Application of Modern Street Lighting with COB LED's

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Abstract
In recent years, the application of LED's in street lighting has increased significantly. At the same times are looking for ways to cut the costs of construction of street lighting fixtures for increasing they competitive in the proposed solutions for street lighting. The usage of COB LED's gives such an alternative.
The report presents the application of the developed street illuminator with COB LED's for street lighting. Lighting calculations are made for some typical lighting situations. There are made energy-economic comparison between conventional street lighting and LED street lighting with LED and COB LED. There are evaluated the advantages and disadvantages of various options. It was also stated application developed for a specific street lamp, and the parameters that are implemented.
Keywords: Street lighting; COB LED; LED Lighting.

Introduction

The application of LEDs and LED technology in street lighting in recent years has increased significantly. These new technological solutions are often with high price, making them unfavorable for investment. There are looking for ways to cut the cost of construction of street lighting, for they are competitive in the proposed solutions for street lighting. The advent of chip-on-board (COB) LED (fig. 1) provides such an alternative. They have the following advantages over classical construction of LEDs: the possibility of greater unit capacity; smaller size; direct integration on board; Lower price; better temperature management and etc.

Figure 1. Chip on board LED module

This work examines the application of the street luminaire designed with COB LEDs for street lighting. Lighting calculations are made for some typical lighting situations. There was made an energy-economic comparison between conventional lighting and LED street lighting with LEDs and COB LED. There are evaluated the advantages and disadvantages of various options. It was also stated application developed for a specific street lamp, and the parameters that have been realized.

Exposition

In Bulgaria street lighting in recent years mainly reconstructed. In most of the settlements lighting fixtures are replaced with more efficient, equipped mainly with sodium high pressure lamps, compact fluorescent lamps and LED sources.

The purpose of this work is to show a developed modern LED illuminator with COB LEDs and its application to a specific type of street.

Company, based in town of Ruse, with the help from the University of Ruse, has developed LED illuminator with use of COB LEDs, suitable glass optical system, finned aluminum casing and developed appropriate driver. The appearance of the luminaire is shown in Figure 2.

Figure 2. Luminaire "Vega 1" with COB LED

The illuminator has the following technical parameters:

Power	W	20 ÷ 50
Power factor	-	> 0.95
Power supply	V	190 - 250
Luminous flux	Lm	2100 ÷ 5250
Color temperature	K	5000
Color rendering index (CRI)	Ra	> 85
Temperature working range	^{0}C	- 35^0 до + 45^0
Internal Protection	IP	66
Lifetime	h	> 50 000
Case	-	Aluminum

For the developed luminaire, there was made: Light distribution curve; Cartesian diagram; Cone diagram, shown in Fig. 3.

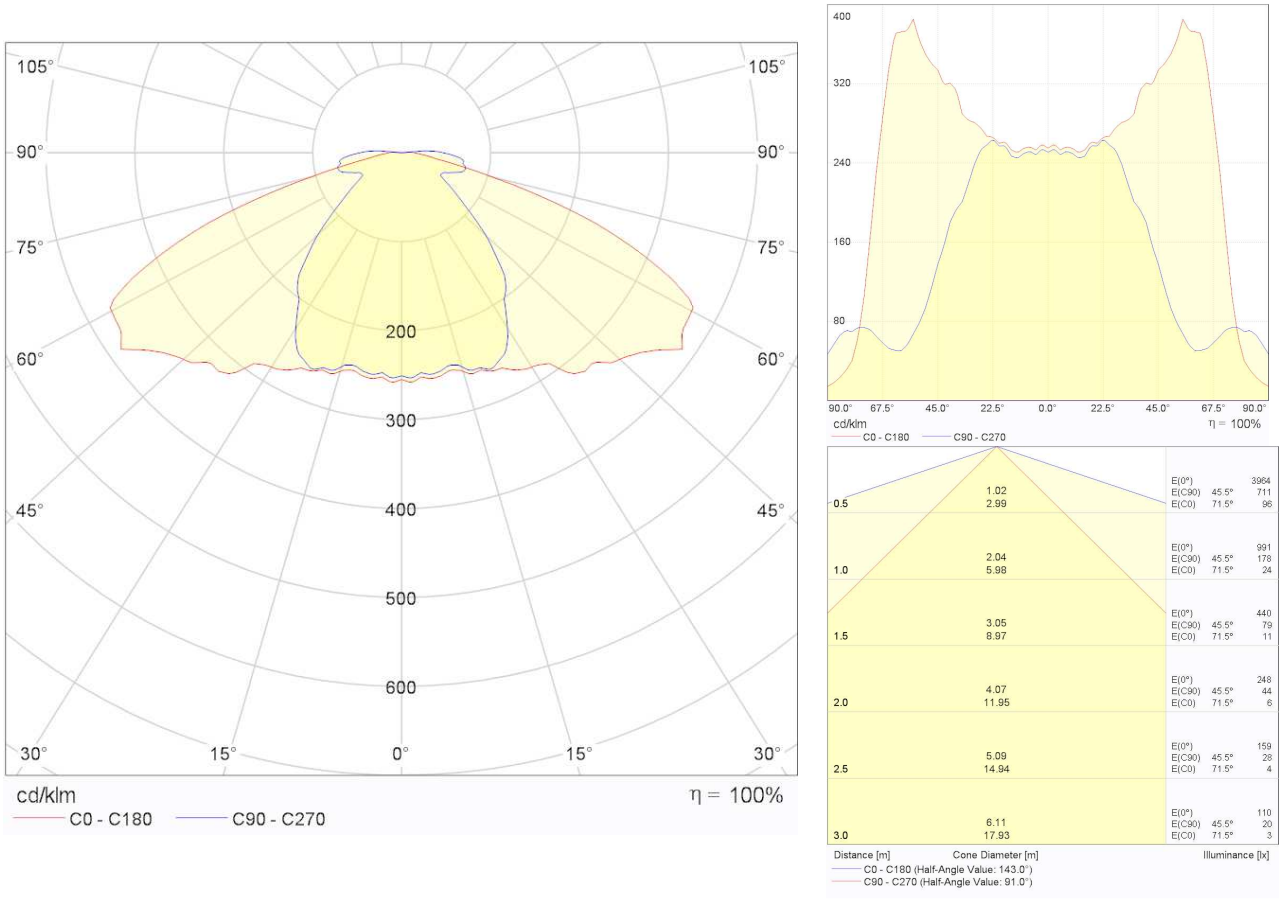

Figure 3. Light distribution curve, Cartesian diagram,
Cone diagram for Luminaire "Vega 1" with COB LED 30W

Developed luminaire is suitable for illumination of medium and small streets, as well as park areas and small open spaces.
In Bulgaria most of the streets in the settlements are similar and meet the conditions of light situation B1, lighting class ME5 or ME6.
In practice, in small settlements mainly streets meeting on the lighting class ME6. For him there was appearing in the standard norm these parameters:

- Average luminance of the roadway - L_{av} = 0,3 cd/m^2;
- General and longitudinal uniformity - U_O > 0,35; U_l > 0,4;
- Threshold index - TI = 15 %.

Typical parameters on roadway, corresponding to class ME6 are:

- Width of roadway - 6...7 m;
- Interpole - 25...30 m;
- Height of suspension luminaire (pillar) - 7...8 m;
- Distance from the edge of the roadway - 0,8 m;
- Console - 1 m.

To perform photometric calculations there are used the software Dialux 4.12. There was used data developed for the street illuminator and data from leading manufacturers of street lighting fixtures. There was made calculations for a specific street with use of various types of lighting fixtures. Figure 4 shows the stages of lighting calculations of the street lighting system.

There was selected a specific street in a little village with the following parameters:

- Width of roadway – 7 m;
- Interpole – 30 m;
- Height of suspension luminaire (pillar) – 7 m;
- Distance from the edge of the roadway – 0,8 m;
- Console – 1 m;
- Tilt angle of the luminaire – 15 °;
- Reflective pavement class – R3.

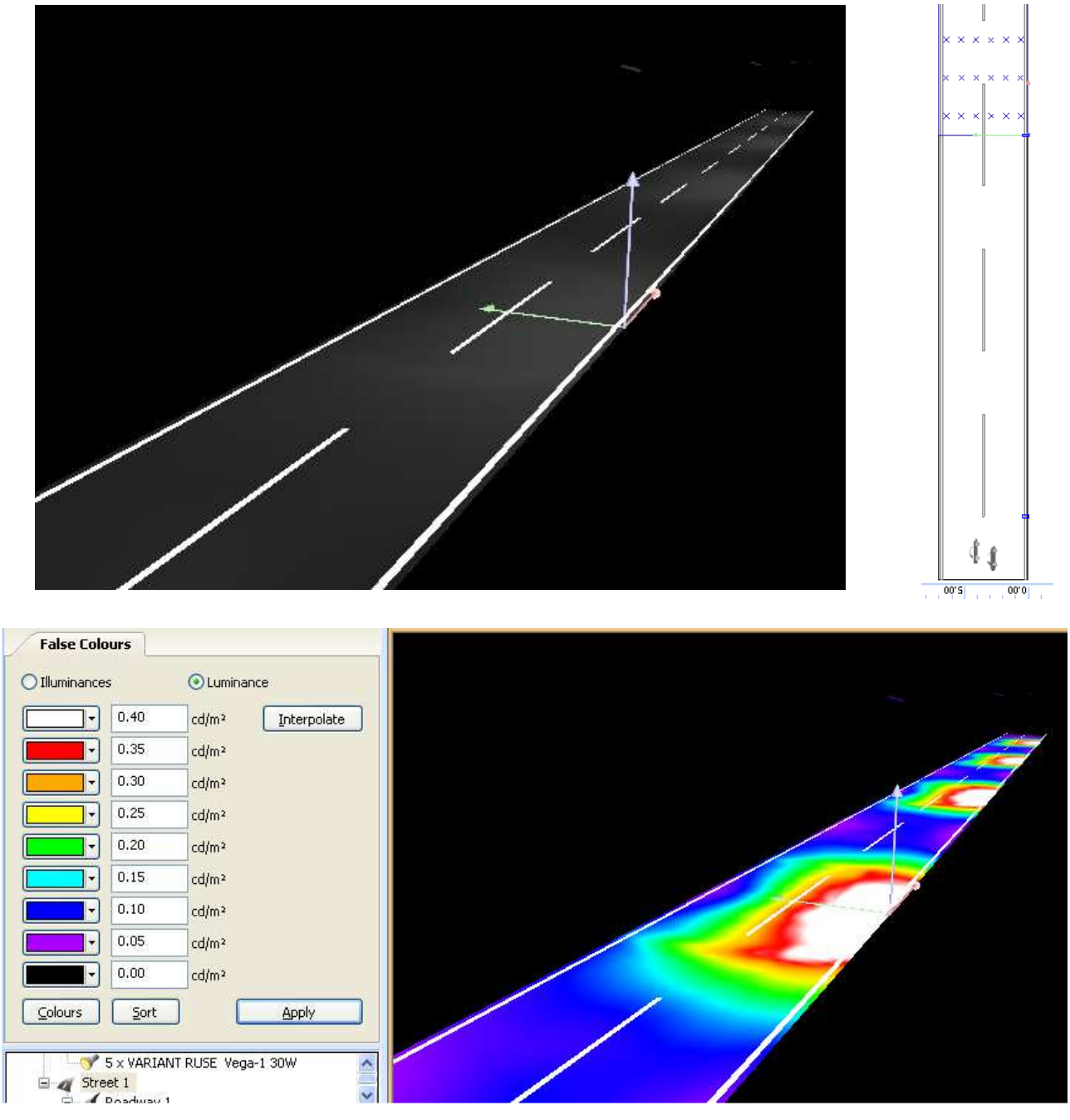

Figure 4. Stages of Lighting Calculation for Typical street

The calculated parameters for street lighting using different types of lighting illuminator are shown in Table 1.

Table 1

Results from photometric calculations for various light sources

Parameter	Luminaire CFL - 36W	Luminaire HPS - 50W	Luminaire LEDs - 30W	Luminaire COB LED - 30W
Average luminance of the roadway, Eav, cd/m^2	0,27	0,53	0,32	0,31
General uniformity, U_o	0,42	0,49	0,47	0,36
Longitudinal uniformity, U_l	0,48	0,59	0,42	0,42
Threshold index, TI, %	5	15	13	9

From the calculations there are shown that options with compact fluorescent lamps (CFL) and with high pressure sodium lamps (HPS), meets the requirements of the standard, but there are not optimal for a particular street. Better parameters are produced in variants with street lamps with LEDs and COB LED. Both variants are nearly identical and similar parameters and electrical power, so it is done and technical and economic comparison, the results of which are presented in Table 2.

Table 2

Energy-economic indicators of the street lighting system

№	**Indicators**	**Indicator values**		
		Luminaire HPS 50 W	**Luminaire LED 30 W**	**Luminaire COB LED 30W**
1	Number of lighting fixtures for street lighting	72	72	72
2	Installed electrical power of street lighting (includes the loss in ballasts or drivers), *kW*	4.320	2.225	2.225
3	Annual electrical energy consumption in street lighting, *kWh/ year*	18 580.32	9 569.73	9 569.73
4	Annual emission of greenhouse gases, *t/ year*	9.290	4.785	4.785
5	Investment for the replacement of lamps, *Euro*	5760	39600	21600
6	Average lifetime, *h*	15000	80000	50000

From table data there are shown, that economic cheapest option is to obtain luminaire with high pressure sodium lamps, but it annual electricity consumption is highest. Both variants with LED lighting fixtures are with similar parameters. It is obvious that it is more cost effective options is with COB LED as it is with a lower investment. The disadvantage is only a short lifetime on COB LED, but with average use of street lighting in the range of 4300 hours per year, receives about 12 years. It is assumed that the rapid development of technology will ensure that after 10 years, these illuminators are obsolete, i.e. replacement will be before they have exhausted their working resource.

Using the COB LED lighting fixtures, gives us additional advantages over sodium lamps:

- A better long life;
- A much better light color;
- Reduction of the emission of greenhouse gases;
- The possibility of smooth dimming;
- Other.

Conclusion

1. There was developed a street lighting luminaire with COB LED light source, with electrical power 20, 30, 40, 50 W, suitable for use in lighting of medium and small streets.
2. There was established a lighting class for most of the streets in the small towns of Bulgaria. It corresponds to classes ME5 and ME6.
3. For specific street there are designed some variants for street lighting with use of illuminators with sodium lamps, compact lamps, LEDs and COB LED sources. It turns out that variants with LEDs and COB LED sources are best and meeting on the regulatory requirements
4. It is done a technical and economic comparison between the developed variants and found that in nearly identical parameters, variant with COB LED sources is preferable and is given the low cost of the luminaire and thus lower investments.

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