

Introduction

Crash Cushions, End Treatments and Barriers

Crash cushions and end treatments are devices designed to reduce the severity of an impact by an errant vehicle and as described herein, they may be located in roadway medians, gore areas, or along the roadside. These devices have been developed for specific applications such as limited shoulder width, temporary construction installations, high frequency impact sites, and the protection of wide hazards.

The approval of these devices by the Federal Highway Administration (FHWA) for use on Federal-Aid projects has created the need to provide up-to-date information on the proper use(s) of each device. The application chart, along with the attached product information sheets, product summaries, and the following glossary, will provide guidance in the selection of these devices on CDOT projects. This updated information reflects the FHWA's 1996 requirement that only devices that have passed crash testing according to the National Cooperative Highway Research Program Report 350 (NCHRP 350) shall be used on Federally funded construction projects. The FHWA has set an October 1, 1998 deadline by which all advertised plans must specify NCHRP 350 approved terminals and crash cushions. It is CDOT's intention to immediately begin use of NCHRP 350 hardware.

GLOSSARY

Crash Cushion: A device designed primarily to safely stop a vehicle within a relatively short distance. A **redirective crash cushion** is designed to contain and redirect a vehicle impacting downstream from the length of need point. A **non-redirective crash cushion** is designed to contain and capture a vehicle impacting downstream from the nose of the cushion.

End Treatment: A device designed to treat the end of a longitudinal barrier. The end treatment may function by (a) decelerating a vehicle to a safe stop in a relatively short distance, (b) permitting controlled penetration of the vehicle behind the device, (c) containing and redirecting the vehicle, or (d) a combination of a, b, and c.

Gating: Gating allows controlled penetration of a vehicle when impacted upstream of the beginning of the length of need of the barrier. The SRT-350 (Colorado's Type 3 guardrail End Anchorage) is a gating type device. It will allow a vehicle to penetrate safely when hit within the first 12.5 feet of its length. A non-gating device is designed to contain and redirect a vehicle when impacted anywhere throughout its length.

Impact Attenuator: Synonymous with crash cushion.

Length of Need: The total length of a fully operational longitudinal barrier required to shield a hazard. The **distance beyond the length of need** is measured from the end (nose) of the device back to the point at which the device is fully redirectional. The term is applicable to end treatments only.

Longitudinal Barrier: A barrier whose primary function is to prevent penetration and safely redirect an errant vehicle away from a roadside or median hazard. CDOT generally uses two types of barriers:

1. **Rigid barrier** - A longitudinal barrier which does not deflect upon impact and dissipates only a minimal amount of the vehicle's impact energy. Example: Type 7 guardrail.

2. **Semi-rigid** - A longitudinal barrier which will dissipate some of the impact energy through yielding of the rail, post elements, and in some cases, the soil. Example: Type 3 guardrail.

Pocketing: If, on impact, a redirective device undergoes relatively large lateral displacements within a relatively short longitudinal distance, pocketing is said to have occurred. Depending on the degree, pocketing can cause large and unacceptable vehicular decelerations.

Transition: A section of barrier intended to transition between objects of differing deflection characteristics. Example: use of a 3G end anchorage consisting of Thrie beam and reduced post spacing to transition between rigid Type 7 guardrail and semi-rigid Type 3 guardrail.

National Cooperative Highway Research Program (NCHRP): A research program administered by the Transportation Research Board (TRB) and publisher of NCHRP Report 230, "Recommended Procedures for the Safety Performance Evaluation of Highway Appurtenances" and NCHRP Report 350, "Recommended Procedures for the Safety Performance Evaluation of Highway Features", upon which the testing of crash cushions and end treatments is based.

Comments on the Use of the Application Chart

APPLICATION: The devices listed in the chart are classified as "end treatments", "crash cushions", or both. These classifications are based on the FHWA approval letters and the functional capabilities of each device.

The designer should consider **all** characteristics of the device including initial cost, impact frequency, repair cost, maintenance, site restrictions, and aesthetics to determine suitability for use at a particular site. Please note that some devices may require transition sections or additional equipment for use or special back-up assemblies depending on the site and hazard type. All necessary equipment should be included in the device's pay item to insure that the device will perform as intended.

LOCATION: The location portion of the chart is divided into three categories: "roadside", "gore", and "median." The roadside location is the area outside the shoulders for an undivided highway. It also includes the area outside the left shoulder in a **wide** median for divided highways. The gore location has traffic passing on each side of the device in the same direction. The median location has traffic passing on each side of the device in opposite directions.

The chart indicates appropriate location(s) for each device.

COSTS: The cost to furnish and install each device may have a wide range. This is due to design speed dependent lengths, available widths to accommodate variable hazard widths, the number of units on the project, the project location, and device competition. For a more precise unit price, contact the CDOT Cost Estimating Unit.

DESIGN SPEED: The maximum required testing speed per NCHRP procedures is 62 mph or 100 km/h. The FHWA approves devices passing the required tests for use on all Federal Aid projects including all Interstate projects. In some instances, devices were tested for various design speeds. These tested design speeds are specified in the chart. However, the FHWA currently allows use of devices passing NCHRP 350 at 62 mph to be used at all higher speeds on the NHS.