Idea 97: Design standards for unobstructed sight lines at left-turn lanes: Literature Search

Tuesday, July 11, 2017

Prepared for: Mitch Bartelt

Prepared by: Jim Byerly, Electronic Resources Librarian

Resources searched: Transport Database, Research in Progress, ASCE Civil Engineering Database, MnDOT Library Catalog, Google

Summary: Results are compiled from the databases named above. Links are provided for full-text, if applicable, or to the full record citation. I completed my searches using the following terminology: left turn, left turn lanes, line of sight, sight line, sightline. The search results are divided into most relevant and least relevant. See below.

Most Relevant Results

Modified Guidelines for Left-Turn Lane Geometry at Intersections
Journal of Transportation Engineering; Vol. 131, Issue 9 (September 2005)
Abstract
Left-turn vehicles need sufficient sight distance to decide when it is safe to turn left and cross the lane(s) used by the opposing traffic. The current policy of the American Association of State Highway and Transportation Officials (AASHTO) recommends that the adequacy of sight distance for left-turn vehicles should be checked because the opposing left-turn vehicles can block a driver’s view of the oncoming traffic. Previous studies have established guidelines for various intersection geometric elements (offset between opposing left-turn lanes, left-turn lane length, and left-turn lane-line width) to ensure that adequate sight distance is provided for left-turn vehicles. However, these guidelines are based on overestimation of the available sight distance. This results in underestimating the requirements for intersection elements. This paper develops modified analytical models and guidelines for various intersection elements, based on the actual available sight distance. The median opening is also introduced as a variable in the models. The results show that the existing guidelines for minimum offset and left-turn lane length are inadequate generally at low and high speeds, differing from the modified guidelines by more than 100 and 15%, respectively. The existing guidelines for minimum lane-line width are also inadequate for low percentiles (by 0.17m at an offset of −0.3m). The modified guidelines ensure that the adequate sight distance for left-turn vehicles is provided at intersections, and therefore should be of interest to traffic and geometric design engineers.
http://ascelibrary.org/doi/10.1061/%28ASCE%290733-947X%282005%29131%3A9%28677%2929

Title: Sight Triangle and Corner Clearance Policies at Intersections and Driveways.
Author: Villaluz Paul
Source: Abstract reprinted with permission from the Institute of Transportation Engineers.
Abstract
This informational report explores the history of corner visibility guidelines, compiles and compares the intersection corner visibility policies and practices in place in the United States and in certain foreign countries, and addresses whether policy consistency on the topic exists. The Technical Council Committee conducted an in-depth listserv/MuniCode search using "Sight Triangles", "Corner Clearance", "Intersection Sight Distance", and other associated terms. In addition, committee members obtained municipal, local, and state government codes, policies, guidelines and handbooks related to intersection or driveway sight distance triangle regulations. A random sample of 85 guidelines from this extensive body of research (more than 850 were collected) was summarized in a database in order to identify recurring methods and requirements. The following observations were made: The American Association of State Highway and Transportation Officials (AASHTO) guidelines were not routinely implemented in the municipal and local government codes. States tend to base their guidelines on AASHTO more than other types of governmental entities (i.e., counties, cities, towns). Many municipalities use sight visibility triangles described by equal distances along edges of pavement, property lines, or right-of-way lines instead of applying AASHTO guidelines. When sightlines are laid out, the calculation methods for the distances along the major street centerline vary greatly. The most common methods include AASHTO methods in the 1990/1994 Green Books, "time gap" based methods from the 2000 and 2011 Green Books, and other arbitrary methods. Most codes do not address the individual cases specified by AASHTO. Those codes that do mostly address Cases B1 (Left Turn from Stop) and B2 (Right Turn from Stop). Cases B3 (Crossing Maneuver) and F (Left Turn from Major Road) are rarely addressed. There are no consistent definitions for the maximum height of a ground obstruction or for the minimum height of a tree canopy obstruction within a sight triangle. The objects allowed within the sight triangle also vary. Those that seem to be regularly allowed are traffic signals, signs, and utility poles.

Publication Year
2014

Title
INEXPENSIVE, INFRASTRUCTURE-BASED, INTERSECTION COLLISION-AVOIDANCE SYSTEM TO PREVENT LEFT-TURN CRASHES WITH OPPOSITE-DIRECTION TRAFFIC.

Author
White B; Eccles K A

Source
Transportation Research Record. 2002. (1800) p. 92-99 (4 Figs., 1 Photos.)

URL
http://dx.doi.org/10.3141/1800-12

Abstract
An infrastructure-based intersection collision-avoidance system (ICAS) designed to provide guidance for left-turning vehicles that have secondary right-of-way and are attempting a turn across the path of opposite-direction traffic is proposed. These types of crashes are most prevalent where a left turn is made from a major road approach. A dominant causal factor in this type of crash is the inability of the left-turning motorist to adequately perceive the required gap for a safe left turn. The proposed ICAS compares the presumed arrival time of the opposite-direction vehicle with the presumed time for a motorist to turn left. Based on this comparison, the system provides guidance to the left-turning motorist in the form of
a dynamic sign placed in the same **line of sight** of opposite-direction traffic, so that motorists will have a "second opinion" to aid in their left-turn decisions. The system is composed of four modules: (a) a left-turn assistance device, (b) left-turn presence detection, (c) opposite-direction detection, and (d) a system processor. The system differentiates between left-turning passenger cars and left-turning heavy vehicles and tailors its guidance appropriately. A non-hardware-specific example of the proposed system at a hypothetical intersection was assessed, along with functional requirements and system limitations.

**Title**
SAFETY IMPROVEMENTS AT INTERSECTIONS ON RURAL EXPRESSWAYS: A SURVEY OF STATE DEPARTMENTS OF TRANSPORTATION.

**Author**
Bonnerson J A; McCoy P T; Truby J E

**Source**
Transportation Research Record. 1993. (1385) p. 41-47 (4 Figs., 1 Refs., 2 Tabs.)

**Abstract**
The current state of the practice of measures used to improve traffic safety at intersections on rural expressways is described. The description is based on the results of a recent survey of 49 state highway departments. In general, highway departments use their access control policy and a variety of safety improvement measures at locations with poor safety records to minimize accident potential. The access control policy typically specifies the justification for and frequency of access openings and median openings. Most states indicated that one access opening is provided per abutting parcel that cannot be served by other means. In contrast, median openings are typically provided only at intersections of the expressway and other public roads. Safety improvement measures identified by the survey respondents were categorized as either traffic control measures or geometric design measures. Seventy-four percent of the states indicated that they consider traffic signal control and flashing beacons for application at high-accident locations. Thirty percent of the states consider turn lane additions or modifications at high-accident locations. One modification of expressway left-turn lane design that appears to have particular merit is the offset left-turn bay. In this design, opposing left-turn bays on the expressway are laterally offset such that stopped vehicles in the bay do not block the **sight lines** of opposing left-turn vehicles.

**Title**
GUIDELINES FOR OFFSETTING OPPOSING LEFT-TURN LANES ON FOUR-LANE DIVIDED ROADWAYS.

**Author**
McCoy P T; Navarro U R; Witt W E
Safety Effects of Protected and Protected/Permitted Left-Turn Phases.
http://rip.trb.org/view/1401286

Abstract: This project will estimate the safety effects of protected and protected/permitted left-turn phases for different intersection conditions and provide operational recommendations. Protected left-turn phases at signalized intersections are intended to reduce the frequency of angle collisions that result from conflicts between left-turning vehicles and opposing through vehicles. Various studies have demonstrated the overall safety effectiveness of protected left-turn phases (e.g., Harkey et al., 2008; Davis and Aul, 2007). The American Association of State Highway and Transportation Officials National Cooperative Highway Research Program (AASHTO’s NCHRP) 500 series also notes that the frequency of rear-end and sideswipe crashes between left-turning vehicles and following-through vehicles can also be reduced with properly timed, protected left turns. There is not a consensus on the extent of this safety effectiveness under different intersection conditions. While separate left-turn phasing may reduce delay for left-turning vehicles, it may increase the overall intersection delay and disrupt traffic progression. It is therefore important to understand the safety effects of protected left-turn phases under a variety of intersection conditions so that appropriate operational and safety trade-offs can be quantified and considered by agency decision makers. Protected/permitted left-turn phasing is sometimes used as a compromise between fully-protected and permitted only phasing. Information on the safety effects of protected/permitted under a variety of intersection conditions is needed as well. Intersection conditions of interest will be selected with input from the project’s technical advisory committee, but may include factors such as turning volumes, opposing through volumes, pedestrian crossing volumes, approach speeds, sight distance, number of lanes, and type of channelization.
<table>
<thead>
<tr>
<th><strong>Title</strong></th>
<th>Methodology for Critical-Gap Analysis at Intersections with Unprotected Opposing Left-Turn Movements.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Author</strong></td>
<td>Ogallo Hellon O; Jha Manoj K</td>
</tr>
<tr>
<td><strong>Source</strong></td>
<td>Journal of Transportation Engineering. 2014/5. Content ID 04014045 (Figs., Refs., Tabs.)</td>
</tr>
<tr>
<td><strong>URL</strong></td>
<td><a href="http://dx.doi.org/10.1061/(ASCE)TE.1943-5436.0000691">http://dx.doi.org/10.1061/(ASCE)TE.1943-5436.0000691</a></td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>This paper presents a methodology for critical gap analysis at signalized intersections with unprotected opposing left-turn movements. Highway capacity manual (HCM) methodology for estimating potential capacity uses base critical gap and base follow-up time, which are adjusted to reflect specific conditions of each intersection. That methodology assumes an unobstructed line-of-sight for drivers while executing left-turn maneuvers. However, the line-of-sight is not always unimpeded. Previous studies have shown that leading noncompact (larger and taller) vehicles and vehicles in the opposing left-turn lane may impede the line-of-sight. Specifically, the studies have demonstrated that the impedance may result in a capacity reduction. In order to quantify the capacity reduction, we present a methodology to modify the HCM critical gap and follow-up time model when the line-of-sight of unprotected left turn maneuver is obstructed. The authors introduce new adjustment factors to account for vehicles in the opposing left-turn lane obstructing the line-of-sight during the left-turn maneuver. Using field data from Baltimore and Annapolis, Maryland, we show that the obstruction increases the left-turn critical gap and the left-turn follow-up time, and hence decreases the potential capacity for left turns at intersections with unprotected left-turn movements. This capacity reduction may be a significant contributor to systemwide delay during rush hour, and may influence dilemma zone and red light running behavior, which are subjects of future research.</td>
</tr>
<tr>
<td><strong>Publication Year</strong></td>
<td>2014</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Title</strong></th>
<th>Design and Implementation of Slot Left-Turn Lanes on the Manitoba Highway Network.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Author</strong></td>
<td>HARTMANN B; DURANT D</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Provincial Trunk Highway (PTH) 12 in the City of Steinbach, Manitoba, is a 4-lane divided roadway. As it was originally designed to expressway standards, the medians are wide to provide appropriate separation of traffic. Making direct left...</td>
</tr>
</tbody>
</table>
turns from PTH 12 is problematic because the large intersection footprint results in poor sightlines when signalized and adds to driver confusion, with many drivers making left turns by passing opposing left-turn traffic on the right. The City of Steinbach has seen rapid growth over the past decade, and development along PTH 12 has necessitated the improvement of operations at several intersections. Manitoba Infrastructure and Transportation (MIT) has begun implementing slot left-turn lanes in an attempt to remediate these issues. Three intersections in Steinbach have received this treatment over the past seven years and public reaction appears to be positive. Proper selection of design speed and vehicle are crucial when designing slot left-turn lanes. Furthermore, signage and lane markings must be appropriate for both seasoned urban drivers and rural drivers who are unfamiliar with this form of channelization. The configuration and location of a raised divisional island must take into account maintenance (snow clearing) and emergency vehicle access. MIT has used the knowledge gained in designing, constructing and operating slot left-turns to refine the design for future applications. (A) For the covering abstract of this conference see ITRD record number 201310RT334E.
Publication  1992
Year