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Conflict areas on the roads which are illuminated by public lighting

***Abstract**. The paper presents complications during designing of the lighting systems in conflict areas. It solves the problems of maintenance too. The paper is aimed to power saving possibilities in connection with different lighting conditions. The paper describes possibilities of different optic systems with various lighting sources. The power savings are demonstrated on the current real examples of lighting systems which were measured by luminance analyzer.*

***Streszczenie.** W artykule opisano różne systemy optyczne I różne źródła światła w układach oświetlenia przestrzeni publicznych. Analizowano sytuacje konfliktowe oraz możliwości oszczędności energii elektrycznej. (**Sytuacje konfliktowe drogi oświetlanej przez publiczne systemy oświetlenia**)*

Keywords: Luminaire, Public lighting, Power savings, LED, Optic system, Light source, Conflict area.
Słowa kluczowe: oświetlenie publiczne, źródła światła, oświetlenie drogi

Introduction

Safety in the conflict areas, e.g. pedestrian crossings, requires good lighting conditions. The luminaires with a relatively high output are frequently used because of fulfil these conditions.

Nowadays, when the market is saturated with a varied range of types of luminaires and lighting sources, designers and managers of public lighting can choose that luminaire, which will be able to illuminate well the conflict areas and also reducing the energy consumption of lighting systems. These two requirements are often contradictory and the right choice requires the analysis of parameters of luminaire and also of illuminated area.

This paper is aimed to clarify the issue of power savings while maintaining the quantitative and qualitative requirements.

The possibilities of optic lighting systems

Light distribution is the most fundamental parameter of luminaire. Based on this information, we see how the luminous flux is distributed to the illuminated area. In the area of pedestrian crossing we need to create a sufficient vertical component therefore we often place luminaires in front of pedestrian crossing in the direction of incoming vehicle. With this location it is the most appropriate to use that luminaire which has the maximal radiated flux to the direction of incoming vehicle.

Fig.1. Photography of pedestrian crossing – luminaire MACH1

Fig 2: Luminance analysis of pedestrian crossing – luminaire MACH1

The reference pedestrian crossing was chosen for the demonstration of possibilities of power saving. Luminaire MACH AS MACH1-250HQIT/SYM/L with a poor asymmetry is installed in the direction of incoming vehicle and THORN Areaflood 150W A/A with a modified light distribution for pedestrian crossings (front and side asymmetry). The luminaires are installed in the same positions.

This conflict area is situated in the street Doktora Malého in Ostrava. The pedestrian crossing is located ahead of roundabout and one part of this pedestrian is crossed with a bicycle path. Luminaire MACH1 ASYM 250W illuminates the pedestrian crossing.

Table 1: Evaluation of pedestrian crossing – luminaire MACH1

		LUMINARE Switch ON			LUMINARE Switch OFF		
		L	L_{min}	L_{max}	L	L_{min}	L_{max}
		(cd/m^2)	(cd/m^2)	(cd/m^2)	(cd/m^2)	(cd/m^2)	(cd/m^2)
1	Pedestrian	**2.39**	0.39	10.87	**0.70**	0.14	2.18
2	Background	0.52	0.14	2.94	0.53	0.14	2.51
3	P. crossing	2.11	0.42	4.09	0.46	0.26	1.71
Contrast (-)		**3.60**			**0.32**		

The luminaire which has just forward distribution of luminous flux was used in considering of the first conflict area. After analysis this luminaire was dismantled and replaced by THORN Areaflood A/A 150W.

Fig 3: Photography of pedestrian crossing – luminaire Areaflood

Fig 4: Luminance analysis of pedestrian crossing – luminaire Areaflood

Table 2: Evaluation of pedestrian crossing – luminaire Areaflood

		LUMINARE Switch ON			LUMINARE Switch OFF		
		L	L_{min}	L_{max}	L	L_{min}	L_{max}
		(cd/m^2)	(cd/m^2)	(cd/m^2)	(cd/m^2)	(cd/m^2)	(cd/m^2)
1	Pedestrian	**2.51**	0.06	11.57	**0.52**	0.03	7.96
2	Background	0.49	0.02	6.12	0.45	0.01	7.20
3	P. crossing	2.24	0.16	6.23	0.63	0.12	1.39
Contrast (-)		**4.12**			**0.15**		

When using the floodlight it is suitable to use the optics with the side asymmetry. When using the luminaire with a lower input but with the side asymmetry optics we kept the same lighting parameters as the original luminaire.

In the choice of a light source we focus on output, the luminous flux, because the quantitative values should be sufficient. From a qualitative point of view we prefer the colour temperature because the temperature should be much higher than the colour temperature of light sources in the surrounding luminaires. For an example three types of light sources are described. The most common type of light sources in luminaires is the high pressure discharge metal halide lamp. The newest type of light sources in luminaires is LED light source. And sometimes we meet with an induction lamp.

The high pressure metal halide lamp

This considered conflict area is situated in Čeladná in the district Frýdek – Místek. The roundabout is located at the end of village near the church and railway station. This roundabout consists of only one traffic lane. The lighting system of pedestrian crossing is made up street luminaires – THORN Civic Peco 150W which are always located on the right side in each traffic lane

Fig 5: Photography of pedestrian crossing – metal halide lamp

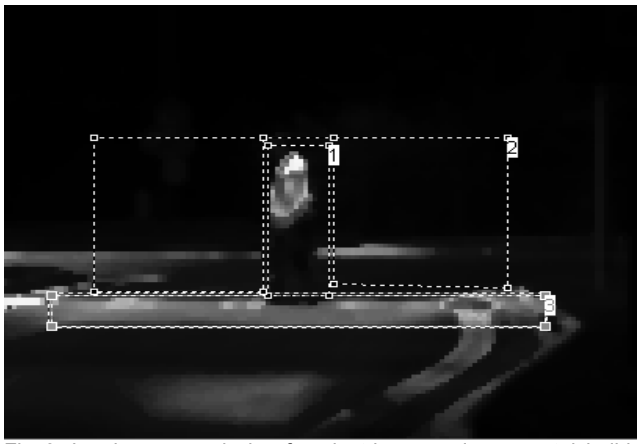

Fig 6: Luminance analysis of pedestrian crossing – metal halide lamp

Table 3: Evaluation of pedestrian crossing – metal halide lamp

		LUMINARE Switch ON			LUMINARE Switch OFF		
		L	L_{min}	L_{max}	L	L_{min}	L_{max}
		(cd/m^2)	(cd/m^2)	(cd/m^2)	(cd/m^2)	(cd/m^2)	(cd/m^2)
1	Pedestrian	**2.87**	0.52	12,10	**1.16**	0.29	4.85
2	Background	1.22	0.15	4,70	1.09	0.08	5.45
3	P. crossing	3.93	1.66	8,16	1.26	0.31	2.74
Contrast (-)		**1.35**			**0.06**		

In this pedestrian crossing using this type of luminaire is necessary because when the luminaire is switch off the luminance of pedestrian and background is almost identical. The value of contrast is around zero and this value highlights the poor lighting conditions. When switching on luminaire the increase of luminance occurs more than double. When using a luminaire with a high pressure metal halide lamp the visual conditions improve.

The luminance analysis was performed with a figurant, who was dressed in bright clothes with a high reflectance in the upper body and at the bottom in dark pants with a low reflectance. The measured figurant was located in the centre of pedestrian crossing (in the both axes).

LED

This considered conflict area is situated in Havířov in the street Okružní. This pedestrian crossing is located in the undeveloped part of city near the bus station. The light system of pedestrian crossing consists of street luminaire iGuzzini ZETAC, 45 x 1.2W which is located only in one traffic lane.

Fig 7: Photography of pedestrian crossing – LED

Fig 8: Luminance analysis of pedestrian crossing – LED

Table 4: Evaluation of pedestrian crossing – LED

		LUMINARE Switch ON			LUMINARE Switch OFF		
		L	L_{min}	L_{max}	L	L_{min}	L_{max}
		(cd/m^2)	(cd/m^2)	(cd/m^2)	(cd/m^2)	(cd/m^2)	(cd/m^2)
1	Pedestrian	**0.78**	0.05	4.35	**0.37**	0.02	2.35
2	Background	1.25	0.05	9.96	0.60	0.04	2.13
3	P. crossing	0.28	0.04	2.36	0.28	0.03	2.34
Contrast (-)		**1,79**			**0.31**		

The additional light system does not influence the luminance of background from the view of incoming driver. This luminance is near 0.28 cd/m^2.

In the situation with switching off the additional light system the average measured luminance of figurant and roadway near the pedestrian crossing is almost identical and is about luminance of 0.45 cd/m^2.

In the situation with switching off the additional light system the measured contrast of figurant against background is 0.3. It means that this figurant and background do not show contrast and figurant blends into background.

In the situation with switching on the additional light system the measured contrast of figurant against background is higher. The value of positive contrast is 1.7 it is at the boundary of differentiation of human eye. The additional light system to improve contrast contributes a very little. The value of contrast should be at least 3.

Induction lamp

This considered conflict area is situated in Havířov in the street u Nádraží. The pedestrian crossing is located in the part of city with residential houses and close to supermarket. The light system of pedestrian crossing consists of floodlight luminaire LVD 0553-3 120W. The luminaire is located in the front part of pedestrian crossing. Between the traffic lanes there is a safety island.

Fig 9: Photography of pedestrian crossing – induction lamp

Fig 10: Luminance analysis of pedestrian crossing – induction lamp

Table 5: Evaluation of pedestrian crossing – induction lamp

		LUMINARE Switch ON			LUMINARE Switch OFF		
		L	L_{min}	L_{max}	L	L_{min}	L_{max}
		(cd/m^2)	(cd/m^2)	(cd/m^2)	(cd/m^2)	(cd/m^2)	(cd/m^2)
1	Pedestrian	**2.31**	0.06	19.61	**0.80**	0.06	4.59
2	Background	1.62	0.21	7.87	0.85	0.13	2.99
3	P. crossing	0.29	0.06	8.85	0.28	0.06	10.12
Contrast (-)		**7.09**			**1.88**		

The luminance analysis was performed with a figurant, who was dressed in bright clothes with a high reflectance in the upper body and at the bottom in dark pants with a low reflectance. The measured figurant was located in the centre of pedestrian crossing (in the both axes).

From the view of incoming driver the additional light system does not influence to the luminance of background. This luminance is about 0.28 cd/m^2.

In the situation with switching off the additional light system the average measured luminance of figurant and roadway near the pedestrian crossing is almost identical and is about 0.8 cd/m^2.

In the situation with switching off the additional light system the measured contrast of figurant against background is 1.8. It means that this figurant is visible against background in a positive contrast against the boundary of differentiation of human eye.

In the situation with switching on the additional light system the measured contrast of figurant against background is much higher. The value of positive contrast is 7 it is very good. However we have to consider that the figurant stands in the centre part of pedestrian crossing. If the figurant stand is in the beginning of pedestrian crossing the measured contrast will be the same as original values without additional light system.

The comparison of inputs and parameters of lighting while the luminaire is on

Table 6: Comparison of lamps parameters

Lamp	Power (W)	Pedestrians Luminance (cd/m^2)	Contrast (-)
Metal halide	*170*	2.87	1.53
LED	*57*	0.78	1.79
Induction lamp	*120*	2.31	7.09

Conclusion

The selection of appropriate luminaire and light source must be thought out carefully. From the measured data it could be stated that significant savings formed by using more quality optical part of luminaire.

For luminaires with different light sources the luminaire with metal halide lamp will provide the most quality conditions. The luminous flux is distributed uniformly to whole pedestrian crossing. For luminaire with induction lamp occurred the highest increase of the luminance of figurant but unfortunately the maximum values are only in the centre of pedestrian crossing. In the case that a pedestrian cross pedestrian crossing at the start the values are minimal. A luminaire with LED light sources has very small light distribution. Just the central axis of pedestrian crossing is illuminated. For this luminaire for quality lighting of pedestrian crossing the inadequate light parameters were measured.

Possible alternatives to high pressure metal halide lamp have lower input but the lighting requirements are not sufficient.

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