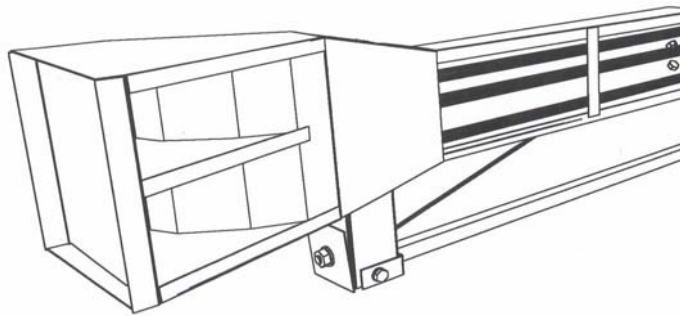


SKT Tangent Terminal

Installation Instructions for

Steel Post Options



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General Information For All SKT Steel Posts Designs

The SKT was crash tested to meet the requirements of NCHRP Report 350 Test Level 3 (100 km/hr) and Test Level 2 (70 km/hr). Refer to specific State DOT standards and specifications for allowable design alternatives. It is the responsibility of the installer to utilize a design approved by the State DOT and to follow all required State procedures in installing the SKT.

This SKT Installation Manual is divided into 4 sections

- General Information for all **SKT** Steel Posts Designs.
- **SKT** Design Options – This area describes the many different post options (steel and wood posts) to choose from for the SKT. (page 4)
- Installing the **SKT** – This section gives a step-by-step procedure on the proper installation of the SKT system. (page 16) Refer to Figures 1 – 13 for details.
- Inspection Checklist for **SKT** Steel Post System – Use this checklist to inspect new installations or recently maintained/repaired installations. (page 21)

The Following Steel Post Options are Accepted for use with the SKT:

- All Bolted Hinged Posts (foundation tubes are not required).
- All Plug Welded Posts (foundation tubes are required at posts #1 & #2).
- Bolted Hinged Posts #1 & #2 and Plug Welded Posts #3 and beyond.
- Bolted Hinged Posts #1 & #2 and Wood CRT Posts #3 and beyond.

The Following Installation Lengths are Accepted for use with the SKT:

The Test Level 3 (100 km/hr design speed) **SKT** system is 50'-0" long.

The Test Level 2 (70 km/hr design speed) **SKT** system is 25'-0" long. This has the same components as the 50'-0" long system with the last 25'-0" eliminated.

The Test Level 3 **SKT-LITE** option may be installed 37'-6" long. This has the same components as the 50'-0" long system with the last 12'-6" eliminated. Check the State standard sheets or contract plans to see if this option is approved in your State.

General Information (continued)

The **SKT** breakaway steel posts are applicable for Test Level 3 (50'-0" long system) and Test Level 2 (25'-0" long system) design speeds. See **Figure 1** for a layout of the **SKT** steel post system.

Shown below is a comparison of the wood post and steel post **SKT** systems.

The following items remain "**unchanged**" from the "**wood**" post systems to "**steel**" post systems:

- Impact head
- All W-beam rail sections
- Cable anchor bracket
- Foundation tubes (only required with the Plug Welded Posts)
- Ground strut (same for Plug Welded Posts / different for Hinged Bolted Posts)
- Cable assembly
- Bearing plate
- Most of the hardware

The following "**items vary**" between the "**wood**" post systems to "**steel**" post systems:

- The **end posts** are steel rather than wood.
- The breakaway **line posts** are steel rather than wood.
- For the Bolted Hinged Post design, a different **ground strut** is used.
- The steel post systems do not use a **pipe sleeve** at post #1.
- The steel post systems use a **routed wood block** or recycled block of similar design.
- The steel post systems use a standard 1 1/4" long splice bolt for the **post bolt at post #2** instead of a 10" long post bolt.
- The steel post systems use 10" long **line post bolts** instead of 18" long.
- The steel post systems use 1/4" hex bolts for the **impact head attachment** not 3/8" lag screws. (The **SKT** impact head is designed to bolt to a steel post or a wood post. See **Figure 11.**)
- The Plug Welded systems **strut channel bolts** are 3/4" at the tube connection not 5/8" bolts.
- The Bolted Hinged posts use a single high strength **post hinge bolt** at the post connection. At post #1, the bolt is 5/8" x 9". At the remaining posts, a 3/4" x 8 1/2" bolt is used.
- The steel post systems bearing plate uses a **retainer/tie** to prevent rotation.

Design Options

The length of the Test Level 3 **SKT** system is 50'-0" long or the system may also be installed 37'-6" long for the **SKT-LITE** option. Check State or local agency standards or contract plans for allowable options.

There are many different options available for the SKT support posts. Available designs are shown in **Table 1**.

SKT Post Design Options	Number of Wood BCT Posts	Number of Wood CRT Posts	Number of Foundation Tubes	Number of Bolted Hinged Steel Posts	Number of Plug Weld Steel Posts
All Breakaway Wood Posts	2, 4 or 8	6, 4 or 0	2, 4 or 8	-0-	-0-
All Hinged Steel Posts	-0-	-0-	-0-	6 medium 2 long	-0-
All Plug Weld Steel Posts	-0-	-0-	2	-0-	2 short 6 medium
Hinged & Plug Weld Steel Posts	-0-	-0-	-0-	2 long	6 medium
Hinged Steel & Wood Posts	-0-	6	-0-	2 long	-0-

Table 1. SKT Post Design Options (50'-0" long system)

(Refer to Wood Post SKT Manual for additional information on the Wood Post SKT System)

Post Lengths & Descriptions: (Reference to the approximate length of posts shown below is for the purpose of identifying a general length relative to the other posts. It is not an exact length.)

BCT Wood Posts are approx. 3.5 feet long and inserted in a steel foundation tube.

CRT Wood Posts are 6 feet long.

Long Hinged Steel Posts are approx 8.5 feet long and must be bolted together in the field.

Medium Hinged Steel Posts are 6 feet long and must be bolted together in the field.

Medium Plug Weld Steel Posts are 6 feet long and shipped as a welded assembly.

Short Plug Weld Steel Posts are approx 3.5 feet long and inserted in a foundation tube. They are shipped as a welded assembly.

Steel Foundation Tubes at post locations #1 & #2 may be either 6 feet long (no soil plate) or 4.5 feet or 5 feet long (with a soil plate).

NOTE: All Bolted Hinged **Steel** Posts must have the lower section installed before bolting the top section. The lower section of the Bolted Hinged steel posts should not be driven with the upper post attached.

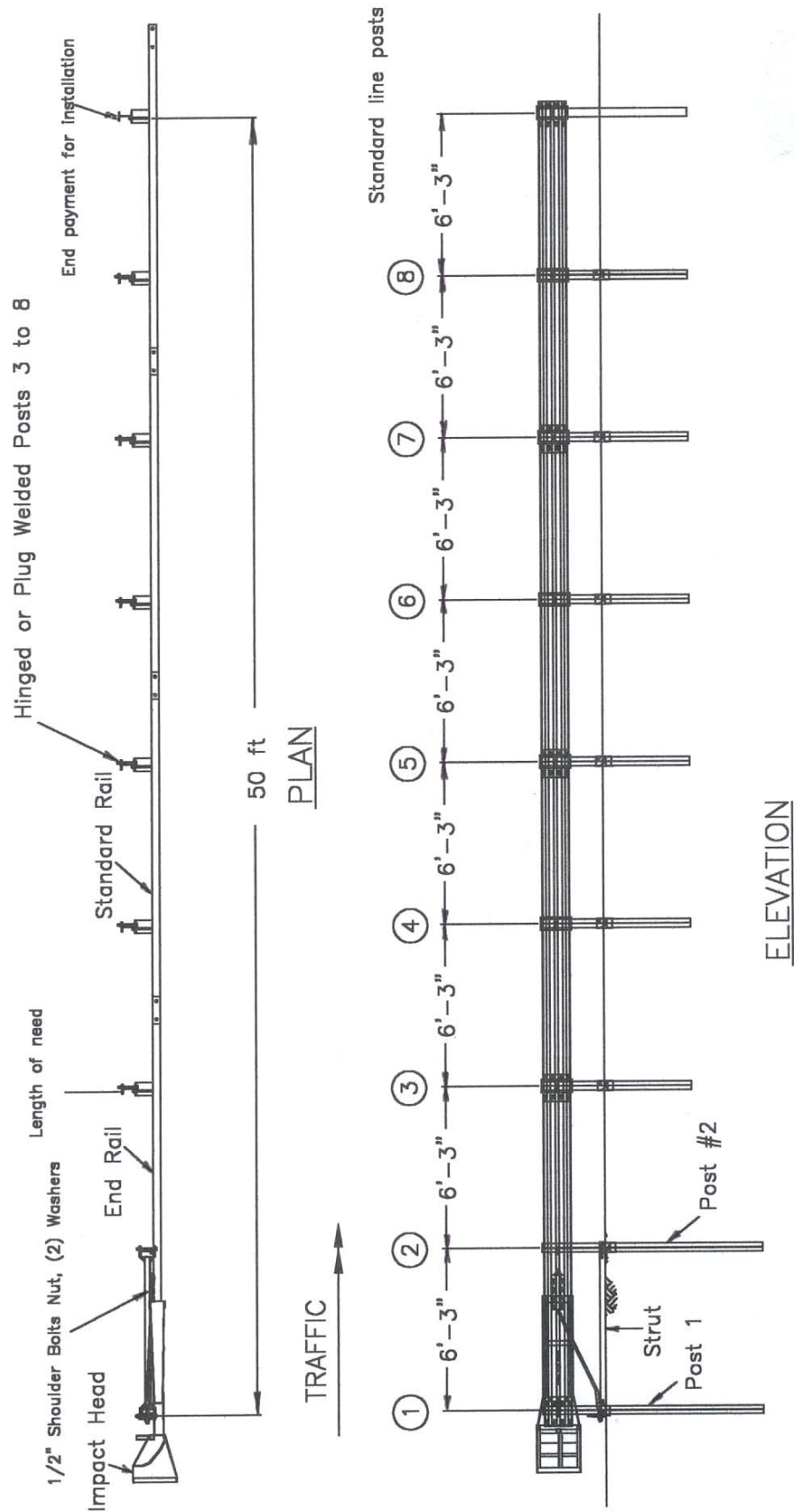


Figure 1. Plan and Elevation View of Steel Post SKT System

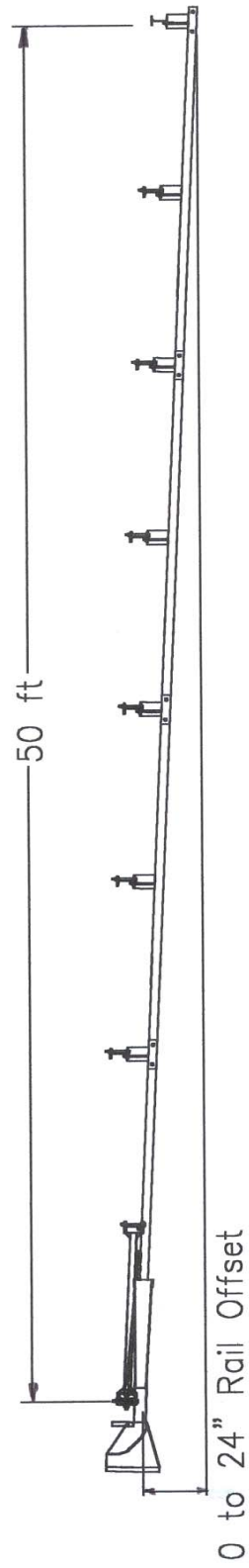


Figure 2. SKT Optional Flared Installation

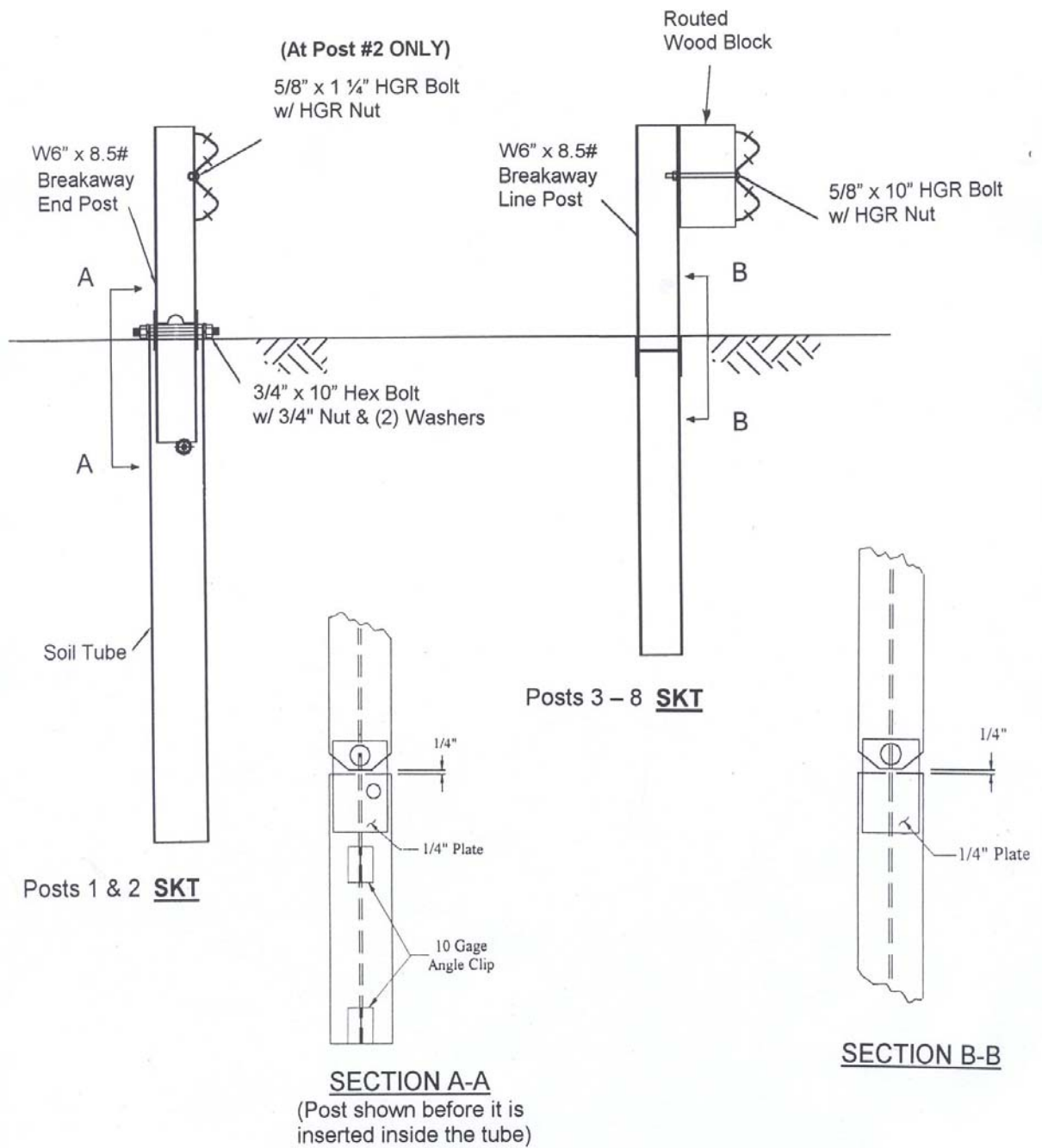


Figure 3. Section View of Plug Welded Steel End Posts and Line Posts

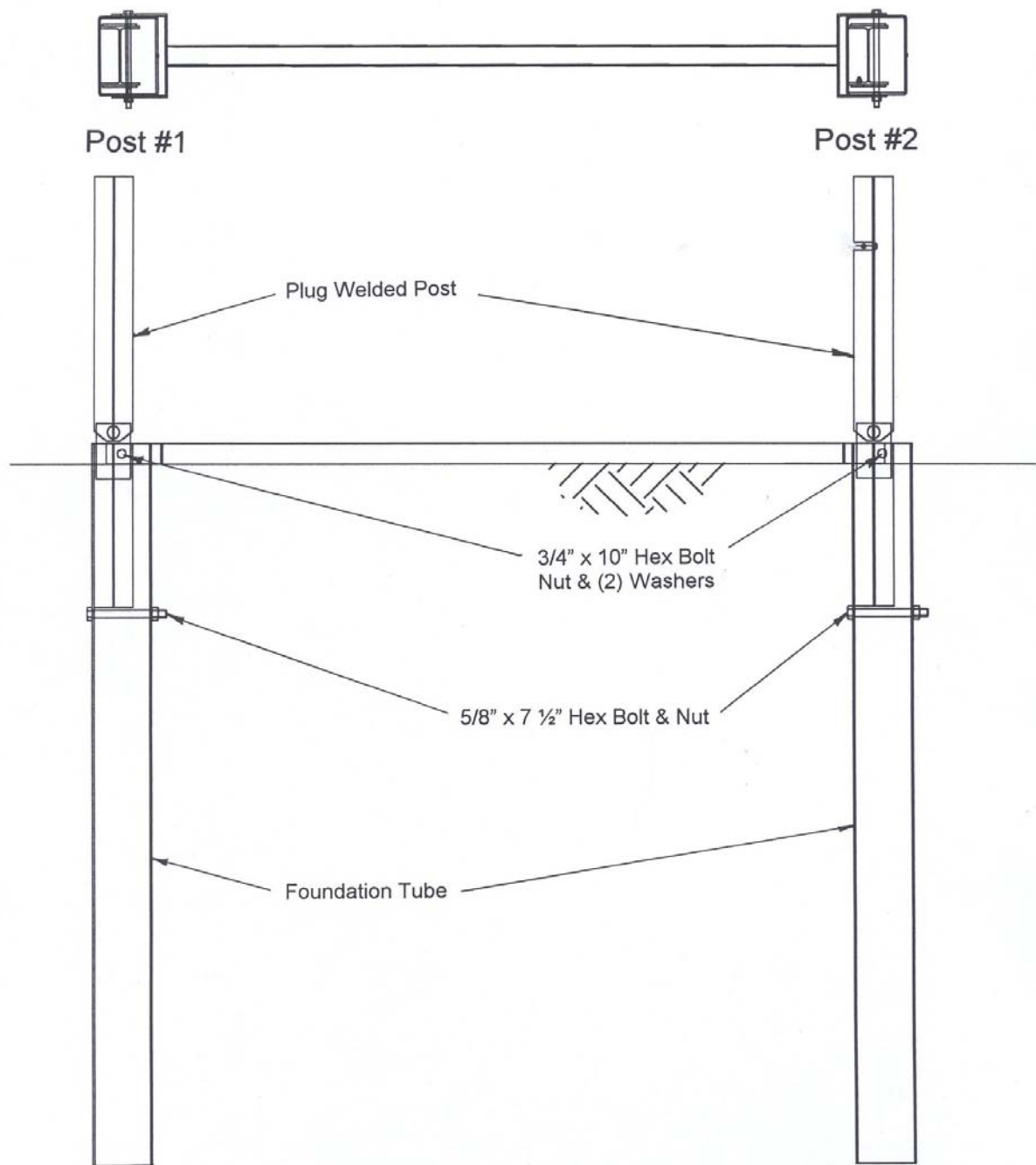


Figure 4. SKT Ground Strut Anchorage for Plug Welded Steel Post

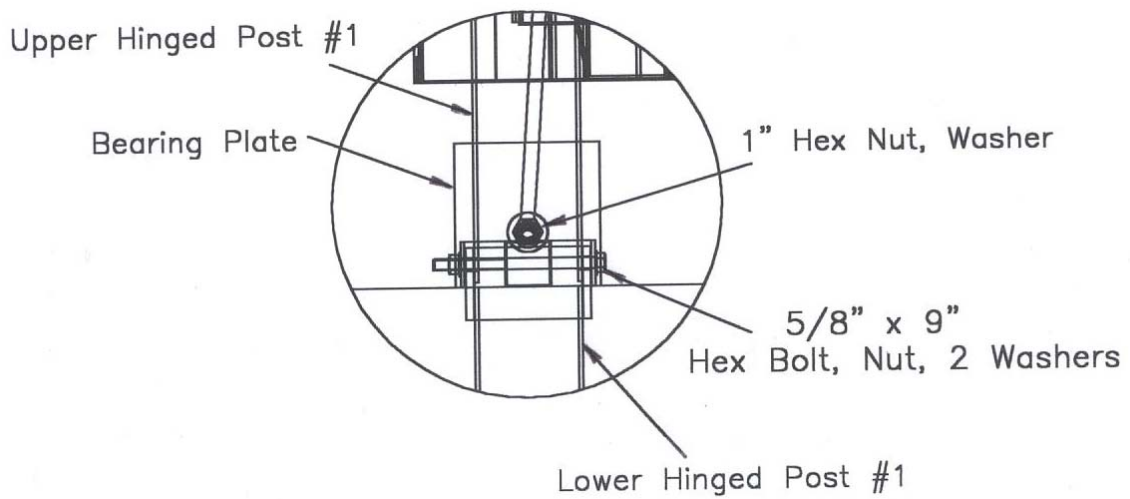
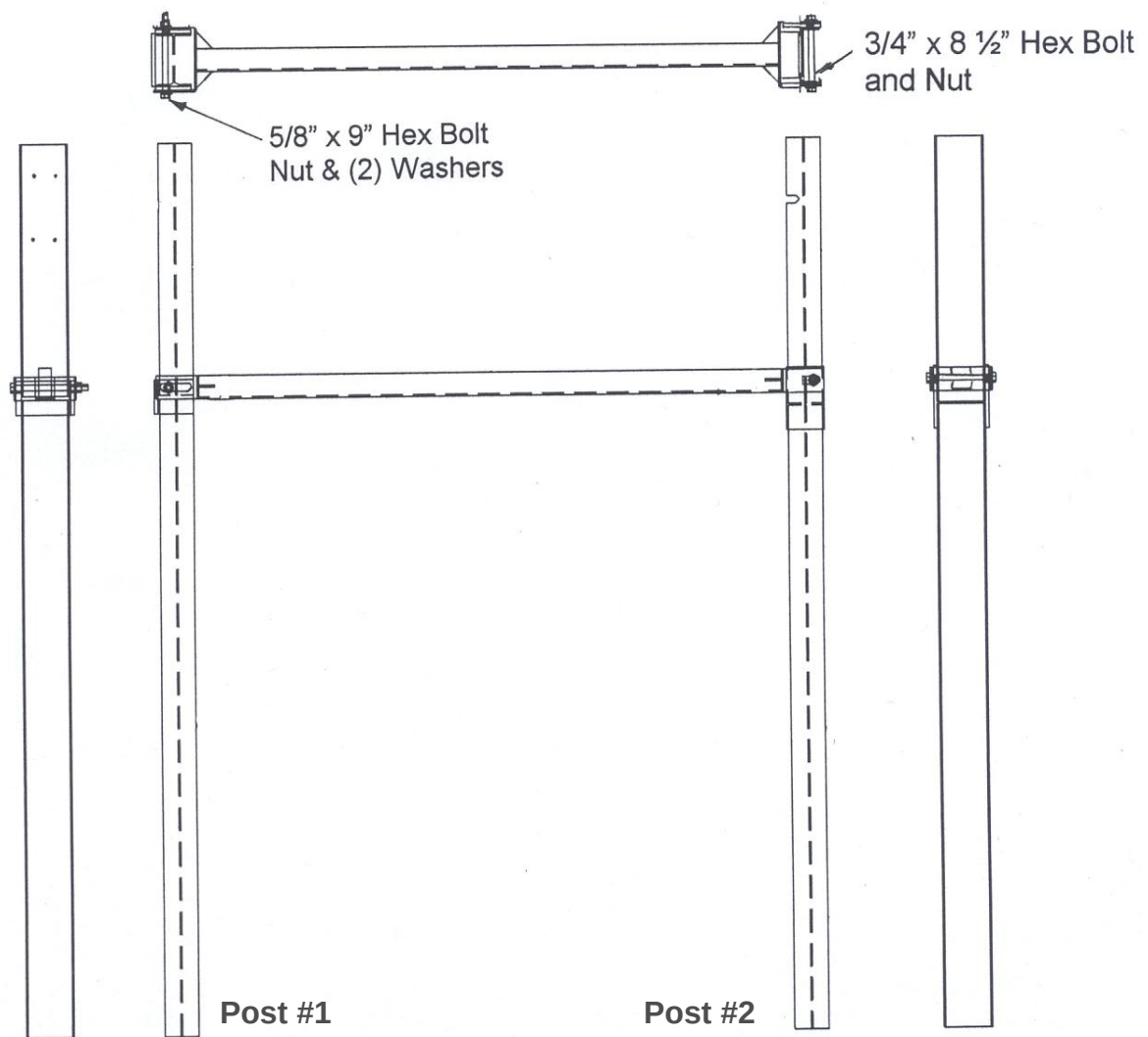
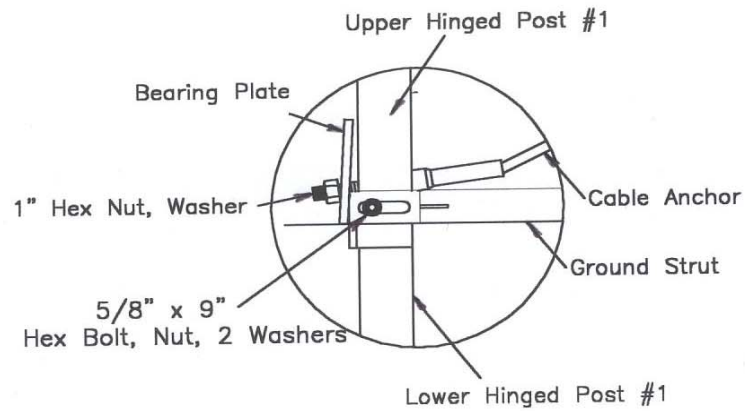
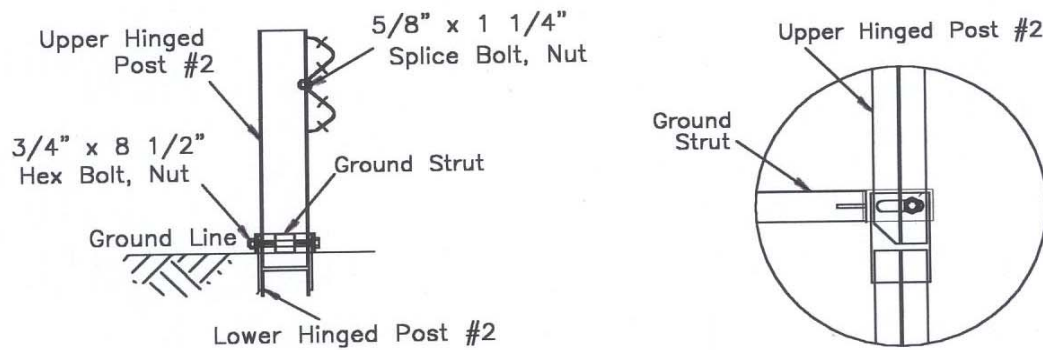


Figure 5. SKT Ground Strut Anchorage for Bolted Hinged Steel Post

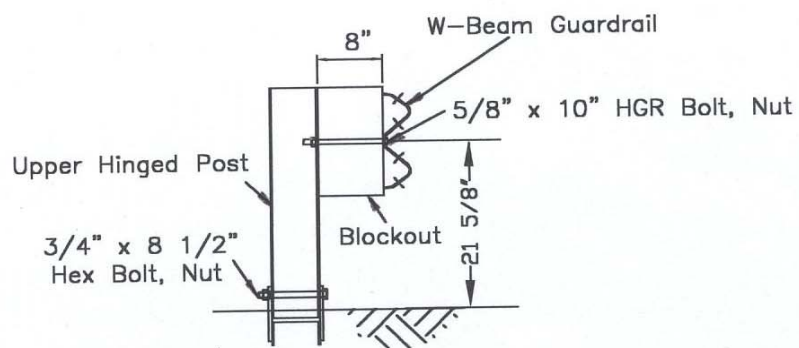


Hinged Steel Post #1 Side View

(Note that retainer/tie to keep bearing plate from rotating is not shown)



Hinged Steel Post #2



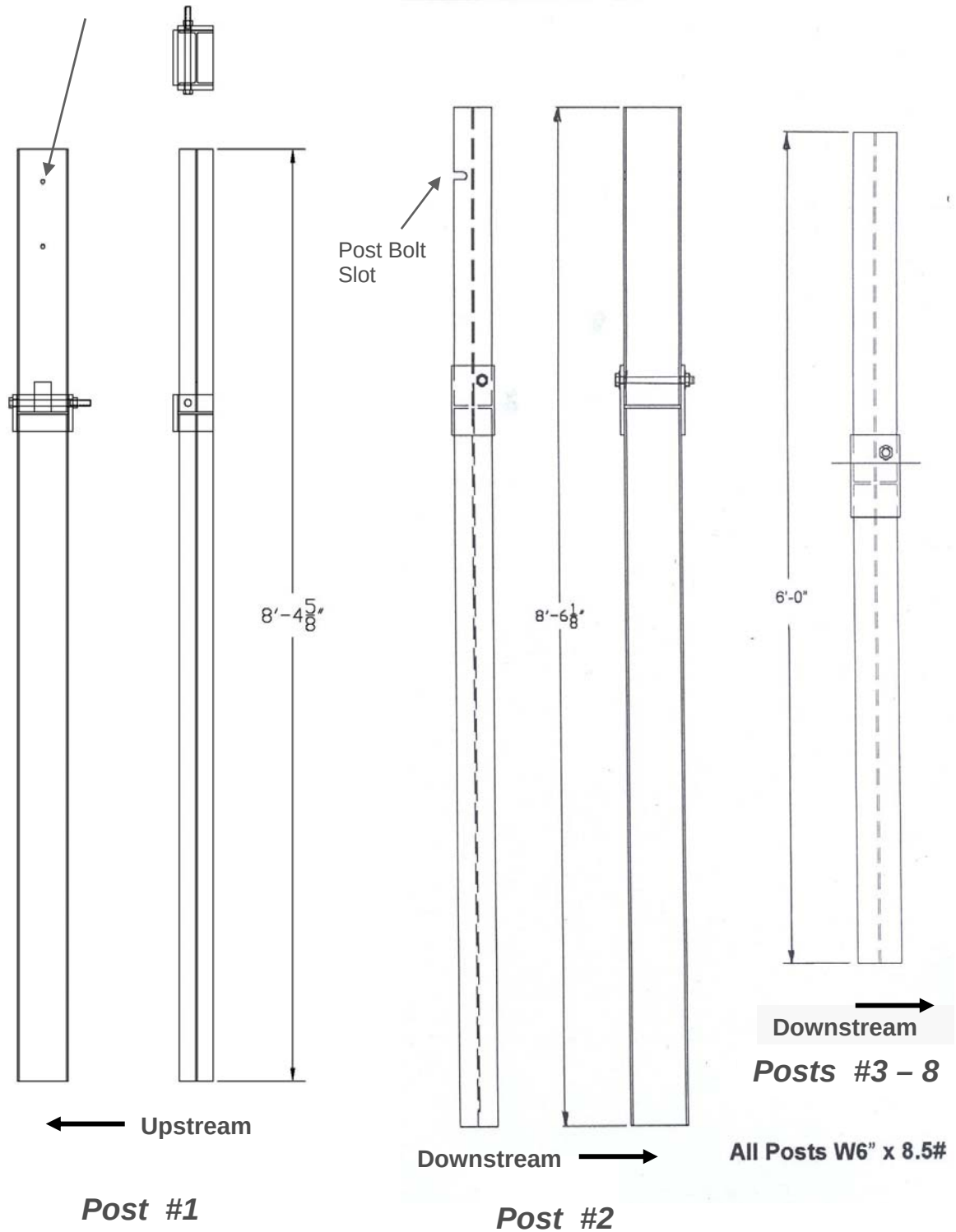
Hinged Steel Posts #3 to #8

NOTE: Be sure the 5/8" x 9" hex bolt at Hinged Post #1 is on the upstream side of the post.

Be sure the 3/4" x 8 1/2" hex bolt at Hinged Posts 2-8 is on the downstream side of the post.

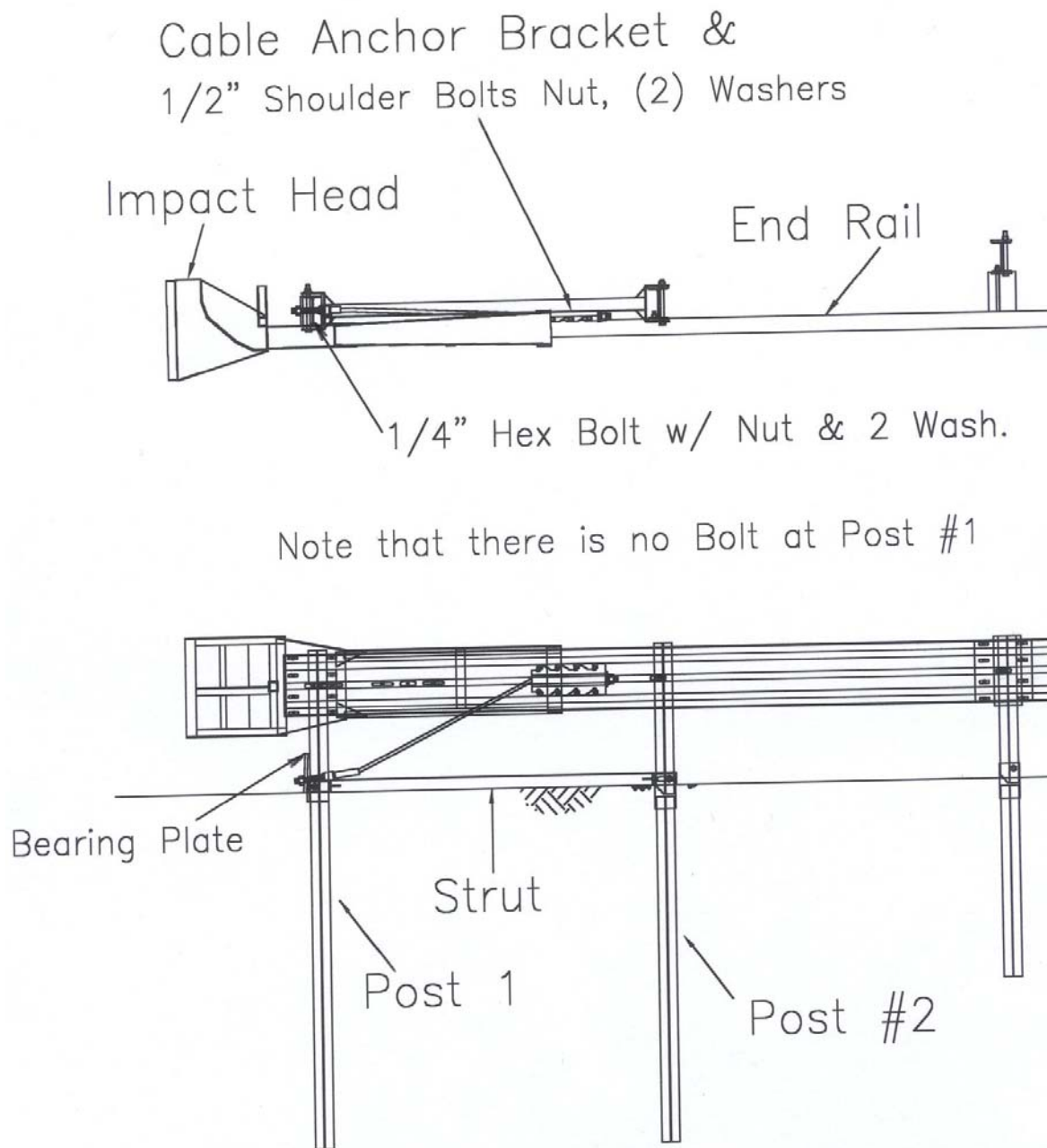
Figure 6. Section Views of Bolted Hinged Steel End Posts and Line Posts

Holes for 1/4" Bolt to Attach Impact Head at Top & Bottom



NOTE: Be sure the 5/8" x 9" hex bolt at Hinged Post #1 is on the upstream side of the post.
Be sure the 3/4" x 8 1/2" hex bolt at Hinged Posts 2-8 is on the downstream side of the post.

Figure 7. Detail of Bolted Hinged Steel End Posts and Line Posts



NOTE: The impact head is attached to post #1. The W-Beam rail section is not attached to post #1.

Figure 8. SKT Above-Ground Details at Post Locations 1 and 2.

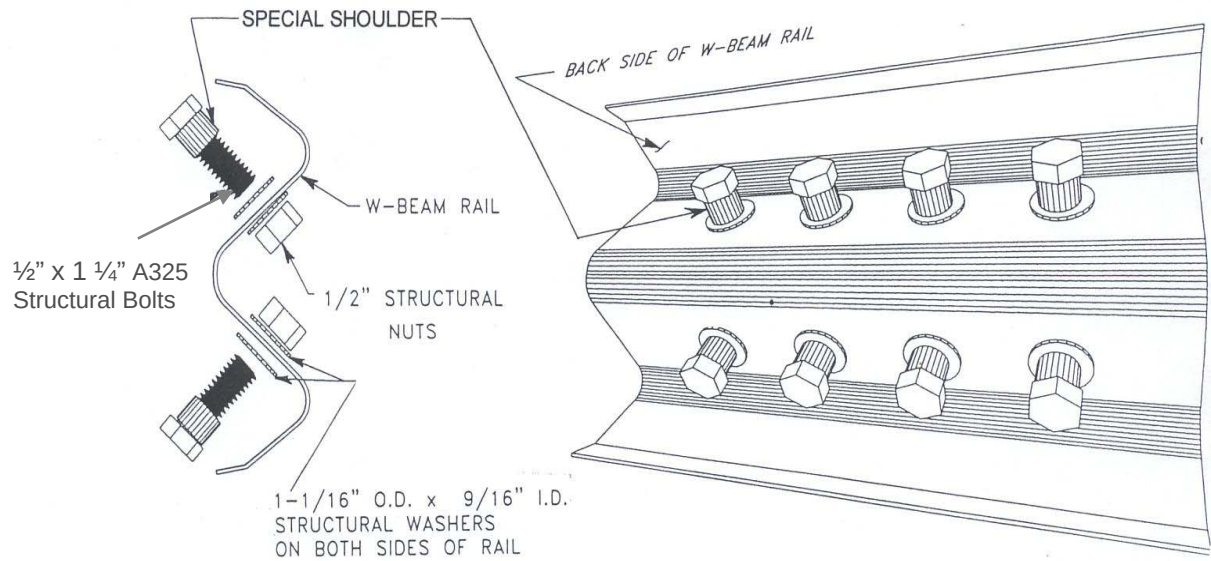
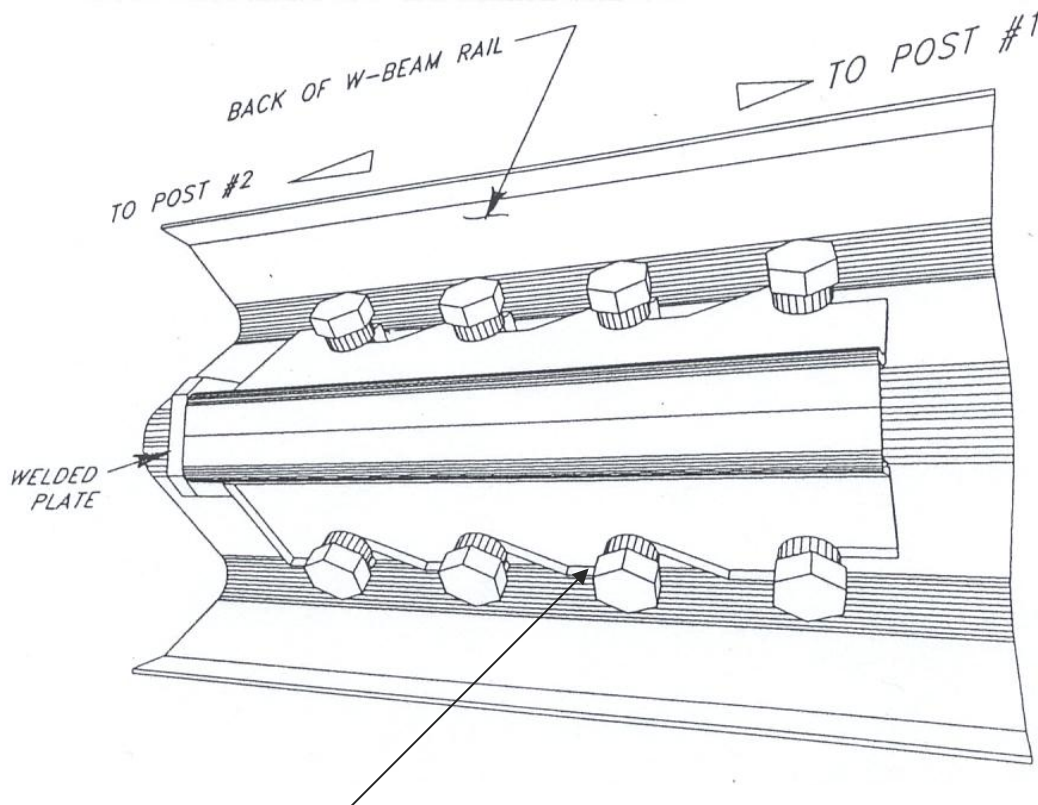


Figure 9. Installation of Cable Anchor Bracket Shoulder Bolts.



It is important that the anchor bracket be fully seated on the shoulder portion of the cable anchor bolts

Figure 10. Installation of Cable Anchor Bracket.

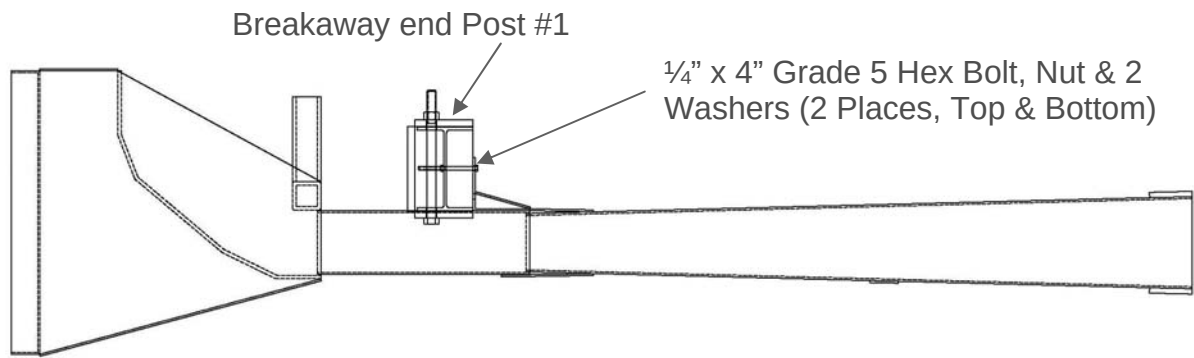
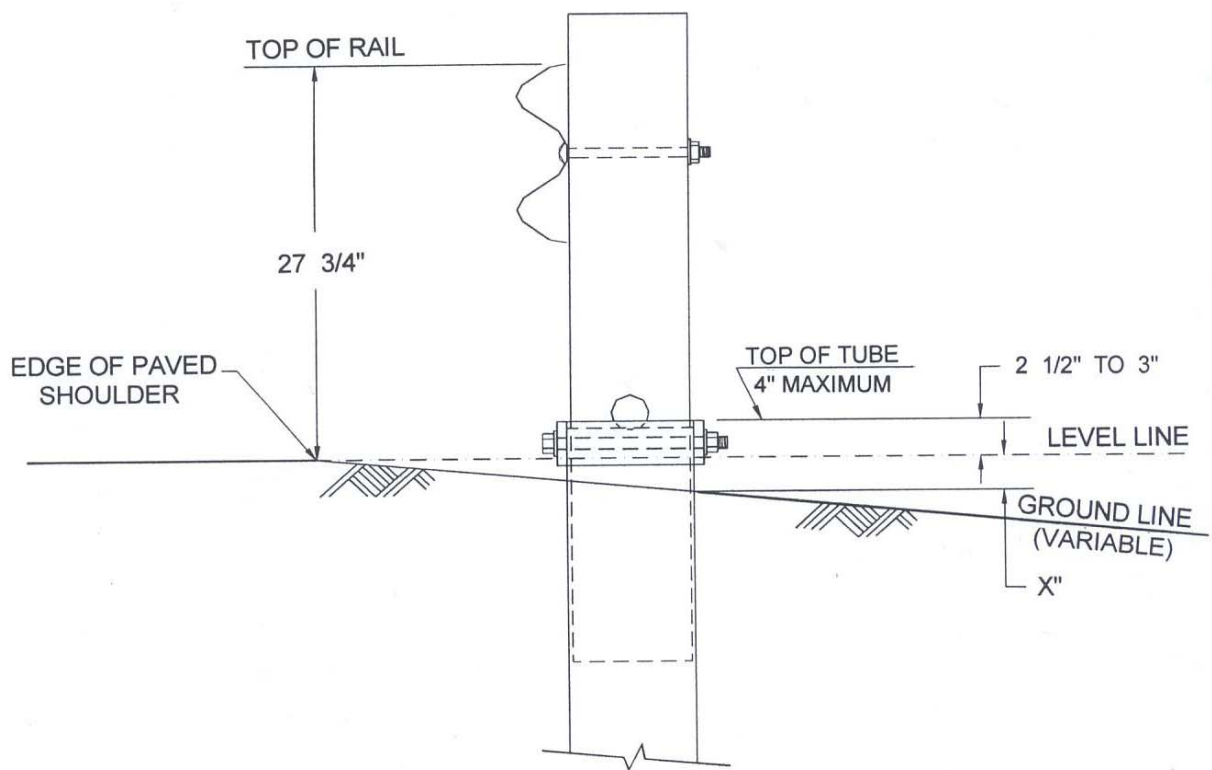
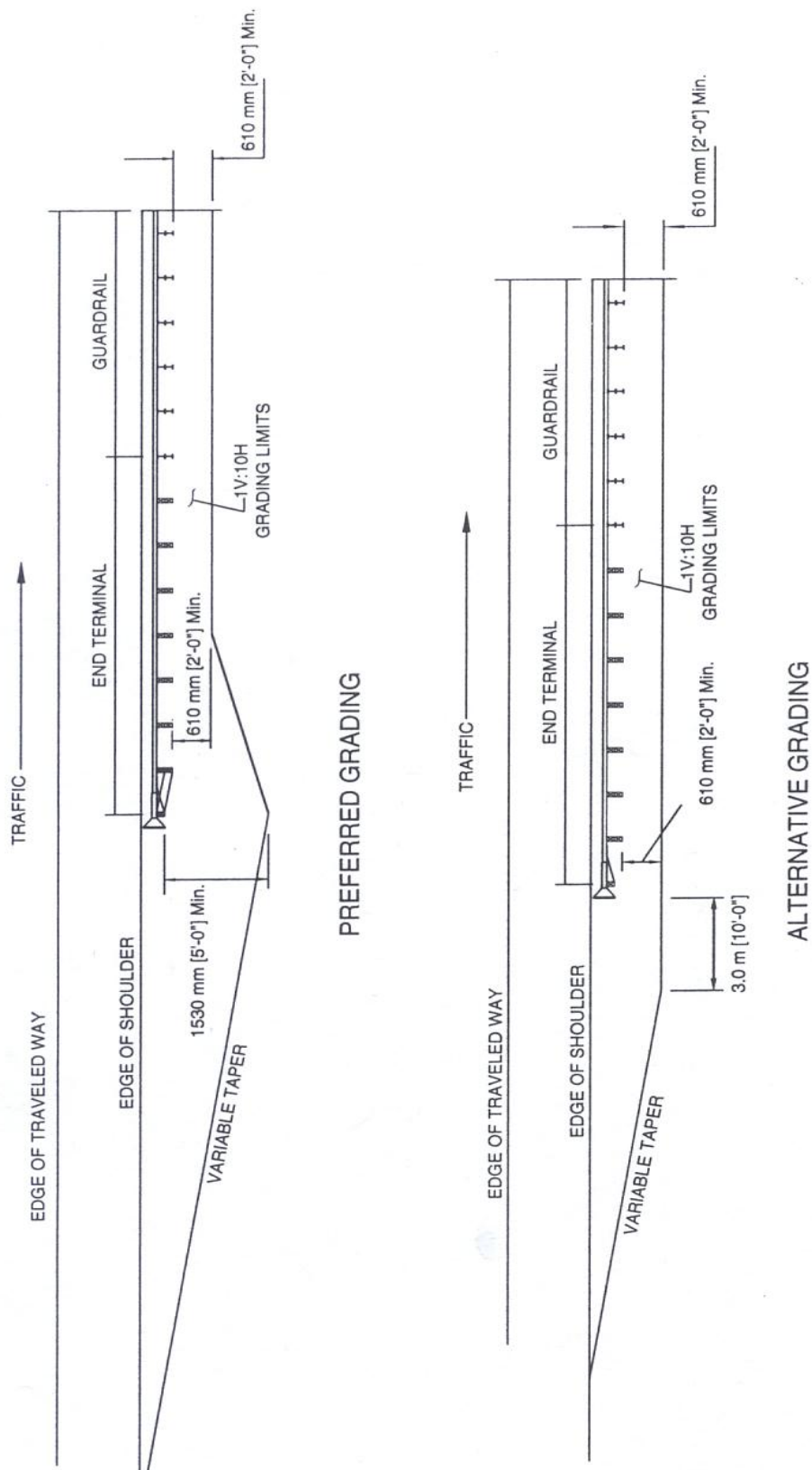


Figure 11. SKT Impact Head Connection to Steel Post



(Wood Post #2 Shown / Steel Post Requirements Similar)

Figure 12. Proper Placement of Foundation Tubes



(Reference AASHTO Roadside Design Guide)

Figure 13. Grading Recommendations for SKT

*The preferred grading layout should be used wherever practical. However, because of site limitations, when upgrading an existing terminal with a crashworthy terminal meeting NCHRP Report 350 criteria, the alternative grading layout may be used.

Installing the SKT

Materials

The length of the **SKT** is 50'-0" long for a Test Level 3 system or the system may also be installed 37'-6" long for the **SKT-LITE** option. A Test Level 2 **SKT** system is 25'-0" long. Refer to contract plans.

Site Preparation

When the guardrail is installed parallel to the edge of the shoulder, a 50:1 (or less) flare away from the roadway is recommended so the impact head will not encroach on the shoulder thereby reducing the potential for nuisance impacts. The flare is not required and may be decreased or eliminated. See **Figure 2**. Minor site grading may be necessary for installations placed beyond the edge of the shoulder to prevent the foundation tubes or the lower section of the breakaway Steel Posts from extending more than 4" above the ground. See **Figures 12 & 13**.

Tools Required

The tools required for installation of the SKT system are the same as those used to install standard highway guardrails (H.G.R.), including sockets & wrenches, a drill, and other equipment such as augers, tampers, and post pounders commonly used in driving guardrail posts.

Installation Procedures

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

- Install steel line posts #3 through #8. The Plug Welded Posts are shop welded and arrive as a single post. (See **Figure 3**). The Hinged Bolted Posts have a top and bottom half that are bolted together in the field. (See **Figure 7**).
- Install steel end posts #1 and #2 with groundline strut. The Plug Welded Posts are inserted in a steel foundation tube. (See **Figure 4**). These posts are shop welded and arrive as a single post. (See **Figure 3**). The Hinged Bolted Posts do not use a foundation tube. (See **Figure 5**). These posts have a top and bottom half that are bolted together in the field. (See **Figure 7**).
- Install guardrail. All posts are spaced at 6'-3". (See **Figure 1**).
- Install cable anchor bracket. (See **Figures 9 & 10**).
- Install the SKT impact head. (See **Figure 11**).
- Install cable assembly.

NOTE: For Plug Welded Steel Post and Wood Post SKT options, foundation tubes must be used at Posts #1 and #2. Those tubes may be either 6'-0" long split tubes without soil plates, 6'-0" long solid tubes without soil plates, 5'-0" long tubes with soil plates, or 4'-6" long tubes with soil plates. The Hinged Steel Post option does not use foundation tubes. See **Table 1** for the allowable steel post and wood post options at Posts # 3 through 8.

Installing Steel Posts 3 Through 8

For the Hinged Steel Post option, all bolted posts must have the lower section installed before bolting the top section. The lower section of the Bolted Hinged steel posts should not be driven with the upper post attached. Bolt upper and lower posts together with a $\frac{3}{4}$ " x 8 $\frac{1}{2}$ " hex bolt and nut.

Be sure when the Hinged Steel Posts #3 through #8 are installed, the hinge bolt is on the downstream side of the post (opposite the impact head). See **Figures 6 & 7**.

For the Plug Welded Steel Post option, most times posts 3 through 8 will be 6 feet long and are shipped as a welded assembly. They can be driven just the same as a standard guardrail post.

For the Plug Welded Steel Post (or Wood Post) SKT options, 2, 4 or 8 foundation tube options are allowable. However, most times only 2 tubes are used (at post #1 & #2) for the Plug Welded Steel Post option. Do not over tighten the bolt at the top of the tube as it may cause the tube to deform.

For stiff soils, drill a 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 for how to proceed. Guidelines will vary from State to State.

NOTE: All of the W-Beam railing within the SKT terminal must be straight. Curving this rail is not permitted.

Installing Steel End Posts 1 and 2 with Groundline Strut

Steel posts 1 & 2 may be installed with either a Hinged Steel Post or Plug Welded Steel Post option. **Figure 8** shows the above ground details. A ground strut is required for both options but note that different struts are used in order to accommodate the 6" Hinged Post as opposed to the 8" wide foundation tube. **Figures 4 & 5** show the ground strut sections.

For the Hinged Steel Post option, all bolted posts must have the lower section installed before bolting the top section. The lower section of the Bolted Hinged steel posts should not be driven with the upper post attached.

Bolt upper and lower Post #2 together with a $\frac{3}{4}$ " x 8 $\frac{1}{2}$ " hex bolt and nut. Bolt upper and lower Post #1 together with a $\frac{5}{8}$ " x 9" hex bolt, nut and (2) washers.

For Hinged Steel Post #2, be sure when the lower segment of the post is installed, the hinge bolt is on the downstream side of the post (opposite the impact head). See **Figures 6 & 7**.

The upper Steel Post #2 has an open-ended slot for post bolt #2. Be sure the slot is on the upstream side of the post (toward the impact head). See **Figure 7**.

For Hinged Steel Post #1, be sure when the post is installed, the hinge bolt is on the upstream side of the post (toward the impact head). See **Figures 6 & 7**.

For the Plug Welded Steel Post (or Wood Post) SKT options, foundation tubes are required at post #1 & #2 locations. **Figure 12** 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, in compliance with AASHTO specifications. Site grading may be required if the top of the foundation tubes or the lower section of the breakaway Steel Posts project more than 4" above the ground line. The finished guardrail height should be approximately 27 $\frac{3}{4}$ " 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 12**, 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 is not more than 1-1/2" to 1" respectively.

Installing Guardrail

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

For ease of installation, we recommended to have the eight 1/2" cable anchor bracket shoulder bolts and the cable anchor bracket 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 and **Figures 9 & 10**.

The rails are to be attached to posts and blockouts at post locations 3 through 8 with 5/8" x 10" H.G.R. bolts and nuts. There is no blockout on posts 1 and 2. The rail is attached to post 2 with a 5/8" x 1 1/4" H.G.R. bolt and nut.

NOTE: A post bolt is not used at post #1.

It is recommended that the post bolt be placed through the rail at post location #5 where the rail splice occurs as that's how the system was crash tested. However, the system will still function properly if the post bolt is not attached to the rail.

Installing Cable Anchor Bracket

For ease of installation, it is recommended to have the eight 1/2" cable anchor bracket shoulder bolts and the cable anchor bracket 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 are attached to the W-beam guardrail end section with two 1-1/16" OD x 9/16" ID structural washers, one on each side of the guardrail, and a 1/2" structural nut. 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 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. The welded plate on the cable anchor bracket should be toward Post #2, as shown in **Figure 10**. Be sure the bracket is fully seated on the shoulder portion of the bolts.

Installing the SKT 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 impact head to the first post with ¼" x 4" Grade 5 hex bolts.

Place the SKT impact head 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 8**. Slide the impact head forward until the post angle attachments on the impact head are aligned with the holes in the web of the first post as shown in **Figure 11**. Attach the impact head to the first post with two ¼" x 4" hex bolts, nut and (2) washers, one each for the top and bottom post angle attachments.

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 may not be included as part of the shipped materials for the SKT unless specifically requested in the contract plans.

Installing Cable Assembly

Place the cable assembly through the cable anchor bracket and through the base of post 1. Place the bearing plate at the base of post 1 with the 5" dimension up and 3" dimension down. See **Figures 5 & 6**. Secure the bearing plate with a retainer/tie to prevent the plate from rotating. Secure both ends of the cable assembly with a 1" hex nut and washer. While tightening the cable, use a hammer to tap the cable anchor bracket from the downstream end to ensure that it is securely interlocked with the shoulder bolts. Restrain the cable at the end being tightened with vice grips or channel lock pliers 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.

NOTE: *It is very important that the cable anchor bracket be fully seated on the shoulder portion of the cable anchor bolts as shown in Figure 10.*

Steel Post SKT Inspection Checklist

State: _____

Date: _____

Project #: _____

Location: _____

- ☐ The rail height is in accordance with the contract plans. This is approximately 27 ¾" above the edge of the shoulder or the finished grade.
- ☐ The rail in the terminal is not curved and is not attached to the post at post location #1.
- ☐ The end rail panel has special slots and all rails are lapped in the proper direction.
- ☐ The ¾" x 8 ½" Hinge Bolt at posts #2 to #8 is on the downstream side of the post.
- ☐ The 5/8" x 9" Hinge Bolt at post location #1 is on the upstream side of the post.
- ☐ If the posts are Plug Welded, the splice plates are secure and the weld has not failed.
- ☐ At post #2, the open-ended slot for the post bolt is on the upstream side of the post.
- ☐ 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 maximum 25:1 taper is permitted to eliminate the potential for encroachment).
- ☐ The two ¼" x 4" hex bolts holding the impact head to post 1 are secured.
- ☐ 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 as shown in Figure 8. A retainer/tie 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.
- ☐ 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.
- ☐ If used, 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 finished SKT installation is in accordance with all specific State DOT guidelines.

Additional notes:

Inspection performed by: _____

NOTES

[illegible]

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