RESEARCH PAYS OFF

Research Predicts Low-Maintenance Attenuator Performance

Texas Department of Transportation

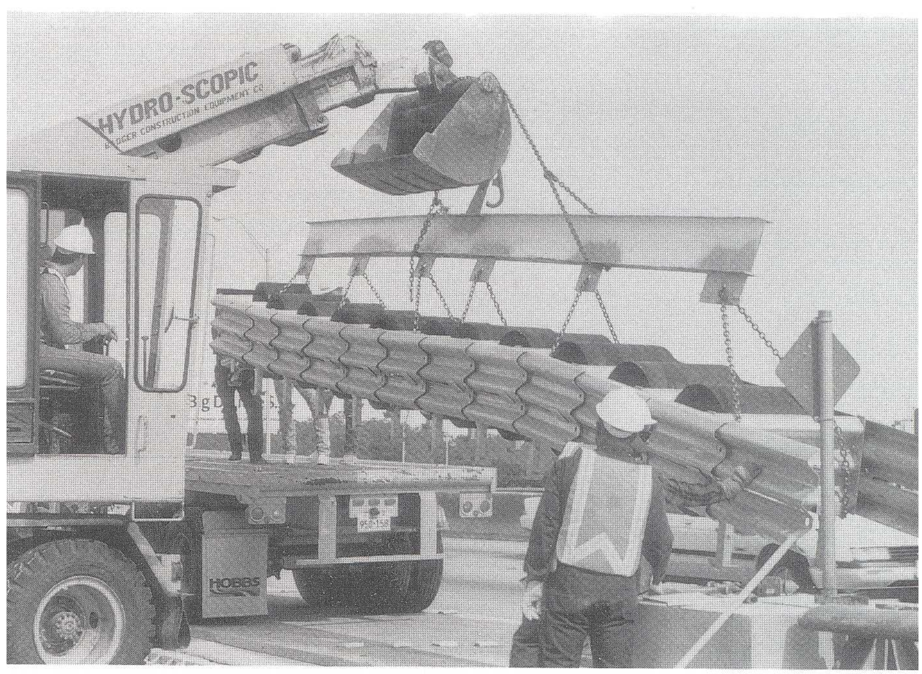
Texas Transportation Institute

Problem

Concrete safety-shaped barriers (CSSBs) have gained widespread use as an almost maintenance-free traffic barrier on high-speed, heavily traveled roadways. However, the blunt end of such a safety shape, untreated and exposed, could be as severe a hazard to motorists as an untreated structural column. Many different end treatments have been tried including sloped ends, flared ends, W-beam guardrail transitions, and crash cushions. Although crash cushions are probably the safest CSSB end treatment, their maintenance can be costly. Existing crash cushions use expendable items such as water, sand, or foam to slow down a head-on impact. Every impact destroys one or more of the energy-absorbing elements, spreading either water or debris onto the roadway. Maintenance activities on heavily traveled streets and freeways interrupt traffic, which increases accident risk. Labor and materials for replacement are costly. Repair cost during the lifetime of a frequently hit crash cushion can be much greater than the initial cost.

Solution

Through the cooperative research program of the Texas Department of Transportation and the Texas Transportation Institute at Texas A&M University, a research study was established to design, construct, and crash test a prototype, low-maintenance end treatment for CSSBs and other narrow rigid objects. The result was a crash cushion based on completely reusable rubber energy-absorbing cells and hinged guardrail fenders that would act as a crash cushion when struck head-on and as a longitudinal barrier when hit from the side.



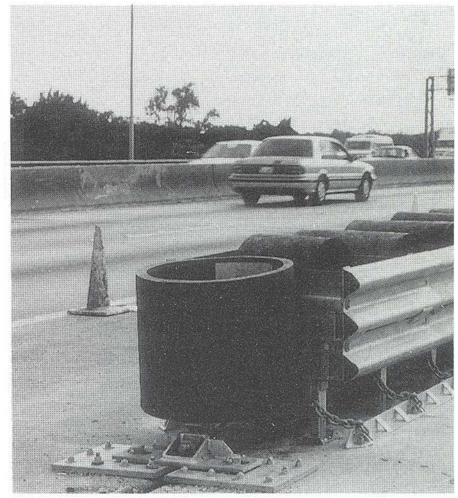
Jse of preassembled low-maintenance attenuator unit saves installation time.

The design, as crash tested, consisted of six thin-walled (1.75-inch) cylinders in the front and seven thick-walled (4.5-inch) cylinders in the rear, separated and supported by steel diaphragms. Skid shoes were welded to the support legs to aid in sliding. Guardrail fender panels were attached to the steel diaphragms. This placement allows unrestrained longitudinal collapse of the cylinders so that they do not drag on the ground, creating excessive frictional forces. Rails and restraining chains prevent excess lateral movement. A rubber cylinder, placed vertically in front of the unit, serves to minimize potential override or underride in vehicle impact.

The end treatment was designed to sustain most impacts without replacement of any parts and to be restored in less than an hour. Because the rubber cartridges do not have sufficient elastic stiffness to completely restore the system after a hit, restraining cables were attached between the diaphragms allowing the cushion to be pulled back into place easily.

TEXAS DEPARTMENT OF TRANSPORTATION

Severe hit sustained by unit on IH-410, San Antonio, Texas.



TEXAS DEPARTMENT OF TRANSPORTATION

Low-maintenance crash attenuator in place.

Application

The performance of low-maintenance attenuators (LMAs) installed in San Antonio and Fort Worth during 1987 demonstrates the reusable nature of the system. San Antonio's LMA installation has been hit at least 20 times in the five years after installation. The hits ranged in severity from collapsing the unit approximately 14 feet to knocking the nose guard slightly askew. In no cases were there fatalities or major injuries. No driver had to be towed from the site. It took, on average, 45 minutes to restore the system, as opposed to the two to three hours required to repair the previous installation of water-filled cylinders.

The LMA installation in Fort Worth, which replaced a high-maintenance sand barrel system, has been hit hard enough to require a crew to pull it back out approximately five times. There have been a number of minor impacts that have not required maintenance. All vehicles striking the LMA have been driven away. It has taken maintenance crews from 15 to 20 minutes to pull the LMA out after it has been hit. During the last five years, major fender hits have required a little more than an hour to repair, at a cost of about $500.

Benefits

The system is performing in the field exactly as predicted by research. The initial cost of an LMA, not including installation, is approximately $28,000, as opposed to $13,000 for more conventional systems. This price difference indicates that the LMA is cost-effective only in an area receiving five or more hits per year. Rather than initial installations on new facilities, LMAs are probably best used as retrofits shielding narrow objects at sites where accident data indicate a high frequency of impacts and where there is no way to eliminate an existing hazard. Additional sites are being proposed for LMAs.

At both the San Antonio and Fort Worth installations, out-of-service time has been minimized and maintenance savings produced compared with the system that was replaced. Department personnel also report that the system performs well in protecting errant motorists from severe injury. For head-on accidents, the end treatment can be repaired in less than an hour and the total repair costs are usually below $100. Additionally, even relatively severe side impacts do not cause major damage to the system.

Accident data for the Fort Worth and Austin LMAs are similar to those of San Antonio.

For additional information, contact Jon Underwood, Engineer of Research and Development, Transportation Planning Division, Texas Department of Transportation, P.O. Box 5051, Austin, Texas 78763-5051 (telephone 512-465-7403).

Suggestions for "Research Pays Off" topics are welcome. Contact Crawford F. Jencks, Transportation Research Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418 (telephone 202-334-2379).