

INFORMATION HANDOUT

For Contract No. 04-4A2604

At 04-Ala,CC-4, 80, 84, 580, 680-Various

Identified by

Project ID 0400001122

MATERIALS INFORMATION

Installation Instructions for the FLEAT 350

SRT-350 Specifications and Drawings

X-Tension Guardrail Terminal End General Specifications

Installation Instructions for the SKT 350

ET-Plus Specifications and Drawings

Installation Instructions
for the
FLEAT 350



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This Installation Manual can be downloaded from RSI web site
www.roadsystems.com

ADDENDUM

June 2001

The FLEAT may now be installed with **all 6'-3" post spacing**. This approval is good for a wood post system or a steel post system. Previously, the middle 12'-6" panel had 4'-2" post spacing.

Although the post spacing is now all 6'-3", the FLEAT still has 7 breakaway posts. This is because there is now a breakaway post at the 37'-6" downstream location where the flare begins.

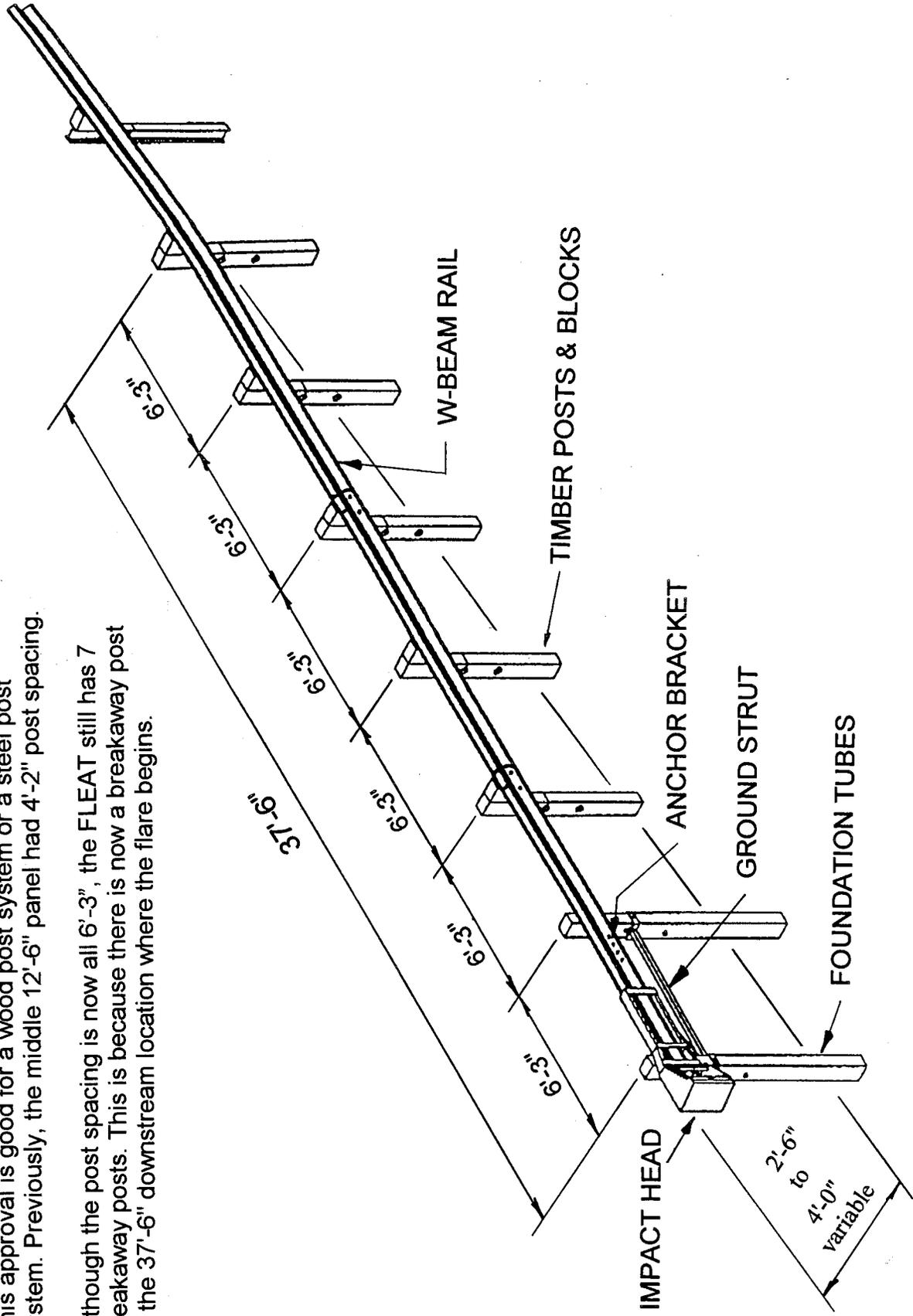


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PUBLICATION ~ 020205

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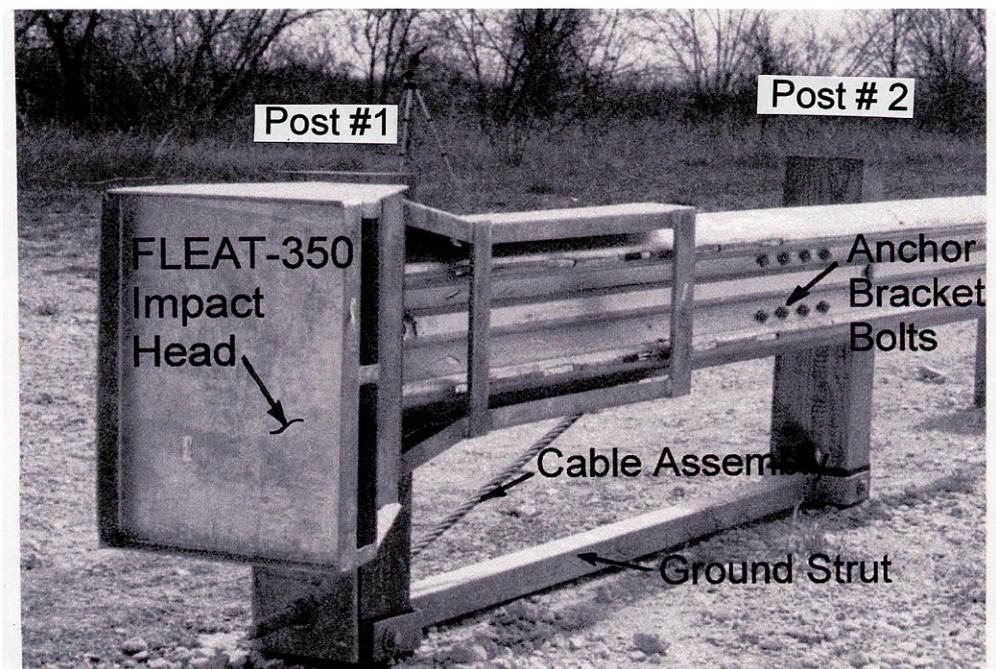
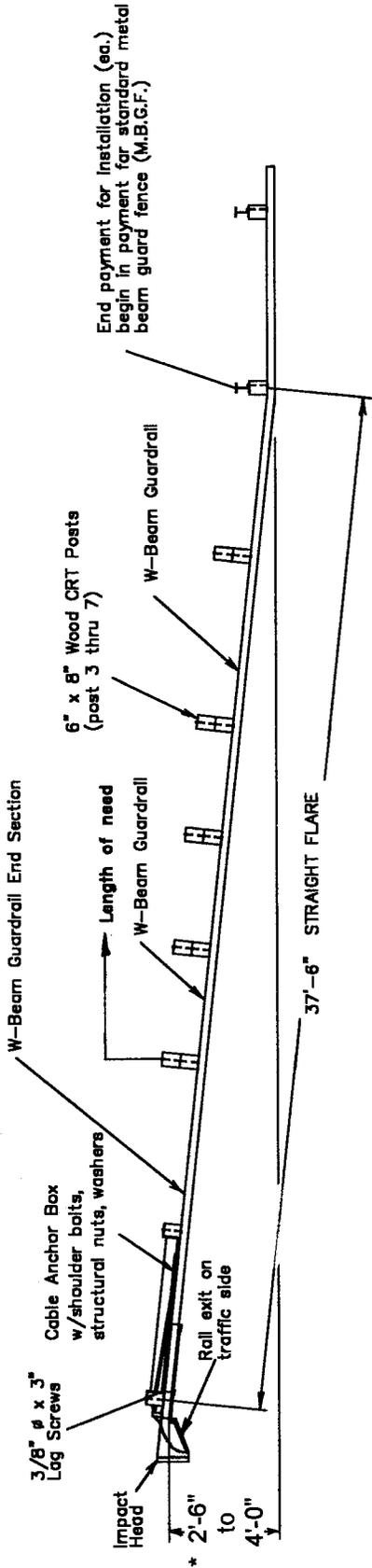


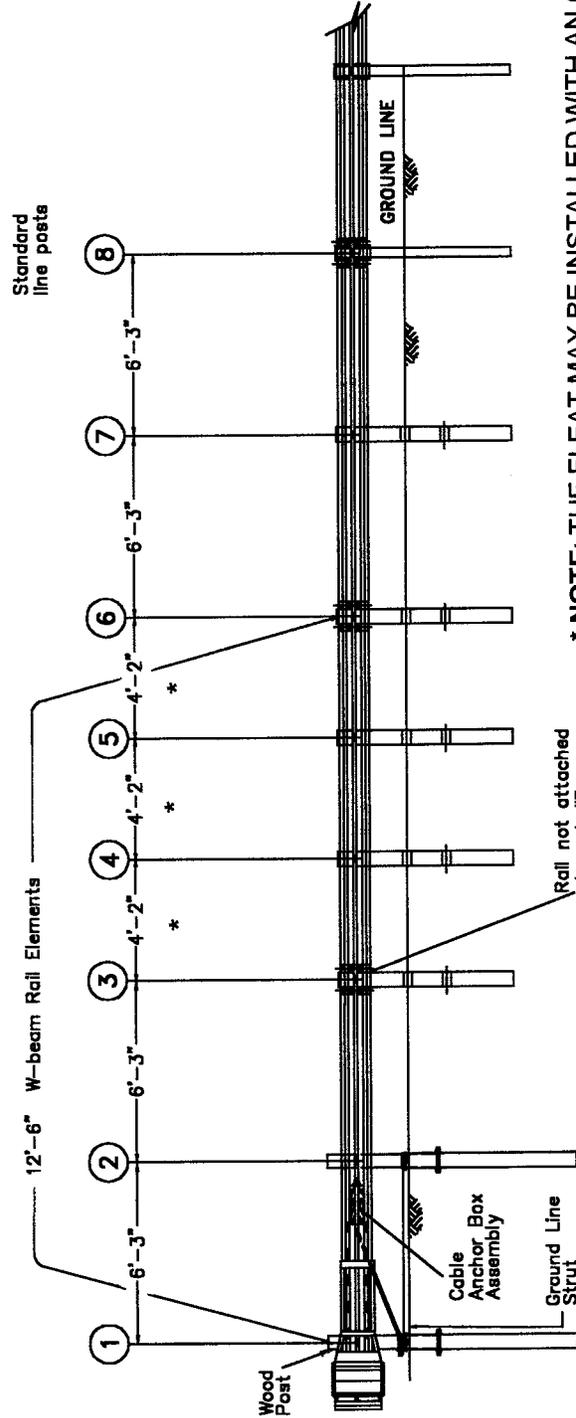
Figure 1. Isometric view of the *FLEAT 350*.



PLAN

* OPTIONAL ALL 6'-3" POST SPACING IS ALLOWABLE

TRAFFIC →



ELEVATION

* NOTE: THE FLEAT MAY BE INSTALLED WITH AN OFFSET ANYWHERE BETWEEN 2'-6" AND 4'-0". REFER TO THE CONTRACT PLANS FOR THE REQUIRED OFFSET.

NOTE: Posts 1 and 3 that are not bolted through the rail should be driven with sufficient accuracy that the slot in the rail is aligned with the post bolt hole after installation.

Figure 2. Plan and Elevation Views of FLEAT 350.

Installing the *FLEAT 350*

Materials

As packaged, the *FLEAT 350* system includes all materials needed for a complete installation except for the impact face object marker. The length of the system in this configuration is 37'-6".

Design Options

There are four foundation tube options as shown in **Table 1** below.

Table 1. *FLEAT 350* Design Options

<i>FLEAT 350</i> Design Options	Total Foundation Tubes	Number of Standard BCT Posts	Number of CRT Posts	Total Number of Posts
6'-0" split Foundation Tube	2	2	5	7
6'-0" solid Foundation Tube	2	2	5	7
5'-0" or 4'-6" Foundation Tubes with soil plate	2	2	5	7

Figure 6 shows a section with the 6'-0" foundation tubes.

Figure 7 shows a section with the 5'-0" or 4'-6" foundation tubes with soil plates.

Table 2. FLEAT 350 Bill of Materials

Code #	Quantity	Description
F3000	1	Impact Head
F1303	1	W-Beam Guardrail End Section, 12 Ga., 12'-6"
F1304	1	W-Beam Guardrail, Center Section (4'-2" spacing) 12 Ga., 12'-6"
G1203	1	W-Beam Guardrail, (6'-3" spacing) 12 Ga., 12'-6"
S730	2	* Foundation Soil Tubes, 6" x 8" x 6'-0" (SEE NOTE BELOW)
E740	1	Pipe Sleeve - 2" Standard Pipe x 5-1/2"
E750	1	Bearing Plate - 8" x 8" x 5/8"
S760	1	Cable Anchor Bracket
E770	1	BCT Cable Anchor Assembly
E780	1	Ground Strut
P650	2	5-1/2" x 7-1/2" x 45" Wood Posts
P671	5	6" x 8" x 6'-0" Wood CRT Posts
P675	5	6" x 8" x 14" Timber Blockouts
Hardware		* The optional 6'-0" long split foundation tubes may be substituted with either solid 6'-0" long foundation tubes without soil plates or standard 5'-0" long or 4'-6" long foundation tubes with soil plates.
B580122	24	5/8" x 1 1/4" Splice Bolts
B580754	2	5/8" x 7 1/2" Hex Bolts
B581004	2	5/8" x 10" Hex Bolts
B581002	1	5/8" x 10" H.G.R. Post Bolt (Post 2 Only / NO BOLT USED AT POST #1)
B581802	5	5/8" x 18" H.G.R. Post Bolts (Posts 3 through 7)
N050	34	5/8" H.G.R. Nuts (Splice - 24, Soil Tubes - 4, Posts 2 to 7 - 6)
W050	10	5/8" Flat Washers (2 each at Soil Tubes + 6 Posts)
N100	2	1" Anchor Cable Hex Nuts
W100	2	1" Anchor Cable Washers
E350	2	3/8" x 3" Lag Screws
SB58A	8	Cable Anchor Bracket Shoulder Bolts
N055A	8	1/2" A325 Structural Nuts
W050A	16	1-1/16" OD x 9/16" ID A325 Structural Washers

Site Preparation

The *FLEAT 350* is installed with a **straight flare offset anywhere between 2'-6" and 4'-0"**. **Refer to the contract plans for the required offset.** Simply measure the offset distance over the 37'-6" length with a straight string line. This offset becomes the location of post #1. A parabolic curve is **not** required. Minor site grading may be necessary to prevent the foundation tubes from extending more than 4" above the ground (see Section on Installation).

Tools Required

The tools required for installation of the *FLEAT 350* system are those used to install standard highway guardrails (H.G.R.), including: 9/16", 7/8", 15/16", 1-1/4", and 1-1/2" sockets and wrenches, a drill with a 1/4" bit, and other equipment such as augers, tampers, and post pounders commonly used in driving posts.

Installation Procedures

Begin installation at the downstream end of the *FLEAT 350* (post location 8) to ensure that the terminal matches up with the standard section of guardrail. The major steps in the installation of the *FLEAT 350* are as follows:

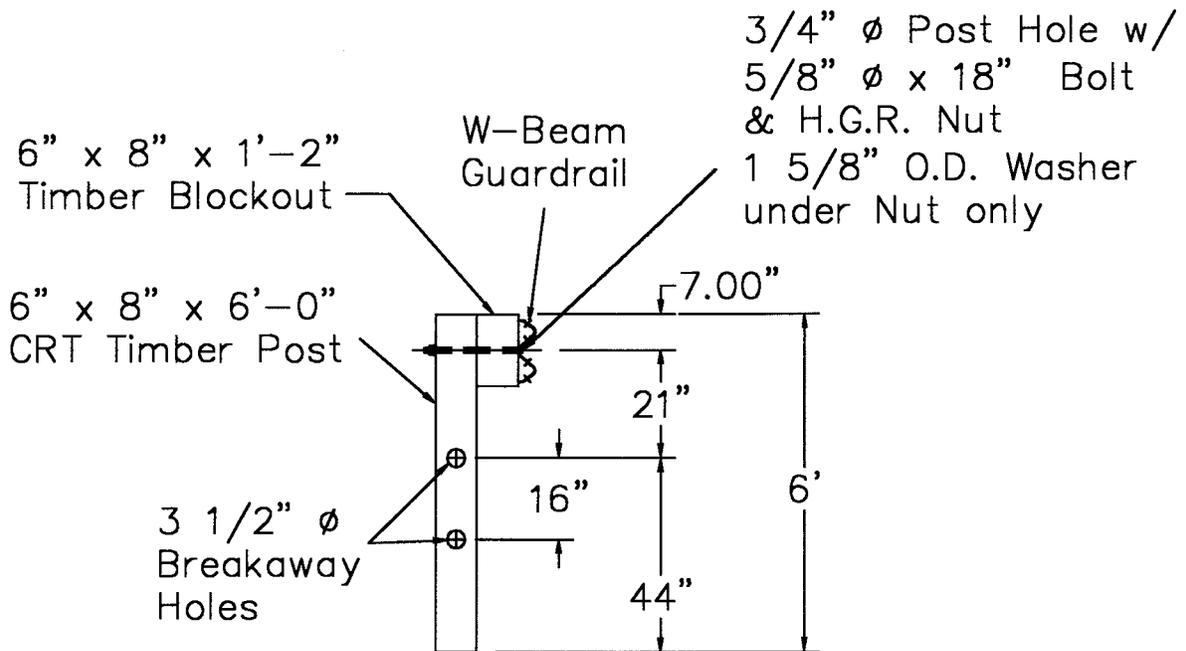
- Install posts 3 through 7,
- Install posts 1 and 2 with groundline strut,
- Install guardrail,
- Install cable anchor bracket,
- Install the *FLEAT 350* impact head, and
- Install cable assembly.

NOTE: The impact head must be placed over the rail prior to tightening the rail to post # 2.

Installing Posts 3 Through 7

Posts 3 through 7 are 6" x 8" x 6'-0" CRT posts (P671). When installed properly, the hole at the ground line of these CRT posts will be parallel to the roadway. **Figure 3** shows the section of a CRT post. The CRT post may be driven with an approved driving head. For stiff soils, drill a 6" pilot hole and force the post to the appropriate depth by impact or vibratory means with an approved driving head. The post may also be installed by augering and backfilling if the contractor so prefers. The initial hole must be large enough to allow adequate room for proper compaction of the soil during backfill. *Care must be taken to carefully compact the backfill to prevent settlement or lateral displacement of the post.*

If rock is encountered during driving or excavation, refer to appropriate State specifications. Guidelines will vary from State to State.



NOTE: THE RAIL IS NOT BOLTED TO POST # 3

SECTION TYPICAL AT POSTS 3 - 7

Figure 3. Section at CRT Post

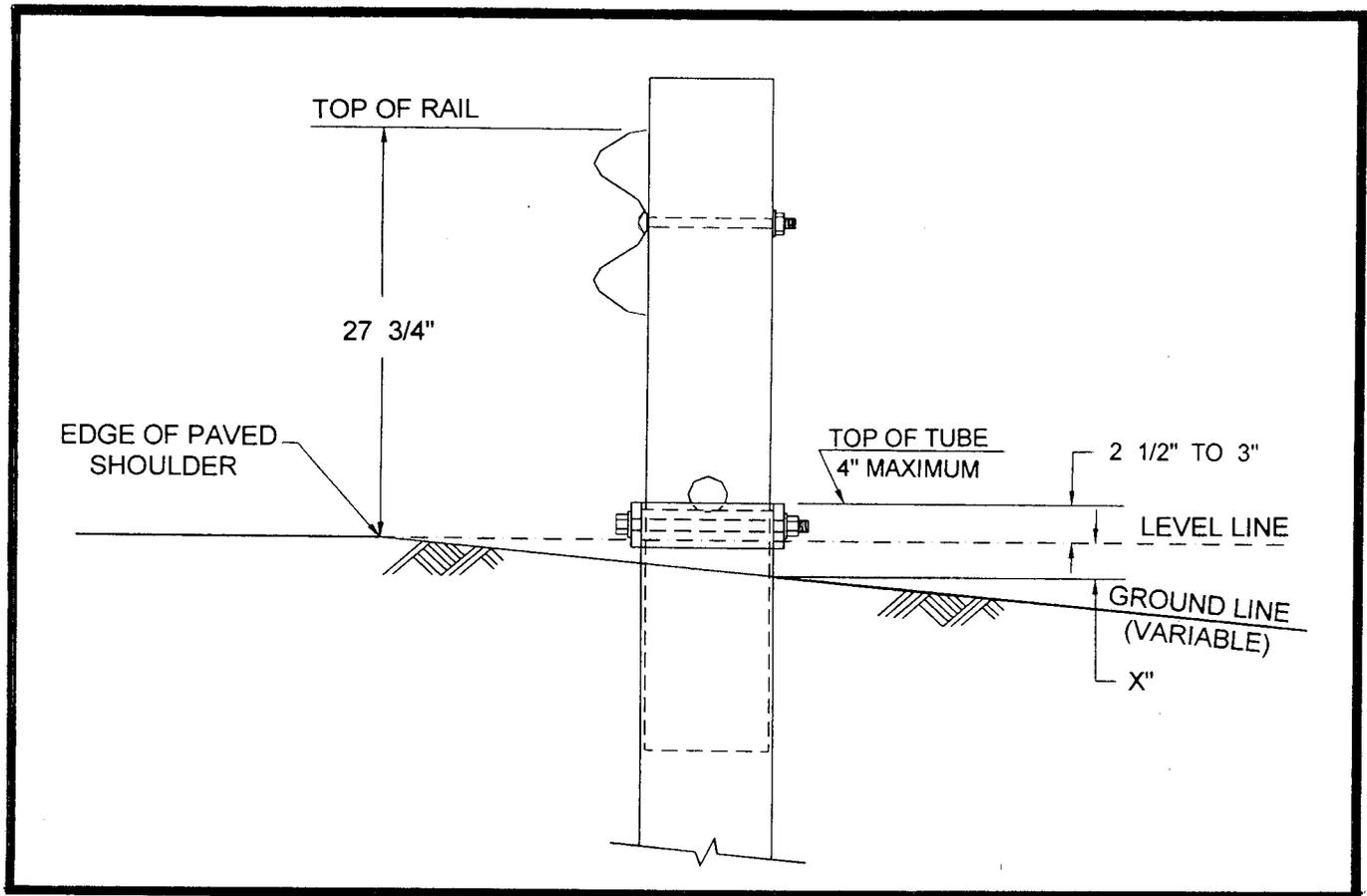


Figure 4. Proper Placement of Foundation Tubes

Figure 4 illustrates the proper placement of the foundation tubes. The top of the foundation tubes should not project more than 4" above the ground line when measured along a 5' cord, according to AASHTO specifications. Site grading may be required if the top of the foundation tubes project more than 4" above the ground line. The finished guardrail height should generally be 27-3/4" above the edge of the shoulder.

Based on a level line from the edge of the paved shoulder, the top of the foundation tube should normally be 2-1/2" to 3" above the level line. The placement of the foundation tube should be an appropriate depth below the level line in order to maintain the 27-3/4" guardrail height from the edge of the shoulder.

If the slope drops off some distance (X ") from the edge of the shoulder to the tube location, as shown in **Figure 4**, the depth of the foundation tube should be reduced by X " in order to maintain the proper guardrail height. The top of the foundation tube will project (X " + 2 1/2") to (X " + 3") above the ground. In order not to exceed the AASHTO 4" maximum projection above the ground, site grading will be necessary to assure that the " X " dimension would not be more than 1 1/2" to 1" respectively.

Installing Posts 1 and 2 with Groundline Strut

Figure 5 shows the above ground details and **Figure 6** shows the section at post locations 1 and 2. Posts 1 and 2 may be installed with either 6'-0" long split foundation tubes (S730) without soil plates, solid 6'-0" long foundation tubes (E731) without soil plates, standard 5'-0" long foundation tubes (S735) with soil plates (SP600) or 4'-6" long foundation tubes (E735) with soil plates (SP600). **Figure 7** shows the optional 5'-0" or 4'-6" foundation tubes with soil plates.

For the **6'-0" long split foundation tube**, fasten one 5/8" x 7-1/2" hex head bolt (B580754) and H.G.R. nut (N050) through the bottom hole of the foundation tube. *Do not over tighten and deform the tube.* The bolt is intended to stop the post from sliding all the way into the tube during installation.

Do not drive the foundation tube with wood post inserted. If the soil is penetrable so that the foundation tube does not deform, the foundation tube may be driven with an approved driving head. For non-penetrable soil, drill a 6" pilot hole and force the tube to the appropriate depth by impact or vibratory means with an approved driving head. The tube may also be installed by augering and backfilling if the contractor so prefers. The initial hole must be large enough to allow adequate room for proper compaction of the soil during backfill. *Care must be taken to carefully compact the backfill to prevent settlement or lateral displacement of the foundation tubes.* If rock is encountered, refer to appropriate State specifications. Guidelines will vary from State to State.

The top of the foundation tubes should not project more than 4" above the ground line when measured along a 5' cord, according to AASHTO specifications (see **Figure 4**).

The installation procedure for the **solid 6'-0" long foundation tubes** without soil plates is the same as that for the split foundation tubes.

The installation for the **standard 5'-0" long foundation tubes** with soil plates or the **standard 4'-6" long foundation tubes** with soil plates is shown in **Figure 7**. Fasten the soil plate to the foundation tube with two 5/8" x 7-1/2" hex head bolts (B580754) and H.G.R. nuts (N050) through the bottom holes of the foundation tubes. *Do not over tighten and deform the tubes.* These bolts attach the soil plate to the foundation tube and stop the post from sliding all the way into the tube during installation.

Insert the pipe sleeve (E740) into the 2 1/2" diameter hole near the base of the 5-1/2" x 7-1/2" x 45" wood post (P650) and install the post in the foundation tube at post location 1. Install the second 5-1/2" x 7-1/2" x 45" wood post in the foundation tube at post location 2, and fit the groundline strut (E780) between the two posts. Secure the post to each foundation tube with a 5/8" x 10" hex head bolt (B581004) and H.G.R. nut (N050) with a washer (W050) under both the bolt head and the nut. These bolts will serve to secure the posts and attach the groundline strut to the foundation tubes, as shown in **Figure 6**.

NOTE that there is
no Bolt at Post #1

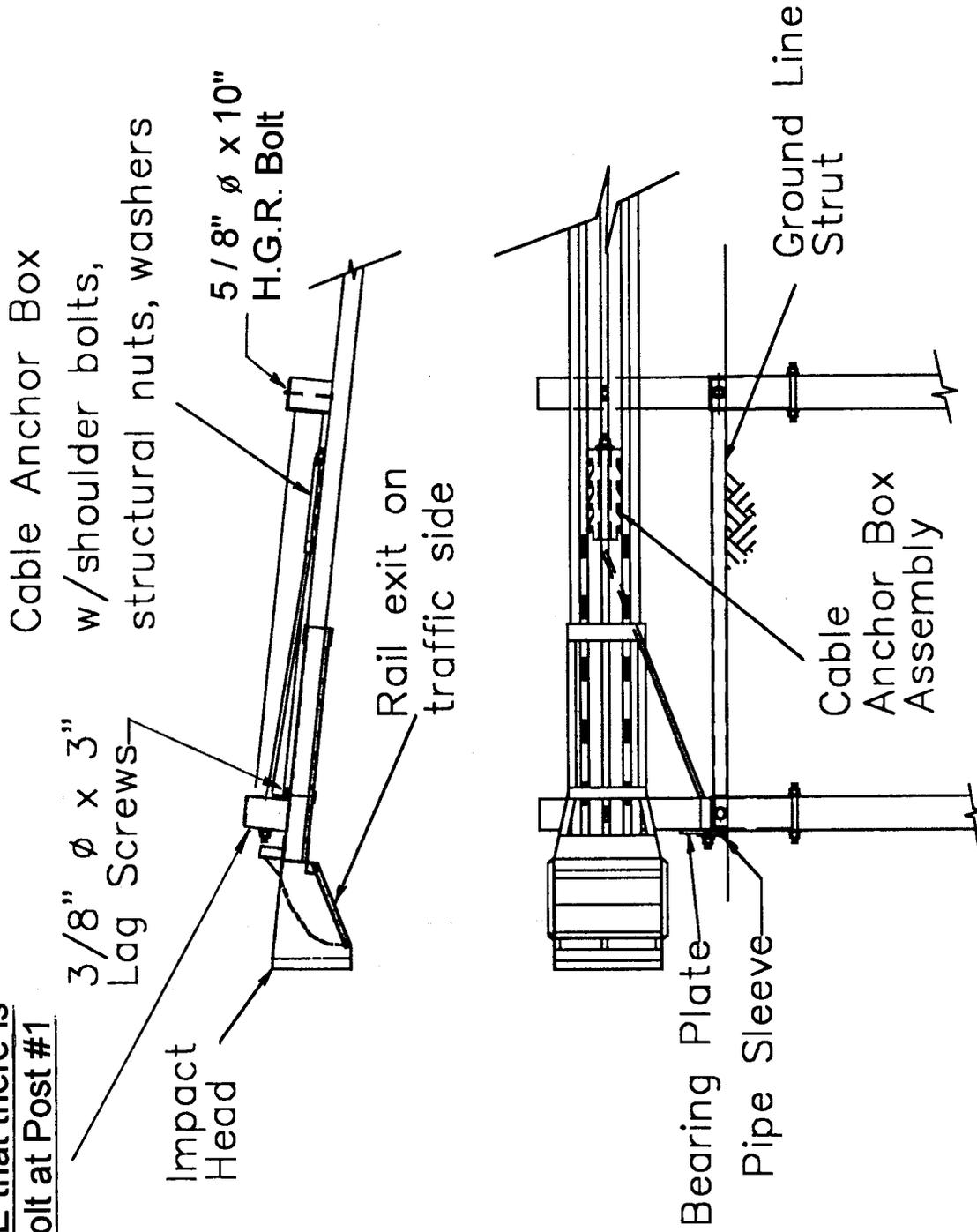
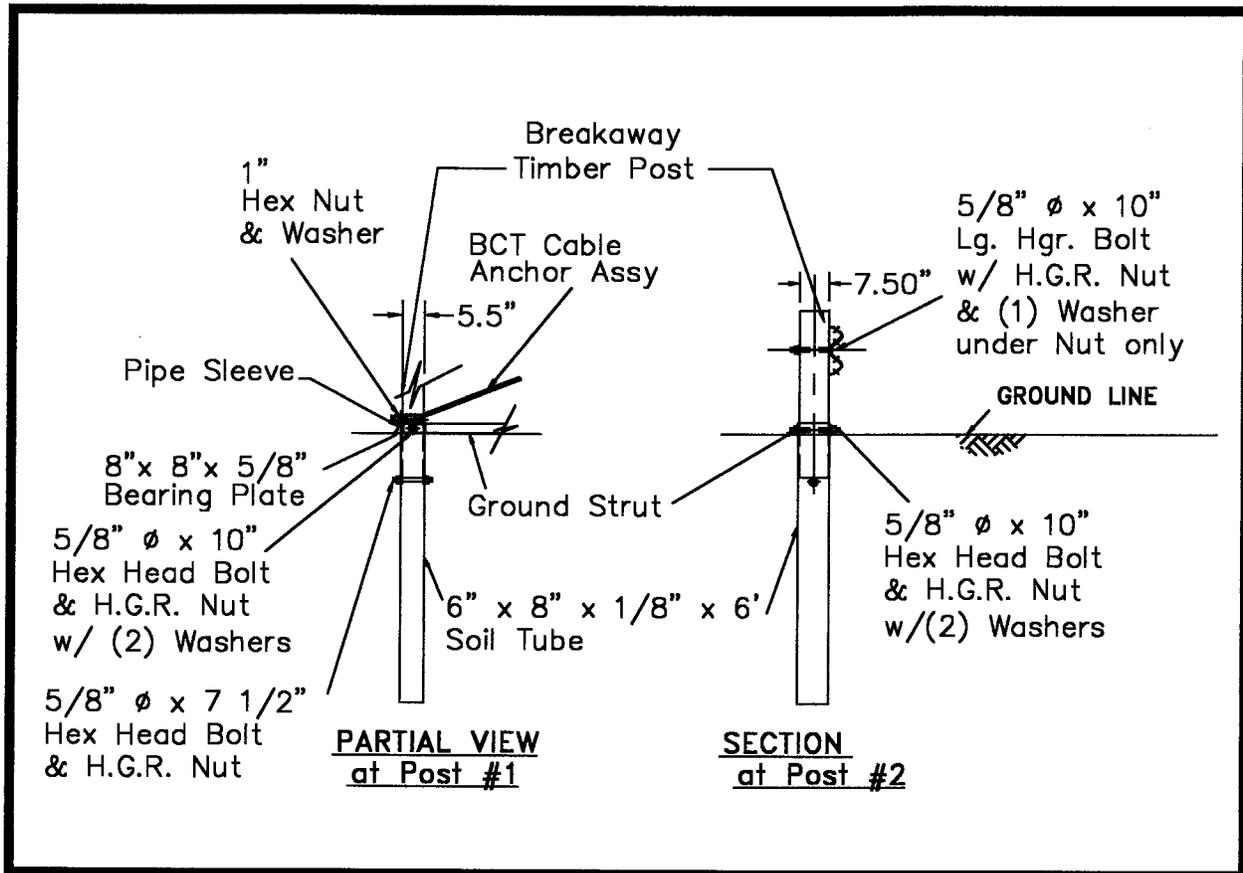


Figure 5. Above-Ground Details at Post Locations 1 and 2.



Note. The optional 6'-0" long split foundation tubes may be substituted with either solid 6'-0" long foundation tubes without soil plates or standard 5'-0" or 4'-6" long foundation tubes with soil plates.

Figure 6. Section at Post Locations 1 and 2.

Deep Beam Guardrail

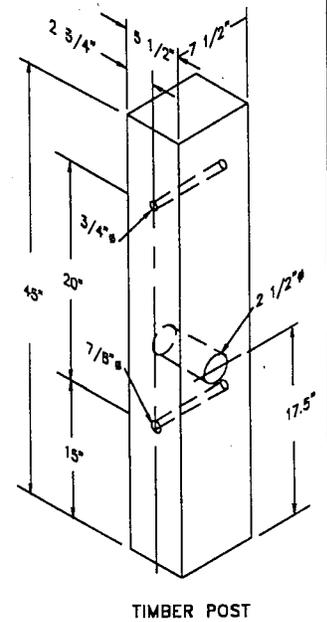
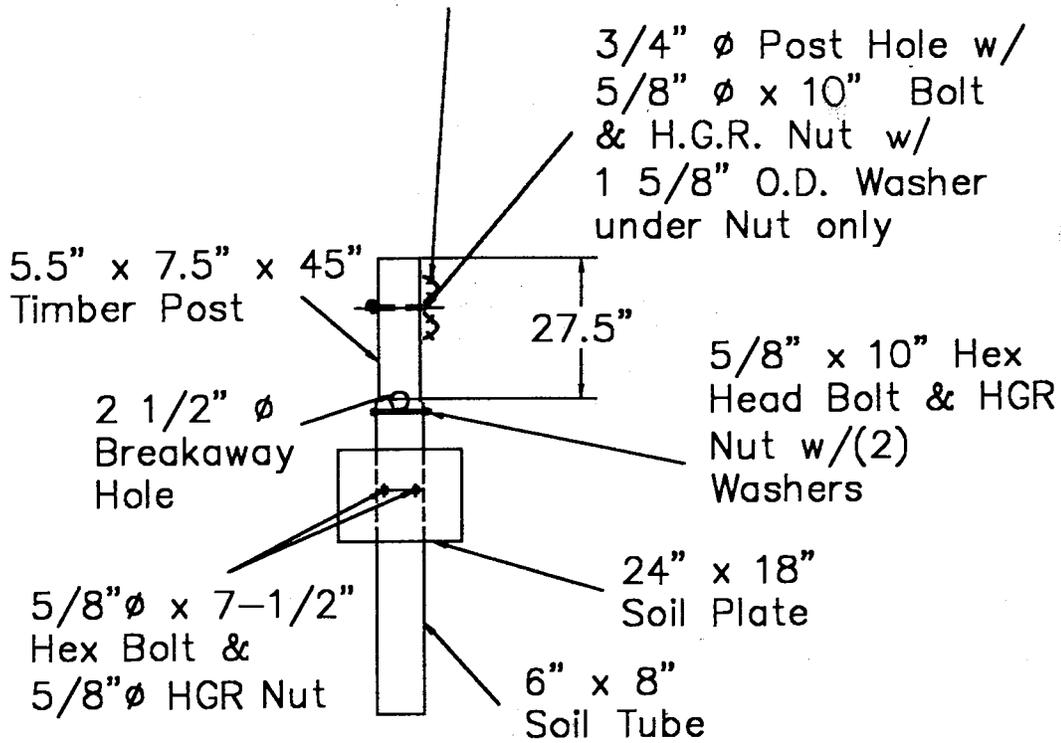


Figure 7. Optional 5'-0" or 4'-6" Foundation Tubes with Soil Plates

Installing Guardrail

The required offset is achieved by first splicing the guardrail panels together and then manually pushing the rails back. Shop curving or bending is not required.

Attach the standard 12'-6" W-beam guardrail section with 6'-3" post spacing (G1203) beginning at post 8 and spanning to post 6. Then attach the standard 12'-6" W-beam guardrail section with 4'-2" post spacing (F1304) which will span from post 6 to post 3. **Note that the rail is not bolted to post #3.** Attach the 12'-6" W-beam guardrail end section (F1303) to span from post 3 to 1. Note that the impact head must be placed over the rail prior to tightening the rail to post # 2. The rail is to be spliced with 5/8" x 1-1/4" H.G.R. bolts (B580122) and 5/8" H.G.R. nuts (N050).

For ease of installation, it is recommended to have the eight 1/2" cable anchor bracket shoulder bolts (SB58A) and the cable anchor bracket (S760) attached to the W-beam guardrail end section prior to attaching the guardrail to the posts. See Section on "Installing Cable Anchor Bracket" for details.

The rails are to be attached to posts and blockouts at post locations 4 through 7 with 5/8" x 18" H.G.R. bolts (B581802) and nuts (N050). **At post location 3, the rail is not bolted to the post.** The bolt only holds the blockout to the post. There is no blockout on posts 1 and 2, and the rail is attached to post 2 only with a 5/8" x 10" H.G.R. bolt (B581002). **Note that no bolt is used at post #1.** Be sure to place a 5/8" flat washer (W050) on the backside of posts 2 through 7 under each nut (N050).

NOTE: After the blockout is attached, drive a galvanized steel 10d common nail through the block and into the post (toe nailed) to prevent rotation if the wood shrinks.

Installing Cable Anchor Bracket

For ease of installation, it is recommended to have the eight 1/2" cable anchor bracket shoulder bolts (SB58A) and the cable anchor bracket (S760) attached to the W-beam guardrail end section prior to attaching the guardrail to the posts. If this procedure is not followed, Post #2 may interfere with attaching the bracket.

The eight 1/2" cable anchor bracket shoulder bolts (SB58A) are attached to the W-beam guardrail end section with two 1-1/16" OD x 9/16" ID structural washers (W050A), one on each side of the guardrail, and a 1/2" structural nut (N055A). The shoulders of the bolts should be on the backside of the guardrail, away from traffic, as shown in **Figure 8**.

For ease of installation, attach the cable anchor bracket shoulder bolts to the rail "finger tight" only. Then align the slots on the cable anchor bracket (S760) with the shoulder bolts and tap the cable anchor bracket onto the shoulder portion of the bolts using a hammer. Tighten the bolts with a wrench when the bracket is in place. When installed properly, the welded plate on the cable anchor bracket should be toward Post #2, as shown in **Figure 9**.

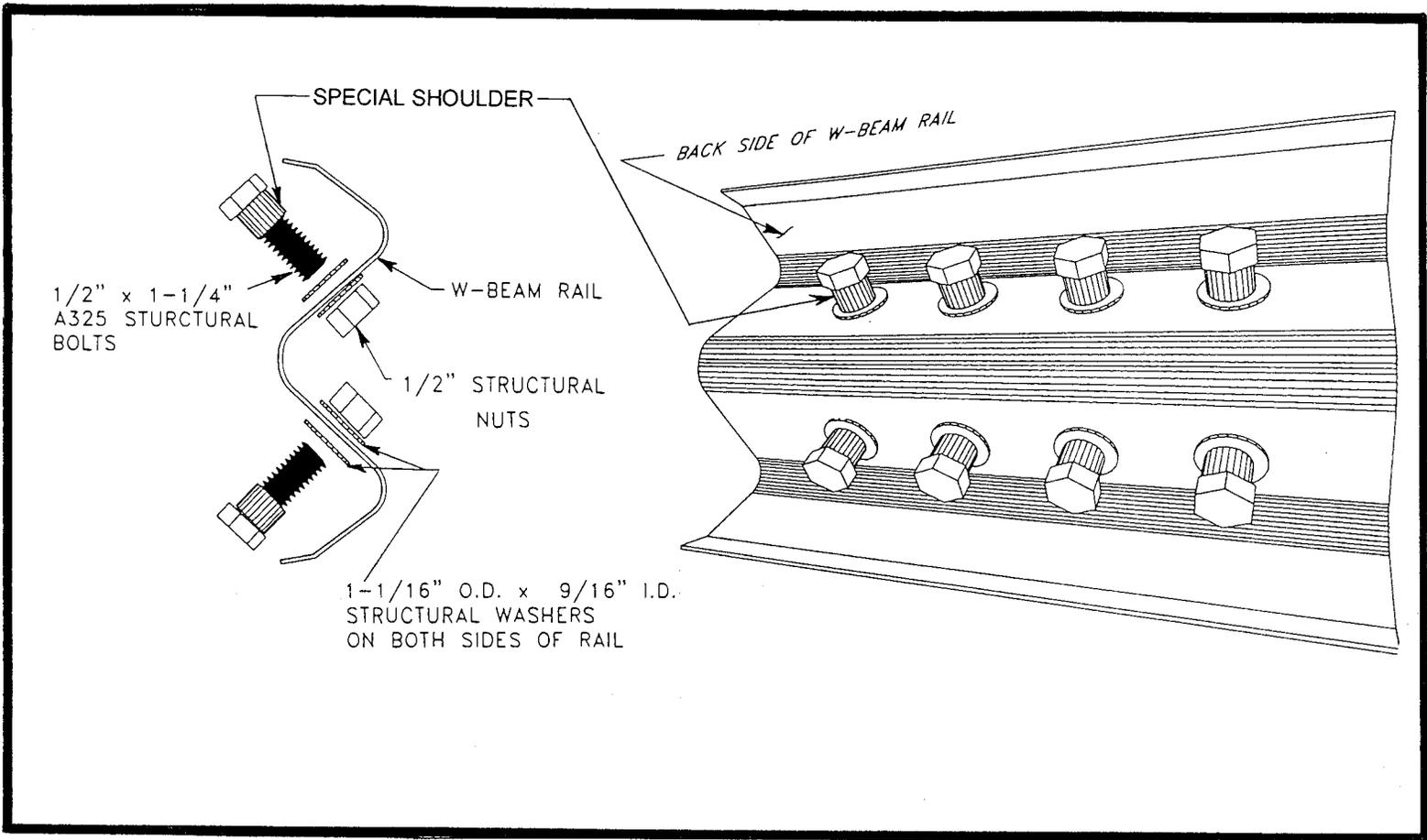


Figure 8. Installation of Cable Anchor Bracket Shoulder Bolts.

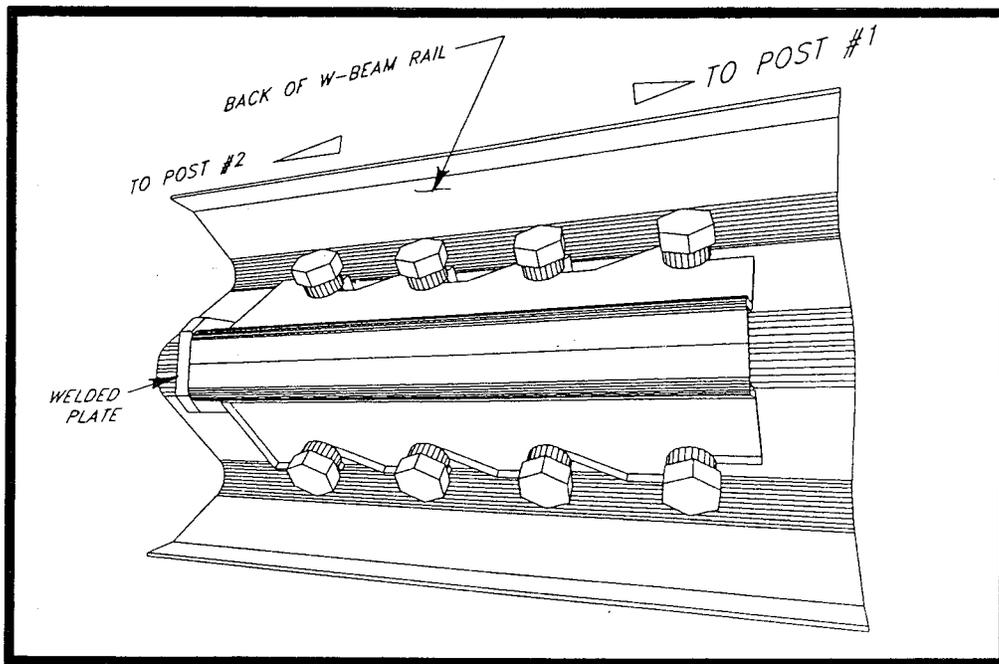


Figure 9. Installation of Cable Anchor Bracket.

Installing the FLEAT 350 Impact Head

The eight cable anchor bracket shoulder bolts and the cable anchor bracket should be attached to the W-beam guardrail end section prior to attaching the **FLEAT 350** impact head to the first post with lag screws.

Prior to tightening the rail to post # 2, place the impact head (F3000) with the guide chute over the end of the W-beam guardrail. **The exit slot will be toward the traffic side.** The impact head should be positioned so that the protruding tube is on the backside of the guardrail, away from traffic as shown in **Figure 2** and **Figure 5**. Slide the impact head forward until the post angle attachments on the impact head are aligned with the downstream side of the first post. This is the side facing post #2. Attach the impact head to the first post with two 3/8" x 3" lag screws (E350), one each for the top and bottom post angle attachments. A 1/4" pilot hole is required to avoid breaking the lag screw.

Note. It is recommended that the face of the impact head be delineated with an object marker that meets State specifications for better night visibility. However, the impact face object marker is not included as part of the shipped materials for the **FLEAT 350** unless specifically requested in the contract plans.

Installing Cable Assembly

Place the cable assembly (E770) through the cable anchor bracket and through the sleeve of post 1. Place the bearing plate (E750) at the base of post 1 with 5" dimension up and 3" dimension down. Place a nail over the bearing plate to prevent the plate from rotating. Secure both ends of the cable assembly with a 1" hex nut (N100) and washer (W100). While tightening cable, use a 2-lb hammer to tap the cable anchor bracket from the downstream end to ensure that it is securely interlocked with the bolts. Restrain the cable at the end being tightened to avoid twisting the cable.

Upon completion of the installation, the cable should be taut and the cable anchor bracket should be fully seated on the shoulder portion of the cable anchor bolts. *It is very important that the cable anchor bracket be fully seated on the shoulder portion of the cable anchor bolts.*

FLEAT 350 Installation Checklist

State: _____

Date: _____

Project #: _____

Location: _____

- The rail height is in accordance with the plans (generally 27-3/4" above the edge of the shoulder).
- The rail at post #1 is placed at a straight flare (offset between 2'-6" & 4'-0") over the 37'-6" terminal length.
- The rail is not attached to the post at post location #3 or post location #1.
- The foundation tubes do not protrude more than 4" above the ground line (measured by the AASHTO 5' cord method). Site grading may be necessary to meet this requirement.
- The bolts at the top of the foundation tubes are not over-tightened, deforming the walls of the tubes.
- The guide chute of the impact head is parallel to the top of the rail and the exit slot of the impact head is facing traffic.
- The two lag screws holding the impact head to post 1 are snug.
- The 8" x 8" bearing plate at post 1 is correctly positioned with the 5" dimension up & the 3" dimension down. The anchor cable is taut and correctly installed. A nail has been placed over the bearing plate to prevent rotation.
- The cable anchor bracket shoulder bolts are properly attached to the W-beam guardrail and the cable anchor bracket is fully seated on the shoulder portion of the bolts.
- Posts #1 and #2 are installed in foundation tubes and have the 2-1/2" breakaway hole located parallel to the roadway with the bottom of the hole at the top of the tube.
- CRT posts at locations 3 through 7 have two 3-1/2" breakaway holes (checked prior to installation) located parallel to the roadway with the center of the top hole located at the ground line.
- If the posts were augered, be sure the backfill material around the posts is compacted.
- No washers are used on the face of the rail except at the cable anchor bracket bolts.

Additional notes: _____

Inspection performed by: _____

Repairing the *FLEAT 350*

Equipment Needed for Repair Operation

- Acetylene torch to cut off the damaged rail,
- S.A.E. wrench or socket sizes 9/16", 7/8", 15/16", 1-1/4", and 1-1/2",
- Vice grip or channel lock pliers,
- Sledge hammer,
- Post remover tool (see **Figures 10 and 11**),
- Other normal guardrail tools.

General Repair Procedures

After an end-on impact occurs with the *FLEAT 350*, it will normally require replacement of the 12'-6" end section of rail and any other damaged rail section(s), any broken post(s) and potentially the impact head. For a traffic face impact, the damage will be to the downstream rail section(s) and associated posts.

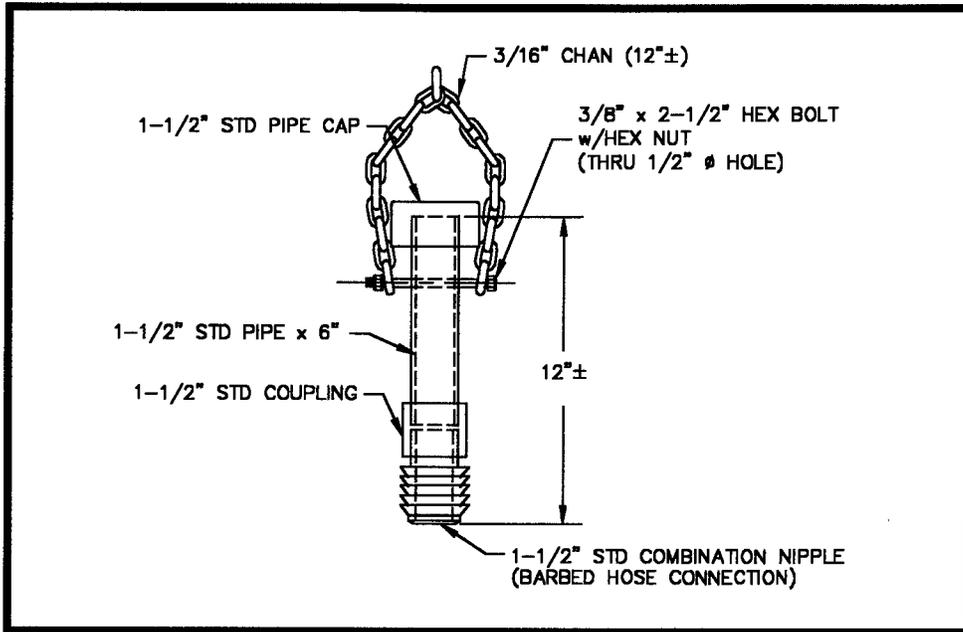
The general step-by-step procedure for repairing a damaged *FLEAT 350* terminal is as follows:

- (1) Check the impact head for damage.
- (2) Check the cable anchor bracket and cable assembly for damage. The bearing plate, nuts, washers, cable anchor bracket, and the special cable anchor bracket shoulder bolts are rarely damaged.
- (3) Check the number of broken posts and wood blockouts that need to be replaced, along with any damaged bolts. Inventory and pick up the reusable parts.
- (4) Torch off the kinked rail near the outlet of the impact head. The impact head should be able to be removed by hand at this point. If not, the impact head is probably not reusable.
- (5) Disconnect and remove the damaged rail from the posts.
- (6) Remove the broken posts from the foundation tubes using one of the two post removal tools (see **Figures 10 and 11**) assembled from "off the shelf hardware" items. Pound the steel pipe or screw the lag screw into the top of the broken post stub and remove the remains of the broken post by pulling on the chain. Use a pry bar as a lever if necessary.
- (7) Reinstall the system following the procedures listed in this manual.

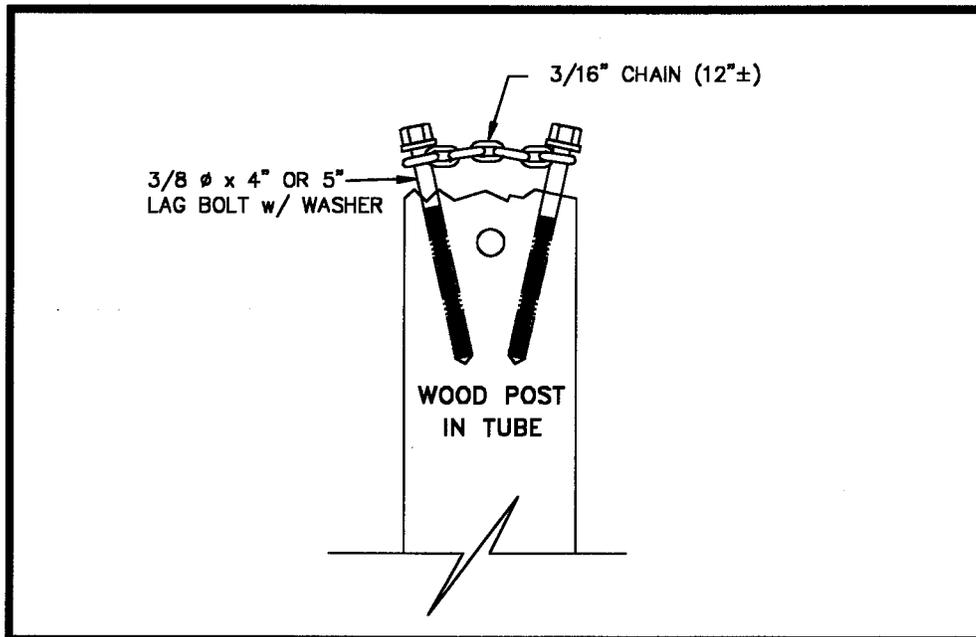
Procedures Immediately Following an Accident (Temporary)

If no repair parts are readily available immediately following an accident, the following procedure should be used to provide temporary protection of the guardrail end. It should be noted that this repair is only for temporary purposes, and the anchor cable cannot be installed to provide tension in the rail for redirection impacts.

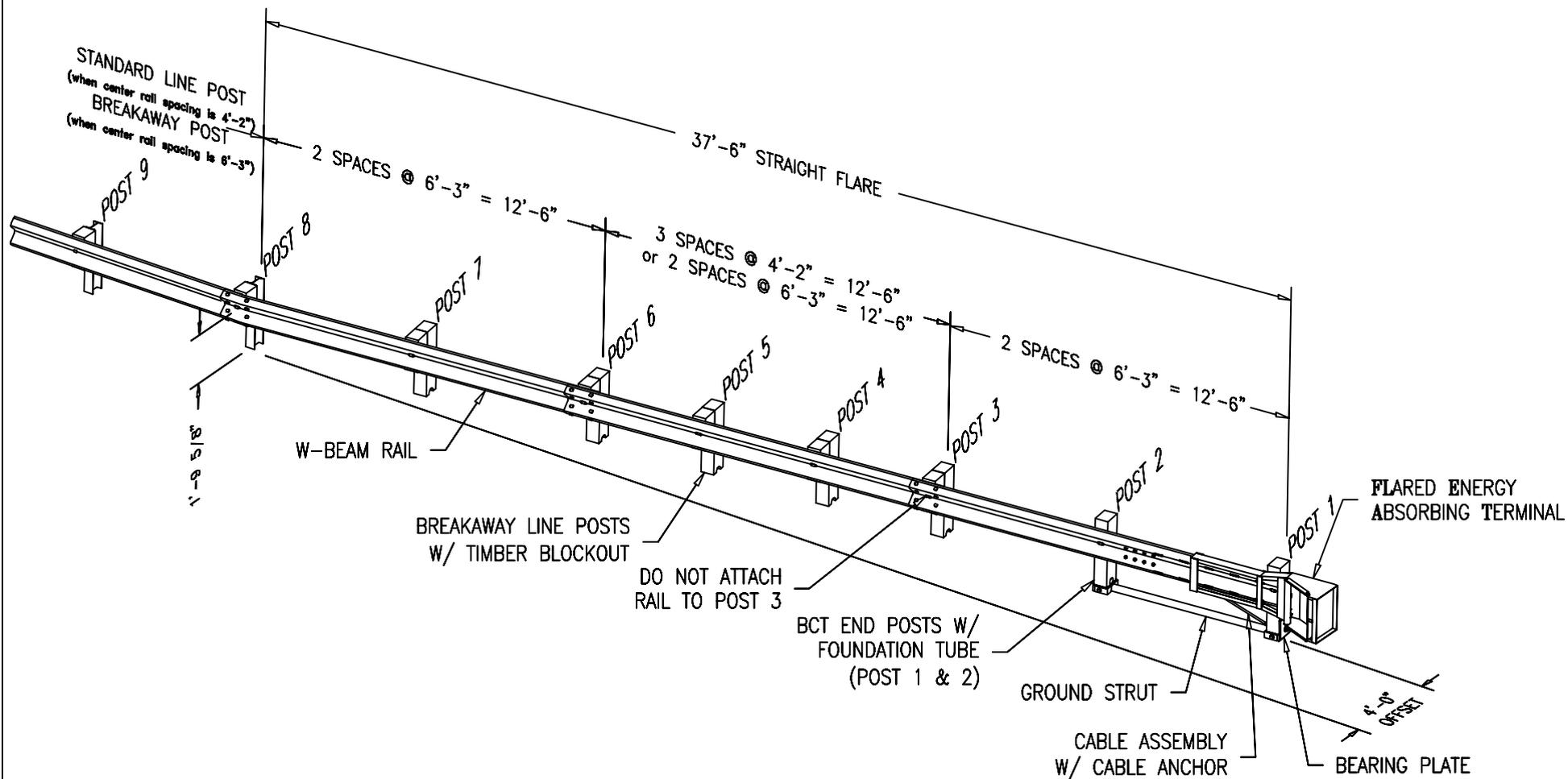
- (1) Remove damaged rail and impact head from the roadway or shoulder area.
- (2) Using an acetylene torch, cut the kinked rail off at the outlet of the impact head and inspect the head for any damage.
- (3) Remove the impact head by hand.
- (4) Locate the first post downstream of any damaged rail and cut this rail off about 9" in front of the post. If the post is at a splice, simply unbolt the damaged rail.
- (5) Install the impact head on the rail and attach it to the post with lag bolts.
- (6) Warning signs should be used where appropriate.



**Figure 10. Wood Post Pulling Tool
(Pipe Option)**



**Figure 11. Wood Post Pulling Tool
(Lag Screw Option)**



NOTES:

1. OFFSET DIMENSIONS ARE SHOWN TO BLOCKOUTS, EXCEPT FOR POSTS 1 & 2
2. CAN BE INSTALLED AT 2'-6" TO 4'-0" OFFSET.
3. WOOD OR STEEL BREAKAWAY POSTS MAY BE USED FOR THIS SYSTEM.
4. NCHRP 350 TEST LEVEL 3 (37'-6" LONG) SYSTEM IS SHOWN. A REDUCED SPEED TEST LEVEL 2 (25'-0" LONG) SYSTEM IS ALSO AVAILABLE.

SPECIFICATIONS

SRT-350™

- Offset: 3'0" to 4'0" (915-1220 mm)
- Length: 37' 6" (11.43 m)
- Length of need: 12'6" (3.81 m)
from the end of the terminal
(at the 3rd post)
- Parabolic or straight flare options

X-Tension Guardrail Terminal End General Specifications

I. Description

The X-Tension guardrail terminal end is designed, manufacture and supplied by Barrier Systems Sales and Service LLC.

The X-Tension is a Tangent, Flared, Median, fully redirective, non-gating terminal end which is energy absorbing. The X-Tension substantially consists of an impact head with a brake bar inside, a slider assembly and slider bracket, a cable anchor bracket, a foundation anchor assembly, ground strut, steel breakaway posts and three standard 12 gauge highway W-beam rails.

The total length of the system is 11.4 meters and may be flared at the head end over the 11.4 meters, 0 - 1219mm / 0 – 4' to the face of the rail.

II. Performance

- A. The X-Tension is capable of redirecting vehicles of 820 to 2000Kg's impacting the side of the system at an angle of up to 20 degrees and 100 KPH when impacting from the length of need. The length of need starts at post #1.
- B. When impacted end on with the 820 to 2000Kg vehicle at speeds of up to 100 KPH, the system is brought to a controlled stop or allowed to penetrate to the back side, depending on the impact conditions.
- C. In all end on impacts, varying amounts of energy are dissipated depending on the length of time the vehicle remains in contact with the impact head.
- D. During end on impacts the head, rail one and the slider, telescope over rail two until rail two comes to rest in the back of the impact head. At this point, the V notch bolts joining rail one and two are sheared allowing the entire rail one, head, slider and rail two assembly to slide over rail three.
- E. As the head is pushed down the two cables, the cables are pulled through the brake bar in a torturous path, which dissipates energy.

III. Materials

A. Impact Head

The impact head shall be fabricated from hot rolled steel that is galvanized after fabrication in accordance with AS/NZS 4680.

The hot rolled steel specification – ASM A36 , AS 3678-250, JISG3101 – SS400, BS4360 -43A.

The impact head shall be attached to the end of rail one with 8 standard splice bolts reversed so that the nut is on the traffic face. The head contains the brake bar through which the cables are threaded before tightening the brake bar.

B. Steel Line Posts

These posts are fabricated from W6 x 13.5 standard I beam section. Standard specification for this section is AASHTO M270M (ASTM A 709M) grade 250steel. Posts #1 and #2 are crimped. Posts 3 – 6 are standard guardrail posts as per AASHTO PWE01, Wide Flange Post.

C. Timber Block Outs

Standard routed block outs H4 treated, Number one rough sawn pine. 5 block outs are required; Post #1 does not have a block out.

D. Slider and Slider Bracket

Shall be constructed from standard, 350 grade, guardrail and hot rolled steel of the same specification as the impact head. The slider is bolted to the downstream end of rail one with 4 standard splice bolts reversed so that the nuts are on the outside. The slider bracket is bolted with 4 splice bolts to the end of rail two in the usual manner. Once rail one is slid over rail two into its final position, the locking angle is bolted to the slider bracket. The combination of these two devices allows the rails to telescope when impacted end on and yet still maintain full ribbon strength in the rail during a redirect impact. Both components are to be hot dipped galvanized after fabrication.

E. Cable Anchor Bracket

The cable bracket is fabricated from hot rolled mild steel, 5mm thick, and attached to the back of the rail at the junction between rails 3 and 4. (Post 7). The bracket is attached using four centre splice bolts that are joining the rails. Bracket is also hot dip galvanized after fabrication.

F. Cables

Two cables are constructed using 19mm 3x7 strand galvanised cable complete with an M24 threaded rod swaged onto each end. The cables are attached to the ground anchor point, threaded through the impact head and brake bar, down the back of the W beam in the “hollows” and attached to the cable anchor bracket at the downstream end. The brake bar is then turned and locked into place before the cables are tightened. Cable specification, DSR Galvanized 320 / ASTM A-603

G. Foundation Anchor

Foundation anchor consists of one C section anchor fabricated from mild steel channel and one I section anchor fabricated from the same section and specification as the Line Posts.

The C section anchor shall be constructed from mild steel conforming to the following specifications ASM A36, AS 3678-300, JISG3101 – SS400, BS4360 - 43A.

H. Ground Strut

Ground strut is fabricated from C section mild steel made to the same standard as the foundation anchor specifications. The ground strut shall join the C section anchor point and the, I section, anchor point which is also the bottom half of post one.

I. Post One and Two

Fabricated from the same section and specification as the line posts. Post #1 is a short post and bolts into the top of the, I section, anchor point. Both Post #1 and #2 are crimped near the ground level. The impact head is bolted to post one with a standard 50mm long splice bolt.

J. Bull nose

Fabricated from a, 3mm thick, polyethylene plastic sheeting. This bull nose is “bent” into position on site.

K. Rail Elements

Standard 12 gauge, 2.7mm BMT, 350 grade galvanised W beam. As per AASHTO M180 Class A rail. Three standard sections are required.

L. Fasteners

All fasteners shall be Class 4.6 (Grade2) or greater and galvanized in accordance with ASTM 153. Washers shall be hardened and galvanized.

IV. Construction

Design, selection and placement of the X-Tension terminal end shall be in accordance with the AASHTO Roadside Design Guide and the details shown in the construction drawings. Installation shall be in accordance with the installation instructions supplied by Barrier Systems.

Damaged systems shall be repaired or replaced immediately at the expense of the owner of the installed system.

V. Performance Specification

All leading Guardrail Terminal Ends must be fully re-directive and non-gating, capable of redirecting an errant vehicle from post one in side on impacts. (up to 2000P at 20 Degrees and 100 kph). The terminal end must be telescoping and energy absorbing in end on impacts with the impacting force held in tension rather than compression. No debris shall be expelled from the system.



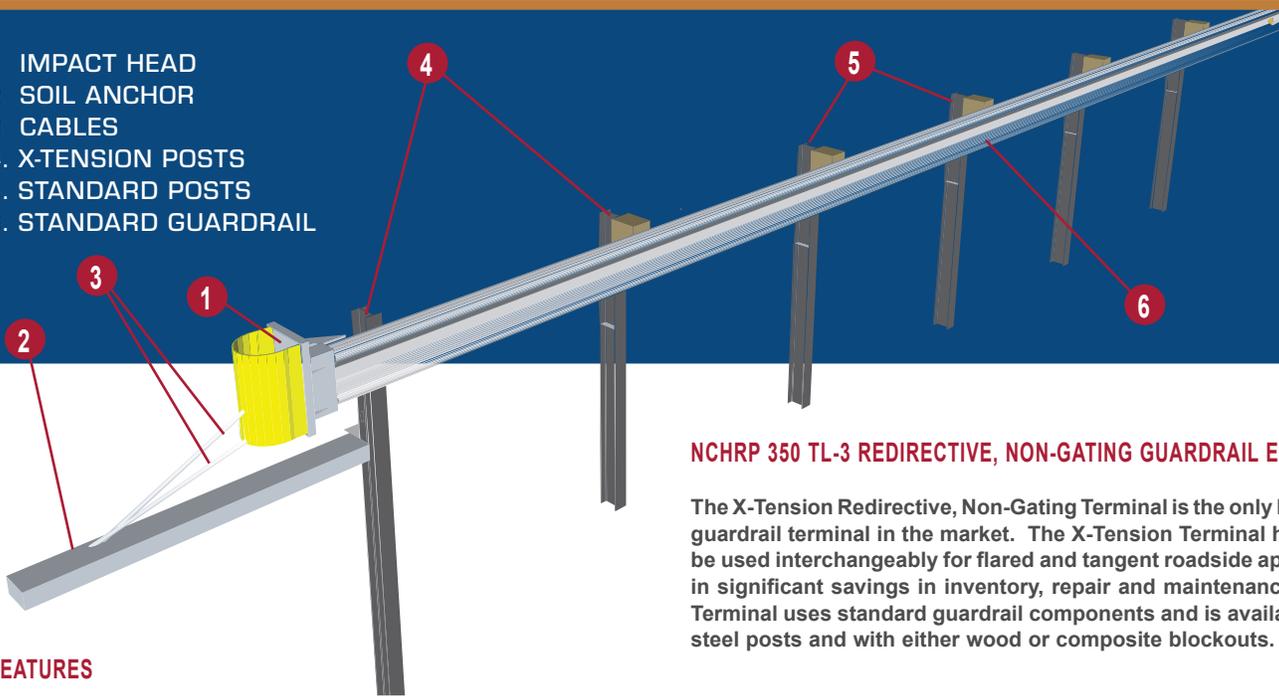
X-Tension™ Redirective, Non-Gating Guardrail End Terminal

- Contractor Friendly
- Simple Installation
- Meets NCHRP 350 TL-3



X-Tension™ Redirective, Non-Gating Terminal

- 1 IMPACT HEAD
- 2 SOIL ANCHOR
- 3 CABLES
- 4 X-TENSION POSTS
- 5 STANDARD POSTS
- 6 STANDARD GUARDRAIL



NCHRP 350 TL-3 REDIRECTIVE, NON-GATING GUARDRAIL END TERMINAL

The X-Tension Redirective, Non-Gating Terminal is the only Redirective, Non-Gating guardrail terminal in the market. The X-Tension Terminal has been engineered to be used interchangeably for flared and tangent roadside applications. This results in significant savings in inventory, repair and maintenance costs. The X-Tension Terminal uses standard guardrail components and is available with either wood or steel posts and with either wood or composite blockouts.

FEATURES

- Only NCHRP 350 tested Redirective Non-Gating Guardrail Terminal available
- Available in 727 or 787mm [28.5 or 31"] heights
- Uses same components for tangent or flared applications
- Easy to install
- Utilizes many standard guardrail components

WHERE TO USE

Side of road where limited clear zone or excessive slope restricts the use of Redirective Gating terminals.

**REDIRECTIVE
NON-GATING**



The X-Tension Terminal can be installed either flared or tangent.

General details for the X-Tension Terminal are subject to change without notice to reflect improvements and upgrades. Additional information is available from Barrier Systems, Inc.

PHYSICAL SPECIFICATIONS

Length	12 m [40']
Width	572 mm [22.5"]
Height	727 / 787mm [28.5/31"]
Weight	534 kg [1179 lb]
Test Level	NCHRP 350 TL-3



FREQUENTLY ASKED QUESTIONS

WHAT MAKES THE X-TENSION TERMINAL DIFFERENT FROM THE OTHER END TERMINALS ON THE MARKET?

The X-Tension Terminal is tested to NCHRP 350 as a Redirective Non-Gating System. All other terminals are tested as Redirective Gating Systems, meaning they will only start to redirect at the third post.

CAN THE X-TENSION TERMINAL BE ATTACHED TO CONCRETE BARRIER?

The X-Tension Terminal can be attached to concrete barrier with the addition of standard transitions.

IS A TRANSITION NEEDED TO ATTACH TO STANDARD GUARDRAIL?

The X-Tension Terminal is designed to attach directly to guardrail with no transition required.

CAN THE X-TENSION TERMINAL BE INSTALLED USING COMPOSITE BLOCKOUTS?

The X-Tension Terminal can be ordered with either wood or composite blockouts.

DISTRIBUTED BY:

BARRIER SYSTEMS

A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

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3333 VACAVALLEY PKWY, VACAVILLE, CA 95688

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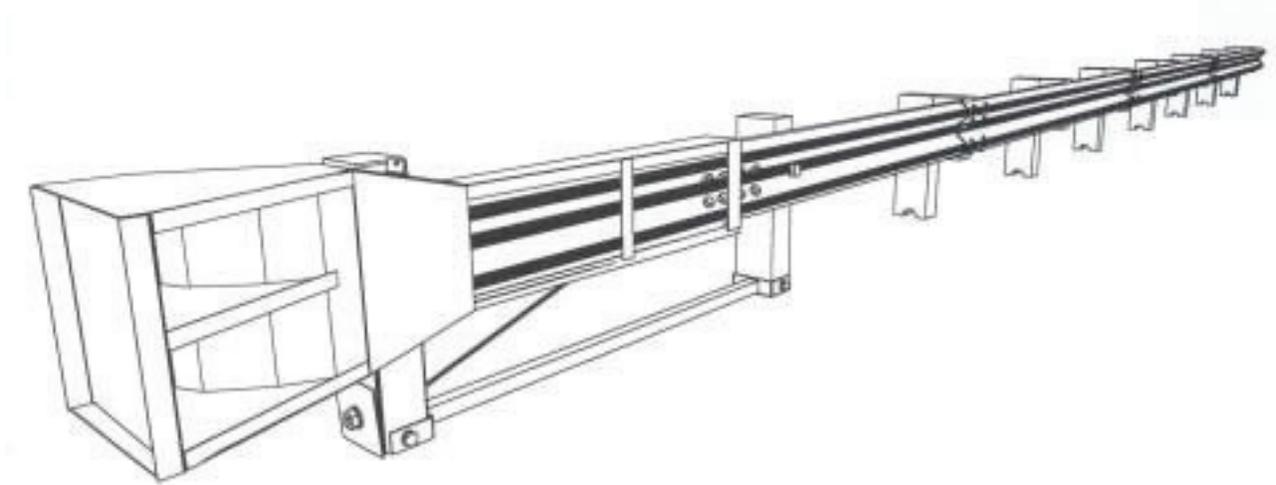
WWW.BARRIERSYSTEMSINC.COM



Installation Instructions

for the

SKT 350



ROAD SYSTEMS, INC.

P. O. Box 2163

Big Spring, Texas 79721

Phone: (432) 263-2435 FAX: (432) 267-4039

Technical Support & Marketing Phone: (330) 346-0721

Technical Support & Marketing Fax: (330) 346-0722

This Installation Manual can be downloaded from RSI web site
www.roadsystems.com

ADDENDUM March 2001

This SKT Installation Manual contains options for the allowable number of steel foundation tubes. See Table 1 on page 3.

Either 2-tube, 4-tube, or 8-tube options are acceptable and normally, the specifying agency will indicate which option will be used. When more than 2 foundation tubes are used, tubes 3 & 4 or tubes 3 through 8 must be the short tube 4'-6" long as shown in Figure 5 on page 11.

It is now permissible to eliminate the soil plates from the tubes used at posts 3 and higher provided it is approved by the specifying agency. The foundation tubes used at posts 1 & 2 must use the soil plate if the 4'-6" long tube is used.

If the 6'-0" long foundation tube (Figure 8, page 15) is used at posts 1 & 2, soil plates are not required.

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NOTE: The SKT 350 has different foundation tube options available.

Where reference is made to a 5'-0" long foundation tube with soil plate, a 4'-6" long foundation tube with soil plate is an acceptable alternate.

See the inside cover for additional information on soil plate options.

PUBLICATION ~ 020105

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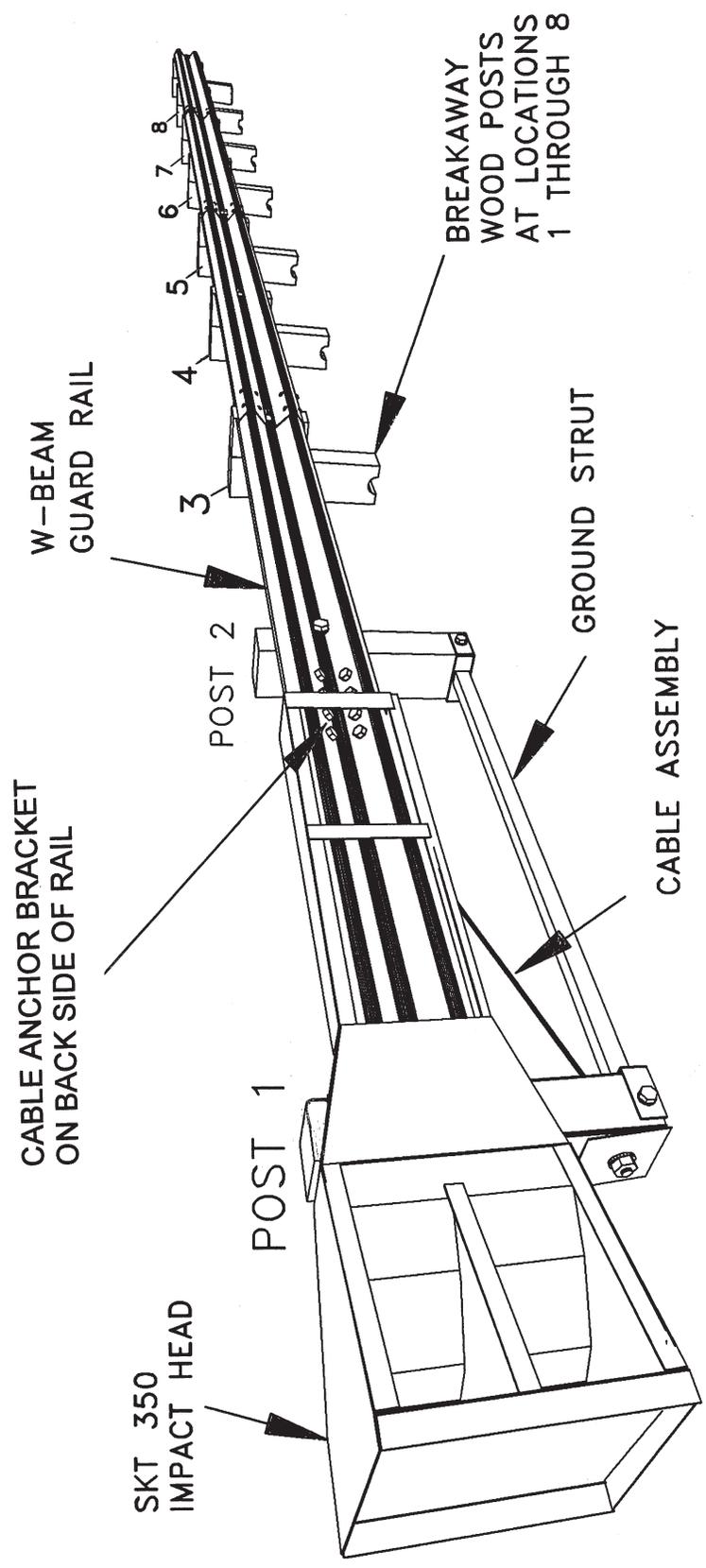


Figure 1. Isometric view of the SKT 350.

Installing the *SKT 350*

Materials

As packaged, the *SKT 350* system includes all materials needed for a complete installation except for the impact face object marker. The length of the system in this configuration is 50'-0".

Design Options

Design options with 2, 4 or 8 foundation tubes are available as shown in **Table 1**. In addition for posts #1 and #2, the optional 6'-0" long split foundation tubes may be substituted with solid 6'-0" long foundation tubes without soil plates, standard 5'-0" or 4'-6" long foundation tubes with soil plates.

Table 1. *SKT 350* Design Options

<i>SKT 350</i> Design Options	*No. of Optional 6'-0" Split Foundation Tubes with No Soil Plate	No. of Standard Foundation Tubes with a Soil Plate	No. of CRT Posts	Total No. of Posts
2 Foundation Tubes	2	0	6	8
4 Foundation Tubes	2	2	4	8
8 Foundation Tubes	2	6	0	8

***Note.** The optional 6'-0" long split foundation tubes may be substituted with solid 6'-0" long foundation tubes without soil plates, standard 5'-0" or 4'-6" long foundation tubes with soil plates.

Figure 1 shows the isometric view and **Figure 2** shows the plan and elevation views of the *SKT 350* for the TWO foundation tube option.

The bills of materials for the three design options are shown in **Tables 2 through 4**, respectively.

Table 2. SKT 350 Bill of Materials - TWO Foundation Tube Option

Code #	Quantity	Description
S3000	1	Impact Head
S1303/S1305	1	W-Beam Guardrail End Section, 12 Ga., 12'-6" or 25'-0"
G1203/G1205	3/1	W-Beam Guardrail, 12 Ga., 12'-6" or 25'-0"
S730	2	* Foundation Soil Tubes, 6" x 8" x 6'-0" (SEE NOTE BELOW)
E740	1	Pipe Sleeve - 2" Standard Pipe x 5-1/2"
E750	1	Bearing Plate - 8" x 8" x 5/8"
S760	1	Cable Anchor Bracket
E770	1	BCT Cable Anchor Assembly
E780	1	Ground Strut
P650	2	5-1/2" x 7-1/2" x 45" Wood Posts
P671	6	6" x 8" x 6'-0" Wood CRT Posts
P675	6	6" x 8" x 14" Timber Blockouts
E3151	1	Impact Face Object Marker (Not Provided)
Hardware * The optional 6'-0" long split foundation tubes may be substituted with either solid 6'-0" long foundation tubes without soil plates, standard 5'-0" long or 4'-6" long foundation tubes with soil plates.		
B580122	16/32	5/8" x 1 1/4" Splice Bolts
B580754	2	5/8" x 7 1/2" Hex Bolts
B581004	2	5/8" x 10" Hex Bolts
B581002	1	5/8" x 10" H.G.R. Post Bolt (Post 2 Only / NO BOLT USED AT POST #1)
B581802	6	5/8" x 18" H.G.R. Post Bolts (Posts 3 through 8)
N050	27/43	5/8" H.G.R. Nuts (Splice - 16/32, Soil Tubes - 4, Posts 2 to 8 - 7)
W050	11	5/8" Flat Washers (2 each at Soil Tubes + 7 Posts)
N100	2	1" Anchor Cable Hex Nuts
W100	2	1" Anchor Cable Washers
E350	2	3/8" x 3" Lag Screws
SB58A	8	Cable Anchor Bracket Shoulder Bolts
N055A	8	1/2" A325 Structural Nuts
W050A	16	1-1/16" OD x 9/16" ID A325 Structural Washers

Table 3. SKT 350 Bill of Materials - FOUR Foundation Tube Option

Code #	Quantity	Description
S3000	1	Impact Head
S1303/S1305	1	W-Beam Guardrail End Section, 12 Ga., 12'-6" or 25'-0"
G1203/G1205	3/1	W-Beam Guardrail, 12 Ga., 12'-6" or 25'-0"
S730	2	* Foundation Soil Tubes, 6" x 8" x 6'-0" (SEE NOTE BELOW)
S735	2	Foundation Soil Tubes, 6" x 8" x 5'-0" (SEE NOTE BELOW)
SP600	2	Soil Plates - 24" x 18" x 1/4" (SEE NOTE BELOW)
E740	1	Pipe Sleeve - 2" Standard Pipe x 5-1/2"
E750	1	Bearing Plate - 8" x 8" x 5/8"
S760	1	Cable Anchor Bracket
E770	1	BCT Cable Anchor Assembly
E780	1	Ground Strut
P650	4	5-1/2" x 7-1/2" x 45" Wood Posts
P671	4	6" x 8" x 6'-0" Wood CRT Posts
P675	6	6" x 8" x 14" Timber Blockouts
E3151	1	Impact Face Object Marker (Not Provided)
Hardware		* The optional 6'-0" long split foundation tubes may be substituted with either solid 6'-0" long foundation tubes without soil plates, standard 5'-0" long or 4'-6" long foundation tubes with soil plates
B580122	16/32	5/8" x 1 1/4" Splice Bolts
B580754	6	5/8" x 7 1/2" Hex Bolts
B581004	4	5/8" x 10" Hex Bolts
B581002	1	5/8" x 10" H.G.R. Post Bolt (Post 2 Only / NO BOLT USED AT POST #1)
B581802	6	5/8" x 18" H.G.R. Post Bolts (Posts 3 through 8)
N050	33/49	5/8" H.G.R. Nuts (Splice - 16/32, Soil Tubes - 10, Posts 2 to 8 - 7)
W050	15	5/8" Flat Washers (2 each at Soil Tubes + 7 Posts)
N100	2	1" Anchor Cable Hex Nuts
W100	2	1" Anchor Cable Washers
E350	2	3/8" x 3" Lag Screws
SB58A	8	Cable Anchor Bracket Shoulder Bolts
N055A	8	1/2" A325 Structural Nuts
W050A	16	1-1/16" OD x 9/16" ID A325 Structural Washers

Table 4. SKT 350 Bill of Materials - EIGHT Foundation Tube Option

Code #	Quantity	Description
S3000	1	Impact Head
S1303/S1305	1	W-Beam Guardrail End Section, 12 Ga., 12'-6" or 25'-0"
G1203/G1205	3/1	W-Beam Guardrail, 12 Ga., 12'-6" or 25'-0"
S730	2	* Foundation Soil Tubes, 6" x 8" x 6'-0" (SEE NOTE BELOW)
S735	6	Foundation Soil Tubes, 6" x 8" x 5'-0" (SEE NOTE BELOW)
SP600	6	Soil Plates - 24" x 18" x 1/4" (SEE NOTE BELOW)
E740	1	Pipe Sleeve - 2" Standard Pipe x 5-1/2"
E750	1	Bearing Plate - 8" x 8" x 5/8"
S760	1	Cable Anchor Bracket
E770	1	BCT Cable Anchor Assembly
E780	1	Ground Strut
P650	8	5-1/2" x 7-1/2" x 45" Wood Posts
P675	6	6" x 8" x 14" Timber Blockouts
E3151	1	Impact Face Object Marker (Not Provided)
Hardware	* The optional 6'-0" long split foundation tubes may be substituted with either solid 6'-0" long foundation tubes without soil plates, standard 5'-0" long or 4'-6" long foundation tubes with soil plates.	
B580122	16/32	5/8" x 1 1/4" Splice Bolts
B580754	14	5/8" x 7 1/2" Hex Bolts
B581004	8	5/8" x 10" Hex Bolts
B581002	1	5/8" x 10" H.G.R. Post Bolt (Post 2 Only / NO BOLT USED AT POST #1)
B581802	6	5/8" x 18" H.G.R. Post Bolts (Posts 3 through 8)
N050	45/61	5/8" H.G.R. Nuts (Splice - 16/32, Soil Tubes - 22, Posts 2 to 8 - 7)
W050	23	5/8" Flat Washers (2 each at Soil Tubes + 7 Posts)
N100	2	1" Anchor Cable Hex Nuts
W100	2	1" Anchor Cable Washers
E350	2	3/8" x 3" Lag Screws
SB58A	8	Cable Anchor Bracket Shoulder Bolts
N055A	8	1/2" A325 Structural Nuts
W050A	16	1-1/16" OD x 9/16" ID A325 Structural Washers

Site Preparation

When the guardrail is installed parallel to the edge of the shoulder, a 50:1 flare away from the roadway is recommended so the impact head will not encroach on the shoulder. However, the flare is not required and may be decreased or eliminated for specific applications. When necessary, a 25:1 flare rate can be used over a distance of 25'-0" or 50'-0", as shown in **Figure 3**. Minor site grading may be necessary for installations placed beyond the edge of the shoulder to prevent the foundation tubes from extending more than 4" above the ground (see Section on Installation).

Tools Required

The tools required for installation of the **SKT 350** system are those used to install standard highway guardrails (H.G.R.), including: 9/16", 7/8", 15/16", 1-1/4", and 1-1/2" sockets and wrenches, a drill with a 1/4" bit, and other equipment such as augers, tampers, and post pounders commonly used in driving posts.

Installation Procedures

Begin installation at the downstream end of the **SKT 350** (post location 9) to ensure that the terminal matches up with the standard section of guardrail. The major steps in the installation of the **SKT 350** are as follows:

- Install posts 3 through 8,
- Install posts 1 and 2 with groundline strut,
- Install guardrail,
- Install cable anchor bracket,
- Install the **SKT 350** impact head, and
- Install cable assembly.

NOTE: Foundation tubes must be used at **Posts #1 and #2**. Those tubes may be either 6'-0" long split tubes (S730) without soil plates, 6'-0" long solid tubes (E731) without soil plates, 5'-0" long tubes (S735) with soil plates (SP600), or 4'-6" long tubes (E735) with soil plates (SP600). **Posts # 3 through 8** may be either CRT wood posts without foundation tubes or short wood posts inside a 5'-0" or 4'-6" long foundation tube with soil plates.

Installing Posts 3 Through 8

For the **two foundation tube option**, posts 3 through 8 are 6" x 8" x 6'-0" CRT posts (P671). When installed properly, the hole at the ground line of these CRT posts will be parallel to the roadway.

For the **four foundation tube option**, posts 3 and 4 are inserted in foundation tubes with soil plates (SP600). Install the 5-1/2" x 7-1/2" x 45" wood posts (P650) in the foundation tubes at the post 3 and 4 locations. Secure the post to each foundation tube with a 5/8" x 10" hex head bolt (B581004) and H.G.R. nut (N050) with a washer (W050) under both the bolt head and the nut. *Do not over tighten and deform the tubes.* Posts 5 through 8 are 6" x 8" x 6'-0" CRT posts (P671).

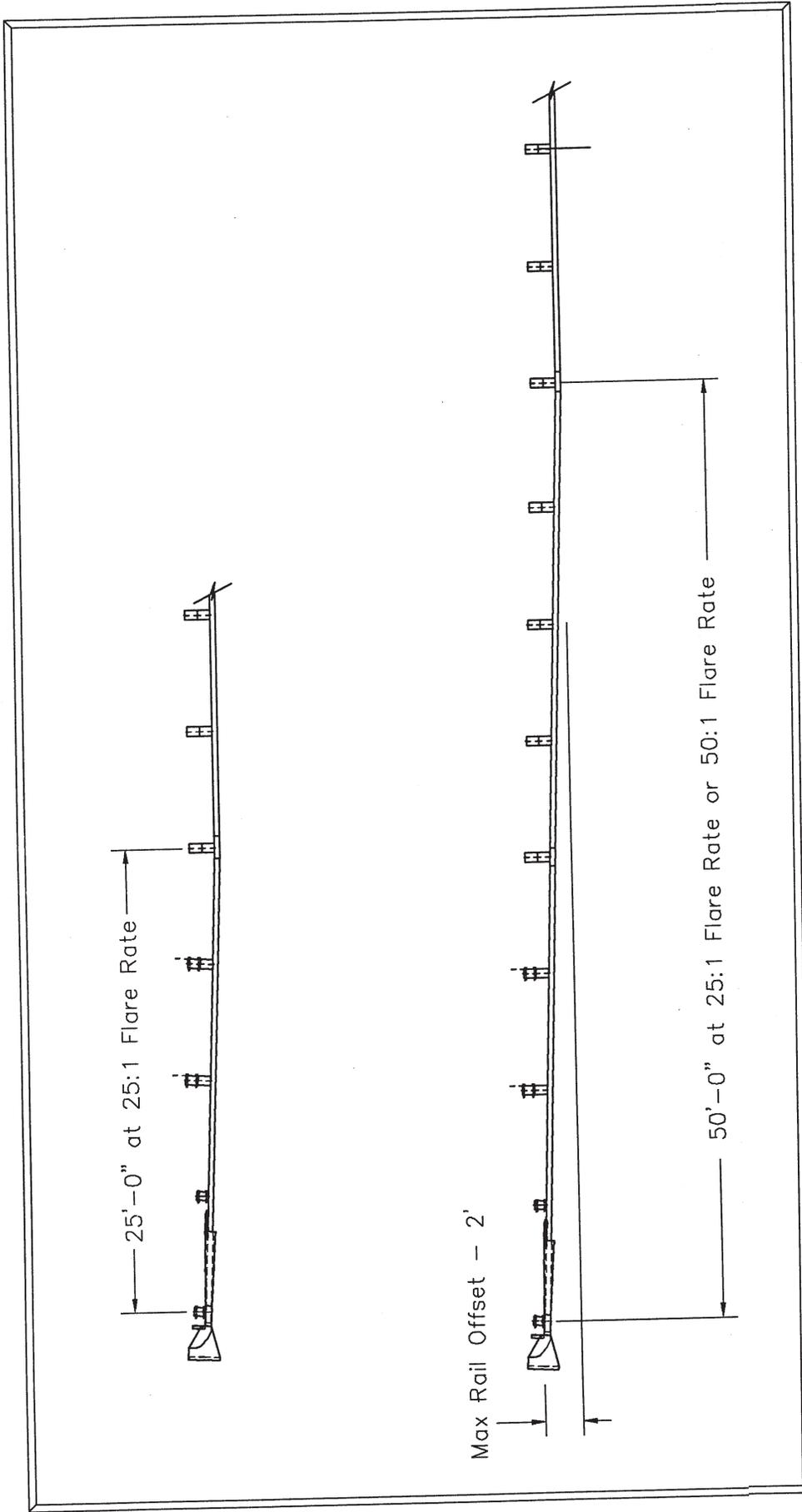


Figure 3. Optional Flared Installation

For the **eight foundation tube option**, posts 3 through 8 are inserted in foundation tubes with soil plates (SP600). Install the 5-1/2" x 7-1/2" x 45" wood posts (P650) in the foundation tubes at the post 3 through 8 locations. Secure the post to each foundation tube with a 5/8" x 10" hex head bolt (B581004) and H.G.R. nut (N050) with a washer (W050) under both the bolt head and the nut. *Do not over tighten and deform the tube.* There are no CRT posts for this option.

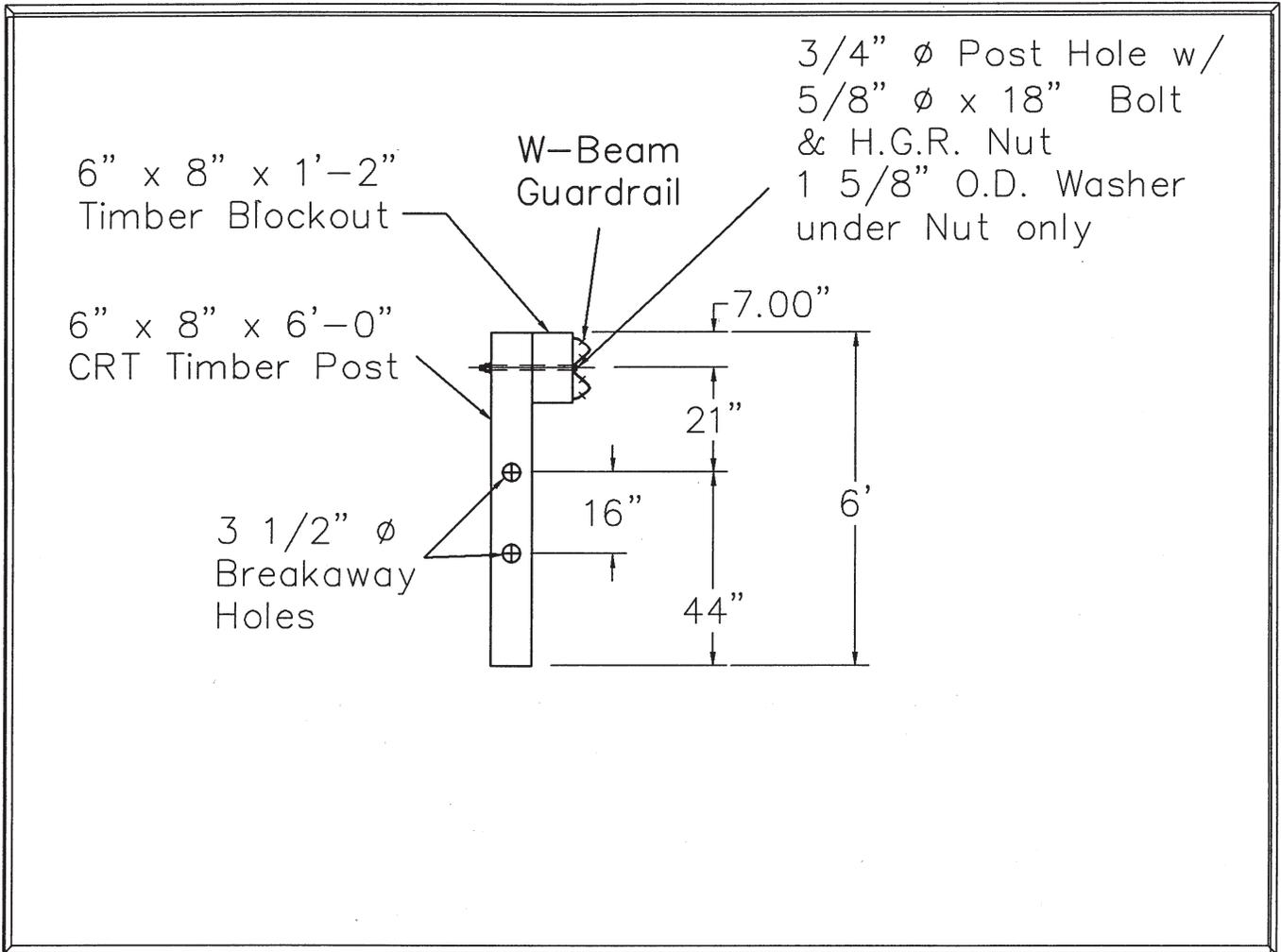
Figure 4 shows the section of a CRT post. The CRT post may be driven with an approved driving head. For stiff soils, drill a 6" pilot hole and force the post to the appropriate depth by impact or vibratory means with an approved driving head. The post may also be installed by augering and backfilling if the contractor so prefers. The initial hole must be large enough to allow adequate room for proper compaction of the soil during backfill. *Care must be taken to carefully compact the backfill to prevent settlement or lateral displacement of the post.*

Figure 5 shows the section of a post in a standard 5'-0" or 4'-6" long foundation tube with a soil plate. Fasten the soil plate to the foundation tube with two 5/8" x 7-1/2" hex head bolts (B580754) and H.G.R. nuts (N050) through the bottom holes of the foundation tubes. *Do not over tighten and deform the tubes.* These bolts attach the soil plate to the foundation tube and stop the post from sliding all the way into the tube during installation.

Do not drive the foundation tube with wood post inserted. If the soil is penetrable so that the foundation tube does not deform, the foundation tube may be driven with an approved driving head. For non-penetrable soil, drill a 6" pilot hole and force the tube to the appropriate depth by impact or vibratory means with an approved driving head. The tube may also be installed by augering and backfilling if the contractor so prefers. The initial hole must be large enough to allow adequate room for proper compaction of the soil during backfill. *Care must be taken to carefully compact the backfill to prevent settlement or lateral displacement of the foundation tubes.*

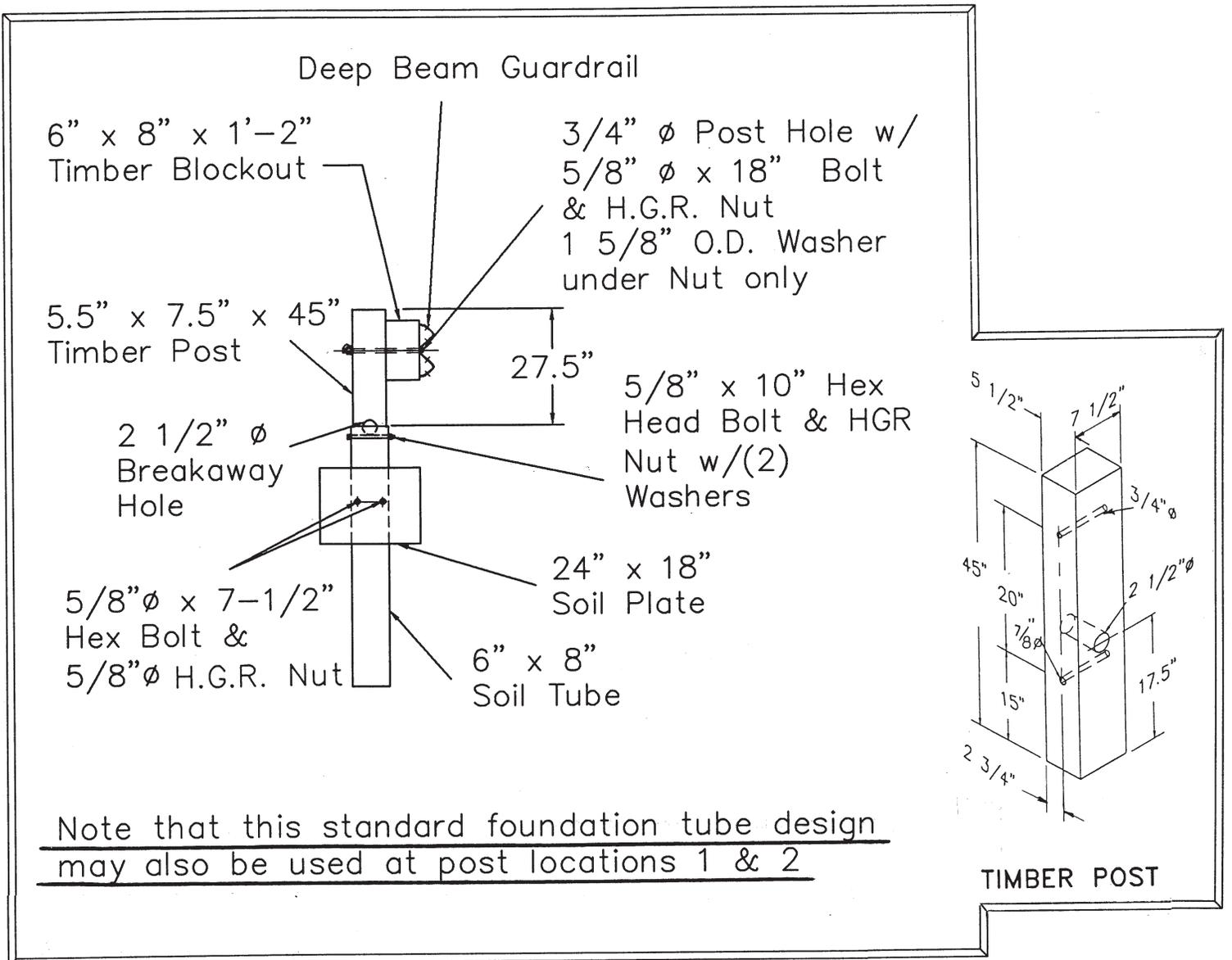
If rock is encountered during driving or excavation, refer to appropriate State specifications. Guidelines will vary from State to State.

Figure 6 illustrates the proper placement of the foundation tubes. The top of the foundation tubes should not project more than 4" above the ground line when measured along a 5' cord, according to AASHTO specifications. Site grading may be required if the top of the foundation tubes project more than 4" above the ground line. The finished guardrail height should generally be 27-3/4" above the edge of the shoulder.



SKT 350 DESIGN OPTION	LOCATION OF CRT POSTS
(2) FOUNDATION TUBES	POSTS 3 THROUGH 8
(4) FOUNDATION TUBES	POSTS 5 THROUGH 8

Figure 4. Section at CRT Post



SKT 350 DESIGN OPTION	LOCATION OF STANDARD FOUNDATION TUBES WITH SOIL PLATES
(4) FOUNDATION TUBES	POSTS 1 THROUGH 4 <u>OR</u> POSTS 3 AND 4
(8) FOUNDATION TUBES	POSTS 1 THROUGH 8 <u>OR</u> POSTS 3 THROUGH 8

Figure 5. Section at Posts with 5'-0" or 4'-6" Foundation Tubes with Soil Plates

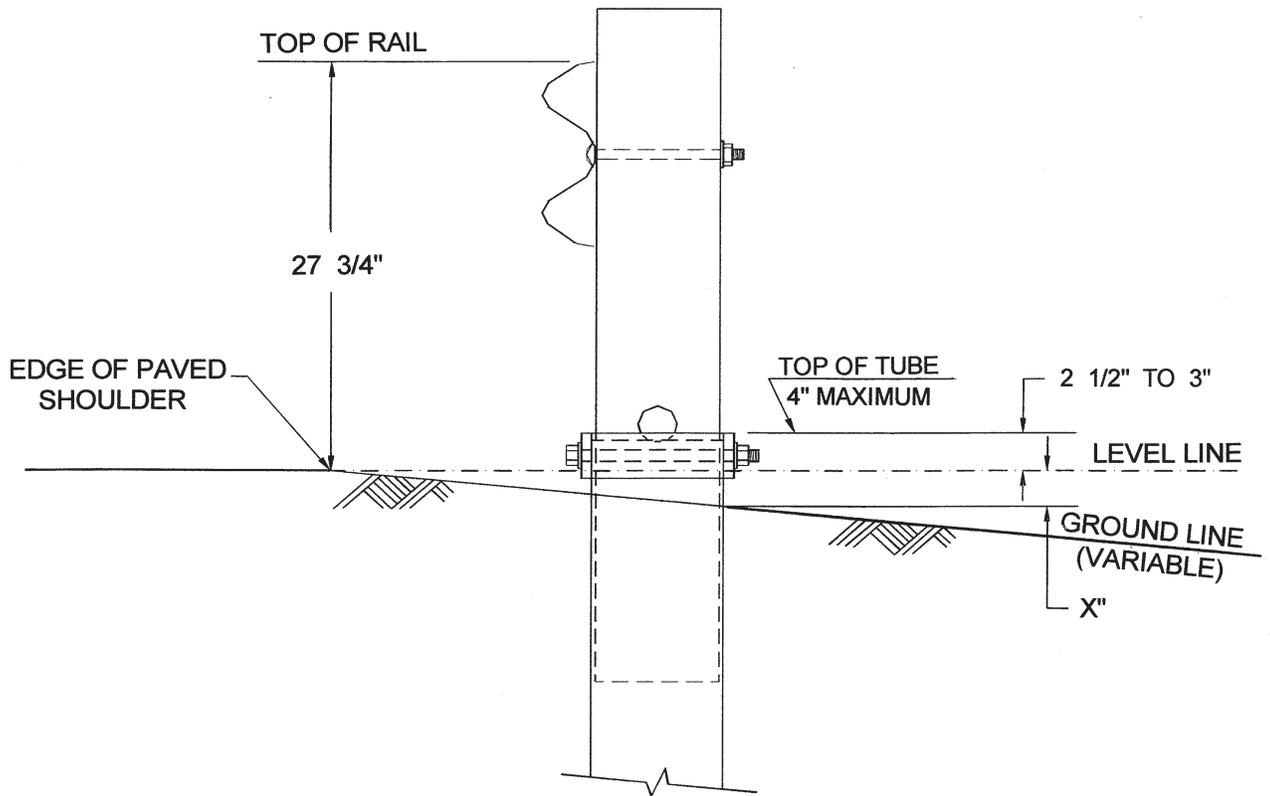


Figure 6. Proper Placement of Foundation Tubes

Based on a level line from the edge of the paved shoulder, the top of the foundation tube should normally be 2-1/2" to 3" above the level line. The placement of the foundation tube should be an appropriate depth below the level line in order to maintain the 27-3/4" guardrail height from the edge of the shoulder.

If the slope drops off some distance (X ") from the edge of the shoulder to the tube location, as shown in **Figure 6**, the depth of the foundation tube should be reduced by X " in order to maintain the proper guardrail height. The top of the foundation tube will project (X " + 2-1/2") to (X " + 3") above the ground. In order not to exceed the AASHTO 4" maximum projection above the ground, site grading will be necessary to assure that the " X " dimension would not be more than 1-1/2" to 1" respectively.

Installing Posts 1 and 2 with Groundline Strut

Figure 7 shows the above ground details and **Figure 8** shows the section at post locations 1 and 2. Posts 1 and 2 may be installed with either 6'-0" long split foundation tubes (S730) without soil plates, solid 6'-0" long foundation tubes (E731) without soil plates, standard 5'-0" long foundation tubes (S735) with soil plates (SP600) or standard 4'-6" long foundation tubes (E735) with soil plates (SP600).

For the **6'-0" long split foundation tube**, fasten one 5/8" x 7-1/2" hex head bolt (B580754) and H.G.R. nut (N050) through the bottom hole of the foundation tube. *Do not over tighten and deform the tube.* The bolt is intended to stop the post from sliding all the way into the tube during installation.

Do not drive the foundation tube with wood post inserted. If the soil is penetrable so that the foundation tube does not deform, the foundation tube may be driven with an approved driving head. For non-penetrable soil, drill a 6" pilot hole and force the tube to the appropriate depth by impact or vibratory means with an approved driving head. The tube may also be installed by augering and backfilling if the contractor so prefers. The initial hole must be large enough to allow adequate room for proper compaction of the soil during backfill. *Care must be taken to carefully compact the backfill to prevent settlement or lateral displacement of the foundation tubes.*

If rock is encountered during driving or excavation, refer to appropriate State specifications. Guidelines will vary from State to State.

The top of the foundation tubes should not project more than 4" above the ground line when measured along a 5' cord, according to AASHTO specifications. Site grading may be required if the top of the foundation tubes project more than 4" above the ground line. The finished guardrail height should generally be 27-3/4" above the edge of the shoulder (see **Figure 6**).

The installation procedure for the **solid 6'-0" long foundation tubes without soil plates** is the same as that for the split foundation tubes. The installation procedure for the **standard 5'-0" long foundation tubes with soil plates** or the **4'-6" long foundation tubes with soil plates** is described previously under the Section on "Installing Posts 3 through 8" and will not be repeated here.

Insert the pipe sleeve (E740) into the 2-1/2" diameter hole near the base of the 5-1/2" x 7-1/2" x 45" wood post (P650) and install the post in the foundation tube at post location 1. Install the second 5-1/2" x 7-1/2" x 45" wood post in the foundation tube at post location 2, and fit the groundline strut (E780) between the two posts. Secure the post to each foundation tube with a 5/8" x 10" hex head bolt (B581004) and H.G.R. nut (N050) with a washer (W050) under both the bolt head and the nut. These bolts will serve to secure the posts and attach the groundline strut to the foundation tubes, as shown in **Figure 8**.

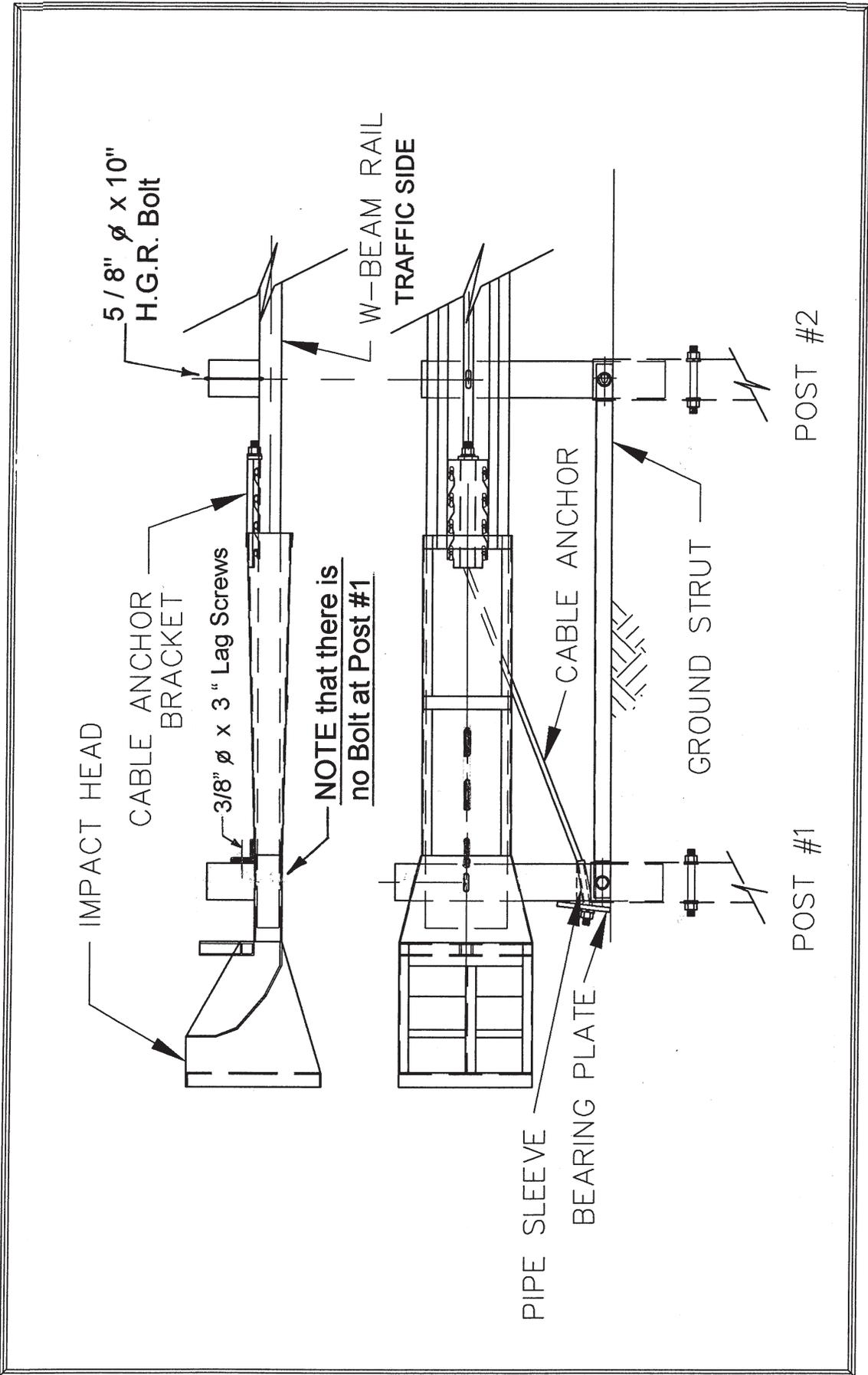
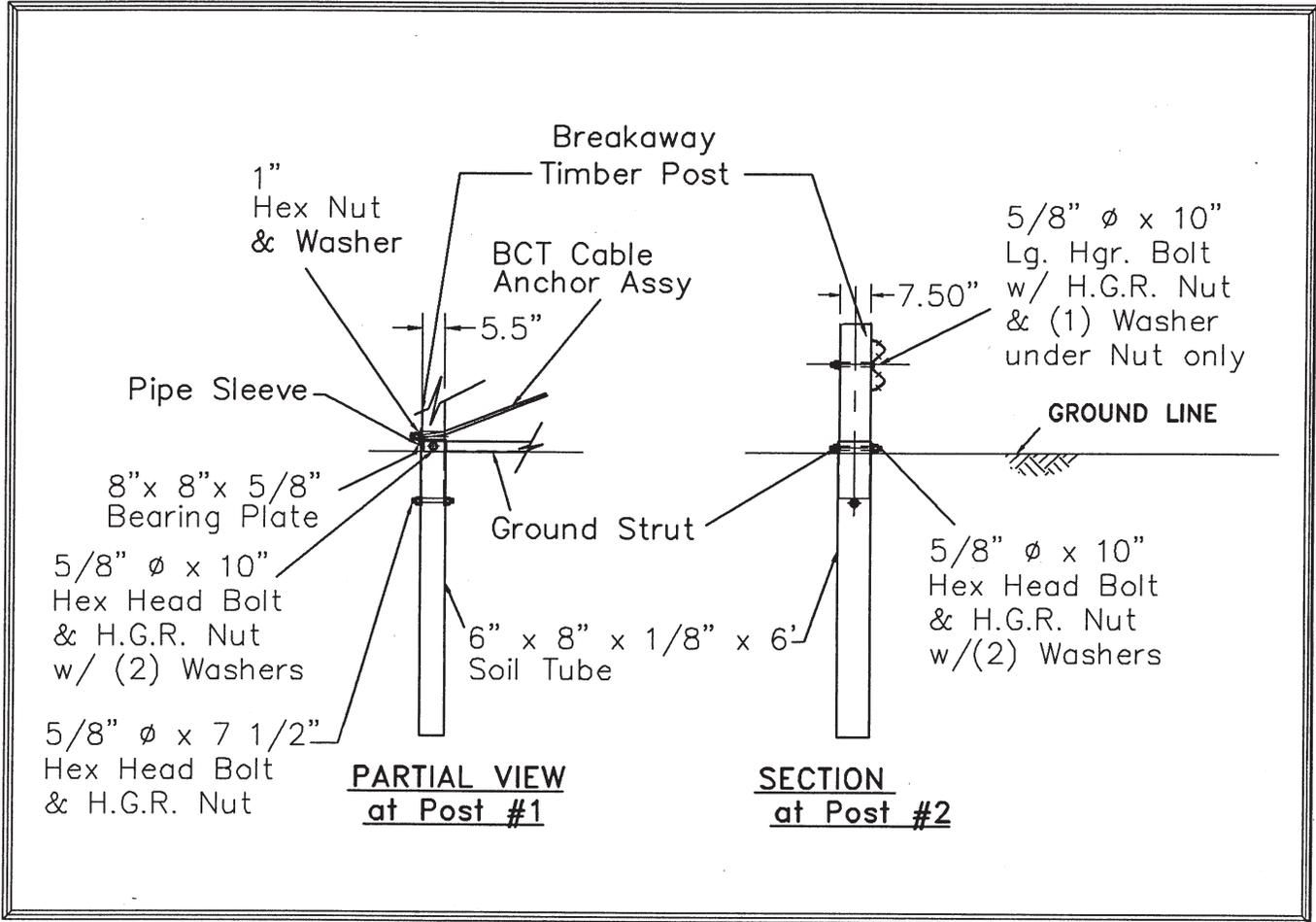


Figure 7. Above-Ground Details at Post Locations 1 and 2.



Note. The optional 6'-0" long split foundation tubes may be substituted with either solid 6'-0" long foundation tubes without soil plates, standard 5'-0" long or 4'-6" long foundation tubes with soil plates.

Figure 8. Section at Post Locations 1 and 2.

Installing Guardrail

Attach the standard W-beam guardrail sections, 12'-6" (G1203) or 25'-0" (G1205), beginning at post 9. Attach the W-beam guardrail end section to span from post 1 to 3 for the 12'-6" rail (S1303), or from post 1 to 5 for the 25'-0" rail (S1305). The rail is to be spliced with 5/8" x 1-1/4" H.G.R. bolts (B580122) and 5/8" H.G.R. nuts (N050).

For ease of installation, it is recommended to have the eight 1/2" cable anchor bracket shoulder bolts (SB58A) and the cable anchor bracket (S760) attached to the W-beam guardrail end section prior to attaching the guardrail to the posts. See Section on "Installing Cable Anchor Bracket" for details.

The rails are to be attached to posts and blockouts at post locations 3 through 8 with 5/8" x 18" H.G.R. bolts (B581802) and nuts (N050). There is no blockout on posts 1 and 2. The rail is attached to post 2 only with a 5/8" x 10" H.G.R. bolt (B581002). **Note that no bolt is used at post #1.** Be sure to place a 5/8" flat washer (W050) on the backside of posts 2 through 8 under each nut (N050).

It is recommended that the post bolt be placed through the rail at post location #5 where the rail splice occurs but it is not necessary.

NOTE: After the blockout is attached, drive a galvanized steel 10d common nail through the block and into the post (toe nailed) to prevent rotation if the wood shrinks.

Installing Cable Anchor Bracket

For ease of installation, it is recommended to have the eight 1/2" cable anchor bracket shoulder bolts (SB58A) and the cable anchor bracket (S760) attached to the W-beam guardrail end section prior to attaching the guardrail to the posts. If this procedure is not followed, Post #2 may interfere with attaching the bracket.

The eight 1/2" cable anchor bracket shoulder bolts (SB58A) are attached to the W-beam guardrail end section with two 1-1/16" OD x 9/16" ID structural washers (W050A), one on each side of the guardrail, and a 1/2" structural nut (N055A). The shoulders of the bolts should be on the backside of the guardrail, away from traffic, as shown in **Figure 9**.

For ease of installation, attach the cable anchor bracket shoulder bolts to the rail "finger tight" only. Then align the slots on the cable anchor bracket (S760) with the shoulder bolts and tap the cable anchor bracket onto the shoulder portion of the bolts using a hammer. Tighten the bolts with a wrench when the bracket is in place. When installed properly, the welded plate on the cable anchor bracket should be toward Post #2, as shown in **Figure 10**.

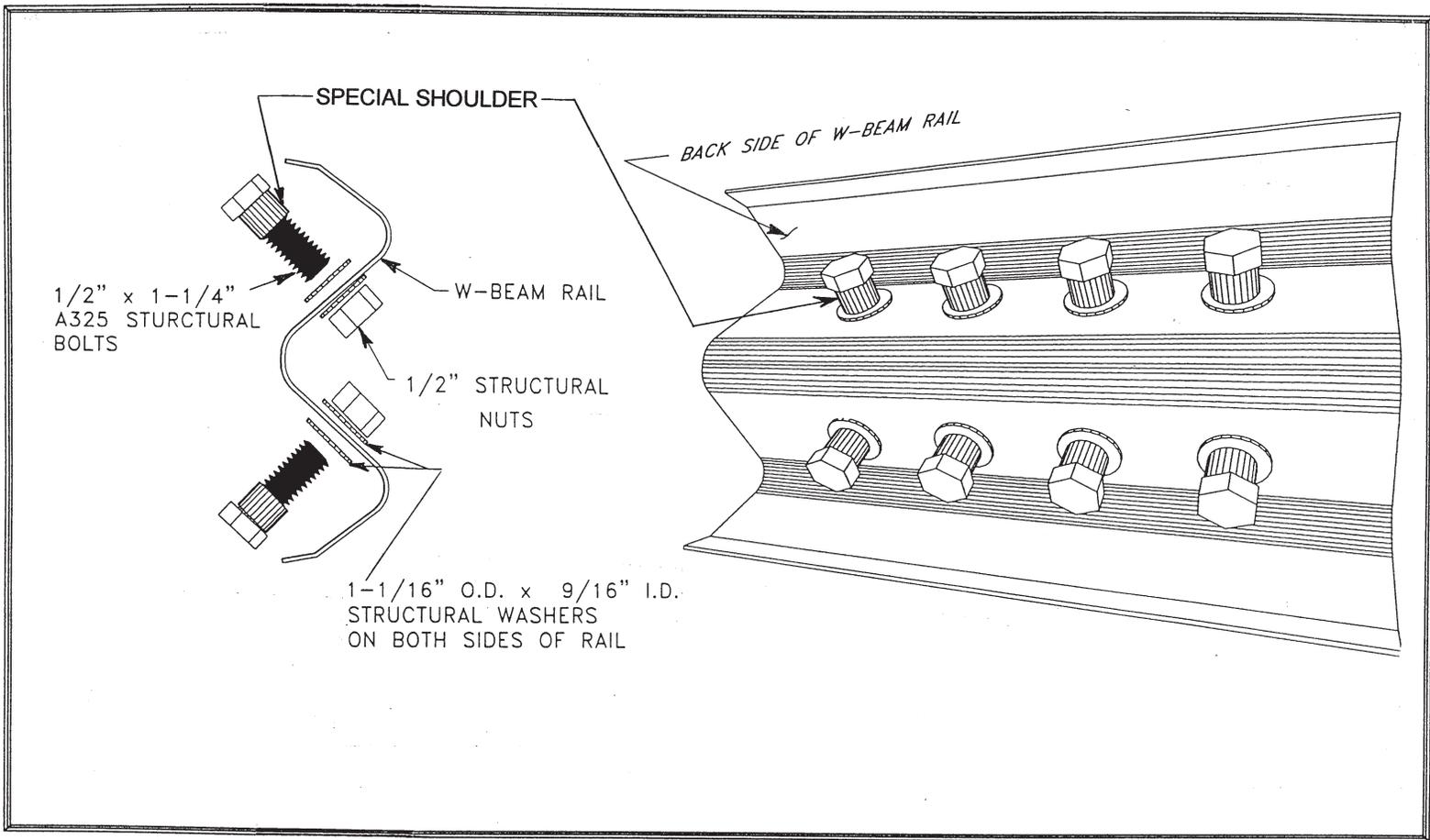


Figure 9. Installation of Cable Anchor Bracket Shoulder Bolts.

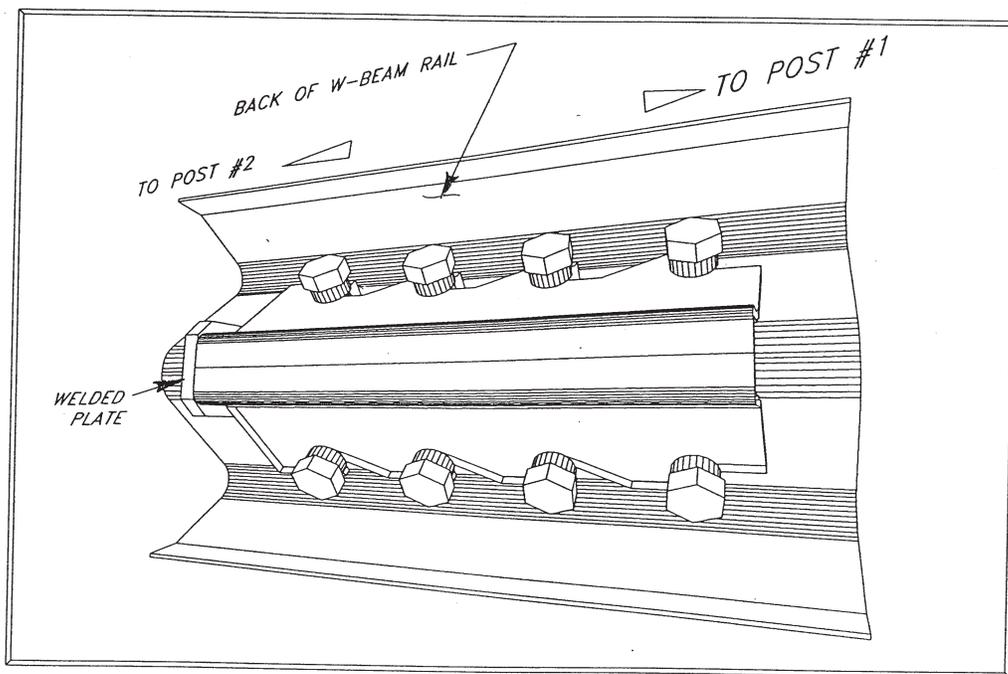


Figure 10. Installation of Cable Anchor Bracket.

Installing the SKT 350 Impact Head

The eight cable anchor bracket shoulder bolts and the cable anchor bracket should be attached to the W-beam guardrail end section prior to attaching the **SKT 350** impact head to the first post with lag screws.

Place the impact head (S3000) with the guide chute over the end of the W-beam guardrail. The impact head should be positioned so that the protruding tube is on the backside of the guardrail, away from traffic as shown in **Figure 2** and **Figure 7**. Slide the impact head forward until the post angle attachments on the impact head are aligned with the downstream side of the first post. This is the side facing post #2. Attach the impact head to the first post with two 3/8" x 3" lag screws (E350), one each for the top and bottom post angle attachments. A 1/4" pilot hole is required to avoid breaking the lag screw. Note that an earlier design of the **SKT 350** impact head had the attachment to post #1 with the post angle attachments of the impact head centered on the first post. This design is still acceptable.

Note. It is recommended that the face of the impact head be delineated with an object marker that meets State specifications for better night visibility. However, the impact face object marker is not included as part of the shipped materials for the **SKT 350** unless specifically requested in the contract plans.

Installing Cable Assembly

Place the cable assembly (E770) through the cable anchor bracket and through the sleeve of post 1. Place the bearing plate (E750) at the base of post 1 with 5" dimension up and 3" dimension down. Place a nail over the bearing plate to prevent the plate from rotating. Secure both ends of the cable assembly with a 1" hex nut (N100) and washer (W100). While tightening cable, use a 2-lb hammer to tap the cable anchor bracket from the downstream end to ensure that it is securely interlocked with the bolts. Restrain the cable at the end being tightened to avoid twisting the cable.

Upon completion of the installation, the cable should be taut and the cable anchor bracket should be fully seated on the shoulder portion of the cable anchor bolts. *It is very important that the cable anchor bracket be fully seated on the shoulder portion of the cable anchor bolts.*

SKT 350 Installation Checklist

State: _____

Date: _____

Project #: _____

Location: _____

- The rail height is in accordance with the plans (generally 27-3/4" above the edge of the shoulder).
- The rail is not attached to the post at post location #1.
- The foundation tubes do not protrude more than 4" above the ground line (measured by the AASHTO 5' cord method). Site grading may be necessary to meet this requirement.
- The bolts at the top of the foundation tubes are not over-tightened, deforming the walls of the tubes.
- The guide chute of the impact head is parallel to the top of the rail and the impact head does not encroach on the shoulder (a 50:1 taper is permitted to eliminate the potential for encroachment).
- The two lag screws holding the impact head to post 1 are snug.
- The 8" x 8" bearing plate at post 1 is correctly positioned with the 5" dimension up & the 3" dimension down. The anchor cable is taut and correctly installed. A nail has been placed over the bearing plate to prevent rotation.
- The cable anchor bracket shoulder bolts are properly attached to the W-beam guardrail and the cable anchor bracket is fully seated on the shoulder portion of the bolts.
- Posts installed in foundation tubes have the 2-1/2" breakaway hole located parallel to the roadway with the bottom of the hole at the top of the tube.
- CRT posts have two 3-1/2" breakaway holes (checked prior to installation) located parallel to the roadway with the center of the top hole located at the ground line.
- If the posts were augered, be sure the backfill material around the posts is compacted.
- No washers are used on the face of the rail except at the cable anchor bracket bolts.

Additional notes: _____

Inspection performed by: _____

Repairing the *SKT 350*

Equipment Needed for Repair Operation

- Acetylene torch to cut off the damaged rail,
- Heavy duty chain to remove the impact head is sometimes required (see **Figure 11**),
- S.A.E. wrench or socket sizes 9/16", 7/8", 15/16", 1-1/4", and 1-1/2",
- Vice grip or channel lock pliers,
- Sledge hammer,
- Post remover tool (see **Figures 12 and 13**),
- Other normal guardrail tools.

General Repair Procedures

After an end-on impact occurs with the *SKT 350*, it will normally require replacement of the first 12'-6" or 25'-0" end section of rail and any other damaged rail section(s) and any broken post(s). For a traffic face impact, the damage will be to the downstream rail section(s) and associated posts.

The general step-by-step procedure for repairing a damaged *SKT 350* terminal is as follows:

- (1) Check the impact head for damage.
- (2) Check the cable anchor bracket and cable assembly for damage. The bearing plate, nuts, washers, cable anchor bracket, and the special cable anchor bracket shoulder bolts are rarely damaged.
- (3) Check the number of broken posts and wood blockouts that need to be replaced, along with any damaged bolts. Inventory and pick up the reusable parts.
- (4) Torch off the kinked rail near the outlet of the impact head. The impact head should be able to be **removed by hand** at this point. If not, then hook up a chain attachment through the opening behind the impact plate of the impact head, as shown in **Figure 11**. Pull the impact head off the rail with the chain attached to a truck frame with the W-beam guardrail still attached to the downstream guardrail posts.

- (5) Disconnect and remove the damaged rail from the posts.
- (6) Remove the broken posts from the foundation tubes using one of the two post removal tools (see **Figures 12 and 13**) assembled from "off the shelf hardware" items. Pound the steel pipe or screw the lag screw into the top of the broken post stub and remove the remains of the broken post by pulling on the chain. Use a pry bar as a lever if necessary.
- (7) Reinstall the system following the procedures listed in this manual.

Procedures Immediately Following an Accident (Temporary)

If no repair parts are readily available immediately following an accident, the following procedure should be used to provide temporary protection of the guardrail end. It should be noted that this repair is only for temporary purposes, and the anchor cable cannot be installed to provide tension in the rail for redirection impacts.

- (1) Remove damaged rail and impact head from the roadway or shoulder area.
- (2) Using an acetylene torch, cut the kinked rail off at the outlet of the impact head and inspect the head for any damage.
- (3) Remove the impact head by hand. If this is not possible, then with a chain hook-up (see **Figure 11**), pull the impact head off the downstream rail that is still attached to the posts.
- (4) Locate the first post downstream of any damaged rail and cut this rail off about 9" in front of the post. If the post is at a splice, simply unbolt the damaged rail.
- (5) Install the impact head on the rail and attach it to the post with lag bolts.
- (6) Warning signs should be used where appropriate.

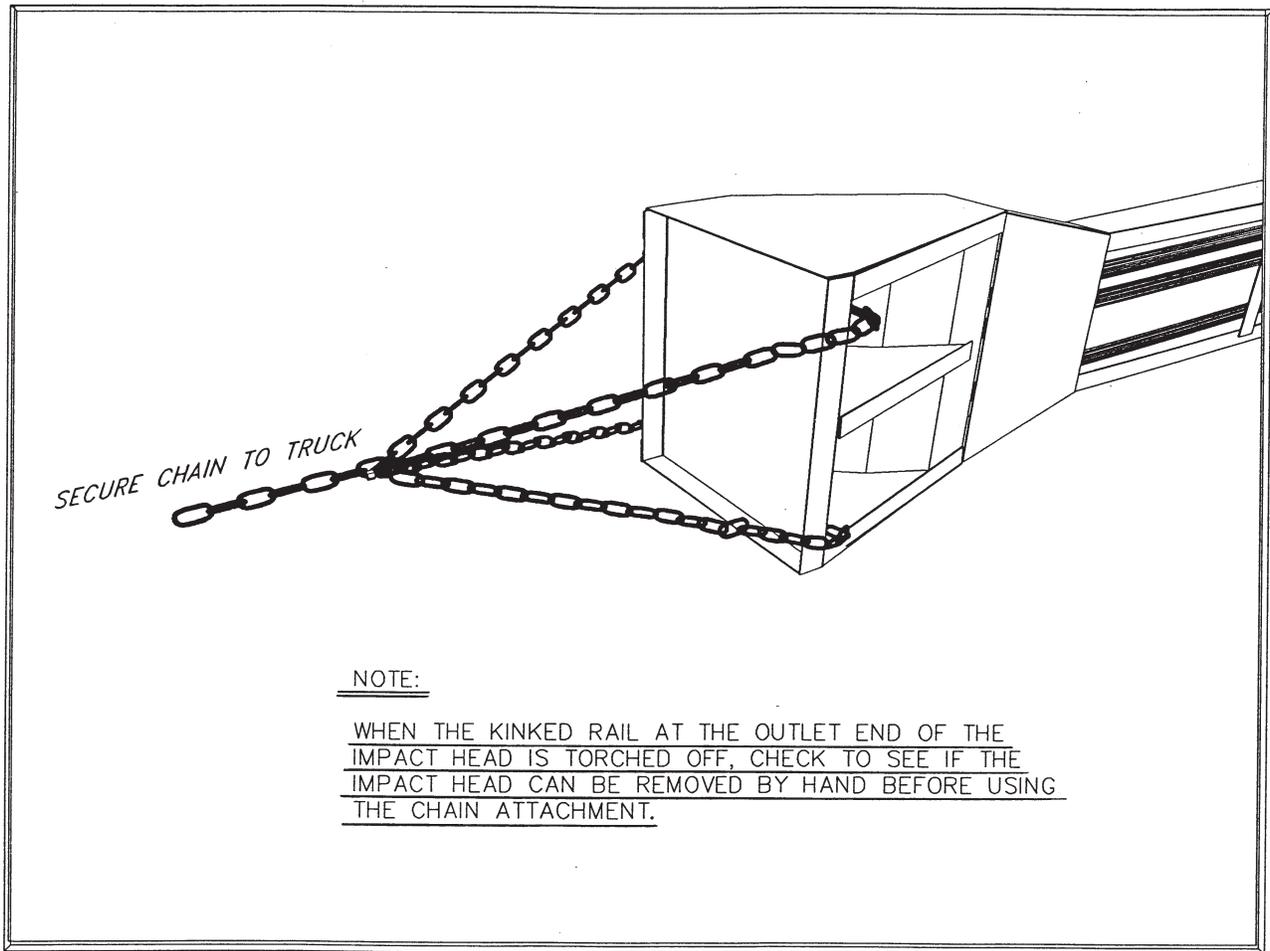


Figure 11. Chain Attachment to Remove Impact Head

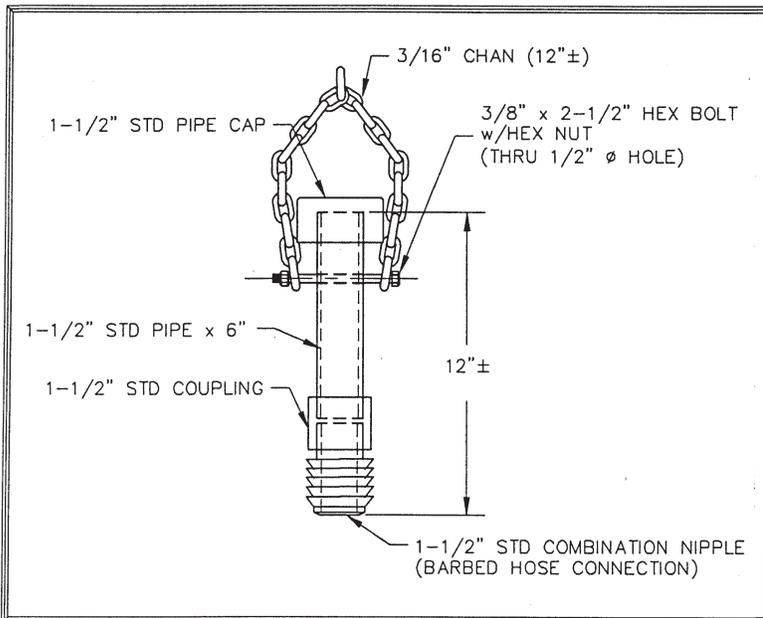


Figure 12. Wood Post Pulling Tool (Pipe Option)

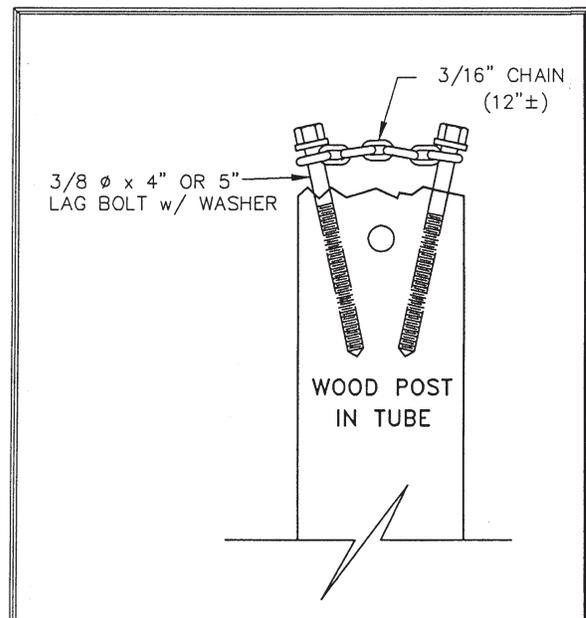
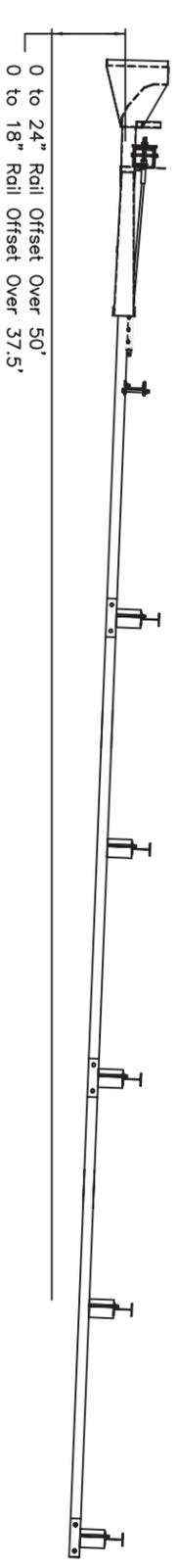
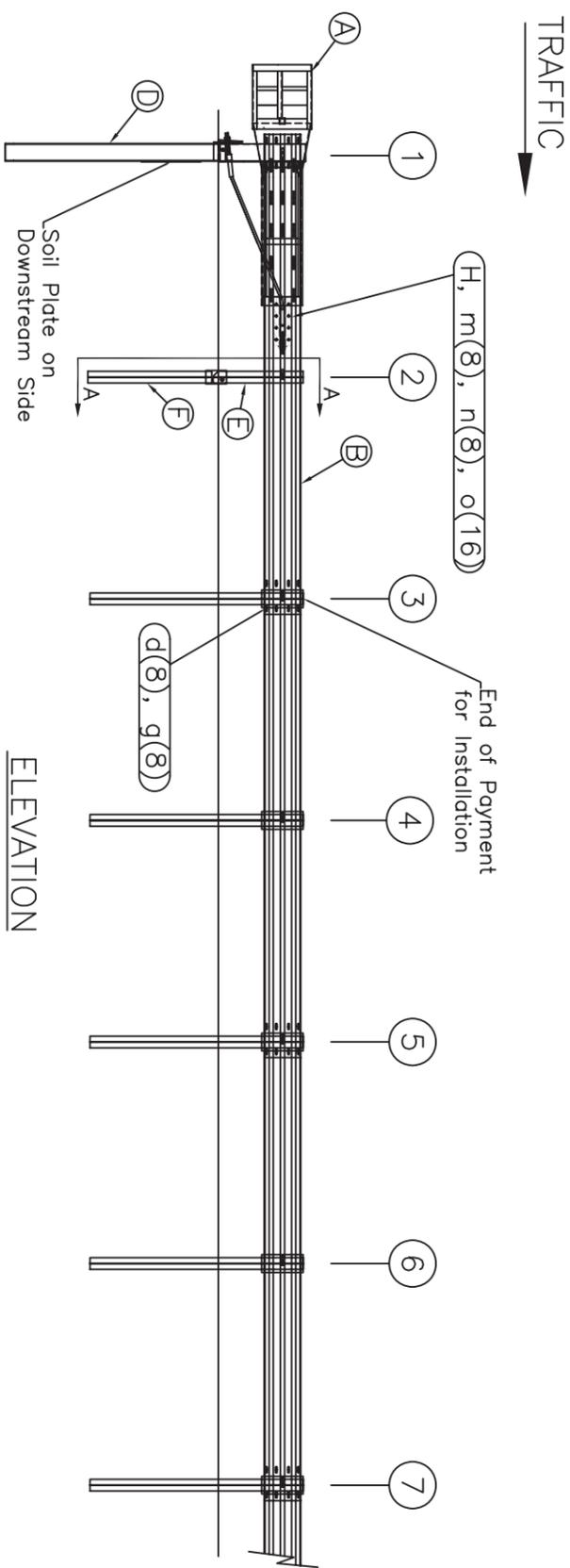
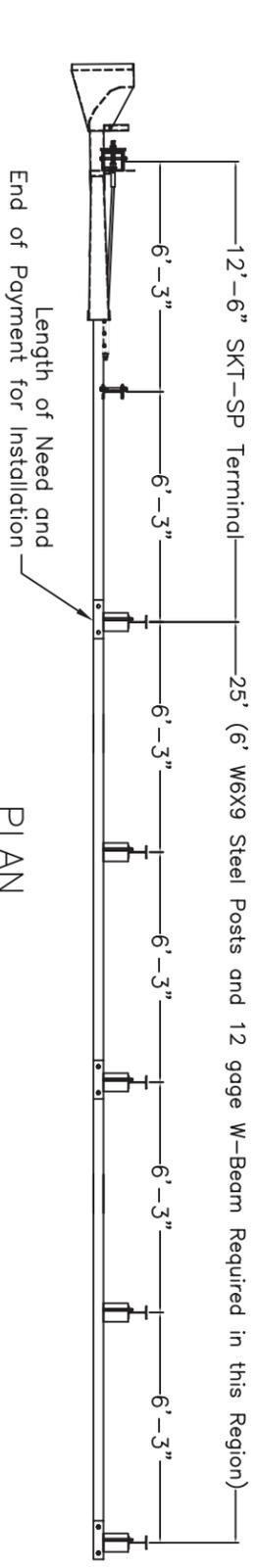
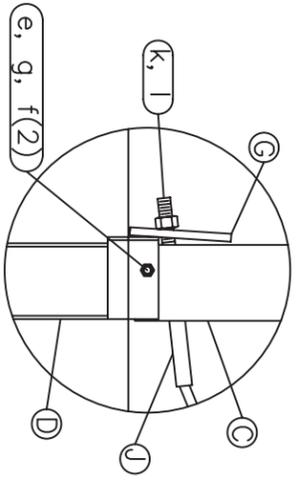


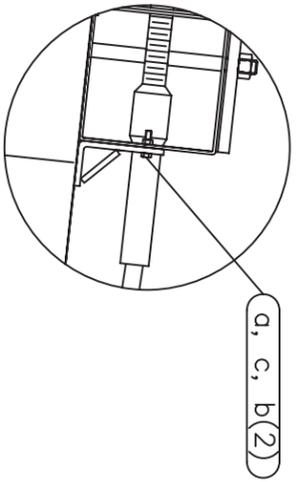
Figure 13. Wood Post Pulling Tool (Lag Screw Option)



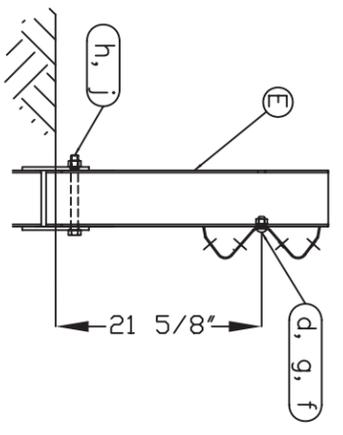
OPTIONAL FLARED INSTALLATION
25:1 maximum flare rate



Post #1 Connection Detail



Impact Head Connection Detail



SECTION A-A
Post #2

ITEM	QTY	BILL OF MATERIALS	ITEM NO.
A	1	IMPACT HEAD	S3000
B	1	W-BEAM GUARDRAIL END SECTION, 12 Ga.	SF1303
C	1	FIRST POST TOP (6X6 $\frac{1}{2}$ " Tube)	TPHP1A
D	1	FIRST POST BOTTOM (6' W6X15)	TPHP1B
E	1	SECOND POST ASSEMBLY TOP	HP2A
F	1	SECOND POST ASSEMBLY BOTTOM	HP3B
G	1	BEARING PLATE	E750
H	1	CABLE ANCHOR BOX	S760
J	1	BCT CABLE ANCHOR ASSEMBLY	E770

HARDWARE (ALL DIMENSIONS IN INCHES)			
a	2	5/16 x 1 HEX BOLT GRD 5	B5160104A
b	4	5/16 WASHER	W0516
c	2	5/16 HEX NUT	N0516
d	9	5/8 Dia. x 1 1/4 SPLICE BOLT (POST #2)	B580122
e	1	5/8 Dia. x 9 HEX BOLT GRD 5	B580904A
f	3	5/8 WASHER	W050
g	10	5/8 Dia. H.G.R NUT	N050
h	1	3/4 Dia. x 8 1/2 HEX BOLT GRD A449	B340854A
j	1	3/4 Dia. HEX NUT	N030
k	2	1 ANCHOR CABLE HEX NUT	N100
l	2	1 ANCHOR CABLE WASHER	W100
m	8	CABLE ANCHOR BOX SHOULDER BOLT	SB58A
n	8	1/2 A325 STRUCTURAL NUT	N055A
o	16	1 1/16 OD x 9/16 ID A325 STR. WASHER	W050A

GENERAL NOTES:

1. All bolts, nuts, cable assemblies, cable anchors and bearing plates shall be galvanized.
2. The lower sections of the Posts 1&2 shall not protrude more than 4 in above the ground (measured along a 5' cord). Site grading may be necessary to meet this requirement.
3. The lower sections of the hinged posts should not be driven with the upper post attached. If the post is placed in a drilled hole, the backfill material must be satisfactorily compacted to prevent settlement.
4. When competent rock is encountered, a 12" Ø post hole, 20 in. deep cored into the rock surface may be used if approved by the engineer for post 1. Granular material will be placed in the bottom of the hole, approximately 2.5" deep to provide drainage. The first post can be field cut to length, placed in the hole and backfilled with suitable backfill. The soil plate may be trimmed if required.
5. A site evaluation should be considered if there is less than 25' between the outlet side of the terminal and any adjacent driving lane.
6. The breakaway cable assembly must be taut. A locking device (vice grips or channel lock pliers) should be used to prevent the cable from twisting when tightening nuts.



Road Systems, Inc.
Big Spring, TX
Phone: 432-263-2435
or Phone: 330-346-0721

**SKT-SP Terminal
(Standard Post)**

2 Post System

Sheet: 1

Date: 01/26/09

By: JRR

Rev: 0

Drawing Name: SKT-SP-S

Scale: None

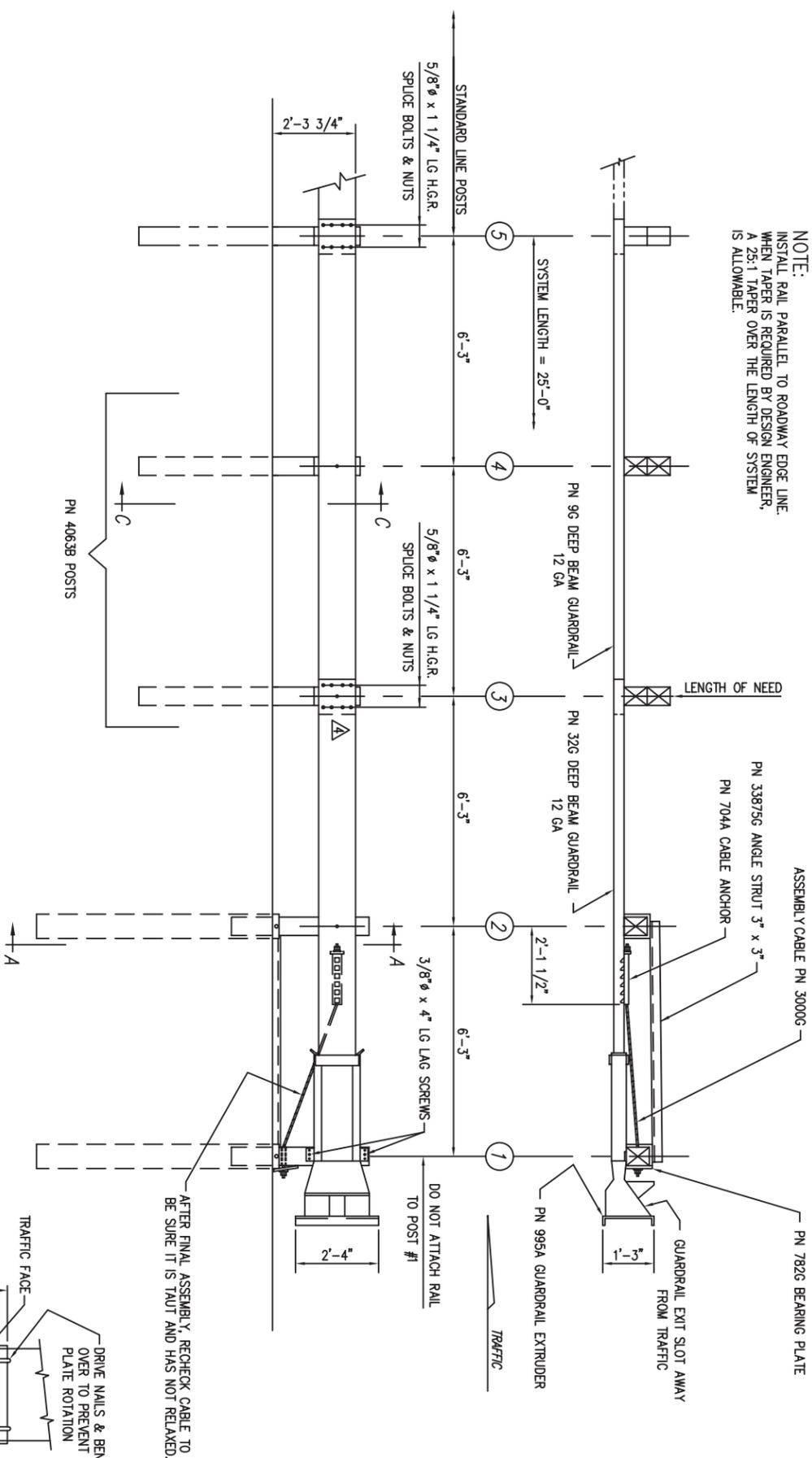
Rev: 0

SPECIFICATIONS

ET-PLUS™

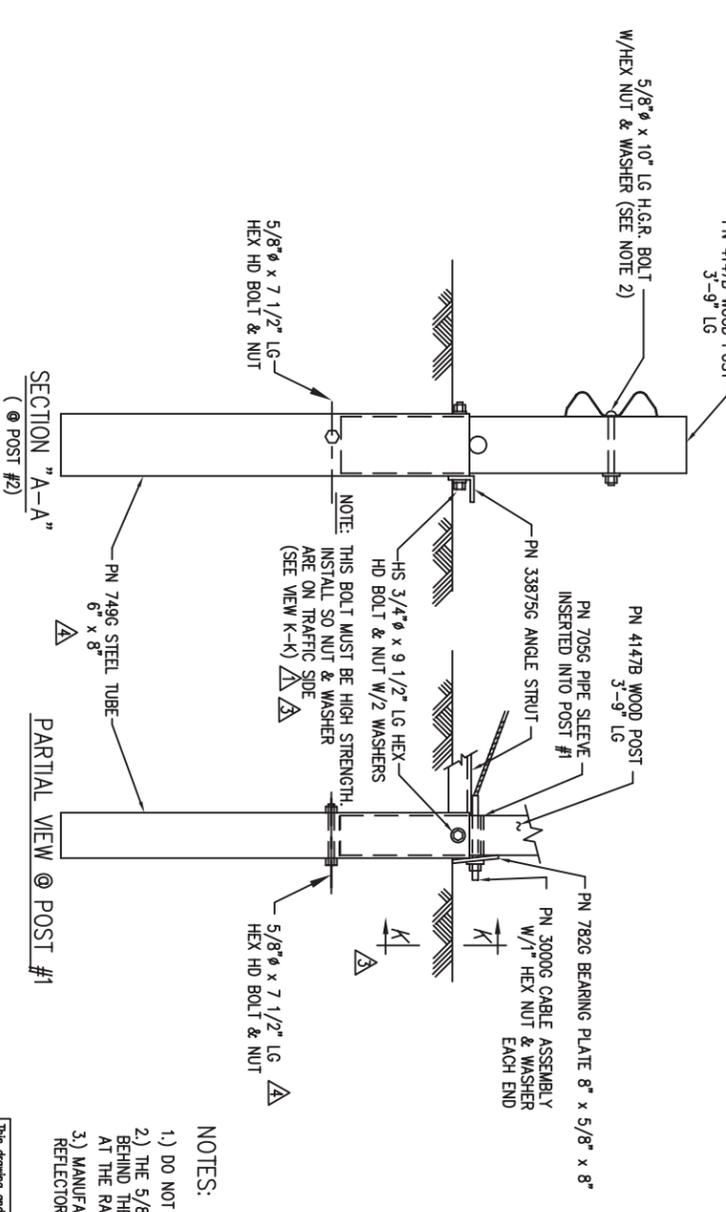
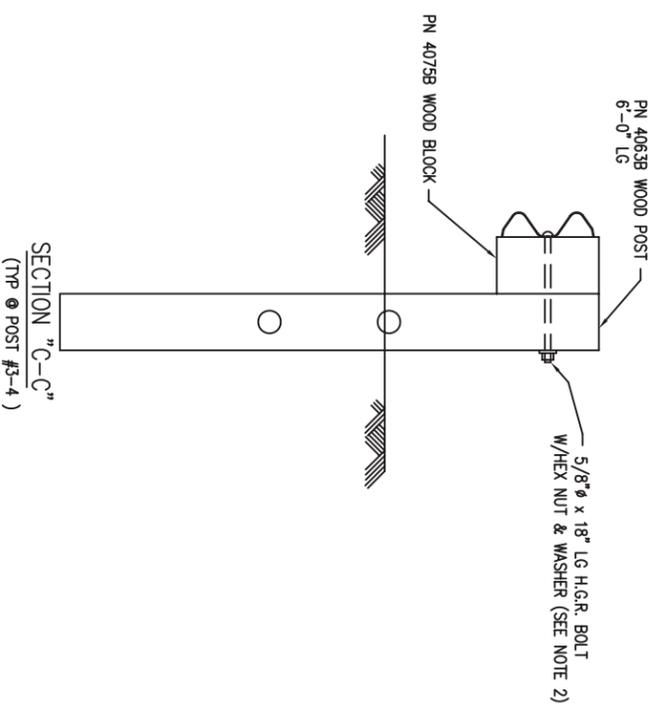
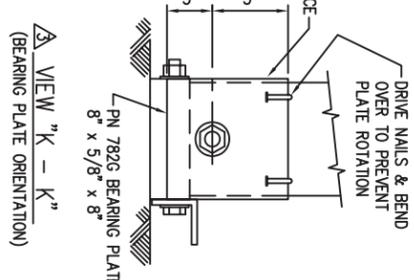
- Offset: 0 to 2' (0-610 mm)
- Length: 25' (7.62 m), 37' 6" (11.43 m)
or 50' 0" (15.24 m)
- Post Spacing: 6'-3" (1905 mm)
- Length of need: 12'6" (3.81 m)

NOTE:
INSTALL RAIL PARALLEL TO ROADWAY EDGE LINE.
WHEN TAPER IS REQUIRED BY DESIGN ENGINEER,
A 25:1 TAPER OVER THE LENGTH OF SYSTEM
IS ALLOWABLE.



BILL OF MATERIAL		
PN	QTY	DESCRIPTION
9G	1	12/126/6/3/S (GUARDRAIL)
32G	1	12/126/6/3/S ANC (GUARDRAIL)
704A	1	CABLE ANCHOR BRACKET
705G	1	2" x 5 1/2" PIPE
749G	2	6.0 TUBE SLEEVE
782G	1	5/8" x 8" x 8" BEARING PLATE
995A	1	ET-PLUS EXTRUDER
3000G	1	CABLE 3/4 x 6'6"
3300G	3	5/8" WASHER
3340G	21	5/8" HEX NUT
3360G	16	5/8" x 1 1/4" SPLUCE BOLT
3478G	2	5/8" x 7 1/2" HEX HD BOLT
3500G	1	5/8" x 10" POST BOLT
3580G	2	5/8" x 18" POST BOLT
3700G	4	3/4" WASHER
3704G	2	3/4" HEX NUT
3900G	2	1" WASHER
3910G	2	1" HEX NUT
4063B	2	WD 6.0 POST 6 x 8
4078B	2	WD BLOCK 12 x 6 x 8 DR
4147B	2	WD 3.9 POST 5 1/2 x 7 1/2
4228G	2	3/8" x 4" LAG SCREW
5148G	2	3/4" x 9 1/2" HEX HD BOLT
33875G	1	ANGLE STRUT

AFTER FINAL ASSEMBLY, RECHECK CABLE TO BE SURE IT IS TAUT AND HAS NOT RELAXED.



NOTES:

- DO NOT ATTACH GUARDRAIL TO POST #1.
- THE 5/8" FLAT WASHER IS USED UNDER THE NUT, BEHIND THE POST ONLY. NO WASHER IS USED AT THE RAIL.
- MANUFACTURER SUGGESTS CUSTOMER TO PROVIDE REFLECTORIZATION OF TERMINAL.

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ET-PLUS, OTHER AVAILABLE OPTIONS:
STEEL HINGED BREAKAWAY (HBA) OR STEEL YIELDING POSTS (SYTP) POSTS AT LOCATIONS 1-2, 1-4
KING BLOCKS (COMPOSITE)
12'-6" OR 25'-0" GUARDRAIL PANELS
6'-0" POST FOUNDATION TUBES WITHOUT SOIL PLATES OR 4'-6" TUBES W/SOIL PLATES (#1 & 2)
2 OR 4 POST FOUNDATION TUBES (SOIL PLATES OPTIONAL ON POSTS #3 & 4)
ENGLISH OR METRIC DRAWINGS

REV.	CHKD.	BY	DATE	REMARKS
4			9/09/05	ATTACHED PANEL TO POST #3, CHANGED TUBE SLEEVE, ADDED NOTE
3	LH		5/22/02	ADDED VIEW K-K, AND NOTE
2	BT		3-30-01	CHANGED 3/4 HEX NUT PN NO
1	BT		9-28-00	ADDED NOTE

ET-PLUS
PLAN, ELEVATION & SECTION
NCHRP 350 TEST LEVEL 2
AVAILABLE OPTIONS

TRINITY HIGHWAY SAFETY PRODUCTS, INC.
2525 STEWARTS FREEWAY
DALLAS, TX 75207

DRAWING NO. SS-151
REV. 4

