National Center for Rural Road Safety

Est. Dec. 2014

Rural Roadway Departure Countermeasures – Part 2

Presented by: Keith Knapp, Iowa LTAP / InTrans/Safety Center

Tori Brinkly, FHWA

Webinar Logistics

- Duration is 11:00 AM - 12:30 PM Mountain
- Webinar – recorded and archived on website. For quality of recording, phone will be muted during presentation
- If listening on the phone, please mute your computer
- To maximize the presentation on your screen click the 4 arrows in the top right of the presentation
- At the end of each section, there will be time for Q&A
- There is a handout pod at the bottom of the screen
- Send group lists to info@ruralsafetycenter.org
- Please complete follow-up surveys; they are vital to assessing the webinar quality

Certificates of Completion/CEUs

- Survey Link –

http://survey.constantcontact.com/survey/a07efu9aofjjoajoolx/start

  - Survey closes 2 weeks after webinar
  - Expect certificate/CEU form 3-4 weeks after webinar
  - Return CEU form to ContinuingEd@montana.edu **NOT** Safety Center
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National Center for Rural Road Safety
Certificate of Completion
is hereby granted to
XXX
to certify that he/she has completed to satisfaction the course
Pedestrian Treatments for Uncontrolled Locations
Granted: January 18, 2018 11:00 AM - 12:30 PM MST
Instructors: Yan Qi and Kyle Armstrong
Jaime L Sullivan
Safety Center Manager

Certificates of Completion/CEUs

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Course Registration Form

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Office of Continuing Education
128 Barnard Hall/PO Box 173860
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Phone: (406) 994-6550/Fax: (406) 994-7856
Email: ContinuingEd@montana.edu
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Course *cex 280717 Pedestrian Treatments for Uncontrolled Locations - Live* Location *Online*

Date *01/18/18 - 01/18/18* REGISTRATION FEE *$0.00* # OF CEU's *0.150* GENDER: M / F

Name _____ (Last) (First) (Middle Initial) _____ (Maiden/Former Name)

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HAVE YOU EVER BEEN ADMITTED TO MSU-BOZEMAN AS A STUDENT? Yes ____ No ____ When? _____

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I AM REGISTERING FOR: Credit ____ Audit ____ Continuing Education Units X

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Academic Technology & Outreach

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Montana State University
128 Barnard Hall
PO Box 173860
Bozeman, MT 59717-3860

VERIFICATION OF COMPLETION

February 2, 2018

REGISTRANT: First Last
123 Main St
Town, ST 59123

ID #:		CEU	Hours
18SCEX280717	Pedestrian Treatments for Uncontrolled Locations - Live January 18, 2018	0.150	1.50
18SCEX280720	Primer on the Joint Use of the HSM and the HFG for February 13, 2018 - February 13, 2019	0.150	1.50
TOTAL:		**0.300** CEU's	**9.00** Hours

Co-Hosted by:

U.S. Department of Transportation
Federal Highway Administration

On-Ramp to Innovation
every day counts

NATIONAL ASSOCIATION COUNTY ENGINEERS
NACE

The Voice of
County Road Officials

National
LTAP & TTAP
Association

Today's Presenters

Keith Knapp
Iowa LTAP/InTrans/Safety Center

Tori Brinkly
FHWA

Goals of this Webinar

Once you have completed this webinar, you will:

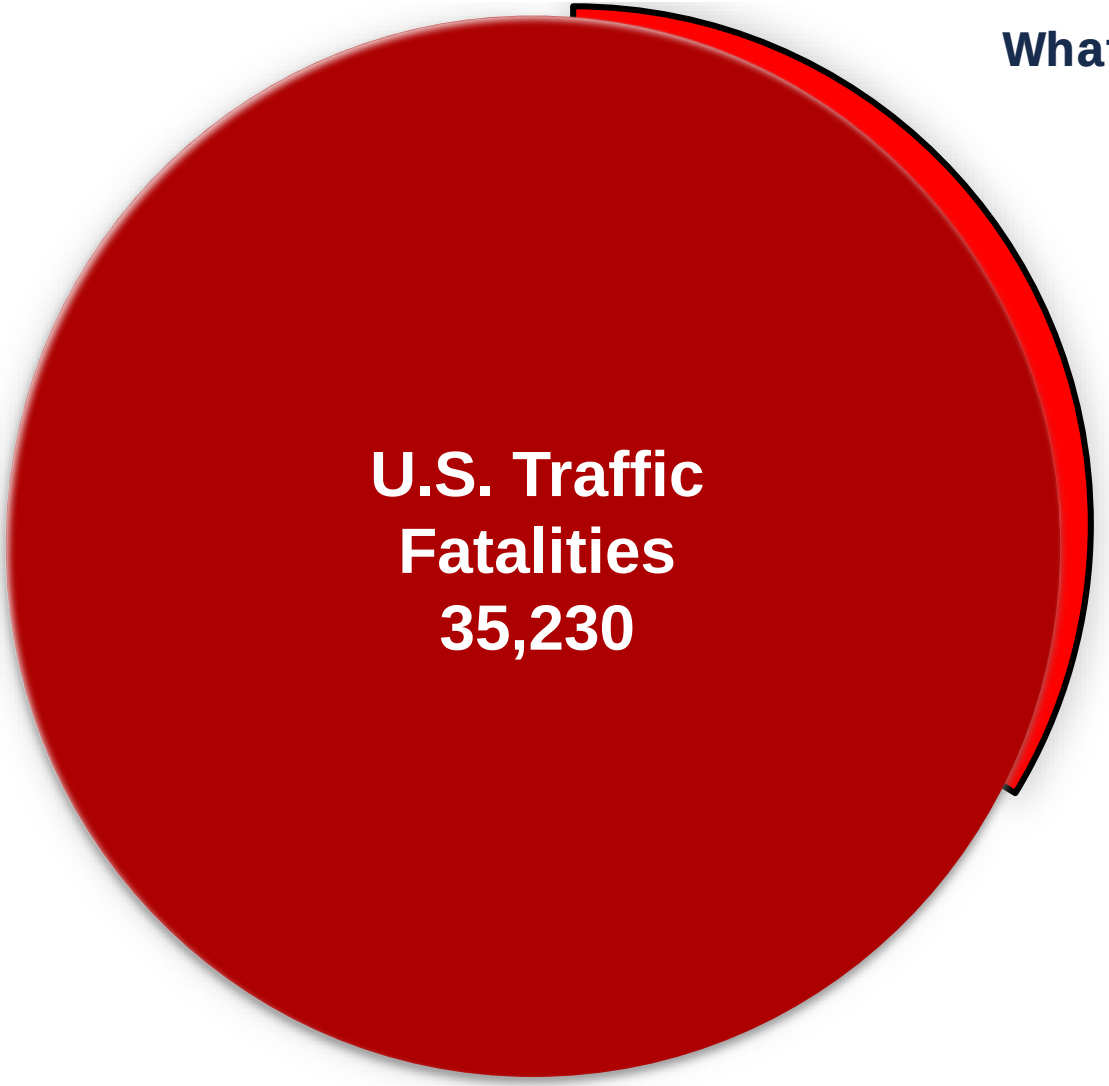
learn about various roadway marking/signing treatments, with a focus on horizontal curves, and how high friction surface treatments can help keep vehicles on the road.

Learning Outcomes

To achieve the webinar goal, you will learn to:

- Summarize what the MUTCD says about pavement markings and horizontal curve signs
- Describe some of what we know about the potential safety benefits of pavement markings and horizontal curve signing
- Describe the role of friction in roadway departures
- Identify effective methods to improve friction
- Describe the safety benefits of high friction surface treatments

The Rural RwD Component of Fatalities



What is a Roadway Departure (RwD)?

FHWA Definition: A crash in which a vehicle crosses an edge line, a center line, or otherwise leaves the traveled way.


Photo credit: Oregon State Police

Source: NHTSA FARS (2014 – 2016 Annual Average)

Addressing Roadway Departures

1st - Keep vehicles on the roadway

2nd - Reduce the potential for crashes

3rd - Minimize the severity

Keep Vehicles on the Roadway

Strategies include:

- Improved curve delineation
- Friction treatments in curves and other spot locations
- Edge line, shoulder & center line rumble strips.

Keith Knapp,
FHWA

National Center for Rural Road Safety

- Summarize what the MUTCD says about pavement markings and horizontal curve signs
- Describe some of what we know about the potential safety benefits of pavement markings and horizontal curve signing
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Keep Vehicles on the Roadway

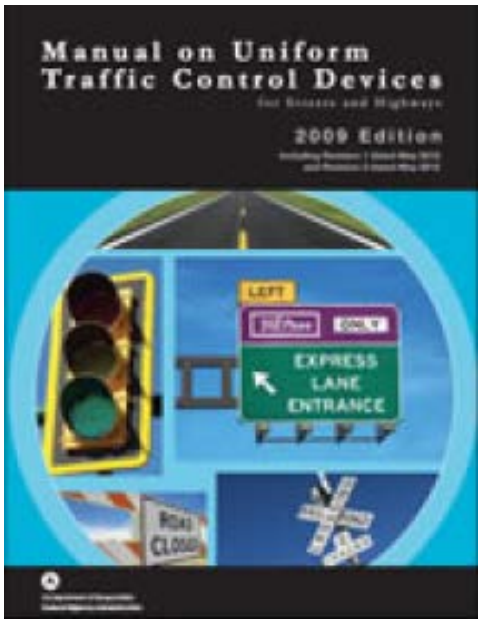
Pavement Markings

MUTCD & Center Lines (Sec. 3B.01)

- **Yellow Center Line Pavement Markings and Warrants**

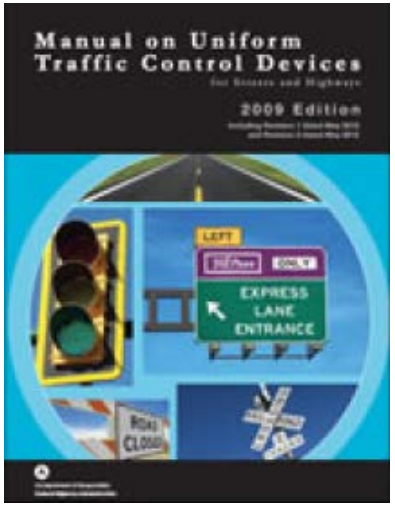
- **<u>Shall</u> be Placed on All Paved Urban Arterials and Collectors that have a Traveled Way ≥ 20 feet and ADT ≥ 6,000**

- **<u>Shall</u> also be Placed on All Paved Two-Way Streets or Highways with ≥ Three Lanes for Moving Motor Vehicle Traffic**



MUTCD & Center Lines (3B.01)

- *Should be Placed on All Urban Arterials and Collectors that have a Traveled Way ≥ 20 feet and ADT ≥ 4,000*
- *Should also be Placed on All Rural Arterials and Collectors that have a Traveled Way ≥ 18 feet and ADT ≥ 3,000*
- *Should also be Placed On other Traveled Ways where an Engineering Study Indicates a Need*
- *Should Use Engineering Judgment to Determine whether to Place on Traveled Ways of < 16 feet*
- *May be placed on other Paved Two-Way Traveled Ways that are ≥ 16 feet*



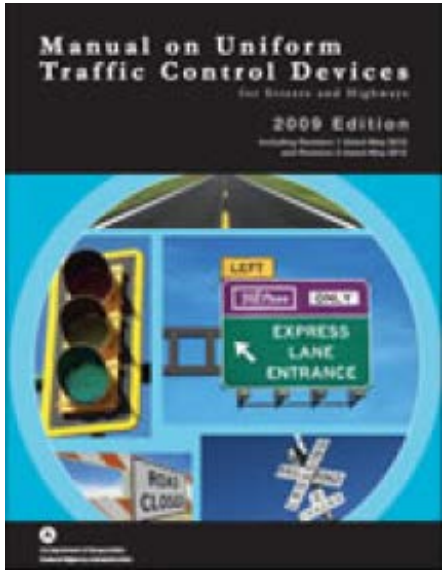
MUTCD Edgeline (Sec. 3B.07)

- **Warrants for Use of Edge Lines**

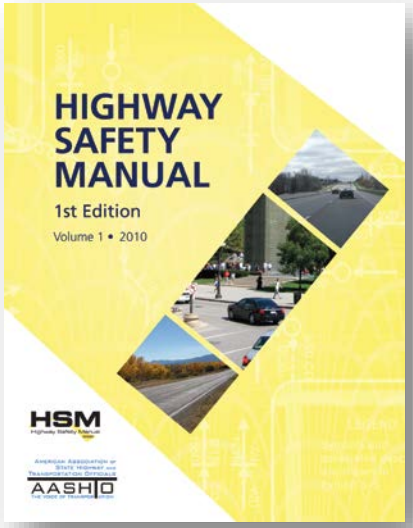
- **Shall be Placed**
  - **Freeways and Expressways**
  - **Rural arterials with a Traveled Way ≥ 20 Feet and ADT ≥ 6,000**

- *Should be Placed*
  - *Rural Arterials and Collectors with a Traveled Way ≥ 20 feet and ADT ≥ 3,000*
  - *Other Paved Streets and Highways Where an Engineering Study Indicates a Need*

- *Should not be Placed where Engineering Study or Judgement Indicates Providing them will Decrease Safety*



Edge and Centerline Markings



Edge lines

Centerlines

Table 13-39. Potential Crash Effects of Placing Edgeline and Centerline Markings (8)

Treatment	Setting (Road Type)	Traffic Volume	Crash Type (Severity)	CMF	Std. Error
Place edgeline and centerline markings	Rural (Two-lane/ Multilane undivided)	Unspecified	All types (Injury)	0.76	0.1

Base Condition: Absence of markings.

Missouri Case Study (1 of 3)

Before 2008, MoDOT did not stripe edge lines for routes with less than 1,000 ADT

From 2005-2007

- 35,000 line miles with ≤ 1,000 ADT
- 339 fatalities & 2,280 disabling injuries
- 13,000 line miles with 400 – 1,000 ADT
- 219 fatalities & 1,500 disabling injuries
- 2/3 of the fatalities and severe injuries
- "Manageable" additional miles to paint edge lines

Missouri Case Study (2 of 3)

- Edge lines painted on 73 routes in 2009
- Study included 1,138 edge line miles
- 2006-2008 before period data
- 2010 & 2011 after period data
- Empirical Bayes Method of analysis used

Missouri Case Study (3 of 3)

Overall Effectiveness	Various Counties	
Severity Level	Total	F & DI
Observed Crashes Before Period	576	105
Observed Crashes After Period	327	46
Effectiveness (% Change)	15.2	19.3
Direction of Change	Decrease	Decrease
Significance	Significant at 95% confidence level	Not significant at 90% confidence level

Install Edgeline Markings

Description	CRF	Crash type	Crash severity	Area Type	Quality
Install edgelines (tangent)***	6.1%	All	All	Rural	★★★☆☆
Install edgelines (curves)***	25.9 %	All	All	Rural	★★★☆☆

Are Wider Edge Lines Better?

4” Width

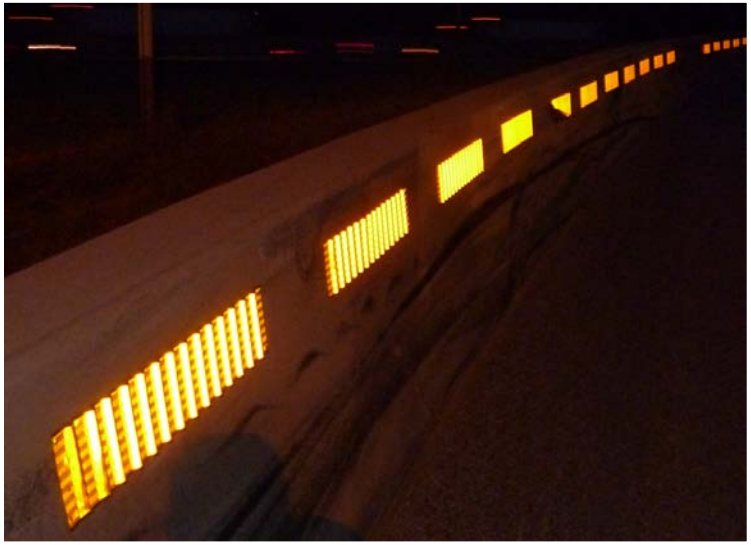
6” Width

CMF
CRASH MODIFICATION FACTORS CLEARINGHOUSE

Countermeasure: Install wider markings WITHOUT resurfacing

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Roadway Type	Area Type
0.78	22	★★★★☆	All	Fatal,Serious injury,Minor injury	Principal Arterial Other Freeways and Expressways	Rural

Reflective Barrier Delineation



Other Markings

- In-Lane Pavement Markings
- Optical Speed Bars
- Small Speed Reductions Found
- CMF Clearinghouse Input

Directing Your Questions via the Chat Pod

1. Chat pod is on left side of screen between attendees pod & closed caption pod

3. Answers will appear here unless addressed verbally

2. Type your question or comment here

Keeping Vehicles on the Roadway

Roadway Curve Signing

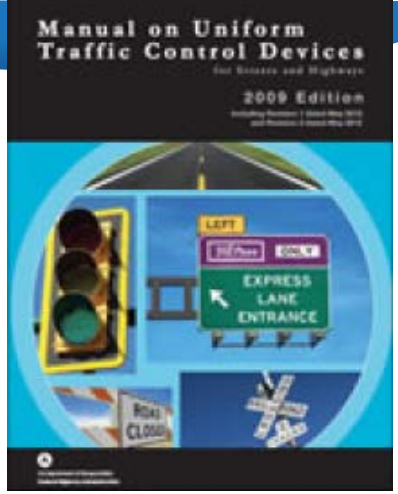
MUTCD: 2003 and Earlier

- **Application of Warning Signs (Section 2C.02): The use of warning signs shall be based on an engineering study or on engineering judgment**

- **Horizontal Alignment Signs (W1-1 through W1-5, W1-11, W1-15) (Section 2C.06)**

The horizontal alignment Turn (W1-1), Curve (W1-2), Reverse Turn (W1-3), Reverse Curve (W1-4), or Winding Road (W1-5) signs (see Figure 2C-1) may be used in advance of situations where the horizontal roadway alignment changes.
A One-Direction Large Arrow (W1-6) sign (see Figure 2C-1 and Section 2C.09) may be used on the outside of the turn or curve.
If the change in horizontal alignment is 135 degrees or more, the Hairpin Curve (W1-11) sign (see Figure 2C-1) may be used.
If the change in horizontal alignment is approximately 270 degrees, such as on a cloverleaf interchange ramp, the 270-degree Loop (W1-15) sign (see Figure 2C-1) may be used.

2009 MUTCD



- **Application of Warning Signs (Section 2C.02): The use of warning signs shall be based on an engineering study or on engineering judgment**

- **Horizontal Alignment Warning Signs (Section 2C.06)**

In advance of horizontal curves on freeways, on expressways, and on roadways with more than 1,000 AADT that are functionally classified as arterials or collectors, horizontal alignment warning signs shall be used in accordance with Table 2C-5 based on the speed differential between the roadway's posted or statutory speed limit or 85th-percentile speed, whichever is higher, or the prevailing speed on the approach to the curve, and the horizontal curve's advisory speed.

MUTCD: Table 2C-5

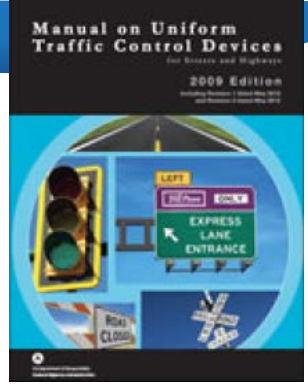


Table 2C-5. Horizontal Alignment Sign Selection

Type of Horizontal Alignment Sign	Difference Between Speed Limit and Advisory Speed				
	5 mph	10 mph	15 mph	20 mph	25 mph or higher
Turn (W1-1), Curve (W1-2), Reverse Turn (W1-3), Reverse Curve (W1-4), Winding Road (W1-5), and Combination Horizontal Alignment/Intersection (W10-1) (see Section 2C.07 to determine which sign to use)	Recommended	Required	Required	Required	Required
Advisory Speed Plaque (W13-1P)	Recommended	Required	Required	Required	Required
Chevrons (W1-8) and/or One Direction Large Arrow (W1-6)	Optional	Recommended	Required	Required	Required
Exit Speed (W13-2) and Ramp Speed (W13-3) on exit ramp	Optional	Optional	Recommended	Required	Required

2009 MUTCD (Section 2C.08)

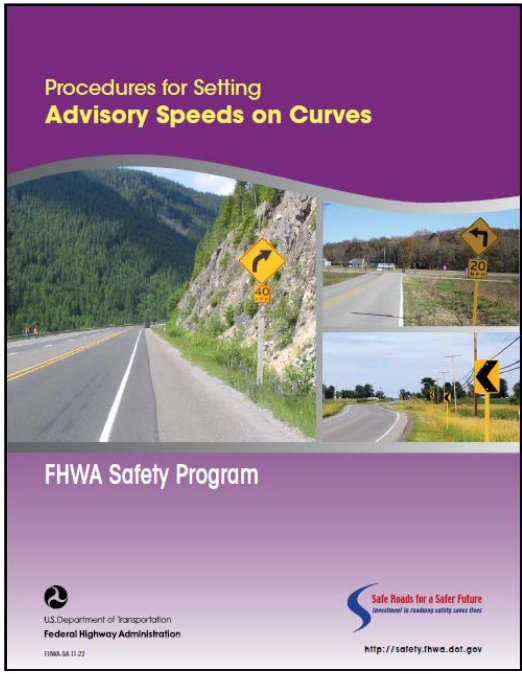
Support: Among the established engineering practices that are appropriate for the determination of the recommended advisory speed for a horizontal curve are the following:

A. An accelerometer that provides a direct determination of side friction factors
B. A design speed equation
C. A traditional ball-bank indicator using the following criteria:
   - 16 degrees of ball-bank for speeds of 20 mph or less
   - 14 degrees of ball-bank for speeds of 25 to 30 mph
   - 12 degrees of ball-bank for speeds of 35 mph and higher

Advisory Speed Guidance

The handbook describes:

1. Guidelines for determining when an advisory speed is needed;
2. Criteria for identifying the appropriate advisory speed;
3. An engineering study method for determining the advisory speed; and
4. Guidelines for selecting other curve related traffic control devices.



http://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa1122/fhwasa1122.pdf

Advance Static Curve Warning Signs

CRASH MODIFICATION FACTORS CLEARINGHOUSE

Countermeasure: Advance static curve warning signs

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Roadway Type	Area Type
0.7	30	★	All	Serious injury,Minor injury	Not specified	Not specified
0.92	8	★	All	Property Damage Only (PDO)	Not specified	Not specified

Enhancements (1/4)

Enhancements (2/4)

Enhancements (3/4)

Overhead Sign with Yellow Warning Flashers

Enhancements (4/4)

Dynamic Signs

Description	CRF	Crash type	Crash severity	Area Type	Quality
Install dynamic speed feedback sign***	5%	All	All	Rural Curve	★★★★★

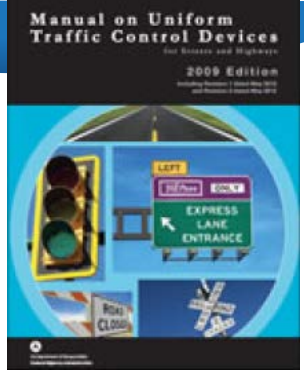
Chevrons

CMF
CRASH MODIFICATION FACTORS CLEARINGHOUSE

Countermeasure: Install chevron signs on horizontal curves

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Roadway Type	Area Type	Reference
0.96	4	★★★★☆	Non-intersection	All	All	Rural	Srinivasan et al., 2009
0.94	6	★★★★☆	Head on,Non-intersection,Run off road,Sideswipe	All	All	Rural	Srinivasan et al., 2009
0.84	16	★★★★☆	Non-intersection	Fatal,Serious injury,Minor injury	All	Rural	Srinivasan et al., 2009
0.75	25	★★★★☆	Nighttime,Non-intersection	All	All	Rural	Srinivasan et al., 2009
0.78	22	★★★★☆	Head on,Nighttime,Non-intersection,Run off road,Sideswipe	All	All	Rural	Srinivasan et al., 2009

MUTCD: Table 2C-5



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Advisory Speed Plaque (W13-1P)	Recommended	Required	Required	Required	Required
Chevrons (W1-8) and/or One Direction Large Arrow (W1-6)	Optional	Recommended	Required	Required	Required
Exit Speed (W13-2) and Ramp Speed (W13-3) on exit ramp	Optional	Optional	Recommended	Required	Required

Chevron Spacing

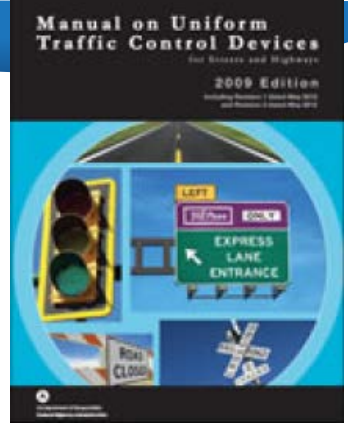


Table 2C-6. Typical Spacing of Chevron Alignment Signs on Horizontal Curves

Advisory Speed	Curve Radius	Sign Spacing
15 or less	Less than 200	40
20 to 30	200 to 400	80
35 to 45	401 to 700	120
50 to 60	701 to 1,250	160
More than 60	More than 1,250	200

Note: The relationship between the curve radius and the advisory speed shown in this table should not be used to determine the advisory speed.

Nighttime Driving

Daytime

Many cues available

Driver task relatively easy

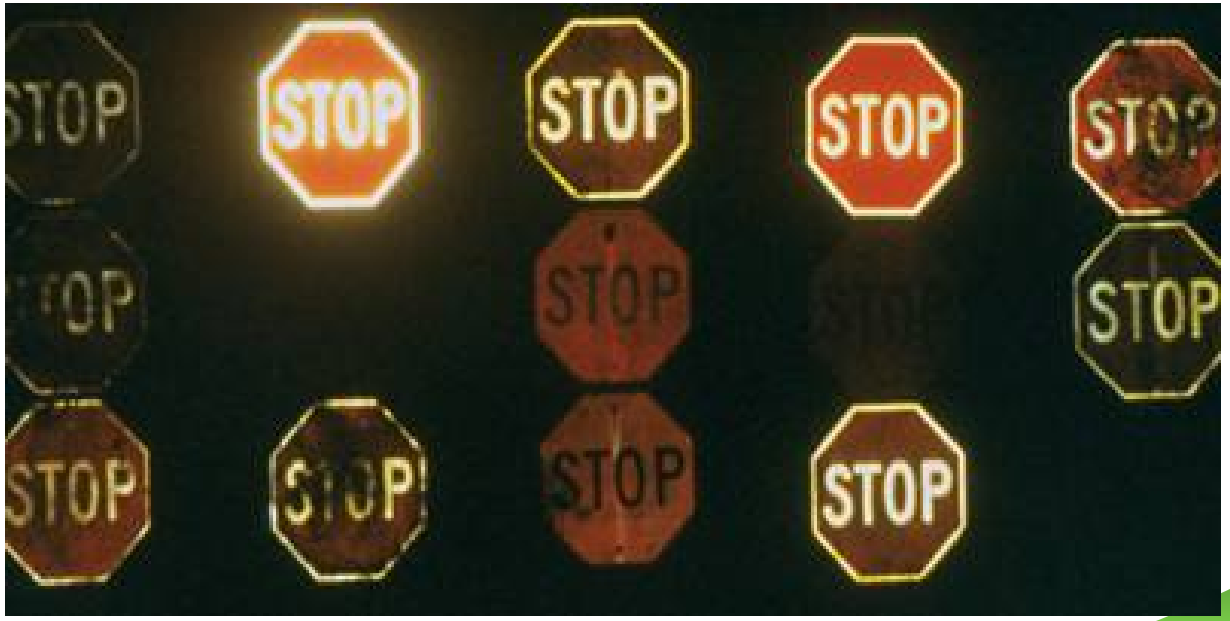
Nighttime

Few cues remain

Task more difficult

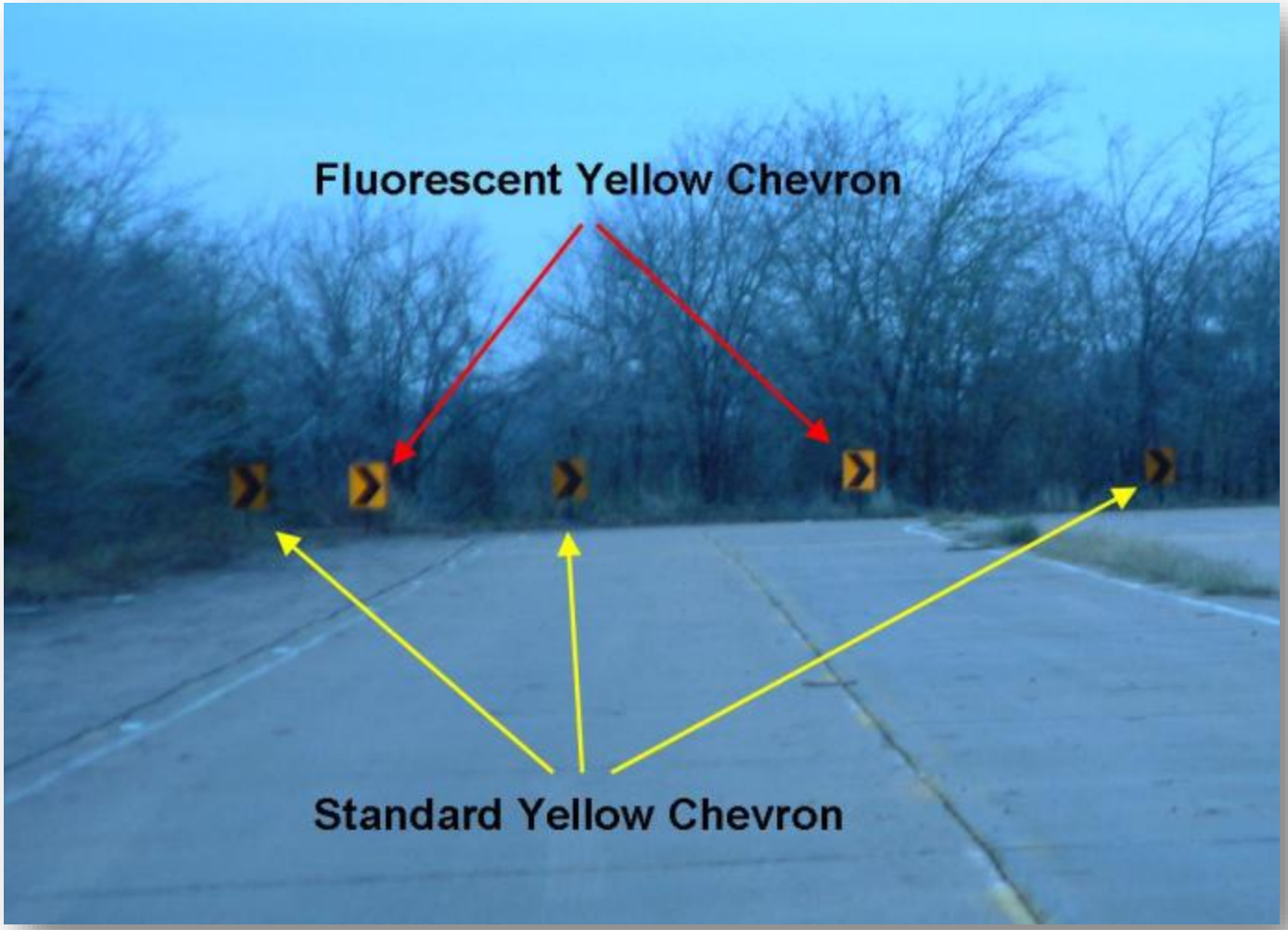
Retroreflectivity provides nighttime guidance

Retroreflectivity



Sign Maintenance is Important

High Grade Sheeting



Source: Texas Transportation Institute

Fluorescent Sheeting for Curves Signs

CRASH MODIFICATION FACTORS CLEARINGHOUSE

Countermeasure: Install new fluorescent curve signs or upgrade existing curve signs to fluorescent sheeting

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Roadway Type	Area Type
0.82	18	★★★★☆	Non-intersection	All	All	Rural
0.82	18	★★★★☆	Head on,Non-intersection,Run off road,Sideswipe	All	All	Rural
0.75	25	★★★★☆	Non-intersection	Fatal,Serious injury,Minor injury	All	Rural
0.65	35	★★★☆☆	Nighttime,Non-intersection	All	All	Rural
0.66	34	★★★★☆	Head on,Nighttime,Non-intersection,Run off road,Sideswipe	All	All	Rural

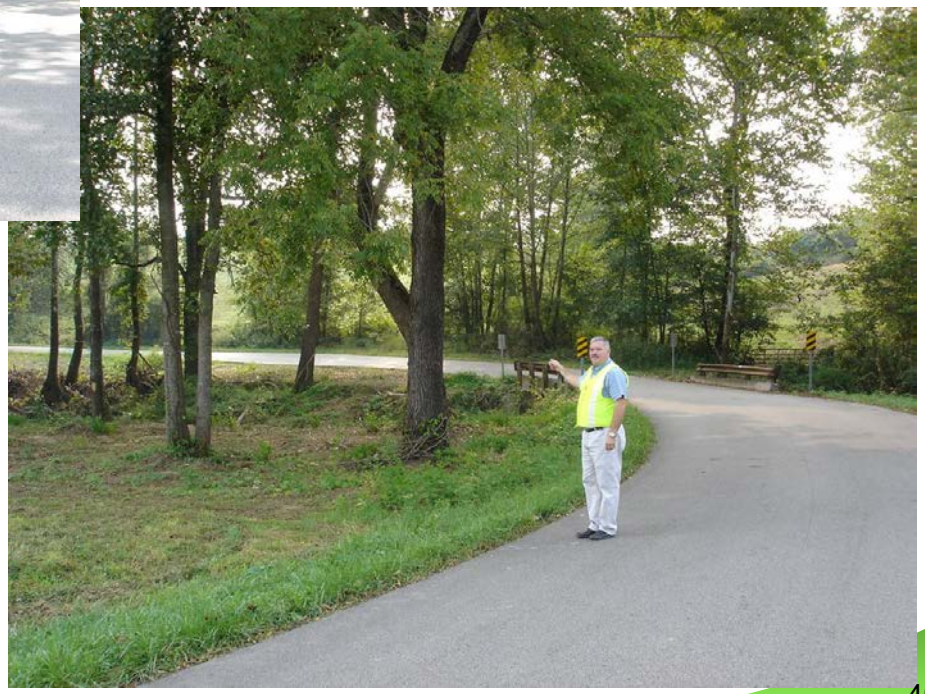
Sheeting and Orientation

Daytime:

Nighttime:

Sign Visibility

Sight Distance Before & After



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FHWA

National Center for Rural Road Safety

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- **Describe the role of friction in roadway departures**
- Identify effective methods to improve friction
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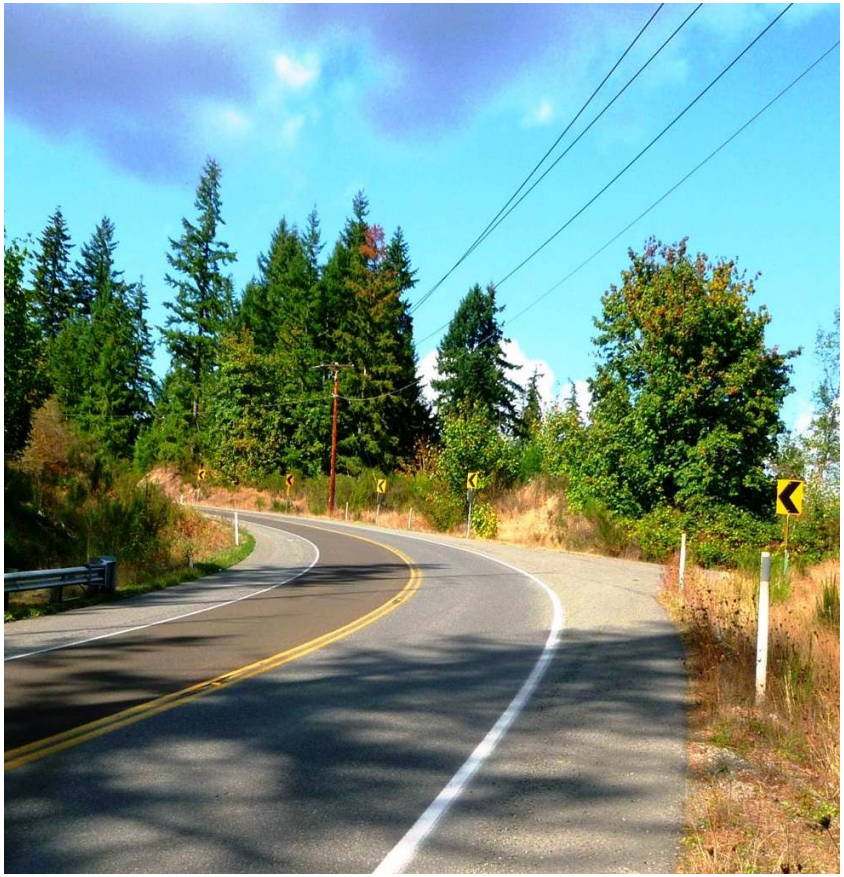
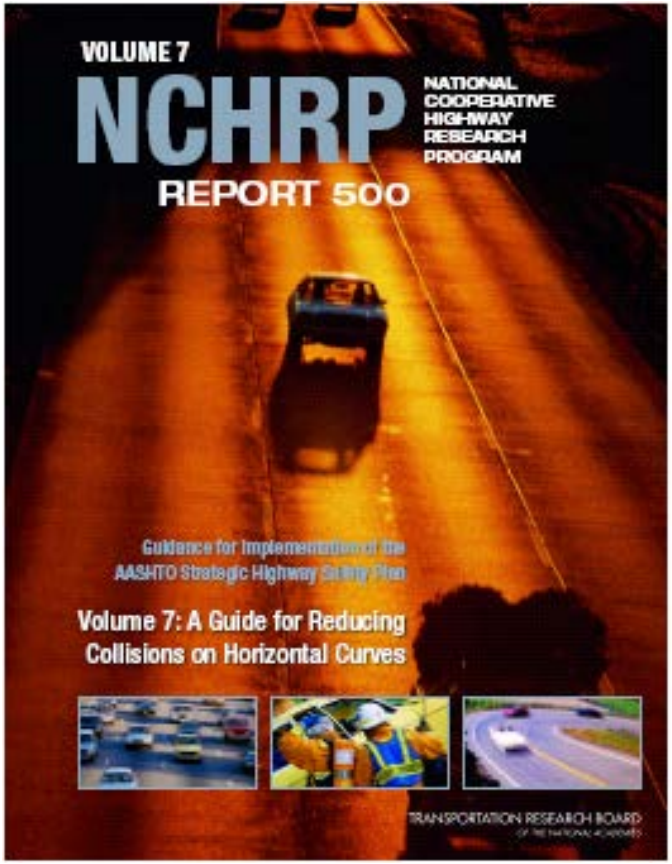
Pavement Friction

Keeping Vehicles on the Roadway



Provide Skid-Resistant Pavement Surfaces

15.2 A - Reduce the likelihood of a vehicle leaving its lane and either crossing the roadway centerline or leaving the roadway at a horizontal curve



http://www.trb.org/Publications/Public/Blurbs/A_Guide_for_Reducing_Collisions_on_Horizontal_Curv_154782.aspx

Provide Skid-Resistant Pavement Surfaces

Since the 1920's it has been recognized that Pavement-Tire friction can make a significant contribution to highway safety, particularly the probability of wet skidding crashes.

Skid Related Crashes are Determined by Many Factors

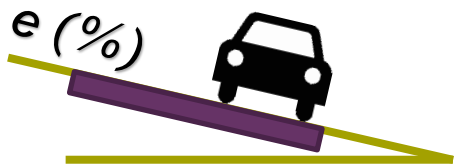
- Tire Issues
- Weather Conditions
- Aggregate Friction Characteristics
- Bond Capability of the Pavement Binder
- Friction Demand

Contributing Factors for Friction Demand

- Road Geometry
- Vehicle Speeds
- Driver Actions
- Trucks
  - Truck tire coefficient of friction is about 70% of passenger cars
  - Truck tires have about 10% higher friction demand

AASHTO Horizontal Curve Design Model

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



Section a-a

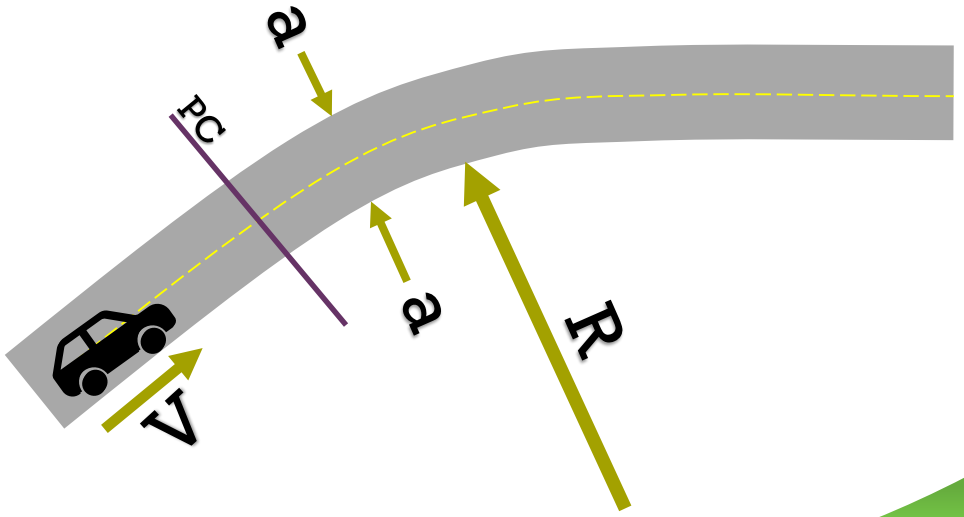
e = superelevation

f = side friction factor

V = design speed (mph)

R = radius of curve (ft)

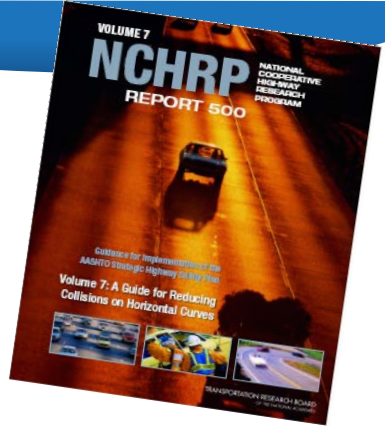
PC = point of curvature



Basis for AASHTO Curve Design Model is for Driver Comfort

Although the curve design policy stems from the laws of mechanics, the values used in design depend on practical limits and factors determined empirically over the range of variables involved.

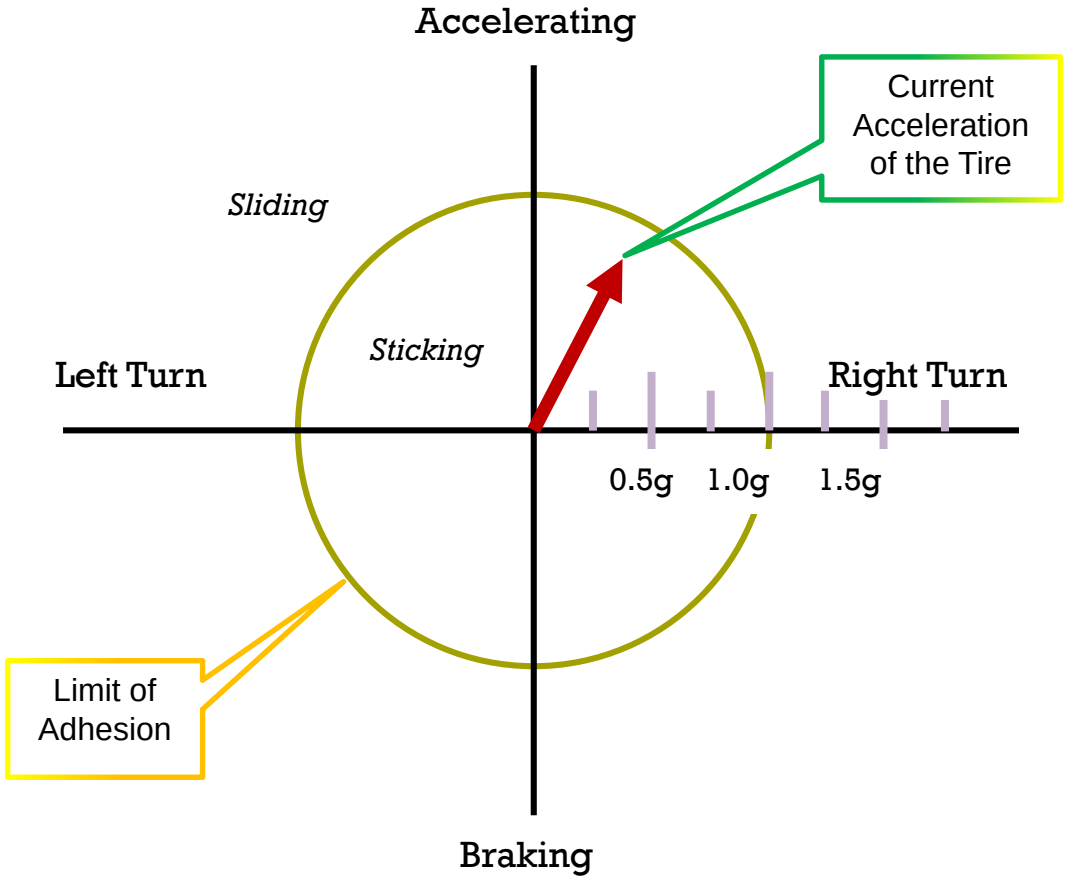
AASHTO Design Assumptions



  - Vehicles do not exceed the design speed, and
  - Vehicles traverse the curve following a constant radius.
- Several studies have shown that under real world conditions both of these assumption are violated.
- Likelihood of skidding increases when these assumptions are violated.

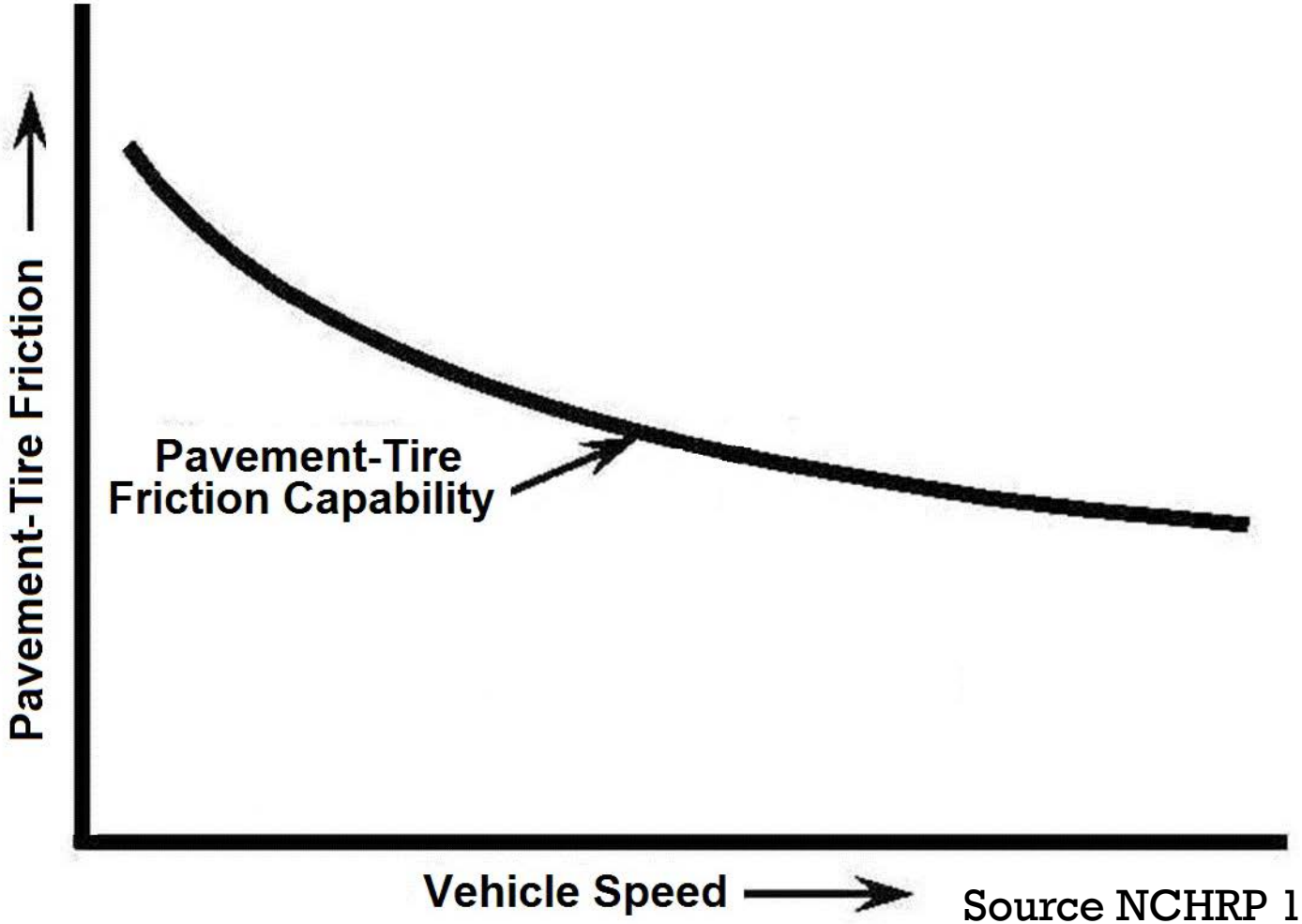
http://www.trb.org/Publications/Public/Blurbs/A_Guide_for_Reducing_Collisions_on_Horizontal_Curv_154782.aspx

Circle of Friction



Conceptual Relationship

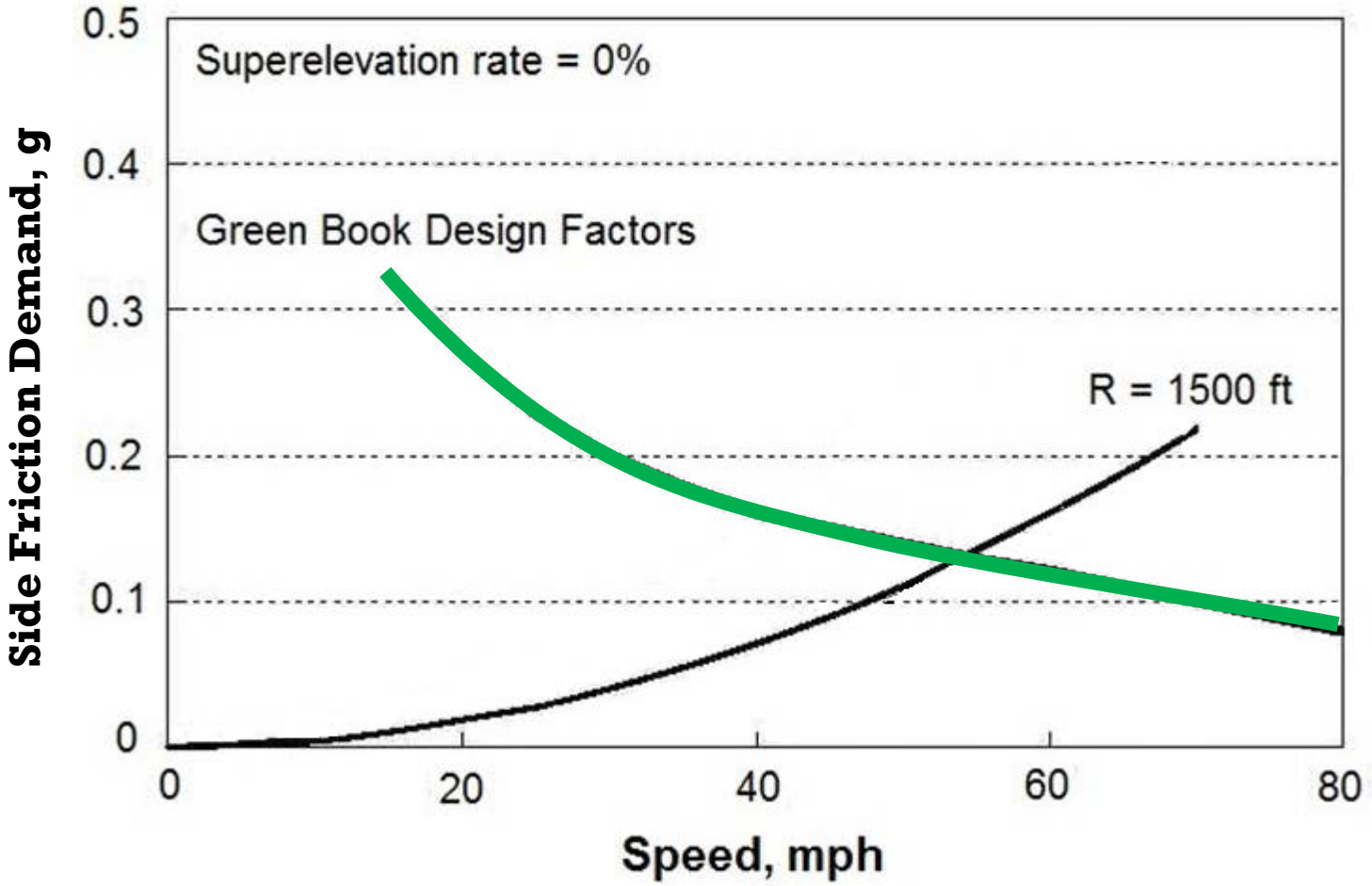
(Friction Demand, Speed and Friction Availability)



Source NCHRP 108

Example of Variable Friction Demand

Relationship between curve speed and side friction demand for two radii



Source TRR 2075

Low Friction Road Video

https://www.youtube.com/watch?v=cgyOOuRZb98

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Tori Brinkly,
FHWA

National Center for Rural Road Safety

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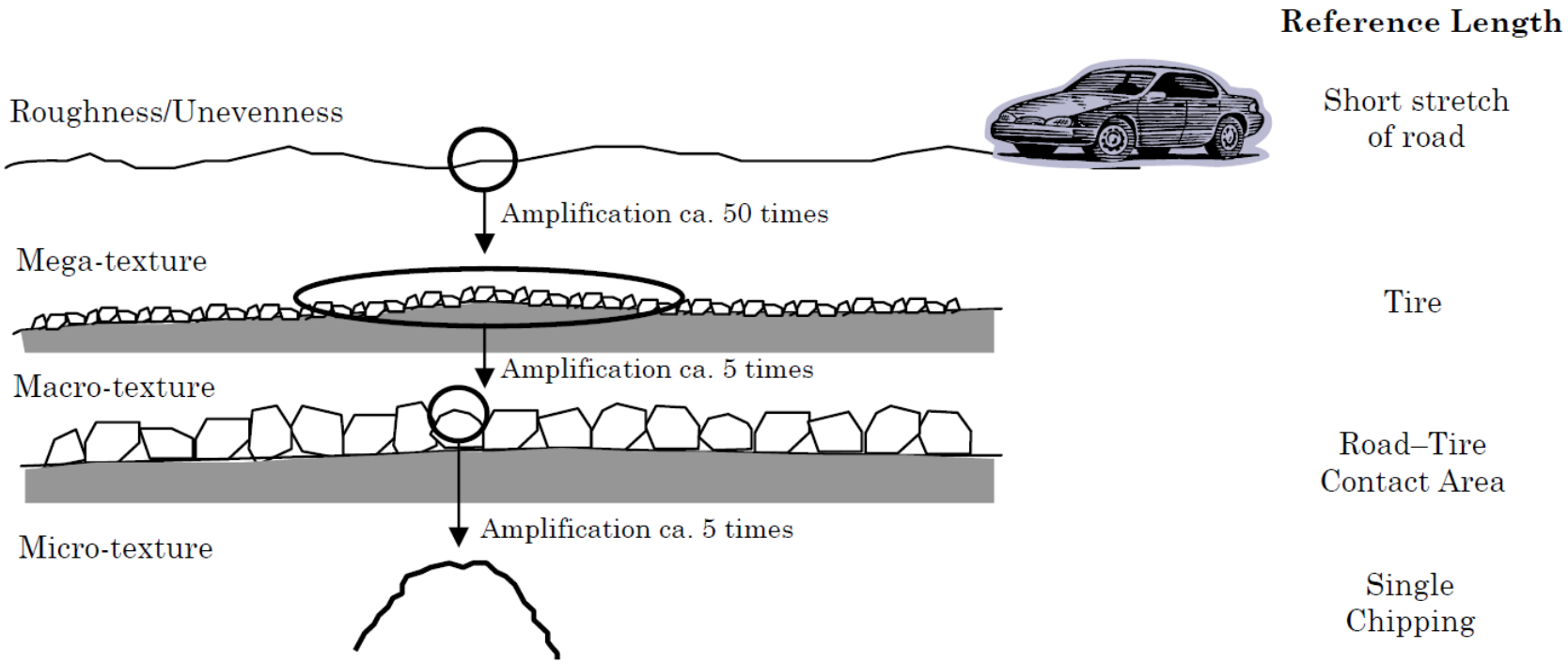
- Describe some of what we know about the potential safety benefits of pavement markings and horizontal curve signing
- Describe the role of friction in roadway departures
- **Identify effective methods to improve friction**
- Describe the safety benefits of high friction surface treatments

Some Common Methods to Restore or Add Friction

- Chip Seal (pavement preservation)
- Micro Milling
- Shot Blasting
- Grooving (concrete)
- Resurface with a friction course
  - NovaChip® (UTBWC)
  - HFST (critical spot Improvement)

Any of these methods may be an appropriate solution depending on the definition of the problem.

Road Texture Ranges



What Defines a High Friction Surface Treatment?

1. A pavement surface that has high friction values.
2. Friction will last a long period of time.

So, the key issue is to define:

- what is a high friction value and
- what is a long period of time

What is a High Friction Surface Treatment (HFST)?

High Friction Surface Treatments (HFST) are pavement surfacing overlay systems:

- With exceptional skid-resistant properties that are not typically acquired by conventional materials
- Which retain the higher friction property for a much longer time.

HFST is applied with commercially available aggregate, resin-based products, and installation processes.

Generally applied in short sections to improve spot locations where friction demand is critical.

HFST Aggregate

3 mm aggregate

Now commercially available from Arkansas!

The aggregate that defines HFST is **Calcined Bauxite** which provides the highest resistance to polishing and friction durability.

HFST Binder

Binder Resin System (all proprietary blends)

- 2-Part Epoxy, Polyester, or Acrylic
- Mixed On-Site
- Temperature and Humidity Specifications

HFST Manual Installation

Manual mixing of epoxy material and application with squeegee; with aggregate tossed by hand.

HFST Automated Installation

Machine mixing and application of epoxy and aggregate (limited hand/squeegee work)

HFST Demo Installation Video

https://www.youtube.com/watch?v=LO9Uu6L3SyM

HFST Specifications

- **AASHTO PP 79-14** "Standard Practice for High Friction Surface Treatment for Asphalt and Concrete Pavements" requires **Calcined Bauxite**.
- In-place friction characteristics must meet a minimum requirement of 65 FN40R when tested in accordance to AASHTO T242 upon completion of the installation.

Some State requirements exceed 65!

HFST Skid Numbers

- The 3 run average, SN40 wet value on the concrete pavement was 52
- The 3 run average, SN40 wet value on the HFST was 85
- Regardless of the speed, the stopping difference was **25% - 30%**

Texas Transportation Institute Friction Test Results

Braking Video

Reductions of 25% to 30% stopping distance.

https://www.youtube.com/watch?v=bJuBIdbviys

How Long Does HFST Last?

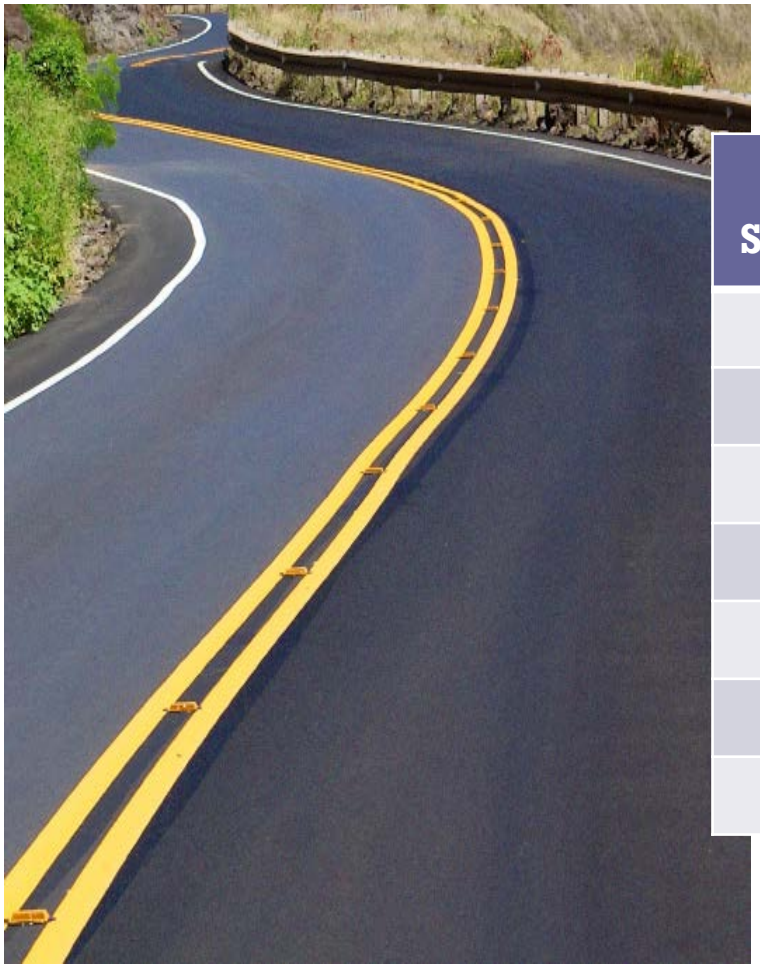
- The most significant issue is existing pavement condition
- Expecting 10+ years based on accelerated test track results and current project experience
- Depends on having a good specification and a good installation

HFST Finished Product

Why Use HFST?

- Pavement in curves receive shear and tensile forces, which can accelerate polishing when excessive friction demand occurs.
- High friction values allows HFST to resist polishing better than other aggregates.
- Properly placed quality polymer binders retain the aggregate, with 50% embedment necessary for superior performance.

Recommended Distance Ahead of the PC to Begin HFST Application

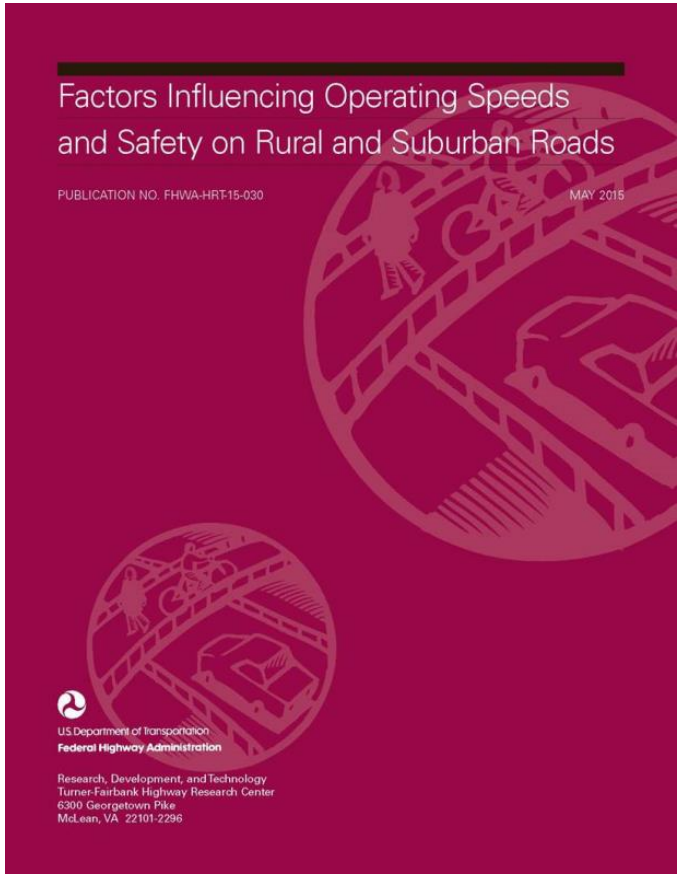


Approach Speed (mph)	Curve Speed (mph)						
	30	35	40	45	50	55	60
35	35	-	-	-	-	-	-
40	76	41	-	-	-	-	-
45	122	86	46	-	-	-	-
50	173	138	97	51	-	-	-
55	230	194	154	108	57	-	-
60	292	257	216	170	119	62	-
65	359	324	284	238	186	130	68

https://static.tti.tamu.edu/tti.tamu.edu/documents/TTI-2012-8.pdf

Operational Effect of HFST on Vehicular Performance

Chapter 4 examined the effect on operating speed when HFST was applied in horizontal curves and found no statistically significant change



https://www.fhwa.dot.gov/publications/research/safety/15030/15030.pdf

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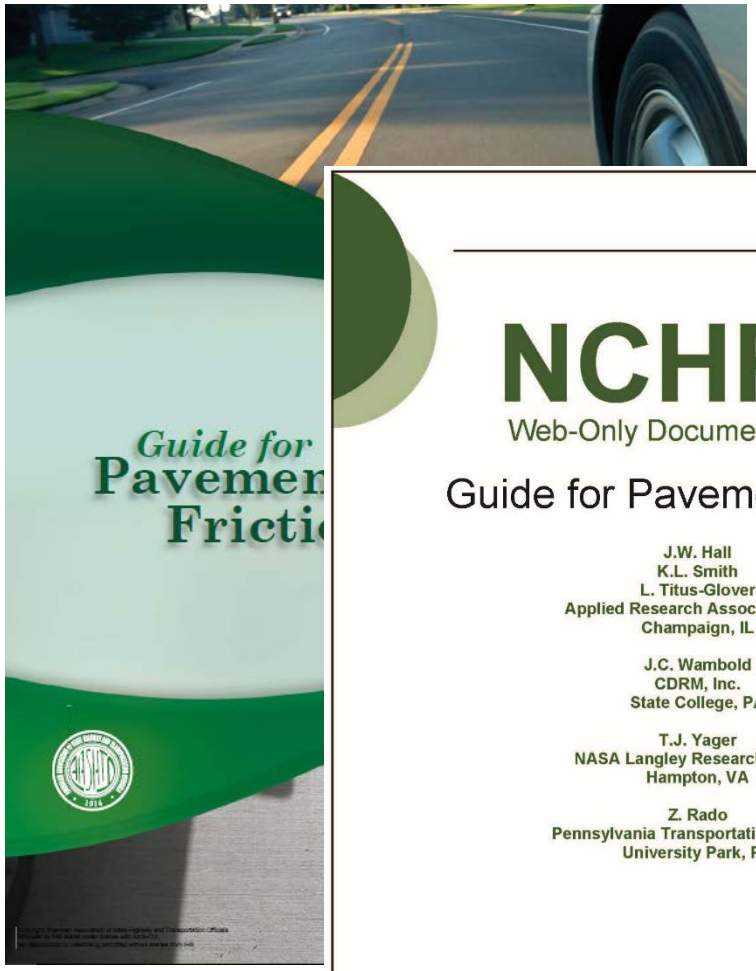
Agency Goals and Expectation?

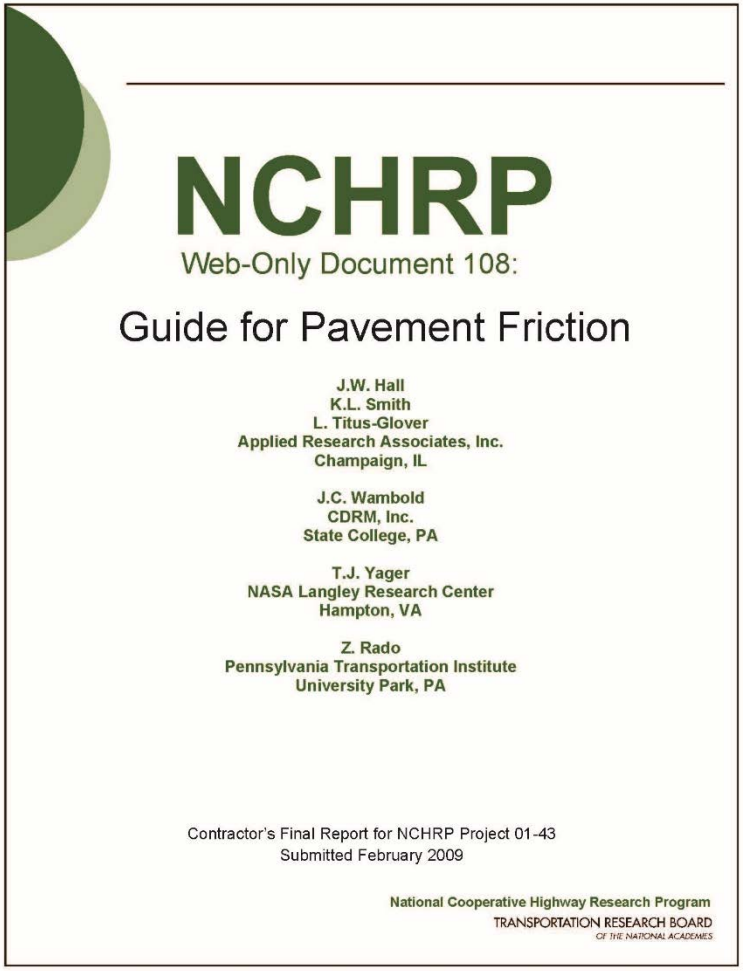
- Safety
  - ✓ High Crash Locations
    - – Usually Wet Weather Related Crashes
    - – High Friction Demand Locations
  - ✓ Systemic Safety
    - – Risk Based (Preventative Action)
- Operations
- Longevity (Durability)
  - ✓ Return on Investment
  - ✓ Concern for Replacement

Provide Skid-Resistant Pavement Surfaces

Crash Types Addressed by Improving Pavement Friction:

- —Wet Weather
- —Curves
- —Other Skidding (e.g. too fast for conditions)





http://www.trb.org/Publications/Blurbs/161756.aspx

Strategies for Reducing Crashes
(Where Can Friction Benefit Safety?)

1. Horizontal Curves
2. Approach to Intersections
3. Grades

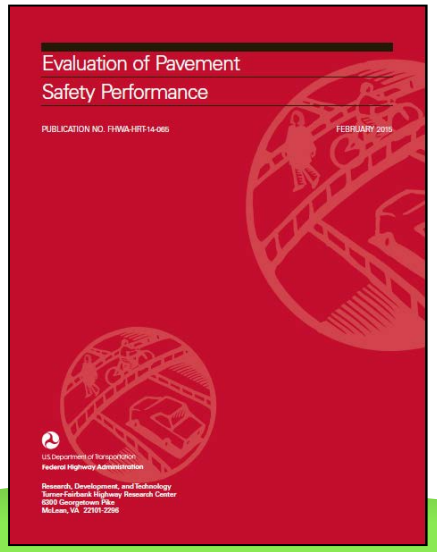
When the pavement has:

- Marginal friction caused by weather
- Friction values not compatible with approach speeds and geometrics (friction demand)

HFST Safety Effectiveness Study

Evaluation of Pavement Safety Performance		8 State Naïve Study	Study w/Comparison Sites
Total Crashes	Ramps CMF (CRF)	0.48 (52%)	0.65 (35%)
	Curves CMF (CRF)	0.63 (37%)	0.76 (24%)
Wet Road Crashes	Ramps CMF (CRF)	0.21 (79%)	0.14 (86%)
	Curves CMF(CRF)	0.37 (63%)	0.48 (52%)

(includes a 25% penalty per HSM)



http://www.fhwa.dot.gov/publications/research/safety/14065/14065.pdf

Kentucky HFST Program

Avg. Annual (70 locations)	Before (2010-2012)	After (2013-2015)	Reduction %
Wet Avg.	212	21	90%
Dry Avg.	65	15	77%
Total Avg.	277	36	87%

(as of 6/22/2015)

Slide Courtesy of Kentucky Transportation Cabinet

HFST Performance in Florida

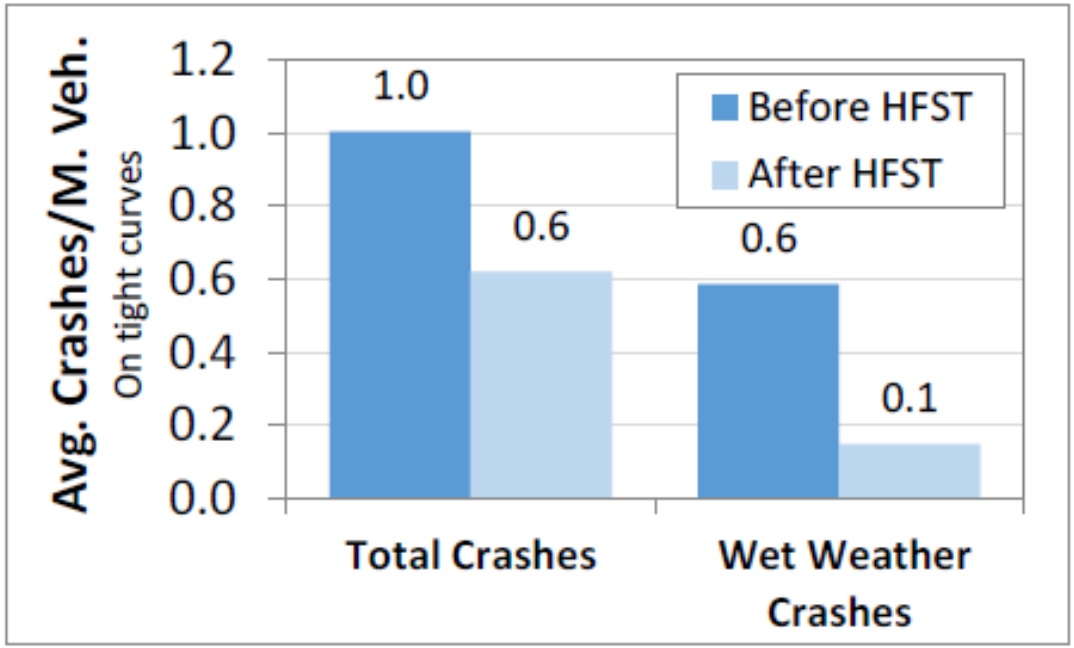


FIGURE 2 – Crash rates before and after HFST on tight curves.

http://www.fdot.gov/materials/pavement/performance/ndt/documents/hfstguidelines.pdf

Pennsylvania Success Story

Pennsylvania Success Story Video

https://www.youtube.com/watch?v=4jjAJytbEls&feature=youtu.be

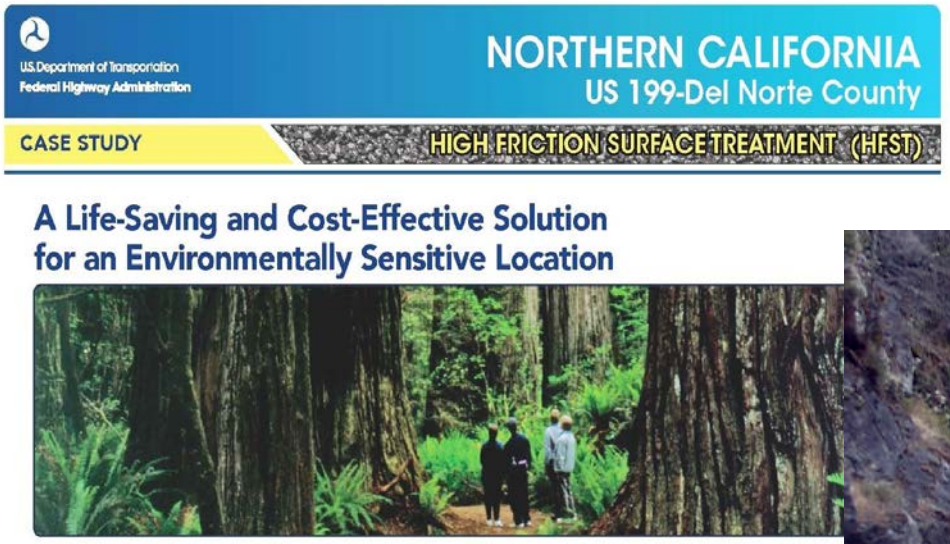
Pennsylvania Project Summary

Installed 27 Oct 2012

Traffic	5,200 AADT =	Hackett Ave
	4,600/8,900 AADT =	Wood Ave
Crashes	3 yrs prior to Install =	26
	Since Installation =	1
Skid Number	Before Install =	22
	After Install =	75

Slide Courtesy of Pennsylvania DOT

California Success Story



- 4,000 ADT, high truck volume
- 280 ft radius, < ¼ -mile curve
- 30 wet crashes from 2006 to 2009
  - 10x statewide injury rate
  - 18x statewide total rate

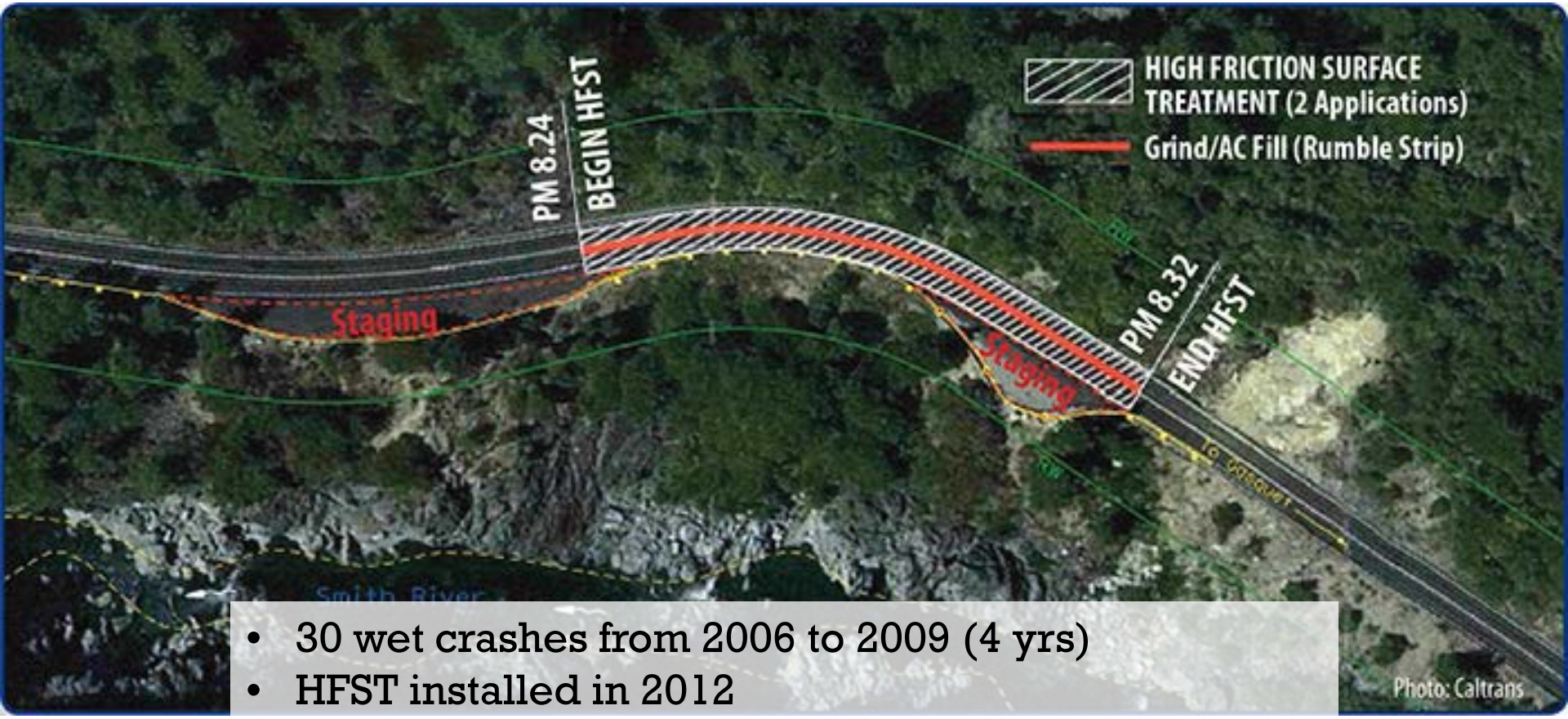
Table 1. Comparison of Factors between HFST and Curve Realignment on US 199

	Environmental Review & Design Timeframe	Construction Duration	Cost
Curve Realignment	2-5 Years	6+ Months	$14,000,000+

Detour

Necessary: Roadway must be closed during construction.

Install HFST Summer of 2012



- 30 wet crashes from 2006 to 2009 (4 yrs)
- HFST installed in 2012
- By mid-2015 there had been no reported crashes since the HFST installation

HFST Conclusion

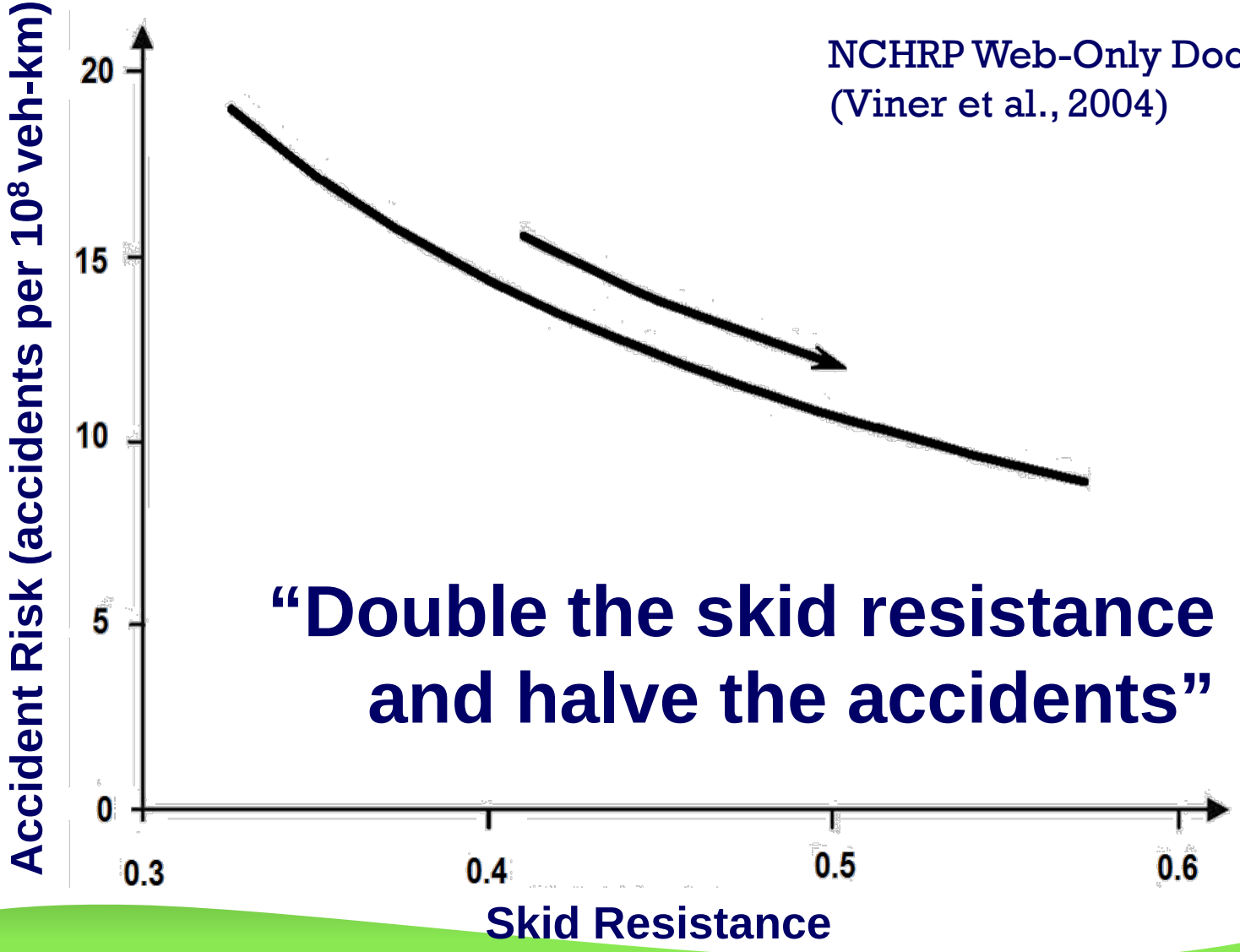
HFST is **not** a pavement treatment that happens to have safety benefits…

HFST is a **great safety treatment** that happens to be a pavement!

To be applicable, HFST must still provide the functions of a pavement for durability, but it must greatly reduce crashes for a significant duration to distinguish its unique value.

Pavement Friction and Crash Risk Relationship

NCHRP Web-Only Document 108
(Viner et al., 2004)



"Double the skid resistance and halve the accidents"

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More HFST Resources

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

http://www.atssa.com/Resources/HighFrictionSurfacing/FAQs.aspx

https://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa1121/index.cfm

Friction Fun – Laws of Motion
https://www.youtube.com/watch?v=_bMxJ4IU6GY

Learning Outcomes

In this webinar, you have learned to:

- Summarize what the MUTCD says about pavement markings and horizontal curve signs
- Describe some of what we know about the potential safety benefits of pavement markings and horizontal curve signing
- Describe the role of friction in roadway departures
- Identify effective methods to improve friction
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SC Upcoming 2018 Webinars

- Rural Roadway Departure Countermeasures – Pt 3

  Dec. 18th, 11:00 AM – 12:30 PM Mountain

- Framework for Bikeway Designation on Rural Roads

  Jan. 31st, 11:00 AM to 12:30 PM Mountain

RRwD Archived Webinars

- EDC5 Reducing Rural Roadway Departures Webinar

https://connectdot.connectsolutions.com/p19821 15wf44/?proto=true

- Rural Roadway Departure Countermeasures – Pt 1

https://ruralsafetycenter.org/training-education/safety-center-trainings/archived-safety-center-trainings/

December 4-6, 2018 Savannah, GA

www.ruralsafetycenter.org/news-events/bridging-the-gap-summit/

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National Center for Rural Road Safety

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