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STUDY THE ABERRATIONS INFLUENCE ON THE ILLUMINATION DISTRIBUTION

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In the area of non-imaging optics using the aberration theory is rare because there is no obvious connection between the required light distribution and aberrations' value. The advantage of designing according to the aberration theory is the speed of calculations. In previous works, we have shown how to apply the third-order aberrations theory to the collimating TIR lens design. In the current study, we analyze more general cases (converging and diverging beam of rays) and the illuminance and intensity distribution through the illuminated area for different variants of aberration correction of a lens.

Introduction. The aberration theory is mainly used for evaluating optical performance of imaging systems. Only small number of cases of non-imaging systems is elaborated for using the aberration theory in design, and as a rule, simultaneous multiple surface (SMS) or ray-mapping methods are used for non-imaging optics working with LED. However, it has been shown that applying to split the LED wide beam into zones together with the theory of aberration may give a high-efficiency solution for the collimating TIR lens. Hence, aberration theory may have the great potential to be applied in non-imaging design and have the guiding significance for lighting design.

Main part. In this work, we study the aberration effects on the illuminance distribution for more general cases such as converging and diverging beams. Designing based on the aberration theory and the aberrations correction using modern optical design software gives a fast result. However, this way for non-imaging area has one disadvantage which is that the influence of the aberration correction onto the illumination (illuminance and luminous intensity) is not direct and not studied enough. In the work, we analyze lighting performance from the point of view of illuminance and intensity according to a various magnification of a lens. Moreover, we consider several possible aberration corrections: correction only of spherical aberration, correction of coma, correction of both aberrations (aplanatic). It is worth noting that we consider a thick lens that can play the role of a central zone in the lens used for achieving the required illuminance distribution.

Conclusions. Results of the study form a basis for generating a starting point of non-imaging systems working with LED. Several variants of the lens with magnification of +1.5, +2, +4, and +8 were analyzed. Comparative analysis has shown that the correction of spherical aberration for the magnification of +2, +4, and +8 have a good optical performance especially the uniformity on the illuminated target with a Lambertian LED.

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