illumination;
- General description of the object and characteristics and the essence of designing outdoor architectural lighting, review was conducted, which identified the goals and objectives of outdoor architectural lighting, as well as its purpose and function.

The following calculations were made in the bachelor's qualifications work:

- Calculation and selection of wire cross-section
- Calculation of the amount of electricity consumed by installing the building Lighting;

Results of lighting calculation of lighting installations and their analysis.

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ASSIGNMENT
FOR QUALIFYING PAPER

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(degree name)
specialty 141 Electrical Power Engineering, Electrical Engineering and Electromechanics
(code and name of the specialty)
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1. Paper topic *Development of a system of the building facade external illumination*

Paper supervisor *Osadtsa Yaroslav Mykhailovych, Ph.D.*
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Chapter	Advisor's surname, initials and position	Signature, date	
		assignment was given by	assignment was received by
Labour occupational safety	*Ph.D., Assistant professor Okipnij I.B.*		
and security in emergency			
situations			
Compliance check	*Ph.D., Assistant professor Osadtsa Y.M.*		

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TIME SCHEDULE

LN	Paper stages	Paper stages deadlines	**Notes**
1	Preparation of the «ANALYTICAL SECTION»	20.08.20 – 20.09.20	
2	Preparation of the «PROJECT DESIGNING SECTION»	21.09.20 – 20.10.20	
3	Preparation of the «CALCULATION AND RESEARCH	21.10.20 – 30.11.20	
	SECTION»		
4	Preparation of the «LABOUR OCCUPATIONAL	01.12.20 – 20.12.20	
	SAFETY AND SECURITY IN EMERGENCY		
	SITUATION»		
5	Preparation of introduction, conclusions,	20.12.20 – 05.01.21	
	Content and summary.		
6	Preparation, execution and printing graphic material of	05.01.21 – 10.01.21	
	Master's thesis		
7	Getting feedback and review of master's thesis	11.01.21 – 24.01.21	
	and drafting a report for the master's defense.		

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CONTENT

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INTRODUCTION

Architectural lighting is an important aspect of the functioning of a modern city. Well-thought-out lighting of buildings allows you to emphasize their design and decorative features in the dark. And the lighting of the facades plays a key role in shaping the attractive appearance of the night streets.

Complex development of lighting systems for different buildings should always be carried out taking into account such general indicators as: the level of aesthetic appeal, the amount of functional light, as well as the degree of electricity consumption. Thus, modern architectural lighting is a kind of art designed to reunite artistic and technical solutions to form a single visual effect.

In addition, architectural lighting of building facades is based on three key ways:

1. Flood lighting is used when necessary to provide not just illumination of facades, but to illuminate the entire building completely, as well as when you want to create lighting for massive non-residential buildings.

2. Local lighting is used to emphasize the special structure of the building and the most expressive parts of the facade by illuminating only certain areas.

3. Concealed lighting of facades is considered a relatively new type of lighting system and is used not as lighting of the surface of the building, but as a separate design element, with its own unique pattern of light rays.

Today, when designing exterior architectural lighting, the traditional lighting calculation, which consists in finding the distribution of light or brightness on the illuminated surface, increasingly plays a secondary role, and the task of computer visual modeling of the object and its lighting comes to the fore.

The use of lighting techniques is not intended to distort, but to emphasize the architectural features of the house, to form its night silhouette, to stand out against the surrounding buildings.

After preliminary selection and placement of luminaires and analysis of the calculated light levels, it is desirable to obtain a computer visualization of the lighting effects of the object.

This is necessary to confirm or correct the decisions made. Lighting of large urban facilities, performed without such design work, in most cases does not perform its tasks.

The diploma project is devoted to the development of the lighting system of the main facade of the building of the Ternopil directorate of Ukrposhta.

SECTION 1
ANALYTICAL SECTION

1.1 Goals and objectives of outdoor architectural lighting.

Exterior lighting of the city is an important and integral part of the engineering and transport infrastructure of the city. Properly designed lighting of squares and streets is the comfort and safety of people in the dark. The importance of outdoor lighting is determined by the fact that there is a separate section in the State Building Regulations of Ukraine on the regulation of outdoor lighting. Recent laws and regulations of Ukraine indicate the problems of outdoor lighting both in the context of developing urgent measures to reduce road accidents, and as part of addressing landscaping.

It is known that high-quality outdoor lighting increases the productivity of the visual apparatus and significantly reduces the number of accidents. It is established that their total number can be reduced by 30%, and on roads of state importance and in areas of special danger (for example, at intersections) - by 45%.

In addition, high-quality outdoor lighting contributes to:

• reduction of electricity consumption;

• reduction of operating costs;

• improving the environmental situation (reducing atmospheric heating, harmful emissions (waste disposal), the effect of light pollution of the sky);

• increase of business, tourist and investment activity.

Properly designed outdoor lighting also helps prevent crime. Practice shows that acts of violence and crimes against property mainly take place in dark places, where criminals feel most comfortable, because in such conditions they are difficult to see and remember, and potential victims are almost helpless.

Increasing the level of horizontal illumination, which is also accompanied by an increase in vertical illumination, in pedestrian areas contributes to a better visual perception of space.

Architectural lighting is one of the main areas of outdoor lighting. Architectural lighting is understood as artificial lighting of facades of buildings, structures, works of monumental art, elements of the urban landscape, which meets the aesthetic requirements of visual perception.

The purpose of lighting architectural objects is:

- emphasizing the effectiveness of the illuminated object;
- exposure invisible during the day, the hidden beauty of the building;
- emphasis on spectacular architectural details;
- creating a romantic, complete mystery of the atmosphere around the object of architectural lighting;
- emotional outpouring on the imagination of observers;
- decoration of the city, in particular certain districts or streets in the evening and at night;
- focusing on noteworthy objects;
- extension of time of use of object thanks to tourists and clients;
- increasing the security of the object and its environment;
- advertising the company whose office is located in a building that is illuminated.

Also an important goal of external architectural lighting is to create another, different from the day view of the object, due to the specifics of the observer's reaction. During the day, the buildings are illuminated from above by sunlight or diffused light from the sky. The background of the building is usually a bright sky.

This species is familiar to the natural perception of man. Therefore, the characteristic appearance of the object, fixed in the memory of the observer in daylight, changes, while being perceived as clear against a dark sky or environment.

Therefore, the effect of external architectural lighting is that the appearance of the object is different than during the day.

Another task of outdoor architectural lighting is to create a romantic atmosphere that surrounds the observer with mystery. This is due to the fact that lighting allows you to organize the creative perception of objects.

Exterior architectural lighting can be divided into two types: functional and decorative. However, more often designers have to deal with cases of combined - functional and decorative lighting.

The direction of design dealing with outdoor and landscape lighting of cities and other areas (lighting design) is based on three main aspects of lighting [8]:

- aesthetic perception - important in the design and implementation of lighting of places with long stays of people: recreation areas, parks, squares, shops, public areas and architectural forms;

- ergonomic aspect - lighting functionality, the ability of light to affect performance, comfort and visual perception;

- energy efficiency - it is necessary to understand whether there are no illuminated surfaces, without good reason; whether there is no lighting of empty spaces, without a certain content load; do not exceed the values of illumination required standards.

In the aesthetic sense, the designer needs to increase the attractiveness of the illuminated space, to understand how the object will interact with the surrounding background (merge or stand out from it), what emotions will be caused by light. It must be remembered that the object will be visible not only at night but also during the day; take into account daylight and safety requirements at night (excessive brightness in the field of view of the observer, color and light pollution, etc.) [7].

Among the aesthetic functions of outdoor lighting can be distinguished that it emphasizes the attractive details of the area. Accented light helps to highlight interesting architectural elements.

Light, of course, solves a number of psychological problems. Once in a new place, a person falls into an unknown space, which creates a feeling of limitation. Warm light can soften the perception, relieving uncertainty, become a landmark that invites you to reach other areas.

Created by artificial outdoor lighting, light and shadow help to reveal all the plastic features of architectural forms and landscape, make the shape and decoration of buildings more expressive, highlight or soften the silhouette of a single object, a whole corner of the complex, house or vegetation [7, 8].

With the help of lighting you can emphasize the profitable in the artistic sense of the fragments of the urban composition and hide its shortcomings. For example, you can highlight an architectural ensemble or a separate object - a sculpture, a fountain, a park, etc. To solve practical and artistic problems use different types of artificial lighting. But these well-known properties and requirements, depending on the parameters of a particular city, park, square, etc. and design concept, can be implemented in very different ways.

Therefore, architectural lighting provides a choice [5]:

- techniques and means of lighting, which determine the nature of the distribution of light on the surfaces of the object and in space;
- brightness levels on vertically placed facades, differently oriented surfaces and details;
- lighting colors of different areas and elements of facades of buildings and structures;
- lighting modes in the evening and at night, on weekdays and holidays, in different seasons.

1.2 Methods and creative means of architectural lighting.

When creating an evening image of the object, two fundamentally different approaches are possible: ensuring the associative similarity of the object of its "day" image or creating a night, decorative and theatrical "counter image" that differs from the day and has its own expressive qualities [5, 9]. In real conditions, illuminated objects in most cases combine to some extent the features of both approaches, but for monuments of history and architecture, visual and stereotypes which have already formed in our minds, the first way is more natural, and for modern buildings the second approach is more creatively productive. An architect and a lighting engineer have a set of the following techniques for creating an artistic image of an object or an entire ensemble in the evening:

- general flood lighting;
- local lighting;

- luminous facades;
- silhouette lighting;
- light graphics;
- illumination lighting;
- contour lighting;
- landscape lighting;
- dynamic color lighting.

The choice of architectural lighting depends on the urban situation, the nature of the object, its purpose, the location of the lighting fixture, the conditions of adaptation of observers, the creative idea of the author, technical and economic opportunities [5].

The general flood lighting of facades or three-dimensional objects with the set uniformity is provided by lighting devices of searchlight type located at considerable and average distances from object. This is the method of architectural lighting. as a rule, retains the similarity of the evening image of the object to the day (Figure 1.1 [10]).

The most effective means of such lighting are floodlights with mirror parabolocylindrical reflectors and a non-concentrated curve of light (KSS) in the vertical plane.

Figure 1.1 - Example of general flood lighting.

Lighting of monuments, sculptural compositions, architectural completions of buildings and structures requires the reception of localized flood lighting (Figure 1.2), which uses lighting fixtures with round symmetrical mirror reflectors and concentrated KSS. Floodlights of the general flooding light are established most often on support, the next buildings, in underground and above-ground specially equipped niches. MHL, SL, GLR are used as light sources. Power range of light sources: from 150 to 2000 W.

Local (local) lighting is used for fragmentary illumination of the object, its tectonic and decorative-plastic elements with placement of the joint venture directly on the object to be illuminated, or at a close distance. Local lighting is carried out by means of small-sized joint ventures designed to work with MHL with a power of 35 - 150 W, GLR or traditional SL, linear and compact LL.

Figure 1.2 - Example of local lighting.

Light from illuminated interiors, which passes through unshielded or uncovered glazed light openings in buildings and structures, creates the effect of illuminated facades (Figure 1.3 [10]). Frequent cases of such reception are facades, domes, towers, covered with glass or transparent plastic, inside which there are joint ventures with white or colored DS, as well as illuminated shop windows, glazed kiosks, pavilions.

Figure 1.3 - Example of a light façade.

With the help of silhouette lighting (Figure 1.4 [10]) the necessary contrast is achieved between the darkened sculptural or architectural elements and their compositions and the illuminated, usually light, facade of the building.

Figure 1.4 - Example of silhouette lighting.

Light graphics (Figure 1.5 [10]) means grouping on the facades of buildings and structures of the JV, which form a characteristic light pattern, in the form of clusters of luminous, possibly multicolored, dots, spots, dotted or solid contour lines. Light graphics settings are characterized by high contrast and visual activity, especially when using dynamic modes of operation of the DS.

Figure 1.5 - Example of light graphics.

Illumination lighting (Figure 1.6 [10]) - decorative lighting with garlands and light cords with colored low-power DS or LEDs. Illumination lighting is used to create luminous long forms and decorations on bridges, overpasses, streets.

Contour lighting (Fig. 1.7 [4]) is used to highlight the main architectural details of buildings and structures. The contours appear in the form of light lines on the background of dimly lit or illuminated facades. Contour lighting installations are performed using traditional decorative garlands and light cords, permanently mounted on the facade of the object. As DS in garlands and cords use low-power LR or light-emitting diodes. The distance between the DS is selected depending on the size of the structure and the distance of the object from the observer. Contour lighting does not create visual discomfort from the DS for pedestrians and drivers.

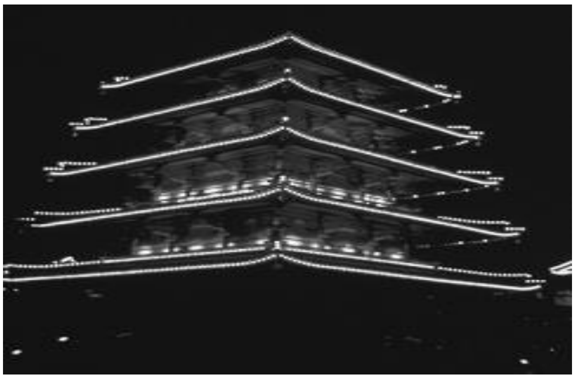


Figure 1.6 - Example of illumination Lighting.

Figure 1.7 - Example of contour lighting.

Landscape lighting (Figure 1.8) is a decorative and functional lighting of greenery, landscape elements and landscaping.

Figure 1.8 - Example of landscape lighting.

Technical means of landscape lighting include decorative supports with brackets, luminaires built into the ground, small architectural forms, for example, in the form of light "columns"; decorative protective covers for the joint venture which are established on the earth, arbours with internal lighting and other elements.

A wide range of creative tools or means is used to illuminate architectural objects, in particular to create a certain effect. These include [1, 6, 10]:

- play of light and shadow (exposure and concealment) and intentional uneven brightness (emphasis on local spectacular architectural elements of the object);
- adjusting the length of the shadow depending on the angle at which the object is illuminated;
- creation of light strips;
- creating the impression of movement

- lighting direction (application of different light levels, lighting dynamics) and use of optical illusion;

- combination of light effects with other creative means;

- operation of the foreground and background, optical zoom in and out, zoom in and out.

1.2.1 Principles of lighting objects of various shapes.

The general principles of lighting the facade of objects include a number of universal guidelines that should be followed both when creating a lighting concept and when performing a working project, regardless of the subject of design.

General principles of external architectural lighting apply to religious buildings, palaces and other types of buildings.

The principle of image integrity. The integrity of the illuminated object is the possibility of its complex perception and review in general from a certain species direction, without vague and misleading areas that could imaginatively change the real architectural composition, which it is perceived in daylight.

The principle of separation of the main and secondary, contrast and nuance, static and dynamic composition - these are the laws associated with aesthetic perception. They are revealed in the process of cognition, as a result of comparison and resemble the architectural scale in this regard. With a large variety, it is better to strive for nuances in the articulations, colors, texture - a greater unity of composition.

The chosen lighting concept should provide this opportunity. In assessing the lighting project, in terms of the integrity of perception, an important role is played by the different distances between light accents ("spots") on the illuminated object, the size of these "spots", their contrast with the background. According to [6, 10], the distances between the light "spots" should not be more than the light "spots" (Figure 1.9).

The brightness of light accents should not be more than 10 times the average brightness of the environment. In this case, the accents on the illuminated object must always be clearly and correctly highlighted.

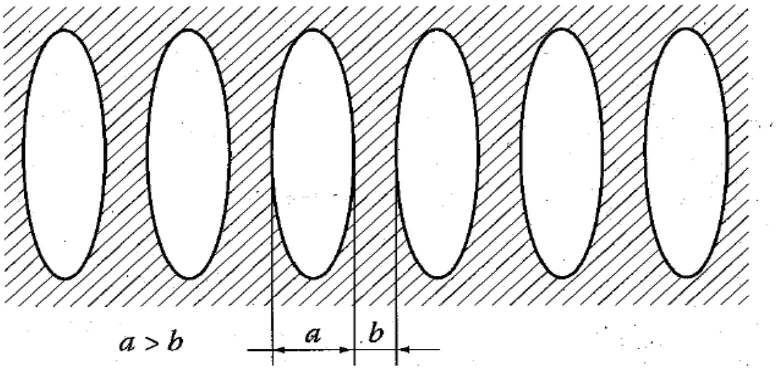


Figure 1.9 - Recommended distances between light spots, which ensure the integrity of the object.

The brightness of light accents should not be more than 10 times the average brightness of the environment. In this case, the accents on the illuminated object must always be clearly and correctly highlighted.

The principle of order. Most objects are characterized by symmetry, horizontal (cornices, floors) and vertical (risalits, pilasters, columns) divisions, which can be emphasized by light accents. There is a certain order, which can be emphasized by the rhythm (windows, columns, reliefs), scale. These signs of orderliness of the day view of the object should not be destroyed by architectural lighting.

This factor is especially important at total action of local illuminations. To maintain a sense of integrity, it is recommended [6] to follow these decisions:

- repetitive architectural elements must be illuminated equally (identical brightness distribution);
- the symmetry inherent in the facades in daylight must be maintained in night light (elements to the left and right of the axis of symmetry must be the same);
- you can emphasize the horizontal lines of architectural divisions (cornices, balustrades);
- it is necessary to provide expressiveness of external corners, outlines of object.

In modern houses, a clear disharmony is brought about by randomly lit windows. The above objects can be accentuated only after a complete shutdown of the interior lighting. Although the planned inclusion of window lighting, which creates a certain pattern on a dark facade, can be an independent reception.

The principle of concealment of lighting equipment. The level of illumination of illuminated objects is usually relatively low. The recommended value of maximum brightness - 12 cd / m2 - is associated with a low level of adaptation of human vision at night. Therefore, it is highly undesirable for bright spots of switched on lights to come into view from the main directions of view.

The most effective projected lighting will not be perceived if light sources are visible against the background of the illuminated object or near it, or shiny reflective surfaces illuminated the fixtures. Figure 1.10 shows an example of unsuccessful lighting of the bridge, where bright light from floodlights destroys the concept of lighting and creates danger for drivers.

It is important to design lighting fixtures so that they are invisible; in addition, they should be provided with accessories (rasters, curtains, etc.) that will prevent glare. All this will create a comfortable environment for viewing the object, will allow the observer to admire the harmonious lighting of individual parts of the object that is illuminated.

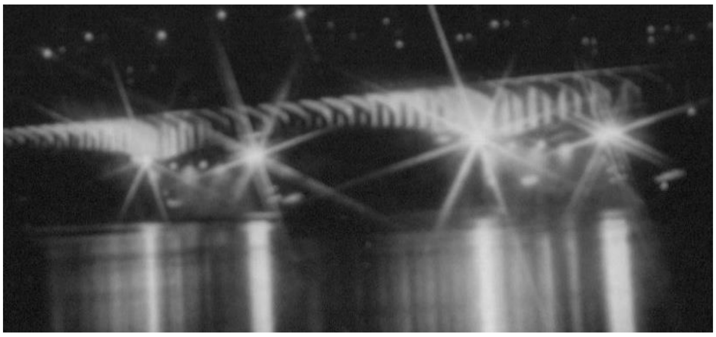


Figure 1.10 - Example of poor lighting of the bridge.

The principle of concealing light sources and reflective lighting fixtures is designed mainly for the observer, who inspects the object from the outside. However, the aesthetics of external perception often has a negative effect on people who are in the illuminated object: when they go outside, they are blinded by a large amount of light. This undesirable phenomenon can be prevented by using the method of spot illumination with local lighting fixtures mounted on or near the facade.

The principle of concealing lighting fixtures also applies to the reflection of light sources on the facade, which often occurs when lighting modern buildings with facades, decorated with glass or polished granite. In case of incorrectly chosen places for illuminators it is necessary to consider the direction of the light beam reflected from a facade.

The analyzed methods of hiding light sources are relevant in daylight, although during the day the problem of blindness is considered less significant. Lighting fixtures can be a very interesting design, but too often they do not fit the facade and look like an inappropriate intervention in its neutral daytime image. Therefore, every effort should be made to hide the lights from observers who admire the object during the day. Noteworthy, although not an exhaustive solution may be luminaires sunk into the ground, but they satisfactorily illuminate only the level of the first floor. Lighting fixtures can also be hidden in special street columns (Figure 1.11), on window sills, behind flower pots, behind bushes, sculptures or architectural elements of facades, etc.

Figure 1.11 - Example of hiding lamps
in special street columns.

The principle of strengthening the roundness of the object. Round objects are structures in the form of vertical cylinders or cut cones or objects that basically form a circle. They include towers, towers, lighthouses, old chimneys and more.

In lighting projects of such objects, there is often a false tendency to create uniform lighting, which requires the installation of a large number of lighting fixtures around the building. In addition, the uniform illumination of the cylindrical surface does not make it possible to clearly demonstrate its shape, especially from a considerable distance. An evenly lit round object looks like a flat surface from afar.

Thus, you lose the opportunity to see its main advantage, ie the convexity or roundness of the facade.

In practice, round objects should be illuminated in such a way that they are underexposed along the length of the circle. As a result, clear and dark vertical stripes are formed, ie the brightness of the illuminated object changes in height. This solution emphasizes the convexity of the object. To obtain this effect, install two, and in the case of large diameter - three illuminators symmetrically to the axis of the structure (Figure 1.12). The direction of the light axes of the lighting fixtures is chosen so that the light spots do not overlap.

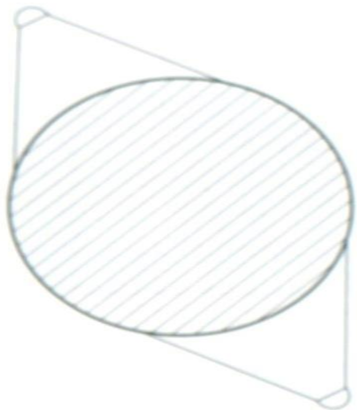


Figure 1.12 - Location of lighting fixtures when illuminating round objects.

1.2.2. The principle of accentuation of faces of mutually perpendicular walls.

Mutual perpendicularity of walls of construction objects or their parts is the most widespread principle of formation of the basic spatial form of a construction. Regardless of the arrangement of each wall and the variety of decorative elements, it is necessary to strive to create such lighting in which the adjacent mutually perpendicular planes of the walls would differ in the level of brightness. This will enhance the three-dimensional composition of the object and emphasize its faces, while the same levels of illumination will level the volume (Figure 1.13).

The spatial effect of mutually perpendicular facades can be enhanced even with a single lighting fixture installed in such a way that a significant difference is formed between the angles of incidence and the light beam on each of the adjacent walls.

Therefore, the location of the projector in the plane of the angle bisector between the illuminated walls is erroneous. Therefore, the projector should be moved towards the wall, which should have a higher brightness (Figure 1.14). The difference in brightness that must be provided on mutually perpendicular adjacent walls for the effect of emphasizing the faces should be not less than 25 - 30%.

Figure 1.13 - Image of a flat view of a lighted building caused by uniform brightness of lighting perpendicular walls.

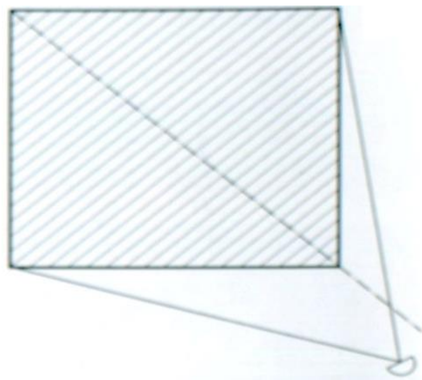


Figure 1.14 - Location of lamps when illuminating objects with perpendicular walls.

The principle of increasing depth and height. The general principle of lighting such facades is as follows: the plane that is at a greater distance or height should be lighter than the nearest or lower. Considering Figure 1.15, we can say that, according to the principle of increasing the depth and height and the principle of accentuating the faces of the walls, the brightest should be the wall marked with the number 1, less bright - the wall under the number 2, etc.

It is believed that at a high level of brightness of the nearest plane, the volume disappears, and vice versa, the effect of volume is enhanced if the pain of the distant plane is the most illuminated.

You can also change the brightness within one wall, for example with tiers separated by a cornice.

If the upper part of such a wall is illuminated more than the lower, it will create the illusion of displacement of the planes, which is an effective means of changing the perception of the established appearance of a flat wall.

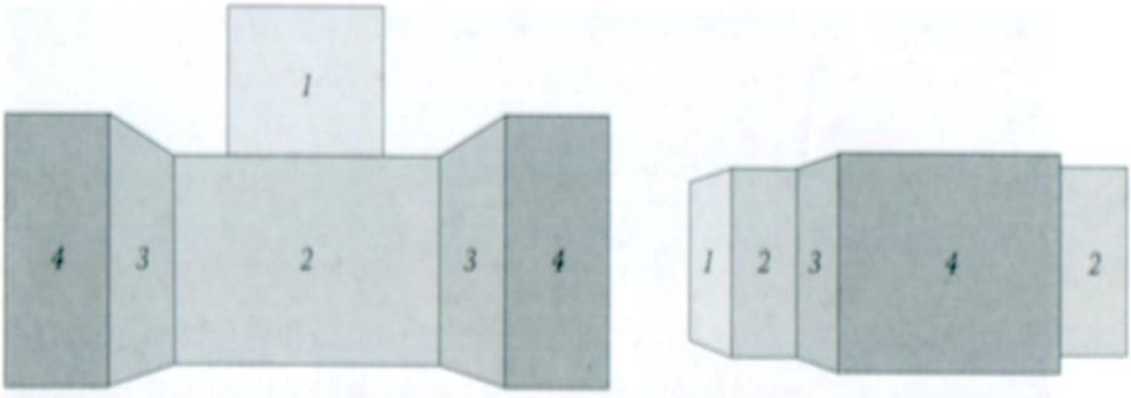


Figure 1.15 - Example of structures with offset vertical walls.

When illuminating displaced planes under the same lighting methods and brightness level (especially if you look at them from a considerable distance, the observer will not notice the protrusions of the walls, will not feel the volume of the building. This means The planes should be illuminated so that the brightness levels differ even several times (within the recommended average brightness levels for the whole object), and the following principle should be followed: the higher or more distant plane should be brighter.

SECTION 2
PROJECT DESIGN PART

2.1. The essence of designing outdoor architectural lighting

Development of the project of architectural lighting (depending on complexity of volume and its sizes) is carried out according to the technical task in one or two stages. A one-stage project is possible to develop lighting for a separate house, building, monument.

At the pre-project stage of work, information material on the object is collected, including historical material for architectural monuments. The location of objects, drawings, photos of facades, floor plans, roofs, general plan on the scale of urban development and geo-base are analyzed [5, 10].

The characteristics of the environment during the day and night are evaluated time. Examination of the existing outdoor functional lighting, illuminated advertising, bright windows will help in determining the levels of illumination and brightness of the object.

For complex and responsible objects it is recommended to carry out full-scale modeling, which will allow to choose light-composition lighting techniques, types of SP, power and spectral composition of DS, to estimate the distribution of light and brightness on the surfaces of the object.

The choice of lighting scheme is based on the visual perception of the object from different points of observation, while determining the light hierarchical subordination of objects in the ensemble, taking into account their architectural, historical and urban significance.

At the first stage of design pedestrian zones and entrances for possible use at installation and operation of mobile auto towers and other prefabricated lifting equipment are investigated, necessity of consultations and coordination with various city services and:

managements is defined, the basic of which: Management of protection of monuments. history and architecture, GAI, Geotrest, Misktrans, Misksvitlo. Technical conditions for connection of electric capacities of installations are made out [10].

On the basis of the received information material the architect together with the lighting designer and the lighting technician develops the concept of architectural lighting. This concept provides [6]:

- the choice of facades of the object, which should be illuminated;
- determining what exactly needs to be exposed and how, and what should be hidden;
- choice of light color;
- choice of lighting method;
- definition of focal points;
- determination of points of attraction;
- determining the method and direction of directing light to individual planes of the facade;
- determination of the desired brightness levels;
- selection of the method of connecting the lighting system (depending on the number of lighting modes.

These data are displayed in the visual part of the project on a color illustration of the general view of the object under artificial lighting, made on a computer using special programs, and an explanatory note.

Thus, the conceptual part of the project of the light ensemble includes:

the main light panorama of the building;

- perspective image of a fragment of a light ensemble or illuminated object at festive and everyday lighting modes with indication of levels of brightness and chromaticity in the main points and zones of a light panorama, ensemble, object;
- plans and facades of objects with locations of OP and targeting points of their axial beams;
- light general plan with reflection of light-color zoning of the territory and objects of the ensemble with indication of types of OP and DS;

- sketches and photographs of developmental or existing small architectural forms;
- an explanatory note, which, in addition to the historical and architectural sections, includes lighting and electrical characteristics of the lighting installation with a brief economic justification for the consolidated indicators.

In the second stage, detailed working drawings are developed for each illuminated object.

Color colorful image of the illuminated object should be considered as a bright composition - the basis of lighting calculation of the lighting installation [10, 11].

Preparatory work for the calculations are [10]:

• acquaintance with the illuminated object, analysis of its architecture, floor plans and characteristic sections;

• analysis of the location of work surfaces, identification of possible obscuring objects;

• definition of the target task of the OP (for example, the creation of a light rhythm, a given distribution of brightness, contrast, uniform lighting, etc.);

• establishment of integrated (spectral) reflection coefficients of finishing materials of architectural objects;

• assessment of the influence of glazing on the selected coefficients of reflection of surfaces;

• establishment of color characteristics of architectural objects (coordinates, color, chromaticity);

• choice of DS type (taking into account the spectrum of radiation and color rendering of light sources);

• the choice of the level of illumination in accordance with current regulations, while specifying the selected DS for compliance with the illumination and color rendering;

• choice of lighting system and reception of architectural lighting;

• the choice of joint ventures and the method of their placement;

• determination in accordance with the current norms of the limit values of cylindrical illumination, the indicator of discomfort, the pulsation coefficient for the calculated OP.

2.2. General description of the object and characteristics.

The complex of buildings of the post office (Figure 2.1) is located at st. Chornovola, 1. This building was erected in 1910, and it belongs to the Monuments of Architecture and Urban Planning of local significance (protection number № 3-M). This complex can be divided into two wings: left and right. The left wing (Figure 2.2) is occupied by the Ternopil branch of PJSC Ukrtelecom.

Figure 2.1 - Picture of the complex of buildings of the post office.

Figure 2.2 - Image of the left wing of the complex of buildings of the post office.

The General Directorate of TD UDPPZ "Ukrposhta" is located in the right wing of the complex. The image of the right wing of the complex is presented in Figure 3.3.

The building of the General Directorate of TD UDPPZ "Ukrposhta" consists of a basement, first and second floors and an attic, which was added in 2010.

The height of the basement is 2.5 m, the height of the first and second floors is 3.7 m; the height of the attic is 2.5 m.

Figure 3.3 - Image of the right wing of the complex of buildings of the post office.

It is located in the basement, Located on the ground floor.

The second floor is occupied by department offices.

The building of the General Directorate is a monolithic frame structure with dimensions of 23.20 15.0 13.0, the thickness of the outer walls of 500 mm, the thickness of the inner walls of 150 mm, and the thickness of the floors of 300 mm. Drawings of the main facade and floor plans are presented on posters 1 and 3 of the graphic part.

In the attic are external enclosures of the case are a brick wall covered with a layer of plaster.

The building is located at vul. Chornovola, bldg. 1 (Figure 3.4 [18]). A characteristic feature of this street is that it is located in the heart of Ternopil and connects the railway station with the Theater Square. Next to the building there are residential buildings with catering establishments ("Ternopil Evening", "Goat-Bar", "Sicily"). Adjacent to the street is a square with greenery, a fountain and a monument to O.ю Pushkin.

Power supply of a network of internal lighting is carried out lighting shields. These shields are designed to receive and distribute electrical energy with a voltage of 220/380 V three-phase current with a frequency of 50 Hz in a network with grounded neutral, as well as to protect lines and electrical equipment from overloads, short circuits and infrequent switching on and off circuits.

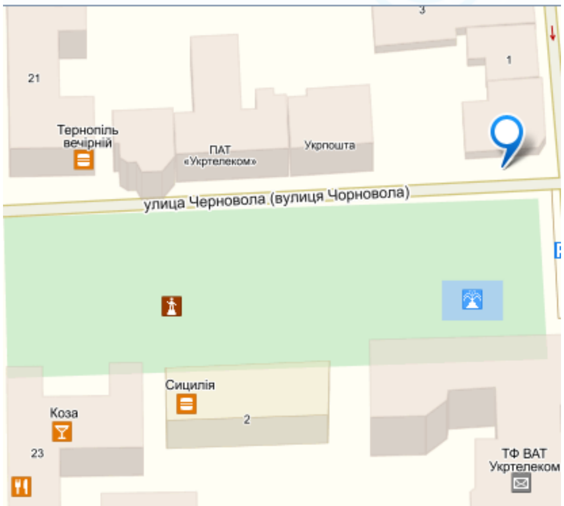


Figure 3.4 - Location of the building on the map of Ternopil.

The guard is made in the form of a metal hinged cabinet, inside which are prefabricated tires and circuit breakers. Access to the shield is provided through the door. The introduction of power wires and wires of outgoing lines are carried out from above and below. The design of the shields provides the possibility of replacing any switch on the front side without breaking the installation of external conductors and the shield itself. The shields can have a zero working insulated bus (N) and a grounded bus (PE), used for protective measures against electric shock in case of damage to the insulation of current-receiving devices. The general view of the shield is shown in Figure 3.5 [17].

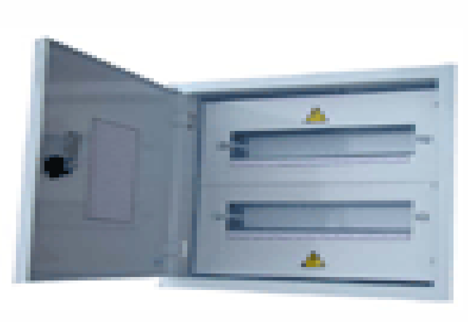


Figure 3.5 - General view and overall dimensions of the lighting shield ЩО-24В.

Conditions of operation of ЩО-24В guards are:

height above sea level up to 2000 m;

ambient temperature from 1 to 35 º C;

relative humidity not more than 98% at a temperature of 25 º C;

the environment is not explosive, does not contain conductive dust, aggressive gases and vapors in concentrations that destroy metal and insulation;

group of mechanical execution of M1 in accordance with GOST 17516.1-90;

working position in space - vertical; deviation from the working position up to 5 º in any direction is allowed;

the installation site must be protected from water, oil, emulsion and direct sunlight and radiation.

Safety requirements according to GOST 22789-94, the current "Rules for the arrangement of electrical installations", "Safety rules for the operation of electrical installations of consumers".

According to the method of protection against electric shock shields comply with class I according to GOST 12.2.007.0-75.

Fire safety requirements according to GOST 12.1.004-91 and GOST 27924-88.

These panels are located in the rooms marked on the plans under numbers 315, 420, 514, 612, 712. The main parameters of the lighting panels brand ЩО-24В are given in table 2.1.

Table 2.1 - The main parameters of the group panels ЩО-24В

Shield brand	Symbol of dimension	Number of circuit breakers	Weight, kg
ЩО-24В	3	24	28.5

The characteristics of the shields of this brand are as follows: rated voltage: 220/380 V; rated current of outgoing circuit breakers: 16; 25 A; degree of protection according to GOST 14254-96 IP20; overall dimensions: 310 × 330 × 90 mm.

2.3 Selection of species directions and characteristic species points.

During the inspection of the illuminated object, the observer pays attention to its individual fragments in a certain sequence.

Therefore, during the design it is not necessary to consider the house completely with all its details, and it is enough to focus on the light exposure. These are focal points and points of view.

The point of attraction of the gaze is an element of the light image of the building, which focuses attention during the inspection as the most expressive element of the object. Focal points are other exposed elements of the facade that attract the observer's attention after the point of attraction. The time-decomposed observation process looks like this. First, the gaze stops at the point of attraction of the gaze, and then the observer examines the details, accentuated by focal points.

When designing the external illumination of the facade, the focal points will be the points placed on the walls between the windows.

The choice of viewing points is determined by the location of the observer, from which you can see the lighting object. The analysis revealed that such places are the viewpoint located in front of the building (point 2) and points (1 and 3) located on the right and left sides of the building, respectively (Figure 2.6).

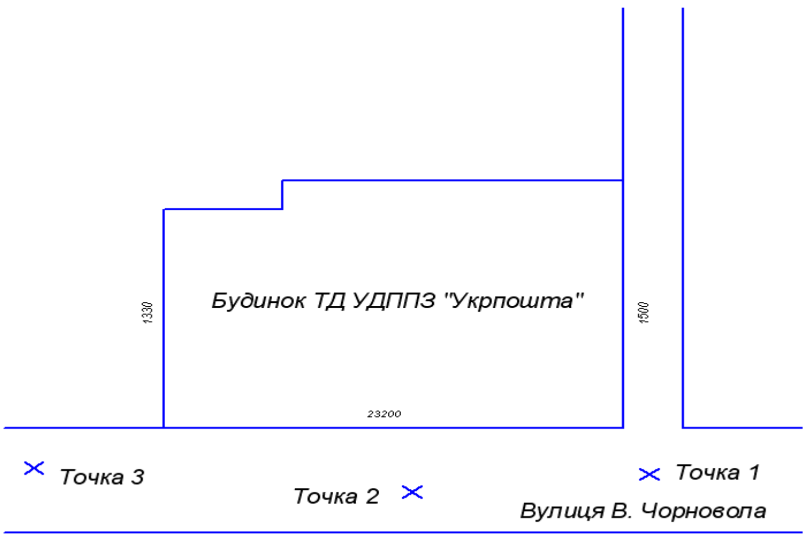


Figure 2.6 - Picture of viewpoints on the plan.

Images of the body from these viewpoints were obtained using a Sony Cyber-shot DSC-S700 digital camera. The technical characteristics of the camera are presented in Table 2.2 [45].

Table 2.2 - Specifications of the Sony Cyber-shot DSC-S700

Maximum expansion	3264 × 2448
Supports extensions	2592 × 1944, 2048 × 1536, 1632 × 1224, 640 × 480
Number of pixels	7.2 MP
Number of active pixels	7.1 MP
Matrix type	CCD (Super HAD CCD)
The size of the sensor	1 / 2.5 «(5.75 × 4.31 mm, 0.24 cm²)
Pixel density	29 MP / cm²
Minimum sensitivity (ISO)	80
Maximum sensitivity (ISO)	1250
Lens focal length	5.8 - 17.4 mm
Image format	JPEG
Electronic shutter speed	1 - 1/2000 s
The relative diameter of the lens inlet	1: 2.8 - 1: 4.8

Images of the building from observation points are presented in Figures 2.7 - 2.9.

Figure 2.7 - Image of the building from the observation point 1

Figure 2.8 - Image of the building from the observation point 2

Figure 2.9 - Image of the building from the observation point 3.

2.4. The choice of normalized lighting

Normalized illumination is the least permissible illumination in the "worst" points of the illuminating surface before the next cleaning of the luminaires. The value of this illuminance is set depending on the nature of visual work, the size of the object, the difference between the background and the contrast of the object with it, the type and lighting system, the type of light source. Standardization of outdoor lighting is carried out based on the domestic standard DBN B.2.5-28-2006 "Natural and artificial lighting" [19] and the international standard CIE Technical Report 94. Guide for Floodlighting [20].

Table 2.1 - Norms of lighting of architectural facades

Category urban space	**Location of the lighting object**	**Illuminated object**	**Flood lighting, average brightness of the facade Lf, cd / m2**	**Flooding and accent lighting, average brightness of the light-accented element Le, cd / m2**	**Local lighting, average brightness L, cd / m2**
AND	Areas of the capital center, zones of city-wide dominants	Architectural monuments of national importance, large public buildings, monuments and dominant objects	10	30	10
	Main streets and squares of city importance	Architectural monuments, history and cultures, houses, buildings and monuments of urban significance	8	25	8
	Parks, gardens, boulevards, squares and pedestrian streets of city importance	Landmarks, buildings, monuments and monuments, unique elements of the landscape	5	15	5
B	Areas of district and district community centers	Sights and monuments, houses and buildings of the district and district significance	7	20	8
	Main streets and squares of district and district value	The same	5	15	5
	Parks, gardens, squares, boulevards and pedestrian streets of district and district	The same is true of the elements of the landscape	3	10	3
IN	Streets and squares, pedestrian roads of local significance	Sights and monuments, landmarks and	5	10	3
	Gardens, squares, boulevards of local significance	The same is true of the elements of the landscape	3	8	3
Note 1. The brightness of dominant objects, which are viewed from a distance of more than 300 m, can be increased up to 50%.					
Note 2. When the location of the lighting object in the environment of the space that is not illuminated, the brightness rate given in table 15, may be reduced to 50%.					

When designing architectural lighting installations, the values of the coefficients fromthe surface of the facades of the illuminated objects are taken according to the measurement data or according to table 2.2.

At uniform flooding illumination of a facade of the relation of the maximum illumination to the minimum should be no more than 3: 1, and on relief and multi-colored facades - up to 5: 1. In this case, the maximum illumination should be created on the main compositional and plastic elements.

Table 2.2 - Coefficients of reflection of the surface of the facades

Surface materials or facade color	The weighted average reflection coefficient of the surface material
White: weather-resistant facade paints, gypsum, ceramic tiles, brushed aluminum, stainless steel, etc.	0.7
Light: paints, marble, white stone (limestone, dolomite, sandstone), concrete and decorative plasters on white cement and light fillers, ceramic tiles, silicate brick, matte brass, travertine, shell rock, etc.	0.6
Medium light: paints, marble, stone (tuff, sandstone, limestone), concrete, colored plasters, ceramic bricks, blocks, tiles, wood (boards), etc.	0.5
Dark: paints, marble, granite, clay bricks, decorative plasters and ceramic tiles, darkened wood, copper, tree leaves, etc.	0.3
Black: paints, stone (gabbro, labradorite, diorite, basalt, granite), cast iron, platinum bronze, decorative plasters, tree leaves, etc.	0.15

At uneven flooding illumination of a facade the ratio of the maximum and minimum illumination within the illuminated zone is accepted no more than 10: 1 and not less than 3: 1, thus the maximum illumination is created on the element accentuated by light.

When designing light architectural ensembles according to table 2.1 the brightness is chosenmessage of the main facade of the dominant object. The average brightness of the illuminated facades of the co-ordinated objects of a single ensemble should, as a rule, be reduced by at least two degrees.

Volumetric monuments, monuments, small architectural forms, which have a comprehensive overview, should be illuminated on two or three sides with a clear main direction of light flux, which determines the calculated plane, which should be compositionally related to the main direction of perception of 'object.

Discharge light sources should be used in architectural lighting installations. At local illumination use of incandescent lamps, mainly halogen, and also sources of chromatic radiation or color light filters is admissible.

For illumination of objects which have "cold" color shades of surfaces, and green plantings it is necessary to accept digit light sources with color temperature more than 4000 K. For illumination of objects which are painted in "warm" colors, light sources with color temperature are accepted. up to 3500 K. When lighting polychrome objects, especially decorative and artistic elements on the facades (mosaic and picturesque panels and friezes, tiles, colored reliefs and sculptures, graffiti, etc.), you should take white light sources with a total color rendering index Ra not less than 80 The use of colored light sources is allowed for artistic and decorative lighting of landscape architecture objects. Architectural lighting fixtures should be located so that their outlets are notfell into the field of view of drivers and pedestrians in the main directions of movement or were shielded by light-shielding devices.

The reserve factor in the design of architectural lighting installations should be taken depending on the orientation of the light aperture of the luminaire in which the light source is used: for discharge lamps Kэ = 1.5, if the glass of the device is oriented vertically or in the lower hemisphere) and K□ = 1.7 when orienting the glass in the upper hemisphere, with incandescent lamps, respectively, Kэ = 1.3 and 1.5.

According to the standard CIE Technical Report 94. Guide for Floodlighting when illuminating an object, it is recommended to use three alternative lighting levels, expressed in terms of medium brightness [6]:

$L_1 \geq 4$ cd / m2;

$L_2 \geq 6$ cd / m2;

$L_3 \geq 12$ cd / m2.

The choice of these values is due to the fact that the illuminated object stands out with its brightness against the background of others. The choice of one of the three values of the average brightness is dictated by the level of illumination of the environment around the object of illumination.

Three definitions of ambient light levels are used:

low;

average;

high

If only an object that is illuminated is visible in the dark, the ambient light level is considered low. When located near an illuminated object, such as houses, the light from the windows and partially reflected light from external lighting create an environment of medium light. If there is a lot of light near and in front of the lighting object (illuminated street, city center), then they are talking about a high level of ambient light.

The recommended brightness values are used in cases where the object is viewed from a short distance, when the losses due to the passage of light through the atmosphere are insignificant.

When illuminating objects that are at a great distance from the observer, it is recommended to increase the brightness to 20 cd / m2 (towers, masts, building complexes on the hills, bridges.

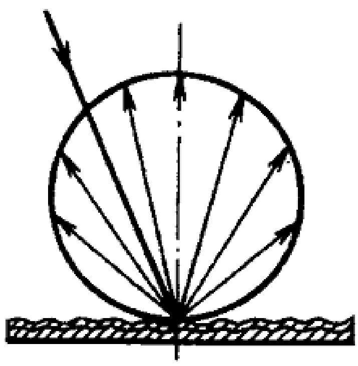


Figure 2.1 - Diffuse reflection

When calculating the lighting installation for architectural lighting, as in other regulations [11, 18, 21], it is necessary to take into account the reflection coefficient . In classical cases of architectural lighting there is a diffuse reflection of light from the surface of the facade (Figure 2.10).

Light diffuse-reflecting surface is determined by the formula:

$$E = p\frac{L}{r}$$

When designing, take into account that light sources with different spectral characteristics will transmit the color of the facade in different ways. For example, light from a high-pressure sodium lamp directed at a brick-yellow masonry will transmit color better than light from another source with an identical luminous flux.

The formula for calculating the initial illuminance (at the time of commissioning of the object) has the form.

$$E = pk_1k_2\frac{L}{r}$$

where k_1 - coefficient that takes into account the type of light source;

k_2 - coefficient that takes into account the contamination of the facade.

The recommended values of light levels, as well as the values of correction factors are given in table 2.4

Under the uniformity of lighting means the ratio of minimum illuminance (brightness) to maximum. In [20] the requirements for uniformity of illumination are given in three values: 1:10, 1: 4, 1: 2, which are respectively the ratio of brightness at the point of attraction to the average brightness of the whole object visible from a certain direction (1:10), brightness at focal points to the brightness of the environment (1: 4) and uniformity of brightness in general on the facade except for the points of attraction and focal points.

Based on the above, we establish that this structure is characterized by a high level of ambient light. Therefore, we accept that cd / m2. We accept the coefficient of reflection of the facade surface , and the coefficients and . Substituting the data into formula (2.2), we obtain;

$$E = 3{,}14 \cdot 1{,}1 \cdot 2{,}0 \cdot \frac{12{,}0}{0{,}5} = 165{,}8 \text{ lk.}$$

Table 2.3 - Recommended values of light levels, as well as the values of correction factors.

Facade material	The recommended level of light intensity			Correction factors				
	Illumination of the point			k_1		k_2		
				Light		The level of cleanliness of the facade		
	low	average	high	mercury	sodium	clean	dirty	very dirty
Light stone, white marble	20	30	60	1,0	0,9	3,0	5,0	10,0
Light gray stone, cement, light marble	40	60	120	1,1	1,0	2,5	5,0	8,0
Dark stone, gray granite, dark armor	100	150	300	1,0	1,1	2,0	3,0	5,0
Light yellow brick	35	50	11	1,2	0,9	2,5	5,0	8,0
Light brown brick	40	60	120	1,2	0,9	2,0	4,0	7,0
Dark brown	55	80	160	1,3	1,0	2,0	4,0	6,0
brick, pink granite	100	150	300	1,3	1,0	2,0	3,0	5,0
Red brick	120	180	360	1,3	1,2	1,5	2,0	3,0
Architectural concrete	60	100	200	1,3	1,2	1,5	2,0	3,0
Aluminum	200	300	600	1,2	1,0	1,5	2,0	2,5
Very rich colors: red - brown - yellow blue - green	120	180	360	1,3 1,0	1,0 1,3	1,5	2,0	2,5
Medium saturated colors: red - brown - yellow blue - green	40	60	120	1,2 1,0	1,0 1,2	2,0	4,0	7,0
Slightly saturated colors	20	30	60	1,1 1,0	1,0 1,1	3,0	5,0	10,0

2.5. Selection of lighting fixtures.

Luminaires are one of the main parts of lighting installations and city lighting devices, and their cost is one of the components of the cost of installations. Lighting properties of luminaires: the nature of light distribution, the value of efficiency and utilization factors determine the cost of electricity. The design of luminaires determines their reliability, durability and ease of operation.

The main functions that the lamp must perform are:

- Implementation of the necessary redistribution of the luminous flux of the light source.
- Protection of the light source from environmental influences.
- Ensuring the possibility of power supply of the light source.

Outdoor lighting fixtures perform their functions when working in harsh conditions, they are exposed to precipitation, wind, dry smoke, vibration and elevated temperatures. Therefore, special requirements are placed on their design, manufacturing technology and materials. Fulfillment of requirements to accuracy of light distribution and its stability leads to necessity of known complication of a design, puts forward difficult and strict requirements to manufacturing technology (accuracy of optical surfaces, accuracy and invariance of a mutual arrangement of parts of the lamp, interchangeability of parts).

The optical system of luminaires for outdoor lighting installations, which due to the need to meet the specific requirements of light distribution, is very complex. It significantly determines its design. To control the distribution of light, use the following phenomena alone or in combination:

- refraction;
- reflection;
- light scattering

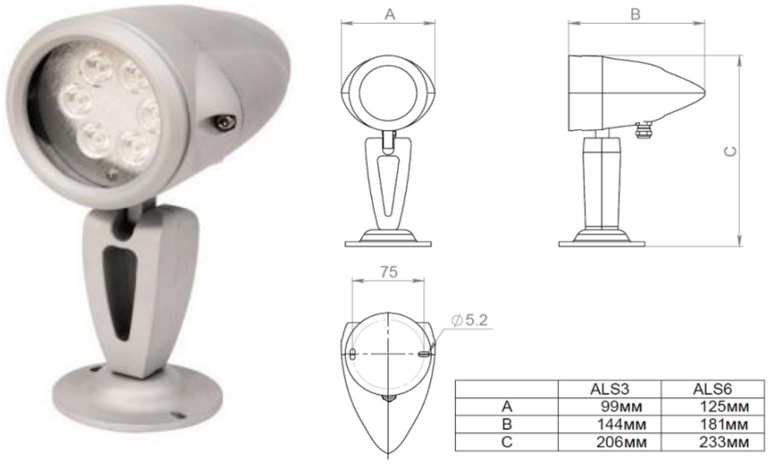
The design of luminaires should provide ease of care and repair, in particular the most typical care operations - replacement of the light source and cleaning of the device [22].

To the lighting fixtures used in architectural lighting, in addition to the generally accepted requirements, there are additional;

- lighting fixtures must have a modern design with small dimensions;
- searchlight-type devices must operate in any position, including the outlet up;
- implementation of the protection against environmental impact should be at the level of IP65;
- the design of a searchlight should allow fastening of protective lattices;
- providing anti-vandal protection of the joint venture.

Compliance with the above requirements makes the design of luminaires for architectural lighting more complex than for luminaires for other purposes, which leads to higher cost of lighting fixtures for outdoor architectural lighting.

The design of luminaires must ensure the performance of their functions during long-term operation without changing their lighting properties with the greatest simplicity and, consequently, the lowest cost of care.



	ALS3	ALS6
A	99мм	125мм
B	144мм	181мм
C	206мм	233мм

Figure 2.11 - Appearance and overall dimensions of the floodlight XLD-ALS6-025WHC.

The design of the lamp must provide not only the necessary nature of light distribution, but also its stability over time. Changes in the distribution of light may occur due to contamination, changes in the reflective properties of the surface or changes in the transparency of the elements of the lamp.

One of the reasons for the change in light properties is a change in the relative position of the light source and optical parts of the lamp, violations when replacing the light source or parts of the lamp, as well as when cleaning it.

Based on the above for lighting the main facade of the building, choose a floodlight type XLD-ALS6-025WHC. The appearance and overall dimensions of the searchlight are presented in Figure 2.11.

The floodlight is intended for illumination of objects of architecture, advertising, landscape design. The searchlight is designed to work in difficult operating conditions at a temperature of -40 to +50 ° C. Features of a design of a searchlight are given in table 2.5.

Table 2.5 - Features of the design of the floodlight XLD-ALS6-025WHC

Corps	Cast from an aluminum alloy
Protective cap	Tempered glass
Gaskets and seals	Silicon
Hermetic outlet	Chrome-plated metal, plastic, rubber
Power cable	Rubber base of the outer braid, UV resistant, black
Light	LED cluster on an aluminum printed circuit board
Power supply	Mounted on the body in a separate compartment, DC
Secondary optics	Optical polycarbonate

Table 2.6 - Specifications of the floodlight XLD-ALS6-025WHC

Luminous flux not less, lm	470
Power consumption, no more	9
Supply voltage, V	24V DC ± 10% / 110..240V AC
Degree of protection	IP66
Temperature range, ° C	from -40 to +50
Power factor	more than 0.95
Weight, net, kg	1.2

The technical characteristics of the searchlight are given in table 3.6, and the curve of light intensity - in Figure 2.12.

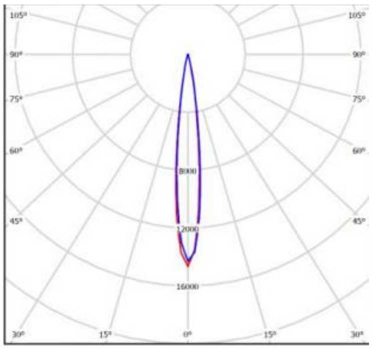


Figure 2.12 - XLD-ALS6-025WHC spotlight light curve.

Figure 2.13 - Layout of lighting fixtures

2.6. Placement of lighting fixtures.

The project proposes the following layout of lighting fixtures. Lighting fixtures should be placed above the cornices. The angles of the lamps are chosen so that the maximum light is directed to the level of the middle of the part of the facade, which is illuminated and located in the middle between the windows (Figure 2.13).

2.7. Design of electric lighting network.

Due to their nature and purpose, electrical networks must meet a number of requirements:

- to ensure uninterrupted and reliable power supply of lighting installations under any environmental conditions;

- to ensure safety in case of fire, explosion, electric shock;
- allow the replacement of damaged or worn wires during operation;
- be clear, serviceable and not spoil the appearance of the building and the premises located inside it;
- have sufficient resistance and strength to possible mechanical actions;
- be made of a minimum of conductive material.

Power sources for lighting fixtures are most often transformer substations powered by power systems, and in some cases local power plants. And they are common for lighting and power loads. To power local installationslighting in rooms without increased danger apply voltages up to 220 V.

The lighting installation is powered by a single-phase network from the ЩО-1 lighting panel. The electric network of external illumination includes two groups of consumers. The first group is floodlights for illumination of the case, and the second - floodlights for illumination of inscriptions, and lamps for illumination of an alley.

Copper two-core cables of the ПВ3 brand were chosen as conductors.

ПВ3 cable - copper single core with plastic isolation PV3. Meets the requirements of GOST 6323-79.

ПВ3 cable is applied to installation in electric boards of apartment houses and the industrial enterprises, and also other power distributing devices as switching devices in electric 1,2-and 3-phase networks with nominal voltage to 450 V and alternating current of frequency of 50, 60, 100 Hz and to 240 V DC. Wires of the PV3 brand are intended for installation of sites of electric networks where bends of wires are possible.

The design of the PV3 cable includes cconductive core: copper, multi-wire, class 2, 3 or 4 for sections from 0.5 to 1.5 mm2 inclusive, class 4 for sections from 2.5 to 4 mm2 incl., class 3 for sections from 6 to 95 mm2 incl. according to GOST 22483. Insulation of the PV3 cable is made of PVC plastic, different colors. Painting is performed solid or in the form of two stripes on the insulation of the main color, which are located diametrically.

Cable ПВ3 is designed to operate at a temperature of - 50 ° to + 40 ° C and a relative humidity of 98% at a temperature of 25 ° C.

Technical characteristics of ПВ3 cable [27]:

type of climatic performance OM and CL, placement category 2 according to GOST 15150-69;

conductors resistant to ambient temperature from - 50 ° C to +70 ° C;

conductors resistant to the action of relative humidity of 100% at a temperature of +35 ° C;

conductors resistant to mold;

conductors resistant to mechanical shocks, linear acceleration, bends, vibration loads;

wires do not spread combustion;

installation of wires should be carried out at a temperature not lower than -15 ° C;

the bending radius during installation must be at least 5 wire diameters;

long-term allowable heating temperature of the cores should not exceed +70 ° C

service life of wires - not less than 15 years

Laying of a network is carried out on surfaces of walls in special cable channels (boxes) of the 40 × 17 TMC brand. Technical characteristics of the box are given in table 2.8.

Table 3.8 - Technical characteristics of the cable channel 40 × 17 TMC

Width, mm	40
Height, mm	17
Length, mm	2000
Color	Brown
Product material	PVC (polyvinyl chloride)
Fire safety	Does not spread combustion
Mounting temperature	From -15 to 60 ° C

The project provides for the use of emcb60 circuit breakers to protect cables and lighting fixtures from overloads and short circuits. 1 professional. The image of the switch and its technical characteristics are given in Figure 2.14 and Table 3.9, respectively.

Table 3.9 - Technical characteristics of emcb60 circuit breakers. 1 professional

Rated shutdown capacity	6 kA
Number of poles	1 p
Rated current	10 A
Rated voltage	AC 230/400 V, 50 Hz
Operating temperature range	-25 ... + 60 ° C
Section of connected wires	1 ... 25 mm2
Tightening torque of screws	5 Nm
Degree of protection	IP 20

Figure 3.14 - Appearance emcb60 switch. 1 professional.

2.8. Control of the lighting system.

In the project it is offered to use instead of manual control of work of system of illumination to use automatic on the basis of the photorelay of the ФР-601 brand (figure 3.15).

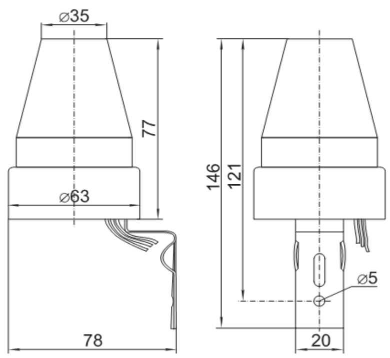


Figure 3.15 - Photorelay ФР-601

This photo relay is designed to automatically turn the lights on and off depending on the light level. The main area of application is for controlling street and indoor lighting.

The main characteristics of the photo relay are given in table 3.11

Table 3.11 - Characteristics of the photo relay ФР-601

Rated voltage, V	220
Rated frequency, Hz	50
Rated load current, A	10
Adjustment of a threshold of operation depending on illumination, lux	5 - 50
Own power, W.	0.45
Photocell	Built-in
Maximum cross section of connecting conductors, mm2	1.5
Degree of protection	IP44
Climatic performance and category of application	In 3.1

The control scheme using a photorelay is shown in Figure 3.16.

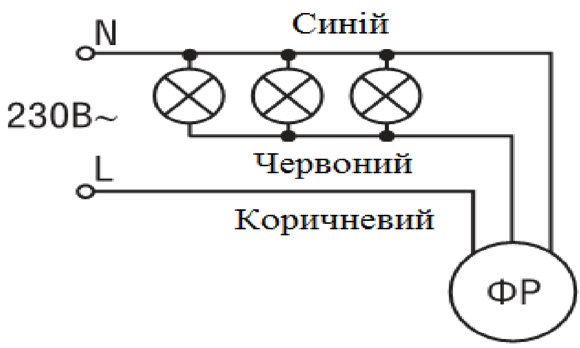


Figure 3.16 - Scheme of connection of the photo relay.

Connection of the photo relay is carried out to conclusions of contact conductors: brown wire - connection of a phase; blue wire - neutral connection; red wire - load connection.

SECTION 3
CALCULATION AND RESEARCH PART.

3.1. Lighting calculation of the architectural lighting system

Lighting calculation includes: choice of light sources, normalized illumination, type and system of lighting, type of lamps, coefficients of stock and additional illumination, choice of placement of lamps, calculation of illumination on the surface of the illuminated object.

3.2. Lighting calculation of lighting installations.

The purpose of lighting calculation of lighting installations (OS) is to determine the number and power of light sources that will provide normalized (with a margin factor) illumination, or to determine the specified location of lamps and power of light sources, illumination created on surfaces.

Illumination on the surface is created by the light flux coming directly from the lamps (a direct component of illumination) and reflected, falling on the calculated surface as a result of repeated reflections from other objects (reflected component).

The direct component of illuminance is calculated on the basis of the light intensity curve of the lamp and the placement of the lamp relative to the selected point. Therefore, its values in some parts of the work surface will be different.

Reflected component determined by the light flux incident on the reflecting surfaces, the reflecting properties of the environment.

The method of calculating the direct component is chosen depending on the applied radiation sources.

Depending on the ratio of the size of luminous elements and their distance to the illuminated surfaces, they can be divided into three groups: point, linear and luminous surfaces.

The accuracy of the luminous element is usually determined by its relative size in relation to the distance of the illuminated surface. In practice, it is customary to consider a luminous body as a point if its size does not exceed 20% of the distance to a point in the space it illuminates.

Therefore, in the practice of calculations, a spot light device is taken as a light point with a conditionally selected light center, which is characterized by the intensity of light in the output directions.

Spot light elements include: floodlights, joint ventures with incandescent lamps, DRL, MHL, HPSL, LPSL, etc.

The position of the joint venture, which has an axis of symmetry of the point element, relative to the calculation point in the General case is determined by the following coordinates (Figure 3.5):

1) height placement of the joint venture relative to the settlement plane;

2) angle, which determines the direction of light intensity to the calculation point.

A light fixture located at a distance commensurate with its dimensions cannot be considered as a spotlight. The light distribution of such a lamp is determined not by the light intensity curve, but by the curves of equal illuminance in the calculation plane. Therefore, the location of the local lighting fixture relative to the calculation point will be determined by the coordinates: height and the distance from the projection of the axis of the lamp on the illuminated plane to the calculation point.

Light surfaces for which the law of squares of distance cannot be applied due to a significant error that occurs in the calculation include the installation of reflected light in the form of light ceilings or niches, the panels are covered with scattering or lattice dimmers. The dimensions of these light elements are proportional to the distances to the calculation points. Light elements of this group are characterized by the following indicators: the shape and size of the light surface, the distribution of brightness in different directions of space and the luminous surface.

When calculating lighting installations of this type, you can take the brightness of the luminous surface, which is equal to its average value. It should be borne in mind that, depending on the conditions of use, the luminous element can be considered differently.

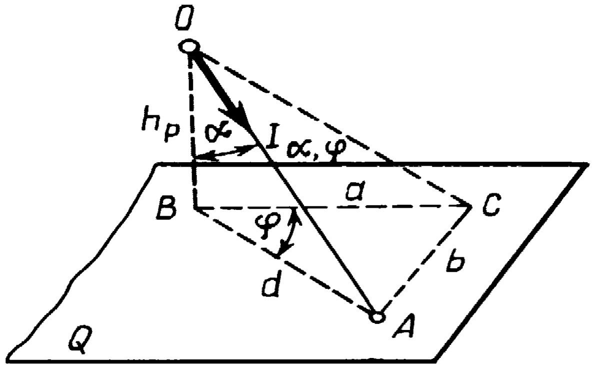


Figure 3.5 - Coordinates that determine the position of the point luminous element relative to the calculated point.

All applied calculation methods are based on two formulas that relate illuminance to the characteristics of lamps and lamps.

$$E = \frac{F}{S} \qquad (3.3)$$

$$E = \frac{I_a \times \cos a}{l^2} \qquad (3.4)$$

The fundamental difference between these formulas is that the first of them, being written in non-differential form, determines the average illuminance of the surface, and the second - the illuminance of a particular point on the surface.

The method that is based on the first formula is called the utilization factor method. In its usual forms, it makes it possible to provide an average illumination of the horizontal surface, taking into account all the streams falling on it, both direct and reflected. The transition from medium to minimum light in this case can only be done approximately.

The method, which is based on the second formula - the point method, allows to provide a given distribution of light on arbitrarily placed surfaces, but only approximately takes into account the light reflected by the surfaces of the room. According to these features, the utilization factor method is used to calculate the overall uniform illumination of horizontal surfaces, as well as to calculate the external illumination in cases where the average illuminance is normalized.

The point method is used to calculate the overall uniform and localized lighting of rooms and open spaces, as well as to calculate local lighting at any location of the illuminated surfaces. Its scope is limited to cases where class P and H luminaires are used.

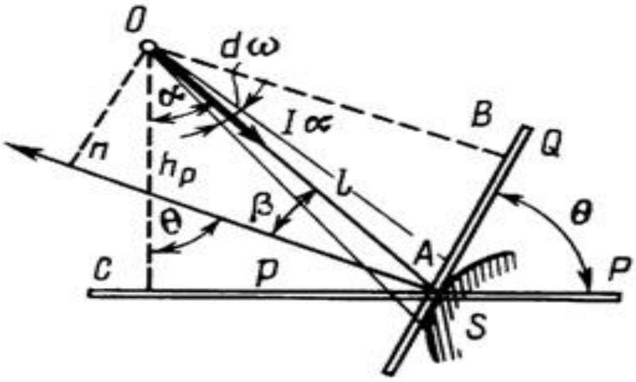


Figure 3.6 - To calculate the illuminance from a point light element with a symmetrical light distribution.

Illumination of point A:

$$E_A = \frac{I_a \cos^3 a}{h_p^2}(\cos q \pm \frac{\overset{*}{p}}{h_p}\sin q) \tag{3.5}$$

where I_a - the light intensity of the light source in the direction of point A;

b - the angle between the direction of light at point A and the normal to the element dS;

l - distance from the joint venture to the calculated surface point.

q - the angle of inclination of the design plane relative to the plane perpendicular to the axis of symmetry of the lamp (horizontal plane);

a - the angle between the direction of light intensity to the calculation point and the axis of symmetry of the lamp;

h_p- the height of the lamp above the horizontal plane passing through the calculation point;

p- the shortest distance from the projection of the axis of symmetry of the lamp on the horizontal plane passing through the calculation point, to the trace of the intersection with the design plane.

In contrast to the calculation of illuminance from a joint venture with a symmetrical light distribution, the location of point A when illuminated by an asymmetrical lamp (having not an axis but a plane of symmetry) is characterized by three coordinates, h_p, corners a and j, which are calculated from the plane of symmetry of the OVS lamp (Figure 3.7).

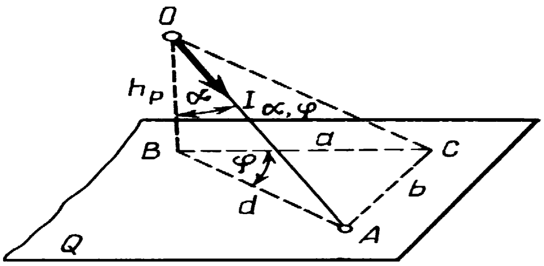


Figure 3.7 - To calculate the illuminance from a point light body with an asymmetric light distribution.

According to the figure value a and j can be found from the formulas

$$a = arctg\frac{d}{h_p}; j = arctg\frac{b}{a}.$$

At these known angles, the intensity of light is determined I_{aj}, and hence the illuminance of the surface at this point according to the equation

$$E_A = \frac{I_a \cos^3 a}{h_p^{\ 2}} (\cos q \pm \frac{{}^{*}p}{h_p} \sin q) \qquad (3.6)$$

3.3. Results of lighting calculation of lighting installations and their analysis.

The control surfaces, ie the surfaces for which the calculation is performed are the surfaces of the walls between the windows of the main facade.

Figure 3.8 and the graphical part show the location of the calculation surfaces.

The calculation is performed in the DiaLux package. The calculation process in the DiaLux package is given in a special part of the project. The results of the calculations are presented in table 3.7. Visualization of the distribution of illumination on the calculated surfaces is presented in Figure 3.9 - 3.11.

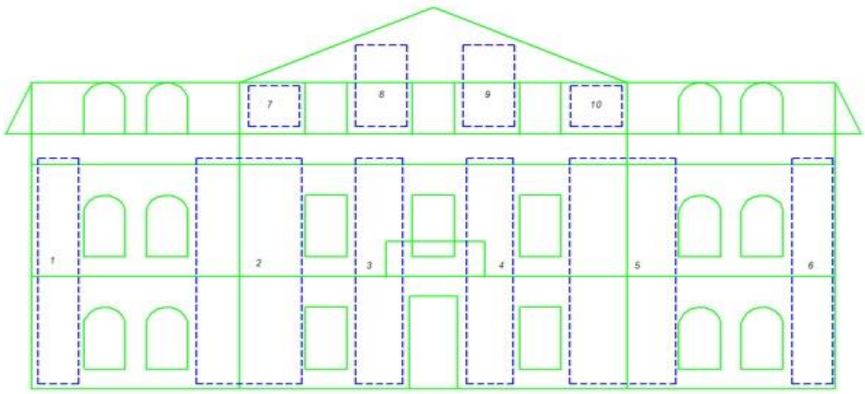


Figure 3.8 - Location of calculation surfaces.

Table 3.7 - The results of lighting calculation of the lighting installation.

Surface	Average illumination, lux
1	172
2	168
3	165
4	175
5	183
6	172
7	201
8	183
9	185
10	202

As can be seen from the results of the calculation, the proposed light fixtures, as well as their location, satisfy our requirements for ensuring the appropriate level of illumination and brightness.

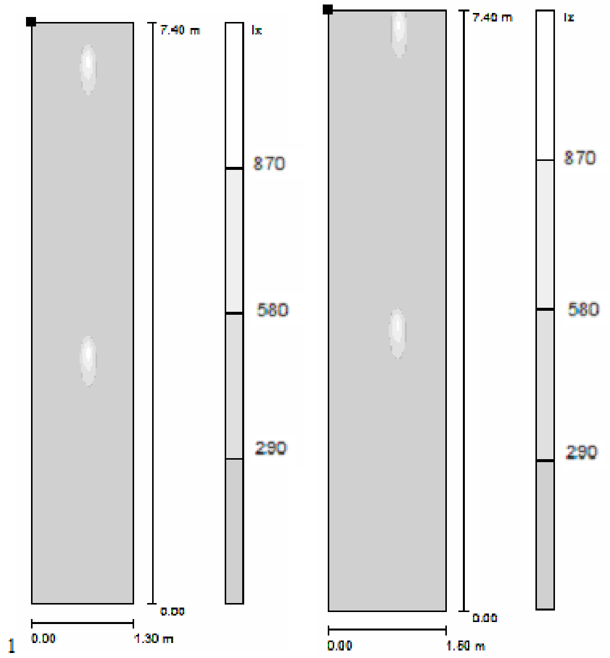


Figure 3.9 - Visualization of light distribution on surfaces 1 and 6

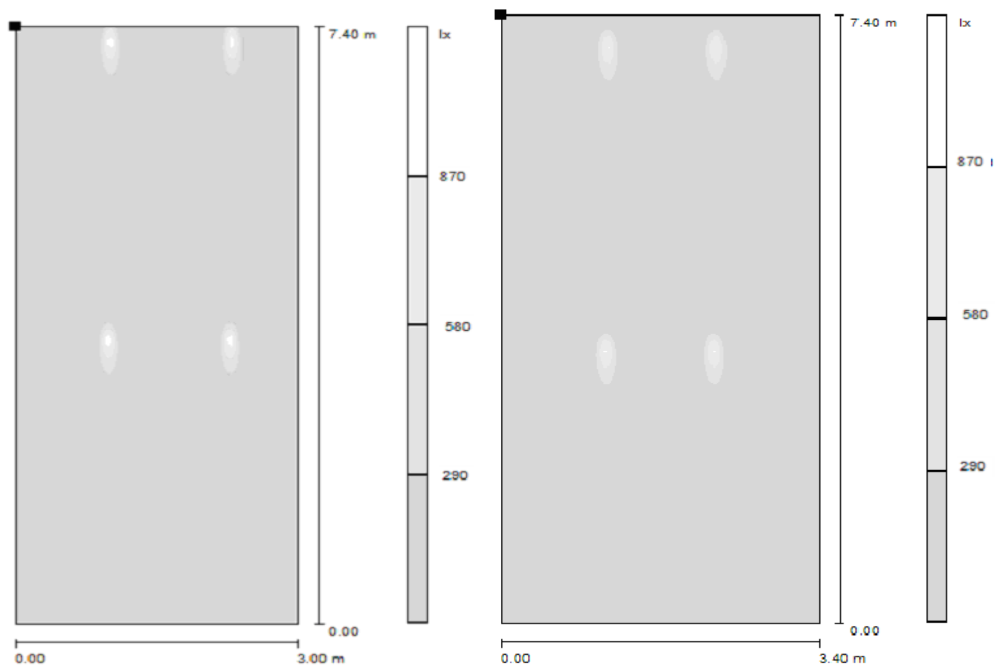


Figure 3.10 - Visualization of light distribution on surfaces 2 and 5

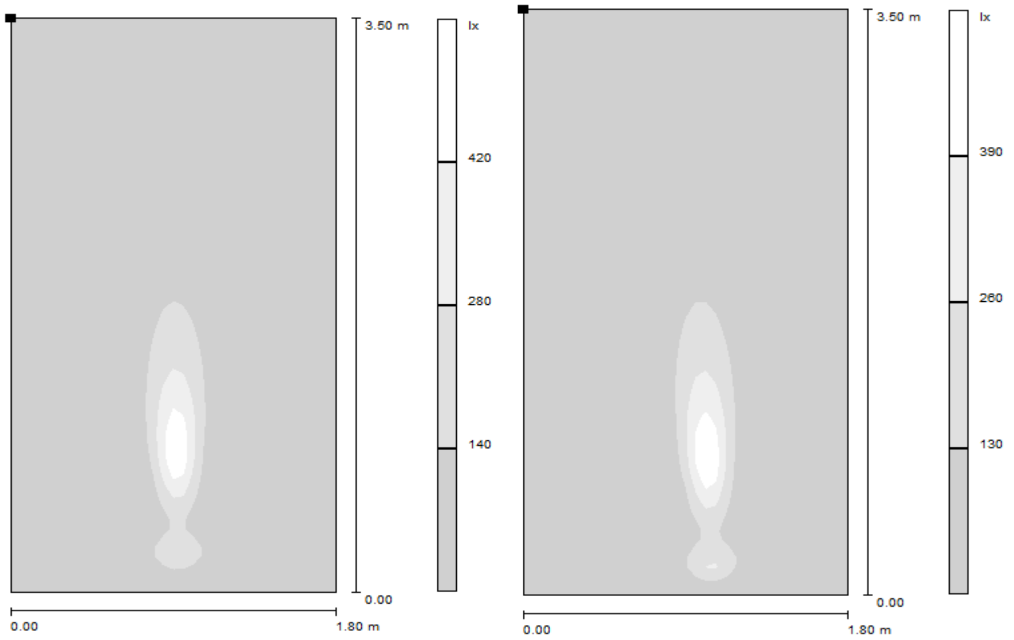


Figure 3.11 - - Visualization of light distribution on surfaces 8 and 9

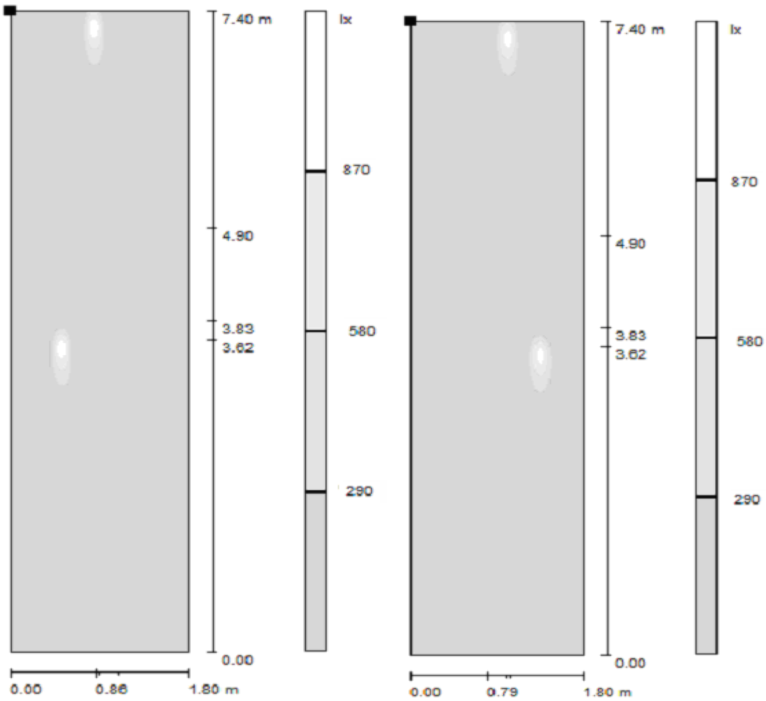


Figure 3.12 - Visualization of light distribution on surfaces 3 and 4.

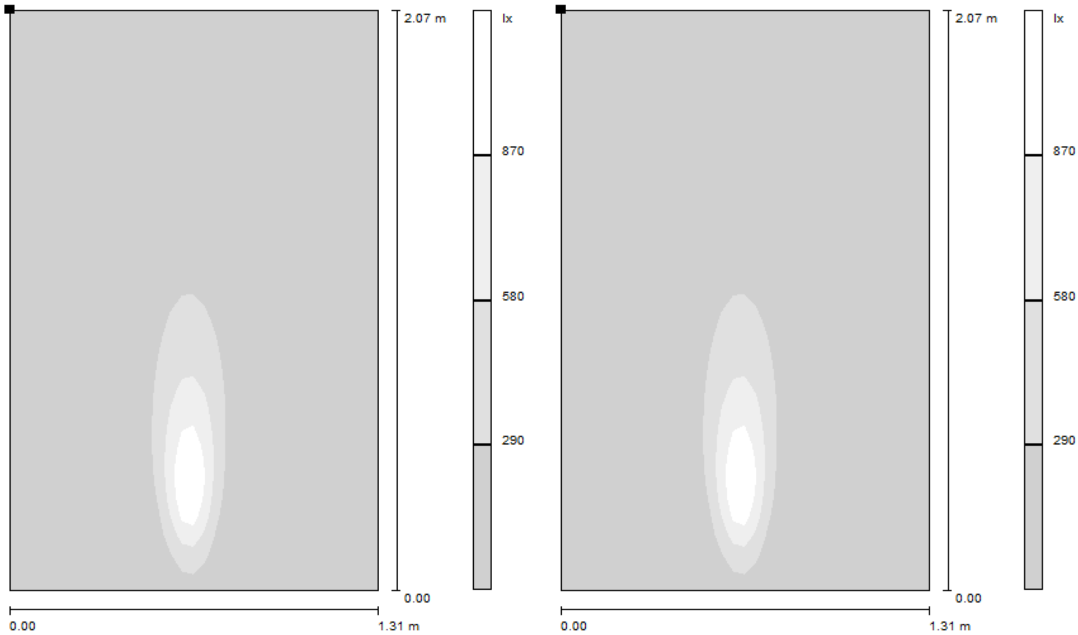


Figure 3.13 - Visualization of light distribution on surfaces 7 and 10.

3.4. Calculation and selection of wire cross-section

The calculation of electric lighting networks (computers) is to determine the cross sections of wires and cables, in which the operating current of the lines does not create overheating of the conductors and provides the required voltage levels from the lamps and sufficient mechanical strength of the conductors.

The calculation of the network is based on the determination of loads and current in individual areas, the current of the protection device (circuit breakers and fuses); development of proposals to increase the power factor in the networks of high-pressure discharge lamps, as well as voltage stabilization in lighting networks.

The cross section of the conductors is determined on the basis of:

1) the minimum allowable voltage at light sources (calculation of voltage loss);
2) the minimum cost of conductive material (calculation of the minimum conductive material);
3) load current according to the allowable heating temperature of the conductors (calculation of the load current);
4) mechanical strength of conductors and cables (choice of mechanical strength).

From the received sections of wires on the listed indicators choose the largest.

Preliminarily before calculation of sections of wires on loading current and voltage loss it is necessary to calculate the established power Py and the estimated load Pp on separate group lines, boards and lines of a power supply network.

Installed lighting power Py defined as the sum of the powers of all lamps that are powered by the relevant section of the network, and for lamps with GL add losses in the ballast:

- for LL at starter inclusion - 20%;
- at starterless ballasts - 30%;
- DRL - 10% of lamp power.

When calculating group lines, the load on all luminaires is taken into account at the same time, ie the calculated load is equal to the installed power.

To determine the estimated load of the power supply, a demand factor is introduce equal to the ratio of the rated load to the installed capacity:

$$P_p = P_y k_d \qquad (3.7)$$

In the absence of data, the demand factor *kc* is equal to:

1.0 - for small industrial and public buildings, retail space and outdoor lighting lines, for lines that supply individual group panels, regardless of their load and purpose of the room;

0.6 - for warehouses, which consist of many separate rooms.

For our case, calculate the installed capacity of each individual line, assuming that kc = 1, the power of one lamp is 9 watts. Our lighting installation consists of 18 luminaires, hence the installed power will be 162 watts.

Let's calculate the lighting network proposed in the project for a minimum of conductive material. The cross-sectional area of the wires is determined by the formula

$$q = \frac{\sum_{i=1}^{i=n} M_i}{c\Delta u\%} \qquad (3.8)$$

where $\sum_{i=1}^{i=n} M_i$ - the sum of electrical load moments, kW · m;

c - coefficient depending on the voltage, material of wires and units of measurement of the sizes included in the formula (determined by reference tables) (for a two-wire line with a copper conductor c = 12);

Δu - estimated allowable voltage loss,%.

For indoor lighting networks at nominal input voltage, the allowable loss is 2.5%, except for residential buildings, for which this value, as well as for outdoor and emergency lighting is 5%. For this case Δu = 5%.

The calculation of the voltage loss network will be based on the formula (3.8):

$$\Delta u\% = \frac{\sum_{i=1}^{i=n} M_i}{c \cdot q} \qquad (3.9)$$

The area of the wires q we determine on the basis of calculation on a minimum of conductive material, and also on the basis of a choice of section of wires on the conditions of mechanical durability. According to these conditions, the minimum cable cross-section for the lighting network must be 1.0 mm2. Therefore, finally for all types of branches choose this section. The allowable current for copper wires of this cross section is 16 A.

To determine whether a certain cross-section of the conductor will withstand the value of the operating current flowing through it, you must perform a test on the condition.

$$I_p \leq I_{доп} \qquad (3.10)$$

where I_p - operating current flowing through the conductor of a given material and cross section;

$I_{доп}$ - permissible conductor current, ie current, long-term flow of which will not cause overheating of the conductor.

To determine the operating current, use the formula for a single-phase (two-wire) line:

$$I_p = \frac{P \cdot 10^3}{U \cdot \cos\varphi} \qquad (3.11)$$

where I_p - rated current of the wire, A;

P - estimated power, kW;

U - phase voltage, B;

cosφ - power factor (for these luminaires cosφ = 0.95)

Substituting values of lengths of sites of wires, capacities, and also kreficents and we obtain the results of the calculation of the network for a minimum of conductive material. The results of the calculation are entered in table 3. 10.

Table 3.10- The results of the electrical calculation.

Branch type	Length	P, kW	$\sum_{i=1}^{i=n} M_i$, kW · m	q, mm2	I_p, A	Δu,%
AND	20	3.24	3.24	0.054	0.78	3.05
1.1	3.08	0.06	0.055404	0.001	0.09	0.07
1.2	6.22	0.06	0.055949	0.001	0.04	0.01
1.3	3.50	0.13	0.126	0.002	0.17	0.21
1.4	3.01	0.08	0.081351	0.001	0.13	0.01
1.5	1.69	0.03	0.030348	0.001	0.09	0.27
1.6	4.40	0.04	0.039578	0.001	0.04	0.06
II	3.70	0.33	0.333	0.006	0.43	1.48
2.1	3.08	0.08	0.083106	0.001	0.13	0.07
2.2	6.22	0.06	0.055949	0.001	0.04	0.01
2.3	3.50	0.19	0.189	0.003	0.26	0.21
2.4	3.01	0.11	0.108468	0.002	0.17	0.01
2.5	1.69	0.03	0.030348	0.001	0.09	0.27
2.6	4.40	0.04	0.039578	0.001	0.04	0.06

Determine the current of the protection device. Currents, automatic devices or fuse-links are calculated by the ratio:

$$I_g \geq k_t I_p \tag{3.12}$$

where I_g - current of the protection device, A;

I_p - rated current of the protected group, A;

k_t - the ratio of the rated current of the fusible insert or installation of the thermal switch of the machine to the operating current of the line; whose values must be not less than those given in table 3.11.

Table 3.11 - The ratio of the minimum current of the fusible insert and the insert of the thermal decoupling of the machine to the operating current of the lamp line.

parat protection	The ratio of the minimum current of the fusible insert and the insert of the thermal decoupling of the machine to the operating current of the lamp line		
	Incandescence	Type DRL	Fluorescent
Fuse	1.0	1.2	1.0
Circuit breaker with thermal release	1.0	1.4	1.0
Circuit breaker with combined release	1.4	1.4	1.0

The reliability of the protection device is checked by the ratio of its rated current and short-circuit current at the end of the lighting line [37]. According to PUE it is possible not to calculate short-circuit current and not to define its multiplicity if concerning long-term admissible to currents of wires of a network protection devices have multiplicity of the rated currents no more than 3 at fuses; 4.5 for electromagnetic and 1 for thermal switches. For most lighting installations, these conditions are met.

As can be seen from table 3.10, the operating current flowing to power the installation of the facade lighting $I_p = 0{,}78$ A Substituting the data into formula (3.12), we obtain:

$$I_t \geq 0{,}78;$$

3.5. Calculation of the amount of electricity consumed by installing the building lighting

Based on the fact that the operating time of outdoor lighting for one year is approximately hours, calculation of energy consumption during this period during the operation of each of the light sources is carried out according to the formula [44]:

$$W = P_p \times T \tag{3.12}$$

where P_p - installed power of the lighting installation.

Substituting in formula (3.12) values $T = 2600$ hours and P_p, shown in table 3.10, we obtain data on electricity consumption by the lighting installation

$$W = 0{,}162 \times 2600 = 421{,}2 \text{ kWh}$$

Therefore, the amount of electricity consumed per year for the proposed lighting system in the project is 421.1 kWh.

SECTION 4

LABOUR OCCUPATIONAL SAFETY AND SECURITY IN EMERGENCY SITUATIONS

4.1 Taking into account the requirements of artificial lighting for public buildings

Artificial lighting is provided in all industrial and domestic premises, where there is not enough natural light, as well as for lighting in the dark. At the organization of artificial lighting it is necessary to provide favorable hygienic conditions for visual work and at the same time to consider economic indicators. Therefore, for general artificial lighting should be used, as a rule, bit light sources, preferring the same power light sources with the highest light output and service life.

According to DBN B 2.5 ‒28‒2018 the light output of light sources for artificial lighting of premises with the minimum allowable color rendering indices should not be less than the values given in table 4.1.

Artificial lighting is divided into working, emergency, security, duty. Emergency lighting is divided into safety lighting and evacuation. Artificial lighting can be of two systems - general and combined. Work lighting should be provided for all rooms of houses, as well as areas of open spaces intended for work, passage of people and traffic. For rooms that have areas with different natural light conditions and different operating modes, separate control of lighting of such zones should be provided. If necessary, part of the work or emergency lighting fixtures can be used for emergency lighting.

Normalized characteristics of lighting indoors and outdoors can be provided both by work lighting fixtures and by joint lighting with safety and (or) evacuation lighting fixtures.

Table 4.1 – Minimum light output of light source

Type of light sourcesource	Minimum light output, lm / W, at the minimum admissible color rendering indices Ra				
	Ra> 80	Ra> 60	Ra> 45	Ra> 25	Ra <25
Fluorescent lamps	65	75	-	-	-
Compact fluorescent	70	-	-		-
Metal halide lamps	75	90	-	-	-
Arc mercury lamps	-.	-	55	-	-
Sodium lamps high pressure	-	75	-	100	-
Incandescent lamps	-	-	-	-	7

Incandescent and gas-discharge lamps are widely used as sources of artificial lighting.

Incandescent lamps belong to thermal light sources. Under the action of an electric current, the filament (tungsten wire) is heated to a high temperature and emits a stream of radiant energy.

These lamps are characterized by simplicity of design and manufacture, relatively low cost, ease of operation, a wide range of voltages and capacities.

Discharge lamps due to electric discharge in the environment of inert gases and metal vapors and the phenomenon of luminescence emit light in the optical range of the spectrum. The main advantage of gas discharge lamps is their efficiency. The light output of these lamps is 40 – 100 lm / W, which is 3 – 5 times higher than the light output of incandescent lamps. The service life is up to 10 thousand hours, and the heating temperature is 30 – 60 ºC.

In addition, gas discharge lamps provide light flux of almost any spectrum, by selecting appropriately inert gases, metal vapors, phosphor.

For the general illumination of rooms it is necessary to use the most economic discharge lamps with light emission not less than 55 lm / W.

The use of incandescent lamps is allowed for general lighting only to meet architectural and artistic requirements and in hazardous areas.

In order to control energy consumption, requirements are set for the maximum allowable specific installed capacity of the general artificial lighting of public buildings of categories A – B. The specific installed power of the general artificial lighting should not exceed the maximum allowable values given in table 4.2.

Table 4.2 - The maximum allowable values of specific installed power of the general artificial lighting.

Characteristics of visual work according to the requirements for color discrimination	Illuminance, lux	The minimum color rendering index of	Color temperature of light sources, K
1	2	3	4
Comparison of colors with high requirements for color separation (drawing rooms, service types of work, cutting departments in the studio, meeting rooms of national importance, chemical laboratories, exhibition halls)	from 300 to 500	85	3500 – 5000
	from 150 to 300	85	3500 – 4500
Distinguishing of color objects at low requirements to color distinction (rooms of circles of educational institutions; supermarkets, trade halls of shops, studios, dry cleaning of clothes, dining halls, indoor pools, gyms; pantries of points of hire, shops)	from 150 to 300	55	3500 – 5000
	from 300 to 500	50	3500 – 4500
	less than 150	50	2700 – 3500
There are no requirements for color discrimination (offices, study rooms, design, drawing bureaus, reading catalogs, archives, bookstores)	from 300 to 500	55	3500 – 5000
	from 150 to 300	50	3500 – 4500
	less than 150	45	2700 – 3500

Continuation of the table 4.2

1	2	3	4
Distinguishing color objects with low requirements for color discrimination (concert halls, auditoriums, theaters, assembly halls, lobbies)	from 300 to 500	80	2700 – 4500
	from 150 to 300	55	2700 – 4200
	less than 150	50	3000 – 3500
There are no requirements for color discrimination (cinema halls, elevator halls, corridors, passages, passages, etc.)	less than 150	45	2700 – 3500

In the premises of public buildings, as a rule, use a system of general lighting. It is allowed to use the system of combined lighting in the premises of administrative buildings, where visual work of A −B categories is performed (offices, study rooms, reading rooms of libraries and archives).

4.2. First aid for a person affected by electric shock.

Electric shock occurs when a current of 0.06 A or more passes through the human body. A current of 0.1 A is lethal to humans. The amount of current flowing through a person depends on the resistance of his body. The resistance of a person to the action of an electric current is a variable and depends on many factors, in particular on a person's fatigue and mental state. The average value of this resistance is in the range of 20 −100 kOm. Under particularly unfavorable circumstances, the resistance can drop to 1 kOm. In this case, a voltage of 100 V and below will be life-threatening. At low voltage, resistance mainly depends on the condition of the skin. The calculated value of the electrical resistance of the human body is taken to be equal to 1.0 kOm.

The resistance of the human body depends on the frequency of the current. It acquires the lowest value at current frequencies of 6 −15 kHz. The passage of current through the heart is especially dangerous. Much of it passes through the heart in the following ways: right arm −legs −6.7%; left arm −legs −3.7; hand −hand −3.3; foot −foot 0.4% of the total striking current.

Direct current is less dangerous. Direct current up to 6 mA is almost not felt. At a current of 20 mA there are cramps in the muscles of the forearm. Alternating current begins to be felt already at 0,8 mA. A current of 15 mA causes contraction of the arm muscles. The risk of direct and alternating current changes with increasing voltage. At voltages up to 220 V, alternating current is more dangerous, and at voltages above 500 V – direct current. The greater the current flowing, the lower the electrical resistance of the body. If the current is not interrupted quickly, death can occur. The degree of damage is also significantly affected by resistance at the point of impact of the person with the ground. In the case of current passing through the victim from hand to foot, the material and quality of shoes are essential. Electric current can cause severe damage, up to cardiac arrest and respiratory arrest. Therefore, you need to be able to provide assistance to the victim before the arrival of the doctor.

First of all it is necessary to quickly release the victim from the action of electric current, ie to disconnect the current circuit with the help of the nearest plug, switch (switch) or by turning the plugs on the shield. If the switch is far from the scene, the wires can be cut or cut (each wire separately) with an ax or other cutting tool with a dry handle of insulating material. If it is impossible to break the circle quickly, it is necessary to pull the victim away from the wire or to throw the end of the broken wire away from the victim with a dry stick. It is necessary to remember that the victim is a conductor of an electric current. Therefore, when releasing the victim from the current, the caregiver must take precautions so as not to be under pressure: wear galoshes, rubber gloves or wrap your hands in a dry cloth.

When releasing the victim from the current, it is recommended to act with one hand. If it is on a ladder, stand or any other device, care must be taken to prevent bumps or fractures from falling. If a person is exposed to a voltage above 1000 V, such precautions are insufficient. It is necessary to turn to specialists who will immediately relieve stress.

First aid measures depend on the condition of the victim after discharge. To determine this condition it is necessary:

– immediately put the victim on his back;
– unbutton clothes that make it difficult to breathe;
– check on the rise of the chest, whether he is breathing; check for pulse (on the radial artery in the wrist or on the carotid artery in the neck);
– check the condition of the pupil (narrow or wide).

A wide stationary pupil indicates a lack of cerebral circulation. Determination of the victim's condition should be carried out quickly, within 15 - 20 seconds. For this:

a) if the victim is conscious, but before that he was unconscious or was under electric shock for a long time, he must be provided with complete rest before the arrival of the doctor and further observation for 2-3 hours;

b) in case of impossibility to call a doctor quickly, it is necessary to urgently take the victim to a medical institution;

c) in case of serious condition or lack of consciousness it is necessary to call a doctor (ambulance) to the scene;

d) in no case should the victim be allowed to move: the absence of severe symptoms after the defeat does not exclude the possibility of further deterioration of his condition;

e) in the absence of consciousness, but the breath is preserved, the victim should be placed comfortably, create a flow of fresh air, sniff ammonia, sprinkle with water, rub and warm the body. If the victim is breathing poorly, very rarely, superficially or, conversely, convulsively, like a dying person, artificial respiration should be performed;

f) in the absence of signs of life (breathing, heartbeat, pulse) can not be considered dead. Death in the first minutes after the injury can only surrender and the

victim can come to life with care. The victim is threatened with irreversible death if he is not immediately treated in the form of artificial respiration with simultaneous heart massage. This event must be carried out continuously at the scene before the arrival of the doctor;

g) the victim should be transferred only in cases when the danger continues to threaten the victim or the person providing assistance.

CONCLUSIONS

1) A literature review was conducted, which identified the goals and objectives of outdoor architectural lighting, as well as its purpose and function. Methods and creative means of external architectural lighting are analyzed. The principles of lighting objects of different shapes are established.

2) The stages of designing external architectural lighting are determined. The choice of species directions and characteristic points is made. As a result of the analysis of a kind of objects from various points, it is established that illumination of the external surfaces located between windows will be most expedient.

3) The calculation and selection of normalized illumination is carried out. For surfaces that need to be illuminated, this value is 165.8 lux.

4) LED floodlights of the XLD-ALS6-025WHC 9 W floodlight were selected to illuminate the facade surface.

5) The lighting calculation of the proposed lighting installation was carried out, as a result of which the average illuminances on the surfaces of the facades were calculated.

6) The electrical calculation of lighting installations was carried out, as a result of which the type and cross-section of cables were determined, protection devices were selected, the amount of electricity consumption by lighting installations for housing illumination was calculated.

7) Visualization of lighting in the DiaLux package was performed.

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Ch.	Sh.	Doc. number	Signat.	Date				
Developed		Onyeji M.C			CONCLUSION	Letter	Sheet	Sheets
Checked		Osadtsa Ya. M.						
Consultant						TNTU, FAT, gr. IEE-42		
Compliance								
Head of Dp.		Tarasenko M.G.						

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