



X-TENSION 350 Guardrail End Terminal Median

Installation Manual for Median Applications

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SMARTER SAFETY SOLUTIONS



Table of Contents

Introduction	3
System Overview	3
Before Installation	3
Limitations and Warnings	4
Safety Statements	4
Parts Identification	5
Preparation	7
Soil Conditions	7
Tools Required	7
Before Starting	7
X-TENSION 350 Median Installation	8

Maintenance

Traffic Face Impact	21
Head on Impacts	22

APPENDIX - Drawings

X350M - X-Tension 350 Median Composite Blockout to Steel Post	23
X350-1 - X-Tension 350 Median Composite Blockout to Steel Post details	24



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X-TENSION 350 Median

Introduction

The X-TENSION 350 Median Guardrail End Terminal has been designed and tested to meet the evaluation criteria of NCHRP 350 Test Level 3 (TL-3). The system has been tested to the guidelines in NCHRP 350 for a non-gating, re-directive guardrail end treatment. When correctly installed and maintained, the system is capable of stopping, containing, or re-directing an errant vehicle in a safe manner under NCHRP 350 impact conditions.

The X-TENSION 350 Median Guardrail End Terminal is a fully re-directive, non-gating guardrail terminal end. The unique X-TENSION 350 Median technology is a tension based solution rather than compression based. It offers exceptional vehicle control and energy absorbing capabilities in head on impacts, where the energy is absorbed with resistance at the impact head rather than being transferred down the rail as occurs with other systems. Even head on, high angle (15° during testing) impacts on the nose resulted in the vehicle being redirected and controlled.

System Overview

The X-TENSION 350 Median Guardrail End Terminal is designed and constructed to provide acceptable structural adequacy, minimal occupant risk and safe trajectory as set forth in NCHRP 350 for guardrail terminal ends.

When impacted head on with an 820 – 2,000kg vehicle at speeds of up to 100kph the impacting vehicle is brought to a controlled stop or allowed to penetrate to the back side, depending on the impact conditions.

Before Installation

Placement and use of the X-TENSION 350 Median Guardrail End Terminal should be done in accordance with the guidelines and recommendations set forth in the “AASHTO Roadside Design Guide”, FHWA memoranda and other government and local standards.

Depending on the application and circumstances at the site, installation and assembly of a TL-3 system should take a two-person crew less than two hours.

The X-TENSION 350 Median Guardrail End Terminal is a highly engineered safety device made up of a relatively small number of parts. Before starting installation ensure that one is familiar with the make of the system.

Limitations and Warnings

The X-TENSION 350 Median Guardrail End Terminal has been rigorously tested and evaluated per the recommendations in the NCHRP 350 guidelines for terminals. The impact conditions recommended in NCHRP 350 are intended to address typical in-service collisions.

When properly installed and maintained, the system is capable of containing and re-directing impacting vehicles in a predictable and safe manner under the NCHRP 350 impact conditions.

Vehicle impacts that vary from the NCHRP 350 impact conditions described for guardrail end terminals may result in significantly different results than those experienced in testing. Vehicle impact characteristics different than or in excess of those encountered in NCHRP 350 testing may result in system performance that may not meet the NCHRP 350 evaluation criteria.

Safety Statements

General Safety

All required traffic safety precautions should be complied with. All workers should wear required safety clothing (high visibility vests, steel capped footwear, gloves, hard hats, safety glasses etc.)

All underground services must be located before installation of any posts.

Only authorised trained personnel should operate any machinery. Where overhead machinery is used, care must be taken to avoid any overhead hazards.

Gloves should be worn at all times. Particular care should be taken to avoid galvanising spikes.

X-TENSION 350 Median Safety Statements

All installers must be well clear of post driving machinery when in use.

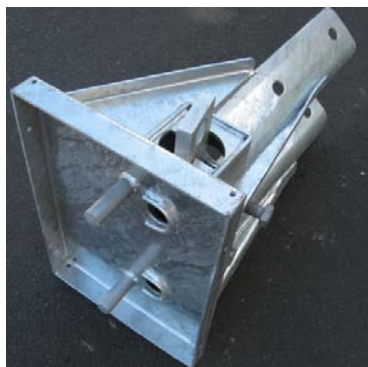
Avoid placing hands or fingers in and around moving parts when components are being lifted and maneuvered into place. (i.e. around splice holes, etc.)

One person only should fit the cables. Other workers should stand clear to avoid being caught in moving cables.

Securely fasten the impact head and rail before turning the friction plate.

The friction plate should be turned manually with a crow bar and extension handle. Do not attempt to turn it with the assistance of machinery. Ensure crow bar is securely held while the 4 locking bolts are tightened. Safe lifting methods must be employed when handling components of the system that weigh more than 20kg. These components are the Impact Head, Soil Anchor, Ground Strut, Post 1 Bottom and the Highway Rail.

X-TENSION 350 Median Parts Identification



Impact Head
(1 required)



Friction Plate
(1 required)



Soil Anchor
(1 required)



Slider Bracket + Angle Bar
(2 required)



Cable Bracket
(1 required)



Cable Assembly
(2 required)



Slider Panel
(2 required)



Post 1 – Top
(1 required)



Ground Strut
(1 required)

X-TENSION 350 Median Parts Identification continued



Post # 2
(1 required)



Standard Steel Line Post (3-6)



Post # 1 Bottom
(1 required)



Standard highway rail
(5 required)



Median Radius rail 1
(1 required – shop curved)



Median Secondary Head
(1 required)



Shear Bolts
(16 required)



Plastic Blockout
(10 required)



Hardware set



Nose Cone

X-TENSION 350 Median - Preparation for all Applications

Before installing an X-TENSION 350 Median, ensure that all materials required for an 11.43m system are on site and have been identified. See parts identification sheet.

Ensure that the area where the X-TENSION 350 Median is to be installed is flat enough so that the soil anchor will not protrude more than 100mm from ground level, when measured with a straight line over a 1.5m cord. The maximum slope should not exceed 7%. Slopes above this may cause the terminal to behave differently in a vehicle impact to what was tested. Minor site grading may be required.

Soil Conditions

The X-TENSION 350 Median has been designed for installation in Median locations and in soil that meets or exceeds the AASHTO “standard soil” specification. If rock is encountered during post installation, refer to local road controlling authority specifications.

Tools Required

The same tools required to install standard highway guardrail will also install an X-TENSION 350 Median.

Specifically: Sockets (commonly used in Guardrail), Drill, Wrenches, Large Crow Bar, String line, Level, Augers, Tampers and Post Pounders commonly used in driving posts.

Before Starting

For all applications, begin the installation from the downstream end of the terminal at the point where it joins the standard guardrail (post 7).

The median application X-TENSION 350 Median connects directly to standard steel post , W-beam highway guardrail.

Follow step-by-step instructions for the appropriate application.

Important note about posts and blockouts:

Median system:

Posts 1 & 2 are always crimped steel

Posts 3 – 6 are standard steel I beam posts

Blockouts are composite plastic

X-TENSION 350 Median - Installation Instructions

This section deals with installation of a X-TENSION 350 Median system as a median guardrail terminal end application.

Step 1 - Site preparation

The Median X-TENSION 350 system is installed parallel to the standard median barrier therefore no offset is used (Figure 1).

Ensure that the area where the X-TENSION 350 Median is to be installed is flat enough so that the soil anchor will not protrude more than 100mm (preferred 75mm) from ground level when measured with a straight line over a 1.5m cord. Minor site grading may be required.

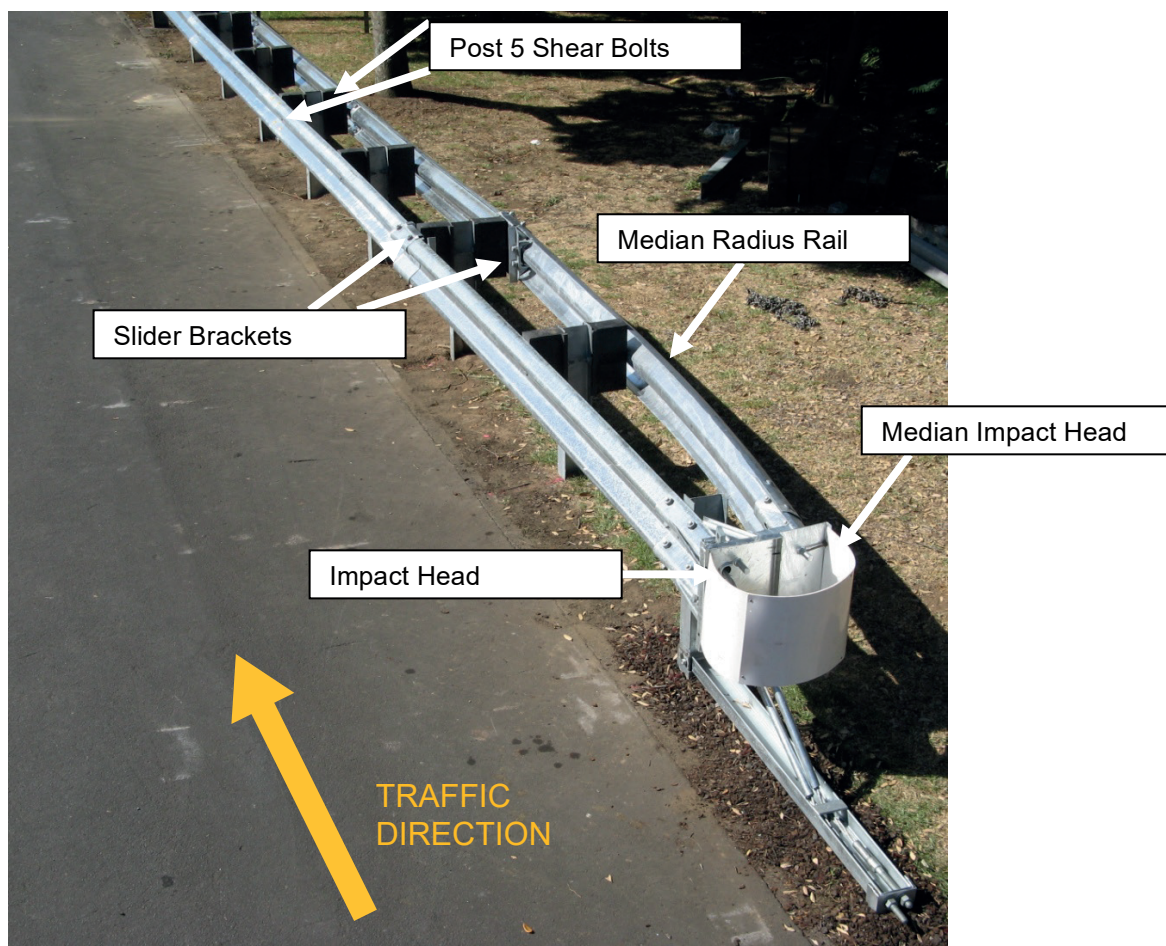


Figure 1. X-TENSION 350 Median installation

The X-TENSION 350 Median is essentially one Tangent X-TENSION 350 installed parallel to one side of the median barrier (Figure 2), with a small number of additional components and rail attached parallel with the other side of the barrier (Figure 3).

Determine which side of the barrier will have the Tangent X-TENSION 350 portion of the Median X-TENSION 350 installed parallel to it. (Usually the side that has the heaviest volume of traffic).

Pull a string line out the length of the system, parallel with the median barrier posts. The string line should be set to follow the side of the posts, on the side that it is desired to install the tangent X-TENSION 350.



Figure 2. Essentially a tangent system installed parallel to Median barrier



Figure 3. Small number of additional components

Step 2 - Installing Tangent X-TENSION 350 Portion

For median applications follow steps 2 – 13, for the Tangent X-TENSION 350 with the following exceptions.

(1) DO NOT set post 3 back 40-50mm as per the instructions in Step 2 of the Tangent installation instructions. For the median application, Post 3 remains parallel with the other line posts.

(2) As noted on page #7, Post 2 must be steel crimped and Post 3-6 are always standard steel I-beam posts.

Step 2 - Installing Posts 6 - 2

Install posts 6 to 2 at standard highway rail spacing 1905mm, to the correct height.

Posts #6 to #3 are standard “I” beam posts. Post 2 is the special crimped “I” beam post (see parts identification photo).

Posts may be directly driven, or in stiff soils a 150mm diameter hole drilled, and the post then driven into the hole. The post may also be placed in an oversized augured hole but care must be taken to ensure the backfill is properly compacted.

When driving steel posts, ensure that a driving cap with timber or plastic insert is used to prevent damage to the galvanising on the top of the posts.

Ensure that Post 2 has the post bolt **holes** on the side nearest the rail, **notches** go to the backside as shown and are only used on the Median application (Figure 5).

Bolt the blockout to the post at post 3, prior to attaching to the rail (Figure 6).



Figure 4. Pull a string line with the desired offset



Figure 5. Notches go to the backside



Figure 6. Bolt the blockout prior to attaching the rail

Step 3 - Post 1, Ground Strut and Soil Anchor

Place the roadside face of post 1 bottom anchor, 200mm towards the roadway to compensate for the lack of blockout (Figure 7). Post 1 bottom the Ground Strut and the Soil Anchor are then placed parallel to the string line at this roadside offset position. Drive or place the bottom of post 1 in the augured hole so that no more than 75mm (100mm max) protrudes above ground level.

Use the Ground Strut as a template to place the Soil Anchor in the correct place. The Soil Anchor can then be driven into place or placed in an augured hole and backfilled. The Ground Strut should be level or lower at the anchor end than at the post 1 bottom end (Figure 8).

Place post 1 top in the post 1 bottom anchor ensuring that the post bolt notches are at the top and facing the Soil Anchor (Figure 9). Use M16 x 200mm hex head bolt with nut and washers. **Do not over tighten bolt.**



Figure 7. Measure 200mm towards roadway



Figure 8. Drive soil anchor into augured hole



Figure 9. Post 1 top in post bottom

Step 4 - Hang Rail 3 and Cable Anchor Bracket

Rail 3 is installed like standard guardrail with post 6 at the centre of the rail and blockouts between the rail and post.

Place the Cable Anchor Bracket on the back of the rail at the joint between rail 3 and rail 4 (post 7) refer to Figure 6. Figure 6A shows the bracket once X350 is fully installed.

The two “boxes” on the cable bracket should be on the impact head side of the splice joint.

Attach rails to post with post bolt and splice rail 3 to rail 4 with 8 standard splice bolts.



Figure 10. Cable Anchor Bracket on back of rail 3



Figure 10A.
Cable Anchor
Bracket post X-350
installation

Step 5 - Hang Rail 2 and Shear Bolts

Before installing rail 2 double check that the blockout is already bolted to post 3.

Bolt rail 2 to the post and blockouts at posts 4 and 5 with the appropriate post bolt (Figure 11). **DO NOT BOLT THE RAIL TO POST 3.**

Splice rail 2 to rail 3 with **the 8 special shear bolts (yellow)** supplied (Figure 12). Put the washer and nut on inside of rail.

IMPORTANT NOTE: DO NOT USE STANDARD SPLICE BOLTS AT POST 5 SPLICE



Figure 11. Bolt rail 2 to post and blockout



Figure 12. Splice rail 2 to rail 3 with 8 special shear bolts

Step 6 - Attach Slider Bracket to Rail 2

Bolt the Slider Bracket to the end of rail 2 at post 3 (Figure 13). Use 4 standard splice bolts. The angle bar end should be closest to the Impact Head end. **Remove the angle bar and 2 x M20 x 40mm bolts (Figure 14).**



Figure 13. Bolt Slider Bracket to end of rail 2 at post 3



Figure 14. Remove angle bar bolts

Step 7 - Assemble Slider Panel onto Rail 1

Start by sitting rail 1 on a blockout or post so that it is raised off the ground as shown (Figure 15). Slide the Slider Panel onto the downstream end of rail at post 3 location (Figure 16) and bolt into place using 4 standard splice bolts, pushing the bolt through from the inside of the slider to the outside so that the **nut is on the traffic face**.

The curved and reinforced (post breaker) end of Slider Panel sits at the rail end. Use guardrail pin bar or crow bar to assist with lining up splice holes.



Figure 15. Sit rail 1 so it is raised off the ground



Figure 16. Slide the Slider Panel onto downstream end

Step 8 - Hang Rail 1

Lift rail 1 with Slider Panel attached and push the slider end over rail 2 (Figure 17). Overlap the rails as per a standard splice joint overlap.

Bolt rail 1 and blockout to post 2 using a standard post bolt that is supplied (Figure 18).

Re-attach the angle bar to the slider bracket on the backside of the rail (Figure 19).



Figure 17. Push Slider Panel over rail 2



Figure 18. Bolt rail 1 and blockout to post 2



Figure 19. Reattach the angle bar

Step 9 - Attach Impact Head

Place Impact Head on upstream end of rail 1 and attach using 8 standard splice bolts with nuts on traffic face (Figure 20). **Hint:** Place bottom two bolts first then use guardrail pin bar to lever head up snug onto rail.

Bolt head and rail 1 to post 1 using the supplied M16 x 50mm guardrail post bolt. Use a 50mm x 50mm washer under the M16 small nut on the inside of post 1 (Figure 21).



Figure 20. Attach Impact Head to rail 1



Figure 21. Bolt head and rail 1 to post 1 with washer

Step 10 - Place the Cables

Push the cables under the steel strap on the Ground Strut (Figure 22) and forward through the holes at the top of the anchor. Lay the cables out parallel to the guardrail, downstream from the anchor.

Ensure that bottom cable (closest to road) has half the thread protruding through the anchor, as shown. Ensure the top cable has the nut wound on a least two turns past the end of the thread (Figure 23).



Figure 22. Push cables under steel strap on Ground Strut



Figure 23. Thread the nuts as shown

Step 11 - Installing the Cables

Install the Friction Plate in the top of the Impact Head, adjustment hole up. Take the cable closest to the road, pick up the downstream cable fitting and walk to the head, passing the cable through the bottom hole, through the Friction Plate (Figure 24) and out the backside of the Impact Head.

Now thread the cable down the backside of the rail following the bottom trough of the W-beam and attach to the bottom “box” on the Cable Bracket at post 7. Repeat this process with the other cable but push it through the top hole and thread it along the top trough of the W-beam.

Place the nuts and washer on the cables at the Cable Bracket end but only run them a few turns. (Figure 25). **Do not tighten cables at this stage (or the Friction Plate will not turn).**



Figure 24 Pass the cable through the bottom hole



Figure 25. Do not tighten nuts at this time

Step 12 - Turning the Friction Plate

Put a crow bar through the hole at the top of the friction plate (Figure 26) and turn in the slot as far as it will go. Using a socket spanner tighten the 4 - M20 x 75mm bolts on the side of the impact head to lock the bar in the turned position (Figure 27).



Figure 26. Use crow bar to turn Friction Plate

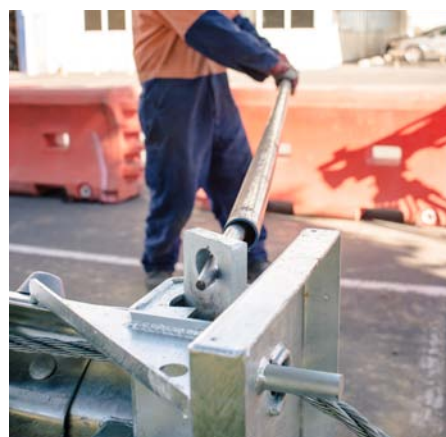


Figure 27. Use socket to lock bar in turned position

Step 13 - Tightening the Cables

Only tighten the cables using the nuts at the Cable Bracket end (post 7) (Figure 28). **Do not tighten the cable nuts at front of the Ground Anchor.**

Tighten the cables until they are taut, i.e. they rest in the backside of the W-beam and do not visibly sag between posts (Figure 29). There is no torque requirement for the cables.



Figure 28. Tighten cables at Cable Bracket end (post 7)



Figure 29. Tighten cables until they are taut

Step 14 - Attach Secondary Impact Head

Fit secondary head to main head by pushing sideways onto the main head as shown below (Figure 30), until the holes in the gussets line up. Fix into place with either the 25mm pin and pin lynch, or 2 M24 x 50mm bolts as shown (Figure 31).



Figure 30. Fit secondary head to main head

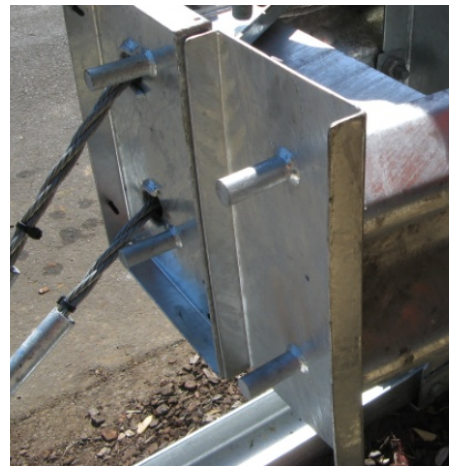


Figure 31. Fix secondary head into place

Step 15 - Attach Backside Rail #3 and Rail #2

Rails 3 and 2 are installed like standard guardrail with blockouts between the rail and post (Figure 32). Attach rails to post 2, 4, 5, 6 and 7 with blockouts and post bolts supplied (do not bolt the rail to post 3). Splice rail 3 to rail 4 with 8 standard splice bolts. At post 7, lap rail in the direction of traffic as per standard Median barrier.

Ensure that rail 2 is spliced to rail 3 using the special shear bolts (yellow head) supplied. DO NOT use standard splice bolts at this joint (Figure 33). Be sure rail 2 is lapped outside rail 3 in both directions.



Figure 32. Rails installed with blockouts



Figure 33. Splice rail 2 to rail 3 with 8 special shear bolts

Step 16 - Attach Slider Bracket to Backside Rail 2

Bolt the Slider Bracket to the upstream end of rail 2 (at post 3) using 4 standard splice bolts. The angle bar end should be closest to the Impact Head end.

Remove the angle bar and 2 M20 X 25mm bolts.

Step 17 - Assemble Slider Panel onto Backside Rail 1

Raise the straight end of the curved median radius rail 1, as per parts identification, and fit the Slider Panel onto the downstream (straight) end of rail (Figure 34). Bolt into place using 4 standard splice bolts, pushing the bolt through from the inside of the slider to the outside so the **nut is on the traffic face**.

The curved and reinforced (post breaker) end of Slider Panel sits at the rail end. Use guardrail pin bar or crow bar to assist with lining up splice holes.



Figure 34. Fit the Slider Panel onto the straight end of rail

Step 18 - Hang Curved Backside Rail #1

Lift rail 1 with Slider Panel attached and push the slider end over rail 2.

Bolt rail 1 and blockout to post 2 using supplied standard post bolt and 50x50mm washer on inside of post bolt notch on the backside of post 2 (Figure 35).

Re-attach the angle bar to the Slider Bracket (Figure 36) on the backside of the rail (at post 3).



Figure 35. Bolt rail 1 and blockout to post 2 using the square washer



Figure 36. Re-attach the angle bar to the Slider Bracket

Splice the rail to the secondary impact head using 8 standard splice bolts (Figure 37).



Figure 37. Use 8 standard splice bolts

Step 19 - Attach Nosing and Nut Protectors

Push nosing into place on the front of the main impact head. Attach using the supplied nylon push rivets (Figure 38). Delineation to be attached to nosing, as per local roading authority requirements.

The X-TENSION 350 Median Plastic Nut Protectors are available for all X-TENSION 350 Median Terminal Ends. They protect pedestrians and cyclists from exposed splice bolt nuts and threads. Fit 8 Nut Protectors on the Impact Head (Figure 39) and 4 on Slider Panel.



Figure 38. Attach nose cone using cable nuts



Figure 39. Nut Protectors fitted on Impact Head

X-TENSION 350 Median Maintenance (Traffic Face Impacts)

**Types of repair are divided into two categories:
Traffic Face Impacts and Head on Impacts (Next Page)**

Traffic Face Impacts

Key Repair Steps:

1. Remove cables
2. Remove damaged rail
3. Remove components from rails
4. Remove damaged posts
5. Assess damage
6. Reassemble

Step 1: Remove Cables

Undo nuts at downstream cable bracket (post 7). Take out the bolts on the side of the impact head that hold the friction plate in place and rotate the locking bar backwards. Pull one cable at a time from the front side of the impact head and completely remove them. Rotating the cables as you pull them will help. Undo nuts at ground anchor end and remove cables.

Step 2: Remove Rails

Unbolt the splice bolts first. Then unbolt the post bolts and lower rails to ground.

Step 3: Remove X-TENSION 350 Median Components

All the X-TENSION 350 Median components are attached to the rails with standard splice bolts. Unbolt and remove the components.

Step 4: Remove Posts

Undo the bolt at the bottom of Post 1 and pull out post. For all other damaged line posts, attach a chain to the top half of the post and pull out of the ground with either a crane truck or digger.

Step 5: Assess the Damage

Any part that cannot be reused must be replaced with a new part. Always replace the yellow shear bolts. Cables can be reused. Generally, all the specialised components of the system such as the head and brackets should be undamaged.

Step 6: Reassemble

Reassemble as per system installation instructions.

X-TENSION 350 Median Maintenance (Head on Impacts)

Head on Impacts

Key Repair Steps:

1. Remove the cables
2. Pull the rails back
3. Remove components from rails
4. Remove damaged posts
5. Assess damage
6. Reassemble

Step 1: Remove Cables

After a head on impact the cables may appear to be slack but may in fact still retain some tension from the impact. Care must be taken when removing the cables.

DO NOT UNDO THE CABLES FROM THE GROUND ANCHOR END FIRST, ALWAYS UNDO THE CABLES FROM THE CABLE BRACKET (post 7) FIRST.

Undo nuts at downstream cable bracket (post 7). Take out the bolts on the side of the impact head that hold the friction plate in place and turn the friction plate back. Pull one cable at a time from the front side of the impact head and completely remove them. Rotating the cables as you pull them will help. Undo nuts at ground anchor end last and remove cables.

Step 2: Pull Rails Back Out

Attach a chain or two ton strap to the front of the impact head and pull upstream to its' original position with a light truck or utility vehicle. The components are easier to unbolt when the rails are separated.

Step 3: Remove X-TENSION 350 Median Components

All components are attached to the rails with standard splice bolts. Unbolt and remove parts.

Step 4: Remove Posts

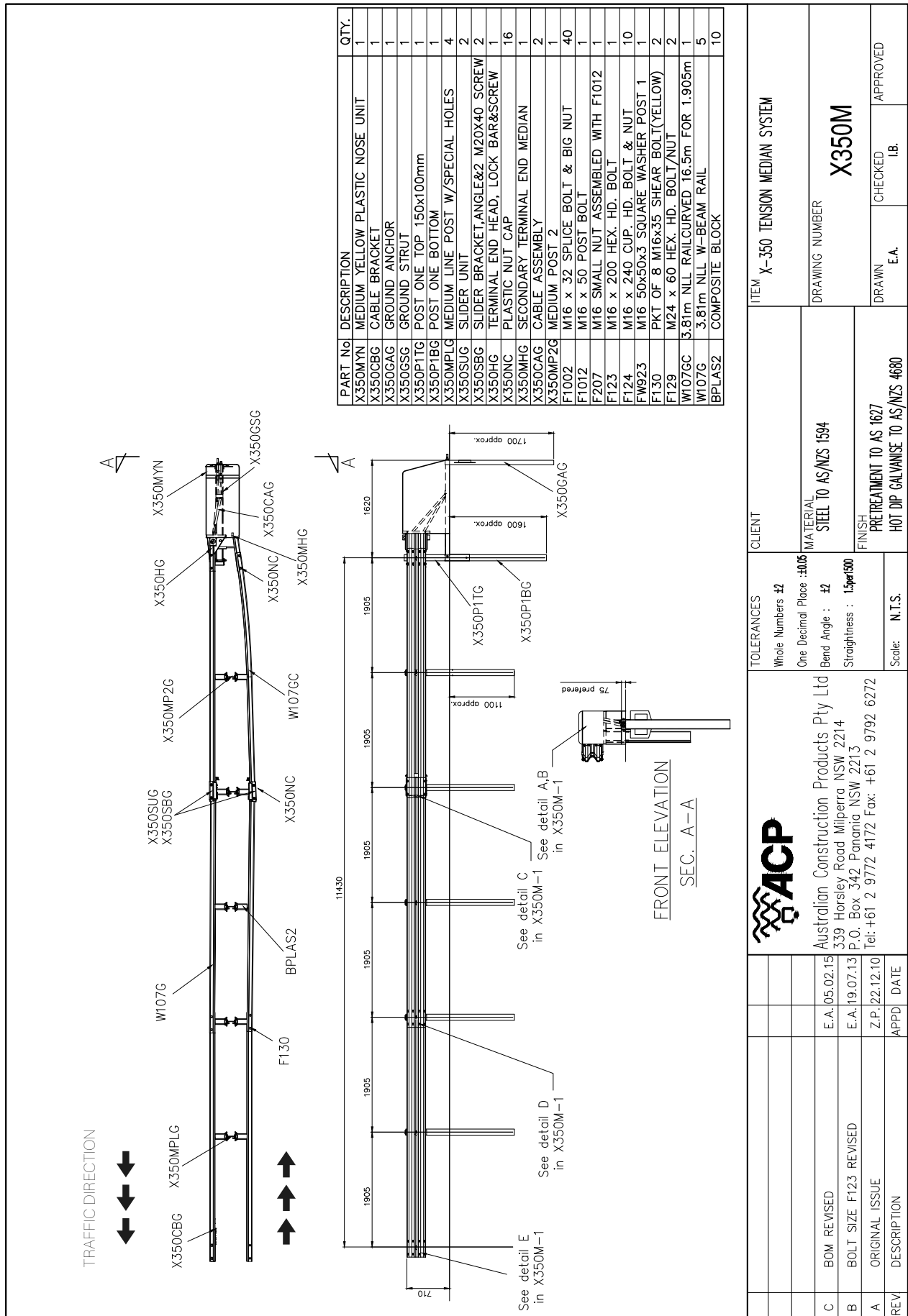
Undo the bolt at the bottom of Post 1 and pull out post. For all other damaged line posts, attach a chain to the top half of the post and pull out of the ground with either a crane truck or digger.

Step 5: Assess The Damage

Any part that cannot be reused must be replaced with a new part. In minor impacts (rails telescoped less than 3m the cables can be reused by turning them end for end. If additional damage has occurred, replace the cables. Generally, all the specialised components of the system such as the head and brackets should be undamaged.

Step 6: Reassemble

Reassemble as per system installation instructions.



DETAIL A
EXTENDED PLASTIC NOSE REMOVED FOR EXTRA VIEWING

DETAIL B

DETAIL C

DETAIL D

DETAIL E

ITEM X-350 TENSION MEDIAN DETAILS

DRAWING NUMBER X350M-1

DRAWN E.A. **CHECKED** I.B. **APPROVED**

CLIENT

TOLERANCES
Whole Numbers : ±2
One Decimal Place : ±0.05
Bend Angle : ±2
Straightness : 1.5per100
Scale : N.T.S.

MATERIAL
STEEL TO AS/NZS 1594
FINISH
PRE-TREATMENT TO AS 1627
HOT DIP GALVANISE TO AS/NZS 4680

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