



## Safety Benefits:

Flatten sideslope from  
1V:3H to 1V:4H:

**8%**

reduction for  
single-vehicle crashes.<sup>2</sup>

Flatten sideslope from  
1V:4H to 1V:6H:

**12%**

reduction for  
single-vehicle crashes.<sup>2</sup>

Increase the distance to  
roadside features from  
3.3 ft to 16.7 ft:

**22%**

reduction for all crashes.<sup>3</sup>

Increase the distance to  
roadside features from  
16.7 ft to 30 ft:

**44%**

reduction for all crashes.<sup>3</sup>

For more information on this and other FHWA Proven Safety Countermeasures, please visit <https://safety.fhwa.dot.gov/provencountermeasures/> and [https://safety.fhwa.dot.gov/roadway\\_dept/countermeasures/safe\\_recovery/clear\\_zones/](https://safety.fhwa.dot.gov/roadway_dept/countermeasures/safe_recovery/clear_zones/).

## Roadside Design Improvements at Curves

Horizontal curves account for 27 percent of all fatal crashes and 80 percent of all fatal crashes at curves are roadway departure crashes.<sup>1</sup> Roadside design improvements at curves is a strategy encompassing several treatments that target the high-risk roadside environment along the outside of horizontal curves. These treatments can reduce roadway departure fatalities and serious injuries by giving vehicles the opportunity to recover safely and by reducing crash severity.

Roadside design improvements can be implemented alone or in combination, and are particularly recommended at horizontal curves—where data indicates a higher risk for roadway departure fatalities and serious injuries.

### Roadside Design Improvements to Provide for a Safe Recovery

In cases where a vehicle leaves the roadway, having strategic roadside design elements, including an added or widened shoulder, flattened sideslopes, or a widened clear zone can provide drivers with an opportunity to regain control and re-enter the roadway in their lane or come to a safe stop before rolling over or encountering a fixed object.

- A **clear zone** is an unobstructed, traversable roadside area that allows a driver to stop safely or regain control of a vehicle that has left the roadway. Agencies should avoid adding new fixed objects such as trees and utility cabinets or poles in the clear zone. AASHTO's *Roadside Design Guide* details the clear zone width adjustment factors to be applied at horizontal curves.
- **Slope flattening** reduces the steepness of the sideslope to increase drivers' ability to keep the vehicle stable, regain control of the vehicle, and avoid obstacles. Slopes of 1V:4H or flatter are considered recoverable (i.e., drivers can retain control of a vehicle by slowing or stopping). Slopes between 1V:3H and 1V:4H are generally considered traversable, but non-recoverable (i.e., errant vehicle will continue to the bottom of the slope).

- **Adding or widening shoulders** gives drivers more recovery area to regain control in the event of a roadway departure.

### Roadside Design Improvements to Reduce Crash Severity

Since not all roadside hazards can be removed, relocated, or redesigned at curves, installing roadside barriers to shield unmovable objects or steep embankments may be an appropriate treatment. Three common types of roadside barriers are:

- **Cable barrier** is a flexible barrier made from steel cables mounted on weak steel posts. Flexible barriers are more forgiving and have the most deflection.
- **Metal-beam guardrail** is a semi-rigid barrier where a W-beam or box-beam is mounted on steel or timber posts. These deflect less than cable barriers, so they can be located closer to objects where space is limited.
- **Concrete barrier** is a rigid barrier that has little to no deflection.



Clear zone provided on the outside of the curve. Source: FHWA.

<sup>1</sup> Fatality Analysis Reporting System.

<sup>2</sup> NCHRP Report 617: Accident Modification Factors for Traffic Engineering and ITS Improvements, (2008).

<sup>3</sup> Elvik, R., and Vaa, T. Handbook of Road Safety Measures, (2004).