MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 19-377 (project 495) | October 2019

Safety Effects of Protected and Protected/ Permissive Left-Turn Phases

the ISSUE

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 and right-turning vehicles. Previous research demonstrated the overall safety effectiveness of protected left-turn phases, but the extent of the safety effects for protected-permissive left-turn phases, particularly with the recent introduction of the flashing yellow arrow indication, has not been clearly established.

the RESEARCH

This study presents an approach-level evaluation of the safety performance of left-turn phases including permissive, protected-permissive, protected, and, in particular, flashing yellow arrow indications. Extensive field data collection and processing were used to create reliable approach-level datasets. These efforts included manual identification of locations and extraction of exact dates of flashing yellow arrow (FYA) installations, extraction and processing of long-term high-resolution left-turn and opposing volumes, and manual verification of crashes to correct travel directions and crash assignments to specific approaches. Statistical models produced consistent trends among the three main groups being evaluated (permissive to FYA, permissive-protected to FYA, and protected to FYA) using an empirical Bayes (EB) before-after methodology. Safety performance functions were developed for permissive, permissive-protected, and FYA indications. Additional analysis included time-of-day, seasonal trends, and possible novelty effects soon after a FYA indication was installed. A risk metric using high-resolution data (5-minute counts) was also proposed to continuously monitor left-turn crash risks.

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Project Title

Safety Effects of Protected and Protected/Permitted Left-Turn Phases

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the **FINDINGS**

Analysis showed similar performance of the FYA indication compared to a permissive phase, and higher crash rates with the FYA indication compared to a protected-permissive left-turn (PPLT) phase (an increase of 0.28 crashes per approach per year for an average approach, and a crash modification factpr (CMF) of 1.33 ± 0.12). An important caveat to direct and strict comparisons between FYA and PPLT arises from differences in their operational capabilities not included in this evaluation. As expected, crashes with protected phases did not show valid systematic trends because crashes were not a result of permissive movements but due to traffic violations. A time-of-day analysis revealed a higher-than-expected concentration of crashes before the afternoon peak (2 p.m.-4 p.m.), pointing at opportunities to further reduce crashes. Lastly, a new metric to estimate risk of left-turn crashes using high-resolution data (5-minute counts) was introduced to monitor intra-day risk fluctuations in real time.

the **IMPACT**

Results will help improve understanding of the safety performance of different left-turn phase indications. Transportation engineers will use such results to model future crash frequencies and guide selection of left-turn phase indications by site, and strategies by time of day. Analyses of such detailed and carefully-harvested datasets are rare in the literature and will complement the current body of literature to support decision making. Exploration of high-resolution data opened new opportunities to obtain real-time metrics to monitor left-turn crash risk.

For more information on this project, download the entire report at https://www.ugpti.org/resources/reports/details.php?id=972

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7767 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.