Introducing SCRIM99 Friction Testing in the United States

21 - 24 May 2017, Auckland, New Zealand

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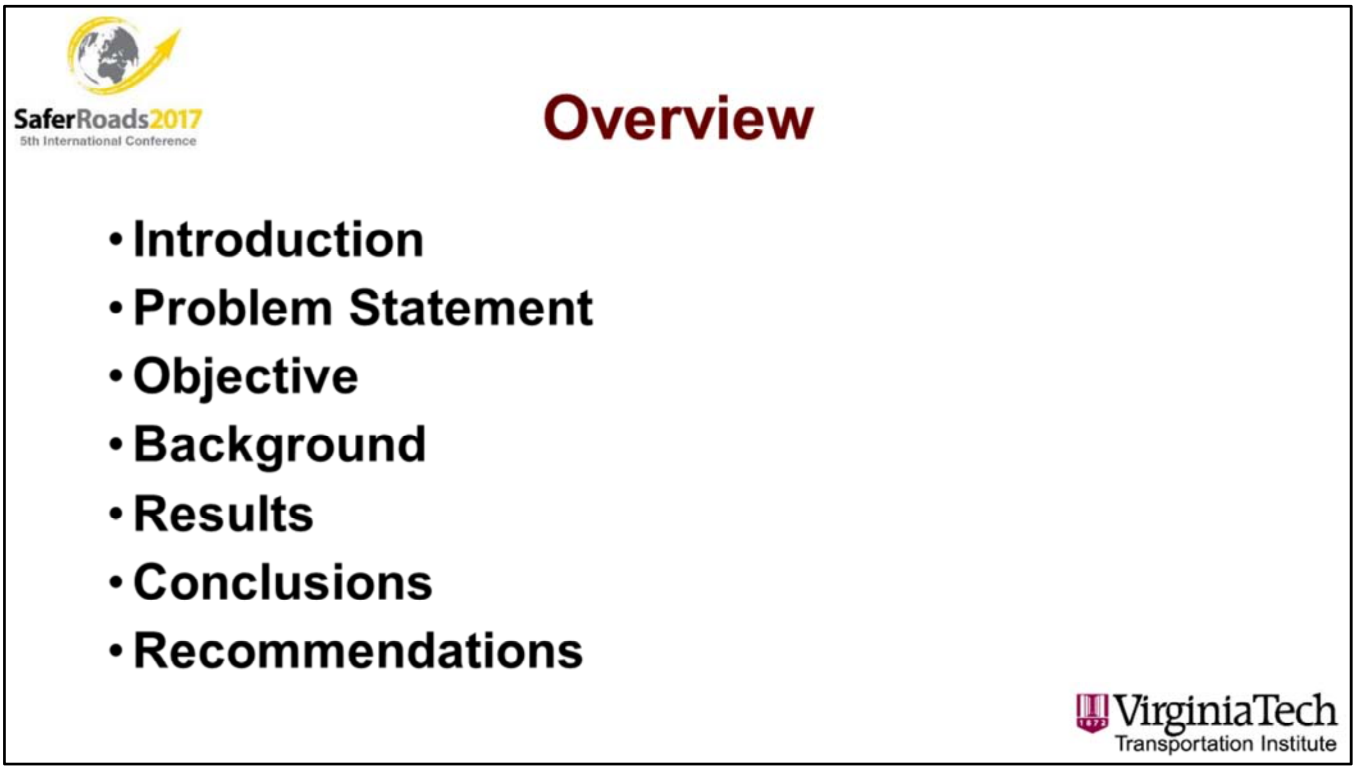
I am very glad to be in Auckland participating in this the most supreme of all friction related conferences in the World. I am hoping we can have it next in the US and that by 2020 there will be more SCRIMS there.

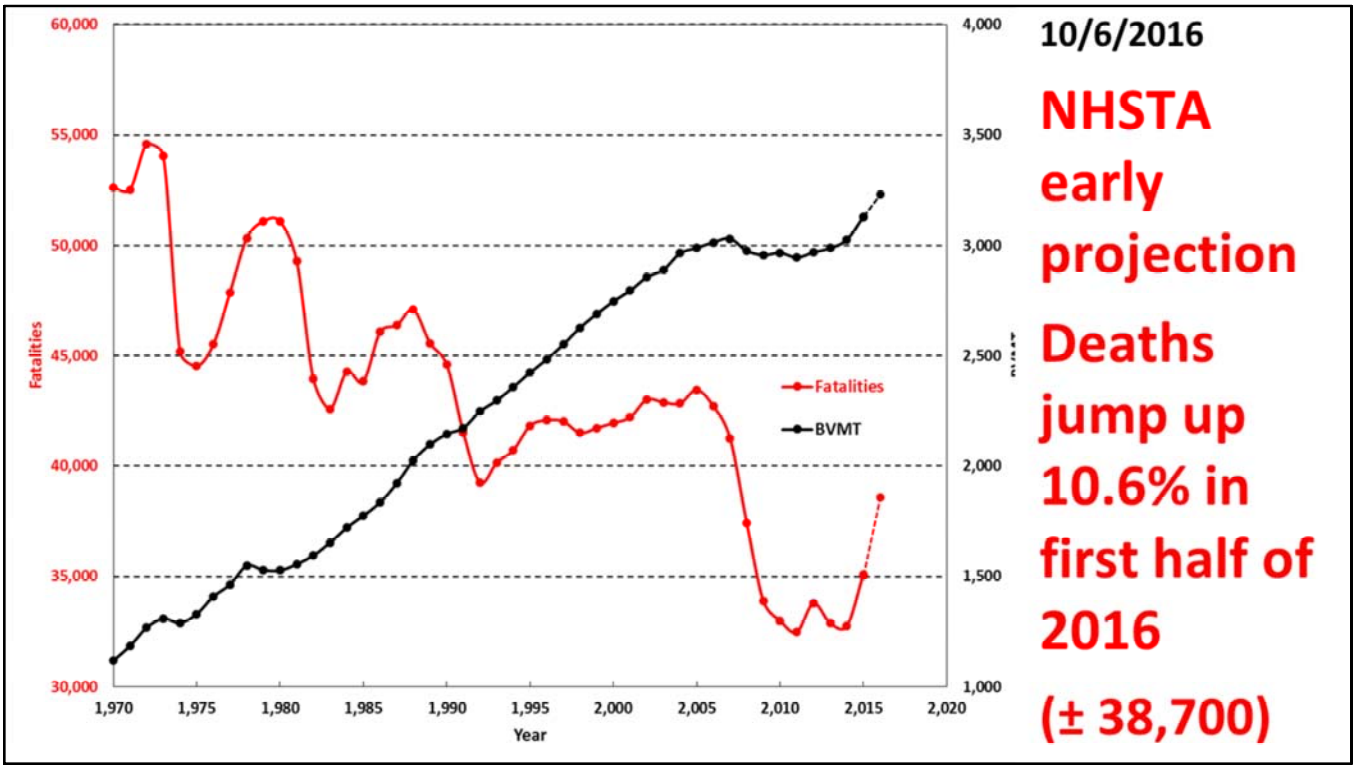
The ice-breaker, what do you see in the circle?

Welcome to Welcome, a friendly place in North Carolina!



The outline of my presentation.

With the approval of the last Highway Bill, the government is trying to make the states accountable for the safety (among other things) of the traveling public, by making sure that crashes are reduced. The repercussions of non-compliance are still not very clear.



Accidents are on the rise again, after a period of improvements. This puts a lot of pressure on highway agencies to try to fix things.

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Introduction

2015: 35,092 fatalities, 2.44M injuries, 6.3M crashes
(+7.2%) (+4.5%) (+3.8%)

Fatalities:

- 9,874 not restrained (28%, up 4.9%)
- 9,557 speed-related (27%, up 3.0%)
- 10,265 impaired driving (29%, up 3.2%)
- 3,477 distracted driving (10%, up 13%)
- 1,938 un-helmeted motorcyclist (5%, has 10x+risk)

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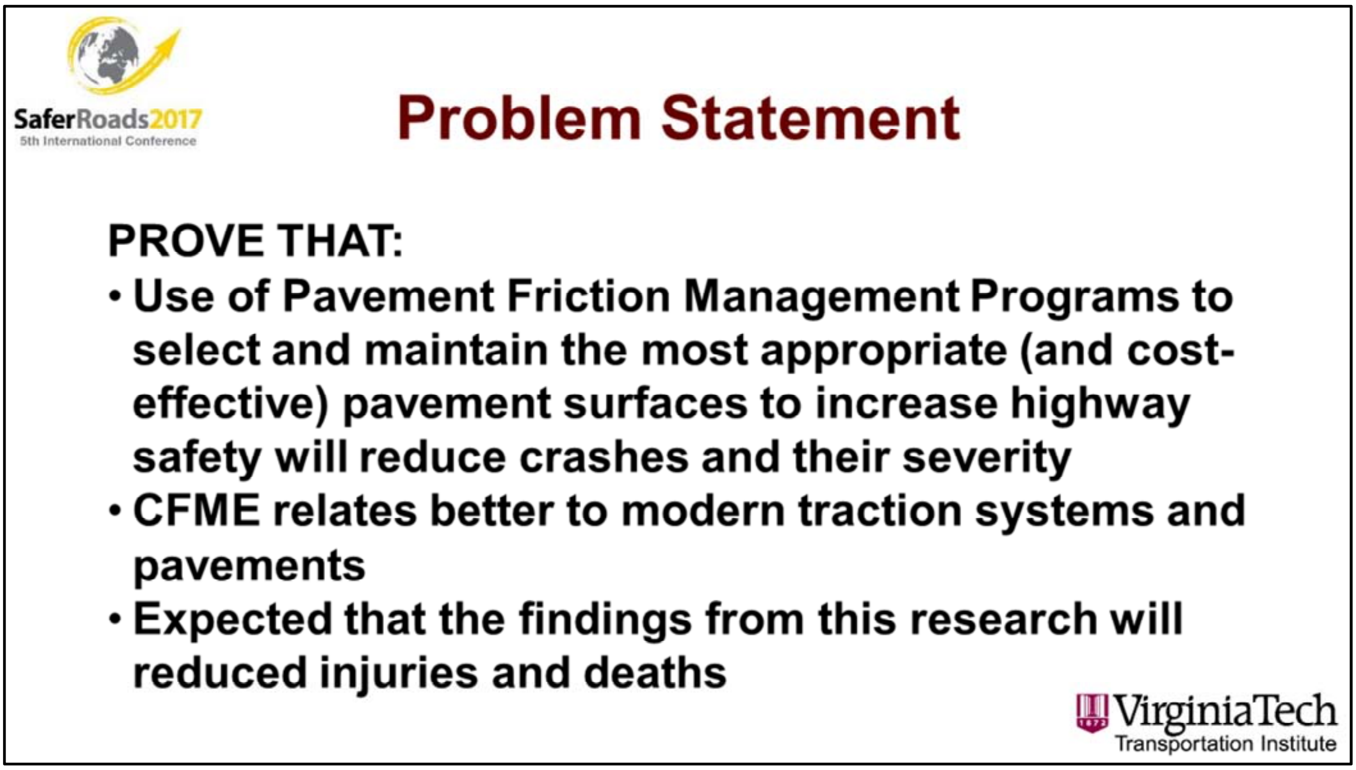
The main causes of the crashes in the United States are not things that highway agencies can fix, but certainly having good friction on the roads does not hurt, and sometimes might even help reduce crashes or their severity.



The FHWA has tasked us to elaborate Pavement Friction Management Programs in such a way that they will reduce crashes systematically.

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Problem Statement (cont.)

- CFME will allow better network–level analysis of friction–related crashes
- The greater granularity of the CFME is able to detect negative conditions that will allow the use of safety performance models to estimate crash rates to develop a proactive, systemic, and cost-effective friction repair treatment plan

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In order to do this, they are supporting the research and paying for the SCRIM truck that was decided on after we recommended it as the best device to move forward with the implementation of PFM.

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Objective

Acceptance Testing and Demonstration of CFME: (DTFH61-09-R-00035)

- Assist 4 states develop Pavement Friction Management Programs (using pavement friction, texture*, crashes, and other data)
- Develop and demonstrate methods
  - Get friction, texture, crash, traffic, other data
  - Define friction demand categories
  - Set investigatory levels of friction/texture

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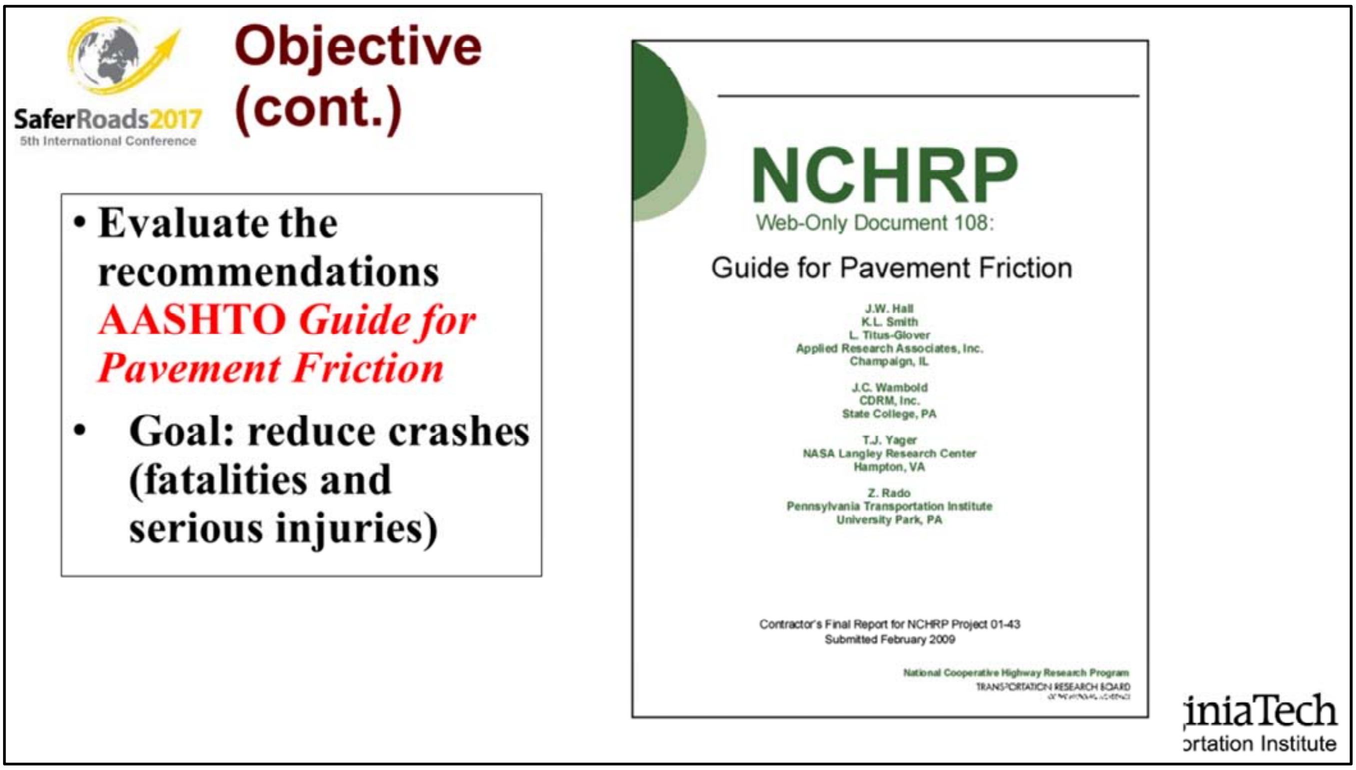
This is the text of the contract we have with FHWA to use the SCRIM. We are very lucky we were chosen to carry forward this wonderful job.



At the end of the process, a complete revision of the Guide for Pavement Friction will be suggested to make policy changes in the treatment of the friction (and texture) of the pavements in the US.

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Background

H. W. Kummer and W. E. Meyer doing the first test runs of the Brake Test Trailer with the Boeing Antilock System Installed The Mechanical Engineering Laboratory, Pennsylvania State University 1959. (History of ASTM E-17)

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Friction work in the US dates to the 1,950s when a lot of work was done in this area.

Unfortunately, ascribing to the old saying "*If it isn't broke, don't fix it*", not much has changed since then and honestly something has to be done to improve the processes to reduce the current trends. Many are pinning their hopes up high on the new automated vehicular technologies, but it is probably very many years away and the fatalities keep happening every day.

“New” locked-wheel skid testers.

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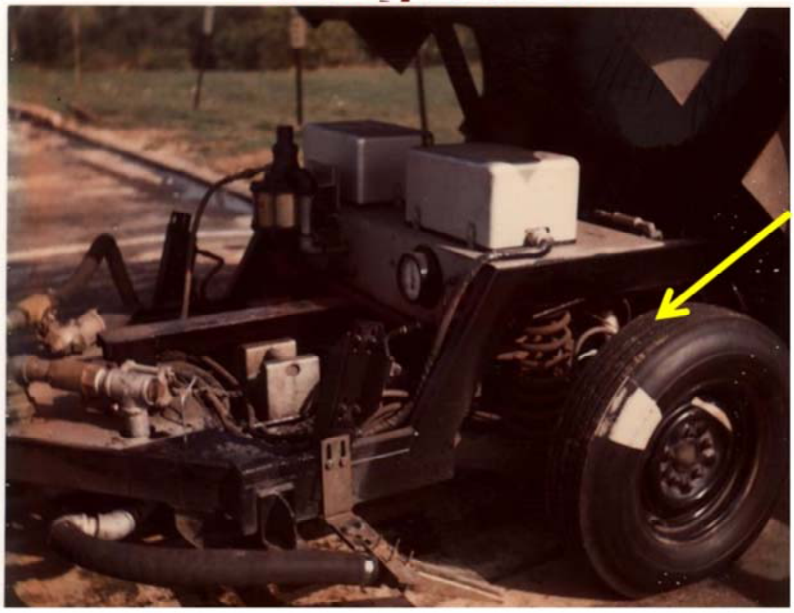
Background



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Inside look at the 1960’s skid tester.

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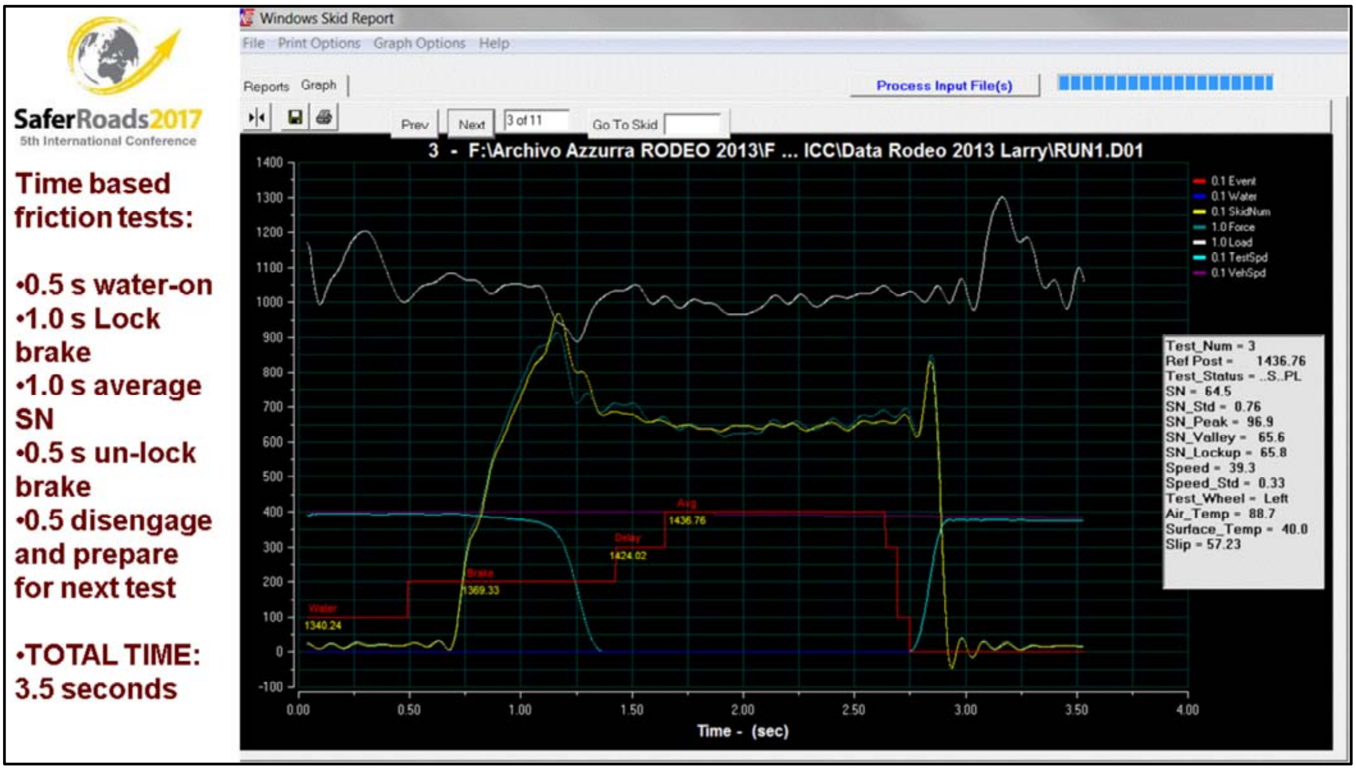
Inside look at the 2,000’s skid tester. Yes, it still looks the same.



Explanation of the cycle of measurement.

Federal Government SCRIM device that arrived to Blacksburg Virginia on June 3, 2015, very late and never too soon, in my opinion.

The chassis was built by Volvo in their Dublin, Virginia plant 10 miles away from Virginia Tech. This plant is the only one in North America and where all the Volvo trucks for Canada, Mexico and the US are built. We literally where there the day it was assembled.

Several months later I was the first American to see the new SCRIM-99 in the WDM factory where it was assembled. We then took it to the TRL trials in the Midlands where it participated with the other SCRIMS from the UK and Ireland.

Arrival in Blacksburg Virginia, June 3, 2015. It was a work of art!

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A star is born!

All of the top-brass from FHWA came to officially put the Federal Tags on it and handing it to VTTI.

Pictures of the tires used in several testers. From left to right:

1. Ribbed tire (ASTM E-501)
2. Smooth or bald tire (ASTM E-524)
3. Tire used by several other CFME in the runway industry (ASTM E-1551)
4. Grip Tester Tire (ASTM E-1844)
5. SCRIM Tire on the “naked” SCRIM.

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Background

• Washington State	575 miles
• Florida	875 miles
• Indiana	875 miles
• Texas	900 miles
Plus	
• North Carolina	550 miles
TOTAL	3,775 miles

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Extent of the surveys done in 2,016 by VTTI.

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Results

CASE 1

- State Route 3 (MM 59.9)
- 0.1 mile comparison with 1.0 mile friction and texture data collection

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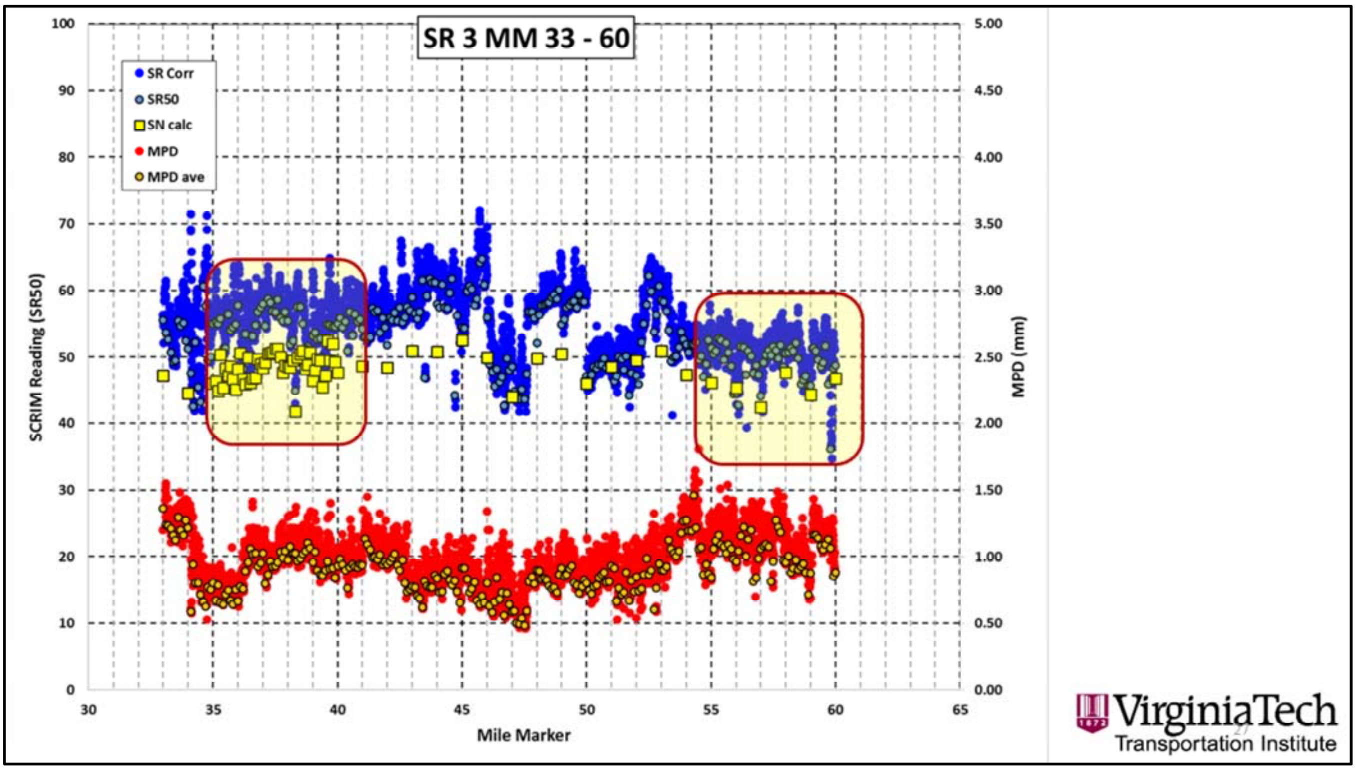
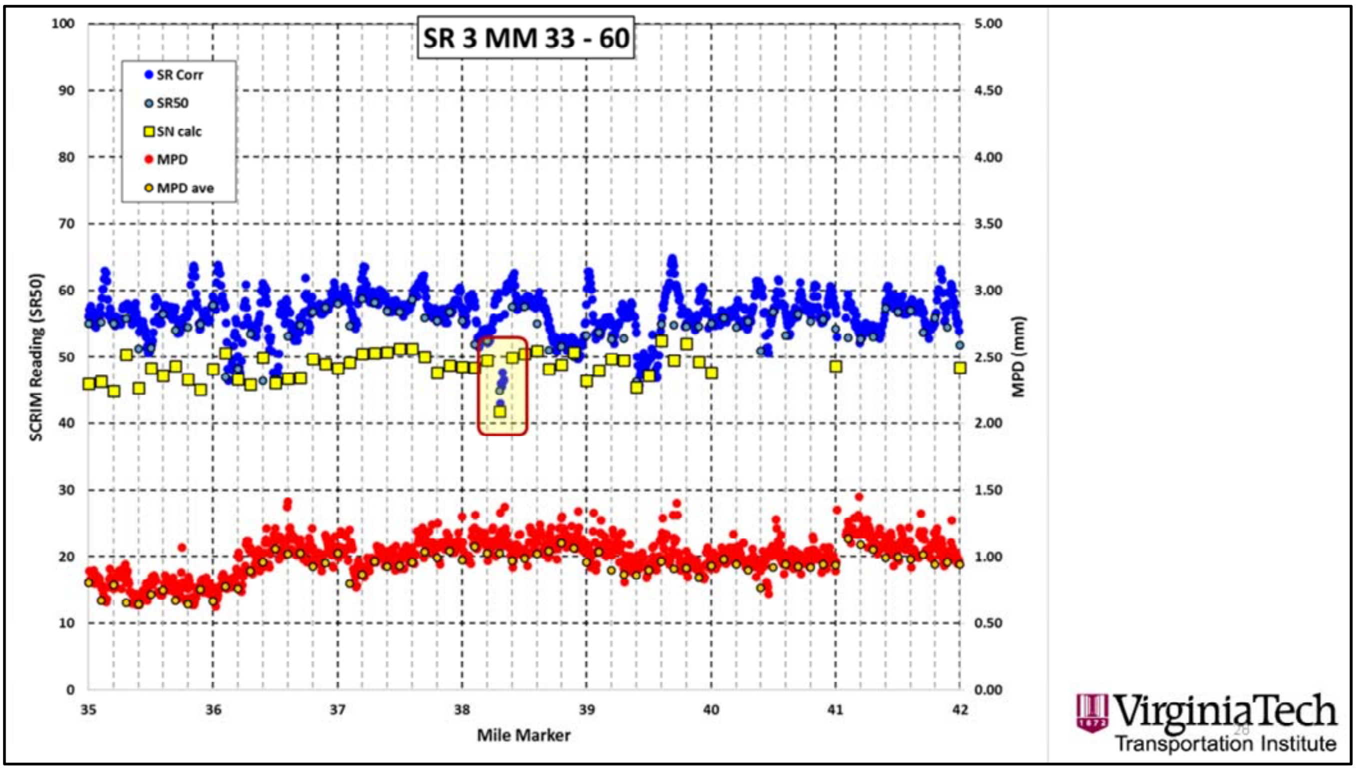
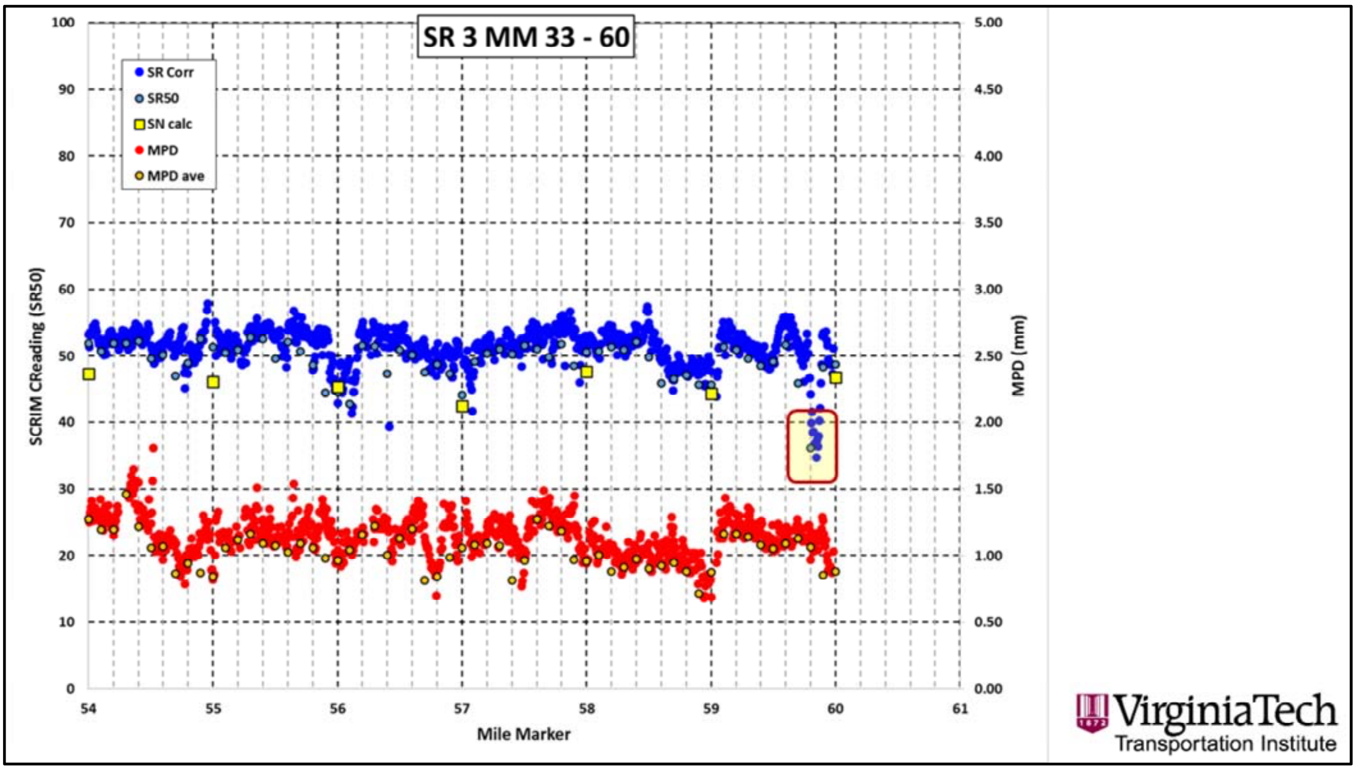
Some interesting examples found in our journeys.



Two areas of a route where E-274 measurements were done every 0.1-mile and the other where it reverted to doing them every 1.0-mile.



If the E-274 could measure every 0.1-mile, it would be a viable device to be used in a PFMP that is intent in matching crashes with friction measurements. Notice the good agreement shown in mile 38.3.



However, when doing it every 1.0-mile, it misses a very obvious low-friction spot on mile 59.9.

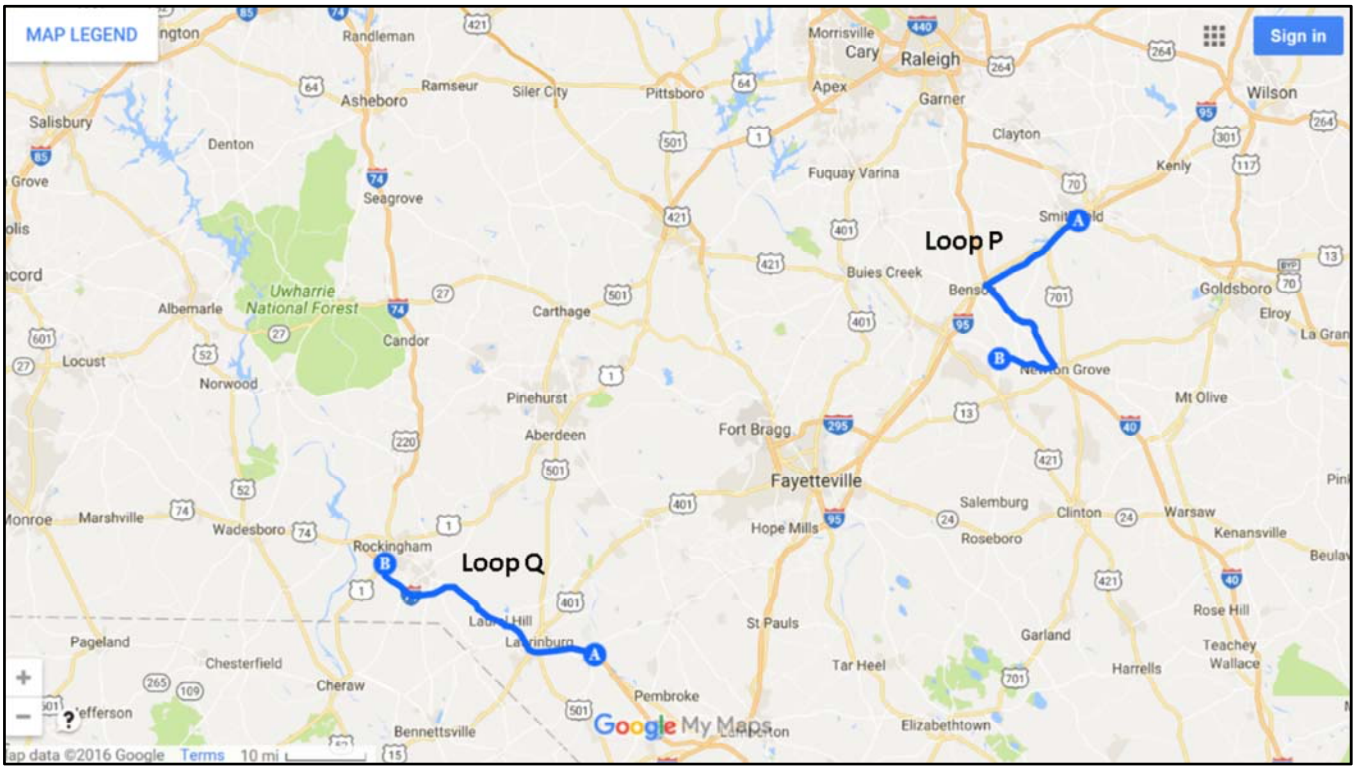
Low friction point at mile 59.9, probably caused by the polishing when vehicles are stopping to turn at this angled-intersection that is also dangerously located in a curve.

Results

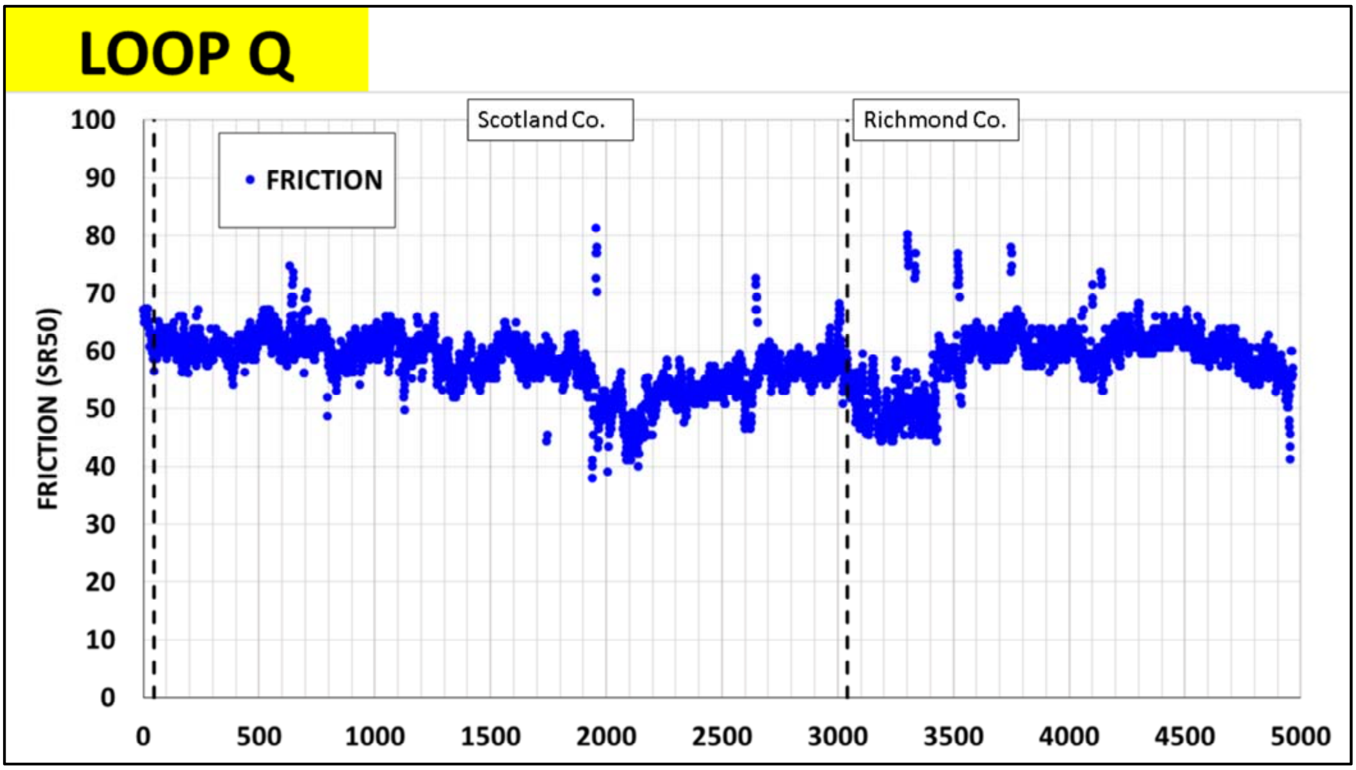
CASE 2

- **LOOP Q**
- **Friction and texture data collection**

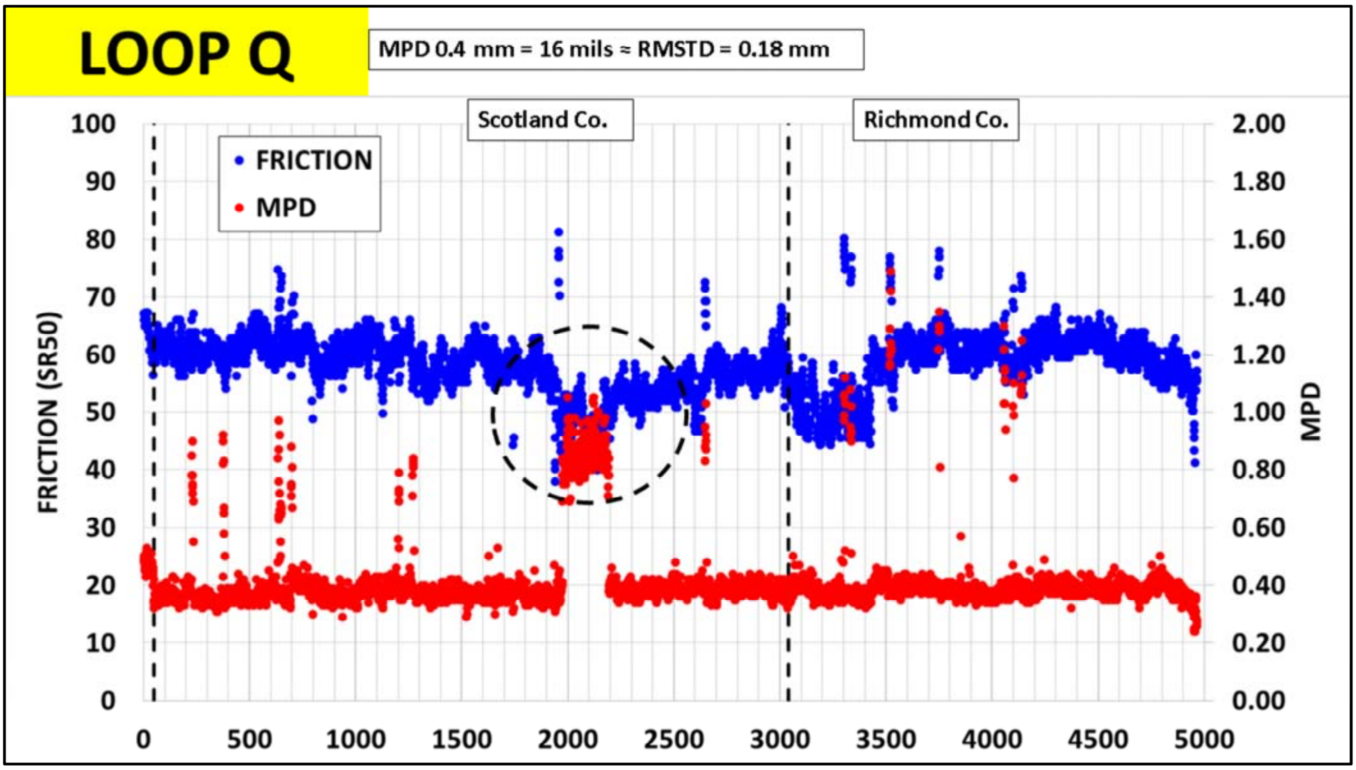
Eye opener case.



Location of road measured.

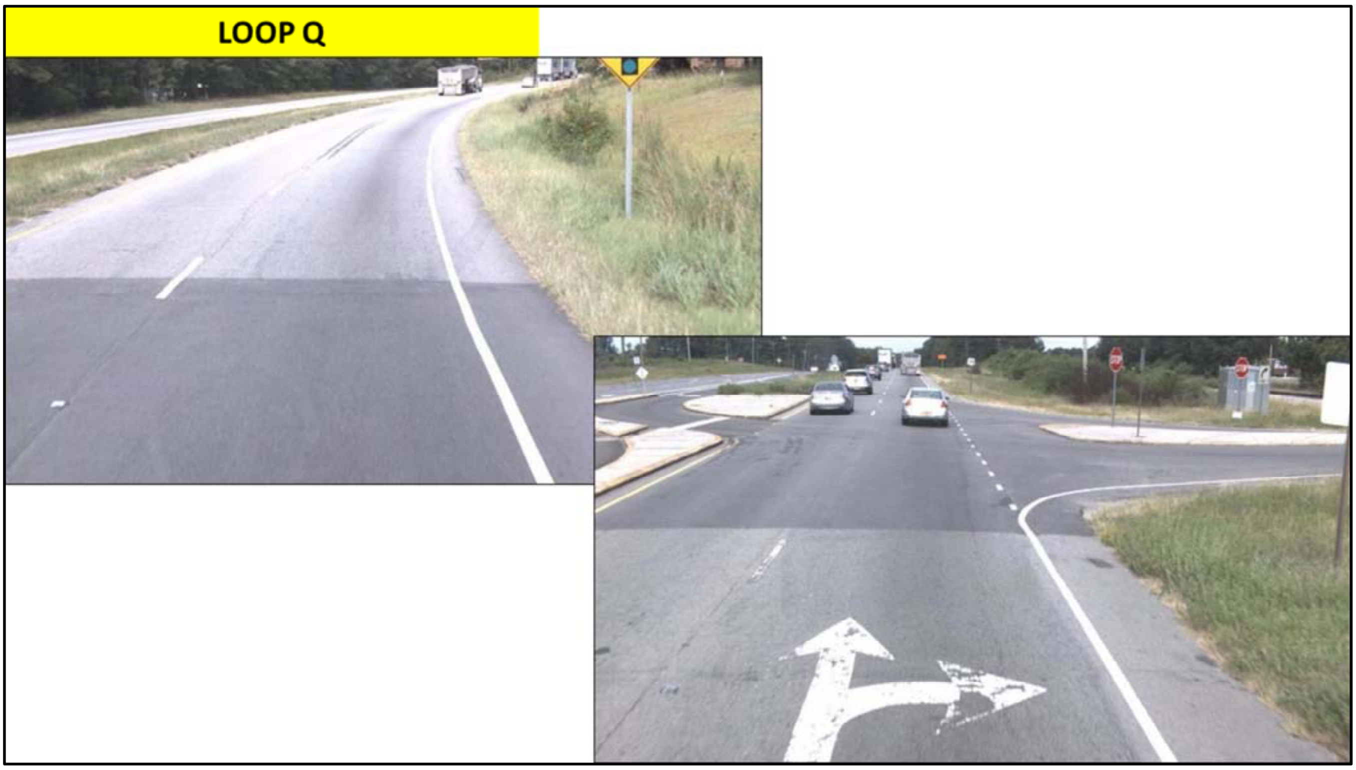


Shown are only the friction results with the SCRIM, not noticing any significant problems as the friction seems very even in the 50-kilometer section. However, we have to remember that the SCRIM friction is usually associated with the microtexture, and that is why SCRIM-99 has a texture laser.



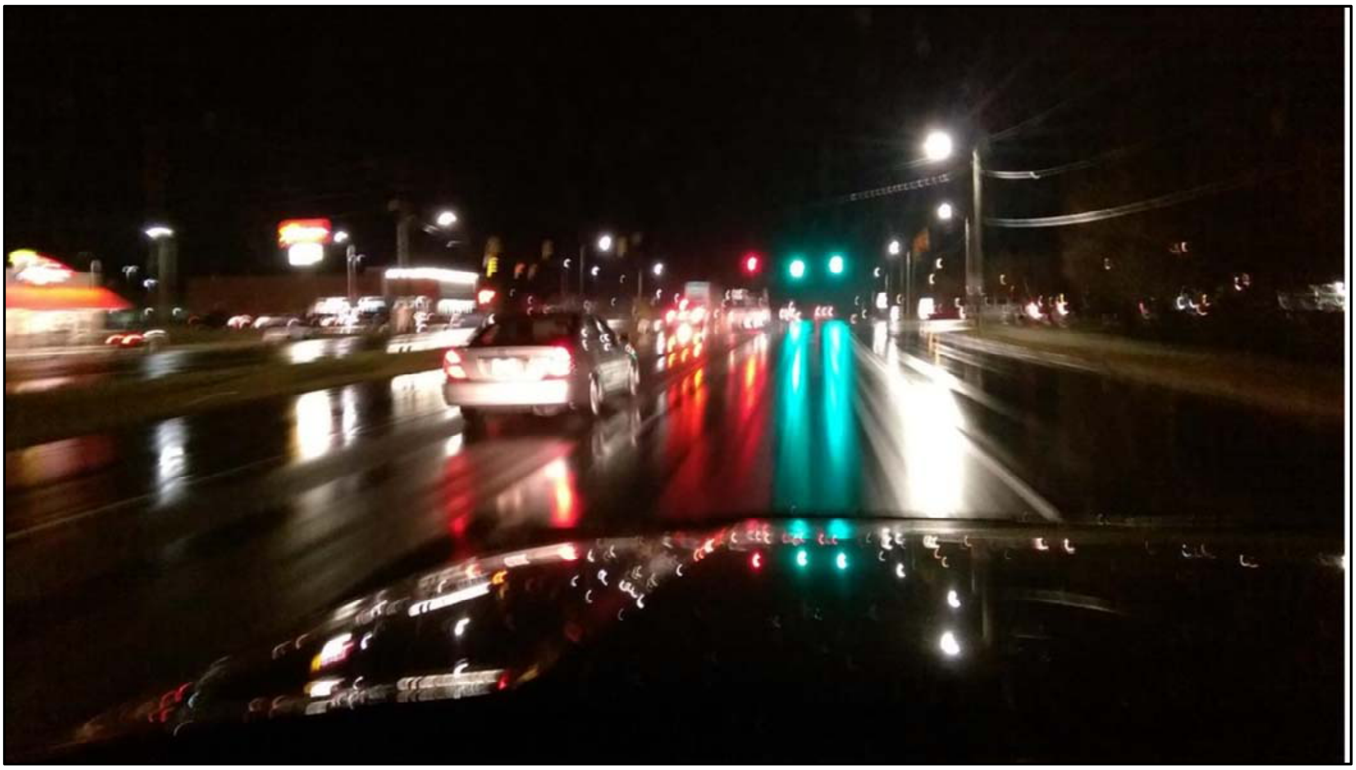
When we add the texture component, it is obvious that there is a section of about 2 km. between 20 and 22 that is very different. The texture in this section is higher than in the rest of the road, the majority of it having an MPD of about 0.40 mm, very low (RMSTD = 0.18 mm). Why?

It is also clear now, that the friction drops when the texture increases in this same spot.



Well, it just so happens that the high texture section is the old pavement section which leaves the majority of the road with a new pavement that is obviously too dense. It is important to point out that there is currently only a handful of states that have any texture requirement, and an even smaller number that actually measures it. Because this is the norm, there are no limits of what is to be considered a “low” value.

In general terms, friction values considered low are SN = 20 for a smooth tire and SN = 30 or 35 for a ribbed tire, but there is no discrimination between different sections of road such as tangents, curves, grade, intersections, etc.



The same sections that had the very low texture values are shown here on a rainy night. It has already stopped raining but the pavement is still very wet and the fact that you can see the lights being reflected on it shows how slippery and dense the pavement, making it harder to stop, especially at high speeds.

Another view of the wet pavement.

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Results

CASE 3

- **Continuous Friction and Texture data collection in chip sealed roads in hot weather (bleeding?)**

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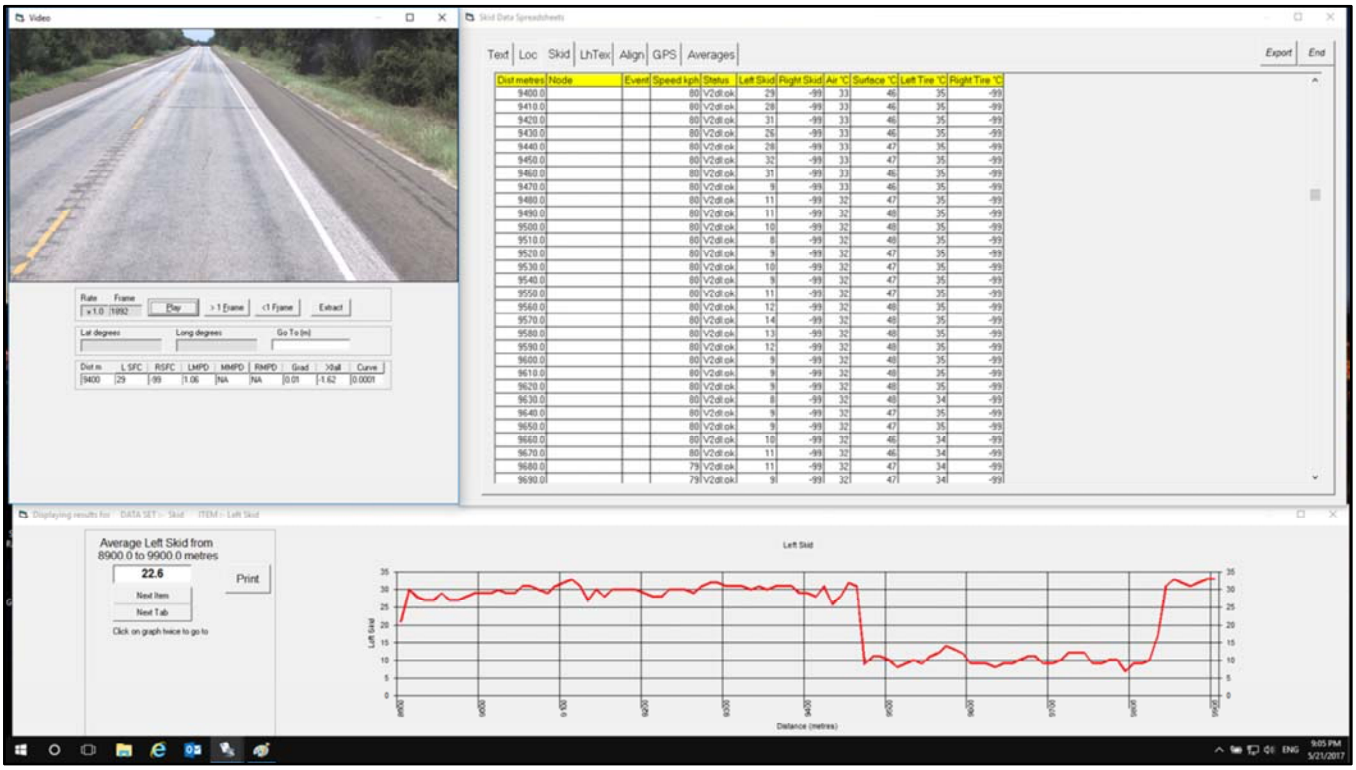
Eye opener case.



Video
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Average Left Skid from
8900.0 to 9900.0 metres
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5/21/2017


Text
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Averages
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Average Left Skid from
9200.0 to 10200.0 metres
23.5
Print
Left Skid
Distance (metres)

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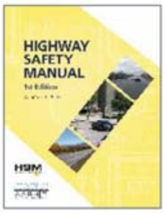
Results



Safety Performance Functions

$$SPF_i = e^{\beta_0 + \sum_j (\beta_j X_{ij}) + \varepsilon}$$

SPF_i = crash rate for the i^{th} segment of roadway

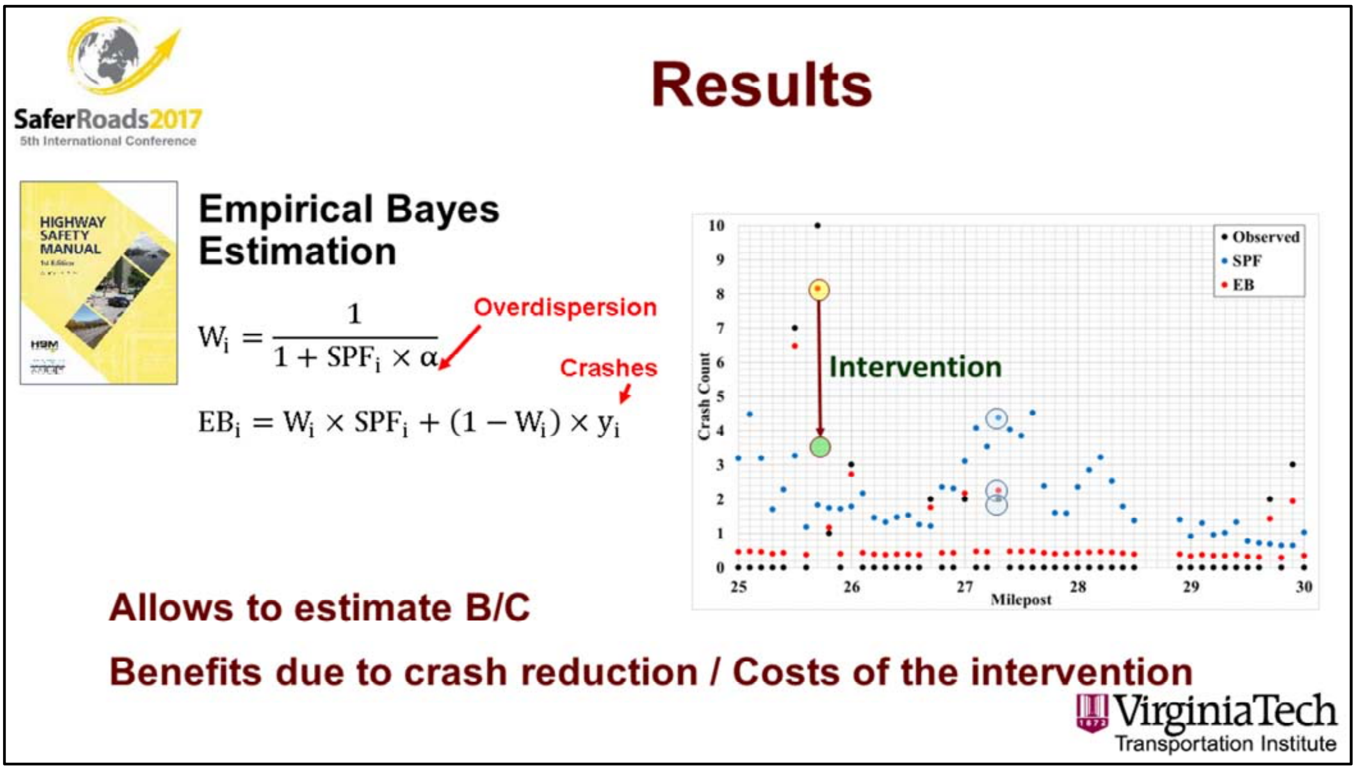
X_{ij} = value of variable j at the i^{th} road segment (friction, macrotexture, curvature, grade, intersection, etc.)

β_j = estimated parameter coefficient for the j^{th} variable (where: $j > 0$)

ε = Gamma distributed error

Model Variables	Coefficient
ln(AADT)	1.201
Divided	-2.685
Intersection	-0.118
Pavement Type	-0.600
SR	-0.046
Gradient	0.032
H. Curvature	0.061
SR*Intersection	0.011
SR*Divided	0.039
SR*Pave Type	0.014
Route ID	-
RTE 3	-0.274
RTE 4	0.336
RTE 5 A	-0.119
RTE 5 B	0.723
RTE 8	-0.025
RTE 12	-0.139
RTE 82	-0.368
RTE 101	0.525
RTE 395	-0.112
RTE 405	0.877

In any case, the real benefit of having a unit that can collect so much data is that because it collects not only friction but also texture, curvature, grade, cross-slope, and then other information such at the type of road section, divided roadway, and other factors, it allows for a very complete analysis to try to match the crashes with these different road conditions.
The Safety Performance Model shown is a negative binomial model that is based on the Highway Safety Manual guidelines and it was developed at 0.1-mile intervals.
Friction was characterized as the minimum 3-point moving average inside every 0.1-mile, to capture the worse conditions without penalizing a section too much by just using a minimum value or letting slick spots slide if the normal average is used.



The SPF model is then improved with the use of Empirical Bayes estimations that compensate for the lack of sensitivity the regression might produce. This is specially true because crashes have many different causes that not necessarily are related to the physical variables we measured. Drunk-driving, distracted-driving, speeding, and other main causes of crashes complicate the matching of the crash sites with the physical characteristics measured.

We estimate that maybe between 10-20% of the crashes might be caused by a series of factors, where one of which might be the friction, texture, etc. that we measured.

So using EB estimators, the predicted number of crashes can be obtained if the friction is allowed to change to an estimated number of a particular treatment that we need to analyze. Based on the cost of the treatment, the number of crashes that the model estimates can be reduced, will either pay or not for the intended treatment. Because different treatments will cost differently and will also have a different friction improvement, the analysis needs to be done for all the sections with the possibility of needing improvement.

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Results

- **Cost/ Benefit Analysis**
  - **Asphalt pavement only**
    - **Estimate the potential savings from applying the treatment.**
  - **Average crash cost = $109,271**
  - **Two treatments:**
    - **HMA Overlay:** Improve to SR = 65, Cost/Lane = $7,040
    - **HFST:** Improve to SR = 85, Cost/Lane = $19,008
  - **Accident reduction**

$$EB_{HMA-OL,i} = \frac{\lambda_{HMA-0L,i}}{\lambda_i} \times EB_i \qquad EB_{HFS,i} = \frac{\lambda_{HFS,i}}{\lambda_i} \times EB_i$$

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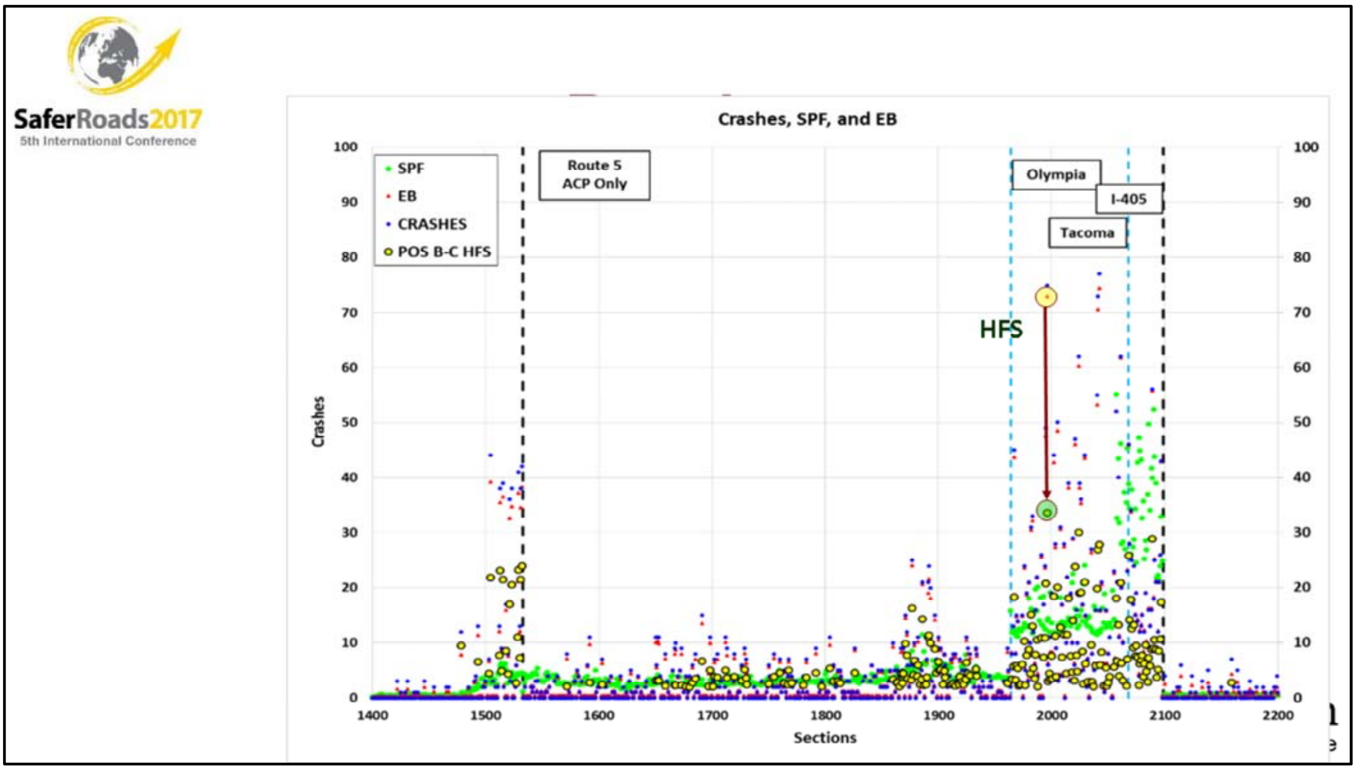
After the costs and the benefits of improving a section is compute, the B/C will determine whether this treatment should be considered for the next construction season.



This method allows to make network-level assessments that will permit focusing on the places where the impact of the improvements will have the largest effect.

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Results

- **Potential benefits for the asphalt network:**

Treatment Options	Potential Crash Reduction		Crash Savings ($1,000)	Treated Segments		Treatment Costs ($1,000)	Total Savings ($1,000)
	Count	% of Total		Count	% of Total		
HMA-OL	798	8%	$87,223	227	7%	$9,428	$77,795
HFS	1,073	11%	$117,294	148	5%	$17,506	$99,788

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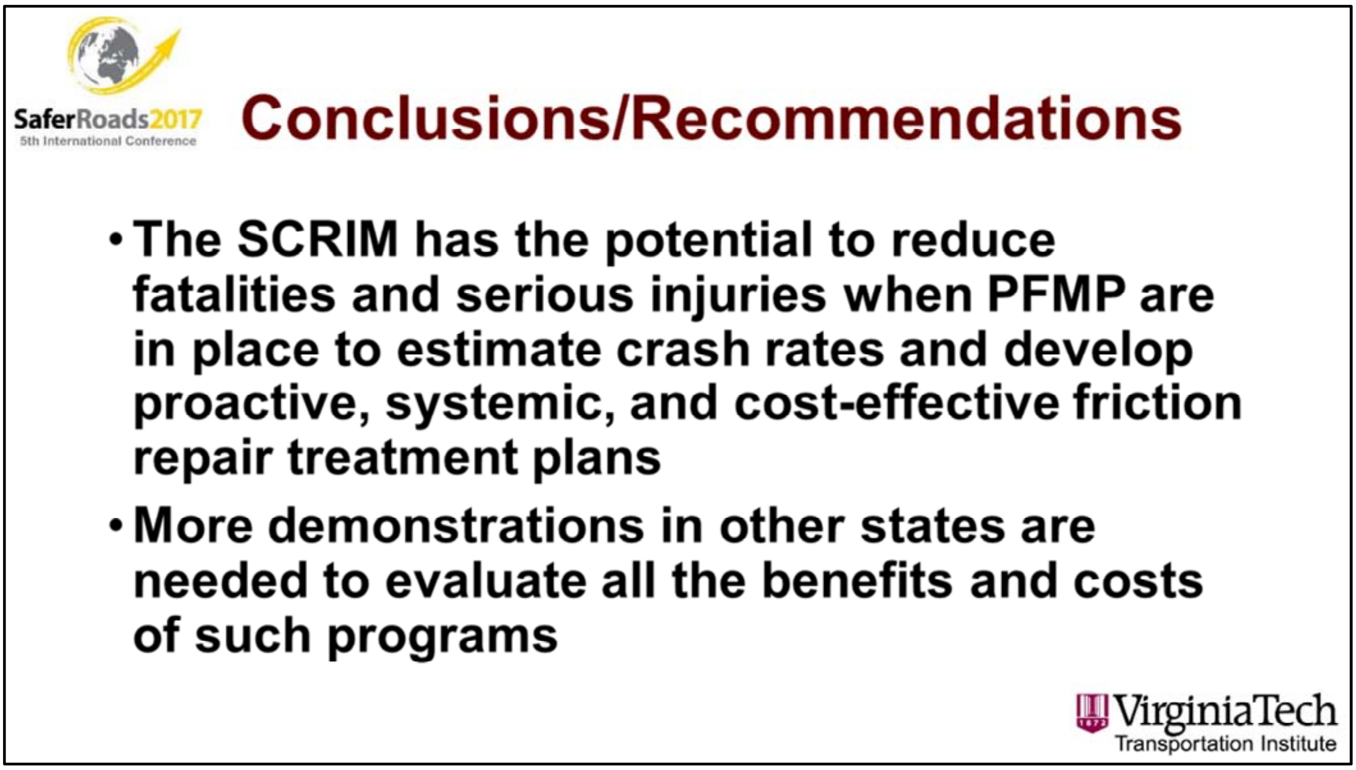
Example of potential benefits and costs for two different treatments.



Being the first time that this methods have been used with such a device to obtain all the data to characterize all the sections measured, a lot more is still being tweaked to get the best results. Hopefully time will confirm the early findings and prove the value of the process.

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Acknowledgements

- Katherine Petros, Jim Sherwood, and Andy Mergenmeier FHWA
- Team Members: Gerardo Flintsch, Samer Katicha, Ross McCarthy
- Kevin McGhee (VTRC), Kelly Smith (AP Tech), James Wambold (CDRM Inc.)

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Acknowledgements to all those in the project.

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email: edeleonizeppi@vtti.vt.edu

"If we stand still, we go backwards…"
Leslie A.J. Gardiner

My information.

Some pictures from the TRL trials in the Midlands where the SCRIM-99 participated in the UK.


Questions?
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S12 WDM