TWENTY-SEVENTH INTERNATIONAL SYMPOSIUM – LIGHTING ENGINEERING 2019

# The influence of pavement reflectance on energy efficiency of lighting

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## Introduction

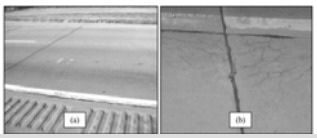
- Standard r-table, defined by the International Commission on Illumination (CIE)
- The amount of pavement reflectance can be described with parameters:
  - $Q_0$, average luminance coefficient
  - S1, mirror factor
- Types of pavement used in calculations:
  - Concrete
  - Asphalt

## R table

| Class | Standard S1 | S1 range | $Q_0$ |
|---|---|---|---|
| R1 | 0.25 | < 0.42 | 0.10 |
| R2 | 0.58 | 0.42 < S1 < 0.85 | 0.07 |
| R3 | 1.11 | 0.85 < S1 < 1.35 | 0.07 |
| R4 | 1.55 | > 1.35 | 0.08 |

## Previous research

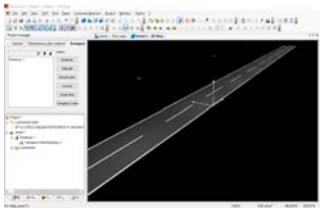
- Change of already existing standard?
- Pavements used in past vs pavements used nowadays
- The paving material should be light and diffuse
  - Luminance coefficient $Q_0$ should be high
  - Mirror (specular) factor *S1*



## Problem definition

- Reflectance of different pavements
- Road surface luminance values and luminance uniformity change easily as pavement surface physical state changes
- Used: fifteen different luminaires
  - luminance approximately 1 $\mathrm{cd/m^2}$;
  - two-lane roadway of 7 m width;
  - operation time of luminaires in Slovenia is approximately 4200 hours;

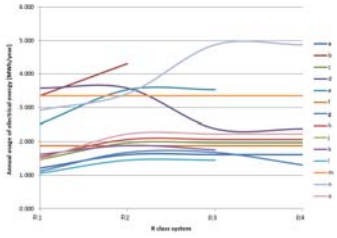
## Problem explanation using DIALux 4.13



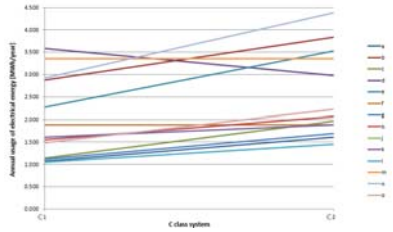
## Calculated results for luminaire "SITECO 5XB26G1B108C Streetlight 20 mini LED

| | Number of luminaires | Luminaire wattage [W] | Lav [cd/m2] | U0 | UI | TI [%] | Eav [lx] | Emin/ Emax | uo | [MWh/year] |
|---|---|---|---|---|---|---|---|---|---|---|
| **R1** | 9 | 32 | 1,00 | 0,73 | 0,90 | 4 | 10 | 0,526 | 0,767 | 1,210 |
| **R2** | 12 | 32 | 1,02 | 0,61 | 0,91 | 5 | 15 | 0,559 | 0,735 | 1,613 |
| **R3** | 12 | 32 | 1,03 | 0,53 | 0,92 | 5 | 15 | 0,559 | 0,735 | 1,613 |
| **R4** | 12 | 32 | 1,04 | 0,47 | 0,91 | 5 | 15 | 0,559 | 0,735 | 1,613 |
| **N1** | 9 | 32 | 1,00 | 0,73 | 0,90 | 4 | 10 | 0,526 | 0,767 | 1,210 |
| **N2** | 12 | 32 | 1,06 | 0,63 | 0,92 | 5 | 15 | 0,559 | 0,735 | 1,613 |
| **N3** | 12 | 32 | 1,03 | 0,53 | 0,92 | 5 | 15 | 0,559 | 0,735 | 1,613 |
| **N4** | 12 | 32 | 1,01 | 0,46 | 0,94 | 5 | 14 | 0,551 | 0,739 | 1,613 |
| **C1** | 8 | 32 | 1,04 | 0,65 | 0,84 | 4 | 11 | 0,473 | 0,737 | 1,075 |
| **C2** | 12 | 32 | 1,05 | 0,52 | 0,84 | 6 | 16 | 0,526 | 0,719 | 1,613 |

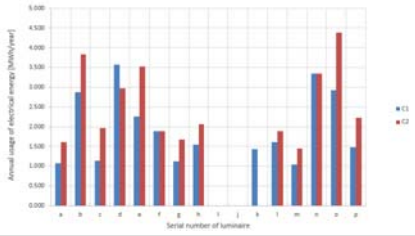
## Annual usage of electrical energy for lighting the road



## Annual usage of electrical energy for lighting the road



## The relation between annual usage of electrical energy for lighting the road, while considering the road surfaces concrete (C1) and asphalt (C2)



## Conclusion

- The paving material should be light and diffuse!
- Road lighting energy savings.
- Consider using dynamic road lighting system (which has already been tested in Finland).