Development Strategy of Technology for Securing Driver's Visibility in Unlit Road Section

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1. Introduction

No road lighting section at night is very dangerous driving environment due to limited front sight distance. Although the vehicle headlights perform a similar function as the road lighting, the reaching distance of headlights is merely 50~60m for low beam and 90~100m for high beam. In general, drivers drive their vehicles on low beam due to inconvenience of changing into high beam. In addition, the headlight irradiating direction on the horizontal and the vertical curves does not match with its changes in linear section, revealing limitation of not shedding light on front linear section and pavement. Despite such issues, about 88% of arterial roads in Korea are left without lighting due to burdensome installation /operation cost.

In this regards, this study reviewed the technology trend of road lighting and vehicle headlights, a typical means of securing nighttime visibility in no road lighting sections. Based on the review, we established a strategy for securing validity of the government budget support on no road lighting sections and for developing technology to provide a proper level of nighttime visual environment.

2. Relationship between Road lighting and Traffic Accidents

Several studies have indicated that more traffic accidents occur on the road with no road lighting and low level of illumination.

Scott (1980) analyzed the relationship between 70 arterial road sections in metropolitan area of the UK and traffic accidents, presenting that the higher the luminance level and the lower the ununiformity is, the lower nighttime accident rate (n/d) is in comparison with daytime (when the luminance level increases by 1 cd/m^2 , 35% of n/d decreases).

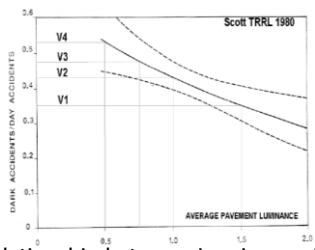

Fig. 1 Relationship between Luminance Level and Daytime/Nighttime Accident Rate

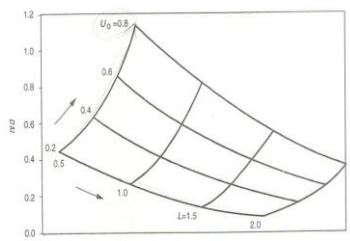

Fig.2 Daytime/Nighttime Accident Rate by Luminance Level and Uniformity (n/d rate)

3. Survey Investigation

To reveal potential risks of driving on no road lighting section, a survey was conducted on the use of high beam and the reason for not using it. According to the survey results, 50% of drivers are not using the high beam in no road lighting sections, which indicates they are exposed to very dangerous situations of checking only about 50m ahead while driving. For the reason of not using high beam in sections with no road lighting, 69% answered that it was inconvenient to change into high beam and 31% answered that they were not aware of potentially dangerous situations.

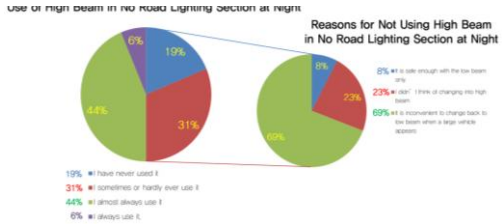

Fig.3 Use of High Beam in No Road Lighting Sections at Night and Reasons for Not Using High Beam

4. Analysis of Domestic/Overseas Environment and Technology Trend

No road lighting section is the politically neglected section because it does not satisfy the standards of required section for lighting installation, and the installation locations are limited due to high installation/maintenance cost. The optimum solution for no road lighting sections is to increase visibility by installing lightings. However, it is always neglected in the priority of the government budget allocation due to high installation/operation cost, resulting in the current situation in which 88% of domestic expressway and national highway is left without lighting.

The typical global technology trend is to use an alternative energy (sun light) or a high-efficiency light source (LED). To maximize energy saving effect, dynamic lighting or remote lighting control system is applied and tested in various forms depending on traffic volume and speed. Such technological application is reported to save 40~60% of energy. Vehicle headlights perform a similar function as road lighting. However, the light reaching distance of general vehicles is merely 50~60m for low beam, and most of drivers are usually driving their vehicles on low beam due to inconvenience of changing into high beam, as described in the previous survey results.

To solve such an issue, advanced headlights technology is applied and expended to mainly high-class vehicles now. Volvo has recently developed Intelligent High Beam Headlights. In this technology, high beam is still maintained but the driver's visual field at night is further improved by protecting glare phenomenon caused by the driver on the opposite lane. A camera is installed on the front area of the room mirror, sensing the location of vehicles on the opposite or front lane and analyzing the location data of other vehicles to calculate high beam cut off range (error range of 1.5°). However, it may take a long time for such highly advanced technologies to be distributed at low cost due to high installation expenses.


Fig.4 Future dynamic Lighting Technology (Netherlands)

Fig.5 Intelligent High Beam Headlights (Volvo)

5. Establishment of Strategy

Despite high effectiveness of reducing traffic accidents by improving visibility in no lighting sections, the support policy was only limited to existing lighting sections such as maximization of existing lighting efficiency, due to lack of awareness in necessity for lighting and high installation/maintenance cost; this results in the current situation in which 88% of domestic main roads are left without lighting. Therefore, in order to reinforce the commitment of installing lighting in the existing sections with no lighting, it is necessary to reduce installation/operation cost to the level available to secure validity of the government budget support.

This study established low (no)-power/low-cost minimum nighttime lighting technology, which can replace the existing high-cost/high-performance, road lighting, as development range. Deliverables and critical technology gained from this technology development is assigned as follows:

(a) Minimum Lighting Technology
- Minimum number of lighting installation by applying technology that maximizes light distribution range of single light source (lens and reflecting plate design)
- Maximum luminous efficiency and anti-glaring by applying low lighting illuminating below the driver's eye level (1.0m)

(b) Nighttime Delineation Technology
- Reinforce delineator by applying new light source such as laser and electroluminescence
- Save installation cost by developing technology of installing attachable delineator on the existing roadway facilities

(c) Lighting Technology using Vehicle Headlights
- Implement no-power road lighting by developing lighting technology that uses vehicle headlights as light source
- Apply to the section such as curves requiring changes in irradiation direction and support safe driving for vehicles unequipped with high-tech headlights

(d) Vehicle Detection Technology, Dynamic Lighting Control Technology, Alternative Energy Utilization Technology
- Apply critical technology elements to save installation/operation cost of minimum lighting technology and nighttime delineation technology

6. Conclusion

A great number of studies have proved that securing visibility on the roadway greatly affects decrease in nighttime traffic accidents. Despite the dangerousness of driving on no road lighting sections, the government is leaving the most of roadway sections with no lighting due to tremendous installation/operation cost of road lightings. Furthermore, about 50% of drivers are driving their vehicles on low beam because of inconvenience of changing into high beam and underestimation of potential threats ahead. In this regard, this study, based on literature analysis, analysis of domestic/overseas environment and technology trend and survey analysis results, established the strategy for securing validity of the government budget support on no road lighting sections and for developing/commercializing technology to provide a proper level of nighttime visual environment as follows:

· Develop the minimum lighting technology by applying technology that maximizes light distribution range of single light source
· Develop nighttime delineation technology with improved delineator using new light source
· Develop no-power lighting technology using vehicle headlights
· Develop vehicle detection technology, dynamic lighting control technology and alternative energy utilization technology

7. Acknowledgement

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8. Reference

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