

Session 6: Guardrail/Terminal Installation and Common Errors

Course Topics

- Session 5 – Temporary Traffic Control Through the Work Area
- **Session 6 – Guardrail/Terminal Installation and Common Errors**

Session 6 Objectives

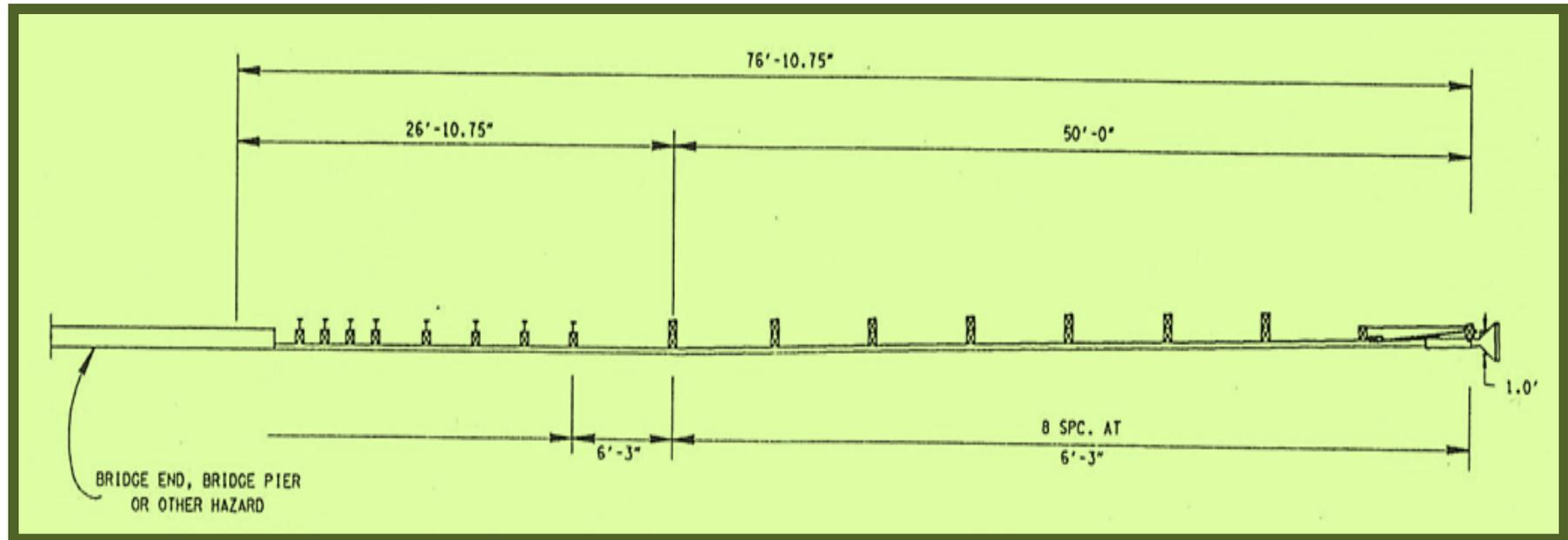
- Describe basic layout and installation techniques for common traffic barriers and terminals helpful to Installers or Inspectors
- Show common installation errors

Session 6 Outline

- Plans, Specifications and Estimates
- Site Grading
- Layout
- Material Handling
- Post Driving
- Guardrail Mounting
- Other Considerations
- Terminal Installation
- Common Installation Errors

Plans, Specifications and Estimates

- Review Plans, Specifications and Project Estimates.



Site Grading

- All site grading should be compacted and completed before installation is to begin.



Site Grading



Site Grading

- When guardrail is installed on a phased project, there may be a possibility that site grading is not completed.
- You must find out the adjusted height requirement and add to finished grade.



Layout

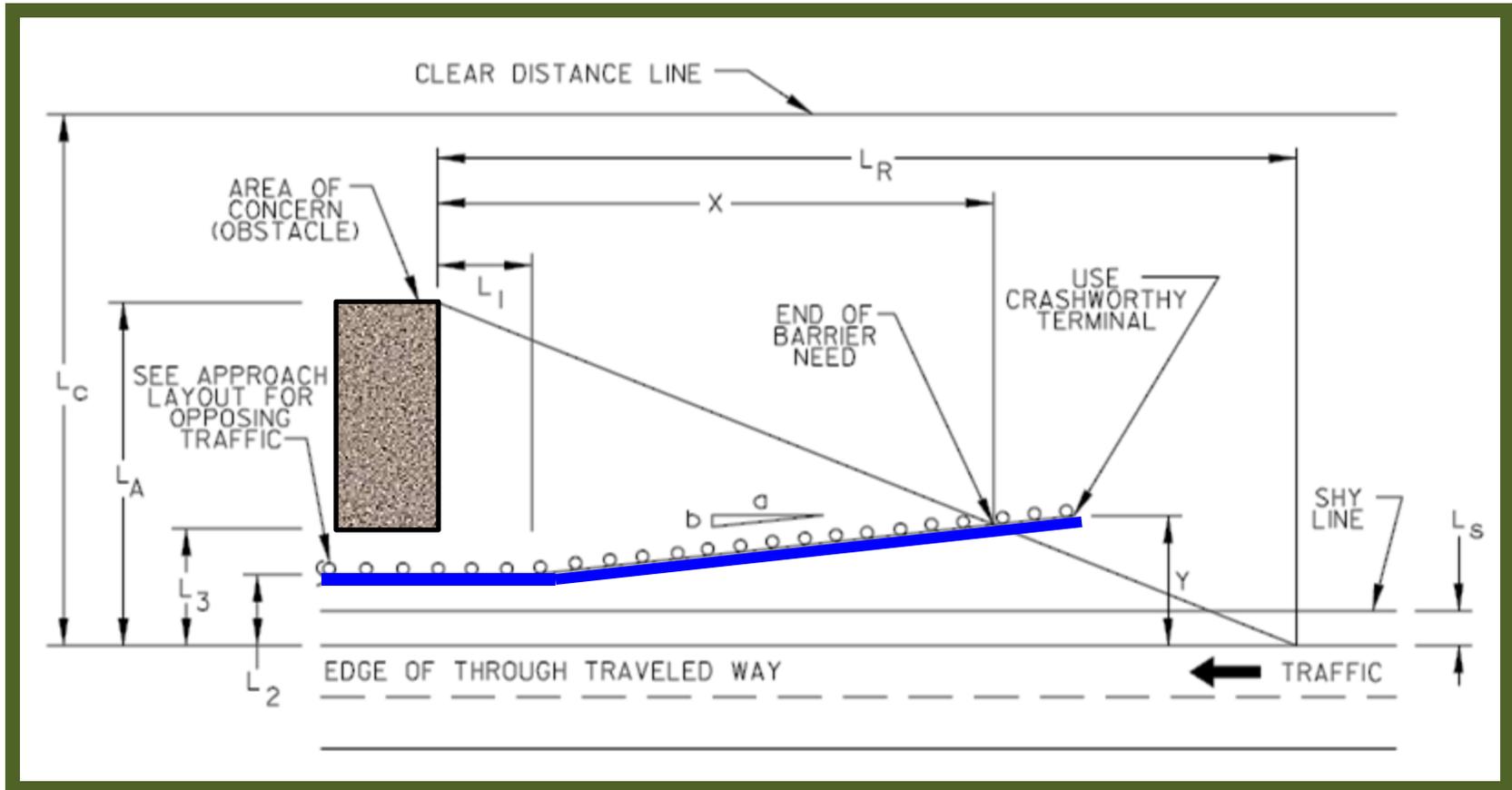
- Establish height requirement (project plans).
- Establish face of rail distance from roadway (project plans).



Layout

- Establish starting point.
 - Point given in project plans in relation to station numbers.
 - Rigid barrier attachment (bridge wall, parapet wall, concrete bridge pier).
 - Terminal beginning or end.
- Verify availability of any special hardware needed at site (e.g. longer posts).

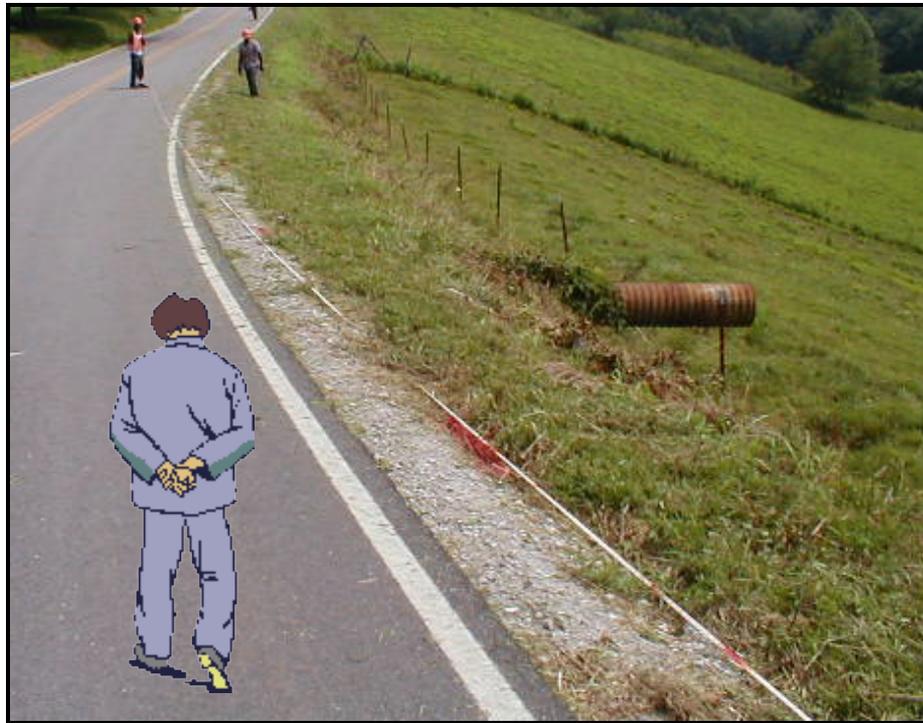
Layout Parameters



Ref: DeIDOT Design Manual, Figure 10-3, Pg 10-17

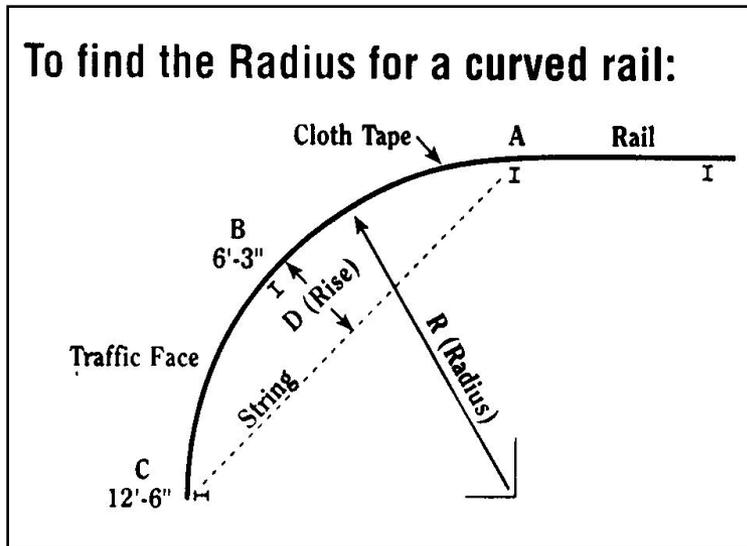
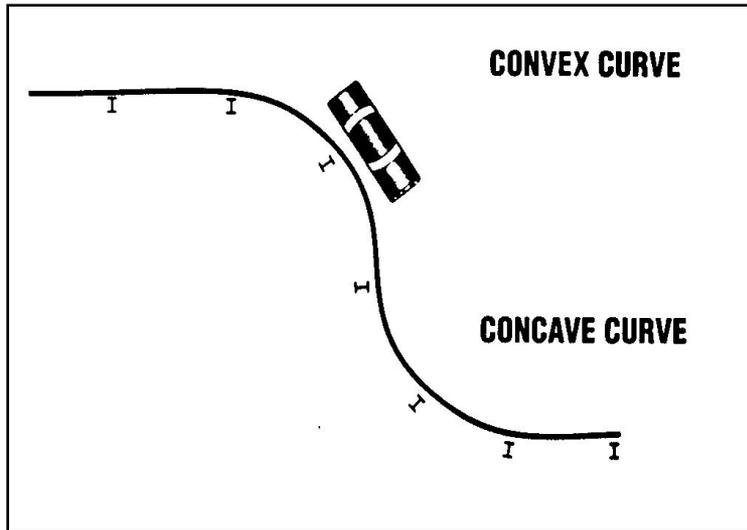
Layout

- Using measuring tape (i.e. 300-ft), mark with paint on ground appropriate post and splice locations.



Layout

Radius Information



RISE (D) (INCHES)	RADIUS (R) (FEET)	RISE (D) (MM)	RADIUS (R) (M)
41	5	1041	1.5
36	6	914	1.8
28	8	711	2.4
26	9	660	2.7
22	10	559	3.1
20	12	508	3.7
18	13	457	4.0
16	15	406	4.6
14	16	356	4.9
11 ⁵ / ₈	20	295	6.1
9 ¹ / ₂	25	241	7.6
7 ³ / ₄	30	197	9.1
6 ³ / ₄	35	171	10.7
6	40	152	12.2
5 ¹ / ₄	45	133	13.7
4 ⁵ / ₈	50	117	15.2
4 ¹ / ₄	55	108	16.8
4	60	102	18.3
3 ⁵ / ₈	65	92	19.8
3 ³ / ₈	70	86	21.3
3 ¹ / ₄	75	83	22.9
3	80	76	24.4
2 ³ / ₄	85	70	25.9
2 ⁵ / ₈	90	67	27.4
2 ¹ / ₂	95	64	29.0
2 ³ / ₈	100	60	30.5
2 ¹ / ₈	110	54	33.5
2	120	51	36.6
1 ³ / ₄	130	44	39.6
1 ⁵ / ₈	140	41	42.7
1 ¹ / ₂	150	38	45.7

Layout

- Drive layout pins or stakes (round rod or rebar) to establish guardrail line to either front or back of guardrail posts.



Layout

- Run string line to grade, using a carpenter's level (i.e. 4-ft) and measuring tape (i.e. 25-ft).
 - Establish height standard for string line (i.e. 12", 14", or 16"). Remember MGS guardrail is 31".
 - Site in string lines for alignment, both in and out and up & down.
 - Inspectors want it straight/level.



Material Handling

- Manually unload **posts and blocks** in orderly position in relation to the post spacing marks and behind string line.
 - Posts face down (rail mounting holes to ground), perpendicular to string line.
 - Rail mounting holes (tops of posts) need to be placed away from string line.
 - Blocks next to posts



Material Handling

- Manually unload **guardrail** in orderly position in relation to the string line:
 - MGS guardrails splice between posts. Ends must match with splice marks made during layout.
 - Guardrail edges appropriate distance from string line and post driver's tires to allow posts to be driven (approx. 2 ft.).
 - End elements to be placed according to need.



Post Driving

- Posts to be driven to depth so that mark on back of post is in line with the string line.
- Posts driven on the center of painted mark on ground.
- Back of posts to be against string line (i.e. within $\frac{1}{4}$ ") for correct alignment.



Post Driving

- Tower or stack of post driving equipment must be level to keep posts straight.
- Drive posts with attention to site conditions such as posts bending in rocky soil.



Guardrail Mounting (Panels)

➤ Lapping

- For one-way traffic, all guardrail panels should be lapped in the direction of traffic with the upstream panel lapping the downstream panel including terminal elements and end sections. (Some exceptions i.e. CAT)
- For two-way traffic always mount guardrail going with traffic meaning rail laps will be opposite on each side of the road.



Guardrail Mounting (Panels)

➤ Lapping Rail in Terminals

- Lap all rail in the terminal in the direction of traffic.



Guardrail Mounting (Panels)

➤ Hardware

- Tighten all splice post bolts to ensure splice hole alignment while hanging.
- Insert splice bolts (8 each for W-Beam; 12 each for Thrie Beam) at each splice and tighten.



Guardrail Mounting (Panels)



Guardrail Mounting (Misaligned Terminal Rails)



Guardrail Mounting (Improperly Curved Rails)



Guardrail Mounting

- MGS Guardrails
 - 31" Tall
 - 12" Blocks
 - Splices off the post



Other Considerations

- Toe Nailing wood post / block-outs



Other Considerations

➤ Barrier Delineations

▪ Final Alignment

- All lines to be pleasing to sight and correct height.
- Any necessary adjustments need to be made with post driver.



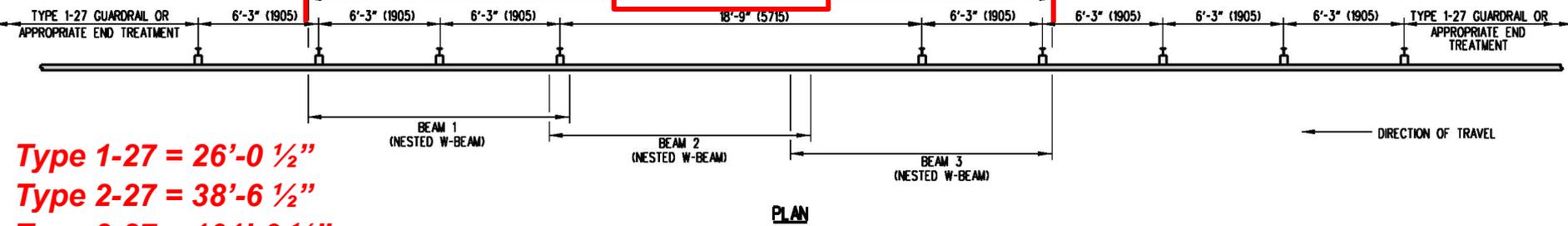
Other Considerations

➤ Spanning an Obstacle



Type 2-27 Nested W-Beam

38'-6 1/2" (11750) LIMIT OF PAYMENT

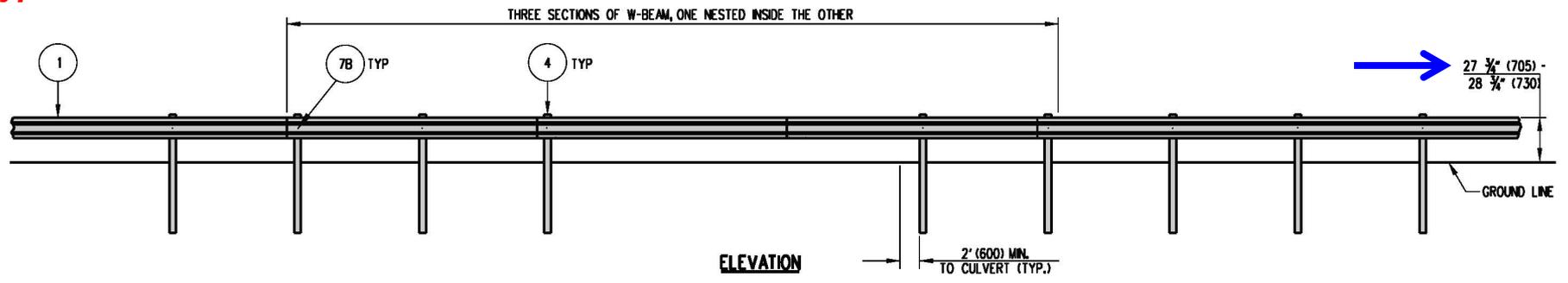


Type 1-27 = 26'-0 1/2"

Type 2-27 = 38'-6 1/2"

Type 3-27 = 101'-0 1/2"

PLAN

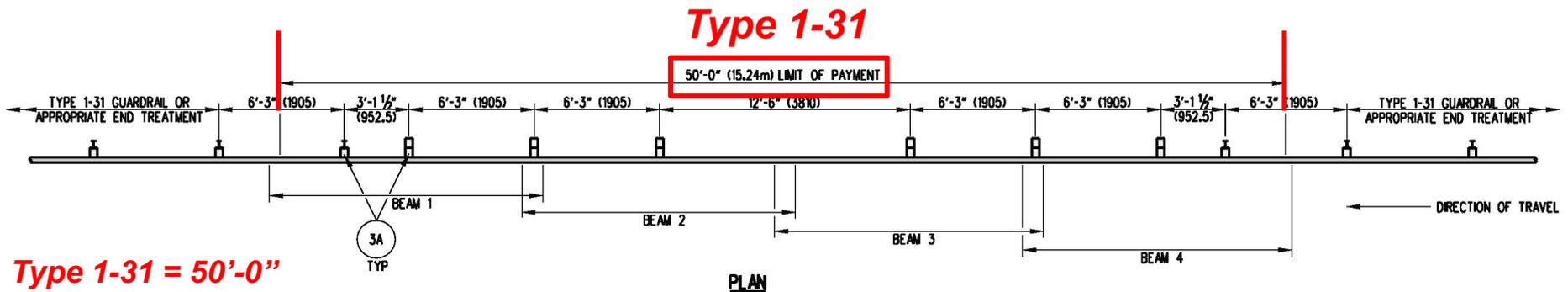


ELEVATION

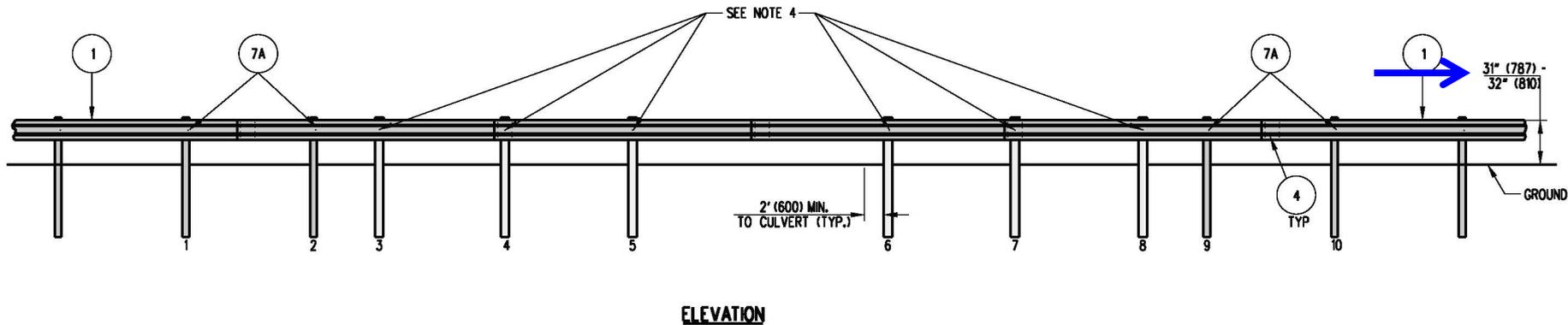
Ref: DELDOT STANDARD CONSTRUCTION DETAILS, B-16

Other Considerations

➤ Spanning an Obstacle



Type 1-31 = 50'-0"
Type 2-31 = 62'-6"
Type 3-31 = 75'-0"



Ref: DELDOT STANDARD CONSTRUCTION DETAILS, B-16

Nested Rail Panels



Other Considerations

➤ Base Plated Post



Terminal Installation

- See manufacturer's installation instructions and State standards.



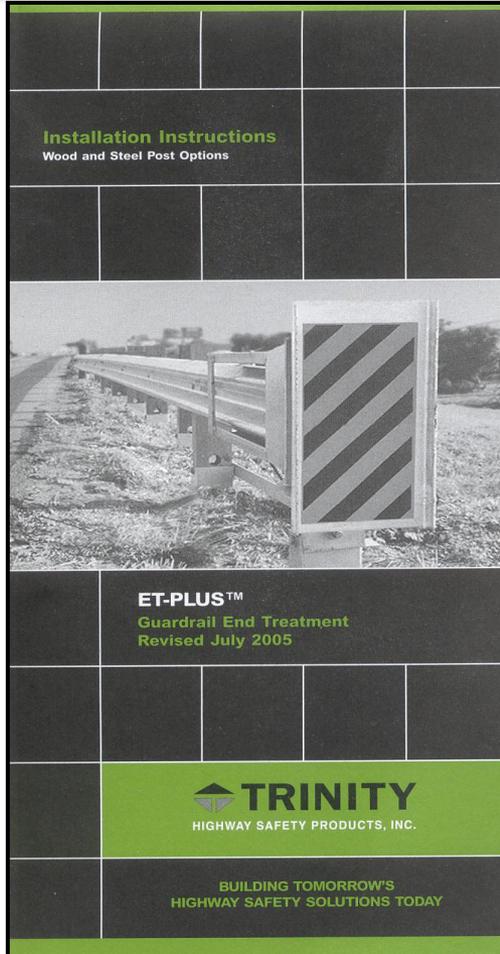
Crashworthy
approach end terminal



Non-crashworthy
trailing end terminal

Terminal Installation: Example

Tangent Terminals ET-Plus and SKT



Assembly Instructions for

SKT-SP Tangent Terminal & FLEAT-SP Flared Terminal

SP – Standard Post System Guardrail Terminals

RSI
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

All RSI Installation Manuals can be downloaded from RSI web site
www.roadsystems.com

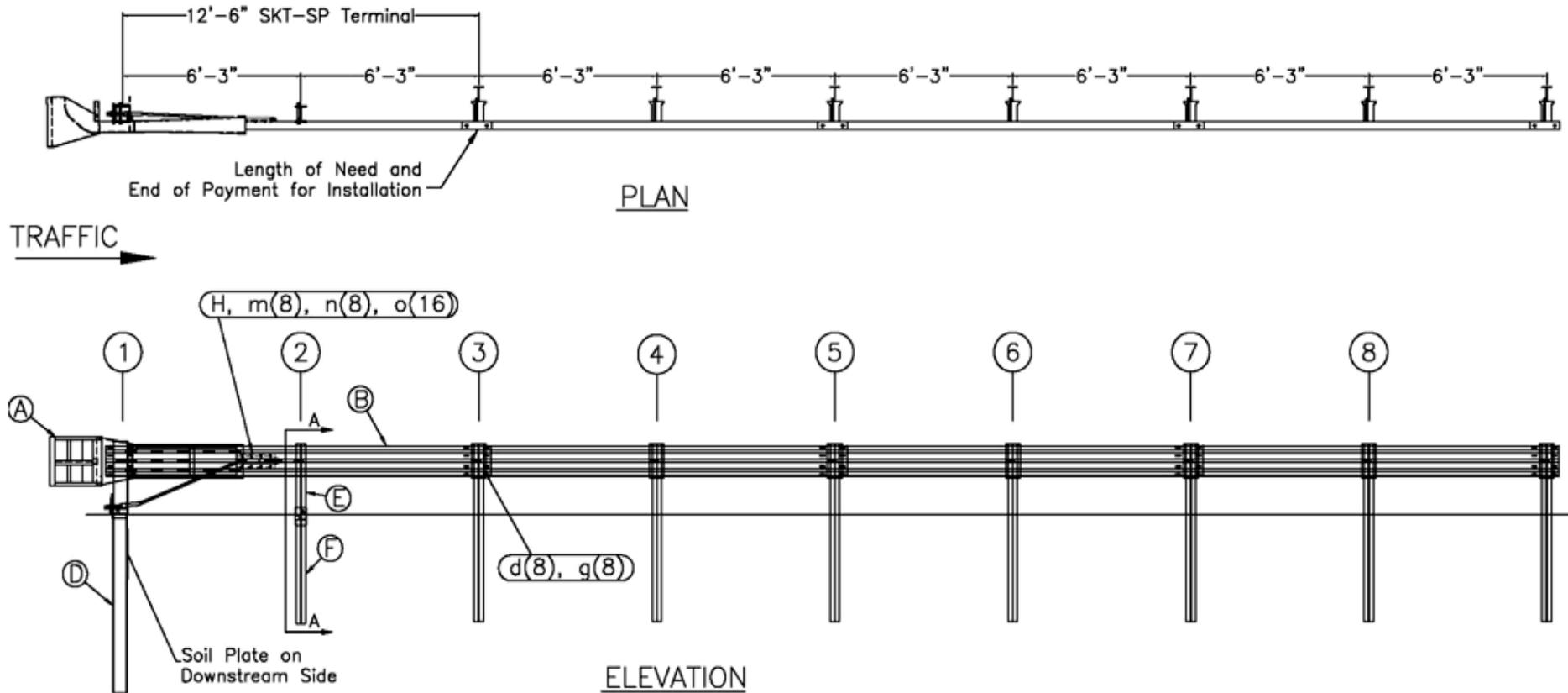
Terminal Installation: Example

➤ DeIDOT uses MGS Terminals

- 31" tall
- 12" blocks
- Rail splices between posts



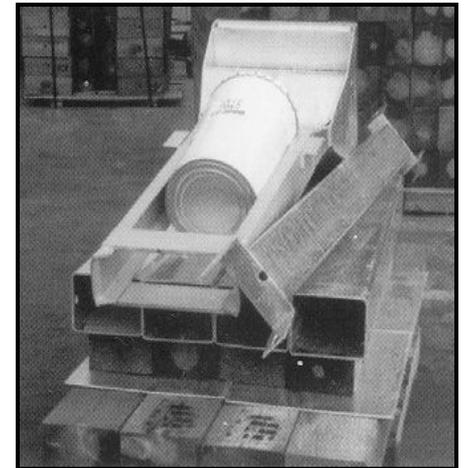
Terminal Installation: Example



Terminal Installation: Example

➤ Installing the Terminal

- Materials (all included in package)
- Site Preparation
 - 50:1 (or 25:1) taper recommended.
 - Minor site grading may be necessary to prevent foundation or post stubs tubes from extending more than 4" above the ground.
- Tools Required
 - Ordinary guardrail tools, such as sockets, wrenches, augers, post pounders.



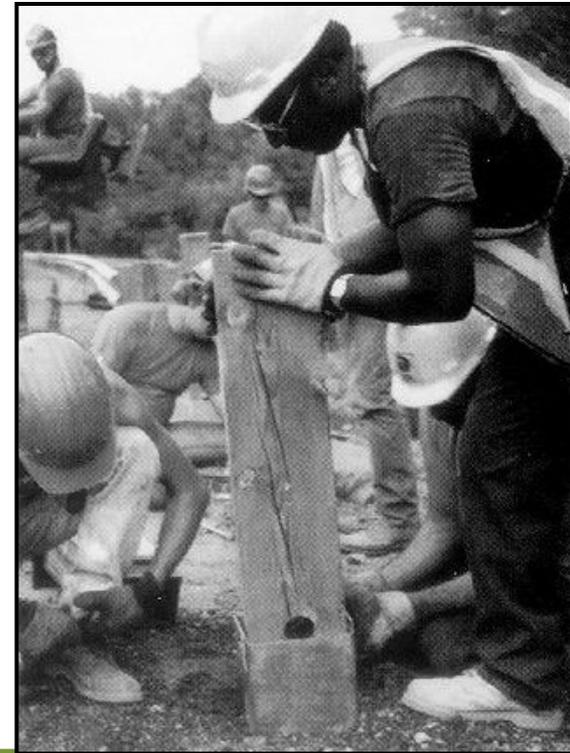
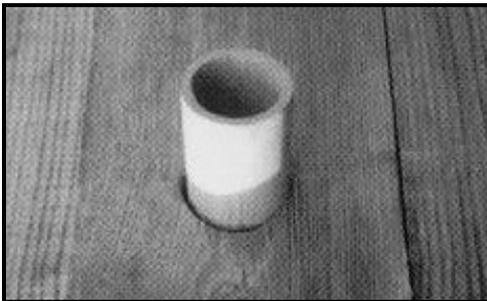
Terminal Installation: Example

- Terminals can be wood post or steel post systems.
- Delaware has gone to all MGS (31") terminals for new construction.
- Steel posts may be hinged. Some may be driven.



Terminal Installation: Example

- Wood - Bolt the soil plates to the foundation tubes
- Place foundation tubes (options include drilling, driving, etc.)
- Install posts
 - Insert pipe sleeve in wood post 1.
 - Install wood posts in steel tubes.
 - Attach posts to tubes with bolts.



Terminal Installation: Example

➤ Install guardrail and block-outs.

- Wood or plastic block-outs used at posts 3 through 8.
- Attach rails to posts and blocks with bolts at locations 2, 3, 4, 6, 7, and 8.
- For some systems, at post 5, attach block-out to post only.
- If wood posts & wood blocks, toe nail block to prevent rotation.



Terminal Installation: Example

➤ Install guardrail and block-outs.

- Attach W-Beam guardrail panel starting from the downstream end of the terminal. MGS guardrail splices between posts.
- Attach unique end panel from post 3 to post 1.
- Splice rails together with bolts.



Terminal Installation: Example

- Be sure the correct end panel has been used.



Terminal Installation: Example

➤ **Install ground strut if one is used.**

➤ **Install anchor cable.**

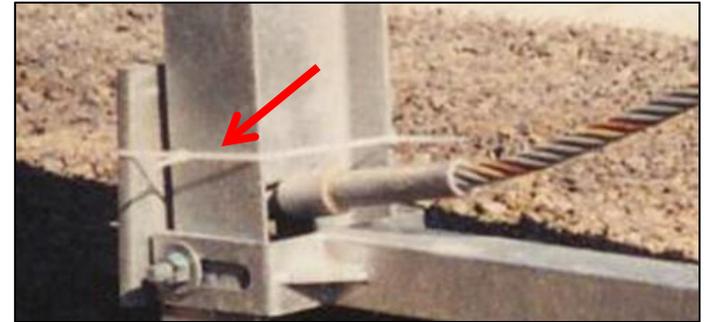
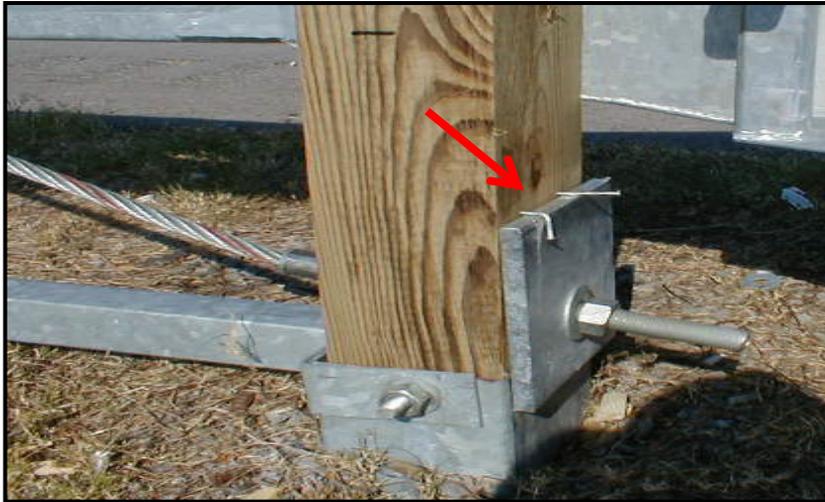
- Place cable anchor bracket on back side of guardrail.
- Place cable assembly through the bracket and through post 1.
- Place bearing plate at the base of post 1 (Note 5" side up & 3" side down). Secure to prevent rotation.
- Secure both ends of cable assembly holding the cable to prevent twisting.



Terminal Installation: Example

➤ Secure Bearing Plate.

- Wood Post – Toe nail.
- Steel Post – Use retainer tie or bearing plate with bent tabs.



Terminal Installation: Example

- Install impact head bolted to post #1, not guardrail.
 - Wood Post – Lag Screw
 - Steel Post – Hex Bolt

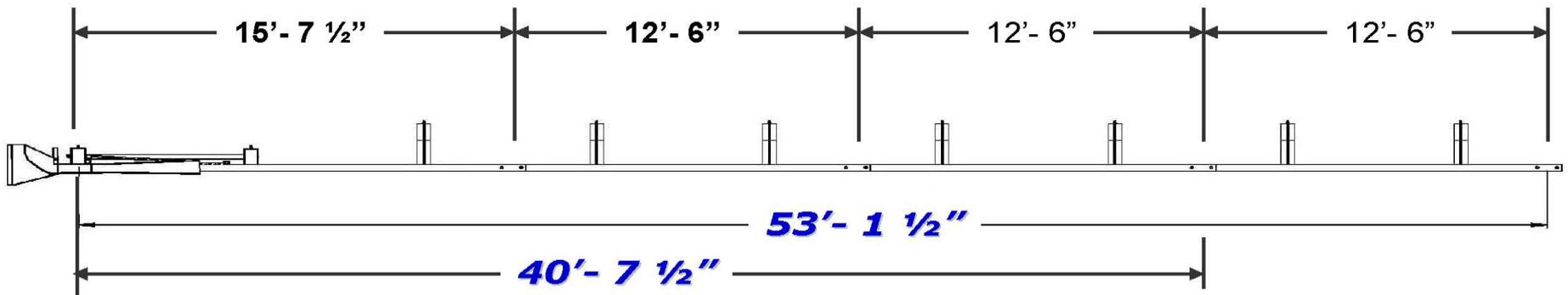
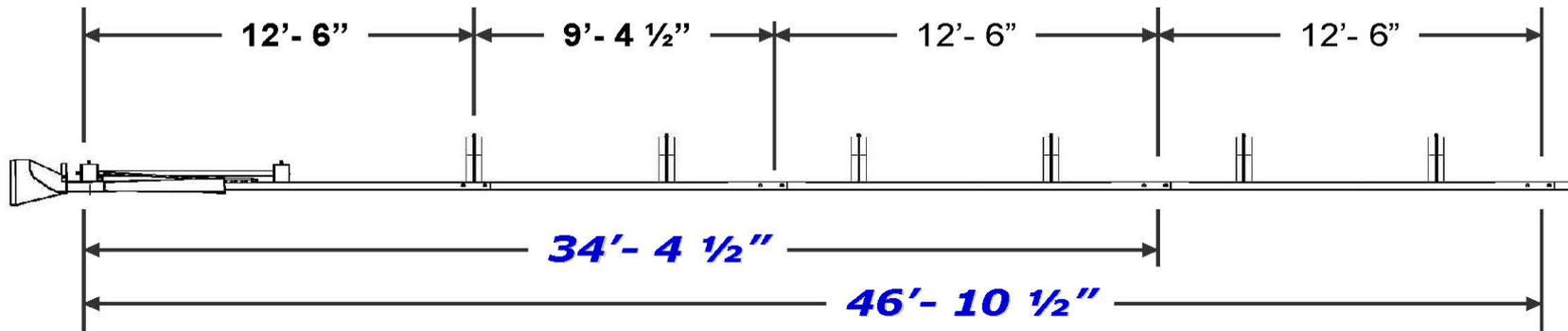
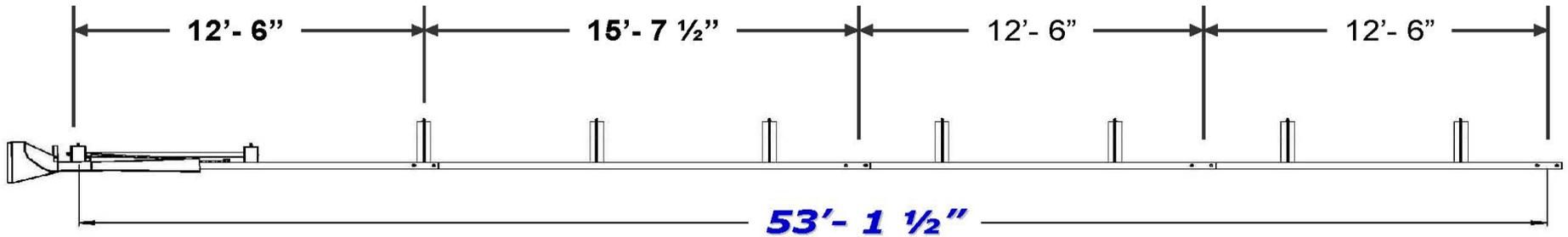


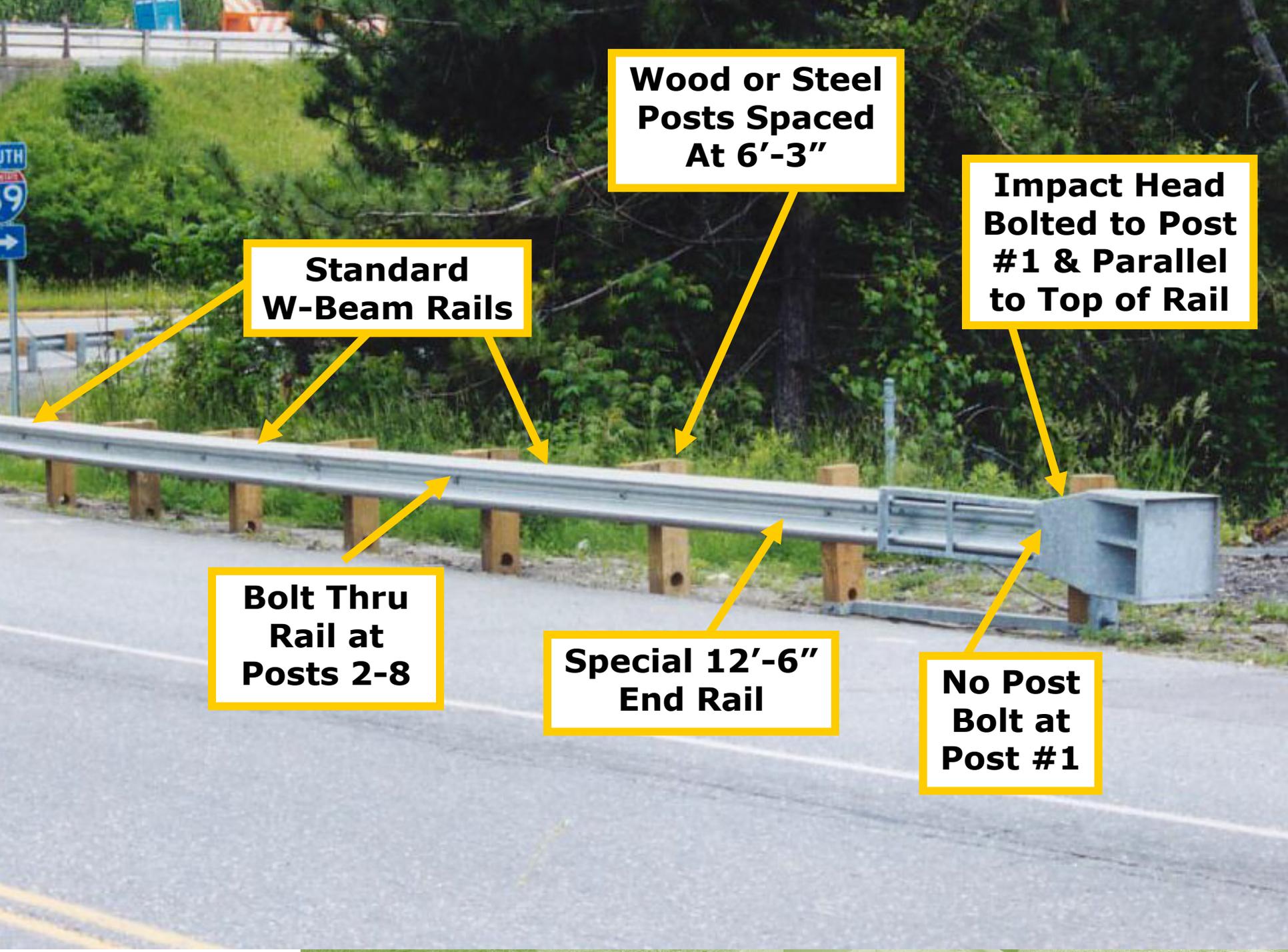
Terminal Installation: Example

- Delineate the impact head – install object marker on the front face meeting local standard requirements.



MGS Terminal Lengths





Wood or Steel Posts Spaced At 6'-3"

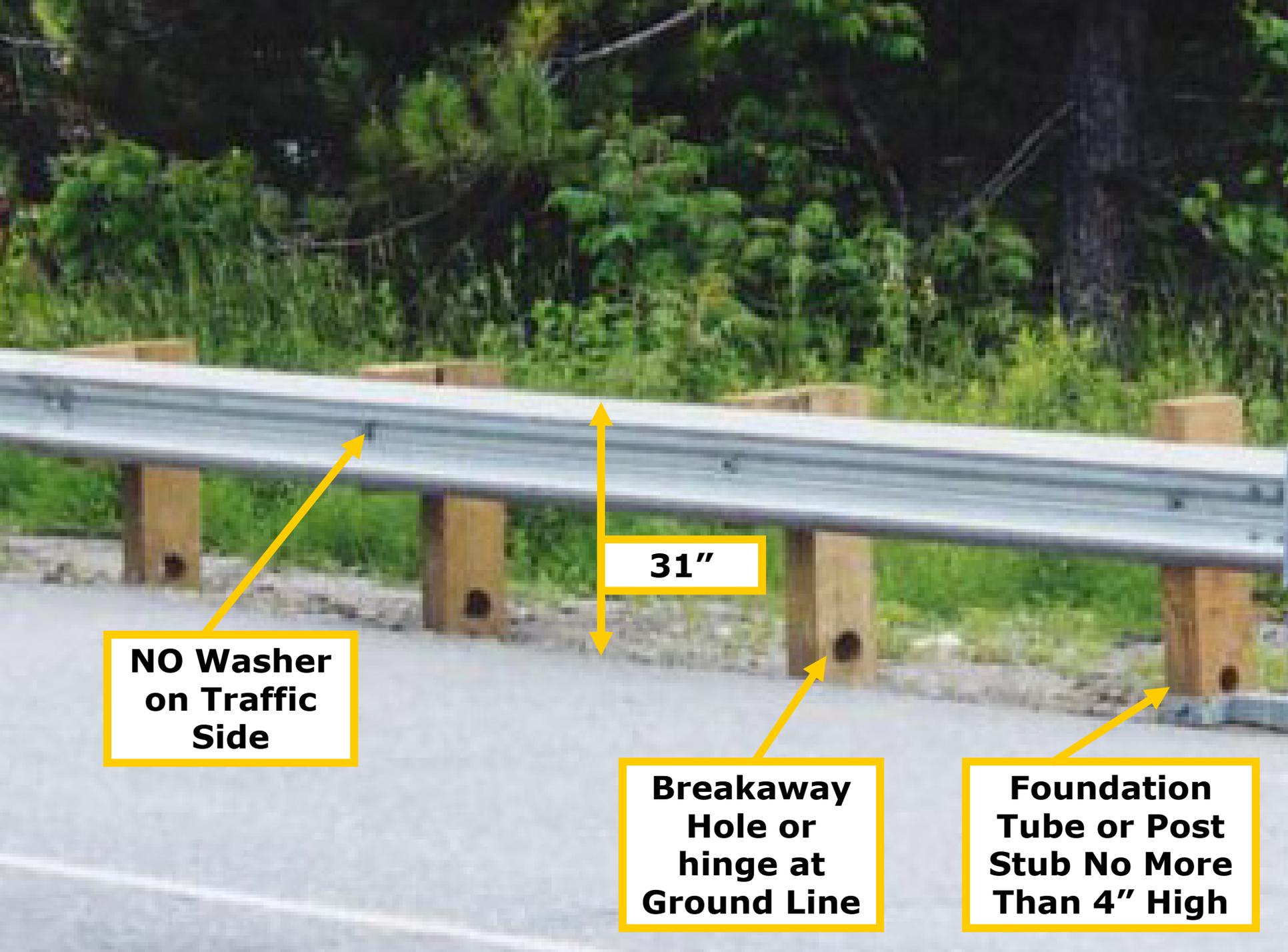
Impact Head Bolted to Post #1 & Parallel to Top of Rail

Standard W-Beam Rails

Bolt Thru Rail at Posts 2-8

Special 12'-6" End Rail

No Post Bolt at Post #1



**NO Washer
on Traffic
Side**

31"

**Breakaway
Hole or
hinge at
Ground Line**

**Foundation
Tube or Post
Stub No More
Than 4" High**

Common Installation Errors

The most common error with all barrier types is:

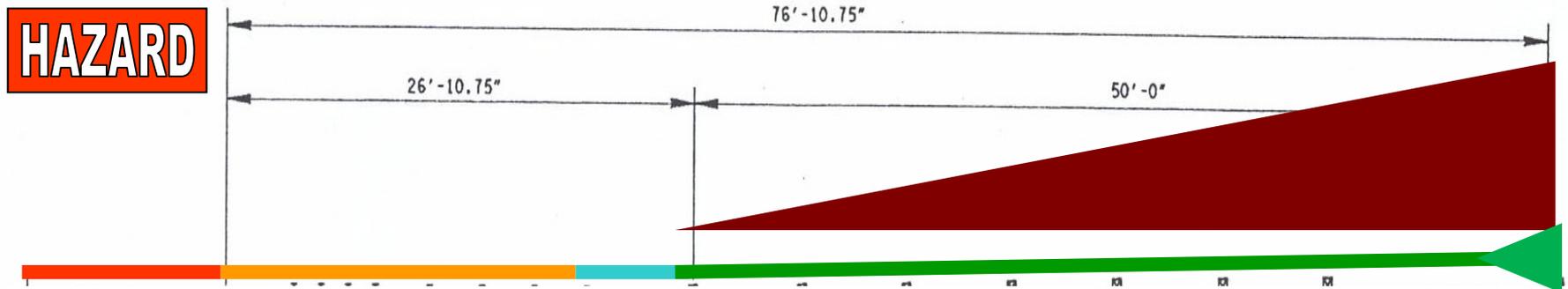
Improper Slope
Poor Earthwork



Properly setting up the base material and ensuring smooth ground-line features is the first goal of any good installation.

Common Installation Errors

Minimum length installation for tangent energy absorbing terminal (NCHRP 350 TL-3)



Make sure you understand why a barrier is being used and how the area surrounding the guardrail installation needs to be setup.

Common Installation Errors: Corrugated Systems

- Lack of a thorough on-site inspection.
 - Locate utilities, overhead power lines, culverts, etc.
 - Make sure all hazards are clearly marked for personnel.

Common Installation Errors: Corrugated Systems

➤ Incorrect height of the system.

- Check the State standard sheets to make sure that the top of the post and the top of the rail are at the correct elevation. DeIDOT was 27 $\frac{3}{4}$ " ...now 31".
- Where should height should be measured from? Face of the barrier? From the pavement if a curb is within 12" of the rail.
- Consider blacktop thickness when measuring height of rail, especially if installing the barrier before the final top coat of blacktop is installed.

Common Installation Errors: Corrugated Systems



Rail too high



Rail too low

Common Installation Errors: Corrugated Systems



Twisted or Missing block-outs

Common Installation Errors: Corrugated Systems

- Errors while driving posts.
 - If you hit rock when driving Posts:
 - Do not cut off bottom of Post.
 - Do not crush top of Post.
 - Do not “nick” cut flanges of Post, as to make it “curl” underground.
- YOU MUST drill rock and backfill hole.



Tops of steel post should be touched up with galvanizing paint if damaged during driving.

DeIDOT Standard in Rock

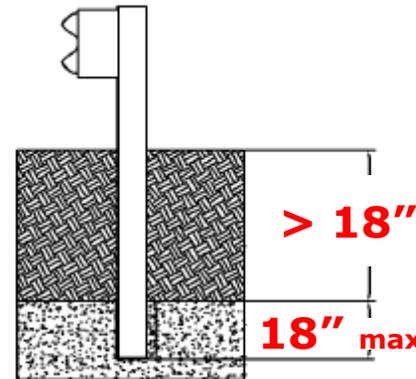
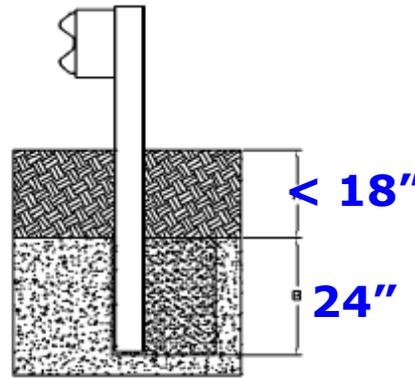
For terminal posts #1 and #2 – Drill a 12”- 16” diameter hole so that the guardrail post is a minimum of 20” into the rock. Extra length may be cut off. Touch up / galvanize end.

Concrete cannot be used as backfill.

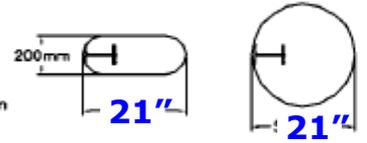
Ref: DELDOT SPECIFICATIONS 720566

Common Installation Errors: Corrugated Systems

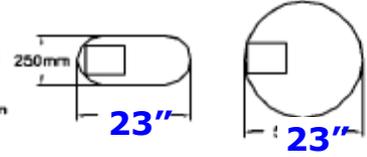
➤ Posts in Rock



Plan View Steel Posts
Either hole configuration acceptable



Plan View Wood Posts
Either hole configuration acceptable



Notes
For overlying soil depths (A) ranging from 0 to 460 mm, the depth of required drilling (B) is equal to 610 mm.

Notes
For overlying soil depths (A) ranging from 460 to the embedment depth of the post, depth of required drilling (B) is equal to either 305 mm or the desired embedment depth minus the depth of soil which ever is less.

Common Installation Errors: Corrugated Systems

- Incorrect post spacing.
 - Post spacing must be accurate on all systems.
 - Post spacing may need to be adjusted when going up-hill, downhill and around curves. Always fit radius rail to suit field conditions.
 - Panel requirements and post spacing on a curve are generally covered by specifications and State standards. Follow the Specifications!

Common Installation Errors: Corrugated Systems

- Concrete Anchors are not installed properly.
 - Concrete anchors should be level with the ground.
- Panel lapped in the wrong direction.
 - The panel should be lapped *with* the traffic flow.
- Wrong hardware is used.
 - Common at Transitions. Be sure to use correct hardware!
- **Note:** after the system is installed, it should be “Pleasing to the Eye.”

Common Installation Errors: Corrugated Systems



Does Not Allow for Deflection

Common Installation Errors: High-Tension Cable Guardrails

- Refer to latest manufacturer installation instructions and bid documents.
 - New systems with new parts & new rules.
 - Are posts to be socketed?
 - Is cable to be prestretched?
 - Deflection & post spacing requirements?
 - Grading
 - Anchor locations
 - Curves



Common Installation Errors: High-Tension Cable Guardrails

➤ Sockets

- Be prepared for a 30" x 12" concrete cylinder spaced at 6... 10... 12 ½ ... 20 feet.
 - Spacing's change based upon design deflection –
**CHECK PROJECT PLANS
AND SPECIFICATIONS!!!**
- Cast in Place vs. Pre-Cast Cylinders?
 - Drill?
 - Dig?
 - Pound?



Common Installation Errors: High-Tension Cable Guardrails

➤ Sockets

- Concrete reinforcement is crucial.
- Also soil adequacy and concrete mix!



Cast – In – Place Socketed Post



Prefabricated Post Foundations and End Terminals



Common Installation Errors: High-Tension Cable Guardrails

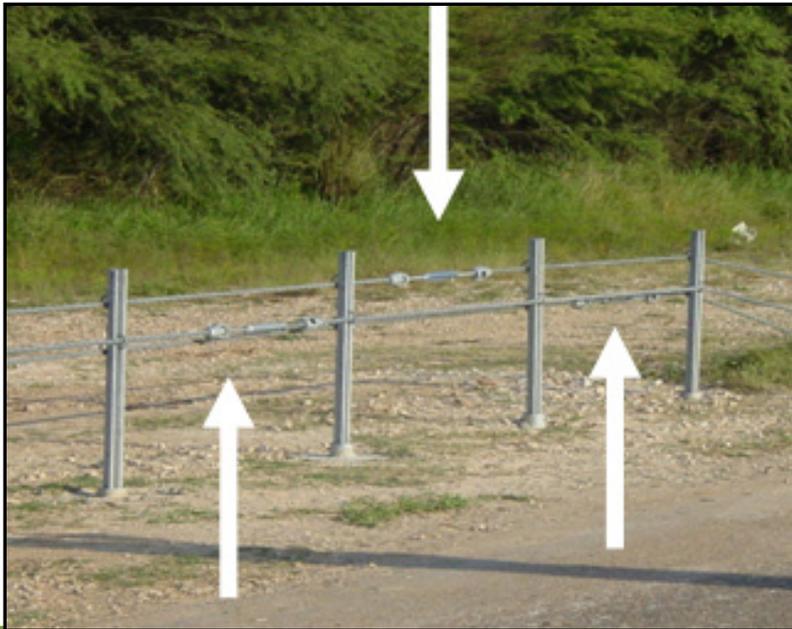
➤ Tensioning the system...

- Make sure to have the right tools and tensioning measurement device. (Usually supplied by manufacturer)
- Follow manufacturer instructions for temperature variations in required tension.
- Locations of splice turnbuckles varies by system.



Common Installation Errors: High-Tension Cable Guardrails

- Make sure to check manufacturers instructions for locations of splice or tensioning turnbuckles.



- Offset splice locations and leave room next to posts.



Common Installation Errors: Terminals

- Improper “offset” on a flared terminal.
- Improper “flare” on a flared terminal or an unnecessary flare or radius on a tangent terminal.



Common Installation Errors: Terminals

- Terminal is placed too close to the hazard.
- Check to see which posts are bolted to the rail. Some terminals use posts that are backup posts and should not be bolted to the rail.



Common Installation Errors: Terminals

- Steel foundation tubes, stubs for hinged/breakaway posts, ground struts should not be more than 4" above the ground line to avoid snagging and/or instability in the vehicle.
- Terminals with an impact head: the impact head should be attached to post #1 and parallel to the rail.



Common Installation Errors: Terminals

- Terminals with an impact head: the end of the first W-beam rail section should be pushed against the throat area of the impact head so the end of the rail cannot be seen.



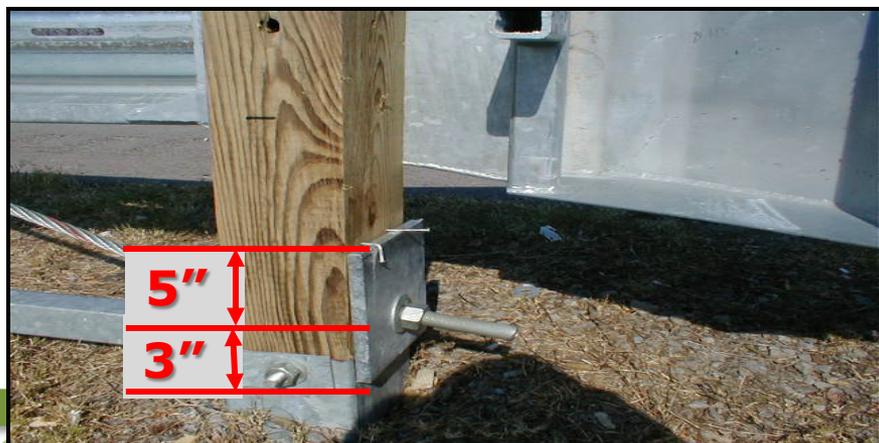
Common Installation Errors: Terminals

- Be sure impact head is facing the proper direction.
- Check the type and combination of breakaway posts against the State standards and the manufacturer's instructions.
- Not all posts in all terminals use a block-out.
- Check to see that the correct cable anchor bracket is used and it is properly attached to the rail.



Common Installation Errors: Terminals

- The cable assembly should be taut and correctly installed.
- Many terminals will not function as designed if washers are used on the traffic side. Check the manufacturer's instructions to see if and when washers are to be used.
- Check to see that bearing plate is properly oriented.

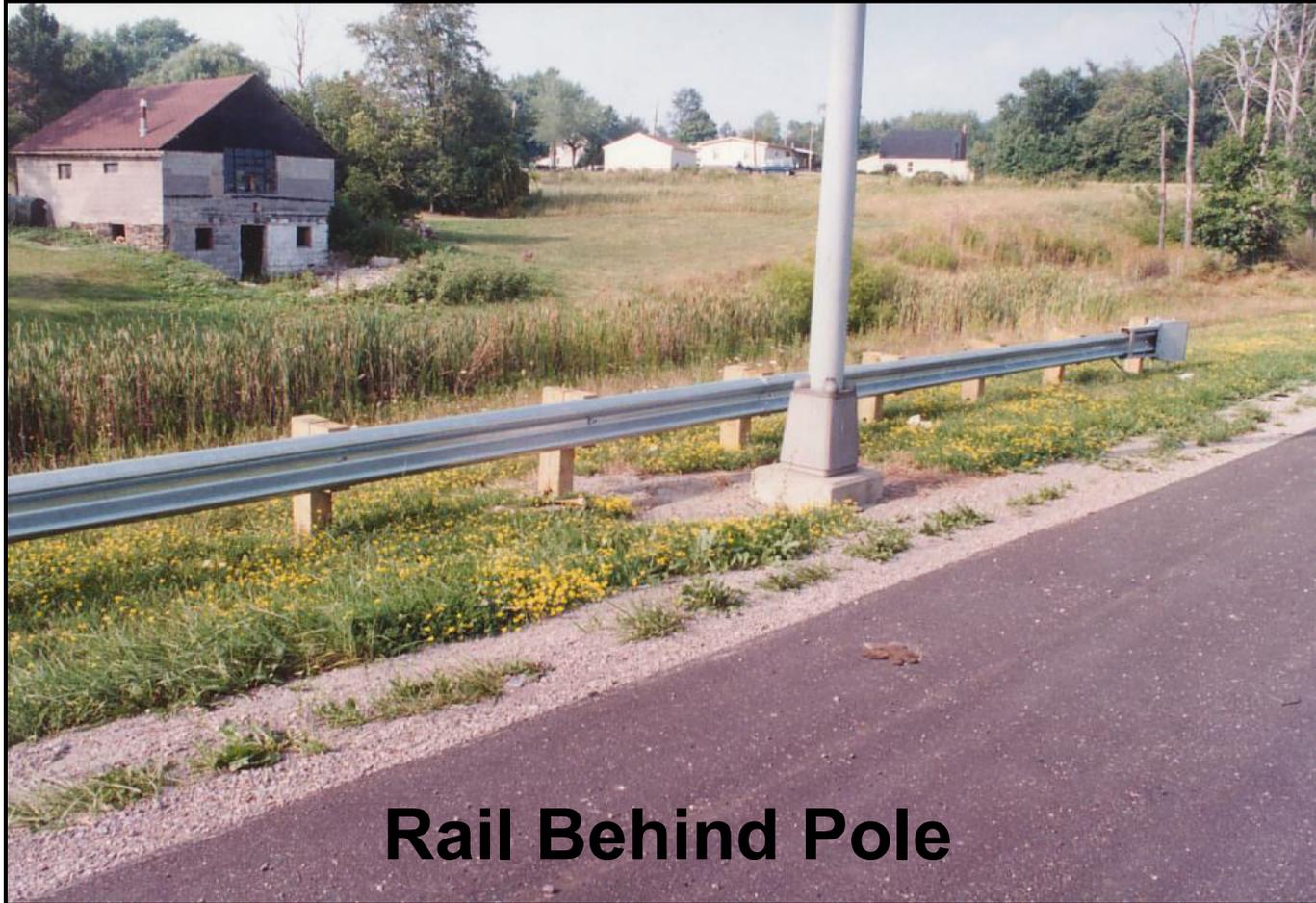


Common Installation Errors: Terminals

- Specialty components and hardware specific to each terminal should be checked against the manufacturer's instructions.
- If a terminal is attached to a barrier with a different stiffness, a transition may be needed.
- Never attach additional materials to the terminal itself that could alter the impact performance of the terminal.



Common Installation Errors: Terminals



Common Installation Errors: Terminals



Fixed Objects and No Downstream Anchor

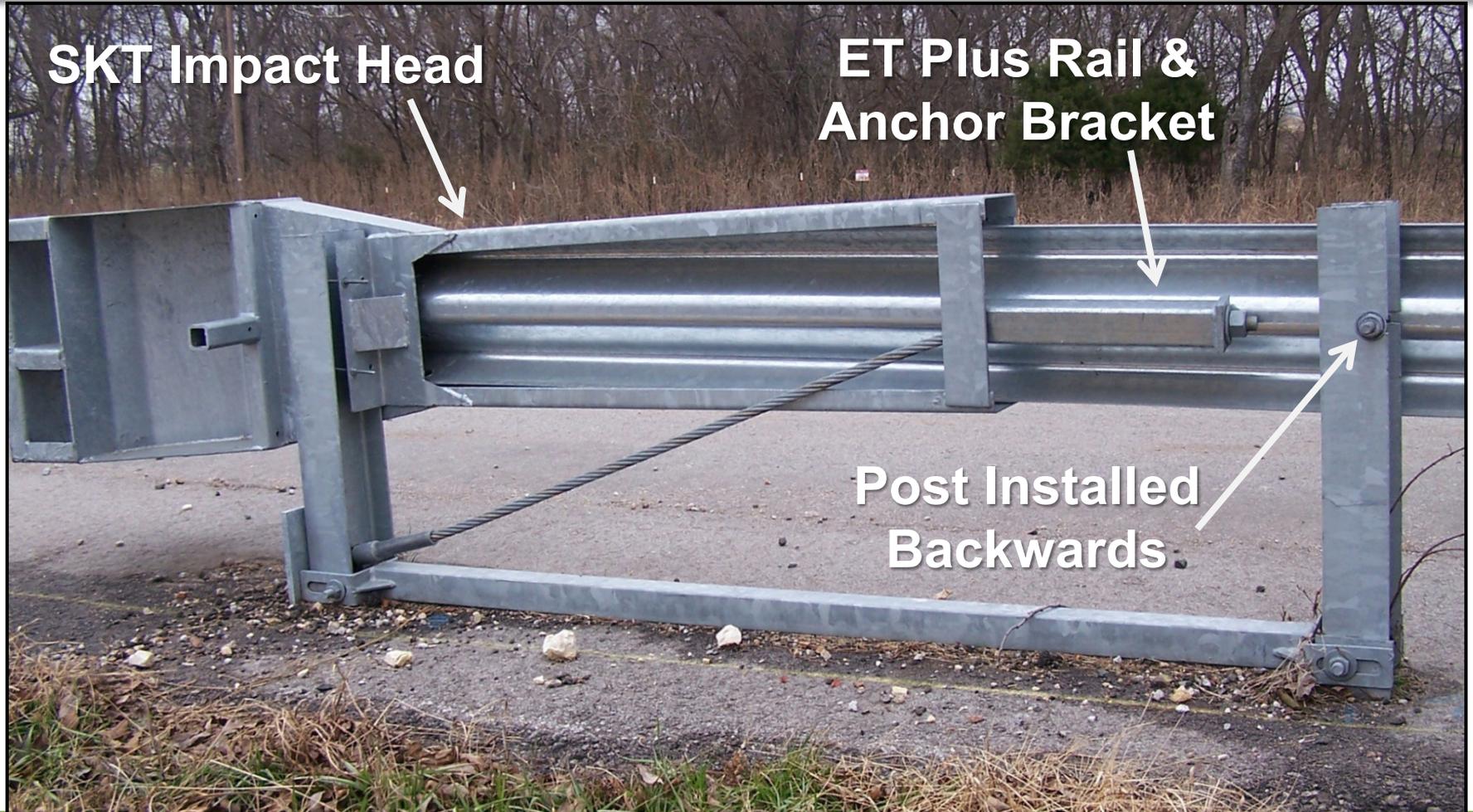
Common Installation Errors: Terminals



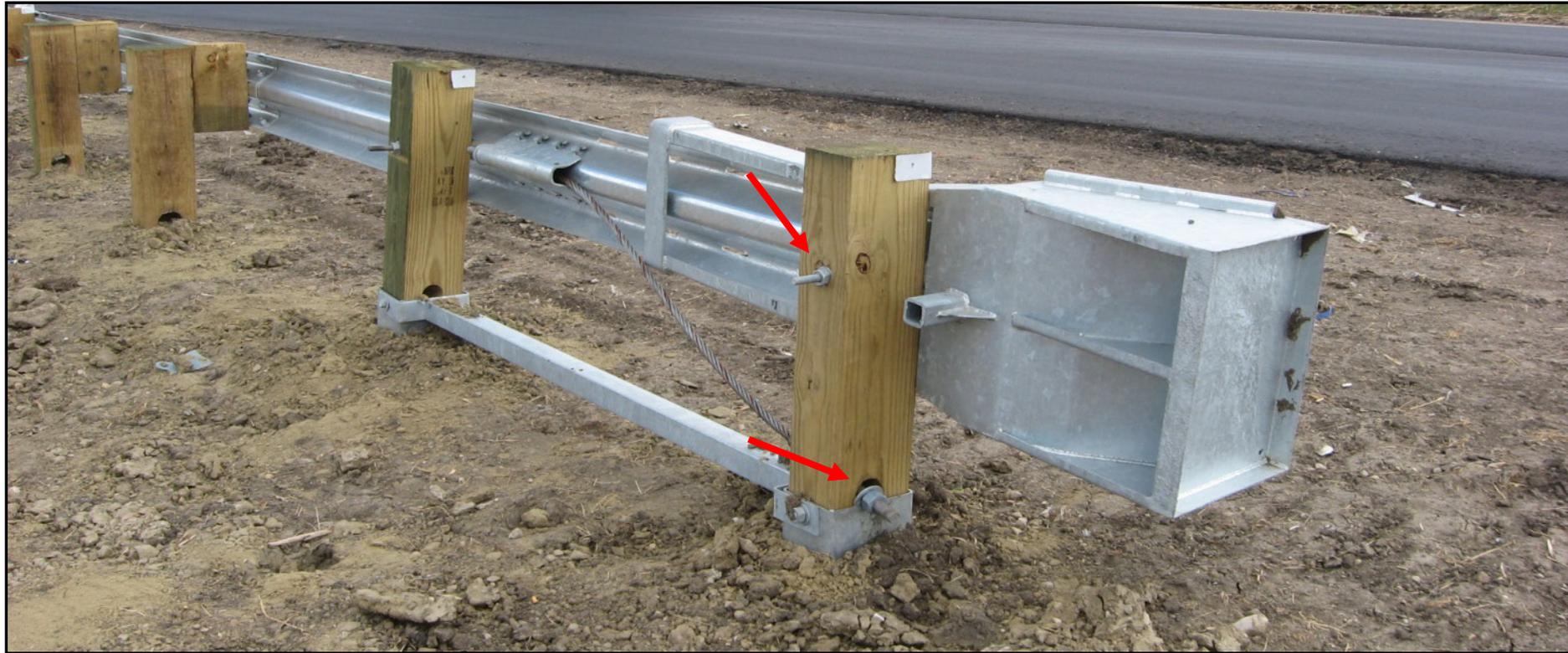
**Secondary Wooden Rail
Could Penetrate Vehicle**



Common Installation Errors: Terminals



Common Installation Errors: Terminals



Common Installation Errors: Terminals



Common Installation Errors: Terminals



Common Installation Errors: Improper Application



Common Installation Errors: Improper Application



Common Installation Errors: Improper Application



Common Installation Errors: Improper Application



Common Installation Errors: Improper Application



Common Installation Errors: Improper Application



Common Installation Errors: No Clear Zone



Terrible Results





Terrible Results



Session 6 Outcomes

- Layout & install traffic barriers in accordance with plans and specifications following recognized construction techniques.
- Install effective barrier terminals following manufacturers' instructions.
- Recognize and avoid common installation errors for barriers and terminals.