

High Friction Surface Treatment A Proven Countermeasure

Caroline Trueman
Safety Engineer
FHWA NJ Division Office
(609)637-4234

WHYs

Safety Performance Targets

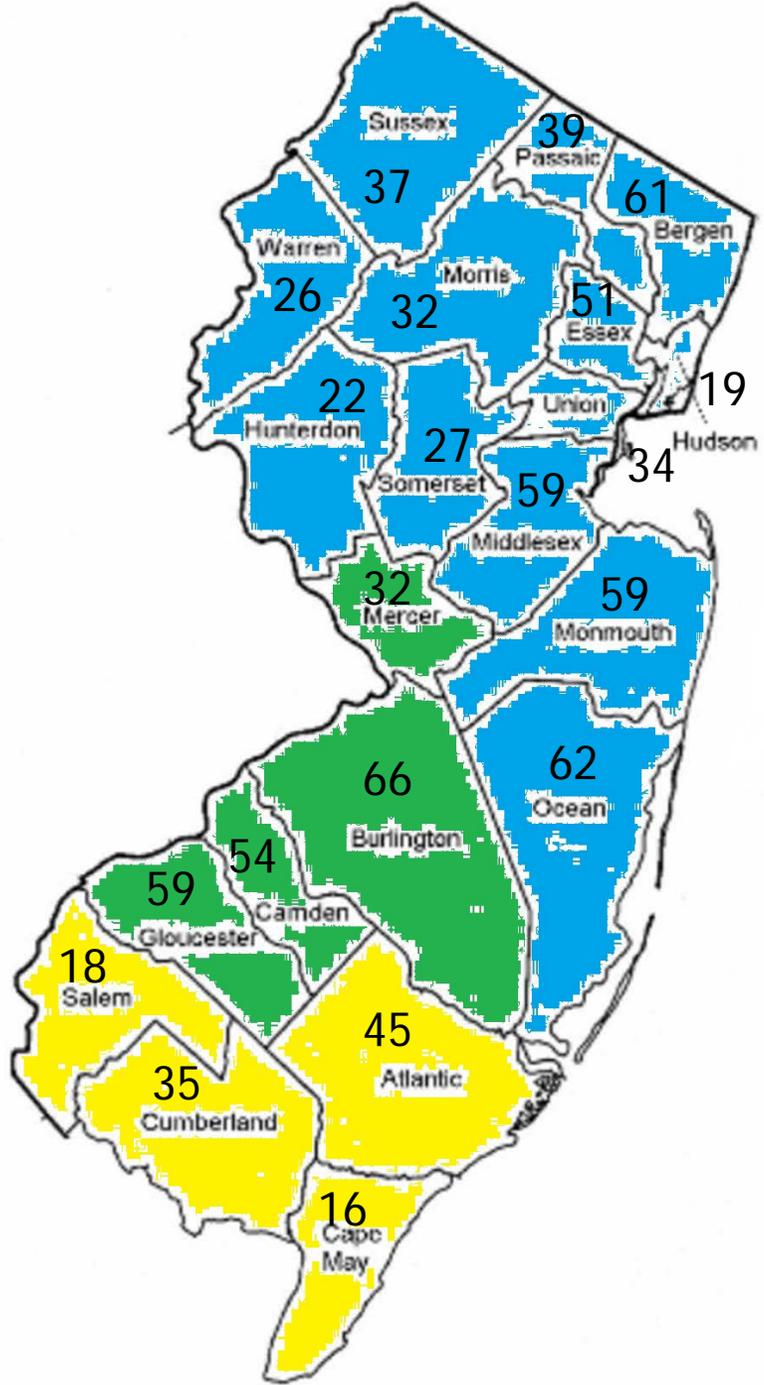
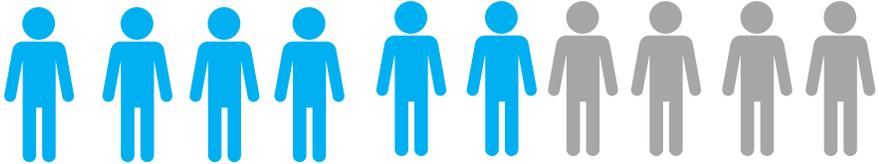
| PERFORMANCE MEASURE | TARGET 5 YEAR ROLLING AVERAGE | 2014-2018 -BASELINE 5 YEAR ROLLING |
|--|----------------------------------|--|
| NUMBER OF FATALITIES | 586.0 | 571.0 |
| FATALITY RATE | 0.778 | 0.762 |
| NUMBER OF SERIOUS INJURIES | 1105.0 | 1135.6 |
| SERIOUS INJURY RATE | 1.467 | 1.516 |
| NUMBER OF NON-MOTORIZED FATALITIES AND SERIOUS INJURIES | 386.5 | 390.3 |

| PERFORMANCE MEASURE | TARGET 5 YEAR ROLLING AVERAGE | 2014-2018 -BASELINE 5 YEAR ROLLING | 2012-2016 5 YEAR ROLLING AVERAGE |
|--|----------------------------------|--|-------------------------------------|
| NUMBER OF FATALITIES | 586.0 | 571.0 | |
| FATALITY RATE | 0.778 | 0.762 | |
| NUMBER OF SERIOUS INJURIES | 1105.0 | 1135.6 | |
| SERIOUS INJURY RATE | 1.467 | 1.516 | |
| NUMBER OF NON-MOTORIZED FATALITIES AND SERIOUS INJURIES | 386.5 | 390.3 | |

"IMPROVING LIVES BY IMPROVING TRANSPORTATION"
New Jersey Is An Equal Opportunity Employer • Printed on Recycled and Recyclable Paper

2016 Lane Departure Serious Injuries & Fatalities

336 Fatalities
517 Serious Injuries



National Data

5%



23%

% Fatalities on
Horizontal Curves

% Horizontal Curves
on US Roads

Contributing Factors

Horizon Curve Crashes



- Poor Pavement Condition
- Complex Driving Task Negotiating Curve
- Wet Road Hydroplaning
- High Friction Demand of Vehicle in Curve

Factors Contributing to Skid Related Crashes

- Tire issues
- Weather Conditions
- Friction Demand
 - Road Geometry
 - Vehicle Speeds
 - Driver Actions
 - Vehicle Characteristics



AASHTO Horizontal Curve Design Model

$$R = V^2/15(e + f)$$

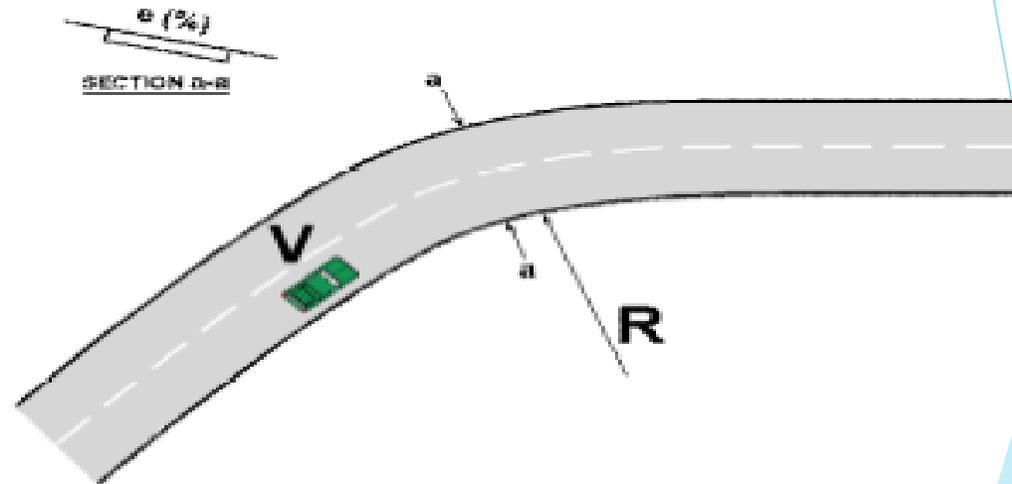
$$e + f = V^2/15 R$$

e = superelevation

f = side friction factor

V = design speed (mph)

R = radius of curve (ft)



| US Customary | Metric |
|--|--|
| $R = \frac{V^2}{15(e+f)}$ | $R = \frac{V^2}{127(e+f)}$ |
| where R = Radius of circular curve (ft) V = Design speed (mph) e = Superelevation f = Side "friction" or comfort | where R = Radius of circular curve (m) V = Design speed (km/h) e = Superelevation f = Side "friction" or comfort |

Office of Safety Proven Safety Countermeasures



These nine countermeasures address crashes that occur in the focus areas of intersections, pedestrians, and roadway departure.



Improving safety is a top priority for the U.S. Department of Transportation, and FHWA remains committed to reducing highway fatalities and serious injuries on our Nation's highways. We are highly confident that certain processes, infrastructure design techniques, and highway features are effective and their use should be encouraged.

Memo

2012 "Guidance Memorandum on Promoting the Implementation of Proven Safety Countermeasures" ([HTML](#), [PDF 78 KB](#))

In January 2012, FHWA issued a "Guidance Memorandum on Promoting the Implementation of Proven Safety Countermeasures". This guidance takes into consideration the latest safety research to advance a group of countermeasures that have shown great effectiveness in improving safety. Safety practitioners are encouraged to consider this set of countermeasures that are research-proven, but not widely applied on a national basis.

Click on one of the nine countermeasures below for more information and a downloadable fact sheet. Each fact sheet provides more detailed descriptions, related research studies, and evaluations of each of these countermeasures. Further information on each countermeasure can also be found at the Crash Modification Factors Clearinghouse (<http://www.cmfclearinghouse.org/>).



Roundabouts



Corridor Access Management



Backplates with Retroreflective Borders



Longitudinal Rumble Strips and Stripes on Two-Lane Roads



Enhanced Delineation and Friction for Horizontal Curves



Safety EdgesSM



Medians and Pedestrian Crossing Islands in Urban and Suburban Areas



Pedestrian Hybrid Beacon



Road Diet

Why High Friction Surface Treatment

Why High Friction Surface Treatment

CMF Clearinghouse >> C x

www.cmfclearinghouse.org/detail.cfm?facid=7900#commentanchor

Improve pavement friction (HFS-High Friction Surfacing)

Description: The safety benefit of High Friction Surfacing Treatment (HFS)

Prior Condition: Individual curve with perceived friction-related crash problem

Category: Roadway

Study: [Evaluation of Pavement Safety Performance, Merritt et al., 2015](#)

Star Quality Rating: ★★★★★ [View score details]

| Crash Modification Factor (CMF) | |
|---------------------------------|-------|
| Value: | 0.759 |
| Adjusted Standard Error: | |
| Unadjusted Standard Error: | 0.067 |

| Crash Reduction Factor (CRF) | |
|------------------------------|--|
| Value: | 24.1 (This value indicates a decrease in crashes) |
| Adjusted Standard Error: | |
| Unadjusted Standard Error: | 6.7 |

24% Reduction in Crashes

Benefits of HFST (Cont'd)



- ▶ Restoration or enhancement of skid resistance on existing or new pavements
- ▶ Provides a solution for “spot treatment” of a pavement where friction demand is highest
- ▶ Low Cost Treatment (when compared to removal and replacement existing pavement)

Benefits of HFST (Cont'd)

- ▶ Installation during short (4-6 hour) lane closures of the pavement
 - ▶ one lane at a time
- ▶ Minimal additional thickness or (1/8" - 1/4") thickness for limited overhead clearances
- ▶ Installed over virtually all pavement types
- ▶ Can be colored for delineation purposes

What is HFST

HFST, High Friction Surface Treatment = anti-skid surfaces, composed of polish-resistant, abrasion-resistant aggregates bonded to the pavement surface using a resin.



GRIT & GLUE



Aggregate Properties

- ▶ The surface of aggregate provides micro-texture pavement
- ▶ High Polish Resistance, polished stone value (PSV)
- ▶ Ideal aggregate abrasion value (AAV) are polish resistance and abrasion resistance.
- ▶ Calcined bauxite most commonly used aggregate for HFST



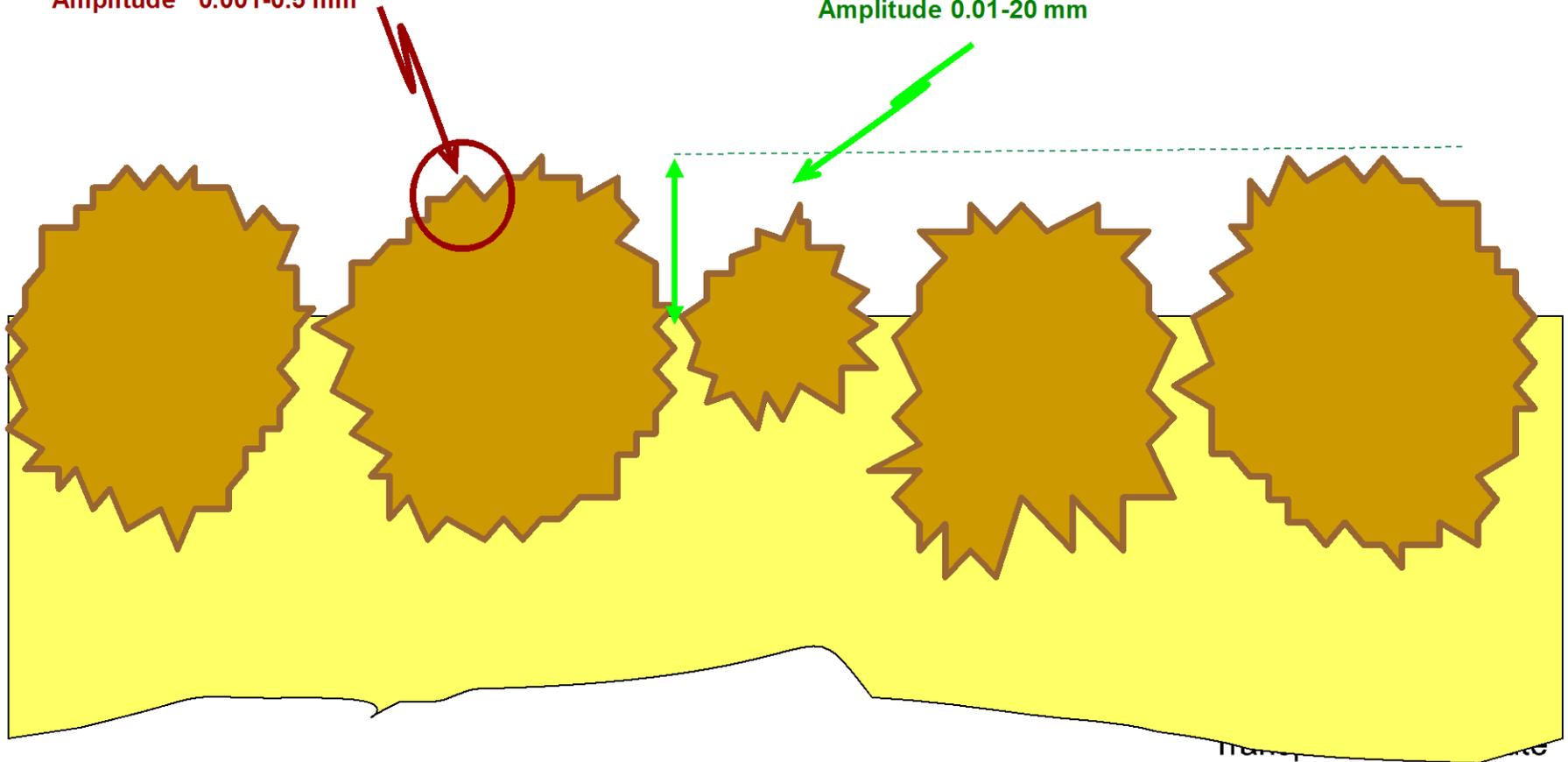
Textures that affects friction

Microtexture

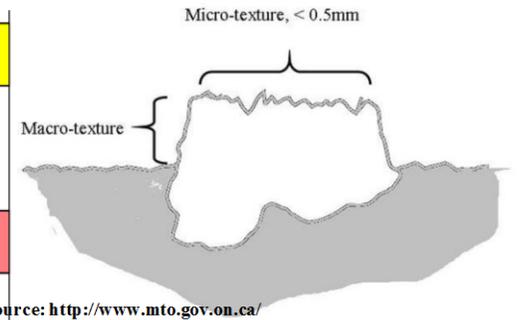
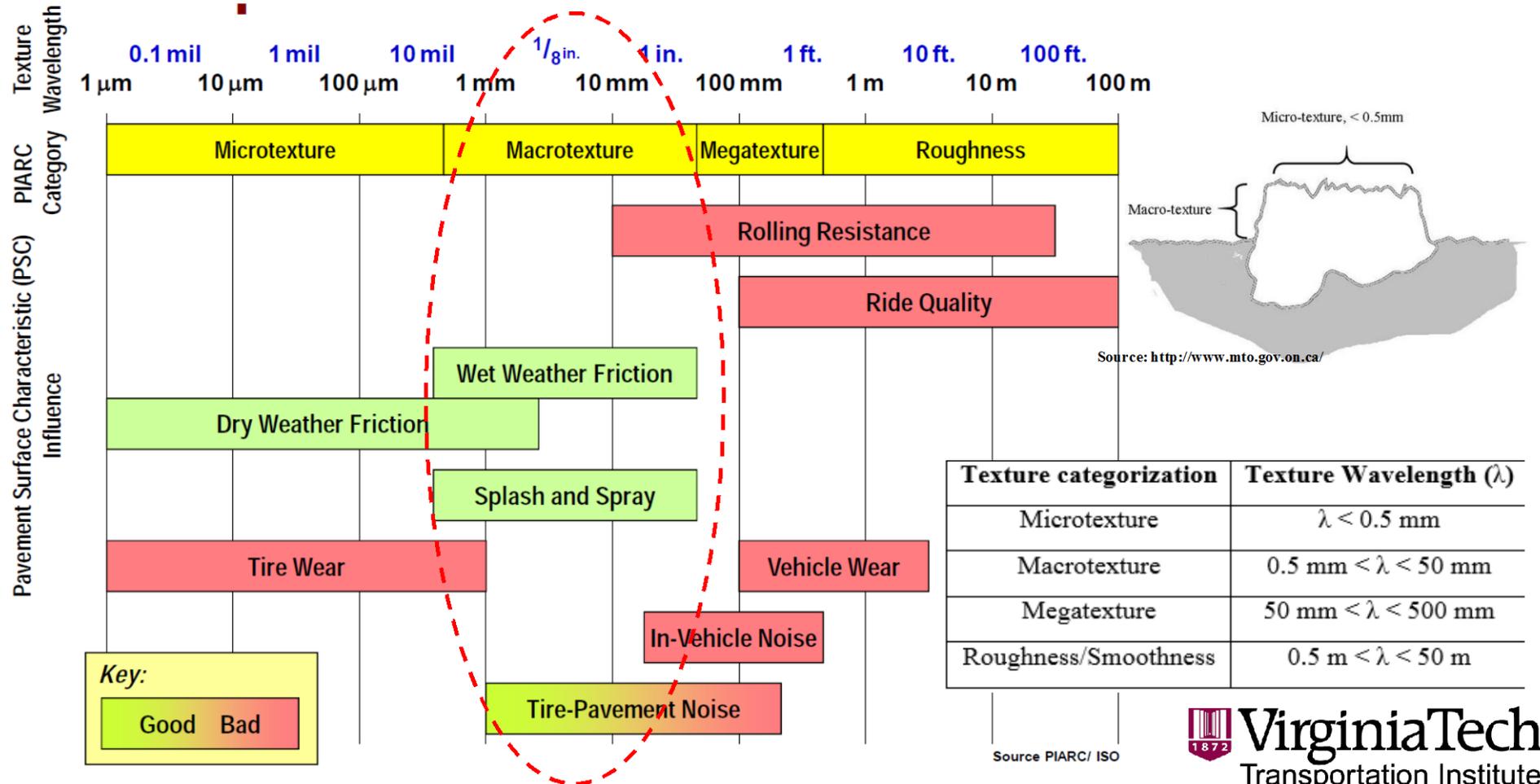
Amplitude 0.001-0.5 mm

Macrotexture

Amplitude 0.01-20 mm



Texture Wavelength Influence on Pavement Surface Characteristics



Binder Properties



- ▶ **Epoxy-resin** - two-component system. Both parts are mixed on-site.
- ▶ **Rosin-ester** - "premixed", meaning the resin & the chippings are bagged as a dry powder. On-site the powder is heated and spread.
- ▶ **Polyurethane-resin** - A multi-component binder cures chemically & is hand applied. The aggregate is then applied after.
- ▶ **Acrylic-resin** - Similar to epoxy-resin, however faster curing time.

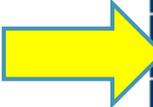
Considerations When Using HFST



- ▶ Pavement should be in good condition.
- ▶ Clean & Dry Pavement Surface; free of oils, grease, etc.
- ▶  temperatures will accelerate curing & hardening.
- ▶ Surface temperatures > **50F** are required for most resins.
- ▶ Excess aggregate must be removed
 - ▶ The new surface will naturally shed aggregate first several days, requiring additional sweeping.
- ▶ Life expectancy 5-7 years under heavy traffic, 10-15 years for low traffic

Resources

http://safety.fhwa.dot.gov/roadway_dept/



- RwD Strategic Planning
- Pavement Friction
- Safety Edge
- Rumble Strips
- Horizontal Curve Safety
- Clear Zones/Roadside Design
- Hardware Eligibility Letters
- Hardware Policy/Guidance
- Research/Resources

Roadway Departure Safety

The FHWA's Roadway Departure Safety Program provides important information for transportation practitioners, decision makers, and others to assist them in preventing and reducing the severity of roadway departure crashes.

Roadway departure crashes are frequently severe and account for the majority of highway fatalities. In 2014, there were 17,791 fatalities as a result of roadway departure crashes, which was 54 percent of the traffic fatalities in the United States. A roadway departure crash is defined as a crash which occurs after a vehicle crosses an edge line or a center line, or otherwise leaves the traveled way. FHWA uses the the National Highway Traffic Safety Administration (NHTSA) Fatal Analysis Reporting System (FARS) to compute statistics on roadway departure crashes.

Roadway Departure Strategic Planning

The FHWA Roadway Departure Team has developed a [Strategic Plan](#) to provide a data-driven focus with a vision to "Pursue a proactive approach Towards Zero Deaths and serious injuries involving roadway departure events." The plan shows a need to focus efforts in three primary emphasis areas, outlined in this [brochure](#). There are a number of other resources for implementing a [strategic approach](#) to reducing roadway departure crashes.

Roadway Departure Toolbox

- [Pavement Friction](#)
- [Safety Edge](#)
- [Rumble Strips](#)
- [Horizontal Curve Safety](#)
- [Clear Zones and Roadside Design Principles](#)

Crash-Tested Hardware Eligibility Letters

Federal-Aid Reimbursement Eligibility Process

- [Barriers/Guardrails](#)
- [Breakaway Sign/Lighting Supports](#)
- [Work Zone Devices](#)

Policy/Guidance

[Click here](#) to find more information about FHWA's roadside hardware crashworthiness policy. FHWA policy requires the roadside hardware used on the National Highway System (NHS) to be performance-tested for crashworthiness. While FHWA oversight is limited to the NHS, the FHWA strongly recommends the use of crashworthy devices on all public facilities where run-off-the-road crashes may occur. This link will also bring you to [Frequently Asked Questions](#) on roadside barriers and crashworthy work zone traffic control devices.

See the [FHWA Policy and Guidance Center](#) for all FHWA policy and guidance, including other Roadway Departure

| Category | Count | Percentage |
|----------|-------|------------|
| HEAD-ON | 4,570 | 25% |
| ROLLOVER | 5,285 | 20% |
| TREES | 3,508 | 19% |
| OTHER | 5,223 | 28% |

HFST web content

Pavement Friction

Friction Management Program

Traditional Friction Treatments

High Friction Surface
Treatments

Case Studies and Noteworthy
Practices

FAQs, Links, and Other
Resources

- **Case Studies** from Iowa DOT, South Carolina, California DOT, Kentucky Transportation Cabinet, Tennessee DOT, TXDOT and Penn DOT
- **FAQs** - ATSSA HFST FAQs, HFST 101 - High Friction Roads, FHWA HFST FAQs
- **Specifications** - ATSSA State Specifications
- **Other Resources** - HFST Curve Selection and installation Guide, FHWA-HFST Video, Penn DOT HFST Video, Oklahoma FHWA/OKDOT HFST Pilot Video, KTC Calcined Bauxite Video, ATSSA HFS website, NCAT - Alternative Aggregates Study, FHWA HFST CMF's research

The background features abstract, overlapping geometric shapes in various shades of blue, ranging from light sky blue to deep navy blue. These shapes are primarily located on the left and right sides of the frame, creating a modern, dynamic feel. The central area is a clean, white space.

Questions