

QuadGuard® II

Assembly Manual



TRINITY
HIGHWAY

Ahead of the Curve®

QuadGuard® II

The QuadGuard® II has been tested pursuant to National Cooperative Highway Research Program (“NCHRP”) Report 350 specifications. The QuadGuard® II has been deemed eligible for federal-aid reimbursement on the National Highway System by the Federal Highway Administration (“FHWA”).

Assembly Manual



2525 N. Stemmons Freeway
Dallas, Texas 75207



Warning: The local highway authority, distributors, owners, contractors, lessors, and lessees are **RESPONSIBLE** for the assembly, maintenance, and repair of the QuadGuard® II. Failure to fulfill these **RESPONSIBILITIES** with respect to the assembly, maintenance, and repair of the QuadGuard® II system could result in serious injury or death.



Important: These instructions are for standard assembly specified by the appropriate highway authority. In the event the specified system assembly, maintenance, or repair would require a deviation from standard assembly parameters, contact a Trinity Highway representative. This system has been deemed eligible by the FHWA for use on the national highway system under strict criteria utilized by that agency.

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

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Customer Service Contacts

Trinity Highway is committed to the highest level of customer service. Feedback regarding the QuadGuard® II, 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) +1 214 589-8140 (International)
E-mail:	product.info@trin.net
Website:	trinityhighway.com

Important Introductory Notes

The performance of the QuadGuard® II as designed, and approved for reimbursement by the FHWA pursuant to its NCHRP Report 350 standard, is dependent upon the proper assembly, deployment and future maintenance of the system. These instructions must be read in their entirety and understood before assembling the QuadGuard® II. These instructions are to be used in conjunction with the assembly of QuadGuard® II 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, please contact the highway authority that has planned and specified this assembly and, if needed, contact Trinity Highway Customer Service. 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 specified herein for the QuadGuard® II during the assembly or repair (pp. 7 – 11 / 63 - 64).

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 herein. 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.

Safety Symbols

This section describes the safety symbols that appear in this 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.



Warning: Read safety instructions thoroughly and follow the assembly directions and suggested safe practices before assembling, maintaining, or repairing the QuadGuard® II. It is the responsibility of the installer to follow these warnings. 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.



Important: Please keep up-to-date instructions for later use and reference by anyone involved in the assembly of the product.

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. 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 trinityhighway.com. Please contact Trinity Highway if you have any questions concerning the information in this manual or about the QuadGuard® II.

It is the responsibility of the installer to 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, eye protection, safety-toe shoes, and back support should be used.



Warning: It is the responsibility of the installer to use all safety measures incorporating appropriate traffic control devices specified by the highway authority. These measures must be used to protect all personnel while at the assembly, maintenance, or repair site.



Warning: 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 FHWA.



Warning: Use only Trinity Highway parts on the QuadGuard® II for assembly, maintenance, or repair. The use of component parts not specified herein is **strictly prohibited**. The QuadGuard® II assembled with Trinity Highway parts has been tested, approved, and accepted for state use by the FHWA. A QuadGuard® II using parts other than those specified herein has not been tested, approved, or accepted for state use by the FHWA. Failure to follow this warning could result in increased risk of serious injury or death in the event of a vehicle impact.

Limitations and Warnings

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

The QuadGuard® II 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. 1800 lb. [820 kg]) to full size pickup trucks (approx. 4400 lb. [2000 kg]). 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: 43 mph [70 km/h]

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

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 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.



Warning: Do not assemble, maintain, or repair the QuadGuard® II 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: Ensure that all of the QuadGuard® II 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.

System Overview

The QuadGuard® II is a re-directive, non-gating crash cushion for roadside obstacles ranging in width from 24" to 126" (610 mm to 3200 mm). It consists of energy-absorbing cartridges surrounded by a framework of Quad-Beam Panels.



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.

The QuadGuard® II 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.

Impact Performance

The 5 Bay QuadGuard® II has 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 62 mph [100 km/h] at angles up to 20 degrees.

During head-on impact testing, within NCHRP Report 350 criteria, the QuadGuard® II 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.



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



Warning: It is the responsibility of the project engineer and / or local highway authority and its engineer to ensure that the QuadGuard® II and delineation used meet all federal, state, specifying agency, and local specifications.



Warning: It is the responsibility of the project engineer and / or local highway authority and its engineer to ensure delineation on the assembly meets all appropriate Manual on Uniform Traffic Control Devices ("MUTCD") and local standards.

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.

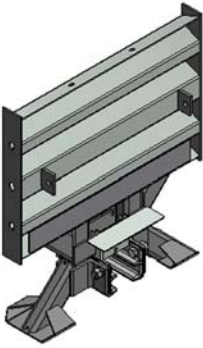
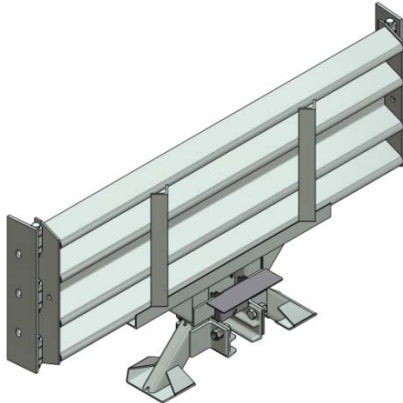
System Components

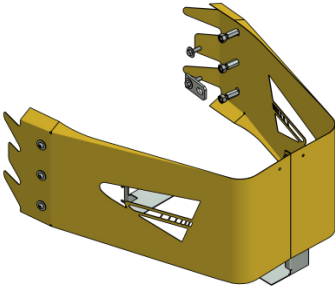
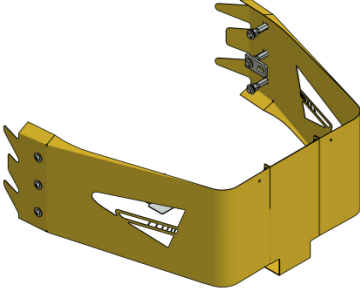
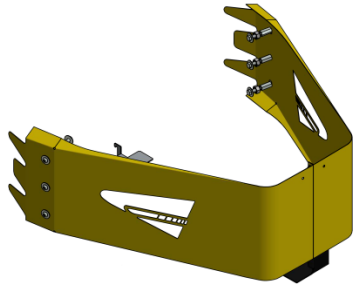
Below is a list of system components to be used in the repair of your particular QuadGuard® II configuration. Please call Trinity Highway customer support if you have any system questions (p. 3).



Warning: Use only Trinity Highway parts that are specified herein for the QuadGuard® II for assembling, maintaining, or repairing the QuadGuard® II. **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.

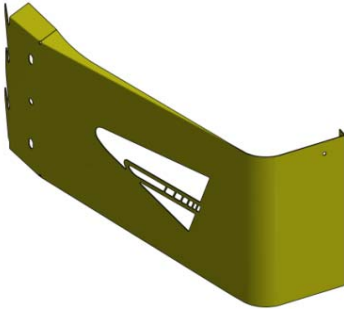
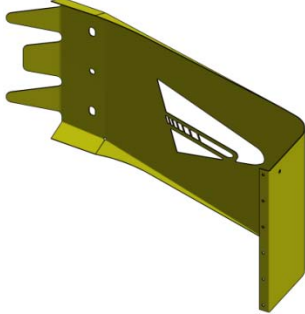
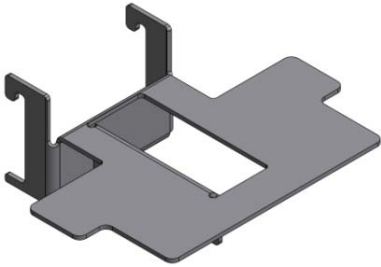
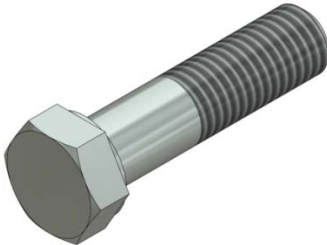
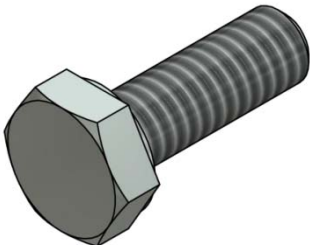
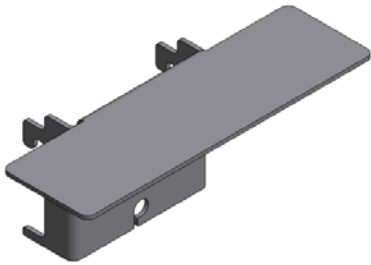
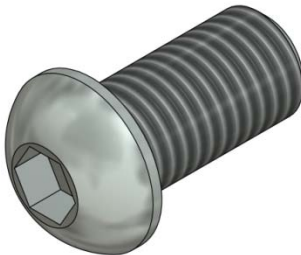
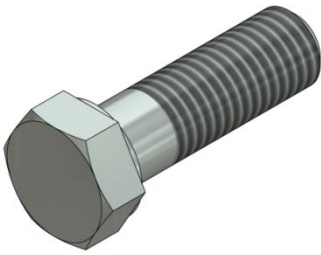
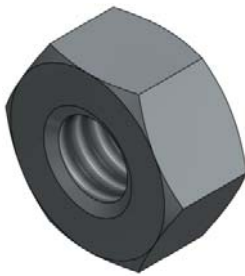
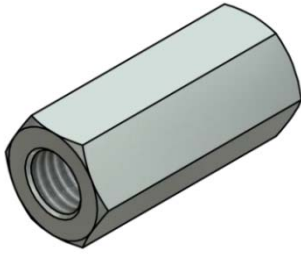


Narrow Diaphragm Assemblies *	Wide Diaphragm Assemblies *		
 625650 - 24" 625651 - 30" 625652 - 36" 606810 - 48"	 607173 - 26.48" 607174 - 29.65" 607175 - 32.78" 607176 - 35.93" 607177 - 39.08" 607145 - 42.23" 607146 - 45.38"	 607148 - 48.53" 607149 - 50.11" 607150 - 51.68" 607151 - 54.83" 607152 - 57.98" 607156 - 59.56"	 607157 - 61.13" 607158 - 64.28" 607159 - 68.06" 607160 - 70.58" 607162 - 73.73" 607163 - 76.88" 607164 - 80.04"

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

* Assemblies include multiple parts.

<p>Mushroom Washer</p> 	<p>Flat Screw 5/8X8 1/2" Wide</p> 	<p>Die Spring, 6", Wide</p> 
<p>617045</p>	<p>116879</p>	<p>117458</p>
<p>Flat Screw 5/8X5", G8, Narrow</p> 	<p>Die Spring, 1 1/2", Narrow</p> 	<p>Rail Nut, Hex, 5/8"</p> 
<p>116878</p>	<p>117459</p>	<p>003340</p>
<p>Rail Bolt, 5/8X2"</p> 	<p>Panel, Fender Assembly, QG</p> 	<p>Washer, Flat, 5/8" X 1 3/4"</p> 
<p>003400</p>	<p>608236</p>	<p>003300</p>
<p>Nose, L, Wide, W/Logo</p> 	<p>Nose, R, Wide, W/Logo</p> 	<p>Bracket, Cart Support, Nose</p> 
<p>611672</p>	<p>611683</p>	<p>605430</p>

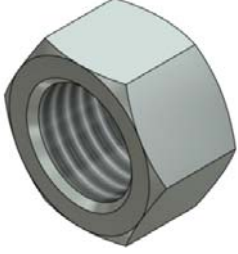

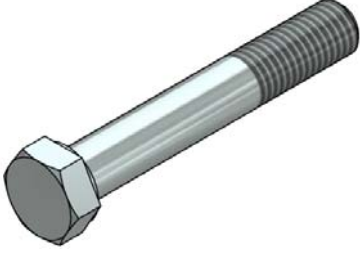


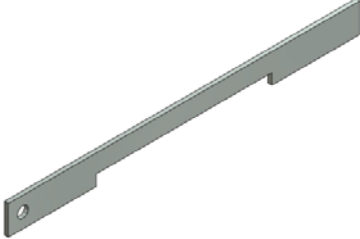
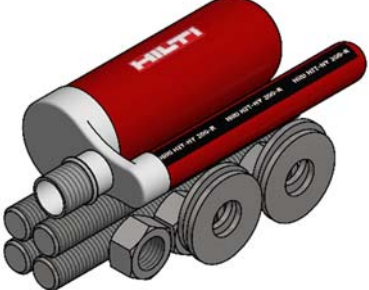

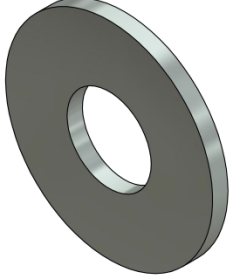
* Parts in red are included in assemblies.

<p>Nose, L, Narrow, W/Logo</p> 	<p>Nose, R, Narrow, W/Logo</p> 	<p>Bracket, Cart, Nose</p> 
<p>611669</p>	<p>611680</p>	<p>605420</p>
<p>Bolt, Hex, 5/8" X 2 1/2", G5</p> 	<p>Bolt, Hex, 1/4" X 3/4", G5</p> 	<p>Bracket, Cartridge Support</p> 
<p>118232</p>	<p>113518</p>	<p>605446</p>
<p>Bolt, Bt, 5/8" X 1 1/4", Hex Socket</p> 	<p>Bolt, Hex, 5/8" X 2", G5</p> 	<p>Nut, Hex, 1/4"</p> 
<p>113404</p>	<p>118570</p>	<p>115946</p>
<p>Nut, Hex, Coupling, 5/8" 11" X 2 1/8"</p> 	<p>Washer, Lock, 1/4"</p> 	<p>Washer, Lock, 5/8"</p> 
<p>115986</p>	<p>118085</p>	<p>118100</p>



* Parts in red are included in assemblies.

<p>Bracket, Angle, 2" X 1", W/Holes</p>  <p>617387</p>	<p>Washer, Flat 3/8" X 1"</p>  <p>118036</p>	<p>Nut, Hex, 3/8"</p>  <p>115960</p>
<p>Bolt, Hex, 3/8" X 1", G5</p>  <p>113596</p>	<p>Washer, Fender, 3/8" X 2"</p>  <p>118038</p>	<p>Bolt, Hex, 5/8" X 1 1/2", G5</p>  <p>113654</p>
<p>Bracket, Pull-Out</p>  <p>605535</p>	<p>Shim Kit, 1/8" X 3 5/8" X 8"(2)</p>  <p>614050</p>	<p>Washer, Lock, 3/4"</p>  <p>118089</p>
<p>Bolt, Hex, 3/4" X 2", G8</p>  <p>113555</p>	<p>Monorail Guide</p>  <p>611368</p>	<p>Nut, Heavy Hex, 3/4"</p>  <p>003704</p>

* Parts in red are included in assemblies.

<p>Nut, Heavy Hex, 5/8"</p> 	<p>Hinge Plate, Fender Panel</p> 	<p>Bolt, Hex, 5/8" X 4", G5</p> 
<p>003354</p>	<p>610172</p>	<p>113666</p>
<p>Panel, Side, QG</p> 	<p>Bracket, Cartridge Support TS B/U</p> 	<p>Locking Bar, Cartridge Support</p> 
<p>611898</p>	<p>605447</p>	<p>611266</p>
<p>Anchor Kit, Hilti, 3/4" X 7" (4) *</p> 	<p>Stud, 3/4" X 7", G5</p> 	<p>Washer, Flat, 3/4" X 2"</p> 
<p>619316</p>	<p>117542</p>	<p>118027</p>

*See Trinity Highway Approved Adhesive Anchoring System section on page 16.

<p>Cartridge Assy, Type I</p> 	<p>Cartridge Assy, Type II</p> 
<p>606027</p>	<p>606029</p>

* Parts in red are included in assemblies.

Foundation/Anchoring



Important: It is the responsibility of the local DOT or appropriate authority to ensure this assembly conforms to the AASHTO Roadside Design Guide.



Warning: It is the responsibility of the installer to ensure that your assembly procedure meets all appropriate Occupational Safety and Health Administration (OSHA) and local standards.

Asphalt Installations

QuadGuard® II Narrow systems with a Tension-Strut Backup may be temporarily installed in construction zones on asphalt. Assemblies on Asphalt Concrete (“**A.C.**”) must provide a minimum of 3” [76 mm] layer of asphalt over a minimum of 3” [76 mm] layer of **Portland Cement Concrete** (“**P.C.C.**”), 6” [152 mm] layer of asphalt over 6” [152 mm] layer of subbase, or 8” [203 mm] layer of asphalt with no subbase.



Important: Only 18” [460 mm] threaded rods, utilizing Trinity Highway approved adhesive, can be used with asphalt foundations. Contact Customer Service for a complete list of approved adhesives (p. 3).

Concrete Installations

For concrete installations, the QuadGuard® II should be installed only on an existing or freshly placed and cured concrete base (4000 psi [28 MPa] 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.

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

Foundation A: Concrete Pad or Roadway

Foundation: 6” [150 mm] minimum depth P.C.C.

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

Foundation B: Asphalt over P.C.C.

Foundation: 3” [76 mm] minimum A.C. over 3” [76 mm] minimum P.C.C.

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

Foundation C: Asphalt over Compacted Subbase (“C.S.”)

Foundation: 6” [150 mm] minimum A.C. over 6” [150 mm] minimum **C.S.**

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

Foundation D: Asphalt Only

Foundation: 8” [200 mm] minimum A.C.

Anchorage: Approved adhesive with 18” [460 mm] studs - 16 1/2” [420 mm] 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 six months. See Post Impact Instructions and Maintenance and Repair instructions on page 58.

Recommended Tools

Documentation

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

Personal Protective Equipment

- Eye Protection
- Gloves
- Safety Toe Shoes

Cutting Equipment

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



Important: Trinity Highway recommends using double-fluted drill bits to achieve optimum tensile strength when applying an approved adhesive to the anchoring system (p. 16).

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: 12" [300 mm]
- Allen Wrench: 3/8"



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 12" [300 mm]
- Center Punch
- Tape Measure 25' [7.5 m]
- Chalk Line
- Concrete Marking Pencil
- 7/8" Diameter steel tube brush for cleaning drilled boreholes
- Rags, water, and solvent for clean 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 entirely the responsibility of the specifying highway authority and the authority's selected contractor performing the assembly of the system at the authority's specified assembly site.

Site Preparation/Foundation

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 8" [200 mm] 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: It is the responsibility of the appropriate highway authority to select the location for the QuadGuard® II in accordance with the AASHTO Roadside Design Guide. Trinity Highway is not responsible for choosing the location for system placement.



Warning: Ensure proper site grading for QuadGuard® II placement as directed by the state or specifying agency pursuant to the AASHTO Roadside Design Guide.



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

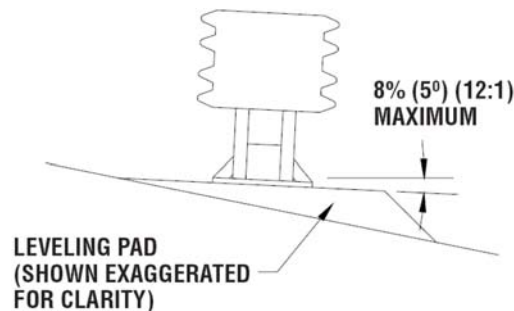


Figure 1
Cross-Slope



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 30" [760 mm] from their pre-impact location. Position the Backup so that the rear ends of the last Fender Panels are a minimum of 30" [760 mm] 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.



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

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 and washers. 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 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 gloves and eye protection during application.

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

2) Drill Boreholes



Caution: It is the responsibility of the installer to consult OSHA silica respiratory standard 29 CFR 1910.134 for debris removal from borehole(s) and use Trinity Highway approved adhesive to achieve optimum tensile strength. Do not use diamond drill bits for drilling boreholes.

Use the Monorail(s) and Tension Strut Backup as drilling templates. Use a rotary hammer drill to drill the boreholes 7/8" [22 mm] diameter to the recommended depth. See the approved adhesive instructions provided with your kit. Check to ensure each borehole is drilled to the proper depth and aligned with the part to be anchored per chart below.

Anchoring Information					
Stud Size:	Orientation	Bit Size	Minimum Depth	Torque	Medium
3/4"x 6 1/2"	Horizontal	7/8" [22 mm]	5 1/4" [133 mm]	Manufacturer Spec	Concrete
3/4"x 7"	Vertical	7/8" [22 mm]	5 3/4" [145 mm]	Manufacturer Spec	Concrete
3/4"x 18"	Vertical	7/8" [22 mm]	16 3/4" [425 mm]	10 ft-lb [15 N-m]	Asphalt



Important: When mounting on asphalt, initial torque shall be as shown above. Due to the properties 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 six (6) months to the proper initial torque specified.

3) Clean the Boreholes

Blow the concrete dust from the borehole using oil-free compressed air. Thoroughly brush it 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 and then blow it clean to remove all water using oil-free compressed air.

Note: Use of the Trinity Highway approved vacuum drilling equipment is authorized to replace the blowing and brushing requirement of Step 3.

4) Apply Approved Adhesive

Fill the borehole 100% full.



Caution: Fill borehole 100% full so it is even with the pavement surface per manufacturer's instructions.

5) Add Nuts to Anchor Studs

Place a flat washer onto the stud then thread a nut on until the end of the stud is flush with the nut (Figure 2).

6) Insert Studs in Boreholes and Wait for Adhesive to Cure

Push the stud down through the part to be anchored and into the borehole.



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

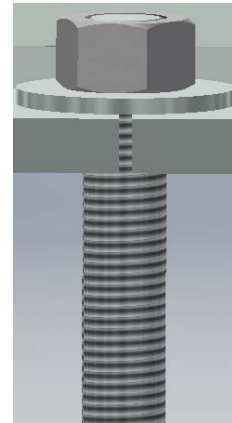


Figure 2
Vertical Application
(Before Applied Torque)

7) Torque the Nuts

Once the adhesive has fully cured, torque the nut to the adhesive manufacturer's recommended values.

Anchor Assembly Cautions

1) Steel rebar

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

A) Use a rebar drill bit for the **rebar only** and then switch back to the concrete bit to finish drilling into the underlying concrete until the proper borehole depth is reached.



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

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: Fill borehole 100% full so it is even with the surface of the hole per manufacturer's instructions.

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 so the **nut is flush with end of stud**.

3) Insert each Stud with Washer and Nut into Borehole

Push stud with washer and nut into borehole.



Important: The stud should be flush with the top of the nut in both **vertical** and **horizontal** applications prior to tightening (Figure 3).

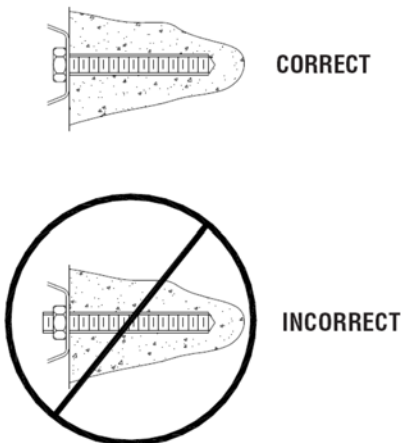


Figure 3
Horizontal Application
(Before Applied Torque)



Warning: Do not disturb or load the stud until the approved adhesive material has hardened (**see approved adhesive kit instructions for cure times and torque values**).

4) Torque the nuts

Once the adhesive has fully cured, torque nut(s) to the approved adhesive manufacturing specification.

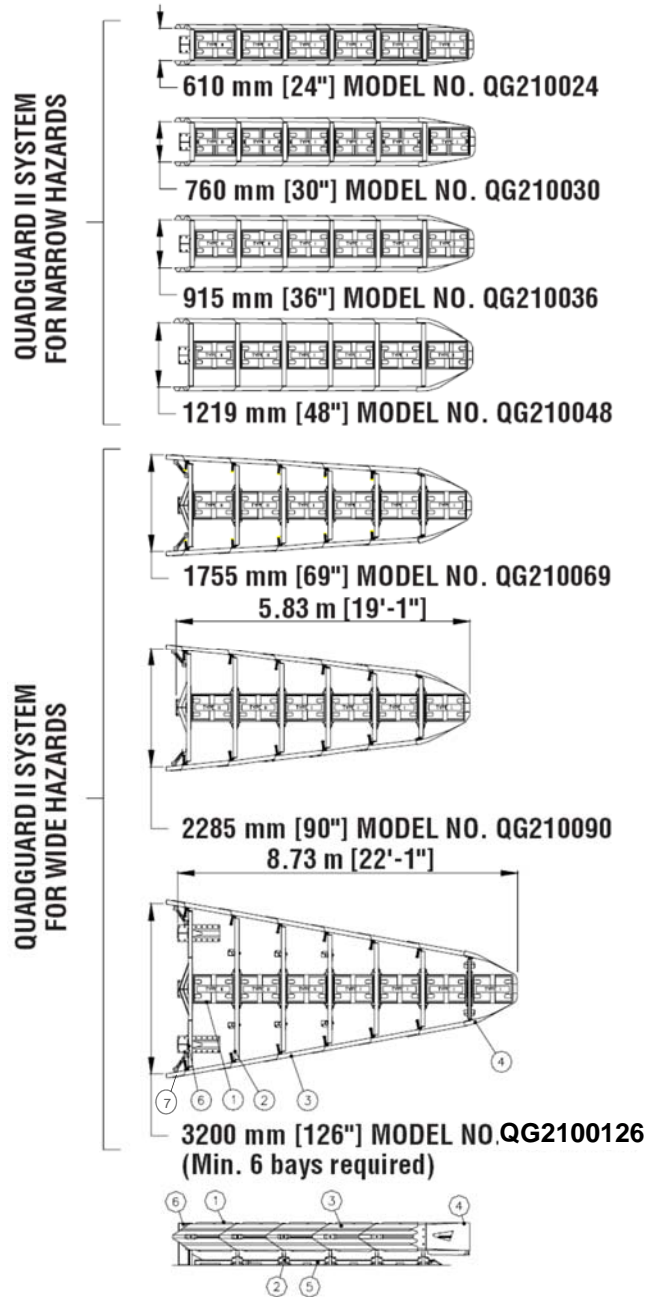


Figure 4 Plans & Elevation
 (Five Bay systems with Tension Strut Backups shown, except as noted)

Key

- 1) Cartridge
- 2) Diaphragm
- 3) Quad-Beam Fender Panel
- 4) Nose
- 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 (pp. 63 & 64).

Note: 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 (Figure 5). The Three Bay system is shown below.

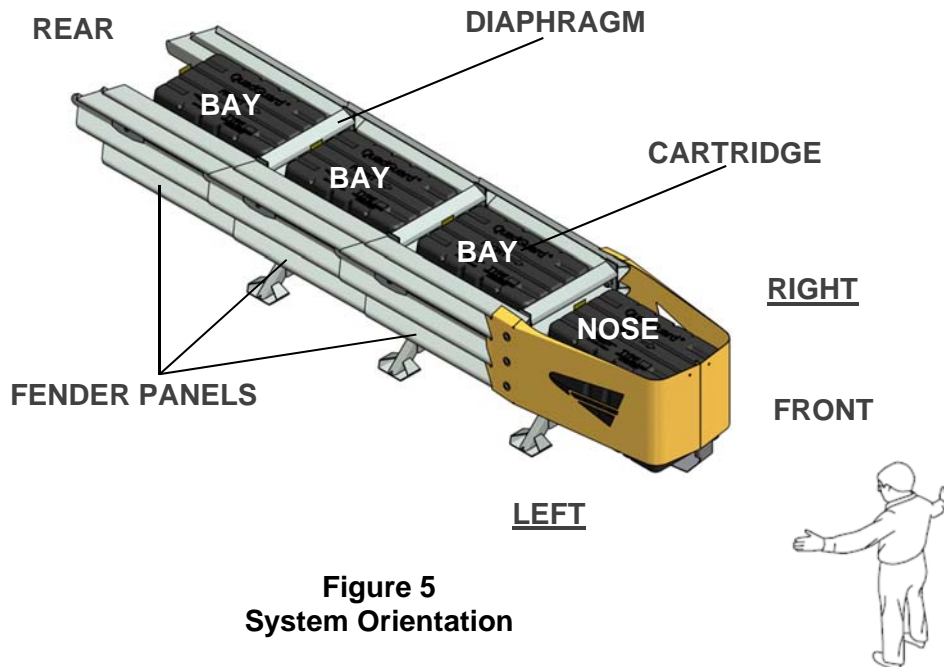


Figure 5
System Orientation

Measuring the Width

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

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

The nominal width of a **Narrow (parallel)** system is the width of the Backup diaphragm (Figure 6).

The nominal width of a **Wide (flared)** system is the width at the location shown in Figure 7.

The outside or overall width of the system is approximately 6" [150 mm] to 9" [230 mm] wider than the nominal width.

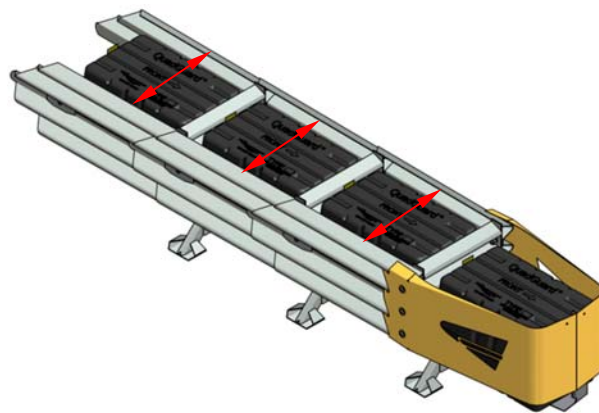


Figure 6
Narrow (Parallel) System

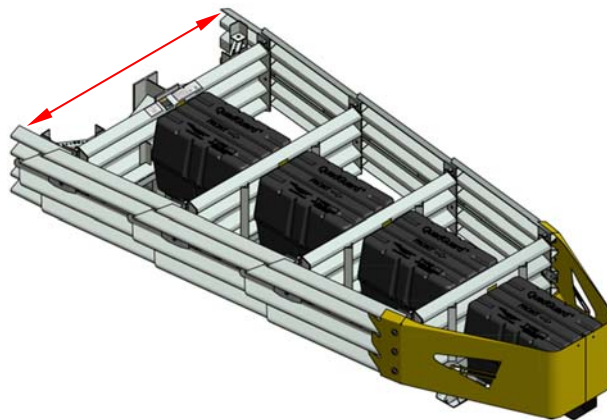


Figure 7
Wide (Flared) System

Narrow (Parallel) Systems

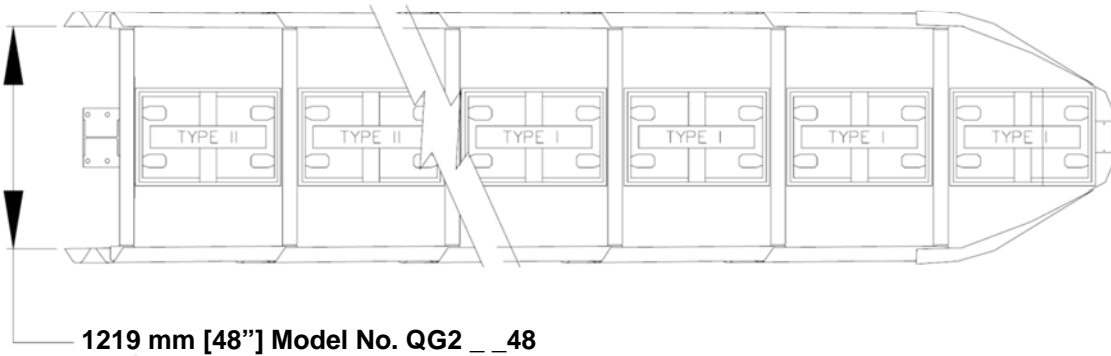
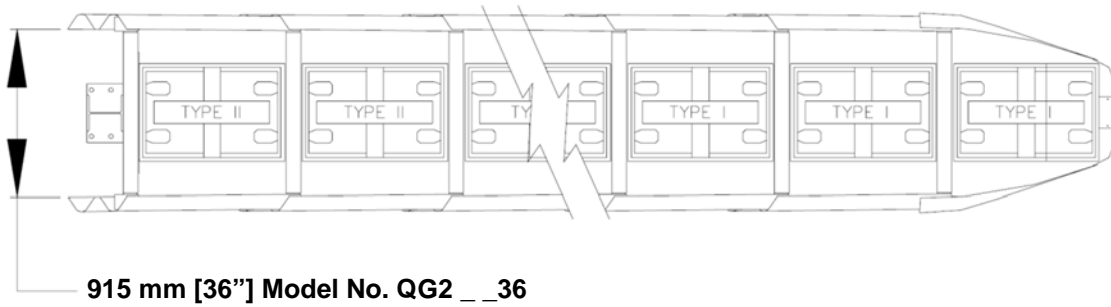
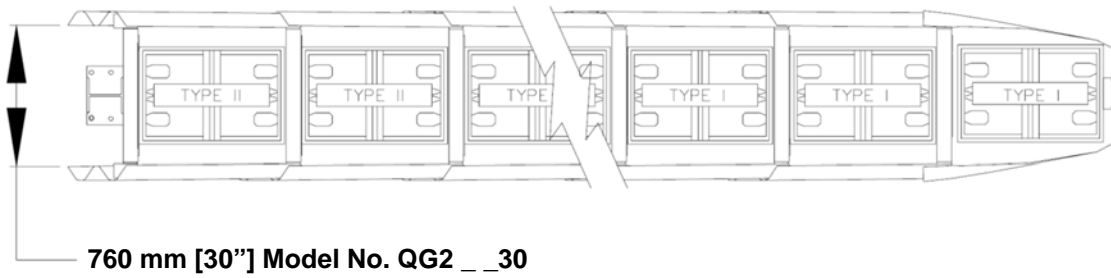
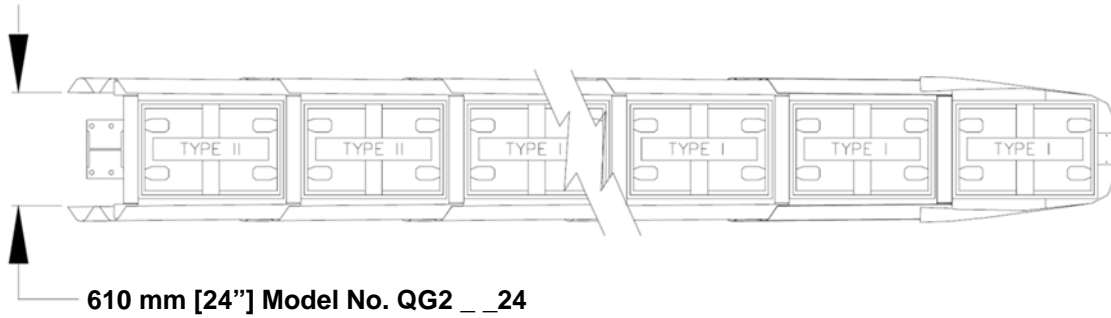


Figure 8
Narrow System(s) and Model Numbers

Assemble Narrow (Parallel)

Determine Backup and Transition Type

The QuadGuard® II is available with a Tension Strut Backup or a Concrete Backup. Refer to Figures 9 and 10, 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 11 - 16 and the Manufacturer's Drawing Package to determine which type of Panels to attach.

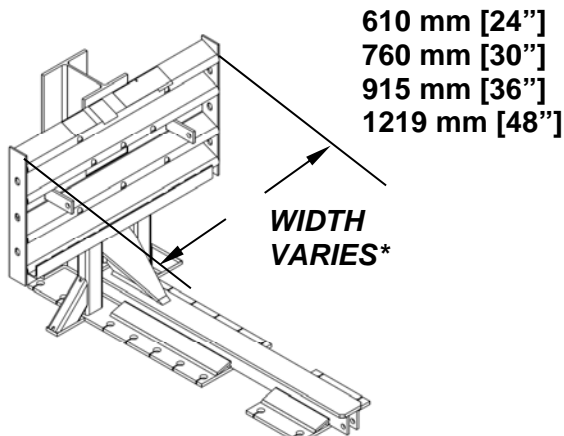


Figure 9
Tension Strut Backup

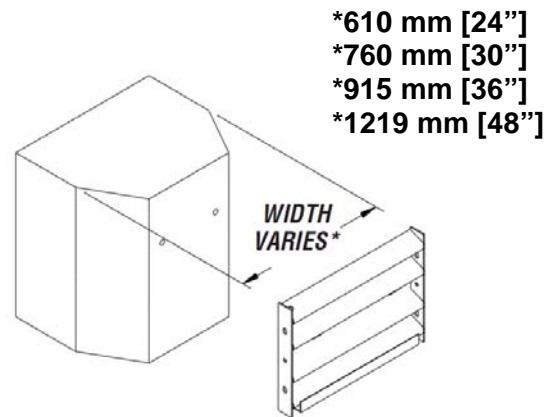


Figure 10
Concrete Backup

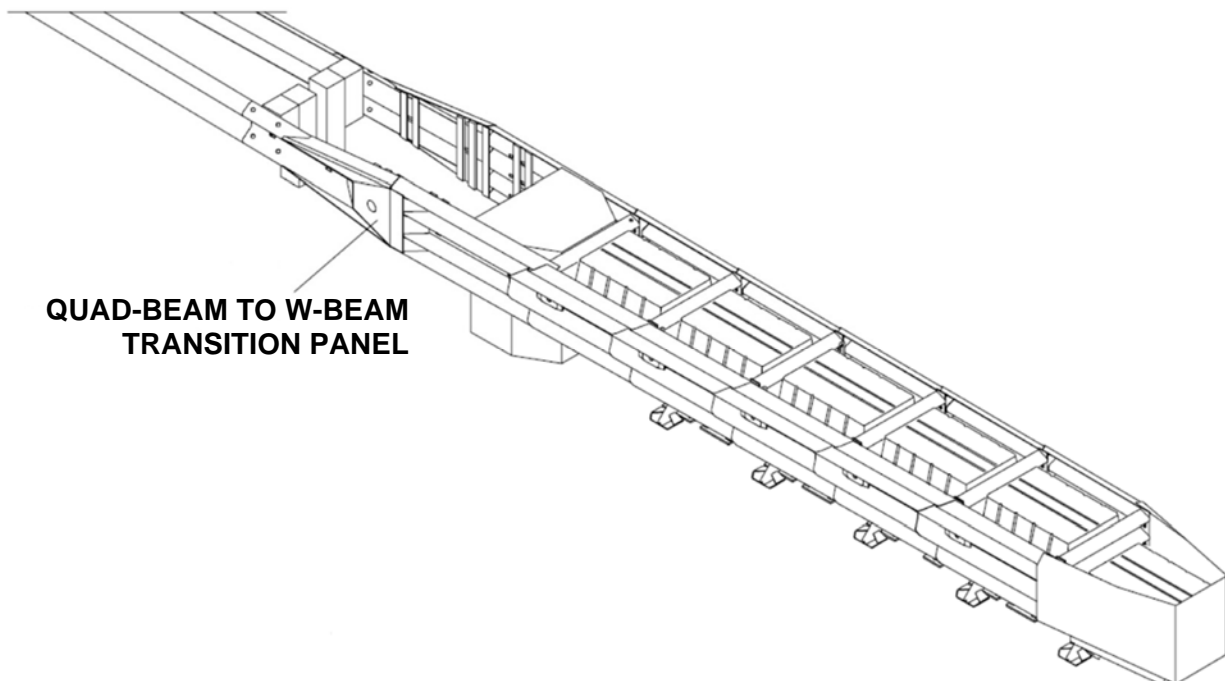


Figure 11
Transitioning the QuadGuard® II

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 is shielding. Contact Customer Service prior to deployment if you have any questions (p. 3).

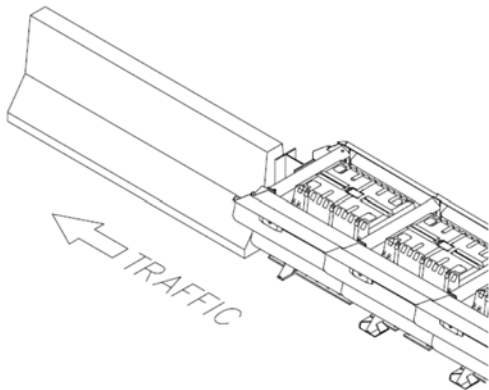


Figure 12
No Transition

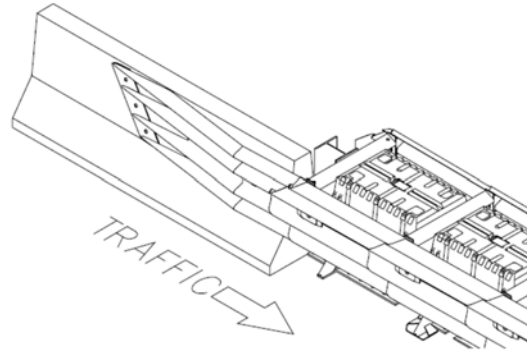


Figure 13
Quad-Beam to Safety Shape Barrier

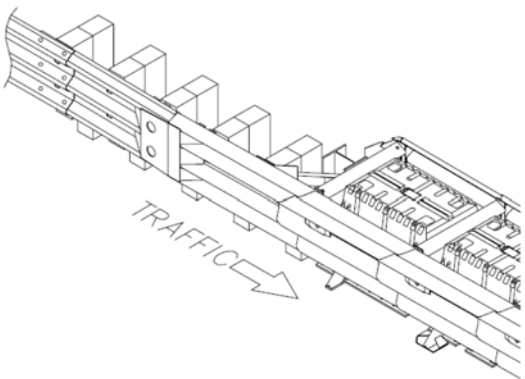


Figure 14
Quad-Beam to Thrie-Beam

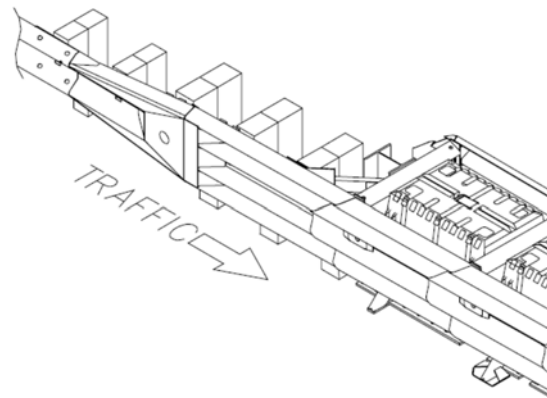


Figure 15
Quad-Beam to W-Beam

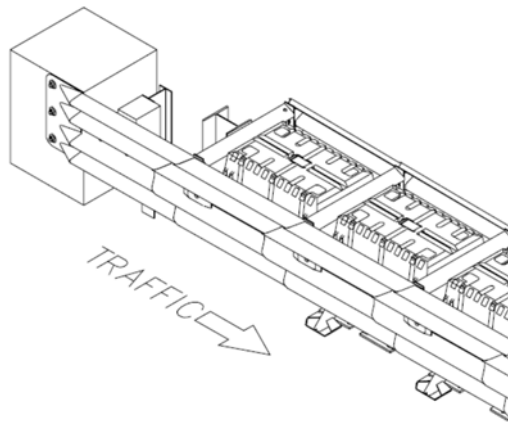


Figure 16
Quad-Beam End Shoe

1) 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 6.5" [165 mm] to one side as shown in Figure 17. 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 17
(Top view of concrete foundation)

2) Anchor the Backup

A) Concrete Backup Construction (Figure 18)

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 (p. 16).

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 hole in the Backup and Monorail must be anchored using an approved adhesive (p. 16).

B) Tension Strut Backup Assembly (Figure 19)

Locate Tension Strut Backup and Monorail on foundation with side of Monorail on the construction line (Figure 20 on p. 27). **Verify that any applicable Transition Panels fit properly before anchoring Backup.** Drill 7/8" [22 mm] diameter by 5 3/4" [145 mm] deep anchor boreholes in foundation using the Backup as template. Anchor the Backup to the concrete foundation using an approved adhesive supplied with the QuadGuard II (p. 16).

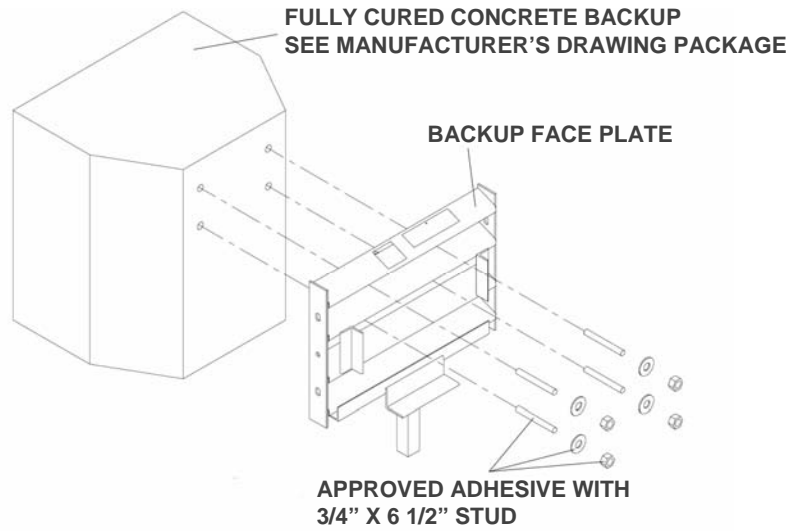


Figure 18
Anchoring Backup Face Plate to
Concrete Backup

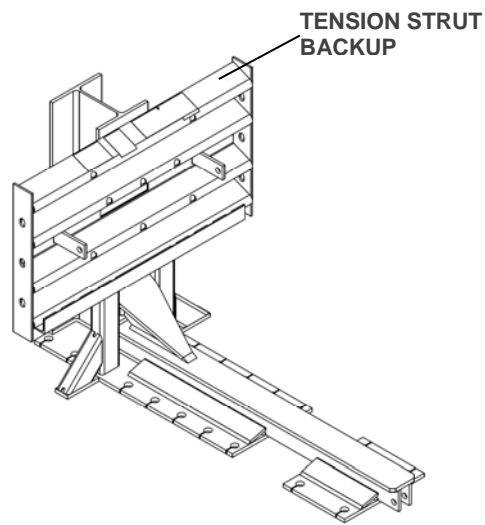


Figure 19
Anchoring Tension Strut Backup
to Foundation

3) Anchor the Monorail

A) Monorail Placement for Concrete Backup (Figure 20)

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 (Figure 20).

Orient the Monorail so that the Monorail tongues face Backup (Figure 20).

Drill 7/8" [22 mm] diameter by 5 3/4" [145 mm] deep 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 (Figure 23).

Anchor each Monorail section using an approved Trinity Highway adhesive kit. See Figure 20 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 ($\pm 1/4"$ [6 mm]).



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

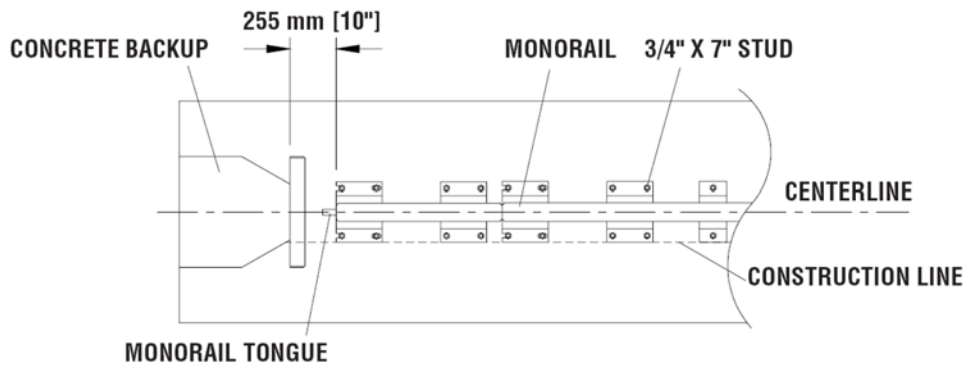


Figure 20
Monorail Placement for Concrete Backup

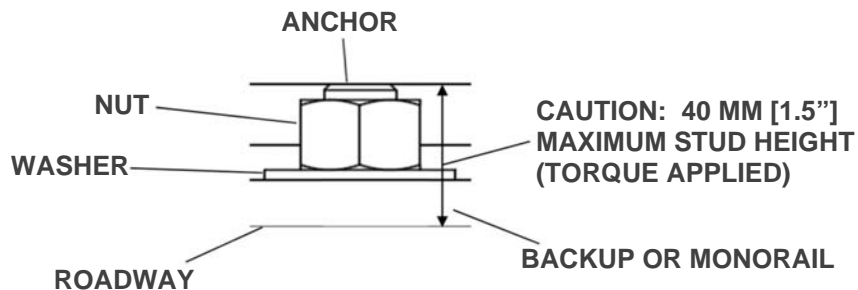


Figure 21
Proper Stud Height
(Torque Applied)

B) Monorail Placement for Tension Strut Backup (Figure 22)

Locate Monorail on foundation with side of Monorail on the construction line and rear edge of Backup foot 4" forward of edge of foundation (Figure 22).

Orient the Monorail so that the Monorail tongues face the Backup (Figure 23).

Drill 7/8" [22 mm] diameter by 5 3/4" [145 mm] deep 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 Figure 21 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 ($\pm 1/4"$ [6 mm]).



Warning: Improper alignment at the Monorail splice joints will prevent proper system collapse during an impact (Figure 23).

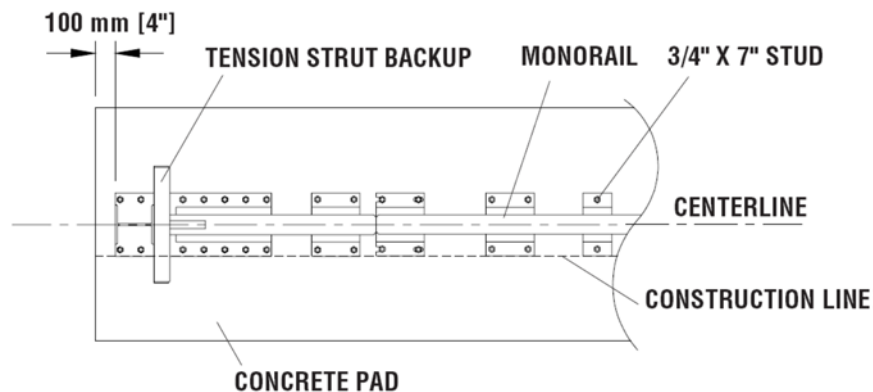


Figure 22
Backup and Monorail Placement for Tension Strut Backup

It is important to align each segment of Monorail from the back to the front of the system ($\pm 1/4"$ [6 mm]). Anchor each Monorail section using the provided Trinity Highway approved adhesive kit.

Drill 7/8" [22 mm] diameter by 5 3/4" [145 mm] deep boreholes using the Monorail as a template. Do not drill through foundation.

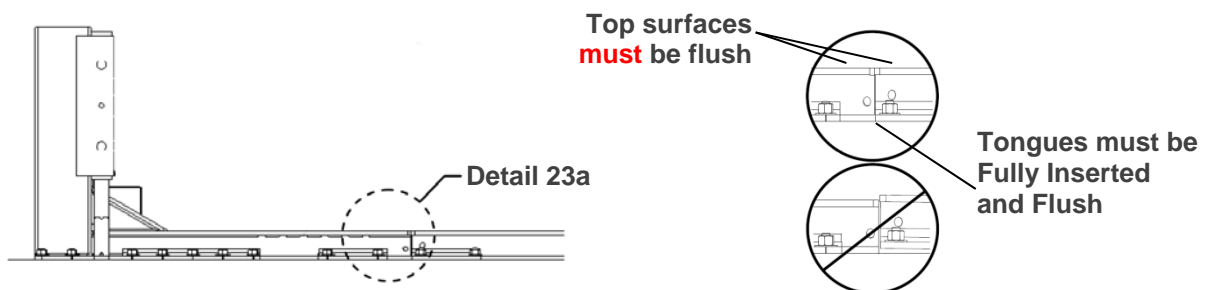


Figure 23
Rail Height and Alignment

Detail 23a

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

Attach Transition Panel or Side Panel to side of Backup using 5/8" X 2" rail 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.

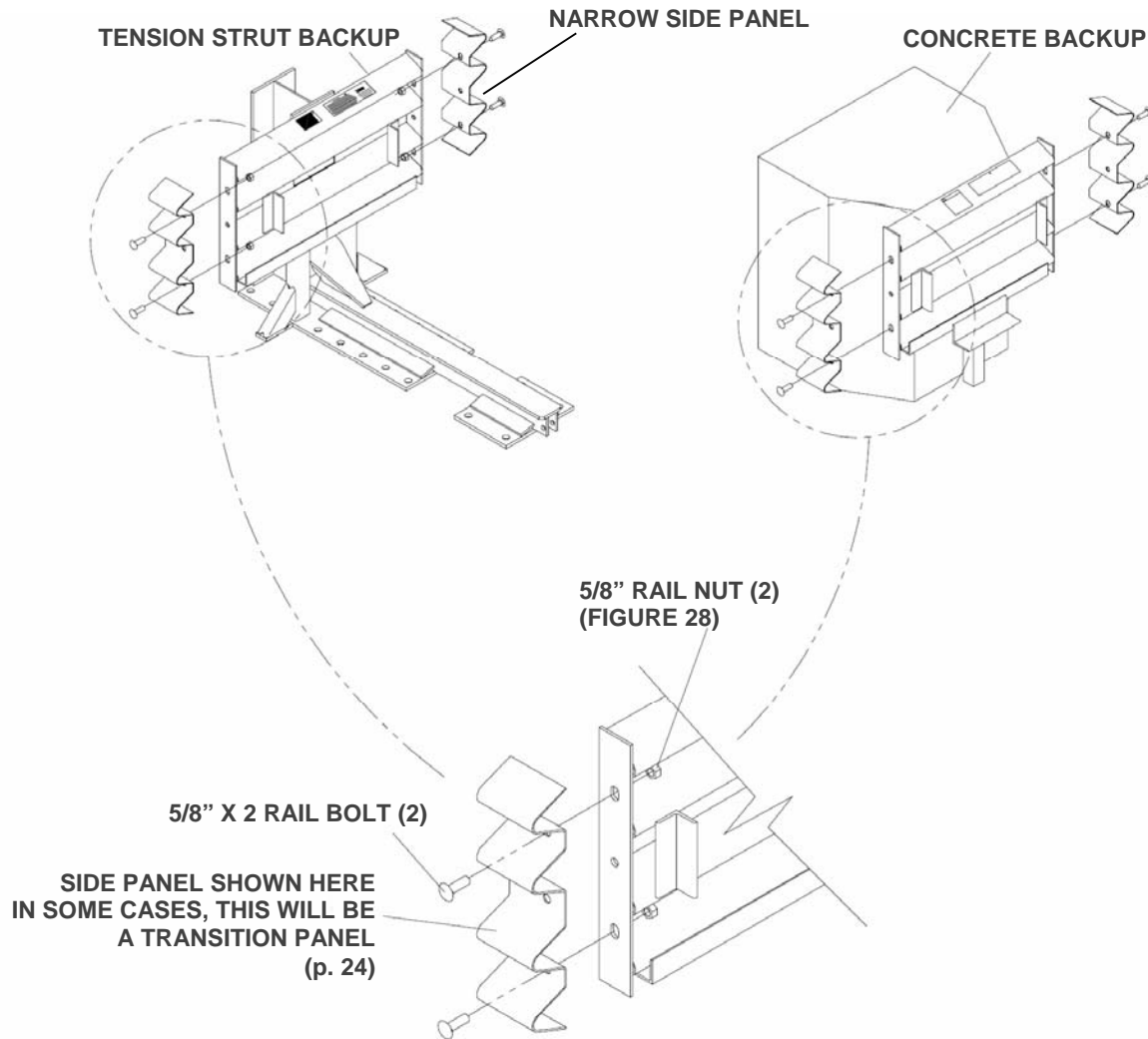


Figure 24
Side Panel/Transition Panel Attachment

5) 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 25. 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.

6) 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 26.



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 36" [915 mm] in front of the Backup

Orient and slide all other Diaphragms onto Monorail and position each approximately as shown in Figure 27.

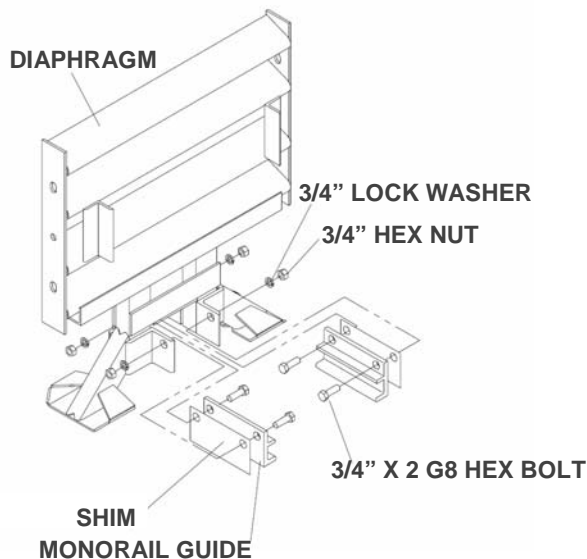


Figure 25
Monorail Guide Attachment

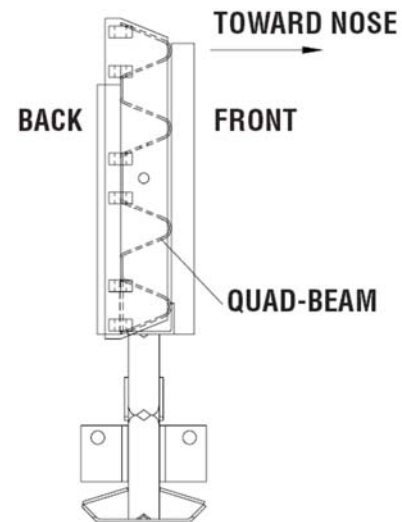


Figure 26
Diaphragm Orientation

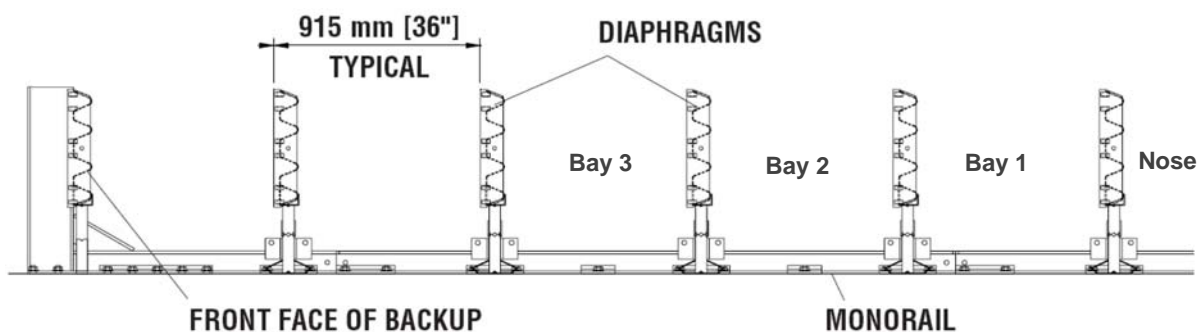


Figure 27
Diaphragm Spacing

7) Attach Fender Panels



Important: Do not mix the 5/8" rail nuts (large) with the 5/8" hex nuts (small) (Figure 28).

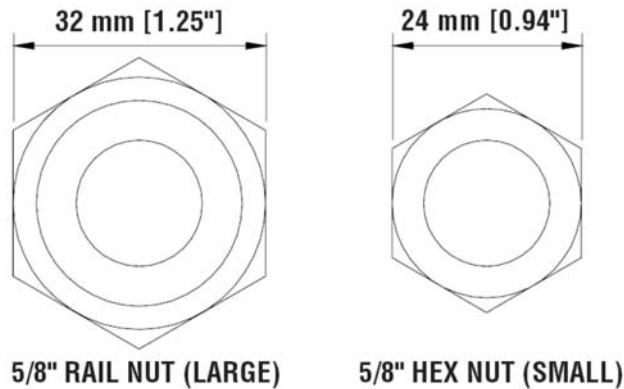


Figure 28
Rail Nuts are Oversize

Starting at the Backup, attach left and right Fender Panels shown on page 32 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.

Install the Mushroom Washer Assembly as shown in Figure 29 and Detail 29a and Detail 29b, 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 rail nuts per side. Use only the top and bottom holes; leave the center hole open until the next Fender Panel is attached.

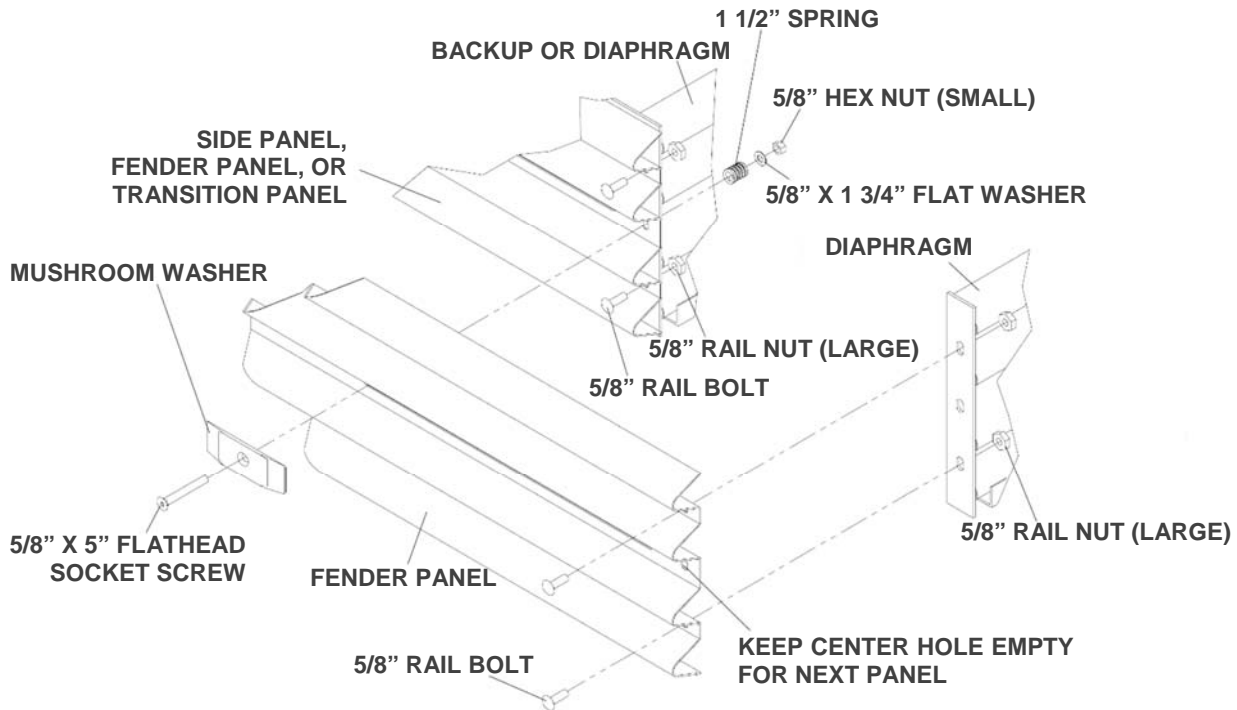
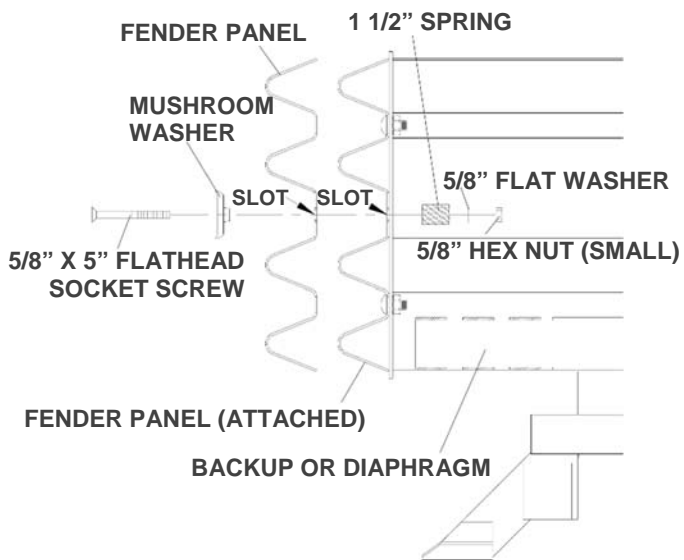


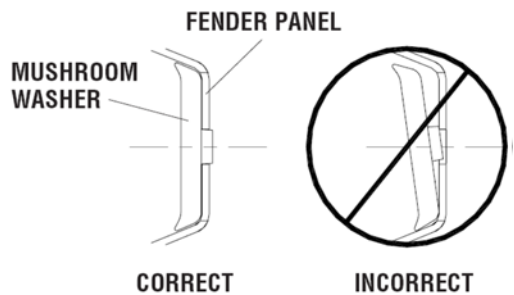
Figure 29
Fender Panel Assembly

Step 5

Ensure Mushroom Washer lays flat against the Fender Panel as shown in Figure 29b. Standoff on Mushroom Washer must be seated completely through slot.



Detail 29a
Mushroom Washer Attachment



Detail 29b
Mushroom Washer Orientation

Step 6

Check Diaphragm spacing to ensure 36" [915 mm] between rear faces of consecutive Diaphragms, as shown in Figure 30 and Fender Panel Assembly drawing.

Step 7

Once proper spacing has been achieved, tighten the Mushroom Washer Assembly (small hex) nut until it reaches the end of the threads. Tighten rail nut (large hex) at the front of the Fender Panels. Ensure rail bolt shoulder is seated within the Fender Panel slot.

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

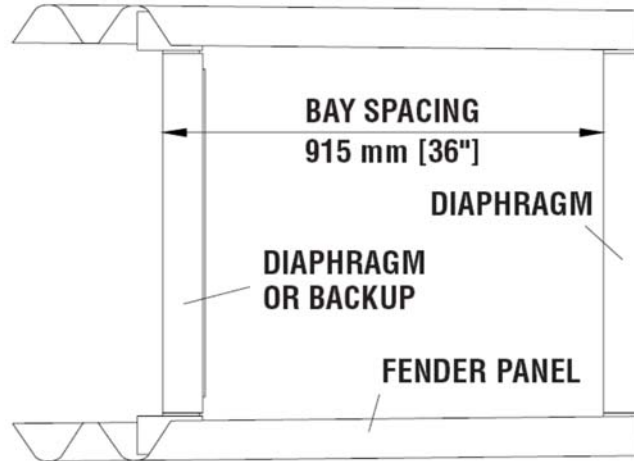


Figure 30
Proper Diaphragm Spacing

8) Attach End Cap (Figure 31)

Using a 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.

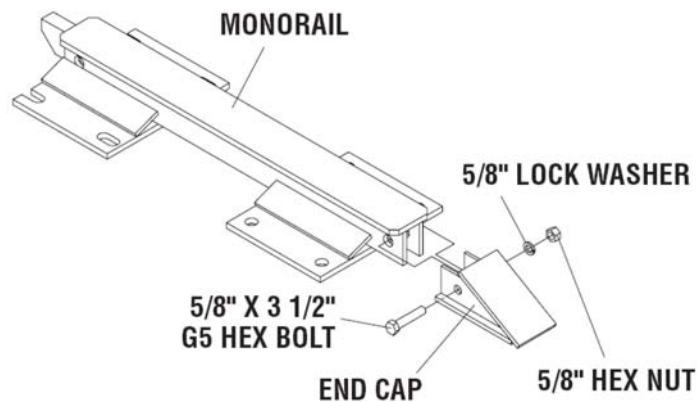


Figure 31
Monorail End Cap Assembly

9) Attach Cartridge Support Brackets (Figure 32)

Attach lower Cartridge Support Bracket to front and back of all Diaphragms and front of Backup, as shown in Figures 32 to 35 and Backup Assembly drawings.

Note: 24" [610 mm] wide systems do not have Side Cartridge Support Brackets: 30" [760 mm], 36" [915 mm] and 48" [1219 mm] wide systems have Side Cartridge Support Brackets welded to the Backup and Diaphragms.

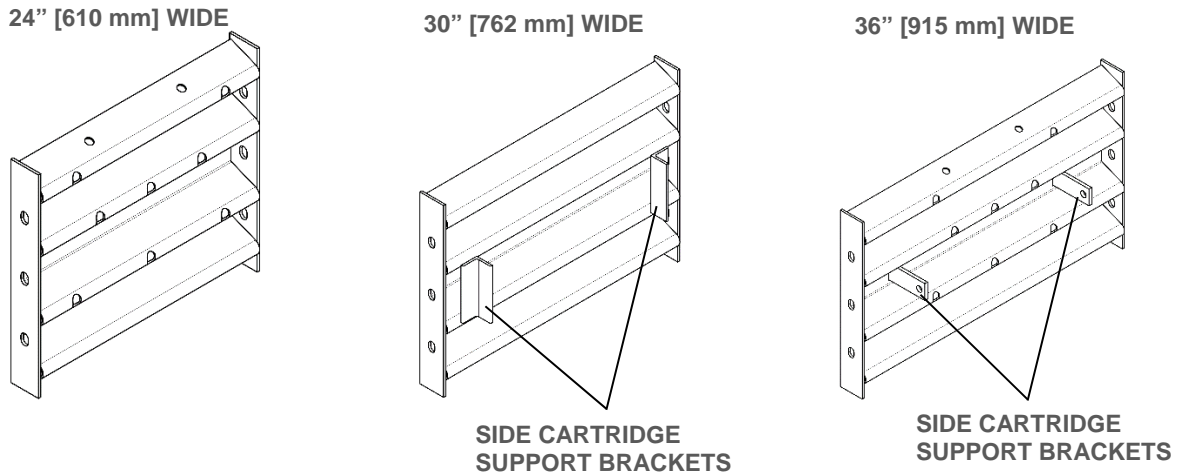


Figure 32
Side Cartridge Support Brackets

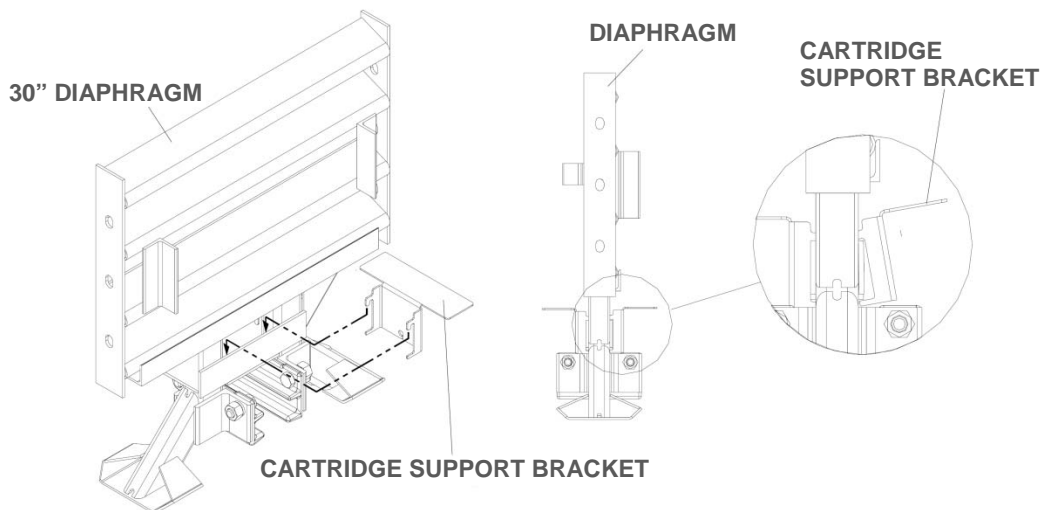


Figure 33
Lower Cartridge Support Bracket Assembly

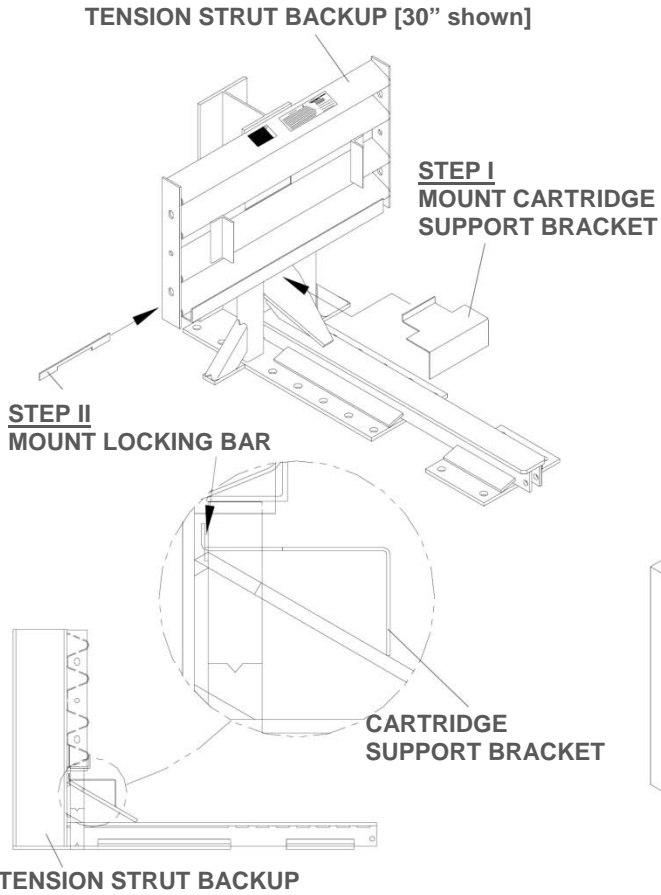


Figure 34
Lower Cartridge Support Bracket Assembly
(Tension Strut Backup)

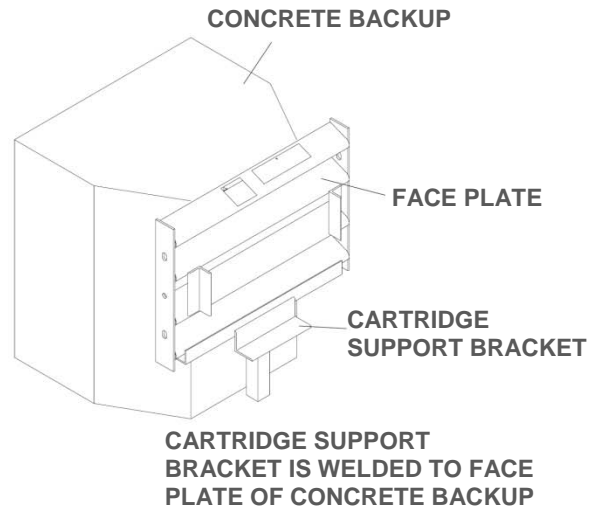


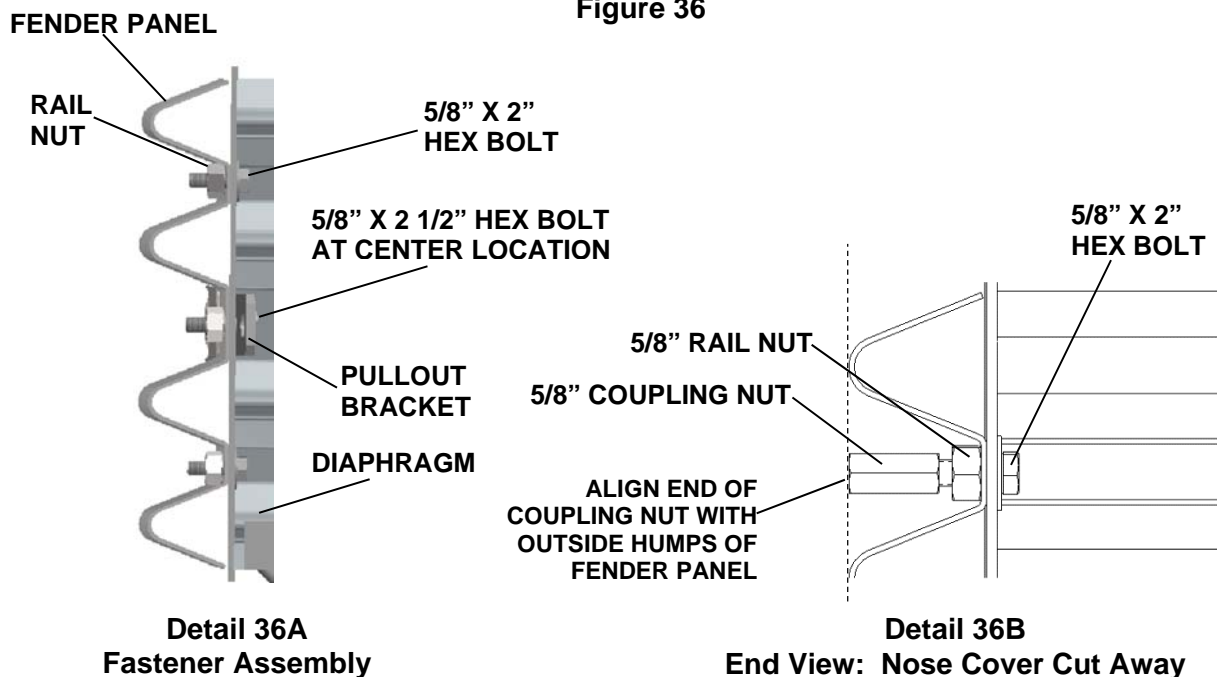
Figure 35
Lower Cartridge Support Bracket
(Concrete Backup)

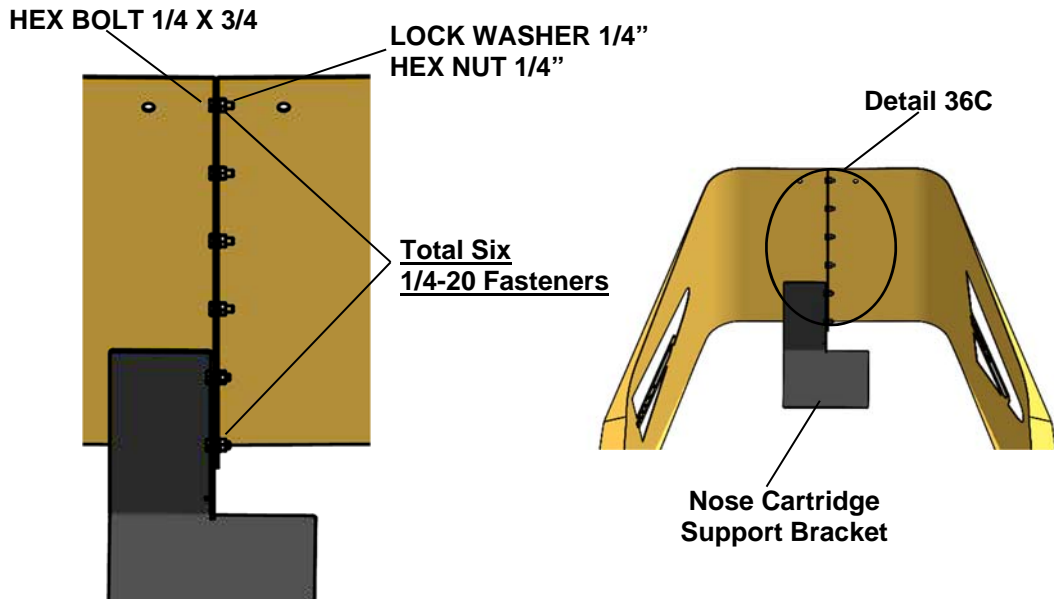
10) Attach Steel Nose Assembly

- A) Install two (2) 5/8" X 2" hex bolts and one (1) 5/8 X 2 1/2" hex bolt with Pullout Bracket through Diaphragm side plate. Fasten all three (6 total) bolts with 5/8" rail nuts on each side and tighten (Detail 36A).
- B) Thread 5/8" coupling nuts on 5/8" hex bolts to align with outside of Fender Panel (Detail 36B).
- C) Join Steel Nose halves using 1/4" X 3/4" hex bolts, lock washers and nuts. Include Cartridge Support Nose Bracket in lower two fastener sets (Detail C & D).
- D) Attach Steel Nose to Diaphragm using 5/8" X 1 1/4" hex socket bolt and 5/8" x 1 1/4" flat washer (Detail 69E). Steel Nose top edge should be 32 1/8" above concrete surface.
- E) Place the Cartridge Support Bracket on the front of the first Diaphragm (Detail 36F). Place a Type I Cartridge in the Nose Bay.



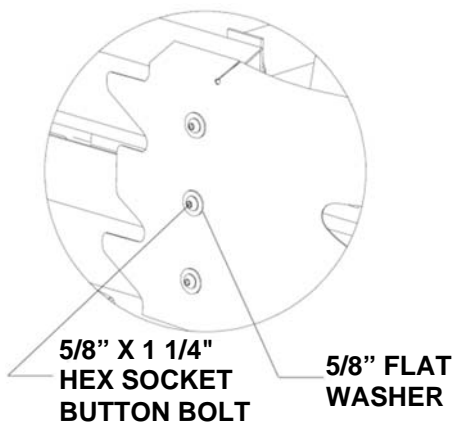
Figure 36



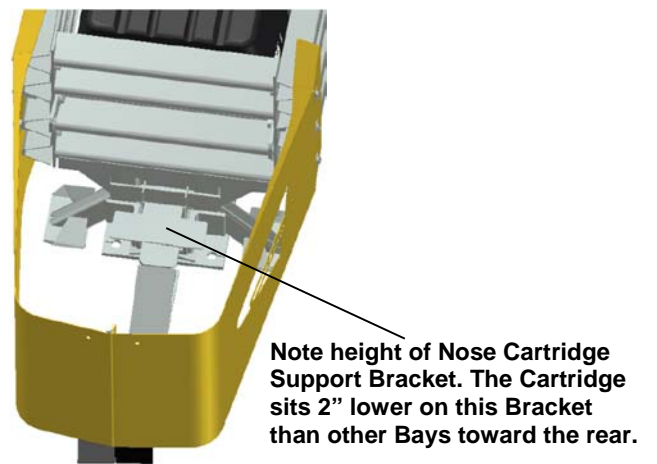


Detail 36C

Detail 36D



Detail 36E



Detail 36F

Detail 36D shows proper placement of front Cartridge Support Bracket.

11) 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 (Figure 37). Verify the top of the Steel Nose is 32 1/8" above the roadway (p. 36).



Warning: Ensure that the QuadGuard® II 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:	
Anchor Requirements	
Anchor Studs – Anchoring Information Table, p. 16 May slightly protrude above nuts	
Critical Clearances	
Anchor Studs above nuts – Figure 21, p. 27 Fender Panel Gap Narrow – 7/8" [22 mm] see below	

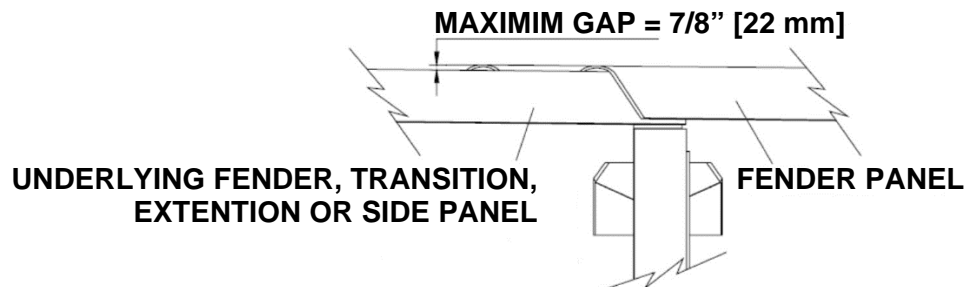


Figure 37
Fender Panel Gap for Narrow Systems

13) Cartridge Placement

Be sure the Adjustable Cartridge Support in the Nose is attached correctly (p. 37). The top surface of the Nose Cartridge should be horizontal.

To complete the assembly of a QuadGuard® II, 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 (Figures 38 and 39). Ensure all Cartridges are pointed toward the front of the system per Cartridge direction arrow(s).



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.

I - TYPE I CARTRIDGE
II - TYPE II CARTRIDGE

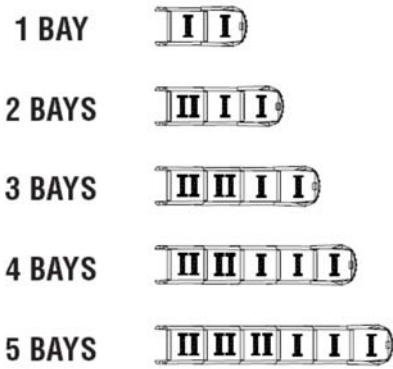


Figure 38
Cartridge Placement

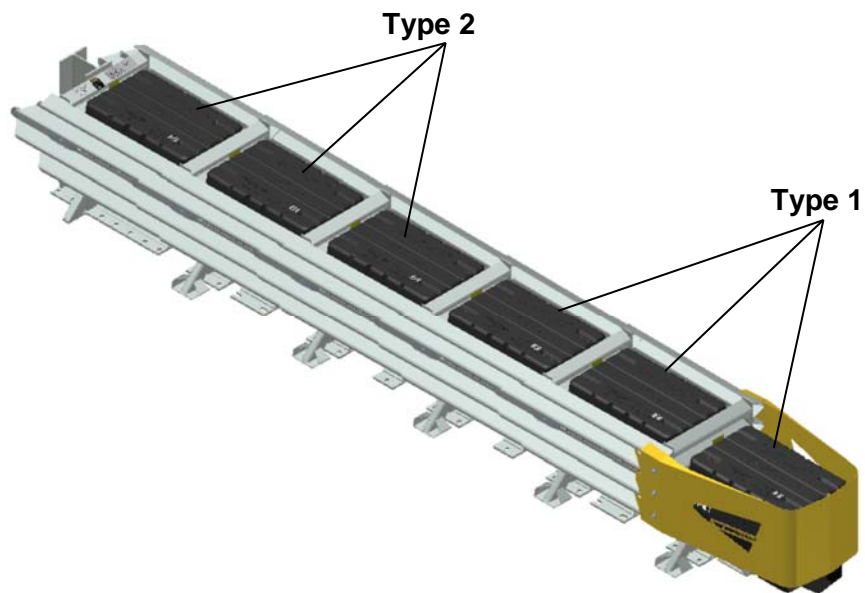
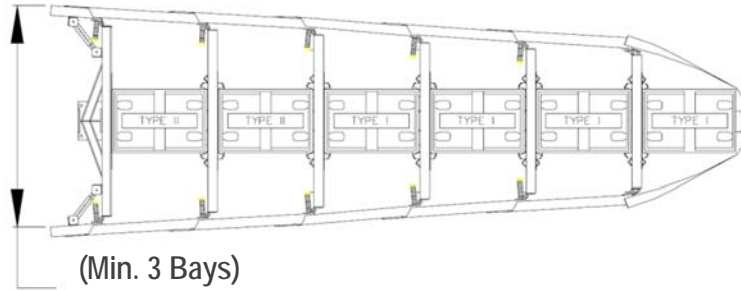
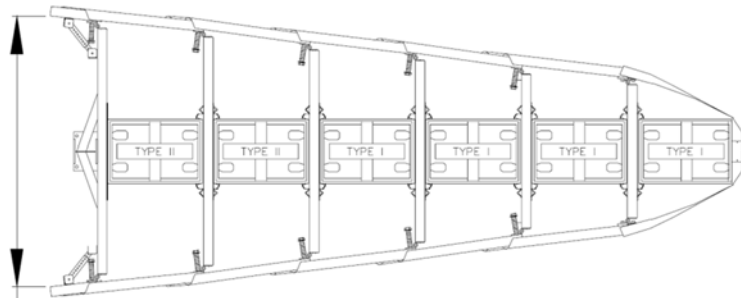


Figure 39
Five Bay System

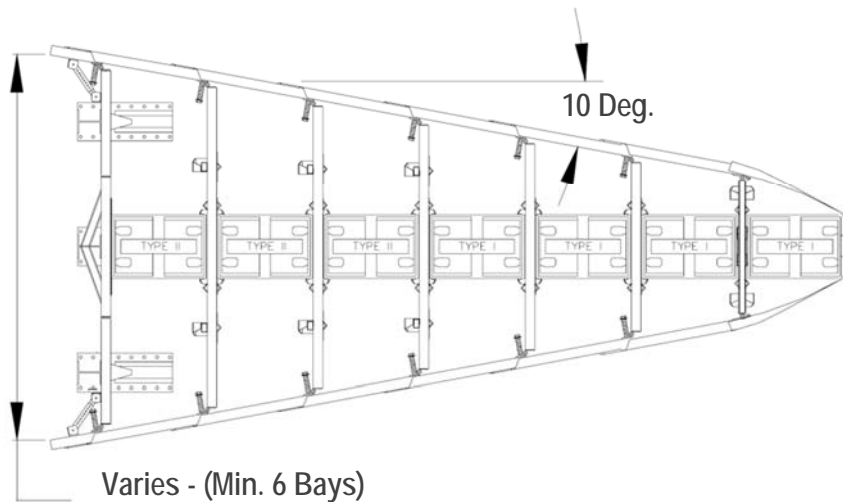
Wide (Flared) Systems



(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 40
Wide System(s) and Model Numbers

Assemble Wide (Flared)



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.

Determine Backup and Transition Type

The QuadGuard® II is available with a Tension Strut Backup or a Concrete Backup. See Figures 41 and 42, 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. See Figures 44 through 48 and the Manufacturer's Drawing Package to determine which types of Fender Panels to attach.

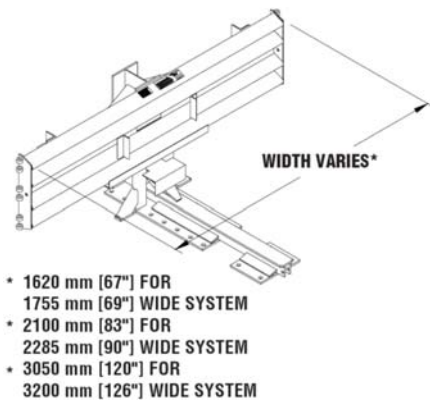


Figure 41
Tension Strut Backup

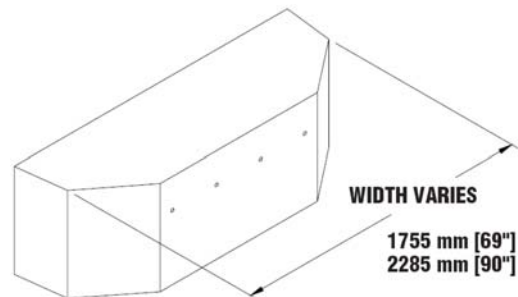


Figure 42
Concrete Backup

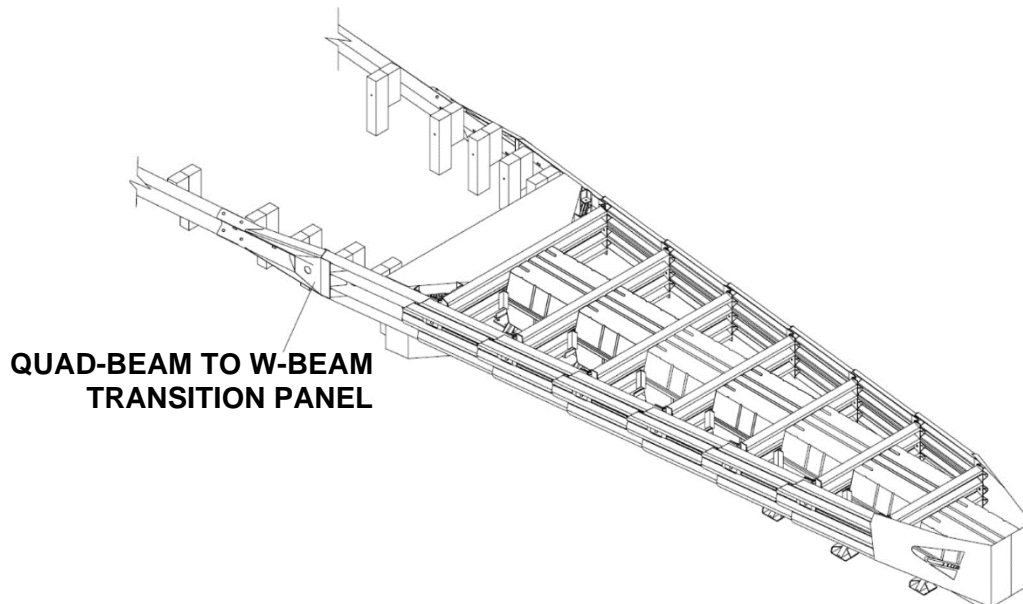


Figure 43
QuadGuard® II Transitioning



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 is shielding.** Contact Customer Service prior to deployment if you have any questions (p. 3).

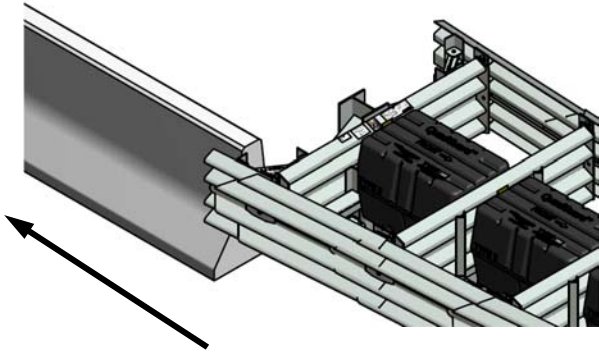


Figure 44
No Transition

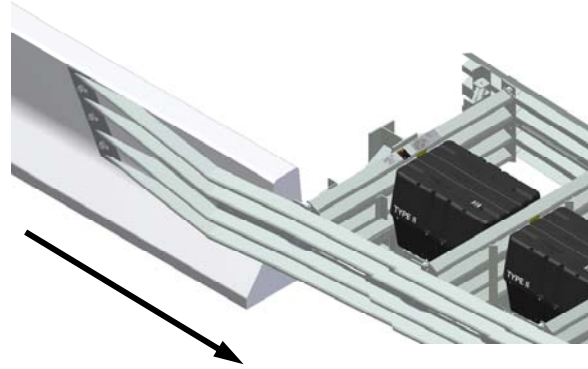


Figure 45
Quad-Beam to Safety Shape Barrier

Note: Arrows indicate traffic direction.

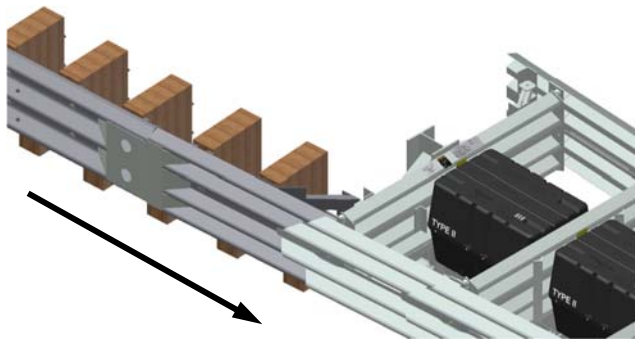


Figure 46
Quad-Beam to Thrie-Beam

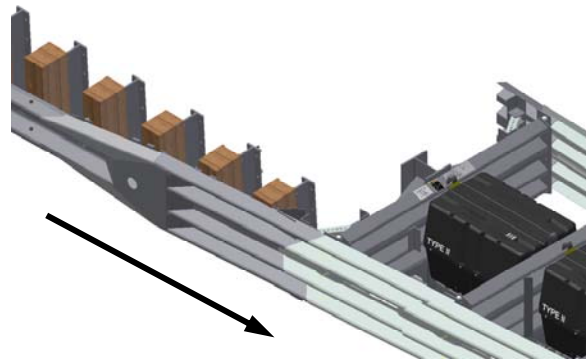
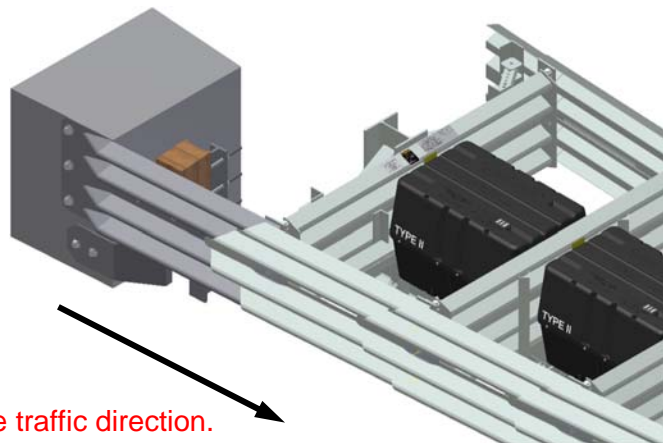


Figure 47
Quad-Beam to W-Beam



Note: Arrows indicate traffic direction.

Figure 48
Quad-Beam End Shoe

1) 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 6.5" [165 mm] to one side as shown in Figure 49. 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 49
(Top view of concrete foundation)

2) Anchor the Backup

A) Concrete Backup Construction (Figure 50)

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 (p. 16).

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 51)

Locate the Tension Strut Backup and Monorail on foundation with side of Monorail on the construction line (p. 47). **Verify that any applicable Transition Panels fit properly before anchoring Backup.** Drill 7/8" [22 mm] diameter by 5 3/4" [145 mm] deep 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 (p. 16).

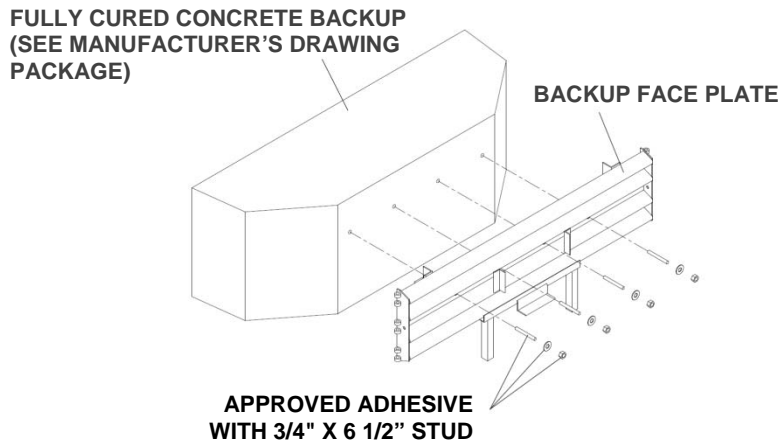


Figure 50
Anchoring Backup Face Plate to Concrete Backup

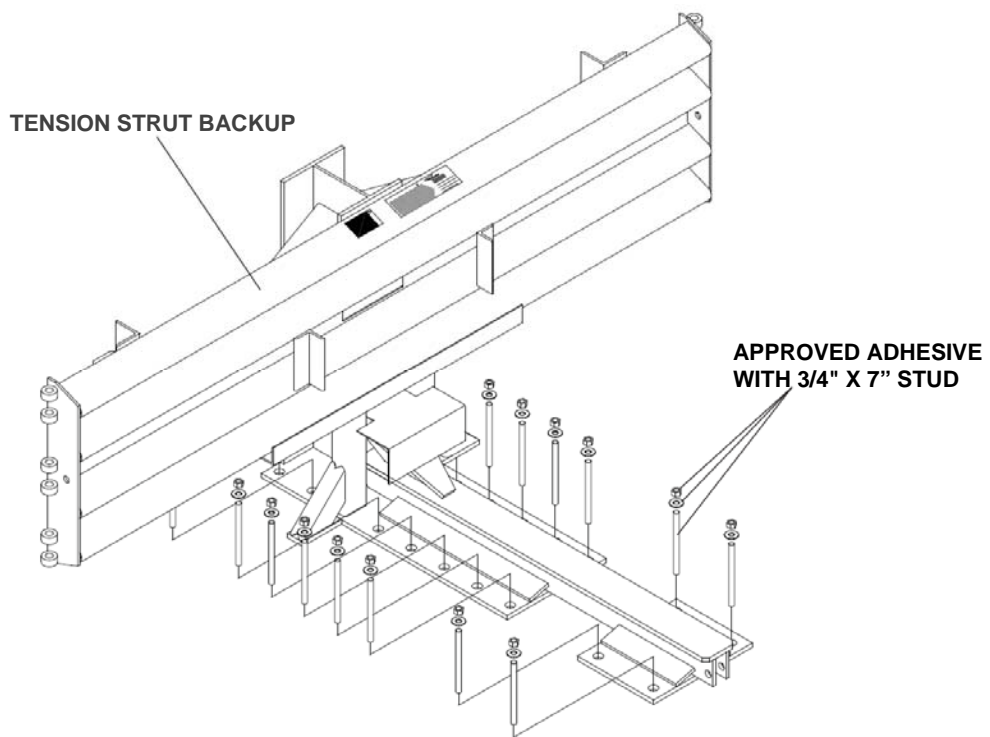


Figure 51
Anchoring Tension Strut Backup to Foundation

C) Extra-Wide Tension Strut Backup Assembly (Figure 52)

Locate the Extra-Wide Tension Strut Backup **center** section and Monorail on foundation with side of Monorail on the construction line.

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 52 and Detail 52a.

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 (p. 16).



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

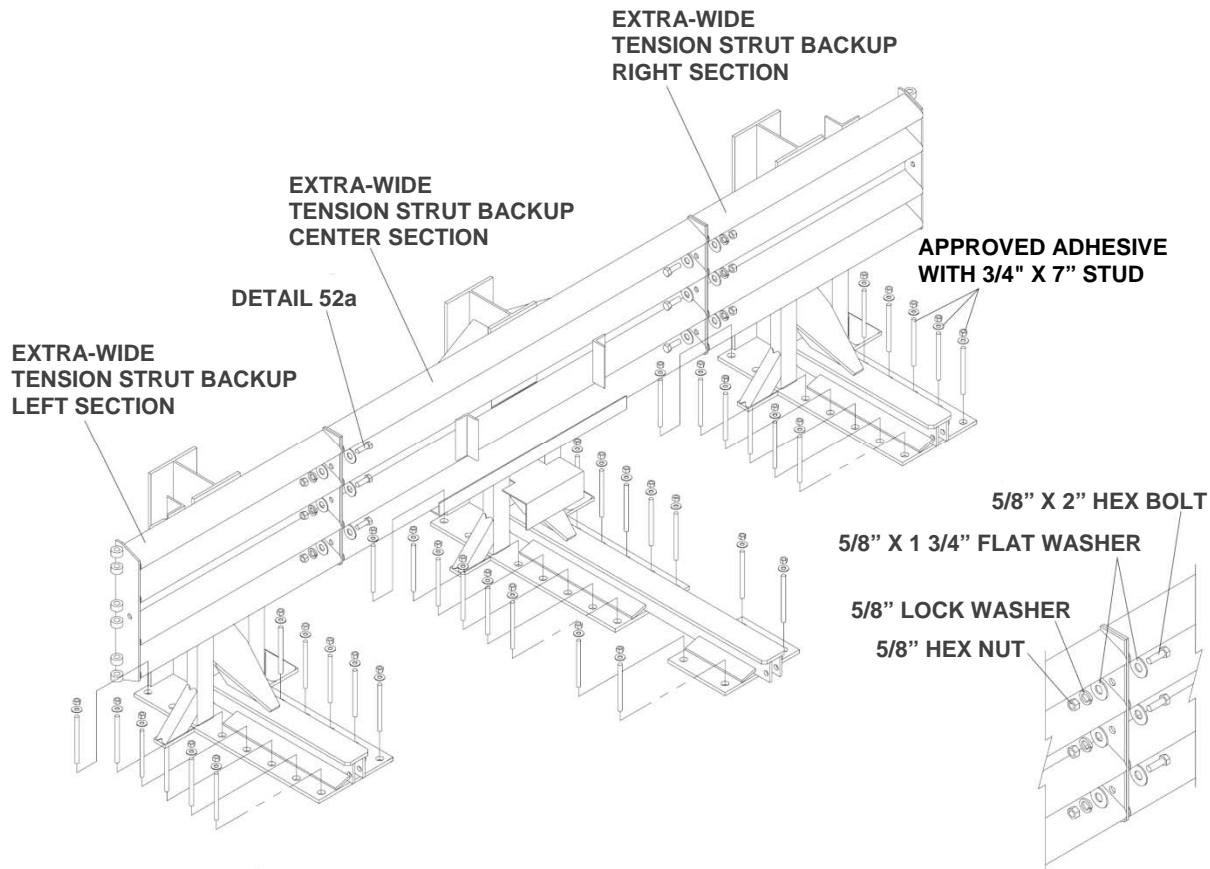


Figure 52
Anchoring Extra-Wide Tension Strut Backup to Foundation

Detail 52a

3) Anchor the Monorail

A) Monorail Placement for Concrete Backup (Figure 53)

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 (Figure 53).

Drill 7/8" [22 mm] diameter by 5 3/4" [145 mm] deep 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 (Figure 56).

Anchor each Monorail section using an approved adhesive kit (p. 16). It is important to attach each segment of Monorail in alignment from the back to the front of the system ($\pm 1/4"$ [6 mm]).



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

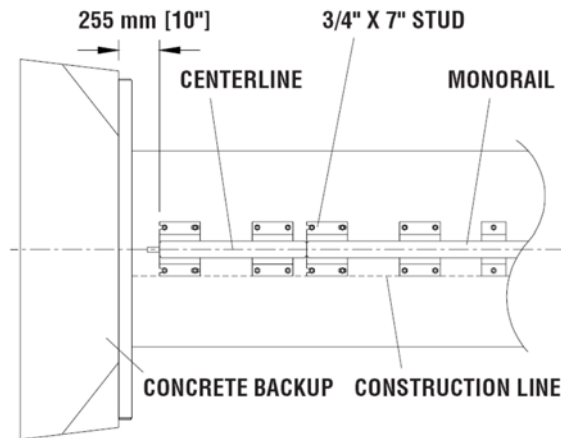


Figure 53
Monorail Placement for Concrete Backup

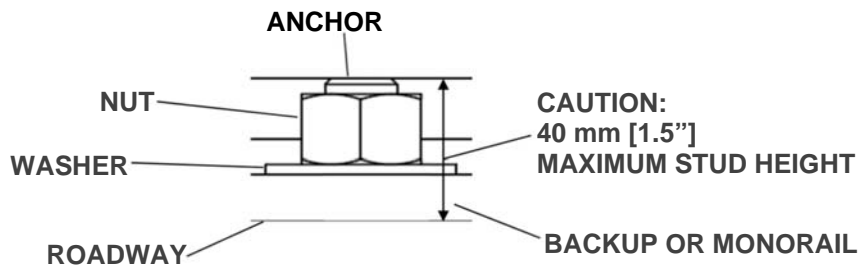


Figure 54
Proper Stud Height

Monorail Placement for Tension Strut Backup (Figure 55)

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 (Figure 56 & Detail 56a).

Drill 7/8" [22 mm] diameter by 5 3/4" [145 mm] deep 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 Figure 54 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 ($\pm 1/4"$ [6 mm]).



Warning: Improper alignment at the Monorail splice joints will prevent proper system collapse during an impact (Figure 56).

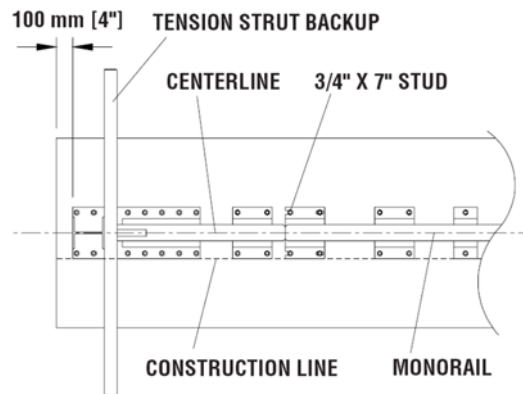


Figure 55
Backup and Monorail Placement for Tension Strut Backup

It is important to align each segment of Monorail from the back to the front of the system ($\pm 1/4"$ [6 mm]). Anchor each Monorail section using the provided Trinity Highway approved adhesive kit.

Drill 7/8" [22 mm] diameter by 5 3/4" [145 mm] deep boreholes using the Monorail as a template. Do not drill through foundation.

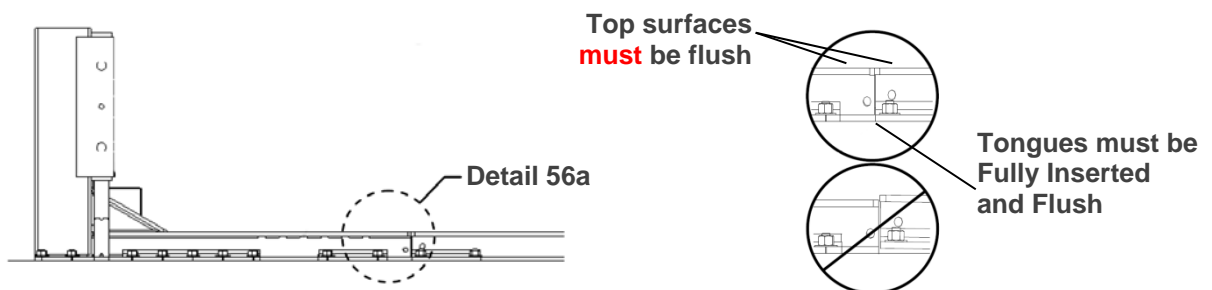


Figure 56
Rail Height and Alignment

Detail 56a

4) Attach Side Panels and/or Transition Panels to Backup Assembly (Figure 57)

- 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 Backup using 5/8" hex bolt, 5/8" lock washer and 5/8" hex nut (three places each side of Backup).
- 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 57.

Note: A Side Panel is not needed when a Transition Panel is used. Diagonal braces are not used with some Transition Panels per the 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.

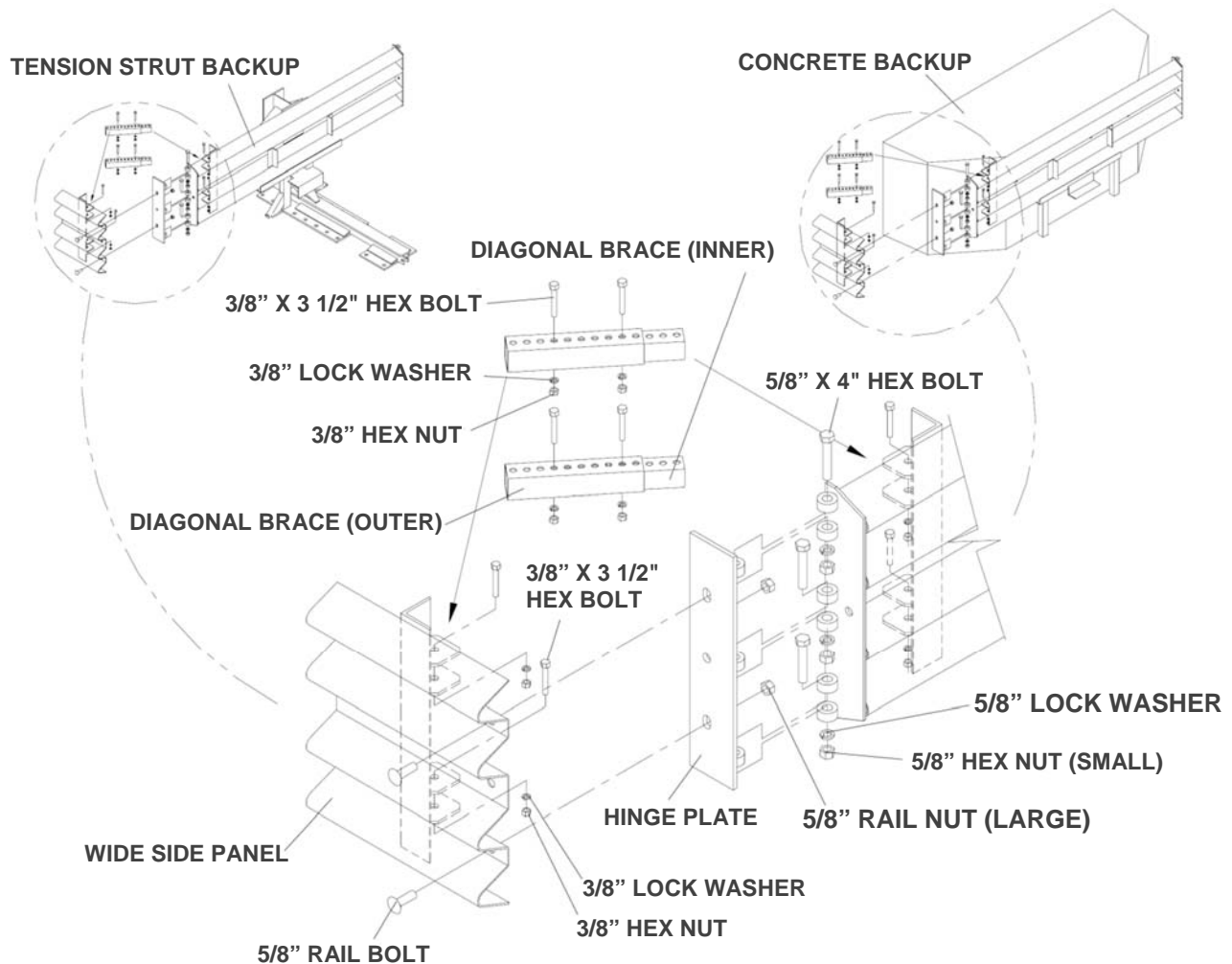


Figure 57
Side Panel/Transition Panel Attachment

5) Attach Monorail Guides

Attach Monorail guides to Diaphragm as follows:

Insert 3/4" x 2" G8 hex bolt through Monorail guide and Diaphragm (Figure 58). Check orientation and secure hex bolt 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.

6) 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 59. **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 36" [915 mm] in front of the Backup.

Orient and slide all other Diaphragms onto Monorail and position each approximately as shown in Figure 60.

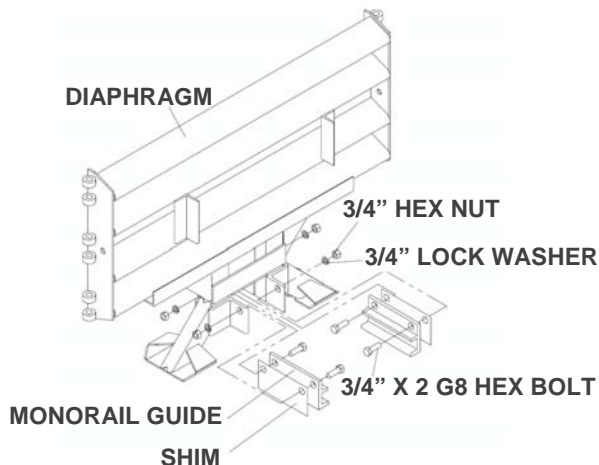


Figure 58
Monorail Guide Attachment

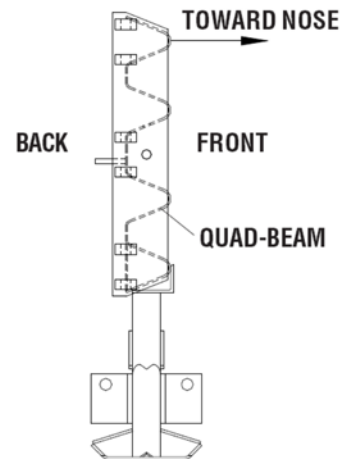


Figure 59
Diaphragm Orientation

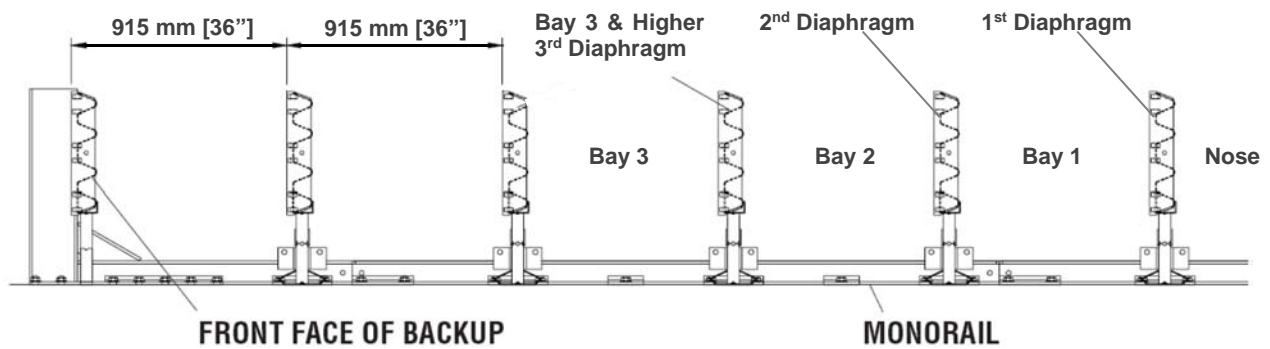


Figure 60
Diaphragm spacing

7) Attach Hinge Plate onto Fender Panels



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

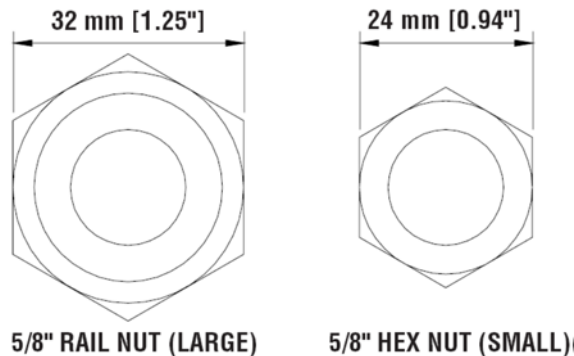


Figure 61
Rail Nuts are Oversize



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 62.

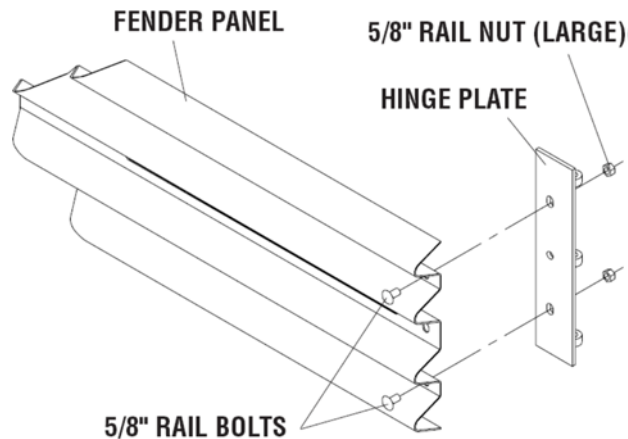


Figure 62
Hinge Plate Assembly

8) Attach Fender Panels

Starting at the Backup, attach left and right Fender Panels as shown in Figure 63.

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.

Install the Mushroom Washer Assembly as shown in Figure 63 and Detail 63A, but do not torque at this time (this will help 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 rail 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 Figure 63B. Standoff on Mushroom Washer must be seated completely through slot.

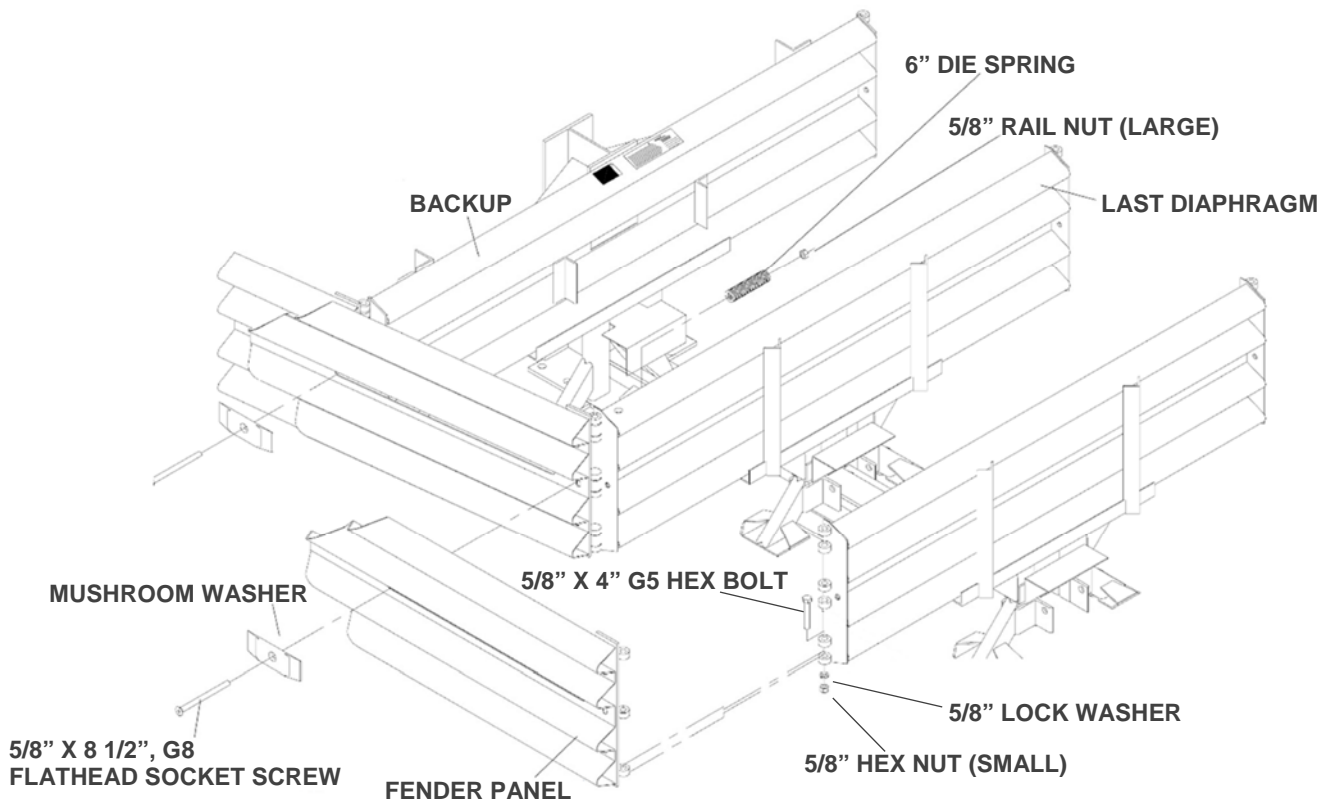


Figure 63
Wide Fender Panel Assembly

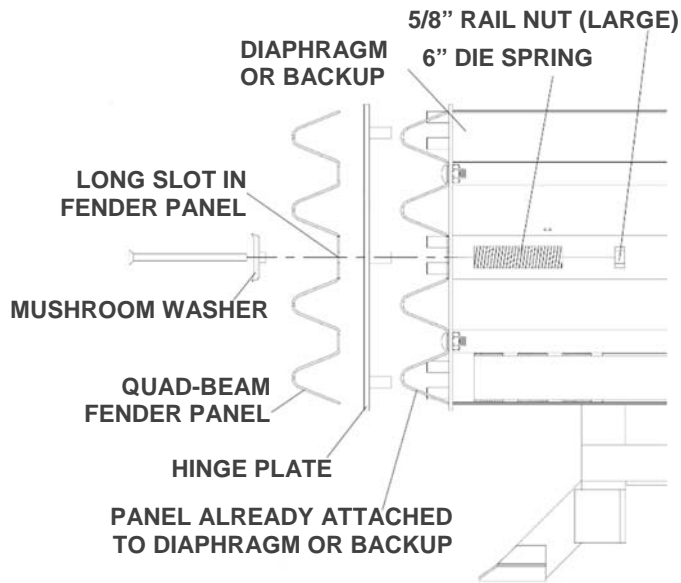


Figure 63A
Mushroom Washer Attachment

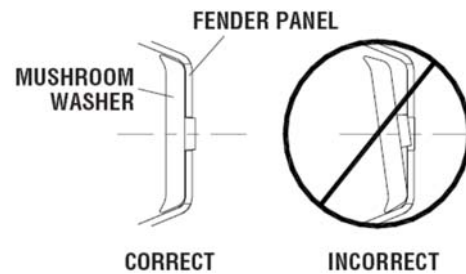


Figure 63B
Mushroom Washer Orientation

Step 6

Check Diaphragm spacing to ensure 36" [915 mm] 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, tighten the Mushroom Washer Assembly (large rail nut) until it reaches the end of the threads. Assemble the remaining Diaphragms and Fender Panels following the same procedures. Tighten rail nut (large hex) at the front of the Fender Panels. Ensure the rail bolt shoulder is seated within the Fender Panel slot.

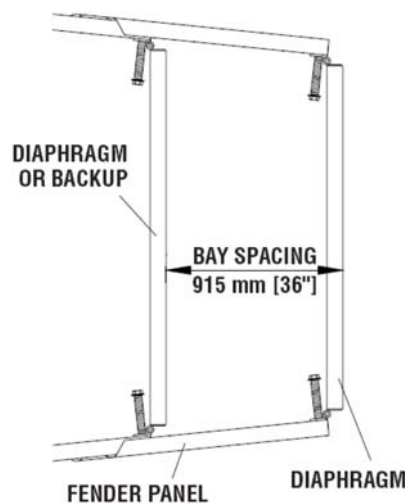


Figure 64
Proper Diaphragm Spacing

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.

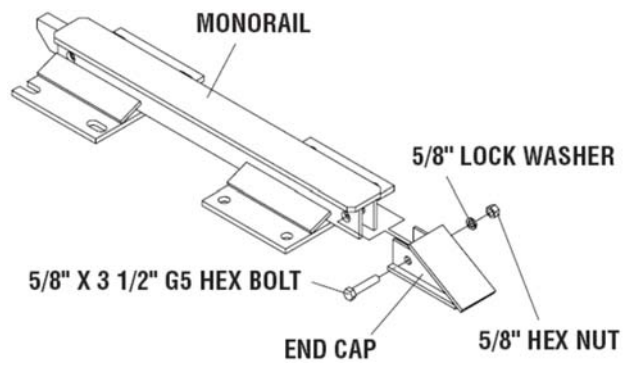


Figure 65
Monorail End Cap Assembly

10) 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.

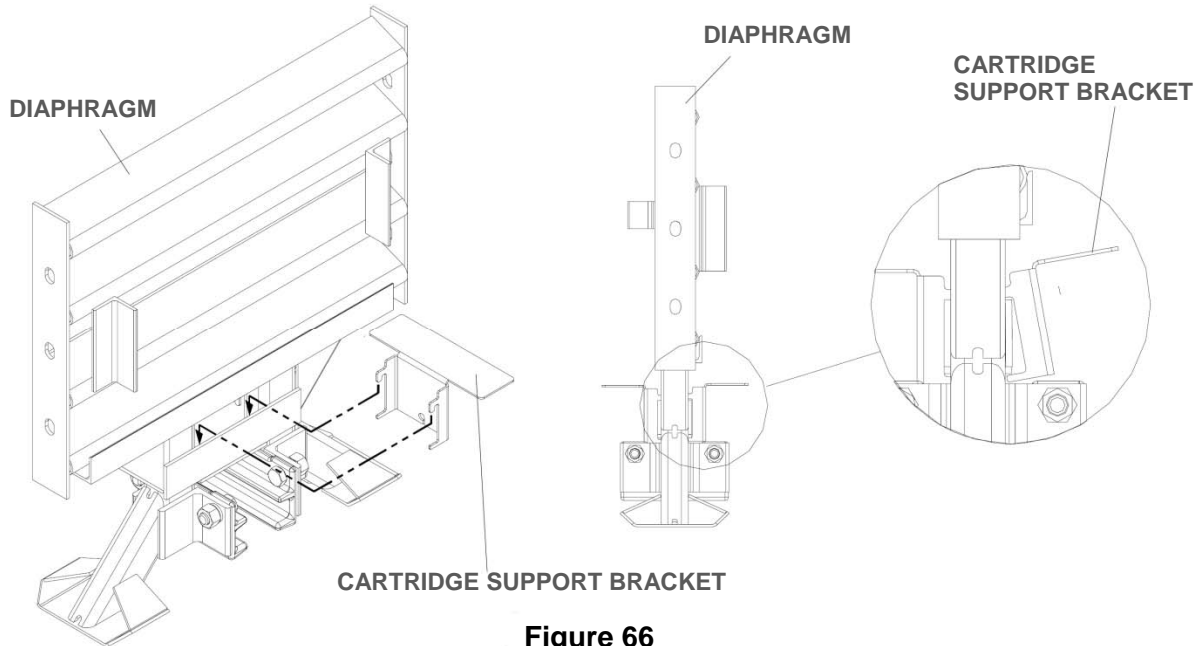


Figure 66
Diaphragm with
Cartridge Support Bracket

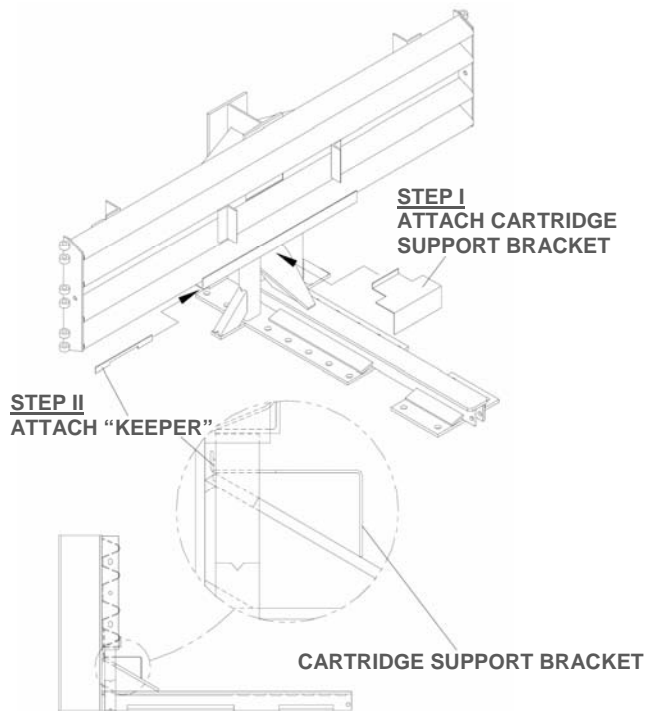


Figure 67
Cartridge Support Bracket
(Tension Strut Backup)

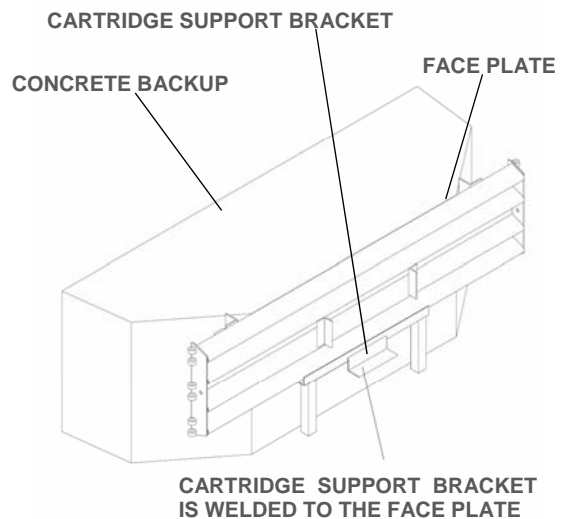


Figure 68
Cartridge Support Bracket
(Concrete Backup)

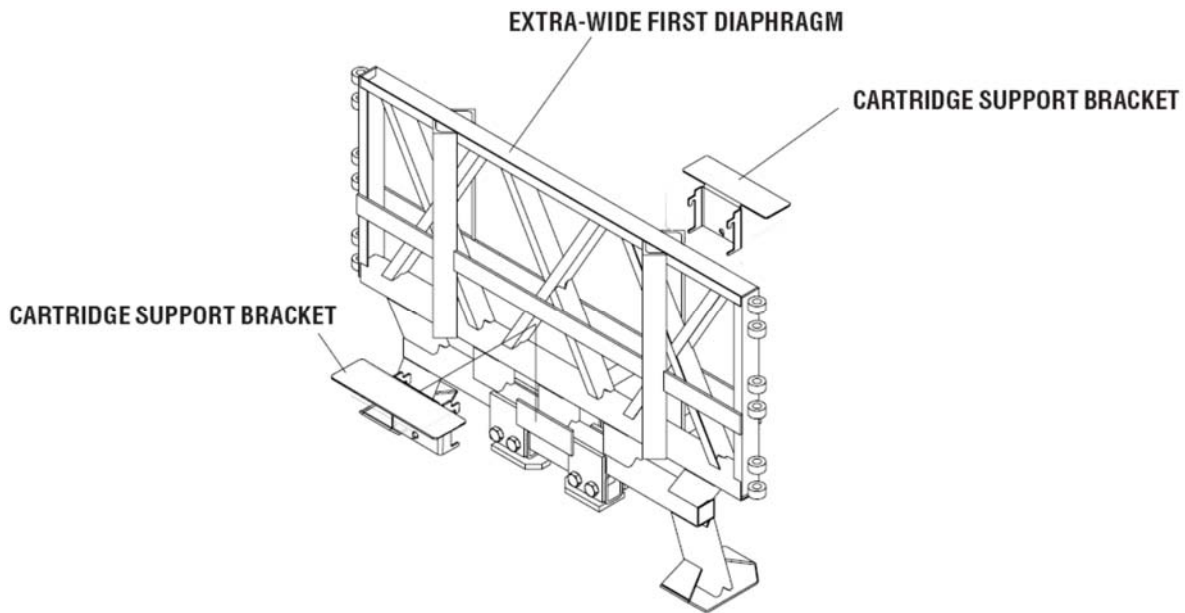


Figure 69
Extra-Wide First Diaphragm with Cartridge Support Bracket
 (See Drawing Package)

11) Attach Nose Assembly

See pages 36 and 37 for Nose Assembly instructions.

12) 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 (Figure 70). Verify top of Steel Nose height is 32 1/8" above the roadway (p. 36).



Warning:
Anchor Requirements
Anchor Studs – Anchoring Information Table, p. 16 May slightly protrude above nuts
Critical Clearances
Anchor Studs above nuts – p. 46, Figure 54 Fender Panel Gap Wide – 1.00" [25 mm] see below

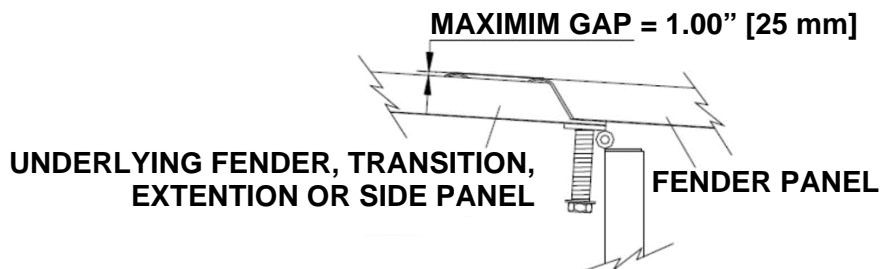


Figure 70
Fender Panel Gap for Wide Systems

13) Cartridge Placement

Ensure the Adjustable Cartridge Support in the Nose is attached correctly (p. 36). The top surface of the Nose Cartridge should be horizontal.

To complete the assembly of a QuadGuard® II, 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 (Figures 71 and 72). Ensure all Cartridges are pointed toward the front of the system per Cartridge direction arrow.



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.

I - TYPE I CARTRIDGE
II - TYPE II CARTRIDGE

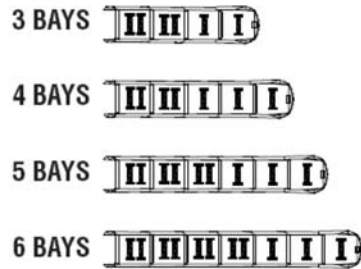


Figure 71
Cartridge Placement

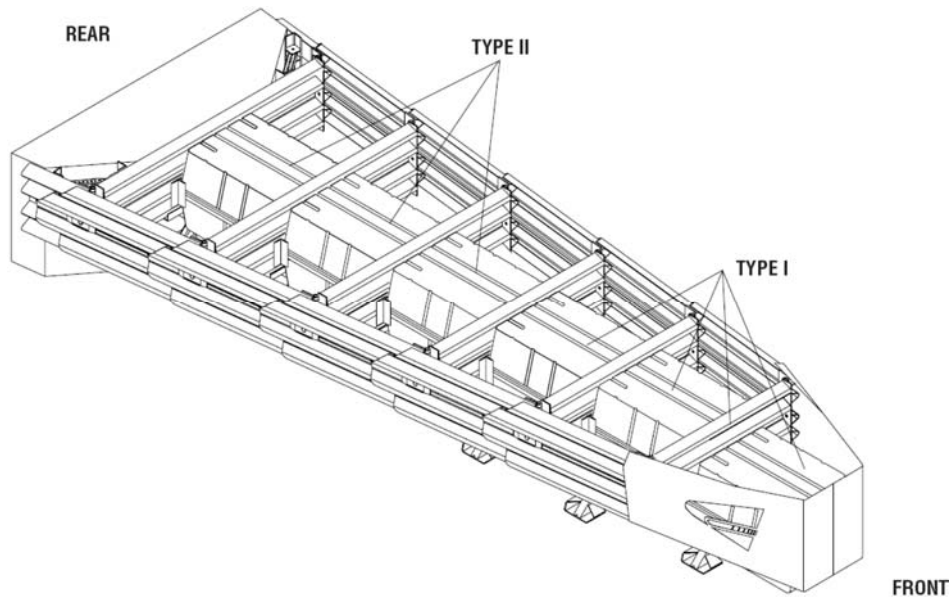


Figure 72
Five Bay System

QuadGuard® II Final Inspection Checklist

Date: _____

Site Location: _____

Inspector: _____

Refer to the QuadGuard® II manual and/or drawing package.

- Minimum clearance of 30" behind rear Fender Panels for movement (p. 15)
- Proper Transition Panel is used for the type of barrier (p. 24, 42)
- Every borehole and slot in Backup and Monorail is utilized (p. 25, 27, 28, 45, 46, 47)
- Anchor stud(s) height is 1.5" or less above the pad (p. 27)
- If no transition is used, narrow side panels are used with backup (p. 29, 48)
- Monorail guides are attached to the Diaphragms with shims (p. 30, 49)
- Mushroom Washer tabs lay flat within fender panel slots (p. 32, 51)
- Mushroom Washer nuts are bottomed out to shank on Mushroom Washer bolt (p. 32, 52)
- Monorail End Cap Assembly in place (p. 33, 53)
- Cartridges are level and the same height in each Bay (p. 39)
- Nose Cartridge is level (p. 36)
- Fender Panel gap is 7/8" or less for Narrow (parallel) systems (p. 38)
- Fender Panel gap is 1" or less for Wide (flared) systems (p. 55)
- Cartridge types are in order, correctly seated, and facing the front of the system (p. 39, 56)
- Bolts and nuts are properly tightened throughout the system (p. 38, 55)
- Anchor nuts are torqued to adhesive manufacture specification (p. 16)
- System is clear of debris



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.

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 Narrow systems on asphalt (p. 16).

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 39 and 56.

- 3) Verify the Steel Nose is properly attached and at 32 1/8" above roadway surface.
- 4) Note the location and condition of the QuadGuard® II and the date of visual drive-by inspection.

Walk-Up Checklist

- Clear and dispose of any debris on the site.
- Clear and remove excessive dirt from around the Monorail and Diaphragm feet.
- Fasteners (nuts/bolts) are tight and rust free.
- Anchor bolts are securely anchored.
- Diaphragm legs are straight.
- All Mushroom Washer Assemblies are properly seated.
- Fender Panels and Transition Panels should nest tightly against the system.
- Cartridges have not been damaged and are properly seated on their Support Brackets. To ensure intended speed characteristics, partially crushed Cartridges (due to low speed impacts) must be replaced.
- Post-Impact Instructions (p. 59)
- To determine if a product should be replaced or is potentially reusable, a trained engineer experienced in highway products and directed by the DOT, or other appropriate local highway authority, must be consulted.

Post-Impact Instructions



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.



Warning: If the QuadGuard® II 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 18" [460 mm] threaded rods.

Narrow (Parallel) 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 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 (Flared) 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.



Important: Performance of the system depends on the Monorail Anchors being properly anchored.



Caution: QuadGuard® II wide systems should not be anchored to asphalt.

- 3) Clear and dispose of any on site debris.
- 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) Ensure that each Diaphragm is properly attached to the Monorail.

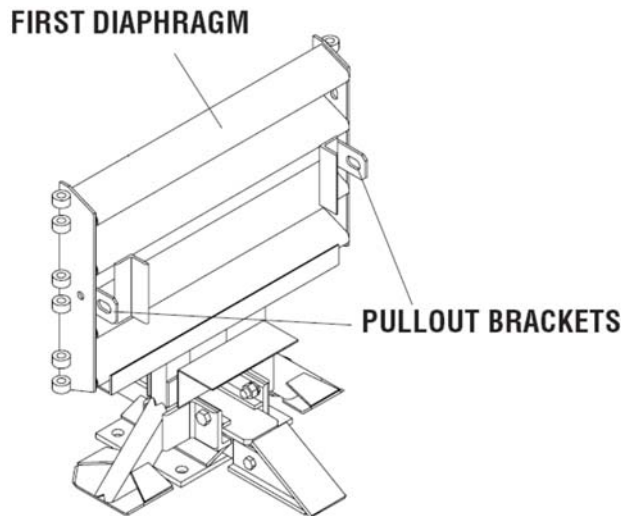


Caution: Use eye protection and gloves when refurbishing the Mushroom Spring Assembly. Do not place fingers underneath an assembled Mushroom Washer. Parts may suddenly shift and fingers may be pinched. If the spring is still under compression as the nut is nearing the end of the bolt, to prevent injury, 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 (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**



Important: Slowly pull the QuadGuard® II 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



Warning:	
Fender Panel	Maximum gap allowed:
Narrow Systems	7/8" [22 mm]
Wide Systems	1.00" [25 mm]

10) Check the **gaps between Fender Panels**. The maximum gap allowed for these overlapping parts (including Fender Panels overlapping Panels behind the system) is 7/8" [22 mm] for **narrow systems** and 1.00" [25 mm] for **wide systems**. Be sure the Mushroom Washer Assemblies are tightened 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.

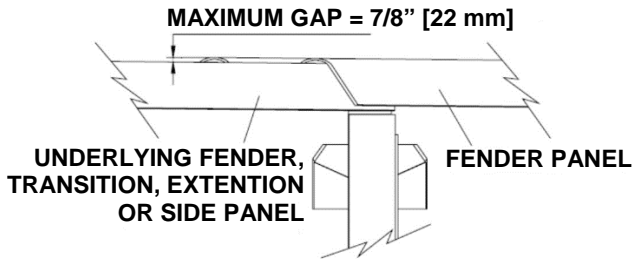


Figure 74
Narrow Systems Fender Panel Gap

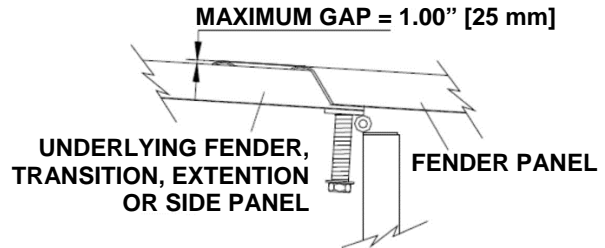


Figure 75
Wide Systems Fender Panel Gap

- 11) Replace all crushed Cartridges. See Cartridge Placement on pages 39 and 56.
- 12) Remove damaged Nose Assembly and attach the new Nose (p. 36 and 37).



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.



Warning:
Anchor Requirements
Anchor Studs – p. 16
Critical Clearances
Anchor Studs above nuts – Figure 54, p. 46 Fender Panel Gap Narrow – 7/8" [22 mm] Fender Panel Gap Wide – 1.00" [25 mm]

- 13) Verify all bolts on the system are tight (p. 16).
- 14) Ensure that the site is free from any debris.
- 15) The QuadGuard® II is now ready for use.

Parts Ordering Procedure

Make a list of all damaged parts using part descriptions shown on the components pages 7 - 11 and on the system images (p. 63 and 64). Answer the following questions in the spaces provided. This information is necessary to receive the proper parts.

QuadGuard® II Ordering Information Chart		
Description:	Choices	Fill in this section
What is the width of the system (p. 21)?	24" [610 mm] 30" [760 mm] 36" [915 mm] 48" [1219 mm] 69" [1755 mm] 90" [2285 mm] 126" [3200 mm]	
What is the Number / Type of Bays? See Bay information on pages 39 and 56.	Narrow Systems: 1 through 5 Wide Systems: 3 through 6	
What Type of Backup Does the System Have? Figures 9 or 10 (p. 23).	Concrete Tension Strut	
What Type of Transition Panel? Reference "Side Panel and Transition Panel Types" (pp. 24 and 42). Be sure to specify right side, left side, or no Transition(s). See "How to Determine Left/Right" on page 20.	Quad to W Quad to Thrie Quad to Safety Shape Barrier Quad to End Shoe 4" Offset Panel	

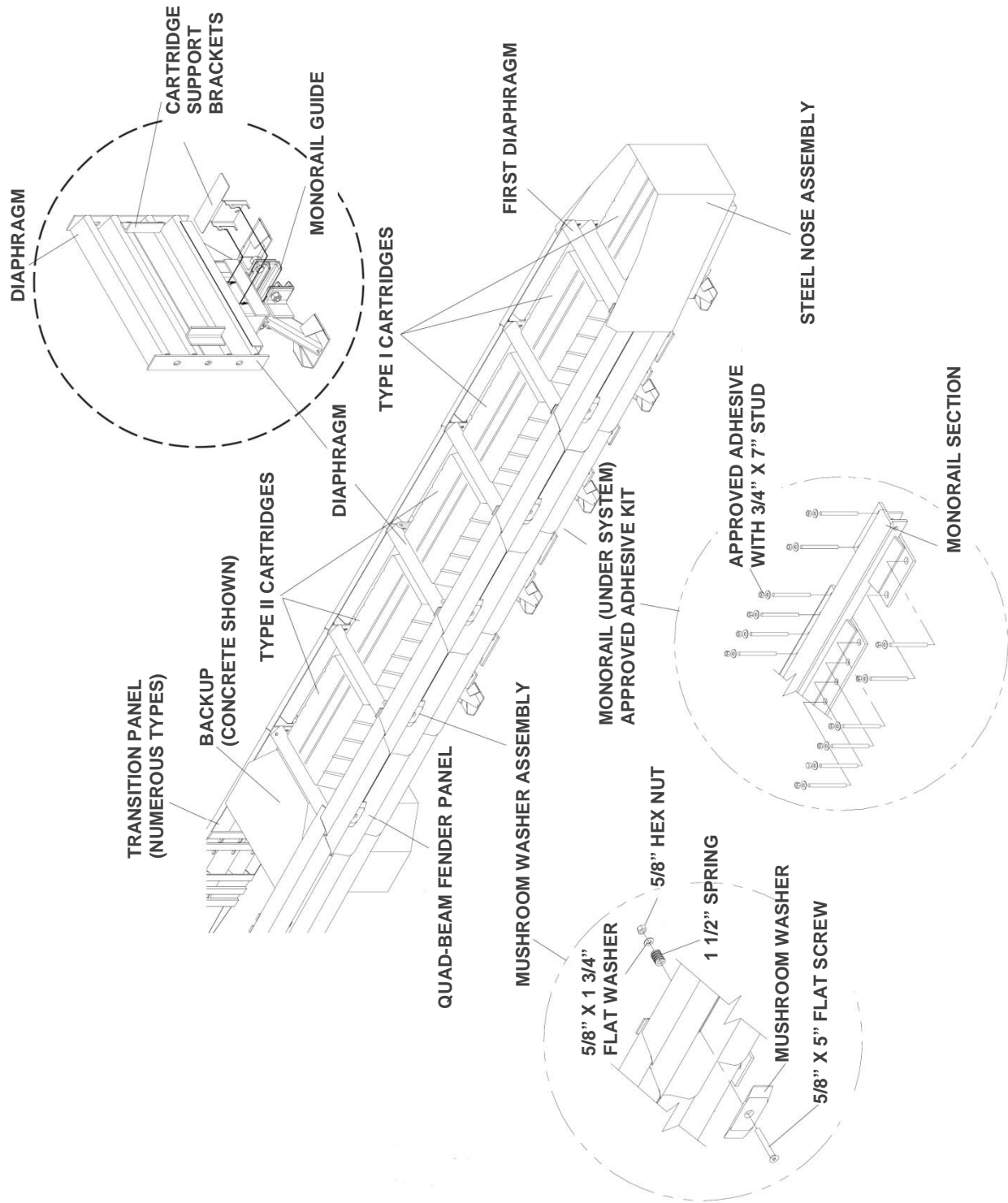


Figure 76
QuadGuard® II for Narrow
Roadside Obstacles

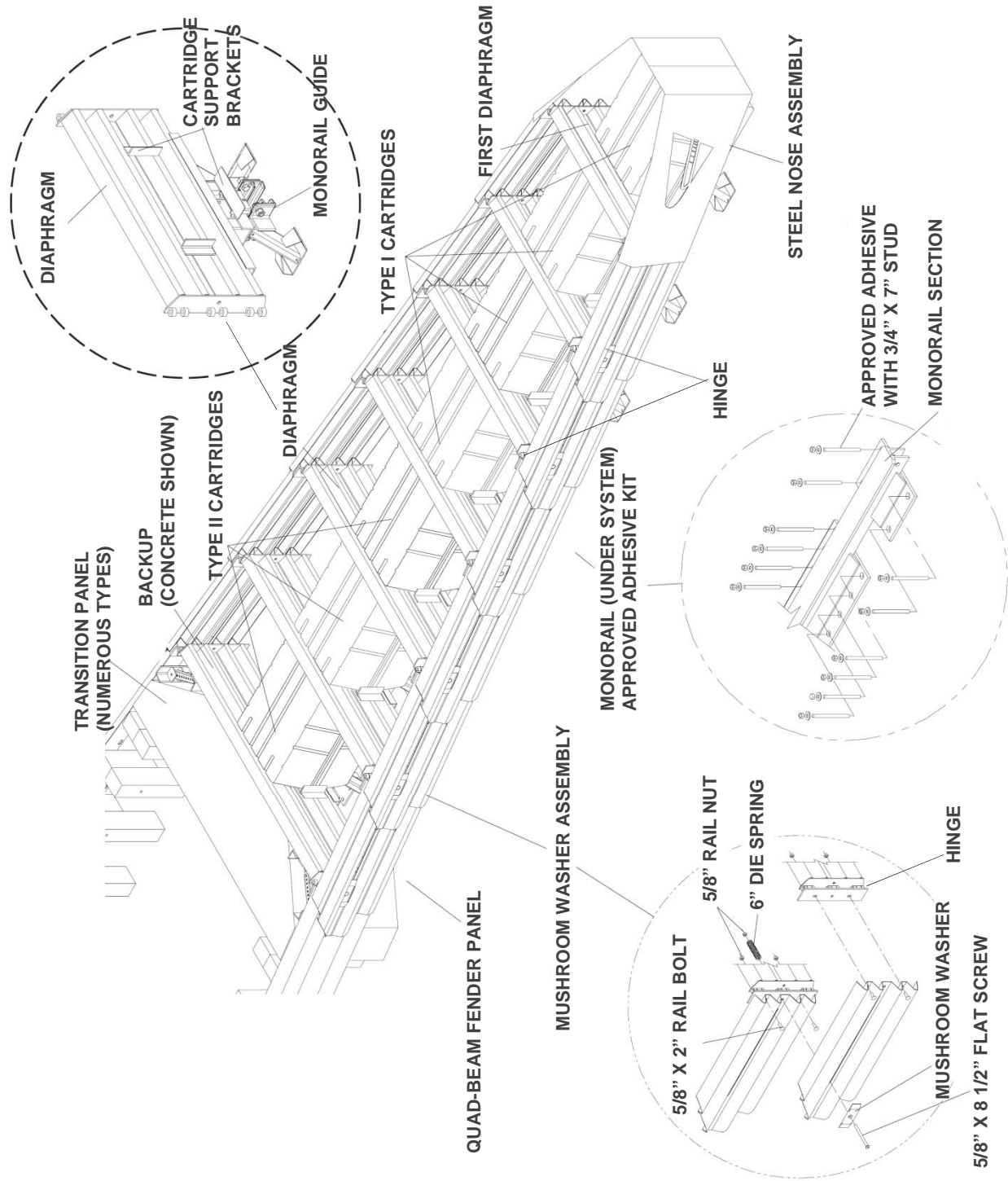


Figure 77
QuadGuard® II for Wider
Roadside Obstacles

Notes:

Notes:



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