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Monitoring of the subsequent LED lighting installations in Warsaw

Abstract. *LEDs are more and more frequently used for luminaire construction. Photometric parameters given by manufacturers (distributors) are neither complete nor reliable. As a result of the cooperation between ZDM in Warsaw and Lighting Division of the Warsaw University of Technology, arose the idea to verify such installations operating in practice. The next part of the trial street with experimental LED luminaires in Warsaw was selected for testing. The Lighting Division employees were monitoring the lighting conditions on the streets currently. The results of the investigations were reported in this paper.*

Streszczenie. *LED-y są coraz częściej wykorzystywane przy konstruowaniu opraw oświetleniowych. Parametry fotometryczne podawane przez producentów (dystrybutorów) są często niekompletne lub mało wiarygodne. Stąd w wyniku współpracy ZDM w Warszawie oraz ZTŚ PW powstała idea sprawdzenia jak zachowują się tego typu instalacje w praktycznym zastosowaniu. W Warszawie został wytypowany kolejny odcinek ulicy, na którym zainstalowano testową instalację, wykorzystującą LED. Pracownicy ZTŚ na bieżąco monitorowali stan oświetlenia wytypowanej ulicy. Wyniki przeprowadzonych badań zostały zawarte w niniejszym opracowaniu.* ***(Monitoring kolejnych instalacji oświetleniowych, wykorzystujących diody elektroluminescencyjne, w Warszawie).***

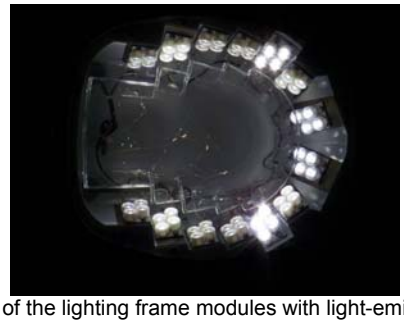
Keywords: LEDs, road lighting, verification procedures.
Słowa kluczowe: diody elektroluminescencyjne, oświetlenie drogowe, weryfikacja oświetlenia.

Introduction

In case of a lighting installation, only certain predetermined verification procedures (measurements) can evaluate reliability of the projects, quality of the applied lighting and correctness of their assembly. Verification measurements performed periodically make it also possible to check maintenance, during exploitation of the lights, of the required level of particular lighting parameters. This is especially meaningful in case of new road lighting LED-based installations, when experience connected with their usage is missing. These are the reasons for which we decided to take up this problem.

The choice and characteristics of lighting installation

As a result of cooperation of Zarząd Dróg Miejskich (ZDM) (Municipal Roads Authority) in Warsaw and Zakład Techniki Świetlnej (ZTŚ) (Lighting Division) of the Warsaw University of Technology, an attempt was undertaken to monitor the condition of lighting of a *test* lighting installation. ZDM chose new luminaires with light emitting diodes and selected the place of their installation – Karmelicka street in Warsaw. ZTŚ employees took to monitoring the condition of the lighting in the test fragments of the street at predetermined intervals.



Pic. 1. View of the lighting frame modules with light-emitting diodes

The new luminaires were mounted instead of the hitherto classic lights, which means that their arrangement was predetermined. Finally six luminaires with LED, offered by Tebis company, were installed.

The technical parameters of the luminaires and the street were as follows:

- type of the applied luminaires: LU4 (14 LED modules, 4 diodes in each module – all in all, 56 LEDs);
- power of the luminaire: about 100W;
- type of the road: single, two-lane, two-directional road;
- width of the street: W = 7 m, width of the lane: WL=3,5 m;
- system of localization of the lanterns: one-sided;
- space between the lanterns: S = 28,2 m;
- height of suspension of the luminaire: H = 9 m;
- protrusion of the luminaires into the road (overhang): O =1 m;
- angle of luminaire inclination: approximately s = 10°;
- type of asphalt : R3.

Methodology of the realized research

The stretch of the street on which the new lights were installed is presented in picture 2.

Measurements of the street lighting condition were conducted on basis of norm PN-EN 13 201:2007. The luminance distribution and illuminance were measured in accordance with the norm.

The measurement module was chosen between the second and third light, counting from Miła street towards Stawki street. The measurement prism was adopted according to the standard, i.e. on each lane there was a net of points 3 x 10.

Pic. 2. View of Karmelicka street illuminated with luminaires of LED type (six subsequent luminaires)

Results of the lighting monitoring

The measurements were conducted since July 2011 at approximately one month-long intervals. With a view to constancy of the reflexive properties of the street, monthly luminance measurements (excluding the initial ones) were given up and solely the illuminance measurements were continued.

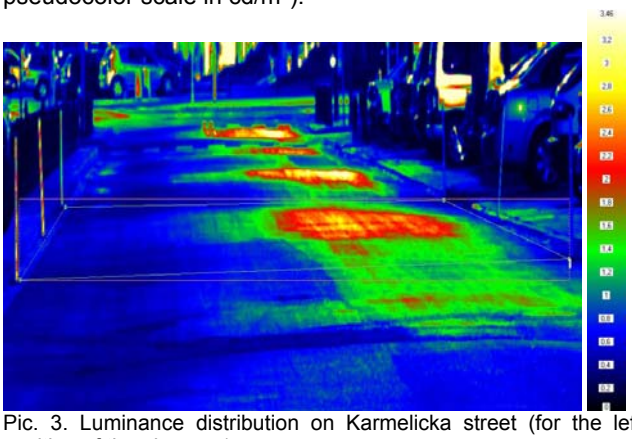
Table 1 contains a comparison of the results of photometric tests conducted for the given examined measurement section. The compared data include the

measurement date and the calculated values of average luminance and the average illuminance, as well as their uniformity.

Table 1. Results of the photometric tests for the given section (LED luminaire)

Date of measurements	Photometric measurements				
	Luminance			Illuminance	
	$L_{śr}$	δ_o	δ_o	$E_{śr}$	δ_E
	[cd/m^2]	[-]	[-]	[lx]	[-]
12.07.2011	1,54	0,37	0,47	15,63	0,56
17.08. 2011	-	-	-	15,56	0,56
06.09. 2011	-	-	-	15,64	0,56
05.10. 2011	-	-	-	16,05	0,56
04.11. 2011	-	-	-	16,36	0,57
27.03.2012	-	-	-	16,21	0,56
22.05.2012	-	-	-	15,24	0,58

Table 1 contains results of the measurements of: average luminance ($L_{śr}$), overall uniformity of luminance (δ_o) and the longitudinal uniformity of luminance (δ_1), as well as the average illuminance ($E_{śr}$) and its uniformity (δ_E).
Moreover, picture 3 presents luminance distribution on the street surface (for the left position of the observer) – the figure is accompanied by a luminance scale (on pseudocolor scale in cd/m^2).



Pic. 3. Luminance distribution on Karmelicka street (for the left position of the observer).

It was noticed that LED luminaires caused intrusive light appear on the building adjacent to the tested installation.

Analysis of the lighting research results

What can be observed over the period of a few months is constancy of photometric parameters of the examined lighting installation. A slight increase of the average illuminance (by over 5%) can be explained by a drop in the external temperature as it improves the operating conditions of light emitting diodes [7]. Next, in the spring period, a drop below the initial value, just like in the previous case, can be explained by an increase of the external temperature above the one in which the initial measurements were conducted. The slight increase of the lighting uniformity was connected with some staining (after a year-long period of exploitation) of the luminaire optical systems.

What was observed in case of the examined lighting installation was low luminance uniformity (especially longitudinal uniformity – below 0,4), which rules out the possibility of applying such luminaires on a street with similar geometrical and localization parameters– which is best illustrated in pic. 3.

What is more, considerable undesired light was also noticed – a strong light spot on a building remote from the street. Just like with previous monitoring cases [1], the luminaire was of a photometric block inappropriate for the given street fragment.

In addition, the need to check in laboratory conditions, photometric and electrical parameters before installation and after removal of LED lighting is recognized. This would allow to determine the change in light output and what quality of LED power suppliers were used in luminaire (because their quality varies considerably) [8]. The energy efficiency aspect of road lighting should also be taken into account. The potential [9] and dynamics [10] of lighting energy efficiency should be regarded and any analyzed lighting situation should be rated and classified with the help of a practical evaluation system, e.g. [11], of road lighting energy efficiency.

5. Summary

LED luminaires are a new and promising technical solution. They offer a range of advantages but they also have some drawbacks [2,3,4,5]. Despite constant improvements of their photometric and colorimetric parameters, from the point of view of proper light beam emission, optical systems used in such luminaires often make their application in street lighting (for given street parameters) impossible – as confirmed by the conducted measurements, which were part of the lighting monitoring program.

To sum up, before the decision to change the street luminaires is made, all arguments should be thought over thoroughly, based on objective factors – the best solution is to turn for assistance to independent research institutions which will help you make a rational decision.

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