Florida Department of
TRANSPORTATION

Crash Cushion Inspection Training

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Office of Construction

Course Objective

- At the end of this course, you will be:
  - Able to identify common products and their components,
  - Aware of the installation requirements for common products, and
  - Able to recognize some common issues with Crash Cushion installation found in the field during MOT Process Reviews

Course Outline

Crash Cushion Inspection Training

- Identifying Common Products
  - Length of Need for Common Products
  - Truck/Trailer Mounted Attenuators (TMA'S)
- Installation of Common Products
- MOT Process Review Findings

Crash Cushions

- Redirective (Non-Gating)
  - The principle device to shield approach ends of barrier wall

9. *A yellow Type I Object Marker shall be centered 3' in front of the crash cushion nose. As an option, the contractor may install Retroreflective Sheeting on the nose of the crash cushion. The sheeting to be used must be solid yellow, Type IV or better and must be a product listed on the Department's Approved Products List (APL). The sheeting to be applied to the nose of the crash cushion shall be a minimum of 360 square inches with a minimum height of 15 inches. Mounting hardware, Object Markers or Retroreflective Sheeting shall be in conformance with Section 993 of the Standard Specifications for Road and Bridge Construction.*

Crash Cushions – Identifying Common Products

In this section, we will take a look at how to identify a few common products.

Crash Cushions – Identifying Common Products

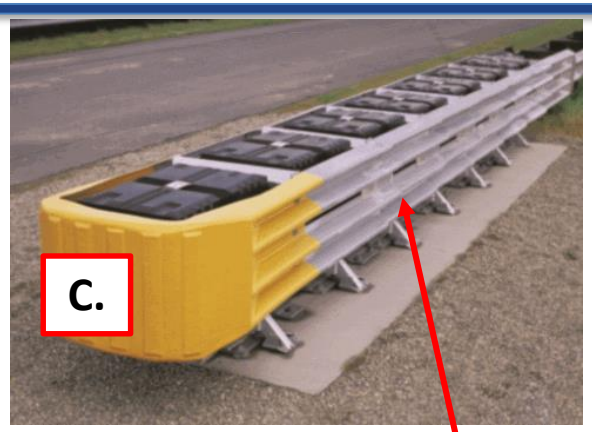
Crash Cushions (Impact Attenuators):

Quadguard (Narrow & Wide) - Proprietary

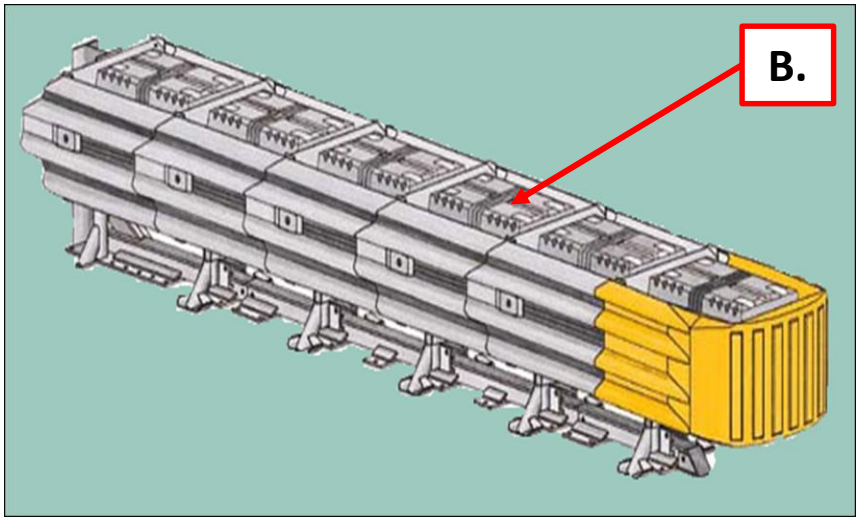
Energy Absorption Systems, Inc.

Unique Feature:

A. Quadruple Corrugated Fender Panels
B. Rectangular Cartridges
C. Plastic Nose
D. Monorail Base



Quadguard



Crash Cushions – Identifying Common Products

Crash Cushions (Impact Attenuators):

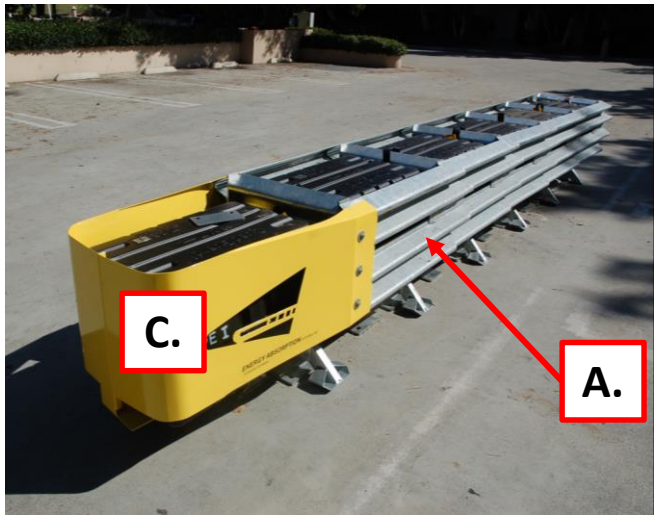
Quadguard II (Narrow & Wide) – Proprietary

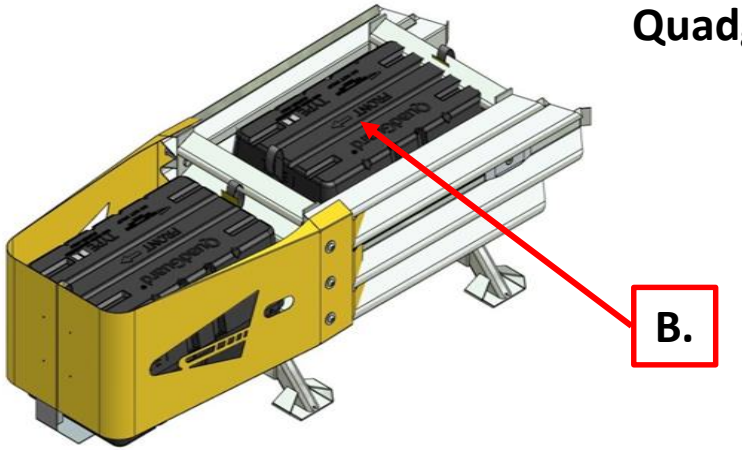
(Shorter than the Original Quadguard)

Energy Absorption Systems, Inc.

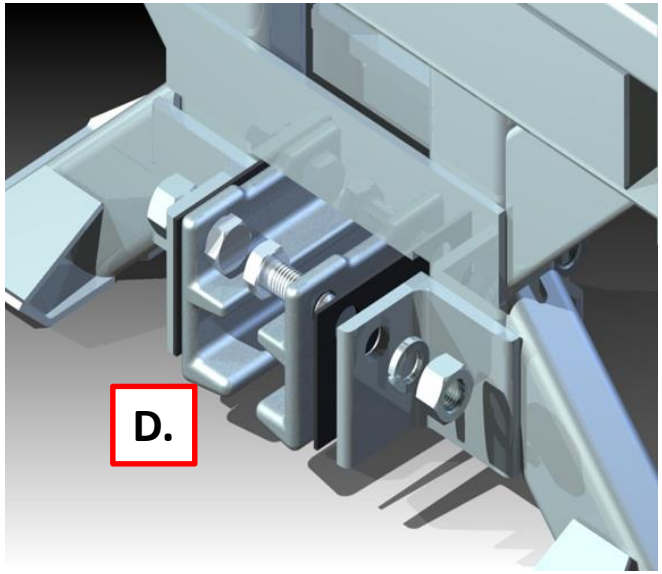
Unique Feature:

A. Quadruple Corrugated Fender Panels
B. Rectangular Cartridges
C. <u>Steel Nose</u>
D. <u>Monorail Guide Stabilizers</u>





Quadguard II



Crash Cushions – Identifying Common Products

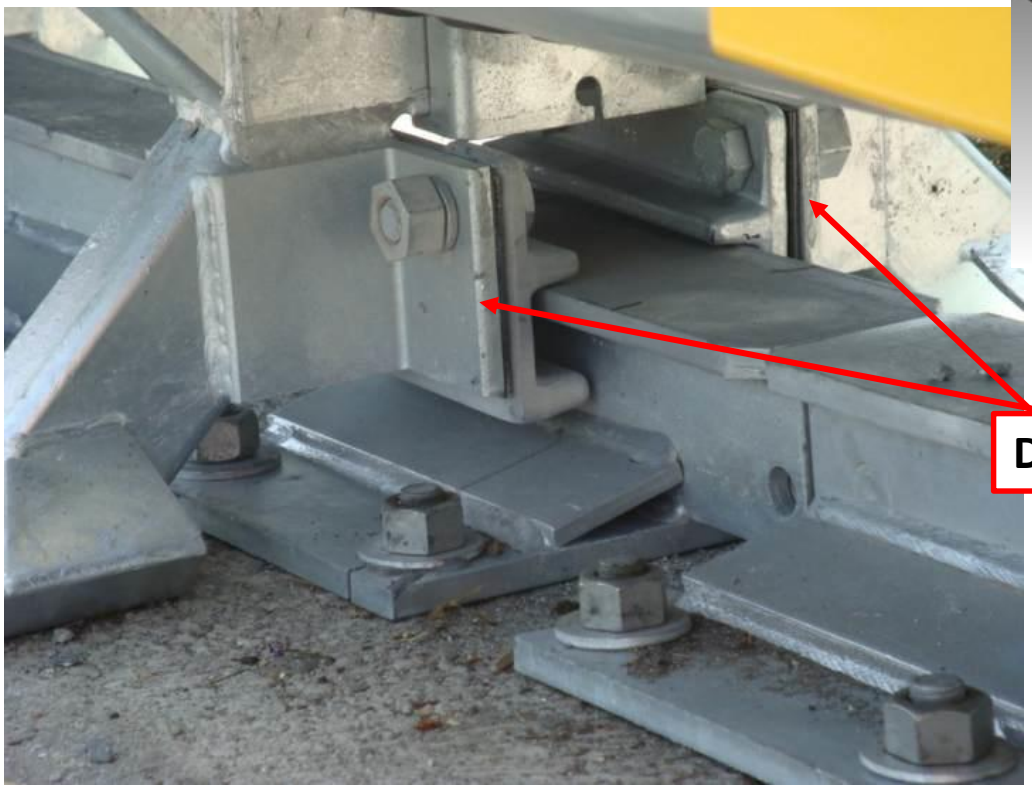
Crash Cushions (Impact Attenuators):

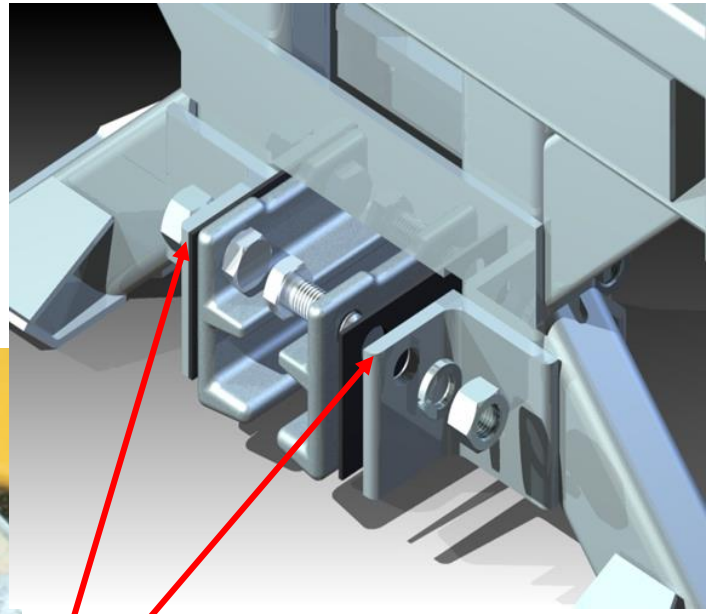
Quadguard II (Narrow & Wide) – Proprietary

(Shorter than the Original Quadguard)

Energy Absorption Systems, Inc.

D. <u>Monorail Guide Stabilizers</u>





Quadguard II

Crash Cushions – Identifying Common Products

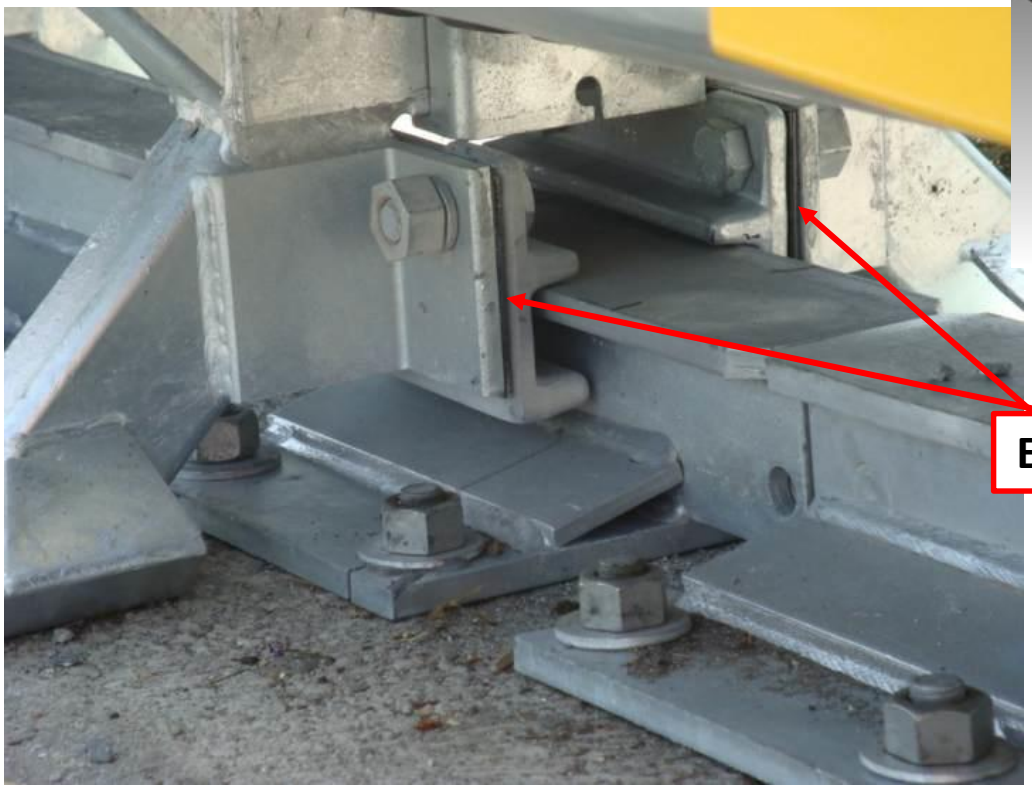
Crash Cushions (Impact Attenuators):

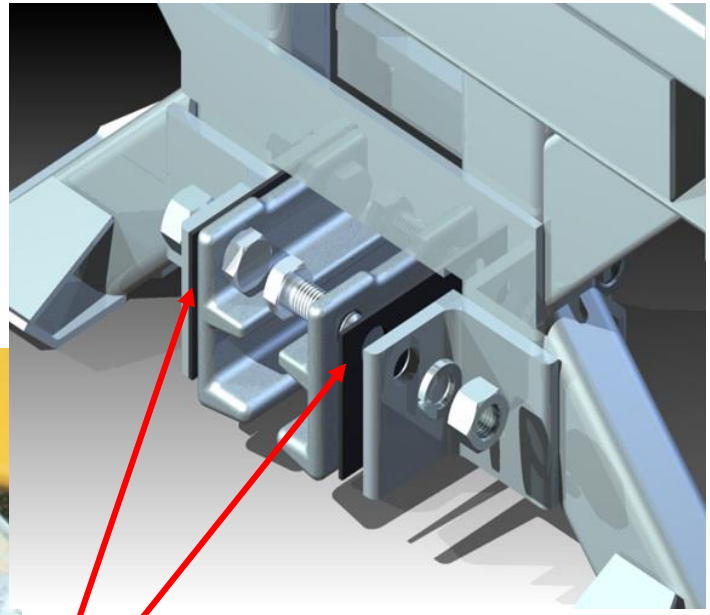
Quadguard II (Narrow & Wide) – Proprietary

(Shorter than the Original Quadguard)

Energy Absorption Systems, Inc.

E. <u>Shims</u>





Quadguard II

Crash Cushions – Identifying Common Products

Crash Cushions (Impact Attenuators):

Quadguard Elite (Narrow & Wide) – Proprietary

(Reusable Cylinders)

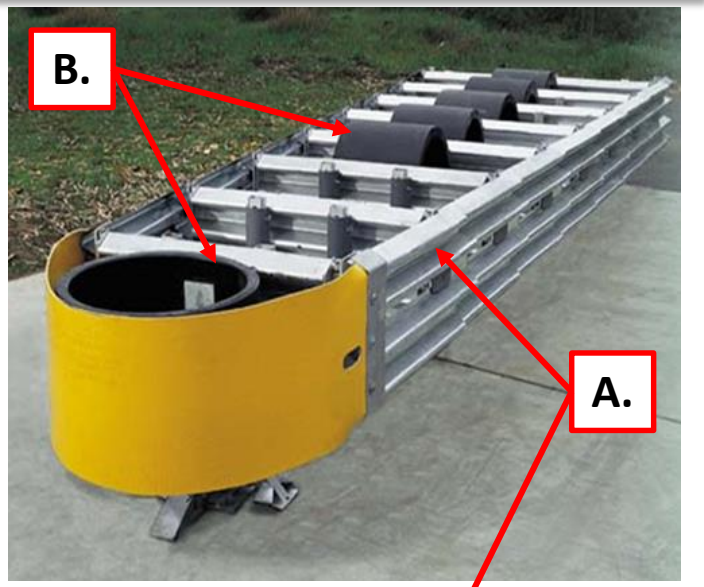
Energy Absorption Systems, Inc.

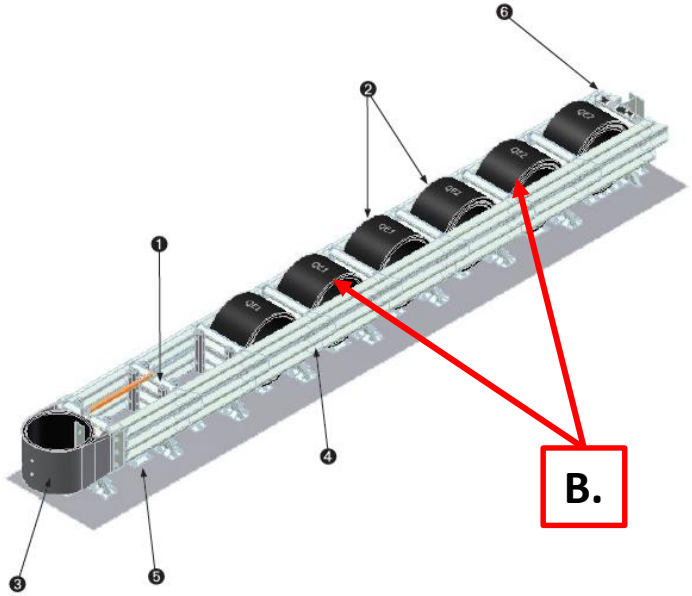
Unique Feature:

A. Quadruple Corrugated Fender Panels

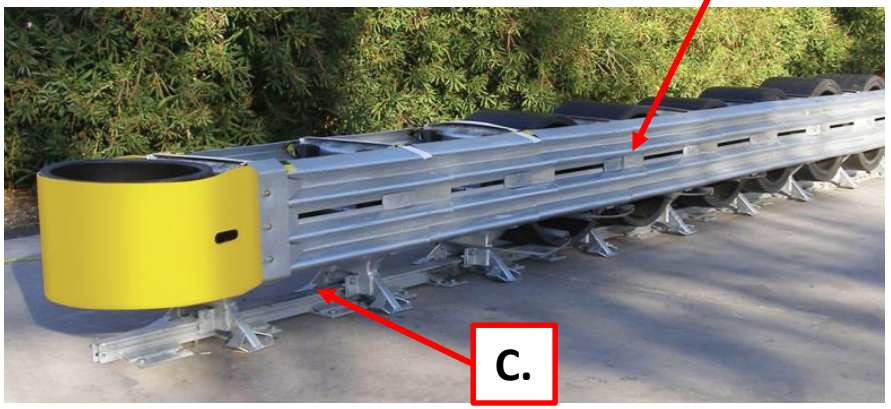
B. HDPE Cylinders

C. Monorail Base





Quadguard Elite



Crash Cushions – Identifying Common Products

Crash Cushions (Impact Attenuators):

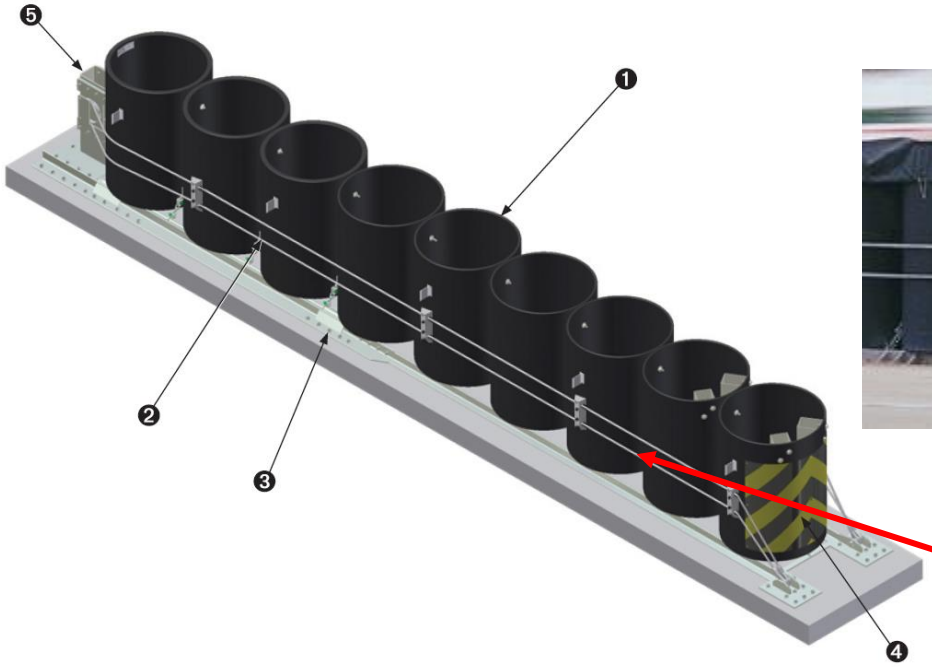
REACT 350 – Proprietary

Energy Absorption Systems, Inc.

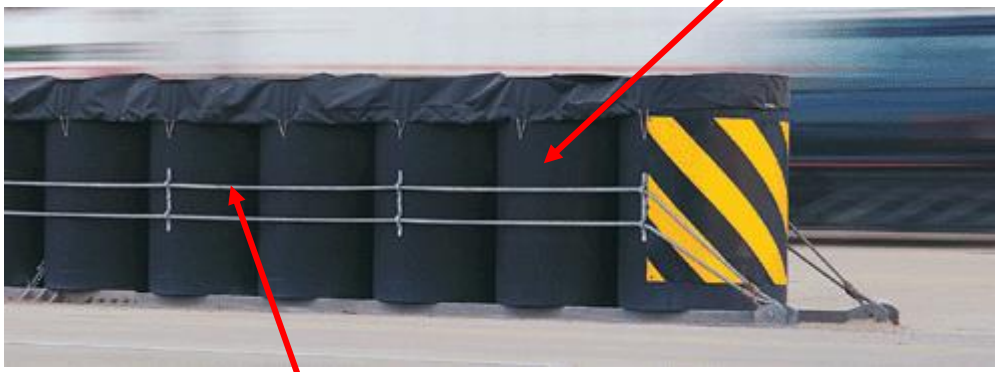
Unique Feature:

A. Large Diameter HDPE Cylinders

B. Redirective Cables



REACT 350



Crash Cushions – Identifying Common Products

Crash Cushions (Impact Attenuators):

TRACC – Proprietary

Trinity Attenuating Crash Cushion (TRACC)

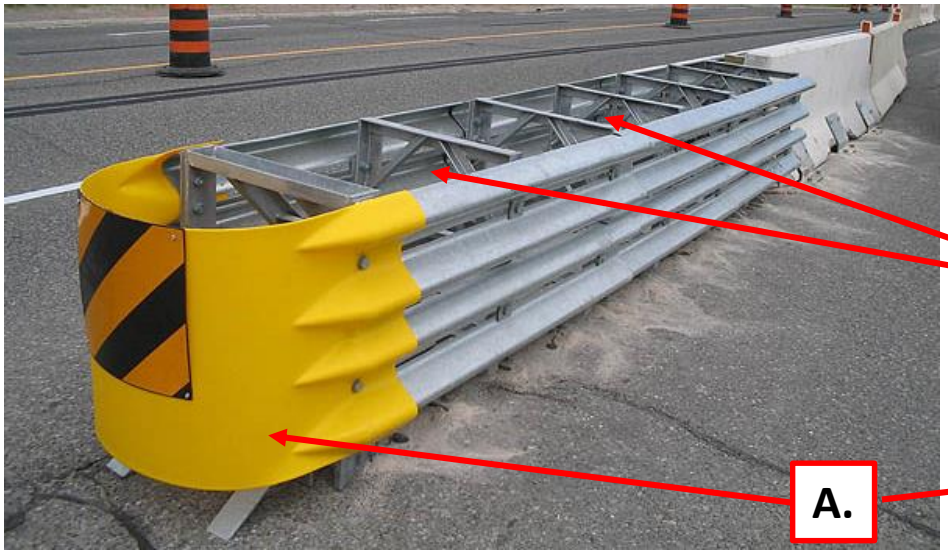
Trinity Highway Products, LLC.

Unique Feature:

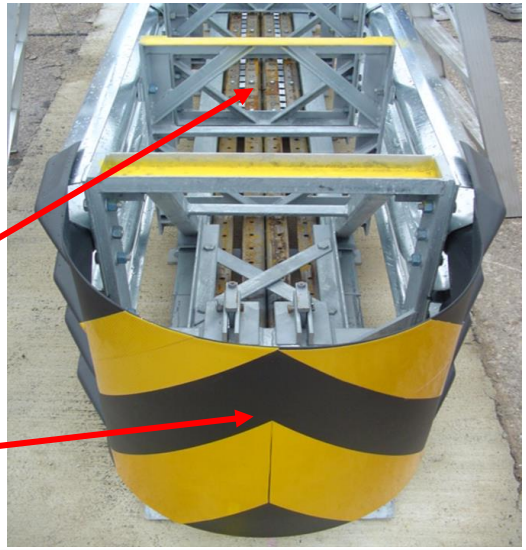
A. Plastic Nose

B. No Cartridges

C. Stacked Modified W-Beam Fender Panels



TRACC



Crash Cushions – Identifying Common Products

Crash Cushions (Impact Attenuators):

TAU II – Proprietary

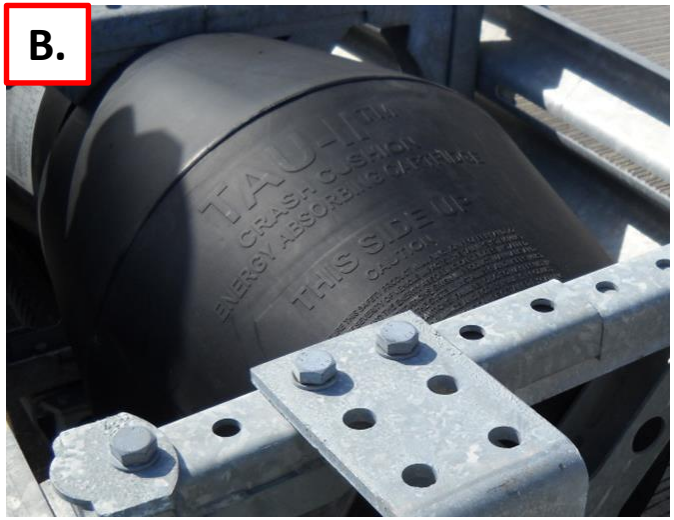
Lindsay Transportation Solutions/Barrier Systems

Unique Feature:

A. Plastic Nose

B. Conical Shaped Cartridges

C. Modified Thrie-Beam Fender Panels



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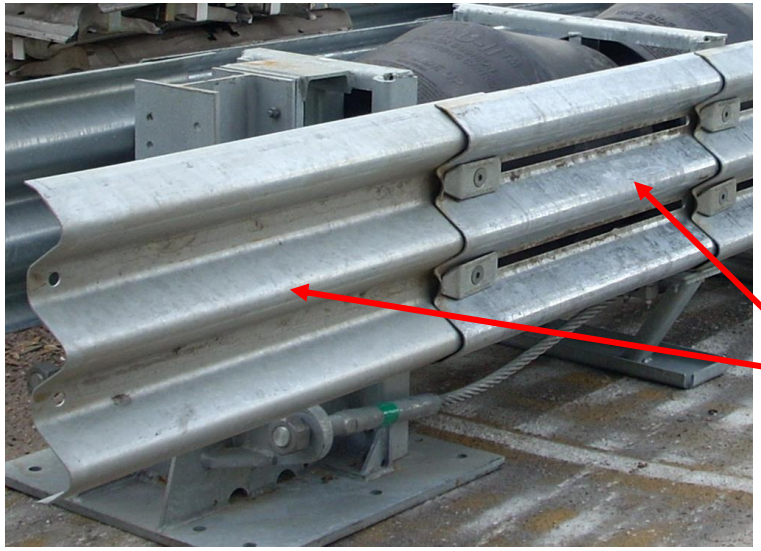
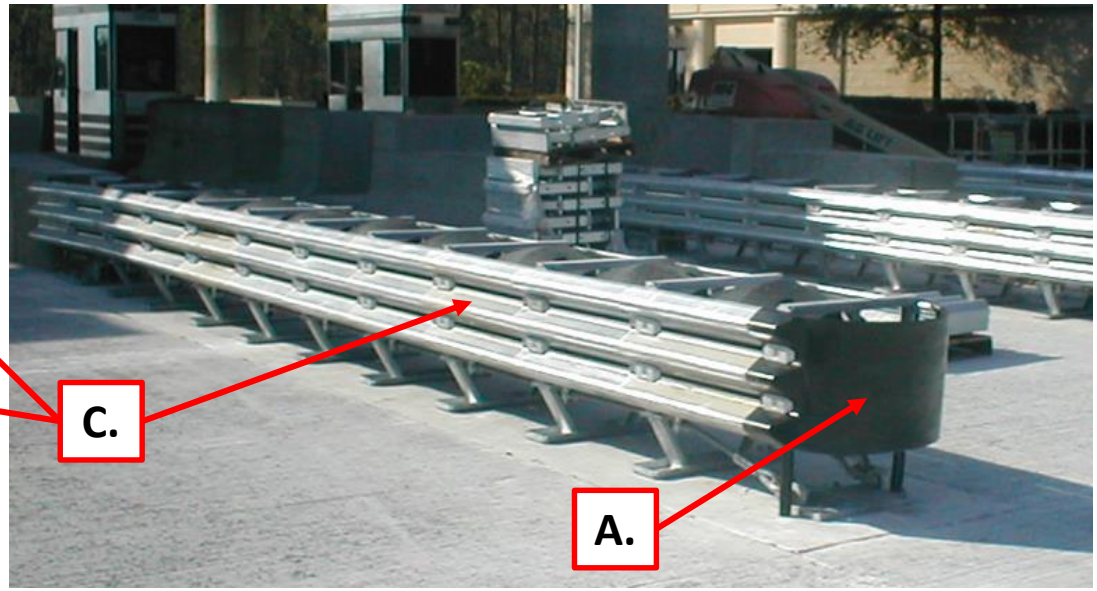


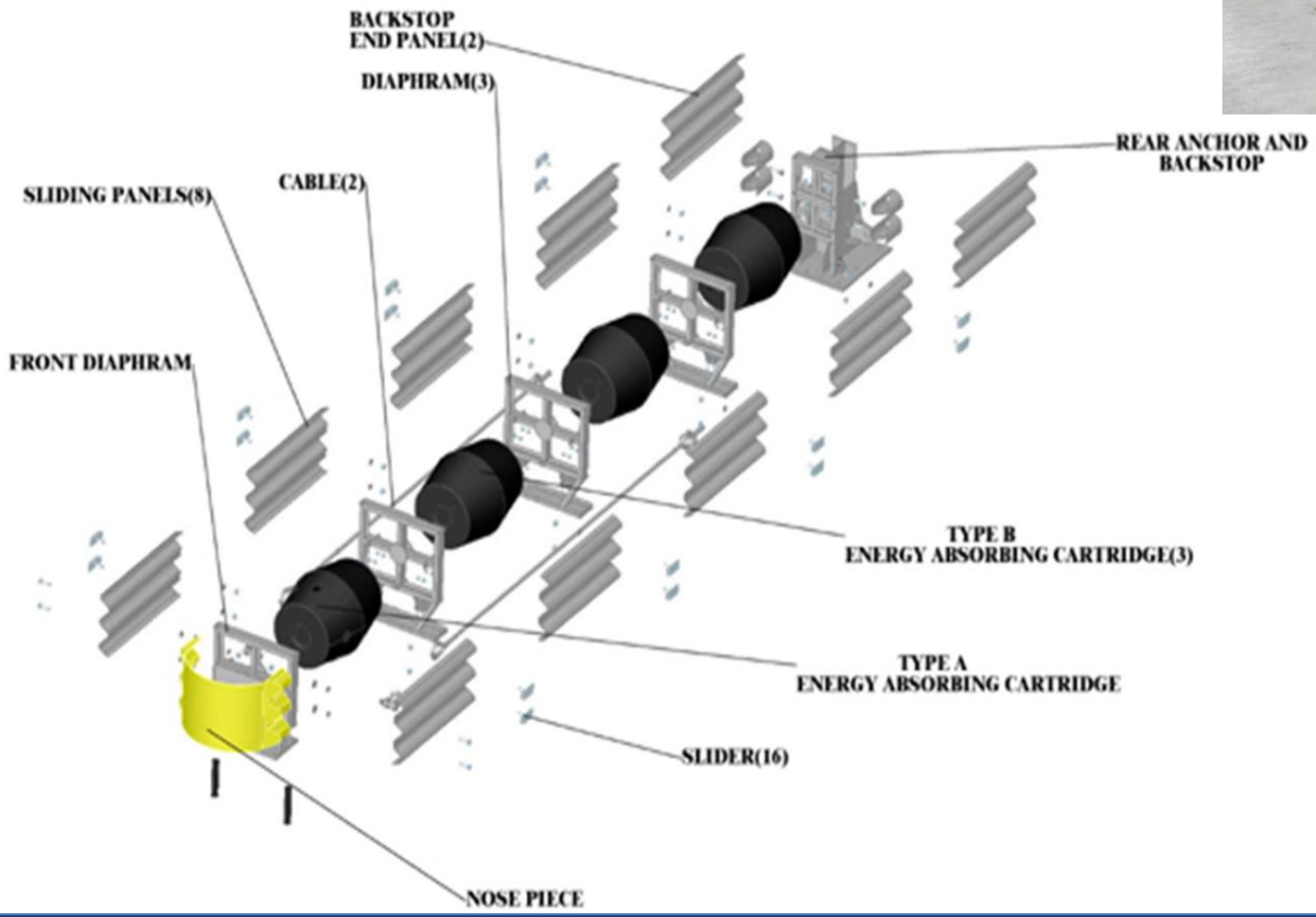


Crash Cushions – Identifying Common Products

Crash Cushions (Impact Attenuators):

TAU II – Proprietary

TAU II



Crash Cushions – Identifying Common Products

Crash Cushions (Impact Attenuators):

SCI Smart Cushion – Proprietary

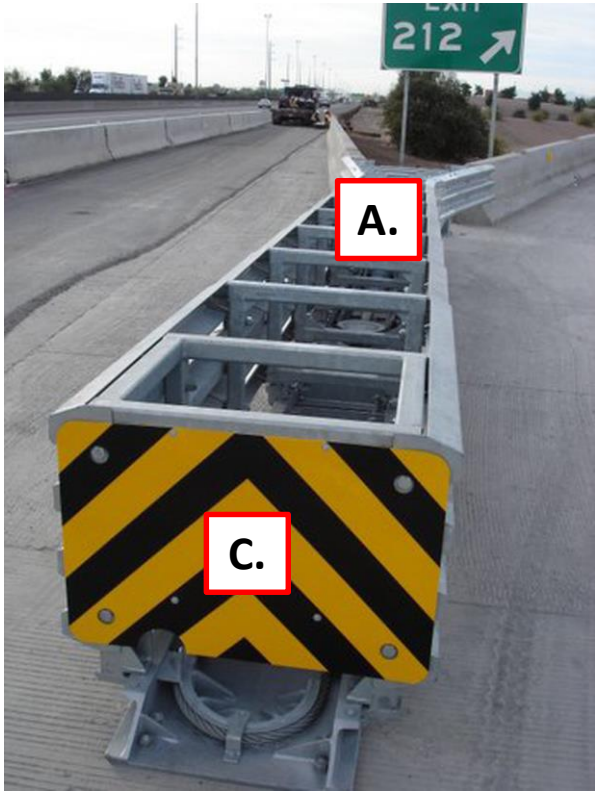
Work Area Protection, Inc.

Unique Feature:

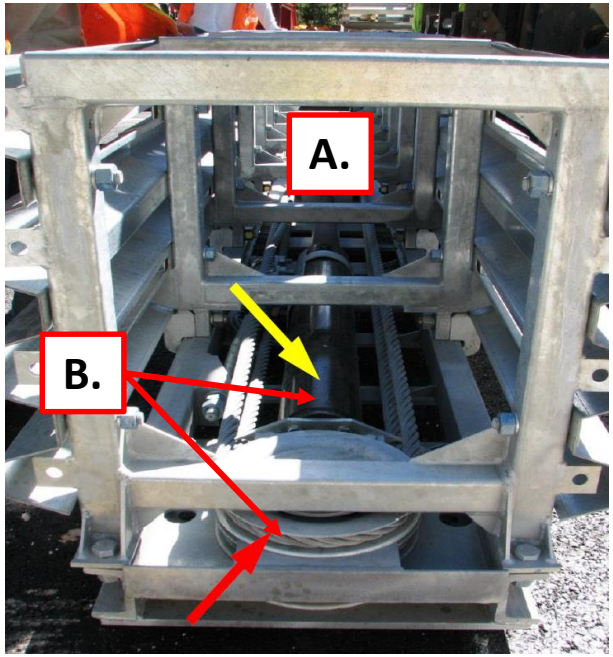
A. No Cartridges

B. Hydraulic Cylinder w/Cable

C. Blunt/Square Nose



SCI Smart Cushion



Crash Cushions – Identifying Common Products

Crash Cushions (Impact Attenuators) :

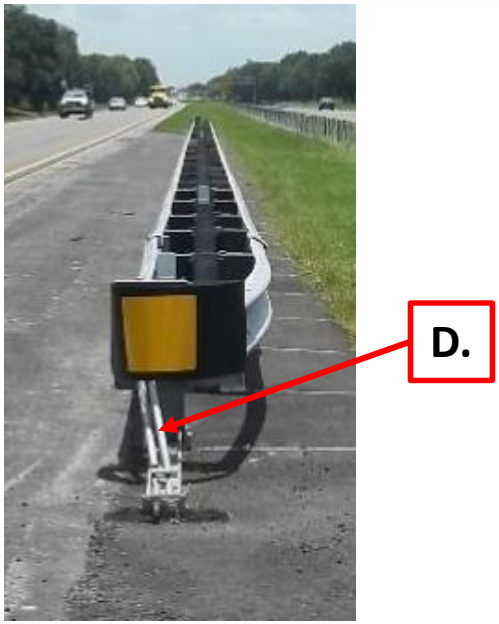
X-MAS – Proprietary

(*Double Faced Version of the X-Tension Terminal*)

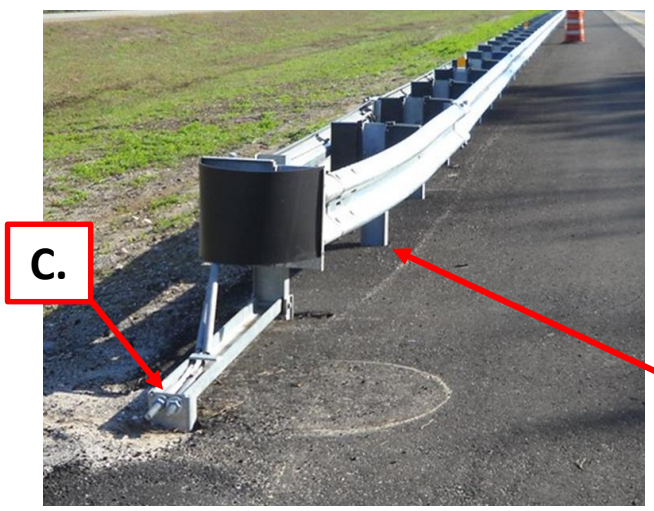
Lindsay Transportation Solutions/Barrier Systems

Unique Feature:

A. W-Beam Panels w/Slider Bracket
B. Standard Driven Posts
C. Forward Anchorage
D. Duel Tension Cables

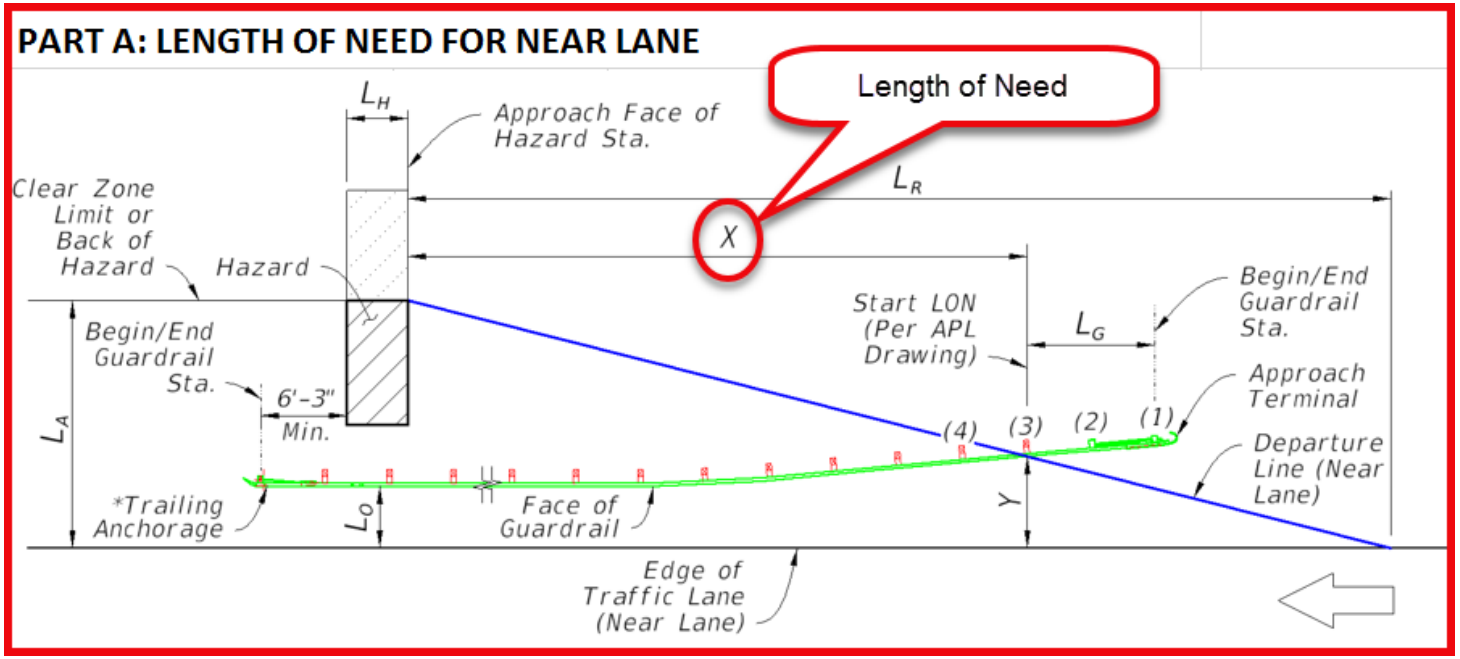


X-MAS

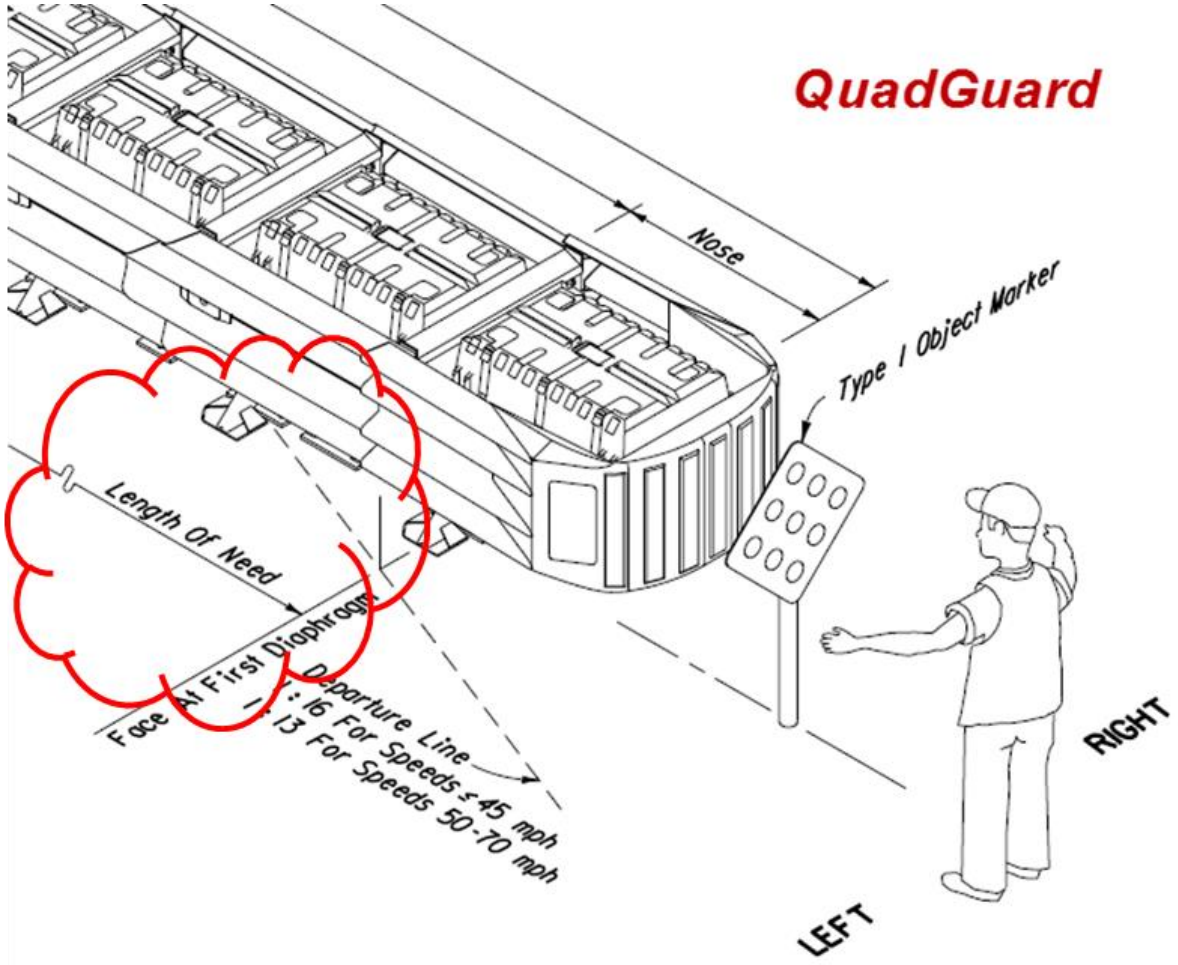


Crash Cushions - Length of Need for Common Products

Length of Need (LON) - the length of crash cushion needed in advance (upstream) of a fixed object hazard or a non-traversable terrain feature to prevent a vehicle that has left the roadway from reaching the shielded feature.

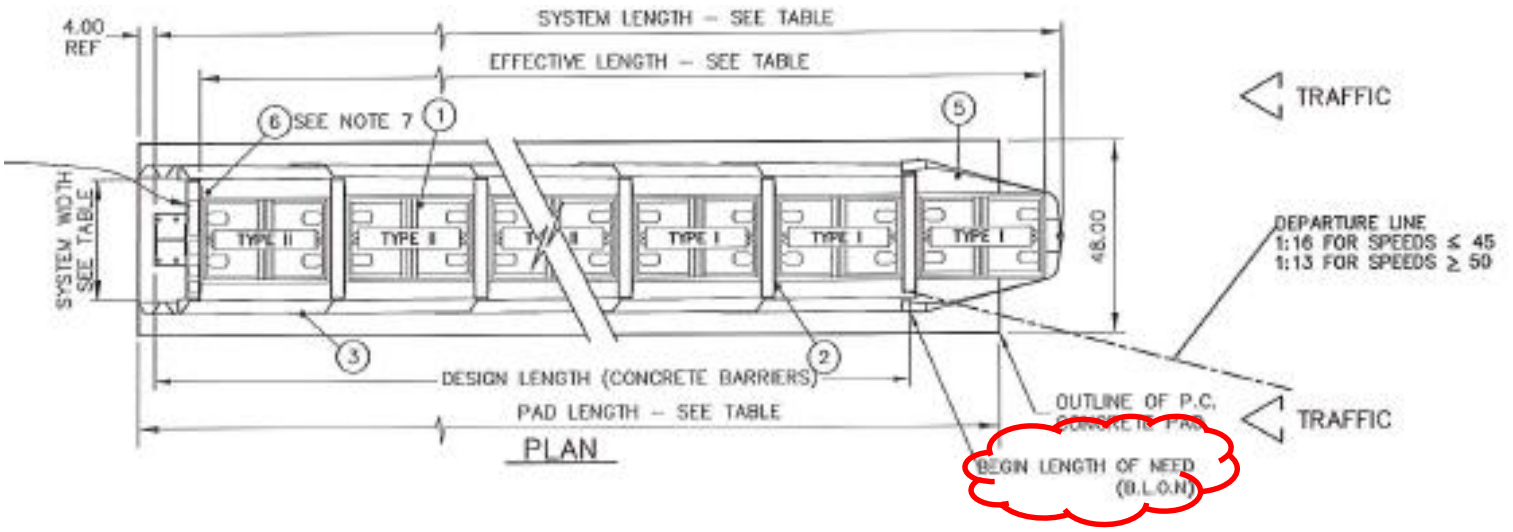


Crash Cushions - Length of Need for Common Products

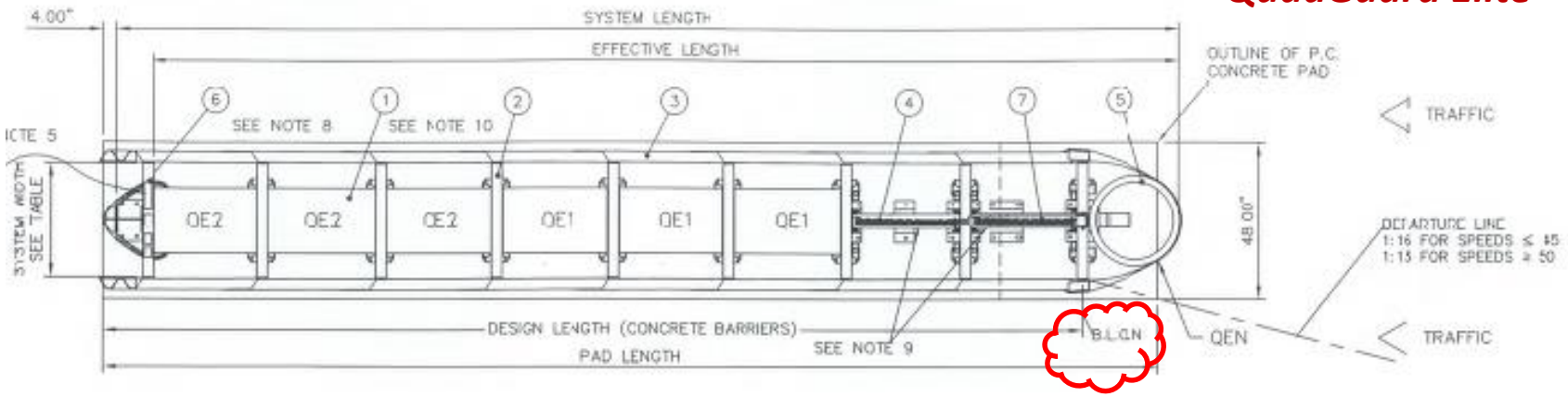


Crash Cushions - Length of Need for Common Products

QuadGuard II

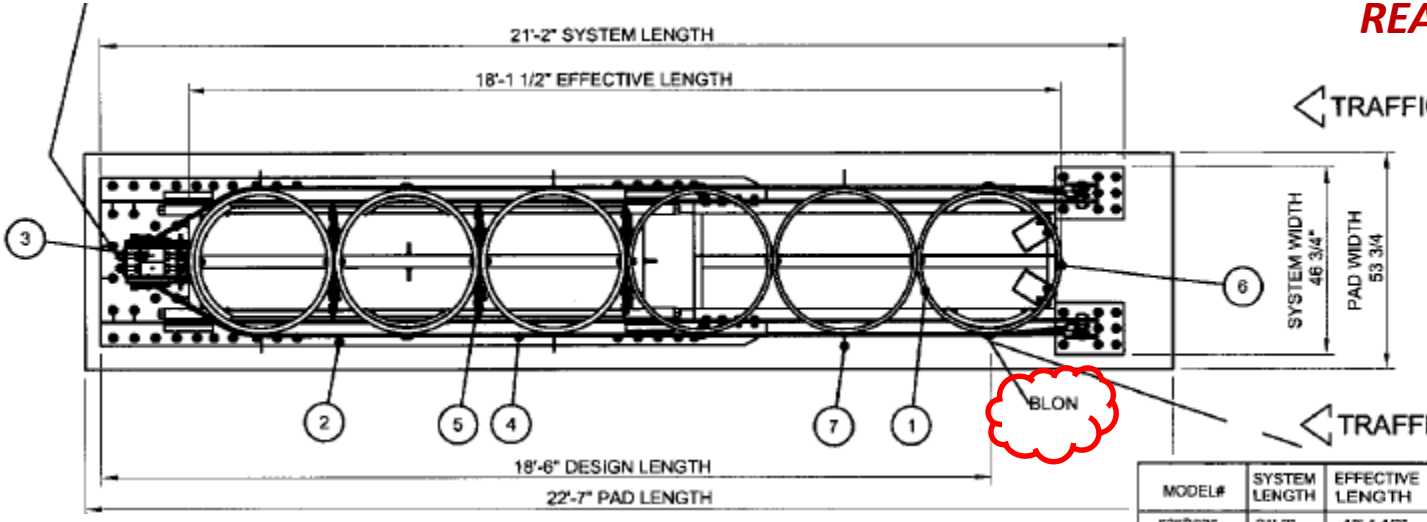


QuadGuard Elite



Crash Cushions - Length of Need for Common Products

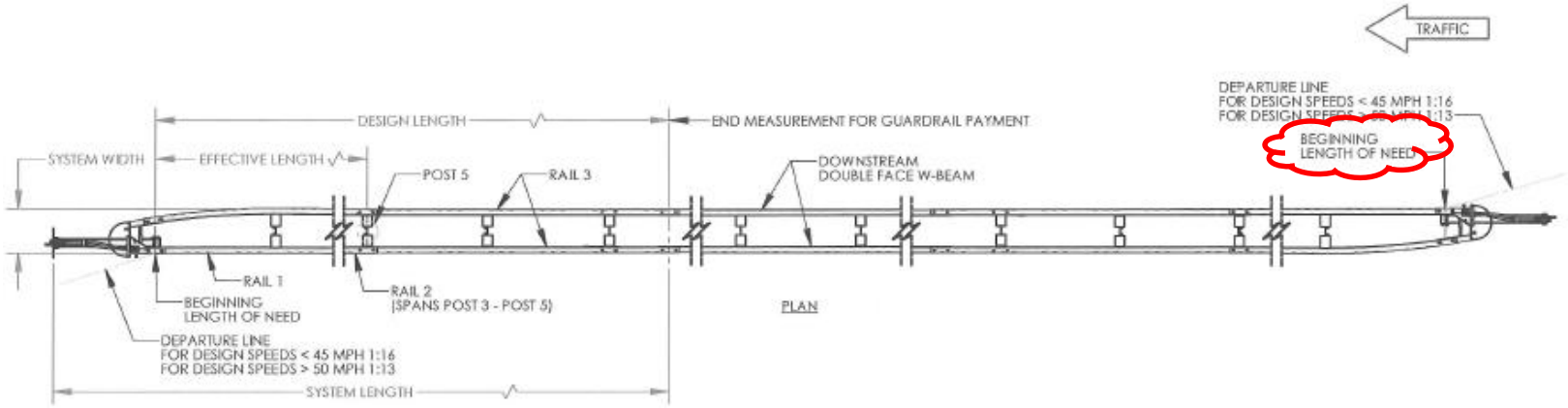
REACT 350



MODEL#	SYSTEM LENGTH	EFFECTIVE LENGTH	PAD LENGTH	WORKZONE SPEED	DESIGN LENGTH	TESTED TO
625B036	21'-2"	18'-1 1/2"	22'-7"	60 mph *	18'-6"	TL-3

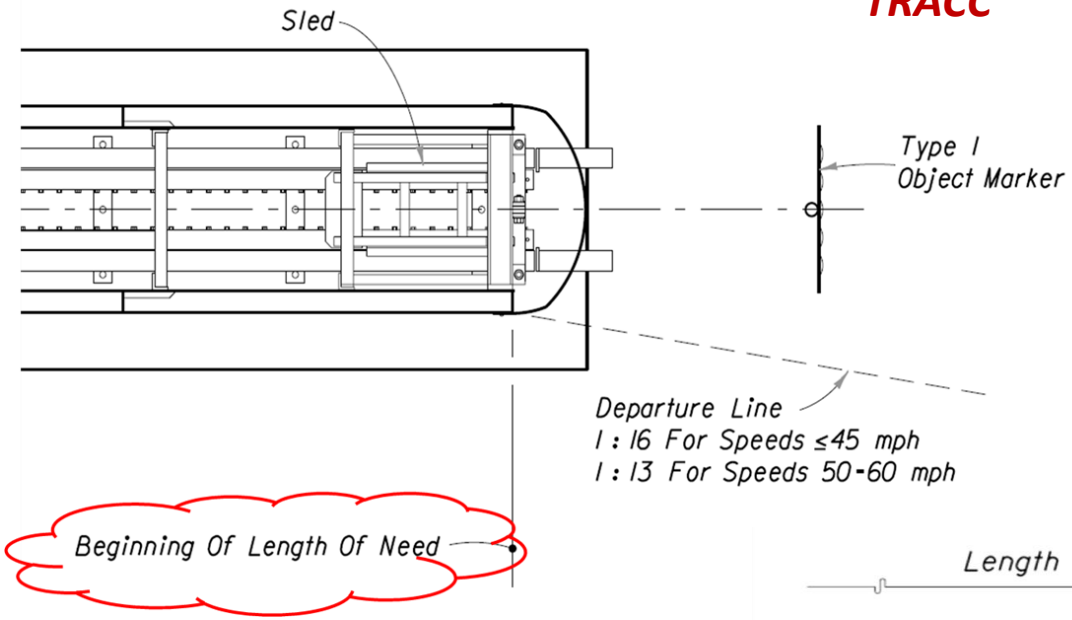
* FOR HIGH SPEED FACILITIES WITH A WORKZONE SPEED OF ≥ 60 mph USE A 6 CYLINDER REACT II SYSTEM. ALSO SEE NOTE 6.

X-MAS

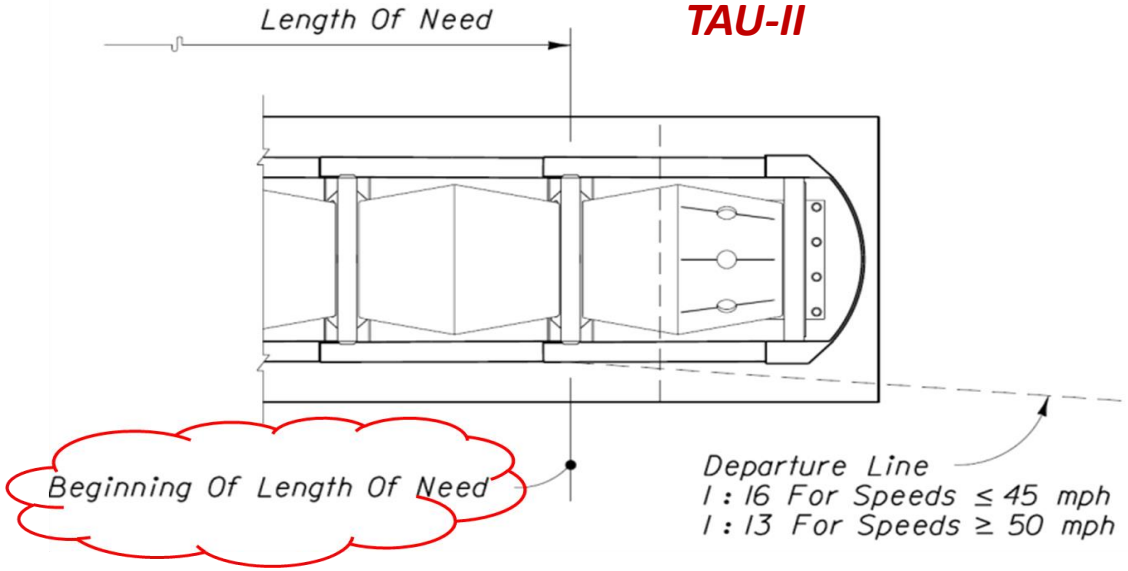


Crash Cushions - Length of Need for Common Products

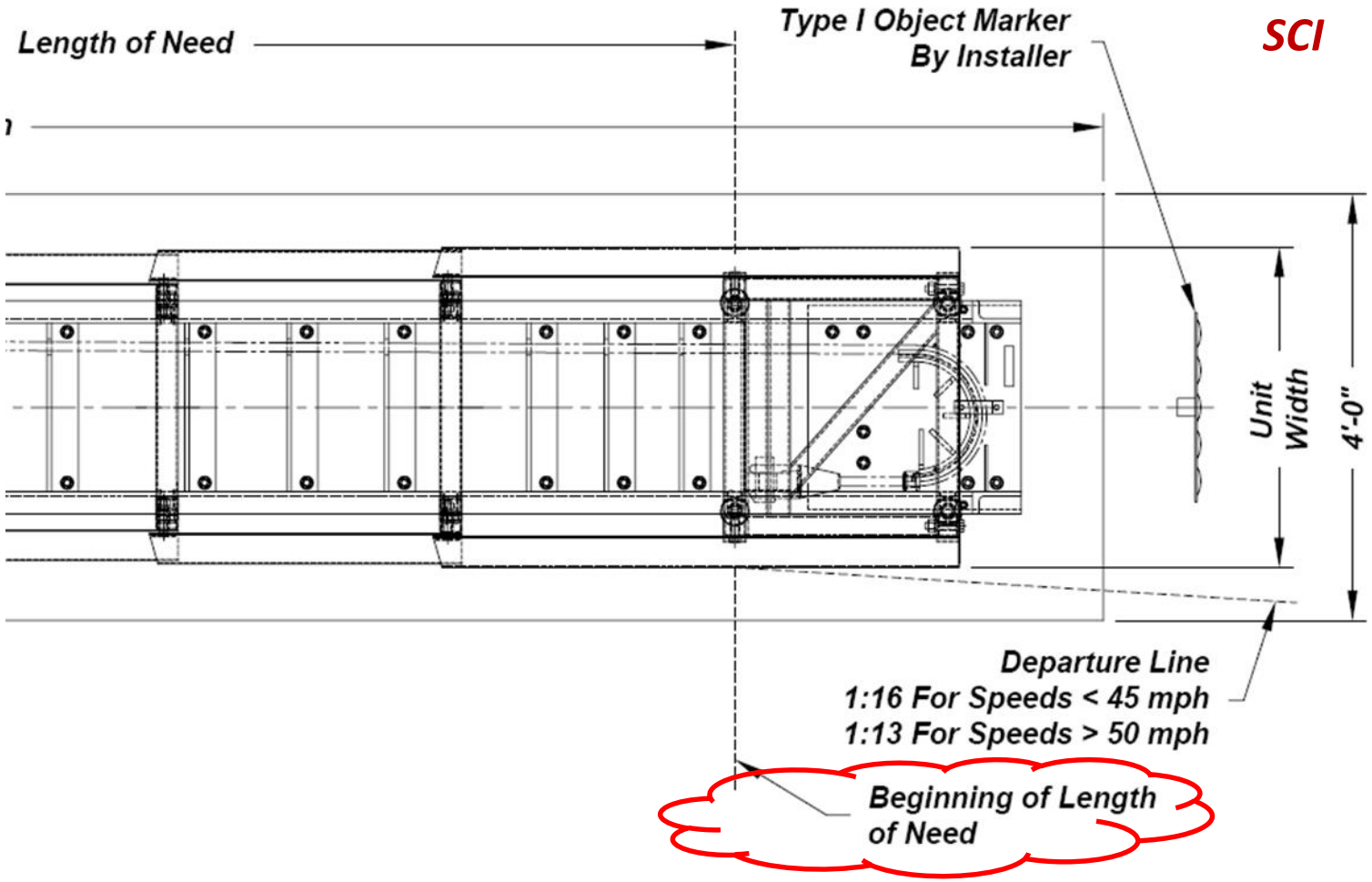
TRACC



TAU-II



Crash Cushions - Length of Need for Common Products



Truck/Trailer Mounted Attenuators (TMA'S)

- Truck or Trailer Mounted
  - Listed on APL
- Indexes 607 & 619
- Mounted by Manufacturer's Recommendations

Crash Cushions – Installation of Common Products

In this section, we will take a closer look at some of the installation requirements for a few common products.

Always refer to the vendor product manuals listed on the APL for full installation requirements.

Crash Cushions – Installation of Common Products

TAU-II

UNIVERSAL TAU-II

FDOT APL 102-041-021

Crash Cushions – Installation of Common Products

TAU-II

Foundation Options

Chart is in APL 102-041-021 Vendor Drawings

FOUNDATION SPECIFICATIONS:

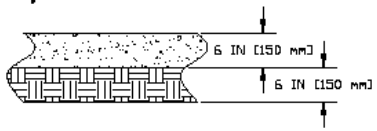
THE UNIVERSAL TAU-II CRASH CUSHION SYSTEM HAS BEEN DESIGNED TO ATTACH TO CONCRETE OR ASPHALT FOUNDATIONS. USE THE ANCHORAGE SPECIFIED BELOW DEPENDING ON THE FOUNDATION AT THE JOB SITE. REFERENCE TAU-II FOUNDATION DRAWINGS FOR FURTHER DETAIL.

1.) CONCRETE PAD

FOUNDATION: MINIMUM 6 IN. [150 mm] REINFORCED PCC PAD OR 8 IN. [200 mm] NONREINFORCED PCC PAD

ANCHORAGE: 3/4 IN. [20 mm] X 8 1/4 IN. [210 mm] GALVANIZED ANCHOR WITH 6 IN. [150 mm] EMBEDMENT OR 3/4" MECHANICAL ANCHORS WITH AN EMBEDMENT THAT IS IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS

2.) ASPHALT OVER SUBBASE



FOUNDATION: MINIMUM 6 IN [150 mm] AC OVER 6 IN. [150 mm] COMPACTED DGA SUBBASE

ANCHORAGE: 3/4 IN. [20 mm] X 18 IN. [460 mm] GALVANIZED ANCHORS WITH 16 IN. [410 mm] EMBEDMENT.

ASPHALT ANCHORING KIT REQUIRED

3.) ASPHALT ONLY

FOUNDATION: MINIMUM 8 IN. [200 mm] AC

ANCHORAGE: 3/4 IN. [20 mm] X 18 IN. [460 mm] GALVANIZED ANCHORS WITH 16 IN. [410 mm] EMBEDMENT.

ASPHALT ANCHORING KIT REQUIRED

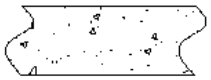
4.) ASPHALT OVER P.C. CONCRETE

FOUNDATION: AC OVER PCC.

ANCHORAGE: 3/4 IN. [20 mm] GALVANIZED ANCHORS WITH MINIMUM 6 IN. [150 mm] EMBEDMENT IN PCC - NO ASPHALT ANCHORING KIT REQUIRED
OR
3/4 IN. [20 mm] X 18 IN. [460 mm] GALVANIZED ANCHORS WITH 16 IN. [410 mm] EMBEDMENT - ASPHALT ANCHORING KIT REQUIRED

MATERIAL SPECIFICATIONS

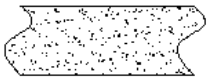
PORTLAND CEMENT CONCRETE (PCC)



STONE AGGREGATE CONCRETE MIX, 4,000 PSI [28 MPa] MINIMUM COMPRESSIVE STRENGTH (SAMPLING PER ASTM C31-64 OR ASTM C42-64A, TESTING PER ASTM C39-64)

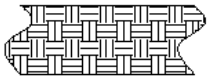
THE CONTRACTOR IS TO FURNISH A CERTIFICATION THAT THE CONCRETE INSTALLED MEETS THE REQUIRED STRENGTH AND TESTING REQUIREMENTS

ASPHALTIC CONCRETE (AC)



ASPHALT CONCRETE TYPE SP 12.5 TRAFFIC LEVEL C OR HIGHER (FDOT SPECIFICATION 334)

COMPACTED SUBBASE (DGA)



ROCK BASE (FDOT SPECIFICATION 200) OR GRADED AGGREGATE BASE (FDOT SPECIFICATION 204)

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM
A	ADDED NOTE TO CONCRETE PAD ANCHORAGE	10/21/08	JR			

SCALE: FULL

	DATE	INIT.
DRAWN BY	01/09/04	GAD
APPR'D BY		JSM

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16
Dec .XXX=± .010
Dec .XX=± .030

TITLE: FOUNDATION SPECIFICATIONS

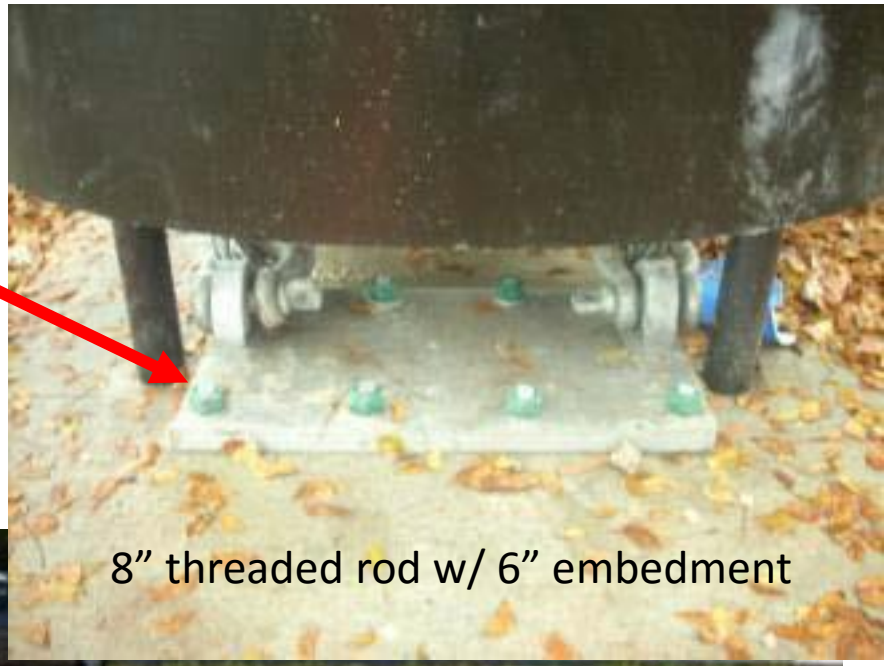
MODEL	DRAWING NUMBER	REV.
	A040113-FL-U	A

Crash Cushions – Installation of Common Products

TAU-II

Foundation Options

Examples of Concrete Foundations



Crash Cushions – Installation of Common Products

TAU-II

Foundation Options

Examples of Asphalt Foundations

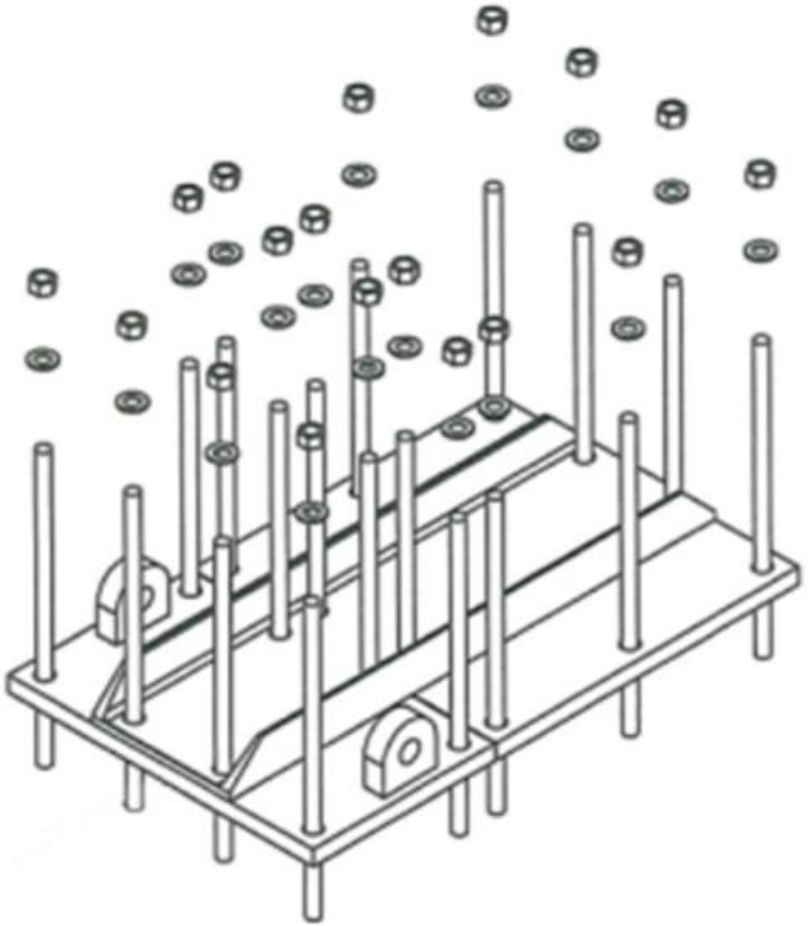
18” threaded rod w/ 16” embedment

Crash Cushions – Installation of Common Products

TAU-II

Anchor Embedment

- Chemical or mechanical anchors are acceptable.
- Most common method is using all-thread rod & epoxy.
- For a concrete pad, ¾” x 8” threaded rod is used with an embedment depth of 6” in the pad.
- For asphalt foundations, a ¾” x 18” threaded rod is used with an embedment depth of 16” in the asphalt.



TAU-II

Anchor Embedment

- For any anchors in the concrete barrier wall, ¾” mechanical anchors (wedge bolts) are acceptable.
- Proper anchor installation procedures are key
- Dust is blown out of holes
- Generous amount of epoxy put into holes
- Epoxy given ample time to cure before tightening, etc.
- **Not all adhesives listed under QPL 937 HV Type are acceptable.**
- Manufacturer publishes periodic list of those evaluated and found acceptable per manufacturer’s requirements.

TAU-II

Anchor Embedment Depth

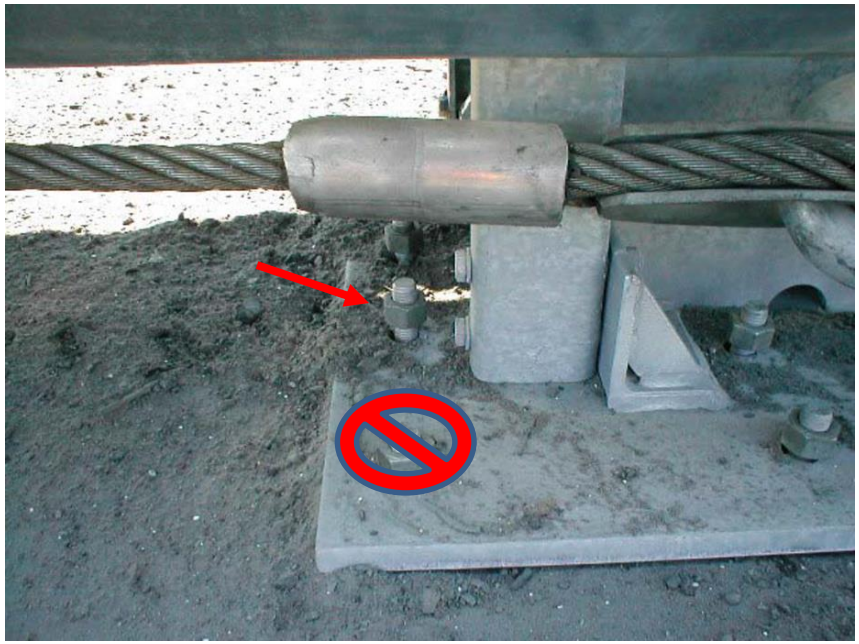
Threads should not extend more than ¼” above the top of the nut when the nut is tight against the backstop ground plate.

Crash Cushions – Installation of Common Products

TAU-II

Do's and Don'ts - Anchor Embedment Depth

Nuts are not torqued down. No evidence of epoxy flooding out around bolt holes which could indicate not enough epoxy in holes.



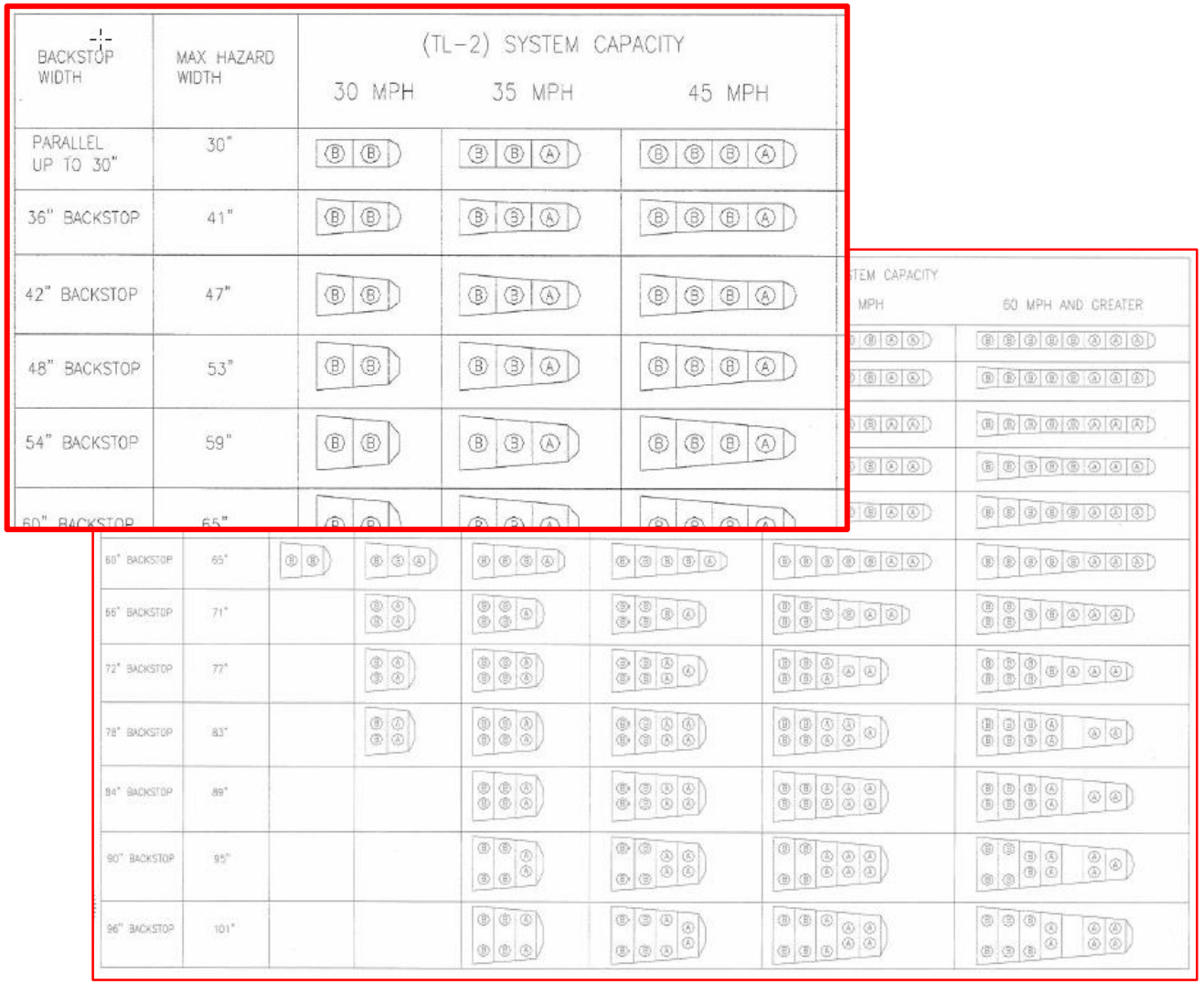
Properly installed front cable anchor plate. Note some epoxy flowing out of holes. No more than ¼" of threads extending above nuts.

Crash Cushions – Installation of Common Products

TAU-II

Cartridge Placement

Chart is in APL 102-041-021 Vendor Drawings

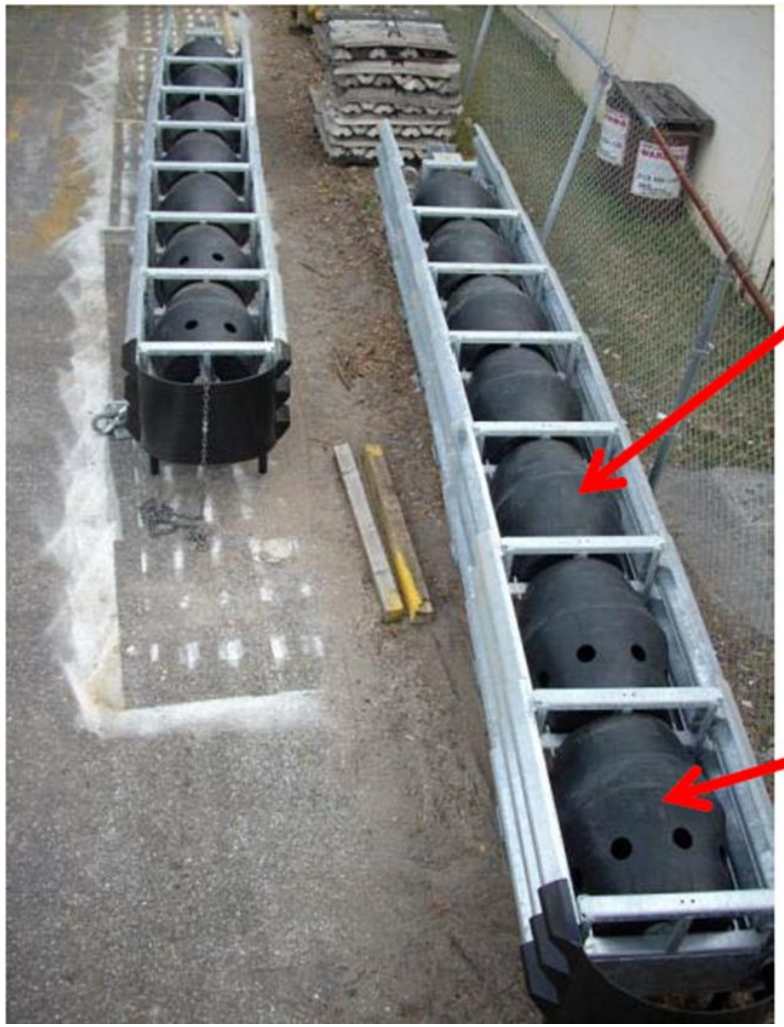


BACKSTOP WIDTH	MAX HAZARD WIDTH	(TL-2) SYSTEM CAPACITY 30 MPH	35 MPH	45 MPH
PARALLEL UP TO 30"	30"	Ⓑ Ⓑ	Ⓑ Ⓑ Ⓐ	Ⓑ Ⓑ Ⓑ Ⓐ
36" BACKSTOP	41"	Ⓑ Ⓑ	Ⓑ Ⓑ Ⓐ	Ⓑ Ⓑ Ⓑ Ⓐ
42" BACKSTOP	47"	Ⓑ Ⓑ	Ⓑ Ⓑ Ⓐ	Ⓑ Ⓑ Ⓑ Ⓐ
48" BACKSTOP	53"	Ⓑ Ⓑ	Ⓑ Ⓑ Ⓐ	Ⓑ Ⓑ Ⓑ Ⓐ
54" BACKSTOP	59"	Ⓑ Ⓑ	Ⓑ Ⓑ Ⓐ	Ⓑ Ⓑ Ⓑ Ⓐ
60" BACKSTOP	65"	Ⓑ Ⓑ	Ⓑ Ⓑ Ⓐ	Ⓑ Ⓑ Ⓑ Ⓐ

Crash Cushions – Installation of Common Products

TAU-II

Cartridge Placement



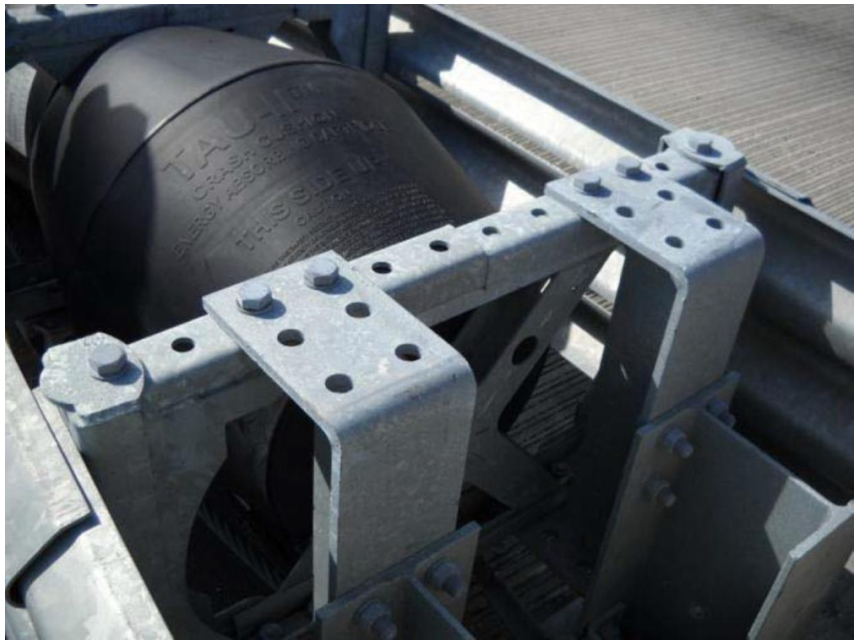
Crash Cushions – Installation of Common Products

TAU-II

Cartridge Placement

The writing on the cartridge should face up and is to be legible when standing behind the crash cushion looking towards the nose.

The TAU Configuration chart is printed on the bottom side of each cartridge.

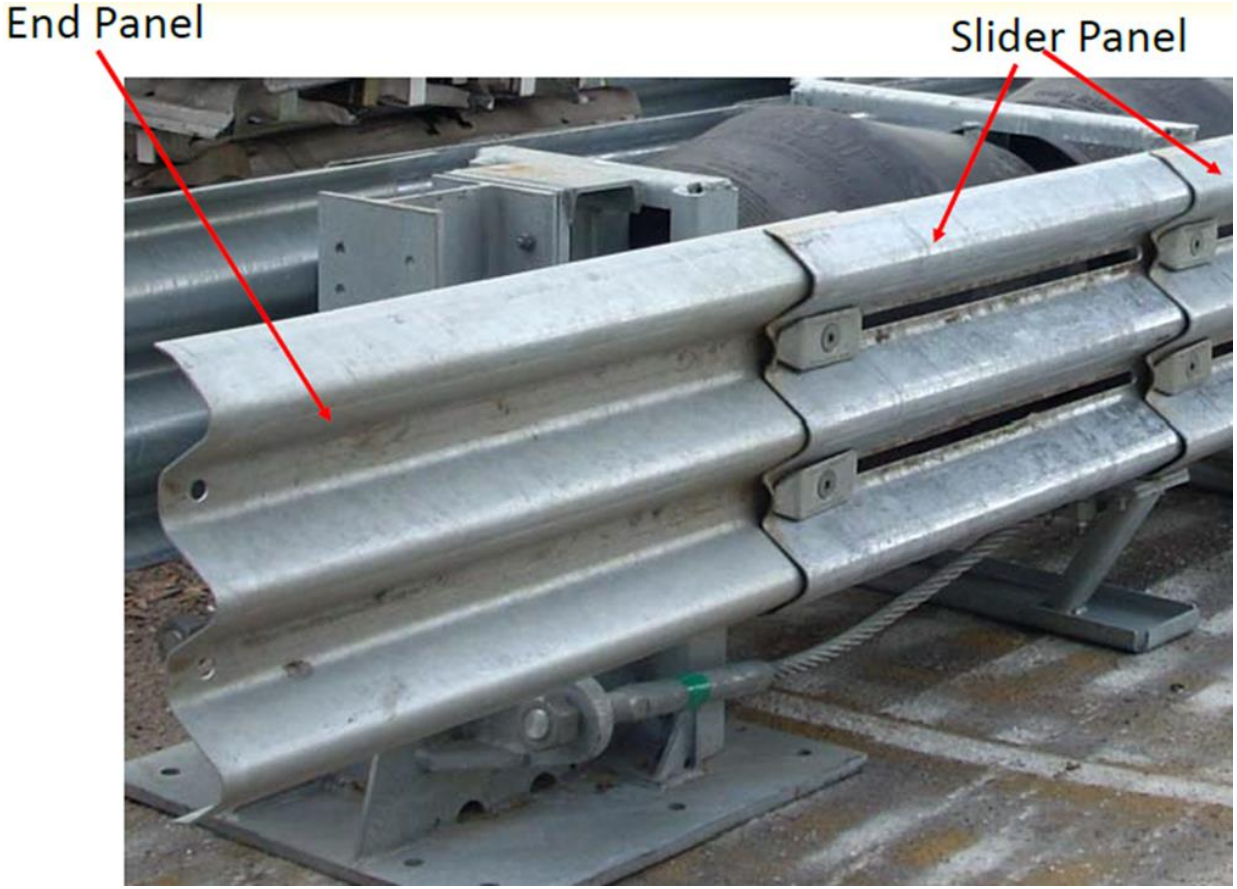


Crash Cushions – Installation of Common Products

TAU-II

Slider and End Panels

The slider panels overlap the end panel so the slider panels can slide back and over the end panel when the crash cushion is hit.



Crash Cushions – Installation of Common Products

TAU-II

Slider and End Panels

The rearward panel is “on top” of the forward panel. When impacted, the attenuator will telescope rearward.

TAU-II

Slider and End Panels

The gap between the slider panels should not exceed 3/4”.

If you can get your finger in the gap, it’s more than 3/4”!

Crash Cushions – Installation of Common Products

TAU-II

Slider and End Panels

The end panel is needed even in uni-directional situations to adequately protect the backstop.

Crash Cushions – Installation of Common Products

TAU-II

Bi-Directional Conditions

If traffic is approaching the TAU from the backside, a bi-directional transition wing is used to mitigate a reverse impact into the backstop.

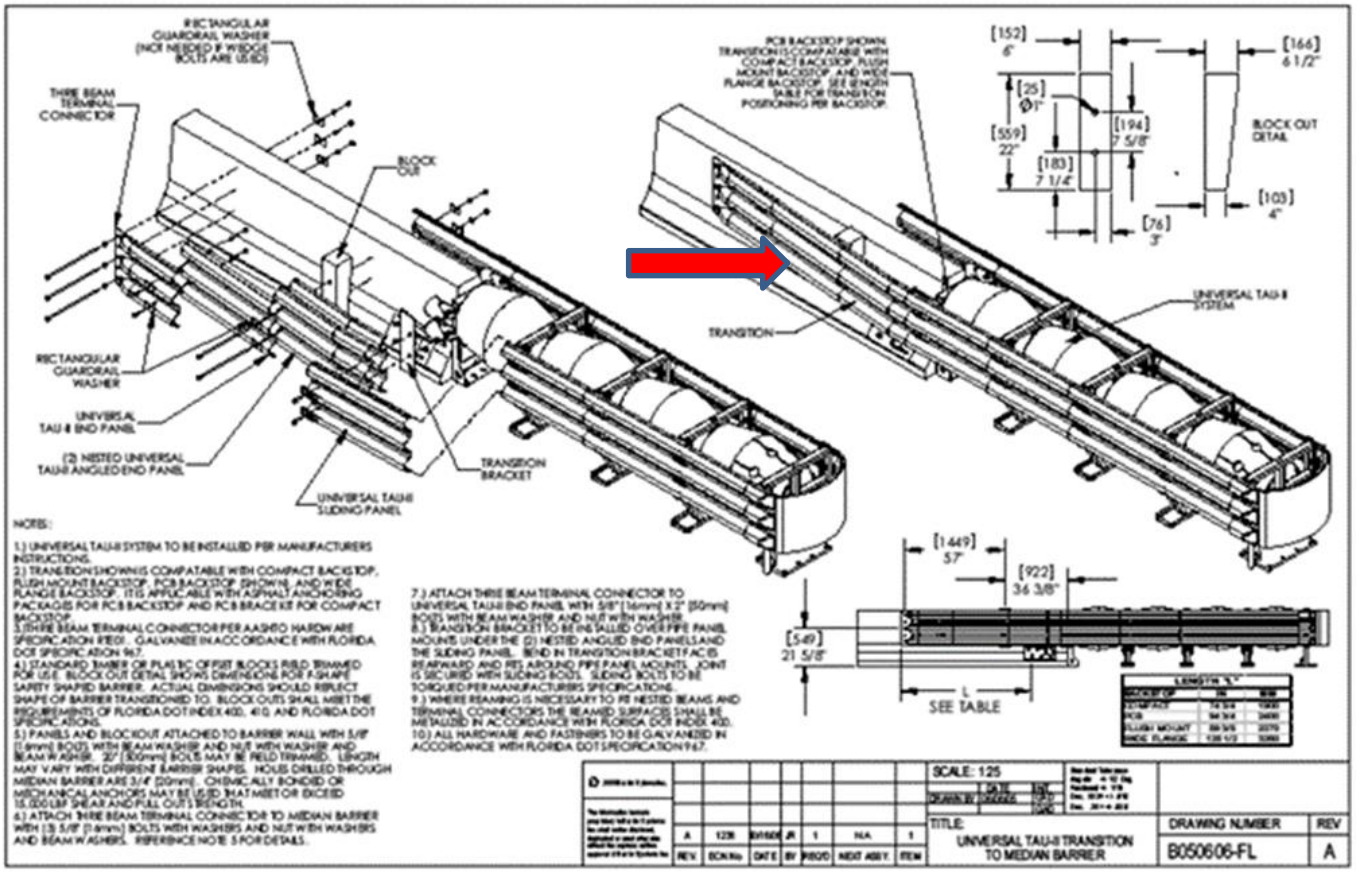
A “kit” is available for this wing (pictured) or a piece of thrie-beam guardrail and end shoe can be used.

Crash Cushions – Installation of Common Products

TAU-II

Bi-Directional Conditions

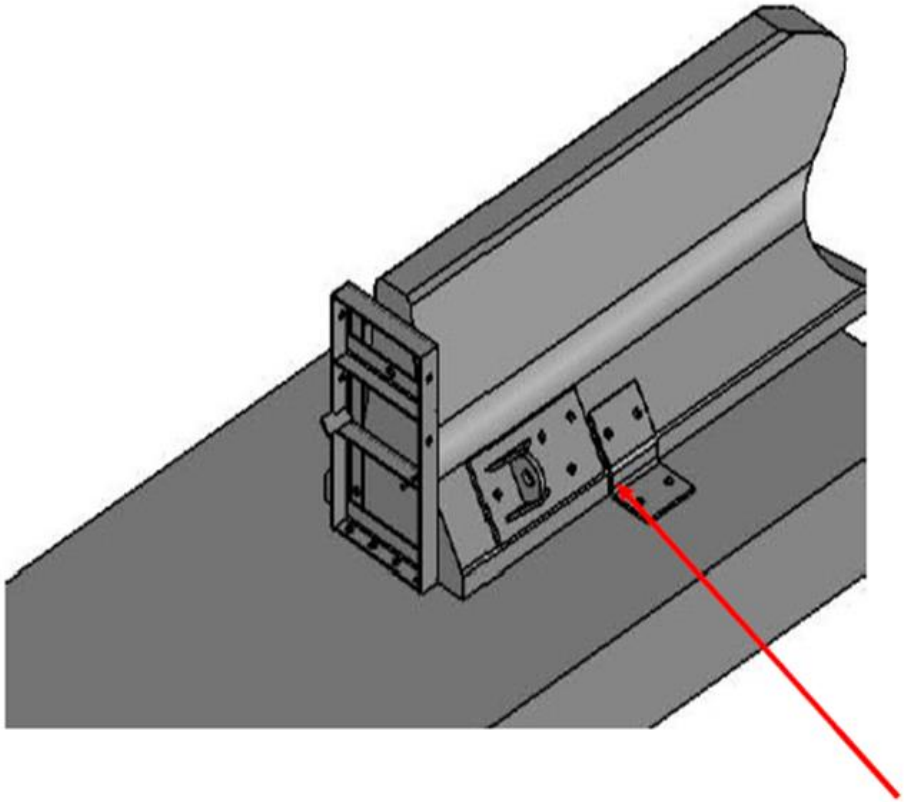
Drawing is in APL
102-041-021
Vendor Drawings



TAU-II

Barrier Wall Anchoring

The TAU-II uses two barrier wall anchor tabs – one on each side of the barrier. Whenever the PCB backstop is used on an asphalt foundation, even if not in a bi-directional configuration, the anchor tabs should be used.



TAU-II

Torque

Slider bolts: 20 ft-lbs

If the slider bolts are too tight, the system will not telescope rearward when impacted!

Crash Cushions – Installation of Common Products

TAU-II

Torque

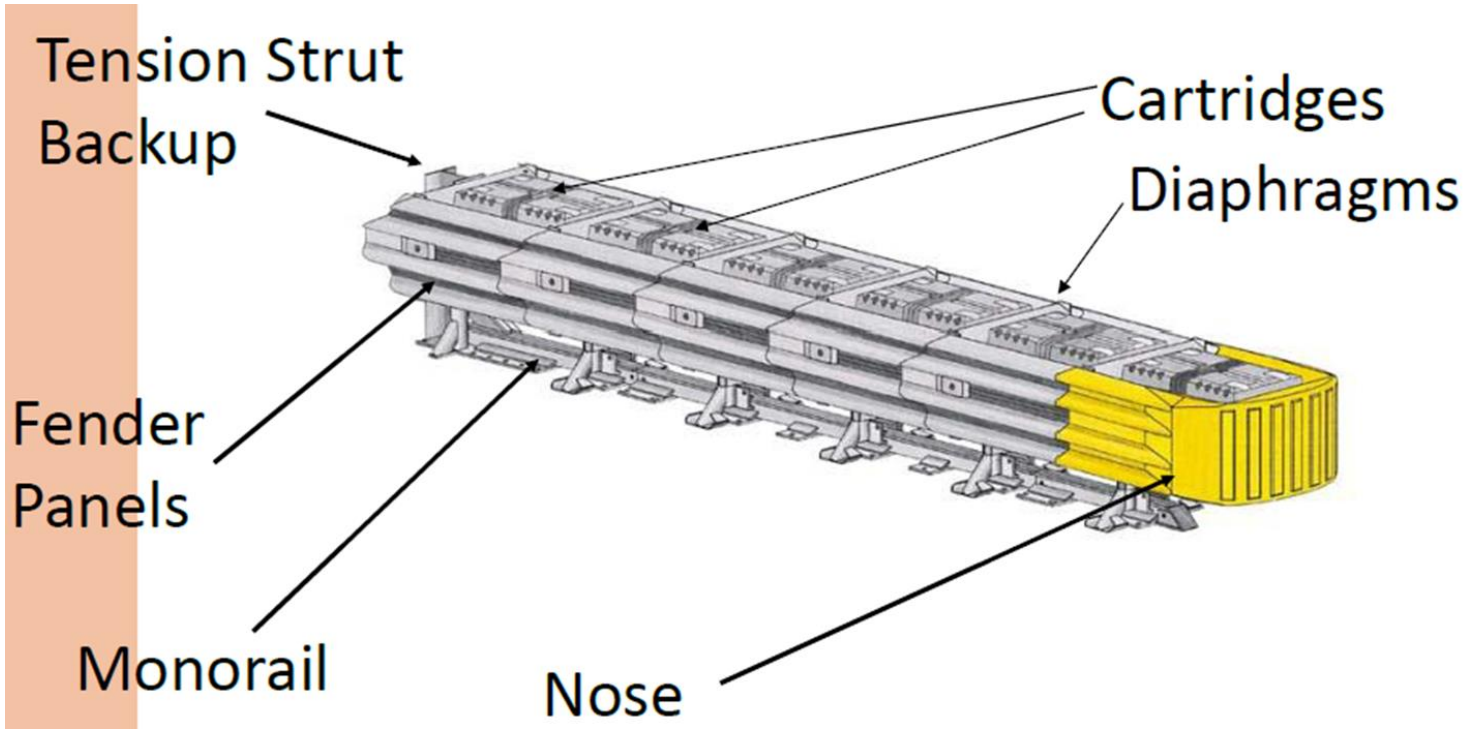
Anchors in pad & barrier:
On concrete pads –120 ft-lbs
On asphalt pads –5 ft-lbs

Cables:
On concrete pads –500 ft-lbs
On asphalt pads –120 ft-lbs

QuadGuard

QUARDGUARD SYSTEM

FDOT APL 102-041-018

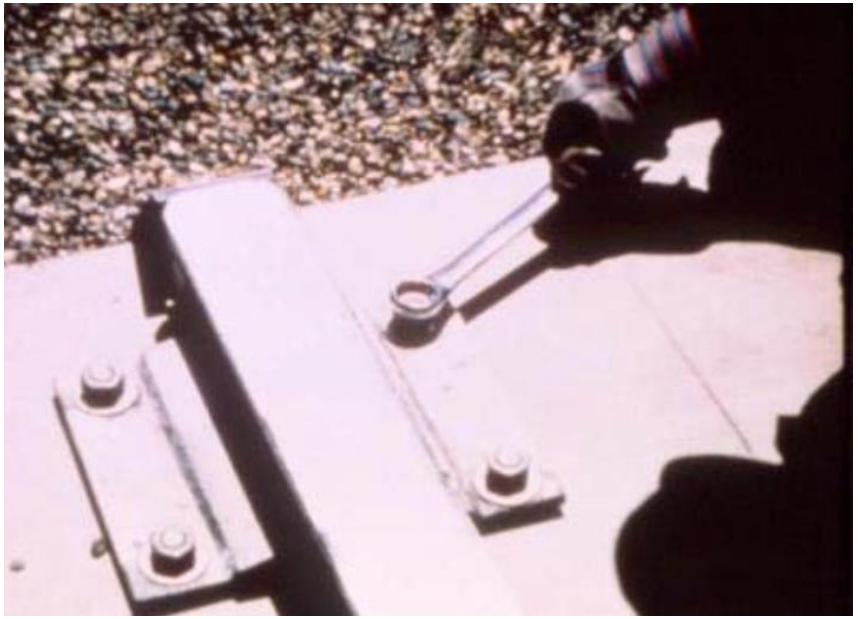


QuadGuard

Installation and Maintenance Tips

Mix and pour the 2-part epoxy

Torque anchors to 120 ft/lbs

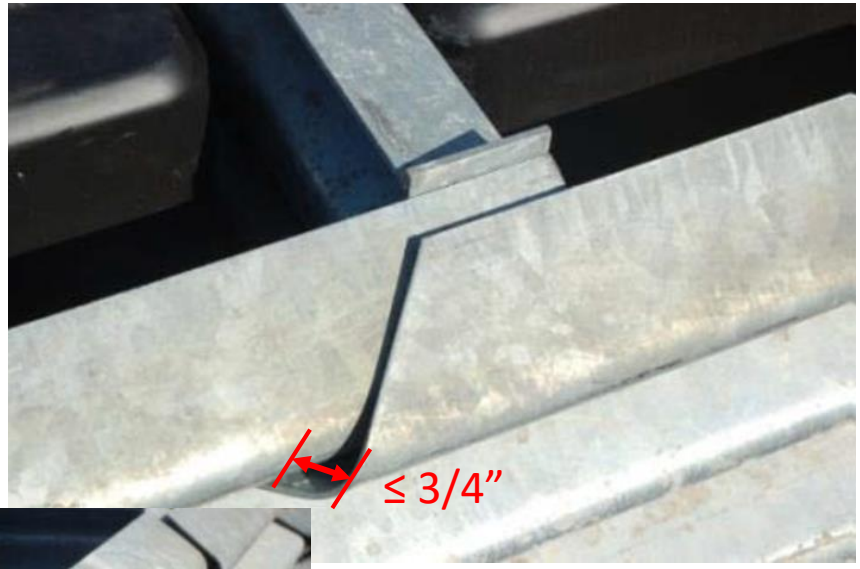


Crash Cushions – Installation of Common Products

QuadGuard

Installation and Maintenance Tips

Fender Panel Gap should be ¾” or less.



QuadGuard

Installation and Maintenance Tips

Example of well nested panels.

QuadGuard

Installation and Maintenance Tips

Type I Cartridges are placed in the front of the System

Type II are in the rear of the System

QuadGuard

Installation and Maintenance Tips

Cartridges should be level.

Crash Cushions – Installation of Common Products

QuadGuard

Common MOT Process Review Finding

The third cartridge in the QuadGuard crash cushion was a Type II – Per the APL Vendor Drawings, it should be a Type I.

QuadGuard

Installation and Maintenance Tips

Mushroom washers should nest flat

GOOD

BAD

QuadGuard

Installation and Maintenance Tips

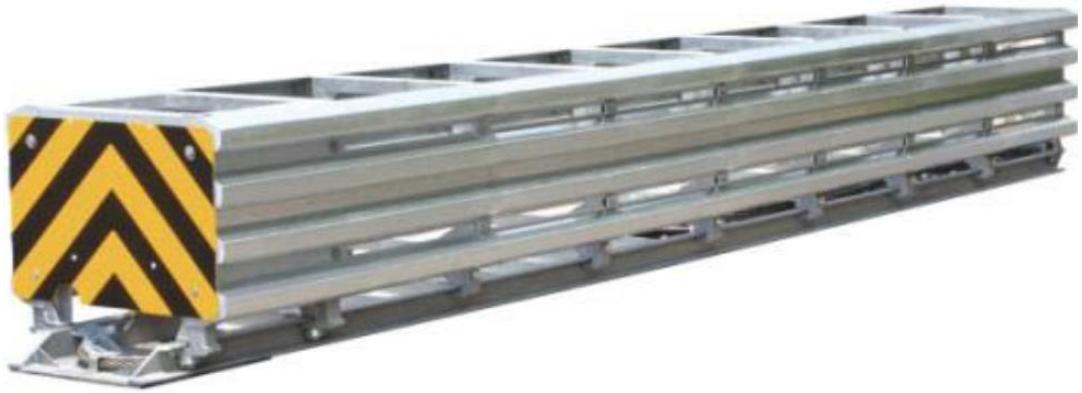
Clear zones are still important with Redirective, Non-Gating Systems.

SCI Smart Cushion

SCI SMART CUSHION

FDOT APL 102-041-010

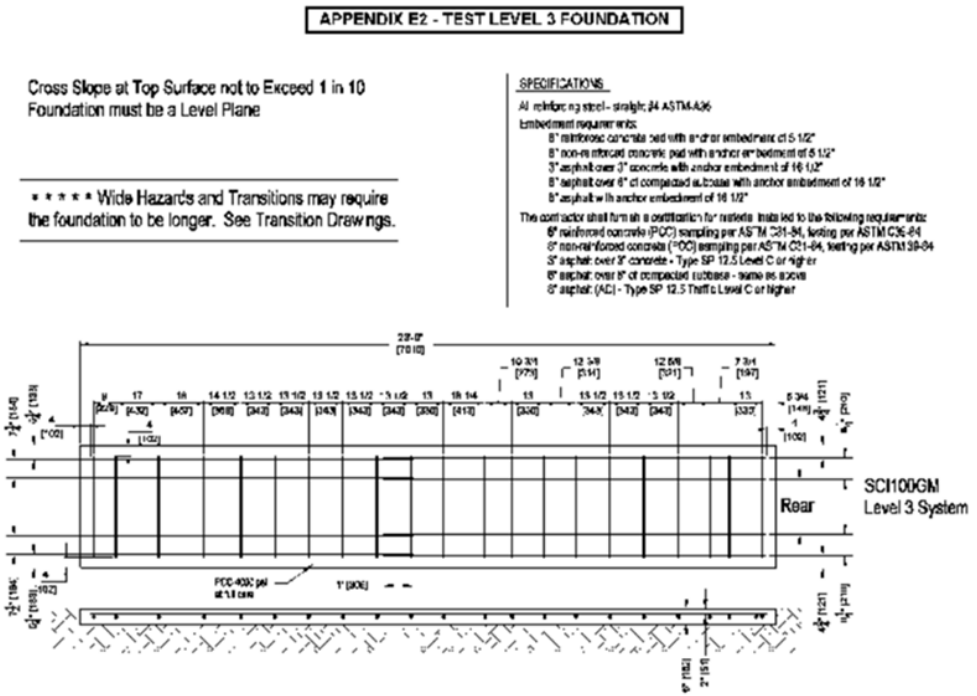
NCHRP 350 Approved
Test Level 213’6” L X 24” W X 34” H
Test Level 321”6” L X 24” W X 34”H
Fully Redirective
Non-gating, Bi-directional
Available for wide application
Low Cost Repair
30 Minute Reset (typical)



SCI Smart Cushion

Inspection for Proper Installation

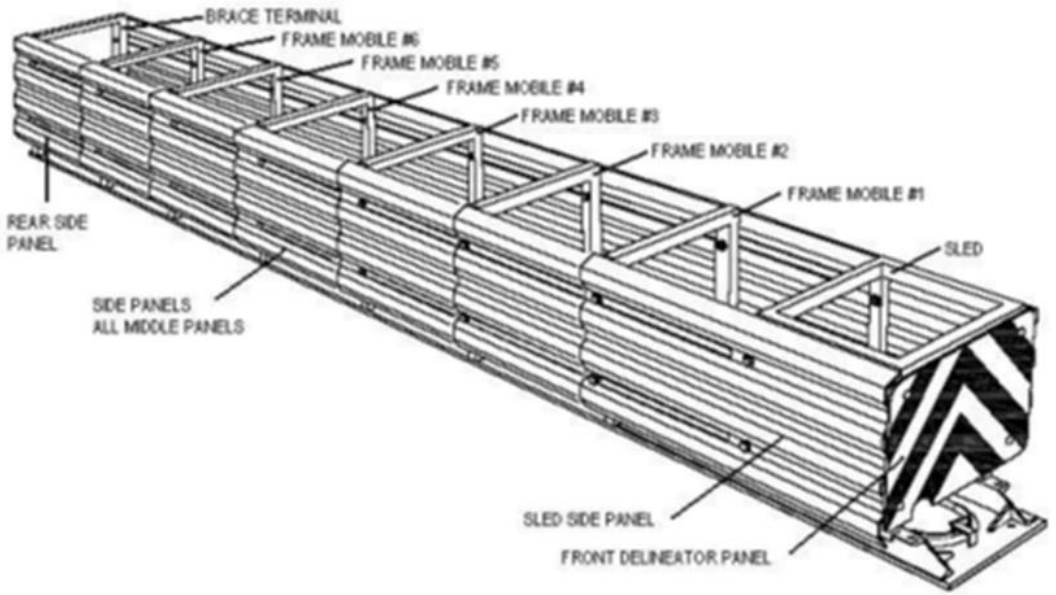
Pad must be per specifications as found in the manufacturer's Design and Installation Manual.



SCI Smart Cushion

Inspection for Proper Installation

The SCI SMART CUSHION® is shipped in one piece, fully assembled. During installation the unit only needs to be properly positioned on the pad. Once positioned, the holes in the base are used as a template to drill holes to accept the epoxy anchors.



SCI Smart Cushion

Inspection for Proper Installation

Unit should be centered on the barrier

Attenuator should be level and properly oriented on pad

SCI Smart Cushion

Inspection for Proper Installation

Check to make sure all anchors are in place and nuts are tight.

Proper torque is 125 ft-lbs.

The manufacturer recommends RedHead A7 Fast Dispensing, Fast Curing Acrylic Adhesive epoxy or equivalent.

Proper care should be taken to make sure epoxy is within date code.

SCI Smart Cushion

Inspection for Proper Installation

On a full collapse, the last set of side panels will telescope 30” beyond the last terminal brace at the rear of the crash cushion.

All objects that may interfere with this motion can affect the performance of and cause undue damage to the crash cushion.

SCI Smart Cushion

Inspection for Proper Installation

Check that the front section is pulled out to within 1” of the front stop bolt.

Verify that shear bolts are installed on the mobile sheaves.

SCI Smart Cushion

Inspection for Proper Installation

The cables should be visually inspected for damage or any sign of deterioration, broken wires or localized wear.

Inspect Side Keeper Bolts and Side Panels

SCI Smart Cushion

Inspection for Proper Installation

The SCI SMART CUSHION® is a 24” wide unit.

To protect a barrier wider than 24” a transition needs to be installed. If needed, insure that the transition is properly assembled and anchored per the specifications as found in the manufacturer’s Design and Installation Manual.

SCI Smart Cushion

Final Inspection

Walk the area to make sure all tools or other equipment have not been left within the SCI SMART CUSHION® structure.

Crash Cushions – Installation of Common Products

TRACC

TRINITY ATTENUATING CRASH CUSHION

FDOT APL 102-041-011

Arrives Assembled

26 Anchor Rods

Resettable Design

No Cushions

TRACC

Attenuator Inspection

Foundation Anchoring

No more than ½” thread exposed.

TRACCs require flat and lock washer.

TRACC

Attenuator Inspection

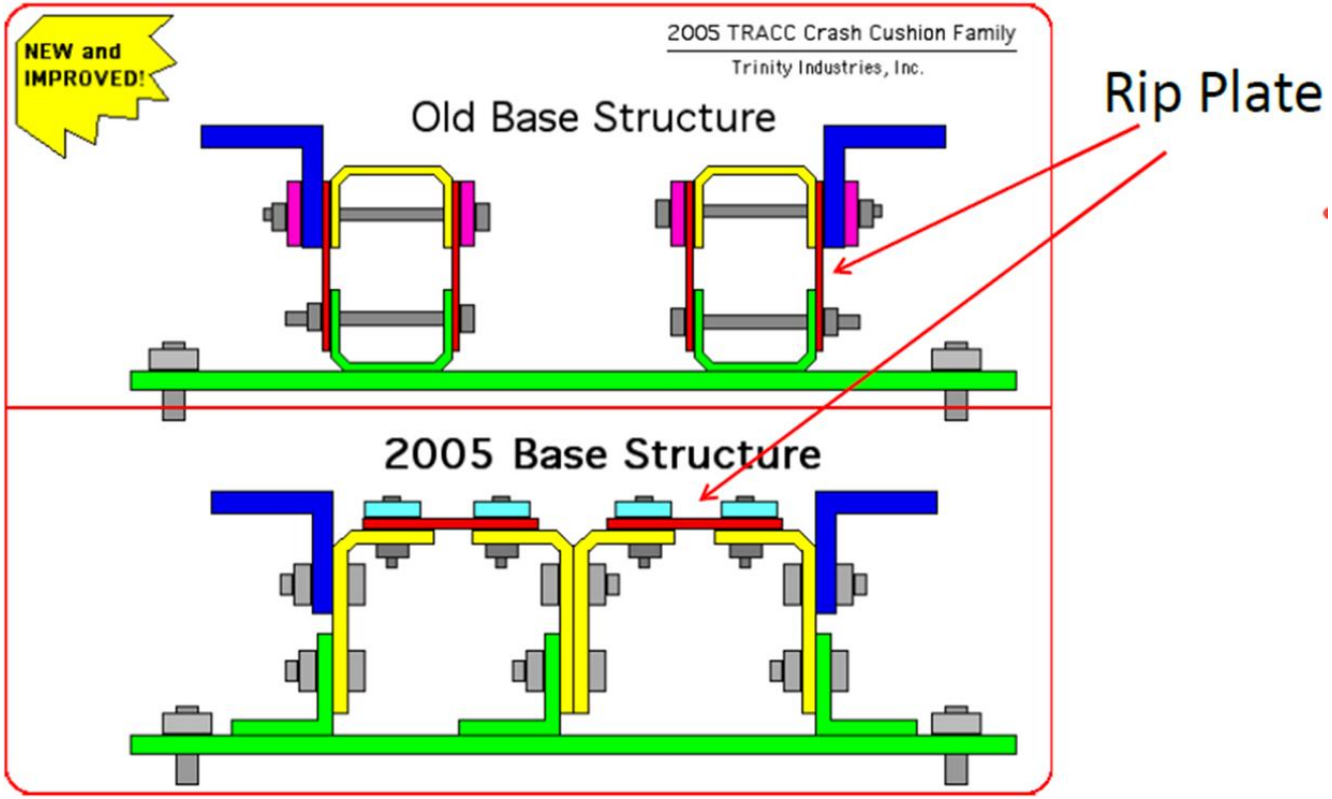
Foundation Anchoring

Check the tightness of anchor hardware.

TRACC

Attenuator Inspection

Galvanized Steel Components



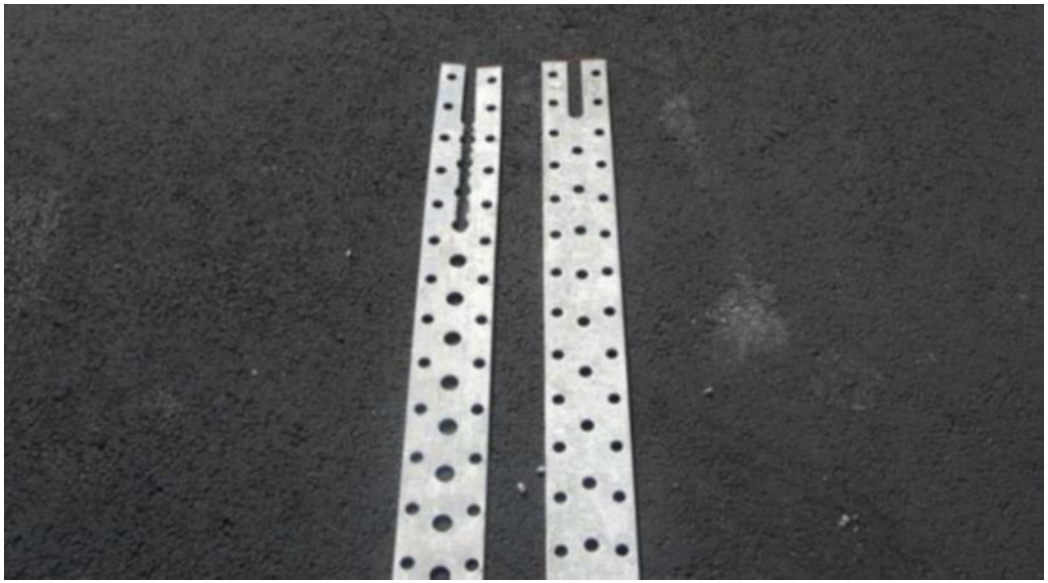
TRACC

Attenuator Inspection

Galvanized Steel Components

Units will have 1 to 4 rip plate stages.

Inspect for rip plate damage.



Crash Cushions – Installation of Common Products

TRACC

Attenuator Inspection

Galvanized Steel Components

Overhead of base w/ rip plates installed

TL-2 UNIT

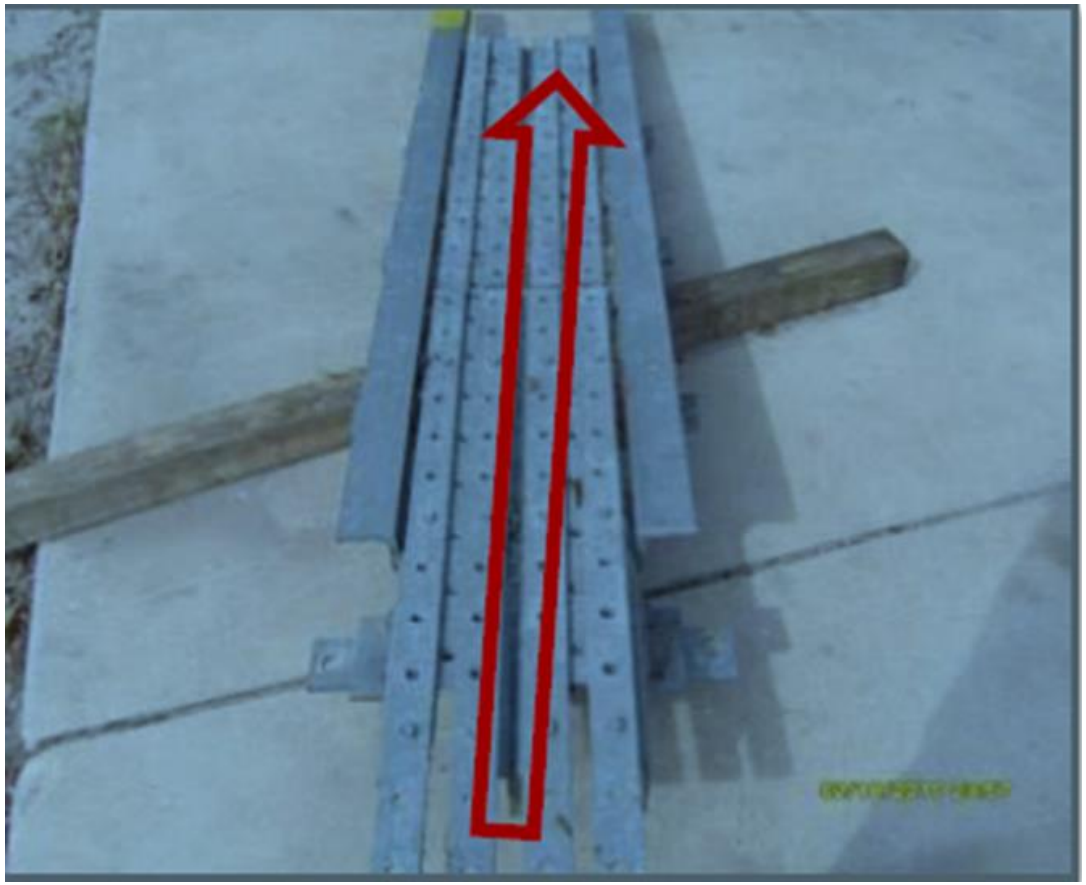
- 2ea Base Assembly

TL-3 UNIT

- 3ea Base Assembly

TL-3+ UNIT

- 4ea Base Assembly



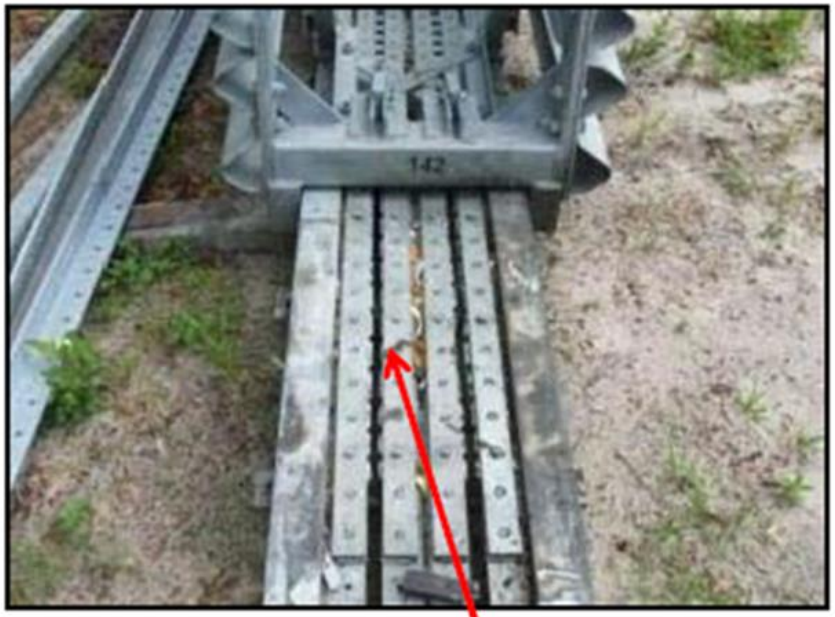
TRACC

Attenuator Inspection

Galvanized Steel Components

Look for damaged rip plates

OK



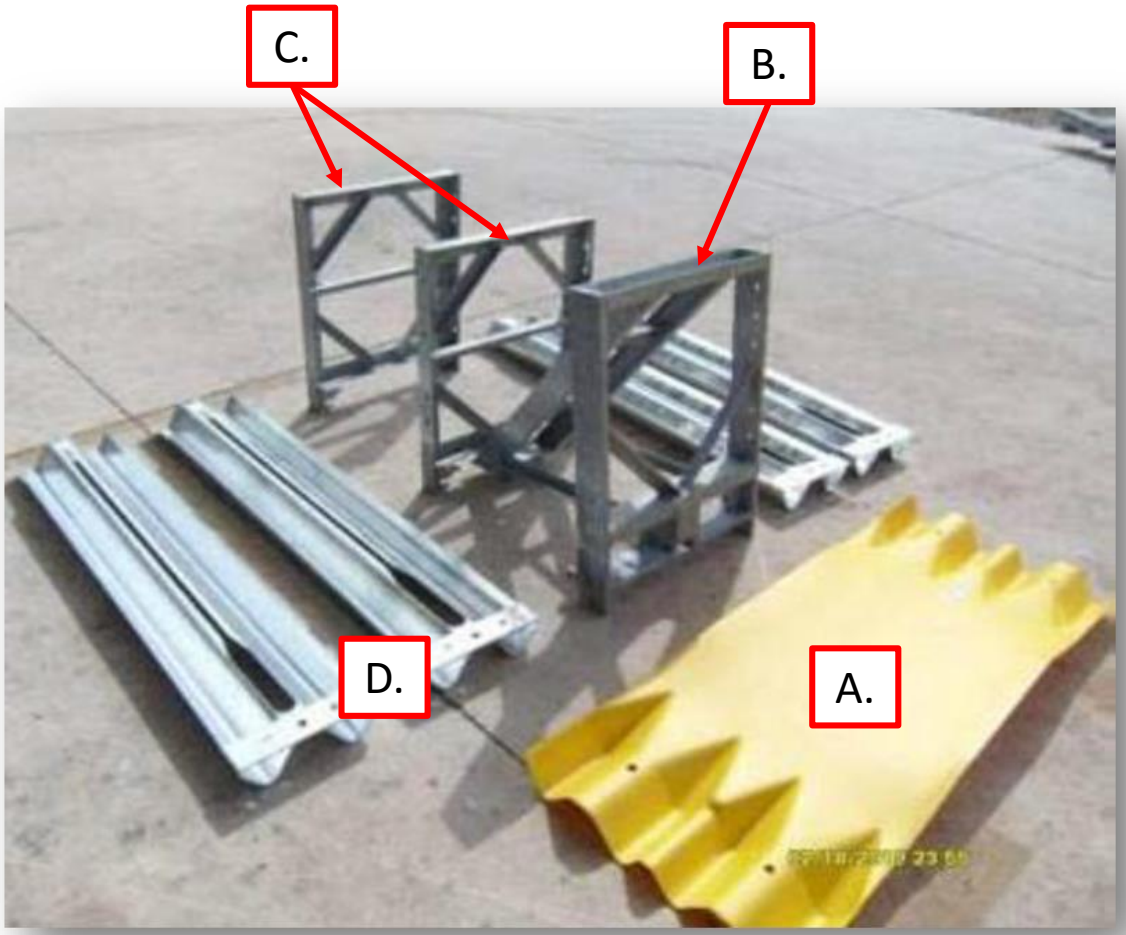
DAMAGED

TRACC

Attenuator Inspection

Galvanized Steel Components

A. Nosepiece
B. Sled
C. Frames
D. Fender Panels



Crash Cushions – Installation of Common Products

TRACC

Attenuator Inspection

Galvanized Steel Components

Sled slides on impact

Cutter bar slices thru rip plate

Friction slows vehicle

Crash Cushions – Installation of Common Products

TRACC

Attenuator Inspection

Galvanized Steel Components

Crash Cushions – Installation of Common Products

TRACC

Attenuator Inspection

Hardware

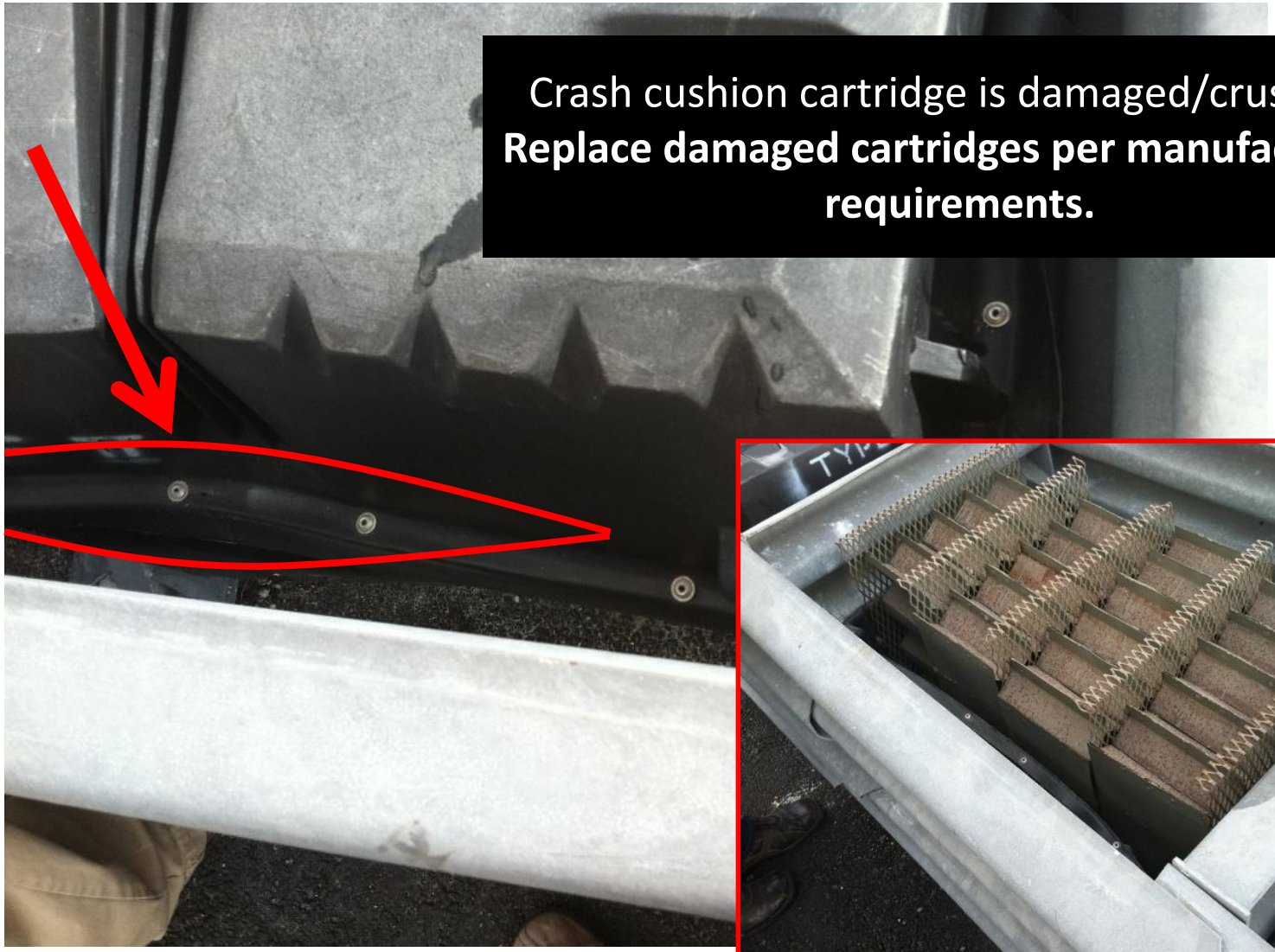
Install 4 L-Brackets per TRACC Unit Installation

Install Barrier Straps per FDOT Design Standard Index 415

Crash Cushions – MOT Process Review Findings

In this section, we will take a look at some common issues with Crash Cushion installation found during MOT Process Reviews.

Common MOT Process Review Findings



Crash cushion cartridge is damaged/crushed – **Replace damaged cartridges per manufacturer's requirements.**

Common MOT Process Review Findings

Crash cushion nose support missing – **Nose support is required per the manufacturer's installation manual.**

Common MOT Process Review Findings

Loose nuts on anchor bolts for crash cushions installed on concrete – **APL Vendor Drawing require 120 ft/lbs.**

Common MOT Process Review Findings

Debris/above ground hazard in clear zone – **Index 600 requires 30 foot clear zone (runout) for 60-70 mph. The stockpiled debris is between the departure line and the clear zone, which shall be free of hazard.**

Common MOT Process Review Findings

Crash cushion foundation thickness questionable on shoulder – **APL Vendor Drawings require minimum of 6 inches of asphalt.**

Crash Cushion Inspection Training

Contact Information:

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