

NINE PROVEN SAFETY MEASURES TO IMPROVE SAFETY ON GEORGIA ROADS

Georgia Partnership for Transportation
Quality

Athens, Georgia
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Nine Proven Safety Countermeasures

1. Road Safety Audits (RSAs)
2. Rumble Strips and Rumble Stripes
3. Median Barriers
4. Safety Edge
5. Roundabouts
6. Left- and Right- Turn Lanes
7. Yellow Change Interval
8. Pedestrian Refuge Areas
9. Walkways

Objectives

- Description of the Countermeasure
- Safety Benefits
- Current GDOT Policies and Practices
- Increasing the use of this countermeasure

Left- and Right-Turn Lanes at Stop-Controlled Intersections (Description)

- Left turn lanes provide auxiliary lanes for storage or speed change of left-turning vehicles.
- Installation of left-turn lanes
 - Reduces crash potential,
 - Reduces motorist inconvenience, and
 - improves operational efficiency.
- Right-turn lanes provide a separation between right-turning traffic and adjacent through traffic at intersection approaches,
- Installation of right-turn lanes
 - reduces conflicts and
 - improves intersection safety.

Left- and Right-Turn Lanes at Stop-Controlled Intersections (Description)

- Countermeasure is effective on intersections with
 - 3- and 4- legs
 - two-way stop control on the minor road
 - significant turning volumes
 - a history of turn-related crashes
- Urban and Rural roadways
 - Major roadway vpd = 1,520 – 40,600
 - Minor roadway vpd = 200 – 8,000
- Reduces total crashes and fatal/injury crashes in all cases
- Can add turn lane on one or both major road approaches

Left- and Right-Turn Lanes at Stop-Controlled Intersections (Safety Benefits – Rural LT)

- Addition of a left-turn lane in **one direction** on the major roadway results in reductions of
 - 28 – 44% of total crashes
 - 35 – 55% of fatal/injury crashes
- Addition of a left-turn lane in **both directions** on the major roadway results in a 48% reduction of total crashes



Left- and Right-Turn Lanes at Stop-Controlled Intersections (Safety Benefits – Urban LT)

- Addition of a left-turn lane in **one direction** on the major roadway results in reductions of
 - 27 – 33% of total crashes
 - 29% of fatal/injury crashes
- Addition of a left-turn lane in **both directions** on the major roadway results in a 47% reduction of total crashes

Left- and Right-Turn Lanes at Stop-Controlled Intersections (Safety Benefits – Rural and Urban Right-Turn Lanes)

- For right-turn lane additions the minor roadway volumes are different
 - Minor roadway vpd = 25 – 26,000
- Addition of a right-turn lane in **one direction** on the major roadway results in reductions of
 - 14% of total crashes
 - 23% of fatal/injury crashes
- Addition of a right-turn lane in **both directions** on the major roadway results in a 26% reduction of total crashes

Left- and Right-Turn Lanes at Stop-Controlled Intersections (GDOT's Current Policies and Procedures)

- GDOT currently installs right turn lanes on the mainline at all major intersections on State Routes
- GDOT installs left turn lanes on the mainline at all signalized intersections on State Routes

Left- and Right-Turn Lanes at Stop-Controlled Intersections

(Increasing the use of this countermeasure)

- Traffic Operations should present this countermeasure to the Design Policy Committees.
- GDOT/FHWA should write an article in the LTAP newsletter highlighting installation and safety benefits of turn lanes for applicable intersections.
- District Engineers
 - Implement the countermeasure on State Routes in their districts
 - Traffic Operations should ask that GDOT District Engineers encourage local agencies to use the countermeasure.

Yellow Signal Timing Interval (Description)

- The yellow change interval is the interval following a green signal
- Warns drivers of the impending change in right of way assignment
- Inconsistent yellow change intervals create a dilemma zone in which drivers can neither stop safely nor reach the intersection before the signal turns red.
-
- Red Light Running (RLR) is one of the most common causes of intersection crashes.



Yellow Signal Timing Interval (Description)

- Yellow Signal Timing Interval should be optimized using the 1985 ITE proposed practice
 - $Y = t + v / (2a + |g| - 64.4g)$
 - Y = yellow interval
 - t = reaction time, set at 1.0 second
 - v = 85th percentile approach speed, in ft/sec (ft/sec = 1.47 x mph)
 - a = deceleration rate, set at 10 ft/sec²
 - g = grade of approach over the braking distance in percent/100
 - Note: If flat use 0 (subtract for negative grade, add for positive)
- 0.5 seconds should be added for each
 - Significant truck traffic
 - Older drivers
 - If more than 3% of the traffic is entering on red

Yellow Signal Timing Interval (Safety Benefits)

- Optimizing yellow interval timing helps to reduce RLR violations
- From various research yellow interval timing optimization has reduced crashes anywhere from 36 to 50%
- According to Retting, Chapline & Williams
 - 8% total crash reduction
 - 4% right angle crash reduction
 - 37% ped/bike crash reduction
- In KY and MO
 - 15% total crash reduction
 - 30% right angle crash reduction

Yellow Signal Timing Interval (GDOT's Current Policies and Procedures)

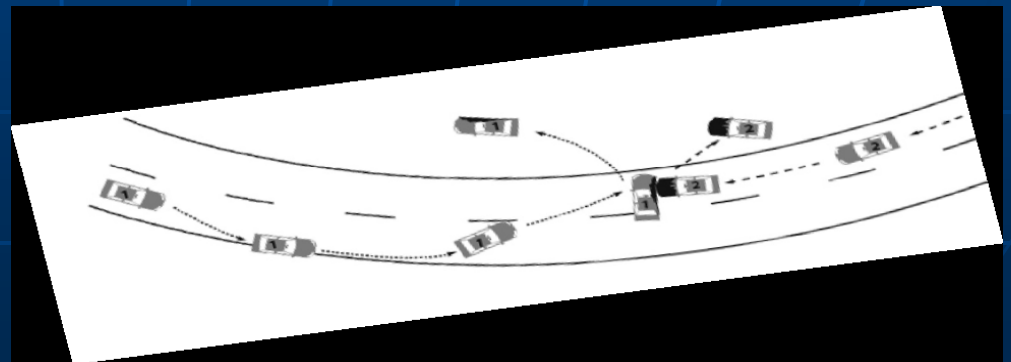
- Georgia routinely utilizes the 1985 ITE kinematic formula to calculate yellow intervals
- Georgia Code - at all intersections where RLR cameras are installed the yellow signal interval shall comply with the 1985 ITE kinematic formula **plus** an additional 1 second.
- **House Bill 77** requires that GDOT permit and approve all potential intersections based on a traffic engineering study indicating that the camera is placed solely for safety purposes.
 - Several additional relevant codes: 40-14-20, 40-14-21, 40-14-22, 40-14-24, 40-14-25 and 40-14-26

Yellow Signal Timing Interval (Increasing the use of this countermeasure)

- Ensure that the countermeasure is met when looking at signal timing, especially with regard to the additional yellow interval timing
- Get word out to locals

Safety Edge (Description)

- The Safety Edge is an asphalt paving technique where the interface between the roadway and graded shoulder is paved at an optimal angle to minimize vertical drop-off and provide a safer roadway edge.
- Safety Edge is a preferred Countermeasure with a low cost for use on two lane roadways to aid in the prevention of several types of crashes
 - Head-on
 - Roll over
 - Opposite side
 - Roadside hazard, and
 - Roadway departure (vehicle/object collisions)



Safety Edge (Description)



- Common locations of edge drop-offs are
 - Horizontal curves
 - Near mailboxes
 - Turnarounds
 - Shaded areas
 - Eroded areas, and
 - Asphalt pavement overlay

Safety Edge (Description – Hardware)



GDOT Version IV



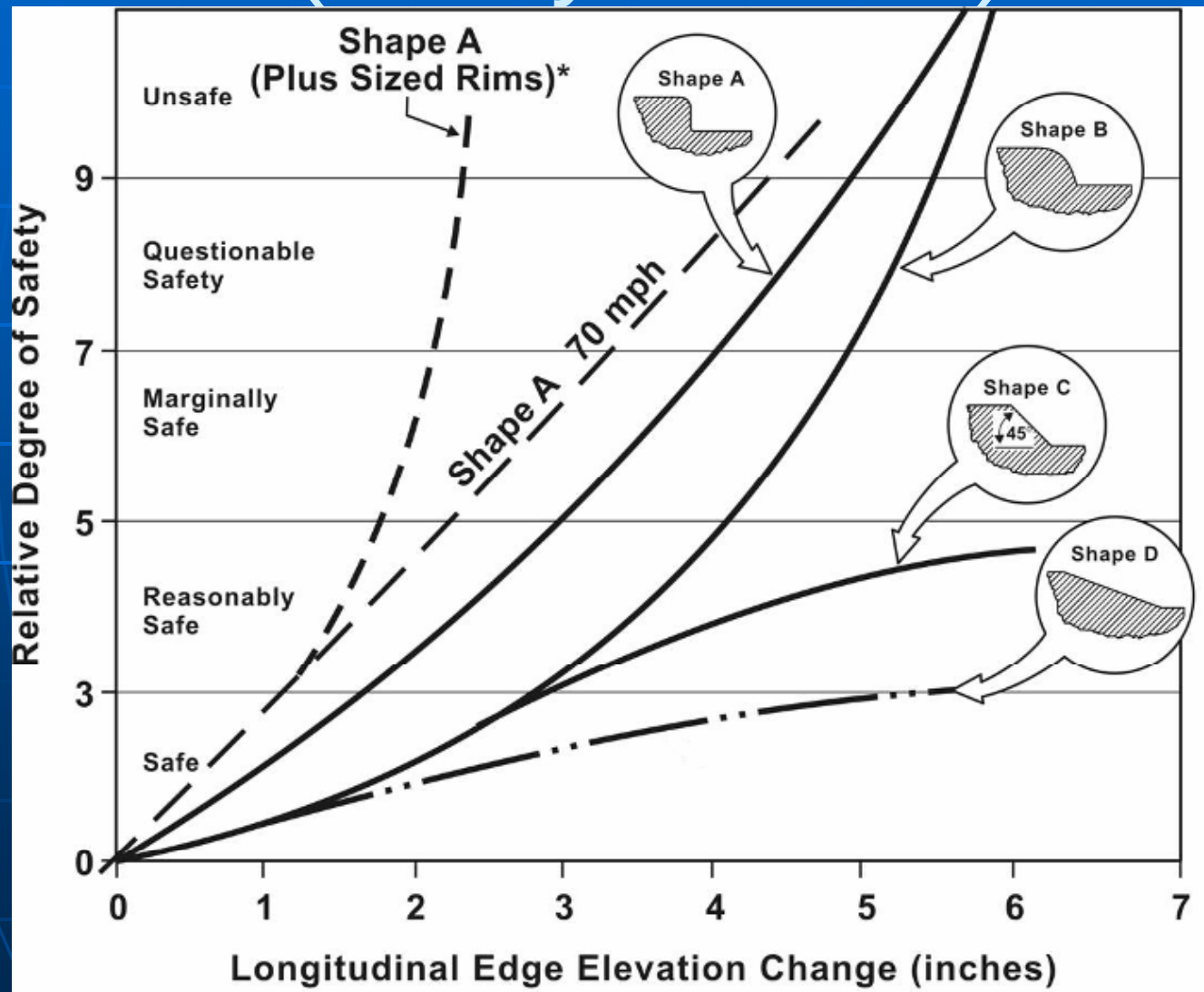
GDOT Version V

Safety Edge (Safety Benefits)

- Temporary Safety benefit during construction
- Permanent Solution for future drop-off re-emergence
- Aid vehicle re-entry
- Minimal hardware, labor, or material costs
- Increased Pavement Edge durability



Safety Edge (Safety Benefits)



Safety Edge (GDOT's Current Policies and Procedures)

- Safety Edge use is currently standard on all GDOT resurfacing.
- Georgia Tech Study and pooled fund study

Safety Edge

(Increasing the use of this countermeasure)

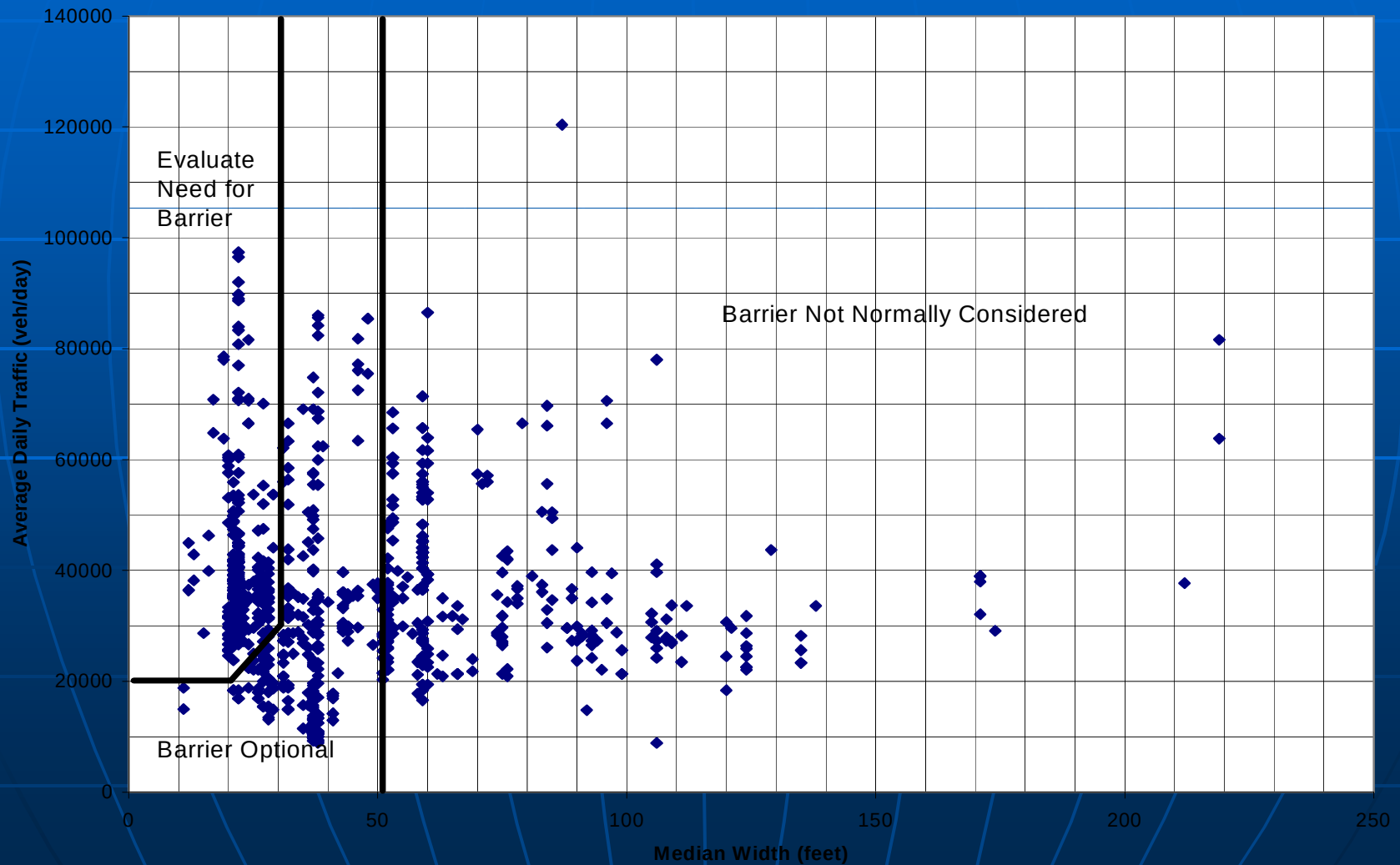
- Serve as an example to other states
- Knowledge sharing
- Work with locals/LTAP to increase the use

Median Barriers (Description)



- Median barriers are longitudinal barriers used to separate opposing traffic on a divided highway.
- Designed to redirect vehicles striking either side of the barrier.
- Can significantly reduce the occurrence and severity of cross-median crashes

Median Barriers (Safety Benefits)



Median Barriers (Safety Benefits)

- As shown in previous slide 2/3 of cross median crashes occur within a 50' median
- Cross median crashes have a 22% fatality rate
- Originally thought that medians over 30' did not necessitate a median barrier
- In the 80s and 90s research showed that medians up to 50' should be considered for barrier implementation
- The 2006 Roadside Design Guide (Chapter 6) is revised to reflect the findings

Median Barriers (Safety Benefits)

- **Reduce crash rates and points of conflict**
- **Uniform traffic flow while concentrating and improving left turns and U-turns**
- **Pedestrian refuge at mid-block and intersection crossings**
- **Landscaping opportunities providing aesthetic benefits**
- ✓ **Better access management results...**

Median Barriers (Safety Benefits)

- Ideally, all areas should have an engineering study to determine necessity of median barriers width
 - Take into account opposite traveling traffic
 - ADT
 - Proximity to interchanges
 - Within 2 miles of interchanges x-median crashes tend to be more severe
- States should give strong consideration to using cable median barrier based on its performance history



Median Barriers

(GDOT's Current Policies and Procedures)

Urban Interstates

- All urban interstates will have positive barrier separation.
- All urban multi-lane roadways interchanging with the interstate will have a raised median for a distance of 1,000 feet from the ramp termini or the first major intersection.

Source: Chief Engineer's design guidance January 7, 2003

Median Barriers

(GDOT's Current Policies and Procedures)

Rural Interstates

- All rural interstates will require a depressed median as specified in the green book or positive barrier separation in areas of right-of-way restrictions.
- All rural multi-lane roadways interchanging with the interstate will have a raised median for a distance of 1,000 feet from the ramp termini or the first major intersection.

Source: Chief Engineer's design guidance January 7, 2003

Median Barriers

(GDOT's Current Policies and Procedures)



- 94 miles of Cable Barrier installed in 9 interstate locations since July 2005
- 2 additional projects (24 additional miles) underway now.
- Department plans to install approximately 60 miles per year

Median Barriers

(Increasing the use of this countermeasure)

- Perform engineering studies on roadways with high median cross over crashes to determine the best locations for barrier
- Develop a standard policy that would place median barriers along interstates within 2 miles of interchanges

Pedestrian Refuge Areas (Description)

- **Median:** area between opposing lanes of traffic, excluding turn lanes. Medians can either be open (pavement markings only) or they can be channelized (raised medians or islands) to separate various road users.
- **Pedestrian Refuge Areas:** raised islands placed in the street at intersection or midblock locations to separate crossing pedestrians from motor vehicles.
 - also known as crossing islands, center islands, refuge islands, pedestrian islands, or median slow points



Pedestrian Refuge Areas (Safety Benefits)

- Raised medians (refuge areas) should be considered in
 - curbed sections of multi-lane roadways
 - urban and suburban areas, particularly in areas
 - mixtures of a significant number of pedestrians
 - high volumes of traffic (more than 12,000 ADT)
 - intermediate or high travel speeds.
- Medians/refuge islands should be
 - at least 4 feet wide (preferably 8 feet wide for accommodation of pedestrian comfort and safety)
 - of adequate length to allow the anticipated number of pedestrians to stand and wait for gaps in traffic before crossing the second half of the street.

Pedestrian Refuge Areas (Safety Benefits)

- Approximately 65% of pedestrian crashes occur at non-intersections
- 153 Pedestrian Fatalities in 2007
- 68 were improper crossing, darting
- Refuge Areas allow pedestrians to cross one direction at a time
- CRF of 56% for refuge island (FHWA)

Pedestrian Refuge Areas (GDOT's Current Policies and Procedures)



- Islands should be considered for roads too wide for pedestrians to cross all at once. They must be large enough for drivers to see, cannot get in the way of turns, and should not make the intersection larger.

Source: GDOT Design Policy Manual, Chapter 7

Pedestrian Refuge Areas (Increasing the use of this countermeasure)

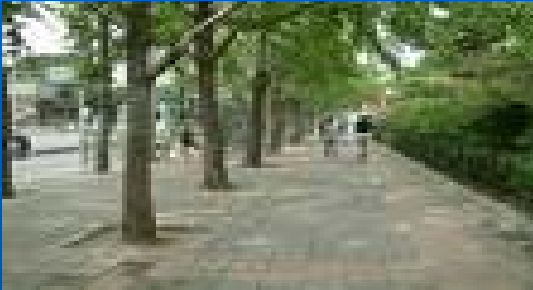
- Find a way to mitigate the costs of ROW in urban areas needing refuges to make them possible
- Determine a standard for refuge area placement based on ped counts, ADT, etc



Walkways (Description)

- Pedestrian Walkway (Walkway): A continuous way designated for pedestrians and separated from motor vehicle traffic by a space or barrier.
- Shared Use Path: A bikeway or pedestrian walkway physically separated from motorized vehicular traffic by an open space or barrier—either within a highway right-of-way or within an independent right-of-way. Shared use paths may also be used by pedestrians, skaters, wheelchair users, joggers, and other nonmotorized users. Shared use paths also may be referred to as “trails” or “multiple-use trails.”
- Sidewalks: Walkways that are paved and separated from the street, generally by curb and gutter.
- Roadway Shoulder: In rural or suburban areas where sidewalks and pathways are not feasible, gravel or paved highway shoulders provide an area for pedestrians to walk next to the roadway.
- Pedestrian: Any person traveling by foot, and any mobility impaired person using a wheelchair.

Walkways (Safety Benefits)



- Approximately 8% of pedestrian crashes occur while walking along roadway
- Sidewalks have a CRF of 88%
- Locations with no sidewalks were more than twice as likely to have pedestrian/motor vehicle crashes than sites where sidewalks existed
- The presence of a sidewalk was found to have a particularly large safety benefit in residential and mixed residential areas.

Walkways

(GDOT's Current Policies and Procedures)

- Provide 5' sidewalk behind all curb and gutter
- Mow strip is preferred for separation between curb and gutter and sidewalk
- Outside shoulders width is 10' for all non-curb and gutter collectors and arterials

Walkways

(Increasing the use of this countermeasure)

Educate local agencies on the benefits of walkways through LTAP

Provide FHWA Crash Reduction Factor information to local agencies

Road Safety Audit (RSA) (Description)

A road safety audit is a
formal safety performance
examination
of an existing or future road or
intersection
by an independent audit team.

A road safety audit also...

- considers the safety of all road users



- considers interactions at the borders or limits of the project
- examines the interaction of project elements
- may proactively consider mitigation measures

A road safety audit is NOT....

... a simple standards check for adherence to design guidelines.

... an opportunity to redesign the project.

Why do we
need RSAs?



When do we conduct RSAs?

■ Pre-construction:

- planning / feasibility
- preliminary (draft) design
- detailed design



■ Construction:

- work zones
- pre-opening



■ Post-construction/operational:

- existing roads



Who Should Initiate a RSA?

- State Highway Agency
- City Government
- County Government
- Law Enforcement
- GOHS
- Others



Georgia Experience

- Several RSA Courses
- RSAs in Gainesville, Albany, Brooks County, Ware County

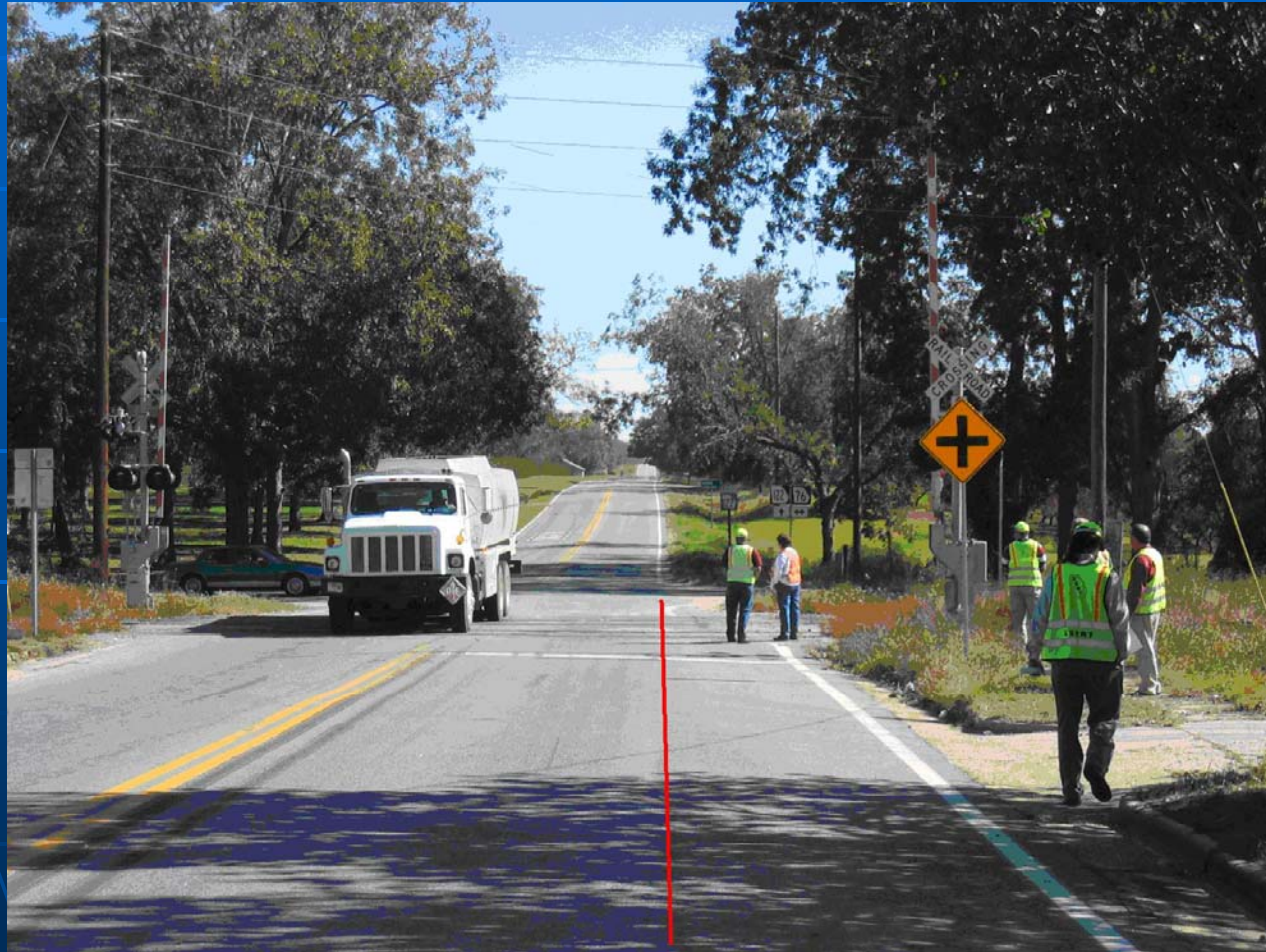
Georgia's Experience (continued)

- Gainesville
 - Preconstruction RSA
- Brooks County
 - Existing Intersection
- Ware County
 - Existing Roadway Segment

Ware County RSA Photo



Brooks County Photo



Georgia's Experience (continued)

■ Albany

- 1 Preconstruction RSA
- RSAs on 5 off-system locations with most severe safety needs
- Planned RSAs on 5 state route locations with greater anticipated safety needs

Road Safety Audits

(Increasing the use of this countermeasure)

- Article in LTAP Newsletter
- Additional Courses
- Partner with Law Enforcement, ITE, Local Agencies
- GDOT District Offices
- Develop GDOT Policy

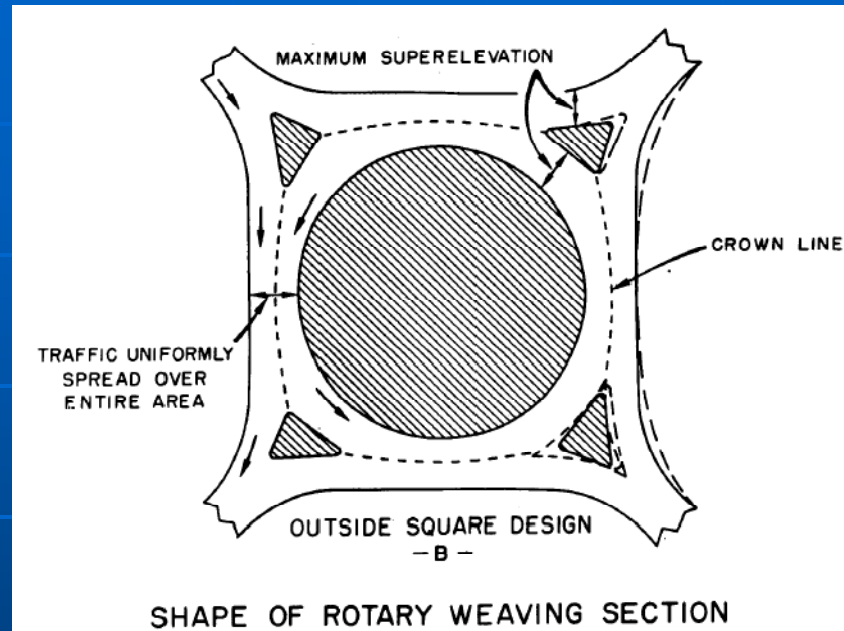
Roundabouts (Description)

- The modern roundabout is a type of circular intersection defined by the basic operational principle of entering traffic yielding to vehicles on the circulatory roadway and certain key design principles to achieve deflection of entering traffic by channelization at the entrance and deflection around a center island.
- Modern roundabouts have geometric features providing a reduced speed environment that offers substantial safety advantages and excellent operational performance.

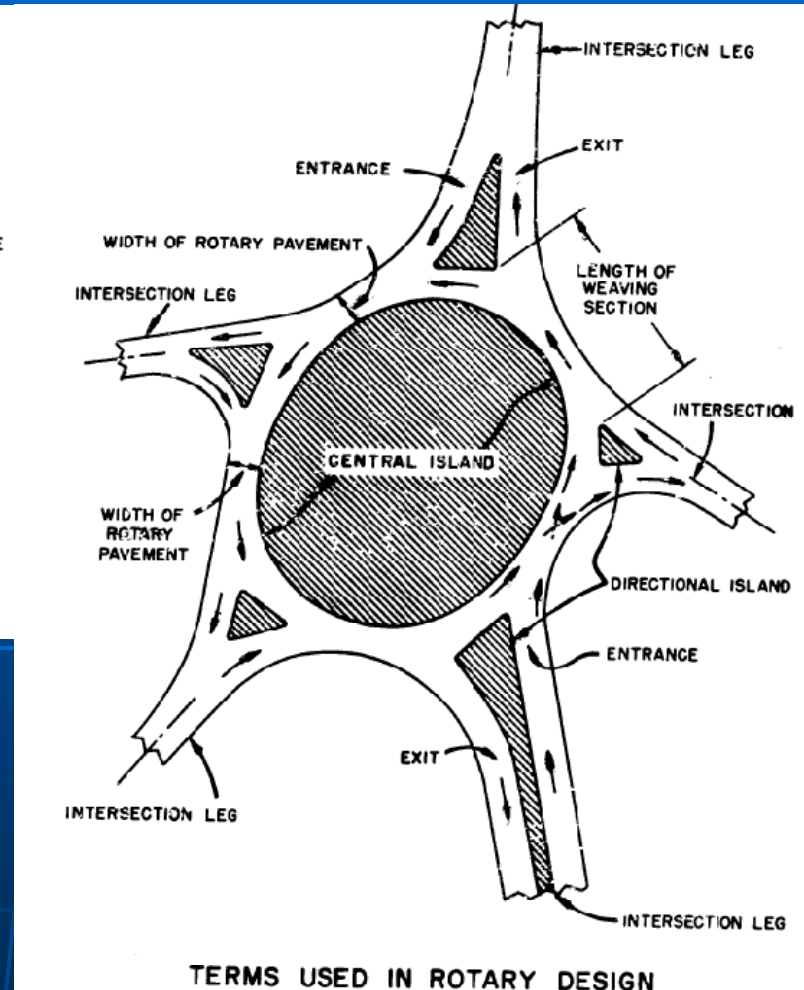
Roundabouts (Description)



Modern roundabouts are different from the older “Rotary” style intersections!!!



Source: "A Policy on Geometric Design of Rural Highways", AASHO 1965



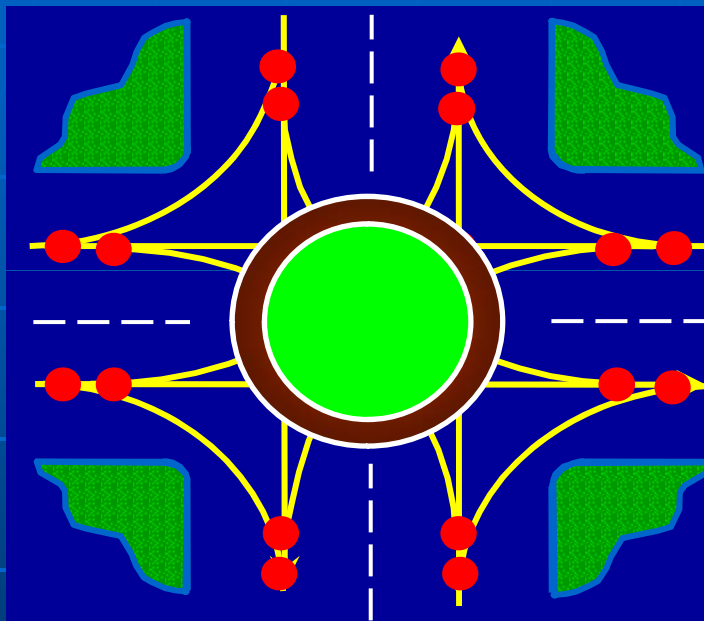
Common distinctions between modern roundabouts and older rotary type intersection:

Typically, modern roundabouts are –

- smaller than rotaries
- designed for slower entry, circulating, and exit speeds
- always following a “yield-at-entry” traffic control principle
- designed with a raised splitter island to slow and deflect traffic prior to entry
- designed to facilitate safer pedestrian crossings
- designed to follow a same lane entry/lane exit principle at multilane roundabouts (NO LANE CHANGES in the circulatory roadway)

Why are roundabouts safer? The laws of physics!!!

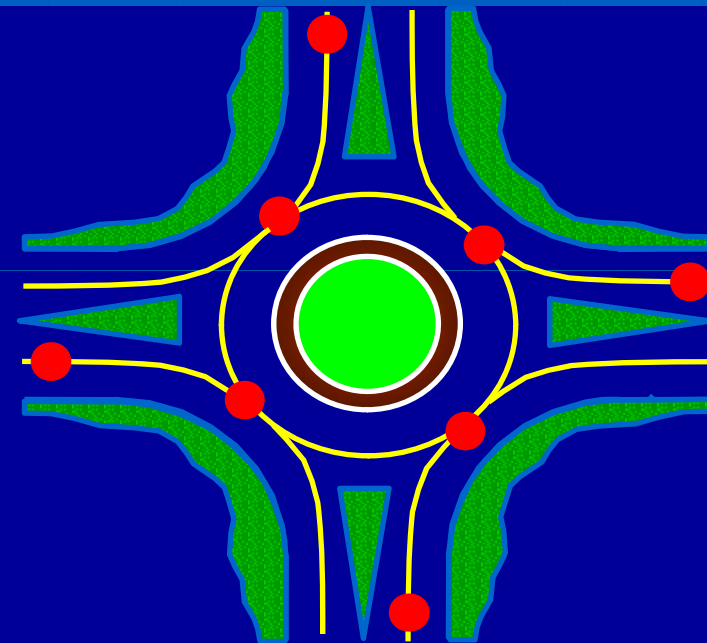
Comparison of Vehicle Conflict Points



32 conflict points

- High-speed
- High-angle
- High-energy

75% fewer
conflicts



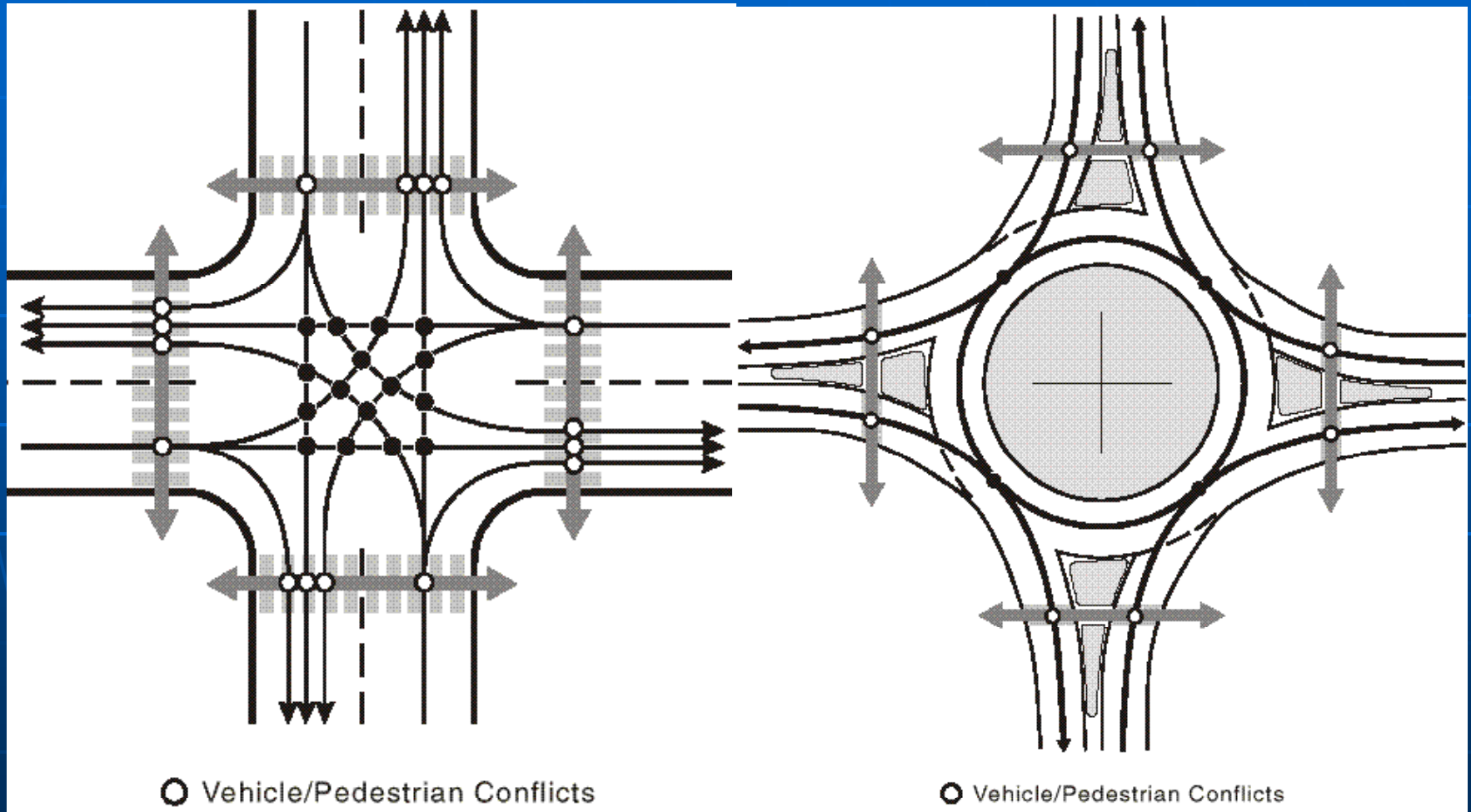
8 conflict points

- Low-speed
- Low-angle
- Low-energy

Roundabouts Operate Very Similarly – All Movements are “Right In / Right Out”



Roundabouts also reduce the number of Vehicle - Pedestrian Conflicts



16 Conflicts

8 Conflicts

That all sounds good in theory but what do the “numbers” show?

The Insurance Institute for Highway Safety – U.S. Roundabout Safety Report

- Before-after studies at 24 intersections
- 39% overall decrease in crashes
- 76% decrease in injury crashes
- 89% decrease in fatal/incapacitating crashes
- 75% reduction in traffic delays!

NCHRP Report 572 – Roundabouts in the US

- Before-after studies at 55 intersections
- 35% overall decrease in crashes
- 76% decrease in injury crashes
- 81% decrease in fatal/incapacitating crashes for single lane urban roundabouts
- 71% decrease in fatal/incapacitating crashes for single lane rural roundabouts

Key Message:: *Roundabouts are SAFER !!!*

Roundabouts

Georgia's Experience

- Roundabout at SR 5/SR 166
- Several additional roundabouts under design
- GDOT has a roundabout policy on TOPPS

What is your State or local agency doing to advance
the use of roundabouts?

Does your agency have ...

- ✓ A policy favoring the use roundabouts?
- ✓ Roundabouts identified in your highway design manual?
- ✓ A roundabout steering group to guide projects statewide?
- ✓ Information about roundabouts on your agencies web site?

How many roundabouts does your agency currently have in design, construction or operation?

Rumble Strips (Description)

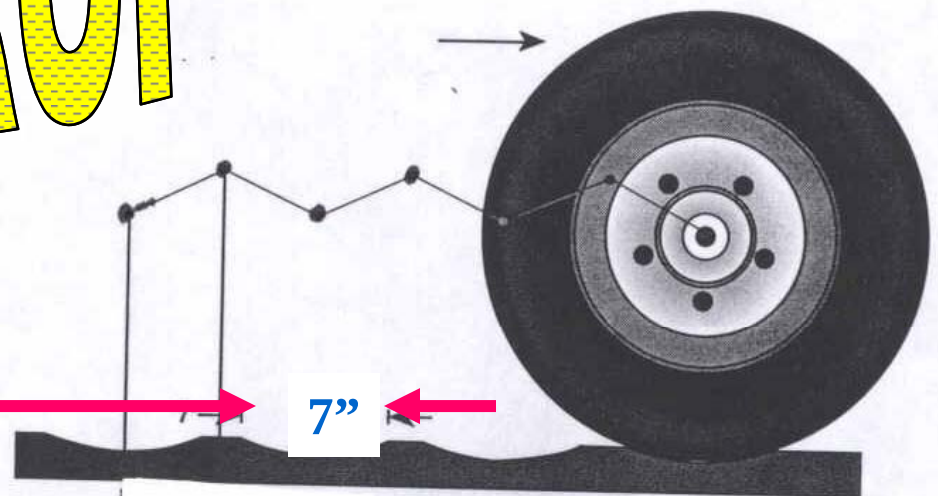
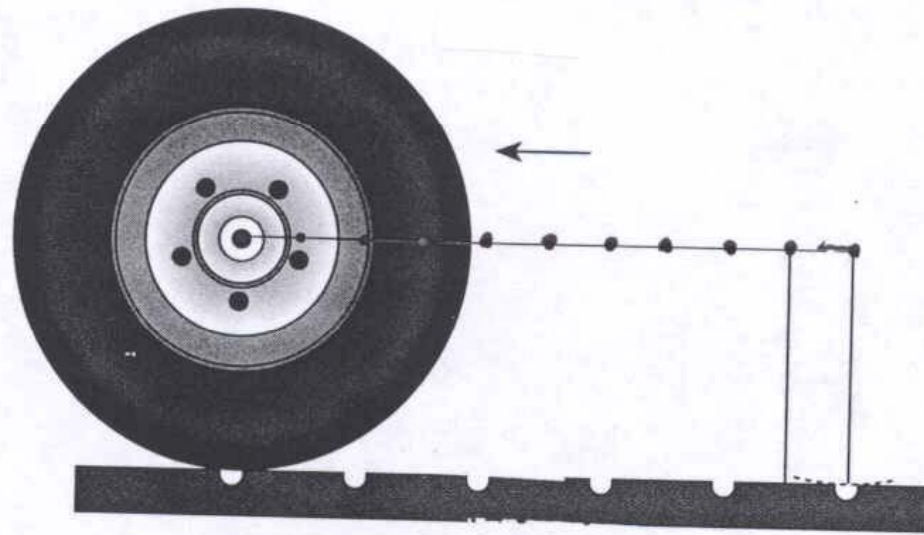
- Rumble strips are raised or grooved patterns on the roadway that provide both an audible warning (rumbling sound) and a physical vibration to alert drivers that they are leaving the driving lane. They may be installed on the roadway shoulder or on the centerline of undivided highways. If the placement of rumble strips coincides with centerline or edgeline striping, the devices are referred to as rumble stripes.

Why do milled work better than rolled?

Tire drops approx 10 times
deeper into the milled strip

TIRE DROP

Proper depth = $\frac{1}{2}$ to $\frac{5}{8}$ "
7 inches across gap



Rumbles close to driving lane



**Colorado DOT - 1100 miles
zero offset since 1998**

Centerline Rumbles



PennDOT Policy

Consider Centerline rumbles
on all roads >1500 ADT

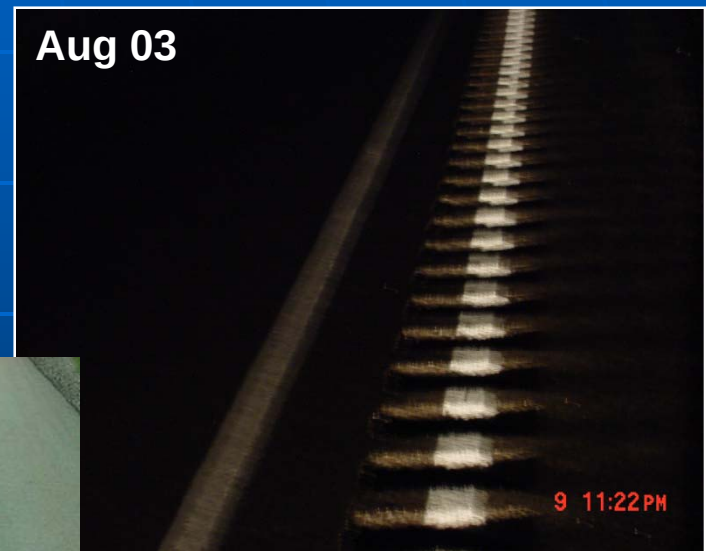
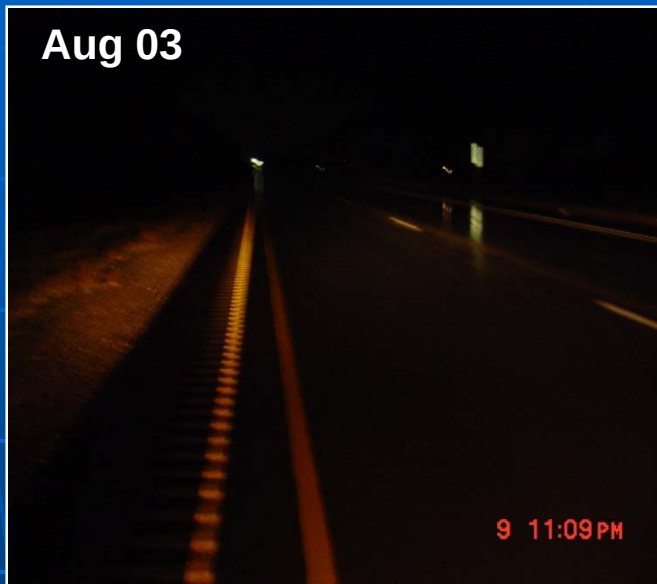
Pennsylvania DOT
250 locations, approx 1500 miles

Edgeline Rumble Stripes

MDOT / MSU Research

Four 1-Mile test strips

July 2003



(I-75 & US-127, North Region)

After one winter - wet night



Rumble Strips (Safety Benefits)

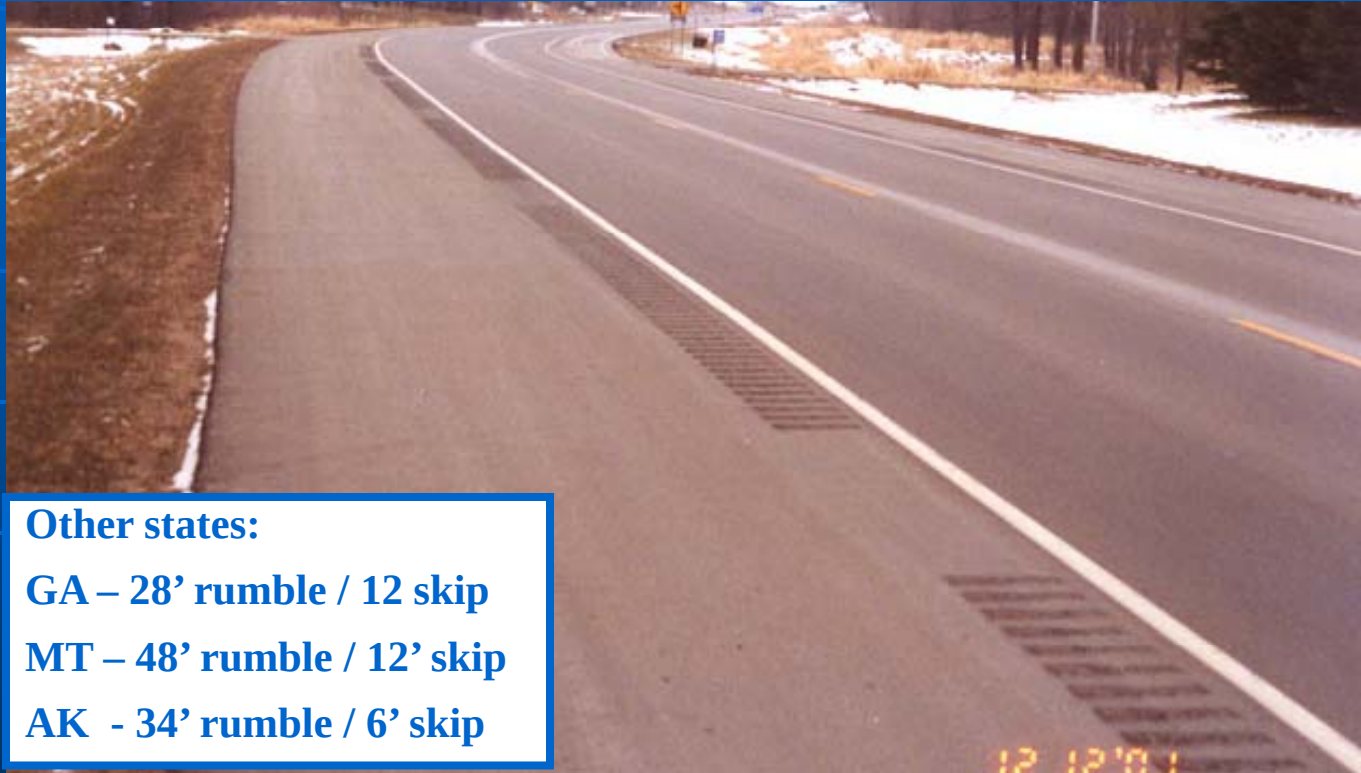
- Rumble Strips Crash Reduction Factors
 - Shoulder
 - All Crashes – 16
 - All ROR Crashes – Rural – 38
 - Centerline
 - All Crashes – 14
 - Head-on Crashes – Rural - 68

Rumble Strips

GDOT's Policy

- Milled
 - 16" wide x 7" Length x ½" deep
 - 5' Apart
- Skip pattern used on all shoulders 4' wide or greater
- Edge line rumble stripes considered for narrower shoulders
- Over 200 miles of centerline rumble stripes

Rumble Strips Skip Pattern



Other states:

GA – 28' rumble / 12' skip

MT – 48' rumble / 12' skip

AK - 34' rumble / 6' skip

Minnesota – 48' rumble, 12' skip

Rumble Strips

(Increasing the Use)

- Work with LTAP to encourage local agencies to use rumble strips
- Increase shoulder width to better accommodate rumble strips on roads with no or narrow shoulders - expensive

Questions?

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