NCHRP 17-113 COUNTERMEASURES

Flatten Side Slopes

ROAD WAY DEPARTURE

Gentle, flatter slopes provide a safer recovery area and decrease the chance of vehicle rollover or collision with fixed objects.

Implementation Strategy

How and Where to Apply

- Apply on high-speed rural arterials, expressways, and freeways with limited shoulders and steep roadside slopes.
- Flatten side slopes from steep grades to more gradual slopes, particularly in areas with frequent run-off-road crashes or horizontal curves.
- Improvements can be made during reconstruction, resurfacing, or safety retrofit projects, and are especially beneficial where clear zone standards cannot be fully met due to terrain or right-of-way limitations.

Use in a Safe System Approach

This countermeasure helps mitigate consequences of human error by modifying the roadside environment to absorb or reduce crash energy. Flattened slopes give errant vehicles more space and time to recover, reducing both crash frequency and severity in line with SSA goals.

Key Stakeholders

State DOTs, Highway Designers, Roadside Safety Engineers

Proactive Implementation

Use roadway inventory data and crash reports to identify segments with high run-off-road crash rates, especially near horizontal curves and rural high-speed corridors. Integrate slope flattening into pavement or shoulder rehabilitation projects to minimize added cost and disruption. Where full flattening isn't feasible, consider partial grading or safety hardware to reduce risk.

Countermeasure Overview

Objective: Reduce the severity of the crash.

Strategy: Improve design and application of barrier and attenuation systems.

Selected Related Countermeasures

- CM1 Clear Zone Improvements
- CM2 Guardrails where slope flattening is not feasible
- CM3 Enhanced Curve Delineation

Cost: Moderate

Service Life: 20 years

Benefit-Cost Ratio: 1.28:1

Targeted Solution

CONTRIBUTING FACTORS	▪ High-speed Traffic with Limited Buffer Space
TARGET CRASH TYPE	▪ Run-off Road
ROAD FACILITY TYPE (ARTERIAL, COLLECTOR, LOCAL)	▪ Principal Arterial ▪ Freeways, expressways
AREA TYPE	▪ Rural

Safety Linkage

NCHRP 500 Series	SAFE SYSTEM APPROACH
Run-off road	Safe Roads
AASHTO'S TOWARD ZERO DEATHS	SAFE SYSTEM ROADWAY DESIGN (TIER 1, TIER 2, TIER 3, TIER 4)
Safer Infrastructure	Tier 1

Slope requiring flattening, Source: highways.dot.gov

Safety Benefits

14% Reduces fatal and injury crashes on rural, and flattened slopes.[1]

[1] CMF ID: 7179

Resources

- Cost-Effective Side-Slope Countermeasures for Alaska