Joint Transportation Research Program

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Safety and Cost Performance of Intersection Lighting

Introduction

It has been reported that, nationwide, about one quarter of roadway travel occurs after dark, and half of roadway traffic fatalities occur at night. The nighttime traffic crash fatality rate is about three times the daytime rate, with many crashes occurring at unlit or poorly lit critical roadway safety spots such as interchanges, intersections, and railroad and highway crossings, particularly in adverse weather conditions.

This study was conducted to investigate lighting effects on crashes at Indiana intersections. An analysis of Indiana nighttime crash data was completed to identify contributing factors. Study intersection sites were selected based on crash frequencies and severities. Before and after field light tests were conducted to verify in-service light performance, including illuminance distribution and uniformity ratio. AGi32 simulation was also performed for three selected intersections to compare with field test results. In addition, long-term performance of demonstration luminaires at the I-74 and US 231 interchange was tracked and documented. This activity provided a better understanding of maintenance issues, cycles, and costs. Surveys were sent to both State Highway Agencies (SHAs) and communities in order to identify perceptions from SHAs and the public about lighting improvement. The community survey included questions such as public attitudes toward intersection lighting, effectiveness of lighting, and visibility and safety improvement. To quantify the safety effects of lighting at intersections, crash modification factors (CMFs) were developed by using two methodologies: before-and-after analysis and cross-sectional statistical analysis. The developed CMFs could be used to justify roadway lighting projects. Life cycle cost analysis

(LCCA) was conducted to determine the best lighting solution given a real project scenario. The analysis considered initial (luminaire and installation) cost, operation and maintenance cost, and energy cost.

Findings

The following tasks were completed during the course of this study:

- Illuminance values at the selected intersection sites were measured. The performance of new and existing luminaires was evaluated based on the measured luminance distributions.
- CMFs for various types of intersections were developed through the before-and-after analysis and cross-sectional statistical analysis. Since the cross-sectional analysis used a much larger data sample than the before-and-after analysis, lighting CMFs from cross-sectional analysis are deemed more representative for Indiana intersections.

This study evaluated new lighting projects with life cycle benefit and cost analysis and lighting retrofit projects with life cycle cost analysis. The benefits estimated in the new lighting project applied the CMF developed in this study, and the project was well justified from an economic perspective. During this study an Excel-based worksheet was developed to facilitate the life cycle analysis on new and retrofit lighting projects, and it is recommended that this worksheet be used as a standard procedure when life cycle cost analysis and life cycle benefit and cost analysis need to be performed by the agency.

Implementation

The illuminance-based evaluations and developed CMFs provide INDOT with useful tools for intersection lighting design and safety assessments. The life cycle cost methods, together with the application software, will enable INDOT to conduct project evaluations effectively. The research results also provide a rational basis for INDOT to develop or modify the standard related to intersection lighting.

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