



Safer Nighttime Construction Zones Through Better Lighting

Illinois Develops and Applies Practical Guidelines

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Daytime lane closures causing motorist delays and queues have become unacceptable. For the past several years, therefore, the Illinois Department of Transportation (DOT) has scheduled construction on expressway projects in the Chicago area at night. The nighttime repair and resurfacing of roadways has expanded to other urban facilities and to most rural Interstates. For many of the nighttime construction projects, portable light towers had been the primary source of illumination.

Problem

In 2001, Illinois DOT sponsored research to evaluate lighting requirements and to recommend a lighting specification for nighttime construction. The resulting specification stipulated lighting requirements that were similar to those recommended by the Occupational Safety and Health Administration. The contractor had to submit a detailed lighting plan drawn up by a professional engineer, a lighting layout for each work area, and lighting design calculations, along with standards for uniformity and for the measurement of the lighting levels by the engineer.

The design, installation, and operation of the lighting had to avoid glare, which can interfere with traffic on the roadway.

The specification was good, but it was not practical for design, installation, or inspection. The review and approval of the required lighting plan, for example, could take up to 30 days—some projects could be near completion in that time. In addition, department engineers, inspectors, and contractors found that the lighting requirements were not easy to understand; moreover, no procedures for measuring glare and determining what was acceptable were readily available. As a result, the specification would be rewritten for different contracts, meeting the minimum requirements, but allowing the contractors to install and provide lighting to suit their needs.

During the next few years, traffic control reviewers observed a variety of lighting schemes in nighttime work zones. Many times, the placement of portable tower lighting or spotlights was blinding to motorists and workers. Department inspectors and materials personnel also filed complaints about insufficient lighting—but increasing the number of light towers only increased the glare for the workers and motorists.



Flaggers shield their eyes to distinguish oncoming traffic.



Raised headlights and roller lighting generate a blinding glare for oncoming traffic in the adjacent lane.

Solution

In 2006, the Illinois Center for Transportation, a research partnership between Illinois DOT and the University of Illinois, sponsored another research project to develop an easy way to measure glare and to rewrite the lighting specification to be more user-friendly and practical. The researchers visited nighttime construction projects that included patching, milling and resurfacing, and bridge beam replacement. Some work sites were in urban locations with existing roadway lighting and others were on rural Interstates.

The researchers' observations included the following:

- ◆ Patching is a fast-moving operation across many locations along several miles of highway. In a closed lane on a rural Interstate, for example, workers had difficulty moving the lighting with the patching operations; some work locations, therefore, were lit only with the headlights of the equipment or the pickup truck. Tower lighting, when used, produced significant glare for the workers.

- ◆ Milling and paving projects consistently used a new type of balloon lighting on each paving machine—that is, a light source enveloped in a balloon-shaped, translucent material, diffusing the light; other projects, however, had no consistent lighting sources. Rollers, sweepers, milling machines, flagger stations, and materials testing locations relied on the equipment lighting, makeshift lighting, and other creative lighting sources. The lighting often was nonexistent or poor—yet even poor lighting could create a blinding glare for workers and motorists.

- ◆ The researchers measured the veiling luminance ratio—that is, the glare—from some of the lighting sources on the construction sites. The ratio ranges were as follows:

- For extended headlights on a roller: 2.74 to 3.55;
- For a portable light tower: 1.31 to 5.01; and
- For balloon lighting on a paving machine: 0.02 to 0.51.

The balloon lighting produced substantially less glare—10 percent to 15 percent of the ratios from the other sources; for minimizing glare, therefore, the balloon lighting was superior. The balloon lighting also provided a larger diameter of light for those working around the perimeter of the paving equipment and on the shoulders.

Calculation of the veiling luminance ratio in and around construction sites requires measuring the vertical luminance and the pavement luminance. On roadway construction sites, however, the locations at which these measurements can be taken are often constrained by safety considerations—such as adjacent traffic—and by the layout of barriers on the site.

Researchers gained more insight into the problem through meetings with district traffic control supervisors and other groups and through discussions about nighttime construction projects. Consequently, one of Illinois DOT's districts developed a specification that required balloon lighting on all equipment used in paving operations (see photo, page 34)—the milling machine, the paving machine, the sweepers, the rollers, and the flagger stations—and at all work locations within the work zone.

At one project applying this specification, the researchers and the review panel found that the lighting was adequate where needed, was glare-free, and provided an atmosphere that felt safer to the workers. The lighting on this project, therefore, served as the model, and balloon lighting became the preferred lighting system.



Buoy light in the back of a pickup shone directly into the eyes of approaching workers and drivers.



Balloon lighting in use on paving equipment.

Applications

Some projects employed an early version of the balloon lighting specification. The results were favorable from the motorists' and workers' points of view. The workers noted that the work environment was safer; moreover, the sites were basically glare-free on drive-through inspections.

The researchers have finalized the lighting specification, which has gained approval for all nighttime construction projects. Luminaries on light towers are still allowable but must be aimed downward at the work to minimize the glare and can be rotated outward no more than 30 degrees from the straight-down position.

Few restrictions apply to balloon lighting. The

specification describes lighting levels for specific nighttime construction operations, such as work areas for layout, testing, and inspection personnel; traffic control setup and removal; and pavement marking and raised reflective pavement marker installation. Many of these operations previously were isolated and were not considered for lighting.

Benefits

The research goal of providing a means for measuring glare was accomplished. The many variables of placement, types of lighting, location on the roadway, and aiming of luminaries, however, make the preparation of a simplified table or calculation for contractors and construction inspectors almost impossible. The final specification, "Nighttime Work Zone Lighting," provides a safer work environment that offers the visibility for higher quality work. The specification can be easily understood, inspected, monitored, and applied in the field; application on several projects has gained positive feedback from workers on site and from Illinois DOT inspectors.

In addition, the research increased awareness about the problems of lighting in nighttime work zones among all involved with the construction, materials, maintenance, safety, work zone layout, and roadway lighting of highway projects. Portable light tower manufacturers have become more aware of the need for an improved, glare-free system, and more suppliers are now producing different types of balloon lighting.

Applying the new specification is expected to increase safety for workers and for drivers by eliminating or reducing glare; to enhance the quality of work, including inspection, through sufficient lighting; and possibly increase productivity as a result of the improved work conditions on the construction site.

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Night Lights for Highway Work

NCHRP Report 498, *Illumination Guidelines for Nighttime Highway Work* (2004), presents the findings of a research project conducted by the University of Florida, Gainesville. The report makes recommendations for (a) illumination guidelines for nighttime highway work; (b) guidelines for work zone illumination design; and (c) guidelines for the use of temporary roadway lighting for nighttime construction and maintenance. The guidelines address such concerns as visibility requirements, lighting equipment, lighting configuration and arrangement, lighting system design, system operation and maintenance, and economic considerations.

For more information, www.TRB.org/news/blurb_detail.asp?id=2316.

Suggestions for "Research Pays Off" topics are welcome. Please contact G. P. Jayaprakash, Transportation Research Board, Keck 488, 500 Fifth Street, NW, Washington, DC 20001 (telephone 202-334-2952, e-mail gjayaprakash@nas.edu).