Evaluating Pavement Texture Uniformity in Connecticut

September 17, 2014

Pavement Evaluation Conference

Blacksburg, Virginia

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ConnDOT - Engineering Services

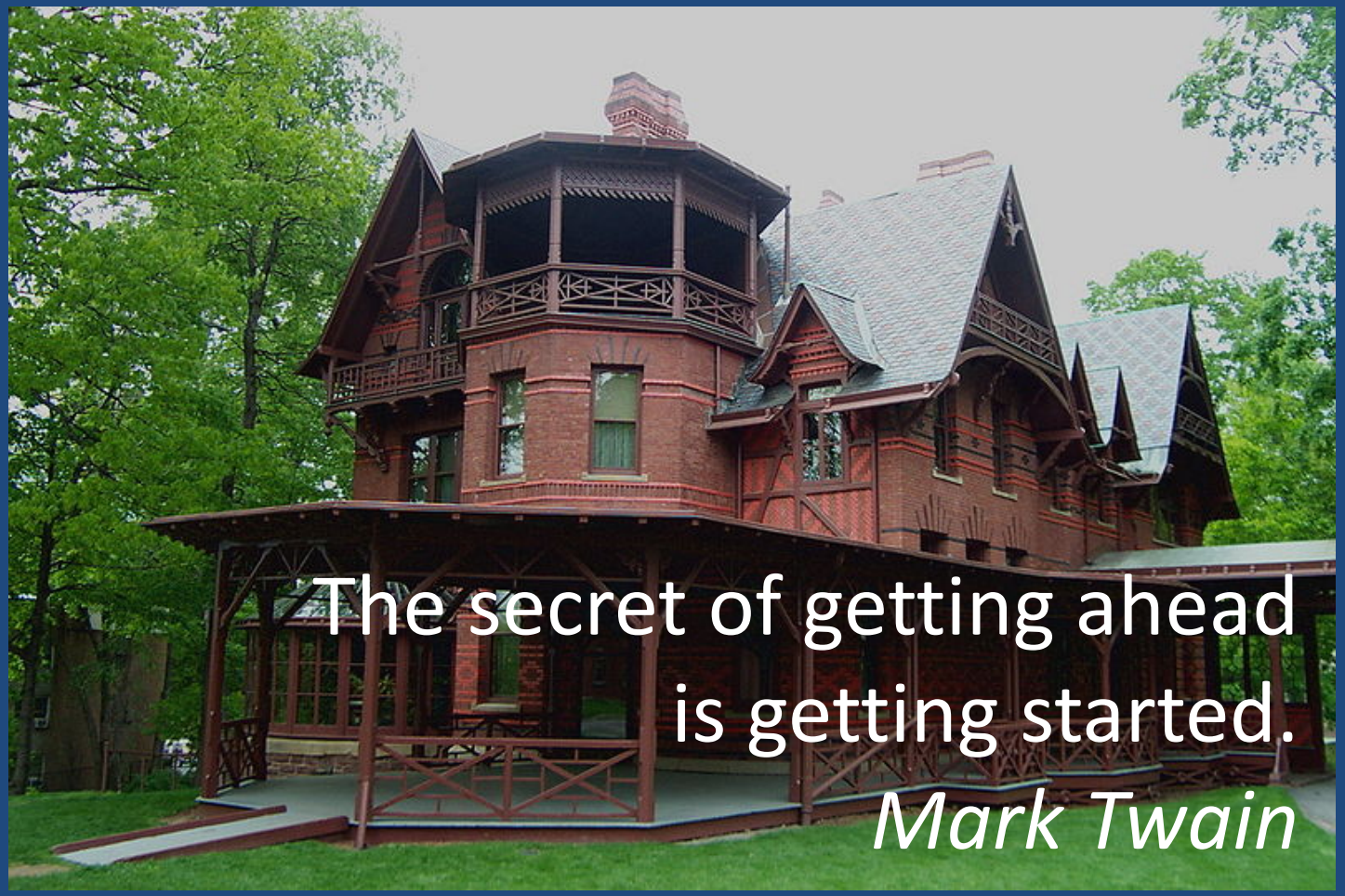
Outline of Today's Presentation

- To brag about UConn's 2014 NCAA Men's Basketball National Championship.
- To brag about the UConn's 2014 NCAA Woman's Basketball National Championship.

Outline of Today's Presentation

- Update on ConnDOT's Pavement Surface Properties Program.
- ConnDOT's Ultra-thin Bonded HMA.
- A true success story about a surface treatment.
- Evaluating Pavement Texture Uniformity in Connecticut (my "Feature Presentation").

Interesting Quote from One of Connecticut's Own



May 1968 Bureau of Public Roads Skid Tester Demonstration

In 1970, ConnDOT's first pavement friction tester was this "one-of-a-kind" unit from TestLab Corp. of Chicago

ConnDOT's Program: Equipment

ASTM E 274 Dynatest Locked-Wheel Pavement Friction Tester

ConnDOT's Program: Equipment - Standard Testing Tires

ASTM E 501
Standard Rib Tire –
Relates to Pavement Micro-texture
($\lambda < 0.02$ inches)

ASTM E 524
Standard Smooth Tire –
Relates to Pavement Macro-texture
($0.02 < \lambda < 2$ inches)

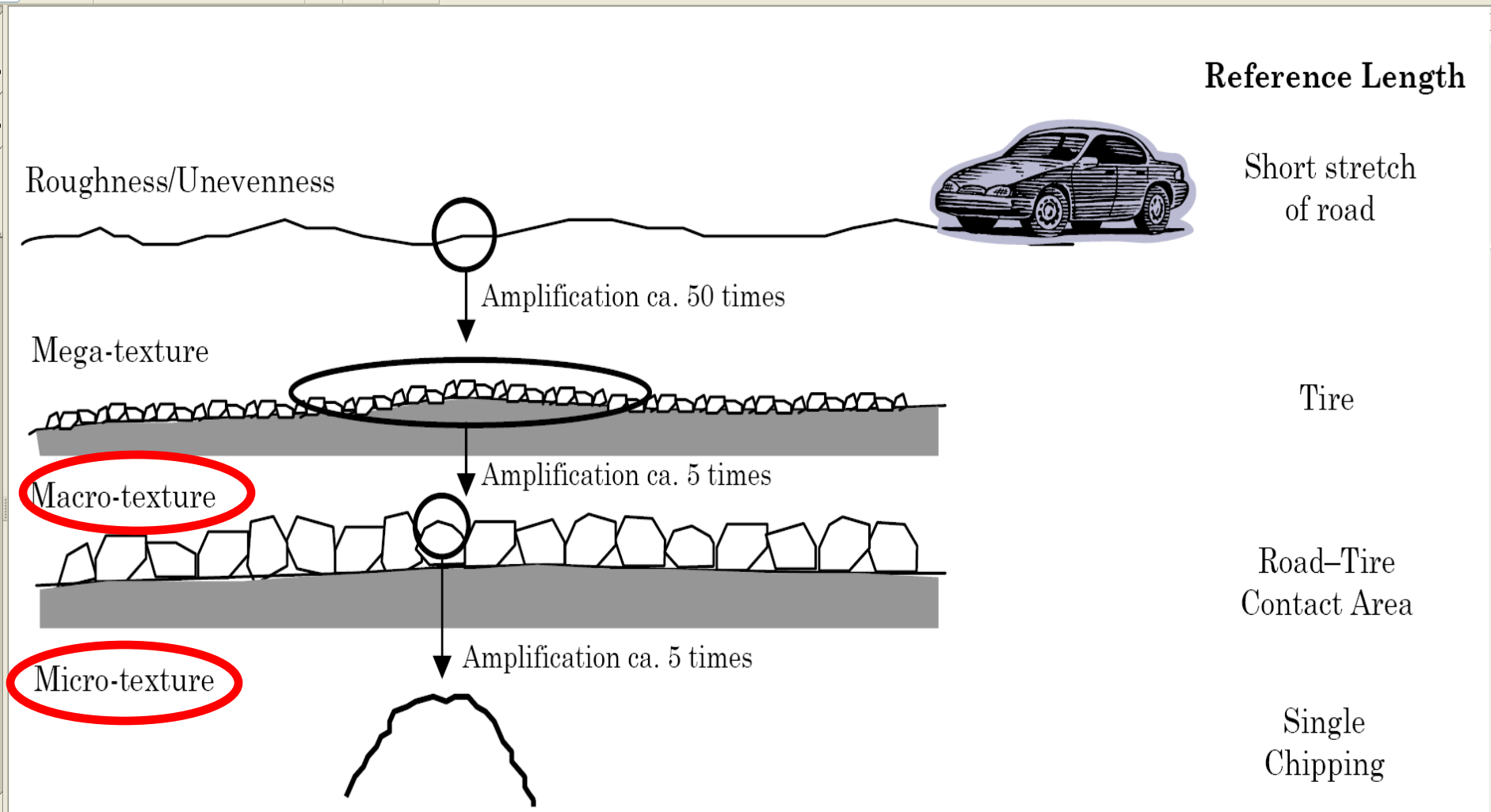
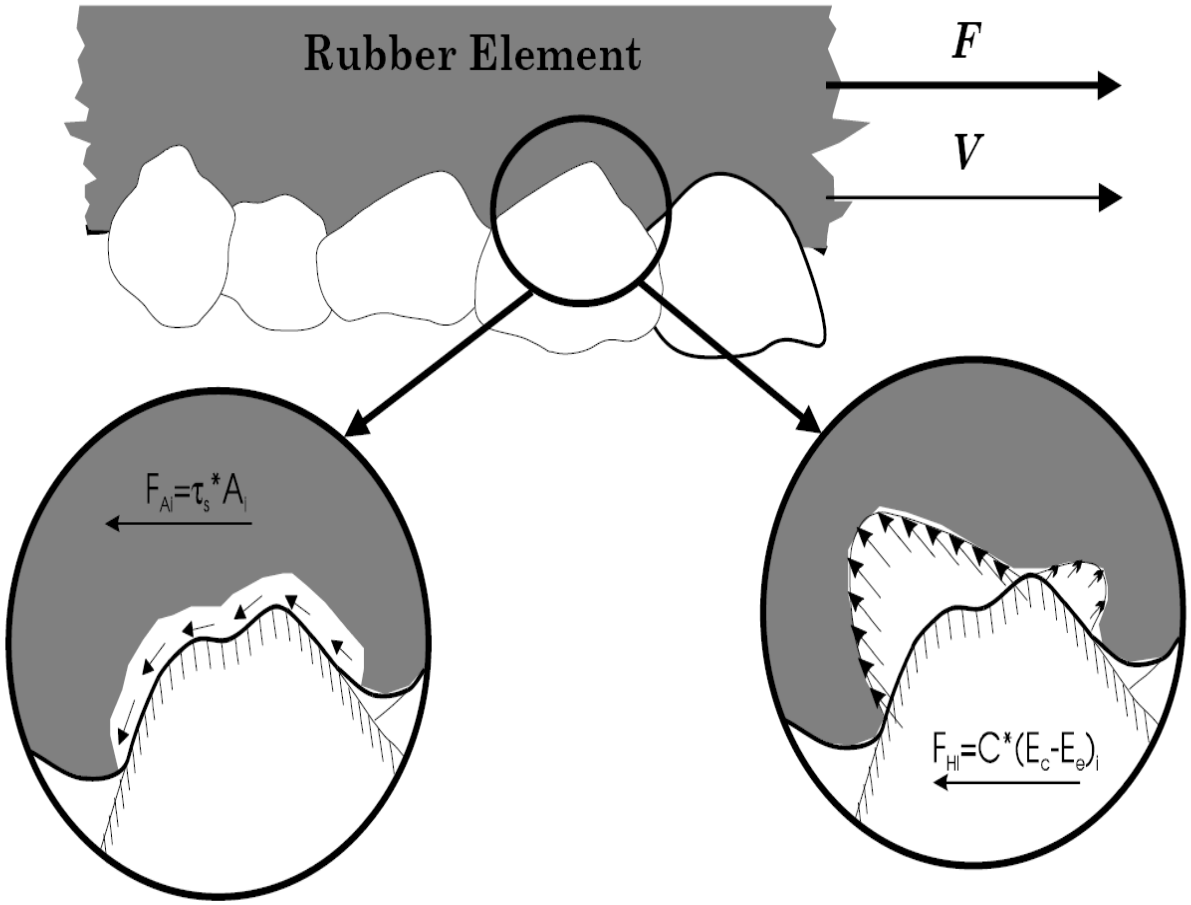


Figure 9. Simplified illustration of the various texture ranges that exist for a given pavement surface (Sandburg, 1998).



Adhesion

Depends mostly on micro-level surface roughness

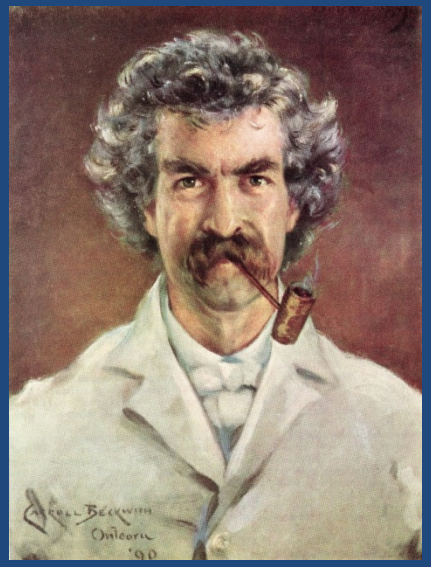
Hysteresis

Depends mostly on macro-level surface roughness

ConnDOT's Program: Equipment

2006

ASTM 2157 Circular Track Meter (CTMeter)

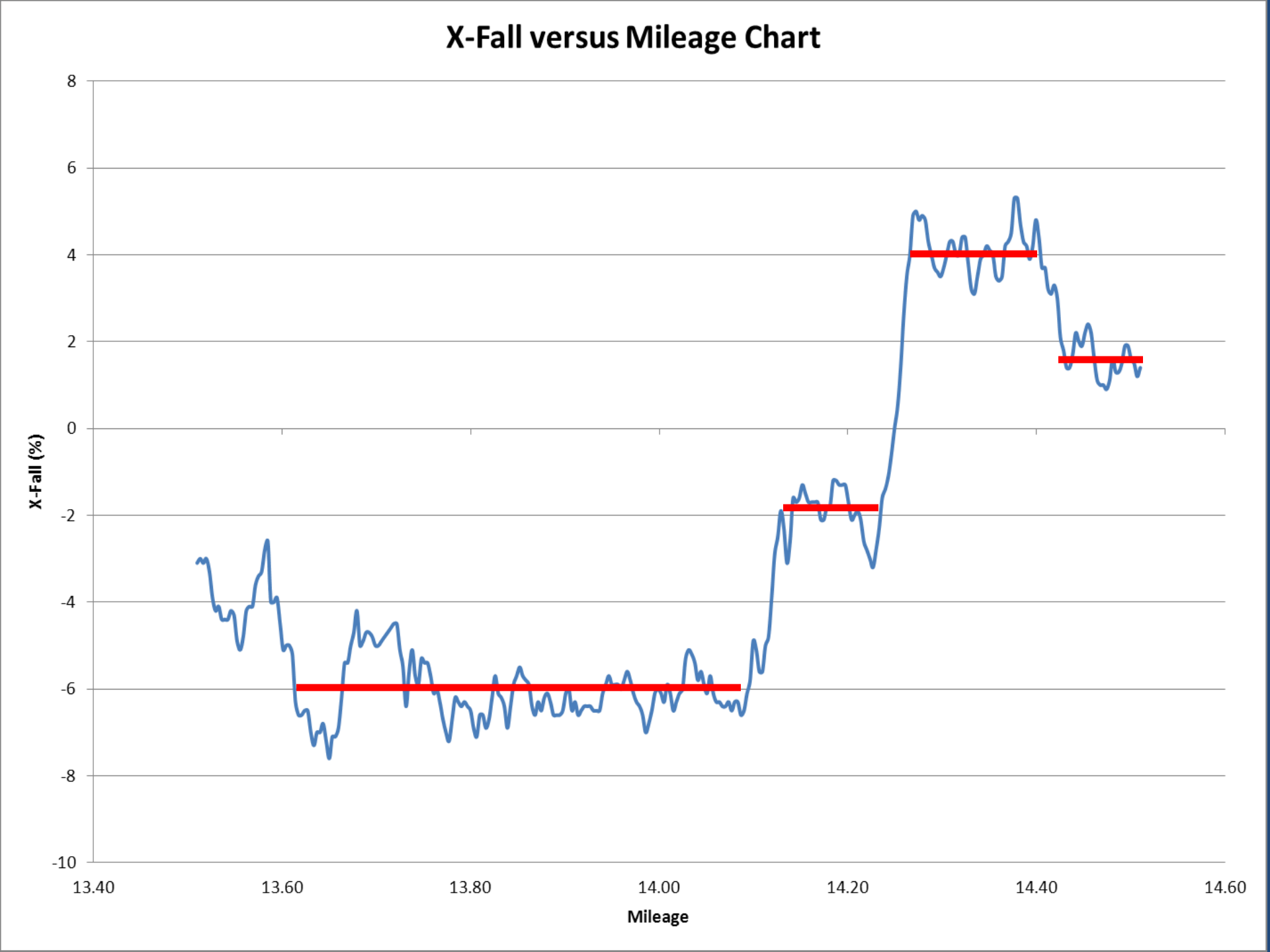


To succeed in life,
you need two things:
ignorance and confidence.

Mark Twain
of Hartford, CT

Reviews by Engineering Services

- Skid Data (Smooth and Ribbed Tires)
- Traffic Data (ADT, 85% Speeds)
- Collision Data (Wet Surface Conditions)
- Pavement Data (IRI, pavement condition, PCI)
- Geometric Data
  - Horizontal Curvature (using MicroStation and aerial images)
  - Grade
  - Cross Slope (including superelevated sections)


X-Fall versus Mileage Chart
8
6
4
2
0
-2
-4
-6
-8
-10
X-Fall (%)
13.40
13.60
13.80
14.00
14.20
14.40
14.60
Mileage

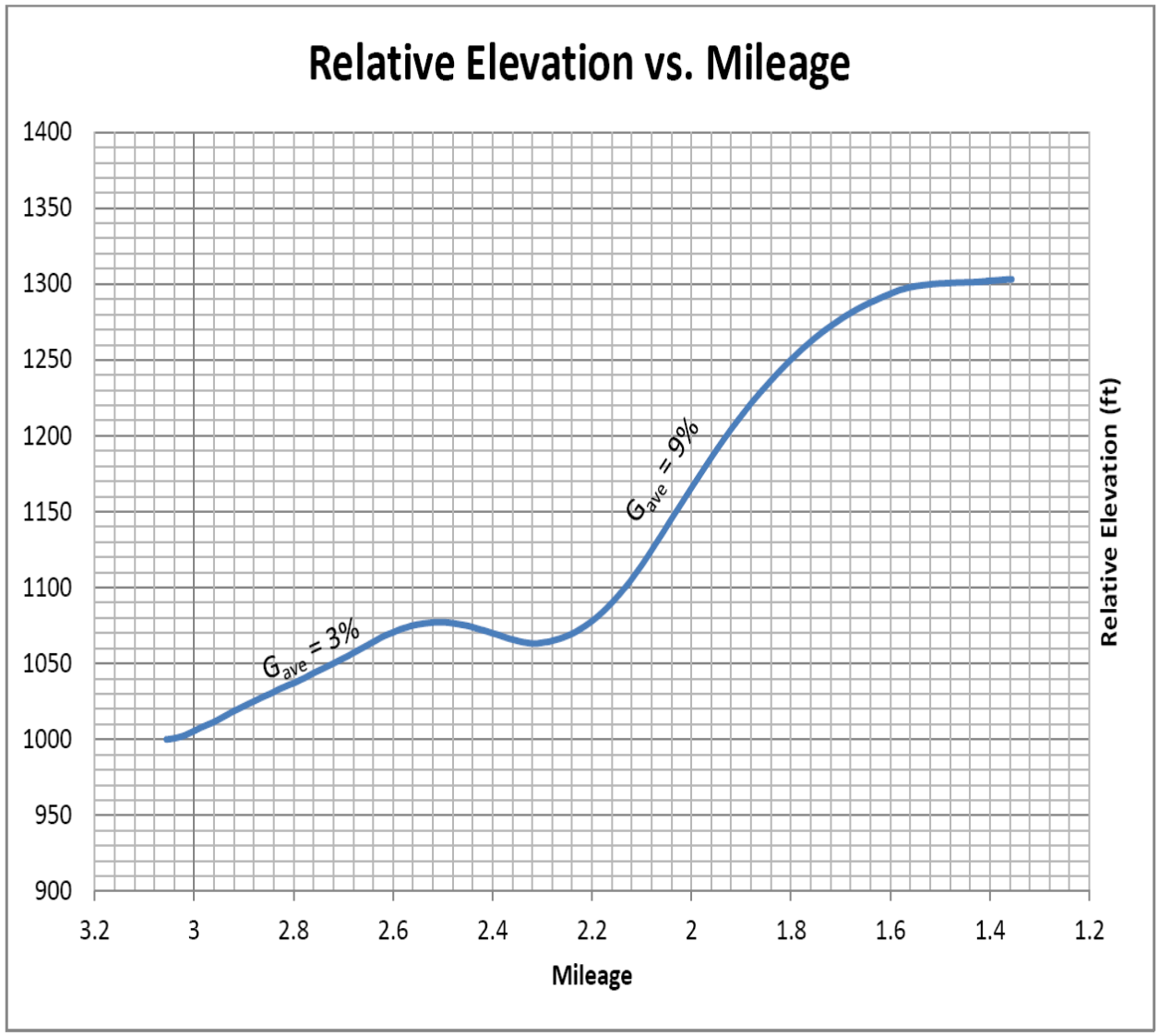


FIGURE 1 Profile from DigitHiway datastream for Route 262 Southbound (shown in reverse log direction).

001	L	115.40	- 116.57	2	Stonington	Stonington	0.08 mi. n/o OP Anguilla Bk	0.21 mi. s/o Rte 234	1.17	U		Comp	2009	8.5	8.5	8.5	193	6.6
001	L	116.57	- 117.37	2	Stonington	Stonington	0.21 mi. s/o Rte 234	R.I. SL	0.80	U		Comp	2010	8.5	25.6	16.8	151	7.3
001A	L	0.00	- 1.93	2	Stonington	Stonington	US 1	US 1	1.93	U		Flex	2002	2.2	4.4	2.9	153	5.3
002	L	0.00	- 0.44	1	Hartford	East Hartford	Columbus Blvd	0.02 mi. w/o EB Exit To Pitkin St	0.44	D		Comp	1998	27.7	30.5	27.7	191	3.8
002	L	0.44	- 1.19	1	East Hartford	East Hartford	0.02 mi. w/o EB Exit To Pitkin St	0.08 mi. w/o EB Acc Fr SR 502	0.75	D		Comp	2013	9.4	71.6	71.6	191	9.0

Pavement Condition Report

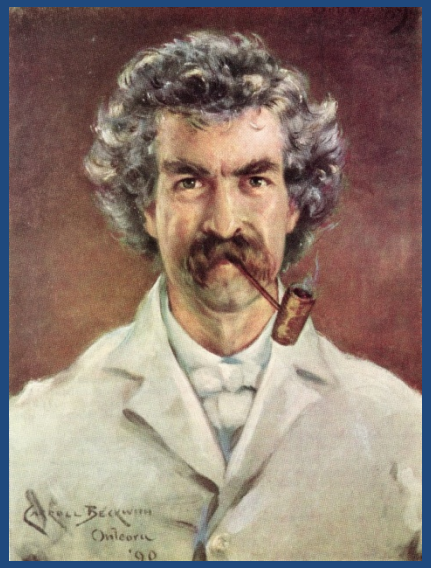
Road		From	- To	Dist	Begin Town	End Town	Begins at	Ends at	Length	Div	Ovlp	P.Typ	Year	ADT (x1000) Min	- Max	- Typ	IRI	PCI
002	R	35.21	- 35.85	2	Norwich	Norwich	0.03 mi. w/o WB Acc Fr Rte 32	Bgn OP SR 642	0.64	D		Flex	2009	24.0	28.5	24.0	72	6.8
002	R	35.85	- 38.15	2	Norwich	Norwich	Bgn OP SR 642	Rte 169	2.30	D		Flex	2001	16.2	40.3	22.4	79	5.8
002A	L	0.00	- 3.33	2	Norwich	Montville	Rte 2 EB & Rte 32 SB	Norwich - Montville TL	3.33	D	Y							
002A	L	3.33	- 3.93	2	Montville	Montville	Norwich - Montville TL	0.60 mi. e/o Norwich - Montville TL	0.60	D	Y							
002A	L	3.93	- 4.67	2	Montville	Montville	0.60 mi. e/o Norwich - Montville TL	0.26 mi. e/o End OP I-395	0.74	D		Flex	2013	11.3	37.3	11.3	91	9.0
002A	L	4.67	- 6.23	2	Montville	Montville	0.26 mi. e/o End OP I-395	0.26 mi. e/o End OP SSR 433	1.56	D		Flex	2009	20.1	37.3	25.7	91	7.3
002A	L	6.23	- 7.05	2	Montville	Preston	0.26 mi. e/o End OP SSR 433	Bgn Ovlp Rte 12	0.82	U		Flex	1996	20.1	23.7	23.7	155	4.9
002A	L	7.05	- 7.35	2	Preston	Preston	Bgn Ovlp Rte 12	E Jct Rte 12	0.30	U	Y							
002A	L	7.35	- 9.11	2	Preston	Preston	E Jct Rte 12	Bgn Ovlp Rte 117	1.76	U		Flex	2007	8.2	13.1	13.1	116	6.9
002A	L	9.11	- 9.91	2	Preston	Preston	Bgn Ovlp Rte 117	Rte 2	0.80	U	Y							
002A	R	4.65	- 6.50	2	Montville	Montville	WB Exit To I-395 NB	Bgn OP RR & Thames Rv	1.85	D		Flex	2000	20.1	37.3	25.7	113	5.2
003	L	0.00	- 0.76	1	Middletown	Middletown	Rte 66	0.44 mi. n/o End OP Coginchaug Rv	0.76	U		Flex	2000	13.8	17.4	17.4	147	4.8
003	L	0.76	- 2.48	1	Middletown	Middletown	0.44 mi. n/o End OP Coginchaug Rv	0.48 mi. s/o Middletown - Cromwell TL	1.72	U		Flex	2000	15.3	16.3	15.3	173	4.7
003	L	2.48	- 3.04	1	Cromwell	Cromwell	0.48 mi. s/o Middletown - Cromwell TL	0.08 mi. n/o Middletown - Cromwell TL	0.56	U		Comp	2001	16.3	16.3	16.3	163	4.6
003	L	3.04	- 4.39	1	Cromwell	Cromwell	0.08 mi. n/o Middletown - Cromwell TL	0.74 mi. n/o Bgn OP Rte 9	1.35	U		Flex	1996	9.5	18.7	9.5	179	4.2
003	L	4.39	- 6.09	1	Cromwell	Rocky Hill	0.74 mi. n/o Bgn OP Rte 9	Bgn OP I-91	1.70	U		Flex	2001	8.6	15.8	10.9	142	4.6
003	L	6.09	- 7.41	1	Rocky Hill	Rocky Hill	Bgn OP I-91	0.01 mi. n/o N Jct Rte 160	1.32	U		Flex	1990	8.5	22.0	18.2	190	3.3
003	L	7.41	- 10.37	1	Rocky Hill	Wethersfield	0.01 mi. n/o N Jct Rte 160	Rte 99	2.96	U		Flex	2012	8.5	12.1	8.6	102	7.9
003	L	10.37	- 10.98	1	Wethersfield	Wethersfield	Rte 99	0.01 mi. s/o Elm St	0.61	U		Flex	2002	17.1	20.8	20.8	184	5.2

Descriptive Statistics for Ribbed-Tire Skid Tests Performed at 40 mph (SN_{40R}) on September 8, 2014 on Route 3 NB

2005 Pavement Surface (13.51 to 14.14 Miles)	N	Valid	18
		Missing	0
	Mean		48.0
	Std. Deviation		3.3
	Minimum		40.5
	Maximum		53.1
	Percentiles	25	45.5
		50	48.3
		75	50.8
2009 Pavement Surface (14.14 to 14.48 Miles)	N	Valid	6
		Missing	0
	Mean		52.9
	Std. Deviation		2.9
	Minimum		48.6
	Maximum		56.7
	Percentiles	25	50.6
		50	53.1
		75	55.4

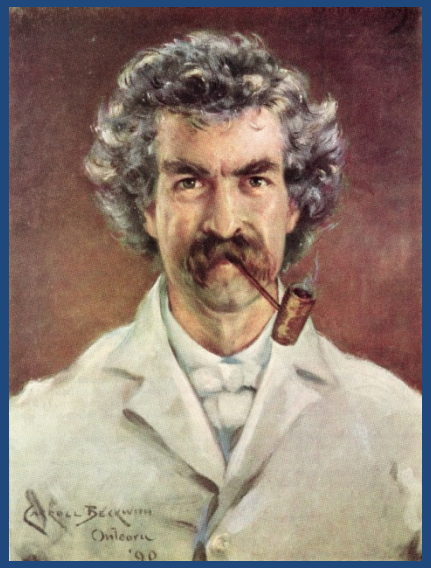
Descriptive Statistics for Smooth-Tire Skid Tests Performed at 40 mph (SN_{40S}) on September 8, 2014 on Route 3 NB

2005 Pavement Surface (13.51 to 14.14 Miles)	N	Valid	18
		Missing	0
	Mean		43.5
	Std. Deviation		3.2
	Minimum		36.6
	Maximum		49.2
	Percentiles	25	40.5
		50	44.3
		75	46.1
2009 Pavement Surface (14.14 to 14.48 Miles)	N	Valid	6
		Missing	0
	Mean		34.2
	Std. Deviation		2.9
	Minimum		29.8
	Maximum		38.0
	Percentiles	25	31.8
		50	34.2
		75	36.9



Get the facts first,
then you can distort them
as you please.

Mark Twain
of Hartford, CT



There are three kinds of lies: Lies, damned lies, and statistics

Mark Twain of Hartford, CT

Ultra-Thin Bonded HMA

Consists of

- Warm polymer-modified asphalt emulsion tack coat.
- Followed immediately by an ultra-thin (5/8”) lift of HMA.

Coarse Aggregate Properties

Property	Method	Requirement
LA Abrasion Coefficient, maximum % Loss	AASHTO T 96	25
Maximum percent passing 0.075mm sieve, %	AASHTO T 11, T 27	2
Soundness, maximum % loss	AASHTO T 104	10

Coarse Aggregate Gradation

Screen Size	Type B (% Passing)
¾ inch	100
½ inch	100
3/8 inch	85-100
¼ inch	0-15
#4	0-3
#8	0

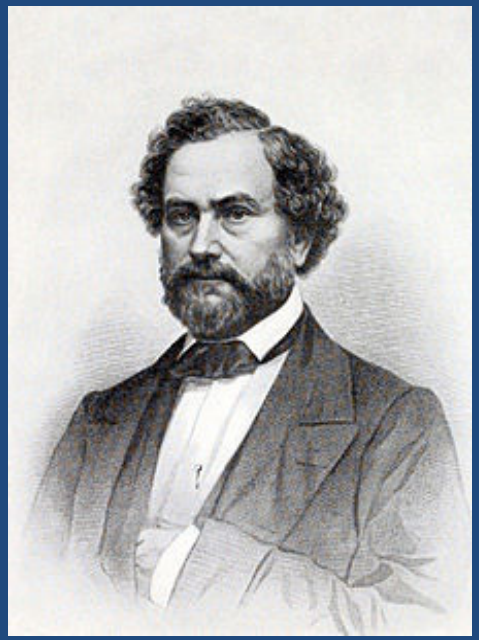
A Connecticut Success Story…

I-91 SB Colt Curve in Hartford

- Pavement overlaid in 2006 in response to wet-weather collisions
- By November 2009 State Police noted an increase in wet-weather collisions again
- December 1, 2009 Before Treatment
  - SN_{40R} ranged from 35 to 45
- May 25, 2010 After Treatment
  - SN_{40R} ranged from 53 to 57

Interesting Fact

The Colt Armory was opened in 1867 and replaced the 1855 East Armory that was almost completely destroyed by a fire in 1864



Samuel Colt

The Blue Onion

Colt Curve – Beginning of Treatment

Colt Curve

Colt Curve

Colt Curve

Colt Curve


GOVERNOR'S FOOT GUARD
MEMORIAL HIGHWAY
MIX AND MATCH
COOLATTA FLAVORS
DUNKIN' DONUTS

Colt Curve – End of Treatment

Crashes 3 Years Before Treatment

Table 6 - Road Surface Condition

Road Surface Condition	2007	2008	2009	2010	Total	%
Dry	10	12	9	4	35	29.17
Wet	4	24	51	3	82	68.33
Snow/Slush	0	0	2	0	2	1.67
Other	0	0	0	1	1	0.83
TOTAL	14	36	62	8	120	100.00%

Crashes 3 Years After Treatment

Table 6 - Road Surface Condition

Road Surface Condition	2010	2011	2012	2013	Total	%
Dry	11	15	8	3	37	71.15
Wet	3	7	3	0	13	25.00
Snow/Slush	0	0	1	1	2	3.85
TOTAL	14	22	12	4	52	100.00%

I-91 SB Colt Curve
3-Year Before/After Treatment

Before Treatment:

- 120 total collisions
- 82 wet road surface condition collisions
- 68% occurred on wet pavement

After Treatment:

- 52 total collisions
- 13 wet road surface condition collisions
- 25% occurred on wet pavement

I-91 SB Colt Curve
3-Year Before/After Treatment

100%*(82-13)/82 = 84%

84% Reduction in Wet Pavement Surface Condition Accidents for the 3-Year Period After the Treatment vs.
the 3-Year Period Before Treatment

Memorial to Samuel Colt

Church of the Good Shepherd

Crossed Colt Pistols and Revolver Parts Carved into Sandstone

Evaluating Pavement Texture Uniformity in Connecticut

Evaluating Pavement Texture Uniformity in Connecticut

- Ultra-thin Bonded HMA used on a project on CT Route 4.
- Several isolated areas of bleeding (fat spots) were identified on mat following construction.
- A dispute between the contractor and ConnDOT regarding texture uniformity arose.

Texture Uniformity

Evaluating Pavement Texture Uniformity in Connecticut

- Language in Special Provisions to replace areas observed to deviate in texture occurring in 1.5% (or greater) of the surface.
- So, for a 100 ft lane width (12 ft) we have,

  (100 ft) * (12 ft) = 1200 SF
- Therefore, 1.5% of this would be,

  (0.015)*(1200 SF) = 18 SF

Evaluating Pavement Texture Uniformity in Connecticut

The objective:

- Measure macrotexture, expressed as Mean Profile Depth (MPD), in areas with suspect uniformity.
- Compare to an MPD considered characteristic of the surface.

Evaluating Pavement Texture Uniformity in Connecticut

30 random baseline characteristic measurements

Sample	Area	Direction	Longitudinal Position (ft)	Latitudinal Position (ft)	MPD (mm)
1	Area 1	EB	17.2	6.2	1.19
2	Area 1	EB	47.4	6.6	1.35
3	Area 1	EB	73.5	3.3	1.62
4	Area 1	EB	78.6	8.0	1.55
5	Area 1	EB	93.8	0.7	1.57
6	Area 1	EB	95.2	2.2	1.47
7	Area 1	EB	102.1	9.4	2.15
8	Area 1	EB	114.2	11.8	1.94
9	Area 1	EB	143.4	7.6	1.28
10	Area 1	EB	143.8	2.0	1.70
11	Area 1	EB	145.8	9.2	1.28
12	Area 1	EB	182.4	4.6	1.32
13	Area 1	EB	186.7	11.8	1.31
14	Area 1	EB	210.5	9.9	1.28
15	Area 1	EB	223.1	8.3	1.48
16	Area 1	EB	233.1	11.8	1.24
17	Area 1	EB	271.1	5.7	1.16
18	Area 2	WB	275.3	3.2	1.57
19	Area 2	WB	289.5	10.2	1.20
20	Area 2	WB	297.4	9.3	1.19
21	Area 2	WB	322.5	9.8	1.22
22	Area 2	WB	346.9	11.4	1.03
23	Area 2	WB	396.3	8.7	1.41
24	Area 2	WB	441.2	6.1	1.34
25	Area 2	WB	488.3	1.9	1.27
26	Area 2	WB	499.4	8.4	1.21
27	Area 2	WB	512.1	1.0	1.36
28	Area 2	WB	535.0	8.4	1.51
29	Area 2	WB	573.1	6.2	1.12
30	Area 2	WB	578.6	1.3	1.21

Boundary Values for Measuring Suspect-Texture Areas

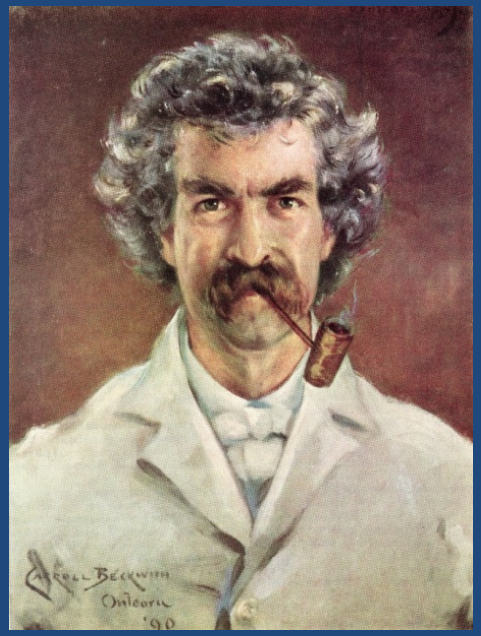
Entire job, original only				
		MPD	Avg	1.384
			Std dev	0.242
	Lower bound	Upper bound		
+/- sd				
1	1.142	1.626		
2	0.900	1.868		

Lot	Location	Avg MPD (8 measurements)	Result
1	Rte 4 EB, 10’ past bus shelter, Left Wheelpath	1.253 (a)	“uniform”
2	Rte 4 EB, 10’ past bus shelter, Rt Wheelpath	0.96	“uniform”
3	Rte 4 WB, 40’ past bus shelter, Left WP (Sta 11+00)	0.76	“non-uniform”
4	Rte 4 WB, between stopbar and crosswalk, Right WP (Sta 11+00)	0.43	“non-uniform”
5	Rte 4 EB, Sta 15+00, Left WP	0.92	“uniform”
6	Rte 4 EB, Sta 17+00, Right WP	0.70	“non-uniform”
7	Rte 4 EB, Sta 23+20 to 24+00, Right WP	0.78	“non-uniform”
8	Rte 4 EB, House #1451 E+W, Approx Sta 29+50, Right WP	0.87	“non-uniform”
9	Rte 4 EB, Approx 10’ past Woewassa Intersection, Left WP	0.81	“non-uniform”
10	Rte 4 EB at SNET Pole #507, at Valero Gas Station	0.83	N/A *
11	Rte 4 EB at SNET Pole #507, at Valero Gas Station	0.84	“non-uniform”
12	Rte 4 WB, House # 1450	1.02	“uniform”
13	Rte 4 WB, Sta 14+25	1.18	“uniform”
Totals			Lots measured: 13 “Uniform”: 5 “Non-uniform”: 7 N/A: 1

Results/Recommendations

- 7 areas with MPD's less than 0.900mm.
- Confirmed visual observations of the team of engineers that these areas had lower texture.
- Subsequently, the contractor removed and replaced, at their expense, the Ultra-thin Bonded HMA for 0.63 miles of Route 4.
- Recommend using this procedure in future specs to reduce disputes.

It is better to keep your mouth closed and let people think you are a fool than to open it and remove all doubt.



Mark Twain
of Hartford, CT

Thank You