# Research Problem Statement

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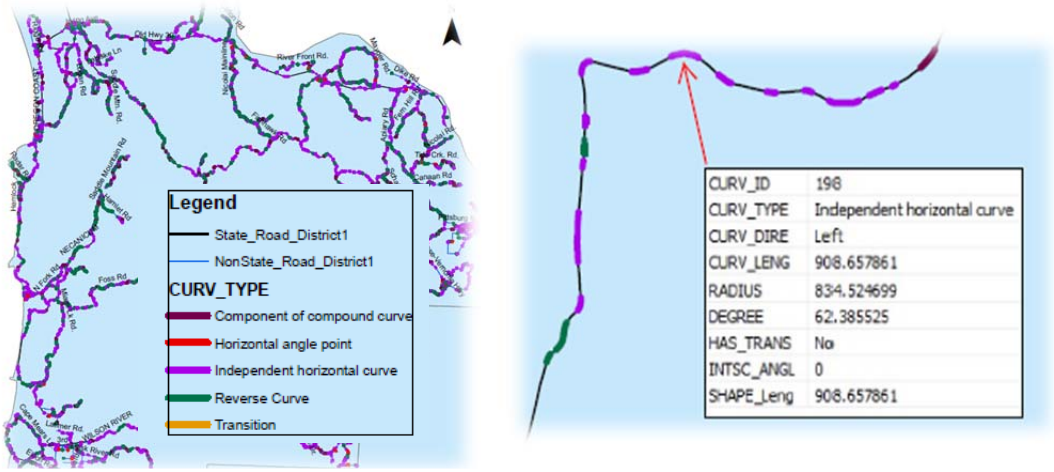
## I. TITLE

**17-063 Developing Horizontal Curve Database and Curve Safety Performance Functions for Oregon Public Highways**

## II. PROBLEM

Horizontal curves are changes in the alignment or direction of the road, as opposed to vertical curves, which are a change in the slope. In 2008, more than 27 percent of fatal crashes occurred at horizontal curves; the vast majority (over 80 percent) were roadway departures. Roadway departure crashes consistently account for more than half of the fatalities and fatal crashes in the United States (51% in 2011, FHWA). In Oregon, roadway departure crashes account for 66% of all highway fatalities, the majority of which happen in rural highways. Due to the predominance of horizontal curves on typical rural roads, a higher percentage of fatal curve-related crashes occur on rural roads, particularly on two-lane roadways in rural areas.

Having a complete horizontal curve database covering all roads, including county and local roads is essential to reach the Towards Zero Deaths goal and meet the MUTCD and MAP-21 requirements. Although, ODOT has good coverage of curve data on state owned routes, curve data on non-state routes are needed for comprehensively understanding and addressing curve safety issues (more road departure crashes on local roads). With complete curve data on all Oregon public roads, safety performance functions along with crash modification factors can be developed to facilitate addressing curve issues through appropriate countermeasures, considering most road departure cashes occurred on local roads rather than state trunk routes.

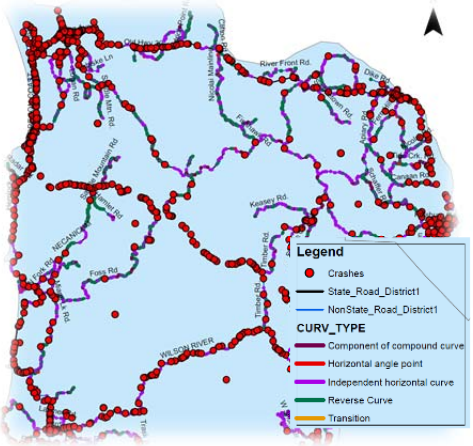



Proof-of-concept pilot: MIRE-compatible curve data on state and non-state routes in ODOT District 1

The goal of this project is to develop a MIRE (Model Inventory of Road Elements)-compatible horizontal curve database (including Curve ID, Curve Type, Curve Direction, Curve Length, Radius, Degree of Curvature, Transition, and Intersection Angle) for all public roads in Oregon. Based on the curve data and crash data, this research can create dedicated curve safety performance functions, which can be basis for mitigating curve-related roadway departure crashes on all Oregon highways. The curve data extracted in this project can also serve as alternative dataset to validate existing curve data available in ODOT.

## III. PROPOSED RESEARCH, DEVELOPMENT, OR TECHNICAL TRANSFER ACTIVITY

This project would include using an automatic GIS procedure to extract horizontal curve data for both state and local highways in Oregon. The procedure accurately extracts MIRE-compatible horizontal curve data from GIS roadway shapefiles without any need of field data collection. The required input to this procedure is statewide GIS highway network including state and non-state highways. Different curve types will be




Proof-of-concept pilot: Crash data vs. Curve Data for ODOT District 1

identified including (1) Component of compound curve; (2) Horizontal angle point; (3) Independent horizontal curve; (4) Reverse Curve; and (5) Transition. With the statewide curve database covering all public roads, dedicated curve safety performance functions will be developed for all roadway classes or for speed classes. To develop the curve SPF, Oregon crash database will be explored and crashes happened on curves from state and non-state highway will be mapped. All curve related crashes (within curve vicinity) will be included in the sample for safety performance function development.

Specific research tasks for this project will include;

- Task 1: Literature Review: A thorough literature review will be conducted on safety issues on horizontal curves, especially the curve safety modeling on various road classes including rural two-lane highways (Oregon has a higher percentage of rural two-lane highways).
- Task 2: Data Preparation and Collection: Data collection including collecting state and non-state Oregon public highway GIS network for curve data extraction. This data is available from ODOT through TransGIS resources and crash database. Crash data will be collected and reviewed to identify curve related crashes.
- Task 3: Development of horizontal curve database for all Oregon public roads including state and non-state public highways. A quality assurance and control will be employed to assure accuracy of the curve location and geometric information (i.e., radius, degree of curvature, curve length, etc.).
- Task 4: Development of curve safety performance functions for different road classes by integrating the both discrete and continuous curve elements such as curve type, curve proportion, radius, and etc as crash modification factors. Other variables, such as roadway geometric, traffic, speed, road surface, weather related variables will also be considered as potential crash modification factors.
- Task 6: Results analysis and final report.

## IV. POTENTIAL BENEFITS

Oregon DOT safety engineers and city planners will benefit from this project in a number of ways. Fist of all, this project will provide a complete database of the horizontal curve database for the entire state of Oregon state and non-state public highways, as long as covered in the GIS roadway shapefile. Despite availability of curve data on state owned routes, curve data on local roads that will be extracted in this project will facilitate comprehensive understanding and treatment of curve safety issues (more road departure crashes on local roads). Engineering and planners can use the curve information to design low-cost counter measures to mitigate curve related crashes to bring down the roadway departure crashes on Oregon highways. In addition, this project will develop curve SPF that provides an alternative predictive tool to evaluate curve safety by connecting the crash rates on curves with curve attributes. As a result, low-cost countermeasures or treatments can be made to mitigate the high-risk curves to provide safer curves in Oregon to meet the goal of eliminating deaths and severe injuries on Oregon's transportation system.

## V. IMPLEMENTATION

Three major products will be generated from this project: (1) a complete Oregon highway horizontal curve database; (2) Curve safety performance functions; and (3) an Excel spreadsheet based tool (HSM-alike) that implements the safety performance functions. This method can be implemented on an entire state, a subarea, or a district network. This product could be used for horizontal curve safety evaluation, whether or not we have recorded past crashes on the curve. The curve SPF combined with curve attributes can be used to inform project selection, prioritization between projects, identify appropriate and cost-effective treatments, and/or ARTS safety program priorities.

## VI. LIST OF REFERENCES

Bauer, K. and Harwood, D. (2012), Safety Effects of Horizontal Curve and Grade Combinations, Submitted to Federal Highway Administration.

Dixon, K., C. Monsere, F. Xie, and K. Gladhill (2012), Calibrating the Future Highway Safety Manual Predictive Methods for Oregon State Highways, Final Report SPR 684, OTREC-RR-12-02, Oregon State University and Portland State University, Oregon.

## VII. CONTACT INFORMATION

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