C30 Luminance as a Metric for Accident Reconstruction and Avoidance Analyses of Headlamp-Only Vehicle/Pedestrian Collisions

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The goal of this presentation is to present a scientifically-valid luminance-based method for evaluating visibility distance to dark-clad pedestrians under headlamp-only illumination.

This presentation will impact the forensic science community by showing how identification luminance can be used to determine identification distances to pedestrians for the reconstruction and avoidance analyses of many common types of nighttime vehicle/pedestrian collisions.

Photometry is the measurement of quantities associated with light. Two primary quantities of light that can be measured directly are illuminance (measured in footcandles or lux) and luminance (measured in footlamberts or candelas/meter squared). Where illuminance is the density of luminous flux (light) incident on a surface, luminance is the quantity of light reflected or emitted off the surface in a given direction.

For practical forensic applications, the luminance of an object or pedestrian is a function of the amount of light falling onto the surface, the reflectance of the surface, and depending on the type of reflection, the relative orientation and position of the surface with respect to both the light source and the observer. In the case of headlamp-only automobile/pedestrian collisions, light falling onto the pedestrian is exclusively from the headlamps of the colliding vehicle, measured as illuminance.

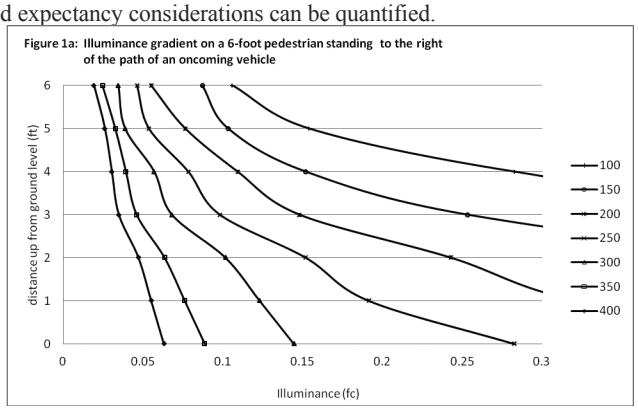
The illuminance gradient falling on a pedestrian from an approaching vehicle is shown in figures 1a and 1b for a pedestrian standing to the left and right side of the path of the vehicle, respectively, for distances from the approaching vehicle in 50 foot increments from 400 to 100 feet. The figures are demonstrative of how illuminance gradients vary for pedestrians on the left compared with those on the right, as the vehicle approaches.

Whether the pedestrian is visually detected, recognized and then perceived by an approaching driver depends on the extent to which the pedestrian is more or less luminous than the background upon which he is visualized. To detect an object means to discover or determine its presence. A detected object that is also a hazard, however, may not necessarily be recognized as a hazard. To see the object, simply means to perceive it by the eye or by vision. To perceive it means to become aware of its presence through the senses (here by vision). An object is visible if it is capable of being seen. An object is conspicuous if it attracts or tends to attract the attention of an observer so as to be readily discovered by vision. Conversely, an object is inconspicuous if it is not readily noticeable or discoverable by vision. The term conspicuity, then, is the capacity of an object to stand out in relation to its background so as to be readily discovered by vision.

Figures 2a and 2b are cumulative probability plots of identification distance and identification luminance of a dark-clad pedestrian under U.S. low-beam headlamp illumination for pedestrians standing to the left and right of the vehicles path. How these figures were derived is described elsewhere.[1]

The results of this analysis allow the accident reconstructionist to determine visibility distance from luminance measurements or calculations for many common collisions involving vehicles operating with low beam headlamps and dark-clad pedestrians. A luminance-based analysis permits interpolation and extrapolation to be made for different pedestrian positions in the roadway and different clothing reflectance. Additionally, with a luminance-based analysis driver/observer statistics and expectancy considerations can be quantified.

Figure 1a: Illuminance gradient on a 6-foot pedestrian standing to the right of the path of an oncoming vehicle



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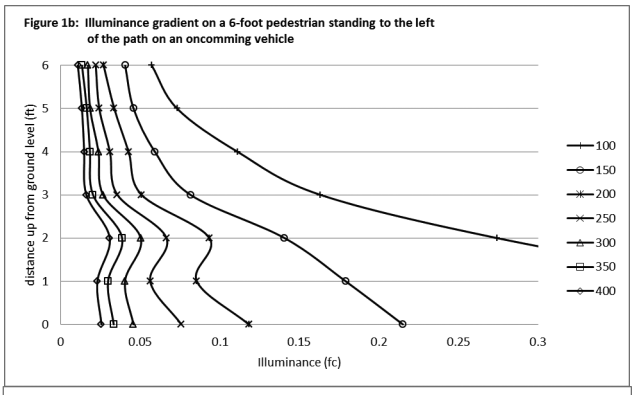

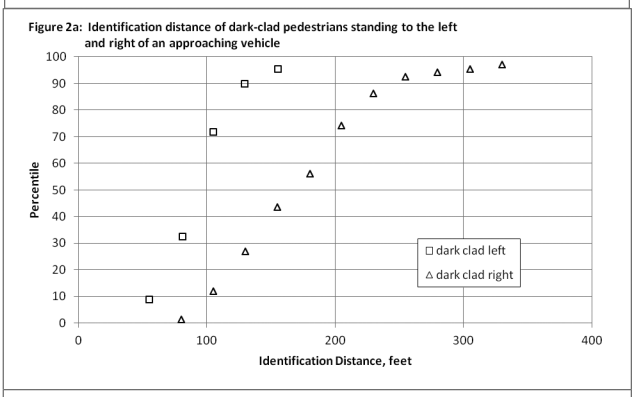

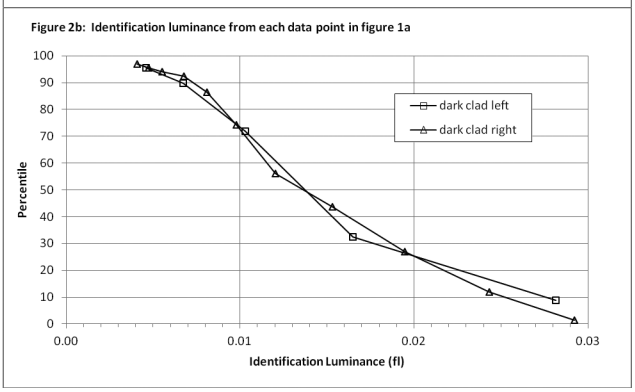

Reference:

[1.] Hyzer, J.B., "A Luminance-Based Analysis of Olson and Sivak's 1984 Research on Visibility Response Distance to Dark-Clad Pedestrians Under Headlamp-Only Illumination." *Proceedings of the 57th Annual Scientific Meeting of the American Academy of Forensic Sciences*, Dallas, TX, February, 2004. Colorado Springs, CO: American Academy of Forensic Sciences, 2004

Accident Reconstruction, Visibility, Illumination

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