SCDOT

Research Summary

South Carolina Department of Transportation | Office of Materials and Research

Safety Analysis of Highway Curves Where Crashes Occur in South Carolina

Project Information

SCDOT No.: SPR 771

FHWA No.: FHWA-SC-26-01

Report Date: February 1, 2026

In Cooperation with: The Federal Highway Administration (FHWA) and SCDOT

Research Administration

Principal Investigator

Wayne Sarasua
Professor
Glenn Department of Civil Engineering
Clemson University
sarasua@clemson.edu
(864) 656-3318

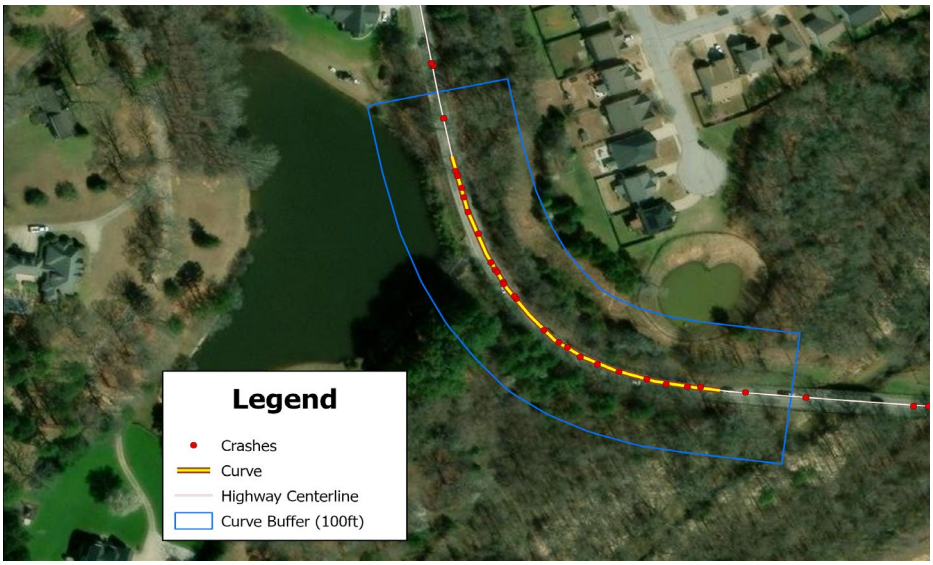
Please contact us for additional Information:

Research Unit
803-737-6697 | WatfordJE@SCDOT.org

SCDOT Research Website:
http://www.scdot.scltap.org/

This final report is available online at:
http://www.scdot.scltap.org/projects/

The design of highway curves has significant impact on traffic safety. More than 25% of fatal crashes in the United States occur on horizontal curves, and the crash rate for curves is approximately three times higher than other highway sections. This research focuses on a detailed analysis of curves where vehicle crashes occur in South Carolina. Eight years of crash data and an inventory of circular curves are analyzed to identify trends and the effectiveness of countermeasures. The research achieved several objectives including identifying potential locations of compliance issues related to curve signage and also identifying curve locations of highest crash frequency that can benefit from potential countermeasures.



Associating crashes with curves using a curve buffer

Problem

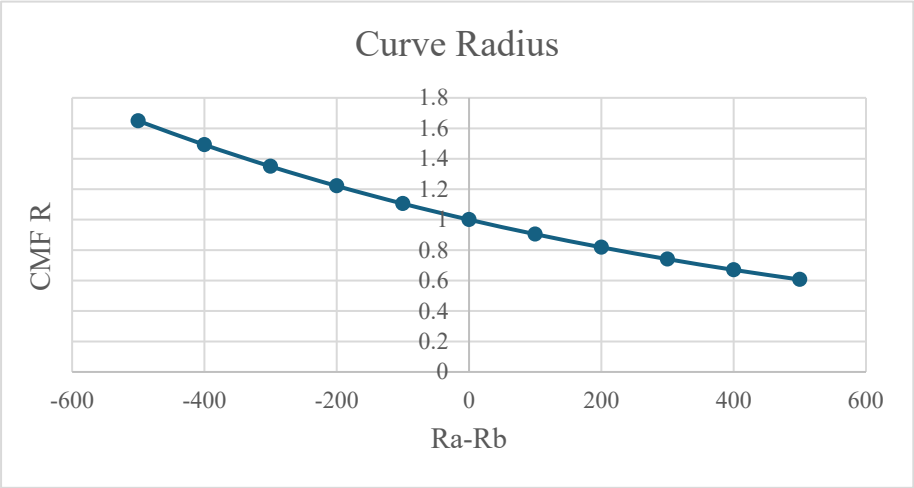
South Carolina has the second highest fatality rate per hundred million vehicle miles traveled and the fourth highest fatality crash rate per 100,000 population in the country based on 2023 fatal crash data. Because of the high proportion of crash fatalities that occur on highway curves, research that can potentially reduce fatality rates is significant. This research explores methods to improve horizontal curve safety.

Research and Results

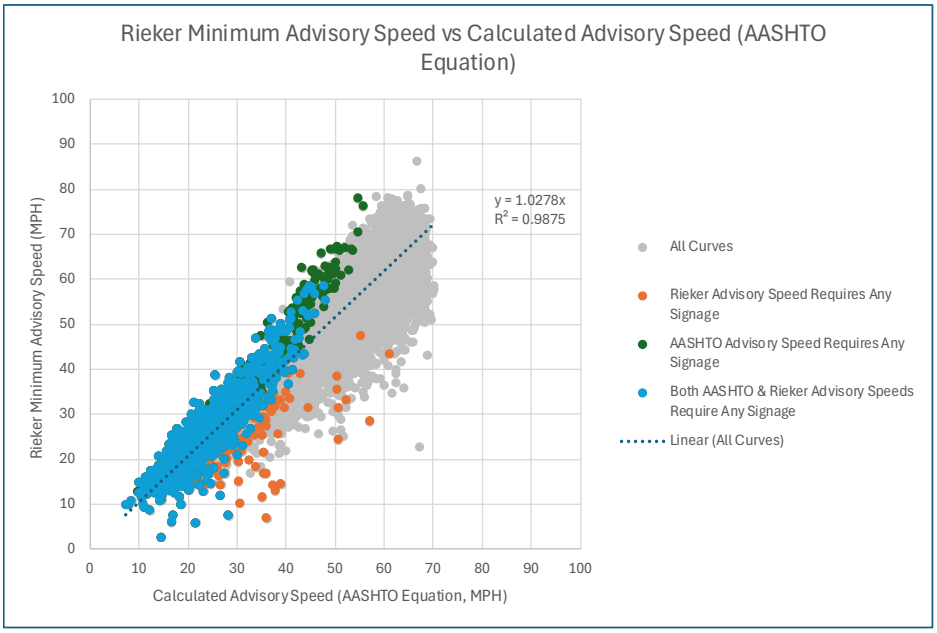
Previous research has almost uniformly relied on crash report codes, aggregate data and/or curve samples. The innovative geographic information system (GIS) techniques used in this research to associate crashes with curve buffers allows for statewide analysis and screening of curve crash incidence. Further, published highway crash countermeasures for curves from other states and jurisdictions are not

calibrated for South Carolina. The modeling aspects of this research provide more appropriate crash modification factors for certain countermeasures. The negative binomial crash analysis indicated that traffic volume, radius, and posted speed limit were significant estimators for total crashes, severe crashes, and single vehicle crashes. Grade was significant for single-vehicle crashes. Superelevation was significant for rural 2-lane severe crashes (fatal and incapacitating injury). Crash modification factors were developed for all of the significant parameters except for traffic volume.

The researchers developed a GIS based workflow for determining signing needs and compliance for horizontal curves. The workflow uses design equations along with curve attributes to determine the advisory speed for a curve. The GIS centerline database was populated with curve attributes (curve radius, super elevation) using automated methods. The GIS automated method for determining advisory speeds is novel and efficient, requiring no additional field data collection. It provides comparable advisory speed results to Rieker CARS which is a vehicle based inertial system used by many states.



Sample 2-lane roads CMF for curve radius



Value & Benefit

The results of the research will have significant benefits for SCDOT and the traveling public, as well as other DOTs. Direct benefits to SCDOT include increased safety on highway curves through highly targeted countermeasures. Enhanced safety includes reduced crash frequency, reduced crash rates, and reduced crash severity. This final report includes a workflow that can be followed by SCDOT to facilitate future highway curve safety analysis and prioritize investment in highway curves to enhance safety in the most efficient manner. Traffic crashes in South Carolina annually equate to $7.7 billion in economic losses. Enhanced safety from this research should provide cost savings to South Carolina.

The research recommendations revolve around all of the products of this research. In the near-term, SCDOT should focus on MUTCD sign compliance by making use of the list of locations that may be in need of signage. The tables of roadway curves with highest crash frequency should be scrutinized and prioritized for potential funding of counter-measures. The researchers recommend that SCDOT takes advantage of the data products of this research including curve attributes, greatly expanded posted speed limit data, and the improved curve sign inventory.

The Principal Investigator would like to thank the co-PIs Pamela Murray-Tuite from Clemson, and William J. Davis and Kweku Brown from the Citadel. Several students were invaluable to the research including Farhad Farzinpour.