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Efficiency and Safety Evaluation of Unconventional Intersections

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Abstract

The conventional countermeasures such as pre-timed, semi-actuated, and actuated signals, signal coordination systems, multiple left-turn lanes, and intelligent transportation systems are not able to overcome the safety and operational problems of traffic congestion (e.g., delay, fuel consumption, crashes, and pollution) in many urban and suburban areas. The unconventional designs have therefore attracted engineers' attention as an alternative to solve these problems. Two main objectives of the unconventional designs are reducing delay and the number of conflict points. The unconventional alternatives may reduce the number of conflict points by re-routing some left-turns. It is, however, vital to know whether they can improve safety by reducing the number and intensity of traffic conflicts between vehicles. This research focuses on evaluating the efficiency and estimating the number and intensity of conflicts between vehicles (as a surrogate safety measure) for six most common unconventional intersection (unsignalized median U-turn, signalized median U-turn, super street, bowtie, forward jughandle, and reverse jughandle) and three conventional intersection (pre-timed, optimized, and actuated) designs by simulating the real-world traffic information using VISSIM, Synchro and Surrogate Safety Assessment Model (SSAM) software. According to the final results, pre-timed conventional intersection has the worst performance, while unsignalized and signalized median U-turn intersections have the best performance (i.e., lowest average delay, highest average speed, and lowest number of conflicts, except their high conflicts' intensity and their long travelled distances). Furthermore, forward and reverse jughandles are safest designs. In addition, super streets cannot be appropriate design alternatives due to their low average speed, high average delay, and high number of conflicts.

Keywords: Traffic Simulation, Unconventional Intersections, Traffic Conflicts, Measures of Effectiveness

1. INTRODUCTION

As the growth rate of population and auto ownership is higher than construction of new roadways and transportation facilities, traffic congestion is a major problem in many urban and suburban areas. Congestion leads to several operational, environmental, and safety problems as well as increase in fuel consumption. Since transportation engineers have not overcome these problems using demand management policies and other conventional countermeasures, unconventional designs have gained their attention [1]. Two main principles of unconventional alternatives are reducing delay to through vehicles and the number of conflict points at intersections [2]. However, it is still important to study how much they can reduce the delay and what is their effect on the number and intensity of traffic conflicts. Six types of unconventional intersections are studied in this research, including unsignalized median U-turn, signalized median U-turn, super street, bowtie, forward and reverse jughandle.

Their effectiveness is compared after simulation in VISSIM [3] using the real-world information. The number and intensity of conflicts between vehicles is also studied using Surrogate Safety Assessment Model (SSAM) software [4]. Comparing these unconventional designs with the basic conventional intersections including pre-timed, optimized (simulated in Synchro [5]), and actuated (simulated in VISSIM) signals helps to