International Journal of Engineering Science Invention
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 6 Issue 11|| November 2017 || PP. 35-39

Review of optimal road surface luminance considering dazzling by headlight of the car running in the opposite direction

Wonbum Cho
Senior Researcher, Korea Institute of Civil Engineering and Building Technology, Korea
Ph.D. Student, Department of Transportation Engineering, University of Seoul, Korea
Corresponding Author: Wonbum Cho

ABSTRACT: *Appropriate road surface luminance shall be provided by roadway lighting for the drivers to recognize the alignment at a certain distance for the safety at night. Luminance of road surface when no median strip is available shall be granted taking into account of dazzling and low visibility due to headlight of the car on the opposite lane. This study thus is intended to analyze the optimal luminance of road surface which allows the driver to recognize the alignment ahead at the high beam condition by the car running in opposite direction. Consequently, 75% of the subject could recognize the alignment 22m ahead when road surface brightness was 0.25cd/㎡ and 85% of them could recognize when the brightness was 0.42 cd/㎡. The outcome of this study is expected to make commitment to determining the road surface illuminance that will secure the road safety at night.*

KEYWORDS: *Nighttime, Visibility, High-beam, UC-WinRoad, Threshold Increment*

Date of Submission: 27-10-2017 Date of acceptance: 09-11-2017

I. INTRODUCTION

Roadway lighting is intended to provide the drivers at night with visual information to recognize the obstacles. That is, it's ultimately aimed at providing the drivers with visual information so as to recognize and avoid the dangerous factors such as obstacles ahead. Drivers visually obtain more than 90% of information necessary for driving on road and thus visibility on road at nighttime is closely related with traffic accident. Viewing from such a point, roadway lighting that will provide the drivers with good visibility is an ideal solution in mitigating the traffic accident at night.

Appropriate level of road luminance shall be provided by roadway lighting for the driver to recognize the alignment change from a certain distance for the safety of the drivers. Luminance of road surface when no median strip is available shall be granted taking into account of dazzling and low visibility due to headlight of the car on the opposite lane. This study thus is intended to evaluate the optimal luminance of road surface which allows the driver to recognize the alignment ahead at the high beam condition by the car running in opposite direction through the test with the subject.

II. METHOD AND PROCEDURE OF THE STUDY

In this study, simulation was conducted in a way that the car running on opposite lane ran with headlight on at high beam using the road and headlight simulator so as to identify the distance where the driver recognized the alignment change and the curve while the subject is driving the straight alignment.

1) Implementation of high beam TI (Threshold Increment) of the car running in opposite direction

Visibility was applied at same level by comparing real high beam and headlight simulator TI(Threshold Increment, dazzling index)

①Measuring and analyzing with TI every 10m by headlight condition (high & low beam) of opposing car at 10~110m distance

※ Using luminance meter (LMK, German TechnoTeam) at driver's eye height(1.2m)

②Displaying the road image from road driving simulation program (UC-WinRoad) on OLED TV and headlight simulator comprising of 2 COB(Chip on Board) type LEDs is mounted on opposing car.

③ Setting headlight simulator TI same as maximum TI analyzed in ①

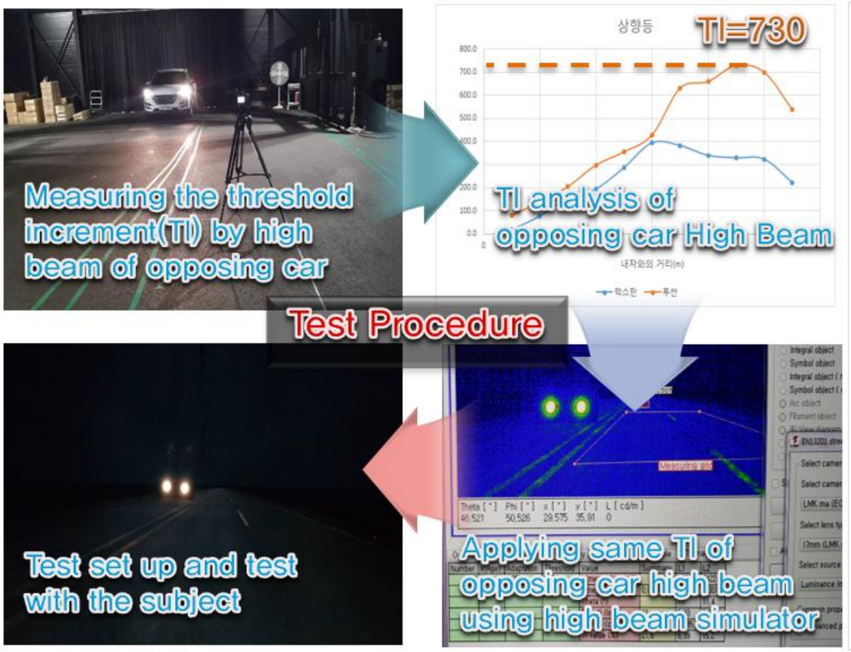
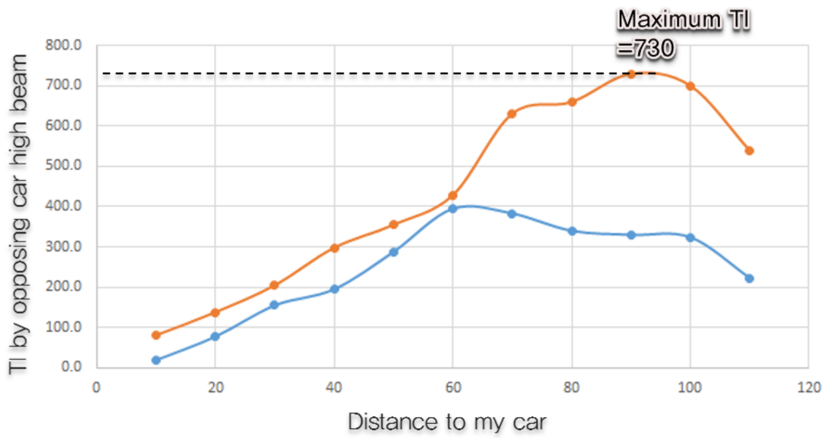


Fig. 1 TI determination procedure at high beam condition of opposing car

TI of RV 1 was higher than RV2 and maximum TI of RV 1 was 730 measured at 90m high beam condition. Based on this, TI by headlight of opposing car to be applied to the test finally was determined as 730.

Table 1 Real car TI analysis result

Distance (m)	Low beam		High beam	
	RV1	RV2	RV1	RV2
10	3.2	2.5	81.0	18.9
20	6.4	4.4	138.0	77.4
30	13.0	6.8	205.0	155.0
40	6.2	6.2	298.0	195.0
50	2.9	5.5	355.0	288.0
60	2.9	4.4	429.0	395.0
70	2.7	4.6	631.0	383.0
80	2.9	4.1	660.0	340.0
90	1.7	4.3	730.0	330.0
100	1.8	2.5	700.0	324.0
110	1.5	2.2	539.0	223.0



Distance to my car

Fig. 2 Real car TI analysis result (high beam)

2)Realization of road surface luminance

Road surface luminance, 0.05, 0.1, 0.25(M6), 0.5(M5), 1.0(M3), 1.5(M2) and 2.0(M1) cd/㎡ were selected for the test. Road luminance displayed on TV was varied by adjusting the brightness of roadway lighting in road driving simulation program (UC-WinRoad) and road luminance of the road (one lane) on which the subject is driving was measured and analyzed using luminance meter so as to implement the road luminance for the test.

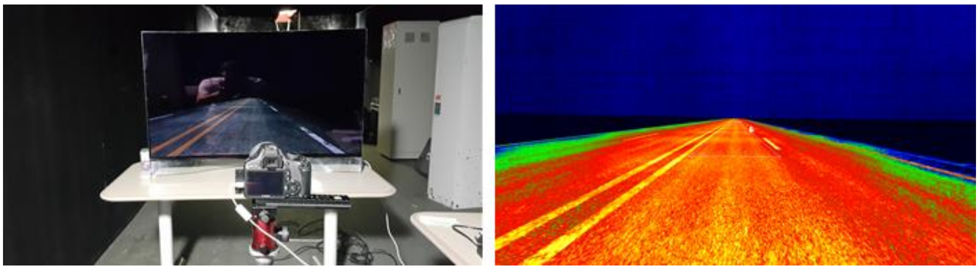


Fig. 3 Road luminance measurement and analysis method

3) Driving test to determine the standard road luminance

Geometric structure and road luminance were realized by implementing road driving simulation program (UC-WinRoad) and TI (high beam) by opposing car at high beam condition was realized by implementing headlight simulation so as to conduct the test with the subject. The conditions for the test were set as follows.

- Geometric structure: straight length 700m, 11 sections with plane curve radius 280m

※ lane curve radius 280m corresponds to minimum plane curve radius of the roadwith design speed 80kph

-Road luminance condition: 0.05, 0.1, 0.25(M6), 0.5(M5), 1.0(M3), 1.5(M2) and 2.0(M1) cd/㎡ were applied in sequence.

- TI condition : Maximum high beam value (TI 730) was maintained till 500m ahead of curve ~ curve start point

- Conditions of the subject: 84 subjects, at ratio of driver's license by age

※ Number of the subject by age: 5(20s), 12(30s), 16(40s), 20(50s), 29(60s) and 2(70s).

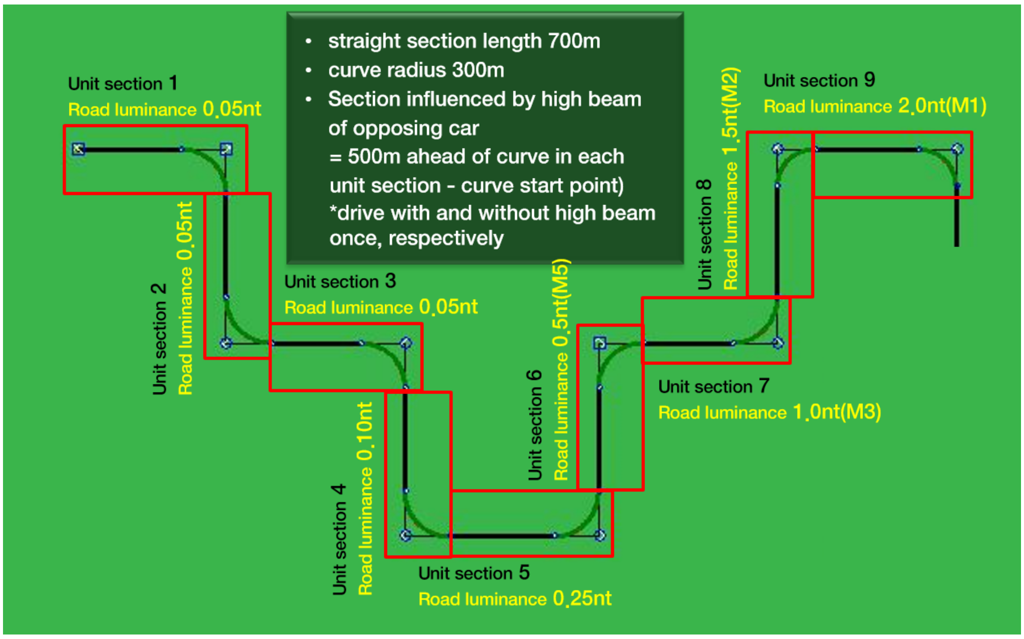


Fig. 4 Configuration of the test to determine the optimal road luminance to recognize the alignment change ahead

The test was conducted according to following procedure.

- The subject put the brake upon recognizing the curve ahead while driving at 80kph and notified the test operator of the curve direction.
- When curve direction notified to the test operator was correct, distance to curve is measured using braking point recorded in simulation program.

※ The subject conducted the test with and without high beam condition once, respectively, and the test result without high beam was used as the base for reduction of the subject.

III. ANALYSIS OF THE RESULT

Distance to recognize the alignment (curve) ahead was analyzed by road luminance level using driver's braking point. As a result of analysis with the running distance of 22m (80kph) for a second to handle the steering wheel after braking as the base for determining the optimal road luminance,

- When influenced by high beam of opposing car: 75% of the total subject when road luminance was 0.25 cd/㎡ or more and 85% of the subject when road luminance was 0.42 cd/㎡ recognized the alignment change from 22m ahead

※ Which is similar with the road luminance M6(0.3 cd/㎡) and M5(0.5 cd/㎡)

※ Road luminance M6 is the requirement in CIE roadway lighting criteria, but not in domestic standard.

- When not influenced by high beam of opposing car: 75% of the total subject when road luminance was 0.05 cd/㎡ and 85% of the subject when road luminance was 0.13 cd/㎡ or more recognized the alignment change from 22m ahead.

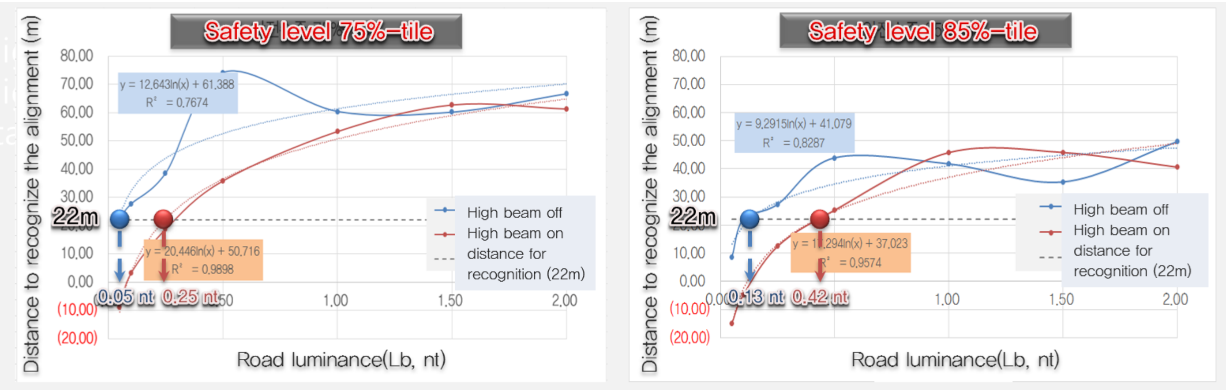


Fig. 5 Analysis of optimal road luminance to recognize alignment change ahead

IV. CONCLUSION

In this study, driving test using the simulator to determine the optimal road luminance that allows torecognize the alignment change ahead at the high beam condition of opposing car was conducted. Consequently, 75% of the total subject when road luminance was 0.25 cd/㎡ or more and 85% of the subject when road luminance was 0.42 cd/㎡ recognized the alignment change from 22m ahead. 22m corresponds to the running distance for a second for handling the steering wheel at 80kph. The ratio of the drivers who recognized the alignment change at a certain road luminance may be translated in a way that such ratio of the drivers could recognize the alignment change at the lower road luminance, that is, it has same meaning as safety level that could be granted by a certain road luminance. Hence, road luminance 0.25 cd/㎡ with which 75% of the subject recognized the alignment ahead corresponds to safety level 75% and road luminance 0.42 cd/㎡ with which 85% of the subject recognized the alignment ahead also corresponds to 85% of safety level.

Road manager shall determine the safety level in consideration of traffic volume, speed and the risk of traffic accident at night such as complexity and then determine the road luminance accordingly and the outcome of this study is expected to be useful in such process.

ACKNOWLEDGEMENTS

This research was supported by a grant from a Strategy Research Project (Development of Enhancement and Evaluation Technologies for Driver's Visibility on Nighttime – 1st research field: Development of Enhancement Technology for Driver's Visibility on Nighttime) funded by the Korea Institute of Civil Engineering and Building Technology.

REFERENCES

[1]. Commission Internationale de l'Eclairage (2010) CIE 115-2010 : Lighting of Roads for Motor and Pedestrian Traffic.
[2]. Duco Schreuder (1998) Road lighting for Safety, ThomasTelford.
[3]. Duco Schreuder (2008) Outdoor Lighting : Physics, Vision and Perception, Springer.
[4]. Green, Bobby, Olkan Culvaci, Sanjaya Senadheera, Karl Burkett, and Gransberg Douglas (2002) Evaluation of Roadway Lighting Systems Designed by Small Target Visibility(STV) Methods. Final Report No. 0-1704-8, Department of Civil Engineering Texas Tech University Lubbock, Texas 79409.
[5]. Illuminating Engineering Society of North America (2014) RP-8-14 : Roadway Lighting.

Wonbum Cho Review of optimal road surface luminance considering dazzling by headlight of the car running in the opposite direction." International Journal of Engineering Science Invention(IJESI), vol. 6, no. 11, 2017, pp. 35-39.