Michigan Department of Transportation - M•DOT

# Mates

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## TEMPORARY CONCRETE BARRIER— IT'S ALL IN THE CONNECTION

Temporary concrete barrier helps keep our workers safe by redirecting errant traffic away from the work zone. It also protects the motoring public by separating two-way traffic in construction areas.

A row of temporary concrete barrier is assembled using individual sections, each at least 10 ft long, placed end to end. When an errant vehicle strikes one section of barrier, part of the load is transferred through the end attachment system to the adjacent sections. Thus, if the end attachment system is strong enough, all sections of the barrier act in unison when redirecting an errant vehicle.

### Early Development

A Standard Plan for "Temporary Concrete Barrier" (II-52 A) was first developed in 1972. These first barrier sections were cast in forms, their end attachments consisting of threaded anchors cast into the barrier face. Eye-bolts were attached to the threaded anchors, and a pin was inserted through the eyes to connect adjoining barrier sections (Fig. 1). Since that time the standard has undergone several revisions, changing not only the shape of the barrier (we now use what is known as the 'New Jersey shape' which is steeper and narrower than the earlier 'General Motors shape') but the end attachment system as well.

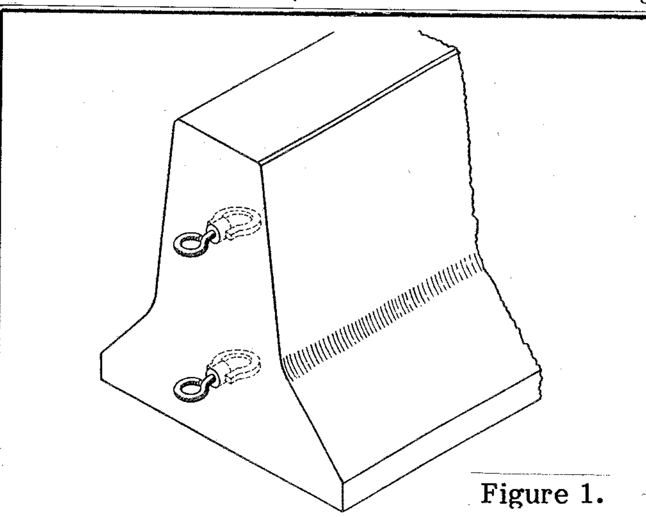

Figure 1.

During the evolution of this standard it was decided that not only would form-cast barrier be allowed, but barrier sections that had been retrofitted from slip-formed barrier could be used. The end attachment system for the retrofitted barrier sections generally consisted of two pieces of reinforcing steel bar, one placed in a hole near the top of the barrier section, and one placed in a hole near the bottom, which were then pushed into similar holes in the next section of barrier (Fig. 2).

In the 1980s, a national research project, sponsored by the Federal Highway Administration (FHWA) developed mathematical models simulating many of the barrier end attachment systems used throughout the U.S. These models evaluated the shear, tensile, and torsional strengths of each barrier end attachment. Based on this work, MDOT decided to investigate barrier end attachment details.

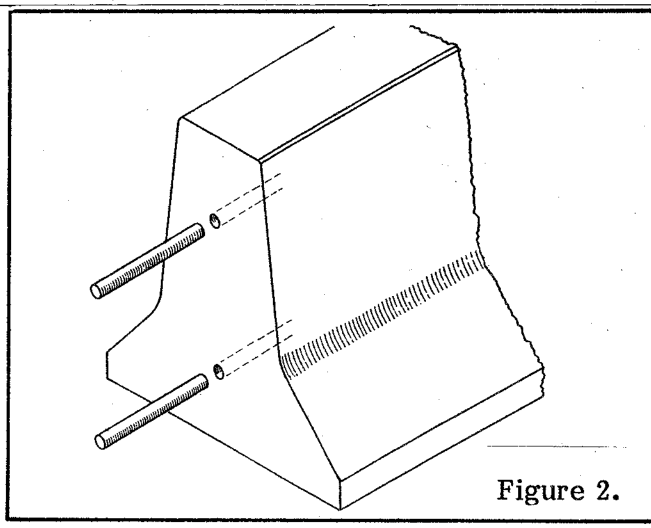

Figure 2.

The eye-bolt and rebar pin attachment systems then current, along with others, were chosen for evaluation. Initial testing involved the mathematical stress model developed in the FHWA-sponsored research. Final testing involved full-scale loading of the individual end attachment systems. The results from both phases of the testing scored MDOT's existing end attachment systems fairly low. One of the other evaluated systems was chosen for development and inclusion in the now-current Standard Plan (II-52 E). This method used a length of 1/2-in. cable bent into a loop and fastened together with two cinches and embedded in a 1-1/2-in. diameter hole 12-in. deep, with an epoxy adhesive cement (Fig. 3). This method proved to be the best during testing, but it requires a large amount of expensive epoxy bonding material to fill the 1-1/2-in. hole. This makes it more expensive than the method discussed below.

In 1989, a contractor suggested a cheaper way using two holes, one for each cable end (Fig. 4). This suggestion

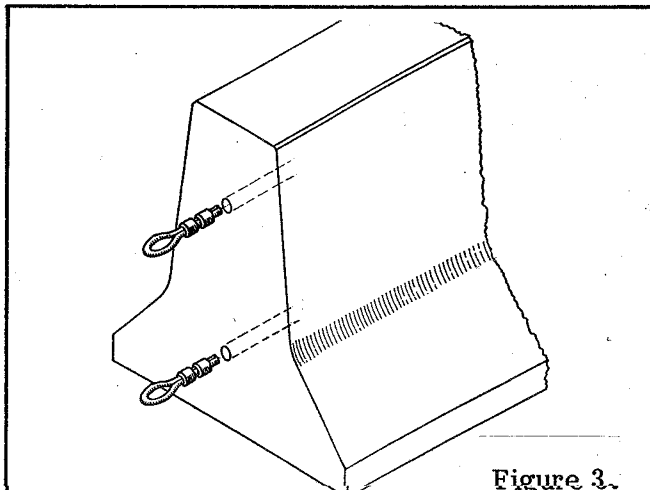

Figure 3.

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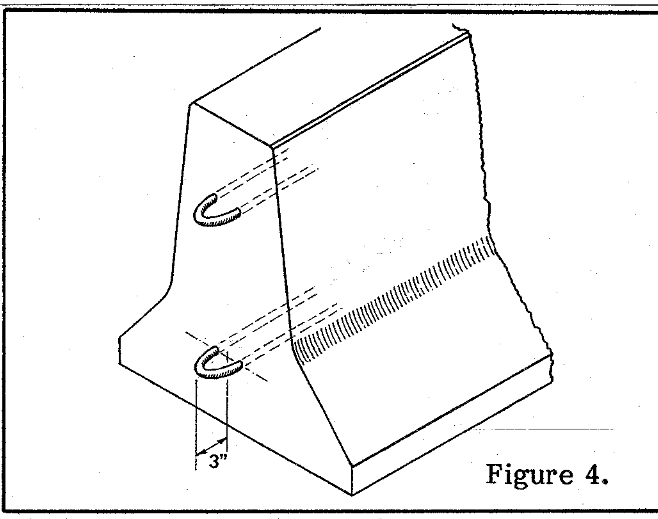


Figure 4.

was reviewed, extensively tested, and is the method described in the "Special Provision for Temporary Concrete Barrier." This special provision is being updated, and will be issued as a supplemental specification.

## Retrofitting Barrier

Some sections of barrier may have been retrofitted previously with a non-standard or obsolete end attachment system. If this is the case, the existing system may or may not need to be removed, but a new end attachment system must be installed.

It is important that the holes be laid out correctly, for if they are drilled too close to the edge of the barrier, the concrete near the edges may fail before the end attachment system reaches its required strength. The standard calls for two 5/8-in. holes. It is important that this diameter not be changed. Most epoxy bonding agents require only a small space between the wall of the hole and the item being inserted if they are to work well. As the hole diameter increases, the strength of the bonded anchorage decreases.

Holes must be drilled a minimum of 12 in. deep and blown out with dry, oil-free compressed air. The holes must be carefully brushed out to remove concrete dust that has adhered to the inside surface, blown and brushed a second time, and blown out one final time. These steps are important, as epoxy cannot bond to a dusty surface. Once the holes are clean, they can be filled with a bonding material selected from the MDOT Qualified Products List (QPL). No matter which approved product the contractor chooses, the anchorage is still required to pass the pull-out test. To form a bond that will develop the maximum pull-out strength it is essential that bonding material displace the air at the back of the hole. A long nozzle or an extender must be used that can reach to the back of the hole when filling the space with the bonding material.

A length of clean, dry 1/2-in. galvanized, wire-centered, steel cable with a tensile strength (ultimate, breaking strength) of 23,000 lb is used. It is important to remove any petroleum-based residue from the cable, lest it weaken the adhesion between the bonding material and the cable. Once the cable is inserted, the distance from the outer edge of the cable loop to the end face of the barrier is checked. This distance must be 3 in. or less. This 3-in. dimension heavily influences the distance between assembled barrier sections. If the 4-in. allowable distance between the barrier sections is exceeded, the FHWA will not participate in the cost of the barrier. For this reason, if any loop exceeds the 3-in. dimension by any amount, no matter how small, the individual barrier anchorage should be rejected.

## End Attachment Systems for Cast Barrier

Two end attachment methods for precast barrier sections are allowed, the cinched method and the continuous cable method. The cinched method, now modified in the supplemental specification, calls for a length of cable to be bent in half. The two ends are then tied together using three cinches. The loop must have a 2-in. inside diameter and be embedded 18 in. The loop can extend no farther than 3 in. from the face of the barrier to the outside edge of the cable. The continuous cable method uses a length of cable which extends through the whole length of the cast section. The ends of this cable are bent back, and then attached to the cable using two cinches. The cable end must extend back into the barrier a minimum of 12 in., and the loop must have a 2-in. inside diameter. The cable can extend no farther than 3 in. from the face of the barrier to the outside edge of the loop.

## Testing the Barrier Sections

Once all barrier sections have been fabricated and the end attachments installed, the contractor contacts the MDOT District office to schedule testing. Testing of the barrier can take place either in the contractor's yard or at the job site, but under no circumstances should any barrier be placed until all testing has been completed. Each end attachment system on every section of barrier must be checked for dimensional tolerances.

Pull-out testing is conducted on a selected number of barrier loops. A standard pull-out test unit has been issued to each MDOT District. Each unit should be returned to the Materials & Technology Division annually for calibration. If a unit is leaking hydraulic fluid, or its results are suspect for any reason, its use should be discontinued immediately and the unit returned to Lansing. A detailed description of the testing routine is available as Michigan Test Method (MTM) 715-91.

## On-Site Barrier Installation

Once the barrier sections have been delivered to the construction site, the overall condition of all the barrier sections is checked. Those that exhibit excessive spalling are rejected. Before placement of the barrier sections the contractor is required to clean the roadway surface area where the barrier sections are to be placed, as well as the underside of the barrier, so that any materials that will reduce friction between the barrier section and the underlying pavement are removed. This includes sand, gravel, dirt, ice, snow, and other debris.

Correct placement of barrier sections requires that the cable loops and the pin be fully engaged. After the first barrier section is placed the next section is swung into alignment. The pin is then placed in the loops and the barrier section pulled away from the first, to ensure that the pin and steel cable loops are fully engaged. Once assembled, the gap between the sections must not exceed 4 in. The barrier sections must present a smooth appearance toward traffic, so that snagging and associated damage to an errant vehicle will not occur.

## Alternative Attachments

In its on-going effort to improve the safety and effectiveness of job site barriers, MDOT continues to explore promising alternatives. Recently a contractor submitted two alternate end attachment designs for review. Both were extensively tested, and have passed all the tests required of the two-hole method. These two methods have been approved on a one-time basis to see how well they perform in the field.

-Bard Lower

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