

INTERSECTION SIGHT DISTANCE FOR UNPROTECTED LEFT-TURN TRAFFIC

PROBLEM STATEMENT

With increasing urbanization, especially in suburban areas, will come more four/plus-lane divided arterials. Such arterials contain medians that vary in size. Field studies have shown that wide medians tend to complicate the left turning maneuver of vehicles moving from major roads onto minor streets. The increase in median width increases the likelihood of sight-distance restrictions due to the opposing left-turn vehicles. When a left-turning vehicle is confronted by an opposing left-turning vehicle, the result is the creation of a blind zone for both vehicles. Drivers attempting this turn during an unprotected signal phase may unintentionally accept a small gap because they can't see the opposing through-vehicles concealed in the view-blocked area. Acceptance of even a very small gap could contribute to potential traffic conflicts and possibly serious angle collisions. Moreover, inadequate sight distance may cause cautious drivers to reject physically adequate gaps because they need more time to make sure that the opposing through lanes are clear; this can lead to needless delays for the left-turning traffic.

OBJECTIVES

The goal of this research was to improve intersection sight distances and traffic operation, especially for left-turn drivers attempting turns during the unprotected phase at signalized intersections. Specific objectives included the following:

- develop geometric models to calculate sight distance for those drivers under different geometric configurations
- advance understanding of the relationship between highway visibility and traffic operation, specifically, left-turn capacity
- identify the changes of gap-acceptance behavior clearly associated with restricted sight distances due to the opposing left-turn vehicles (through a field study)

FINDINGS AND CONCLUSIONS

This study focused on six geometric models as the basis for calculating left-turn sight distance for intersections with different configurations, including intersections located on

- linear roads
- curved roads
- linear segments leading a curved segment
- curved segments leading a linear segment

For linear-type intersections, researchers focused on the design aspect as affects left-turning drivers. Geometric models were developed to evaluate two design methods. The first proposes offsetting the two left-turn lanes, while the second explores angling them. Based on the sight-distance calculation, the sight-distance problem for left-turners could occur even on the traditional left-turn lane design with 14- to 18-foot medians at high major-road design speeds. For an opposite linear approach leading a curve segment, the presence of a curve can mitigate the sight-distance problem when drivers are making a left turn toward the inside of the curve. Conversely, if drivers are making a left turn toward the outside of the curve, the major road curve can result in a serious sight-distance problem.

For intersections located on a horizontal curve, sight-distance calculation models for left-turn maneuvers toward the outside of the curve and toward the inside of the curve are presented in this study, respectively. The former model concluded that for the 12-foot median, the available sight distance might be insufficient for the higher design speed on the major road even if the curve is not sharp. The latter model indicated that the curve radius is negatively related to the sight distance and that there is a threshold for curve radius for different median widths. Only if the radius is larger than the threshold value could the opposing left-turn vehicle be a potential sight obstruction.

The field study confirmed the negative effect of the sight-distance problem on traffic operation efficiency and safety. The results showed that sight obstruction due to the opposite turning vehicles may contribute to significant increments of the critical gaps for both left-turn and U-turn drivers. With the sight-distance problem, a driver's left-turn follow-up time is also significantly increased (i.e., compared to a driver not experiencing that problem). The capacity model results showed that the capacity reduction rate increases with the increase of the opposing-through volume and the volume-to-capacity ratio for the opposing left-turn traffic. The video analysis showed that traffic conflicts tended to increase when left-turn or U-turn drivers with the sight-distance problem accepted gaps smaller than normal.

BENEFITS

This research should prove helpful in identifying intersections with sight-distance problems that may contribute to inappropriate gap acceptance, traffic conflicts, and accidents, and in offering potential remedies. The models presented in this study can be used to assist in the geometric design of intersections, to evaluate the sight-distance problem for an existing intersection configuration, and to identify better locations for existing intersections. The research may also be useful for identifying when an exclusive-only signal phase would be more appropriate. Ultimately, the results of this study should contribute to improved safety by providing useful insights into and suggestions for mitigating sight-distance problems that lead to traffic delays and incidents.

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