



Safety of Marked Crosswalks vs. Unmarked Crosswalks

Prepared for
WisDOT Northeast Region

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Transportation Literature Searches are prepared for WisDOT staff and investigators to identify completed research and other authoritative information in an area of interest. The citations below are representative, rather than exhaustive, of available English-language studies on the topic. Primary online resources for the literature searches are OCLC's [WorldCat](#) and [TLCat](#), U.S. DOT's [TRIS Online](#), the National Transportation Library ([NTL](#)), TRB's Research in Progress ([RiP](#)) database, and other academic, engineering and scientific databases as appropriate.

To request a literature search, contact the WisDOT Library at library@dot.state.wi.us or (608) 264-8142, or WisDOT Research at research@dot.state.wi.us or (608) 261-8198.

Topic/Problem Statement: Document relevant research studies concerning the comparative safety of marked pedestrian crosswalks and unmarked crosswalks.

Keywords: Crosswalks, pedestrian safety, traffic calming, marked crosswalks, unmarked crosswalks.

Summary

We found multiple citations dating back to 2000 that address these topics. In the course of this literature search, we identified two kinds of studies. The primary citations deal with the comparative safety of marked crosswalks vs. unmarked crosswalks. Closely connected to this basic issue are studies designed to measure the relative effectiveness of various methods of "marking" crosswalks for increased effectiveness, including both actual marking (paint, lighting) as well as crosswalk and roadway design ("traffic calming").

The citations below are arranged according to these subcategories. While some studies do not fit strictly under these headings, we have grouped each study according to its primary focus area as follows:

- Safety of marked vs. unmarked crosswalks (3 studies)
- Crosswalk marking methods (8 studies)

Citations

Results are listed chronologically within each category, with the most recent citations first. Links to online copies of cited literature are provided when available. Contact the WisDOT Library to obtain hard copies of citations.

Safety of Marked vs. Unmarked Crosswalks

Title: Safety Effects of Marked versus Unmarked Crosswalks at Uncontrolled Locations: Final Report and Recommended Guidelines

Author(s): C.V. Zegeer, J.R. Stewart, H.H. Huang, P.A. Lagerwey, J. Feaganes, B.J. Campbell

Date: September 2005

Source/URL: FHWA Publication HRT-04-100, <http://www.tfhrc.gov/safety/pubs/04100/04100.pdf>

Description: 114 pp.

Contents: Pedestrians are legitimate users of the transportation system, and they should, therefore, be able to use this system safely. Pedestrian needs in crossing streets should be identified, and appropriate solutions should be selected to improve pedestrian safety and access. Deciding where to mark crosswalks is only one consideration in meeting that objective. The purpose of this study was to determine whether marked crosswalks at uncontrolled locations are safer than unmarked crosswalks under various traffic and roadway conditions. Another objective was to provide recommendations on how to provide safer crossings for pedestrians. This study involved an analysis of 5 years of pedestrian crashes at 1,000 marked crosswalks and 1,000 unmarked comparison sites. All sites in this study had no traffic signal or stop sign on the approaches. Detailed data were collected on traffic volume, pedestrian exposure, number of lanes, median type, speed limit, and other site variables. Poisson and negative binomial regressive models were used. The study results revealed that on two-lane roads, the presence of a marked crosswalk alone at an uncontrolled location was associated with no difference in pedestrian crash rate, compared to an unmarked crosswalk. Further, on multilane roads with traffic volumes above about 12,000 vehicles per day, having a marked crosswalk alone (without other substantial improvements) was associated with a higher pedestrian crash rate (after controlling for other site factors) compared to an unmarked crosswalk. Raised medians provided significantly lower pedestrian crash rates on multilane roads, compared to roads with no raised median. Older pedestrians had crash rates that were high relative to their crossing exposure. More substantial improvements were recommended to provide for safer pedestrian crossings on certain roads, such as adding traffic signals with pedestrian signals when warranted, providing raised medians, speed-reducing measures, and others.

Title: Safety Analysis of Marked versus Unmarked Crosswalks in 30 Cities

Author(s): C.V. Zegeer, C. Tan Esse, J.R. Stewart, H.F. Huang, P. Lagerwey.

Date: 2004

Source/URL: *ITE Journal*

Description: 8 pp. (34-41).

Contents: Marked crosswalks are often provided at uncontrolled locations in order to facilitate pedestrian crossings. However, there is concern and controversy regarding the safety impacts of such crosswalks. This study evaluates marked crosswalks at uncontrolled locations to determine whether marked crosswalks were safer than unmarked crosswalks under various traffic and roadway conditions. Recommendations are also given on how to provide safer crossing for pedestrians. A treatment and matched comparison site methodology was used to quantify the pedestrian crash risk of marked versus unmarked crosswalks. Detailed information was collected at each of 2,000 sites, including pedestrian crash history, estimates of daily pedestrian volumes and average daily traffic volume (ADT). All sites were intersection or midblock locations with no traffic signals or stop signs on the main road approach. Poisson modeling and negative binomial regression were used in the data analysis. The results suggest that marked crosswalks were not found to have any positive or negative effect on pedestrian crash rates on two-lane roads and low volume multi-lane roads. For three-lane roads, adding marked crosswalks alone without any other substantial crossing improvements generally is not recommended for an ADT greater than 12,000. Marked crosswalks alone also are not recommended at uncontrolled crossing locations on multi-lane roads where traffic volume exceeds approximately 12,000 vehicles per day with no raised medians or approximately 15,000 ADT with raised medians that serve as refuge areas. In some situations such as low speed, two-lane streets in downtown areas, installing a marked crosswalk may help consolidate multiple crossing points. Overall results suggest that marked crosswalks are best used in combination with other treatments.

Title: Safety Effects of Marked versus Unmarked Crosswalks at Uncontrolled Locations: Analysis of Pedestrian Crashes in 30 Cities (with Discussion and Closure)

Author(s): C.V. Zegeer, J.R. Stewart, H. Huang, P. Lagerwey.

Date: 2001

Source/URL: *Transportation Research Record 1773, Part 2: Bicycle and Pedestrian Research*, 2001: 56-68.

Description: 13 pp.

Contents: Pedestrians are legitimate users of the transportation system and they should, therefore, be able to use the system safely. Pedestrian needs in crossing streets should be identified, and appropriate solutions should be selected to improve pedestrian safety and access. Deciding where to mark crosswalks is only one consideration in meeting that objective. This study involved an analysis of 5 years of pedestrian crashes at 1,000 marked crosswalks and 1,000 matched unmarked comparison sites. None of the sites in this study had a traffic signal or stop sign on the approaches. Detailed data were collected on traffic volume, pedestrian exposure, number of lanes, type of median, speed limit, and other site variables. Poisson and negative binomial regressive models were used. Study results revealed that on two-lane roads the presence of a marked crosswalk alone at an uncontrolled location was associated with no difference in pedestrian crash rate, compared with an unmarked crosswalk. Further, on multilane roads with traffic volumes above about 12,000 vehicles per day, having a marked crosswalk was associated with a higher pedestrian crash rate (after controlling for other site factors) compared with an unmarked crosswalk. Raised medians

provided significantly lower pedestrian crash rates on multilane roads, compared with roads without a raised median. Older pedestrians had crashes that were high relative to their crossing exposure. More substantial improvements were recommended to provide for safer pedestrian crossings, including adding traffic signals (with pedestrian signals) when warranted, providing raised medians, and implementing speed-reducing measures.

Crosswalk Marking

Title: Pedestrian and Bicyclist Intersection Safety Indices: User Guide

Author(s): D.L. Carter, W.W. Hunter, C.V. Zegeer, J.R. Stewart.

Date: 2007

Source/URL: Publication FHWA-HRT-06-130, <http://www.tfhrc.gov/safety/pedbike/pubs/06130/06130.pdf>

Description: 62 pp.

Contents: The primary objective of this study was to develop safety indices to allow engineers, planners, and other practitioners to proactively prioritize intersection crosswalks and intersection approaches with respect to pedestrian and bicycle safety. The study involved collecting data on pedestrian and bicycle crashes, conflicts, avoidance maneuvers, and subjective ratings of intersection video clips by pedestrian and bicycle experts. There were a total of 68 intersection crosswalks selected for the pedestrian analysis from the cities of Philadelphia, PA; San Jose, CA; and Miami-Dade County, FL. The bicycle analysis included 67 intersection approaches from Gainesville, FL; Philadelphia, PA; and Portland and Eugene, OR. Prioritization models were developed based on expert safety ratings and behavioral data. Indicative variables included in the pedestrian safety index model included type of intersection control (signal or stop sign), number of through lanes, 85th percentile vehicle speed, main street traffic volume, and area type. Indicative variables in the bicycle safety models (for through, right-turn, and left-turn bike movements) included various combinations of: presence of bicycle lane, main and cross street traffic volumes, number of through lanes, presence of on-street parking, main street speed limit, presence of traffic signal, number of turn lanes, and others. Through this User Guide, practitioners will be able to use the safety indices to identify which crosswalks and intersection approaches have the highest priority for in-depth pedestrian and bicycle safety evaluations and subsequently use other tools to identify and address potential safety problems.

Title: Overall Level-of-Service of the Urban Walking Environment and Its Influence on Pedestrian Route Choice Behavior: Analysis of Pedestrian Travel in Sapporo, Japan

Author(s): Thambiah Muraleetharan; Toru Hagiwara.

Date: 2007

Source/URL: TRB Annual Meeting CD-ROM, 2007.

Description: 16 pp.

Contents: The objective of this study is to better understand and quantify the influence of overall level-of-service (LOS) of the urban walking environment on pedestrian route choice behavior. A methodology was developed for estimating the overall LOS of pedestrian walkways and crosswalks based on the concept of total utility value, which comes from a stated preference survey. Each sidewalk and crosswalk link was assigned with an overall LOS according to its operational and geometrical characteristics collected from the field measurements. For analysis of pedestrian behavior, this study uses data from a revealed preference survey on individual route choice behavior. A geographic information system (GIS) network database was used to store the characteristics of routes used by pedestrians. Network analysis in ArcGIS was used to perform route analysis, which includes finding the shortest-path routes and the optimized LOS-path routes between origin-destination pairs. A comparative analysis between actual routes and estimated alternative routes was performed. Based on the results, a multinomial logit model was developed to quantitatively express the route choice behaviors of pedestrians. The model results indicate that pedestrians choose routes not only for distance, but also for the overall LOS of sidewalks and crosswalks. On longer travel paths, pedestrians divert from the shortest-path route and are found to use high LOS sidewalks and crosswalks. On shorter routes, pedestrians tend not to avoid low LOS sidewalks or crosswalks. This analysis suggests that efforts to accommodate pedestrians in urban areas should focus on improving the walking environment of the road network.

Title: New Cooperative Research Programs Report: Improving Pedestrian Safety at Unsignalized Crossings

Author(s): K. Fitzpatrick.

Date: 2007

Source/URL: *TR News No. 251.*

Description: 2 pp.

Contents: Award-winning research jointly sponsored by the National Cooperative Highway Research Program (NCHRP) and the Transit Cooperative Research Program (TCRP) has produced quantitative guidelines to help engineers and transit agencies determine the recommended treatments appropriate for unsignalized pedestrian

crossings in various street environments and traffic conditions. This article briefly introduces TCRP Report 112–NCHRP Report 562, discusses its quantitative procedures, and points out its development of supporting information on pedestrian walking speeds and the yielding behavior of motorists.

Title: Pedestrian Scramble Signal in Chinatown Neighborhood of Oakland, California: An Evaluation

Author(s): A.K. Bechtel, K.E. MacLeod, D.R. Ragland.

Date: 2004

Source/URL: *Transportation Research Record 1878*, 2004: 19-26.

Description: 8 pp.

Contents: In 2002 the city of Oakland, California, implemented a scramble signal at the intersection of 8th and Webster Streets. Scrambles are traffic signals that give pedestrians exclusive access to an intersection by stopping vehicular traffic on all approaches, allowing pedestrians to cross diagonally or conventionally. The primary objective of this evaluation was to determine whether the installation of the pedestrian scramble at this location increased pedestrian safety. An analysis was conducted of pedestrian–vehicle conflicts and pedestrian violations occurring at the intersection before and after the signal was modified, and pedestrians were surveyed to ascertain public attitude toward and comprehension of the change. The modification to scramble signal phasing at the intersection resulted in a statistically significant decrease in conflicts between pedestrians and vehicles and a statistically significant increase in pedestrian violations. In general, pedestrians understood the change in the way the intersection operated and were accepting of the change. These results suggest that the scramble has been effective overall in improving safety conditions at the site. The increased number of violations occurring despite decreased conflicts is in part due to a proportion of pedestrians who cross illegally on the “safe side” crosswalk (i.e., the crosswalk parallel to moving traffic in which there are no opportunities for conflicts). It is important that the scramble signal be monitored over time to quantify the extent to which reduced vehicle–pedestrian conflicts associated with the scramble translate into measurable reductions in pedestrian injuries and fatalities.

Title: Methodology to Assess Design Features for Pedestrian and Bicyclist Crossings at Signalized Intersections

Author(s): N. Steinman, D.K. Hines.

Date: 2004

Source/URL: *Transportation Research Record 1878*, 2004: 42-50. A similar paper also appears in the proceedings of the 2nd Urban Street Symposium, held July 2003 in Anaheim, Calif.; see http://www.urbanstreet.info/2nd_sym_proceedings/Volume%202/Hines.pdf.

Description: 9 pp.

Contents: The Department of Transportation of the city of Charlotte, North Carolina, has developed a methodology to assess the important design features that affect pedestrians and bicyclists crossing signalized intersections. Referred to as level of service, this methodology identifies and evaluates features according to their influence on the comfort and safety of pedestrians and bicyclists. Among the key features identified and rated are crossing distance, roadway space allocation (i.e., crosswalks, bike lanes), corner radius dimension, and traffic signal characteristics. This methodology can be used as a diagnostic tool to assess and improve pedestrian and bicyclist levels of comfort and safety by modifying design and operational features of intersections. Results can be compared with those for traffic levels of service of an intersection and weighed according to user priorities. This methodology will be included in Charlotte’s new street design guidelines and will be used to select design and operational features that can help achieve desired levels of service for pedestrians and bicyclists.

Title: Toward Vision Zero at Zebra Crossings: Case Study of Traffic Safety and Mobility for Children and the Elderly, Malmö, Sweden

Author(s): C. Johansson, P. Gårder, L. Leden.

Date: 2003

Source/URL: *Transportation Research Record 1828*, 2003: 67-74.

Description: 8 pp.

Contents: The Swedish Vision Zero’s goal is to eliminate all fatalities and incapacitating traffic injuries. One step toward Vision Zero is through traffic. Code changes are also part of this effort. The Swedish Code concerning car drivers’ responsibility to give way to pedestrians was strengthened in 2000. A study was done to evaluate the short-term effects of the change in the code, as well as of the reconstruction of urban intersections to eliminate overtaking and speeding over 30 km/h. The focus of the evaluation was on children and elderly people, as pedestrians and cyclists. Between 1995 and 1999, an average of 7 pedestrians were killed and about 60 seriously injured at unsignalized zebra crossings. In 2001, those numbers were 8 and 70, respectively, despite the fact that some crosswalks were eliminated in connection with the change of the code. The conclusion is that the change of code has not improved safety. Field studies in Malmö in regard to behavior, speed, and conflicts, as well as analysis of crash

data, show that the code change has increased mobility for cyclists, whereas motor vehicle speeds did not change significantly. The reconstruction increased mobility further and, at least based on indirect measures, improved safety. Also, safe traffic behavior, expressed as one's looking sideways, increased somewhat at the reconstructed intersections, but stopping at the curb before crossing the street decreased. Children and the elderly did not benefit more than people in other age groups.

Title: Effects of Innovative Pedestrian Signs at Unsignalized Locations: Three Treatments

Author(s): H. Huang, C. Zegeer, R. Nassi.

Date: 2000

Source/URL: *Transportation Research Record 1705*, 2000: 43-52.

Description: 10 pp.

Contents: Three types of devices that have been used in conjunction with marked crosswalks in an attempt to improve pedestrian safety were evaluated: an overhead crosswalk sign in Seattle, Washington; pedestrian safety cones (which read, "State Law: Yield to Pedestrians in Crosswalk in Your Half of Road") in New York State and in Portland, Oregon; and pedestrian-activated overhead signs (which read, "Stop for Pedestrians in Crosswalk") in Tucson, Arizona. The signs were used under varying traffic and roadway conditions. The effects of these three treatments on pedestrian and motorist behavior were evaluated. The variables of interest were whether pedestrians had the benefit of motorists yielding to them; whether pedestrians had to run, hesitate, or abort their crossing; and whether pedestrians crossed in the crosswalk. The New York cones and Seattle signs were effective in increasing the numbers of pedestrians who had the benefit of motorists yielding to them. At one location in Tucson, the overhead sign increased motorist yielding to pedestrians. The signs in Seattle and Tucson were effective in reducing the number of persons who had to run, hesitate, or abort their crossing. None of the treatments had a clear effect on whether people crossed in the crosswalk. By themselves, these devices cannot ensure that motorists will slow down and yield to pedestrians. It is essential to use these and other devices along with education and enforcement, but creation of friendlier pedestrian environments (e.g., by means of implementing geometric improvements) for the purpose of reducing vehicle speeds may be more important.

Title: Effects of Traffic Calming Measures on Pedestrian and Motorist Behavior

Author(s): H.F. Huang, M.J. Cynecki.

Date: 2000

Source/URL: *Transportation Research Record 1705*, 2000: 26-31.

Description: 6 pp.

Contents: By slowing down vehicle traffic, shortening crossing distances, and enhancing motorist and pedestrian visibility, traffic calming treatments may benefit pedestrians who are crossing the street. The effects of selected traffic calming treatments on pedestrian and motorist behavior were evaluated at both intersection and midblock locations. Before and after data were collected in Cambridge, Massachusetts (bulbouts and raised intersection), Corvallis, Oregon (pedestrian refuge island), Seattle, Washington (bulbouts), and Sacramento, California (refuge islands). The key findings include that none of the treatments had a significant effect on the percentage of pedestrians for whom motorists yielded, the treatments usually did not have a significant effect on average pedestrian waiting time, and refuge islands often served to channelize pedestrians into marked crosswalks. The raised intersection in Cambridge also increased the percentage of pedestrians who crossed in the crosswalk. While traffic calming devices have the potential for improving the pedestrian environment, these devices by themselves do not guarantee that motorists will slow down or yield to pedestrians.