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LIGHTING INSTALLATIONS IN A POOR VISUAL RANGE**

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STUDY ON IMPROVEMENT OF LOW POSITION ROAD LIGHTING INSTALLATIONS IN A POOR VISUAL RANGE

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Abstract

Low position road lighting installations are effective to prevent collapse and drop of ancillary road facilities in the event of accidents and disasters, provide ease of inspection and produce less light pollution. From these factors, they have become a mainstream of road lighting system taking the place of lighting poles. This paper reports the advantages of Low position road lighting installations demonstrated by operational experiments in a poor visual range.

Keywords: low position road lighting, roadside lighting, poor visual range, glare,

1 Key considerations

In a poor visual range such as in dense fog or heavy rain, irradiation from road lighting installations may produce veiling effects, resulting in a further decline in visibility. Low position road lighting installations that are mounted on a lower position emit considerably less light in space, namely producing less veiling effects as compared with lighting poles. In addition, a shorter distance between each lighting installation provides ease of recognition of road alignments. Strengthening these advantages of Low position road lighting installations may contribute to enhanced driving safety at high speed.

With this in view, this paper conducted operational experiments with the aim of finding the best combination of color temperature and luminous intensity distribution in a poor visual range.

2 Experiments and results

2.1 Steps of experiments

(1) Preliminary experiment 1 Period: February 28, 2018, Place: National Traffic Safety and Environment Laboratory (Law Visibility Test room)

(2) Preliminary experiment 2 Period: June 5, 2018, Place: Chuo Expressway, up-line (on an obsolete road near Dangozaka Service Area)

(3) Experiment Period: August 7-9, Place: Japan Automobile Research Institute (Specific Environment Laboratory)

2.2 Details of experiments

(1) Preliminary experiment 1

[Objective] Evaluation of the visibility of the preceding vehicle, white line in different color temperatures in a poor visual range.

[Equipment] Low position road lighting installations: 3 units (at a distance of 6 m respectively), upward luminous flux: 2.6%

[Conditions]

- Environmental conditions: Visual range in fog: 10 m

- Color temperature: 5000 K, 4000 K, 3000K

- Lighting conditions: Ordinary lighting and roadside lighting (see Figure 1,2)

[Measurement items] Horizontal illuminance, vertical illuminance, veiling luminance and visual range

[Evaluation method] Subjective evaluation of color temperature and glare of lighting installations at a standstill (10 lighting engineers)

Figure 1 – Cross-sectional view of two different lighting conditions (Ordinary lighting and Roadside lighting)

Figure 2 (1) – Ordinary lighting (visual range: 50 m)

Figure 2 (2) – Roadside lighting (visual range: 100 m)

(2) Preliminary experiment 2

[Objective] Verify glare and flickering on actual roads in normal visual range.

[Equipment] Low position road lighting installations: 10 units (at a distance of 6 m respectively), upward luminous flux: 2.6%

[Conditions]

- Environmental conditions: Nighttime

- Color temperature: 5000 K

- Lighting conditions: Ordinary lighting and roadside lighting (see Figure 1,2)

[Measurement items] Horizontal illuminance and vertical illuminance

[Evaluation method] Subjective evaluation of glare and flickering under driving conditions (10 lighting engineers)

(3) Experiment

[Objective] Evaluate effective lighting conditions in a poor visual range

[Equipment] Low position road lighting installations: 17 units (at a distance of 6 m respectively in a lighting section of 96 m), upward luminous flux: 1.2%

[Conditions] As shown in Table 1

[Evaluation method] Subjective evaluation of visibility of preceding vehicle, recognition of road alignments and flickering from lighting installations in a visual range of 50 m/100 m (10 lighting engineers)

Table 1 – Experiment evaluation conditions

	weather conditions		lighting system	luminance, Illuminance
Nighttime	Fog	Visual range of 50 m	Ordinary	1,0/0,5cd/m ²
		Visual range of 100 m		
		Visual range of 50 m	Roadside	25 /60lx
		Visual range of 100 m		
	Rain	30mm/h	Ordinary	1,0/0,5cd/m ²
			Roadside	25 /60lx

2.3 Results of evaluation

(1) Preliminary experiment 1

No differences were observed in visibility (preceding vehicle, white line) in a poor visual range between color temperatures.

It was verified that roadside lighting had a capability of reducing veiling effects significantly as compared with ordinary lighting and of improving visibility of a tail lamp of preceding vehicle and roadside white lines.

(2) Preliminary experiment 2

It was found that adverse effects on visual appearance of the driver were caused by trespass of a small amount of light into the vehicle from lighting installations (with upward luminous flux ratio of approx. 2.6%) that had no glare issues in standstill experiment.

(3) Experiment

1) Nighttime fog

a) Visibility of preceding vehicle

In subjective evaluation, ordinary lighting (1,0 cd/m²) had slightly better results in a visual range of 50 m. In a visual range of 100 m, however, there were no significant differences between the two types of lighting installations (Figure 3 (1) and (2)).

From the evaluation opinions, the roadside lighting (60 lx) got favorable feedback such as “affording high visibility of a tail lamp of preceding vehicle”.

b) Recognition of road alignments

In subjective evaluation, the luminaires on the roadside lighting installations provided a longer visible distance approximately by 20% than others in the visual range of 50 m (Figure 4).

From the evaluation opinions, the roadside lighting (60 lx) got favorable feedback such as “making a roadside clearly visible” and “affording high visibility of white lines.”

c) Glare

In subjective evaluation, all luminous intensity distributions produced “almost no annoying glare” (Figure 5). From the evaluation opinions, the roadside lighting was advantageous in reducing glare. But, even on the ordinary lighting installations, the luminaires with strictly restricted upward luminous flux produced favorable results.

2) Nighttime rain

In subjective evaluation, Ordinary lighting is slightly better than roadside lighting for the appearance of the preceding car (Figure 6). But, water splashes by driving vehicles and veiling effects could not be replicated. In a video taken on an actual road after the subjective experiment, strong veiling effects were caused by water splashes in rainfall of 20 mm per hour (Figure 7).

Figure 3 (1) – Visibility of preceding vehicle (visual range: 50 m)

Figure 3 (2) – Visibility of preceding vehicle (visual range: 100 m)

Figure 4 – Recognition of road alignments (visual range of 50 m)

Figure 5 – Glare (visual range of 50 m)

Figure 6 – Visibility of preceding vehicle (in rainfall of 30mm/h)

Figure 7 – Water splashes by a driving vehicle in actual road

3 Conclusion

Low position road lighting installations with strictly restricted upward luminous flux not only contribute to environmental conservation and prevention of glare, but also reduce veiling effects in foggy weather etc., providing higher visibility.

Under veiling effects in nighttime dense fog, sufficient roadside lighting (60 lx) brings the effects to provide “better recognition of road alignments” and “higher visibility of a tail lamp of preceding vehicle and white lines.” It is deemed appropriate that color temperature is set uniformly to 5000 K in view of the continuance from tunnel lighting and luminous efficiency based on the results of preliminary experiments.

On actual expressways, however, there are local irregularities in the density of fog and in the intensity of rain and it is difficult to set and manage uniform thresholds according to a visual range and a rainfall per unit time. Therefore, it is advisable to switch from ordinary lighting to roadside lighting in line with designation of speed limit segments (50 km per hour) in foggy or rainy weather in nighttime.

In conclusion, we would like to express our sincere gratitude to Professor Toru Hagiwara, Hokkaido University for his advices and suggestions for this study.

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