

CHAPTER 3 – END TREATMENTS

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3.1—INTRODUCTION

When a roadside barrier (w-beam guardrail, cable barrier, bridge railings, roadway barrier or temporary barrier) has an untreated or unprotected end, a crashworthy end treatment is typically used at the end of these barriers unless it is not required due to the location of the barrier. Typical end treatments consist of trailing end anchorages, end terminals and crash cushions. Each treatment type is typically required to be test level 3 (TL-3).

3.2—ANCHORAGES

Anchorages are typically used with flexible (cable barrier) and semi-rigid barrier (w-beam guardrail) to anchor the barrier to the ground to develop its tensile strength during an impact. Anchorages are not considered crashworthy and are typically used on the trailing end of a roadside barrier on one-way roadways or on the approach or trailing end of a barrier outside the clear zone that is not likely to be impacted by an errant vehicle or that is shielded by another barrier system. Refer to the DOTD guardrail **Standard Plan** trailing end detail for further information. Anchorages are typically crash tested for Test Level 3 (TL-3) applications.

3.3—TERMINALS

Crashworthy end treatments or terminals are used to anchor a flexible or semi-rigid barrier normally at the end of the barrier located within the clear zone or likely to be impacted by errant vehicles. Most terminals are proprietary and are designed for vehicular impacts from only one side of the barrier. However, a few terminal designs have been developed for median applications for possible impact from both sides.

Refer to the DOTD guardrail **Standard Plans** for end treatment details and the DOTD Materials Section Approved Materials List (AML) for a listing of approved DOTD end treatments. End treatments are typically crash tested for Test Level 3 (TL-3) applications.

3.4—IMPACT ATTENUATOR INTRODUCTION

Impact attenuators or crash cushions are protective systems that help aid an errant vehicle from impacting an object by either gradually decelerating the vehicle to a stop when hit head-on or by redirecting it away from the feature when struck from the side. Impact attenuators are typically used at sites where rigid objects or other features cannot be removed, relocated or made breakaway or where they cannot be adequately shielded by a longitudinal barrier.

Impact attenuators may also be used in the protection of work zones particularly with the use of temporary barriers or other barriers. Impact attenuators may commonly be applied at an exit ramp gore area on an elevated or depressed structure in which a bridge rail end merits shielding. Impact attenuators may be used to shield roadway median barrier ends. Crash cushions are typically crash tested for Test Level 2 (TL-2) or Test Level 3 (TL-3) applications.

Impact attenuators can be classified in many different manners. A fully re-directive or non-gating crash cushion will safely redirect a vehicle that impacts any location along the face of the device. A non-re-directive or gating device will either capture an impact vehicle or allow it to pass through when hit along the face of the device. Impact attenuators are rated for different speeds and also vary in width based on the object the device is protecting or may require transition hardware. Depending upon the crash cushion type, a foundation pad and rigid backup may be needed for installation purposes. All systems have their own designs and shall be installed according to the manufacturer's recommendations.

Manufacturers also classify their systems based on repair, restoration and maintenance costs. As per the AASHTO Roadside Design Guide, impact attenuators can be classified as sacrificial, reusable, or low

maintenance/self-restoring. Sacrificial attenuators are designed for single impacts only and must be replaced. Reusable attenuators may be able to survive most impacts intact and can be salvaged when the unit is being repaired, but some of the components may need to be replaced to make the system crashworthy again. Low maintenance impact attenuators typically suffer very little damage from most impacts and can easily be placed back into their full operation condition, however a full inspection after impact is always required.

Depending on the expected crash frequency at a particular location, a specific category may be warranted for use. DOTD preference is to use fully re-directive/non-gating devices that are either reusable or low maintenance. Sacrificial attenuators shall not be used in permanent applications on DOTD projects without permission from the Bridge Design Administrator.

Refer to the DOTD Non-Standard (NS) Special Provisions and pay items for permanent and work zone applications. The impact attenuator systems allowed shall be listed on the DOTD Approved Materials List (AML).

3.4.1—DESIGN CRITERIA AND SELECTION

In general, attenuators are to be aligned parallel to the roadway. Impact attenuators are to avoid placement of curbs between the attenuator and traffic. Refer to the specific attenuator manufacturer's instructions if considering placement of curbing between an attenuator and the traveled way. It is desirable that existing curbing be removed and the surface smoothed with asphalt or concrete pavement before an impact attenuator is installed.

To select an appropriate impact attenuator system, factors such as posted speed, operating speed, ADT, repair crew exposure, proximity to roadway, anticipated number of yearly impacts, available space, maintenance costs, initial costs duration of use (permanent or temporary use), and width of object to be shielded should be considered. It is important that fixed objects, either permanent or temporary (such as construction equipment), are not located behind the non-redirective portion of these devices. A system tested for a higher speed than the posted or operating speed is acceptable for use.

For all permanent installations, only test level 3 attenuators shall be used unless otherwise noted in the plans. If the site cannot accommodate a test level 3 attenuator and the posted speed is 45 mph or less, a test level 2 attenuator may be used with an approved design waiver from the Bridge Design Administrator.

In selecting a system, the anticipated exposure to traffic of workers making any maintenance repairs should also be considered. Thus areas with high traffic exposure should consider a low maintenance system that can be repaired quickly.

Installation of low maintenance impact attenuators should be considered at locations that meet more than one of the following criteria:

- Sites with ADT of 25,000 or greater
- Sites with a history/anticipation of more than one impact per year.
- Sites with unusually challenging conditions such as limitations on repair time, a likelihood of frequent night repairs or narrow gore areas.

A design waiver is required from the Bridge Design Administrator to use any device other than a low-maintenance device in the project design documentation for the project locations meeting more than one of the above criteria. For all other locations, use the reusable impact attenuator category. For a description of requirements that need to be met in order to be included in the low maintenance impact attenuator category AML, see Section 3.4.2.

3.4.2—LOW MAINTENANCE ACCEPTANCE CRITERIA

The LA DOTD Bridge Design Section maintains a list of low maintenance impact attenuator systems that are used by our designers in the preparation of project plans and specifications as per our DOTD Approved Materials List (AML). In order to be classified as low maintenance attenuator and included on the list, cost data collected by LA DOTD must confirm that the average repair cost (not including mobilization and traffic control pay items) for the unit is \$1,000 or less. The low maintenance attenuator DOTD AML list is reviewed periodically by the Bridge Design Section using available data from the LA DOTD District offices to confirm that the devices qualify under the repair cost threshold and consider whether new devices should be added.

Approved impact attenuator systems that have little or no performance history with LA DOTD may also be considered for inclusion on the DOTD AML with concurrence from the Bridge Design Engineer Administrator. Interested vendors or distributors are responsible for requesting and obtaining approval and providing backup documentation. In order to be considered for acceptance as a low-maintenance device, the following requirements shall be met:

- The attenuator system must have a FHWA eligibility letter and be listed on the LA DOTD Approved Materials List (AML).
- The attenuator system must have been in service for a minimum of two years.
- A two-year “In service evaluation report” must be provided. The report can be based on the usage in Louisiana and/or other states that represents a minimum of 25 impacts as a basis for repair history. The impacts provided must include both side and leading end impacts. At a minimum, the “In-Service Evaluation Report” must include the following:
 - Incident type such as side hit, frontal hit, unknown, etc. (if available)
 - Repair date and location of device
 - Parts name and/or designations that were needed for repair (itemized list)
 - Cost of parts and labor needed for repair
 - Repair time needed to complete the repair (hours)
 - Man hours needed to complete the repair (hours)
 - Repair personnel contact information (if available)

The LA DOTD Bridge Design Section is responsible for maintaining the low maintenance attenuator AML and reserves the right to interpret information about device performance, developed either by LA DOTD or provided by other parties in evaluating data and drawing conclusions on low-maintenance performance.