

Brifen Wire Rope Safety Fence (TL-4 WRSF)

PRODUCT MANUAL

Includes Installation & Repair Procedures



**Because Our Families
Drive Where You Do**

BRIFEN★USA INC.
WIRE ROPE SAFETY FENCE

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Ofc: 405.751.8062

Note:

This document covers the installation, maintenance and repair of the 4-Rope (Cable) TL-4 Brifen Wire Rope Safety Fence (WRSF) System in detail. Procedures for the TL-3, 3-Rope and 4-Rope Systems are similar; however, drawings for the particular system being installed should be reviewed prior to start of work, as post type and size, rope heights, etc. vary.

Caution:

End anchor and line post foundation sizes are determined by soil classification, condition, temperature extremes, etc. If loose, wet or otherwise questionable soils are encountered at the site, please contact the responsible agency representative or Brifen USA, Inc. for recommended foundation modifications.

The information herein is proprietary to BRIFEN USA, Inc., and shall not be disclosed, duplicated or used otherwise without the express written consent of BRIFEN USA.

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Brifen Wire Rope Safety Fence (WRSF)

General:



Brifen WRSF Socketed Post
Post Cap Optional

Brifen Wire Rope Safety Fence (WRSF) is a high-tension median or roadside cable (wire rope) barrier system widely used around the world and in many U.S. states. It is available in several designs, all approved by the Federal Highway Administration as fully complying with NCHRP 350 crash test requirements. The basic types are the 3-Rope TL-3, 4-Rope TL-3, and 4-Rope TL-4 Systems. The $\frac{3}{4}$ " galvanized wire ropes are pre-stretched during manufacturing to reduce stretching during impact, and thus easier maintained. The top rope is typically placed in a slot at the top of the special steel line posts. All other ropes are interwoven around the posts, with all ropes securely anchored to the end terminal at each end. The ropes are not attached to the posts; small nylon "locating pegs" on the side of all posts (except Post 1 in the end anchor) position the ropes at the proper heights. Brifen WRSF is unique among cable barriers due to the patented interweaving of the wire ropes and use of the nylon pegs to position the ropes on the posts.

Each pre-stretched wire rope is highly tensioned, which, together with the above noted weave, creates high post/rope friction. This causes each post to act as a "mini-anchor," which helps limit the extent of damage during impacts, eliminates the need for intermediate anchors, and assures satisfactory performance even around curves. A major benefit of interweaving the wire ropes is that deflections are more predictable, even when long sections (typical in real world installations) are impacted. Research has shown that with straight (non-woven) systems, deflections increase with system length.

Brifen USA offers several types of end terminals; the "Standard," the "WRGT-FL," the "WRGT-RD," and the "Attachment to Guardrail". The Standard end terminal is rarely used, in locations where it cannot be impacted. The WRGT-FL is crashworthy and is the end terminal of choice if the WRSF is to be placed within the clear zone. The WRGT-RD end terminal may be used if it cannot be impacted head-on, such as downstream ends of WRSF, near departing ends of bridges, etc. The "Attachment to Guardrail" end terminal is available for use with flared approach guardrail (or Thriebeam) and at downstream ends of guardrail.

Brifen Drawings and Specifications (See Attachments 5 & 6) should be carefully reviewed prior to starting an installation. If there are any questions or concerns, a Brifen USA representative should be contacted immediately at 1.866.427.4336, toll free.

Site Review/Layout:

Prior to beginning an installation, the proposed site should be carefully checked:

- ◆The area should be relatively smooth, with compacted soil and no edge drop-offs, abrupt slope changes, holes, debris, etc. that could prevent a vehicle from impacting the WRSF with all wheels on the ground and suspension normal. Some filling and/or grading and compaction may be necessary. The ropes must be placed at design height above ground, and maximum deviation is $\pm 1"$. When the horizontal distance from the WRSF to the edge of the pavement is 2' or less, the rope heights are measured from the edge of the pavement. Elsewhere the rope heights are measured from general ground level beneath the line of WRSF.
- ◆Placement in the bottom of a median ditch is generally not recommended due to conflicts with drainage inlets and dikes, which create difficulty in maintaining correct rope heights. Also, these locations may be wet and offer poor support for post and anchor foundations. Offsets from median ditches should preferably be 10' or more, but within 1' of the ditch bottom may be acceptable.
- ◆Slopes on the traffic approach side should be typically no steeper than 6:1, although the TL-4 design may be used in certain instances on slopes as steep as 4:1; contact Brifen USA for more information. The back side slope can be steeper if it is unlikely that traffic can impact the system from that side.
- ◆Adequate clearance to rigid obstacles such as bridge piers, sign supports, power poles, trees, etc. is critical. With normal post spacing, minimum clearance should generally be at least 8', but 10' or more is preferable. By reducing the post spacing in the vicinity of an obstacle, clearances can be reduced. This post spacing reduction should begin at least 100' in advance of the obstacle and continue past the obstacle by a minimum of 50'. Contact Brifen USA for more information.
- ◆When the WRSF must be placed in the vicinity of other barriers, special considerations are required. An example is a barrier at bridge approaches. If the side slopes are relatively flat (no steeper than 6:1) and the other barrier is basically parallel to the roadway, the WRSF can be tapered over and the end terminal placed behind the other barrier. A minimum clearance of 10' from the end treatment of the parallel barrier is recommended. If the other barrier is flared, the WRSF can be placed on the traffic side using a WRGT-FL or WRGT-RD end terminal. Or, the WRSF may be connected to the metal beam guardrail (or Thriebeam) using the Attachment to Guardrail end terminal.

End Anchor Terminals:

As previously mentioned, there are several types of end anchor terminals available. The Standard terminal, which utilizes two separate concrete foundations for anchoring the ropes, must be placed where it cannot be impacted.



Standard Terminal

The WRGT-FL flared terminal is crashworthy and can be located anywhere within the clear zone and anchors all the ropes in one foundation. The WRGT-FL end terminal is generally the preferred type and consists of a large concrete foundation offset 2' and frequently with steel reinforcement. It has an anchor frame and 4 special posts (Posts 1 thru 4) placed in socketed foundations.

Note: The Post 1 socket is placed at an angle. Each of these four posts has a weakening cut just above the ground line, which must be placed **toward** the end anchor. All ropes are interwoven around Posts 2 & 3, and there is no slot in the top of these posts. The 4th post has a slot for the top rope.

The WRGT-RD end terminal is similar to the WRGT-FL except that standard line posts (with top slot) are used. It is typically used near departing ends of bridges (or other shielded locations) and on downstream ends if outside the clear zone for opposite-direction traffic. It is not to be used where head-on impacts are likely.



Wire Rope Gating Terminal (WRGT-FL)



Attachment to Guardrail

The "Attachment to Guardrail" end terminal utilizes special brackets that are bolted to the guardrail (or Thriebeam) at normal splice points, then one rope is connected at each bracket, using either a threaded end and nut or a mechanical fitting. Extra posts are used on the approach (upstream) end of the guardrail but are not needed if the attachment is on the downstream end.

End Terminal Foundations:

Foundation sizes vary, depending on soil type and condition, water table depth, temperature extremes, etc. If loose, wet or otherwise questionable soils are encountered at the site, please contact the responsible agency representative or Brifen USA for advice on sizes. Specific detailed drawings are available if not included in the project plans. All plans and drawings should be reviewed for end terminal locations and system offsets from edge of travel lane and from obstacles. End terminal and post foundation concrete should be the strength specified and adequate cure time must be allowed, typically at least one week or until strength test cylinders indicate minimum concrete strength has been attained before tensioning the WRSF.

A **neat excavation** (vertical sides and flat bottom) for the foundation is required, with **minimum disturbance of the natural ground**. If surrounding soil is disturbed, loose materials must be removed and the foundation either 1) over-excavated and forms set, reinforcing steel and concrete placed and, later (after form removal), backfilled using compaction equipment to attain 95% density, or 2) over-excavated, with vertical sides and flat bottom, and the loose material removed. After reinforcing steel placement, the entire over-excavation is then filled to flush with ground line using extra concrete. **NOTE:** The anchor frame reinforcing cage **must** be placed into the concrete so that anchor plate will be at the required 12° angle. This angle can be checked using a small level with an attached angle scale. The anchor plate must not be buried in the concrete; it should sit flush on top of the sloping concrete surface, so that if necessary it can be unbolted, removed and re-placed. The area should be shaped to drain. All concrete placement should comply with agency requirements.

Line Post Types:

◆ Posts with Concrete Socketed Foundations

See above cautions regarding foundation sizes and construction details. If in doubt regarding sizes, contact an agency representative or Brifen USA. Post caps are optional, if specified.

◆ Driven Posts

Although rarely used, driven line posts are available. Post sizes are based on use in firm, strong soil, and if questionable soils are encountered, contact an agency representative or Brifen USA. Post caps are optional if specified.

◆ Posts with Driven Socket Foundations

Contact a Brifen USA representative for details.

◆ Surface Mount Post

Contact a Brifen USA representative for details.



Concrete Socketed Post Foundation
Post Cap Optional

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Alignment and Placement:

Great care should be taken to assure proper alignment of the WRSF, both horizontal and vertical, with no abrupt changes so that when the wire ropes are placed in position, they will be at the correct line and elevation. Vertical tolerance is $\pm 1"$. Prior to starting, it is recommended that the ground surface be graded or otherwise shaped and compacted as necessary to provide a smooth, firm surface both under and on the approaches to the WRSF. It may be necessary to remove any accumulated material adjacent to the shoulder or to place and compact additional material.

If drainage inlets, dikes, etc. are encountered and cannot be adjusted to the proper grade, the WRSF alignment should be gradually transitioned around them to assure that correct rope heights above the ground line will be maintained. This will ensure that performance of the WRSF is not compromised by steep slopes in the vicinity of dikes and inlets. Horizontal transitions should preferably be made on a 50:1 or flatter taper, but no steeper than 25:1. Abrupt changes in alignment are to be avoided. If underground pipes or other conflicting features are encountered, post spacing may be reduced to miss them. Longer spacings than standard are to be avoided.

Line post locations should be marked in good alignment and at the proper spacing called for on the project. Posts 1 thru 4 at the WRGT-FL end terminal are spaced at 6'-6" and the Post 1 socket is placed at an angle toward the end anchor concrete foundation. Post 1 in the WRGT-RD terminal is spaced at 8'-4". Post foundation holes are excavated to proper depth (with no spoils remaining in the hole) then filled with concrete to approximately flush with the ground line. The sides must not slough off and partially fill the hole. At least one steel reinforcing ring is placed into the concrete to a depth of approximately 2" to strengthen the top of the foundation. Additional rings and reinforcing steel may be required. (See Attached Drawing.)

The socket is pushed down into the concrete. This can be done using a wooden board sized slightly smaller than the socket, with small hand levels attached to aid in placing the socket plumb (vertical). Sockets for line posts must be within 2° of vertical so that when the posts are inserted they will be plumb. For TL-4 posts, the top of the post should not be out of plumb by more than 4" ($\pm 1"$). **NOTE:** The Post 1 socket is placed at 79° angle from horizontal leaning toward the end anchor, see below. The top of the foundation when complete should have the socket approximately flush with the top of the concrete. It should not extend above the concrete surface, to avoid future socket damage during impacts.

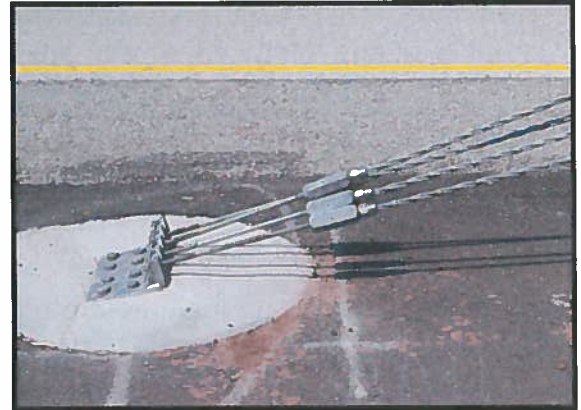


Post 1 at 79° Angle

REMINDER: The only socket not placed vertical is at WRGT-RD end anchor terminals. This socket is placed at 79° (from horizontal), leaning toward the end anchor concrete foundation.

REMINDER: The anchor plate must sit on top of the concrete anchor foundation, at 12° from horizontal.

REMINDER: The sockets are pushed down into the center of the concrete, being careful not to allow concrete or other debris to enter the socket.



Anchor Plate at 12° Angle

Post Installation:

After the concrete has cured sufficiently, the posts are placed into the sockets. Each post has an "excluder" (gasket), which is pushed down against the top of the socket to prevent debris from entering. These can be placed on the posts either before or after the posts are in the socket, but **must** be in place before the ropes are installed. The nylon "locating pegs" are placed into pre-drilled holes on the sides of the posts. Care must be used to avoid breaking the pegs. They will go into the holes easier if the pointed tip of the peg is slightly squeezed together by placing it against the hole at an angle, then pressing the tip closed while lightly tapping with a small hammer. At the WRGT-FL and WRGT-RD end terminals, Post 1 has steel lugs welded to the sides and does not require pegs. Posts 2 & 3 have pegs in all 4 holes, since all 4



Post 1 & Excluder

of the wire ropes interweave around these posts. Post 4 and all line posts have the top rope placed in a slot at the top, while the other ropes weave.

VERY IMPORTANT: The four WRGT-FL posts (1 thru 4) have a weakening cut on one side near ground line. This cut **must** be placed toward the end anchor.



Weakening Cuts (Toward Anchor)

Wire Rope Placement & Tensioning:

After the end terminal and line post foundation concrete has cured sufficiently and the posts are in place with the locating pegs attached, stringing of the wire ropes can begin. The ropes (normally in 1000' lengths) are delivered on large reels, four lengths per reel, with left and right hand, color-coded, threaded ends pre-attached. Each of the ropes are connected to the end terminals using shorter "tail ropes," sized to fit the length of the total wire rope run (section). These tail ropes are delivered on separate reels. The tail rope for the bottom rope (D) is placed first. It is first connected to the anchor frame (See Attachment 1) then to the first 1000' length of rope using a "rigging screw" (turnbuckle). **NOTE:** Turnbuckles should be lubricated before connection to facilitate tension adjustment or if removal is required during maintenance or repair. A copper anti-seize lubricant is recommended. The threaded ends (left and right hand) of each rope should extend into the turnbuckle at least 1 ½". While being unreeled, the rope is interweaved (back & forth) around the posts and laid on the locating pegs previously placed on the sides of the posts. As each rope is unreeled, it is connected to the previous one using a turnbuckle. Rope slack should be pulled out and kept to a minimum by temporarily clamping it at a nearby post using cable clamps or "Vice-Grips". This process is continued until the other end anchor is reached. The other tail rope is attached, and connected to the other end anchor frame.



Temporarily Clamp the Rope

The other two weaving ropes (B & C) are installed in similar fashion. The top rope (A) is slightly different. It is also interweaved around Posts 1, 2 & 3 at the end terminals, as noted above, but the remainder of the top rope length is placed in a slot at the top of the line posts, starting with Post 4.

Occasionally turnbuckles will land at line posts and this is normal and acceptable. However, a turnbuckle will not fit into the standard top-rope slot and for this case there are two options:

1. Place top rope and turnbuckle outside the slot, on the side opposite the next lower rope.
2. Enlarge post slot (treat the widened slot with zinc-rich paint) so turnbuckle will lay in the slot without interference or use special wide-slot post.

After all ropes are connected to both end anchor terminals, they can be tensioned. (See Attachment 2.) **NOTE:** Post 1 has steel lugs welded to each side.

The last steps are the placement of the reflective sheeting on the posts at the spacing and of the color specified.

After approximately 3 weeks, the complete system should be re-checked for proper rope tension and documented.

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Recommended Tools:

- Tension meter
- Infrared Thermometer
- Chop saw
- Miscellaneous hand tools (wrenches, hammer, measuring tape, screwdriver, etc.)
- Foundation excavation equipment
- Small hand level(s)
- Small hand level with angle measuring capability
- Come-along
- Cable clamps or "Vice-Grips"



Completed Section of Brifen WRSF
TL-4 (4-Rope)



Completed Section of Brifen WRSF
TL-4 (4-Rope)

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Attachment 1

End Anchor Rope Connection

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END ANCHOR ROPE CONNECTION

WRGT-FL AND WRGT-RD END TERMINAL ROPE CONNECTION PROCEDURE:

(4-Rope Shown; 3-Rope Similar)

The flared Wire Rope Gating Terminal (WRGT-FL) is illustrated. All wire ropes are anchored to a single large concrete foundation for both the WRGT-FL and WRGT-RD terminals. Only 3 ropes are used on the 3-Rope TL-3 system.

A "Tensile Rod - Combination Mechanical Fitting" is used to connect each of the wire ropes to the anchor frame, which is bolted to the concrete foundation. The steps below illustrate connection of one rope end at the second end terminal.

1. Before starting the connection, as much slack as possible should be pulled out of the rope. A "come-along" can be used, hooked to the anchor frame and clamped to the rope approximately 5' from the anchor frame. The rope is then pulled tight.

(See Picture 1.1)

2. The end is cut off approximately 19" short of the anchor frame.

(See Picture 1.2)

3. The threaded socket section of the combination mechanical fitting is slid over the rope end, leaving approximately 2" of rope exposed.

(See Picture 1.3)

4. Gently force a screwdriver between the strands to unlay the rope. When done correctly, the strands will form a symmetrical basket. Do not straighten out the spiral lay of the strands, unlay any wires that make up the strand, or allow the strands to cross each other inside the sleeve.



Picture 1.1



Picture 1.2



Picture 1.3



Picture 1.4



Picture 1.5

END ANCHOR ROPE CONNECTION (Cont.)

5. Place the brass plug in the center of the strands, starting with the small tapered end. Use a metal punch and hammer to drive the plug into the threaded socket while assuring that the strands are spaced somewhat equally around the plug. Drive the plug until firmly seated and no more than 1/3 of the plug is visible outside the threaded socket.

(See Pictures 1.6, 1.7 & 1.8)

6. Using adjustable pliers or hose clamps, bend the strands toward the center enough that the threaded sleeve can be slipped over all the strands. Coat the threads with a copper anti-seize lubricant for easier tightening.

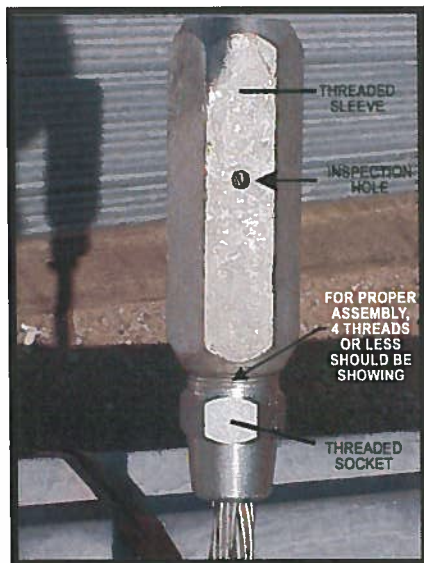
(See Pictures 1.9 & 1.10)

7. With the threaded sleeve over the strands, engage the threads and tighten until four or fewer threads are visible. If more than four threads are visible, proof load the cable and retighten the threaded socket.

(There is no specific requirement for torque.)

8. Prior to proof loading, strands visible through the inspection hole are your assurance of a proper assembly.

(See Picture 1.11)



Picture 1.11
Combination Mechanical Fitting

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Picture 1.6



Picture 1.7



Picture 1.8



Picture 1.9



Picture 1.10

END ANCHOR ROPE CONNECTION (Cont.)

NOTES: The threaded socket section can be removed from the threaded sleeve at any time for inspection of corrosion or excessive seating due to overloading. This will not affect the holding efficiency of the sleeve and plug when reconnected.

9. The threaded tensile rod is connected to the anchor frame using a square steel washer, round washer and two nuts (one is a locking nut) with a square HDPE/Nylon washer placed against the steel anchor frame. The nut is then tightened to take up slack in the rope, the lock nut added and the come-along released.

(See Picture 1.12)

10. After all ropes are fastened to the anchor frame, the retainer pin is inserted and the ends bent to keep it in place.

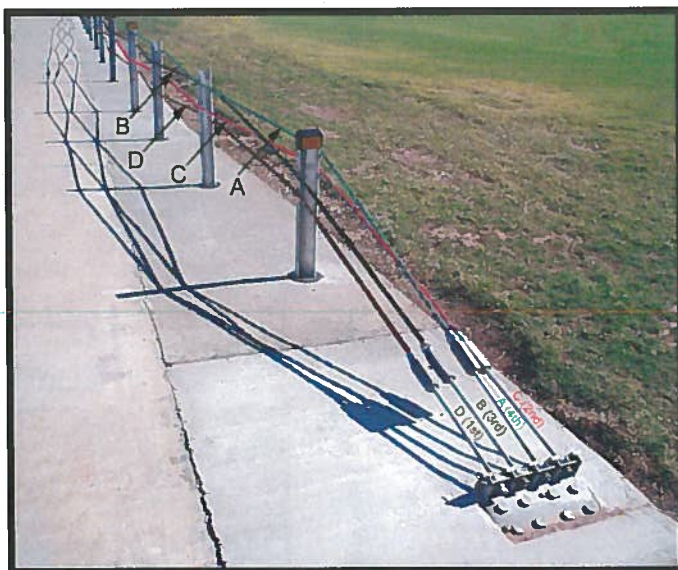
(See Picture 1.13)

Tensioning of the system can now be done.

(See Attachment 2)

Completed views of the WRGT-FL:

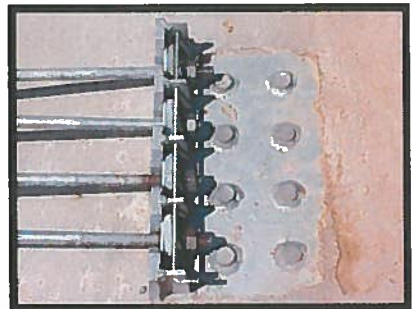
(See Pictures 1.14, 1.15, & 1.16)



Picture 1.16
WRGT-FL (Flared)



Picture 1.12



Picture 1.13



Picture 1.14 (RD)



Picture 1.15 (FL)

END ANCHOR ROPE CONNECTION (Cont.)

◆ SPECIAL NOTES:

WRGT & WRGT-FL Anchors:

- ◆ Be sure to use the special posts (1 thru 4) that have weakening cuts at ground line and install them with the weakening cut **toward** the end anchor concrete.
- ◆ Post 1 has welded steel “ears” and is angled toward the concrete anchor. Posts 1, 2 and 3 do not have a slot and the ropes weave along the sides.
- ◆ Standard rope heights are attained at Post 4, the first post with a slot at the top.
- ◆ In the TL-4 system, Post 3 is approximately 3” longer than Post 2 and neither have a slot at the top. Post 4 has a slot at the top and is similar to standard line posts, except for the weakening cut at ground line.

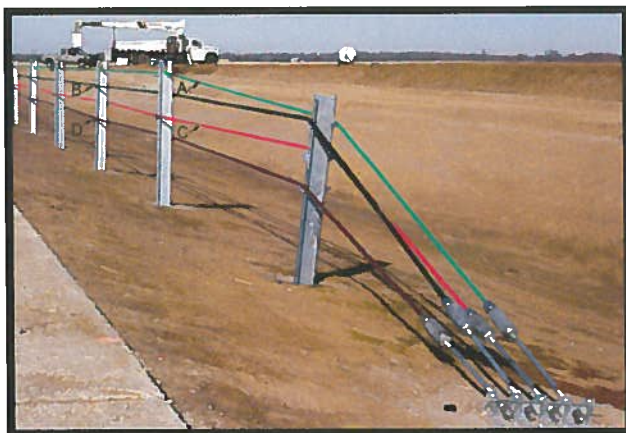
(See Picture 1.16)

- ◆ The weave is correct when Ropes B and D are on one side of Posts 2 & 3 and Ropes A and C are on the other. The ropes do not weave between the end anchor tiedown point and Post 1. At Post 4 and beyond, Rope A is in slot at top. When weave is correct, it will appear as in Picture 1.16.

WRGT-RD Anchors:


- ◆ All posts (except Post 1) are standard line posts. Standard rope heights are attained at Post 2.

(See Picture 1.17)



Picture 1.17
WRGT-RD (Non-Flared)

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Attachment 2

Tensioning

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TENSIONING

PROCEDURE FOR TENSIONING THE WRSF:

1. Ensure that all rigging screws (turnbuckles) have the minimum thread engagement of 1" (25mm) and that the slack is taken out of the ropes.

(See Picture 2.1)

2. Check that each tail rope is securely fastened to the end anchorage frames:

a. WRGT-FL/WRGT-RD End Terminals:

The tensile rod end of the combination mechanical fitting should be down to the bottom of the anchor frame slot and secured with a square steel washer, around washer, and two nuts (one is a locking nut) with a square HDPE or Nylon washer placed against the steel anchor frame. The nuts should be tight, and there should be at least three threads showing on the outside of the locking nut.

(See Picture 2.2)

OR

b. Standard End Terminal:

Each tail rope should be down to the bottom of the anchor frame slot and have an infinitely adjustable mechanical anchor fitting slipped over it. The fitting should be up tight against a square steel washer and an HDPE or Nylon square washer placed against the anchor frame and tightly secured.

(See Picture 2.3)

c. Attachment to Guardrail

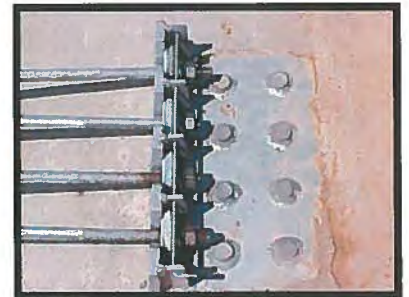
●Upstream (Approach End)

After removing any slack in the guardrail and retightening the splice bolts, each rope should be passed through it's respective attachment bracket. The mechanical fitting should then be slipped over the rope and up tight against the bracket and securely tightened.

(See Pictures 2.4 & 2.5)



Picture 2.1
Rigging Screw (Turnbuckle)



Picture 2.2
WRGT-FL End Terminal Anchor Frame



Picture 2.3
Standard End Terminal Anchor Frame



Picture 2.4
Attachment to Guardrail



Picture 2.5
Attachment to Guardrail

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TENSIONING (Cont.)

● Downstream (Trailing End)

Attachment bracket bolts to guardrail similar to upstream, with tapered end toward approach traffic, as in Picture 2.5. Threaded end of rope is inserted through downstream end of bracket and double nutted inside the bracket.

3. Start at one end of the fence in the vicinity of the first rigging screw. Turn the meter on by pressing the on-off button and pulling out the pin. Open the lever arm and hang the meter on one of the ropes. Ensure that all 3 sheaves (rollers) are riding on the rope, then close the lever arm and lock it into position. The center sheave will deflect the rope. Read the rope tension in the display.

(See Picture 2.6)

4. Aim the infrared thermometer at the rope being tensioned, and read the temperature. Then refer to the Rope Tension Table to determine the proper rope tension for that rope temperature.

(See Picture 2.7 & Figure 1.1)

a. Adjust the rigging screw until the desired rope tension has been reached.

(See Picture 2.8)

b. Release the lever arm and move the tension meter to another rope. Repeat above procedures.

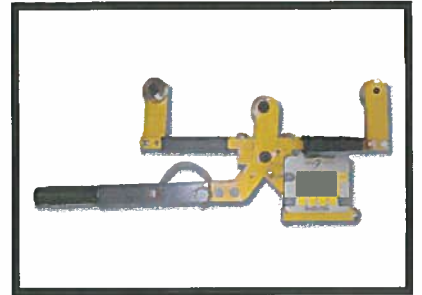
(See Picture 2.9)

c. Log the date, time, rope temperature and rope tension settings on the Tension Log provided as tensioning is performed.

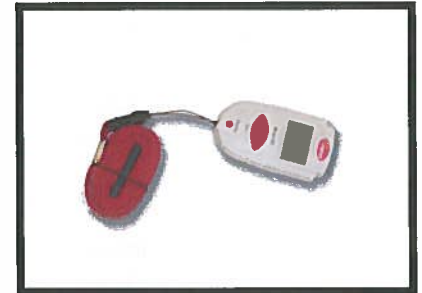
(See Figure 1.2)

◆ SPECIAL NOTES:

◆ The rope temperature should be checked each time the meter is attached to a rope, since rope temperature may vary widely from the ambient temperature and from previously tensioned ropes.



Picture 2.6
Tension Meter



Picture 2.7
Infrared Thermometer



Picture 2.8



Picture 2.9



Completed Section of Brifen WRSF

TENSIONING (Cont.)

♦ Appropriate tension settings must be determined using the Rope Tension Table.

(See Figure 1.1)

♦ The rigging screws should have been lubricated before assembly to facilitate adjustment and/or removal during maintenance or repair of the safety fence. If lubricant is needed, a copper anti-seize lubricant is recommended.

♦ Tensioning the ropes, especially the lower (interwoven) ropes so they reach the correct tension throughout the length of the section may be difficult when there are curves, close post spacing or long runs.

It has been found that the appropriate tension may be obtained by applying an initial tensile force of approximately 120% of that required and vibrating the ropes by rapping the line posts with a hammer or by use of a mechanical vibrator. This accelerates the creep and redistribution of the tensile force by reducing the friction between the posts and the interwoven ropes.

When a tensile force of $\pm 20\%$ of the Rope Tension Table value is recorded along the length of the rope, the procedure is complete.

♦ Due to the natural settling and redistribution of tension in the ropes, a second tensioning is recommended after approximately a two or three week period. Use the tensions listed on the Rope Tension Table for the rope temperature, and record findings on the Tension Log.

(See Figure 1.2 and Attachment 7)

Future checks of tension should be within approximately $\pm 20\%$ of these values.

♦ Future tension checks at varying locations after installation can have significant variation from the Tension Table values but this is normal and expected. As long as the ropes are tight enough to prevent droop in the ropes between posts, the system will operate as designed.

ROPE TENSION TABLE

Rope Temp. F°	Load lbs.	Rope Temp. C°	Load kN
0	5700	-17.8	25.4
5	5550	-15.0	24.7
10	5400	-12.2	24.0
15	5250	-9.4	23.4
20	5100	-6.7	22.7
25	4950	-3.9	22.0
30	4800	-1.1	21.4
35	4650	1.7	20.7
40	4500	4.4	20.0
45	4350	7.2	19.3
50	4200	10.0	18.7
55	4050	12.8	18.0
60	3900	15.6	17.3
65	3750	18.3	16.7
70	3600	21.1	16.0
75	3450	23.9	15.3
80	3300	26.7	14.7
85	3150	29.4	14.0
90	3000	32.2	13.3
95	2850	35.0	12.7
100	2700	37.8	12.0
105	2550	40.6	11.3
110	2400	43.3	10.7
115	2250	46.1	10.0
120	2100	48.9	9.3
125	1950	51.7	8.7
130	1800	54.4	8.0
135	1650	57.2	7.3
140	1500	60.0	6.7

Figure 1.1

TENSION LOG

DATE	ROPE TEMP*	TIME	kN/LBS	RIGGING SCREWS			
				A	B	C	D

*Using infrared temperature or similar.

Figure 1.2

BRIFEN★**USA** INC.

WIRE ROPE SAFETY FENCE

Ofc: 405.751.8062



Attachment 3

Crash Vehical Removal

BRI FEN★USA^{INC.}
WIRE ROPE SAFETY FENCE
12501 N. Santa Fe Ave.
Oklahoma City, OK 73114
Ofc: 405.751.8062

CRASH VEHICLE REMOVAL

PROCEDURES TO REMOVE VEHICLES FROM ROPES

Problem:

Wire rope slid under hood and then became lodged under the pick-up's bumper. The truck then pulled away from system causing more tension in the rope than normal. The rope could not be removed at this point.

Solution:

Wire rope was too tight to remove with pry bar. Four bolts were removed from the truck's bumper, which allowed the rope to be removed from the truck.

It took one worker approximately 30 minutes to free the truck from the wire ropes and repair the fence. The WRSF was back in service before the wrecker left the area.

No re-tensioning was required.

(See Pictures 3.1 & 3.2)

Other Removal Methods:

1. Wrecker could pull truck back in line with fence, allowing ropes to be picked up from behind bumper and removed.

No re-tensioning required.

2. Remove several nearby posts to un-weave ropes making them more slack, using the Rope Spreader Tool.

(See Picture 3.3)

If tool is not available, cut several posts off at ground line and remove.

No re-tensioning required.



Picture 3.1



Picture 3.2



Picture 3.3



Picture 3.4



Picture 3.5

BRIFEN★USA INC.

WIRE ROPE SAFETY FENCE

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CRASH VEHICLE REMOVAL (Cont.)

3. Loosen nearest "rigging screws" (turnbuckles) to relieve tension and make ropes more flexible.

If one or more of the ropes are on top of the vehicle or if the vehicle is between the ropes, remove some posts and/or loosen nearby turnbuckles, as previously mentioned, to gain some slack.

However, this may require re-tensioning.

(See Picture 3.4)

4. In a life-threatening situation **only**, and as a last resort, cutting ropes may be necessary. However, if this is required, cut only at center of nearby turnbuckles so as not to damage the ropes.

If a vehicle tangled in the ropes has deflected the ropes, the tension may be greater than normal. Before attempting to disengage the ropes or before cutting any ropes, remove additional posts and/or loosen nearby turnbuckles to relieve tension.

Re-tensioning will be required if turnbuckles were loosened. If turnbuckles have not been loosened, then re-tensioning should not be necessary.

However, if tension is checked immediately after repair, it may be lower than normal, since the system needs some time to settle out and tension stabilize due to temperature changes.

(See Picture 3.5)

Note:

Pictures 3.6 through 3.8 are examples of large vehicle impacts contained by Brifen WRSF ---- there are many others. Most were removed from the WRSF without loosening turnbuckles or cutting any ropes, making repairs easier.




Picture 3.6



Picture 3.7



Picture 3.8



Attachment 4

Repair

BRI FEN★USA^{INC}
WIRE ROPE SAFETY FENCE

12501 N. Santa Fe Ave.
Oklahoma City, OK 73114
Ofc: 405.751.8062

REPAIR

REPAIR IN MID-RUN

(TL-4 Shown; TL-3 Similar)

The following are instructions for repairing mid-run hits to Brifen WRSF after the vehicle(s) have been removed from the system. Please see Crash Vehicle Removal if vehicles are still present before repairing WRSF.



Typical 5 Post Hit

1. Remove bent or damaged post(s). If a post is tight in a socket, use a pry bar to break it loose and then lift post straight up. Posts frozen in sockets may need to be heated (weed burner, torch, steam, etc.).

(See Picture 4.1 & 4.2)

2. If there are an odd number of posts needing to be replaced, every other post can be inserted through the ropes (now un-woven). Excluders (gaskets) should be in place on the posts before insertion.

(See Pictures 4.3 & 4.4)

3. If there are an even number of posts needing to be replaced, the weave will still be present.

(See Picture 4.5)

- ◆ Remove one more post; at this point, the weave will not be present and every other post can be dropped down through the ropes.

- ◆ For the remaining posts, follow the procedures for interweaving the posts through the ropes as described on the following pages.



Picture 4.1



Picture 4.2



Picture 4.3



Picture 4.4



Picture 4.5

BRIFEN★USA INC.
WIRE ROPE SAFETY FENCE
Ofc: 405.751.8062

REPAIR (Cont.)

One Person Repair (TL-3 Shown; TL-4 Similar)

1. Slide the post between Ropes B, C and D, so that Ropes B and D are on the same side of the post, while Rope C is on the opposite side.

(See Picture 4.6)

2. Put excluder (gasket) on bottom of post.

(See Picture 4.7)

3. Place hammer or other tool in the top slot of the post, twist the post 90°, and start placing it into the socket.

4. Post/cable friction will prevent the post from going down. Place drive cap on the post and **drive the post** down through the ropes until it reaches the bottom of the socket.

(See Picture 4.8)

5. Repeat Steps 1 through 4 to weave the remaining replacement posts.

6. When all posts have been replaced, place Rope A in the top slot of each post.

(See Picture 4.9)

7. Pull Ropes B, C, and D up to just above proper height and insert the locating pegs using a small hammer to tap them into the small holes on the sides of the posts. Push the ropes back down into place, so each rope slightly rests on the top of each peg.

(See Picture 4.10)

8. Replace post caps and attach reflective sheeting if required.



Picture 4.6



Picture 4.7



Picture 4.8



Picture 4.9



Picture 4.10

REPAIR (Cont.)

Two Person Repair (TL-4 Shown; TL-3 Similar)

1. Slide Rope Spreader Tool between Ropes B, C and D, so that ropes B and D are on the same side of the Spreader, while Rope C is on the opposite side.

(See Picture 4.11)

2. With the handle parallel to the ropes, slide the Spreader towards the ground and put the tip into the soil. This will help stabilize the Spreader. Turn the handle 90° to spread the ropes.

CAUTION: Hold the handle securely to avoid injury.

(See Picture 4.12)

3. After placing the excluder (gasket) on the post, the second person can now drop the post into the socket.

(See Picture 4.13)

4. Slowly release the ropes by twisting the Spreader. This will allow the ropes to squeeze the post.

5. Repeat this procedure for the remaining posts.

6. Position Ropes B, C and D just above their correct height so that the locating pegs can be inserted.

7. Using a small hammer, tap the locating pegs into the small holes on the sides of the posts and push the ropes down so they rest on top of each peg.

(See Picture 4.14)

8. Pull Rope A up and over into the slot in the top of each post. Replace post caps and attach reflective sheeting if used.

(See Picture 4.15)



Complete Repair



Picture 4.11



Picture 4.12



Picture 4.13



Picture 4.14



Picture 4.15

BRI FEN★USA INC.
WIRE ROPE SAFETY FENCE
Ofc: 405.751.8062

REPAIR (Cont.)

REPAIR NEAR END ANCHOR (WRGT, WRGT-FL & WRGT-RD)

If any of the first four posts at the end anchor need replacing, be sure to use special posts that have weakening cuts at ground line and install them with the weakening cut **toward** the end anchor concrete.

WRGT anchor: The first 4 posts (A, B₁, B₂ & B₃) are slightly larger than other posts, and the next 15 posts (8 Gauge) are used to transition from the anchor to the regular line posts. None of these posts have a slot at the top and all ropes weave along the sides of the posts.

WRGT-FL anchor: No transition posts are used and standard height is attained at Post 4, the first post with a slot in the top. Posts 1, 2 and 3 do not have a slot and the ropes weave along the sides.

WRGT-RD anchor: No transition posts are used and all posts (except Post 1) are standard line posts. Standard rope heights are attained at Post 2.

If Post 1 (with steel ears and angled toward concrete anchor) is undamaged and ropes are still attached to the anchor, repair is similar to that in the middle of the run. If Post 1 is damaged and needs replacing or the ropes have been released from the anchor due to a reverse-direction hit, then repair is as follows:

1. With damaged posts removed and special posts in place (weakening cuts toward concrete anchor) start by re-weaving the ropes and re-attaching them to the anchor.

Note: In a TL-4 system, Post 3 is approximately 3 inches longer than Post 2, and neither have a slot at top. Post 4 has a slot at top and is similar to standard line posts, except for the weakening cut at ground line. A come-along or other means will be needed and several turnbuckles may need loosening to gain enough slack to re-attach the ropes to the anchor. The come-along can be hooked to either the sides of the anchor frame or to a



Picture 4.16
Come-Along Hooked to D-Ring



Picture 4.17
Come-Along Hooked to Side of
Anchor Frame



Picture 4.18
Hi-Lift Jack Raising Ropes

REPAIR (Cont.)

special D-Ring (available from Brifen USA) that bolts to the anchor frame.

(See Pictures 4.16 & 4.17)

2. Weave bottom Rope D first and re-attach it at the anchor frame. Lift it up and onto the lower steel ear on the side of Post 1. A Hi-Lift or similar bumper-style jack or other device may be needed to lift the ropes.

(See Picture 4.18)

Re-attach and raise Ropes D, C, B and A, in that order. The correct weave is in place when Ropes B and D are on one side of Posts 2 & 3 and Ropes A and C are on the other. The ropes do not weave between the end anchor tiedown point and Post 1. Install locating pegs for positioning ropes. At Post 4 and beyond, Rope A is in slot at top. When weave is correct it will appear as in Pictures 4.19 & 4.20.



Picture 4.19
WRGT-RD (Non-Flared)



Picture 4.20
WRGT-FL (Flared)

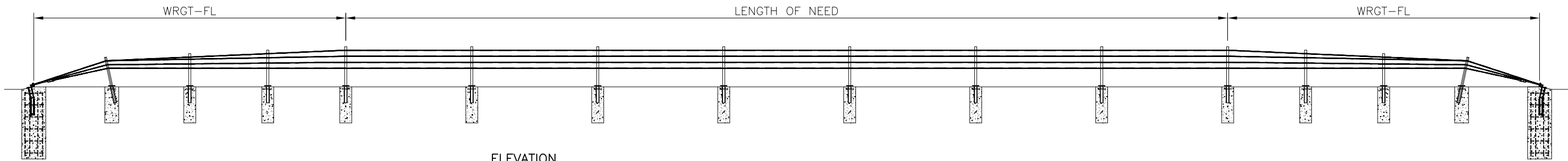
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WIRE ROPE SAFETY FENCE
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Attachment 5

Drawings

BRIFEN★USA INC.
WIRE ROPE SAFETY FENCE
12501 N. Santa Fe Ave.
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Ofc: 405.751.8062

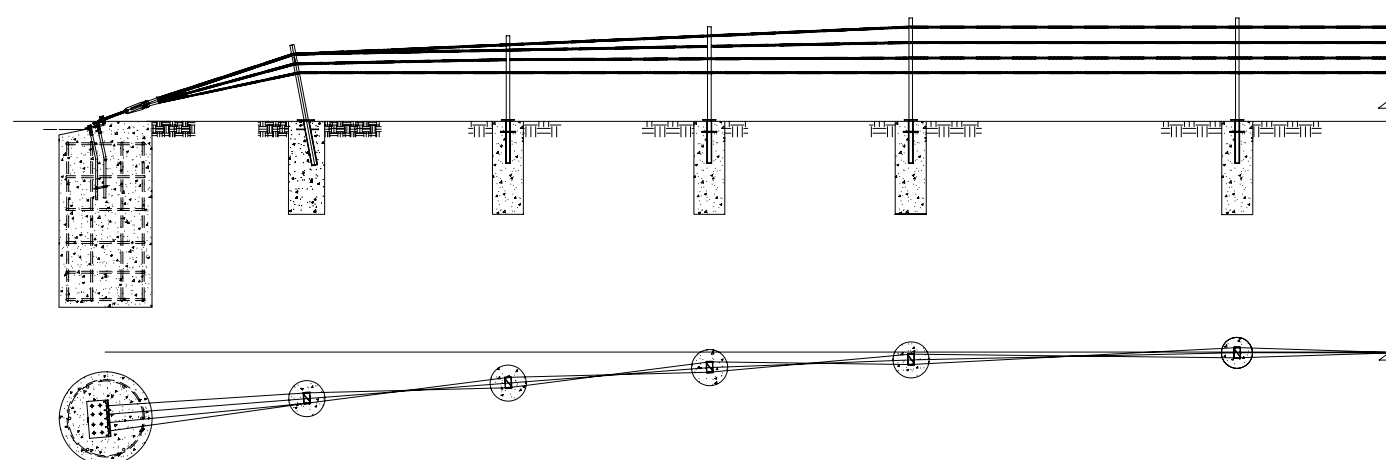


ELEVATION



PLAN

WRGT-FL END ANCHOR



* SEE SHEET 3 OF 3 FOR FURTHER INFORMATION

ROPE TENSION TABLE		
ROPE TEMP. (F°)	TENSION (LBS)	TENSION (kN)
0	5700	25.4
5	5550	24.7
10	5400	24.0
15	5250	23.4
20	5100	22.7
25	4950	22.0
30	4800	21.4
35	4650	20.74
40	4500	20.0
45	4350	19.3
50	4200	18.7
55	4050	18.0
60	3900	17.3
65	3750	16.7
70	3600	16.0
75	3450	15.3
80	3300	14.7
85	3150	14.0
90	3000	13.3
95	2850	12.7
100	2700	12.0
105	2550	11.3
110	2400	10.7
115	2250	10.0
120	2100	9.3
125	1950	8.7
130	1800	8.0
135	1650	7.3
140	1500	6.7

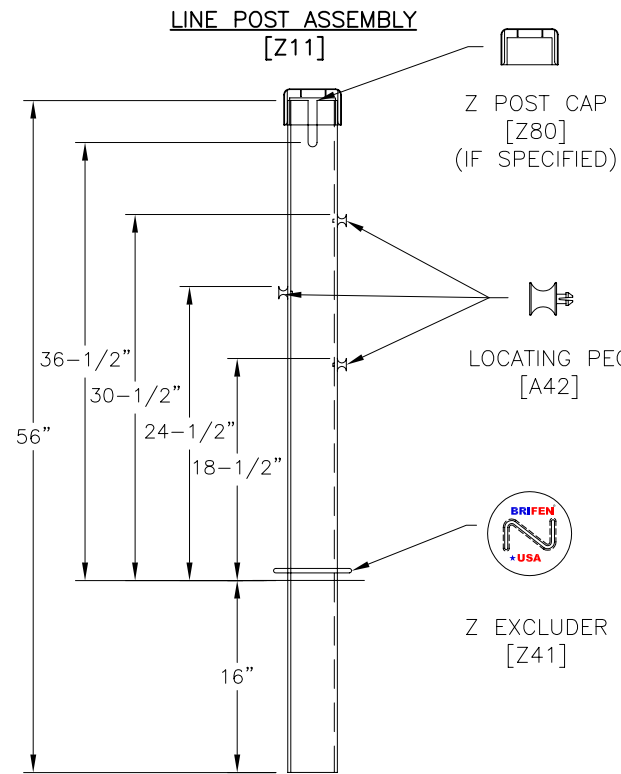
GENERAL NOTES:

- BRIFEN DRAWINGS, SPECIFICATIONS, AND PRODUCT MANUAL SHOULD BE REVIEWED PRIOR TO STARTING AN INSTALLATION. FOR ADDITIONAL INFORMATION OR QUESTIONS, CONTACT BRIFEN USA, INC. AT 1-866-427-4336.
- THE BRIFEN WRSF HAS BEEN SUCCESSFULLY TESTED TO NCHRP 350 TL-4 CONDITIONS ON SLOPES 6:1 OR FLATTER AND NCHRP 350 TL-3 CONDITIONS ON SLOPES 4:1 TO 6:1.
- THE POST SPACING SHALL BE DETERMINED BY THE SPECIFYING AGENCY. POST SPACING MAY BE DECREASED TO AVOID OBSTRUCTIONS OR UTILITIES. IN NO EVENT SHALL THE POST SPACING EXCEED 21'-0".
- BRIFEN WRSF SHALL BE PLACED ON A SMOOTH SURFACE, WITHOUT HUMPS, DROP-OFFS, HOLES, ETC THAT WOULD INTERFERE WITH THE STABILITY OF THE ERRANT VEHICLE. GRADING, FILL AND COMPACT MAY BE REQUIRED TO ASSURE THAT ROPES ARE INSTALLED AT THE DESIGN HEIGHT.
- THE WRGT-FL END ANCHOR HAS BEEN SUCCESSFULLY TESTED TO NCHRP 350 TL-3 CONDITIONS. THE LENGTH OF NEED BEGINS 31'-0" FROM THE END ANCHOR. POSTS A THROUGH POST B3, SPACED 6'-6" APART, HAVE WEAKENED CUTS AT THE GROUND THAT SHALL FACE THE ANCHOR.
- ANCHOR AND LINE POST DIMENSIONS AND STEEL REINFORCEMENT WILL BE DETERMINED ON PROJECT SPECIFIC SOIL CLASSIFICATION, PROPERTIES AND TEMPERATURE EXTREMES. CONTACT BRIFEN USA, INC. FOR ADDITIONAL INFORMATION.
- ALL REINFORCEMENT AND CONCRETE FOR THE ANCHORS AND LINE POSTS PROVIDED BY OTHERS.
- REINFORCEMENT AND CONCRETE PROPERTIES SHALL MEET AGENCY SPECIFICATIONS.
- FOR PLACEMENT NEAR GUARDRAIL OR OTHER OBSTACLES CONTACT BRIFEN USA, INC. FOR ADDITIONAL DRAWINGS AND SUPPORT.
- TAPER RATES FOR THE BRIFEN WRSF ARE AS FOLLOWS:
 HORIZONTAL: 25:1 MAXIMUM, 50:1 PREFERABLE
 VERTICAL: 25:1 MAXIMUM, 50:1 PREFERABLE

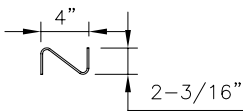
* ROPE TENSION: ±20% AFTER 2-WEEK INTERVAL

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BRIFEN USA INC.			BRIFEN WRSF NCHRP 350 TL-4 INSTALLATION & LAYOUT DETAILS		
Revision			Date 6.27.12	Drawn By Manita Elizondo	Scale None
No.	Date	By			
1.			VERSION 12.1		
2.					
3.			Dwg. No.	WRGTFL-11-001b	Sheet No 1 OF 3
4.					
5.					



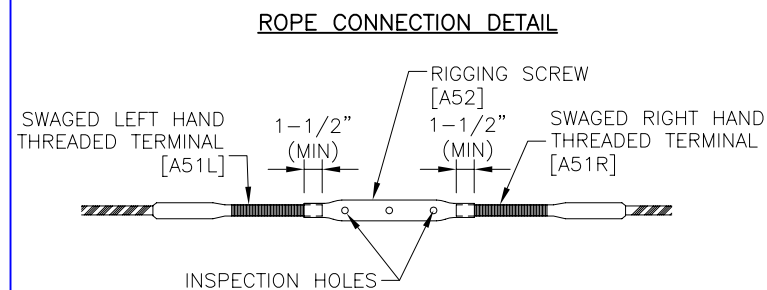
ELEVATION



PLAN

NOTES SPECIFIC TO LINE POST ASSEMBLY

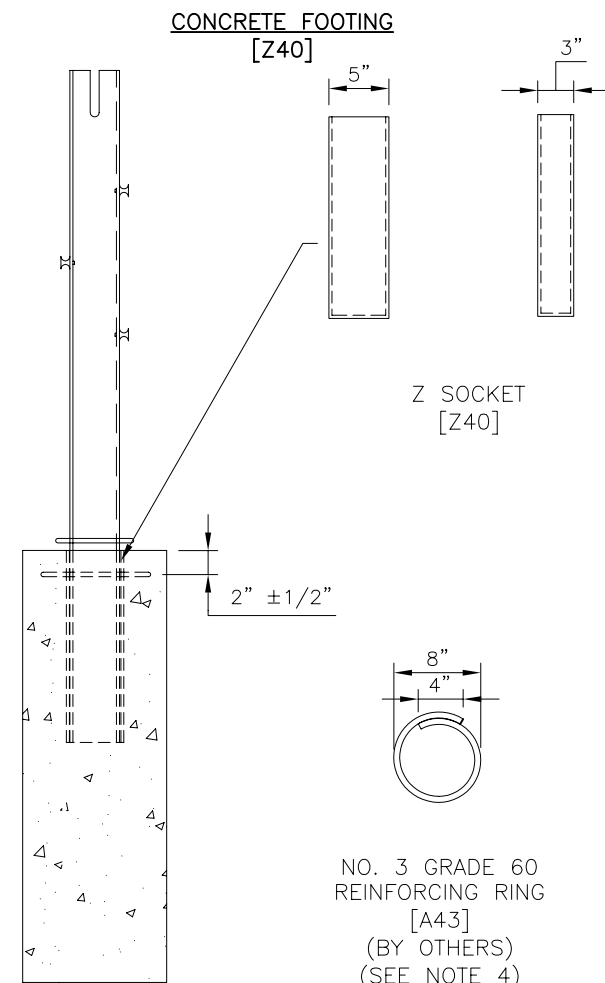
1. ROPE HEIGHTS SHALL BE $\pm 1"$ TO GROUND LINE.
2. POST SHALL BE $\pm 4"$ FROM VERTICAL PLUMB.
3. POST CAPS SHALL BE USED IF SPECIFIED.
4. REFLECTORS SHALL BE SPACED ACCORDING TO AGENCY SPECIFICATIONS.
5. REFLECTORS CAN BE PLACED ON THE POST CAP OR POST.



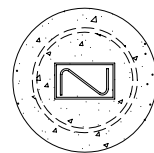
NOTES SPECIFIC TO ROPE CONNECTION DETAIL

1. THE WIRE ROPE TERMINALS SHALL BE THREADED A MINIMUM OF 1-1/2" INTO RIGGING SCREW.
2. AFTER FINAL TENSIONING, THE TERMINALS SHALL BE VISIBLE IN THE INSPECTION HOLES.

SOCKET ASSEMBLY



ELEVATION

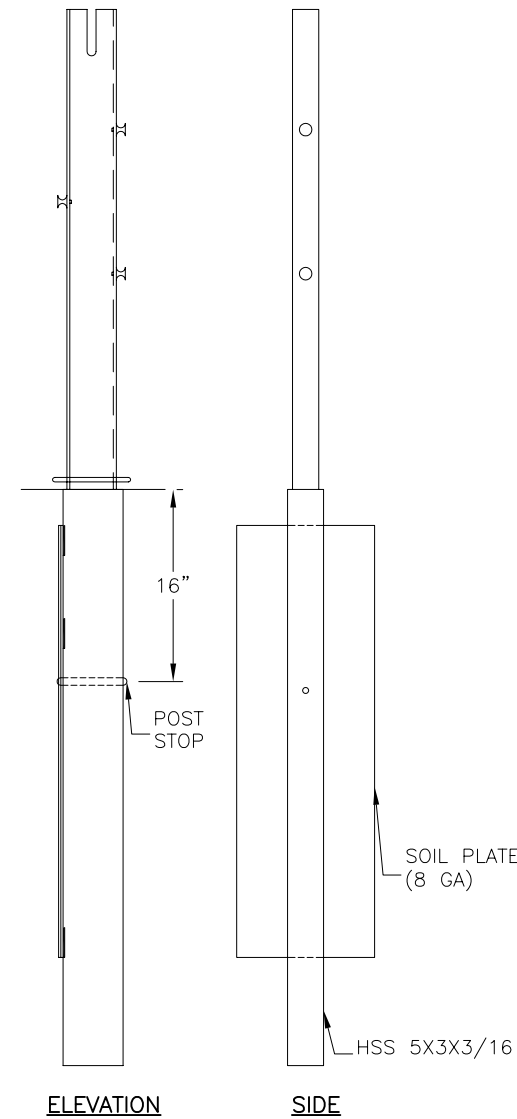


PLAN

NOTES SPECIFIC TO CONCRETE FOOTING

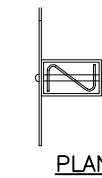
1. SIZE OF FOOTING WILL BE DETERMINED BY SOIL CONDITIONS, FOUNDATION TYPE AND PROJECT CONDITIONS.
2. CONCRETE BASED ON AGENCY SPECIFICATIONS.
3. CONCRETE BY OTHERS.
4. REINFORCING RING (BY OTHERS) WILL BE USED ACCORDING TO FOUNDATION SIZE AND TYPE. THE REINFORCING RING MAY BE OMITTED IF THE FOOTING IS PLACED IN A CONTINUOUS CONCRETE MOW STRIP.
5. FOOTING SHALL BE FLUSH WITH THE GROUND LINE, TO A MAXIMUM OF 1 INCH BELOW OR ABOVE GROUND LINE.
6. SOCKET SHALL BE $\pm 2'$ OF VERTICAL PLUMB.

DRIVE SOCKET [Z44]



ELEVATION

SIDE



PLAN

NOTES SPECIFIC TO DRIVE SOCKETS

1. SIZE OF SOIL PLATE WILL BE DETERMINED BY SOIL CONDITIONS AND PROJECT CONDITIONS.
2. THE SOIL PLATE SHALL BE PARALLEL TO ROADWAY AND CAN FACE TOWARD OR AWAY FROM THE TRAVEL LANE.
3. FOOTING SHALL BE FLUSH WITH THE GROUND LINE, TO A MAXIMUM OF 1 INCH BELOW OR ABOVE GROUND LINE.
4. SOCKET SHALL BE $\pm 2'$ OF VERTICAL PLUMB.
5. SOCKETS SHALL BE DRIVEN IN A MANNER TO NOT DISTORT OR DESTROY THE TOP OF SOCKET TO A DEGREE THAT PLACES THE SOCKET OR LINE POST OUT OF CONSTRUCTION TOLERANCES.

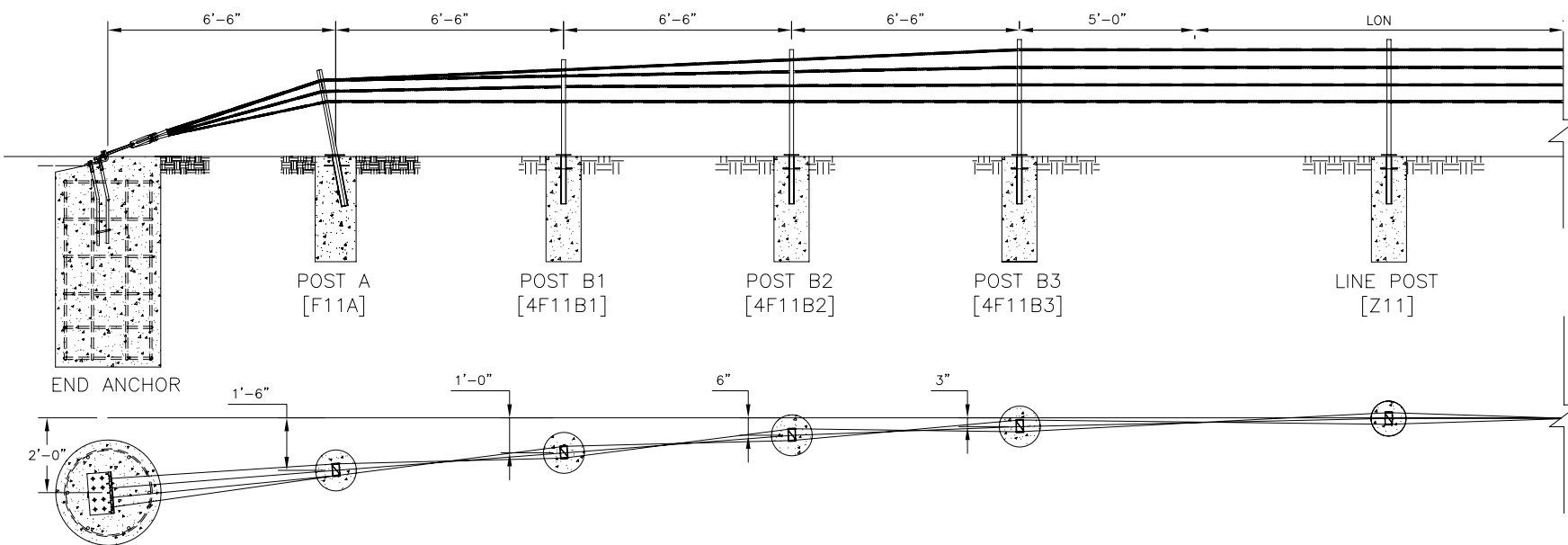
GENERAL NOTES:

1. BRIFEN DRAWINGS, SPECIFICATIONS, AND PRODUCT MANUAL SHOULD BE REVIEWED PRIOR TO STARTING AN INSTALLATION. FOR ADDITIONAL INFORMATION OR QUESTIONS, CONTACT BRIFEN USA, INC. AT 1-866-427-4336.
2. THE BRIFEN WRSF HAS BEEN SUCCESSFULLY TESTED TO NCHRP 350 TL-4 CONDITIONS ON SLOPES 6:1 OR FLATTER AND NCHRP 350 TL-3 CONDITIONS ON SLOPES 4:1 TO 6:1.
3. THE POST SPACING SHALL BE DETERMINED BY THE SPECIFYING AGENCY. POST SPACING MAY BE DECREASED TO AVOID OBSTRUCTIONS OR UTILITIES. IN NO EVENT SHALL THE POST SPACING EXCEED 21'-0".
4. BRIFEN WRSF SHALL BE PLACED ON A SMOOTH SURFACE, WITHOUT HUMPS, DROP-OFFS, HOLES, ETC THAT WOULD INTERFERE WITH THE STABILITY OF THE ERRANT VEHICLE. GRADING, FILL AND COMPACTION MAY BE REQUIRED TO ASSURE THAT ROPES ARE INSTALLED AT THE DESIGN HEIGHT.

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BRIFEN USA INC.			BRIFEN WRSF NCHRP 350 TL-4 LENGTH OF NEED COMPONENTS		
Revision			Date	Drawn By	Scale
No.	Date	By	6.27.12	Manita Elizondo	None
1.			VERSION 12.1		
2.			Dwg. No.	WRGTFL-11-002b	Sheet No
3.					2 OF 3
4.					
5.					

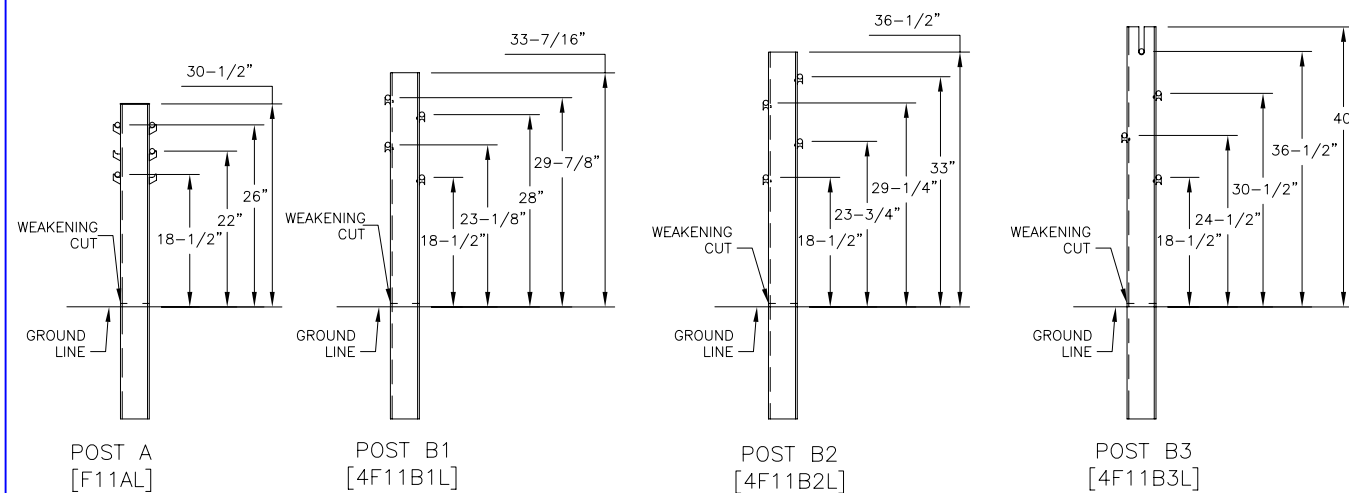
WRGT-FL END ANCHOR LAYOUT



GENERAL NOTES:

1. BRIFEN DRAWINGS, SPECIFICATIONS, AND PRODUCT MANUAL SHOULD BE REVIEWED PRIOR TO STARTING AN INSTALLATION. FOR ADDITIONAL INFORMATION OR QUESTIONS, CONTACT BRIFEN USA, INC. AT 1-866-427-4336.
2. THE WRGT-FL END ANCHOR HAS BEEN SUCCESSFULLY TESTED TO NCHRP 350 TL-3 CONDITIONS. THE LENGTH OF NEED BEGINS 31'-0" FROM THE END ANCHOR. POSTS A THROUGH POST B3, SPACED 6'-6" APART, HAVE WEAKENED CUTS AT THE GROUND THAT SHALL FACE THE ANCHOR.
3. ANCHOR AND LINE POST DIMENSIONS AND STEEL REINFORCEMENT WILL BE DETERMINED ON PROJECT SPECIFIC SOIL CLASSIFICATION, PROPERTIES AND TEMPERATURE EXTREMES. CONTACT BRIFEN USA, INC. FOR ADDITIONAL INFORMATION.
4. ALL REINFORCEMENT AND CONCRETE FOR THE ANCHORS AND LINE POSTS PROVIDED BY OTHERS.
5. REINFORCEMENT AND CONCRETE PROPERTIES SHALL MEET AGENCY SPECIFICATIONS.
6. FOR PLACEMENT NEAR GUARDRAIL OR OTHER OBSTACLES CONTACT BRIFEN USA, INC. FOR ADDITIONAL DRAWINGS AND SUPPORT.

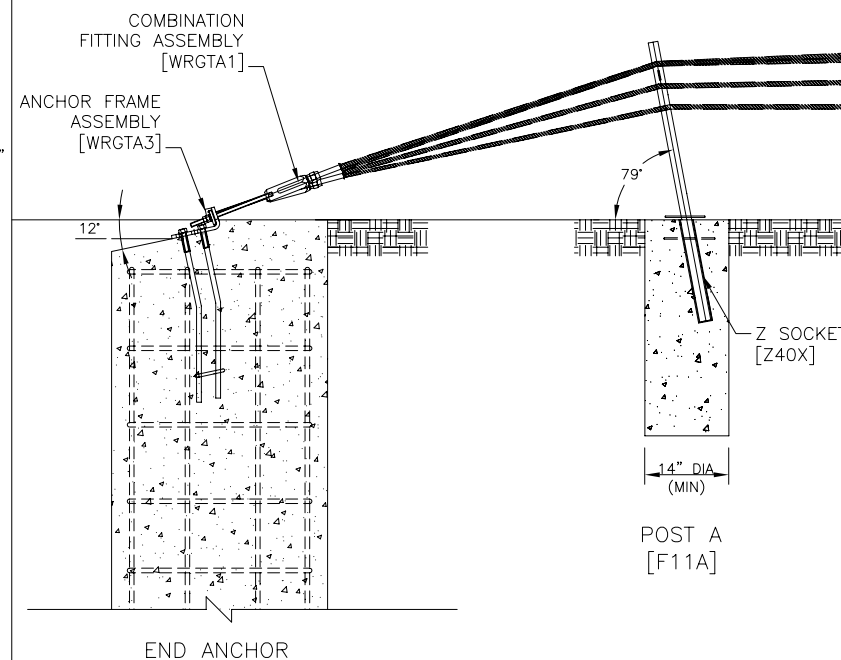
WRGT-FL POST DETAILS



NOTES SPECIFIC TO WRGT-FL POST DETAIL

1. ROPE HEIGHTS SHALL BE $\pm 1"$ TO GROUND LINE.
2. POST SHALL BE $\pm 4"$ FROM VERTICAL PLUMB.
3. POST CAPS SHALL BE USED IF SPECIFIED.
4. REFLECTORS SHALL BE SPACED ACCORDING TO AGENCY SPECIFICATIONS.
5. REFLECTORS CAN BE PLACED ON THE POST CAP OR POST.
6. Z EXCLUDER (Z41) SHALL BE USED.
7. POST A & SOCKET SHALL BE PLACED $79^\circ (\pm 4^\circ)$ TOWARD END ANCHOR FROM THE HORIZONTAL PLANE.
8. POST A SOCKET SHALL BE PLACED IN 14" (MIN) CONCRETE FOUNDATION. DEPTH TO BE DETERMINED FROM SOIL CONDITIONS AND PROJECT CONDITIONS.
9. FOUNDATIONS FOR POST B1 THRU B3 SHALL BE THE SAME AS THE LINE POST ASSEMBLY'S FOR THE PROJECT.
10. WEAKENED CUTS SHALL FACE END ANCHOR.

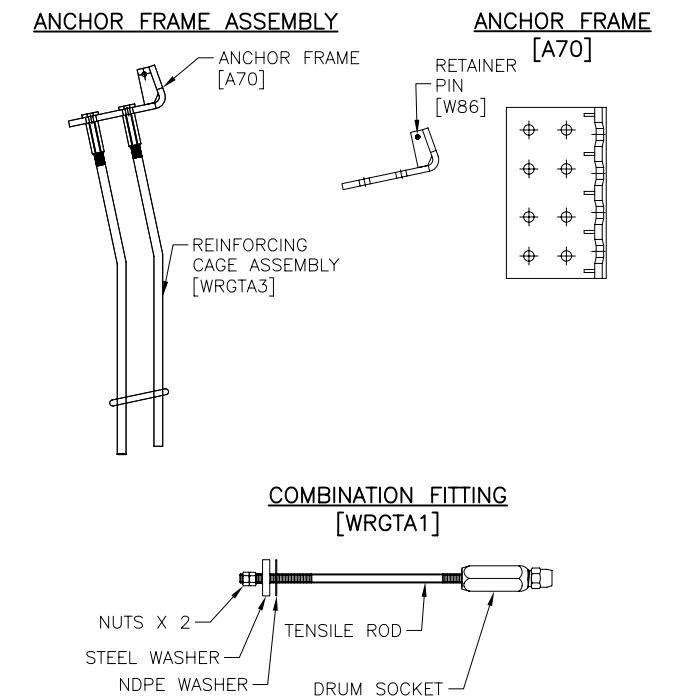
END ANCHOR DETAILS



NOTES SPECIFIC TO END ANCHOR DETAIL

1. THE END ANCHOR ASSEMBLY SHALL BE PLACED $12'$ (+3', -1') BELOW HORIZONTAL PLANE.
2. POST A & SOCKET SHALL BE PLACED $79^\circ (\pm 4^\circ)$ TOWARD END ANCHOR FROM THE HORIZONTAL PLANE.
3. POST A SOCKET SHALL BE PLACED IN 14" (MIN) CONCRETE FOUNDATION. DEPTH TO BE DETERMINED FROM SOIL CONDITIONS AND PROJECT CONDITIONS.


END ANCHOR COMPONENTS



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BRIFEN USA INC.

Revision			BRIFEN WRGT-FL END TERMINAL INSTALLATION & LAYOUT DETAILS		
No.	Date	By	Date	Drawn By	Scale
1.			6.27.12	Manita Elizondo	None
2.			VERSION 12.1		
3.					
4.			Dwg. No.	WRGTFL-11-003b	Sheet No 3 OF 3
5.					



Attachment 6

Specifications

BRIFEN★USA INC.
WIRE ROPE SAFETY FENCE

12501 N. Santa Fe Ave.
Oklahoma City, OK 73114
Ofc: 405.751.8062

WIRE ROPE SAFETY FENCE (WRSF) SPECIFICATIONS TL-4

1.0 Description

This specification covers all materials used in the installation of Wire Rope Safety Fence (WRSF) meeting requirements of NCHRP 350, TL-4, together with construction methods for installation.

2.0 General

The WRSF described by these specifications shall be four (4) rope type, capable of roadside or median mounting meeting NCHRP 350 TL-4. Only designs which incorporate "interwoven" technology may be used whereby a minimum of three (3) of the ropes are each woven on alternating sides of sequential line posts. Each rope, beginning with the bottom rope is placed on the opposite side of the next higher rope. Only socketed posts are to be used unless otherwise specified. End anchorage and post foundation sizes shall be determined based on soil classification, condition and temperature extremes. The manufacturer shall provide the Federal Highway Administration (FHWA) letters of acceptance, and provide technical assistance as needed. Installation shall conform to manufacturers Product Manual.

3.0 Materials

All materials used in this construction shall comply with the following requirements:

3.1 Wire Rope

- (a) The galvanized wire rope shall be ¾" (19mm) 3 X 7 construction meeting AASHTO M 30-92 (2000)/ASTM A741-98 Type 1 Class A coating except as modified below:

Table 1 Type 1 Breaking Strength Minimum = 39,000 pounds (17.7 tonne)

- (b) In addition to this provision, the wire rope shall be prestretched during manufacture to exhibit a minimum modulus of elasticity of 11,805,090 pounds/in². (8300 kg/mm²) after prestretching.

3.2 Fittings

- (a) **Threaded Terminals** (swaged type) shall be furnished and may be shop or field swaged. Threaded terminals shall be Right Hand (RH) or Left Hand (LH) threaded M24 X 3 pitch to ANSI B1.13M. The body of the threaded terminal shall provide a minimum of 5.9 inches (150 mm) wire rope engagement depth. Fully fitted ropes shall develop a Minimum Breaking Load (MBL) of 36,800 pounds (16.7 tonne.) Threaded terminals shall be galvanized, after threading, to ASTM A-153.
- (b) **Turnbuckle or Rigging Screws**, as they are sometimes called, shall be of the size and shape as shown in the plans. One end of the rigging screw shall be threaded RH and the other end LH to ANSI B1.13M M24 X 3 to accept threaded rope terminals. Rigging screws shall be of the solid or closed body type with two (2) inspection holes and shall allow for a minimum of six (6) inches (150mm) of penetration from each end. Rigging screws shall develop minimum tensile load without yielding to 36,800 pounds (16.7 tonne) and shall be galvanized to ASTM A-153 after threading.
- (c) **Combination Mechanical Fittings** shall be of a cylindrical design into which the wire rope is inserted and threaded to accept tensile rod, mechanical splice, or mechanical threaded terminal. The fitting shall insure proper adjustment of the wire rope for length and shall develop minimum tensile load of the entire wire rope of 36,000 pounds.

- (d) **Tensile Rod** shall be provided at the ends of each wire rope when attached to WRGT-FL or WRGT-RD end terminals. The tensile rod shall be capable of being threaded into a combination mechanical fitting to connect to the wire rope. The tensile rod shall be M-16 thickness and composed of ASTM A193/A193M Grade B7 material.

3.3 Line Posts

All posts shall be of the size and shape shown in the plans, with rounded edges on the traffic approach side. And, unless otherwise specified, shall be placed in socketed foundations utilizing a metal sleeve for insertion of the post. A driven post version with welded soil plate may be used if specified. All required welding shall be by Certified Welders to AWS D1.1. Posts and soil plates shall be domestic hot rolled mild steel of the size and shape as shown in the plans galvanized to ASTM A-123, after fabrication, unless powder coating is specified and the Engineer waives the galvanizing requirement. Otherwise, powder coating shall be applied over the galvanizing. All posts shall have a means of holding the wire ropes at the design height without metal hooks or other metal hardware.

A low-density polyethylene excluder, profiled to fit tightly around each post, shall be provided to prevent debris from entering the socket. If specified, post caps shall be provided including retro-reflective sheeting properly sized to fit the traffic approach side of the cap, and shall be the color and spacing per agency requirements. If post caps are not used the sheeting may be placed on the posts.

Sockets conforming to the plans shall be provided. Driven steel sockets or steel sockets placed in concrete foundations are available. Sockets placed in concrete foundations shall be fabricated from minimum ten (10) gauge, hot rolled mild steel galvanized to ASTM A-123, after fabrication. A No. 3 deformed rebar reinforcing ring shall be furnished and placed in concrete foundations as shown in the plans. Driven steel sockets shall be fabricated from ASTM A-36 steel conforming to the dimensions shown in the plans and galvanized to ASTM A-123 after fabrication.

3.4 End Terminals

Three types of end terminals are available for use within or outside the clear zone. These are the WRGT-FL, the WRGT-RD (except as noted) and the Attachment to Guardrail. The Standard End Terminal may also be appropriate, contact Brifen USA.

1. WRGT-FL End Terminal (NCHRP 350 Compliant)

All wire ropes are anchored into one concrete foundation of the size and shape required; four special posts (1 thru 4) placed in sockets set in concrete foundations shall be included.

- (a) **Fabricated anchor components** shall be of the size and shape shown in the plans. The 4-slot breakaway anchorage frame assembly, top six (6) inches of the attached reinforcing cage, posts and sockets shall be fabricated from materials meeting ASTM A-36 and galvanized after fabrication to ASTM A-123. All welding is to be per AWS D1.1.
- (b) **Heavy Duty Steel Washers and HDPE Plastic or Nylon Washers** shall be furnished at each slotted end anchor point. They shall be of the size and shape shown in the plans. Heavy steel washers shall be fabricated from ASTM A-36 material galvanized after fabrication to ASTM A-123. All posts shall be placed in sockets set in concrete foundations unless otherwise specified.

2. WRGT-RD End Terminal (NCHRP 350 Compliant)

This end terminal meets all NCHRP 350 requirements except for head-on impacts. It is similar to the WRGT-FL, except that all posts are standard TL-4 line posts other than end post A. This post is similar to WRGT-FL post 1.

3. Attachment to Guardrail

This end terminal utilizes special brackets bolted to the guardrail, with one rope connected at each bracket using either a threaded end and nut or a mechanical anchor fitting. Eight (8) extra line posts are used on the approach (upstream) end of the guardrail; none are needed on the departing (downstream) end.

4. Standard End Terminal

This end terminal incorporates two separate concrete anchor foundations, each of which anchors two wire ropes, and includes two deflection posts placed in sockets set in concrete foundations.

- (a) **Fabricated anchor frames and deflection posts with sockets** shall be of the size and shape shown in the plans and shall be fabricated from materials meeting ASTM A-36 and galvanized after fabrication to ASTM A-123. All welding is to be per AWS D1.1. Deflection posts shall be placed in sockets set in concrete foundations.
- (b) **Safety Check Ropes** shall be furnished for each ¾" (19mm) wire rope end anchor termination and shall be 5/16" (8mm) galvanized 6 X 19 construction with eye terminals on each end. Each main wire rope is fed through one end of their respective safety check rope prior to end anchorage termination with mechanical fitting. The other end of the safety check rope is attached to the end anchorage by use of a screw pin shackle.
- (c) **Heavy Duty Steel Washers and HDPE Plastic Washers** as in 1. (b) shall be furnished at each slotted end anchor frame.

3.5 Concrete

The concrete for end terminal foundations shall be placed in excavations of natural, undisturbed ground, to the size and shape (vertical sides, flat bottom) shown in the plans. If over-excavation is unavoidable, extra concrete shall be used to completely fill the excavation. The foundations may be formed and cast, then backfilled per state specifications to minimum density of 95% after form removal. Cost for excavation, reinforcement and concrete shall be included in the bid price for a complete & functional End Terminal.

All concrete used shall be a minimum strength of 3,500 psi and meeting all requirements of Agency specifications for Portland cement concrete.

4.0 Construction Methods

4.1 Description

This work shall consist of furnishing all labor, materials, equipment, and performing all operations in connection with the installation of a complete and operational WRSF.

4.2 General

The alignment and location of the WRSF shall be according to the plans or as directed by the Engineer. The area shall be relatively smooth, without edge drop-offs, holes, other depressions or abrupt slope changes between edge of traveled way and WRSF. Before starting installation of the WRSF, any necessary filling and compaction shall be done and the area graded smooth. Asphalt millings, compacted earth or other material may be used as directed by the Engineer. The type of soils in the area shall be noted prior to beginning foundation installation. If wet, loose, or otherwise unsuitable soils are encountered, this shall be reported to the Engineer for advice on any necessary foundation modifications.

Posts shall be of the type specified, spaced as shown in the plans, set plumb and in line to provide an aesthetically pleasing line of sight. Extreme care shall be taken to insure proper wire rope height. Wire rope shall be placed per manufacturer's recommendations and tensioned immediately after initial installation. Each wire rope rests on nylon "locating pegs" placed in pre-drilled holes in the sides of the line posts. Care must be used during installation to avoid breakage. The pegs will go into the holes easier if the pointed tip of the peg is slightly squeezed together by placing against the hole at an angle, then pressing the tip closed while lightly

tapping with a hammer. Tension shall be rechecked approximately two (2) to three (3) weeks after initial tensioning and adjusted, if necessary. A tension log form shall be completed showing the time, date, location, ambient temperature, and final tension reading, signed by the person performing the tension reading. This log shall be furnished to the Engineer upon completion of work. This form shall also include the WRSF manufacturer's recommended tension table.

4.3 Basis of Acceptance

Acceptance of the WRSF furnished shall be based upon the following:

1. FHWA approval as set forth under this specification, Section 2.0 above.
2. Visual inspection of all items furnished for condition and conformance with dimensional and other requirements.
3. Receipt of manufacturer's certification and material test reports for wire rope, posts, and anchor frames.
4. Determination (at project site prior to installation) of the weight of galvanized coating by means of a magnetic gauge

4.4 Method of Measurement

Unless otherwise specified, WRSF will be measured complete, in place. Measurement will be as follows:

- (a) The length shall be measured to the nearest linear foot (meter), not including End Terminals on each segment. Unless specified otherwise in the contract documents, socket-type posts shall be used.
- (b) WRSF End Terminal units, either WRGT-FL or WRGT-RD, will be measured separately by the unit. One End Terminal unit is required for each end of the WRSF. The contract documents shall specify the type and number of end terminals.
- (c) WRSF Attachment to Guardrail, if specified and shown on the plans, will be measured separately by the unit.

4.5 Basis of Payment

Unless otherwise specified in the contract documents, work completed, measured and accepted as provided above will be paid for at the contract unit price bid per linear foot (meter) for WRSF and per each WRSF End Terminal Unit. The price bid shall be full compensation for furnishing all material; installing all posts, excluders, caps, wire rope and reflectors (if specified); for all grading and compaction; foundation excavation, reinforcement, concrete, backfill as needed and for all labor, equipment, tools, and incidentals necessary to complete the work. Payment will be made under:

<u>Description</u>	<u>Pay Unit</u>
WRSF Socketed Line Post System (4 Rope TL-4)	Linear Foot (Meter)
WRSF End Terminal (WRGT-FL)	Each
WRSF End Terminal (WRGT-RD)	Each
WRSF Attachment to Guardrail	Each
Standard End Terminal	Each

8/13/10



Attachment 7

Tension Log

BRIFEN★USA INC.
WIRE ROPE SAFETY FENCE

12501 N. Santa Fe Ave.
Oklahoma City, OK 73114
Ofc: 405.751.8062



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12501 N. Santa Fe Ave. Oklahoma City, OK 73114

Toll Free: 1.866.427.4336
Office: 405.751.8062
Fax: 405.751.8338
www.brifenusacom

TENSION LOG

Customer: _____

Contract: _____

Fence No.: _____

Length: _____

Direction: _____

DATE	ROPE TEMP*	TIME	KN/LBS	RIGGING SCREWS			
				A	B	C	D

*Using infrared thermometer or similar.