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, in areas with frequent run-off-road crashes or horizontal curves.
- Improvements can be made during reconstruction, resurfacing, or retrofits, especially where clear zones cannot be met due to terrain or right-of-way, but not where flattening is infeasible and guardrails required.

Use in a Safe System Approach

Slope flattening supports Safe Roads and Safe Road Users by modifying the roadside to absorb crash energy. By giving errant vehicles more space and time to recover, it lowers run-off-road crash risks and severity, reinforcing the SSA principle that human mistakes should not cause death or serious injury.

Key Stakeholders

Sate DOTs, MPOs, engineering consultants, advocacy groups, construction contractors.

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.

Targeted Solution

CONTRIBUTING FACTORS	▪ High-speed Traffic with Limited Buffer Space
TARGET CRASH TYPE	▪ Run-off Road
ROAD FACILITY TYPE	▪ 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
Safer Infrastructure	Tier 1

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: 1.2:1 to 1.5:1

Safety Benefits

31% Reduces all types of crashes and severity levels K, A, B, and C on rural two-way roads (CMF ID: 11204)

12% Reduces cross-median, fixed-object, and run-off-road crash types across severity levels K, A, B, and C on rural divided four-lane principal arterial freeways and expressways (CMF ID: 7141)

Resources

- Cost-Effective Side-Slope Countermeasures for Alaska

Slope Requiring Flattening. Source: FHWA.