Source: St. Louis County, Minnesota

The Four Pillars of FoRRRwD

Systemic Approach

Roadway departures (aka lane departures) on the rural road network account for one-third of traffic fatalities. The FoRRRwD (Focus on Reducing Rural Roadway Departures) initiative encourages a systemic application of countermeasures that help keep vehicles in their travel lanes, reduce the potential for crashes, and decrease the severity of crashes that do occur.

FoRRRwD is supported by four pillars that work together to reduce rural roadway departures:

- Proven Countermeasures
- **Systemic Approach**
- Safety Action Plans
- All Public Roads

30 people will die today from rural roadway departure crashes. Let's save the people behind the numbers.

https://safety.fhwa.dot.gov/FoRRRwD/

Definition of Systemic

A "systemic safety improvement" means a proven safety countermeasure(s) that is widely implemented based on high risk roadway features that are correlated with particular severe crash types, rather than crash frequency.[1]

Severe crash locations are random. Severe crash types are not. A fundamental challenge on rural roads is that roadway departure (aka lane departure) crash locations are often scattered across the network and tend to change from year to year. In these situations, it is often not cost-effective to solely apply countermeasures where crashes already happened when they are unlikely to happen again at the same location in the near future.

The systemic approach uses crash data and roadway characteristic data to identify the types of crashes with the most potential for safety improvements (e.g. lane departure), as well as the roadway types where these severe crashes occur most often (e.g. two lane rural collectors). The agency can then identify risk factors—such as curve radii, traffic volumes, or shoulder widths—that are typically associated with these crashes. These risk factors can be used to identify locations with higher risk for future severe crashes and apply proven countermeasures at these locations.

Benefits of a Systemic Approach:

- Targets locations of higher risk.
- Applies proven countermeasures at locations of higher risk.
- Prevents future severe crashes.

U.S. Department of Transportation
Federal Highway Administration

ZERO IS OUR GOAL
A SAFE SYSTEM IS HOW WE GET THERE

[1] 23 USC 148(a)(12)

FHWA-SA-21-085

Noteworthy Practices

The following are examples of how local agencies have successfully implemented systemic safety improvements in their area. These agencies analyze data to identify risk factors, prioritize locations for projects, and institutionalize the systemic approach in policy and allocation of funding. The results have led to safer roads with fewer roadway departure fatalities and serious injuries.

Systemic Safety for All Public Roads

Minnesota

Minnesota has institutionalized the systemic approach at both the State and local level. Since 2011, Minnesota has seen their 5-year averages decrease each year for lane departure fatalities. The Minnesota Highway Safety Improvement Program (HSIP) emphasized low-cost, high-benefit safety countermeasures that can be widely deployed on both State and local systems based on risk factors. The countermeasures that were deployed as a result of the systemic approach include horizontal curve signs, pavement marking and delineation, rumble strips, pavement widening with SafetyEdge℠, and cable median barriers.

Nearly all rural roadways in the State are covered through District Safety Plans (State roads) and County Road Safety Plans (CRSPs) for each of the 87 counties (locally owned roads). Both these types of plans follow the same systemic analysis process, which includes analyzing crash data to identify risk factors and prioritizing projects with the largest number of risk factors. Then, analysts select countermeasures to address specific issues, which results in safety projects that can be submitted for funding. When administering the local HSIP, MnDOT prioritizes projects identified in CRSPs, which come from a documented systemic analysis.

The following table shows the risk factors for curves and segments used in the 2016 District Safety Plans Update analysis for rural two-lane undivided county roads.

Table 1. Risk factors used in District Safety Plans. Source: recreated from MnDOT's District Safety Plans Update.

Curves	Segments
ADT ≥ 2,000 vehicles per day.	ADT ≥ 3,500 vehicles per day.
Shoulder width ≤ 4 feet.	Shoulder width ≤ 2 feet.
Severe lane departure density ≥ 0.007 crashes per curve per year.	Severe lane departure density ≥ 0.014 crashes per mile per year.
Curve radius 500 to 1,800 feet.	Critical radius curve density ≥ 0.1 curves per mile.
Presence of visual trap.	Edge risk assessment of 2 (medium) or 3 (high).
Presence of an Intersection on the curve.	Access density ≥ 8 accesses per mile.

Addressing High Risk Rural Roads

Kansas Department of Transportation

Between 2003 and 2008, over 65 percent of fatalities on Kansas roadways were the result of lane departures. During this same period, the greatest number of non-State road fatalities and serious injuries were on rural major collectors with a four-year average of 207. However, prior to 2011, High Risk Rural Roads (HRRR) projects were site-specific, manually plotted, and had no patterns identified due to the random nature of crashes; therefore, funds could not be used on sites without observed crash histories (even through risk factors were present). This resulted in Kansas not being able to justify enough projects to use the entire HRRR allotment (i.e., over 85 percent of funds were unobligated).

In 2011, Kansas DOT adopted a systemic approach for HRRR funds to focus on rural major collectors. Kansas continued the HRRR program even after it was no longer a required set-aside of the HSIP. The HRRR funds are provided to local agencies that maintain roadways. Local agencies used funds to install low-cost countermeasures including striping, signing, high friction surface treatment, rumble strips and stripes, and clear zones improvements (extending culverts, tree removal). These countermeasures contributed to a decrease in fatalities and serious injuries on non-State rural major collectors to 189 annually from 2012 to 2016.

In 2020, Kansas allocated $4.5M exclusively for locally-owned roads and all of this funding was obligated. To further the best use of HRRR funds, Kansas will require counties to have a Local Road Safety Plan (LRSP) to apply for HRRR funds. Each LRSP costs approximately $50,000, and with 90-percent federal share for HSIP, the county share is approximately $5,000. They are developing 20 plans per year and in 2021 will have completed plans for 60 counties. The LRSPs will be data-driven and focus on rural major collectors and other paved county roads.

Figure 1. Chevrons at a horizontal curve in Kansas. Source: KDOT.

Institutionalizing the Systemic Approach

Texas Department of Transportation

The Texas Department of Transportation (TxDOT) revised its HSIP Guidelines to include systemic projects beginning in June 2020 for projects to be let in Fiscal Year (FY) 2022 and beyond. TxDOT will allocate 40 percent of their HSIP funds for systemic projects, with 25 percent for Districts (approximately $3M for each of the 25 Districts) and 15 percent for statewide systemic projects, such as median barrier.

The TxDOT HSIP Guidelines have a list of four approved systemic roadway departure countermeasures that are proven to reduce fatalities and serious injuries - median barriers, roadway widening, corridor lighting, and enhanced delineation of curves. To prioritize locations with the most potential for safety improvement, TxDOT lists the following risk factors for the roadway departure systemic countermeasures:

- For median barrier, locations with medians of 70 feet or less are prioritized in the following order:
  1. Roadway type (interstate, non-interstate freeways, other principal arterials).
  2. Urban and rural median widths 0 to 45 feet.
  3. Median width greater than 45 feet in rural areas.
  4. Median width greater than 45 feet in urban areas.
- For roadway widening, the State prioritizes rural two-lane undivided highways with paved surface width less than 24 feet. This also provides an opportunity to add rumble strips to further improve safety.
- For enhanced delineation of curves, agencies will treat curves within a geographical area or roadway type, not single locations.
- For corridor lighting, agencies will implement continuous safety lighting along roadway corridors where no lighting exists, not single locations.

TxDOT has approved 174 systemic HSIP projects in the FY 2022-2024 call for projects; 97 projects (56 percent) are lane departure projects. These lane departure projects include 14 projects installing chevrons and LED chevrons at curves, 31 projects adding or widening shoulders, and 52 median barrier projects.

The systemic approach is also being institutionalized into the District Safety Plans beginning in FY 2020. The District Safety Plans act as a project planning document across all funding categories, including the HSIP, and will be updated annually.

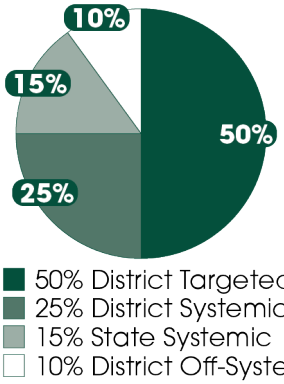

Figure 2. Breakdown of HSIP funding allocation. Source: recreated from TxDOT's HSIP Guidelines.

Prioritizing Systemic Projects for Horizontal Curves

Rhode Island Department of Transportation

The Rhode Island Department of Transportation (RIDOT) performed a systemic analysis that identified focus crash and facility types for horizontal curves to identify risk factors for prioritizing locations for safety improvement. With Rhode Island being a small State, using fatal and serious injury crashes provided a small sample size; therefore, the analysis used all injury crashes. The risk factors identified for the systemic analysis were curve radius, shoulder width, Average Annual Daily Traffic (AADT), and functional classification. The existing RIDOT Model Inventory of Roadway Elements (MIRE) data was used to identify the presence of the risk factors and obtain a risk "score" for each curve location. This score assisted RIDOT in prioritizing the curve locations for countermeasure implementation into their Transportation Improvement Plan and HSIP.

As an example, for fixed-object crashes at horizontal curves with radii less than 400 feet, RIDOT used the following risk factor scoring:

- No shoulder present: 2
- Right shoulder width between 1 feet and 4 feet: 1
- AADT less than 2,500 vehicles per day: 2
- AADT between 2,500 and 7,500 vehicles per day: 1
- Predicted KA curve crashes as a function of radius (in feet): $31.377 \times \text{Radius} - 0.391$

RIDOT developed a flow chart which streamlined the diagnosis process. The designer begins with planning-level MIRE data and collects additional data in the field, such as stopping sight distance, speeds, and presence of signage for each project. RIDOT uses the information collected in the field, along with a detailed crash review (if crashes occurred) and applies it to the flow chart to select the appropriate countermeasure (or enhancements to existing countermeasures). Once a countermeasure is identified, the improvements are programmed to be implemented via maintenance work order (signing, striping, guardrail) or as part of a contract (High Friction Surface Treatment, shoulder widening).

Figure 3. High friction surface treatment at a curve in Foster, RI. Source: RIDOT.

Figure 4. Center line and edge line rumble strips on a horizontal curve in Maine. Source: Maine DOT.

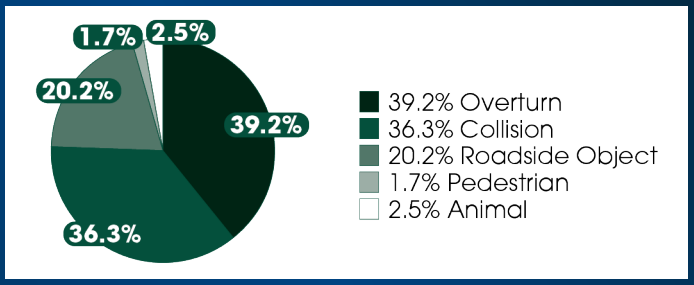

Figure 5. Injury Crash Types, 2009-2018. Source: recreated from SWO Tribal Transportation Safety Plan.

Horizontal Curve Safety for Two-Lane Rural Roads

Maine Department of Transportation

Lane departure crashes are a major concern for Maine, with 72 percent of fatal crashes being classified as went-off-road (49 percent) and head-on (23 percent). Two thirds of the fatal and serious injury crashes occur on rural two-lane roads. To address the lane departure crashes, Maine DOT used the systemic approach to prioritize locations for treatment based on risk factors.

The risk factor categories evaluated included horizontal curvature, vertical curvature, grade, posted speed limit, light condition, road surface condition, and AADT. For each of the risk factor categories, Maine DOT used a "relative risk ratio" to determine relative risk by comparing the percentage of fatal and serious injury crashes to the exposure, measured in vehicle miles traveled (VMT).

The analysis found that horizontal curvature represented the greatest risk factor for rural two-lane highways. A more detailed review of fatal and serious injury crashes found that 84 percent of the crashes are directed toward the outside of the curve and 39 percent involve vehicles crossing the centerline. Maine DOT plans to install center line rumble strips and edge line rumble strips on the outside (high-side) of the curve to target a greater proportion of crashes. To identify curves where rumble strip could be implemented cost-effectively, Maine DOT estimated the benefit/cost (B/C) ratios of rumble strip installations on hypothetical curves of varying AADT and horizontal curvature using crash modification factors and the risk factor analysis. The results showed that very high B/C ratios can be achieved on rural two-lane highways where AADTs are relatively high (10,000 to 15,000) and radii is relatively small (less than 1,400 ft). Maine DOT will install rumble strips in coordination with the resurfacing and paving schedule for two-lane rural highways to minimize costs.

Improving Safety in Tribal Areas

Sisseton-Wahpeton Oyate Tribe

In the Lake Traverse Reservation, 70 percent of fatalities and 60 percent of injury crashes are attributed to vehicles leaving the roadway. To address this trend, the Sisseton-Wahpeton Oyate (SWO) Tribe participated in a safety improvement program through the Wyoming Technology Transfer Center/Local Technical Assistance Program and the Northern Plains Tribal Technical Assistance Program.

A systemic safety study was conducted for the SWO Tribe, which included crash data analysis and a field safety evaluation. The field evaluation provided scoring for 5 categories—general roadway conditions, intersections, signage and pavement markings, fixed objects, and shoulder/right-of-way. The field evaluations scores were ranked and combined with the crash data ranking to provide a list of proposed roadways to be considered for safety improvements. The combination of historical crash data and field evaluations provided a substantive basis for identifying high risk locations.

Cost estimates and a benefit-cost analysis gave the SWO Tribe a method to prioritize the projects. The analysis showed that for straight roadways with little or no shoulder, the majority of crashes were run-off-road (rollovers or hit fixed object). To combat this issue, the plan recommended (1) longitudinal shoulder rumble strips where shoulders exist and (2) a rumble strip applied at the edge line on roadways without shoulders. As a result of these findings, the Tribe received a grant from the Federal Highway Administration Office of Tribal Transportation's Tribal Transportation Program Safety Fund to implement edge line rumble stripes on almost 31 miles of roadways with these higher-risk characteristics.

Resources

FHWA Systemic Safety Web Page https://safety.fhwa.dot.gov/systemic/
FHWA has developed a 4-hour training course on the systemic approach that can be requested through your LTAP Center https://nltapa.org/regions/, **State DOT** https://www.fhwa.dot.gov/about/webstate.cfm, **or FHWA Division Office** https://www.fhwa.dot.gov/about/field.cfm.