

# JOINT TRANSPORTATION RESEARCH PROGRAM

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## Performance of Alternative Diamond Interchange Forms

### *Volume 1 Research Report*

#### Introduction

Service interchanges connect freeways to arterial roads and are the backbone of the U.S. road network. Improving the operations of service interchanges is possible by increasing the capacity of the off-ramp intersections with a crossing road and eliminating or reducing the traffic interference between these two closely spaced intersections. Recently proposed solutions use three different methods: (1) eliminating the interference by merging the two intersections into a single one (single-point interchange), (2) adding roundabouts to eliminate traffic signals (single- or dual-roundabout diamond), or (3) improving the traffic flow by swapping the directions of traffic within the interchange area and redesigning traffic signals (diverging diamond). In addition, tight diamonds are proposed where space restrictions in the developed areas force planners and designers to reduce the interchange footprint. Together with a traditional diamond interchange, decision makers have available several forms of service interchanges.

These alternatives may perform quite differently depending on traffic and local conditions. The existing research for selecting alternative diamond interchange forms is incomplete for site-specific conditions. This study investigated the operational performance of six alternative diamond interchange forms: conventional diamond (DI), tight diamond (TDI), diverging diamond (DDI), single point (SPI), and double and single roundabout (RA). Performance comparison has been used for developing guidelines (Volume 2 of this report) for early stage screening of diamond forms. The guidelines will help identify the traffic and/or geometric conditions that support the use of one type of interchange over another, focusing on the traffic performance.

#### Findings

VISSIM has been used to perform 13,500 experiments to simulate the traffic performance of the studied alternative interchanges during a typical day for 25 geometry and traffic scenarios. Five measures of effectiveness (MOEs) were chosen for the alternative interchange performance comparison of the alternative diamond interchanges. These MOEs can effectively demonstrate the actual time lost at signalized and unsignalized interchange intersections and the queue spillback onto the freeway and adjacent surface intersections, as well as the perception of the traffic conditions by drivers. Five performance measures were investigated in this research: daily-average delay, level of service (LOS) of critical movement, daily-average number of stops, longest off-ramp queue, and longest crossing road queue.

##### **Daily-Average Delay**

- The obtained daily-average delays at the alternative interchanges were consistent with expectations.
- Roundabouts had the highest average delay across all off-ramp and crossing road traffic shares; TDI had the second highest average delay; and with an increase in the off-ramp volume share, DDI exhibited a lower average delay.
- Overall, SPI had the lowest average delay among all the alternatives.

##### **Level of Service (LOS) of Critical Movement**

- Roundabouts outperformed DI and TDI in terms of critical movement delay for 20 and 30 percent off-ramp volumes in the lower range of non-freeway flow rates.
- With the increased share of off-ramp traffic, DDI exhibited lower critical movement delays.

- With 50 percent and 60 percent off-ramp shares, DDI exhibited critical movement delays similar to SPI's.

### Daily-Average Number of Stops

- Roundabouts had the lowest number of average stops among all the alternatives up to 30,000 non-freeway AADT across all off-ramp and crossing road traffic shares.
- DI, TDI, and roundabouts had almost double the number of stops of DDI and SPI.
- With an increase in the off-ramp traffic share, DDI exhibited a smaller number of stops.
- Overall, SPI had the lowest number of average stops among all the alternatives.

### Longest Off-Ramp Queue

- DDI had the shortest and roundabouts had the longest queues on the off-ramp among all the alternatives across all off-ramp and crossing road traffic shares.
- With an increased share of off-ramp traffic, SPI exhibited queues on off-ramps shorter than DI and TDI.

### Longest Crossing Road Queue

- TDI had shorter queues on the crossing road DDI, DI, and roundabouts up to 3,500 veh/hr across all off-ramp and crossing road traffic shares.
- With the increased share of off-ramp traffic, DDI exhibited shorter queues on the crossing road.
- Overall, SPI had the shortest queues among all the alternatives.

## Implementation

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The results of this study were used to develop guidelines (Volume 2 of this report) that exhibit operational performance of six alternative diamond interchanges for 25 traffic and geometric scenarios and a wide range of traffic volumes. Each of these scenarios involve five performance measures (average delay, critical movement delay, average stops, longest queue on the off-ramp, and longest queue on the crossing road) to compare the alternative interchanges against each other. The guidelines provide a fair comparison procedure for alternative diamond interchanges in the preliminary planning and conceptual design stages.

## Recommended Citation for Report

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