TRUCK MOUNTED IMPACT ATTENUATORS USED IN VIRGINIA

by

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Virginia Highway & Transportation Research Council
(A Cooperative Organization Sponsored Jointly by the Virginia Department of Highways & Transportation and the University of Virginia)

Charlottesville, Virginia

May 1984
VHTRC 84-R33

TASK GROUP ON MOBILE IMPACT ATTENUATORS

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ABSTRACT

The dense, high speed traffic on some of Virginia's highways necessitates taking the extreme measure of protecting the Department's maintenance personnel by placing a blocking truck in a lane that has been closed for repairs. To protect anyone who might crash into the blocking truck, an impact attenuator (TMA) can be attached to the back of the truck. The purpose of the study reported here was to gain experience in the construction and use of the Connecticut type attenuator and to assess its acceptance by field personnel.

For this study, six Connecticut type units were built in three districts. Additionally, at least 2 units were in service in the Richmond District, one of them on the Richmond-Petersburg Turnpike. An analysis of the information obtained from personnel who use the TMA's revealed that their view of its use was influenced most by --

1. the extent to which they understood its purpose,

2. the degree to which they perceived it to protect them on the job,

3. the attitude of their supervisors towards its use, and

4. the extent to which they believed its use to make operations with the truck difficult and to conflict with the Department's policy on "utilization percent" for trucks.

It is recommended that the Department develop a policy on the use of TMA's and guidelines for their use. Also, it is recommended that crews who use the TMA's should be given appropriate training.

PREFACE

In the late 1970s, the Richmond District and the Richmond-Petersburg Turnpike requested that the Virginia Highway and Transportation Research Council determine the state of the art of truck mounted impact attenuators. In response to this request, the Council issued the report entitled "Mobile Impact Attenuators -- State of the Art" in July 1978. Less than a year later, the Department's value engineering unit did a report on TMA's, and then contacted the Council with the suggestion that 402 - federal highway safety funds might be obtained for building TMA's and investigating their acceptance by the crews in the field. Thus, the Virginia Department of Transportation Safety came to support the study reported here. A task group of R. L. Fink, assistant maintenance engineer; D. O. McAllister, traffic engineer with the crash investigation team of the Division of Motor Vehicles; A. L. Thomas, traffic and safety engineer; M. B. Vann, assistant construction engineer; and W. E. Winfrey, materials engineer (formerly assistant district engineer, Richmond District) was formed to provide guidance for the study.

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INTRODUCTION

With the increase in multilane, high speed highways and the need for highway workers to perform various tasks on the roadway came the need to protect those workers from errant vehicles. The use of a blocking truck has been one method of providing such protection. While the blocking truck has been effective in protecting work crews, it has constituted a relatively stationary object, and the crashes in which cars have impacted it from the rear have been quite severe. To try to decrease the severity of this type of crash, impact attenuation devices have been designed to be either towed or carried behind the blocking truck.

A 1978 report by the writer provides considerable information on three types of TMA's.(1) The most noticeable difference in these units is in the materials used for the crushable components. The Connecticut unit uses four steel pipes supported in a guidance frame, see Figure 1; the Texas unit, Figure 2, uses 55-gallon (0.208 m^3) drums arranged in various configurations depending on the amount of force it is designed to attenuate; and the Energy Absorption Systems, Inc. (EASI) unit, Figure 3, uses lightweight concrete cylinders encased in plywood boxes.

The decision to experiment with the Connecticut unit in Virginia was based on the following reasons:

1. It had been more thoroughly crash tested according to the guidelines in NCHRP Report 153 "Recommended Procedure for Vehicle Crash Testing of Highway Appurtenances" than had the other two.(2)

2. It appeared to be sturdier and thus would require less maintenance than the other two.

3. It was easier to inspect than the EASI unit, because of its open construction.

Figure 1. Connecticut type impact attenuator attached to a dump truck.

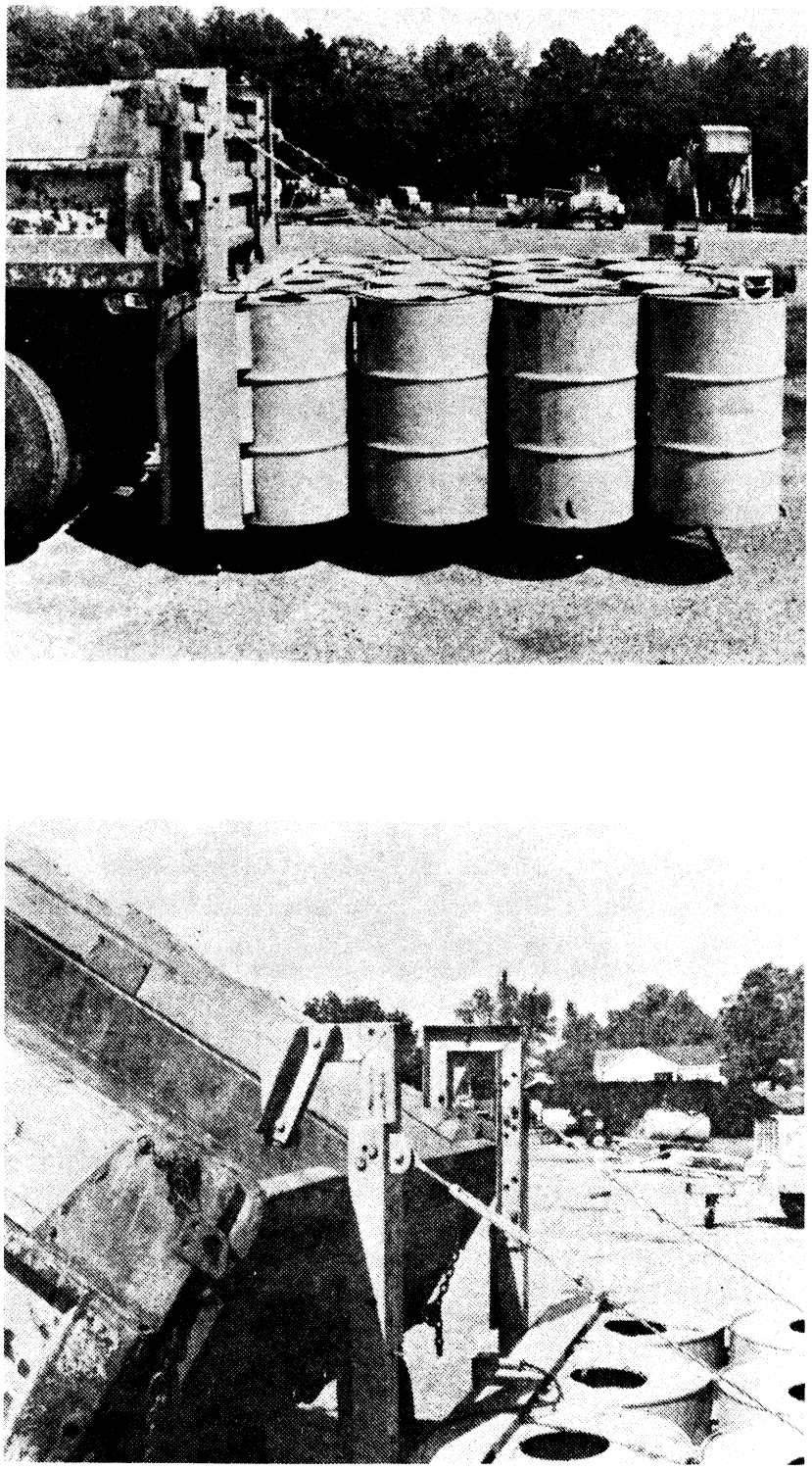

Figure 2. The Texas unit that uses steel drums as the crushable component.

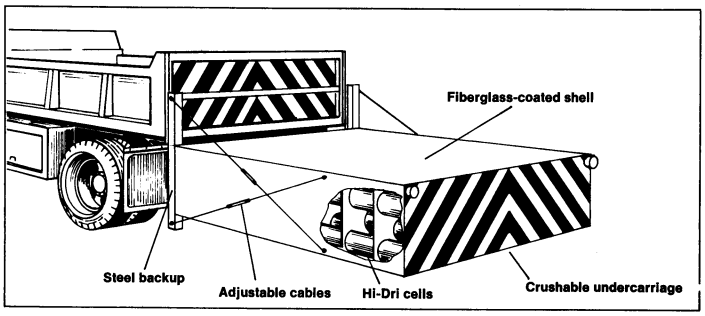

Figure 3. EASI unit showing the internal arrangement of the lightweight concrete crushable cylinders.

PURPOSE

The purpose of the study reported was to construct six Connecticut type TMA's, gain experience in the construction techniques, use the TMA's in the field in maintenance and striping operations, and assess the acceptance of the TMA's by field personnel.

SCOPE

The scope was limited to an evaluation of the acceptance by field personnel of the TMA's based on interviews with the members of the crews using them. Three districts participated in the program, but personnel in only two of the three gave interviews. Inasmuch as Connecticut type TMA's were already in use in the Richmond District, interviews were solicited from some of the district's field personnel.

METHOD

Sketches of the various components and a list of the materials needed for the construction of the Connecticut type TMA were distributed to the district equipment engineers. One equipment engineer had a set

of work drawings prepared and made them available to the others. Liaison between the Department's engineers and the Connecticut Department of Transportation's engineers was provided by the Council, so that questions relative to the construction of the TMA were answered and minor modifications to the device were discussed with the engineer who designed the TMA.

Observations were made of the units in use and of maintenance situations where a unit might appropriately have been used. After the TMA's had been used for at least one season, a questionnaire was administered to some of the field personnel to gain insight into those factors that affect what they think about the TMA's. After completing an interview session, the pertinent comments that were made by the field personnel were noted.

The pertinent comments made by the field personnel prior to and after the interview session and during all other conversations, either in person or on the phone, were noted.

RESULTS

Construction Process

Constructing the TMA's provided the Department with valuable experience. The welding of the aluminum used in the impact plate assembly and the movable component of the guidance frame was not a routine welding task. It was accomplished, with a minimum of warping, by using a Miller wire welder with 0.035 inch (0.9 mm) diameter aluminum wire and a gaseous mixture of argon and carbon dioxide as a flux and for cooling. Two minor modifications were suggested by departmental personnel to ameliorate two problems that had been noted as the TMA's were used. The slots that were cut in the rearmost pipe were elongated in normal usage by vibration. Holes much wider in diameter than the width of the slot were either drilled or burned at the ends of the slots to stop, or at least impede, further elongation of the slot, Figure 4. Second, the abrupt lower edges of the impact plate assembly tended to hang up on any sharp projections from the pavement surface. Railroad tracks were particularly objectionable. To eliminate this problem, three steel shoes were attached to the bottom of the assembly, Figure 5.

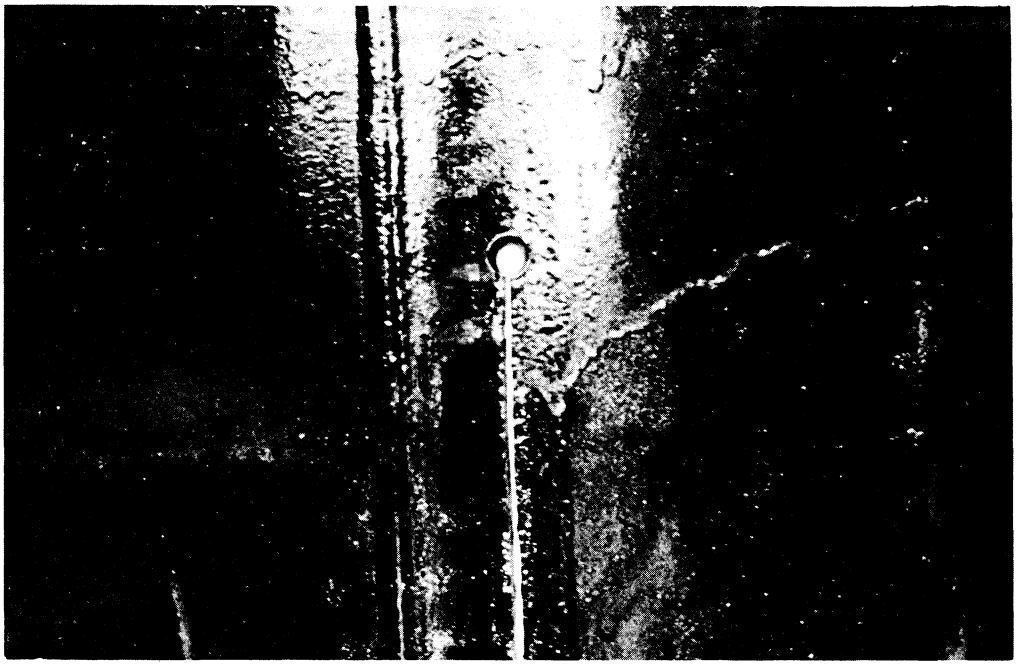

Figure 4. Slot cut to initiate collapse of pipe, with hole at ends to impede cracking.

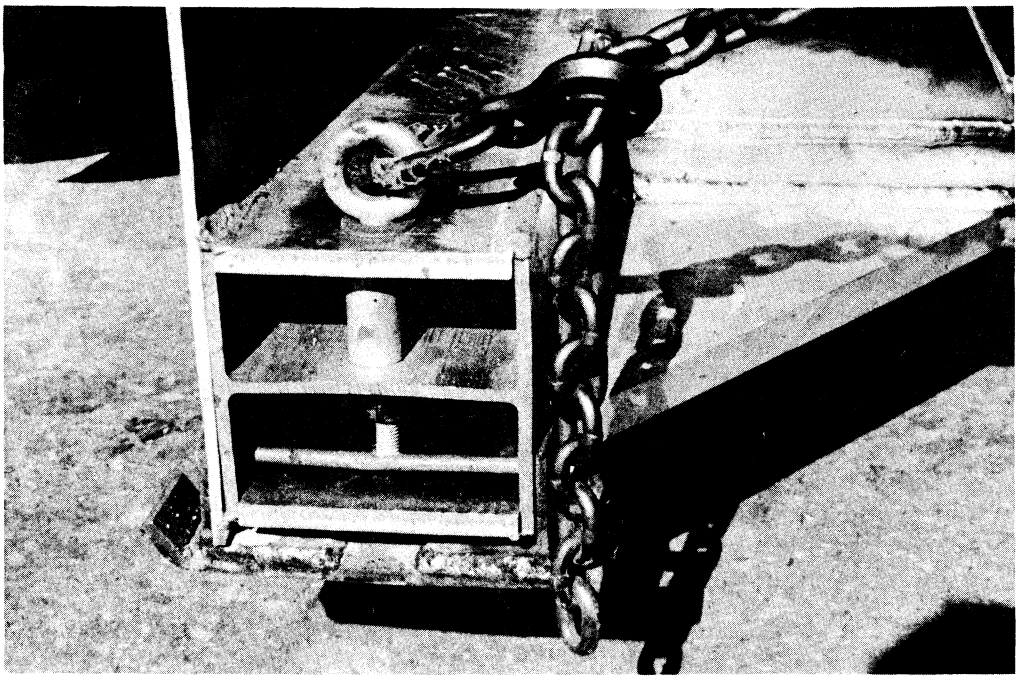

Figure 5. Shoe on bottom of impact plate and its support.

Questionnaire Interview

The purpose of the TMA was to help protect the crew, the blocking truck and driver, and the driver and passengers in a crashing vehicle. The answers to the questionnaire indicated that the persons who best understood the purpose of the TMA tended to favor its continued use. The responses also demonstrated that the workers who felt safe because the TMA was used wanted to continue using it. Also, when the supervisor of a crew had a positive attitude toward the TMA, the crew members tended to have positive attitudes as well.

Conversations with Field Personnel

The most frequently voiced comment was a complaint about the effect of the TMA on the handling or maneuverability of the truck. Limits use of truck, TMA drags pavement, and manpower was wasted by the operator staying with the device were among the many complaints.

One complaint that was not anticipated and is of special interest related to having to adhere to the Department's rule on the percentage of time (92) a vehicle had to be utilized, called utilization percent, for the truck that carried the TMA. The rationale was that if the Department was going to force a crew to use a piece of equipment in what to them was an abnormal, inefficient manner, the least the Department could do would be to relax some of the rules and regulations governing the use of that equipment, such as decrease the utilization percent or the rental rate. However, the answers to the questionnaire indicated that none of the crews attached and detached the TMA from the blocking truck as might be needed to make it easier to use the truck in the normal manner. Regardless of the rationale applied, the subject is worthy of administrative consideration.

A reasonably fair generalization is that nobody wants to use good or new equipment as a blocking truck. Because if it does get hit, it is usually demolished. Thus, the tendency has been to use older trucks that ofttimes are a nuisance to keep running.

Two of the supervisors who had positive attitudes toward the TMA mentioned that educating the crews in the purpose and handling of the TMA might tend to develop a more positive attitude toward its use.

One crew stated that manpower was wasted because a man had to stay with the truck when the TMA was attached. This is an incorrect assumption, as is explained later. During field observations it was noted that the operator of a blocking truck with a TMA attached stayed relatively close to the truck, and thus did not participate in the normal work of the crew. Such a practice seems to be both wasteful and dangerous; however, it was necessary because a flashing arrow was being run

off the truck's electrical system and if the engine had stopped the arrow would quickly have run down the truck's battery. Thus the complaint is irrelevant, inasmuch as the man stayed with the truck because of the flashing arrow, regardless of whether or not the TMA was attached. Ideally, there should be no activity or people in proximity to a stationary blocking truck because of the potential for injury should the truck be struck.

An EASI unit has been assigned to the Van Dorn maintenance headquarters in the Northern Virginia Division ever since the completion of a contract in the late 1970s to install glare paddles on top of the median barrier for I-495. The supervisor said that the unit is in good repair and that he expects to use it in situations where the work crew is especially vulnerable. The specific situation he mentioned, by way of illustration, was when work must be done on a stationary impact attenuator located in a gore area.

A second EASI unit of more recent design has been ordered for the Manassas Residency. The purchase request was initiated by the resident engineer because of his concern for the safety of personnel who must work in slowly moving work zones along I-66 and I-95.

The maintenance supervisor for the Richmond-Petersburg Turnpike has three Connecticut type TMA's. He intends to assign one to each of the three areas into which the 35 miles (56.3 km) of turnpike are divided for the purpose of maintenance. He plans to permanently leave a unit on the blocking truck that works out of the turnpike headquarters on State Route 10. The other units will be attached to blocking trucks in April and will be removed in November. The TMA's are to be used whenever a blocking truck is used. When the supervisor was reminded that the TMA's should be relatively easy to put on and take off, thus maintaining the versatility of the truck, he remarked that the foremen and supervisors don't always have the time to oversee such operations, and that when such a task is left to laborers and operators minor damage is frequently done to the equipment. Thus, it is easier and, in the long run, more productive to leave the equipment on the trucks for relatively long periods of time.

CONCLUSIONS

The Virginia Department of Highways and Transportation is using two types of TMA's and has a third type on order. The Department does not have guidelines for their use; thus, they are being used in whatever manner is deemed best by the supervisors. This tends to lead to inconsistency in use. Most of the circumstances under which the TMA's are being used involve high speeds and volumes of traffic such as occur on the interstate highways. However, the frequency of their use and the physical parameters (type truck to which they are attached, location of the unit relative to the work crew, type work site, etc.) under which they are used are quite varied. The inconsistency in usage can be illustrated, on a different basis, by comparing the Tidewater, Richmond plus Petersburg, and the Northern Virginia Division areas, three of the areas in the state that have high speed and high density traffic. As is shown in Table 1, the areas have comparable interstate and toll road mileages, yet drastically different levels of usage of TMA's. The differences in miles of roadway to which one TMA is dedicated is obvious, ranging from 18 miles in the Richmond-Petersburg area to 82 miles in the Northern Virginia Division. The Tidewater area does not have a TMA. However, there are differences in usage even for the Richmond-Petersburg area, which has five units. The turnpike has one TMA dedicated to each 12 miles of its roadway while the rest of the area has one TMA per 32 miles. In addition, there seems to be a difference in the commitment to use the TMA's for the supervisor for the turnpike is enthusiatic, while the supervisors in charge of the other two TMA's are lukewarm. This lack of consistency may create situations for the public and the Department's work crews in which the Department could be liable.

Table 1

Comparison of Approximate Mileages of Interstate
And Toll Roads With Assigned TMA's

Area	Mileage	Number of TMA's
Tidewater	74	0
Richmond-Petersburg	91	5
Northern Virginia Division	82	1

As regards the workers' attitudes toward the TMA, it appears that the extent of the workers' understanding of the purpose of the TMA, their sense of safety, and the attitude of the supervisors toward the TMA have a direct affect.

RECOMMENDATIONS

It is recommended that the Department develop a policy on the use of TMA's on blocking trucks and, as an adjunct to the policy, develop guidelines that would take into consideration where, when, and how to use TMA's.

It is also recommended that crews who will be using the TMA's be given appropriate training.

ACKNOWLEDGEMENTS

A study of this nature involves a great many people, from those who initiate the action that eventually is the subject of the study to those who carry out some activity in the study. The concern over the subject of this study that was expressed throughout the Virginia Department of Highways and Transportation was appreciated. The researcher would like to call attention to three individuals who contributed to the study in a significant way. M. O. Harris, technician supervisor, administered the questionnaire, talked with crew members and noted their informal comments. His handling of the interviews and developing a rapport with the field personnel was greatly appreciated. H. L. Everette (retired) and E. M. Mitchell, district equipment engineers, attacked the task of constructing the TMA's with enthusiasm. They were innovative in adapting the design of the TMA to their equipment and were quite helpful to the other equipment engineers who constructed units.

REFERENCES

1. Noble, D. F., "Mobile Impact Attenuators - State of the Art", Virginia Highway and Transportation Research Council, Charlottesville, Virginia, July 1978.

2. Bronstad, M. E., and J. D. Michie, "Recommended Procedures for Vehicle Crash Testing of Highway Appurtenances", National Cooperative Highway Research Program - Report No. 153, Transportation Research Board, Washington, D. C., 19 pp., 1974.