APPENDIX 'C'

CRASH ATTENUATION BARRIERS

PN 115270

Revision C December 2016

QuadGuard® II

Assembly Manual

TRINITY HIGHWAY

Ahead of the Curve™

QuadGuard® II

The QuadGuard® II system has been tested pursuant to National Cooperative Highway Research Program ("NCHRP") Report 350 specifications. The QuadGuard® II system has been deemed eligible for federal-aid reimbursement on the National Highway System ("NHS") by the Federal Highway Administration ("FHWA") as a TL-2 or TL-3 device.

Assembly Manual

2525 N. Stemmons Freeway
Dallas, Texas 75207

Important: These instructions are to be used only in conjunction with the assembly, maintenance, and repair of QuadGuard® II systems. These instructions are for standard assembly specified by the appropriate highway authority only. In the event the specified system assembly, maintenance, or repair would result in a deviation from these assembly instructions, contact the appropriate highway authority engineer. This system has been deemed eligible by the FHWA for use on the NHS under criteria utilized by that agency. **Trinity Highway** representatives are available for consultation if required.

This manual must be available to the worker overseeing and/or assembling the product at all times. For additional copies, contact Trinity Highway directly (888) 323-6374 or visit www.trinityhighway.com.

The instructions contained in this manual supersede all previous information and manuals. All information, illustrations, and specifications in this manual are based on the latest QuadGuard® II system information available to Trinity Highway at the time of printing. We reserve the right to make changes at any time. Please contact Trinity Highway to confirm that you are referring to the most current instructions.

Part No. 115270
Revision C December 2016

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Customer Service Contacts

Trinity Highway is committed to the highest level of customer service. Feedback regarding the QuadGuard® II system, its assembly procedures, supporting documentation, and performance is always welcome. Additional information can be obtained from the contact information below:

Trinity Highway

Telephone:	(888) 323-6374 (USA) +1 312 467 6750 (International)
E-mail:	product.info@trin.net
Website:	www.trinityhighway.com

Important Introductory Notes

Proper assembly of the QuadGuard® II system is critical to achieve performance that has been evaluated and deemed eligible by the FHWA per NCHRP Report 350. These instructions should be read in their entirety and understood before assembling the QuadGuard® II system. These instructions are to be used in conjunction with the assembly of QuadGuard® II system and are for standard assemblies only as specified by the applicable highway authority. If you need additional information, or have questions about the QuadGuard® II system, please contact the highway authority that has planned and specified this assembly and, if needed, contact Trinity Highway's Customer Service Department. This product must be assembled in the location specified by the appropriate highway authority. If there are deviations, alterations, or departures from the assembly instructions specified in this manual, the device may not perform as tested.

Important: **DO NOT** use any component part that has not been specifically approved for this system during the assembly or repair of this system (see p. 8 – 12 for component parts).

This product has been specified for use by the appropriate highway authority and has been provided to that user who has unique knowledge of how this system is to be assembled. No person should be permitted to assemble, maintain, or repair this system that does not possess the unique knowledge described above. These instructions are intended for an individual qualified to both read and accurately interpret them as written. These instructions are intended only for an individual experienced and skilled in the assembly of highway products that are specified and selected by the highway authority.

A manufacturer's drawing package will be supplied by Trinity Highway upon request. Each system will be supplied with a specific drawing package unique to that system. Such drawings take precedence over information in this manual and shall be studied thoroughly by a qualified individual who is skilled in interpreting them before the start of any product assembly.

Important: Read safety instructions thoroughly and follow the assembly directions and suggested safe practices before assembling, maintaining, or repairing the QuadGuard® II system. Failure to follow this warning can result in serious injury or death to workers and/or bystanders. Please keep up-to-date instructions for later use and reference by anyone involved in the assembly of the product.

Warning: Ensure that all of the QuadGuard® II system Danger, Warning, Caution, and Important statements within the QuadGuard® II manual are completely followed. Failure to follow this warning could result in serious injury or death in the event of a collision.

Safety Rules for Assembly

*** Important Safety Instructions ***

This manual must be kept in a location where it is readily available to persons who are skilled and experienced in the assembly, maintenance, or repair of the QuadGuard® II system. Additional copies of this manual are available from Trinity Highway by calling (888) 323-6374, or by email at product.info@trin.net, or at www.trinityhighway.com. Please contact Trinity Highway if you have any questions concerning the information in this manual or about the QuadGuard® II system.

Always use appropriate safety precautions when operating power equipment, mixing chemicals, and when moving heavy equipment or QuadGuard® II components. Safety articles including but not necessarily limited to work gloves, apron, safety goggles, safety-toe shoes, and back protection should be used.

Warning: Safety measures incorporating appropriate traffic control devices specified by the highway authority must be used to protect all personnel while at the assembly, maintenance, or repair site.

Safety Symbols

This section describes the safety symbols that appear in this QuadGuard® II manual. Read the manual for complete safety, assembly, operating, maintenance, repair, and service information.

Symbol	Meaning
	**Safety Alert Symbol:** Indicates Important, Caution, Warning, or Danger. Failure to read and follow the Important, Caution, Warning, or Danger indicators could result in serious injury or death to the workers and/or bystanders.

Warnings and Dangers

Read all instructions before assembling, maintaining, or repairing the QuadGuard® II system.

Danger: Failure to comply with these warnings could result in increased risk of serious injury or death in the event of a vehicle impact with a system.

Warning: Do not assemble, maintain, or repair the QuadGuard® II system until you have read this manual thoroughly and completely understand it. Ensure that all Danger, Warning, Caution, and Important statements within the manual are completely followed. Please call Trinity Highway at (888) 323-6374 if you do not understand these instructions.

Warning: Do NOT modify the QuadGuard® II system in any way.

Warning: Ensure that the QuadGuard® II system and delineation used meet all federal, state, specifying agency, and local specifications.

Warning: Ensure delineation on the assembly meets all appropriate Manual on Uniform Traffic Control Devices (“MUTCD”) and local standards.

Important: It is the sole responsibility of the project engineer and/or the local highway authority and its engineers to determine whether use or reuse of any part of the system is appropriate or acceptable following an impact. Trinity Highway makes no recommendation or suggestion regarding this determination. Each impact is unique.

Important: It is critical that you inspect this product after assembly is complete to make certain that the instructions provided in this manual have been strictly followed.

Limitations and Warnings

Trinity Highway contracts with FHWA approved testing facilities to perform crash tests, evaluate test results, and submit results to the Federal Highway Administration for review.

The QuadGuard® II system has been deemed eligible for reimbursement by FHWA as meeting the requirements and guidelines of NCHRP Report 350. NCHRP Report 350 tests are designed to evaluate product performance involving a range of vehicles on roadways, from lightweight cars (approx. 820 kg [1800 lb.]) to full size pickup trucks (approx. 2000 kg [4400 lb.]). A product can be certified for multiple Test Levels. The QuadGuard® II system is certified to the Test Level(s) as shown below:

Test Level 2: 70 km/h [43 mph]

Test Level 3: 100 km/h [62 mph]

These FHWA directed tests are not intended to represent the performance of systems when impacted by every vehicle type or every impact condition existing on the roadway. This system is tested only to the test matrix criteria of NCHRP Report 350 as approved by FHWA.

Trinity Highway expressly disclaims any warranty or liability for injury or damage to persons or property resulting from any impact, collision or harmful contact with products, other vehicles, or nearby hazards or objects by any vehicle, object or person, whether or not the products were assembled in consultation with Trinity Highway or by third parties.

The QuadGuard® II system is intended to be assembled, delineated, and maintained within specific state and federal guidelines. It is important for the highway authority specifying the use of a highway product to select the most appropriate product configuration for its site specifications. The customer should be careful to properly select, assemble, and maintain the product. Site lay out, vehicle population type; speed, traffic direction, and visibility are important elements that require evaluation in the selection of a highway product. For example, curbs could cause an untested effect on an impacting vehicle.

After an impact occurs, the debris from the impact should be removed from the area immediately and the specified highway product should be evaluated and restored to its original specified condition or replaced as the highway authority determines as soon as possible.

System Overview

The QuadGuard® II system is a potentially reusable, re-directive, non-gating crash cushion for roadside obstacles ranging in width from 610 mm to 3200 mm (24" to 126"). It consists of energy-absorbing cartridges surrounded by a framework of Quad-Beam™ Panels. The decision as to whether this product is reusable after impact rests solely within the sound discretion of the trained engineer, experienced in highway products, who is working at the direction of the local DOT, or appropriate highway authority, which specified and now owns the product.

The QuadGuard® II system utilizes two types of cartridges in a staged configuration designed to address both lighter cars and heavier, high center-of-gravity vehicles. Its modular design allows the system length to be tailored to the design speed of a site. See the QuadGuard® II Product Manual to determine the appropriate number of Bays (see p. 66 & 67 for an illustration of Bay) for a given speed.

Impact Performance

The 5 Bay QuadGuard® II systems have successfully passed the requirements outlined in NCHRP Report 350, Test Level 3 tests with both the light car and pickup at speeds of up to 100 km/h [62 mph] at angles up to 20 degrees.

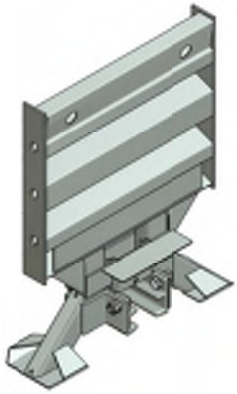
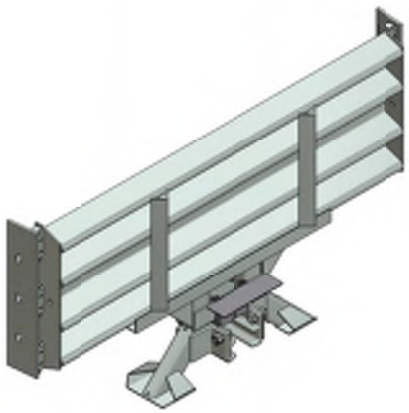
During head-on impact testing, within NCHRP Report 350 criteria, the QuadGuard® II system is designed to telescope rearward to absorb the energy of impact. When impacted from the side, within the applicable NCHRP Report 350 criteria, it is designed to redirect the vehicle back toward its original travel path and away from the roadside obstacle.

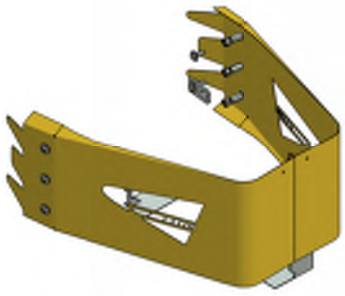
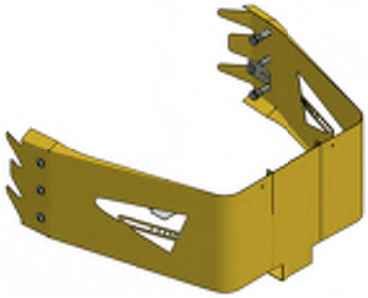
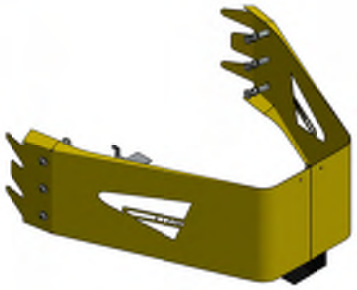
System Components for Replacement

Below is a list of system components to be used in the repair of your particular QuadGuard® II configuration. Please call Trinity Highway customer support if you have any system questions (see p. 3).

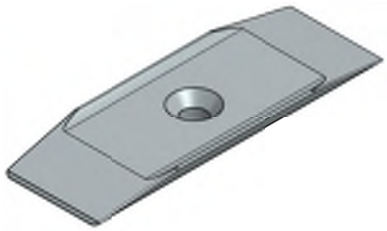
Warning: Use only Trinity Highway parts that are specified herein for the QuadGuard® II for assembling, maintaining, or repairing the QuadGuard® II system. **Do not utilize or otherwise comingle parts from other systems even if those systems are other Trinity Highway systems.** Such configurations have not been tested, nor have they been deemed eligible for use. Assembly, maintenance, or repairs using unspecified parts or accessories is strictly prohibited.

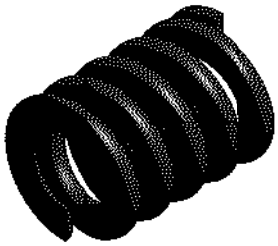
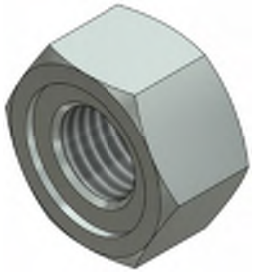
Note: Components are not shown to scale.

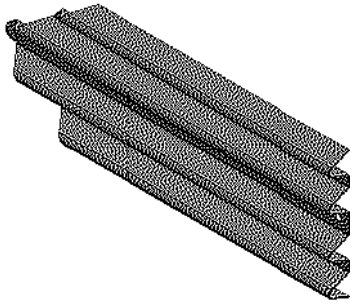
Narrow Diaphragm Assemblies *	Wide Diaphragm Assemblies *		
			
607113 - 24” 607114 - 30” 607115 - 36” 606810 - 48”	607173 - 26.48” 607175 – 32.78” 607176 – 35.93” 607177 – 39.08” 607145 – 42.23” 607146 – 45.38”	607148 – 48.53” 607149 – 50.11” 607150 – 51.68” 607151 – 54.83” 607152 – 57.98” 607156 – 59.56”	607157 – 61.13” 607158 – 64.28” 607159 – 68.06” 607160 – 70.58” 607162 – 73.73” 607163 – 76.88”

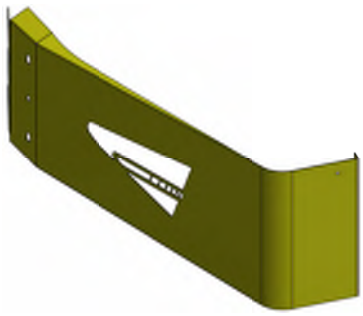
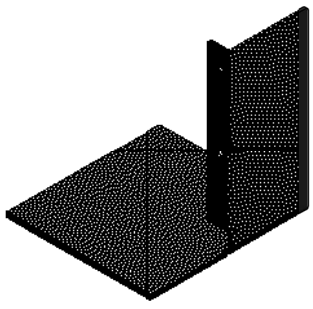
Nose, Narrow Assembly *	Nose, Narrow Assembly 48” *	Nose, Wide Assembly *
		
611580 - Galvanized 611581 - Yellow 611579 - Black	611577 - Galvanized 611578 – Yellow 611576 - Black	611583 – Galvanized 611584 – Yellow 611582 - Black

***Parts in red are included in assemblies.**

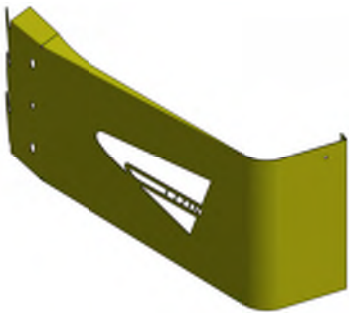
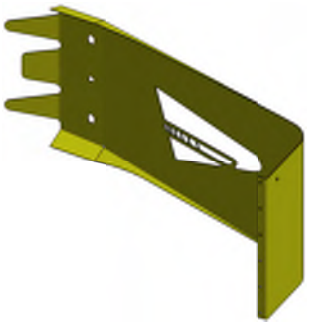
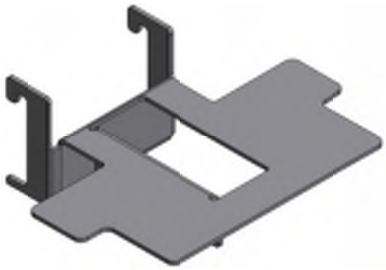
Mushroom Washer	Flat Screw 5/8X8 1/2" Wide	Spring, 6”, Wide
		
617045	116879	117458

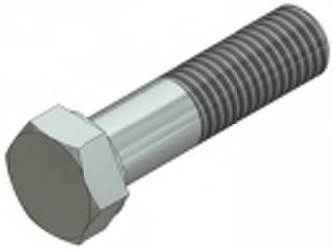
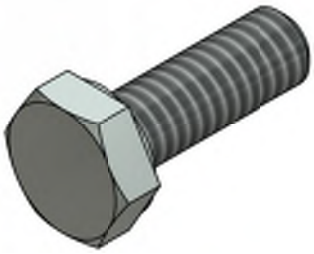
Flat Screw 5/8X5”,G8, Narrow	Spring, 1 1/2”, Narrow	Rail Nut, Hex, 5/8”
		
116878	117458	003340

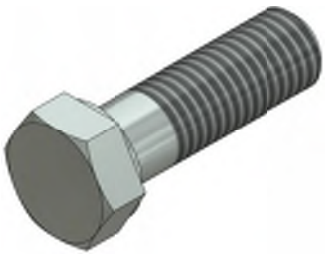
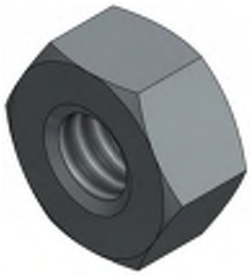
Rail Bolt, 5/8X2”	Panel, Fender Assembly, QG	Washer, Flat, 5/8” X 1 3/4"
		
003400	608236	003300

Nose, L, Wide, W/Logo	Nose, R, Wide, W/Logo	Bracket, Cart Support, Nose
		
611672	611683	605430

***Parts in red are included in assemblies.**

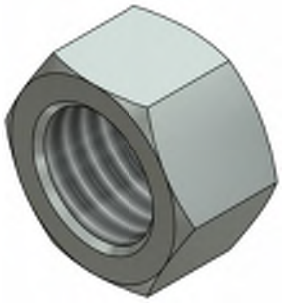
Nose, L, Narrow, W/Logo	Nose, R, Narrow, W/Logo	Bracket, Cart, Nose
		
611669	611680	605420

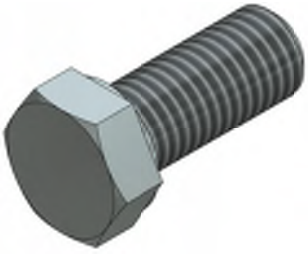
Bolt, Hex 5/8” X 2 1/2", G5	Bolt, Hex, 1/4" X 3/4", G5	Bracket, Cartridge Support
		
118232	113518	605446

Bolt, Bt, 5/8” X 1 1/4", Hex Socket	Bolt, Hex, 5/8” X 2”, G5	Nut, Hex, 1/4"
		
113404	118570	115946

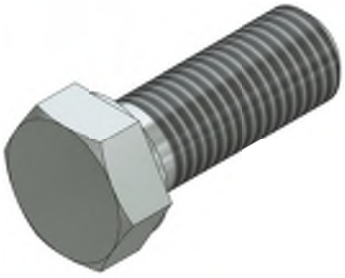
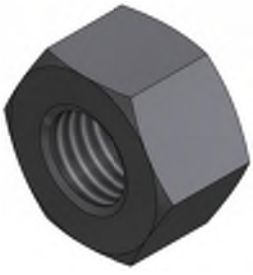
Nut, Hex, Coupling, 5/8” 11” X 2 1/8”	Washer, Lock, 1/4"	Washer, Lock, 5/8”
		
115986	118085	118100

***Parts in red are included in assemblies.**

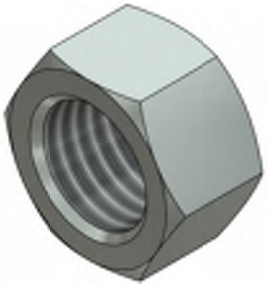
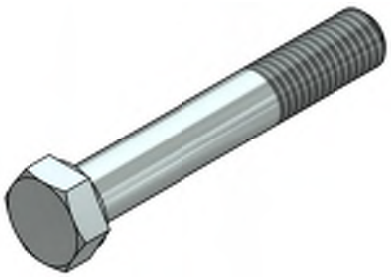
Bracket, Angle, 2” X 1”, W/Holes	Washer, Flat 3/8” X 1”	Nut, Hex, 3/8” X 1”
		
617387	118036	115960

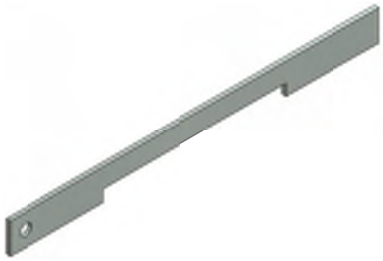
Bolt, Hex, 3/8” X 1”,G5	Washer, Flat, 3/8” X 2”	Bolt, Hex, 5/8”X 1 1/2", G5
		
113596	118038	113654

Bracket, Pull-Out	Shim Kit, 1/8” X 3 5/8” X 8”(2)	Washer, Lock, 3/4"
		
605535	614050	118089

Bolt, Hex, 3/4" X 2”, G8	Monorail Guide	Nut, Heavy Hex, 3/4"
		
113555	611368	003704

***Parts in red are included in assemblies.**

Nut, Heavy Hex, 5/8”	Hinge Plate, Fender Panel	Bolt, Hex, 5/8” X 4”, G5
		
003354	610172	113666

Panel, Side, QG	Bracket, Cartridge Support TS B/U	Locking Bar, Cartridge Support
		
611898	605447	611266

Approved Adhesive *	Stud, 7”, G5	Washer, Flat, 3/4"
		
619316	117542	118027

*See Trinity Highway Approved Adhesive Anchoring System section on page 15.

Cartridge Assy, Type I	Cartridge Assy, Type II
	
606027	606029

QuadGuard® II Foundation/Anchoring

Warning: Ensure the proposed assembly site conforms with the guidance provided by the AASHTO Roadside Design Guide, including, but not limited to, guidance regarding placement on or adjacent to curbs.

Asphalt Installations

Systems with a Tension-Strut Backup may be temporarily installed in construction zones on asphalt. Assemblies on asphalt must provide a minimum of 76 mm [3”] layer of asphalt over a minimum of 76 mm [3”] layer of Portland Cement concrete, 152 mm [6”] layer of asphalt over 152 mm [6”] layer of subbase, or 203 mm [8”] layer of asphalt with no subbase.

Important: Only 460 mm [18”] threaded rods, utilizing Trinity Highway approved adhesive, can be used with (asphalt) foundations. Contact Customer Service at (888) 323-6374 for a complete list of approved adhesives.

Concrete Installations

For concrete installations, the QuadGuard® II system should be installed only on an existing or freshly placed and cured concrete base (28 MPa [4000 psi] minimum). Orientation of the concrete base and the attenuator must comply with the project plans or as otherwise determined by the project engineer or appropriate highway authority.

Recommended dimension and reinforcement specifications for new concrete pads can be found on the standard drawings.

The QuadGuard® II system may be installed on any of the following foundations using the specified anchorage:

Foundation A: Concrete Pad or Roadway

Foundation: 150 mm [6”] minimum depth Portland Cement Concrete (P.C.C.)

Anchorage: Approved adhesive with 180 mm [7”] studs 140 mm [5 1/2”] embedment

Foundation B: Asphalt over P.C.C.

Foundation: 76 mm [3”] minimum asphalt concrete (A.C.) over 76 mm [3”] minimum P.C.C.

Anchorage: Length of anchor required is 460 mm [18”] 420 mm [16 1/2”] embedment

Foundation C: Asphalt over Subbase

Foundation: 150 mm [6"] minimum A.C. over 150 mm [6”] minimum Compacted Subbase (C.S.)

Anchorage: Approved adhesive with 460 mm [18"] studs 420 mm [16 1/2”] embedment

Foundation D: Asphalt Only

Foundation: 200 mm [8”] minimum A.C.

Anchorage: Approved adhesive with 460 mm [18”] studs - 420 mm [16 1/2”] embedment

Important: Systems mounted on asphalt must be replaced and mounted on fresh, undisturbed asphalt if more than 10% of anchors are found to be loose, broken, or show signs of pull out. If 10% or fewer anchors are damaged, replace the damaged anchors in the existing asphalt. Anchor bolts used on systems mounted on asphalt must be inspected every 6 months. See Post Impact Instructions and Maintenance and Repair instructions on page 60.

Foundation Specifications

For Foundations A, B, C and D mentioned above:

A. C. (Asphalt Concrete)

AR-4000 A. C. (per ASTM D3381 '83) 3/4” Maximum, Medium (Type A or B) aggregate

Sieve Size	Operating Range (%) Passing
1"	100
3/4"	95-100
3/8"	65-80
No. 4	49-54
No. 8	36-40
No. 30	18-21
No. 200	3-8

Caution: Walk-up inspections should be conducted at least once every six months for installations on asphalt.

P.C.C. (Portland Cement Concrete)

Stone aggregate concrete mix

4000 psi minimum compressive strength

(Sampling per ASTM C31-84 or ASTM C42-84a, testing per ASTM C39-84)

C.S. (Compacted Subbase)

150 mm [6”] minimum depth 95% compaction

Class 2 aggregate

Sieve Size	Moving Average % Passing
3"	100
2 1/2"	90-100
No. 4	40-90
No. 200	0-25

Trinity Highway Approved Adhesive Anchoring System

A Trinity Highway approved adhesive anchoring system is required to securely anchor crash cushions. Each approved adhesive kit contains adhesive, studs, nuts, washers and instructions. Both vertical and horizontal assemblies are possible using an approved adhesive anchoring system.

Vertical Assemblies

Note: Read all Trinity Highway approved adhesive instructions before starting.

1) **Prepare the Concrete Foundation**

Warning: Do not allow anchoring adhesive to contact skin or eyes. See material safety data sheet supplied with adhesive kit for first-aid procedures. Use only in well-ventilated area. Do not use near open flame.

Warning: Wear safety goggles and gloves during construction.

The anchor bolts (studs) that anchor the QuadGuard® II system Backup and/or Monorail sections to the concrete foundation must be those shipped in the kit or of high strength steel (830 MPa [120,000 psi] minimum tensile strength or equal). These studs must be set in minimum 28 MPa [4000 psi] concrete. Allow the concrete to cure a minimum of seven days before applying anchoring adhesive.

2) Drill Boreholes

Note: Trinity Highway recommends using double-fluted drill bits to achieve optimum tensile strength when using an approved adhesive anchoring system.

Use the part that is to be anchored as a drilling template. Drill the boreholes 3 mm [1/8”] larger than the stud diameter to the recommended depth, using a rotary hammer drill. If a diamond drill bit is used, the surface will be too smooth for the approved adhesive to adhere and full strength will not be achieved. See the approved adhesive instructions provided with your kit. Check to be sure all the boreholes are drilled to the proper depth and aligned with the part to be anchored (see Table A).

Table A
Anchoring Information

Stud Size:	Concrete Bit Size	Minimum Depth	Recommended Torque
3/4”x 6 1/2"	22 mm [7/8”]	125 mm [5”]	Manufacturer Spec
3/4”x 7"	22 mm [7/8”]	140 mm [5” 1/2"]	Manufacturer Spec
3/4”x 18"	22 mm [7/8”]	420 mm [16 1/2”]	15 N-m [10 ft-lb]⚠

Important: When mounting on asphalt, initial torque shall be as shown in Table A. Due to the potential instability of asphalt, anchors may loosen over time. For this reason, anchoring to asphalt should be limited to deployment at temporary locations. It is recommended to re-torque anchors in asphalt every six (6) months to the initial specified torque.

3) Clean the Boreholes

Blow the concrete dust from the borehole using oil-free compressed air. Thoroughly brush the borehole with a 7/8" diameter steel bristle tube brush and then blow it out again. If the borehole is wet, completely flush it with water while brushing. The boreholes must be free of debris, dust, water, ice, oil, grease and other contaminates prior to adhesive injection.

4) Apply Approved Adhesive

Fill the borehole 1/3 to 1/2 full.

Caution: Do not overfill or under-fill the borehole. If the borehole is overfilled, there will not be enough grout to anchor all of the studs provided in the kit. If borehole is underfilled, the grout may not develop the required pull out strength.

5) Add the Washers and Nuts

Place a flat washer onto the stud then thread a nut on until **1 or 2 threads of the NUT** are left exposed.

6) Insert Studs in Boreholes and Wait for Grout to Harden

Push the stud down through the part to be anchored and into the borehole. Give the stud several twists in the approved adhesive to wet the threads.

Caution: Do not disturb or load the stud until the approved adhesive material has hardened (see instructions supplied with the approved adhesive kit).

7) Torque the Nuts

Once the grout has hardened, torque the nut to the recommended values (see Table A on p. 15).

Assembly Cautions

1) Steel rebar

If steel rebar is encountered while drilling an anchor bolt borehole, apply one of the following solutions:

A) Using a diamond core drill bit or rebar drilling tool, drill through the rebar only, then switch back to the concrete bit and drill into the underlying concrete until the proper hole depth is reached.

Danger: Do not drill through rebar without first obtaining permission to do so from the project engineer and only per the engineer's instructions.

B) Drill a new borehole down at an angle past the rebar to the proper depth. Anchor the stud by completely filling both boreholes with an approved adhesive.

Horizontal Assemblies

The horizontal approved adhesive kit is the same as the vertical kit.

Caution: Do not overfill or under fill a borehole. Fill borehole approximately 1/3 to 1/2 full. If the borehole is overfilled, there will not be enough grout to use all of the anchor studs/kit. If borehole is under filled, the grout may not develop the required pull out strength.

1) **Follow the instructions supplied with your approved adhesive kit**

   Apply approved adhesive to each anchor per instructions.

2) **Add the Washers and Nuts**

   Put washer and nut on stud, leaving nut flush with end of stud (see Figure 1).

3) **Insert Studs into Boreholes**

   Push stud through part to be anchored and into borehole. Twist the stud in the approved adhesive to wet the threads.

Note: In horizontal applications the stud should be flush with the top of the nut (see Figure 1).

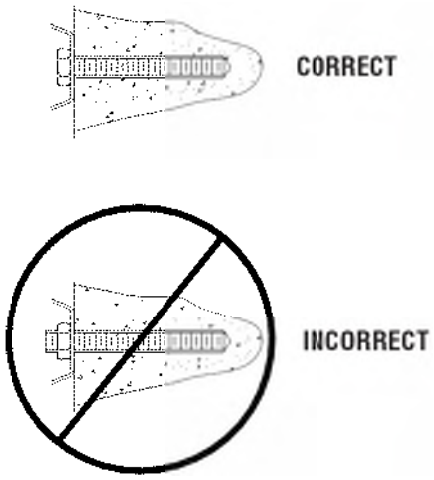


Figure 1
Horizontal Application

Caution: Do not disturb or load the stud until the approved adhesive material has hardened (see approved adhesive kit instructions for hardening times).

4) **Torque the nuts**

   Once the grout has hardened, torque the nut to the approved adhesive manufacturing spec (see p. 15).

Recommended Tools

Documentation

- Manufacturer's Assembly Manual
- Manufacturer's Drawing Package

Cutting Equipment

- Rotary Hammer Drill
- Rebar Cutting Bit
- Concrete Drill Bits – 22 mm [7/8"] (*Double-Fluted)
- Grinder, Hacksaw or Torch (optional)
- Drill Bits 1/16" through 7/8"

* Trinity Highway recommends using double-fluted drill bits to achieve optimum tensile strength when applying an approved adhesive to the anchoring system.

Hammers

- Sledgehammer
- Standard hammer

Wrenches

- Heavy Duty 1/2" drive impact wrench
- 1/2" drive Sockets: 9/16", 11/16", 3/4", 15/16", 1 1/8", 1 1/4"
- 1/2" drive Deep Well Sockets: 15/16", 1 1/4"
- 1/2" drive Ratchet and Attachments
- 1/2" drive Breaker Bar – 24" long
- 1/2" drive Torque Wrench: 200 ft-lb
- Crescent Wrench: 300 mm [12"]
- Allen Wrench: 3/8"

Personal Protective Equipment

- Safety Glasses
- Gloves
- Safety Toe Shoes

Important: Trinity Highway makes no recommendation whether use or reuse of any part of the system is appropriate or acceptable following an impact. It is the sole responsibility of the project engineer and/or the local highway authority and its engineers to make that determination. It is critical that you inspect this product after assembly is complete to make certain that the instructions provided in this manual have been strictly followed.

Miscellaneous

- Traffic Control Equipment
- Lifting and moving equipment (A lifting device is preferred although a forklift can be used.) Minimum 5,000 lb. capacity required.
- Air Compressor (100 psi minimum) and Generator (5 kW)
- Long Pry Bar
- Drift Pin 300 mm [12”]
- Center Punch
- Tape Measure 7.5 m [25’]
- Chalk Line
- Concrete Marking Pencil
- 7/8” Diameter steel tube brush for cleaning drilled boreholes
- Rags, water, and solvent for touch-up

Note: The above list of tools is a general recommendation and should not be considered an exhaustive list. Depending on specific site conditions and the complexity of the assembly specified by the appropriate highway authority the required tools may vary. Decisions as to what tools are needed to perform the assembly properly are in the sole discretion of the specifying highway authority and the authority’s selected contractor performing the assembly of the system at the authority’s specified assembly site.

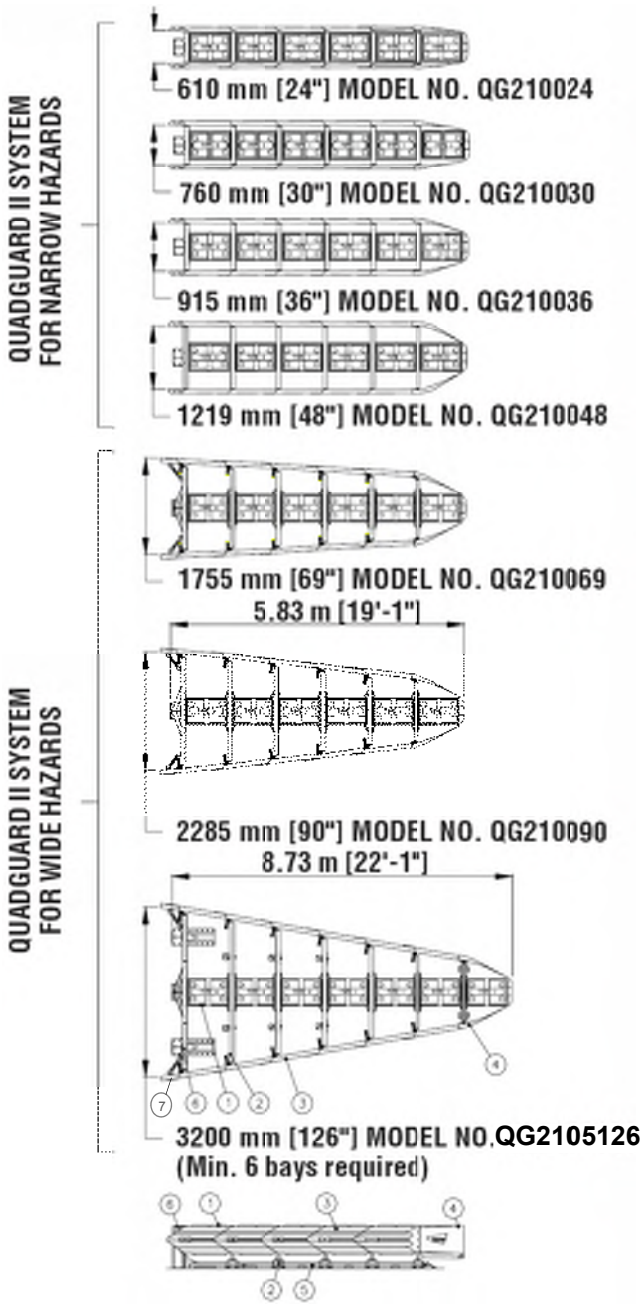


Figure 2 Plans & Elevation
(Five Bay systems with Tension Strut Backups shown, except as noted)

Key

1) Cartridge
2) Diaphragm
3) Quad-Beam™ Fender Panel
4) Nose Cover
5) Monorail
6) Backup
7) Side Panel

How to Determine Left/Right

To determine left from right when ordering parts, stand in front of the system facing the roadside feature. Your left is the system's left and your right is the system's right.

Counting the Number of Bays

One Bay consists of one Cartridge, one Diaphragm, two Fender Panels, etc. The Nose section is not considered a Bay, though there is a Cartridge in the Nose of each system (see p. 66 & 67 for illustrations). Note that this means there will always be one more Cartridge in the system than the number of Bays in the system. To determine number of Bays, count Fender Panels on one side (see Figure 3). The Three-Bay system is shown below.

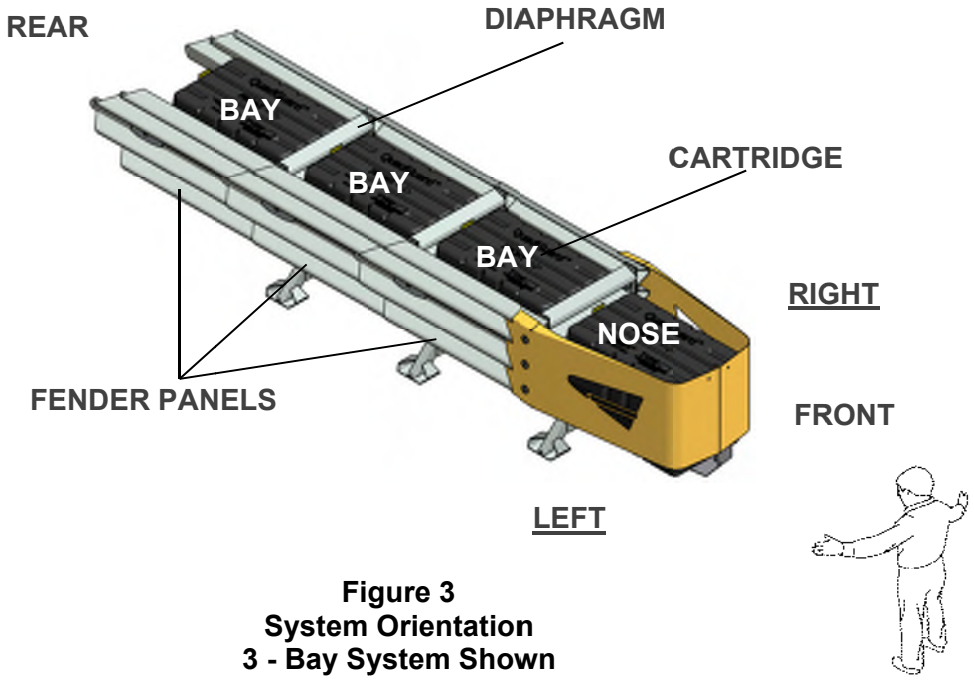


Figure 3
System Orientation
3 - Bay System Shown

Measuring the Width

The QuadGuard® II system is available in seven (7) nominal widths:

- 610 mm [24”]
- 760 mm [30”]
- 915 mm [36”]
- 1219 mm [48”]
- 1755 mm [69”] ┐
- 2285 mm [90”] ┘ (Minimum 3 Bays Required)
- 3200 mm [126”] —— (Minimum 6 Bays Required)

The nominal width of a parallel system is the width of the diaphragm (see Figure 4).

The nominal width of a wide system is the width at the location shown in Figure 5.

The outside width of the system is approximately 150 mm [6”] to 230 mm [9”] wider than the nominal width. The width of the system is not the same as the width of the Backup (see p. 66 & 67 for illustrations).

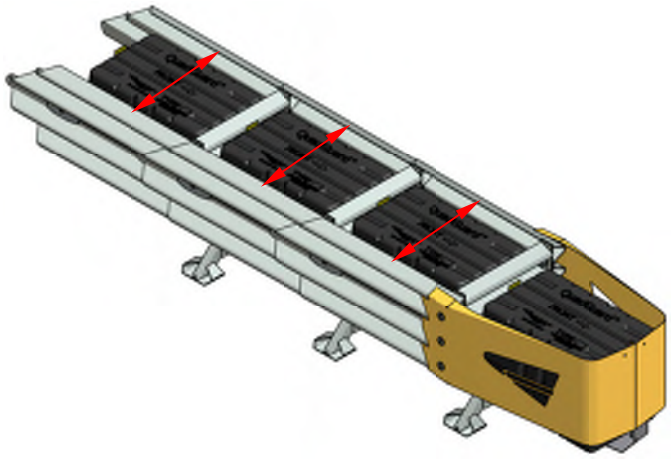


Figure 4
Width of Parallel system

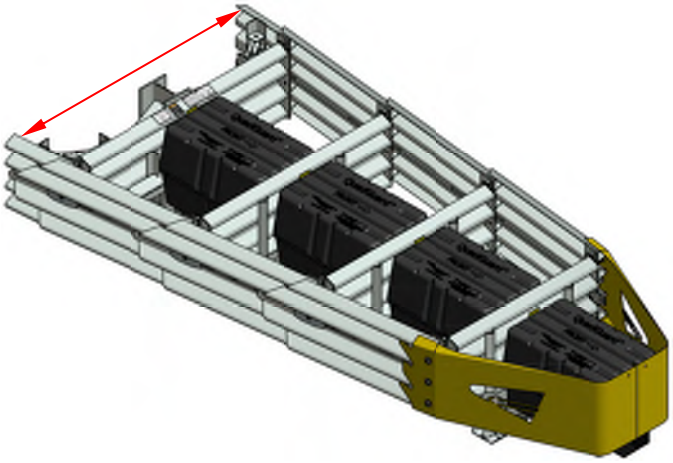


Figure 5
Width of Wide system

Narrow Systems

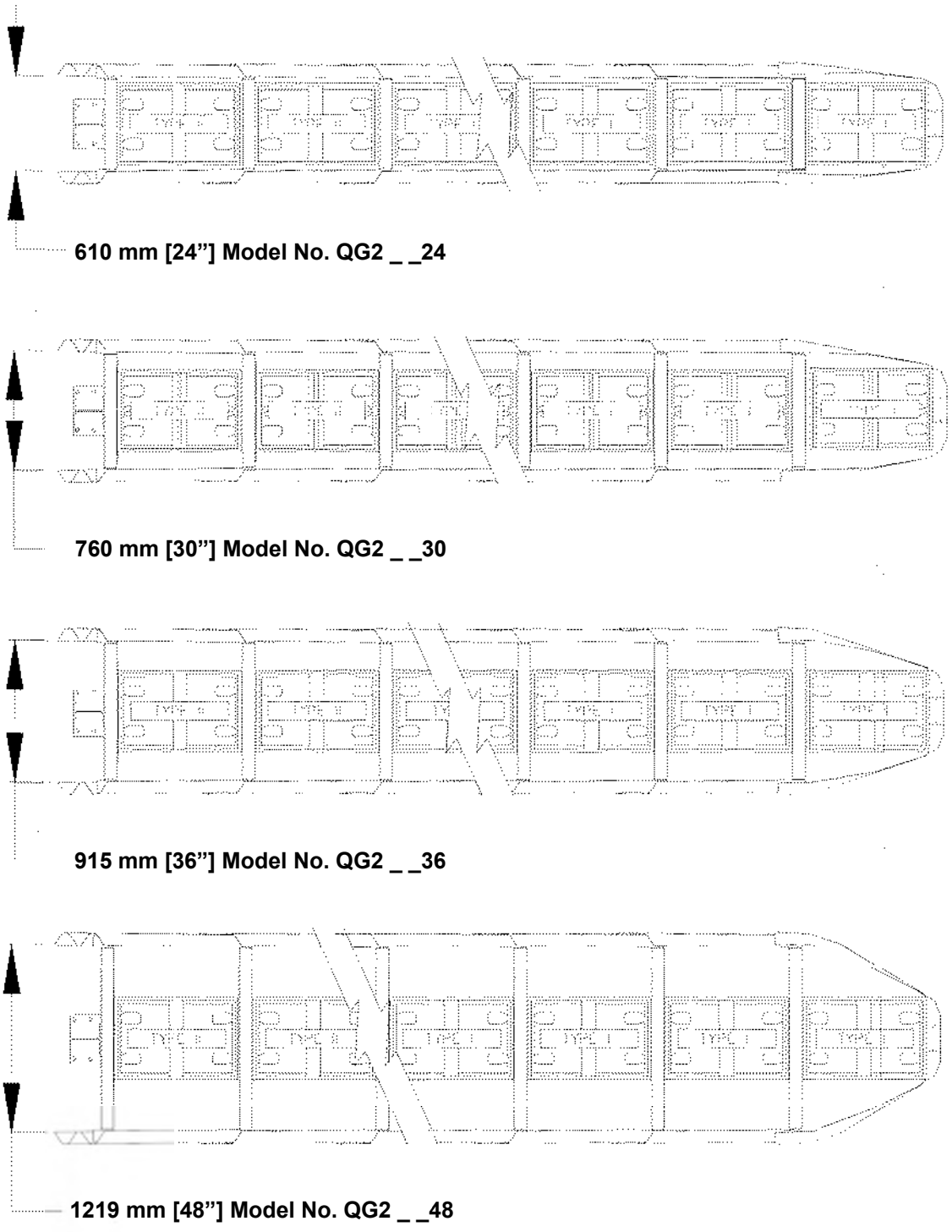


Figure 6
Narrow System and Model Numbers

Site Preparation/Foundation Narrow

A QuadGuard® II system should be assembled only on an existing or freshly placed and cured concrete base (28 MPa [4000 psi] minimum). Location and orientation of the concrete base and attenuator must comply with project plans or as otherwise determined by the local highway authority.

Recommended dimension and reinforcement specifications for new concrete foundations are provided in Trinity Highway concrete foundation drawings, supplied with the system. The system may be assembled on a non-reinforced concrete roadway (minimum 200 mm [8”] thick). Deployment cross-slope shall not exceed 8% and should not twist more than 2% over the length of the system; the foundation surface shall have a light broom finish.

Warning: Ensure that there is proper site grading for the QuadGuard® II placement as dictated by the state or specifying agency, pursuant to AASHTO guidelines.

Caution: Accurate placement of all steel rebar is critical to avoid interference with the concrete anchor bolts.

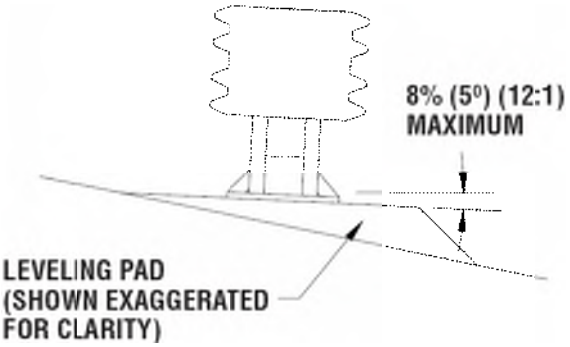


Figure 7
Cross-Slope

Warning: Location of the Backup in relation to nearby objects will affect the operation of the attenuator. Upon impact, the Fender Panels are designed to telescope rearward and extend beyond the rigid Backup as much as 876 mm [34.5”] from their pre-impact location. Position the Backup so that the rear ends of the last Fender Panels are a minimum of 760 mm [30”] forward of objects that would otherwise interfere with movement of the rearmost Fender Panels. Failure to comply with this requirement is likely to result in system performance that has not been crash tested pursuant to NCHRP Report 350 criteria and may also cause component damage which will necessitate maintenance or replacement of the system.

Assembly Narrow

Inspect Shipping

Before deploying the QuadGuard® II, check the received parts against the shipping list supplied with the system. Make sure all parts have been received.

Important: The Manufacturer's Drawing Package supplied with the QuadGuard® II must be used with these instructions for proper assembly and should take precedence over these general instructions.

1) Determine Backup & Transition Type

The QuadGuard® II is available with a Tension Strut Backup or a Concrete Backup. Refer to Figures 8 and 9, along with the Backup Assembly drawing, to determine which type of Backup is being deployed.

A Transition Panel or Side Panel must be used on each side of the Backup. A Side Panel is not needed when a Transition Panel is used. Several types of Transitions are available for use with the QuadGuard® II. Refer to Figures 10 - 15 and the Manufacturer's Drawing Package to determine which type of Panels to attach.

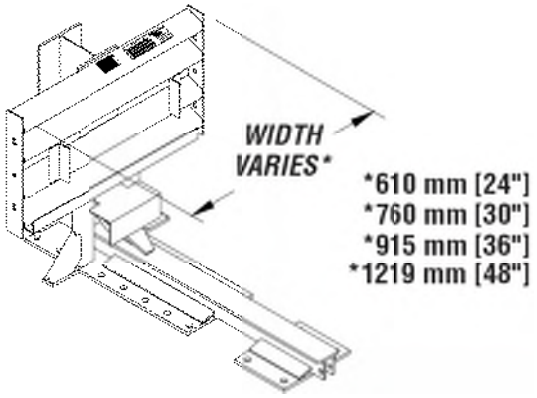


Figure 8
Tension Strut Backup

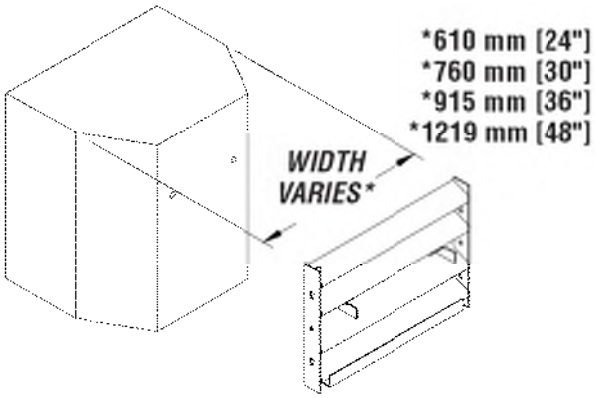


Figure 9
Concrete Backup

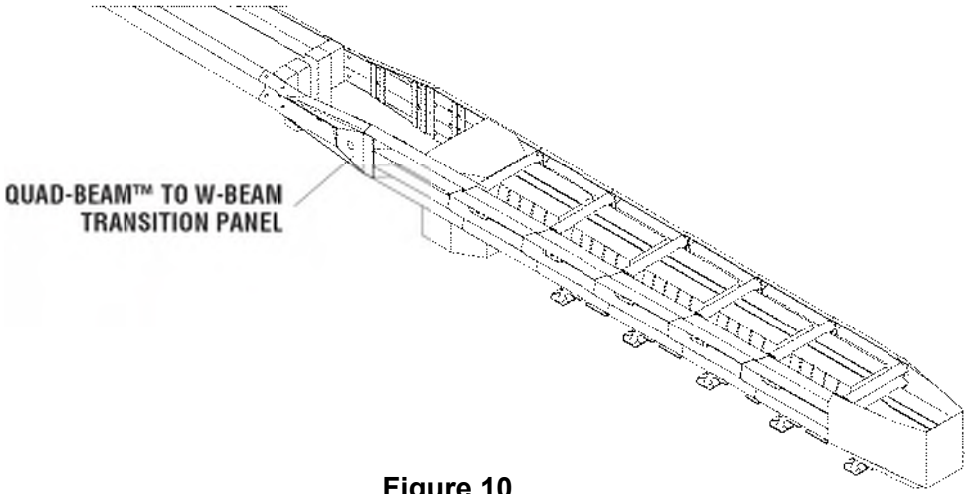


Figure 10
Transitioning the QuadGuard® II System

Transition Panel Types Narrow

Note: The proper Transition Panel or Side Panel must be used for impact performance of the system. The correct Panel(s) to use will depend on the direction of traffic and what type of barrier or roadside obstacle the QuadGuard® II system is shielding. Contact the Customer Service Department prior to deployment if you have any questions.

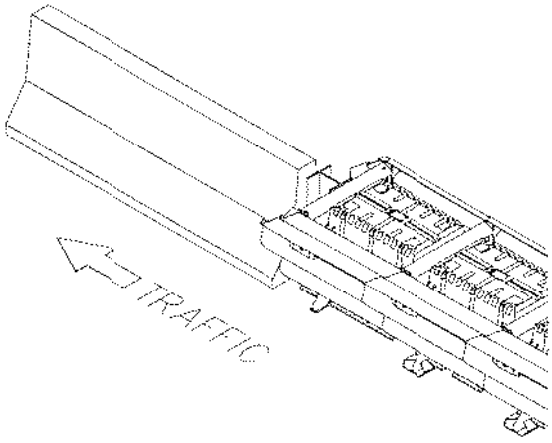


Figure 11
No Transition

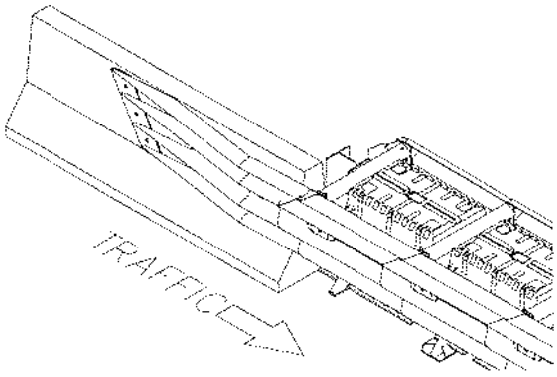


Figure 12
Quad-Beam™ to Safety Shape Barrier Transition Panel

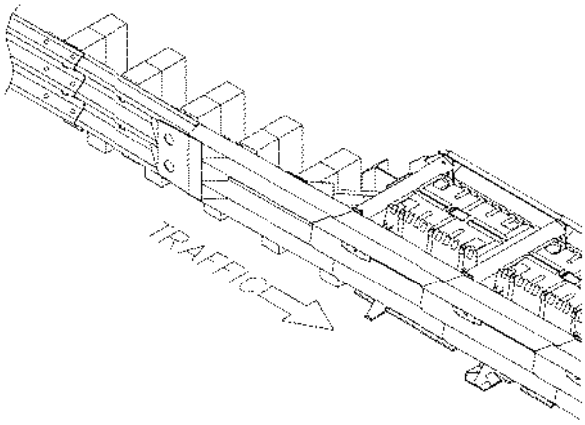


Figure 13
Quad-Beam™ to Thrie-Beam Transition Panel

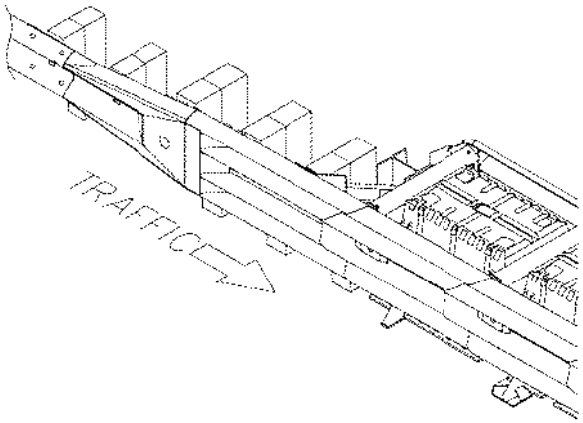


Figure 14
Quad-Beam™ to W-Beam Transition Panel

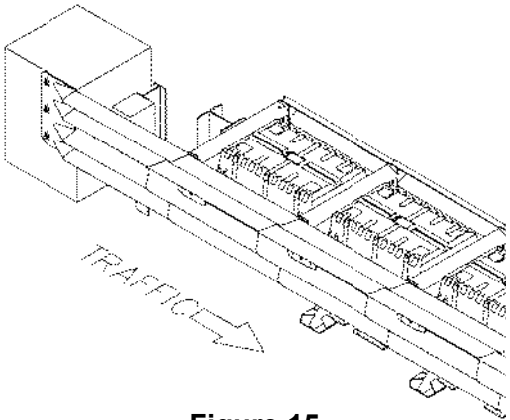


Figure 15
Quad-Beam™ End Shoe Transition Panel

2) Mark System Location

Locate the centerline of the system by measuring the proper offset from the roadside feature. See the Manufacturer's Drawing Package supplied with the system. Place chalk line to mark the centerline of the system. Mark a construction line parallel to the center line and offset 165 mm [6.5"] to one side as shown in Figure 16. The edge of the Monorail will be positioned on this line.

Note: The concrete foundation shall comply with the Manufacturer's Drawing Package supplied with the system.

Warning: Location of system with respect to the roadside obstacle is critical and dependent on the type of Transition Panel used. See the Manufacturer's Drawing Package supplied with the system for details.

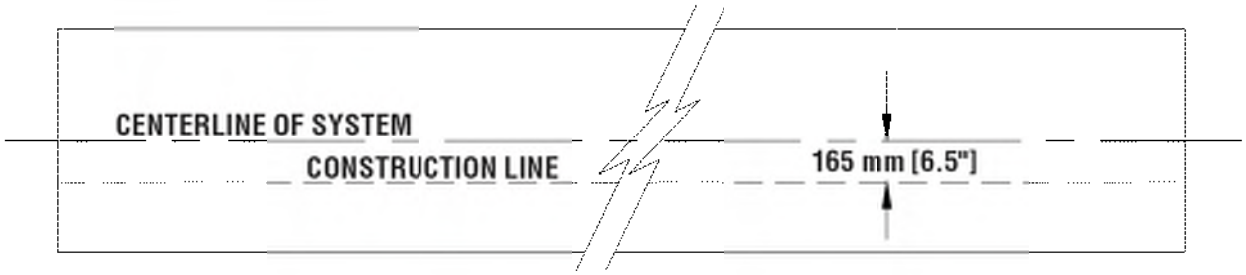


Figure 16
(Top view of concrete foundation)

3) Anchor the Backup

A) Concrete Backup Construction (Figure 17)

Locate Backup Face Plate using the Backup Assembly drawing. Verify that any applicable Transition Panels fit properly before anchoring the Face Plate. Drill anchor boreholes in the Concrete Backup using the Face Plate as a template. Anchor the Face Plate to the Concrete Backup using an approved adhesive supplied with the QuadGuard® II system (see Approved Adhesive section, p. 15).

A Trinity Highway approved adhesive anchoring system is required to securely anchor crash cushions and other common highway devices. Each approved adhesive kit contains adhesive, studs, nuts and washers. Both vertical and horizontal assemblies are possible using an approved adhesive anchoring system.

Warning: Every borehole and slot in Backup and Monorail must be anchored by a stud using an approved adhesive.

B) Tension Strut Backup Assembly (Figure 18)

Locate Tension Strut Backup and Monorail on foundation with side of Monorail on the construction line (see Figure 21 on p. 30). Verify that any applicable Transition Panels fit properly before anchoring Backup. Drill anchor boreholes in foundation using the Backup as a template. Anchor the Backup to the concrete foundation using an approved adhesive supplied with the QuadGuard II system (see Approved Adhesive section, p. 15).

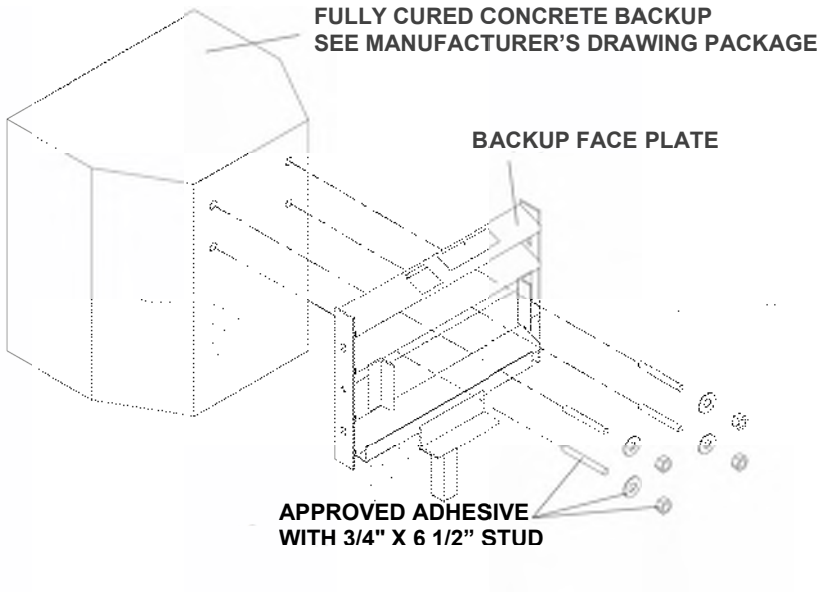


Figure 17
Anchoring Backup Face Plate to Concrete Backup

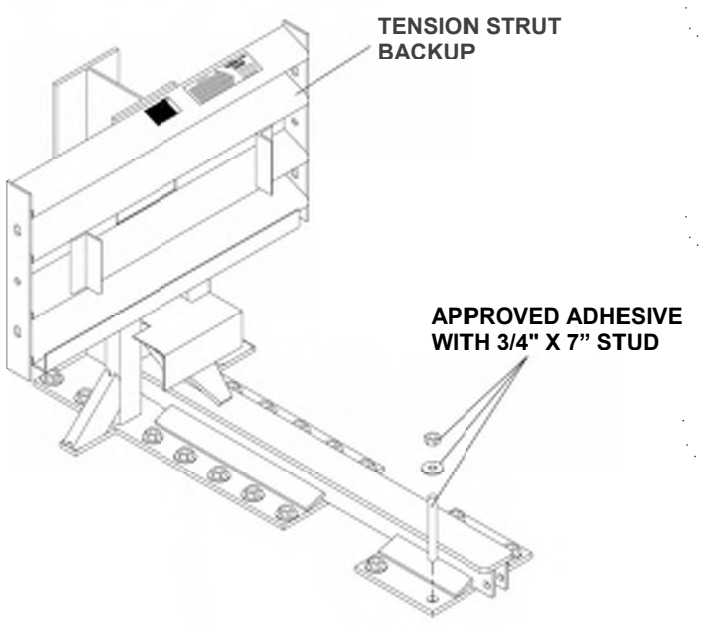


Figure 18
Anchoring Tension Strut Backup to Foundation

4) Anchor the Monorail

A) Monorail Construction for Concrete Backup (Figure 19)

Locate Monorail on foundation with side of Monorail on the construction line and rear edge of Monorail foot 10” forward of front face of Concrete Backup (see Figure 19).

Orient the Monorail so that the Monorail tongues face Backup (see Figure 19).

Drill 140 mm [5 1/2"] deep anchor boreholes using the Monorail as a template. Do not drill through foundation.

Warning: Improper alignment at the Monorail Sections will prevent proper system collapse during impact.

Anchor each Monorail section using an approved Trinity Highway adhesive kit. See Figure 19 and the approved adhesive instructions included with the adhesive kit. It is important to attach each segment of Monorail in alignment from the back to the front of the system (± 6 mm [1/4”]).

Warning: Every borehole and slot in Backup and Monorail must be anchored by a stud using an approved adhesive.

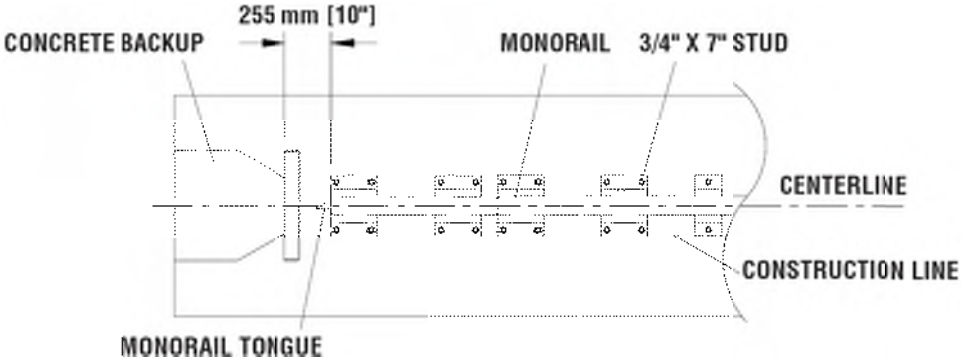


Figure 19
Monorail Location for Concrete Backup

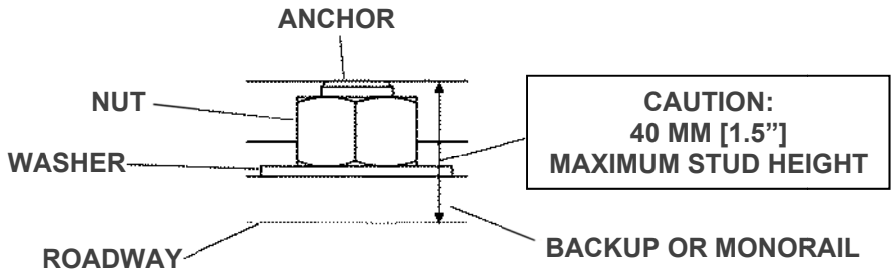


Figure 20
Proper Stud Height

B) Monorail Construction for Tension Strut Backup (Figure 20)

Locate Monorail on foundation with side of Monorail on the construction line and rear edge of Backup foot 4” forward of edge of foundation (see Figure 21).

Orient the Monorail so that the Monorail tongues face the Backup (see Figure 21).

Drill 140 mm [5 1/2"] deep anchor boreholes using the Monorail as a template. Do not drill through foundation.

Warning: Every borehole and slot in Backup and Monorail must be anchored by a stud using a Trinity Highway approved adhesive.

Anchor each Monorail section using the Trinity Highway approved adhesive kits provided. See Detail 20a and the approved adhesive instructions included with each kit. It is important to attach each segment of Monorail in alignment from the back to the front of the system (± 6 mm [1/4”]).

Warning: Improper alignment at the Monorail splice joints will prevent proper system collapse during an impact.

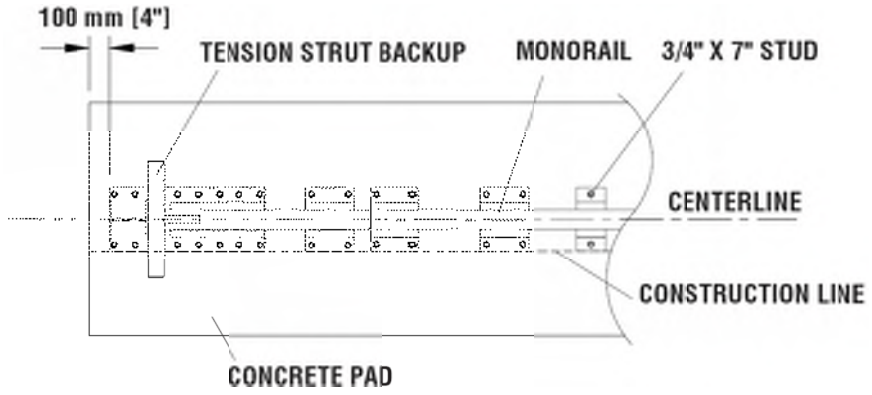
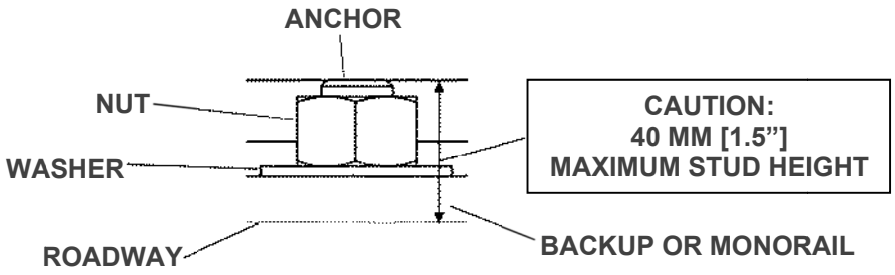


Figure 21
Backup and Monorail Location for Tension Strut Backup



Detail 21a
Proper Stud Height

5) Attach Side Panels and/or Transition Panels to Backup Assembly

Attach Transition Panel or Side Panel to side of Backup using 5/8" hex bolt and 5/8" rail nut (two places - top and bottom holes only). See Backup Assembly drawing(s) **below.**

Note: A Side Panel is not needed when a Transition Panel is used.

Assembly tip:

Use drift pin to align the center hole of the Panel with the center hole of the Backup before inserting the rail bolts.

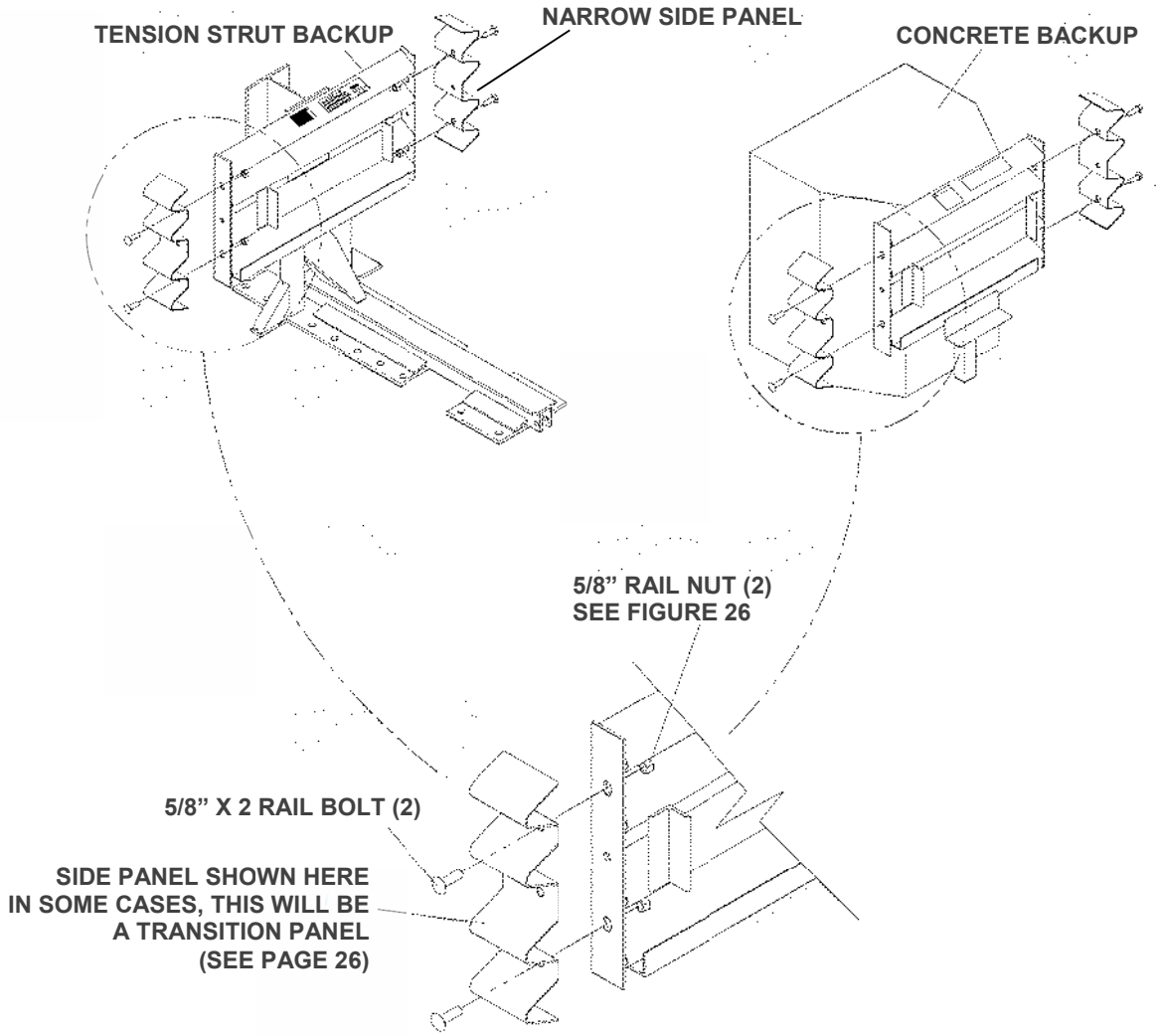


Figure 22
Side Panel/Transition Panel Attachment

6) Attach Monorail Guides

Attach Monorail guides to Diaphragm as follows:

Insert 3/4" x 2” G8 hex bolt through Monorail guide and Diaphragm, oriented as shown in Figure 23. Secure with 3/4" lock washer and 3/4" hex nut (typical 4 places). See also Diaphragm Assembly drawing. Shims are sandwiched between the Rail Guide and Diaphragm.

Repeat process for each Diaphragm.

7) Attach Diaphragms

Orient a Diaphragm so that the front face of the Diaphragm shape faces toward the Nose of the system as shown in Figure 24.

Important: Slide one Diaphragm all the way to the Backup to ensure the system is able to collapse properly during impact. Once this has been verified, slide the Diaphragm to approximately 915 mm [36”] in front of the Backup

Orient and slide all other Diaphragms onto Monorail and position each approximately as shown in Figure 25.

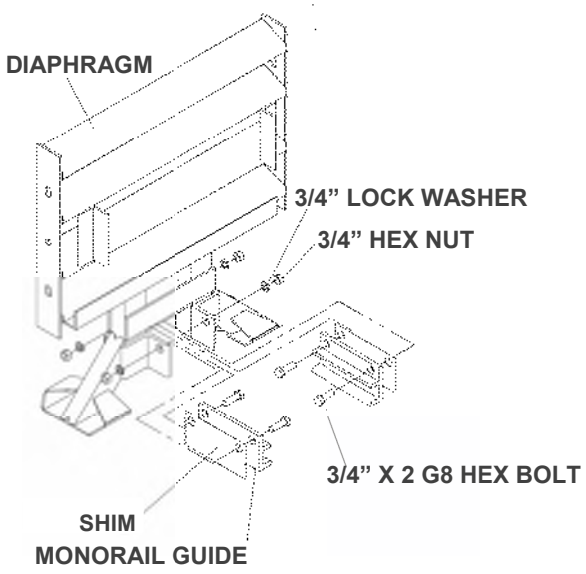


Figure 23
Monorail Guide Attachment

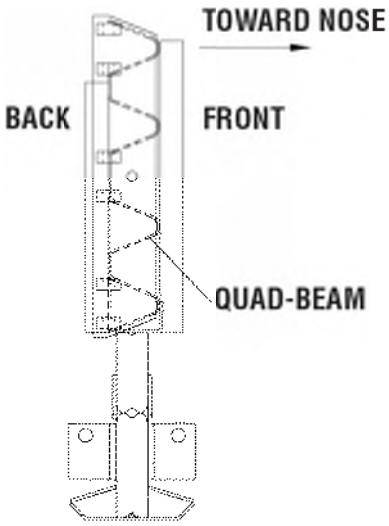


Figure 24
Diaphragm Orientation

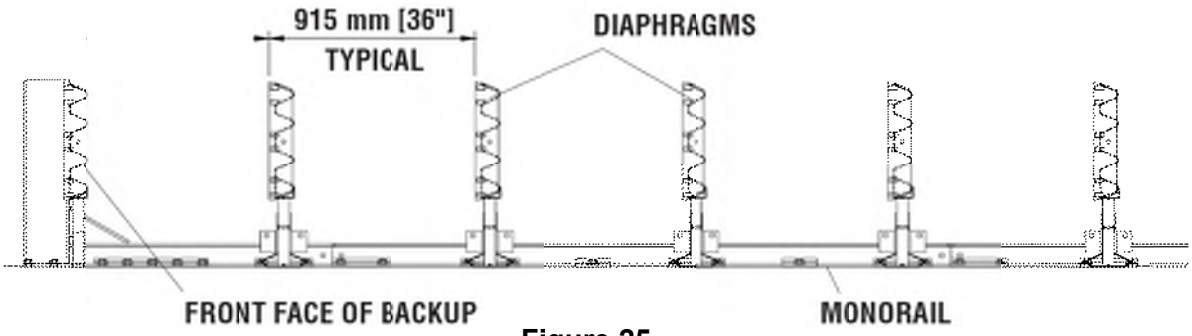


Figure 25
Diaphragm Spacing

8) Attach Fender Panels

Important: Do not mix the 5/8” rail nuts (large) with the 5/8” hex nuts (small) (see Figure 26).

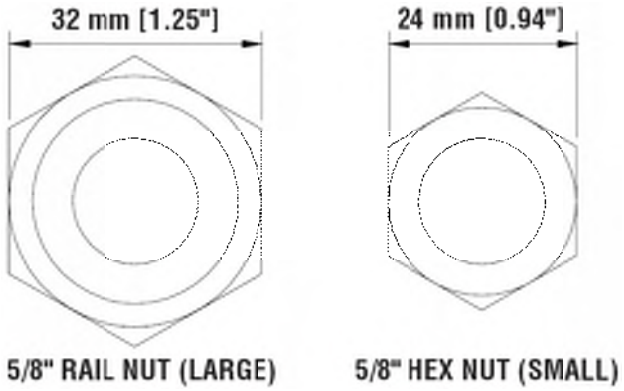


Figure 26
Rail Nuts are Oversize

Starting at the Backup, attach left and right Fender Panels shown on page 31 and Fender Panel Assembly drawing.

Step 1

Place the Fender Panel so that the center of the slot of the rearward Diaphragm is lined up with the approximate center of the slot in the Fender Panel.

Attach Mushroom Washer Assembly as shown in Figure 27 and Detail 27a and Detail 26b, but do not torque at this time. This (Step 1) helps to balance the Fender Panel.

Step 2

Slide the Fender Panel forward until the holes in the Fender Panel line up with the holes in the forward Diaphragm.

Step 3

Use a drift pin to align the center hole of the Fender Panel with the center hole of the Diaphragm.

Step 4

Attach the front of the Fender Panels to the next Diaphragm using two (2) rail bolts and large hex nuts per side. Use only the top and bottom holes; leave the center hole open until the next Fender Panel is attached.

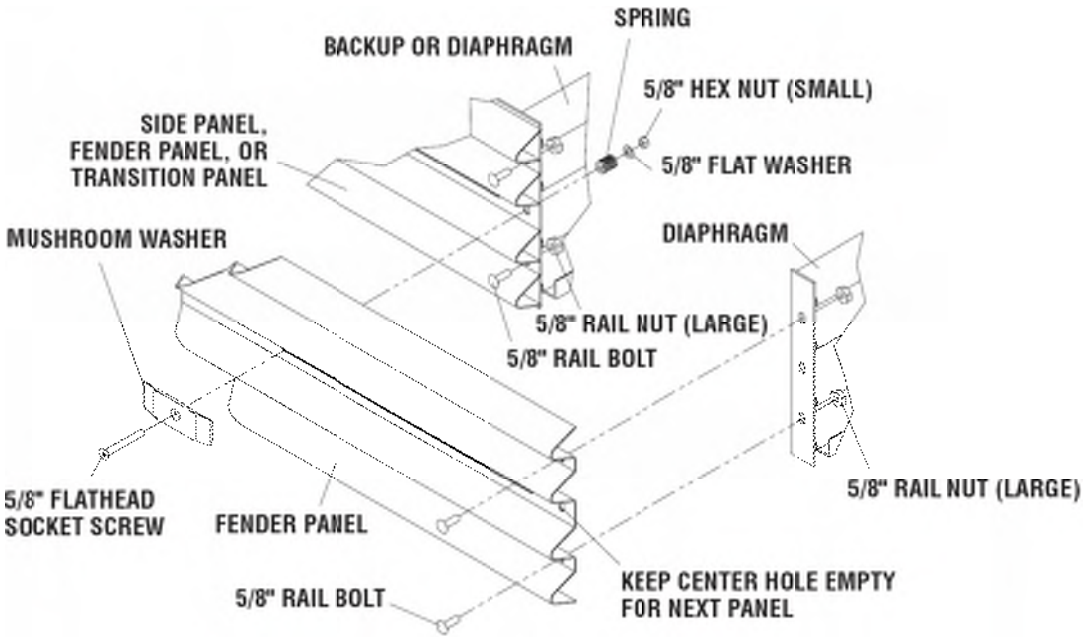
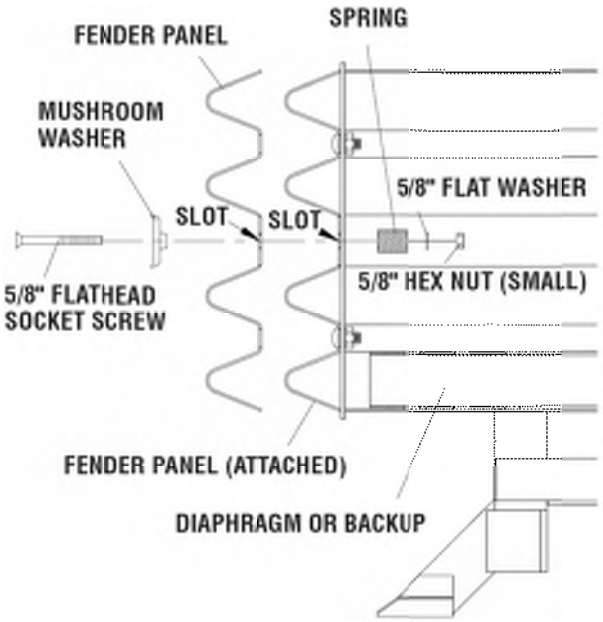


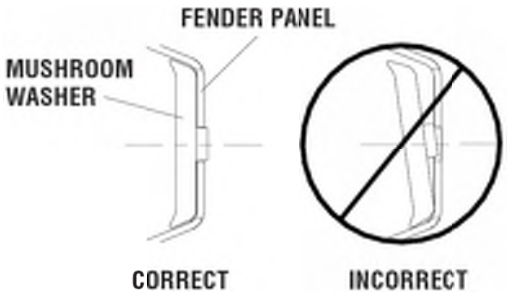
Figure 27
Fender Panel Assembly

Step 5

Ensure Mushroom Washer lays flat against the Fender Panel as shown in Figure 27b. Standoff on Mushroom Washer must be seated completely through slot.



Detail 27a
Mushroom Washer Attachment



Detail 27b
Mushroom Washer Orientation

Step 6

Check Diaphragm spacing to ensure 915 mm [36”] between rear faces of consecutive Diaphragms, as shown in Figure 28 and Fender Panel Assembly drawing.

Step 7

Once proper spacing has been achieved, torque the Mushroom Washer Assembly (small hex) nut until it reaches the end of the threads.

Assemble the remaining Diaphragms and Fender Panels following the same procedures.

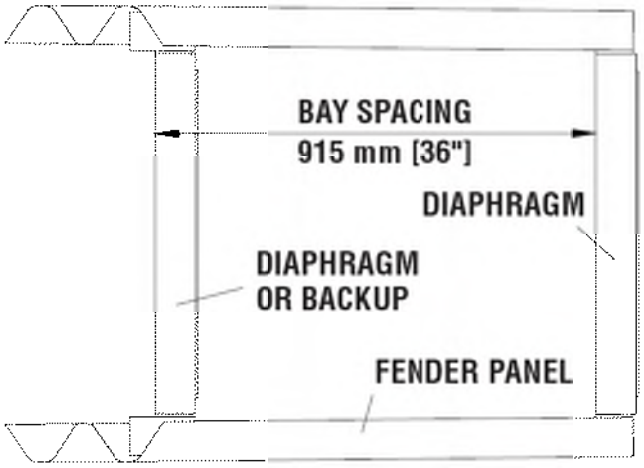


Figure 28
Proper Diaphragm Spacing

9) Attach End Cap

Using 5/8” x 3 1/2" G5 hex bolt, 5/8” hex nut and 5/8” lock washer, attach the End Cap to the front of the first Monorail segment, as shown in Figure 29 and Monorail Assembly drawing.

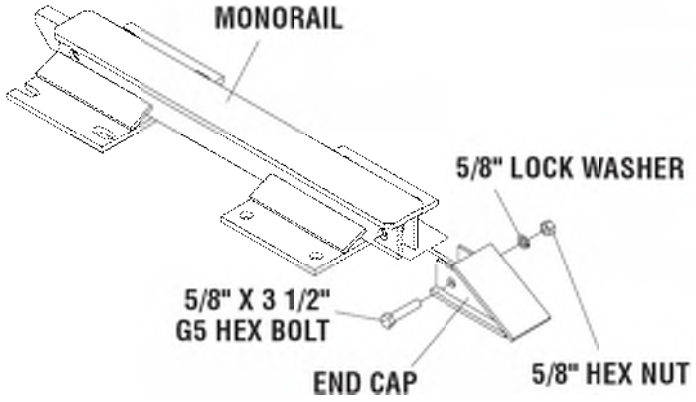


Figure 29
Monorail End Cap Assembly

10) Attach Cartridge Support Brackets

Attach lower Cartridge Support Bracket to front and back of all Diaphragms and front of Backup, as shown in Figures 31 to 33 Diaphragm Assembly drawings, and Backup Assembly drawings.

Note: 610 mm [24”] wide systems do not have Side Cartridge Support Brackets: 762 mm [30”], 914 mm [36”] and 1219 mm [48”] wide systems have Side Cartridge Support Brackets welded to the Backup and Diaphragms.

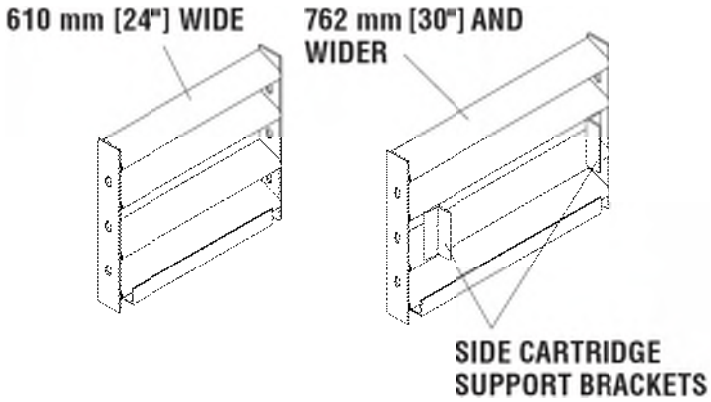


Figure 30
Side Cartridge Support Brackets

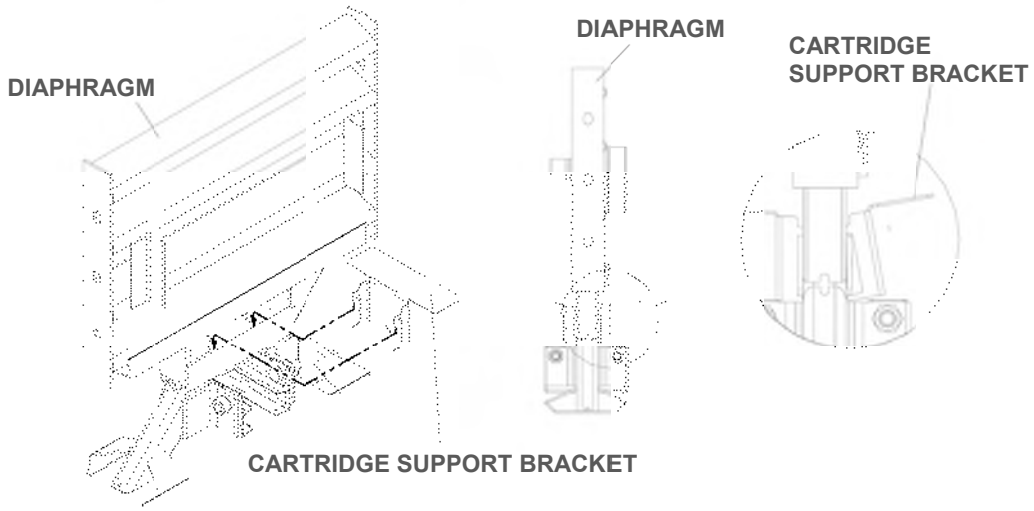


Figure 31
Lower Cartridge Support Bracket Assembly

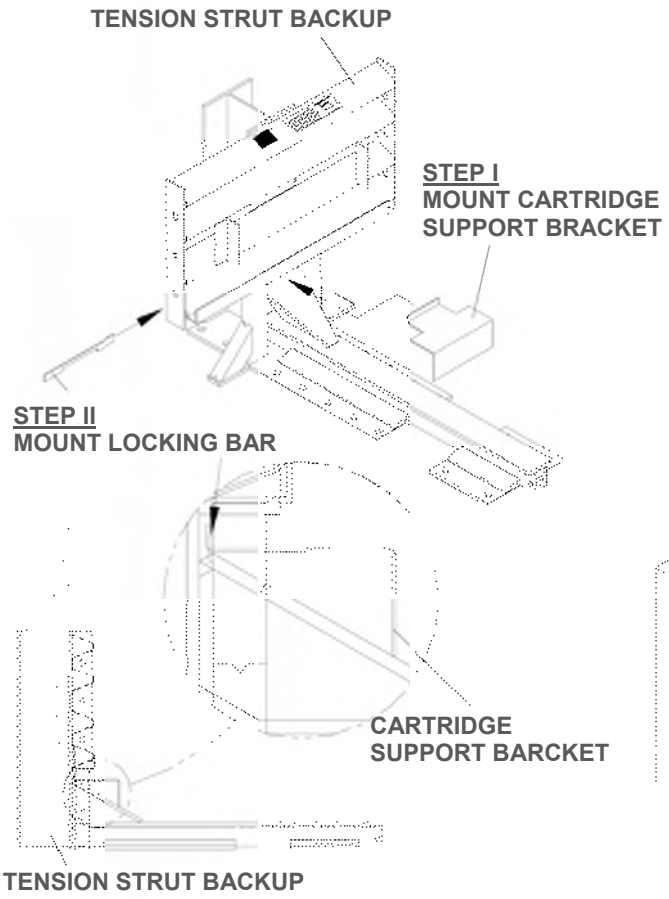


Figure 32
Lower Cartridge Support Bracket Assembly
(Tension Strut Backup)

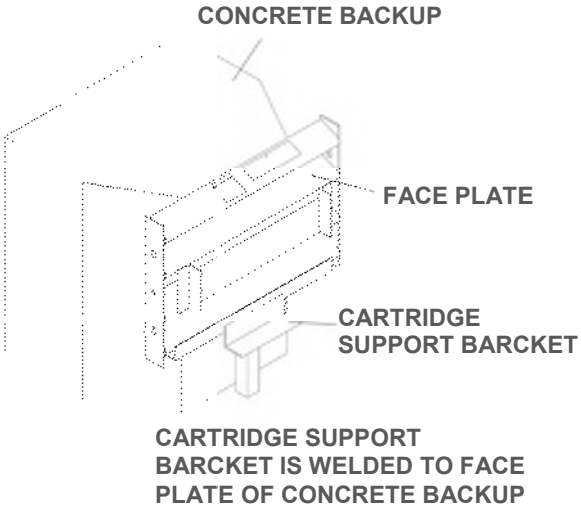


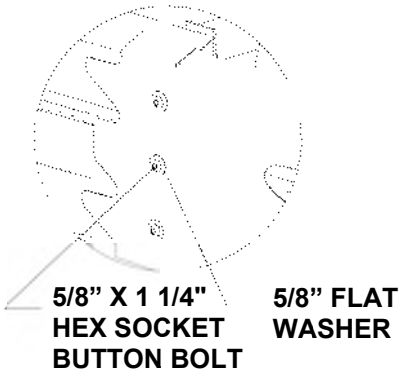
Figure 33
Lower Cartridge Support Bracket
(Concrete Backup)

11) Attach Nose Assembly

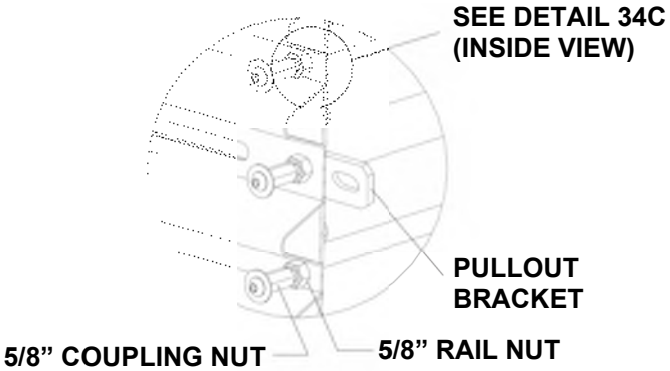
Bolt the Nose directly to the front Diaphragm, as shown in Figures 34a through 34c and the Nose Assembly drawing.

Place Pullout Brackets under center bolts.

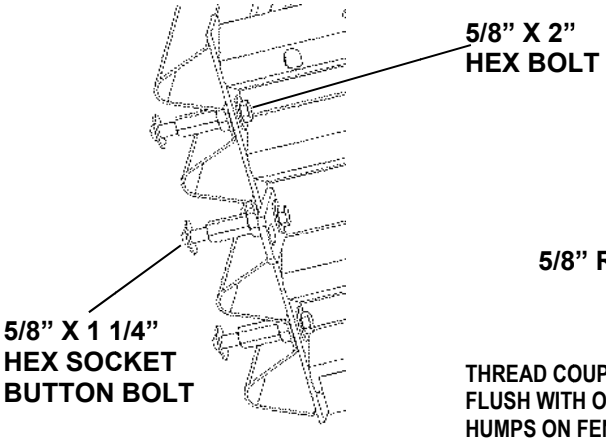
Figure 34



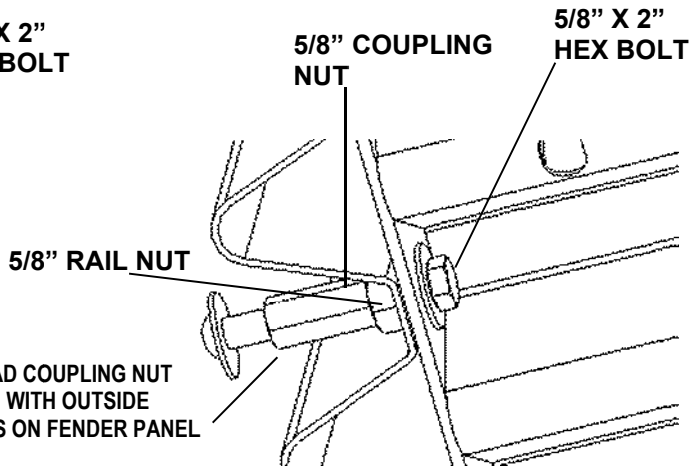
Detail 34a
Fastener Assembly



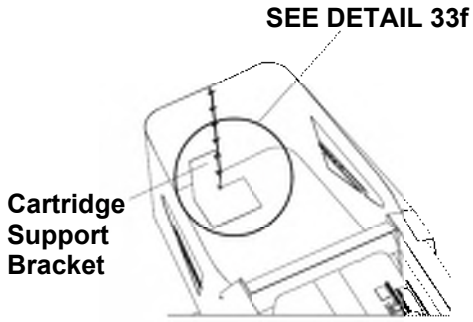
Detail 34b
Steel Nose not shown for Clarity



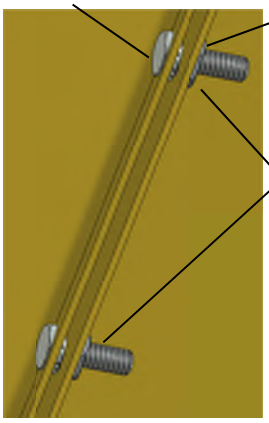
Detail 34c
End View Without Nose Cover



Detail 34d
End View: Nose Cover Cut Away

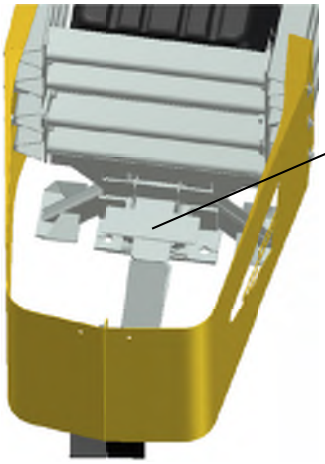


Detail 34e



Detail 34f

Detail 33f shows proper placement of front Cartridge Support Bracket.



Detail 34g

12) Checking the System Assembly

Recheck to ensure that all fasteners are properly tightened throughout the system (anchor bolts, etc.). See torque requirements below. Check all Fender Panels. If they do not fit tightly against the underlying Fender Panel, system realignment may be necessary (see Figure 35).

Warning: Ensure that the QuadGuard® II system and delineation used meet all federal, state, specifying agency, and local specifications.

Warning: Ensure delineation on the assembly meets all appropriate MUTCD and local standards.

Warning:
Bolt Torque Requirements
Anchor Studs – see Table A, p. 15 May slightly protrude above nuts
Critical Clearances
Anchor Studs above nuts – see Figure 20, p. 29 Fender Panel Gap Narrow – 20 mm [0.78”] see below

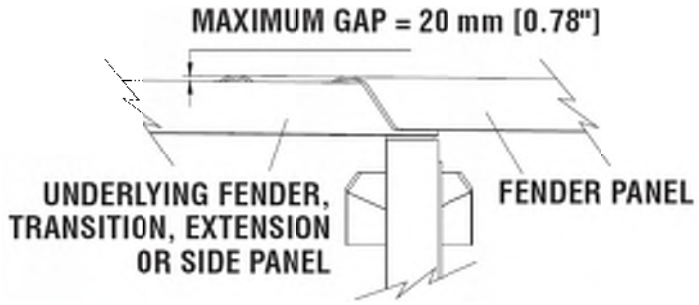


Figure 35
Fender Panel Gap for Narrow Systems

13) Cartridge Assembly

Be sure the Adjustable Cartridge Support in the Nose is attached correctly. See “Attach Nose Assembly” on page 38. The top surface of the Nose Cartridge should be horizontal.

To complete the assembly of a QuadGuard® II system, place the appropriate Cartridge in each Bay and Nose section of the system. Type 1 Cartridges are placed toward the front (Nose) of the system; Type 2 Cartridges are placed toward the rear (Backup) of the system (see Figures 36 and 37).

Warning: Placing the wrong Cartridge in the Nose or any Bay will result in system performance that has not been crash tested pursuant to the NCHRP Report 350 criteria.

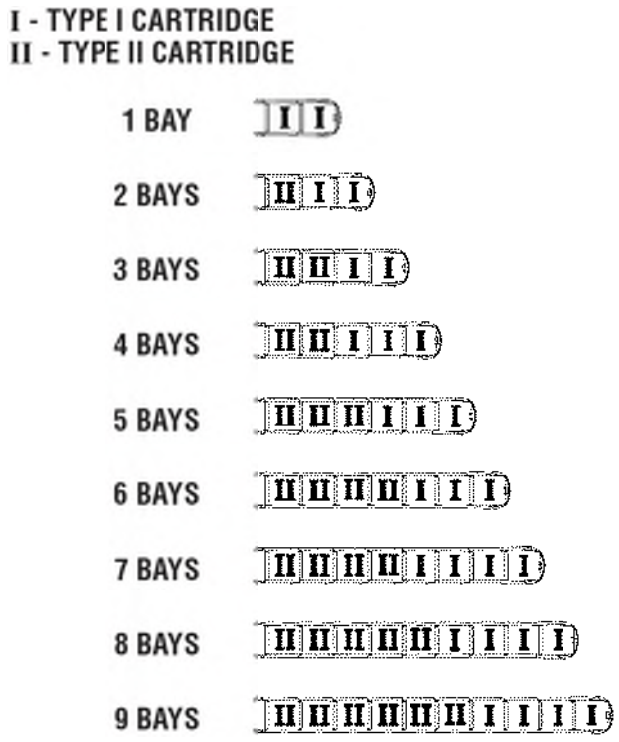


Figure 36
Cartridge Placement

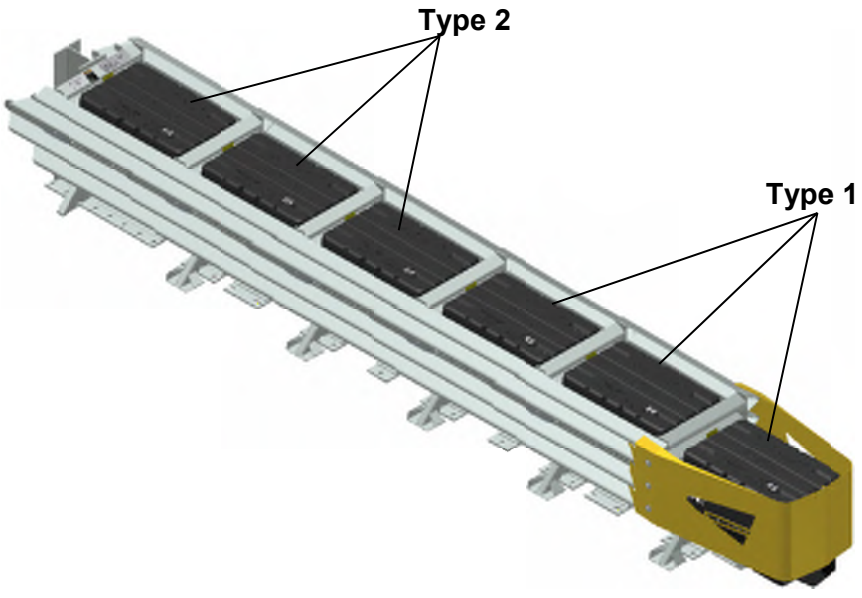
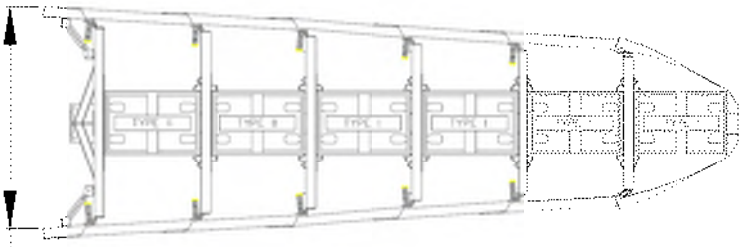
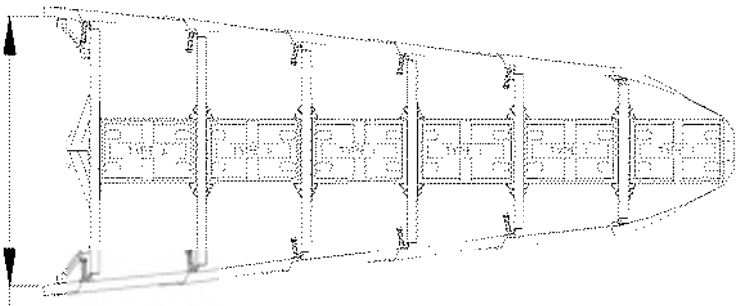


Figure 37
Typical Cartridge Layout 5 Bay System Shown

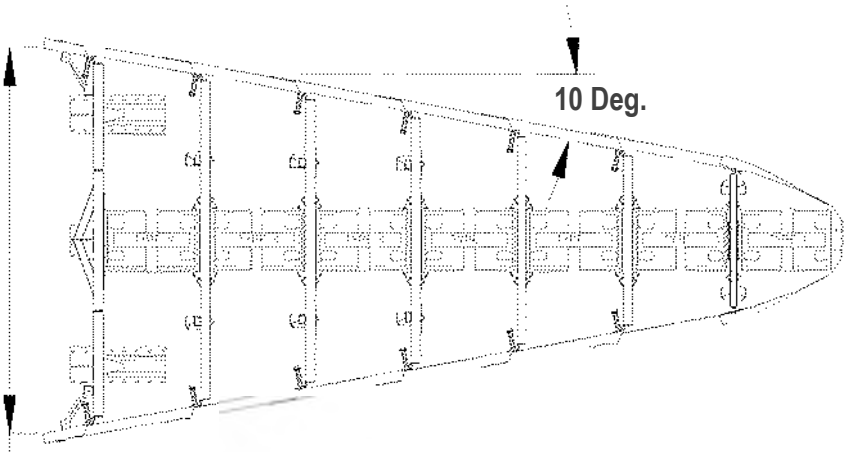
Wide Systems



(Min. 3 Bays)
1755 mm [69”] Model No. QG2 _ _ 69



(Min. 3 Bays)
2285 mm [90”] Model No. QG2 _ _ 90



Varies - (Min. 6 Bays)
3200 mm [126”] Model No. QG2 _ _ 126

Figure 38
Wide Systems and Model Numbers

Site Preparation/Foundation Wide

A QuadGuard® II system should be constructed only on an existing or freshly placed and cured concrete base (28 MPa [4000 psi] minimum). Location and orientation of the concrete base and attenuator must comply with the Manufacturer's Drawing Package supplied with the system and the project plans specified by the local highway authority.

Recommended dimension and reinforcement specifications for new concrete foundations are provided in the Manufacturer's Drawing Package supplied with the system. The system may be assembled on a non-reinforced concrete roadway (minimum 200 mm [8"] thick). Deployment cross-slope shall not exceed 8% and should not twist more than 2% over the length of the system (see Figure 39). The foundation surface shall have a light broom finish.

Warning: Ensure that there is proper site grading for the QuadGuard® II system placement as dictated by the state or specifying agency, pursuant to AASHTO guidelines.

Caution: Accurate placement of all steel rebar is critical to avoid interference with the concrete anchor bolts.

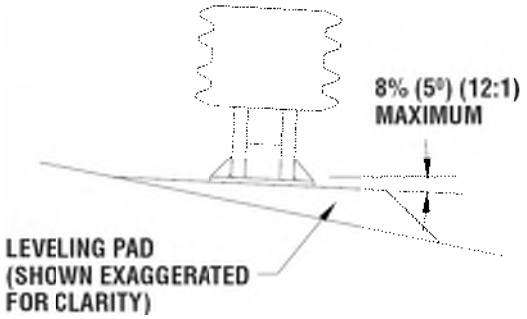


Figure 39

Warning: Location of the Backup in relation to nearby objects will affect the operation of the attenuator. Upon impact, the Fender Panels telescope rearward and extend beyond the rigid Backup as much as 876 mm [34.5"] from their pre-impact location. Position the Backup so that the rear ends of the last Fender Panels are a minimum of 760 mm [30"] forward of objects that would otherwise interfere with movement of the rearmost Fender Panels. Failure to comply with this requirement is likely to result in system performance that has not been crash tested pursuant to NCHRP Report 350 criteria and may also cause component damage which will necessitate maintenance or replacement of the system.

Assembly Wide

Inspect Shipping

Before deploying the QuadGuard® II system, check the received parts against the shipping list supplied with system. Make sure all the parts have been received.

Assembly Procedures

Important: The Manufacturer's Drawing Package supplied with the QuadGuard® II system must be used with these instructions for proper assembly and should take precedence over these general instructions.

1) Determine Backup and Transition Type

The QuadGuard® II is available with a Tension Strut Backup or a Concrete Backup. See Figures 40 and 41, along with the Backup assembly drawing, to determine which type of Backup is being deployed.

A Transition Panel or Side Panel must be used on each side of the Backup. A Side Panel is not needed when a Transition Panel is used. Several types of transitions are available for use with the QuadGuard® II system. See Figures 43 through 47 and the Manufacturer's Drawing Package to determine which types of Fender Panels to attach.

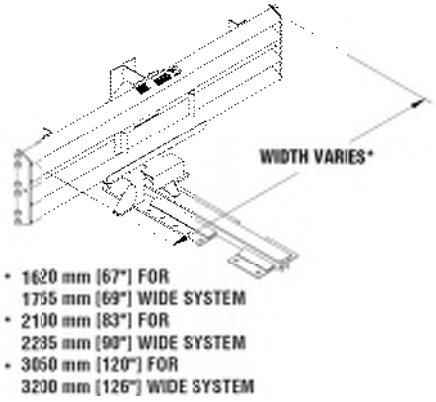


Figure 40
Tension Strut Backup

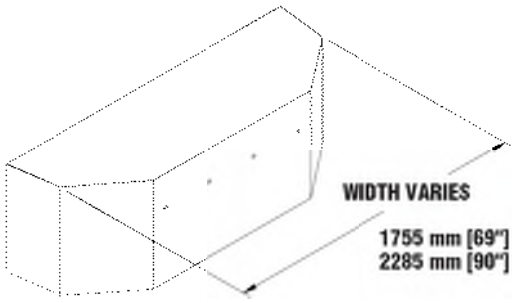


Figure 41
Concrete Backup

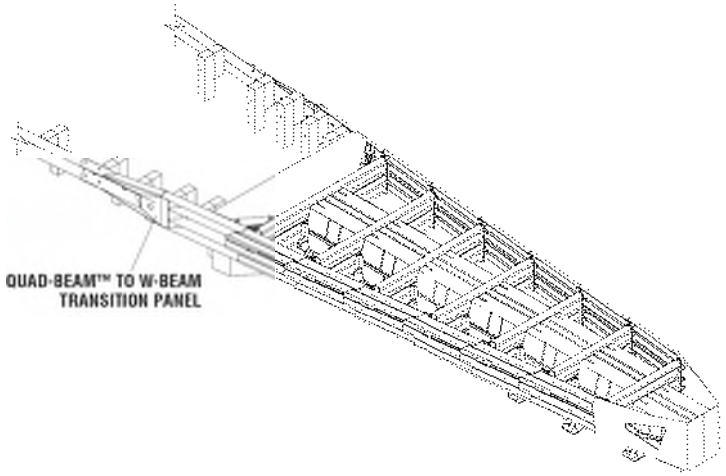


Figure 42
Transitioning the QuadGuard® II System

Transition Panel Types Wide

Important: The proper Transition Panel or Side Panel must be used to perform as crash tested. **The correct Panel(s) to use will depend on the direction of traffic and what type of barrier or roadside obstacle the QuadGuard® II system is shielding.** Contact the Customer Service Department prior to deployment if you have any questions.

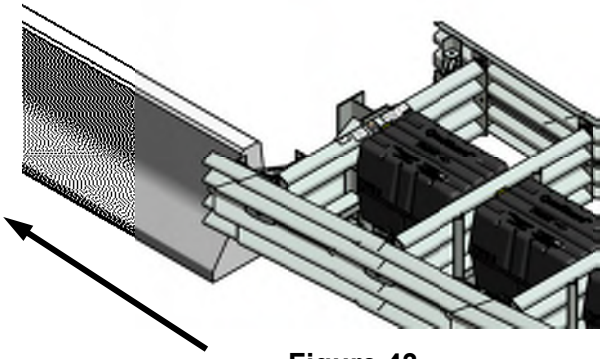


Figure 43
No Transition

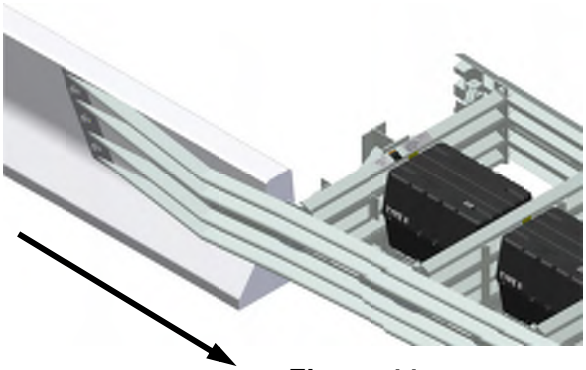


Figure 44
Quad-Beam™ to Safety Shape Barrier Transition Panel

Note: Arrows indicate traffic direction.

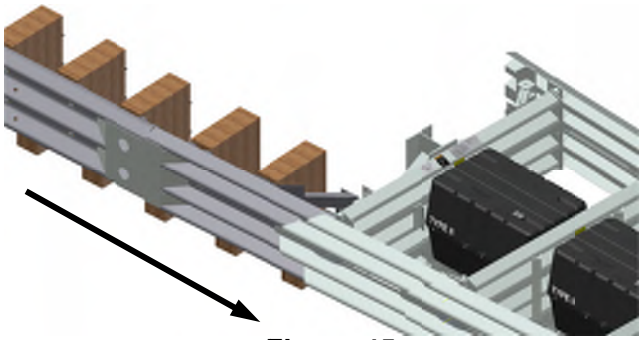


Figure 45
Quad-Beam™ to Thrie-Beam Transition Panel

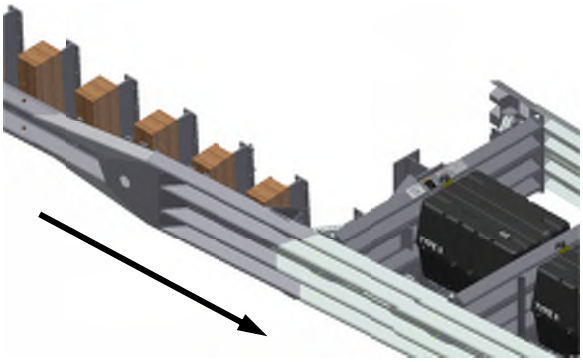
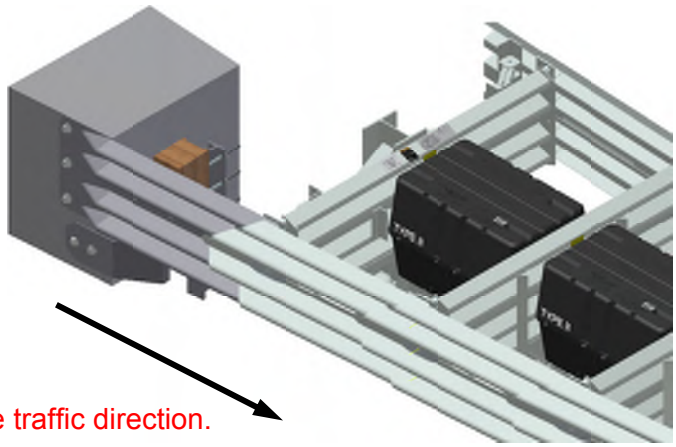


Figure 46
Quad-Beam™ to W-Beam Transition Panel



Note: Arrows indicate traffic direction.

Figure 47
Quad-Beam™ End Shoe Transition Panel

2) Mark System Location

Locate the centerline of the system by measuring the proper offset from the roadside obstacle. See the Manufacturer's Drawing Package supplied with the system. Place chalk line to mark the centerline of the system. Mark a construction line parallel to the center line and offset 165 mm [6.5"] to one side as shown in Figure 48. The edge of the Monorail will be placed on this line.

Note: The concrete foundation shall comply with the Manufacturer's Drawing Package supplied with the system.

Warning: Location of system with respect to the roadside object is critical and dependent on the type of Transition Panel used. See the Manufacturer's Drawing Package supplied with the system for details.

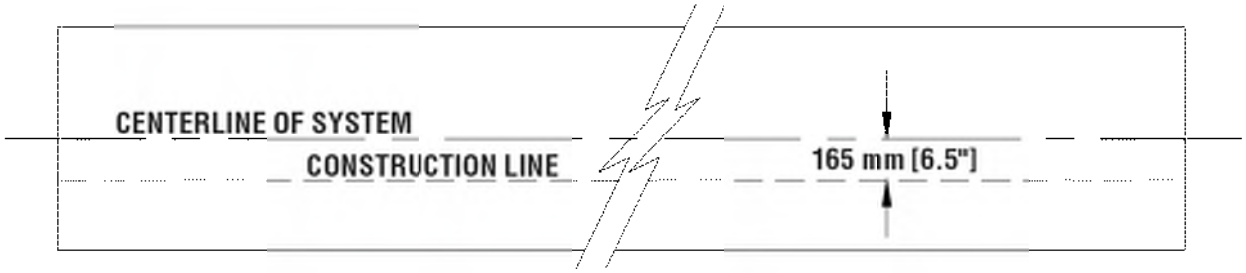


Figure 48
(Top view of concrete foundation)

3) Anchor the Backup

A) Concrete Backup Construction (Figure 49)

Locate Backup Face Plate using the Backup assembly drawing. Verify that any applicable Transition Panels fit properly before anchoring the Face Plate. Drill anchor boreholes in the Concrete Backup using the Face Plate as a template. Anchor the Face Plate to the Concrete Backup using a Trinity Highway approved adhesive supplied with the QuadGuard® II system (see Trinity Highway Approved Adhesive section, p. 15).

A Trinity Highway approved adhesive anchoring system is required to securely anchor crash cushions and other common highway devices. Trinity Highway approved adhesive features high pullout strength, vibration resistance, and durability. Each approved adhesive kit contains adhesive, studs, nuts and washers. Both vertical and horizontal assemblies require an approved adhesive anchoring system.

Warning: Every borehole and slot in Backup and Monorail must be anchored by a stud using an approved adhesive.

B) **Tension Strut Backup Assembly (Figure 50)**

Locate the Tension Strut Backup and Monorail on foundation with side of Monorail on the construction line (see Figure 54, p. 50). Verify that any applicable Transition Panels fit properly before anchoring Backup. Drill anchor boreholes in foundation using the Backup as template. Anchor the Backup to the concrete foundation using the Trinity Highway approved adhesive supplied with the QuadGuard® II system (see Trinity Highway Approved Adhesive section, p. 15).

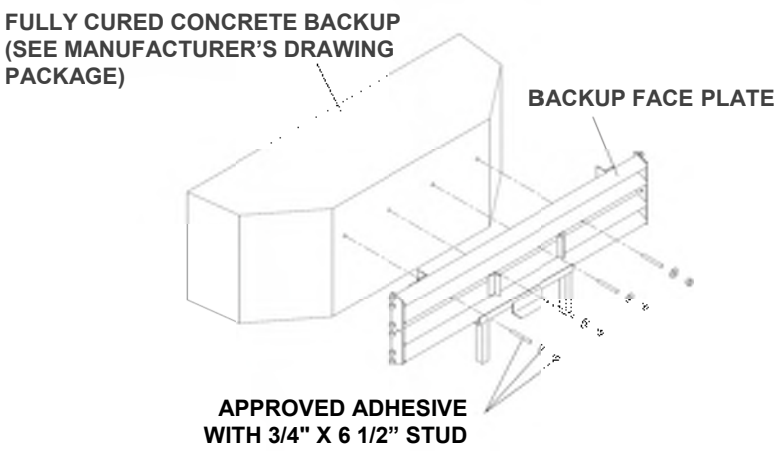


Figure 49
Anchoring Backup Face Plate to Concrete Backup

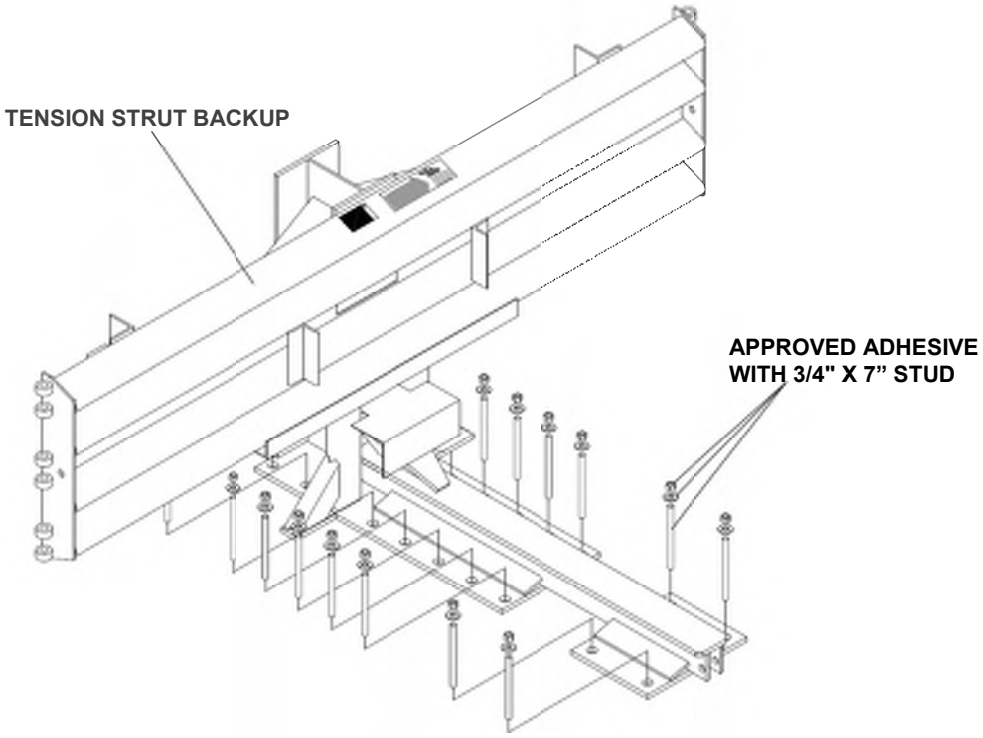


Figure 50
Anchoring Tension Strut Backup to Foundation

C) Extra-Wide Tension Strut Backup Assembly (Figure 51)

Locate the Extra-Wide Tension Strut Backup **center** section and Monorail on foundation with side of Monorail on the construction line (see Figure 54, p. 50).

Locate the Extra-Wide Tension Strut Backup **left** section on the left side of the center section, aligning the three holes in the side plates.

Locate the Extra-Wide Tension Strut Backup **right** section on the right side of the center section, aligning the three holes in the side plates.

Secure the Backup sections to each other using 5/8” x 2” hex bolt, 5/8” x 1 3/4" flat washer (2), 5/8” lock washer and 5/8” hex nut (6 places) as shown in Figure 51 and Detail 51a.

Verify that any applicable Transition Panels fit properly before anchoring Backup. Drill anchor boreholes in foundation using the Backup as template. Anchor the Backup to the foundation using Trinity Highway approved adhesive kits supplied with the QuadGuard® II system (see Trinity Highway Approved Adhesive section p. 15).

Warning: Every borehole and slot in Backup and Monorail must be anchored by a stud using a Trinity Highway approved adhesive.

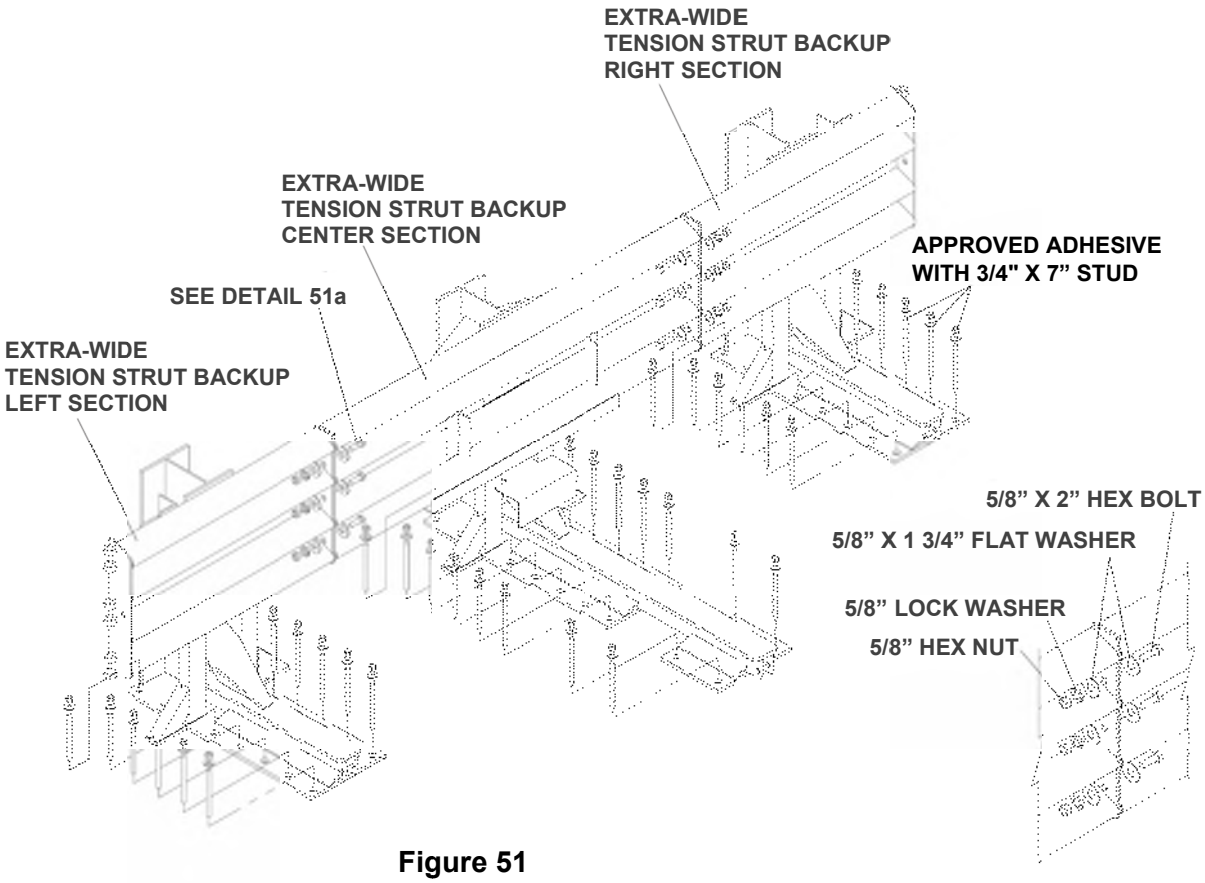


Figure 51
Anchoring Extra-Wide Tension Strut Backup to Foundation See Manufacturer’s Drawing Package

Detail 51a

4) Anchor the Monorail

A) Monorail Construction for Concrete Backup (Figure 52)

Locate Monorail on foundation with side of Monorail on the construction line and rear edge of Monorail 10” forward of front face of Concrete Backup. Orient the Monorail so that the Monorail tongues face Backup (see Figure 52).

Drill 140 mm [5 1/2"] deep anchor boreholes using the Monorail as a template. Do not drill through foundation.

Warning: Improper alignment at the Monorail Splice Joints may prevent proper system collapse during impact.

Anchor each Monorail section using an approved adhesive kit (see p. 15). See Figure 52 and the approved adhesive instructions included with the adhesive kit. It is important to attach each segment of Monorail in alignment from the back to the front of the system (± 6 mm [1/4”]).

Warning: Every borehole and slot in Backup and Monorail must be anchored by a stud using an approved adhesive.

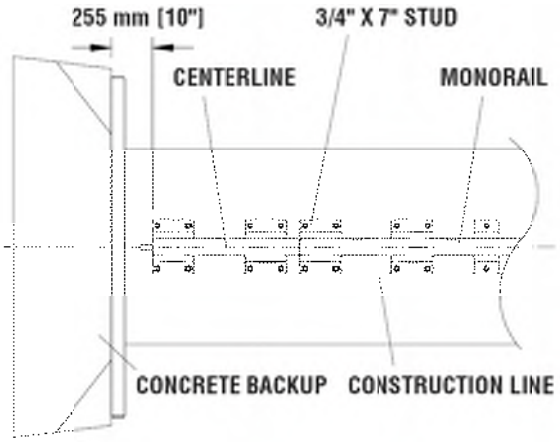


Figure 52
Monorail Location for Concrete Backup

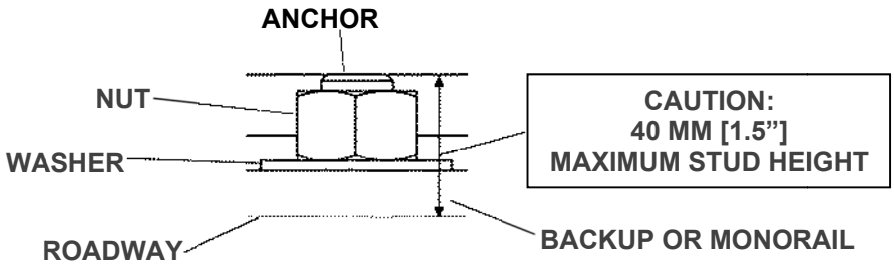


Figure 53
Proper Stud Height

Monorail Construction for Tension Strut Backup (Figure 54)

Locate Monorail on foundation with side of Monorail on the construction line and rear edge of Backup 4” forward of edge of foundation. Orient the Monorail so that the Monorail tongues face the Backup (see Figure 54).

Drill 140 mm [5 1/2"] deep anchor boreholes using the Monorail as a template. Do not drill through foundation.

Warning: Every borehole and slot in Backup and Monorail must be anchored by a stud using an approved adhesive.

Anchor each Monorail section using the Trinity Highway approved adhesive kits provided. See Detail 20a and the approved adhesive instructions included with each kit. It is important to attach each segment of Monorail in alignment from the back to the front of the system (± 6 mm [1/4”]).

Warning: Improper alignment at the Monorail splice joints will prevent proper system collapse during an impact.

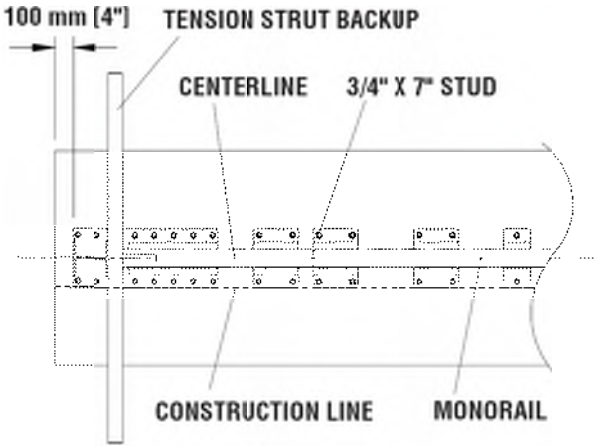


Figure 54
Backup and Monorail Location for Tension Strut Backup

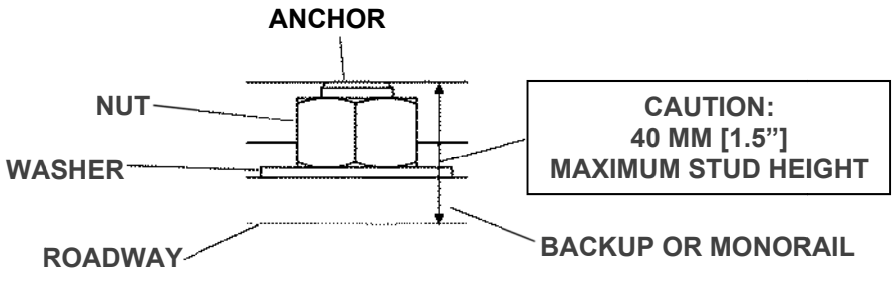


Figure 55
Proper Stud Height

5) Attach Side Panels and/or Transition Panels to Backup Assembly

a. Attach Hinge Plate to the Transition Panel or Side Panel using 5/8” rail bolt and 5/8” rail nut (two places – top and bottom holes only).

b. Attach Transition Panel or Side Panel assembly to side of Backup using 5/8” hex bolt, 5/8” lock washer and 5/8” hex nut (three places each side of Backup) (see Figure 56).

c. Attach diagonal brace to Fender Panel and Backup using 3/8” hex bolt, 3/8” lock washer and 3/8” hex nut (two (2) places per brace: four (4) places per side).

d. Secure each diagonal brace with a 3/8” hex bolt; 3/8” lock washer, and 3/8” hex nut (two (2) places per brace) as shown in Figure 56.

Note: A Side Panel is not needed when a Transition Panel is used. Diagonal braces not used with some Transition Panels (see Manufacturer’s Drawing Package).

Assembly tip:

Use drift pin to align the center hole of the Panel with the center hole of the Backup before attaching the rail bolts.

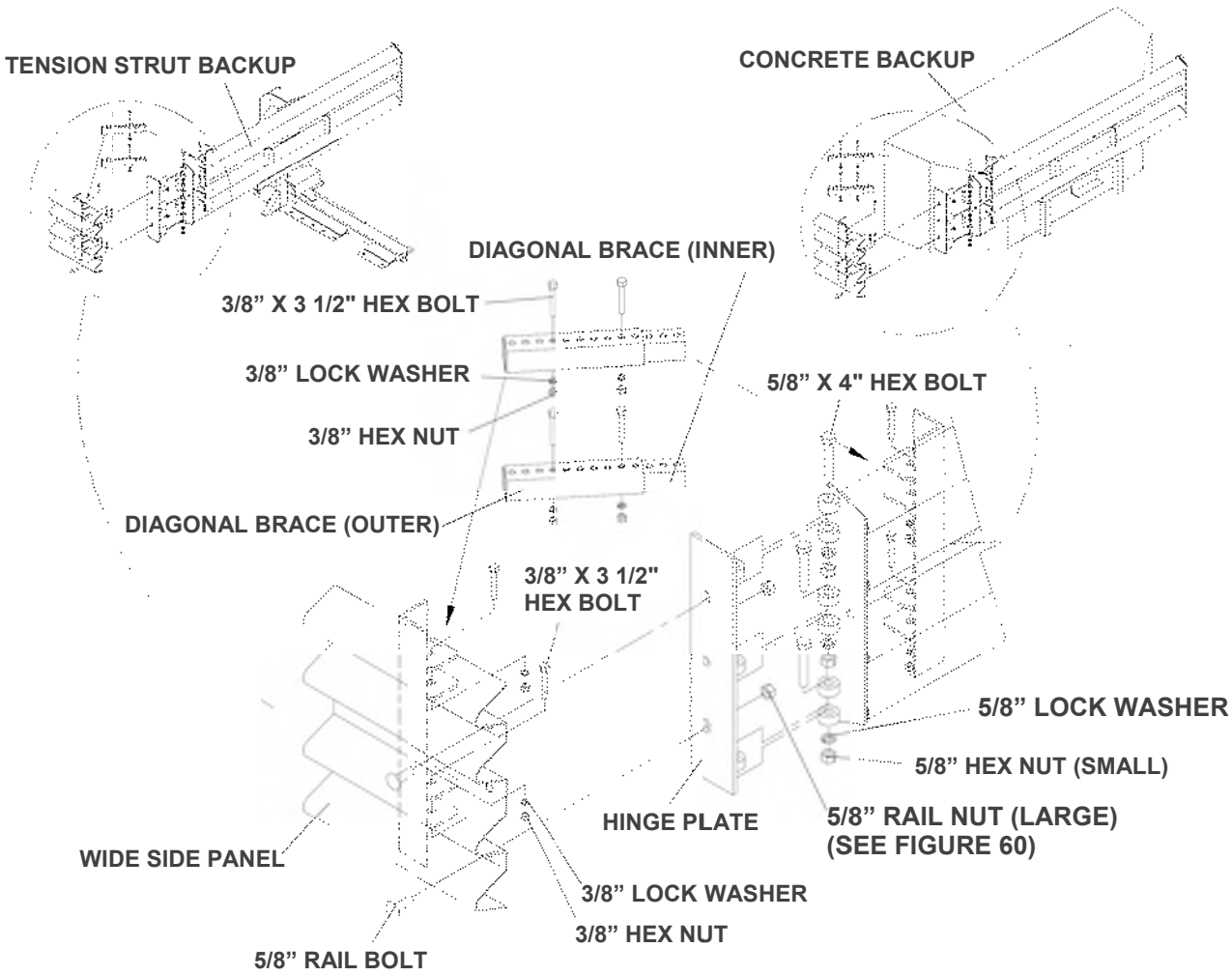


Figure 56
Side Panel/Transition Panel Attachment

6) Attach Monorail Guides

Attach Monorail guides to Diaphragm as follows:

Insert 3/4" x 2” G8 hex bolt through Monorail guide and Diaphragm, oriented as shown in Figure 57. Secure with 3/4" lock washer and 3/4" hex nut (typical two places per guide). See also Diaphragm assembly drawing. Shims are sandwiched between Monorail guides and Diaphragm.

Repeat process for each Diaphragm.

7) Attach Diaphragms

Orient the widest Diaphragm so that the front face of the Diaphragm shape faces toward the Nose of the system as shown in Figure 58. **The widest Diaphragm must be attached closest to the Backup with each subsequent Diaphragm being progressively narrower.**

Important: Slide the widest Diaphragm onto the Monorail and all the way to the Backup to ensure system is able to collapse properly during impact. Once this has been verified, slide the Diaphragm forward to approximately 915 mm [36”] in front of the Backup.

Orient and slide all other Diaphragms onto Monorail and position each approximately as shown in Figure 59.

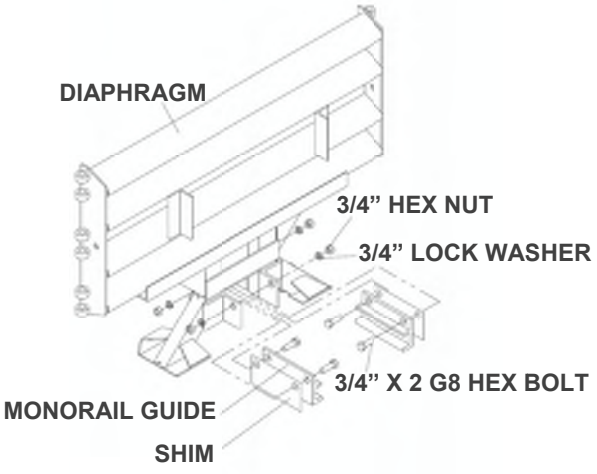


Figure 57
Monorail Guide Attachment

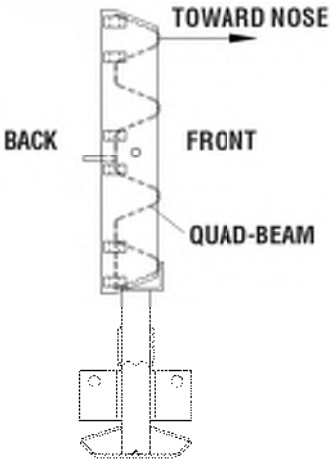


Figure 58
Diaphragm Orientation

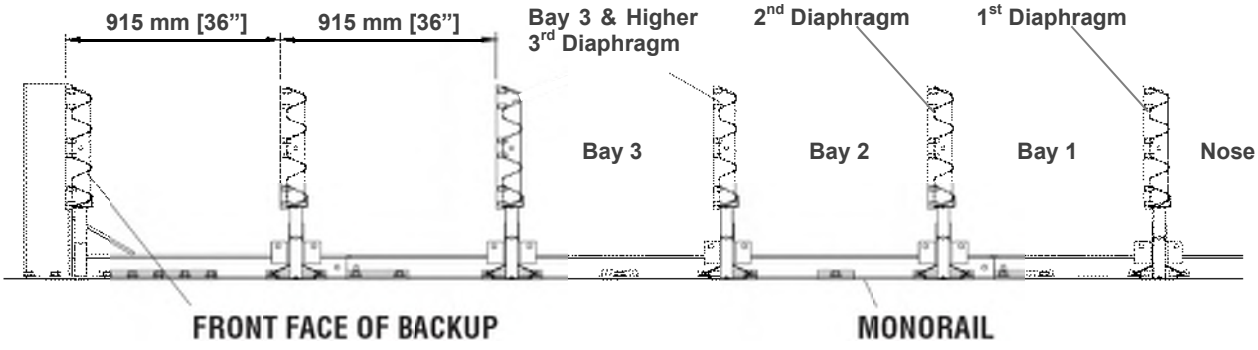


Figure 59
Diaphragm spacing

8) Attach Hinge Plate onto Fender Panels

Important: Do not mix the 5/8” rail nuts (large) with the 5/8” hex nuts (small).

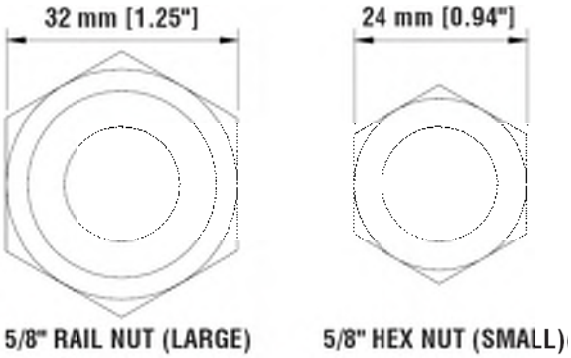


Figure 60
Rail Nuts are Oversize

Important: For proper impact performance, wide systems must use Hinge Plates.

Attach Hinge Plate on each Fender Panel using two (2) 5/8” rail bolts and two (2) 5/8” rail nuts, using top and bottom holes only, leaving the center-hole open as shown in Figure 61.

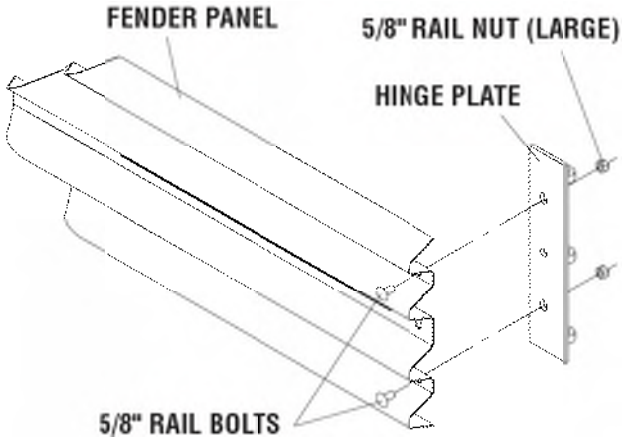


Figure 61
Hinge Plate Assembly

9) Attach Fender Panels

Starting at the Backup, attach left and right Fender Panels as shown in Figure 62.

Step 1

Place the Fender Panel so that the center of the slot of the rearward Diaphragm is lined up with the approximate center of the slot in the Fender Panel.

Attach Mushroom Washer Assembly as shown in Figure 62 and Detail 62a, but do not torque at this time (this helps to balance the Fender Panel).

Step 2

Slide the Fender Panel forward until the holes in the Fender Panel line up with the holes in the forward Diaphragm.

Step 3

Use a drift pin to align the center hole of the Fender Panel with the center hole of the Diaphragm.

Step 4

Attach the front of the Fender Panels to the next Diaphragm using two (2) rail bolts and large hex nuts per side. Use only the top and bottom holes; leave the center hole open until the next Fender Panel is attached.

Step 5

Be sure Mushroom Washer lays flat against the Fender Panel as shown in Detail 59a. Standoff on Mushroom Washer must be seated completely through slot.

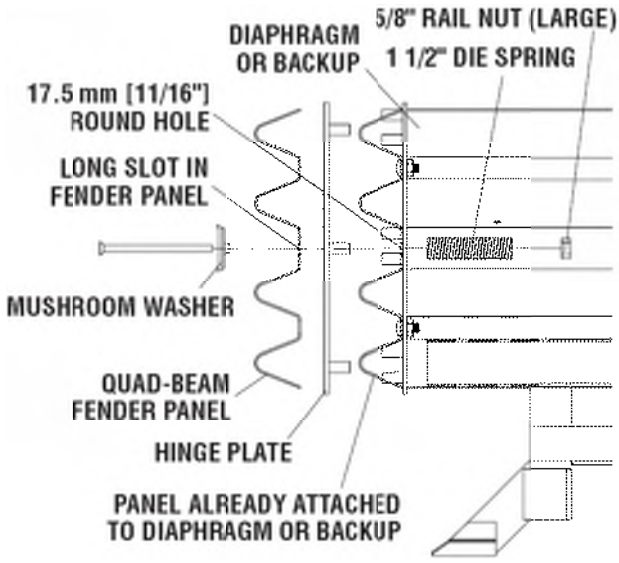
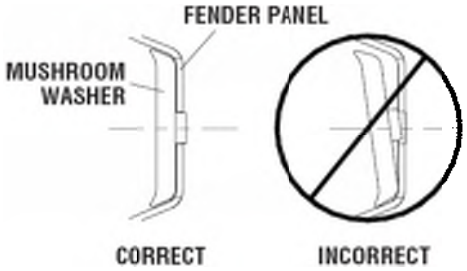


Figure 62
Mushroom Washer Attachment



Detail 62a
Mushroom Washer Orientation

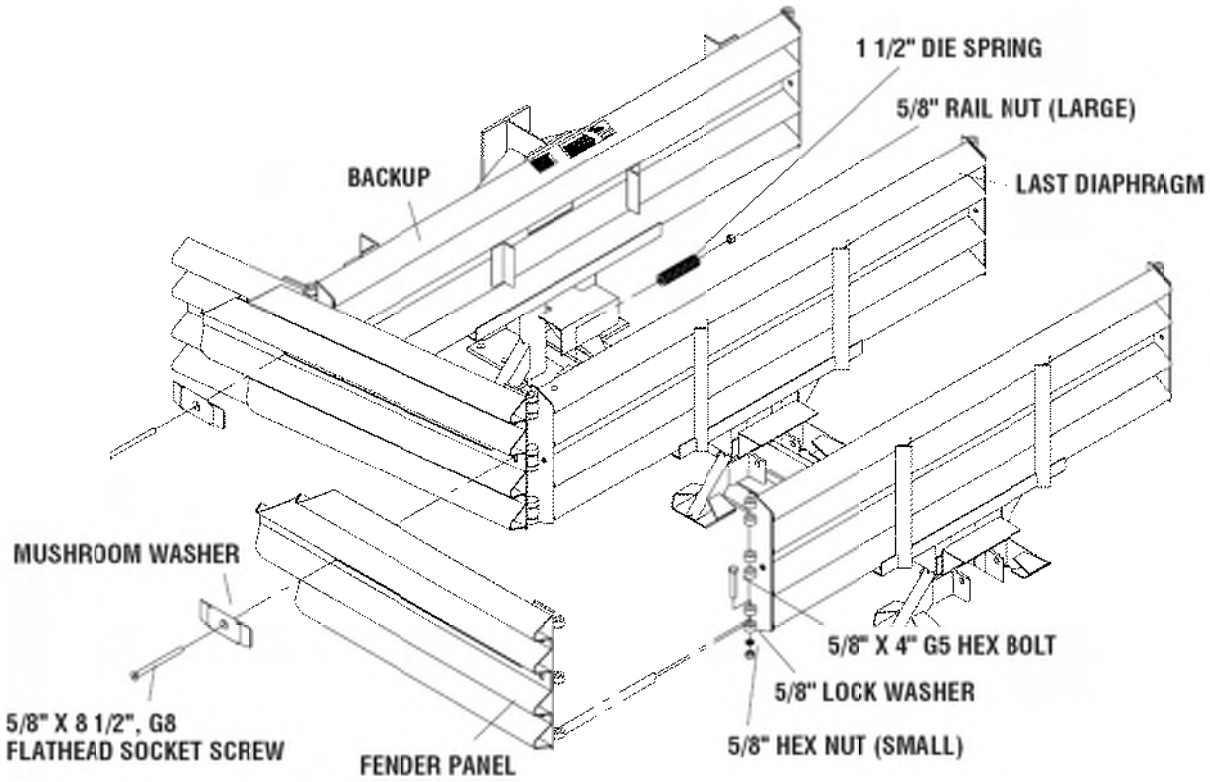


Figure 63
Fender Panel Assembly

Step 6

Check Diaphragm spacing to ensure 915 mm [36”] between rear faces of consecutive Diaphragms as shown in Figure 64 and Fender Panel Assembly drawing.

Step 7

Once the proper spacing has been achieved, torque the Mushroom Washer Assembly (small hex nut) until it reaches the end of the threads. Assemble the remaining Diaphragms and Fender Panels following the same procedures.

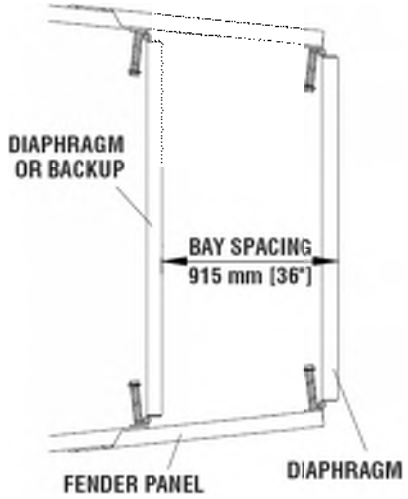


Figure 64
Proper Diaphragm Spacing

10) Attach End Cap

Using 5/8” x 3 1/2” G5 hex bolt, 5/8” hex nut and 5/8” lock washer, attach the End Cap to the front of the first Monorail segment as shown in Figure 65 and the Monorail Assembly drawing.

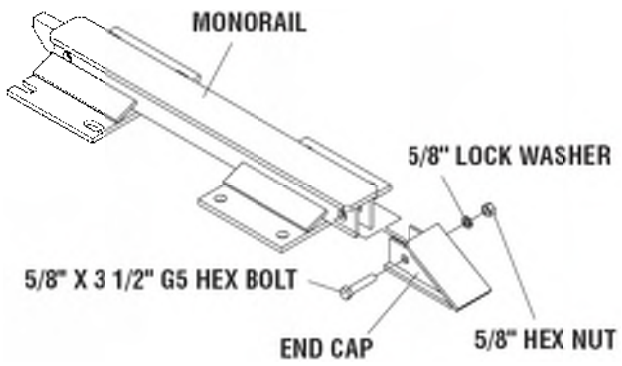


Figure 65
Monorail End Cap Assembly

11) Attach Cartridge Support Brackets

Attach Cartridge Support Bracket to all Diaphragms and Backup as shown in Figures 66 - 69, the Backup Assembly drawing, and the Diaphragm Assembly drawing.

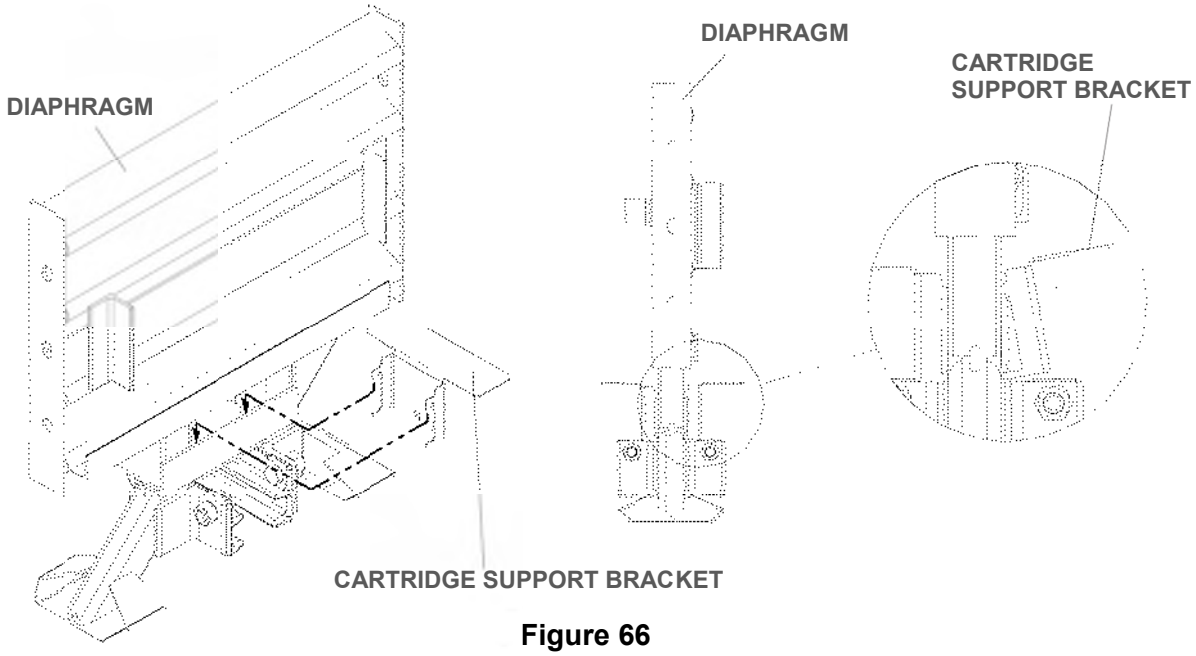


Figure 66
Diaphragm with
Cartridge Support Bracket

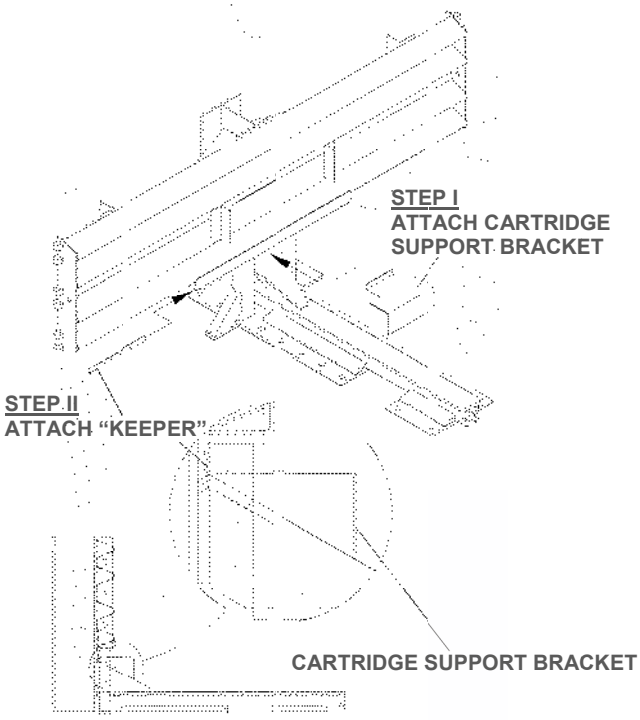


Figure 67
Cartridge Support Bracket
(Tension Strut Backup)

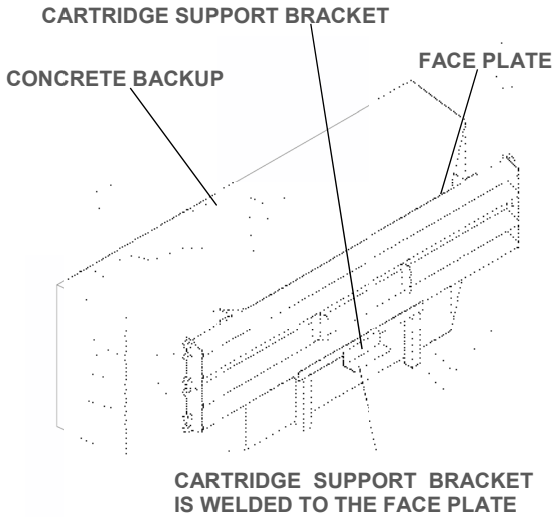


Figure 68
Cartridge Support Bracket
(Concrete Backup)

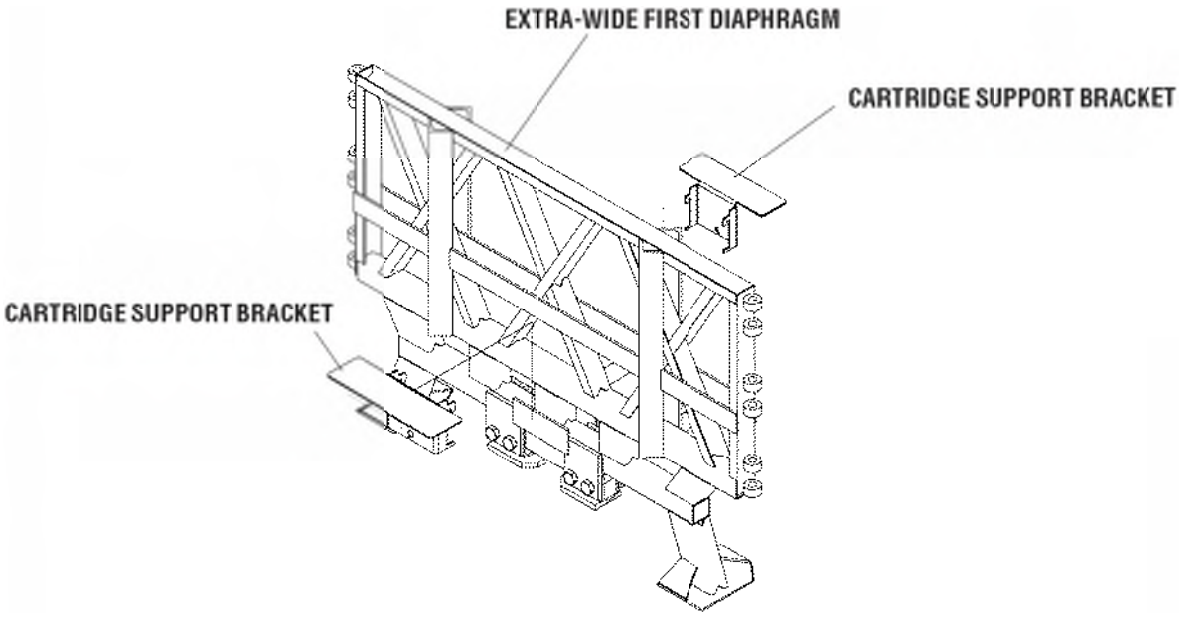


Figure 69
Extra-Wide First Diaphragm with Cartridge Support Bracket
(See Drawing Package)

12) Attach Nose Assembly

See pages 35 and 36 for Nose Assembly instructions.

13) Checking the System Assembly

Recheck to ensure that all fasteners are properly tightened throughout the system (anchor bolts, etc.). Review torque requirements below and inspect all Fender Panels. If they do not fit tightly against the underlying Fender Panels, system realignment may be necessary (see Figure 70).

Warning:
Bolt Torque Requirements
Anchor Studs – see Table A, p. 15 May slightly protrude above nuts
Critical Clearances
Anchor Studs above nuts – see Figure 55, p. 50 Fender Panel Gap Wide – 25 mm [1.00”] see below

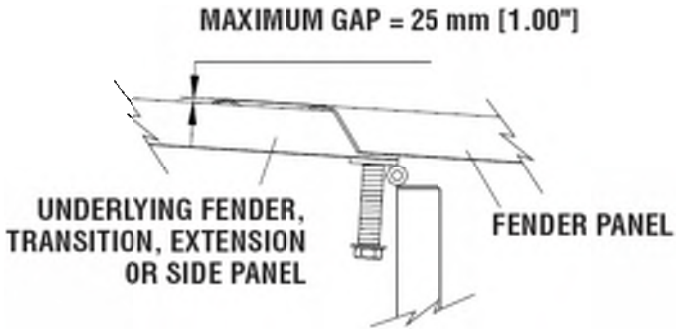


Figure 70
Fender Panel Gap for <u>Wide Systems</u>

14) Cartridge Attachment

Ensure the Adjustable Cartridge Support in the Nose is attached correctly. See “Attach Nose Assembly” in Step 11 on page 35. The top surface of the Nose Cartridge should be horizontal.

To complete the assembly of a QuadGuard® II system, place the appropriate Cartridge in each Bay and Nose section of the system. Type I Cartridges are placed toward the front (Nose) of the system; Type II Cartridges are placed toward the rear (Backup) of the system (see Figures 71 and 72).

Warning: Placing the wrong Cartridge in the Nose or any Bay will result in system performance that has not been crash tested pursuant to the NCHRP Report 350 criteria.

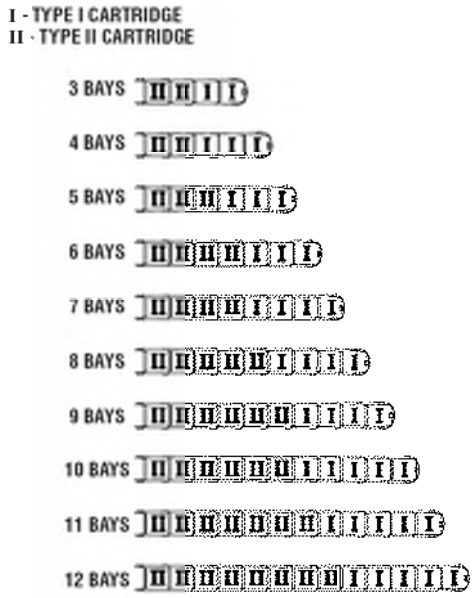


Figure 71
Cartridge Placement

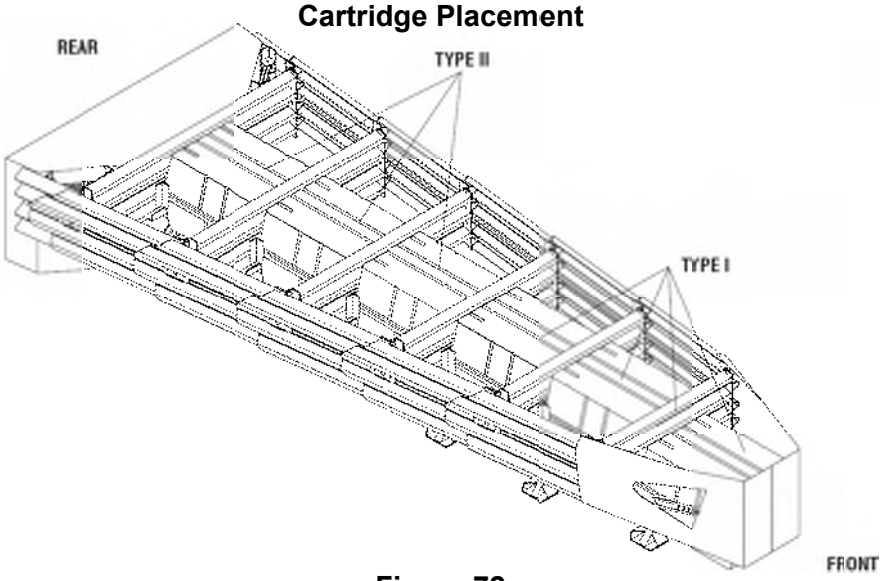


Figure 72
Typical Cartridge Layout (5 Bay System Shown)

Maintenance and Repair

Inspection Frequency

Inspections are recommended as needed based upon volume of traffic and impact history. Visual Drive-By Inspections are recommended at least once a month. Walk-Up Inspections are recommended at least twice a year for QuadGuard® II systems on asphalt (see p. 15).

Visual Drive-By Inspection

1) Check to see if there is evidence of an impact. If so, a walk-up inspection will be necessary.
2) Check to see if the Cartridges appear to be off the Support Brackets. Any damaged Cartridges will need to be replaced.

Warning: See Cartridge placement instructions on pages 38 and 57.

3) Be sure the Steel Nose is in place.
4) Note the location and condition of the QuadGuard® II system and the date of visual drive-by inspection.

Walk-Up Inspection

1) Clear and dispose of any debris on the site.
2) Ensure bolts are tight and rust free.
3) Ensure all anchor bolts are securely anchored (see Table A, p. 15).
4) Ensure Diaphragm Legs are straight.
5) Ensure all Mushroom Washer Assemblies are properly aligned and positioned.
6) Ensure Fender Panels and Transition Panels are nested tightly against the system.

Warning:	
Fender Panel	Maximum gap allowed:
Narrow Systems	**20 mm [0.78”]**
Wide Systems	**25 mm [1.00”]**

See Figures 76 and 77 on page 63.

7) Ensure Cartridges have not been damaged and are properly positioned on their Support Brackets. Replace crushed or sagging Cartridges. To ensure 100% of the intended speed characteristics, partially crushed Cartridges (due to slow speed impacts) shall be replaced.
8) Make all necessary repairs as described above. See Post-Impact Instructions on page 62 for more information.
9) Note the location and condition of the QuadGuard® II system and any work done in the Impact Attenuator Inspection Logbook under the date of this inspection. If further repair is necessary, note repair request date in logbook. See Post-Impact Instructions on page 62, and the Assembly section on page 22 of this manual for more information.
10) In deciding if a product should be replaced, or is potentially reusable, a trained engineer, experienced in highway products, directed by the DOT, or other appropriate local highway authority, must be consulted.

Post-Impact Instructions

Danger: If either (**wide or narrow**) system is anchored to asphalt and less than 10% of the total anchors are damaged, then each damaged anchor must be replaced. If more than 10% of the anchors are damaged, then the system must receive a fresh, undisturbed asphalt foundation and be redeployed using 460 mm [18”] threaded rods.

Narrow Systems

1) Deploy the appropriate traffic-control devices for protection.
2) Check to see that all anchor bolts have remained firmly anchored in the roadway surface. Replace any that are loose, broken, or pulled out.

   The proper performance of the system during an angle impact depends on the Monorail anchors being properly anchored.
3) Clear and dispose of any debris on the site.
4) Check the system to be certain that the Mushroom Washer Assemblies holding the Fender Panels together are still intact and that the system has not been deformed in a way that would prevent pulling it back to its original position.
5) Be sure that the Diaphragm Support Legs are all properly attached to the Monorail.

Wide Systems

1) Deploy the appropriate traffic-control devices for protection.
2) Check to see that all anchor bolts have remained firmly anchored in the roadway surface. Replace any that are loose, broken, or pulled out.

   The proper performance of the system during an angle impact depends on the Monorail Anchors being properly anchored.

Caution: QuadGuard® II wide systems should never be anchored to asphalt.

3) Clear and dispose of any debris on the site.
4) Check the system to be certain that the Mushroom Washer Assemblies holding the Fender Panels together are still intact and that the system has not been deformed in a way that would prevent pulling it back to its original position.
5) Be sure that the Diaphragm Support Legs are all properly attached to the Monorail.

Caution: Use safety goggles and gloves when refurbishing the Mushroom Spring Assembly. Do not place fingers underneath an assembled Mushroom Washer. Parts may suddenly shift and fingers may be pinched. If the spring is still under compression as the nut is nearing the end of the bolt, to prevent injury, make sure that the spring is restrained with a clamp so it does not suddenly release when nut is removed from the Mushroom Washer Bolt.

6) Attach chain to Pullout Brackets on first Diaphragm (see Figure 73). Attach both ends of chain to a heavy vehicle (such as a 1 ton pickup).

Warning: Stand clear in case chain breaks or becomes disconnected.

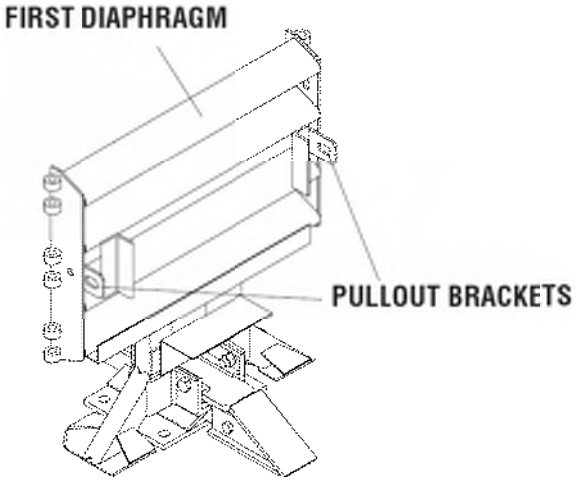


Figure 73
Pullout

Slowly pull the QuadGuard® II system forward until the system reaches its original length. Have someone watch the system during repositioning to be certain previously undetected damage does not cause the Diaphragms to bind or pull out improperly.

7) Remove all crushed Cartridges from within the system.

8) Check to see that the Diaphragms are in usable condition. Diaphragms which are bowed or have bent legs must be replaced.

9) Check that the Fender Panels are properly attached with the Mushroom Washer Assemblies. Damaged Fender Panels and Transition Panels must be replaced. Often, Cartridge Support Brackets with minor damage can be straightened and reused by doing the following:

   a. Remove damaged Cartridge Support Bracket from Diaphragm.

   b. Clamp Cartridge Support Bracket to Backup and begin bending using pipe wrench as shown in Figure 74.

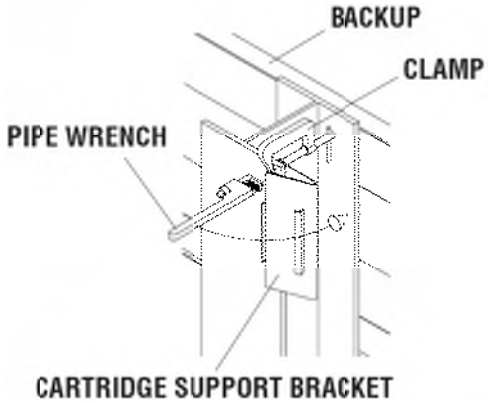


Figure 74
Straighten Cartridge Support Bracket

c. Then, using a sledge hammer and Quad-Beam™ Panel on Backup as an anvil, straighten Cartridge Support Bracket back into 90° shape (see Figure 75).

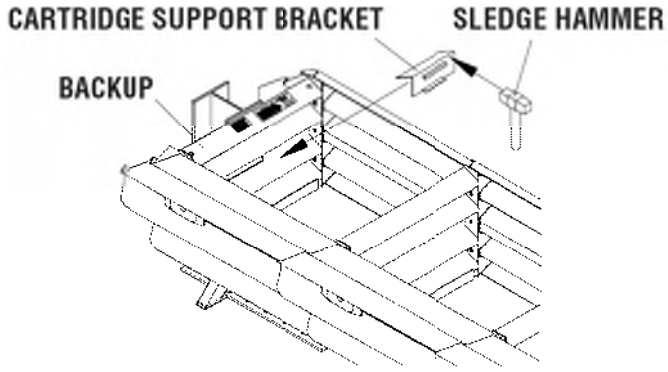


Figure 75
Form Cartridge Support Bracket

Warning:	
Fender Panel	Maximum gap allowed:
Narrow Systems	**20 mm [0.78”]**
Wide Systems	**25 mm [1.00”]**

10) Check the **gaps between Fender Panels**. The maximum gap allowed for these overlapping parts (including Fender Panels overlapping Panels behind the system) is 20 mm [.78”] for **narrow systems** and 25 mm [1.00”] for **wide systems**. Be sure the Mushroom Washer Assemblies are torqued to the end of the threads. If the gaps between the Fender Panels are still too large, it may be necessary to replace bent parts.

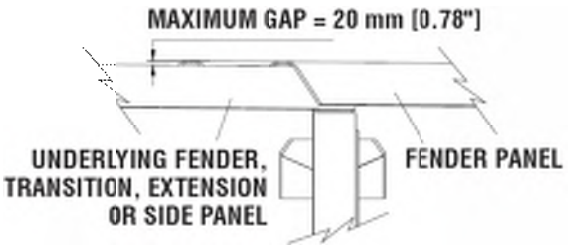


Figure 76
Fender Panel Gap for Narrow Systems

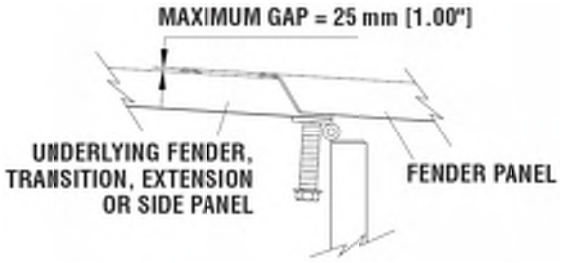


Figure 77
Fender Panel Gap for Wide Systems

11) Replace all crushed Cartridges. See Cartridge Placement on pages 41 and 59.

12) Remove damaged Nose Assembly and attach the new Nose to the first Diaphragm. See pages 38 and 39 for system Nose Assembly.

Important: Trinity Highway makes no recommendation whether use or reuse of any part of the system is appropriate or acceptable following an impact. It is the sole responsibility of the project engineer and/or the local highway authority and its engineers to make that determination. It is critical that you inspect this product after assembly is complete to make certain that the instructions provided in this manual have been strictly followed.

Table C

Warning:
Bolt Torque Requirements
Anchor Studs – see Table A, p. 15 May slightly protrude above nuts – see Figure 55, p. 50
Critical Clearances
Anchor Studs above nuts – see Figure 20, p. 29 **Fender Panel Gap Narrow – 20 mm [0.78”]** **Fender Panel Gap Wide – 25 mm [1.00”]**

13) Check the torque of all bolts on the system (see Table A, p. 15).

14) Check to be certain that the site is free from any debris. The QuadGuard® II system is once again ready for use.

Parts Ordering Procedure

Make a list of all damaged parts using part descriptions shown on pages 65 and 66 of the system images. Answer the following questions in the spaces provided. This information is necessary to receive the proper parts.

Table D

QuadGuard® II System Ordering Information Chart

Description:	Choices	Fill in this section
What is the width of the system? See “Measuring the Width” on page 19.	610 mm [24”] 760 mm [30”] 915 mm [36”] 1219 mm [48”] 1755 mm [69”] 2285 mm [90”] 3200 mm [126”]	
What is the Number / Type of Bays? See Bay information on pages 21 and 59.	Narrow Systems: 1 through 9 Wide Systems: 3 through 9	
What Type of Backup Does the System Have? See Figures 8 or 9 on page 25.	Concrete Tension Strut	
What Type of Transition Panel? (See “Side Panel and Transition Panel Types” on page 26.) Be sure to note right side, left side, both sides (see “How to Determine Left/Right” on page 21) or no Transitions.	• Quad to W • Quad to Thrie • Quad to Safety Shape Barrier • Quad to End Shoe • 4” Offset Panel	

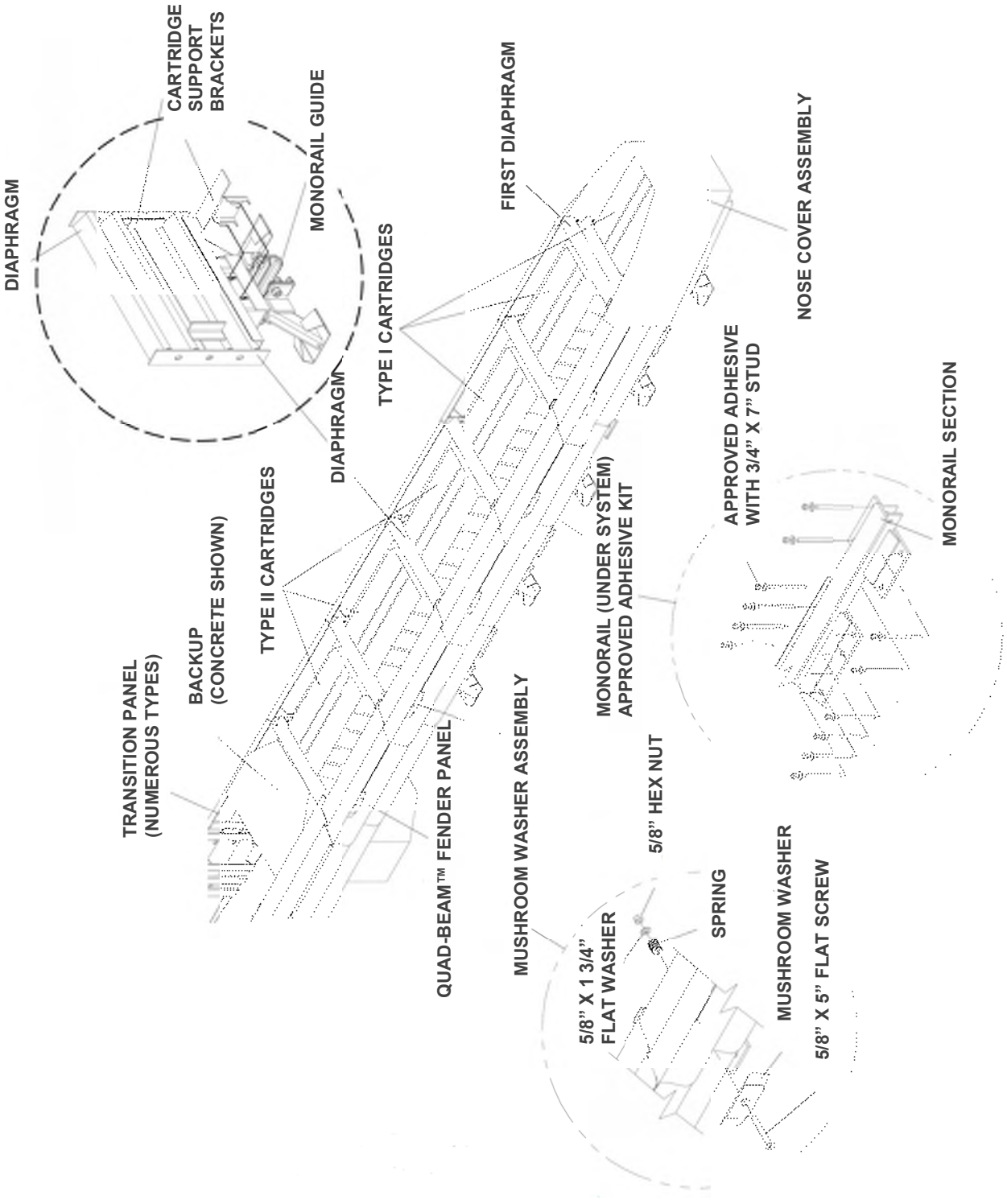


Figure 78
QuadGuard® II for Narrow Roadside Obstacles

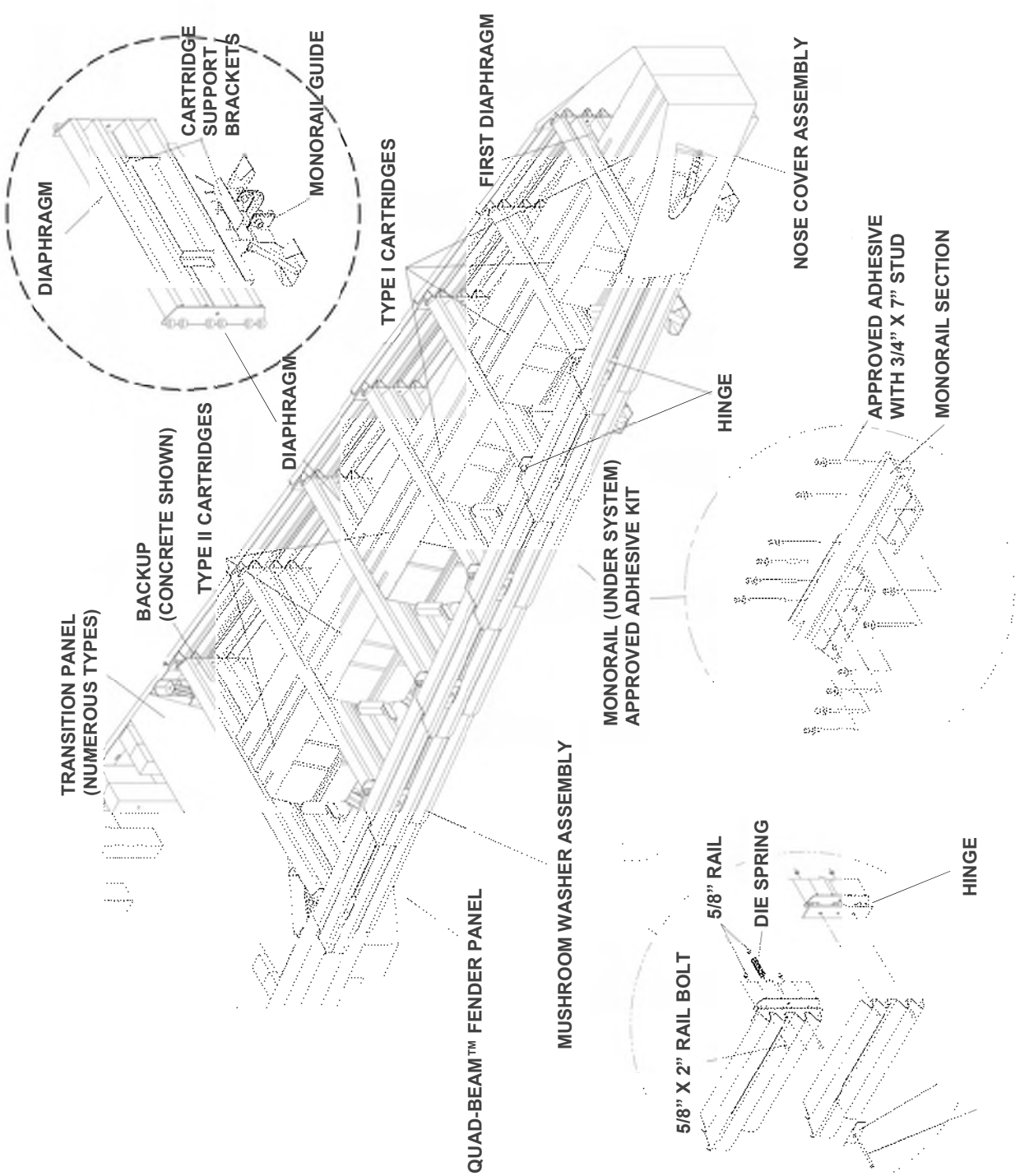


Figure 79
QuadGuard® II for Wide
Roadside Obstacles

TRINITY
HIGHWAY

Ahead of the Curve™

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PN 115350

Revision C August 2014

REACT 350®
Narrow (36")
Assembly Manual

TRINITY HIGHWAY

Ahead of the Curve™

REACT 350®
Narrow (36”)

Assembly Manual

2525 Stemmons Freeway
Dallas, Texas 75207

Important: These instructions are to be used only in conjunction with the assembly, maintenance, and repair of the REACT 350® Narrow system. These instructions are for standard assemblies specified by the appropriate highway authority only. In the event the specified system assembly, maintenance, or repair would require a deviation from standard assembly parameters, contact the appropriate highway authority engineer. This system has been accepted by the Federal Highway Administration for use on the national highway system under strict criteria utilized by that agency. Trinity Highway representatives are available for consultation if required.

This Manual must be available to the worker overseeing and/or assembling the product at all times. For additional copies, contact Trinity Highway at (888) 323-6374 or download copies from the website below.

The instructions contained in this Manual supersede all previous information and Manuals. All information, illustrations, and specifications in this Manual are based on the latest REACT 350® Narrow system information available to Trinity Highway at the time of printing. We reserve the right to make changes at any time. Please contact Trinity Highway to confirm that you are referring to the most current instructions.

Part No. 115350
Revision C August 2014

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Customer Service Contacts

Trinity Highway is committed to the highest level of customer service. Feedback regarding the REACT 350® Narrow system, its assembly procedures, supporting documentation, and performance is always welcome. Additional information can be obtained from the contact information below:

Energy Absorption Systems, Inc. dba
Trinity Highway

Telephone:	(888) 323-6374 (USA) (214) 589-8140 (International)
E-mail:	product.info@trin.net
Website:	www.trinityhighway.com

Important Introductory Notes

Proper assembly of REACT 350® Narrow system is critical to achieve performance that has been evaluated and accepted by the Federal Highway Administration (FHWA) per NCHRP Report 350. These instructions should be read in their entirety and understood before assembling the REACT 350® Narrow system. These instructions are to be used only in conjunction with the assembly of the REACT 350® Narrow system and are for standard assemblies only as specified by the applicable highway authority. If you need additional information, or have questions about the REACT 350® Narrow system, please contact the highway authority that has planned and specified this assembly and, if needed, contact Trinity Highway's Customer Service Department. This product must be assembled in the location specified by the appropriate highway authority. If there are deviations, alterations, or departures from the assembly protocol specified in this Manual, the device may not perform as it was tested and accepted.

This system, like other Trinity Highway systems, has been crash tested pursuant to NCHRP Report 350 mandated criteria

Important: DO NOT use any component part that has not been specifically crash tested and/or approved for this system during the assembly or repair of this system.

This product has been specified for use by the appropriate highway authority and has been provided to that user who has unique knowledge of how this system is to be assembled. No person should be permitted to assist in the assembly, maintenance, or repair of this system that does not possess the unique knowledge described above. These instructions are intended for an individual qualified to both read and accurately interpret them as written. These instructions are intended only for an individual experienced and skilled in the assembly of highway products that are specified and selected by the highway authority.

A manufacturer's drawing package will be supplied by Trinity Highway upon request. Each system will be supplied with a specific drawing package unique to that system. Such drawings take precedence over information in this Manual and shall be studied thoroughly by a qualified individual who is skilled in interpreting them before the start of any product assembly.

Important: Read safety instructions thoroughly and follow the assembly directions and suggested safe practices before assembling, maintaining, or repairing the REACT 350® Narrow system. Failure to follow this warning can result in serious injury or death to workers and/or bystanders. Such failure also compromises the acceptance of this system by the FHWA. Please keep up-to-date instructions for later use and reference by anyone involved in the assembly of the product.

Warning: Ensure that all of the REACT 350® Narrow system Danger, Warning, Caution, and Important statements within the REACT 350® Narrow system Manual are completely followed. Failure to follow this warning could result in serious injury or death in the event of a collision.

Safety Rules for Assembly

*** Important Safety Instructions ***

This Manual must be kept in a location where it is readily available to persons who assemble, maintain, or repair the REACT 350® Narrow system. Additional copies of this Manual are immediately available from Trinity Highway by calling (888) 323-6374 or by email at product.info@trin.net. Please contact Trinity Highway if you have any questions concerning the information in this Manual or about the REACT 350® Narrow system. This Manual may also be downloaded directly from the website below.

Always use appropriate safety precautions when operating power equipment, mixing chemicals, and when moving heavy equipment or REACT 350® Narrow system components. Work gloves, apron, safety goggles, safety-toe shoes, and back protection should be used.

Safety measures incorporating traffic control devices specified by the highway authority must be used to provide safety for personnel while at the assembly, maintenance, or repair site.

Safety Symbols

This section describes the safety symbols that appear in this REACT 350® Narrow Manual. Read the Manual for complete safety and assembly information.

Symbol	Meaning
	**Safety Alert Symbol:** Indicates Danger, Warning, Caution, or Important. Failure to read and follow the Danger, Warning, Caution, or Important indicators could result in serious injury or death to the workers and/or bystanders.

Warnings and Cautions

Read all instructions before assembling, maintaining, or repairing the REACT 350® Narrow system.

Danger: Failure to comply with these warnings could result in increased risk of serious injury or death in the event of a vehicle impact with a system that has not been accepted by the Federal Highway Administration (FHWA).

Warning: Do not assemble, maintain, or repair the REACT 350® Narrow system until you have read this Manual thoroughly and completely understand it. Ensure that all Danger, Warning, Caution, and Important statements within the Manual are completely followed. Please call Trinity Highway at (888) 323-6374 if you do not understand these instructions.

Warning: Safety measures incorporating appropriate traffic control devices specified by the highway authority must be used to protect all personnel while at the assembly, maintenance, or repair site.

Warning: Use only Trinity Highway parts that are specified herein for the REACT 350® for assembling, maintaining, or repairing the REACT 350® Narrow system. **Do not utilize or otherwise comingle parts from other systems even if those systems are other Trinity Highway systems**. Such configurations have not been tested, nor have they been accepted for use. Assembly, maintenance, or repairs using unspecified parts or accessories is strictly prohibited. Failure to follow this warning could result in serious injury or death in the event of a vehicle impact with an UNACCEPTED system.

Warning: Do NOT modify the REACT 350® Narrow system in any way.

Warning: Ensure that the REACT 350® Narrow system and delineation used meet all federal, state, specifying agency, and local specifications.

Warning: Ensure that your assembly meets all appropriate Manual on Uniform Traffic Control Devices (MUTCD) and local standards.

Warning: Ensure that there is proper site grading for the REACT 350® Narrow system placement as dictated by the state or specifying agency, pursuant to Federal Highway Administration (FHWA) acceptance.

Warning: Use only Trinity Highway parts on the REACT 350® Narrow system for assembly, maintenance, or repair. **The assembly or comingling of unauthorized parts is strictly PROHIBITED.** The REACT 350® Narrow and its component parts have been accepted for state use by the FHWA. However, a comingled system has not been accepted within the applicable criteria.

Important: Trinity Highway makes no recommendation whether use or reuse of any part of the system is appropriate or acceptable following an impact. It is the sole responsibility of the local highway authority and its engineers to make that determination. It is critical that you inspect this product after assembly is complete to make certain that the instructions provided in this Manual have been strictly followed.

Warning: Ensure that this assembly conforms with the guidance provided by the AASHTO Roadside Design Guide, including, but not limited to, those regarding placement on or adjacent to curbs.

Limitations and Warnings

Trinity Highway, in compliance with the National Cooperative Research Highway Program 350 (NCHRP Report 350) "Recommended Procedures for the Safety Performance of Highway Safety Features", contracts with FHWA approved testing facilities to perform crash tests, evaluation of tests, and submittal of results to the Federal Highway Administration for review.

The REACT 350® Narrow system has been approved by FHWA as meeting the requirements and guidelines of NCHRP Report 350. These tests typically evaluate product performance defined by Report 350 involving a range of vehicles on roadways, from lightweight cars (approx. 820 kg [1800 lb.]) to full size pickup trucks (approx. 2000 kg [4400 lb.]).. A product can be certified for multiple Test Levels. The REACT 350® Narrow is certified to the Test Level(s) as shown below:

Test Level 2: 70 km/h [43 mph]
Test Level 3: 100 km/h [62 mph]

These FHWA directed tests are not intended to represent the performance of systems when impacted by every vehicle type or every impact condition existing on the roadway. This system is tested only to the test matrix criteria of NCHRP Report 350 as approved by FHWA.

Trinity Highway neither represents nor warrants that the impact results of these federally established test criteria prevent or reduce the severity of any injury to person(s) or damage to property. These tests only demonstrate the occurrence of certain results following an impact within NCHRP Report 350 criteria. Every departure from the roadway is a unique event.

The REACT 350® Narrow system is intended to be assembled, delineated, and maintained within specific state and federal guidelines. It is important for the highway authority specifying the use of a highway product to select the most appropriate product configuration for its site specifications. The customer should be careful to properly select, assemble, and maintain the product. Careful evaluation of the site lay out, vehicle population type; speed, traffic direction, and visibility are some of the elements that require evaluation in the selection of a highway product. For example, curbs could cause an untested effect on an impacting vehicle.

After an impact occurs, the debris from the impact should be removed from the area immediately and the specified highway product should be evaluated and restored to its original specified condition or replaced as the highway authority determines as soon as possible.

System Overview

The REACT 350® Narrow is a potentially reusable, redirective, non-gating crash cushion for roadside obstacles ranging in width from 203 mm to 914 mm (8" to 36").

The REACT 350® Narrow system utilizes three types of Cylinders in a “staged” configuration to address both lighter cars and heavier, high center-of-gravity vehicles. Its modular design allows the system length to be tailored to the design speed of a site. Refer to the REACT 350® Narrow 36” Product Manual to determine the appropriate length system for a given speed.

Impact Performance

The 4 Cylinder REACT 350® Narrow (TL-2) system has successfully passed the requirements stipulated in NCHRP Report 350, with both the light car and pickup at speeds of up to 70 km/h [43 mph] at angles up to 20 degrees.

The 9 Cylinder REACT 350® Narrow (TL-3) system has successfully passed the requirements stipulated in NCHRP Report 350, with both the light car and pickup at speeds of up to 100 km/h [62 mph] at angles up to 20 degrees.

During head-on impacts, within the above-referenced criteria, the REACT 350® Narrow travels rearward and crushes to absorb the energy of impact. When impacted from the side, within same criteria, it redirects the vehicle back toward its original travel path and away from the roadside obstacle.

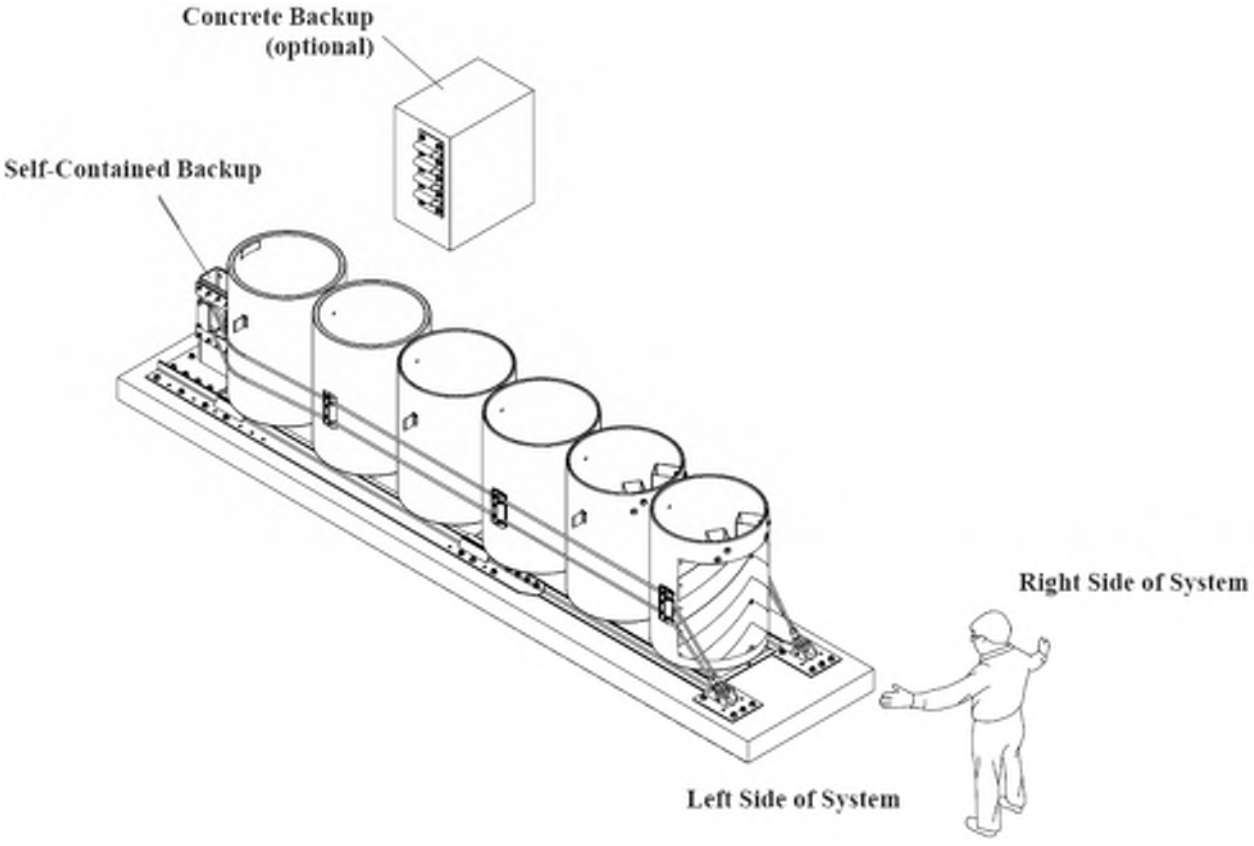


Figure 1
REACT 350® Narrow (36”) with Self-Contained Backup

Assembly

Recommended Tools

Documentation

- Manufacturer's Assembly Manual
- Manufacturer's Drawing Package

Cutting equipment

- Rebar cutting bit
- Rotary hammer drill
- Concrete drill bits – 22 mm [7/8"] x 178 mm [7"] (*Double-Fluted)
- Grinder, Hacksaw or Torch (optional)

* Trinity Highway recommends using double-fluted drill bits to achieve optimum tensile strength when applying the MP-3® anchoring system.

Hammers

- Sledgehammer

Wrenches

- Heavy duty impact wrench
- Standard adjustable wrench
- 1/4", 5/16", 3/8", 3/4" sockets
- 3/4", 1 1/16", 1 1/8", 1 1/4" Deep Hex-head Sockets
- Ratchet and extensions for above sockets
- Standard adjustable wrench
- 1 1/16", 1 1/8", 1 1/4", 9/16", 5/8" combination wrenches
- Large Pipe Wrench

Screwdrivers

- Screw gun or Standard Drill with adapter chuck for small screws/bolts
- Flat Screwdriver
- Phillips Screwdriver

Personal Protective equipment

- Safety Glasses
- Gloves
- Safety-Toe Shoes
- Apron for MP-3® application

Miscellaneous

- Traffic control equipment
- Lifting and moving equipment (A lifting device is preferred although a forklift can be used.) Minimum 2722 kg [6,000 lb.] capacity required. For the 4 Cylinder REACT 350® Narrow (36") on the precast pad, 4536 kg [10,000 lb.] capacity required. Do not lift overhead.
- Compressor (100 psi) and Generator (5 kW)
- Long pry bar
- Drift pin
- Tape measure 7.5 m [25']
- Chalk line
- Nylon bottle brush for cleaning drilled holes
- Rags, water, and solvent for touch-up

Note: The above list of tools is a general recommendation. Depending on specific site conditions and the complexity of the assembly specified by the appropriate highway authority, additional or fewer tools may be required. Decisions as to what tools are needed to perform the job are entirely within the discretion of the specifying highway authority and the authority's selected contractor performing the assembly of the system at the authority's specified site.

Note: Refer to Assembly Procedures for a complete list of instructions.

Site Preparation/Foundation

A REACT 350® Narrow should be assembled on an existing or freshly placed and cured concrete base (28 MPa [4000 psi] minimum). Use 178 mm [7”] Threaded Rods attached with the two-part MP-3® grout. Location and orientation of the concrete base and attenuator must comply with project plans or as otherwise determined by the resident project engineer.

For an independent, soil-supported concrete foundation, include a below-grade anchor block as part of the foundation. The large block will keep the foundation from sliding during an impact. Additional details can be found on the standard drawings and project plans.

Recommended dimension and reinforcement specifications for new concrete foundations are provided in Trinity Highway concrete foundation drawings, supplied with the system. The system may be assembled on a non-reinforced concrete roadway (minimum 200 mm [8”] thick).

Caution: Accurate placement of all steel rebar is critical to avoid interference with the concrete anchor bolts.

Inspect Shipping

Before deploying the REACT 350® Narrow, check the received parts against the shipping list supplied with the system. Make sure all parts have been received.

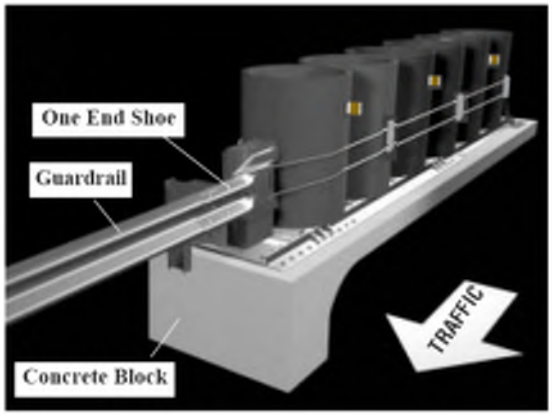


Figure 2
Permanent Construction which requires Below-Grade Anchor Block

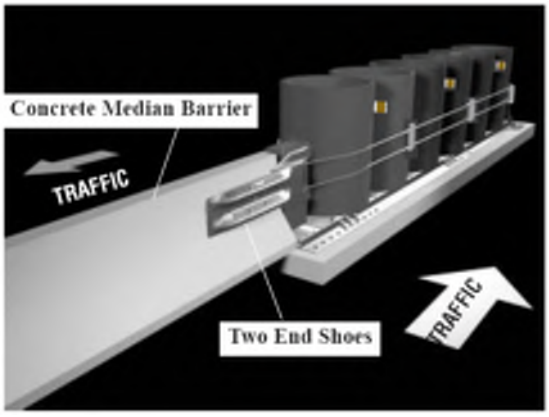


Figure 3
Permanent Construction which does not require Below-Grade Anchor Block

Foundation Specifications

Concrete Anchoring

For concrete anchoring, the REACT 350® Narrow should be mounted only on an existing or freshly placed and cured concrete base (28 MPa [4000 psi] minimum). Orientation of the concrete base and the attenuator must comply with the project plans or as otherwise determined by the resident project engineer or appropriate highway authority.

Recommended dimension and reinforcement specifications for new concrete pads can be found on the standard drawings.

Asphalt Anchoring

Assemblies on asphalt must provide a minimum of 76 mm [3”] layer of asphalt over a minimum of 76 mm [3”] layer of Portland Cement concrete, 152 mm [6”] layer of asphalt over 152 mm [6”] layer of subbase, or 203 mm [8”] layer of asphalt with no subbase. 460 mm [18”] Threaded Rods, installed with the two-part MP-3® grout, must be used for these foundations.

Important: Systems mounted on asphalt must be replaced and mounted on fresh, undisturbed asphalt if more than 10% of anchors are found to be loose, broken, or show signs of pull out. If 10% or fewer anchors are damaged, replace the damaged anchors in the existing asphalt. Anchor bolts used on systems mounted on asphalt must be inspected every 6 months. See Post Impact Instructions and Maintenance and Repair instructions on page 34.

The REACT 350® Narrow may be placed on any of the following foundations using the specified anchorage:

Foundation A: Concrete Pad or Roadway

Foundation: 150 mm [6”] minimum depth Portland Cement Concrete (P.C.C.)

Anchorage: MP-3® with 180 mm [7”] studs 140 mm [5 1/2”] embedment

Foundation B: Asphalt over P.C.C.

Foundation: 76 mm [3”] minimum asphalt concrete (A.C.) over 76 mm [3”] minimum P.C.C.

Anchorage: Length of anchor required is 460 mm [18”] 420 mm [16 1/2”] embedment

Foundation C: Asphalt over Subbase

Foundation: 150 mm [6"] minimum A.C. over 150 mm [6”] minimum Compacted Subbase (C.S.)

Anchorage: MP-3® with 460 mm [18"] studs 420 mm [16 1/2”] embedment

Foundation D: Asphalt Only

Foundation: 200 mm [8”] minimum A.C.

Anchorage: MP-3® with 460 mm [18”] studs - 420 mm [16 1/2”] embedment

Foundation Specifications

For Foundations A, B, C, and D mentioned above:

A. C. (Asphalt Concrete)

AR-4000 A. C. (per ASTM D3381 '09) 3/4” Maximum, Medium (Type A or B) aggregate

Sieve Size	Operating Range (%) Passing
1"	100
3/4"	95-100
3/8"	65-80
No. 4	49-54
No. 8	36-40
No. 30	18-21
No. 200	3-8

Caution: Walk-up inspections are recommended at least once every six months for installations on asphalt.

P.C.C. (Portland Cement Concrete)

Stone aggregate concrete mix

4000 psi minimum compressive strength

(Sampling per ASTM C31 or ASTM C42, testing per ASTM C39)

C.S. (Compacted Subbase)

150 mm [6”] minimum depth 95% compaction

Class 2 aggregate

Sieve Size	Moving Average (%) Passing
3"	100
2 1/2"	90-100
No. 4	40-90
No. 200	0-25

Self-Contained Backup Assembly

Note: The Drawing Package supplied with the REACT 350® Narrow must be used with these instructions for proper assembly and should take precedence over these general instructions.

1) Deploy Traffic Control

A traffic control plan appropriate to the complexity of the project should be prepared and understood by all parties before the REACT 350® Narrow is deployed.

Deploy the appropriate work zone safety devices prior to beginning the deployment and keep them present through all phases of the assembly.

2) Determining the Basepoint and Centerline

Typically the basepoint of the REACT 350® Narrow will be the midpoint of the roadside obstacle at its front face. This may change if bidirectional traffic or expansion joints are present (see “Offsetting the System” on p. 22).

Extend a chalk line from the basepoint, perpendicular to the roadside obstacle face, or as determined by the project engineer to a distance greater than the maximum length of the REACT 350® Narrow (refer to the drawings provided). This chalk line will become the centerline for the REACT 350® Narrow (see Figure 8).

Note that the REACT 350® Narrow, when properly deployed, appears to be an extension of the object which it is shielding.

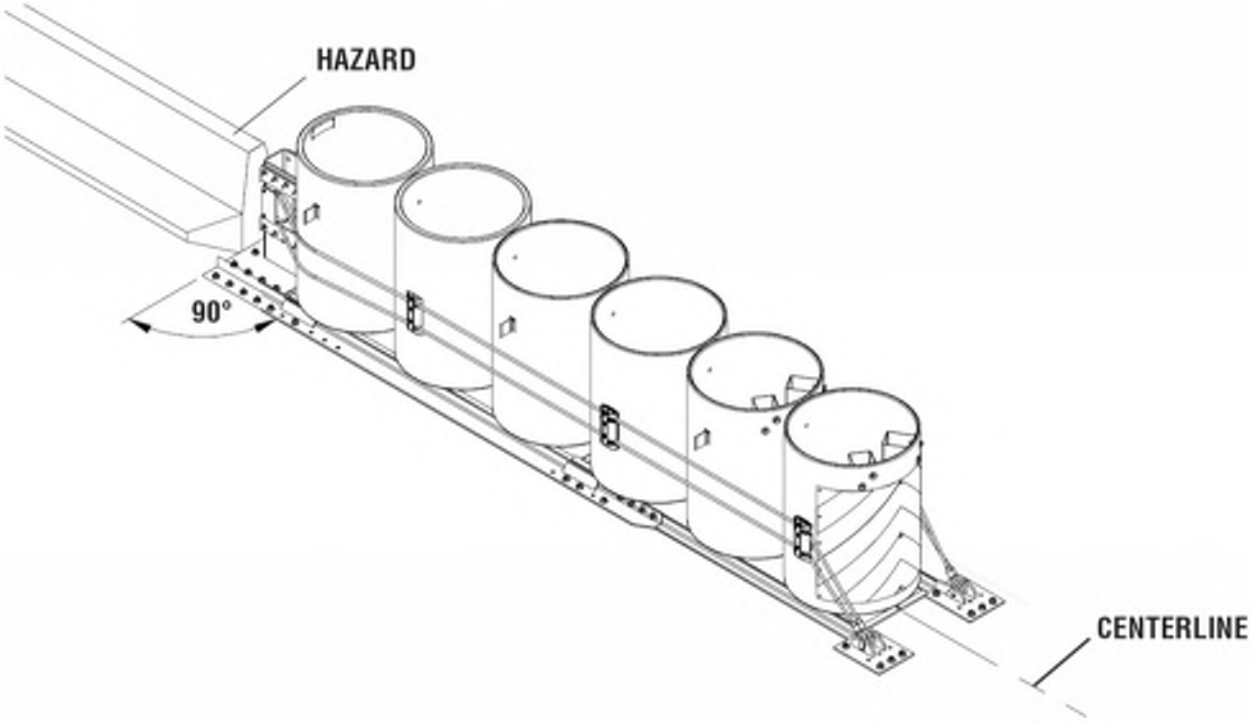


Figure 8
REACT 350® Narrow (36”) Placement

3) Lifting/Placing the System

Mark the centerline on the front and rear of the base track. Use the lifting eyes located on the middle rail of the rear base track (look down into the Cylinders) to lift the REACT 350® Narrow into place (see Figure 10).

Use fixed-length slings with a 2,722 kg [6,000 lb.] minimum capacity. Fixed slings will prevent system tipping. Do not lift overhead. Measure the deployment from the centerline to ensure that the REACT 350® Narrow is centered and at the proper angle. The steel base track will rest flush against the roadside obstacle face for assemblies that do not require Transitions.

For Self-contained Backup Assemblies requiring Transition hardware to concrete wall or safety shape barrier, the Steel Base Track should be 127 mm [5”] forward of the roadside obstacle face (see Figure 9).

Note: For systems with Concrete Backup (see p. 17).

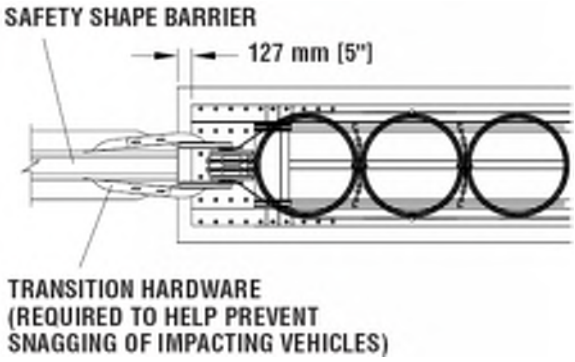


Figure 9
Base Track Location

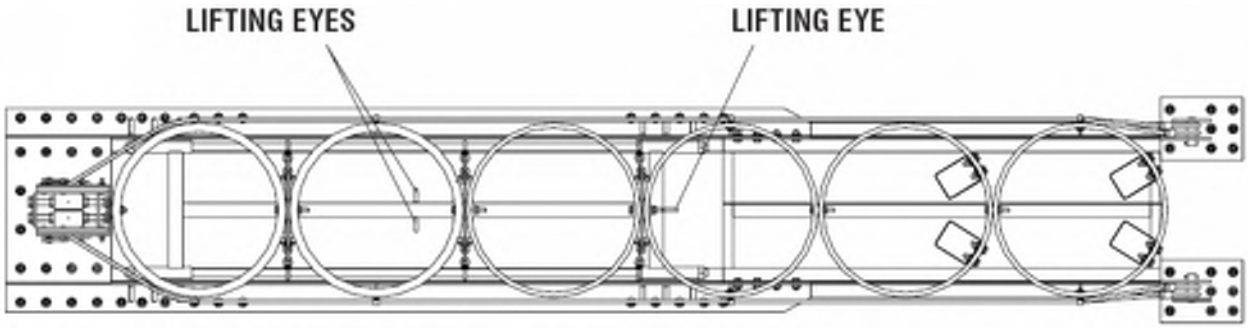


Figure 10
Lifting Eye Locations

4) Drill and Set Anchors

Use the holes in the base track as a template to locate and drill fifty-six (56) holes, 22 mm [7/8”] diameter x 140 mm [5 1/2"] deep into the concrete pad or roadway surface (see Figure 11). **All holes in base plate must be used to anchor the REACT 350® Narrow to the foundation.** Use the vertical MP-3® kits to assemble 3/4" diameter x 7" long studs using instructions included with kit. After grout is hardened, use 3/4" flat washers and nuts provided with kit to anchor base track to foundation.

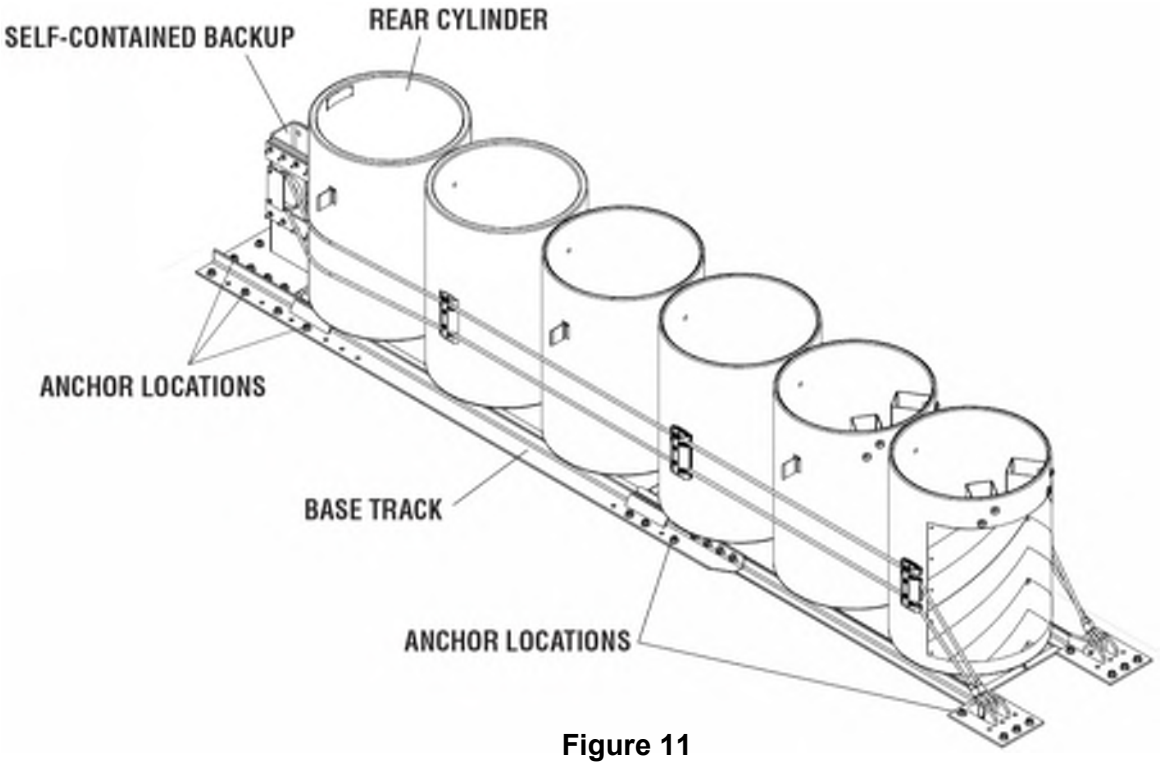


Figure 11
Anchoring the System

Warning: Once the grout has hardened, torque nuts per Table A on page 26. Refer to Table B on page 28 for hardening times.

5) Tension Restraining Cables

Use the two adjusting nuts at the rear of the Backup to tension the cables (see Figure 12).

When properly tensioned, the cables should not deflect more than 75 mm [3”] with 45 kg [100 lb.] downward pressure.

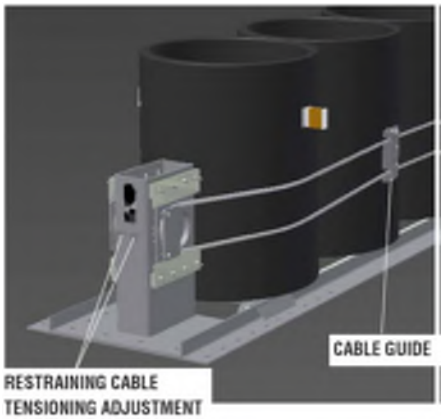


Figure 12
Restraining Cable Adjustment

Taper Toe Barrier

Transition panels must be added to any side exposed to traffic and the lower base or “toe” of the barrier must be tapered back at 15° maximum relative to traffic for a total width of 330 mm [13”]. This helps prevent interaction of wheels on impacting vehicles (see Figure 13 for Transition Panels removed for clarity).

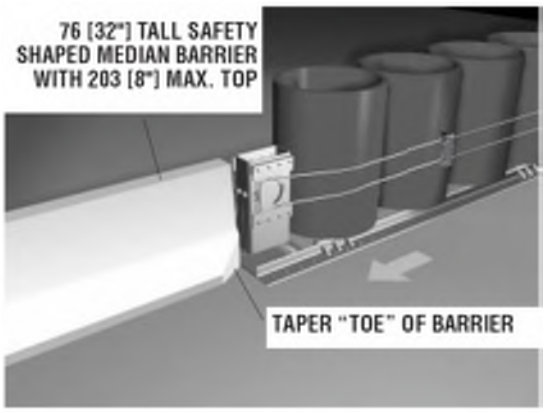


Figure 13
REACT 350® Narrow (36”) with Self-Contained Backup Shielding Safety Shape Barrier

Bidirectional Traffic

Self-Contained, Steel Backup

If a REACT 350® Narrow with Self-contained Backup is placed in a location where traffic will be approaching from the rear, a transition from the object being shielded to the Backup may be required. See “Offsetting the System” on page 22 and “Lifting/Placing the System” on page 18. Hardware is available to mount w-beam guardrail or a safety shaped barrier to the Self-contained Backup of the REACT 350® Narrow. A folded Transition Plate and w-beam connector can mount to either or both sides of the Backup Assembly (see Figure 14). Special post spacing, rail, and rub rail will be required for guardrail.

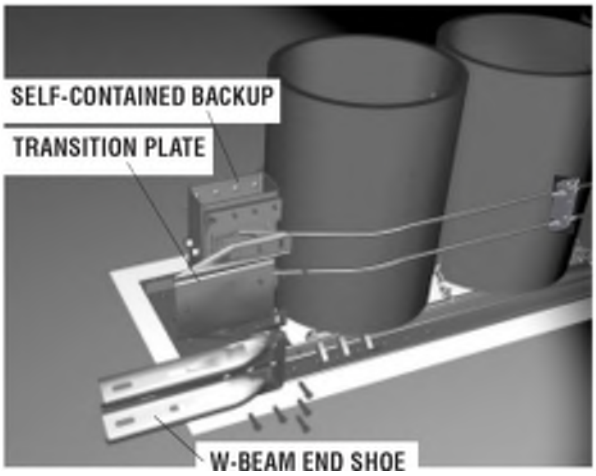


Figure 14
Transition Hardware

Concrete Backup Assembly

Note: The Drawing Package supplied with the REACT 350® Narrow must be used with these instructions for proper assembly and should take precedence over these general instructions.

1) Deploy Traffic Control

A traffic control plan appropriate to the complexity of the project should be prepared and understood by all parties before the REACT 350® Narrow is deployed.

Deploy the appropriate work zone safety devices prior to beginning the deployment and keep them present through all phases of the assembly.

2) Determining the Basepoint and Centerline

Typically the basepoint of the REACT 350® Narrow will be the midpoint of the roadside obstacle at its front face. This may change if bidirectional traffic or expansion joints are present (see “Offsetting the System” on p. 22).

Extend a chalk line from the basepoint, perpendicular to the roadside obstacle face, or as determined by project engineer to a distance greater than the maximum length of the REACT 350® Narrow (refer to the drawings provided). This chalk line will become the centerline for the REACT 350® Narrow (see Figure 15).

Note that the REACT 350® Narrow, when properly deployed, appears to be an extension of the object which it is shielding.

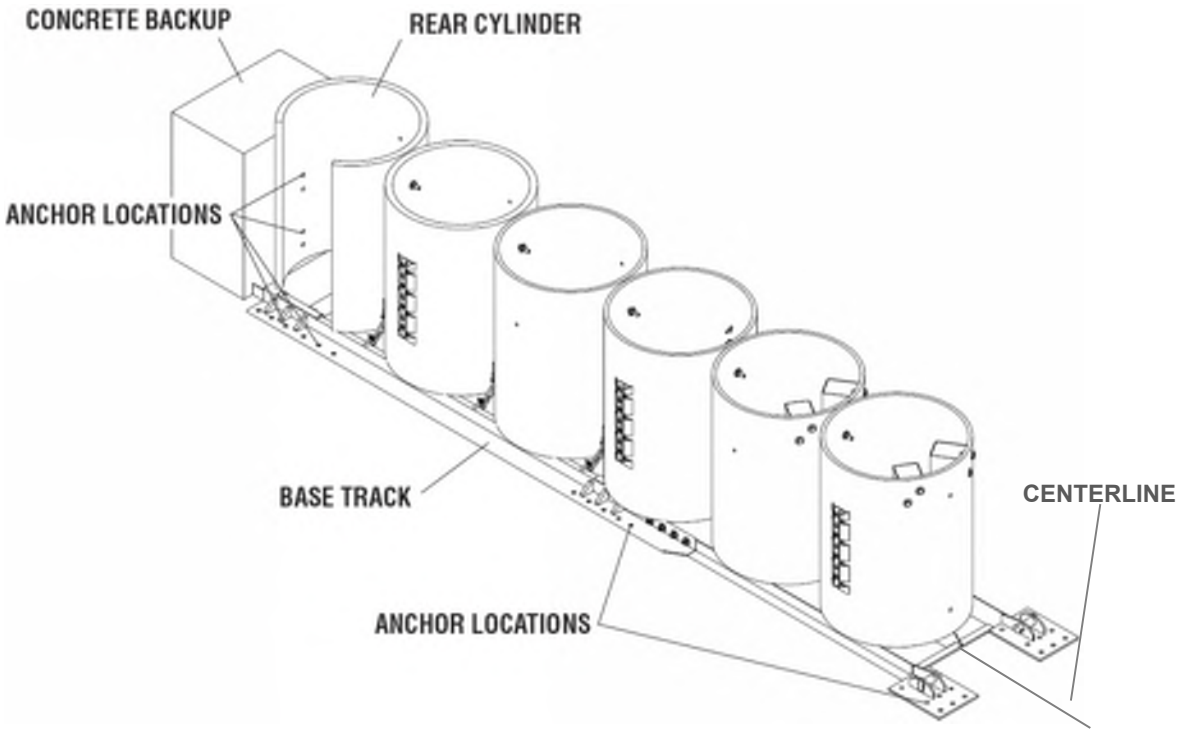


Figure 15
Anchoring the System

3) Lifting/Placing the System

Mark the centerline on the front and rear of the base track. Use the lifting eyes located on the middle rail of the rear base track (look down into the Cylinders) to lift the REACT 350® Narrow into place (see Figure 10).

Use fixed-length slings with a 2,722 kg [6,000 lb.] minimum capacity. Fixed slings will prevent system tipping. Do not lift overhead. Measure the deployment from the centerline to ensure that the REACT 350® Narrow is centered and at the proper angle. The steel base track will rest flush against the roadside obstacle face for assemblies that do not require Transitions.

4) Rear Cylinder Attachment

Use the holes in the Rear Cylinder as a template to locate and drill two holes, 22 mm [7/8”] diameter x 140 mm [5-1/2"] deep into the Concrete Backup (see page 17). Use horizontal MP-3® kit to assemble the 3/4” diameter x 8-1/2" long studs using instructions included with kit. After grout is hardened, use 3/4” nuts and flat washers included with MP-3® kits to attach Cylinder assembly to Concrete Backup (see Figure 15).

5) Drill and Set Anchors

Use the holes in the Base Track as a template to locate and drill thirty eight (38) holes, 22 mm [7/8”] diameter x 140 mm [5 1/2"] deep into the concrete pad or roadway surface (see Figure 15). **All holes in Base Track must be used to anchor the REACT 350® Narrow to the foundation.** Use vertical MP-3® kits to assemble 3/4" diameter x 7" long studs using instructions included with kit. After grout is hardened, use 3/4" nuts and flat washers included with MP-3® kits to anchor base track to foundation.

Warning: Once the grout has hardened, see Table B on page 28 for hardening times and torque to Table A specifications on page 26.

6) Drill and Set Side Anchor Plate Anchors

For REACT 350® Narrow with a Concrete Backup, Side Cable Anchor Plates must be attached.

Caution: The vertical placement of the Side Anchor Plates is critical to the performance of the REACT 350® Narrow. If an existing Backup is not tall enough to fulfill these requirements, special brackets are available. Consult Trinity Highway (see p. 3).

When properly deployed, the top of the Side Cable Anchor Plates should be 991 mm (39”) from the road surface. The front edge of the Side Cable Anchor Plates should be 76 mm [3”] from the front face of the Backup to avoid reinforcing steel. The tapered side of the Side Cable Anchor Plates should face the front of the system (see page 19). Use the holes in the Side Cable Anchor Plates as templates to match drill ten (10) holes per side of Backup, 22 mm [7/8”] diameter x 140 mm [5 1/2"] deep into the Concrete Backup. Use horizontal MP-3® kit to assemble the (20) 3/4" diameter x 6 1/2" long studs using instructions included with kit. After grout is hardened, use 3/4" nuts and flat washers included with MP-3® kit to attach Side Cable Anchor Plates, one for each side, to Concrete Backup (see Figure 16 on p. 19).

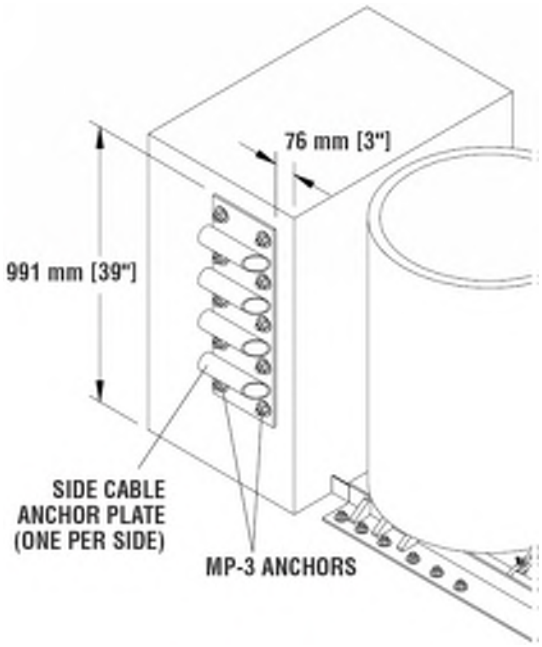


Figure 16
Side Cable Anchor Plates

Warning: Once the grout has hardened, see Table B on page 28 for hardening times and torque to Table A specifications on page 26.

7) Attach Restraining Cables

Four Restraining Cables must be attached: two on each side of Backup.

1. Slide the threaded end of a Restraining Cable through the third guide down and attach flat washer and nut (see Figure 17). Tighten the nut so it is flush with the end of the threaded end of cable.
2. Route the Restraining Cable through the Cable Guides on the sides of the Cylinders, around the Restraining Cable pin as shown on page 21, back through the Top Cable guides of the Cylinders, and through the Top Cable Guide of the Side Plate (see Figure 17).
3. Pull on the cut end of the cable removing all possible slack. Slide the 3/4" flat washer and the ferrule over the end of the non-threaded end of the Restraining Cable. Mark the cable 2" back from the Anchor Plate. Leaving the ferrule and washer in place, cut the cable at the mark with a grinder or hack saw. Do not use a torch to cut the cable. Unbraid the end of the cable and insert the middle strand of the cable between the two halves of the wedge. Carefully wrap the remaining 6 stands into the slots around the wedge then push into ferrule to tighten (see Figure 17 and detail A). Use a drift pin and sledge hammer to seat the ferrule into the cable receptacles.

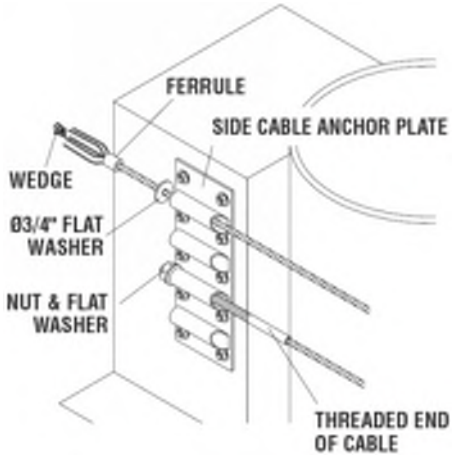


Figure 17
Routing First Cable

detail A
Cable Ferrule

Repeat these steps for remaining three Restraining Cables ensuring that the threaded ends of the Restraining Cables are attached through the lower two Guides as shown in Figure 19 on page 21.

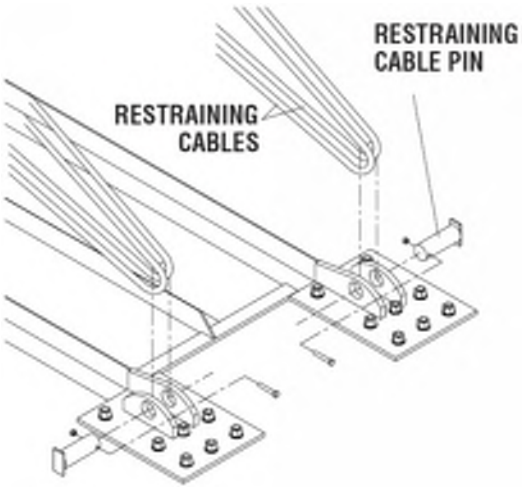


Figure 18
Front of System Cable Attachment
(Concrete Backup)

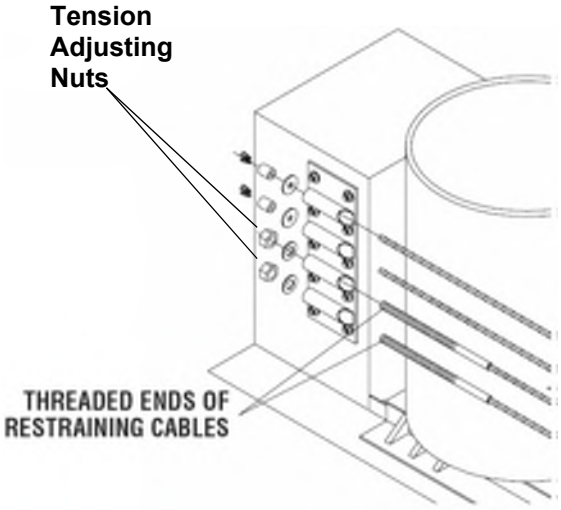


Figure 19
Rear of System Cable Attachment
(Concrete Backups)

8) Tension Restraining Cables

Use the nuts on the threaded end of the Cables to tension the cables (see Figure 19).

When properly tensioned, the Cables should not deflect more than 75 mm [3”] with 45 kg [100 lb.] downward pressure.

Bidirectional Traffic

Concrete Backup

If a REACT 350® Narrow (36”) with Concrete Backup is placed in a location where traffic will be approaching from the rear, the Backup should not protrude beyond the roadside feature being shielded. Concrete tapering may be required. Also, an additional standard Side Anchor Plate should be rotated 180 degrees and placed behind the first Anchor Plate (see Figures 21 and 22). In this case, the Backup must be 762 mm [30”] long. Refer to Figure 22 on page 22 for placement and Step 6 on page 18 for anchoring information.

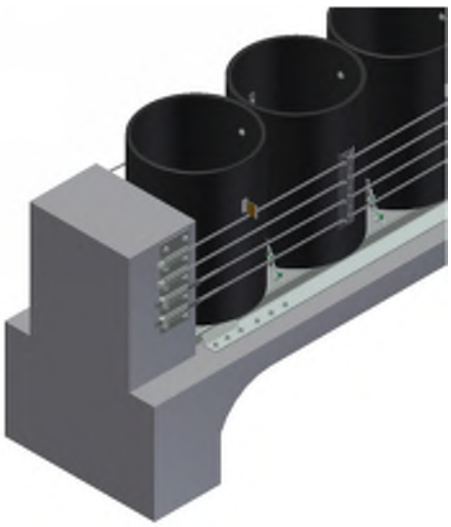


Figure 20
Restraining Cable Adjustment
(Concrete Backup)

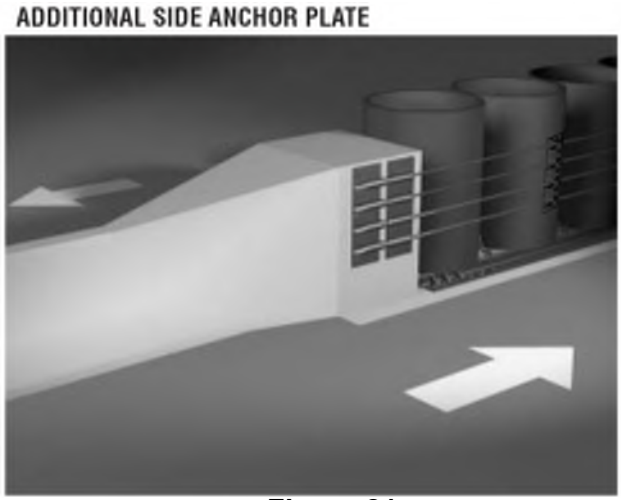


Figure 21
Transitioning to the REACT 350®
Narrow (36”) with Concrete Backup

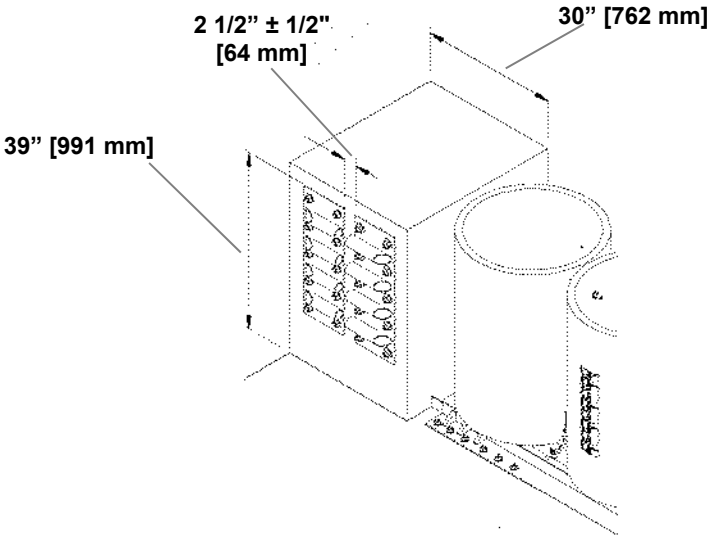


Figure 22
Assemble additional Anchor Plate for Bidirectional Traffic

Roadside Obstacle Width

The REACT 350® Narrow with a Concrete Backup may shield obstacles up to 914 mm [36"] wide. The Backup must be 762 mm [30"] to 914 mm [36"] wide to use standard Side Anchor hardware.

The REACT 350® Narrow with Self-contained Backup may shield roadside features up to 610 mm [24"] (see "Offsetting the System" below).

Offsetting the System

If space permits, REACT 350® Narrow may be offset from the center of the roadside obstacle. Offsetting may be necessary for two reasons:

1) To shield an obstacle wider than 200 mm [8"]
2) If bidirectional traffic is present

When offsetting the REACT 350® Narrow, align the vertical face of the Backup structure with the face of the barrier (see Figure 23). With this method, REACT 350® Narrow with Self-contained Backup may shield roadside obstacles up to 610 mm [24"]. If a wider obstacle is present, a Concrete Backup may be required. Contact Trinity Highway Customer Service Department if you have questions concerning Concrete Backup requirements (see p. 3).

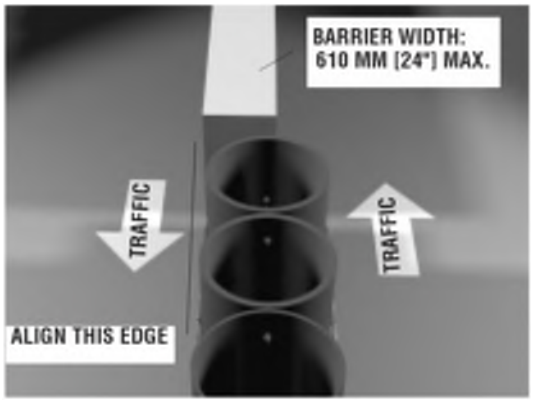


Figure 23
Offsetting the REACT 350® Narrow

Attach Nose Cover

1. Ensure the nose cover suits the site (see Figure 24 – Nose Cover Selection below). Refer to local standards and “Manual on Uniform Traffic Control Devices” (MUTCD) for nose.

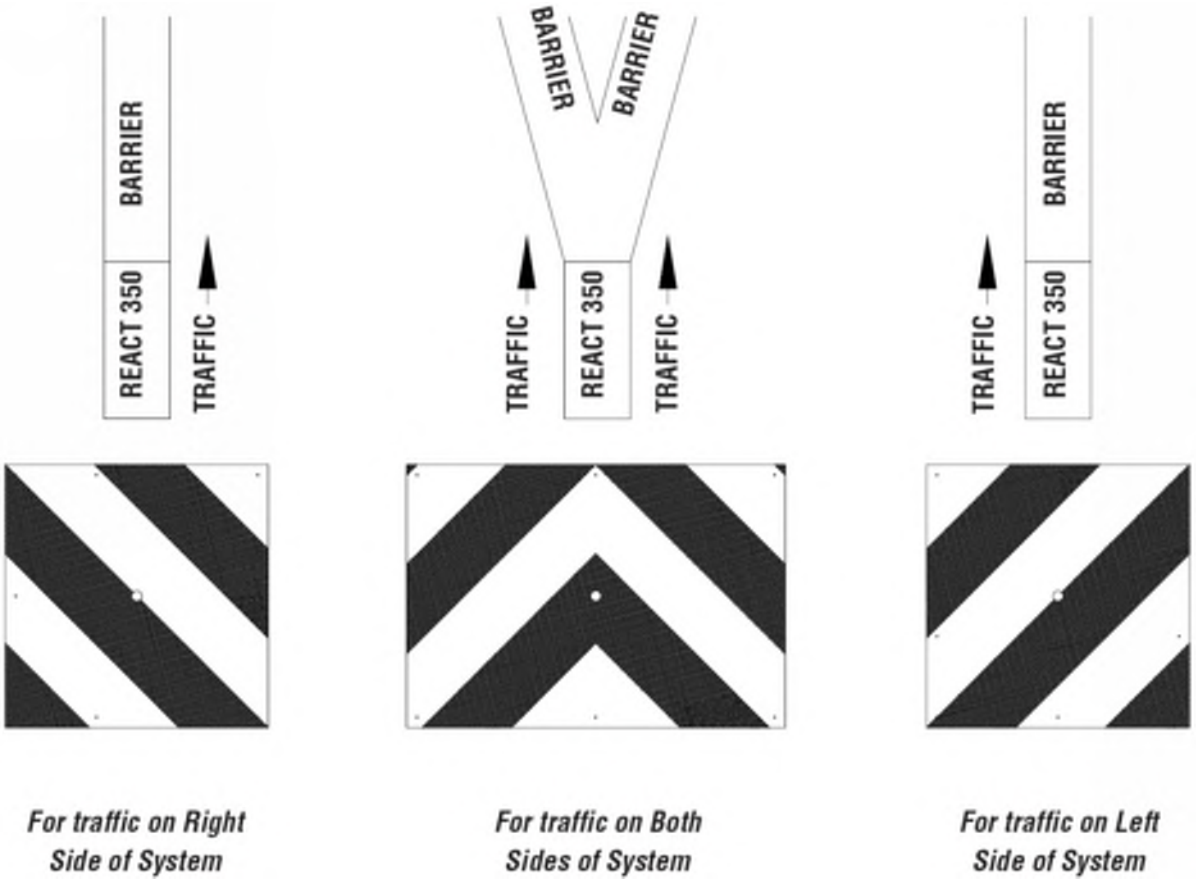


Figure 24
Nose Cover Selection

2. Align 1” diameter hole in nose cover with 1” diameter hole in Cylinder.
3. Screw 1/4" self-tapping screw into Cylinder punching through reflective tape and the existing holes in nose cover until head of fastener is flush for all 12 places (see Figure 25 on p. 24).

Attach Side Mount Reflectors

Refer to local standards and “Manual on Uniform Traffic Control Devices” (MUTCD) for Reflectors.

For Side Mount Reflectors, attach to traffic side(s) of the system with the white side facing traffic by screwing 1/4" self-tapping screws through the Reflector and into the Cylinder until head of fastener is flush for two places per Reflector (see Figure 26 on p. 24).

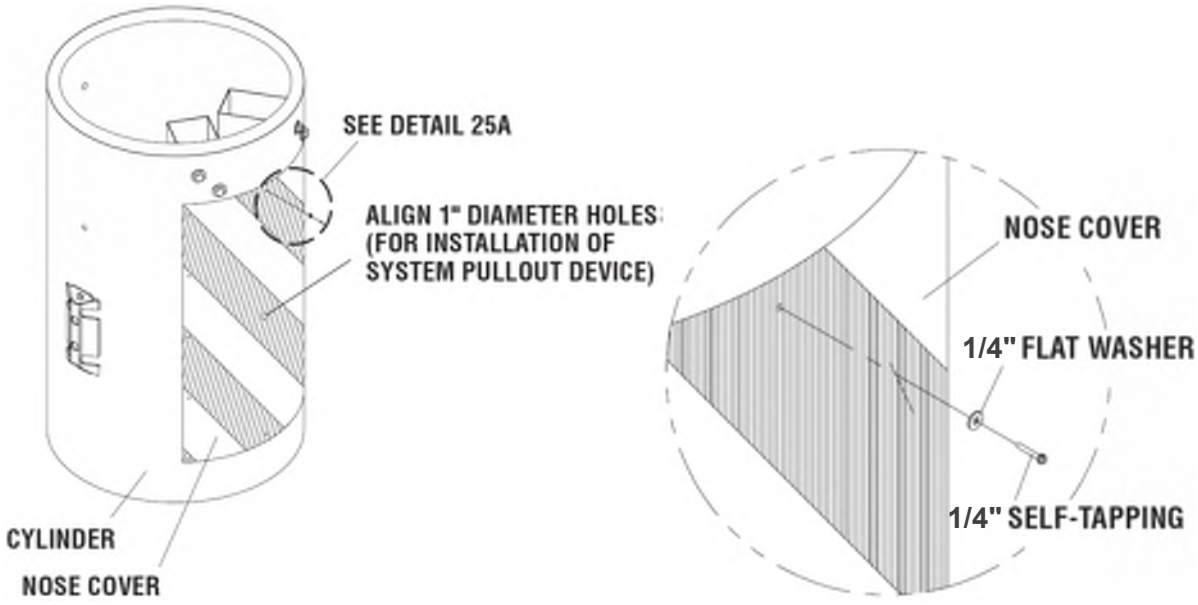


Figure 25
Nose Cover Assembly

detail 25A

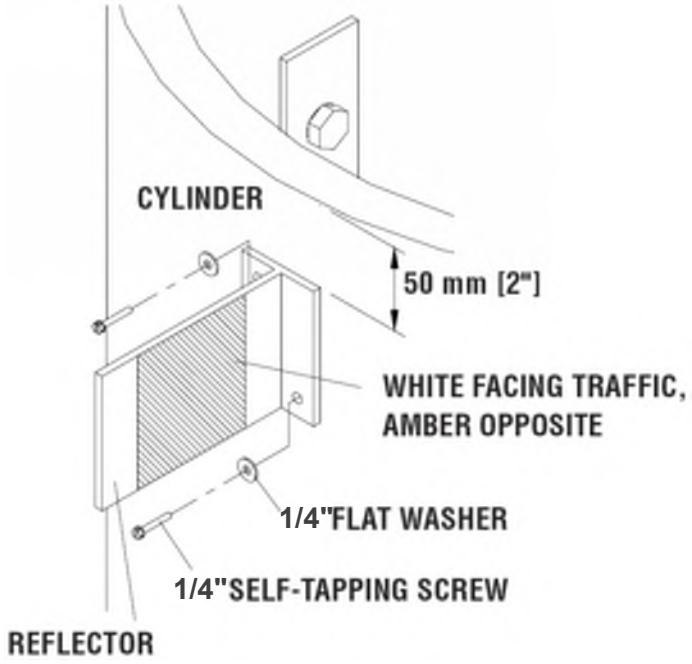


Figure 26
Side Mounted Reflector

Optional Debris Covers

To attach Optional Debris Covers, center a cover on Cylinder 1. Note the orientation of the grommets. The two grommets closest together should be located in the front or rear of the Cylinder (see Figure 27).

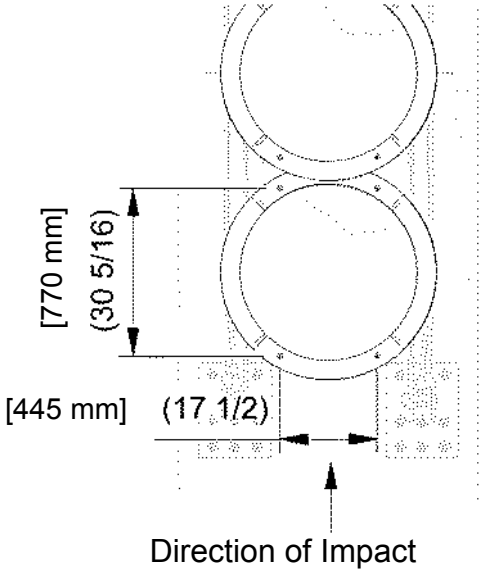


Figure 27

Next attach the four (4) #10 flat head self-tapping screws and fender washers, ensuring all screws are positioned in the middle of the Cylinder wall (see Figure 28).

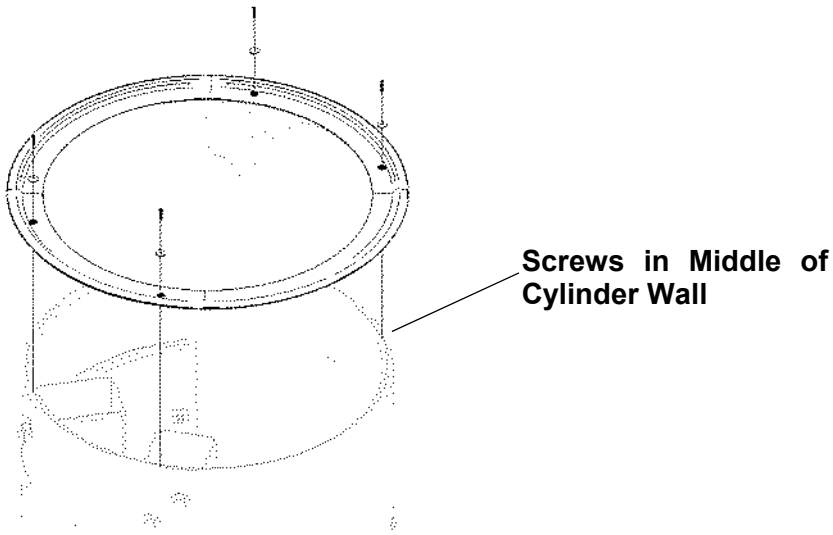


Figure 28

Continue to attach the remaining covers as described above.

Note: The covers may overlap; however, the overlap direction is not critical to system performance.

MP-3® Polyester Anchoring System

The MP-3® Polyester Anchoring System is a quick and easy way to securely anchor crash cushions and other common highway devices. MP-3® features high pull-out strength, superior vibration resistance and exceptional durability.

Each MP-3® kit contains a can of MP-3® resin, hardener, cold-weather promoter, studs, washers, nuts and a complete safety sheet. The cold-weather promoter shortens hardening time by as much as seven hours. Both vertical and horizontal assemblies are possible using the MP-3® system.

Vertical Assemblies

Warning: Do not allow the MP-3® resin or hardener to contact skin or eyes. See material safety data sheet available for the MP-3® kit for first-aid procedures. Use only in well-ventilated area. Do not use near open flame.

Warning: Wear safety goggles, apron, and gloves during application.

Note: Read MP-3® Instructions before starting.

1) Prepare the Concrete Pad

The anchor bolts (studs) that anchor the REACT 350® Narrow system Backup and/or base track sections to the Concrete Pad must be those shipped in the kit or of high strength steel with 830 MPa [120,000 psi] minimum tensile strength or equivalent. These studs must be set in minimum 28 MPa [4000 psi] concrete. Allow the concrete to cure a minimum of seven days before drilling the anchor holes or applying MP-3®.

2) Drill Holes

Note: Trinity Highway recommends using double-fluted drill bits to achieve optimum tensile strength when applying the MP-3® anchoring system.

Use the part that is to be anchored as a drilling template. Drill the holes 3 mm [1/8”] larger than the stud diameter to the recommended depth, using a rotary hammer drill. If a diamond drill bit is used, the surface will be too smooth for the MP-3® to adhere and full strength will not be achieved. Refer to the MP-3® assembly instructions provided with your kit. Check to be sure all the holes are drilled to the proper depth and aligned with the part to be anchored.

Table A

MP-3® Anchoring Information

Stud Size:	Concrete Bit Size	Minimum Depth	Recommended Torque
6 1/2"	22 mm [7/8”]	140 mm [5-1/2”]	165 N-m [120 ft-lb]
7-1/2” & 8-1/2”	22 mm [7/8”]	140 mm [5-1/2"]	165 N-m [120 ft-lb]
18"	22 mm [7/8”]	420 mm [16-1/2”]	15 N-m [10 ft-lb] ⚠

Important: When mounting on asphalt, initial torque shall be as shown in Table A. Due to the instability of asphalt, anchors may loosen over time. For this reason Trinity Highway recommends anchoring to asphalt only at temporary locations. It is recommended to re-torque anchors in asphalt every 6 months to the proper initial torque specified.

3) Clean the Holes

Blow the concrete dust from the hole using oil-free compressed air. Thoroughly brush it with a stiff-bristled brush and then blow it out again. If the hole is wet, completely flush it with water while brushing then blow it clean using oil-free compressed air.

4) Mix the Resin and Hardener

Wearing apron, gloves and safety goggles, remove the lids from the MP-3® Part A-resin and Part B-hardener containers. Pour Part B into Part A then mix vigorously for 30 seconds to form MP-3® grout (an anchor stud may serve as a stirring rod).

5) Add Cold-Weather Promoter (in Cold Weather)

For faster hardening in cold weather, promoter may be used. Add the entire contents of the partially filled promoter container to the MP-3® grout then mix for an additional 30 seconds. Use immediately because the MP-3® grout will thicken quickly. Refer to page 28 for hardening times.

Warning: Do not use promoter when the temperature is above 15 degrees Celsius (60 degrees Fahrenheit). Grout will harden too quickly. Use only in well-ventilated area. Do not use near open flame.

6) Pour Grout into Holes

Crimp the mouth of the can to form a sprout and pour the MP-3® grout mixture down into the hole through the part. Fill the hole to 1/3 - 1/2 full.

Caution: Do not overfill or under fill the hole. If the hole is overfilled, there will not be enough grout to use all of the anchor studs/kit. If hole is under filled the grout may not develop the required pull-out strength.

7) Add the Washers and Nuts

Place a flat washer and nut on the stud leaving nut flush with the end of the stud.

8) Insert Studs in Holes and Wait for Grout to Harden

Push the stud down through the part to be anchored and into the hole. Give the stud several twists in the MP-3® to wet the threads.

Caution: Do not disturb or load the stud until the MP-3® material has hardened (see Table B on p. 28).

9) Torque the Nuts

Once the grout has hardened, torque the nut per Table A on page 26.

Table B
Approximate Hardening Times in hours

Temperature		Hardening Times (hours)	
(C)	(F)	No Promoter	With Promoter
>26	>80	1/2	N/R*
22-26	70-79	1	N/R
16-21	60-69	2	N/R
10-15	50-59	4	3/4
4-9	40-49	8	1
-1-3	30-39	N/R	1 1/2
<-1	<30	N/R	N/R**

*Not recommended
**Contact Customer Service Department for more information

MP-3® Horizontal Assemblies

The horizontal MP-3® kit is the same as the vertical kit except that a cartridge for a standard caulking gun is supplied in the horizontal kits and the resin for the horizontal kits is a thixotropic (TX) resin. The TX-Resin is a gelled resin intended to keep the grout in place in horizontal holes during application.

When using the horizontal MP-3® kits follow the vertical instructions with the following exceptions:

1) Thread Dispensing Tip onto Dispenser

Prior to mixing the grout, carefully thread the dispensing tip onto the dispenser.

2) Pour Mixed Grout into Dispenser

Once the grout is mixed, crimp the mouth of the can to form a spout and pour the MP-3® grout into the open end of the dispenser (use mixing stud to scrape out the portion remaining in the can). You may use the box to hold the dispenser upright. Close the box lid and poke the dispenser tip into the top of it. Seal the dispenser with the plunger provided.

3) Place Dispenser in Caulking Gun and Dispense Grout

Cut the small end of the dispenser tip off. Place the dispenser into a caulking gun and dispense until MP-3® TX grout reaches the tip of the dispenser then release pressure. Push the dispenser tip through the part to the bottom of the hole and dispense while slowly withdrawing the tip.

Caution: Do not overfill or under fill the hole. Fill hole approximately 1/3 to 1/2 full. If the hole is overfilled, there will not be enough grout to use all of the anchor studs/kit. If hole is under filled, the grout may not develop the required pull-out strength.

4) Add the Washers and Nuts

Put washer and nut on stud, leaving nut flush with end of stud (see Figure 29).

5) Insert Studs into Holes

Push stud through part to be anchored and into hole. Twist the stud in the MP-3® grout to wet the threads.

Note: In horizontal applications the stud should be flush with the top of the nut (see Figure 29).

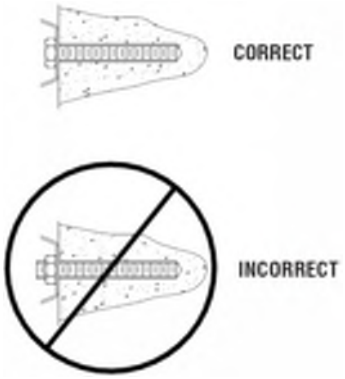


Figure 29
MP-3® Horizontal Application

Caution: Do not disturb or load the stud until the MP-3® material has hardened (see Table B on p. 28).

6) Torque the nuts

Once the grout has hardened, torque nuts per Table A on page 26.

MP-3® Assembly Cautions

1) Shelf life

If the shelf life of the MP-3® has expired (see MP-3® kit for expiration information), mix a small amount of MP-3® in the proportions of one part A to two parts B by volume. If the material does not set according to the instructions, replace with new MP-3® that is within shelf life.

Warning: Do not use the MP-3® if: the material fails to set up, Part A-Resin had gelled (for vertical applications), or TX-Resin is NOT gelled (for horizontal applications).

2) Steel rebar

If steel rebar is encountered while drilling an MP-3® anchor bolt hole, apply one of the following solutions:

A) Using a diamond core drill bit or rebar drilling tool, drill through the rebar only then switch back to the concrete bit and drill into the underlying concrete until the proper hole depth is reached.

Caution: Do not drill through rebar without first obtaining permission to do so from the local project engineer.

B) Drill a new hole down at an angle past the rebar to the proper depth. Anchor the stud by completely filling both holes with MP-3®.

Maintenance and Repair

The REACT 350® system, through crash testing, has been shown to be a potentially reusable crash cushion. After those impacts observed within NCHRP Report 350 criteria, it has been observed that, potentially, the bulk of the system can be reused. However, whether or not a system is reusable is the sole discretion of the highway authority specifying their use.

Warning: After an impact, always follow the "Post-Impact Instructions" on page 34.

Estimated Time for Maintenance

An experienced two-person crew with the proper tools and spare parts should be able to complete the work in one to three hours depending on the damage done to the system.

Life Expectancy

Environment

It is anticipated, given typical environmental conditions that the plastic cylinders will survive in a highway environment for a period ranging from 5 to 15 years from the date of deployment unless impact damage renders them otherwise. However, the life of a system in each specific application should be determined by the highway authority specifying their use and maintaining the system.

Impacts

Potential life expectancy of the system is also dependent on the impacts. This includes:

1. The number of impacts to the system
2. The severity of the impacts
3. The temperature at the time of the impacts

The REACT 350® system must be inspected after each impact. Depending on the impact, components may get damaged and need replacement. A cylinder requires replacement when the minor axis of the cylinder stays permanently at 460 mm [18"] or less (see Figure 30) or the system does not reach 90% of the original length. It is critical that all cables and anchoring be checked and returned to original assembly conditions. Any parts used in the repair of the system must be original Trinity Highway parts (see p. 3).

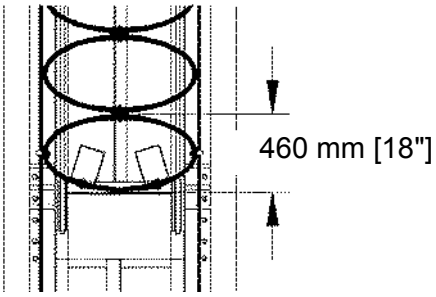


Figure 30 - Measure Minor Axis

Recycling Information

When parts need to be replaced, it is recommended that the old parts be recycled as follows:

Steel should be sold as scrap to a local metal recycler.

HDPE plastic cylinders should be sold to a plastic recycler if available. If a recycler is unavailable, dispose of the material as plastic refuse.

Parts Ordering Procedure

1. Locate the Product Decal attached to the inside of the Rear Cylinder. Copy the sales order information from the decal.
2. Make a list of any damaged parts, using part numbers and descriptions found on the reference drawings included with the REACT 350® system.
3. Only parts specified to be used in this system may be used during repair. The use of a part not specified in this system design renders this system as one that HAS NOT BEEN accepted by FHWA for use on the National Highway System and all observed crash testing to determine system performance is negated. The use of a part not contained herein during the repair renders the systems as something other than that which was tested and accepted by the FHWA for use on the national highway system.

Inspections

Inspections by the appropriate highway authority are recommended as determined by that authority based upon volume of traffic and impact history. Visual drive-by inspections are recommended at least once every three months. Walk-up inspections are recommended at least twice a year.

Warning: After an impact, always follow the “Post-Impact Instructions” on page 34.

Visual Drive-By Inspection

1. Check to see if there is evidence of an impact. Check to verify that the REACT 350® system is fully extended from the backup. If it is not, a walk-up inspection will be necessary to determine the cause.
2. Note the location and condition of the REACT 350® system and the date of visual drive-by inspection on a log sheet.

Warning: Debris, snow, or ice inside the cylinders may prevent the REACT 350® system from absorbing the impact of a crash as observed in NCHRP Report 350 compliant crash testing. Perform a walk-up inspection as needed to check for and dispose of any debris inside the Cylinders. Failing to remove this debris or other material infringes upon the performance of the system observed in FHWA accepted crash testing.

Walk-Up Inspection

1. Check for any foreign matter that may interfere with the smooth operation of the REACT 350® system. Check for and remove any debris found inside the Cylinders. Check for and remove any debris found under and around the REACT 350® system.
2. Check for evidence of bent or damaged parts. Replace as soon as possible (see “Parts Ordering Procedure” on page 32).
3. Verify that all nuts and bolts are tight and rust free.
4. Be sure MP-3® Concrete Anchor Bolts are securely anchored.
5. Verify that all Cylinders are in good condition and properly positioned on the Base Track. Any Cylinder that is cracked or otherwise damaged should be replaced. Measure the minor axis of the Cylinders. Cylinders require replacement when the minor axis of the cylinders measures 460 mm [18”] or less (see Figure 30 on page 31).
6. Ensure all cables are attached with parts specified for use in this system.
7. Note the location and condition of the REACT 350® system and any work done for the date of this inspection. If further repair is necessary, note the repair requested. Refer to the standard drawing and assembly section of this Manual for more information.

Warning: The correct safety equipment and approved traffic management must be used as required for walk-up inspections of the REACT 350® system.

Post-Impact Instructions

1. Deploy the appropriate **traffic control** devices to protect your crew.

Warning: The correct safety equipment and approved traffic management must be used as required for walk-up inspections of the REACT 350® system.

2. Check to see that all anchor bolts have remained firmly anchored in the roadway surface and in the Concrete Backup, if applicable. Replace any anchors that are loose, broken, or pulled out.

   If the system is anchored to asphalt, up to 10% of the total anchors may be replaced if damaged. If more than 10% of the anchors are damaged, the system should be relocated to fresh, undisturbed asphalt and redeployed using the 460 mm [18”] threaded rods.

3. Clear and dispose of any debris inside the cylinders and on the site.
4. Check the condition of the Cylinders. Any Cylinder that is cracked or otherwise damaged should be replaced. Measure the minor axis of the Cylinders. Cylinders require replacement when the minor axis of the Cylinders measures 460 mm [18”] or less (see Figure 30 on p. 31).
5. The REACT 350® system must be pulled out to its original length after each impact. The Pullout Assembly must be attached prior to this procedure and removed and stored when finished (see Figure 31).

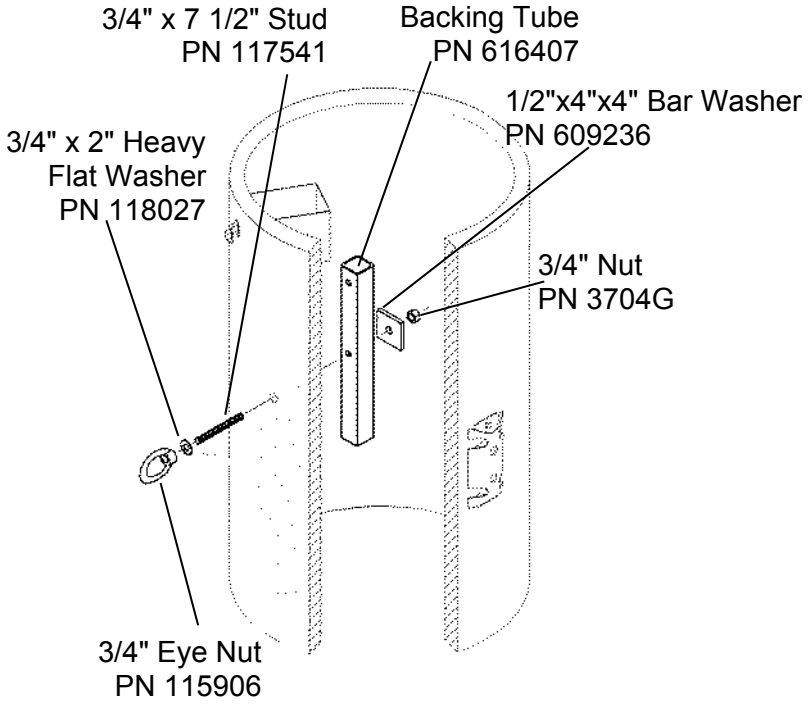


Figure 31 - Pullout Assembly

Drawing Request Form (Please copy this form)

Created by_____ Date Submitted_____

Company_____ Drawings Required by _____

Site Location / Title _____

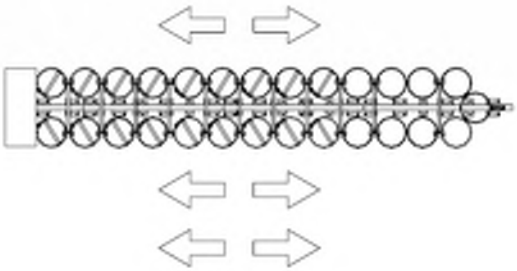
City/County_____ State/Country_____

Location of hazard:

___ Median ___Gore ___Roadside ___Toll ___Other

Temporary/Construction Zone or Permanent

Direction of traffic (circle all appropriate arrows)



Object being protected: (sketch hazard and dimension)

___Concrete Barrier (show barrier with dimensions)

___New Jersey Barrier, ___F Shape Barrier,

___Single Slope Barrier, ___Other

___Guardrail (show cross section with dimensions)

___Thrie-Beam, ___W-Beam, ___Other

Design Speed of Roadway _____ (mph or km/h)

Foundation ____Grade, ____Deck structure, ____Continuous concrete pavement

Does expansion joint pass through System location? ___ No, ___Yes. If yes, attach a drawing of site showing the exact location of the joint. What is the maximum movement in the joint? _____ Show the direction of movement.

Does curbing exist? _____ No, _____Yes If yes, what is the curb height?

Is cross slope greater than 8%? _____No, ____Yes If yes, what is the slope?

Provide photos and/or sketches of the site. Be sure to give dimensions for obstacles.

(Use the back of this sheet or attach an additional sheet with sketches of the site.)

Number of impacts expected per year? _____

Drawings requested

_____ Quantity _____ Drawing Size (11x17 unless specified)

_____ Set _____Cover Sheet Only _____ Cover sheet and Concrete Work

Order Form (Please copy this form)

Bill To: _____

_____

_____

Ship To: _____

_____

_____

Date: _____ Order No. _____

Job No. _____

Job Name: _____

Project No. _____

Section No. _____

IMPORTANT: Use one sheet per System unless the Systems are identical.

Special instructions _____

_____

Transitions

_____

_____

_____

Reflective Nose Cover (Specify one)

____ Right ____ Gore ____ Left ____ Special



Notes:

Notes:

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For more complete information on Trinity Highway products and services, visit us on the web at www.trinityhighway.com. Materials and specifications are subject to change without notice. Please contact Trinity Highway to confirm that you are referring to the most current instructions.