TECHBRIEF

Safety Comparison of Interchange Configurations

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This document is a technical summary of the forthcoming Federal Highway Administration report *Safety Comparisons Between Interchange Types*.

INTRODUCTION

Interchange Access Requests (IARs) document potential safety performance impacts to justify new or modified interchanges. Typically, IARs are written early in the project planning and design process, with information generally consistent with conceptual design. The details required for using the *Highway Safety Manual* (HSM) predictive methods for freeways, ramps, and ramp terminals are often unknown at that stage (American Association of State Highway and Transportation Officials (AASHTO) 2010). Without these details, accurately predicting crash frequency and severity for interchange components is difficult. Furthermore, aggregating site-by-site predictions may not fully capture the safety performance impacts when the project location is considered.

To further explore and address the safety-related components of an IAR application, the Federal Highway Administration (FHWA) developed planning-level models and tools to predict crash frequency and severity for an existing or proposed interchange. Model inputs were limited to the following:

- The details known at the planning and conceptual design stage.
- The variables expected to affect crash frequency and severity.

The planning-level models allow analysts to compare the potential safety performance effects of freeway access and interchange design decisions at the planning level.

STATE SURVEY

This project identified interchange configurations that account for at least 75 percent of those considered in IARs. The project team surveyed FHWA division offices to determine the most common interchange configurations considered and constructed and the planning-level factors considered in the safety analysis. Additional questions revealed that most IARs focus on urban applications and service interchanges.

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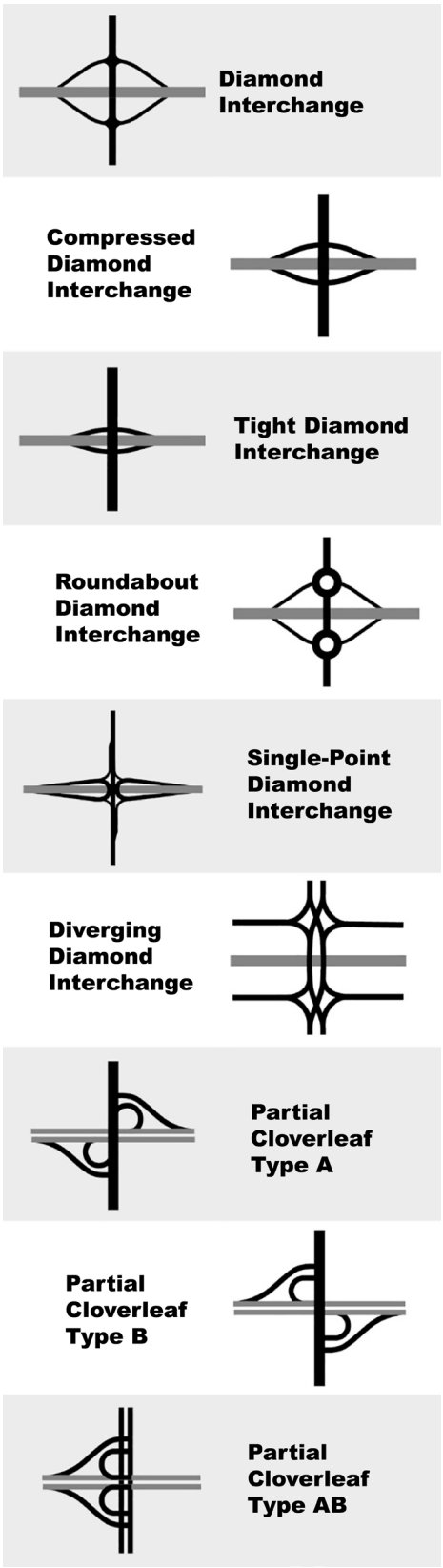
Figure 1. Graphic. Interchange configurations.



Source: FHWA.

APPLICABILITY

The predictive method applies to the interchange configurations shown in figure 1:

- Diamond interchange.
- Compressed diamond interchange.
- Tight diamond interchange.
- Roundabout diamond interchange.
- Single-point diamond interchange.
- Diverging diamond interchange.
- Partial cloverleaf type A.
- Partial cloverleaf type B.
- Partial cloverleaf type AB.

PREDICTIVE MODELS

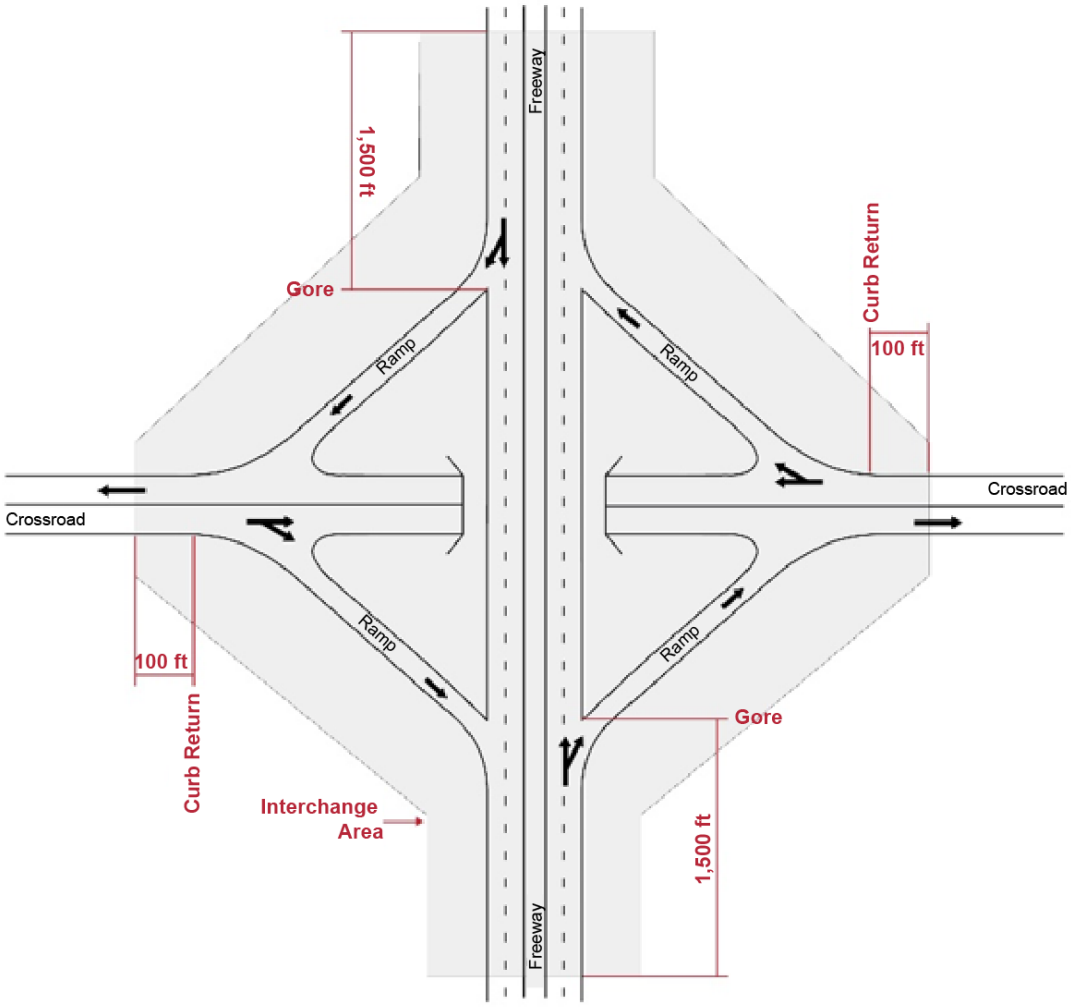
The predictive models developed provide annual predicted crash frequency for the interchange area, as shown in figure 2. The interchange area includes the freeway mainline, crossroad, ramps, and ramp terminals within the bounds shown in figure 2. Supplemental analyses, such as the HSM, provide additional support for influence areas larger than the interchange area (AASHTO 2010).

Predictive models provide crash frequency for fatal and injury crashes and for property damage only crashes based on freeway, ramp, and crossroad annual average daily traffic (AADT) volume and interchange configuration type. In addition to configuration type, the predictive models provide adjustments for the number of freeway through lanes, number of crossroad through lanes, area type, interchange skew angle, presence of nearby interchange gores on the freeway, presence of managed lanes on the freeway, number of crossroad left-turn lanes at terminals, and variation in ramp AADT.

Predictive models also provide adjustments for crash severity within fatal and injury crashes based on the following factors:

- Interchange configuration type.
- Presence of nearby interchange gores on the freeway.
- Presence of nearby intersections on the crossroad.
- Freeway AADT.
- Crossroad AADT.

Figure 2. Graphic. Interchange area for crash prediction.



Source: FHWA.

- Freeway posted speed limit.
- Crossroad posted speed limit.
- Number of right-turn conflicts with pedestrians.
- Number of freeway lanes.
- Number of crossroad lanes.

IMPLEMENTATION TOOL

The predictive method is implemented through a spreadsheet tool, which provides separate outputs for fatal and injury crashes and property damage only crashes. The spreadsheet tool also provides predictions for individual injury severity levels from the KABCO injury classification scale (K, A, B, and C levels) (National Highway Traffic Safety Administration n.d.). The implementation tool includes an estimate of the prediction's variability so users can assess the predictions for interchange configuration types under consideration.

CONCLUSIONS

This project aimed to develop planning-level models and tools to predict crash frequency and severity for an existing or proposed interchange to support analysis for IARs. This project identified interchange configurations that account for at least 75 percent of those considered in IARs. The final interchange configurations included in the predictive models are shown in figure 1. The predictive models use planning-level features and traffic volume information to provide an estimated crash frequency for comparative analysis. The predictive method is implemented through a spreadsheet tool, allowing users to assess predictions for various interchange configuration types under consideration.

REFERENCES

AASHTO. 2010. *Highway Safety Manual*, 1st ed. Washington, DC: American Association of State Highway and Transportation Officials. https://www.highwaysafetymanual.org/Pages/About.aspx, last accessed December 19, 2022.

National Highway Traffic Safety Administration. n.d. *Model Minimum Uniform Crash Criteria* (*MMUCC*), 4th ed. Definitions. Washington, DC: National Highway Traffic Safety Administration. https://safety.fhwa.dot.gov/hsip/spm/conversion_tbl/pdfs/kabco_definitions.pdf, last accessed December 19, 2022.

Researchers—This study was conducted by VHB under contract DTFH6116D00040. Scott Himes (ORCID: 0000-0003-2932-7691), Vikash Gayah (ORCID: 0000-0002-0648-3360), Jeff Gooch (ORCID: 0000-0003-1227-0967), Ginny O'Connor, and Thanh Le (ORCID: 0000-0001-7558-8978) were the main researchers for this study.

Distribution—This TechBrief is being distributed according to a standard distribution. Direct distribution is being made to the FHWA divisions and Resource Center.

Availability—This TechBrief may be obtained at https://highways.dot.gov/research.

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