



Project Summary Report 0-4692-S
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Project 0-4692: Development of Portable Concrete Traffic Barriers
for Maintenance Operations

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Short, Portable Concrete Barrier Simplifies Maintenance Operations

PROJECT SUMMARY REPORT

Standards of the Texas Department of Transportation (TxDOT) for portable concrete traffic barriers have evolved over the years to incorporate rail segments that are 30 ft in length and weigh approximately 14,000 lb each. While these barriers serve their function well once they are in position, barrier segments are only nominally “portable” in that they usually require a crane to lift and place them. Maintenance sections do not typically have this type of heavy equipment and must, therefore, rely on rented cranes and operators. The delay between the time the need for the traffic barrier occurs and the time that it is placed can sometimes turn into days. This introduces additional levels of expense and liability and precludes use for many routine and emergency maintenance and construction operations that would benefit from the quicker response time that

a truly portable rail system would provide.

The objective of this research was to develop and test a portable barrier system for high-speed applications that can be easily transported and erected by TxDOT maintenance forces using readily available equipment such as a front-end loader. Consideration was given to factors such as segment length, segment weight, connection method, barrier constructability, and dynamic barrier deflection.

What We Did...

The project panel selected the F-shape barrier with X-bolt connection for further evaluation during this project. This technology was developed in TxDOT Project 0-4162. Adaptation of the X-bolt connection for use in the maintenance barrier provides compatibility with the standard TxDOT X-bolt, F-shape barrier without the need for a special barrier

transition section. Ease of placement, inspection, and repair is an additional reason the X-bolt connection was selected.

The primary means of achieving better portability involved reducing the length of the barrier segments from 30 ft to 10 ft. The measured weight of prototypes of the 10-ft barrier segments with X-bolt connection was 4530 lb. A review of equipment capabilities available to most TxDOT maintenance offices for barrier transport and erection was conducted to determine if this barrier weight and size could be readily accommodated. The preferred method of barrier deployment is to transport the barriers to the work site with a haul truck and put the barriers in place using a district’s existing wheel loaders with approved forklift attachments. Several manufacturers verified that their front-end loaders fitted with fork attachments can safely lift and place



the 10-ft barrier segments. The location and size of the drainage troughs at the base of the barrier segments were modified to readily accept such fork attachments.

Unless there is room to flare the end of a temporary barrier out of the clear zone at an acceptable rate (i.e., one that will not compromise impact performance), a crashworthy end treatment is required to shield motorists from the ends of the barrier. It is important that any end treatment considered for use with the portable maintenance barrier be equally portable using equipment readily available to TxDOT's district offices. A review of available end treatments for concrete median barriers (CMB) was conducted to identify existing products suitable for use with the new barrier. Weight, portability, and ease of deployment were among the factors considered during the product review. Several suitable products were identified, some of which are already approved for use in Texas.

Various analyses were performed to help assess the ability of this barrier system to meet *National Cooperative Highway Research Program (NCHRP) Report 350* impact performance criteria and quantify its design deflection. Predictive finite element computer simulations provided Texas Transportation Institute (TTI) researchers and TxDOT engineers with a more detailed understanding of the three-dimensional impact response of the barrier prior to conducting full-scale crash testing.



Figure 1. Barrier before Test 446924-1.

Subsequent to design and simulation, a full-scale crash test was conducted to assess impact performance and quantify the design deflection of the cross-bolted F-shape barrier (see Figures 1 to 3). The test involved a 5000-lb pickup truck impacting the barrier at a speed of 62 mph and an angle of 25 degrees. The weight of the pickup truck reflects an increase of approximately 15 percent from the weight of 4409 lb of the current design test vehicle in *NCHRP Report 350*. This is a proposed change being considered as part of the update to *NCHRP Report 350* that is in progress in NCHRP Project 22-14(2).



Figure 2. Vehicle Trajectory after Test 446924-1.

What We Found...

The new TxDOT portable concrete barrier satisfied *NCHRP Report 350* evaluation criteria for the modified test designation 3-11 impact conditions. The structural integrity of the barrier and its

connections was maintained, and the barrier successfully contained and redirected the test vehicle in an upright manner. The occupant risk factors were within the preferred limits specified in *NCHRP Report 350*. Although the barrier sustained some damage that would require repair, there





Figure 3. Vehicle/Barrier during Test 446924-1.

were no detached elements, fragments, or other debris that showed potential for penetrating the occupant compartment or that presented a hazard to workers or others in the area.

The dynamic barrier deflection in the more severe impact conditions used for the test was 27 inches. This deflection is less than the 3-ft deflection constraint imposed by TxDOT at the onset of the project. In fact, even though the impact severity was 15 percent greater than required in *NCHRP Report 350*, the F-shape barrier system with 10-ft barrier segments and cross-bolt connection has the lowest deflection of any free-standing, portable concrete barrier approved to *NCHRP Report 350* requirements (other than the original TxDOT X-bolt barrier with 30-ft segments).

The Researchers Recommend...

Based on the results of the testing and evaluation, the new

precast, cross-bolt, F-shape concrete traffic barrier with 10-ft barrier segments is considered suitable for implementation on high-speed roadways. The cross-bolt connection system adapted for use in the new barrier helps limit dynamic deflection during an impact. The low deflection and ease of placement and repair make the barrier well suited for maintenance and work zone operations.

The tolerance available in the X-bolt connection assists with barrier constructability and placement of the barrier on horizontal and vertical curves. When deployed in 10-ft segments, the barrier has a minimum radius of curvature of approximately 125 ft.

Finite element impact simulations were conducted to investigate the minimum installation lengths appropriate for the barrier. A 100-ft installation with free ends and a 50-ft installation with constrained

ends were simulated, and the results showed successful redirection of the finite element vehicle with reasonable barrier deflections. The unrestrained end condition is intended to represent use of the barrier with a free-standing, unanchored end treatment or crash cushion. The restrained end condition corresponds to the use of a fully anchored end treatment or crash cushion. It should be noted that the minimum barrier lengths selected for the restrained and unrestrained end conditions are based on impact performance and dynamic deflection. The required barrier length of need should be determined following appropriate guidelines with consideration given to site conditions, size and lateral offset of hazards being shielded, and protection of workers in the work zone area.

The F-shape profile of the barrier maintains compatibility with the standard TxDOT X-bolt, F-shape barrier with 30-ft segments without the need for a special barrier transition section should it be desirable to connect the systems together. The F-shape barrier profile should provide improved safety in comparison with New Jersey profile barriers by reducing the frequency of rollover crashes. Full-scale crash testing indicates that vehicles impacting barriers with an F-shape profile experience less climb and remain more stable compared to those that impact barriers with a New Jersey profile.



For More Details...

The research is documented in the following report:

Report 0-4692-1: *Portable Concrete Traffic Barrier for Maintenance Operations*

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