

광루사 방법을 이용한 가로등 디자인 개선

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Improved Road light Design using Ray-tracing method

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Abstract

In this study, it was studied about the improved road light design for drivers and pedestrians using ray- or reverse ray-tracing method. Many of conventional road lights are not suitable for drivers and pedestrians because it has some serious problems such as glare effect or randomness of illuminated areas. It was oriented from customary design method which was pointed at simple target such as luminance or electrical power. But it was not truth any more that the high luminance or electrical power consumption mean more bright and good road light. We studied ray-tracing method for road light reflector design to get the several goals. It means that good road light has easy for drivers and pedestrians eyes and illuminating objects on the road clearly. So, we set the design targets such as uniformity on the road area per one road light, shading angles and continuous luminance uniformity on the long distance road. We designed ideal road light conditions using ray-tracing method. We set the height of drivers and pedestrians eyes and calculated design guideline to make above design targets. Then we designed road light reflector using reverse ray-tracing method. And we achieved same luminance on the road almost half power consumption because we reduced loss of light. We achieved ideal design guide as 75 degrees of shading angles and 0.5 of luminance uniformity on the road area. Finally, we suggested reflector design for 250 watts power consumption CDM light source.

Keywords: Road light, ray-tracing method, shading angles, luminance uniformity

1. 서 론

Recently, it is very important that energy saving application in the public facilities. Most of public electrical power consumption is light for drivers or pedestrians on the road during night time. Many of conventional road light has been powered up because more convenient road condition for drivers and pedestrians. It is really important that drivers recognize objects on the road during night time because it prevents traffic accident. But vehicle's head lamp is not sufficient for generating required luminance. So that, many of

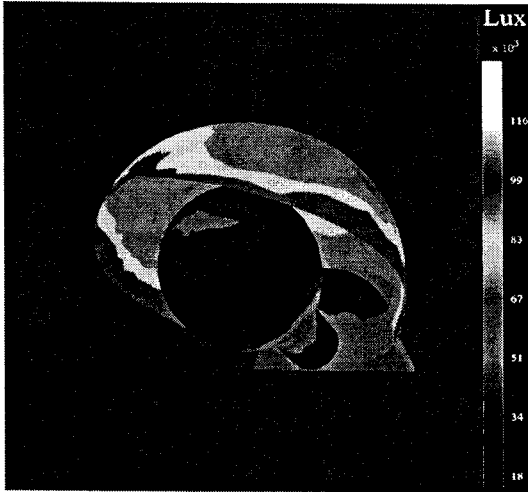
countries set the standard guide in road light luminance. Therefore, it is not always true that more bright light cause safer road condition. It is more important that well-tuned road light for drivers and pedestrians must be installed actual road circumstance. It means proper energy consumption and easy for human eyes. Many of road light is tuned high power consumption because it came from serious misunderstood such as brighter road light mean safer road condition. Besides, brighter road light focused on the developing high power consumption lamp and required circuit system. But it is more important that optimized lamp reflector design bring to low power consumption and proper luminance condition on the road.

We investigated optimized lamp reflector design using ray-tracing method¹⁾. It shows that optimized lamp reflector cause definite energy saving effects such as 250W CDM lamp is capable to 400W sodium lamp application. We designed half-bowl shaped reflector and improved it. It is investigated that the curves of luminance at 180 degrees view and realistic luminance simulation on the road. And we presented optimized reflector design based on the half-bowl shape.

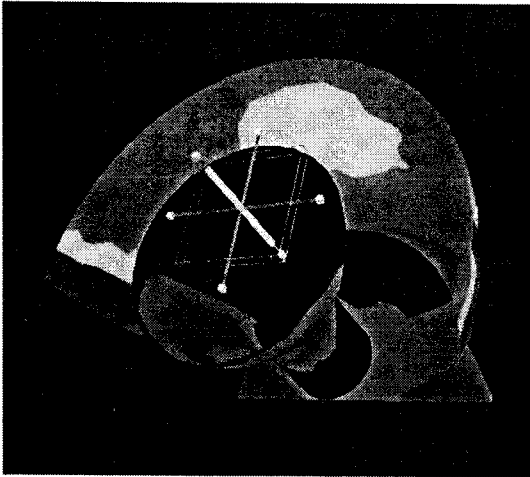
At last, we calculated road condition and uniformity of road. It shows that using optimized reflector, road brightness uniformity is improved²⁻³⁾. We set the several road light, and then investigated continuous road brightness uniformity condition⁴⁾.

2. 본 론

Using ray-tracing method, we designed conventional half-bowl shaped lamp reflector and calculated brightness characteristics on the road. Figure 1 shows traditional design such as bowl shaped basic reflector of road light. Figure 1 shows the role of reflection on the reflector parts, and Figure 2 shows that the brightness on the right bottom of designed road light. And Figure 3(a) and (b) show horizontal and perpendicular brightness curve on the illuminated road. It is clearly recognized from figure 3, luminance of central point is 17 Lux and brightness averages counted 6.7 Lux. Based on the Figure 1, it is most serious defect such as edge part of opening side. It is displayed red colour and it means this edge part has many reflection light from CDM lamp

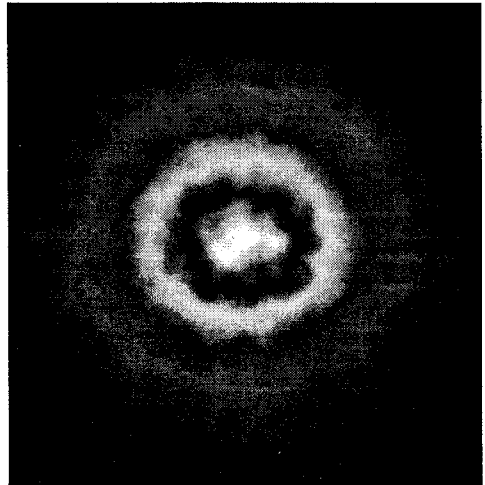


(a)

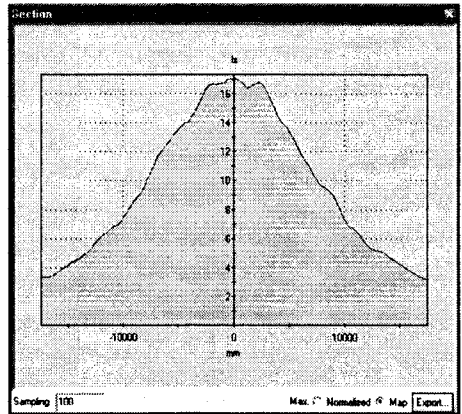


(b)

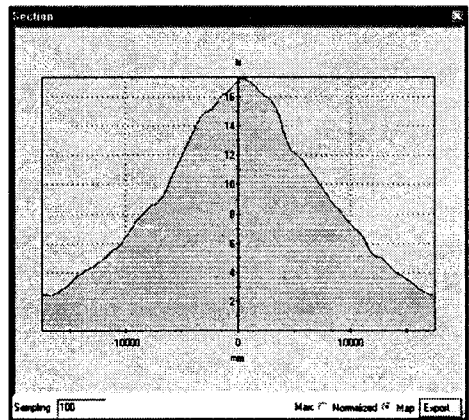
<Figure 1> Conventional lamp reflector design ;
 (a) Main mapping design, (b) cutting images of design



<Figure 2> Brightness characteristics on the road surface



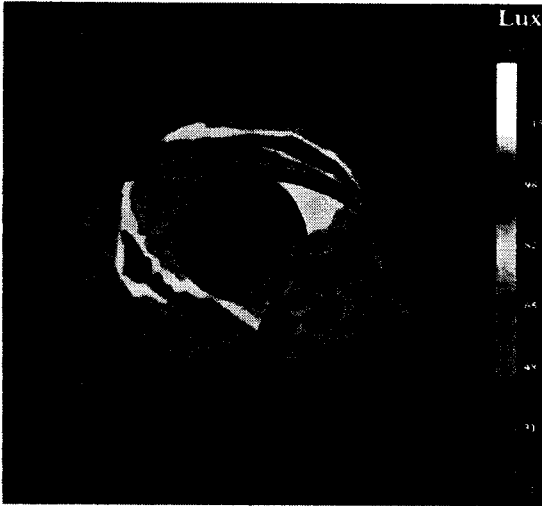
(a)



(b)

<Figure 3> Brightness curves on the road surface ;
 (a) Brightness curve at horizontal direction,
 (b) Brightness curve at perpendicular direction

And then we improved above design in the edge parts. It is changed con-shaped edge shape and it is good role to send light to the road surface. Figure 4 shows improved design. And Figure 5 and Figure 6 show improved brightness characteristics on the road surface. As optimized design using ray-tracing method, it is dramatically rise up at 40 Lux of central luminance and 8.7 Lux of average brightness. It shows that the improvement of lamp reflector is major elements at road light design.

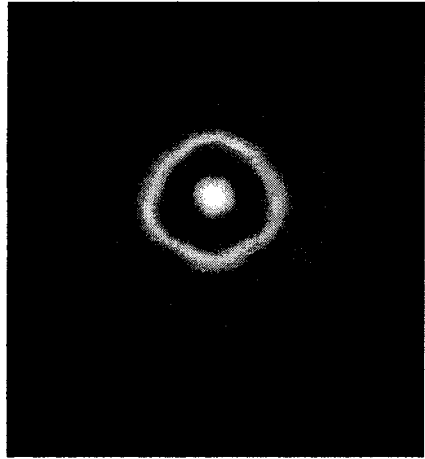


(a)

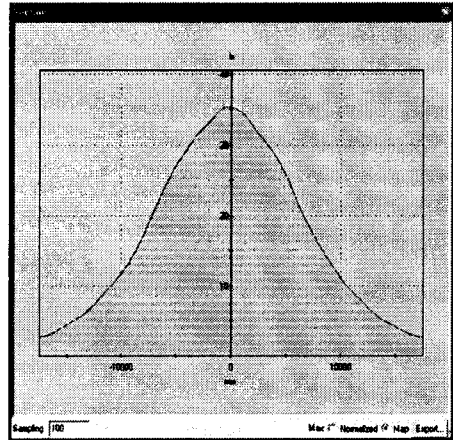


(b)

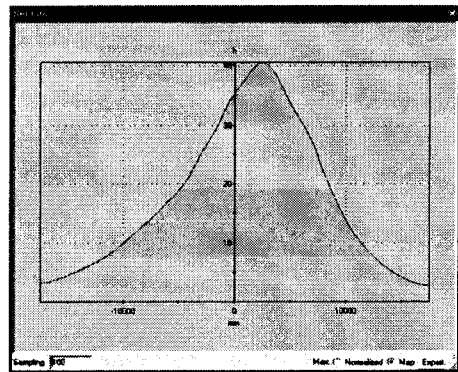
<Figure 4> Optimized lamp reflector design ;
 (a) Mainmappingdesign,(b)cuttingimagesofdesign



<Figure 5> Brightness characteristics on the road surface



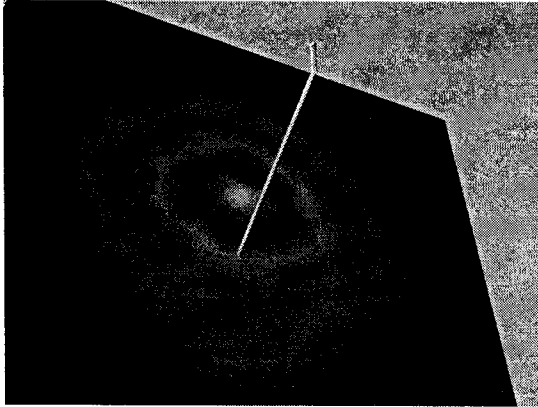
(a)



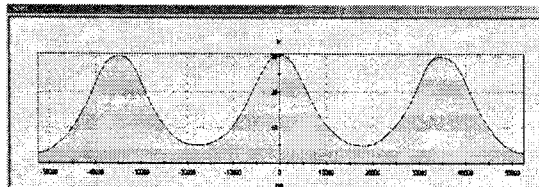
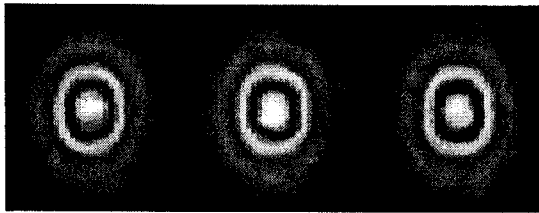
(b)

<Figure 6> Brightness curves on the road surface ;
 (a) Brightness curve at horizontal direction,
 (b) Brightness curve at perpendicular direction

At last, we investigated actual installation simulation. Figure 7 shows brightness characteristics on the road surface. Road light was set the height of 12 meter and 2meter of distance of pole to light. And road surface set the 35meter * 35 meter. And Figure 8 shows brightness uniformity of road surface at several road lamp installed 35meter intervals.



<Figure 7> Brightness characteristics of road surface



<Figure 8> Brightness uniformity at 3 lamps installed 35 meter intervals

We investigated road light improvement design using ray-tracing method. First, we presented improved lamp reflector shape design in the edge shape of reflector and it cause significant improvement result such as 40 Lux of central brightness in traditional half-bowl shape reflector. And it was good result of improvement average brightness and at the same time. At last, we presented simulation result at actual road condition and reviewed uniformity of several road light installed condition.

3. 결 론

As a result, Using optical simulation such as ray-tracing method, it is very significant method of road light reflector design. And it means that low energy consumption is able to design high efficiency reflector design. So that, optimized road light design is necessary elements of energy saving and improvement road circumstance at the night time.

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