Curve Warning and Delineation

The purpose of this countermeasure package is to improve driver awareness of higher risk horizontal curves through warning signs and enhanced delineation. The following countermeasures can be included in this package:

- Edge Line Markings on Paved Roads.
- MUTCD Compliant Curve Warning Signs.
- Speed Feedback Signs.

The edge line markings and MUTCD compliant curve warning signs included in this package as roadway departure countermeasures are low cost and can be installed using maintenance resources.

Edge Line Markings on Paved Roads

Key Takeaways

Edge line markings provide a visual representation of the edge of the traveled way. They should be used where required by the MUTCD and where additional delineation may reduce roadway departures. Edge lines have been shown to reduce crashes by 15 percent when added. They can be enhanced by widening them to six or eight inches (standard is 4 inches).

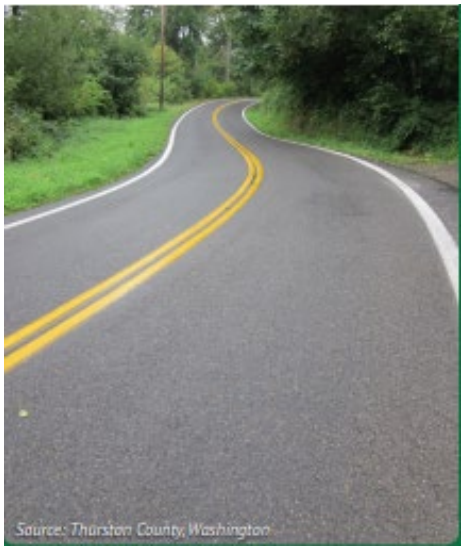

Figure 1. Edge line marking applications in Washington.

Description

Retroreflective edge line pavement markings improve nighttime highway visibility and are expected to reduce the following crash types:

- Curve crashes.
- Nighttime crashes.

Figure 1 is an application of edge line markings in Washington.

Where to Use

Consider edge lines for use on paved roads based on engineering judgment, even when not required or recommended by the MUTCD. Louisiana and Missouri found significant crash reduction when adding edge lines where no striping was present on low volume roads.

Factors municipalities should consider when reviewing edge lines include:

- Existing delineation – if signs or delineators are already present, edge lines may be useful as a supplement. If budgets are limited, consider prioritizing sites with the fewest existing safety enhancements to maximize the impact of this countermeasure.
- Curve radius – curves with smaller radii (i.e., “sharper” curves) require more attention from drivers, so delineation is more advantageous for those horizontal curves compared to broader curves.
- Pavement width – narrow pavement increases the odds of a roadway departure, and edge lines can be used to delineate the edge of narrow pavement; narrower roads will require more frequent maintenance because there may be more vehicle tracking over the markings.
- Crashes – horizontal curves with a history of roadway departure crashes can benefit from edge lines.

Safety Effectiveness

Edge lines reduce crashes by 15 percent for pavement widths as narrow as 20 ft, or even narrower if an engineering study illustrates there would be a safety benefit (CMF Clearinghouse ID 5646).

Enhancements

- Wider edge lines (6 inches to 8 inches) – 22 percent reduction (CMF ID 4792).
- Center line and edge line striping – 24 percent injury reduction (CMF ID 101) when both are provided.

Costs and Service Life

FHWA recommends a service life of 1 year for edge line pavement markings[1], which require annual restriping by the municipality to maintain visibility and safety benefits. VTrans estimates costs of $1,900 per mile for new installations of waterborne painted edge lines.

More Information

https://safety.fhwa.dot.gov/roadway_dept/night_visib/pavement-markings.cfm

[1] https://safety.fhwa.dot.gov/hsip/docs/FHWA-SA-21-021_Countermeasure_Serv_Life_Guide.pdf

MUTCD Compliant Curve Warning Signs

Key Takeaways

Horizontal curve warning signs are used to provide advance warning to drivers of a curve. The signs reduce roadway departure crashes by 22 percent. They can be enhanced with flashing beacons.

Description

Advance curve warning signs warn drivers that the horizontal road alignment is changing ahead, which may require speed reduction and careful attention. In-curve warning signs (such as chevrons) delineate the outside edge of the road on curves and reinforce the intended path of travel. These are expected to reduce the following crash types:

- Curve crashes.
- Nighttime crashes.

Figure 2 is an application of these signs on Vermont roads.

Figure 2. MUTCD Compliant Curve Warning Signs in Vermont.

Where to Use

Local agencies in Vermont can consider advance warning signs and chevron alignment signs (W1-8), both shown in Figure 3, on any road where horizontal curves are not readily expected/visible for drivers, or where there is already a history of roadway departure crashes. Refer to tables 2C-5 and 2C-6 in the MUTCD for additional guidance on sign selection based on the estimated speed reduction required to safely navigate curves. Note that consistency in messaging across similar sites is critical for establishing driver expectancy and promoting effective roadway operations.

Figure 3. Curve warning signs per the MUTCD. [Source: MUTCD Figure 2C-1]

Safety Effectiveness

Chevrons reduce nighttime crashes on curves by 25 percent (CMF Clearinghouse ID 2438) and non-intersection fatal and injury crashes by 16 percent (CMF Clearinghouse ID 2439).

Enhancements

- Advisory speed plaque, with an advisory speed set in one of three ways recommended by the MUTCD:
    - An accelerometer that provides a direct determination of side friction factor.
    - A design speed equation.
    - A traditional ball-bank indicator using the following thresholds:
        - 15 - 16 degrees of ball-bank for speeds of 20 mph or less.
        - 13 - 14 degrees of ball-bank for speeds of 25 to 30 mph.
        - 0 - 12 degrees of ball-bank for speeds of 35 mph or more.
- One or more large arrow sign (W1-6) used in lieu of chevrons based on the difference in posted speed limit and advisory speed limit.
- For safety improvements on curves with existing warning signs, consider oversized and/or doubled-up (i.e., signs on both sides of the road) advance warning signs. Refer to MUTCD Table 2C-2 for conventional and oversized sign dimensions.
- Retroreflective strips (same color as sign background color) on signposts can be added to existing or new signs when the desired effect is not achieved.
- Fluorescent yellow reflective sheeting, particularly in areas with frequent fog or shadows.

Enhancements are intended for implementation with an incremental approach based on local site conditions, funding available, and engineering judgement.

Costs and Service Life

FHWA recommends a service life of 15 years for curve warning signs[2]. VTrans estimates costs of $800 per sign (including post) for curve warning signs. Local agencies should monitor the retroreflectivity of the signs and regular washing is recommended to maintain reflectiveness.

More Information

https://safety.fhwa.dot.gov/provencountermeasures/enhanced_delineation

[2] https://safety.fhwa.dot.gov/hsip/docs/FHWA-SA-21-021_Countermeasure_Serv_Life_Guide.pdf

Speed Feedback Signs

Figure 4. Application of a dynamic radar speed feedback sign in Vermont.

Key Takeaways

Dynamic speed feedback signs provide direct information to drivers about their speed compared to the posted speed. They should be considered for use in areas where excess speed contributes to safety issues. They have been shown to reduce crashes by 5 percent.

Description

Dynamic radar speed feedback signs can be used to supplement chevrons on horizontal curves (W13-20, W13-20aP). These signs warn drivers if they are entering the curve at too high a speed compared to the advisory or posted speed limit. This countermeasure is expected to reduce:

- Curve crashes
- Speeding-related crashes

Figure 4 is an application of dynamic speed feedback signs on Vermont roads.

Where to Use

This supplemental treatment can be used on horizontal curves with a history of speed-related and nighttime roadway departure crashes *after other, lower-cost treatments have been tried*. The treatment is for installation on town highways only. Consideration should be given to solar conditions at the site before a solar-powered solution is selected. A safety analysis of dynamic radar speed feedback signs showed effectiveness on low volume roads and provided an average of 49.8 percent reduction in the fraction of vehicles exceeding the speed limit by 20 mph or more where speed feedback signs were installed at the beginning of horizontal curves. Agencies should only propose installations in compliance with the MUTCD and on municipal roads.

Safety Effectiveness

Dynamic radar speed feedback signs have been found to correlate with a 5 percent reduction in crashes (CMF ID 6885).

Costs and Service Life

FHWA recommends a service life of 10 years for speed feedback signs[3]. VTrans estimates costs of 3,000 - $5,000 each for speed feedback signs.

More Information

https://safety.fhwa.dot.gov/provencountermeasures/speed-safety-cameras.cfm

[3] https://safety.fhwa.dot.gov/hsip/docs/FHWA-SA-21-021_Countermeasure_Serv_Life_Guide.pdf

Intersection Signage, Pavement Marking, and Sight Distance Improvements

FHWA considers the installation of low-cost signage and pavement marking improvements at stop-controlled intersections a "Proven Safety Countermeasure"[4]. The standard approach is to tailor treatments specific to an intersection by selecting appropriate countermeasures from a menu of improvements. Per FHWA, improvements for uncontrolled approaches include:

- Advance intersection warning signs, which can be enhanced by providing one on each side of the road, installing oversized signs, and supplemental street name signs.
- Retroreflective strips on signposts.
- Enhanced (widened and/or wet-reflective) edge line pavement markings to delineate through lanes.
- Flashing beacons can also be used to draw attention to signs which are maintained by the municipality.

Improvements on stop-controlled approaches include:

- Standard or oversized "Stop Ahead" intersection warning signs on both sides of the road.
    - Viable treatment locations include (but are not limited to) town roads intersecting with state highways.
- Oversized Stop signs on both sides of the road.
- Retroreflective strips on signposts.
- Properly placed stop bar.
- Clearing the sight triangle to improve sight distance.
- Double arrow warning sign at T-intersections.
- Flashing beacons mounted on the advance warning and traffic control signs. Consideration should be given to solar conditions at the site before a solar-powered solution is selected.

South Carolina evaluated the performance of these improvements at various locations across the State[5]. The results included:

- A 10 percent reduction in fatal and injury crashes.
- A 15 percent reduction in nighttime crashes.
- A 27 percent reduction in fatal and injury crashes at rural intersections.
- A 19 percent reduction in fatal and injury crashes at 2-lane by 2-lane intersections.
- A benefit-cost ratio of 12 to 1.

The countermeasures included in this package are low cost and can be installed using the local jurisdiction's maintenance resources.

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[4] https://safety.fhwa.dot.gov/provencountermeasures/syst_stop_control.cfm

[5] T. Le et al, "Safety Effects of Low-Cost Systemic Safety Improvements at Signalized and Stop-Controlled Intersections," 96th Annual Meeting of the Transportation Research Board, Paper Number 17-05379, January 2017.

Intersection Signage

Key Takeaways

Several warning signs can be used and enhanced on intersection approaches to warn drivers of an upcoming intersection. These are especially useful at isolated intersections on rural, high speed roads. Combinations of these signs have been found to reduce fatal and injury crashes at intersections by 10 percent.

Description

Enhanced signage at an intersection can warn drivers of a hazardous intersection and reduce the risk of a severe crash. Signage enhancement options include:

- Doubled-up signage (included on both sides of the roadway – also known as “gate-posted”).
- Oversized signage.
- Reflective strips on signposts.
- Additional warning signs.
- “Stop Ahead” warning signs.
- Advanced yellow street name signs as supplemental plaques mounted below warning signs (see Figure 5).
- Increased sign retroreflectivity.
- Flashing beacons. Consideration should be given to solar conditions at the site before a solar-powered solution is selected.

Figure 5 includes an intersection warning sign with an advanced street name sign and a stop-controlled intersection approach with enhanced signage.

Figure 5. Application of intersection signage in Vermont.

Where to Use

Local agencies can apply enhanced signage at several intersections, including:

- Intersections with a history of or high risk for severe crashes.
- Intersections which may violate driver expectancy, such as an isolated intersection or one with severe skew.
- Intersections with poor sight distance.

These should be used in accordance with the MUTCD.

Additional Safety Effectiveness

As stated previously, these signs installed as part of larger packages have a proven history of reducing crash frequency and severity at stop-controlled intersections. The following is a list of the isolated safety effects of several countermeasures included in this package.

- Advanced street name signs (meaning yellow supplemental street name signs installed below warning signs) reduce fatal and injury crashes by 1 percent, although this relates to signalized intersections (CMF ID 2450).
- Doubled-up Stop signs (installed on both sides of the roadway) reduce angle crashes by 55 percent, though the study is only rated 1-star on the CMF Clearinghouse (CMF ID 1661).
- Increased retroreflectivity of Stop signs reduce fatal and injury crashes by 9.4 percent (CMF ID 6052).
- Flashing beacons reduce fatal and injury crashes by 10 percent at stop-controlled intersections (CMF ID 447).

Costs and Service Life

FHWA recommends a service life of 15 years for a sign and for increasing sign retroreflectivity. Average VTrans countermeasure costs include:

- Oversized Stop sign: $800.
- Oversized intersection warning sign: $800.
- Reflective strips: $10 - $30 per sign.
- Advanced street name signs: $600.
- Flashing beacons: $6,000.

Intersection Pavement Marking and Sight Distance Improvements

Key Takeaways

Pavement marking improvements at intersections can provide guidance for navigation to the drivers. Additionally, sight distance improvements make it easier for drivers to identify hazards. Pavement markings can reduce crashes at intersections by 22 percent and increased available sight distance is correlated with decreased crash frequency.

Figure 6. Application of pavement markings at intersections.

Description

Pavement marking enhancements and sight distance improvements, along with signage, can improve safety at stop-controlled intersections. Potential countermeasures include:

- Wide longitudinal pavement markings.
- Properly located stop bar.
- Cleared sight triangle of vegetation, parking, and other obstructions.
- "Stop Ahead" pavement markings.

Figure 6 shows brighter and wider pavement markings used at an intersection, along with broken lines through the minor approaches.

Where to Use

Local agencies can apply enhanced pavement markings and sight distance improvements at intersections under several conditions, including:

- Intersections with a history of or high risk for severe crashes.
- Intersections which may violate driver expectancy, such as an isolated intersection or one with severe skew.
- Intersections with poor sight distance.

Safety Effectiveness

As stated previously, these signs installed as part of larger packages have a proven history of reducing crash frequency and severity at stop-controlled intersections. The following CMFs show the isolated safety effects of several countermeasures included in this package.

- "Stop Ahead" pavement markings reduce injury crashes by 22 percent at rural stop-controlled intersections (CMF ID 396).
- A CMF shows that increasing stopping sight distance reduces fatal and injury crashes related to stopping sight distance at stop-controlled intersection (CMF ID 9657).

Costs and Service Life

Local jurisdictions are responsible for ongoing maintenance beyond initial installation of signs and markings. Due to snowplows and weather-related degradation, water-based pavement markings in Vermont have an expected service life of 1 year and thermoplastic pavement markings have an expected service life of up to 2.5 years based on a 2007 VTrans research project. Installing recessed pavement markings further improves service life and long-term reflectivity compared to surface-applied markings for all marking types. FHWA recommends a service life of 20 years for improving sight distance based on non-vegetation issues (meaning anywhere that driver sight distance is obstructed by anything besides vegetation). The service life for vegetation-based sight distance issues is based on the growth of vegetation. Average 2018-2020 VTrans countermeasure costs include:

- Six-inch longitudinal pavement markings: $0.11/foot (surface-applied waterborne paint), $4.20/foot (surface-applied thermoplastic), $1.50/foot (surface-applied polyurea), or $1.94/foot (recessed polyurea)
- Thermoplastic Stop bar: $13/foot.
- Recessed polyurea Stop bar: $26/foot.
- Thermoplastic “Stop ahead” pavement markings: $157 per letter.
- Recessed thermoplastic “Stop ahead” pavement markings: $424 per letter.
- Sight distance clearing: $1,000 (highly variable depending on local conditions and maintenance labor costs).

Roadside Design Improvements

There is the potential for vehicles to leave the road at any point, but especially in horizontal curves. As a result, FHWA recommends a forgiving roadside. When addressing roadside obstacles, AASHTO presents a six-step hierarchy[6]:

1. Remove the obstacle.
2. Redesign the obstacle so it can be safely traversed.
3. Relocate the obstacle to reduce the likelihood it is struck.
4. Reduce the impact severity by installing a breakaway device.
5. Shield the obstacle with a barrier or crash cushion.
6. Delineate the obstacle.

FHWA considers roadside design improvements a Proven Safety Countermeasure[7]. This includes several countermeasures, including:

- Adding or widening shoulders.
- Widening the clear zone.
- Flattening side slopes.
- Installing barrier.
- Implementing breakaway devices.

The countermeasures in this package may include more labor and costs than a simple sign installation. Note these should be done within existing ROW and where there are no or minimal environmental impacts to limit the complexity of the project, including minimizing costs and project development effort. As such, the best candidate sites are those for which the work can be done within the existing ROW.

[6] American Association of State Highway and Transportation Officials (AASHTO), Roadside Design Guide, 4th Edition, Washington, DC: AASHTO, 2011, pp.1-4.

[7] https://safety.fhwa.dot.gov/provencountermeasures/roadside_design.cfm

Shoulders (Add or Widen)

Key Takeaways

Shoulders provide forgiveness for vehicles departing the lane. They should be used on both paved and unpaved roads where possible. Wider shoulders and more stable material (e.g., paved as opposed to gravel) can reduce crash frequency and severity. Shoulders can be enhanced by providing paved shoulders, as opposed to graded turf or aggregate.

Figure 7. Shoulders used on two-lane roads.

Description

Adding a paved or graded shoulder provides an errant driver an opportunity to regain control. Shoulders are effective at reducing roadway departure crashes.

Figure 7 is a roadway in Vermont with paved shoulders. A state highway is shown here, but this treatment is applicable to town roads as well.

Where to Use

Curves with no or narrow shoulders where there is a history or risk of roadway departure crashes in which a shoulder would increase the space for a recovery. Given their cost, consider using them only where their inclusion is expected to provide a significant increase in chances of recovery for a departing vehicle.

Safety Effectiveness

The HSM includes CMFs for shoulder width on two-lane rural roads. The study that produced these CMFs assumed a baseline shoulder width of 6 feet. The CMFs apply to lane departure crashes and vary based on traffic volume and existing shoulder width. The following are example crash reductions calculated from CMFs in the HSM:

Shoulder width increased from 0 to 2 feet

- AADT < 400 vpd: 2.7 percent reduction
- AADT of 1,000 vpd: 7.2 percent reduction
- AADT > 2,000 vpd: 13.3 percent reduction

Shoulder width increased from 0 to 5 feet

- AADT < 400 vpd: 8.2 percent reduction
- AADT of 1,000 vpd: 16.8 percent reduction
- AADT > 2,000 vpd: 28 percent reduction

Enhancements

Adding shoulders may allow for installation of rumble strips and the SafetyEdge^{SM}. Widening shoulders further through horizontal curves can facilitate the off-tracking of large trucks.

Costs and Service Life

Adding or widening a shoulder has a recommended service life of 20 years. The estimated cost of new paved shoulder is $135 per square yard.

Remove Fixed Objects to Widen Clear Zone

Key Takeaways

Wide clear zones reduce the likelihood of an errant vehicle encountering a fixed object. Wider clear zones are correlated with reduced crash frequency and severity. Clear zone widening should be used where moving a fixed object is likely to produce a safety improvement.

Description

Establishing and maintaining a clear zone provides an unobstructed, traversable area where an errant driver can recover, reducing the likelihood of fixed object crashes.

Figure 8 is an FHWA graphic which shows the expected crash reduction associated with widening a clear zone.

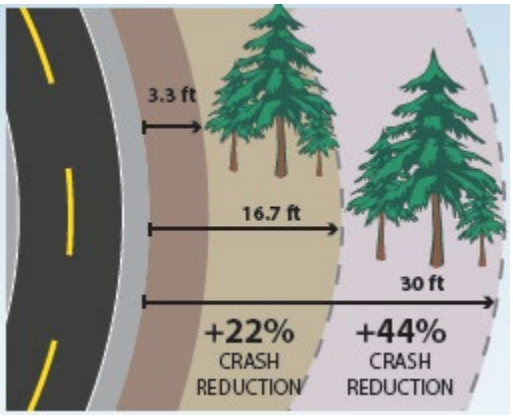

Figure 8. Crash reduction from clear zone widening. Source: FHWA.

Where to Use

Where there are fixed objects in the right-of-way that an errant vehicle can strike, particularly on the outside of a horizontal curve. Curves, and other locations, with elevated risk for a roadway departure should be prioritized for this improvement. Locations where the relocation of fixed objects will not create environmental concerns.

Effectiveness

Increasing distance from the edge of traveled way to trees by 3 feet , 5 feet, 8 feet, 10 feet, and 13 feet reduce crashes by 22 percent, 34 percent, 49 percent, 57 percent, and 66 percent, respectively (NCHRP Report 440).

Enhancements

Maintain existing clear zones where saplings and other vegetation have begun to grow to improve sight distance and remove the potential for future fixed objects.

Costs and Service Life

Removing or relocating a fixed object has a recommended service life of 20 years. Additionally, the estimated cost of such an activity is $1,000 for the removal of a medium sized tree.

More Information

https://safety.fhwa.dot.gov/roadway_dept/countermeasures/safe_recovery/clear_zones/

Flatten Side Slopes

Figure 9. Flat then steep side slope.

Key Takeaways

Recoverable and traversable side slopes provide forgiveness for errant vehicles entering the roadside. Flattened side slopes are correlated with decreased crash frequency. Side slope flattening is costly, so it should be used at high risk locations.

Description

Flattening steep slopes provides a better opportunity for vehicles to traverse the slope, reducing the likelihood of:

- Rollovers.
- Fixed object crashes.

Figure 9 shows a potentially hazardous side slope, protected in this case by guardrail.

Where to Use

Roadsides with non-traversable longitudinal or transverse slopes located close to the edge of the traveled way along a horizontal curve with a history of or risk for roadway departure crashes, especially rollover crashes. Refer to Chapter 3 of the AASHTO Roadside Design Guide for more information, including how to calculate the desired clear zone for the roadside and whether the hazardous slope falls within that clear zone.

Effectiveness

Table 2 describes the results of a safety effectiveness evaluation of side slopes along two-lane rural roads. The authors of the associated study speculated that the low crash frequency along study sites contributed to the low benefit-cost values despite the proven safety effectiveness of the treatment[8].

Table 1. Summary of the Safety Effectiveness of Side Slope Flattening

Initial Slope	Proposed Slope	Total CMF	F+I CMF	RwD CMF	Benefit-Cost
1V:4H	1V:6H or flatter	0.9223	0.6886	0.7844	N/A
1V:4H or 1V:5H	1V:6H or flatter	0.9360	0.7216	0.8220	0.21
1V:3H	1V:4H or 1V:5H	1.0153	0.7432	0.9509	N/A
1V:2H or 1V:3H	1V:4H or 1V:5H	0.9788	0.7443	0.8699	0.13

F+I = fatal + injury
RwD = roadway departure

Enhancements

While performing earthwork on the roadside, local agencies should consider performing additional roadside improvements, including removing, relocating, or protecting fixed objects, correcting potential

[8] https://www.fhwa.dot.gov/publications/research/safety/21075/21075.pdf

drainage issues, and addressing trip hazards (e.g., exposed culverts or other objects that may destabilize, or trip, a vehicle when encountered).

Costs and Service Life

Flattening side slope has a recommended service life of 20 years. The treatment cost will vary significantly with site conditions. The median bid for earth borrow is $10/cubic yard, with an additional $40 per square yard of surface area for topsoil, seeding, limestone, and fertilizer.

More Information

N/A

Install Roadside Barrier

Key Takeaways

Roadside barrier is used where a collision with a barrier is expected to produce a less severe outcome than a vehicle entering the roadside. Barriers have been shown to produce an increase in low severity crash frequency but decrease severe crash frequency. Barrier systems should be Manual for Assessing Safety Hardware (MASH) compliant and include crashworthy end treatments.

Figure 10. Guardrail with crashworthy end treatment.

Description

Roadside and median barriers are designed to redirect and slow vehicles while shielding them from obstacles likely to result in a more severe crash, such as:

- Rigid fixed objects.
- Steep slopes.
- Bodies of water.
- Opposing traffic.

Figure 10 shows a guardrail system with a crashworthy end treatment in Vermont.

Where to Use

Horizontal curve roadsides with non-traversable slopes or fixed objects located close to the edge of the traveled way where there is a history or risk of severe roadway departure crashes. Typically provided when delineation and signing are not sufficient, it is not feasible to clear obstacles and flatten side slopes, and the likelihood of harm from striking the shielded object is greater than the harm from striking the barrier system.

Effectiveness

In locations where non-traversable slopes or fixed objects exist along the roadside, barrier systems produce fewer injuries than the absence of barrier. When placed to protect vehicles from fixed objects more than 20 feet from the roadway, agencies have observed a 57 percent decrease in combined fatal and injury crashes. However, this is associated with the potential for an increase in less severe crashes – agencies observed a 52 percent increase in total crashes when guardrail is used to protect vehicles from fixed objects more than 20 feet from the roadway.

Enhancements

All barrier runs must include a MASH-compliant crashworthy end treatment.

Costs and Service Life

Installation of guardrail on the outside shoulder has a recommended service life of 25 years. Agencies need to restore the barrier to a functional system after a strike. Steel beam guardrail is estimated at $35 per linear foot (materials only). Additionally, agencies are expected to include MASH compliant end treatments, which cost roughly $2,500 each.

More Information

The crashworthiness of barriers is evaluated through crash testing. The current crash test criteria is contained in the AASHTO Manual for Assessing Safety Hardware (MASH) 2016.
https://safety.fhwa.dot.gove/roadway_dept/countermeasures/reduce_crash_severity

Implement Breakaway Devices

Key Takeaways

Breakaway supports provide forgiveness for errant vehicles that strike roadside hardware. These are typically included for all signs and other designed roadside fixed objects. Their presence significantly reduces the potential severity of a collision with roadside hardware.

Description

Breakaway supports for utility poles, signs, and other roadside fixed objects reduce the potential severity of an impact with that device by providing a forgiving target to strike and allowing the vehicle to continue through the object, rather than stopping the vehicle suddenly.

Figure 11 is an example of two breakaway devices where the bolts shear when sufficient lateral force is applied.

Figure 11. Breakaway devices applied in the field.

Where to Use

Fixed objects that are within the clear zone and where the sign or support is not shielded and cannot be removed or relocated, particularly on horizontal curves. Supports should be designed and located to minimize the likelihood of impact by errant vehicles and to protect the breakaway mechanism from environmental conditions.

Effectiveness

No reliable safety effectiveness evaluations have been conducted to date, though their use is standard practice and required for sign posts in the clear zone.

Enhancements

N/A.

Costs and Service Life

Breakaway sign supports have a recommended service life of 15 years. The cost per post and anchor is estimated at $131.

More Information

The crashworthiness of breakaway devices is evaluated through crash testing. The current crash test criteria is contained in the AASHTO Manual for Assessing Safety Hardware (MASH) 2016. https://safety.fhwa.dot.gov/roadway_dept/countermeasures/reduce_crash_severity/