2008-25TS
Published 11-24-08

RESEARCH
SERVICES SECTION

TECHNICAL SUMMARY

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PROJECT COST:
$71,000

Researchers captured speed data for building a right-turn crash prediction model.

LRRB
LOCAL ROAD RESEARCH BOARD

Traffic Volume Thresholds for Requiring Right Turn Lanes and Treatments on Two-Lane Roads

What Was the Need?

When improving or building intersections or driveways on two-lane state highways, local governments and permit applicants must follow criteria established in Mn/DOT's *Road Design Manual* and *Access Management Manual* for what level of traffic triggers the need for right turn lanes. These criteria set thresholds designed to maintain safety near intersections, business driveways and other locations where the main thoroughfare lacks traffic signals or other forms of traffic control.

The manual's current volume warrants are based on engineering judgment rather than quantitative analysis and include volume thresholds that have not been definitively validated by research. As a consequence, it is unclear if the approach to intersection design used by Mn/DOT and local agencies is as cost-effective, safe or efficient as it could be.

There was a need to re-evaluate these policies through a quantitative study and definitively establish the traffic volume thresholds for requiring right turn lanes and related treatments, such as shoulder widening, on two-lane roads.

What Was Our Goal?

The objective of this study was to analyze geometric, traffic, speed and crash data for two-lane roads in Minnesota at locations where the main thoroughfare lacks traffic signals or other forms of traffic control. This data is needed to provide firm empirical grounding for volume-based warrants for the implementation of right turn lanes and other treatments.

What Did We Do?

Researchers focused their analysis on determining the safety and operational effectiveness of right turn lanes and treatments. For the safety assessment, researchers analyzed Mn/DOT crash data, developed a model capable of predicting crashes of different severities caused by right turns, and computed the cost for crashes involving right-turning vehicles.

The crash data included all reported crashes from 2000 to 2002 and 2004 to 2005 on two-lane roads that involved at least two vehicles, as well as a subset of this data for crashes involving right turns. Researchers combined the results of this analysis with Mn/DOT crash cost data to calculate the average cost for crashes involving exclusive right turn lanes (right turn only) and shared lanes (with traffic turning directly from the through lane). They then collected field data at 24 intersections with exclusive and shared right turn lanes to build a model capable of predicting right-turn-related crashes at these types of intersection.

For the operational assessment, researchers examined the effect of right turn lanes and other treatments on delays to through traffic and consequent fuel consumption. Field data was collected at 13 intersections and used in conjunction with CORSIM traffic simulation software and data from Mn/DOT's Office of Investment Management to develop simulation and regression models that calculated the average delays and fuel consumption at these intersections. Researchers then developed 20 provisional, volume-based right turn lane warrants for intersections and commercial and public driveways; these warrants balanced the cost to construct a right turn lane or treatment with the savings gained from reductions in crashes and operational costs.

continued

"The volume thresholds developed in this project provide Mn/DOT with legally defensible criteria for requiring private developers to establish right turn lanes."

–Brian Gage,
Access Management Engineer, Mn/DOT Office of Investment Management

"The warrants developed for this study are sensitive to right turn lane construction costs and fuel prices—key factors that vary over time and with geographic location."

–Amiy Varma,
Associate Professor, North Dakota State University Department of Civil Engineering

Produced by CTC & Associates for:
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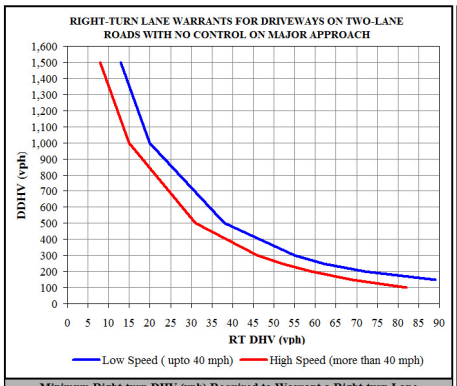
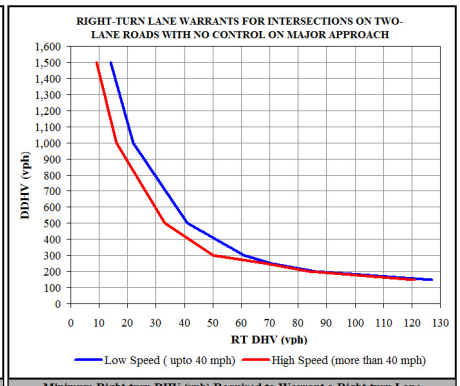


Minimum Right-turn DHV (vph) Required to Warrant a Right-turn Lane
(Right-turn Lane Cost = $30,000 / Cost of Fuel = $3)

Speed (mph)	DDHV (vph)							
	100	150	200	250	300	500	1,000	1,500
≤ 40	NA	89	72	62	55	38	20	13
> 40	82	69	59	52	46	31	15	8



Minimum Right-turn DHV (vph) Required to Warrant a Right-turn Lane
(Right-turn Lane Cost = $30,000 / Cost of Fuel = $3)

Speed (mph)	DDHV (vph)							
	100	150	200	250	300	500	1,000	1,500
≤ 40	NA	127	86	71	61	41	22	14
> 40	NA	121	84	69	50	33	16	9

Researchers developed 20 provisional right turn lane warrants for intersections and driveways, establishing thresholds for volume and speed of through traffic (DDHV) and right-turning traffic (RT DHV) for various turn-lane construction and fuel costs.

Construction costs were calculated with the assistance of the technical advisory panel, with savings due to safety benefits calculated as the difference between the total annual cost for crashes incurred because of vehicles turning from shared right turn lanes and the cost incurred from exclusive right turn lane crashes.

Crash costs were computed using a crash severity model in conjunction with crash cost data from Mn/DOT. Savings due to operational benefits were determined by subtracting the total annual costs for delays and fuel consumed during delays at locations with shared movements from the same costs at locations with exclusive right-turn movements. Costs were assumed to be $13 per vehicle for a typical delay, and $3 or $4 for a gallon of fuel.

What Did We Learn?

The study data suggested that adding exclusive right turn lanes and treatments at intersections and driveways could lead to crash cost savings at high-volume locations where about 45 percent of vehicles on the main thoroughfare turn right: more than $10,000 per year at high-speed locations and $5,000 per year at low-speed locations. At $4 per gallon, exclusive right turn lanes could also save more than $25,000 per year in delay and fuel consumption costs at high-volume locations where about 25 percent of mainline vehicles turn right.

Adding exclusive right turn lanes significantly reduced only rear-end crashes; these had a greater effect on safety at commercial entrances and private driveways than at public intersections.

What's Next?

In the coming months, Mn/DOT will hold discussions about incorporating the results of this study into the *Road Design Manual*. These discussions will incorporate the results of other recent projects, including "How to Determine Optimal Turn Lane Lengths" (2008-14).

This Technical Summary pertains to the LRRB-produced Report 2008-25, "Warrants for Right-turn Lanes/Treatments on Two-lane Roads," published July 2008. The full report can be accessed at http://www.lrrb.org/PDF/200825.pdf.