High Friction Surface Treatment
A Proven Countermeasure

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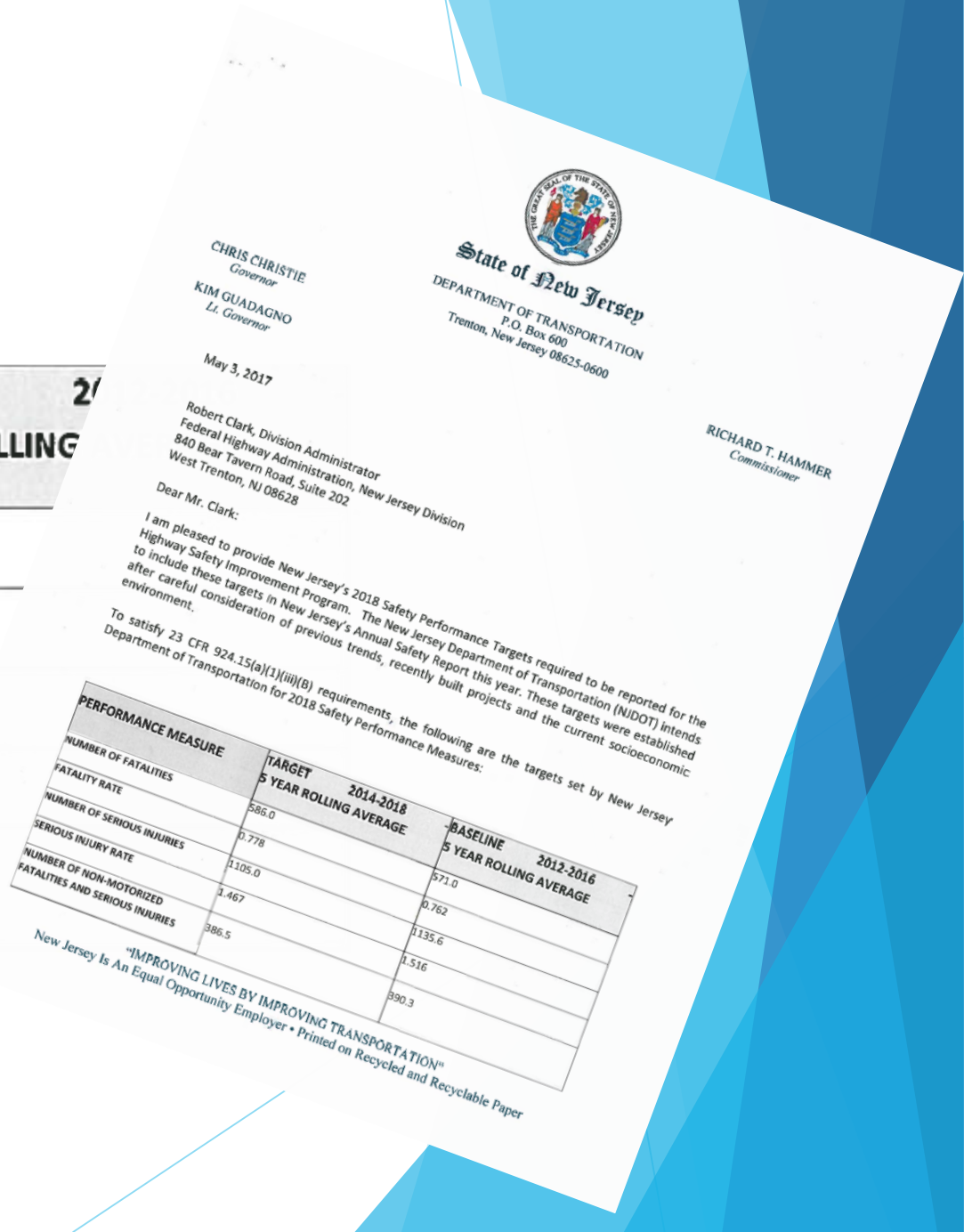
WHYs
Safety Performance Targets

PERFORMANCE MEASURE	TARGET 2014-2018 5 YEAR ROLLING AVERAGE	BASELINE 2 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



CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

State of New Jersey

DEPARTMENT OF TRANSPORTATION
P.O. Box 600
Trenton, New Jersey 08625-0600

RICHARD T. HAMMER
Commissioner

May 3, 2017

Robert Clark, Division Administrator
Federal Highway Administration, New Jersey Division
840 Bear Tavern Road, Suite 202
West Trenton, NJ 08628

Dear Mr. Clark:

I am pleased to provide New Jersey's 2018 Safety Performance Targets required to be reported for the Highway Safety Improvement Program. The New Jersey Department of Transportation (NJDOT) intends to include these targets in New Jersey's Annual Safety Report this year. These targets were established after careful consideration of previous trends, recently built projects and the current socioeconomic environment.

To satisfy 23 CFR 924.15(a)(1)(iii)(B) requirements, the following are the targets set by New Jersey Department of Transportation for 2018 Safety Performance Measures:

PERFORMANCE MEASURE	TARGET 2014-2018 5 YEAR ROLLING AVERAGE	BASELINE 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

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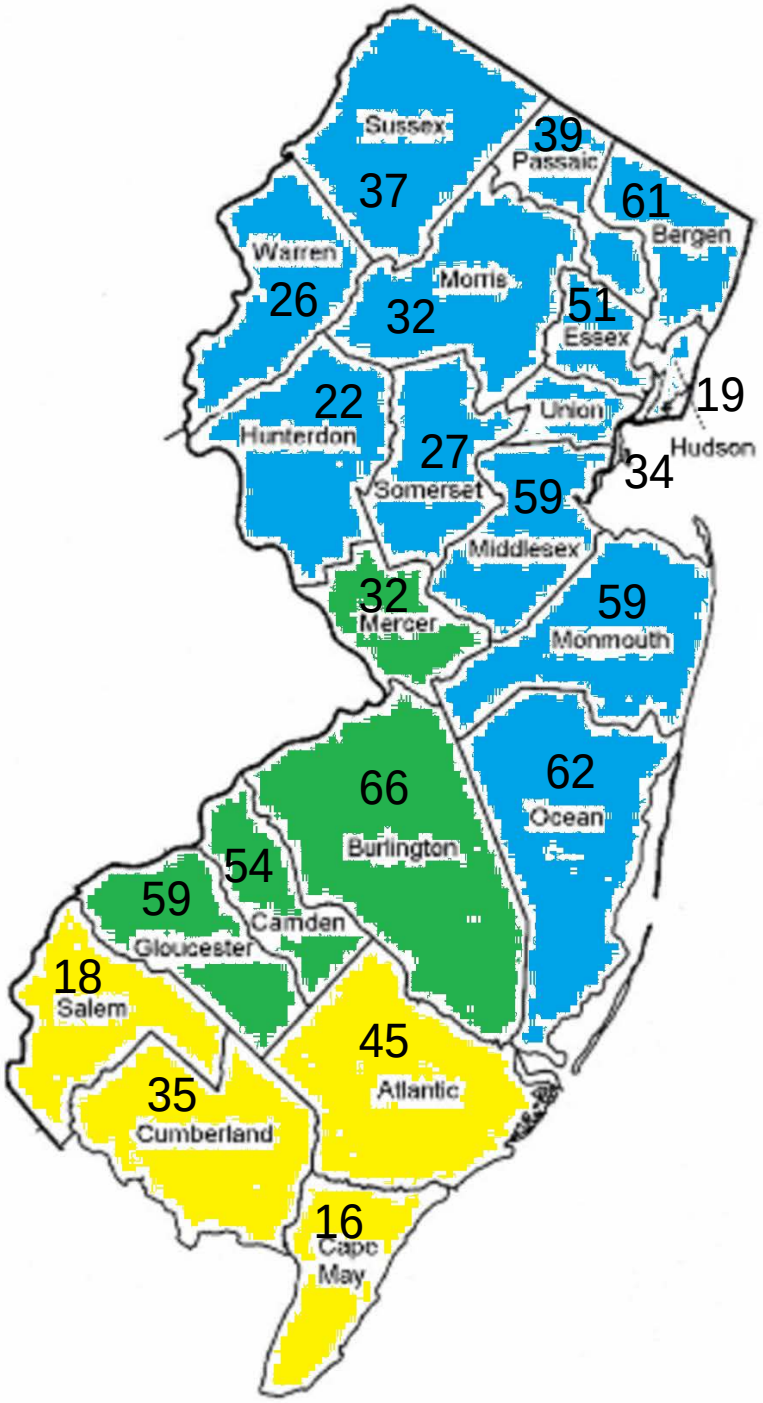
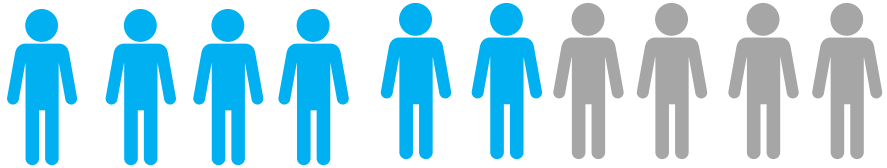


2016 Lane Departure Serious Injuries & Fatalities

336 Fatalities
517 Serious Injuries



National Data

5%

% Horizontal Curves on US Roads

23%

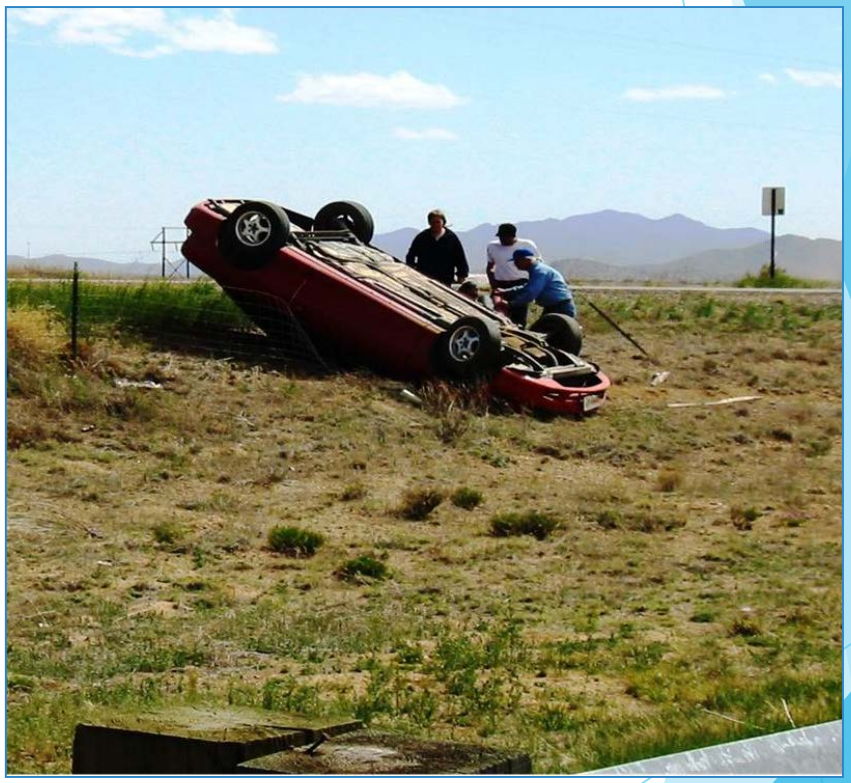
% Fatalities on Horizontal Curves

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

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

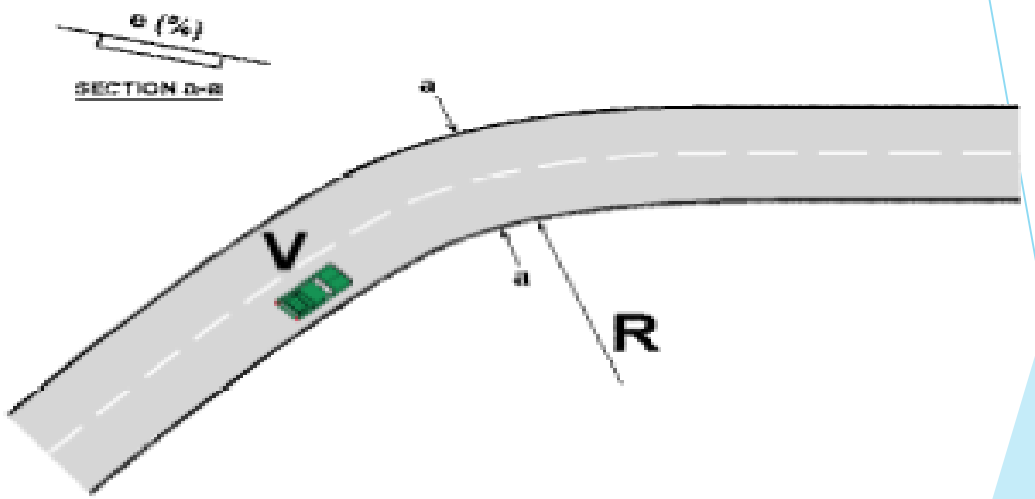
$$e + f = V^2/15\,R$$

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

Proven Safety Countermeasures

Office of Safety

Proven Safety Countermeasures

Safe Roads for a Safer Future
Investment in roadway safety saves lives

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 Edge$_{SM}$


Medians and Pedestrian Crossing Islands in Urban and Suburban Areas


Pedestrian Hybrid Beacon


Road Diet

Why High Friction Surface Treatment

safety.fhwa.dot.gov

Why High Friction Surface Treatment

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.

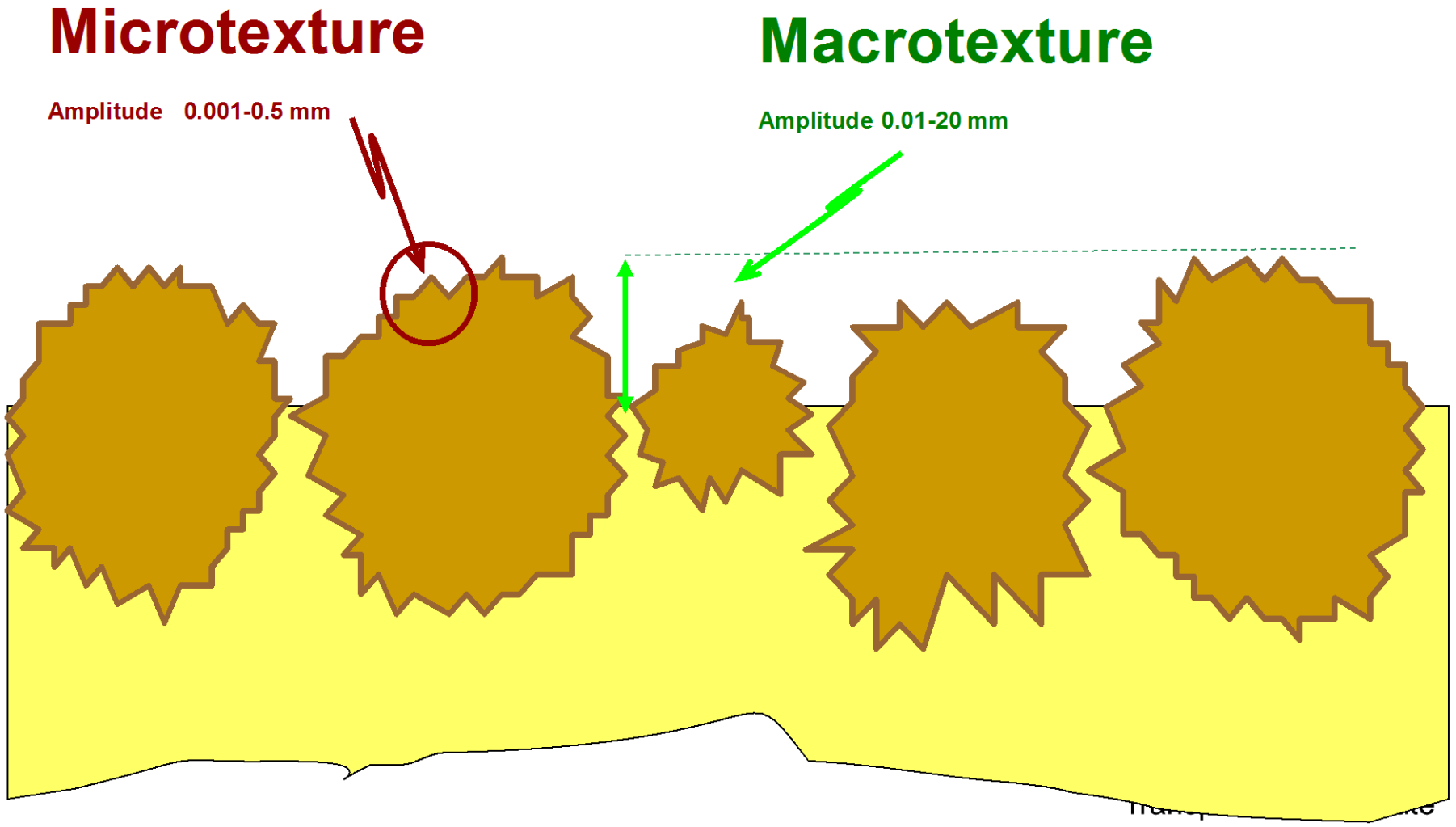
GRIT & GLUE

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

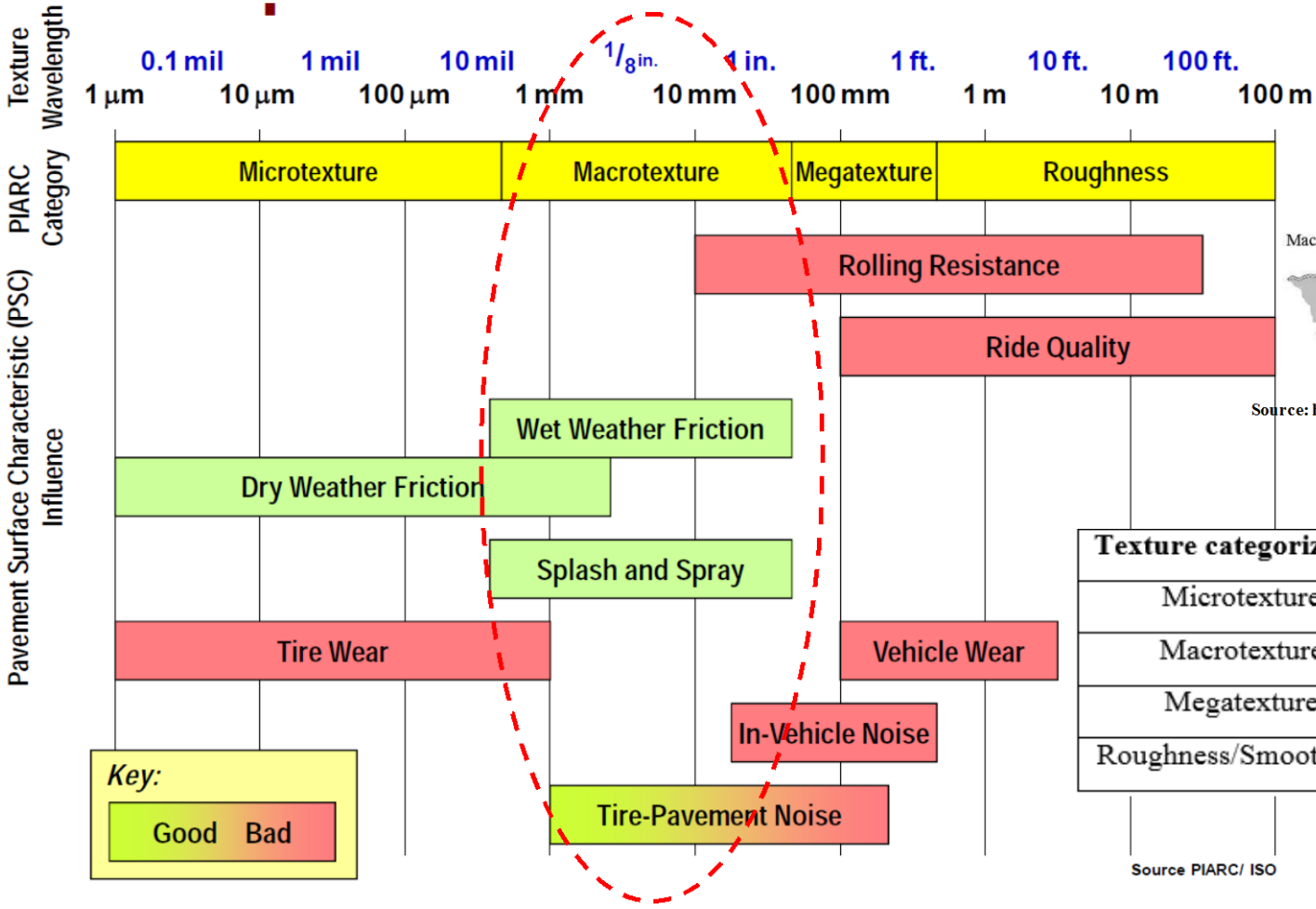
Center for Sustainable Transportation Infrastructure

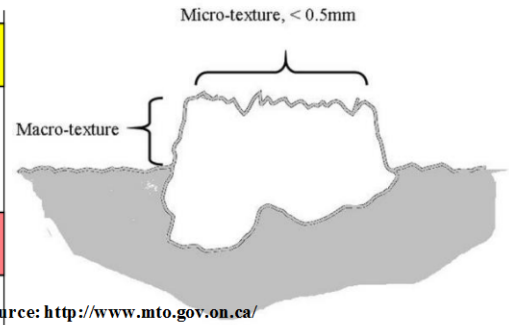
Textures that affects friction



Center for Sustainable Transportation Infrastructure

Texture Wavelength Influence on Pavement Surface Characteristics





Source: http://www.mto.gov.on.ca/

Texture categorization	Texture Wavelength (λ)
Microtexture	$\lambda < 0.5$ mm
Macrotexture	$0.5 \text{ mm} < \lambda < 50$ mm
Megatexture	$50 \text{ mm} < \lambda < 500$ mm
Roughness/Smoothness	$0.5 \text{ m} < \lambda < 50$ m

Source PIARC/ ISO

VirginiaTech Transportation Institute

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

HFST web content

- **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

Questions