Rural Through/ STOP Intersections (1 of 3)

DESCRIPTION AND DEFINITION

The most common type of intersection in rural roadway systems is the through/STOP controlled intersection, and the most severe type of crash occurring at through/STOP intersections is the right-angle crash. Research completed in Minnesota indicates that in approximately 60 percent of the crashes, the at-fault driver stopped at the STOP sign and then pulled into traffic. As a result, the key contributing factor is gap recognition as opposed to intersection recognition. Strategies that can be implemented to address the majority of gap recognition right-angle crashes include:

- *Intersection Geometry*—Roundabouts and directional median intersections designs are effective at reducing, if not eliminating, right-angle crashes (see Intersection Treatments). Consideration should be given to location characteristics (traffic volumes on approaches, topography, truck volumes, adjacent signalized intersections, etc.) before implementation of a roundabout.
- *Mainline Dynamic Warning Sign*—Implementation of a mainline dynamic warning sign includes the installation of loop detectors on the minor leg approaches and a dynamic flashing sign on the major leg approaches. When a vehicle approaches on a minor leg, the loop detectors send a signal to the mainline sign and flashers warn drivers of a vehicle at the STOP sign.
- *Clearing and Grubbing*—Sight distance at intersections can be improved by clearing and grubbing adjacent right-of-way.
- *Street Lights*—See the Rural Lighting Practice Summary for more information on the ability of street lights to reduce right-angle crashes.

If crash records or comments by law enforcement indicate that intersection recognition (drivers running the STOP sign) is contributing to angle crashes, three additional strategies should be considered:

- *Upgraded Signs and Markings*—Installation of standard set of signs and markings, shown in the figure at end of this practice summary, that may also include larger signs or a flashing light on or around STOP sign or far-left STOP signs. The figure also provides a suggested prioritization of the signs and markings if the group of traffic control is going to be implemented individually.
- *Transverse Rumble Strips*—Transverse rumble strips are horizontal grooves in the pavement at approaches to intersections, typically between 450 to 700 feet from the intersection. Their purpose is to alert drivers to the approaching intersection by both noise and tactile sensation. The goal is to reduce unintentional running of STOP-controlled intersections in rural settings.
- *Flashing Lights*—STOP sign-mounted flashing lights. Overhead flashing lights are not recommended because they may confuse drivers into thinking the intersection was controlled by an All-Way STOP.

Typical Costs

Estimated Implementation Costs:

- Roundabouts and Directional Medians = $500,000 to $1,000,000 per intersection
- Mainline Dynamic Warning Sign = $30,000 per intersection
- Clear Sight Triangle = $4,500 for 4-leg intersection and $2,450 for 3-leg intersection
- Street Lighting = $5,000 to $15,000 per intersection
- Upgraded Signs and Markings = (entire layout) $1,850 per minor leg approach (In the event that an agency has already upgraded signs at an intersection, the pavement markings estimated cost is $700 per minor leg approach.)
- Transverse Rumbles = $2,000 to $3,000 per intersection
- Flashing Lights = $1,000 to $2,500 per sign

ROADWAY OPERATIONS

A Local Road Research Board (LRRB) study documented that drivers approaching an intersection with transverse rumbles slowed down sooner than at intersections without the rumbles.

TYPICAL CHARACTERISTICS OF CANDIDATE LOCATIONS

The 2006 LRRB study suggests that a good candidate for transverse rumble strip installation are intersections where cross-traffic is obscured by man-made structures or vegetation on one or both sides of the intersection.

Rural Through/ STOP Intersections (2 of 3)

SAFETY CHARACTERISTICS

Rural through/STOP intersections on the state trunk highway system averaged 0.6 crashes per year in Minnesota in 2009. Of the right-angle crashes, most are associated with the atfault driver's selection of appropriate gaps in traffic to make his or her maneuvers through the intersection. A minority of the crashes are associated with vehicles not recognizing the control at the intersection and running through without stopping.

Roundabouts and directional medians are high-cost strategies for addressing gap selection type crashes. The strategies prevent the minor road traffic from crossing the major road, minimizing the potential for right-angle crashes. While they are the highest cost, roundabouts and directional medians provide the most benefit, with crash reductions between 40 to 70 percent.

Low-cost strategies, such as street lights, dynamic warning signs, and upgraded signs and markings, also provide benefits, but with crash reductions between 25 and 50 percent. Transverse rumbles, while low-cost, have varying results in terms of crash reductions, from 30 percent reduction in one study to another study finding an overall increase of up to 30 percent in crashes.

PROVEN, TRIED, INEFFECTIVE, OR EXPERIMENTAL

Roundabout—Considered a **PROVEN** strategy (see more information in Intersection Treatment Practice Summary).

Directional Median—NCHRP 500 series considers restriction turning maneuvers as a **TRIED** strategy (see more information in Intersection Treatments).

Mainline Dynamic Warning Sign—Considered an **EXPERIMENTAL** strategy, but initial evaluations in other states indicate a 25 to 35 percent reduction in right-angle crashes.

Upgrade Signs and Markings—Considered a **TRIED** strategy, but initial evaluations in other states indicate an up to 25 percent reduction in right-angle crashes.

Street Lights—Considered a **PROVEN** strategy (see more information in Rural Lighting Practice Summary).

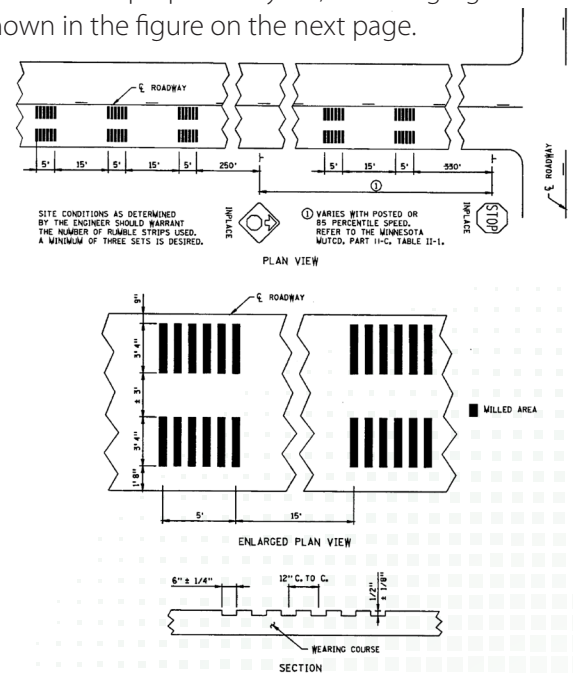
Transverse Rumble Strips—Review of the FHWA Crash Reduction Clearinghouse produced varying results. The crash factors ranged from 30 percent reduction to 30 percent increase in crashes. The challenge with defining a crash reduction is the inability to predict at which end of the range the crash will occur at any given location. Since there is not a clear convergence of crash reduction results, transverse rumbles are considered a **TRIED** strategy.

DESIGN FEATURES

Mainline Dynamic Warning Signs—An example of a mainline dynamic warning sign is shown in the photograph at the end of this Practice Summary.

Upgrade Signs and Markings—The current proposed layout, including sign and marking locations and sizes, is shown in the figure on the next page.

Transverse Rumble Strips—Transverse rumbles should be designed in accordance with MnDOT's Figure 4-4.02D in the *Road Design Manual*.



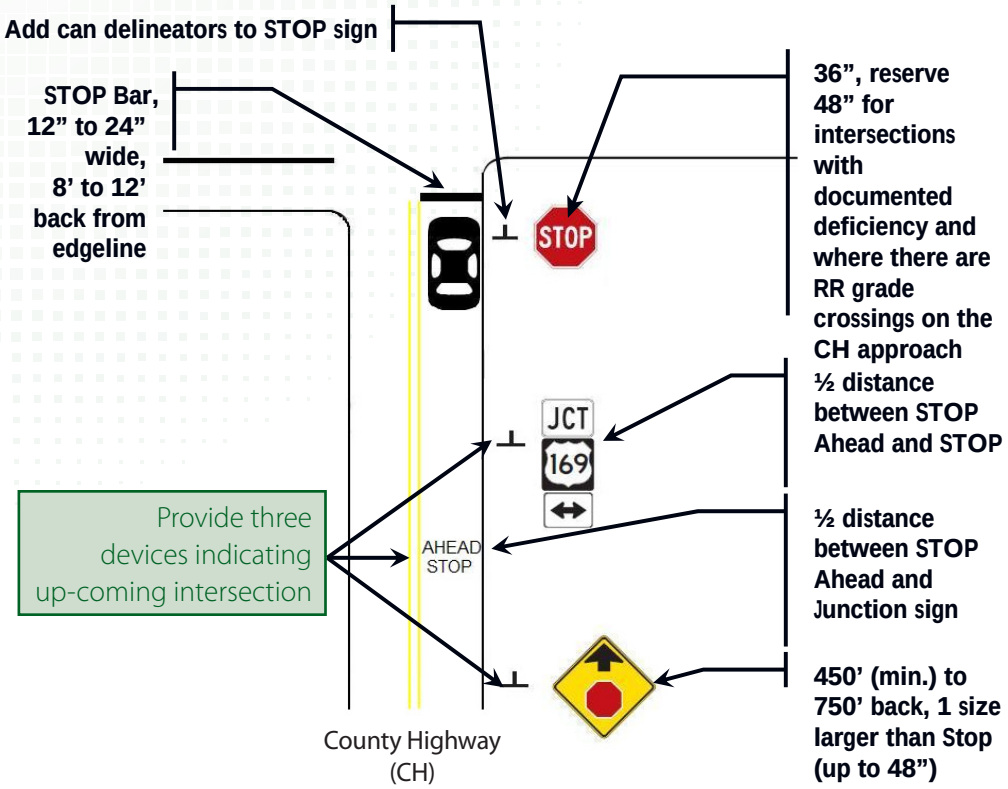
In-lane rumble stips, plan and section views

Rural Through/ STOP Intersections (3 of 3)

Upgrade Sign and Markings Layout

Prioritized/Phasing

1. STOP bar
2. STOP sign
3. Junction sign
4. Stop Ahead Message
5. Stop Ahead Sign



Source: MnDOT Dist 3-13 County RSA - CH2M HILL 2006 Intersections (3 of 8)

Mainline Dynamic Warning Sign

SOURCES

1970d/80d Iowa Highway and Research Board HR-235, Carstens & Woo, A982.
MnDOT's *Transportation Synthesis Report,* TRS 0701, August 2007.
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The Effects of In-Lane Rumble Strips on the Stopping Behavior of Attentive Drivers, Minnesota Local Road Research Board, Report 2002-11, 2002.
The Effect of Rumble Strips on Drivers Approaching Rural, Stop-Controlled Intersections, Minnesota Local Road Research Board, Report 2006-42TS, 2006.
Safety Evaluation of Transverse Rumble Strips on Approaches to Stop-Controlled Intersections in Rural Areas, 2010 Annual Meeting of Transportation Research Board, Srinivasan, R., Baek, J., Council, F., November 2009.

Rural Through/ STOP Intersections Policy

POLICY PURPOSE/INTRODUCTION

The purpose of this policy is to establish uniformity and consistency in the application, installation, and maintenance of through/STOP intersection safety strategies on the ***<Insert Agency>*** roadway system.

POLICY

It is the policy of ***<Insert Agency>*** to implement safety strategies on through/STOP intersections based on a review and prioritization of intersections risk assessment. Strategies that will be considered to address the majority of gap-recognition, right-angle crashes include:

- *Change in Intersection Geometry*—Roundabouts and directional median intersections designs are effective at reducing, if not eliminating, right-angle crashes.
- *Mainline Dynamic Warning Sign*—Implementation of a mainline dynamic warning sign includes the installation of loop detectors on the minor leg approaches and a dynamic flashing sign on the major leg approaches. When a vehicle approaches on a minor leg, the loop detectors send a signal to the mainline sign and flashers warn drivers of a vehicle at the STOP sign.
- *Clearing and Grubbing*—Sight distance at intersections can be improved by clearing and grubbing adjacent right-of-way.
- *Street Lights*—Adding rural street lighting at intersections.

If crash records or comments by law enforcement indicate that intersection recognition (drivers running the STOP sign) is contributing to angle crashes, three additional strategies will be considered:

- *Upgraded Signs and Markings*—Installation of a standard set of signs and pavement markings on the minor intersection approaches.
- *Transverse Rumble Strips*—Transverse rumble strips are horizontal grooves in the pavement at approaches to intersections, typically between 450 to 700 feet from the intersection. Their purpose is to alert drivers to the approaching intersection by both noise and tactile sensation. The goal is to reduce unintentional running of STOP-controlled intersections in rural settings. The long-term success of transverse rumble strips as a traffic control enhancement lies in their very select, limited, and uniform application across an agencies system of intersections that have been identified as being at-risk for right-angle crashes associated with intersection recognition. Transverse rumble strips should not be used as the standard treatment for alerting motorists to conditions ahead. Overuse of transverse rumble strips could reduce their effect on road users, thereby reducing their effectiveness as a safety tool.
- *Flashing Lights*—Flashing lights mounted on STOP signs.

POLICY CRITERIA

Installation of safety strategies should be considered across the system, as opposed to only at individual locations as a reactive application. Research has proven that crashes are not the only indication of risk at rural intersections and decisions to implement should be based on a system-wide evaluation based on the following intersection risk factors:

- Geometry of intersection (skew)
- Geometry of roadway (on or near curves—both vertical and horizontal)
- Commercial development in quadrants
- Distance from previous STOP sign (greater than 5 miles from the previous stop)
- Average Daily Traffic (ADT) ratio (a ratio of 0.4 to 0.8)
- Railroad crossing on minor approach
- Crash history

Rumble strips should be considered only after an adequate trial of less intrusive strategies such as upgrading of signs and marking or flashing STOP signs. The installation of transverse rumble strips should be implemented only after an assessment of the system of intersections, including the review of the following factors:

- The traffic control issues at the site
- Traffic control devices currently in use
- Traffic control alternatives considered or previously used
- Collision history of the site
- The reason transverse rumble strips are being considered
- A description of the location, including distances to nearby residences