

**TECHNICAL
BRIEF**

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Product Specification

Safe-T-Curve™ Longitudinal Barrier for Tight Radius Curves

I. General

The Safe-T-Curve™ system is a Longitudinal Barrier ideally suited for tight radius curves. It is comprised of a combination of Concrete Reactive Tension Quickchange Moveable Barrier (CRTS) and the Universal TAU-II® re-directive, non-gating crash cushion. The CRTS has been tested in accordance with the definitions of the National Cooperative Highway Research Program Report 350 (NCHRP Report 350) for Test Level 3. The Universal TAU-II system has been tested in accordance with the definitions of NCHRP Report 350 and performs in an acceptable manner in accordance with these guidelines at Test Level 2 (70 km/h) and Test Level 3 (100 km/h).

II. Performance

The Safe-T-Curve system is designed to safely redirect and/or contain an errant vehicle in accordance with NCHRP Report 350 guidelines for longitudinal barriers and crash cushions. The system is designed to be used in tight curve applications such as, highway exit or off ramps, with a radius as short as 100 feet (30m). When installed in accordance with the manufacturer's instructions, the Safe-T-Curve system is capable of redirecting and/or capturing a 5,000 lb (2270 kg) pickup truck impacting the system at 100 km/h (62.3 mph).

A. When properly installed according to the manufacturer's recommendations, the Safe-T-Curve system shall be able to meet the recommended structural adequacy, occupant risk, and vehicle trajectory criteria set forth in the NCHRP Report 350 for Test Level 3 Longitudinal Barriers. The NCHRP Report 350 Test Matrix includes the following conditions:

1. A 2000 kg vehicle at 25 degrees impacting the midpoint of the system (3-11).

The Universal TAU-II system is designed to absorb the impact energy of an errant vehicle in accordance with NCHRP Report 350 guidelines for re-directive, non-gating crash cushions. The system is designed for locations where both head-on and angled

impacts are likely to occur and where it is desirable to have the majority of post impact trajectories on the impact side of the system. The design provides for a high degree of flexibility in applying the system to a wide range of hazard widths (up to 2.6 meters (8.5 feet)) in 150mm (6 inch) increments. When installed in accordance with the manufacturer's instructions, the system is capable of safely redirecting or stopping a 2000 kg (4400 lb) pick-up truck or a 820 kg (1800 lb) car impacting the system at 100 km/hr (62.1 mph) within the angles set forth in NCHRP 350.

B. When properly installed according to the manufacturer's recommendations, the systems shall be able to meet the recommended structural adequacy, occupant risk, and vehicle trajectory criteria set forth in NCHRP 350 for Test Level 3 (100 km/hr) re-directive, non-gating crash cushions. The NCHRP 350, Test Level 3 Test Matrix includes the following conditions:

1. An 820 kg vehicle at 0 degrees and an offset of $\frac{1}{4}$ the width of the vehicle from the centerline of the system (Test 3-30).
2. A 2000 kg vehicle at 0 degrees and centered on the front of the system (Test 3-31).
3. An 820 kg vehicle at 15 degrees impacting the front of the system (Test 3-32).
4. A 2000 kg vehicle at 15 degrees impacting the front of the system (Test 3-33).
5. An 820 kg vehicle at 20 degrees impacting the side, near the front of the system (Test 3-36).
6. A 2000 kg vehicle at 20 degrees impacting the side, near the front of the system (Test 3-37).
7. A 2000 kg vehicle at 20 degrees impacting at the Critical Impact Point of the system. The critical impact point was determined to be the front of the backstop along the centerline of the system (Test 3-38).
8. A 2000 kg vehicle at -20 degrees (reverse direction) impact to the midpoint of the system (Test 3-39).

C. The impact velocity of a hypothetical front seat passenger against the vehicle interior, as calculated from the longitudinal vehicle acceleration and 600 mm [23 $\frac{5}{8}$ in] forward displacement, and the lateral vehicle acceleration and 300 mm [12 in] lateral vehicle displacement, shall be less than 12 m/s (39.3 ft/s). The highest 10 ms average vehicle acceleration in the longitudinal and lateral directions subsequent to the instant of hypothetical occupant impact shall be less than 20 g's.

- D. Detached debris shall not show potential for penetrating the vehicle occupant compartment or present a hazard to other traffic, pedestrians, or workers in a work zone. The vehicle shall remain upright during and after the collision although moderate roll, pitch, and yaw may occur.

III. Description of System

- A. The Safe-T-Curve system shall comprise of CRTS barrier and a Universal TAU-II. The system shall be made up of the following components and shall be fabricated from material conforming to the following specifications:

- B. CRTS:

1. Each barrier element shall be 810 mm (32”) high, 460mm (18”) wide and 1000mm (39”) long. Each individual element shall weigh approximately 680 kg (1500 lbs) and rest on four rubber feet to increase the coefficient of friction between the barrier element and the road surface.
2. All steel structural components shall be fabricated from mild steel in accordance with ASTM A-36 or equivalent.
3. All external steel components shall be fabricated from stainless steel or shall be hot dipped galvanized in accordance with ASTM 123 or ASTM B-695 or equivalent.
4. All miscellaneous hardware shall be stainless steel, brass or zinc plated.
5. Each barrier element shall be manufactured by either wet-cast or dry-cast methods using high strength concrete.
6. Minimum concrete 28 day compression strength shall be 276 Bar (4,000 psi).
7. All surface voids or rock pockets shall be repaired.
8. Air entrainment shall be as specified by the ordering agency, +/- 1.50%.

- C. The Universal TAU-II crash cushion is made up of independent collapsible bays that are guided and supported by high strength galvanized steel cables. The system’s energy capacity is provided by an array of Energy Absorbing Cartridges. The Universal TAU-II systems are available in various lengths and width configurations. The systems shall be made up of the following components and shall be fabricated from materials conforming to the following specifications:

1. The foundation system for the Universal TAU-II consists of two cables, a Back Support and Front Cable Anchors.
 - a. All steel structural components of these assemblies shall be fabricated from mild steel in conformance with ASTM A-36 specifications and hot dipped galvanized per ASTM A-123 or equivalent.
 - b. All fasteners shall be Class 5.8 (Grade 2) or greater and galvanized in accordance with ASTM 153 or ASTM B695 or equivalent. Washers shall be hardened and galvanized.
 - c. The steel cables shall be at least 25 mm (1 in) diameter and galvanized in accordance with ASTM A-603 or equivalent.
2. Front and Middle Supports and the various sizes of Bulkheads (XL, XXL and XXXL) separate each independent collapsible bay. Cable Guides bolt to the Middle Supports and Bulkheads, capturing the cables and connecting the bays to the foundation system.
 - a. All Front and Middle Supports, Bulkheads and cable guides shall be fabricated from mild steel in conformance with ASTM A-36 specifications and hot dipped galvanized per ASTM A-123 or equivalent.
 - b. All fasteners shall be Class 5.8 (Grade 2) or greater and galvanized in accordance with ASTM 153 or ASTM B695 or equivalent. Washers shall be hardened and galvanized.
3. Each Bay is enclosed on the sides with Sliding Panels. Sliding Bolts fasten the panels to the Front and Middle Supports and Bulkheads. End Panels are attached to the Back Support and the last bay's Sliding Panels through Pipe Panel Mounts and provide transition mounting points. The Pipe Panel Mounts are bolted to the back support.
 - a. Steel panels shall be fabricated from steel that conforms to the requirements of AASHTO M180 Class B or equivalent.
 - b. Sliding Bolts shall be cast from ASTM 1045 HT steel and galvanized per ASTM A-123 or equivalent.
 - c. Steel Pipe Panel Mounts shall be fabricated from mild steel in conformance with ASTM A513, Type 5 specifications or equivalent.
 - d. Fasteners shall be Class 5.8 (Grade 2) or greater and galvanized in accordance with ASTM 153 or ASTM B695 or equivalent. Washers shall be hardened and galvanized.

4. Flexible Front Support Legs and a Nose Piece mount to the Front Support. The Front Support Legs and Nose Piece are bolted in place. The Nose Piece provides a location to attach suitable delineation in conformance with local specifications (to be supplied by others).
 - a. The front support legs shall be fabricated from either synthetic or natural rubber or polyurethane.
 - b. The Nose Piece shall be fabricated from polyurethane.
 - c. All fasteners shall be Class 5.8 (Grade 2) or greater and galvanized in accordance with ASTM 153 or ASTM B695 or equivalent. Washers shall be hardened and galvanized.
 5. Two types of Energy Absorbing Cartridges provide the primary energy absorbing capacity for the system. The cartridges appear as cylindrical plastic containers measuring approximately 775 mm (30 ½ in) in length and approximately 635 mm (25 in) in diameter. Each cartridge weighs approximately 16 kg (35 lb).
 - a. All plastic parts shall be molded from specially formulated High Density Cross-linked Polyethylene.
 6. The Universal TAU-II shall require attachment to a foundation. Anchoring of the system will require attachment in accordance with the manufacturer's instructions.
- D. The Safe-T-Curve system shall be installed in accordance with the manufacturer's instructions.

IV. Application of Safety Appurtenances

Highway safety appurtenances should be applied to hazardous sites in accordance with the guidelines and recommendations in the American Association of State Highway Transportation Officials (AASHTO), "Roadside Design Guide", and other Federal Highway Administration and State Department of Transportation requirements. Placement of the Safe-T-Curve system must comply with these specifications and guidelines as well as those of the manufacturer.