

Appendix A

Roadway Design Information

Interchange Configurations, Intersections, and Traffic Signals

Tight Diamond Interchange (TDI)

Also known as a compact diamond interchange, this is the most commonly used interchange type for freeway connections to local roads, and most of the existing interchanges along I-10 within Pima County are of this type. This interchange provides for good traffic operations where ROW is restricted, such as the limitations imposed by the railroad along the eastern side of the interstate and the Santa Cruz River along the west. The ramps between the interstate and crossroad form a diamond shape in the traditional interchange layout, and this works well with frontage roads along each side of the freeway. Traffic exiting the interstate merges with other traffic on the frontage road and can turn in either direction onto the crossroad or can continue straight through the intersection to remain on the frontage road. The “tight” or “compact” designation comes from the spacing of the two ramp intersections. Typically, when the intersections are separated by less than 600 feet, it is designated as a “tight” diamond and the traffic signals of the two intersections function together to provide for better flow of traffic through both intersections.

Single Point Urban Interchange (SPUI)

A SPUI is a variation of a diamond style interchange that combines the two intersections of a tight diamond into a single intersection. The four ramps between the interstate and crossroad are the same as other diamond interchanges, but as they approach the crossroad, they converge into a single intersection, either above the freeway on a bridge or below the freeway at grade. The benefit is the one signalized intersection rather than two separate intersections of the tight diamond. Typically, the left turn curves are much higher radii, thus allowing for a higher speed left turn, which increases the volume of traffic that can move through each phase of the signal. Through movements along the frontage roads can be accommodated by adding another phase to the signals, but this diminishes the traffic operation performance and overall interchange capacity. The suitability of type of interchange is also dependent on the geometric configuration of the crossroad to the freeway. If the crossing angle between the two roadways is not close to perpendicular, the curves for the opposing left turns become imbalanced, which significantly increases the structure costs and the length of time required for drivers to clear the intersection. These inefficiencies limit the locations where a SPUI can be used cost effectively.

Diverging Diamond Interchange (DDI)

The DDI is a relatively new type of diamond interchange that is gaining popularity because of the efficiency of traffic movements. There is an intersection on each side of the freeway similar to a tight diamond, but with a DDI, the local street traffic crosses sides, from right to left, within the roadway segment over the freeway. This allows for both crossroad turning movements onto the freeway entrance ramps to be made in a free-flow left manner—the right turn onto the near-side ramps as well as the left turn onto the far-side entrance ramp. The through-movement crosses back over to the normal right side of the roadway at the far-side intersection. In a similar manner, the left and right turns off of the ramps onto the crossroads can be made without conflicts with opposing traffic. This allows the traffic signals at each of the two intersections to be operated with only two phases as opposed to the typical three-phase signals¹⁵ of the TDI. The elimination of one signal phase provides for a greater flow of traffic through the intersections with less delay. One of the major

¹⁵ A signal phase is the total period of time necessary to indicate green, yellow, and red for an individual direction of travel through an intersection.

disadvantages of the DDI configuration is that the traffic exiting the freeway must turn either left or right at the crossroad; there is no allowance for a through movement along the frontage roads. Providing for this movement would introduce another phase in the signal timing, thus forcing the signals to operate the same as a TDI. Another issue with a DDI is that the ROW required along the crossroad can be greater than a standard TDI in order to obtain the necessary roadway geometric layout.

Traffic Signals

The operation of traffic signals consists of establishing the timing of intervals, phases, and cycles. An interval is the period in which the color of the signal (red, yellow, or green) does not change. A signal phase is a group of three intervals—green for proceed, yellow for change, red for clearance and stop—that are assigned for a specific direction of movement through the intersection. A signal cycle is a combination of signal phases in which different approaches of vehicles are assigned to pass through the intersection. Each interval is assigned a discrete amount of time in seconds, and the combination of all interval times for a given cycle is referred to as the cycle length. Longer intervals to allow more vehicles to pass or additional phases of the signal result in longer cycle lengths that can increase the time vehicles are delayed while waiting for a green light. Pedestrian movements can be accommodated at intersections by providing either a concurrent or an exclusive pedestrian phase in the cycle. With an exclusive pedestrian phase, vehicular traffic is stopped in all directions to allow pedestrians to cross in all directions.

The traffic signal controller, an electrical device housed in a cabinet, directs which signal phase is to be called and for how long. The signal control can be either a preset fixed amount of time for each interval or can be actuated by the traffic itself. A fixed-time signal provides the same amount of time for each interval and each phase regardless of the travel demand. Actuated controllers receive signals from detector wiring embedded within the pavement or from detection cameras mounted on the signal mast arms, and have the ability to alter interval timing or to skip signal phases when there is no vehicular demand for a particular movement.