About a method of improving lighting systems for roudabouts*

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Abstract. *In the introductory chapter are presented the norms and rules that form the basis of lighting systems design for roundabouts, both conventional and based on the concept of "**ecoluminance**". In the second chapter are described the underlying methods used in the theoretical study based on Dialux 4.11.0.2 lighting software, whose running results are discussed in the third chapter.*
Finally, the appropriate conclusions are mentioned.

Key words: lighting, roundabout, ecoluminance, conventional

1. Introduction

In recent years, in order to accomplish safer traffic conditions on public roads, engineers look for roundabouts instead of conventional crossroads, whenever possible.

Due to the fact that these crossroads represent traffic conflict areas, suitable lighting systems must be provided during the night.

The design for such areas have to be done in accordance with the Romanian norm **NP 062-2002 – Normativ pentru proiectarea sistemelor de iluminat rutier şi pietonal** and the European norm **CIE 115: 2010 Lighting of Roads for Motor and Pedestrian Traffic**.

The lighting system for a roundabout (fig. 1) must be done, conventionally, as follows: [1], [2]

- for roundabouts characterized by central island of small dimensions – like in the present case study – the lighting poles positioning is done outside the roundabout, preferably on the green spaces, in order to achieve a correct visual guidance; the roundabout must be provided by one access only, due to safety road requirements;
- for roundabouts characterized by central island of large dimensions, as well as for wider roads, an inside positioning of lighting poles is allowed.

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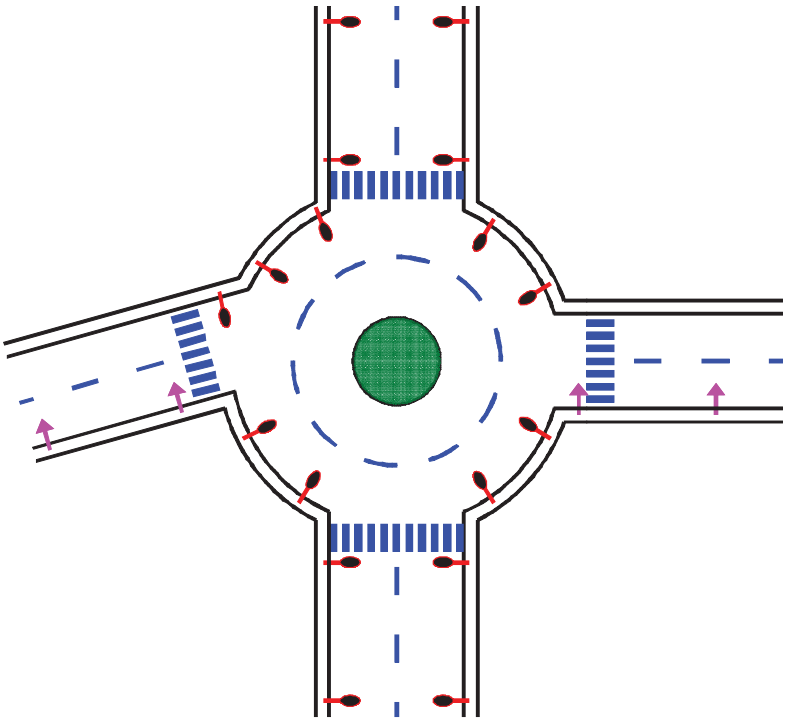

Fig. 1. Lighting system for a roundabout

No matter the roundabout type, the lighting system for such a road intersection has to meet the following requirements:

- to warn in good time the driver about the roundabout presence and, at the same time, to get a correct visual guidance, able to allow the driver to perceive any car approaching the crossroad from another direction, as well as to detect the various geometries (roundabout or any other object related to it).
- to mark properly the traffic signs.

However, problems referring to design lighting systems for such traffic conflict areas are superficially dealt by the decision - making factors, even if lighting engineers, road enginners and urbanist proposed solutions are technically and estetically accurate.

Thus, during the night, especially when traffic values are high and weather conditions are inappropriate, taking also in account violation of traffic rules (running faster than normal), the risk of accidents is significantly increased.

Figure 2 presents an incorrect lighting system for a roundabout (it can be noted that only one luminaire in the top of a lighting pole is present in that crossroad), so the visual guidance doesn't exist and consequently, although reduced, the risk of accident persists particulary during evening and night or if bad weather conditions occur.

Fig. 2. Incorrect lighting system for a roundabout, situated at DN7 to DN71 crossroad

The formerly presented lighting systems are based on utilization of road luminaires equipped with metal vapors (sodium or mercury) at high pressure discharge lamps, illuminance being kept at the same levels all evening and night long, no possibility of dimming being taken into consideration and therefore without considering a saving energy method.

The purpose of this paper is to apply "**ecoluminance**" concept in order to optimize the lighting system for a new designed roundabout.

This concept was developed by an American scientific team from Rensselaer Polytechnic Institute and takes into consideration the following four elements: [3]

- the vegetation from interesting areas (especially the vegetation situated in the central island, mainly in front of the vehicle entrances);
- retroreflective traffic signs;
- the architectural lighting system, based on saving – energy luminaires and characterized by low levels of illuminance and luminance;
- pedestrian lighting system (if applicable), also based on saving – energy luminaires (LED luminaires).

The endpoint is to prove that by applying the "**ecoluminance**" concept in designing lighting systems for roundabouts, a lot of advantages will be obtained in contrast with lighting systems based on conventional method of design:

- a superior aesthetics, by improving the surrounding vegetation;
- an enhanced functionality, by obtaining a better visual guidance;
- important electrical energy savings.

2. Method

In order to accomplish the purpose of the experiment, on one hand, and on the other hand taking into account the difficulty of lighting calculation, an adequate free software, named ***Dialux Professional 4.11.0.2***, will be used.

By using it, the designer can simulate all the architectural shapes of the roundabout (roadways, pavements, central islands and green areas). Besides, it can allow the designer to provide vegetation (grass, bushes, trees of various heights) especially for central island, retroreflective traffic signs and, of course, the desired lighting system, which can be later improved.

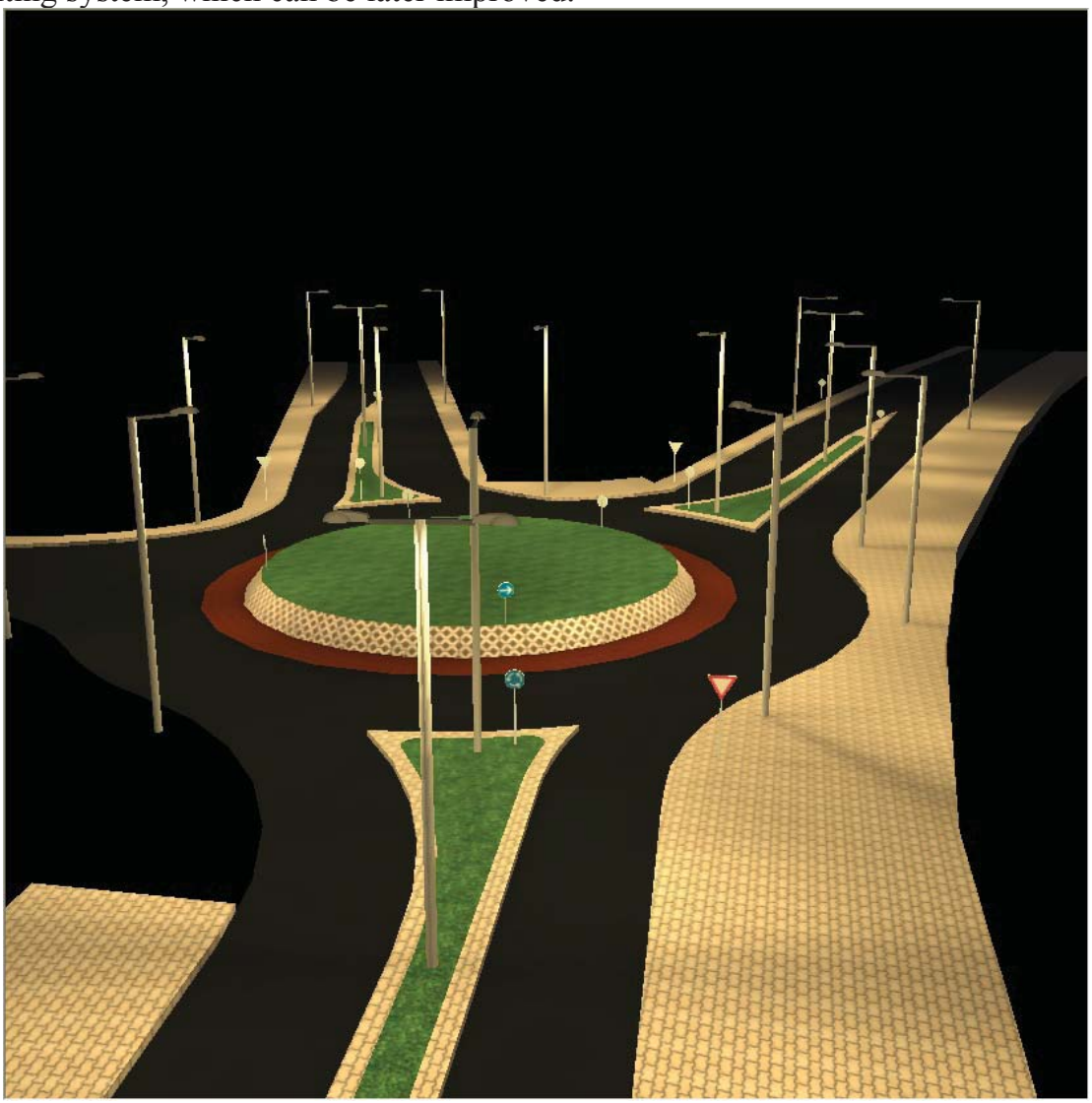

Fig. 3. Dialux simulation of a conventional lighting system for a roundabout

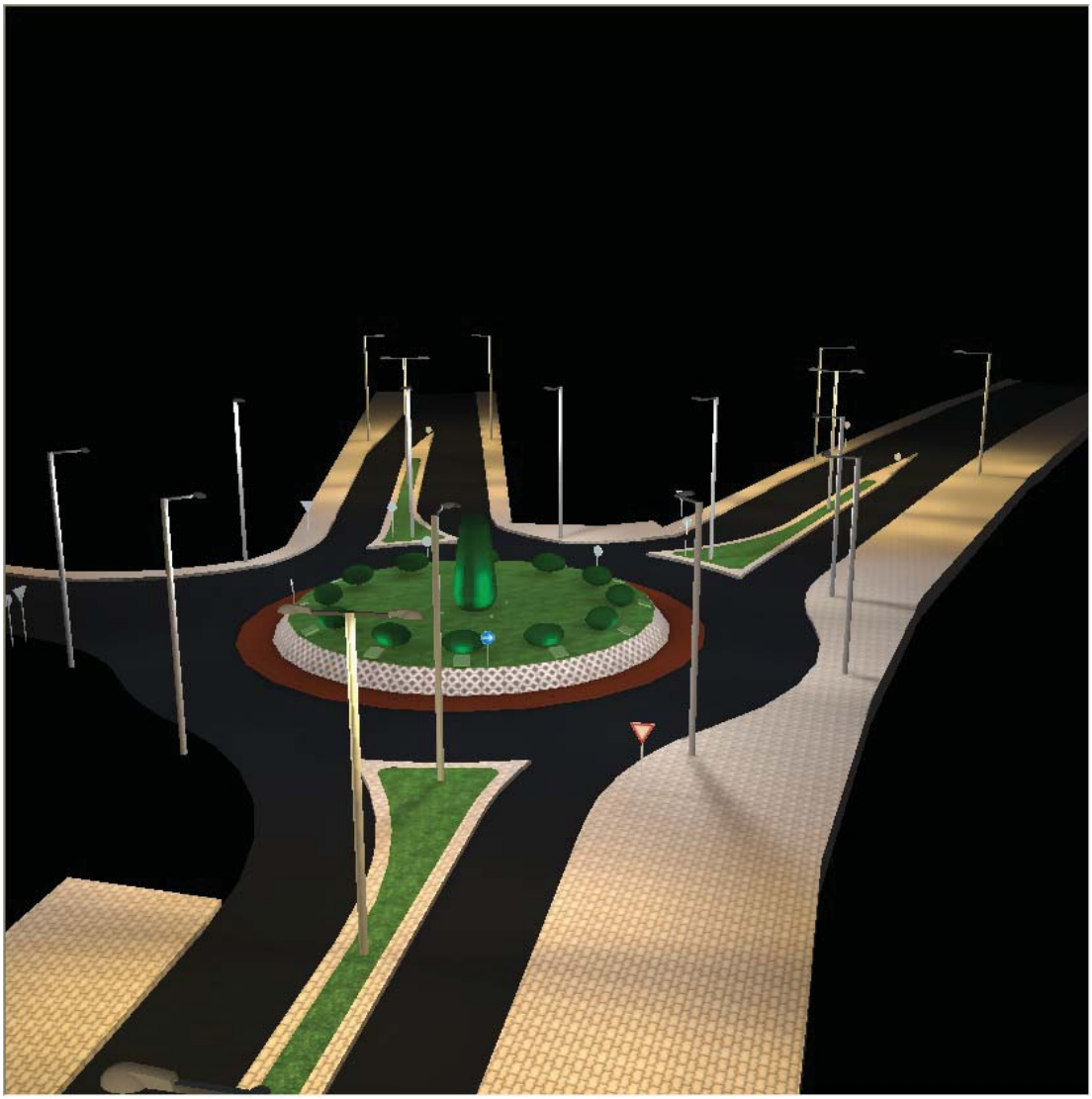

Fig. 4. Dialux simulation of a roundabout lighting system based on "ecoluminance" concept

It will be considered the two formerly described situations, noting that in this project there is no pedestrian crossing within the roundabout, hence there is no specific pedestrian lighting system around the crossroad:

A. Conventional lighting system (fig. 3);

B. Lighting system based on "ecoluminance" concept (fig. 4).

Concerning the conventional lighting system, a minimal configuration of vegetation is used (grass for central island and other green areas) and the road luminaires will be equipped with sodium high pressure discharge lamps of 150 W power (type **PHILIPS Idman 611HGV FG 1xSON-T150W TP P25X)**, 10 meters height**.** Strictly for roundabout lighting system, a number of 10 of such road luminaires are used.

Concerning the lighting system based on "**ecoluminance**" concept, the vegetation elements will be supplemented as follows (bushes and trees included in Dialux database):

- shrubs with oval crown (bushes covered with rich foliage), round (circular) placed at a distance of about 2 m between their centers and the central island circumference, the distance between the centers of two bushes being of about 4 m; shrub dimensions – maximum length 2,25 m, maximum width 1,5 m and maximum height 2,125 m.

- a central positioned tree, with a truncated crown, of dimensions: maximum length 2,25 m, maximum width 2,25 m and maximum height 6 m.

The luminaires that form these lighting systems are type **ELBA Wall Washer LED 15x1 W arh. ext.** for circular placement shrubs (one luminaire per bush), **ELBA RONDO-01-35W striation glass** for central positioned tree (4 pcs.) [4] and 10 road luminaires type **PHILIPS BGP340 1xLED110S/640 DM**, equipped with LED 110S/640/-, that replace the 10 road luminaires type **PHILIPS Idman 611HGV FG 1xSON-T150W TP P25X** used by the conventional solution**.**

3. Results and discussion

Several of the most important results obtained after running ***Dialux Professional 4.11.0.2*** are presented in table 1.

Table 1

Results obtained after running Dialux Profesional 4.11.0.2

Physical quantity and interesting area	Conventional lighting system	Lighting system based on „ecoluminance" concept
Average roadway illuminance, E_{mcar} (lx)	**19**	**17**
Maximum roadway illuminance, E_{maxcar} (lx)	**66**	**53**
Average sidewalk illuminance, E_{mtr} (lx)	**9...17**	**8...16**
Maximum sidewalk illuminance, E_{maxtr} (lx)	**47...62**	**47...53**
Average roadway luminance, L_{mcar} (cd/m^2)	**0,3**	**0,26**
Maximum roadway luminance, L_{maxcar} (cd/m^2)	**1,05**	**0,84**
Average sidewalk luminance, L_{mtr} (cd/m^2)	**1,55...3,23**	**1,49...3,02**
Maximum sideway luminance, L_{maxtr} (cd/m^2)	**8,76...12**	**7,93...9,99**
Total electrical power for the roundabout lighing system only W)	**1690**	**1372**

As a general rule, in order to obtain values similar or close – in both cases – for illuminance and luminance levels, the lighting system based on „**ecoluminance**" concept is more „saving – energy" than the conventional one (about 20%).

But a further improvement of the lighting system based on „**ecoluminance**" is also possible, so greater energy savings are expected.

All these results must be, obviously, confirmed by measurements, but this will become feasible only at the moment of the first practical implementation of a lighting system based on the "**ecoluminance**" concept.

Some areas of interest couldn't be verified by the software – especially bushes and trees that form the vegetation.

Another problem consists in using real species of plants. Dialux does not contain complex shapes of vegetation, but these plants can be imported through various file types. Among them, the most used is 3D Studio Max (*.3ds) type.

Unfortunately, Dialux has problems when trying to import *.3ds files. Only a very limited quantity of electronic information can be imported and this operation needs a very long time in order to be carried out, even using multicore CPUs.

Briefly, at this moment of software development, Dialux is not able to use realistic vegetation.

4. Conclusion

Using "**ecoluminance**" concept in solving the lighting systems for roundabouts represents a step ahead of both improving traffic safety and saving energy.

Besides road and lighting engineering contributions to create better conventional lighting systems for roundabouts, using "**ecoluminance"** involves also the urbanist in an attempt to get better traffic conditions and a more beautiful town.

Authors consider that the approach based on the "**ecoluminance**" concept will gain ground and that solving lighting systems for roundabouts in this way will have positive effects – in terms of functionality, aesthetics and economy.

However, the "ecoluminance" does not represent, for the time being, a concept to be used for lighting systems in Romania.

References

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