



Diverging Diamond Interchanges (DDI) **Point/Counterpoint Analysis**

Brian Toombs, PE

The Federal Highway Administration (FHWA) advocates innovative intersection designs such as the Diverging Diamond Interchange (DDI) to promote safety, increase capacity, decrease congestion and minimize the cost of new infrastructure.ⁱ

DDIs are catching on across the U.S., but concerns still exist about this new type of interchange. Is a DDI the right solution for all transportation systems? Read on for B&N's insight into common perceptions about a DDI.

◀ Point

Driving through a DDI goes against driver expectation.

Because motorists travel to the left side of the road as they cross over through a Diverging Diamond Interchange, there is a concern that this feels “wrong” to drivers.

▶ Counterpoint

Interchange geometry can make a DDI's traffic pattern intuitive for drivers.

In a well-designed DDI, the driver does not notice they are on the left side of the road until it is too late to change their travel pattern because the transition is seamless.

Optimizing the crossover geometry with a well-defined “eyebrow” and the inclusion of a tangent segment through the intersection are good practices to ensure that the driver a) stays

(Continued)

(Continued from Page 1)

in the proper lane and b) doesn't try to turn the wrong way through the crossover intersection.

Other tactics include the use of channelization islands, raised medians, signs and pavement markings – all of which can help focus the driver through the crossover intersection correctly and prevent motorists from deviating into the other lanes.

◀ Point

Because DDIs are a new interchange type in the United States, driver unfamiliarity will result in a higher number of crashes.

▶ Counterpoint

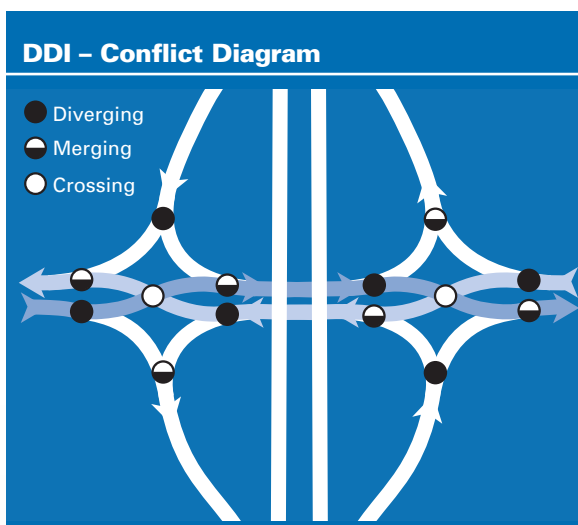
In a DDI, left turns that cross opposing traffic are eliminated, which reduces the number of potential conflict points by 42 percent compared to a traditional diamond interchange. Typically, reducing the number of conflict points reduces crashes.

When evaluating the safety of a location, reducing the severity of crashes is always a top priority. The number of head-on conflict points – typically resulting in the most severe crashes – is reduced by 80 percent in a DDI. In addition, DDIs operate at speeds lower than traditional interchanges, which typically results in less severe crashes.

The first DDI in the state of Ohio was built to replace a former diamond interchange that was plagued with a high frequency of congestion-related crashes. Since the DDI opened in October 2013, the crash rate has been reduced at this location by 31 percent and the crashes that resulted in injuries have decreased 60 percent!

In 2017, FHWA sponsored a field review of seven of the earliest DDIs constructed in the country with the goal of evaluating the safety effects of converting a standard diamond interchange to a DDI. The results of this evaluation suggest a crash modification factor (CMF) of 0.67 for all crashes (anticipate a reduction of 33 percent of all crashes) and a CMF of 0.59 for injury crashes (reduction of 41 percent) when implementing a DDI.*

*Source: Field Evaluation of Diverging Diamond Interchanges' FHWA Publication No.: FHWA DTFH61-10-R-00030





A visual simulation of pedestrians crossing through the center of a DDI.



The completed bike lane on the I-270/Roberts Road DDI in Columbus, Ohio.



In the I-270/Roberts Road DDI, bicyclists can travel on the inside edge of the roadway as they cross the freeway.

Point

DDIs cannot adequately accommodate pedestrians or bicyclists.

A DDI moves traffic efficiently by utilizing more free flow movements that are not as easily traversable by pedestrians. Like motorists, bicyclists may feel the movement of traffic is against expectations.

Counterpoint

Accommodations can be provided for pedestrians and bicyclists in a DDI, if consideration is given during the initial design phases. One simple measure is to make sure that pedestrian paths are clearly identified.

It is possible to reduce the number of vehicular free flow movements by strategically adding traffic signals for specific turning movements. Signalizing right turns from the ramps to the arterial provides a location for pedestrians to cross during a red light, reducing the exposure of pedestrians to vehicles. Because these signals at the ramp terminals are two phases, the intersection will still function well even if the traffic that is turning right is forced to stop at a red light.

Pedestrian accommodations can be added either down the center of the interchange or on the outside of the interchange. Placing them down the center allows for crossing at more signalized intersections, making pedestrians less vulnerable compared to crossing at free-flow ramps; however, placing pedestrian accommodations in the center requires planning ahead. Placing pedestrian accommodations on the outside is a common practice as well. To maximize pedestrian safety, pay attention to sight lines for BOTH the vehicles and the pedestrians when placing crosswalks, especially across free-flow ramps.

Similar to many bicycle facilities on a public roadway, travel patterns for bicycles should be placed on the outside of the roadway as they approach the DDI. Between the crossover intersections, bicyclists will remain on the right side of the adjacent traffic and along the inside edge of the roadway as they cross the freeway.

(Continued)

(Continued from Page 3)

Design for the bicyclists as you would a motorist in this situation – keep the path of the bicyclist as intuitive as possible through the crossover intersections and through the middle of the interchange.

The I-270/Roberts Road DDI in Columbus, Ohio is an example of how pedestrian and bicycle design features can be successfully incorporated into a DDI. It was the first DDI to open in the U.S. with dedicated bike lanes.

◀ Point

DDIs should only be used on low speed facilities.

Because vehicles typically travel through a DDI at less than 45 miles per hour (MPH), there is a belief that this interchange type is not a good fit for a high speed facility due to the speed change that is required.

▶ Counterpoint

While it is best to maintain lower speeds through a DDI (30-35 MPH, maximum), they can work on high speed facilities with proper geometry and speed control measures.

The approach geometry is important to facilitate proper speed control and adjust motorists from a high speed facility down to the desired speed of a DDI. Roadway geometry that will gradually lower the speed before entering the interchange – such as speed reducing curves – are helpful, as well as designing the geometry for acceleration as drivers leave the DDI. Also, the use or lack of super-elevation is a method that can be utilized to discourage high speeds.

Lowering the speed through an interchange can be beneficial, especially from a safety perspective. Lower speeds typically mean less severe accidents. A DDI shouldn't be eliminated as a potential alternative because the arterial is classified as high speed.

In the case of the I-270/Roberts Road DDI in Columbus, Ohio, Roberts Road is a high speed urban arterial with a speed limit of 50 MPH on the west side of the freeway, and a low speed



The driver's perspective approaching the I-270/Roberts Road DDI in Columbus, Ohio.

(Continued)

(Continued from Page 4)

urban arterial with a speed limit of 35 MPH on the east side. The interchange functions well for both directions of travel, regardless of which side of the interchange vehicles are arriving from.

The I-270/Roberts Road DDI geometry lowers the speed to 30 MPH using physical geometry so that motorists slow down before entering the crossover intersection. The geometry allows the operating speeds to increase after the opposite crossover intersection.

◀ Point

DDIs are a good alternative for any interchange.

▶ Counterpoint

DDIs are not a one-size-fits-all solution that will work everywhere.

As with any transportation design project, sound engineering should be the first step to determine if a DDI is the best solution. Details such as interchange skew; available right-of-way; use of ramp metering; adjacent intersection spacing; space from the crossover intersections to the bridges; and traffic volumes along the arterial in the interchange, especially the opposing through volumes, should be carefully analyzed.

Closely spaced adjacent intersections can cause queuing problems through the DDI, which can lead to safety issues. A lack of available right-of-way or heavy skew can cause geometric issues which could increase tendencies for wrong-way driving.



An aerial view of the new DDI at I-270/Roberts Road in Columbus, Ohio.

Is a DDI the Right Solution for Your Location?

Burgess & Niple (B&N) offers expertise in planning, traffic engineering, roadway design, environmental documentation, and right-of-way acquisition. Our transportation experts are ready to help you evaluate the DDI and other alternatives to identify the optimal solution for your project and budget.

Brian's Point of View



Brian Toombs, PE
Project Manager

Burgess & Niple, Inc.
5085 Reed Road
Columbus, OH 43220
614.459.7272 x1543
brian.toombs@burgessniple.com

As the Project Manager of the design team for the first DDI in the state of Ohio, Brian Toombs, PE, has firsthand insight into the successful design and construction of an award-winning Diverging Diamond Interchange. He's had the privilege of assisting with the design of 11 DDIs in six states, including the first DDIs in Ohio, Michigan and Indiana. Five of Brian's DDI projects have already been constructed.

With more than 20 years of experience as a transportation engineer, Brian has presented on DDIs at the state and national level. As a member of the Transportation Research Board, he has led workshop panels and moderated sessions on geometric design and lessons learned during the planning, design and construction of a DDI. He is a member of the American Society of Civil Engineers and American Society of Highway Engineers.

According to Brian, a DDI can be a cost-effective solution for interchanges with congestion and safety problems. In many locations, much of the existing infrastructure can be preserved, which saves money and shortens construction time. Oftentimes, fewer lanes are required to handle the same capacity.

While a DDI is not the right fit for every location, Brian advises that they are a viable alternative to solve traffic and safety issues at many interchanges.

ⁱFrom the U.S. Department of Transportation Federal Highway Administration, TechBrief: Drivers' Evaluation of the Diverging Diamond Interchange <http://www.tfhrc.gov/safety/pubs/07048/index.htm>