



COMPARATIVE EVALUATION ON LEFT TURN SAFETY MEASURES AT SIGNALIZED INTERSECTIONS IN NEW YORK CITY

H. Joon Park
New York City Dept. of Transportation
55 Water St 6Fl, New York, NY 10041
Phone: + 1-212-839-7757 E-mail: hpark@dot.nyc.gov

1. INTRODUCTION

New York City Department of Transportation (NYCDOT) took an exhaustive look in 2016 at the problem of left turn pedestrian and bicyclist injuries and fatalities in New York City. It was studied with querying five years from 2010 to 2014 of citywide crash data which consisted of 1,105 crash reports drawn from the most problematic locations citywide, and 478-intersection analyses where treatments were installed. The study relies on these findings to provide recommendations for additional engineering, planning, and education efforts to prevent and mitigate left turn failure to yield pedestrian and bicyclist injuries. Because they were based on crash report, detailed comparative analysis using field video data is necessary to support those findings in the crash study and extend current left-turn tool box at approximately 13,000 signalized intersections in New York City.

Left turn movements have induced more conflict points with pedestrians and vehicles but have also created adverse impacts to traffic operations. During the permitted phase drivers should find a safe gap for opposing vehicles and conflicting pedestrians in the middle of the intersection. Therefore, as safety improvement measures, many signal or movement control policies such as a full or partial exclusive signal phase for turning vehicle and/or pedestrian movements as well as left-turn prohibitions have been introduced to reduce vehicle-vehicle and vehicle-pedestrian conflicts. Signal timing plans with exclusive left turn phases constraint capacity of traffic and pedestrian movements while left-turn prohibitions cause detours and may transfer traffic impacts to other intersections.

The purpose of this paper is to evaluate effective safety measures and elements for left turn movements at signalized intersections by performing a comparative video analysis on trajectories and speeds, gap time and headway of left-turning vehicle and conflicting pedestrians during the permitted and protected phases. Understanding driver behaviors during both phases and related pedestrian-vehicle, and vehicle-vehicle interactions will help to identify appropriate left-turn control guidelines and designs at signalized intersections and develop effective control policies to provide safe and more efficient environment for pedestrians and vehicles.

2. ANALYSIS METHODOLOGY

Video data were collected and processed at study locations in New York City. It includes video data analyses of trajectories, gap time and headway of left-turn movements and patterns during permitted and exclusive signal phases at selected intersections.

Drivers' gap acceptance time and vehicle trajectories are good fundamental indicators to illustrate left-turn behaviors at signalized intersection. A driver generally makes left-turn movement when an acceptable gap is larger than a critical gap. Vehicle trajectories indicate conflicts points and calculated crash probability at signalized intersection. Statistical tests were applied to explore relationship among gap acceptance time, turning vehicles' irregular trajectories, time to conflict points and the expected

number of crashes accidents. These tests indicate that shorter gap acceptance time and time to conflict points, and irregular turning trajectories would have positive relations with expected number of accidents.



(a) Left turn trajectories during Permitted phase

(b) Left turn trajectories during Permitted phase

Figure 1: Left Turn Vehicle Trajectories and Speeds at Flatbush Avenue and Fulton Street

3. ANALYSIS RESULTS

As expected, drivers tended to accept small gaps during the permitted phase, the probability of crash exposure with opposing vehicles and concurrent pedestrians were significantly increased. In addition, vehicle trajectories during the permitted phase were more varied than those during the protected phase. The result of the gap analysis confirmed the positive effect of the protected phase. Drivers would accept smaller gaps, expand the conflict area of a typical crosswalk, and travel with high speeds during the permitted phase while they took longer passage time to clear the conflict area at the intersections. During the protected phase, drivers generally accept longer gaps and regular trajectory paths than those during the permitted phase. Drivers' aggressiveness in gap and turning trajectories would induce higher probability of crashes. The painted marking and design for trajectory path or control of turning vehicles design on crosswalks can be effective control policies at signalized intersections with high turning and pedestrian volumes. They can help prevent drivers from making aggressive turning maneuvers.

Thus, this study confirms that not only traditional control policies such as leading pedestrian intervals (LPs), left turn restrictions and left turn signals but also new control approach including Enhanced Daylighting/Slow Turn Wedge are effective measurements to improve safety of left-turning vehicles. Red pavement also has a positive effect on increasing the safety of pedestrians.



(a) Pre-implementation condition



(b) Post-implementation condition

Figure 2: NYCDOT's Left Turn Calming Program (Slow Turn Wedge) at 86th Street and Merrick Boulevard

REFERENCES

- Alhajyaseen, W. K., Asano, M., Nakamura, H., & Kang, N. (2011). Gap acceptance models for left-turning vehicles facing pedestrians at signalized crosswalks. In Proceedings of the 3rd International Conference on Road Safety and Simulation.
- Iasmin, H., Kojima, A., & Kubota, H. (2016). Safety effectiveness of pavement design treatment at intersections: Left turning vehicles and pedestrians on crosswalks. *IATSS Research*, 40(1), 47-55.
- Iryo-Asano, M., Alhajyaseen, W., Zhang, X. and Nakamura, H. (2015). Analysis of Pedestrian Speed Change Behavior at Signalized Crosswalks. Proceedings of the Road Safety & Simulation International Conference, Orlando Florida, pp. 1606-1618.
- Lord, D. (1996). Analysis of pedestrian conflicts with left-turning traffic. *Transportation Research Record: Journal of the Transportation Research Board*, (1538), 61-67.
- New York City Department of Transportation (2016), Don't Cut Corners: Left Turn Pedestrian & Bicyclist Crash Study.