Center for Transportation Research and Education

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RESEARCH PROJECT TITLE

Roadway Lighting and Safety: Phase II – Monitoring Quality, Durability, and Efficiency

SPONSORS

Iowa Highway Research Board (IHRB Project TR-601)
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The mission of the Center for Transportation Research and Education (CTRE) at Iowa State University is to develop and implement innovative methods, materials, and technologies for improving transportation efficiency, safety, reliability, and sustainability while improving the learning environment of students, faculty, and staff in transportation-related fields.

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Roadway Lighting and Safety: Phase II – Monitoring Quality, Durability, and Efficiency

tech transfer summary

Even with the far majority of intersections falling below standard illumination levels, the presence of lighting still made a significant impact on safety when compared to non-lighted locations.

Problem Statement

This Phase II project follows a previous project titled Strategies to Address Nighttime Crashes at Rural, Unsignalized Intersections. Based on the results of the previous study, the Iowa Highway Research Board (IHRB) wanted to pursue further research to address the quality of lighting, rather than just the presence of light, with respect to safety.

The previous study confirmed that lighting may have an impact on driver safety at rural intersections. However, the research used lighting as a strictly binary measure during analysis, meaning that the lighting was either present or absent.

Results showed that the night-to-day crash ratios and total night crashes were lower at lighted intersections compared to unlighted intersections. While the results showed lighting enhances driver safety, the data did not account for the quality or level of light at intersections. Moreover, lighting levels at a few locations may detract from driver safety or may provide no safety benefit.

Objectives

1. Collect field lighting levels for 101 study intersections from Phase I.
2. Analyze these data to establish a relationship between crash performance and illumination at rural unsignalized intersections.
3. Investigate lighting levels at rural intersections considering a number of factors (illuminance, uniformity ratio, and glare).

Research Description and Methods

State of the Practice Synthesis

The research team supplemented the literature review completed for the previous study, specifically addressing lighting level in terms of measurement, the relationship between light levels and safety, and lamp durability and efficiency.

Data Collection

The Center for Transportation Research and Education (CTRE) teamed with a national research leader in roadway lighting, Virginia Tech Transportation Institute (VTTI) to collect the data for this phase of the study.

An integral instrument to the data collection efforts was the creation of the Roadway Monitoring System (RMS). The RMS allowed the research team to collect lighting data and approach information for each rural intersection identified in the previous phase.

The entire RMS was synchronized such that information collected at any location contained illuminance, global positioning system (GPS), Data Acquisition System (DAS), and luminance data. The combination of all elements would provide a rich data source, which could then be transferred for further data analysis.

After data cleanup, the final data set contained illuminance data for 101 lighted intersections (of 137 lighted intersections in the first study). (In addition to the illuminance meters and GPS, the roadway lighting mobile monitoring system/RLMMS was equipped to capture luminance, but luminance data were only collected for 39 intersections and an analysis of luminance data was not feasible.)

Data Analysis

This task identified specific lighting levels for each of the data collection sites and related this information directly to the crash statistics obtained from the Iowa Department of Transportation (DOT) crash database from January 2006 through March 2011. Data analysis included a robust statistical analysis based on Bayesian techniques.

Average illuminance, average glare, and average uniformity ratio values were used to classify quality of lighting at the intersections. Details of this classification are given in the statistical analysis section of the report.

Summary of Key Findings

This cross-sectional statistical study evaluated the effect of the quality of lighting and other treatments on the safety benefits for 101 lighted rural intersections as compared to 86 unlighted rural intersections. Based on the results of the analysis, the following conclusions can be made.

- As with any study that includes field data and limited resources, there are limitations on the number of available data points, randomness of data, and ranges of data values (number of crashes, light levels, volume, and intersection control).

- For all but nine of the lighted intersections, the measured illuminance levels were below the recommended values and this limits the robustness of the cluster analysis and results in the inability to contrast different illuminance ranges.

- The negative parameter estimates for lower average illuminance and glare and higher average illuminance and glare suggest lower night-to-day crash ratios for both groups of lighted intersections with respect to unlighted intersections.

- Model results suggest a lower number of nighttime crashes for lower average illuminance intersections when compared with unlighted and higher average illuminance intersections. However, a significant relationship cannot be found due to the high standard deviations of the parameter estimates and there was an imbalance between the data sets with 75 lower-illuminance intersections as opposed to only 26 higher-illuminance intersections.

Implementation Benefits

This project gave the research team an opportunity to determine the impact of illumination levels on safety (nighttime crashes). Based on the findings from both the Phase I and II studies, lighted intersections experience fewer crashes when compared to unlighted intersections.

Even with the far majority of intersections falling below standard illumination levels, the presence of lighting still made a significant impact on safety when compared to non-lighted locations. Identifying optimal lighting levels will likely enhance the detection of relevant driver information and therefore provide a safety benefit.

Implementation Readiness

The results obtained in Iowa suggest a need for further research. Quantifying the safety contribution of light quality remains elusive at best. Specifically, there is a need to identify how intersection infrastructure and geometry influence lighting levels and corresponding crash rates.

The RMS-equipped vehicle drove the route and approached each intersection location from various positions to capture total lighting level based on approach metrics