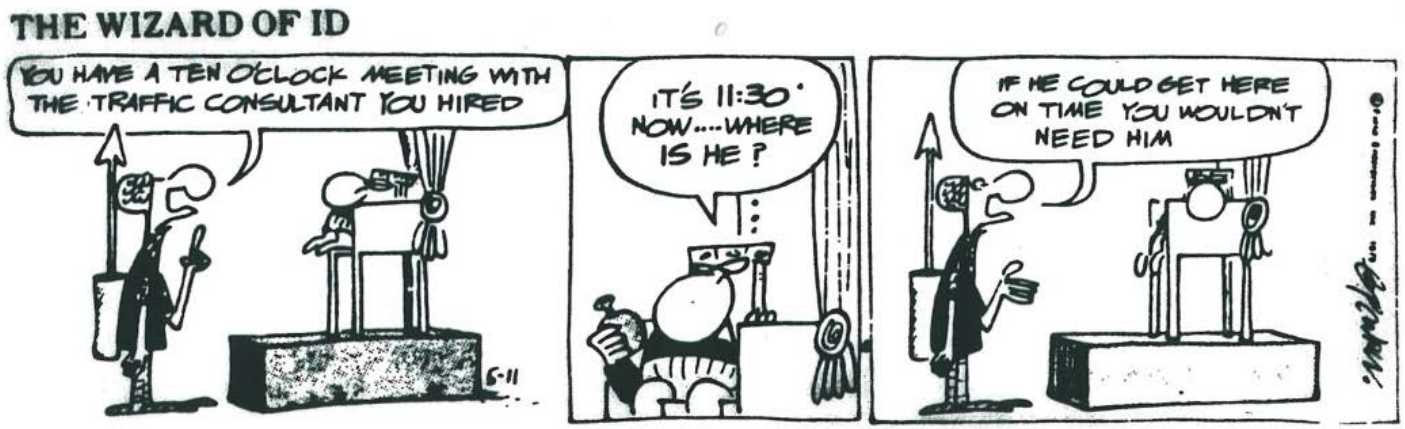
Local Road Safety Peer Exchange

Minnesota Sinusoidal Rumble Strips and Other Traffic Safety Considerations

Victor Lund, PE, Traffic Engineer
St. Louis County, Minnesota
October 11, 2018

Overview

- Prioritization of Safety Strategies
- Development of the Minnesota Sinusoidal Rumble Strip
- Implementation and Public Relations Considerations



Prioritization of Safety Strategies

- Where do you invest safety projects?
- The reality…
  - Most serious crashes occur on the rural highway system.
  - However, serious crashes are infrequent and widely dispersed.
- Think about this…
  - In greater Minnesota, 50 percent of severe road departure crashes occur on curves but 75 percent of curves have had no crashes in a previous 5-year period.
  - There is no such thing as “Dead Man’s Curve”
- How do you prioritize locations with a low density of serious crashes?

Crash Density by Jurisdictional Class

Roadway Jurisdiction	Miles	Total Crashes*	Fatal Crashes*	Total Crash Density**	Fatal Crash Density**
Interstate	916	11,491	25	12.5	0.027
Trunk Highway	10,930	18,747	158	1.7	0.014
CSAH/County Roads	44,958	19,054	141	0.4	0.003
City Streets	22,373	23,682	29	1.1	0.001
Township & Other	63,799	1,798	22	0.03	<0.001

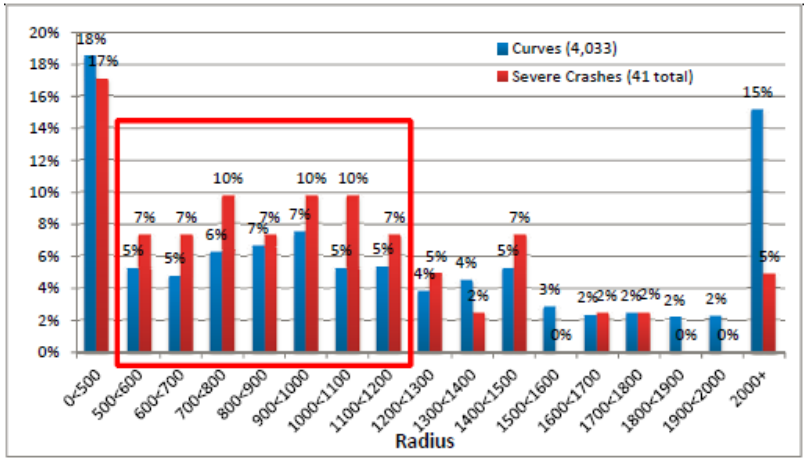
**2015 Crash Data*

***crashes/mile/year*

Data Source: 2015 Minnesota Motor Vehicle Crash Facts

What is the Systemic Approach?

- What it is not…
  - Road safety audits
  - Worst first
  - Specific site safety improvement (e.g. turn lane) based upon an engineering study
- What it is…
  - Result of a planning process
  - Safety improvements based upon risk factors
  - Proactive deployment of low cost safety strategies over entire at-risk system



Source: SLC CRSP

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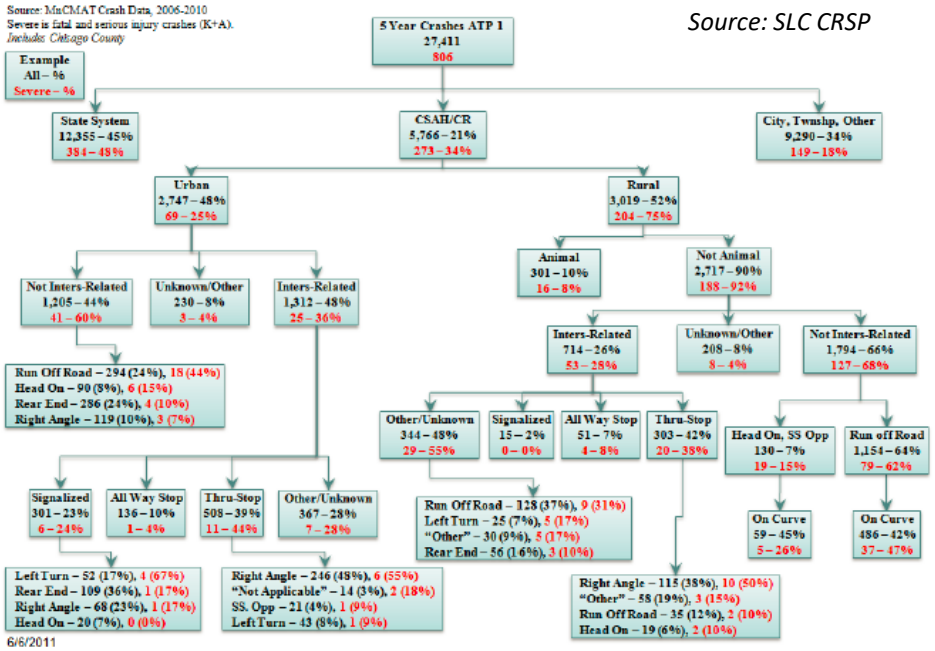
What is the Systemic Approach?

- Approach
  - Traditional: Crashes = Risk, No Crashes = No Risk
  - Systemic: No Crashes ≠ No Risk
- Recognized that ~50% of serious crashes occur on the local road system (county roads)
- Focus
  - Segments
  - Intersections
  - Curves



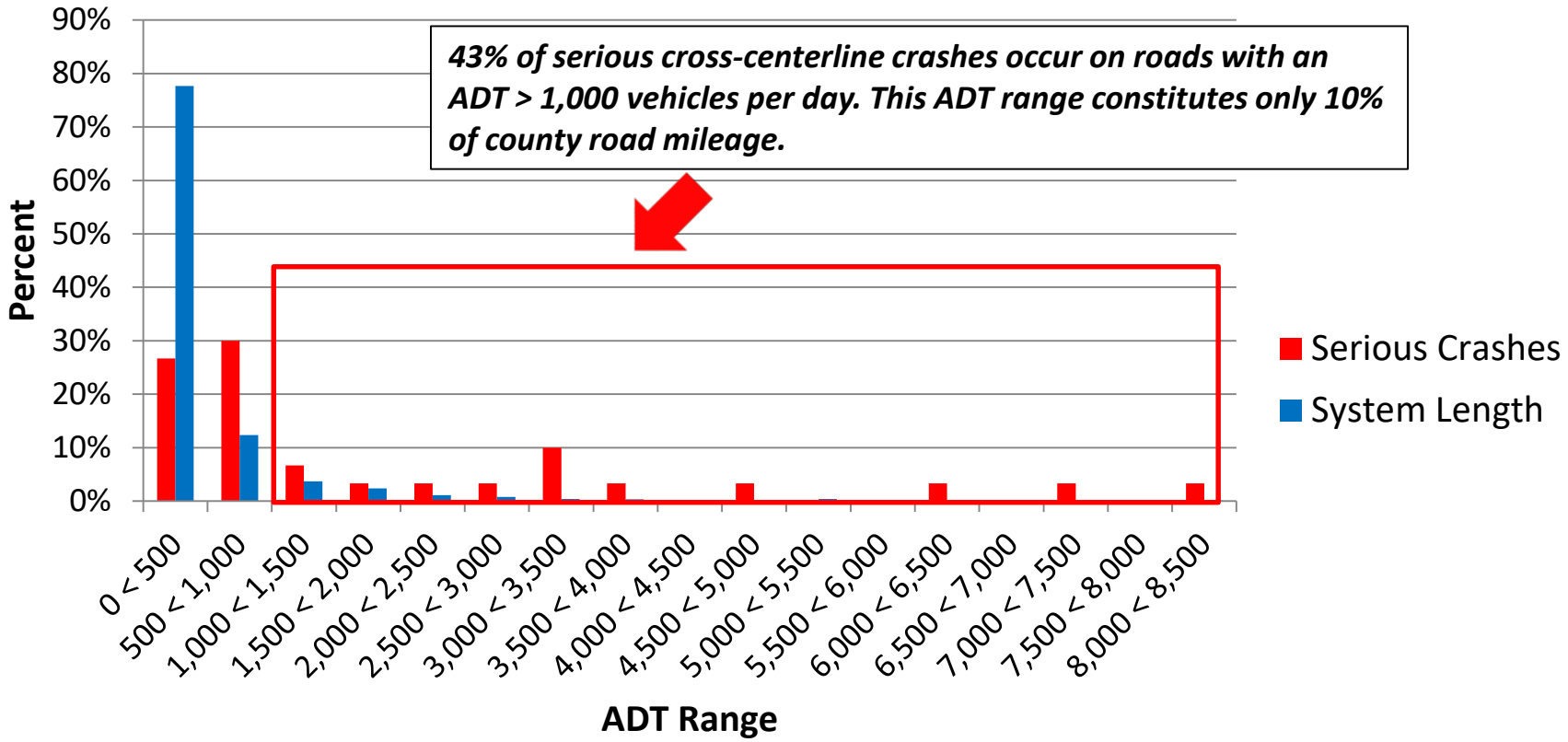
Source: SLC CRSP

Doctors have been doing this for a long time…

- Think about how doctors provide care to their patients…
- Inquire about your
  - Family health history
  - Personal health history
  - Diet/behavior
- Use this information to assess your risk to develop certain diseases
- Proactively work to treat these risk factors before major issues develop later in life

Prioritization of County Road Segments

2005 through 2014 District One Rural Paved County Roads
Serious Cross-Centerline Crashes* (n = 30)



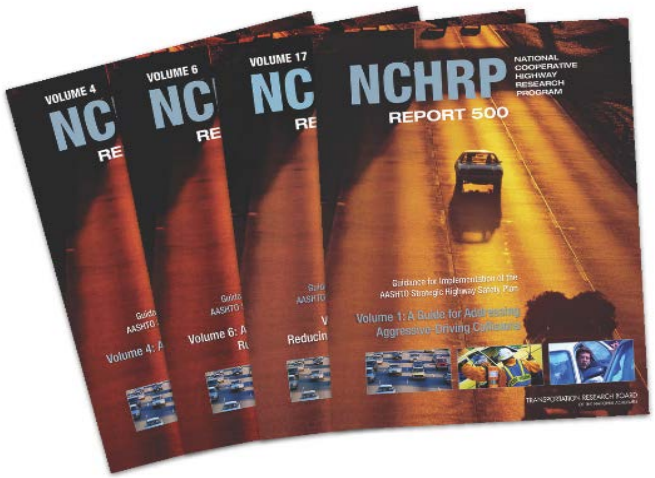
*Serious crashes defined as a fatal or incapacitating injury crash.

Rank	Int #	Sys	#	Intersection Description	Skew	On/Near Curve	Development	RR Xing	Previous STOP (>5mi)	Total Crashes	Ratio (Min/Maj)	Priority	Crash Cost
1	21.14	CSAH	21	CSAH 21 AND MNTH-135	★	★	★		★	★	★	★★★★★★	$1,235,000
2	77.01	CSAH	77	CSAH 77 AND MNTH-169	★	★	★		★	★	★	★★★★★★	$ 539,000
3	52.10	CSAH	52	CSAH 52 AND USTH-53	★	★	★		★	★		★★★★★	$2,959,000
4	23.11	CSAH	23	CSAH 23 AND CSAH-24	★	★			★	★	★	★★★★★	$ 412,000
5	7.09	CSAH	7	CSAH 7 AND CSAH-47 (West)	★	★		★		★	★	★★★★★	$ 227,000
6	25.15	CSAH	25	CSAH 25 AND CSAH-125	★	★			★	★	★	★★★★★	$ 136,000
7	99.05	CSAH	99	CSAH 99 AND CSAH-100	★	★			★	★	★	★★★★★	$ 12,000
8	7.01	CSAH	7	CSAH 7 AND USTH-53 SB	★	★	★			★		★★★★	$1,156,000
9	47.08	CSAH	47	CSAH 47 AND USTH-53	★	★	★			★		★★★★	$ 927,000
10	26.04	CSAH	26	CSAH 26 AND MNTH-135	★	★			★	★		★★★★	$ 590,000
11	26.01	CSAH	26	CSAH 26 AND MNTH-169	★	★	★			★		★★★★	$ 527,000
12	16.20	CSAH	16	CSAH 16 AND USTH-53 (North Intersection)	★		★		★	★		★★★★	$ 445,000
13	22.14	CSAH	22	CSAH 22 AND USTH-53	★		★		★	★		★★★★	$ 436,000
14	3.01	CSAH	3	CSAH 3 AND CSAH-13	★	★				★	★	★★★★	$ 399,000
15	21.01	CSAH	21	CSAH 21 AND MNTH-169	★	★			★	★		★★★★	$ 323,000
16	68.01	CSAH	68	CSAH 68 AND USTH-53A	★	★	★			★		★★★★	$ 148,000
17	16.21	CSAH	16	CSAH 16 AND USTH-53 (South Intersection)	★		★		★	★		★★★★	$ 136,000
18	84.02	CSAH	84	CSAH 84 AND MNTH-73		★			★	★	★	★★★★	$ 103,000
19	46.07	CSAH	46	CSAH 46 AND USTH-2	★	★	★			★		★★★★	$ 84,000
20	115.01	CSAH	115	CSAH 115 AND USTH-53	★		★		★	★		★★★★	$ 36,000
21	223.04	CNTY	223	CNTY 223 AND USTH-2	★		★	★		★		★★★★	$ 24,000
22	16.12	CSAH	16	CSAH 16 AND CSAH-25	★	★			★		★	★★★★	$ -
23	24.11	CSAH	24	CSAH 24 AND CR-422 (Int #2)	★	★			★		★	★★★★	$ -
24	96.01	CSAH	96	CSAH 96 AND CSAH-132	★	★	★				★	★★★★	$ -
25	8.11	CSAH	8	CSAH 8 AND USTH-53	★	★				★		★★★	$1,142,000
26	98.04	CSAH	98	CSAH 98 AND USTH-2	★	★				★		★★★	$ 987,000
27	404.01	CNTY	404	CNTY 404 AND MNTH-1	★	★				★		★★★	$ 960,000
28	88.01	CSAH	88	CSAH 88 AND MNTH-1		★			★	★		★★★	$ 915,000
29	24.17	CSAH	24	CSAH 24 AND CR-422 (Int #5)	★	★				★		★★★	$ 824,000
30	50.02	CSAH	50	CSAH 50 AND MNTH-61	★			★		★		★★★	$ 663,000

Source: St. Louis County Road Safety Plan

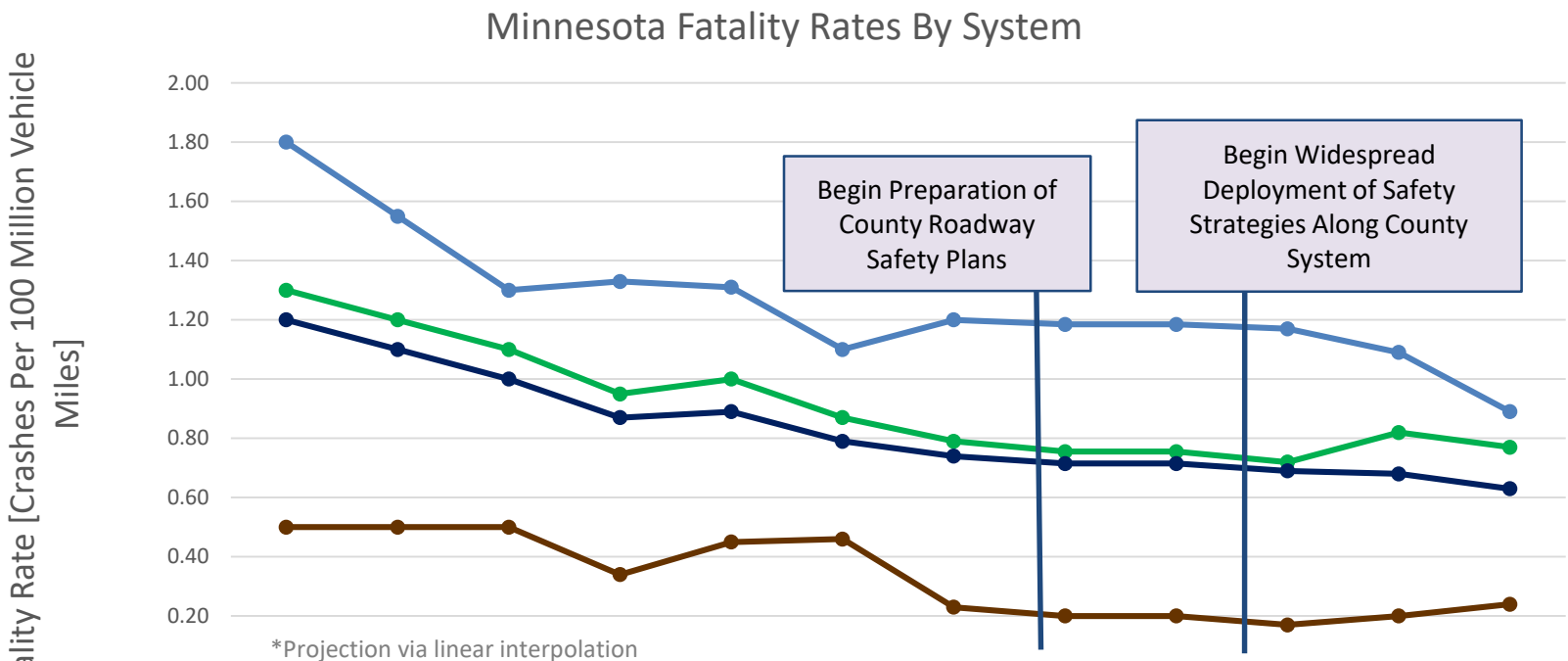
Effectiveness of Safety Strategies

- Decisions to implement a strategy should always consider effectiveness
- National Cooperative Highway Research Program (NCHRP) produces reports documenting effectiveness of various traffic safety strategies



Proven	*Tried*	*Experimental*
• Supported by rigorous academic studies	• Some evaluations • Conflicting experience and results	• New idea • Limited to no formal evaluation completed • Limited deployments
High confidence in effecting a change	May effect a change	Unknown if it will effect a change

Tangible Results



	2003	2004*	2005	2006	2007	2008	2009	2010*	2011*	2012	2013	2014
County	1.80	1.55	1.30	1.33	1.31	1.10	1.20	1.19	1.19	1.17	1.09	0.89
Trunk Highway	1.30	1.20	1.10	0.95	1.00	0.87	0.79	0.76	0.76	0.72	0.82	0.77
State Total	1.20	1.10	1.00	0.87	0.89	0.79	0.74	0.72	0.72	0.69	0.68	0.63
Interstate	0.50	0.50	0.50	0.34	0.45	0.46	0.23	0.20	0.20	0.17	0.20	0.24

25% reduction in fatality rate from 2011 to 2014 on the County System.

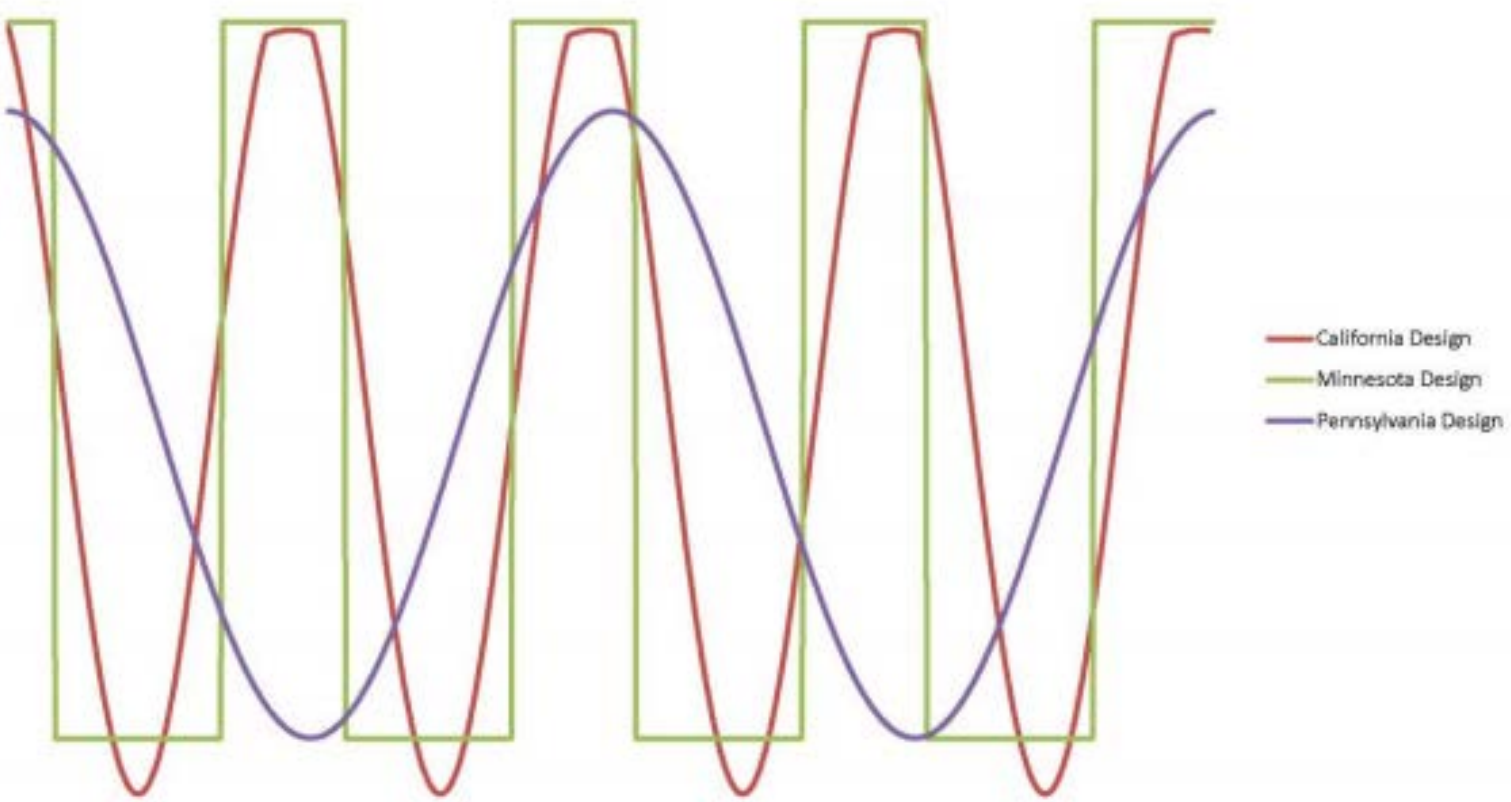
Source: Howard Preston, CH2M, Author of MN CRSP

Minnesota Sinusoidal Rumble Strips

- Rumble strips are a highly effective safety strategy, but they have elicited complaints from adjacent residents
- MnDOT and LRRB completed two studies[1,2] on the noise evaluation of alternative rumble strip designs
- First study evaluated various designs[1]
  - California Design (14” center-to-center, 1/32” – 5/8” depth, 8” wide)
  - Pennsylvania Design (24” center-to-center, 1/8” – 1/2” depth, 8” wide)
  - Minnesota Design (12” center-to-center, 3/8” – 1/2” depth, 16” wide)
- Second study objective was to determine the optimal sinusoidal rumble strip design[2]

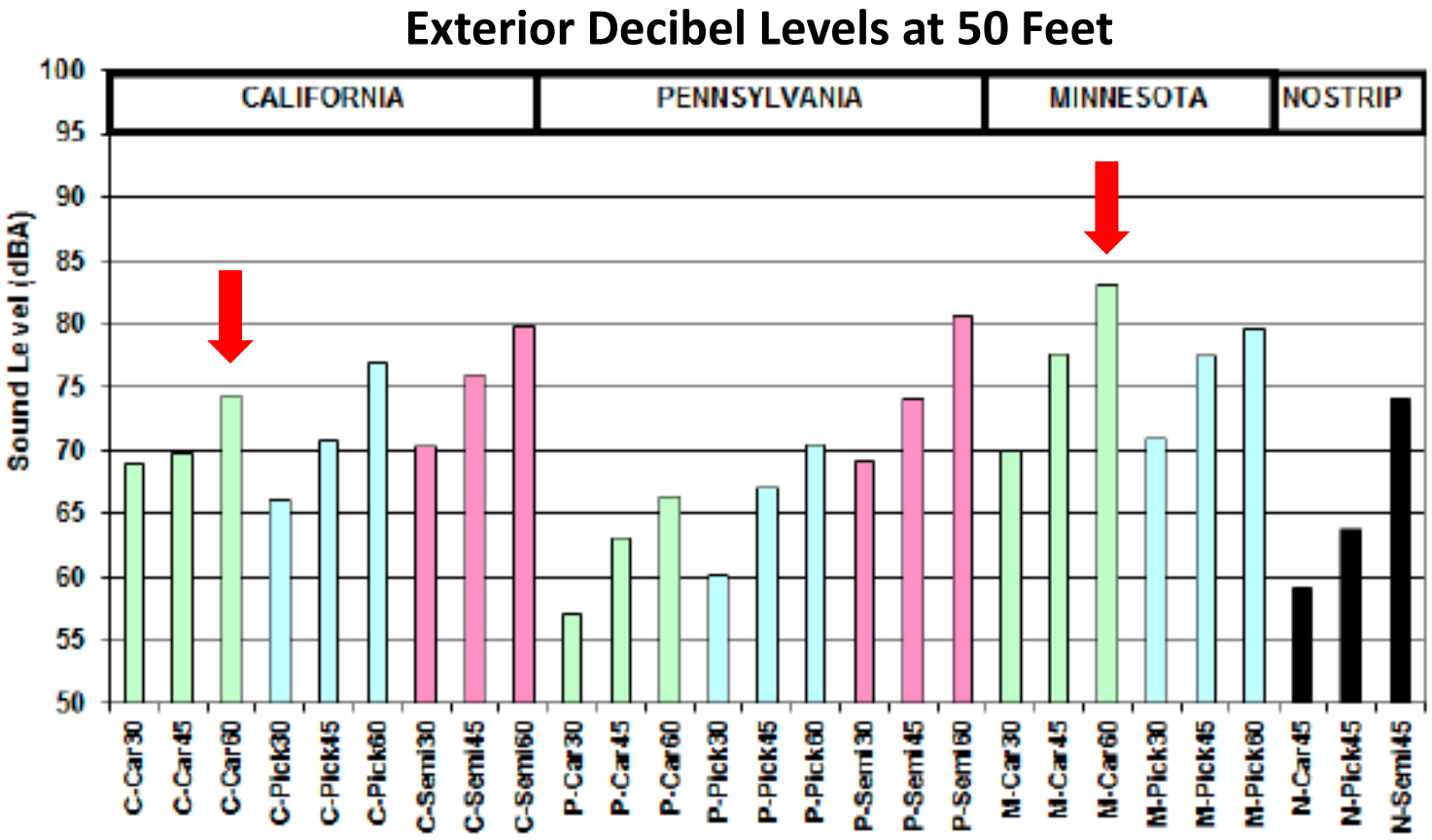
1. Terhaar, E, Braslau, D, February 2015, *Rumble Strip Noise Evaluation*, Minnesota Department of Transportation
2. Terhaar, E, Braslau, D, Fleming, K, June 2016, *Sinusoidal Rumble Strip Design Optimization Study*, Minnesota Department of Transportation

Comparison of Rumble Strip Cross-Sections



Source: Terhaar, E, Braslau, D, February 2015, *Rumble Strip Noise Evaluation*, Minnesota Department of Transportation

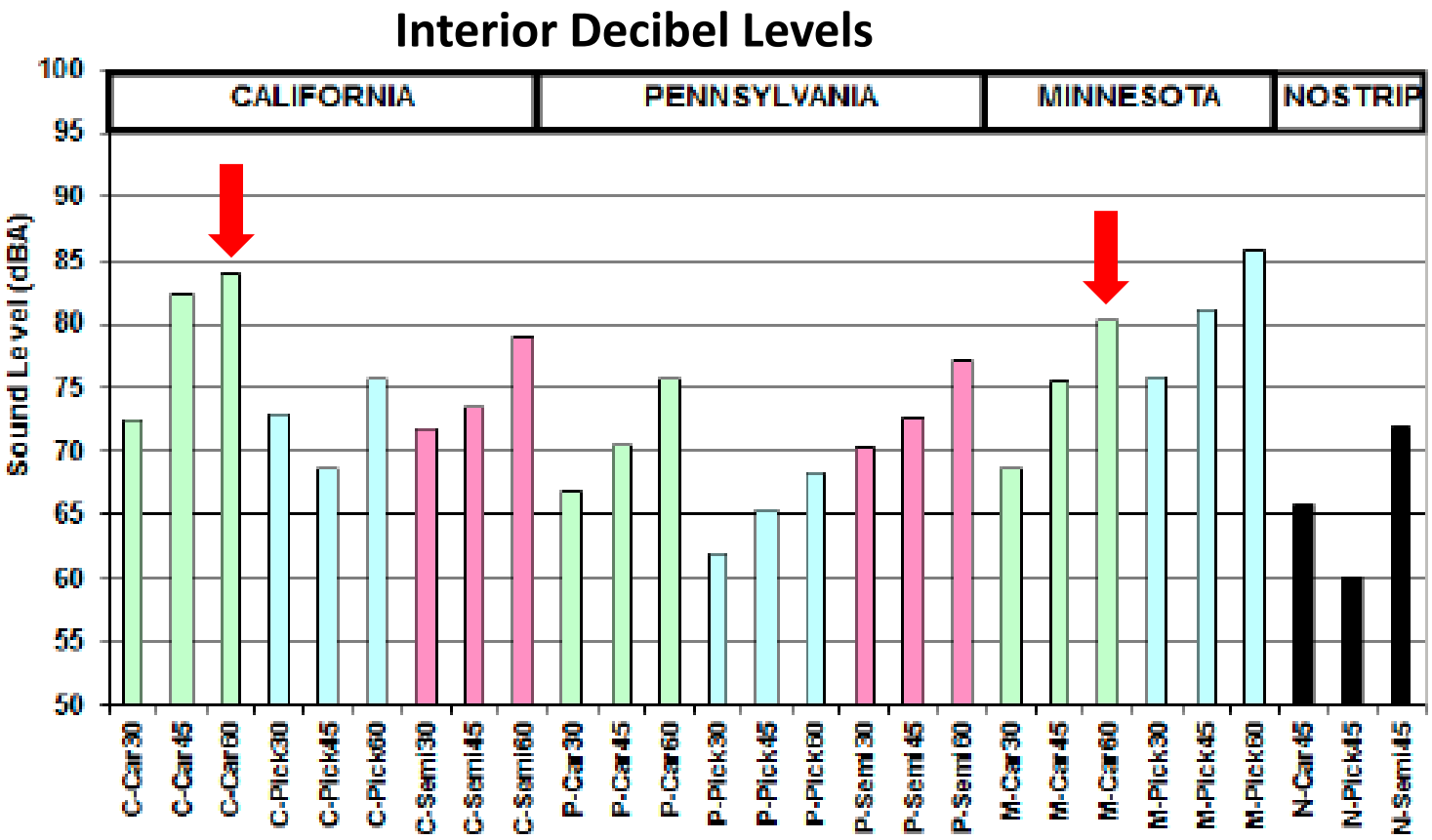
Sinusoidal Rumble Strip Noise Evaluation



Exterior sound of Mumble Strip is ~10 dB lower than the Minnesota Rumble Strip at 50 feet away for a car driving at 60 mph.

Source: Terhaar, E, Braslau, D, February 2015, *Rumble Strip Noise Evaluation*, Minnesota Department of Transportation

Sinusoidal Rumble Strip Noise Evaluation



Interior sound of Mumble Strip is ~4 dB higher than the Minnesota Rumble Strip for a car driving at 60 mph.

Source: Terhaar, E, Braslau, D, February 2015, *Rumble Strip Noise Evaluation*, Minnesota Department of Transportation

Comparison of Rumble Strips

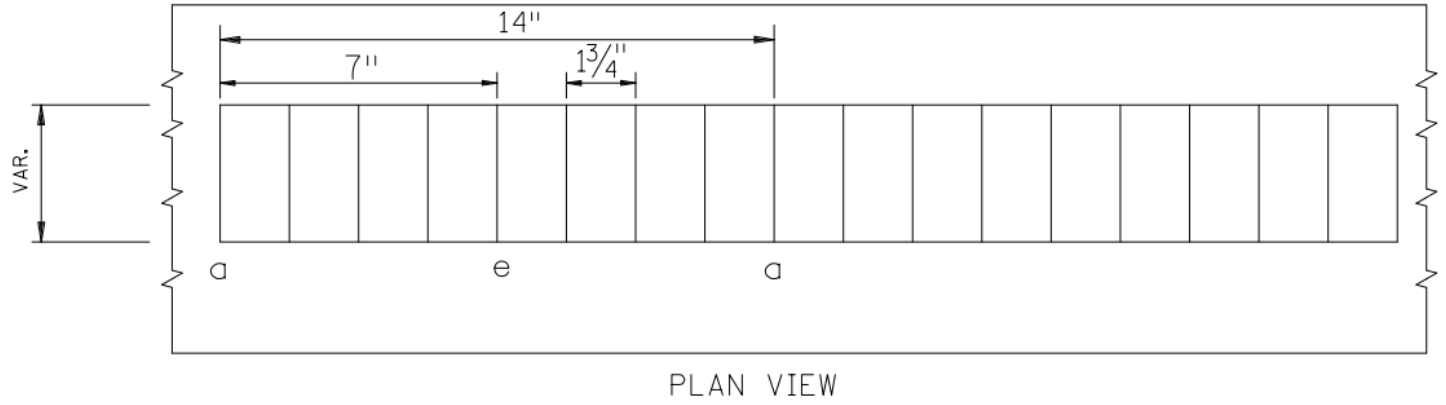
Minnesota Rumble Strip

Sinusoidal Strip

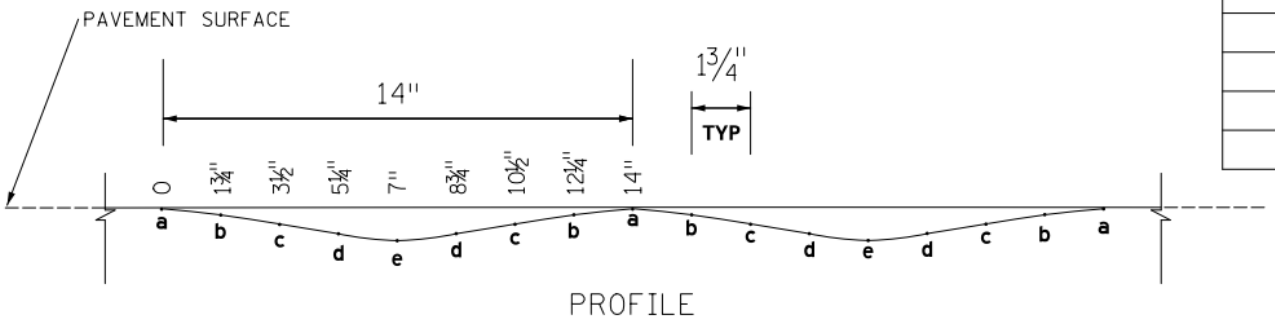
Video: https://youtu.be/W3-uPGb1nmM

Source: Terhaar, E, Braslau, D, February 2015, *Rumble Strip Noise Evaluation*, Minnesota Department of Transportation

Optimized Sinusoidal Rumble Strip



	DEPTH (1)	
LOCATION	MIL	INCHES
a	62.5	1/16"
b	156	5/32"
c	281	9/32"
d	438	7/16"
e	500	1/2"



(1) DEPTH TOLERANCE IS ±1/16" ALONG THE SINUSOIDAL WAVE.

Figure Source: MnDOT Technical Memorandum 17-08-T-02

St. Louis County
Sinusoidal Rumble Strip Project

- The project treated ~65 centerline miles
- Project included the following items (actual 2018 unit prices)
  - Milled Sinusoidal Rumble Strips → $0.25/LIN FT
  - Fog Seal → $0.10/LIN FT
  - Centerline Striping → $0.54/LIN FT (averaged)
  - Total Cost = $0.89/LIN FT or $4,700/mile
- Applied wet-reflective paint in the rumble strip
- Applied ground-in wet-reflective paint in the gaps
- Maintained gaps at all public road intersections

When safety strategies crash…

When safety strategies crash…

Rumble stripe grumbles

A car drives over a rumble stripe along County Road 4 on Thursday south of Biwabik. New highway safety guidelines required the strips to be moved 12 inches toward the center of the road and onto the fog line, turning the old rumble "strip" into a rumble "stripe." Bob King / rking@duluthnews.com

Some see rumble stripes as an annoying but necessary safety measure, but others say the noise has become an intrusion.

JOHN MYERS
jmyers@duluthnews.com

Barbara Hinsz grew accustomed to the quiet at her home just off St. Louis County Road 4 south of Biwabik.

Evenings would get so peaceful that she could sit on a lawn chair and hear her llamas chew their hay.

But Hinsz says a well-intentioned effort to make rural highways safer has ruined her rural serenity.

Thanks to a federally funded highway safety effort, county crews gouged new "rumble stripes" along the highway this summer, but not in their usual place midway in the shoulder. New highway safety guidelines call for the rumble strips to go on the so-called fog line, the continuous white stripe that separates the driving lane from the shoulder.

The problem seems to be the 12-inch move from rumble strips on the shoulder to rumble stripes on the fog line. Instead of serving as an infrequent jolt to remind drifting drivers to return to the driving lane, critics say a reverberating rumble is happening whenever a car or truck strays just a bit to the right. It's especially bad on curves, including where Hinsz lives.

"If you are outside (near rumble stripes), you can't have a conversation."

Barb Hinsz, who lives south of Biwabik, near a part of County Road 4 where rumble stripes have been placed

Over Labor Day weekend, "I sat down to watch a little TV but had to turn it up so I could hear it. With the windows closed," Hinsz said. "The Fourth of July was a treat, too. Just one after another."

Logging trucks, cars puling boats and campers, impaired drivers, inattentive drivers, tourists gawking at the scenery — Hinsz says it seems just about everyone is drifting out of the driving lane just enough to drive over the rumble stripe. Even far down the road, the rumble reverberates into her yard and even into her house.

Neighbors to the new rumble stripes, including some who live a quarter-mile or more off the road, say it's keeping them awake at night. Lake homeowners say it's hurting their property values in addition to their rural lifestyle.

"If you are outside, you can't have a conversation," Hinsz said. "Sometimes we get two cars, going both ways, who hit them at the same time. That's really special."

See Rumble, Page A7

Rumble stripes unpopular in other Minnesota counties, too

St. Louis County isn't the only one dealing with complaints about the new federal rumble stripe guidelines.

Carver and Wright Counties near the Twin Cities received the same complaints when they started rumble striping in 2008. Carver County had so many disgruntled residents that they spent $40,000 to fill the stripes in just months after they were gouged out.

Wright County left the rumbles in place but moved the fog line in on the road where it received the most complaints, slightly narrowing the driving lane but keeping more drivers off the gouged pavement.

In both cases, the counties sacrificed some highway safety benefits to quell neighbor concerns.

"We did rumble stripes on four roads and only one was really an issue, so that's where we took some action," said Wayne Fingalson, Wright County traffic engineer. "We're in a holding pattern now. We still feel the rumble stripes will save lives, but whether they are that much better than rumble strips, I'm not sure."

John Myers

Rumble stripes make highway driving more dangerous

I loved the Sept. 12 story, "Rumble stripe grumbles." It's good to know motorists are not the only ones annoyed by the stripes.

Before the stripes you could drive Minnesota Highway 23 without too much worry about oncoming traffic. Now about one third of all oncoming cars are in your lane to make sure they don't hit the stripes. This causes you to have to cross the stripes and listen to the annoying sound and feel the shudder of them.

Back when I was a kid we had to travel Minnesota Highway 169, which had an up-swinging curb on the right side of that highway. I would imagine it was for the same reason they have implemented the rumble stripe, calling it a safety feature. (Ha-ha!). I believe winter driving will be a real picnic with having to constantly swing to the right over the stripes to avoid head-on collisions.

Hats off to St. Louis County Commissioner Mike Forsman of Ely! I hope he will stay strong and not be bullied by bureaucratic red tape. I'm sure he will be at the top of the safety chain come winter when rollovers skyrocket as people swerve to the right to avoid head-on collisions. We may all have to move to his county to get around the high cost of auto insurance.

'Singing highway' legend growing

On behalf of the Greater Palo/Lakeland Area Tourism Board, I would like to invite Range residents to experience our newest tourist attraction, County Highway No. 4, otherwise known as the "Singing Highway."

Recently, a crude but recognizable rendition of the National Anthem was played out by the drivers of a Mack logging truck, a Coupe DeVille, a Jeep Wrangler and a Toyota Prius; as time goes on, the tunes are sure to get even better.

This new attraction was brought to you by the St. Louis County Highway Department, specifically Jim (Buzz) Feldosi, engineer, and Victor "here's your rumble strip sign" Lund, maintenance supervisor.

Make your next Sunday drive a memorable experience, and cruise the "Singing Highway."

Public Relations Lessons Learned

- Interact (communicate, educate, etc.) with your elected officials
- Public can become very concerned about residual effects of safety treatments – especially noise!
- Inequitable distribution of benefits
- “Measure twice, cut once.”
- Remember our role as engineers…

Contact Information

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Resources

- *Rumble Strips and Stripes on Rural Trunk Highways*, MnDOT Technical Memorandum No. 17-08-T-02, August 2017, https://techmemos.dot.state.mn.us/techmemo.aspx
- *Rumble Strip Noise Evaluation*, MnDOT Research Services, February 2015, https://www.lrrb.org/pdf/201507.pdf
- *Sinusoidal Rumble Strip Design Optimization Study*, MnDOT Research Services, June 2016, https://www.lrrb.org/pdf/201623.pdf
- FHWA Proven Safety Countermeasures, https://safety.fhwa.dot.gov/provencountermeasures/
- Rumble Strips: Saving Lives (video), Minnesota LRRB, https://youtu.be/Ukd6zEqdx2Q