World Academy of Science, Engineering and Technology
International Journal of Civil and Architectural Engineering
Vol:11, No:03, 2017

Performance Evaluation of Various Displaced Left Turn Intersection Designs

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Abstract : With increasing traffic and limited resources, accommodating left-turning traffic has been a challenge for traffic engineers as they seek balance between intersection capacity and safety; these are two conflicting goals in the operation of a signalized intersection that are mitigated through signal phasing techniques. Hence, to increase the left-turn capacity and reduce the delay at the intersections, the Florida Department of Transportation (FDOT) moves forward with a vision of optimizing intersection control using innovative intersection designs through the Transportation Systems Management & Operations (TSM&O) program. These alternative designs successfully eliminate the left-turn phase, which otherwise reduces the conventional intersection's (CI) efficiency considerably, and divide the intersection into smaller networks that would operate in a one-way fashion. This study focused on the Crossover Displaced Left-turn intersections (XDL), also known as Continuous Flow Intersections (CFI). The XDL concept is best suited for intersections with moderate to high overall traffic volumes, especially those with very high or unbalanced left turn volumes. There is little guidance on determining whether partial XDL intersections are adequate to mitigate the overall intersection condition or full XDL is always required. The primary objective of this paper was to evaluate the overall intersection performance in the case of different partial XDL designs compared to a full XDL. The XDL alternative was investigated for 4 different scenarios; partial XDL on the east-west approaches, partial XDL on the north-south approaches, partial XDL on the north and east approaches and full XDL on all 4 approaches. Also, the impact of increasing volume on the intersection performance was considered by modeling the unbalanced volumes with 10% increment resulting in 5 different traffic scenarios. The study intersection, located in Orlando Florida, is experiencing recurring congestion in the PM peak hour and is operating near capacity with volume to a capacity ratio closer to 1.00 due to the presence of two heavy conflicting movements; southbound and westbound. The results showed that a partial EN XDL alternative proved to be effective and compared favorably to a full XDL alternative followed by the partial EW XDL alternative. The analysis also showed that Full, EW and EN XDL alternatives outperformed the NS XDL and the CI alternatives with respect to the throughput, delay and queue lengths. Significant throughput improvements were remarkable at the higher volume level with percent increase in capacity of 25%. The percent reduction in delay for the critical movements in the XDL scenarios compared to the CI scenario ranged from 30-45%. Similarly, queue lengths showed percent reduction in the XDL scenarios ranging from 25-40%. The analysis revealed how partial XDL design can improve the overall intersection performance at various demands, reduce the costs associated with full XDL and proved to outperform the conventional intersection. However, partial XDL serving low volumes or only one of the critical movements while other critical movements are operating near or above capacity do not provide significant benefits when compared to the conventional intersection.

Keywords : continuous flow intersections, crossover displaced left-turn, microscopic traffic simulation, transportation system management and operations, VISSIM simulation model
Conference Title : ICHTE 2017 : International Conference on Highway and Transportation Engineering
Conference Location : Paris, France
Conference Dates : March 29-30, 2017