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UTC Spotlight

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Saving Lives and Reducing Injuries from Cross-Median Crashes

Vehicle run-off-road crashes typically account for 30 to 40 percent of all vehicle-related fatal crashes each year. Although only 2 to 5 percent of all divided interstate crashes are cross-median crashes, a staggering 30 percent result in serious injuries and fatalities.

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Figure 1. Median barriers save many lives. In certain circumstances, however, they can also contribute to crash injuries.

Two types of barriers account for the majority of installations on divided roadways: concrete and cable median barriers. Although these barriers can and do save lives in cross-median crash events, if the barriers are improperly designed and/or installed they can present a safety risk for crash victims. For example, if a vehicle crashes into a cable median barrier there is a chance that the vehicle can pass through, under, or over the cable barrier system as shown in Figure 1. If a vehicle crashes into a concrete barrier, there are generally three major concerns: the vehicle may decelerate too quickly; the vehicle may "climb" the barrier leading to a rollover incident; or an occupant's head may go through the side-window opening and impact the concrete barrier (which is known as "head slap"). All three of these events can lead to serious injury or death.

In response to these safety concerns, the Mid-America Transportation Center (MATC) conducted a number of studies on median barriers that resulted in improved designs and installation guidelines. These improvements, discussed below, currently are being implemented and, as a direct result of this research, the risk of death and serious injury in cross-median crashes has been reduced.

Researchers at MATC analyzed more than 6,000 cable barrier crashes from 12 different states in order to determine the causes of cable median barrier containment failures. It was found that vehicles pass under, over, or through a cable barrier in approximately 10 percent of all cable barrier crashes, and experience rollover in approximately 7 percent of cable barrier crashes.

In addition to the crash analyses, researchers examined the effect of median geometry on cable barrier design and placement. As a result, several cable barrier design recommendations were made, including changes to post placement, cable spacing, cable tension, and cable-post connections. It is hypothesized that as many as 80 percent of passenger vehicle penetrations and 50 percent of severe injuries or fatalities associated with cable barrier crashes could be prevented by utilizing the study's recommended designs. Fortunately, all major U. S. manufacturers of cable barrier systems are currently implementing at least one of the study's recommended design modifications.

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Figure 2. Cody Stolle, a MATC graduate student at the time of this picture, measuring a cable median barrier prior to a crash test. Now a Post-Doctoral Research Associate at the Nebraska Transportation Center's Midwest Roadside Safety Facility, Stolle was honored as MATC Student of the Year for his contributions to this research project.

MATC researchers have also completed an extensive investigation into the optimal geometry of concrete median barriers. Typical barriers installed in the United States, including the New Jersey shape, the F-shape, and the single-slope, utilize one or more sloped faces. Under certain crash conditions the wheels of an impacting vehicle may "climb" the median barrier, which may lead to a roll-over incident. In contrast to the typical design, the research team has developed a new barrier that is nearly vertical, as shown in Figure 3. This vertical shape reduces the probability that a vehicle's wheel will climb the barrier in the event of a crash and thus reduces the probability that the impacting vehicle will either roll over the top of the barrier into oncoming traffic or roll back into it's original traffic lane.

In addition to developing a design that reduced the probability of vehicle rollover, MATC researchers also created new designs

that reduce the probability of the driver's or passenger's head making contact with the barrier in the event of a crash. This new design incorporates a large offset at the top of the concrete barrier, as shown in Figures 3 and 4. In effect, this design minimizes the head ejection envelope, which, in turn, reduces the risk of death and serious injury to the vehicle occupants.

The design was developed by identifying an optimal combination of barrier component sizes and dimensions (including barrier width, longitudinal rebar, and stirrup rebar), with a secondary goal of reducing costs. The construction costs associated with this new design were minimized by utilizing slip-forming methods. While these new concrete median barriers increase the safety of the traveling public, they also cost slightly less than existing designs.

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Figure 3. A crash test of the new concrete median barrier. Note that the design is more vertical than standard designs, which reduces the probability of the vehicle "climbing" the barrier and rolling over.

In order to confirm that the design was appropriate, an empirical crash test was conducted at the Nebraska Transportation Center's Midwest Roadside Safety Facility, associated with the University of Nebraska-Lincoln. In particular, the system was evaluated according to the NCHRP No. 350 Test Level 5 (TL-5) safety performance criteria related to tractor-trailer impacts. A photo from the test is shown in Figure 3. The results of the test revealed the design system successfully met all safety performance criteria, and the Federal Highway Administration approved the barrier for use on the National Highway System.

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Figure 4. Implementation of the new concrete median barrier in Iowa. Note that the top of the barrier is more tapered than traditional designs. This new design reduces the probability of a vehicle occupant's head making contact with the barrier in the event of a crash.

The Nebraska Department of Roads and the Iowa Department of Transportation recently implemented versions of this new concrete barrier, and the preliminary results have been promising. Figure 4 shows an installation of the new concrete median barrier in Iowa.

Thanks to funding by the U.S. Department of Transportation via the University Transportation Center grant and the Midwest States Regional Pooled Fund Program, researchers at the Mid-America Transportation Center were able to conduct timely and critical median barrier research that shaped the contemporary barrier design landscape. The adoption of the designs by major manufacturers, the implementation of the new designs by state transportation departments, and the continuation of their use in future installations should prove to be economically sustainable and save lives.

About This Project

Laurence Rilett, Ph.D., is the Director of the Mid-America Transportation Center (MATC), housed at the University of Nebraska-Lincoln. This research project is the collaborative effort of Ronald Faller, Ph.D., Director of the Midwest Roadside Safety Facility (MwRSF) and Research Associate Professor, Karla Lechtenberg, Research Associate Engineer, M.S., and Cody Stolle, Ph.D., Post-Doctoral Research Associate at MwRSF. For additional information about MATC, please contact Laurence Rilett at: lrilett2@unl.edu.