Roadside Safety Design
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Why worry about the roadside?
15,000 deaths per year in the USA

What is Roadside Safety Hardware?
Basics of Roadside Design

- Prime Directive: Keep the vehicle on the road!

Basics of Roadside Design

Roadside Design First Priority: Remove all hazards!

Basics of Roadside Design

Remove hazards: Some starting points are more difficult than others...
Basics of Roadside Design

• Second Priority: Redesign the feature

Basics of Roadside Design

• Redesign the feature: Breakaway supports

Basics of Roadside Design

• Redesign the feature: Culvert ends match slope
Basics of Roadside Design

• Shield the feature

STEEL W-BEAM GUARDRAIL

Roadside Hardware - Why crash test?

• Does it work?
  – Does the device reduce the severity of the impact? (all hardware)
  – Does the device allow the vehicle to safely traverse the roadside? (breakaway post)
  – Does the safety device safely redirect the vehicle? (guardrail)
  – Does the safety device safely stop the vehicle? (crash cushion)

Testing Standards

• NCHRP 230  Published 1981
• NCHRP 350 “Recommended Procedures for the Safety Performance Evaluation of Highway Features” Published 1993
• MANUAL FOR ASSESSING SAFETY HARDWARE (MASH) Published October ‘09
Why Crash Test? 1. Severity

– Does the device reduce the severity of the impact? (all hardware)
– Crash test uses small automobile at 100 km/hr.
– Accelerometers in vehicle measure the forces generated during the crash.
– Occupant Impact Force and Occupant Deceleration must be survivable.
**Why Crash Test? 2. Strength**

– Does the safety device have **adequate strength** to safely redirect the vehicle?
– Crash tests use trucks at various angles and speeds.
– Vehicle must not penetrate or vault over barrier.
– Components may not spear vehicle.

**Six Test Levels for safety hardware**
- TL-1  2270kg Pickup at 50 km/hr  30 mph
- TL-2  2270kg Pickup at 70 km/hr  45 mph
- TL-3  2270kg Pickup at 100 km/hr  60-65 mph
- TL-4  10 000 kg Box truck at 90 km/hr
- TL-5  36 000 kg Semi Tractor-Trailer Box Truck at 80 km
- TL-6  36 000 kg Tanker Trailer at 80 km/hr
Guardrail Terminals

**MUST AVOID SPEARING VEHICLES**

Guardrail Terminals

**BURIED IN BACKSLOPE**

Guardrail Terminals – End Treatment

**ET-2000 PLUS**
Breakaway Hardware

- Sign Supports – Mandatory within clear zone of all roads open to public travel
- Luminaire Supports – Required on NHS since 1990
- Traffic Signal Poles – Generally not on breakaway supports
- Timber Utility Poles – 2nd most common fixed object involved in fatal crashes
- Mailboxes – unique set of problems
• Crashes into trees result in over 3000 deaths each year in the US.
• Greatest single roadside hazard
• “Breakaway Tree” = 4-inch maximum trunk diameter
Aerial Views

% Fatal Crashes

Legend:
- Additional Lateral Offset at Inside of Curve
- Enhanced Lateral Offset

Figure 16-1. Lateral Offset for Objects on Horizontal Curves on Curved Facilities
Simulations

• Finite Element Modeling of vehicles and crashes
• Useful for developing or improving hardware
• May not be used in lieu of crash testing for FHWA Acceptance
SIMULATION - PORTABLE CONCRETE BARRIER TEST

SIMULATION OF W-BEAM GUARDRAIL TEST

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Roadside Safety: The Importance of Clear Zone and the Forgiving Roadside

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TRB AF20(2) Roadside Safety Design International Research Activities Subcommittee

Learning Objectives

- Discuss the importance of adding and maintaining clear zones
- Identify appropriate countermeasures to address roadway departure crashes
- Make informed decisions on the selection and implementation of roadside hardware to improve safety

Motor Vehicle Fatal Crash Statistics – United States

In 2012: 33,561 Fatalities
1.13 Fatalities per 100 Million Vehicle Miles of Travel

Source: AASHTO Roadside Design Guide
US DOT Traffic Safety Facts
Percent Distribution of Fixed-Object Fatalities by Object Struck

In 2008, 23.1% of total crashes in the US were single-vehicle run-off-the-road crashes.

Source: AASHTO Roadside Design Guide
RHS HLDI, Fatality Facts 2008

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Fixed-Object Crash Test
Utility Pole/Tree Video: 50, 70 & 90 km/h

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Forgiving Roadside Concept
A significant number of serious crashes can be avoided by providing a forgiving roadside.
Forgiving Roadside: Options for Reducing Roadside Obstacles

1. Remove the obstacle
2. Redesign the obstacle so it can be safely traversed
3. Relocate the obstacle to a point where it is less likely to be struck
4. Reduce impact severity by using an appropriate breakaway device
5. Shield the obstacle with a barrier or crash cushion
6. Delineate the obstacle

Clear Zone Concept

Clear Zone

A clear zone is the unobstructed, traversable area provided beyond the edge of the through traveled way for the recovery of errant vehicles.

The clear zone includes shoulders, bike lanes, and auxiliary lanes, except those auxiliary lanes that function like through lanes.

The desired width is dependent upon traffic volumes and speeds and on the roadside geometry.
Suggested Clear Zone Distances

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Suggested Clear Zone Distances (continued)

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Roadside Geometry

- Roadway
- Transverse Slope
- Edge Field
- Transverse Slope
- Transition Slope
- Vertical Slope
- Taper Slope
Drainage Features

Urban Environment

In an urban environment, right of way is often extremely limited and in many cases it is not practical to establish a full-width clear zone using the guidance in the AASHTO Roadside Design Guide.

Urban Environment

- In these environments, a lateral offset to vertical obstructions (signs, utility poles, luminaire supports, fire hydrants, etc., including breakaway devices) is needed to accommodate motorists operating on the roadway and parked vehicles.
Urban Environment

This lateral offset to obstructions helps to:
- Avoid adverse impacts on vehicle lane position and
  encroachments into opposing or adjacent lanes
- Improve driveway and horizontal sight distances
- Reduce the travel lane encroachments from
  occasional parked and disabled vehicles
- Improve travel lane capacity
- Minimize contact from vehicle mounted intrusions
  (e.g., large mirrors, car doors, and the overhang of
  turning trucks)

Urban Environment

- On curbed facilities located in transition areas
  between rural and urban settings there may be an
  opportunity to provide greater lateral offset in the
  location of fixed objects.
- These facilities are generally characterized by
  - higher operating speeds
  - sidewalks separated from the
curb by a buffer strip

Urban Environment

- Lateral Offset: A minimum of
  0.5m (1.5 ft) should be provided
  from the face of the curb with
  0.9m (3 ft) at intersections.
- An enhanced lateral offset of
  1.2m to 1.8m (4 ft to 6 ft) to
  obstructions is a more
  appropriate guide for certain
  situations.
Summary

- Reviewed the importance of the forgiving roadside
- Reviewed AASHTO Roadside Design Guide suggested Clear Zone distances
- Reviewed AASHTO Roadside Design Guide suggested Lateral Offsets and Enhanced Lateral Offsets for constrained urban environments