Engineering 201

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Fergus Falls, MN
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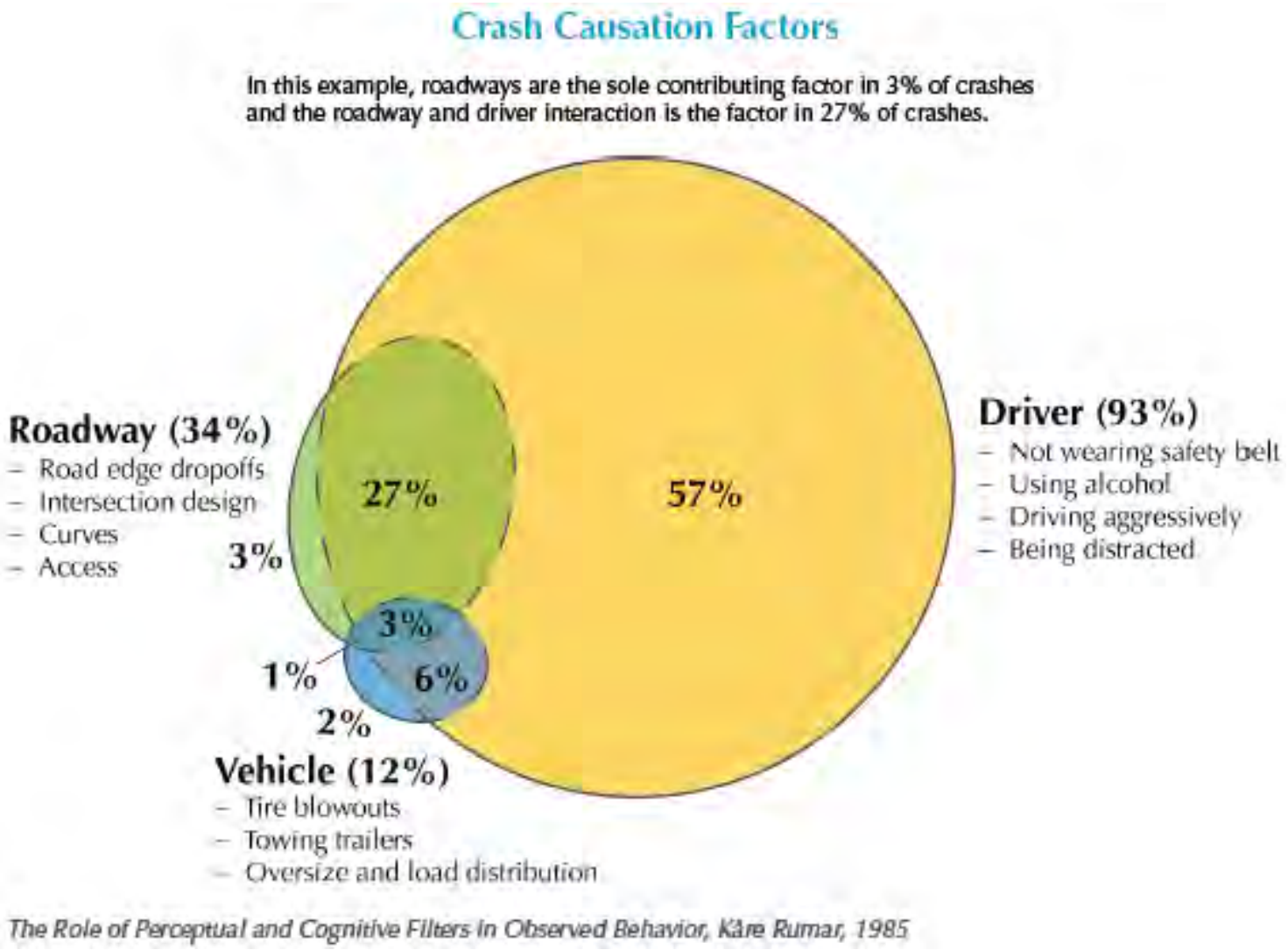
We all have a stake in A TO B

Will Engineering Fix All of Our Problems?



Where Are Crashes Happening?

Roadway Jurisdiction Classification	Miles	Crashes	Fatalities	Crash Rate*	Fatality Rate**
Interstate	916	12,309	25	0.99	0.20
Trunk Highway	10,930	21,221	168	1.04	0.82
CSAH/County Roads	44,958	20,705	151	1.49	1.09
City Streets	22,373	21,975	24	2.42	0.26
Township & Other	63,799	1,497	19	1.21	1.53
State Total	142,976	77,707	387	1.36	0.68

2013 Minnesota Motor Vehicle Crash Facts

* per million vehicle miles (MVM)

** per 100 million vehicle miles (100 MVM)

What Are We Focusing On?

Based on Minnesota's crash data, the following are the seven high-priority safety focus areas:

- Traffic Safety Culture
- Intersections
- Lane Departure
- Unbelted
- Impaired
- Inattentive
- Speeding

Topics Covered

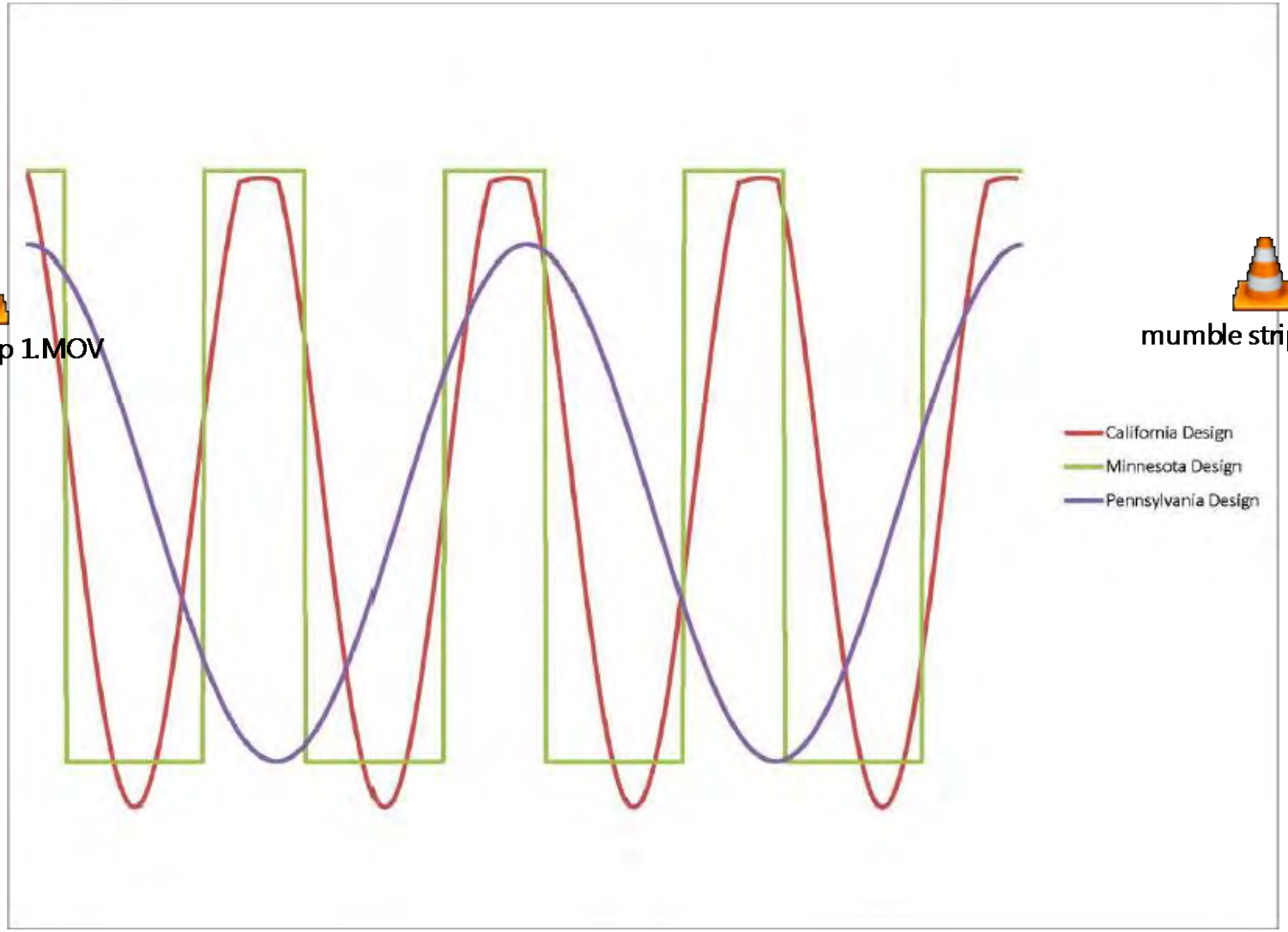
- Mumble Strips and Stripes
- Intersection Lighting
- Chevrons
- Rural Intersection Conflict Warning Systems (RICWS)
- Sign Management
- Speed Zoning

Mumble Strips and Stripes

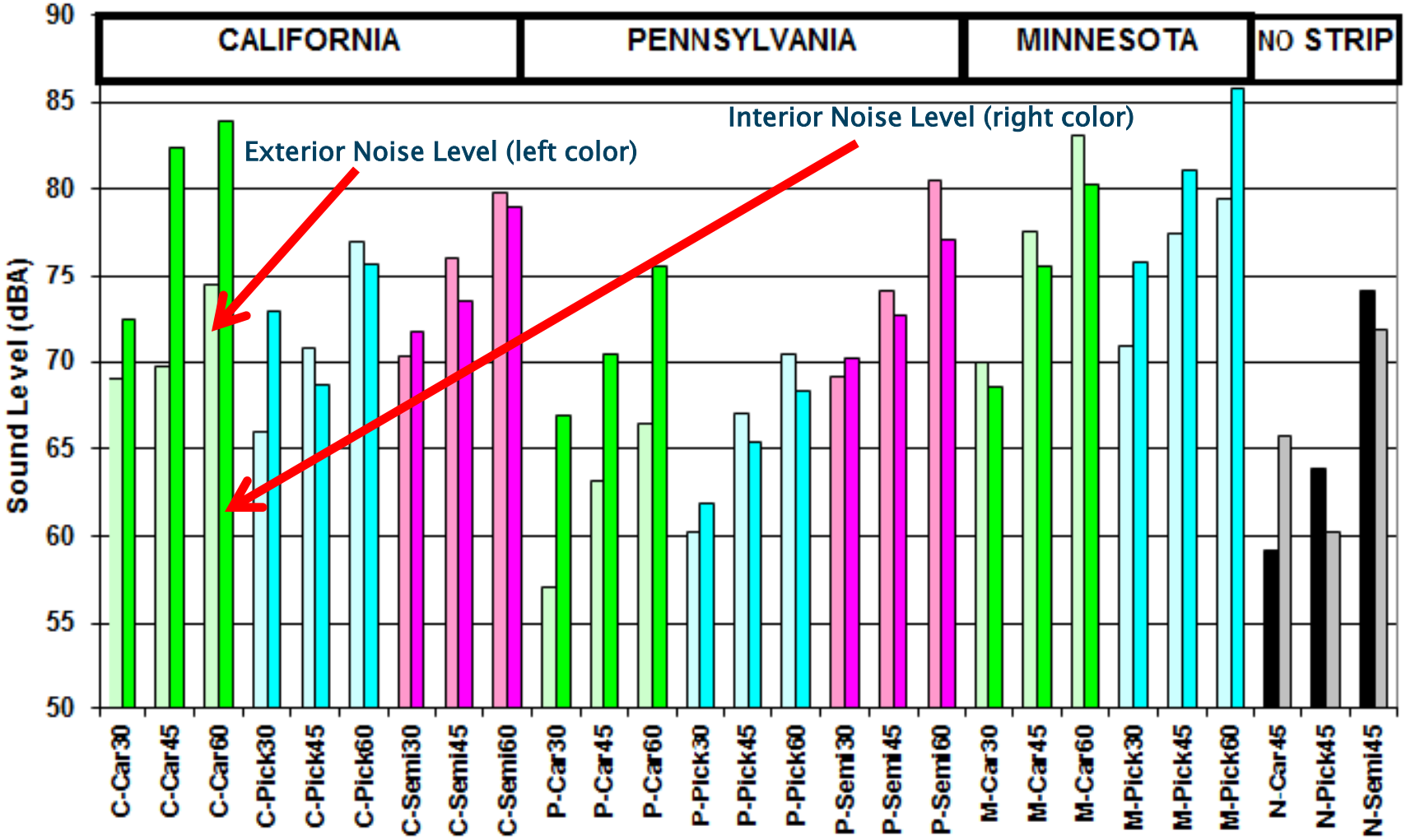
Traditional Rumble Strip Design

Mumble Strip Design

Comparison of Rumble Strip Cross Sections



Sound Level Comparison



Comparative Sound Levels

Sound Source or Location	Level (dBA)
Rocket launching pad	180
Artillery at shooter ear	170
Rifle at shooter ear	160
Loud trumpet at 5 inches	150
Jet takeoff 200 ft	140
Jet aircraft workers on tarmac	130
20 ft from rock band speakers	120
Discoteque, diesel generator room	110
Subway, chain saw, stereo headphone	100
Noise appliances, lawn mower at user ear	90
Typical home stereo level, inside factory	80
Freeway at 200 ft	70
Speech at 3 ft, air conditioner at 20 ft	60
Typical urban ambient	50
Typical rural ambient (35-40), quiet office	40
Quiet rural ambient, quiet library, soft whisper	30
BWCA with no wind, concert hall	20
BWCA in winter	10
Threshold of hearing	0

https://www.youtube.com/watch?v=W3-uPGb1nmM&feature=youtu.be

Intersection Lighting

Typical Benefit/Cost Ratios

Rank	Construction Classification	B/C Ratio
1	Illumination	21.0
2	Relocated Breakaway Utility Poles	17.2
3	Traffic Signs	16.3
4	Upgrade Median Barrier	13.7
5	New Traffic Signals	8.3
6	New Median Barrier	8.3
7	Remove Obstacles	8.3
8	Impact Attenuators	7.8
9	Upgrade Guardrail	7.6
10	Upgraded Traffic Signals	7.4
11	Upgraded Bridge Rail	7.1
12	Sight Distance Improvements	7.0
13	Groove Pavement for Skid Resistance	5.6
14	Replace or Improve Minor Structure	5.2
15	Turning Lanes and Traffic Separation	4.4
16	New Rail Road Crossing Gates	3.9
17	Construct Median for Traffic Separation	3.3
18	New Rail Road Crossing Flashing Lights	3.2
19	New Rail Road Flashing Lights and Gates	3.0
20	Upgrade Rail Road Flashing Lights	2.9
21	Pavement Marking and Delineations	2.6
22	Flatten Side Slopes	2.5
23	New Bridge	2.2
24	Widen or Improve Shoulder	2.1
25	Widen or Modify Bridge	2.0
26	Realign Roadway	2.0
27	Overlay for Skid Treatment	1.9

FHWA, Highway Safety Evaluation System (April 14, 1999)

Benefits of Intersection Lighting

- Installation of street lights at rural intersections reduced:
  - Night crashes by 26% to 40%
  - Night crash rate by 25% to 40%
  - Night single vehicle crashes by 29% to 53%
  - Night multiple vehicle crashes by 63%
  - Night crash severity by 26%
- Installation costs are relatively low ranging from $1,000 to $5,000 per intersection
- Maintenance costs range from $100 to $600 per light

Chevrons

What's So Good About Chevrons?

- They are found to reduce road departure crashes by about 20% to 50%
- It is one of only two types of signs that have been proven effective
- Found to have a benefit/cost ratio of 8:1

Rural Intersection Conflict Warning Systems (RICWS)

Rural Intersection Conflict Warning Systems

View From Blue Car

View From Red Car

https://www.youtube.com/watch?v=9eOJ4qlBrQU&feature=youtu.be

What Are the Studies Saying?

	Total CRF	Injury CRF	Average Cost[1]	Intersection AADT[2]
All Way Stop (Installed with Overhead Flashing Beacons)	82 (+/-4)%	87 (+/-4)%	$20,000	1,400-9,900
All Way Stop (Signs Only)	61 (+/-3)%	72 (+/-4)%	$5,000	680-15,100
VEWF Category 3	32 (+/-8)%	27 (+/-10)%	$21,200	2,800-9,700
VEWF Category 4	25 (+/-12)%	13 (+/-19)%	$28,000	2,400-9,300
Overhead Flashing Beacon	12 (+/-6)%	9 (+/-8)%	$20,000	1,100-14,000
VEWF Category 2	5 (+/-8)%	7 (+/-11)%	$21,900	3,200-12,100
VEWF Category 1	-6 (+/-10)%	8 (+/-11)%	$22,800	1,500-12,200

[1] VEWF costs obtained from sites with available project information in Spot Safety project files. All way stop and flashing beacon costs obtained from prior NCDOT evaluations.

[2] Range of intersection AADTs for locations used in evaluations.

Category 1 – Overhead Signs and Flashers at the Intersection on Major, Loop on Minor
Category 2 – Overhead Signs and Flashers at the Intersection on Minor, Loop on Major
Category 3 – Post Mounted Signs and Flashers in Advance of Intersection on Major, Loop on Minor
Category 4 – Locations with Combination of Category 1 through Category 3

Sign Management

- Do we really need all the signs that are on our roadways?

Which Signs Have Been Proven Effective at Either Reducing Crashes or Changing Driver Behavior?

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

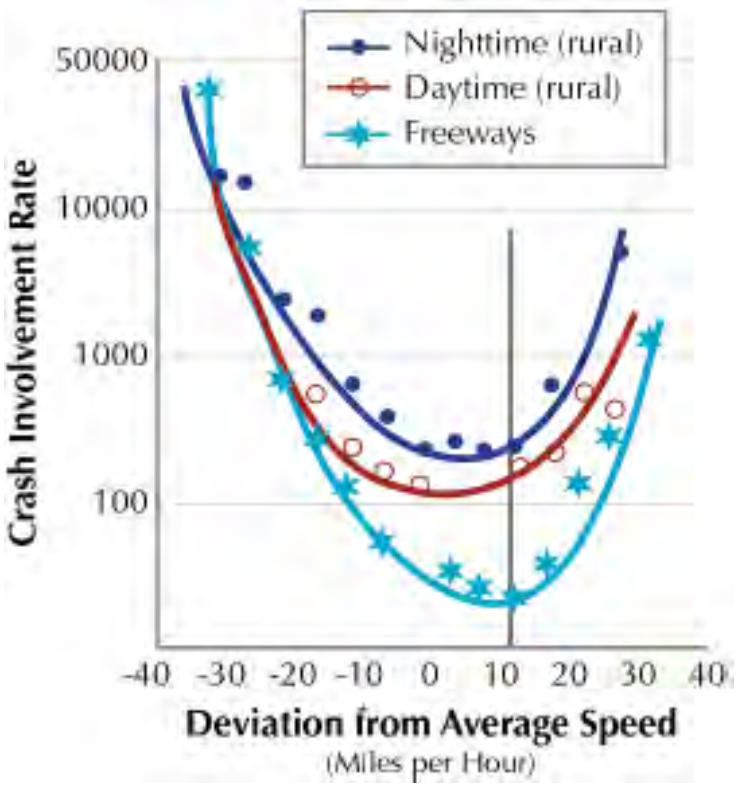
What Should be Considered for Sign Management?

- Remove signs that are not effective!
- Consider Financial Budgeting
  - A typical county highway system consists of approximately 500 miles of rural roadways with an average of 20 traffic signs per mile (both directions)
  - A typical sign replacement cost is $200 per sign
  - Total cost to upgrade/replace signs in a typical county would be about $2,000,000
- Consider basic requirements of a sign to:
  1. Fulfill a need
  2. Command attention
  3. Convey a clear, simple meaning
  4. Command respect from road users
  5. Give adequate time for proper response

Speed Zoning

- Two basic types of speed zones in Minnesota:
  1. Statutory speed limits established by legislature – 30 mph on city streets, 55 mph on rural roads, 65 mph on rural expressways, and 70 mph on rural interstates
  2. Speed zones established based on the results of an engineering study of a particular roadway
- Two primary performance measures of vehicle speeds
  1. 85th percentile speed – The speed below which 85% of the vehicles are traveling
  2. 10 mph pace – The 10 mph range that contains the greatest number of vehicles

Vehicle Speeds and Crash Rates



- Data indicates that where vehicle speeds are in the range of 5 to 10 mph above the average speed (85th percentile speed in most speed profiles) crash rates are the lowest
- Artificially low or high speed limits contribute to a higher risk of crashes
- Most drivers will select a safe and reasonable speed based on their perception of the roadway's condition and environment

http://youtu.be/8edH-toBesM

What Can be Done to Reduce Speed?

Summary of Impacts and Costs of Rural Traffic Calming Treatments				
Treatment	**Change in 85th Percentile Speed (mph)**	**Cost**	**Maintenance**	**Application**
Transverse pavement markings [1]	-2 to 0	$	Regular painting	Community entrance
Transverse pavement markings [1] with speed feedback signs	-7 to -3	$$$	Regular painting	Community entrance
Lane narrowing using painted center island and edge marking	-3 to +4	$	Regular painting	Entrance or within community
Converging chevrons [1] and "25 MPH" pavement markings	-4 to 0	$	Regular painting	Community entrance
Lane narrowing using shoulder markings and "25 MPH" pavement legend	-2 to 4	$	Regular painting	Entrance or within community
Speed table	-5 to -4	$$	Regular painting	Within community
Lane narrowing with center island using tubular markers	-3 to 0	$$$	Tubes often struck needing replacement	Within community
Speed feedback sign (3 months after only)	-7	$$$	Troubleshooting electronics	Entrance or within community
"SLOW" pavement legend	-2 to 3	$	Regular painting	Entrance or within community
"35 MPH" pavement legend with red background (1)	-9 to 0	$	Background faded quickly; accelerated repainting cycle	Entrance or within community

[1] Experimental approval required per Section 1A.10 of MUTCD.

$ = under $2,500
$$ =$2,500 to $5,000
$$$ = $5,000 to $12,000

Traffic Calming on Main Roads Through Rural Communities, FHWA-HRT-08-067, Krammes, R., 2009

Questions?

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