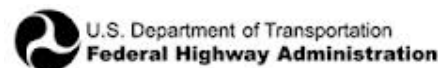


Roadway Safety Professional Capacity Building Program



Through engaging peer workshops, the RSPCB Program matches agencies seeking solutions to roadway safety issues with trailblazers who have addressed similar challenges and emerged with a roadmap and noteworthy practices for approaching the issue.



Horizontal Curve Virtual Peer Exchange

An RSPCB Peer Exchange

INTRODUCTION

This report summarizes the Horizontal Curve Virtual Peer Exchange sponsored by the Federal Highway Administration (FHWA) Office of Safety's [Roadway Safety Professional Capacity Building Program](#) on June 17, 2014. This virtual peer exchange was the fourth in a series of FHWA-sponsored peer exchanges on horizontal curves and roadway departures.

The FHWA Office of Safety and FHWA Resource Center convened representatives from eleven States: Arizona, California, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, South Dakota, Utah, and Wyoming; several Tribal and county agencies; and the Western and Central Federal Lands Highway Divisions. The purpose of this event was to facilitate the exchange of information between States regarding approaches to safety on horizontal curves and to explore opportunities for collaboration between FHWA, State Departments of Transportation (DOTs), and Tribal and local agencies to improve safety on horizontal curves. The full agenda is available in [Appendix A](#).

Key themes that emerged included the advantages of high friction surface treatments (HFST) and systematic signing treatments; challenges related to the implementation of horizontal curve safety projects; opportunities for innovative pilot programs; and strategies for locating horizontal curves and prioritizing curve safety projects.

PEER EXCHANGE PROCEEDINGS

The virtual peer exchange was organized around expert and peer presentations on State practices, followed by facilitated discussions. Throughout the peer exchange participants were encouraged to consider the most important safety issues that emerged and note what changes their agencies would implement. To initiate the discussion of horizontal curves and to establish a baseline for the participating States and agencies, the facilitators of this virtual peer exchange provided a poll for participants to complete and gathered the following responses:

- Can you easily identify curve crashes?
 - Yes, but only on the State system (9.09 percent)
 - Yes, on both State and local roads (36.3 percent)
 - No, it can be done, but not easily (54.5 percent)
 - No, we aren't sure how to do it (0 percent)
- Are HSIP funds allocated in your State split between projects on the State and local systems?
 - Yes, based on percent of crashes (9.09 percent)
 - Yes, based on other prioritization processes (72.7 percent)
 - No (9.09 percent)
 - Don't know (9.09 percent)
- Do you have a safety program or effort that addresses crashes on curves?
 - Yes (81.8 percent)
 - No (18.1 percent)

A brief description of the peer exchange proceedings is provided below.

PLANNING FOR CURVE SAFETY

The first of the four key themes discussed during this event was planning for horizontal curve safety. This portion of the event consisted of two presentations and a roundtable discussion. The presentations highlighted products that automate the process of identifying curve locations and parameters.

One presentation from the Utah Department of Transportation (UDOT) focused on UDOT's strategies for identifying curves by conducting safety analysis on spatial curve data collected through global positioning system (GPS) and LiDAR technologies. UDOT follows two different methodologies for identifying curves and improving curve data, one from Virtual Geomatics (VG) and the other from Brigham Young University (BYU). The VG methodology focuses on LiDAR data, while the BYU methodology involves a Bayesian model that uses horizontal curve data. As a result of these efforts, UDOT can conduct more precise safety analysis on horizontal curves and better plan for low-cost systemic safety treatments on curves.

A second presentation from the Arizona Department of Transportation (ADOT) and the Montana Department of Transportation (MDT) showcased those States' Roadway Departure Safety Implementation Plans. FHWA has helped several focus States, including Arizona, develop such plans, which identify potential sites for safety improvements, estimate the costs of these improvements, and predict the anticipated savings in injuries and crash costs.

In 2012, ADOT received a completed plan from FHWA that identified locations on Arizona roads that could benefit from safety improvements, including several horizontal curves. Over the past two years, ADOT has taken steps to implement safety countermeasures to help prevent roadway departures in those locations. ADOT plans to begin scoping several of these projects and to implement the recommendations of the Roadway Departure Safety Implementation Plan over a period of several years. While Montana was not a focus State for roadway departures, MTD also initiated a plan in 2012 after receiving technical assistance from FHWA's Resource Center. MTD's plan, which is expected to be complete in fall 2014, uses [Highway Safety Manual](#) (HSM)-based methodologies to identify "Sites with Promise" for safety improvements, particularly centerline and shoulder rumble strips on rural two-lane roads.

KEY POINTS

Planning for Curve Safety

- A number of products are available to help State DOTs automate the process of identifying curve locations and defining curve attributes.
- Roadway Departure Safety Implementation Plans identify potential sites for specific improvements, including horizontal curves.

During the roundtable discussion on planning for curve safety, participants discussed issues such as identifying curve locations, determining curve parameters, selecting sites for improvements, and selecting strategies and countermeasures to improve safety on curves. Several participants commented on the utility of rumble strips in preventing roadway departures and various challenges related to rumble strip installation. The participants also discussed the advantages and disadvantages of using linear referencing systems (LRS) and crash reporting forms to identify and inventory horizontal curves. Finally, participants discussed the potential for leveraging new Moving Ahead for Progress in the 21st Century Act (MAP-21) requirements to collect data on curve locations, and the need for data on curve radii, geometry, and curve location.

SIGNING AND DELINEATION PROGRAMS

The second key theme discussed during this event was signing and delineation treatments. This portion of the event consisted of one presentation and a roundtable discussion. The presentation highlighted the importance of signing and delineating curves to improve highway safety along horizontal curves.

The presentation from the Colorado Department of Transportation (CDOT) focused on the agency's innovative use of safety treatments for problem curves on State-owned roads, particularly Wolf Creek Pass on U.S. Route 160, a dangerous hairpin curve on a long, steep downgrade. In recent years CDOT has installed multiple signing and marking treatments along Wolf Creek Pass, including small roadside signs, large overhead signs, LED chevrons, and a reduced speed limit for trucks. CDOT has found that innovative treatments such as speed-activated signs result in useful safety improvements at locations where conventional treatments are not sufficient. CDOT noted that the use of signs and markings can improve driver behavior by helping drivers know what to expect along dangerous curves.

KEY POINTS

Signing and Delineation Programs

- Signing and delineation of curves is critical to improving safety at horizontal curves; consistent use of signs and pavement markings help drivers anticipate curves.
- Innovative signing and marking treatments, such as speed-activated signs and in-lane pavement markings, are useful at high-crash locations where traditional safety treatments are not sufficient.

During the roundtable discussion of signing and delineation programs, participants discussed issues such as signage requirements from the 2009 Manual on Uniform Traffic Control Devices (MUTCD), challenges for signing treatments on local roads, and innovative treatments in place in the participating States. Several participants commented on the value of the consistent approach to signage and delineation treatments challenges related to advisory speed signing, including the need to educate drivers about any changes to highway signage. The participants also discussed the advantages of innovative approaches to signage, such as in-lane pavement markings, enhanced mile markers, optical speed bars, signs that increase in size into a curve, centerline rumble strips between striped lanes in the same direction, and curve markings directly on the pavement.

HFST AND OTHER PAVEMENT TREATMENTS

The third key theme discussed during this event was HFST and other proven pavement treatments that help prevent vehicles from losing control. HFST is a particularly useful safety countermeasure in locations such as curves, where the need for friction is great. This portion of the event consisted of two presentations and a roundtable discussion.

One presentation from the California Department of Transportation (Caltrans) highlighted the agency's successful 2008 HFST pilot project on State Route 20 near Nevada City, CA—a high crash curve location where traditional countermeasures had not proven effective. Caltrans also presented its ongoing efforts to include HFST in its toolbox of traditional pavement safety countermeasures. To begin mainstreaming the use of HFST, Caltrans safety staff have presented the project to the California Traffic Safety Steering Committee, consulted with the Caltrans Office of Pavement, and piloted HFST in other high-profile locations. Caltrans has also developed a special provision for the application of HFST on other

KEY POINTS

Highway Friction Surface Treatments

- HFST is a useful tool to help prevent drivers from losing control at severe curve locations.
- States such as California have successfully demonstrated the value of HFST and are integrating it into their standard set of safety countermeasures.

roads in the State.

A second presentation from the Western Federal Lands Highway Division focused on a selection tool to identify candidate sites for HFST and other safety treatments. Since the Federal Lands Highway Divisions do not own or maintain a network of roadways, but rather design and oversee construction for Federal Land Management Agencies (FLMAs), this tool was developed to establish a uniform decisionmaking process for use of HFST on projects across all three Federal Lands Highway Divisions. The Federal Lands' HFST implementation plan also includes marketing strategies, communication tools, and presentations to FLMAs such as the National Park Service.

During the roundtable discussion of HFST, participants discussed issues such as challenges to the implementation of pavement treatments, the advantages of HFST relative to other pavement treatments, the application of HFST, and the durability of friction treatments. Several participants commented on the advantages of using calcined bauxite in HFST, the necessity of using HFST on pavement that is in good condition, and the costs associated with HFST. The participants also noted the high level of durability of HFST based on test track experiments. Finally, participants discussed strategies for identifying candidate sites for HFST application.

LOCAL AGENCIES, FUNDING, AND PROJECT PRIORITIZATION

The final key theme discussed during this event was local agencies, funding, and project prioritization. Specifically, the participants discussed strategies for addressing the significant portion of severe curve crashes that occur on local roads. This portion of the event consisted of one presentation and a roundtable discussion.

A presentation from Caltrans highlighted local road safety issues in California, where the majority of crashes occur on local roads. Because 90 percent of the State's centerline miles are maintained by local agencies, Caltrans encourages counties and other agencies to install low-cost systemic safety improvements at curves on locally-owned roadways. By using low-cost improvements such as retroreflective signage and high-visibility striping, local agencies can improve safety at many locations and thereby observe a greater impact in reducing crashes than they would by installing more costly countermeasures at just a few locations.

During the same presentation, the Placer County Department of Public Works introduced its Highway Safety Improvement Program (HSIP)-funded Roadway Safety Sign Audit (RSSA) project to identify suitable locations for safety signage improvements based on crash records. The RSSA also helped Placer County determine whether to replace or relocate signs, install chevrons, or add other low-cost countermeasures. The RSSA provided Placer County a tool to calculate project costs and to prepare for comprehensive sign improvements. Once the project is complete, Caltrans plans to prepare a guidance document based in part on the Placer County RSSA project for the benefit of other counties and local agencies that could incorporate RSSA elements into their project planning processes.

During the roundtable discussion of local road safety, participants discussed issues such as challenges to addressing safety on local roads, the relative proportion of crashes on State and local systems, strategies for prioritizing local projects, and the use of HSIP funding for local safety improvements. Several participants discussed the difficulty of accessing reliable crash and roadway data on local roads and strategies

KEY POINTS

Local Agencies and Horizontal Curve Safety

- A significant portion of severe curve crashes occur on local roads, particularly on two-lane roadways in rural areas.
- Low-cost, systemic strategies can be a cost-effective option for improving curve safety across a wide network of local roads.
- Installing the appropriate signs for specific curve sites, rather than replacing signs as needed, is an effective strategy for improving curve safety.

for integrating and sharing crash data. The participants also commented on the need for systemic large-scale safety projects on local and Tribal roads and the availability of HSIP funding and road safety audits to support safety on local and Tribal roads.

CONCLUSION AND NEXT STEPS

The facilitator noted that this virtual peer exchange was a useful opportunity for participating States to learn about noteworthy practices in place at other agencies. Each participating State was asked to highlight the most important safety issues identified during the exchange and note what changes their agency would implement as a result of the discussion during this exchange. Several of the action items were mentioned by multiple agencies.

Key action items identified during the closing portion of the peer exchange included the following:

- Identifying and prioritizing horizontal curves for safety improvements;
- Addressing safety on horizontal curves early during project development, ideally before the design phase;
- Systemically analyzing horizontal curves to identify opportunities for signage improvements and using innovative signs and pavement markings to improve safety on horizontal curves;
- Modifying processes and programs to improve horizontal curve safety;
- Developing a system for using HSIP funding for projects on local roads as well as State highways, involving local agencies in horizontal curve safety, and encouraging local agencies to apply for HSIP funding;
- Strengthening geospatial curve and grade information on the local road system and upgrading roadway attributes databases to locate horizontal curves on all roads;
- Attending future peer events on related topics, including rumble strips; organizing a horizontal curve peer exchange for local agencies;
- Incorporating lessons from this peer exchange into ongoing data-sharing projects and software upgrades;
- Developing an HFST pilot project for intersections and ramps;
- Engaging counties in the State on signage projects and MUTCD requirements;
- Incorporating horizontal curve safety in the next SHSP update.

CLOSING

A significant portion of fatal crashes on the nation's roadways occur at horizontal curves and the vast majority of these crashes are roadway departures. The average crash rate for horizontal curves is about three times that of other types of highway segments. Fortunately, many existing strategies and countermeasures offer effective options to improve safety at horizontal curves. Many of these countermeasures are low-cost and can be installed at prioritized horizontal curves to address safety issues. During this peer exchange, representatives from several western States presented noteworthy practices for identifying horizontal curves, preventing roadway departures, installing low-cost signing and delineation treatments at horizontal curves, applying HFST to horizontal curves, and working with local agencies to address horizontal curves on locally-owned roads. State representatives were able to use this exchange to learn about innovative approaches to improving horizontal curve safety and develop action plans for their respective States.

APPENDIX A

Horizontal Curve Peer Exchange Tuesday, June 17, 2014

12:30 am	Welcome, Introductions, Purpose and Goals
12:50 am	PLANNING FOR HORIZONTAL CURVE SAFETY <i>Locating Curves</i> , Scott Jones, Utah DOT <i>Implementation Plans</i> , Richard Weeks, ADOT and Kraig McLeod, MDT Roundtable Discussion Selecting implementation strategies and countermeasures Locating curves and determining curve parameters Data-driven site selection
2:00 pm	SIGNING AND DELINEATION TREATMENTS <i>Enhanced Treatments for Problem Curves</i> , Alisa Babler, Colorado DOT Roundtable Discussion Status on MUTCD requirements Challenges to treating local roads Innovative treatments
2:30 pm	LUNCH ON SITE
3:00 pm	Discussion Wrap up HFST AND OTHER PAVEMENT TREATMENTS <i>HFST Implementation</i> , Robert Peterson, Caltrans <i>HFST Selection Tool Flowchart</i> , Tori Brinkly, Western Federal Lands Roundtable Discussion Pavement treatment implementation concerns Improved friction versus other treatments
4:00 pm	LOCAL AGENCIES, FUNDING AND PROJECT PRIORITIZATION <i>Sign RSA Project for the Local System</i> , Ted Davini, Caltrans and Stephanie Holloway, Placer County Public Works Roundtable Discussion Challenges to treating local roads Proportion of crashes on State and Local Systems Prioritizing projects Funding projects—HSIP and beyond (funding match, etc.)
5:00 pm	TAKE-AWAY ITEMS—Where Do We Go From Here? What will you do differently? What concerns still need to be resolved? Future peer-to-peer opportunities
5:30 pm	ADJOURN