TECH NEWS
TECHNOLOGY NEWS

November-December 2004

Improving safety at expressway intersections

Tom Maze, CTRE transportation engineer and ISU professor of civil engineering
Tom Welch, state transportation safety engineer, Iowa DOT

This article briefly describes a few innovative safety improvements at problematic at-grade expressway intersections. This information is the result of a study sponsored by the Iowa DOT, Office of Traffic and Safety, and funded by the Iowa Traffic Safety Fund Program.

Conventional safety improvements

The conventional strategy for these intersections is improving signing on the side roads and in the median and then, depending on the crash type experience, adding left and right turn lanes on the main line.

If an intersection continues to have crash problems, the next step may be to add traffic signals. A statistical analysis has not been done to determine if signalization improves safety at rural high-speed expressway intersections. It appears, however, that signalization can convert a right-angle crash problem into a rear-end and red-light-running crash problem.

If right-of-way is available, converting an at-grade intersection to an interchange is the ultimate conventional solution, but a costly one.

Alternative safety improvements

Two-movement cues

The problem with crossing a median-divided expressway intersection in one movement is that it's easy to misjudge a gap in the far-lane traffic. Several low-cost strategies focus on providing cues and guidance to encourage drivers on the side roads to move through the intersection in two movements.

The first movement involves crossing the near lanes and stopping or slowing in the median crossover. The second movement is turning left or crossing the second set of lanes.

Medians

Editor's note

The first article in this two-part series ("Expressway crash data tell an interesting tale," September–October 2004 issue of *Technology News*) reported that crash rates (crashes per million entering vehicles) at at-grade expressway intersections increase with increasing volumes on the side roads. In addition, the proportion of right-angle crashes increases, and crash severity increases.

Intersections on rural commuter routes with moderate volumes on the mainline (10,000 to 12,000 vehicles per day) and high volumes on the side road (above 2,000 vehicles per day) are likely to be the most problematic.

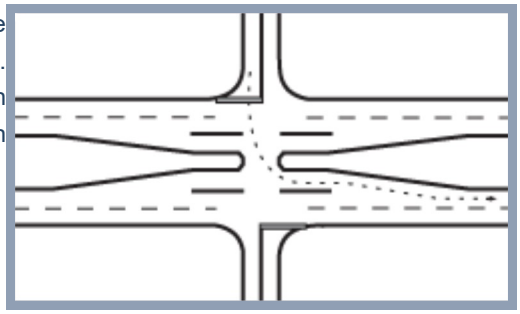


Figure 1. Median left-turn acceleration lane (from Harwood, D.W., "Innovative Intersection Improvements," Midwest Research Institute, Kansas City, MO)

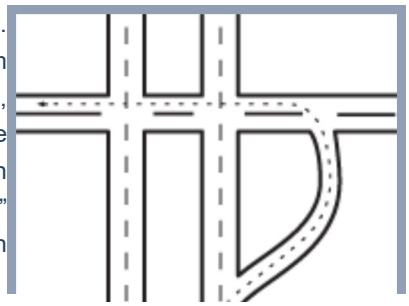


Figure 2. Jughandle (from Harwood, D.W., "Innovative Intersection Improvements," Midwest Research

Several studies have shown that as median width increases, crash frequency declines.
Wider medians encourage drivers to treat the divided expressway lanes as two separate intersections; that is, they encourage a two-movement crossing or left turn. Wide medians also provide ample refuge for long vehicles (e.g., combination trucks and school buses).

However, very wide medians can result in more crashes in the median crossover lanes.

Left-turn acceleration lanes

Unfortunately, not all expressway medians are wide enough to store large vehicles. If widening the median is not feasible, an effective and innovative alternative for traffic turning left from the side road is adding a left-turn acceleration lane in the expressway median, as shown in Figure 1.

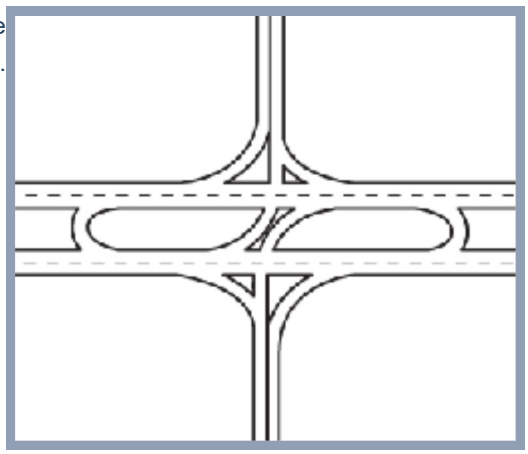
Where this strategy has been applied in Minnesota and Missouri, it has been very popular with drivers and has reduced delays and conflicts.

A left turn using a merge lane is much safer and forgiving than a direct left turn into a high-speed travel lane. The acceleration lane provides large, left-turning vehicles a refuge along the median. By the time the vehicle merges into traffic, it is moving at a speed that reduces the likelihood and severity of rear end crashes.

The acceleration lane also reduces the conflict between a left-turning vehicle from the side road stopped in the median and another vehicle turning left from the expressway. This conflict can be particularly problematic when both vehicles are large trucks.

Institute, Kansas City, MO)

Figure 3.



Directional median opening

Figure 4.

Intersection of U.S. Highways 59 and 34 in Mills County

Ideally, an acceleration lane should be 1,500 feet long to provide heavy trucks with enough distance to accelerate and merge with expressway traffic.

Because most drivers are unfamiliar with left-turn acceleration lanes, some driver education is required. Enhanced pavement markings are also needed to encourage proper use of the acceleration lane.

Indirect left turns

Left turns are a factor in a large percentage of intersection crashes. Some states are implementing strategies to replace left turns, and sometimes cross-traffic movements, with indirect movements.

To eliminate left turns from the expressway onto a side road, jughandles, shown in Figure 2, and loops may be used.
To eliminate left turns from the side road, the median crossover is commonly closed.

In Figure 3, left turns are allowed from the expressway, but left turns from the side road are blocked by a raised median. Drivers wanting to turn left from the side road are forced to turn right and make a U-turn through the median.

Grade-separated intersections

A couple of intersection designs have been built in Iowa that include a grade separation and offset “T” intersections. This design concept could serve as a possible interim improvement to a future full interchange. It involves constructing a bridge over the expressway (the major cost element of an interchange) but not all the ramps, acceleration lanes, and tapers.

Grade-separated intersections are viable alternatives at selected expressway intersections, such as those with narrow medians or restricted rights-of-way or where a lower cost improvement than a full interchange is desired.

An aerial photo of one of Iowa's grade-separated intersections is shown in Figure 4.

This design requires all turns to be made on one connecting turning road and through two T-intersections. It reduces the number of conflict points, and its safety performance is much better than that of similar at-grade intersections. (Turns could be further segregated by building a second connecting turning road in one of the north quadrants of the intersection.)

This design facilitates converting the intersection into a diamond or a partial cloverleaf interchange in the future, if warranted.

For more information

The final report for this project, which contains 17 alternatives for improving safety at expressway intersections, will be online in January 2005.

For information about the study, contact Tom Maze, 515-294-9459, tmaze@iastate.edu, or Tom Welch, 515-239-1267, tom.welch@dot.iowa.gov.