Federal Highway Administration Development of Crash Modification Factors Research

Safety Effects of Corner Clearance at Signalized Intersections

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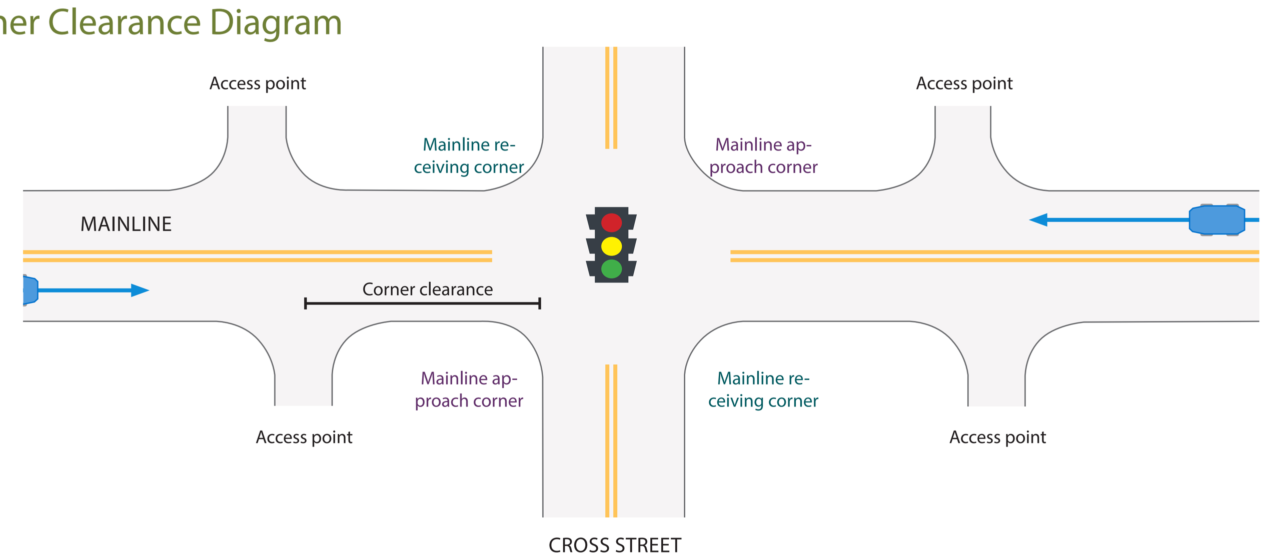
Background

Corner clearance is defined as the distance between an intersection and the nearest access point along the approach. Adequate corner clearance is an important factor in the safety and operations at intersections. However, the presence of conflicting driveways within the functional area is often unavoidable, especially in urban environments.

Corner Clearance Diagram



Purpose

Examine the impacts of corner clearance at signalized intersections by:

» Estimating the safety effects, as measured by crash frequency, using a cross-sectional study design.

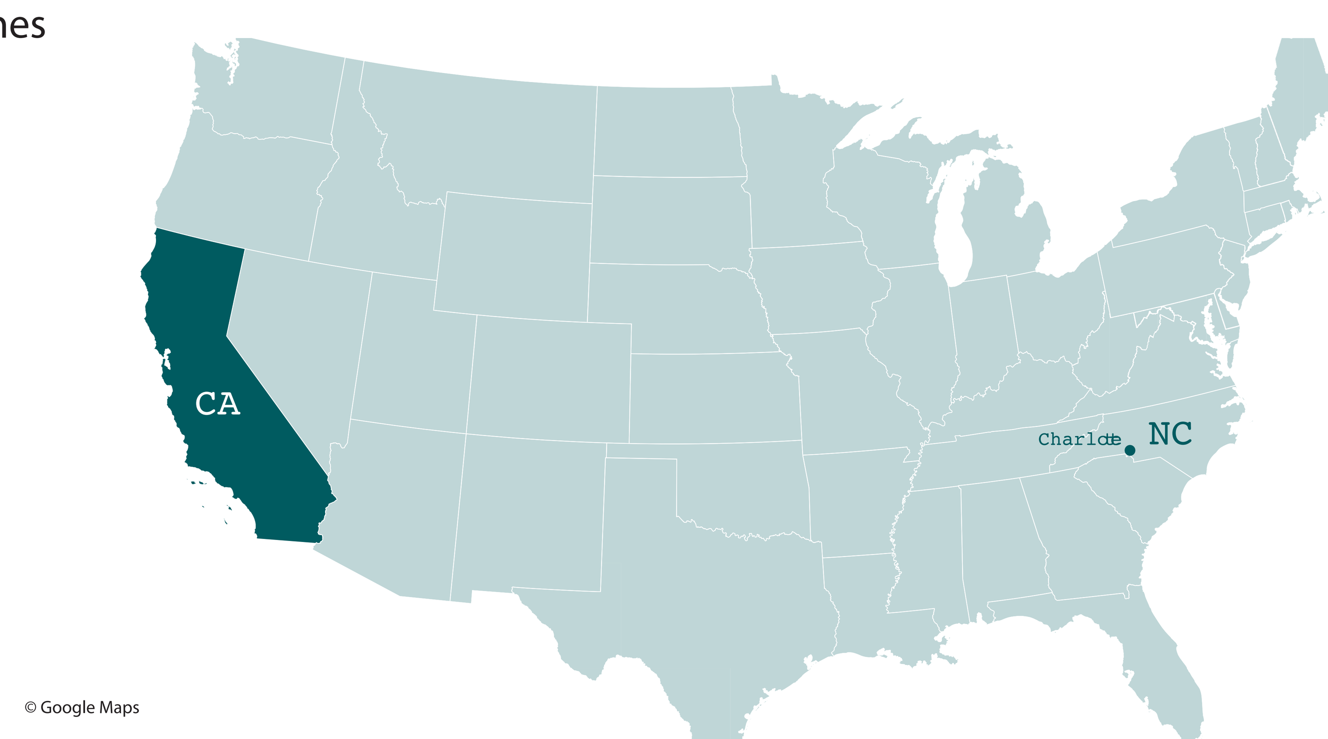
» Examining the factors that may impact safety effects.

» Performing an economic analysis to identify benefit/cost.

Data Summary

This study examined 222 sites from the State of California and 53 sites from the city of Charlotte, North Carolina, using 2009-2011 data. The combined GIS and tabular data set included the following elements:

» Roadway segments
» Intersections
» Access management characteristics
» Traffic
» Crashes



Data Analysis

Negative Binomial crash prediction models were developed for the following crash types:

» Total
» Fatal & injury (KABC)
» Rear-end
» Sideswipe
» Right-angle
» Turning
» Nighttime

Propensity score matching was used to select final study locations for the comparison group. Corner clearance data was categorized by intersection approach and receiving corners. The number of intersection corners with clearance thresholds of 50 ft, 75 ft, 100 ft, 150 ft, 250 ft, and 500 ft were evaluated.

The study focused on the effect of reducing the number of corners with limited corner clearance.

Safety Evaluation Results

Results by Crash Type

Crash Type	Intersection Characteristics	Corner Type	CMF (S.E.)
Total	One corner with clearance ≤ 50 ft	Approach	0.82** (0.08)
		Receiving	1.33** (0.11)
	Two corners with clearance ≤ 50 ft	Approach	0.67** (0.13)
		Receiving	1.76** (0.30)
Fatal & injury (KABC)	One corner with clearance ≤ 50 ft	Approach	0.79** (0.08)
		Receiving	1.29** (0.11)
	Two corners with clearance ≤ 50 ft	Approach	0.62** (0.13)
		Receiving	1.68** (0.29)
Rear-end	One corner with clearance ≤ 50 ft	Approach	0.79**(0.09)
		Receiving	1.36** (0.14)
	Two corners with clearance ≤ 50 ft	Approach	0.63** (0.15)
		Receiving	1.86** (0.38)
Sideswipe	One corner with clearance ≤ 50 ft	Approach	0.83 (0.12)
		Receiving	1.31** (0.14)
	Two corners with clearance ≤ 50 ft	Approach	0.69 (0.19)
		Receiving	1.71* (0.38)
Right-angle	One corner with clearance ≤ 50 ft	Approach	1.03 (0.16)
		Receiving	1.42** (0.20)
	Two corners with clearance ≤ 50 ft	Approach	1.06 (0.34)
		Receiving	2.02* (0.56)
Turning	One corner with clearance ≤ 50 ft	Approach	1.00 (0.15)
		Receiving	1.22 (0.15)
	Two corners with clearance ≤ 50 ft	Approach	1.01 (0.30)
		Receiving	1.49 (0.36)
Nighttime	One corner with clearance ≤ 50 ft	Approach	0.94 (0.12)
		Receiving	1.29** (0.13)
	One corner with clearance ≤ 50 ft	Approach	0.87 (0.23)
		Receiving	1.67* (0.35)

** indicates statistically significant results at 95-percent level.
* indicates statistically significant results at 90-percent level.

Economic Analysis

Practitioners should apply the results to their specific sites to determine the effectiveness of changes to intersection corner clearance.

Benefit-cost ratios for removing receiving corner access points

Number of Access points with Limited corner clearance removed	Lower B/C	Average B/C	Upper B/C
1	94.6	172.0	237.3
2	165.9	301.7	416.3

Discussion and Conclusions

The main results from the study are as follows:

» Increasing number of approach corners with limited clearance is statistically associated with a decrease in crashes for total, fatal and injury, rear-end, sideswipe, and nighttime.

» Increasing number of receiving corners with limited clearance is statistically associated with an increase in crashes for all crash types.

The reduction in crashes with low approach corner clearance is not intuitive. Our team hypothesizes the following potential explanations for this relationship:

» The reduction in rear-end crashes (which represent more than half of all crashes) drives the overall crash reduction on approach corners. Localized congestion may slow down traffic and increase driver awareness, reducing rear-end crashes.

» After passing through the intersection, vehicles may accelerate. The conflicts from turning vehicles in and out of driveways on the receivng corners are likely to results in more crashes.

» Turning vehicles from cross streets add to the overall traffic and potential conflicts. AADT may not reflect this.

» Limited corner clearance represents the overall context of the site and corridor. The observed decrease in crashes is not directly linked to the limited corner clearance itself, but the general corridor characteristics (e.g., potentially higher traffic, higher driveway density, etc.) present in the cross-sectional study.

» Corridors with limited corner clearance at major intersections may indicate more congestion along the corridor, resulting in lower operating speeds not observed by the posted speeds included in the analysis.

Opportunities for future research include the following:

» Explore a before-after study design to detect the direct effects or effects of surrogates.

» Include operating speeds in access management models.

» Conduct analysis with crash data that can be accurately assigned to specific corners and locations within an intersection.

The Federal Highway Administration (FHWA) established the Development of Crash Modification Factors (DCMF) program in 2012 to address highway safety research needs for evaluating new and innovative safety strategies (improvements) by developing reliable quantitative estimates of their effectiveness in reducing crashes. The corner clearance at signalized intersections was one of the strategies selected for safety evaluation under this program.

Acknowledgments

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