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Computer analysis of the imission impact of the illumination of objects

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ABSTRACT: Illumination is an increasingly popular form of creating a night-time image of objects with interesting architecture, including sacred, historical or public buildings. In recent times, there has also been an increase in the share of private facilities, incl. single-family houses for which decorative night lighting was implemented. The rapid development of semiconductor light sources, their high luminous efficiency and lens systems allowing for the formation of complex light distributions made it possible to implement complex illumination projects, difficult to implement with the use of traditional, discharge light sources. An important issue in the implementation of illumination projects is to reduce or completely eliminate the impact of immission lighting within the illuminated object, also called light pollution. The paper presents the results of simulation research related to the immission effect of the illumination of objects. The main factors influencing the shaping of the phenomenon of light immission were analyzed, incl. the arrangement of lighting luminaires and the light distribution curves used. The final computer research with the use of the 3ds Max Studio tool was carried out for the municipal building of the city hall in Zamość.

KEYWORDS: illumination, LED luminaires, calculation tools

1. Introduction

In recent years, the illumination of objects has become an increasingly popular form of night lighting of buildings distinguished by interesting architecture, public or historical buildings [1-3]. The development of semiconductor light sources made it possible to reduce the total power of the illumination luminaires used, which allowed directly to obtain greater energy efficiency of the illuminated objects [4].

When implementing illumination projects, an important issue that should be taken into account is the reduction of the photobiological phenomenon related to lighting pollution. The above-mentioned phenomenon has been gaining importance in recent years and in order to limit it, new regulations and normative requirements are being introduced [5-8]. An example here can be road lighting, in which it is required that the luminous flux of LED luminaires is directed only into the lower half-space and lighting the area of the road between adjacent luminaires. Similarly, in illumination lighting, efforts are made to limit the immission impact of the illumination of objects, but the guidelines for optimizing illumination design in terms of energy efficiency and light pollution are not common here. Illumination lighting of buildings is often associated with the installation of lighting luminaires in the lower part of the building and directing them to the upper part of the building. Inadequate selection of the light distribution of the used luminaires, as well as their incorrect arrangement, results in the loss of a significant part of the luminous flux by radiating it towards the sky and in the immediate vicinity of the object, contributing to the phenomenon of light pollution. An example of such an illumination of an object in which a significant part of the luminous flux was not directed into appropriate zones is the illumination of the Książ Castle in Wałbrzych (Fig. 1).

Fig. 1. The lighting of the Książ castle as an example of the immission effect of illumination

In order to reduce the imission impact, computer illumination projects are performed using advanced computational tools that enable detailed reconstruction of the modeled object, loading photometric solids of lighting luminaires and finally calculating the luminance distribution of the illuminated object [9-10].

The paper presents the results of simulation calculations related to the analysis of factors influencing the immission effect of the illuminated object. Finally, with the use of 3Ds Max software, the project of the illumination of the town hall in Zamość was made, for which the immission impact was determined.

2. Analysis of the factors influencing the immission effect of illuminated objects

The paper presents the results of simulation research related to the analysis of the factors influencing the immission effect of the illuminated object. A model of the object was made, which was illuminated with floodlights and linear luminaires in LED technology. The luminaires used were characterized by narrow and wide symmetrical and asymmetrical beams (Fig. 2), for which the possibility of lighting pollution was assessed.

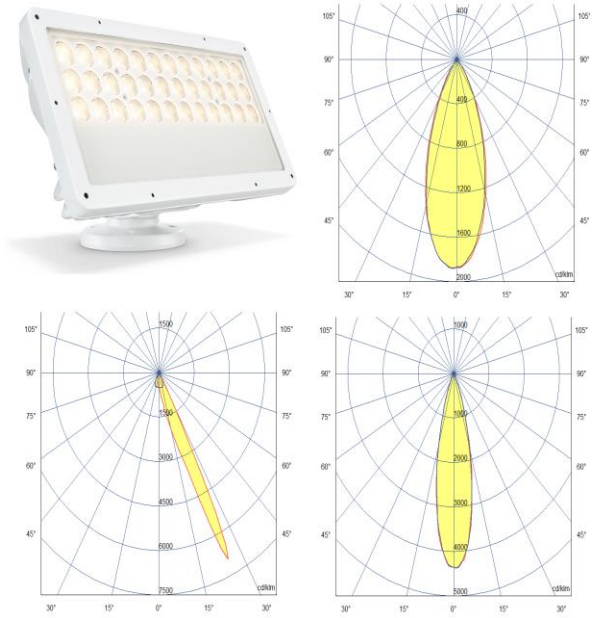


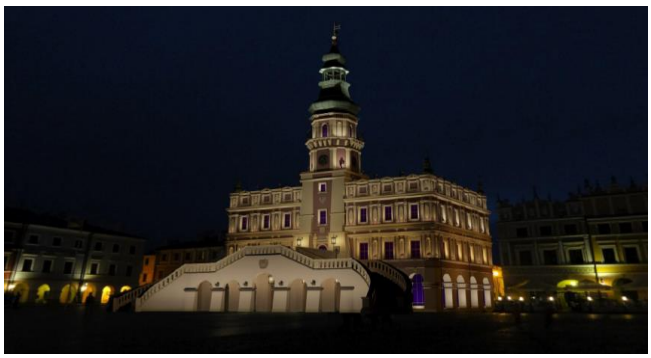
Fig. 2. Floodlight and light distribution curves used

Simulation research were also carried out for various methods of installing lighting luminaires (flood, point and hybrid methods). For the above-mentioned methods, the distance and place of luminaire installation were changed, and then their impact on the phenomenon of light immission was assessed.

3. Computer illumination of the town hall in Zamość

The analysis of the factors influencing the phenomenon of the imission effect of illumination was used to prepare the final illumination project and determine its impact on the phenomenon of light pollution. The computer model of the town hall in Zamość was made with the use of Autodesk 3Ds Max software. The architecture of the building has been recreated in detail, along with small-sized details in the form of cornices and ornaments.

For the implemented computer model, lighting luminaires in LED technology with a total power of 3.9 kW were selected. The final concept of illumination is presented in Fig. 3. The model of the town hall in Zamość has been divided into several illumination zones for which lighting luminaires with different light curves have been selected.



Rys. 3. Final project of the illumination of the town hall in Zamość

A detailed computer model, the selection of appropriate photometric solids and their correct placement made it possible to implement the night lighting of the town hall, emphasizing its architectural values, while minimizing the imission effect of illumination on the surroundings of the building and limiting the phenomenon of lighting pollution.

4. Conclusions

High energy efficiency and limiting the phenomenon of lighting pollution define a properly implemented lighting design, incl. illumination lighting.

The paper presents issues related to the immission effect of illuminated objects.

With the use of computer calculation tools, simulation results were presented regarding the influence of factors influencing the phenomenon of lighting pollution: types of luminous intensity curves used for luminaires, distance and method of installation of luminaires.

Finally, in the 3Ds Max software, a detailed design of the illumination of the town hall in Zamość was made, for which the immission impact of the implemented illumination installation was determined.

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