Simulating Traffic Volumes of Different Interchange Designs Using VISSIM and Assessing Interchange Safety using SSAM

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Abstract

Highway Interchanges are utilized by millions of drivers everyday and can significantly affect the quality of life for those who use it every day. These interchanges must balance the high volume of vehicles with the necessary safety standards to make sure all users can have a safe and efficient journey to their destination. This author seeks to understand the benefits of different interchange designs using computer simulations and identifying conflict points. There are two interchanges being simulated, both connected to the Interstate 215 in San Bernadino County. The first interchange utilizes a partial cloverleaf design while the second interchange uses single exit design. Simulating the traffic on both interchanges will illuminate benefits and drawbacks for each design

Data Preparation

Data for the research was collected from 9 different intersections along the SR 215. Peak hour volume data was collected at each of these intersections in 2020 and documents the volume of vehicles that took either right-hand turns, left-hand turns, or went through in either the north, south, east, or west direction. This data helped simulate the conflict points at the different intersections nearby the two interchanges.

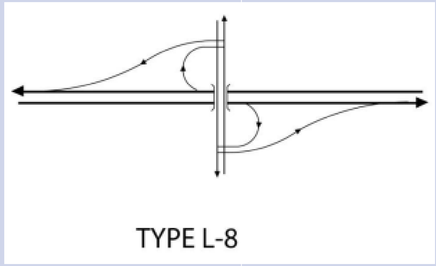
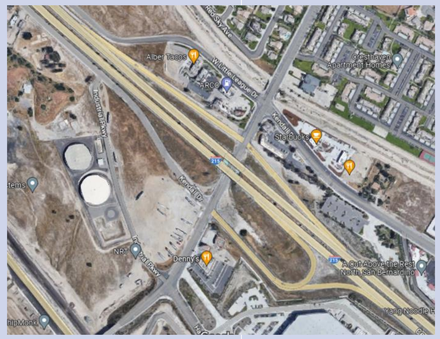
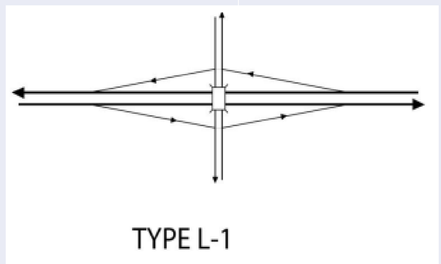
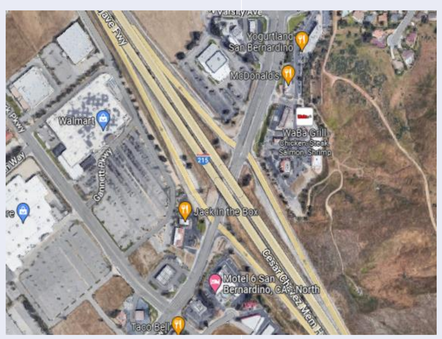
The provided data was hourly volume which needed to be translated to 5-minute loop data. Normally 5-minute loop data is collected from PeMS, the Caltrans Performance Measurement System. PeMS compiles data from loop sensors in roads and highways to give volume data. Since the PeMS data was not available, the 5-minute loop data was extrapolated from the hourly data by splitting the volume into 12 parts each representing 5 minutes of the hour.

SSAM

The Surrogate Safety Assessment Model (SSAM) is an application designed to evaluate traffic conflicts from traffic simulation models. A conflict is a situation where two drivers will likely collide without evasive action. The application also identifies conflict frequency and type of conflict to better aid in assessing the safety of a transportation system

*https://highways.dot.gov/research/safety/ssam/surrogate-safety-assessment-model-overview

Highway Interchange Designs

Type	Depiction & Description	
Partial Clover-Leaf Interchange	 	**Overview** A loop path for exit ramps and smooth path for entrance ramps **Advantages** • Safely accommodates left-turning movements • Good for use in rural or suburban locations **Disadvantages** • Require more right of way area • Requires more travel distance for the left-turning traffic. • Generates a weaving movement within a short distance.
Compact Diamond Interchange	 	**Overview** Straight paths for exit and entrance ramps **Advantages** • Most common therefore meets driver expectation. • Well suited for both rural and urban use. • Adaptable in major-minor road crossings • Lower cost. • Requires less right of way **Disadvantages** • Possible wrong-way entry on the ramps • Dangerous left-turning traffic at the crossroad intersections. • LOS decreases as the volume of traffic on the crossroad becomes heavy.

Methodology

The VISSIM program uses the traffic volume data to run simulations of actual traffic on the intersection. It attempts to mimic the likely behavior or drivers in that intersection using any data that is available. The data used to simulate the intersections was the existing highway design and the existing traffic volume. Using satellite imaging of the area of interest the highway and adjacent roads were mapped out using the programs drawing tools. These roads are then assigned with different pathways that vehicles can possibly take, and traffic volumes are assigned to each of these paths.

With this information the program simulates the vehicle input on the drawn paths and gives a traffic report that could possibly occur on a system like that. This is helpful for analysis as data is timely and costly to collect manually so the program does it artificially.

The traffic report is then analyzed by SSAM, a program that identifies conflict points based on reports like the one provided by VISSIM. This analysis can then be used to potentially to propose design changes of the actual interchange as the simulations predict collisions could occur at significant frequency at certain intersections

Evaluation

The evaluation of each intersection can be conducted with the output from the SSAM application. After inputting the simulation data from VISSIM, SSAM will identify conflict occurrences and type. Using this information, we can see the how the intersection is performing under current conditions and conclude whether its current state is acceptable or requires repair.

After inputting the VISSIM data for both interchanges the Compact Diamond Interchange showed no conflict points. This means the interchange is well designed to meet the traffic needs of the population. For the Partial Cloverleaf Interchange two conflict points were identified. Both conflict point were due lane changing, likely from the sharp curve of the offramps.

From the SSAM result we can conclude that the Compact Diamond Interchange is the safer design for the area of interest.