INDOT Research

TECHNICAL *Summary*

Technology Transfer and Project Implementation Information

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Safety of Intersections on High-Speed Road Segments with Superelevation

Introduction

In recent years, the State of Indiana has built a number of intersections where one or both of the roads are located on curves. The AASHTO *Policy on Geometric Design of Highways and Streets* recommends that in such cases "the alignment should be as straight and the gradient as flat as practical." This wording, consistent with Part V of the Indiana Design Manual, allows for the design of intersections on curves if other solutions prove to be too expensive.

Several of these intersections have raised safety concerns and led to expensive corrective measures. Due to these safety and economic issues, INDOT currently avoids designing intersections on segments with steep superelevation. The focus of this research is to determine what effect curvature and superelevation have on intersection safety. Based on the results, the goal is to provide guidelines for improvement of existing intersections and design of new intersections where the major road is a superelevated curve.

Findings

The safety analysis of intersections where both routes are two-lane roads did not show curvature to have a significant impact on safety in terms of crash frequency or severity. However, this result is unclear and may be partly due to randomness as the sample was relatively small.

Curvature does appear to be a significant factor in the case where the major road is a four-lane divided highway. Full curvature and superelevation was found to increase crashes by 300% in comparison to tangent intersections. Through consultation with INDOT, these results were used to propose maximum recommended and allowable design values for superelevation and curve radius.

The four-lane case provided additional insight into driver behavior at intersection on curves. Crashes tended to be overrepresented at the sample intersections during nighttime conditions, indicating lighting should be a primary concern at such intersections. During adverse weather conditions, crashes in the sample were underrepresented for the intersections on curves. It is possible that drivers travel more cautiously during severe weather because they perceive a greater risk.

Implementation

A number of findings from this study are significant for the geometric design of intersections. For the case where an intersection is located on a curve along a two-lane major road, curvature does not appear to have a negative impact on safety. However, for the case where an intersection is located on a curve along a four-lane divided highway, crashes were found to increase in both frequency and severity.

Based on this finding, design recommendations are proposed for curves with intersections on rural four-lane highways. A maximum design value of 3% is recommended for superelevation. In cases where using such a

design value is prohibitively expensive, a maximum design value of 4% is allowable. A minimum design value for curve radius of 5300 feet (degree of curvature=1.1) is recommended when intersections are to be located on curves. Again, in cases where such a design value is prohibitively expensive, a radius as small as 3500 feet (degree of curvature=1.6) is allowable.

Sight distance does not appear to be affected by curvature. Furthermore, there is no clear pattern between sight distance and crash frequency. Based on these findings, it appears the current sight distance requirements are sufficient.

In comparison to tangent intersections, the intersections on curves experienced a higher proportion of crashes during night conditions. It is recommended that lighting installation be considered in cases where an intersection is located on a curve, particularly where severe superelevation is present.

The draft version of this report will be reviewed by INDOT and design recommendations may be implemented as necessary.

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