Field Test DELTA Snapshots

BENEFITS OF IMPROVED UNIFORMITY WITH LED PARKING LOT LIGHTING

Demonstration and Evaluation of Lighting Technologies and Applications ▲Lighting Case Studies

Outdoor lighting is a rapidly growing market for light-emitting diode (LED) luminaires. LEDs are small point sources with the potential to efficiently provide more uniform illumination compared with conventional high-intensity discharge (HID) luminaires. Improving the uniformity is expected to result in better occupant acceptance and ratings of safety and visibility, potentially allowing for reductions in light level and energy use. The Lighting Research Center (LRC) performed a demonstration to test the relationship between uniformity and occupant acceptance in parking lots.

Objectives

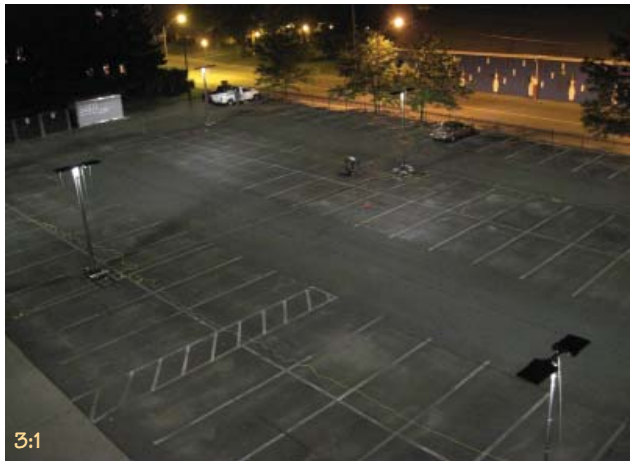
- Confirm the relationship between illuminance, uniformity and:
  - Perception of safety and security
  - Visibility
  - Energy efficiency
- Calculate the advantage LED luminaires offer at producing more uniform beam patterns compared with HID luminaires

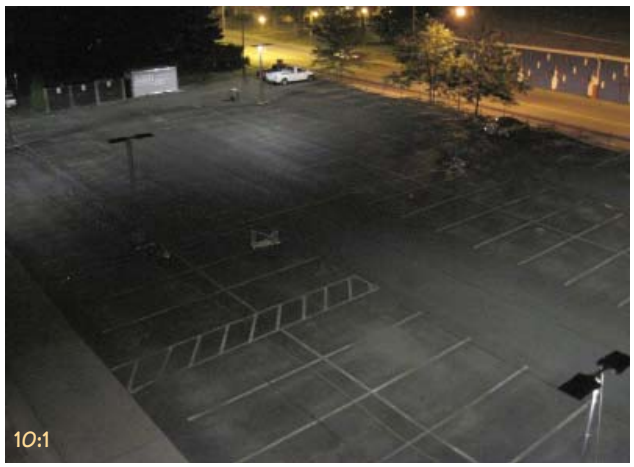
Application Profile

In North America, the recommended practice for parking lot lighting includes a minimum light level criterion (minimum of 5 lux [lx]) and a uniformity criterion (maximum-to-minimum ratio of 15:1).[1]

To test the potential tradeoff between these criteria, a demonstration was created in an urban parking lot in Troy, N.Y.[2] The site measured 150 ft. by 250 ft. and was bordered by illuminated streets on two sides. The LRC illuminated the parking lot with two uniformity conditions—10:1 ("standard") and 3:1 ("improved") maximum-to-minimum ratios—and six light levels (ranging 2 lx – 60 lx).

The installation consisted of six temporary poles, each with two LED luminaires mounted back-to-back at a height of 18 ft. Poles were spaced 70 ft. by 70 ft. The manufacturer-rated specifications of the LED luminaires were 17,500 lumens (initial), 4300 K, and 243 W. The intensity distribution was classified as Type V, square. Each luminaire was retrofitted with dimmable LED drivers; one dimmer controlled both luminaires on each pole. By turning off the central poles, uniformity was reduced to the standard 10:1 ratio.





Improved uniformity (above) compared with standard uniformity (below).

Survey Results

In November 2012, the LRC recruited 15 neighbors, visitors, and regular users of the parking lot to answer questions about the 12 different lighting conditions after dark.

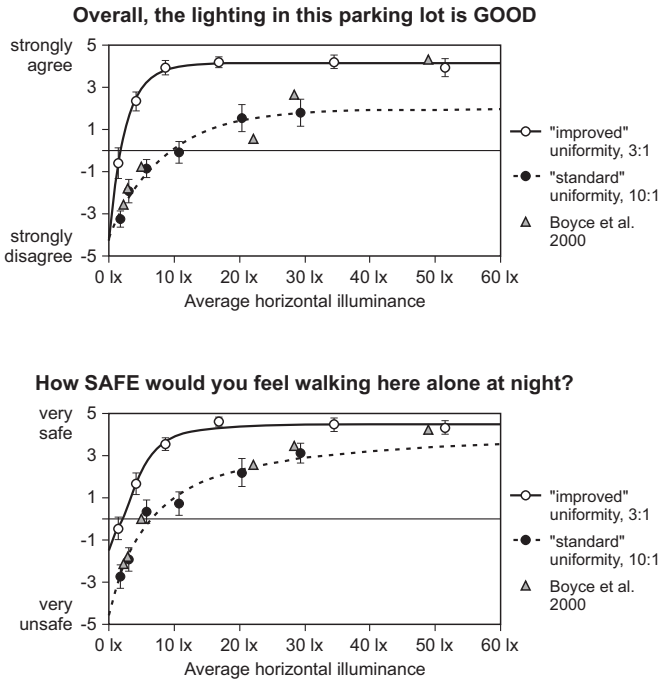
As shown in the graphs on the following page, users perceived the lighting as more "safe" and "good" at lower light levels when presented with improved uniformity (3:1 ratio) compared with standard uniformity (10:1 ratio). Importantly, even when presented with the highest light levels, users rated the standard uniformity as less acceptable than the improved uniformity conditions.

[1] The Illuminating Engineering Society of North America (IESNA) RP-20-14 recommends that, for basic security, parking lots should maintain these levels (1 fc ≅ 10 lx).

[2] For details about the research, see http://www.lrc.rpi.edu/programs/solidstate/parkingLotUniformity.asp

Survey Results (cont'd)

Similar results were found for other lighting quality questions such as perceived brightness, ability to see tripping hazards, recognizing people, and seeing around the parking lot perimeter.[2] These results demonstrate that improved uniformity makes lighting parking lots to an average greater than 10 lx unnecessary. In addition to reducing energy use, this would appeal to those concerned about light pollution. Notably, these results are consistent with past research.



Average ratings for two survey questions about the parking lot's lighting as a function of average illuminance on the ground.

LEDs Can Reduce Power Demand

Using modeling software, the LRC compared the performance of several LED parking lot luminaires (150 lm/W source efficacy) with different HPS parking lot luminaires (107 lm/W source efficacy). The modeling showed that LEDs can not only provide better uniformity, but can do so at twice the application efficacy, thus lowering power demand.[3] Energy savings will increase as LED source efficacy improves in the future. It also should be noted that LEDs can be dimmed to achieve a lower target light level without reducing uniformity, changing spacing or changing mounting height.

Lessons Learned

- For equal average illuminance, improved uniformity (3:1) resulted in higher ratings of perceived safety, brightness, and visibility compared with standard uniformity (10:1).
- Improved uniformity allows equal or greater occupant acceptance at much lower light levels; this is expected to translate to energy savings of up to 75%.
- LEDs are more effective at creating uniform distributions than larger HID sources.
- LEDs can be dimmed to achieve a lower target light level without reducing uniformity, changing spacing or mounting height.
- Industry recommendations for uniformity in parking lots could be made more strict to improve lighting quality while reducing energy use. New industry recommendations for parking lots could be developed to limit maximum light levels.

[3] Application efficacy is a measure of how effective a lighting system is at meeting the photometric requirements of a task area, as opposed to luminous efficacy, which is a function only of light output and power demand. For more information about application efficacy, see http://www.lrc.rpi.edu/programs/solidstate/assist/recommends/parkinglot.asp.

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Field Test DELTA evaluates new energy-efficient lighting products to independently verify field performance claims and to suggest improvements. A primary goal of the Field Test DELTA program is to facilitate rapid market acceptance of innovative energy-efficient technologies.

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