

## MATERIALS AND RESEARCH

Reviewed By:

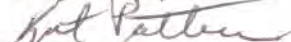


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Prepared By:



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August 22, 2006

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INITIAL REPORT

U 2006-4

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### Brifen Wire Rope Safety Fence

#### **REFERENCES:**

WP – 2005-11

#### **INTRODUCTION**

The following initial report summarizes the implementation and preliminary observations with regards to an experimental highway safety feature known as “Brifen Wire Rope Safety Fence”, a four strand woven wire rope intended to prevent vehicles from veering off a road. This experimental feature is manufactured by Brifen USA Inc. and adheres to NCHRP 350 to test level three. This designation implies that the product can withstand the impact of a vehicle traveling at 60 mph. The purpose of this investigation was to evaluate the woven rope system in comparison to a more widely used three wire rope cable barrier.

Three strand cable barriers were first developed in the 1960’s and found to have several desirable characteristics as compared to other roadside barriers such as guard rail. The cable barriers were less rigid than beam guardrails and concrete barriers which resulted in a reduced force exerted on impacting vehicles. These low tensioned systems can be used in both roadside and median applications and are designed to provide a low cost alternative. Comparatively, the four stand woven wire rope is marketed to provide enhanced levels of safety while providing “substantial reductions in installation, maintenance and repair costs.

#### **PRODUCT DETAILS:**

The general description of the Brifen safety fence provided by the manufacturer is as follows, “The fence consists of four tensioned galvanized steel wire ropes having a top rope height of 585mm (23 inches) and a lower rope height of 490mm (19.3 inches) supported by galvanized steel posts at nominally 2.5m or 3.2m centers. The two (or one) upper ropes are located in a slot in the top of the posts and the two lower ropes are interwoven along the fence between each pair of posts. The ropes are joined and tensioned by means of rigging screws provided at intervals not exceeding 154m. The

ends of the ropes are attached to anchors embedded in the ground or to surface mounted anchors. Where the length of the fence is greater than 1385m intermediate anchors are used. To provide continuity two ropes (i.e. one upper and one lower) of the four ropes are anchored at each intermediate anchor. The connection between each rope and its anchor is designed to uncouple when a vehicle impact occurs in the vicinity of the anchor. The movement of the released rope is restrained by a safety check rope.” Please see Appendix A for an overall view of the fence. It should be noted that the actual height of the top rope is 762 mm (30 inches) and the bottom rope is placed at 533.4 mm (21 inches) from the top of the concrete sonotube. Additionally, the end anchorage detail included in Appendix A does not represent the end anchorage that was installed for this project. The two end anchor terminals were held in place by 6’ x 6’ x 10’ reinforced concrete blocks.

During fabrication each rope is pre-stretched to insure a tight connection and to limit deflection upon impact. According to the manufacturer, the safety fence provides for low decelerations thus resulting in a softer impact with little associated injury. It has been shown to display deflections of 5’ or less during a collision while the standard three cable barrier system typically displays a deflection of 10’ or less. This is most likely due to the fact the three cable barrier system is not pretensioned allowing for additional deflection. Please note that both barriers systems are NCHRP 350 test level three approved.

## **INSTALLATION**

Construction of the Brifen Wire Rope Safety Fence began the week of May 30, 2006. In accordance with the associated Category II Work Plan, WP 2005-R-11, the experimental test section of safety fence was installed on the shoulder of the north bound passing lane of I-89 from MM 56.545 to MM 56.860. Pre installation activities included the removal of underlying substrate for all post hole locations and the application of concrete into round paperboard forms known as “sonotubes”. The sonotubes contained rebar cages in order to support the line of posts required for the fence system. The sonotubes were spaced 10.5 feet apart on average. The spacing decreases to 6.5’ at each end terminal. On June 19<sup>th</sup> the wire and posts were set for erection. (See figure 1) Following the arrival of the representative from Brifen, assembly began on the test site.

The following is a sequence of events from the Resident Engineer, Carl Fielder.

5/30/06 - Project began -augered post holes #26 thru #42. Filled holes with sono tubes to hold open until pour.

5/31/06 - Augered post holes #43 thru #62. Poured post holes #26 thru #53. Used Symons Resi Chem Clear for curing compound.

6/1/06 - Augered post holes #63 to #84. Poured post holes #54 to #78. Excavated side slope for inlet anchor block @ MM 55.545. Set in form that had been prefabricated at Lafayette shop (including rebar) and poured.

6/2/06 - Stripped anchor block forms and backfilled. Augered post holes #85 thru #96. Poured post holes #79 thru #96.

6/5/06 - Augered post holes #97 thru #132. Poured post holes #97 thru #114.

6/6/06 - Augered post holes #133 thru #135 and #1 thru #25. Poured post holes #115 thru #131.

6/7/06 - Augered post holes #135 thru #160. Poured post holes #1 to 25 and #132 and #133. Excavated side slope for outlet anchor block, set form and poured the anchor block.

6/8/06 - Poured post holes #136 thru #160. Stripped anchor block forms and back filled.

6/12/06 - Added borrow material to inlet flare to establish a 1 on 4 slope off the inlet anchor.

6/19/06-Topsoiled, fertilized, limed, seeded and mulched areas around end anchors. Tamped and dressed up areas around posts with aggregate shoulder material. Brifen rep Lyndal Wiseman then instructed the onlookers (Doug Newton D6, Tom Anderson D6, Michael Wilder D6, Carl Fielder Const. and Ken Atkins representing Const.) how to tension the Brifen rail using the equipment supplied thru Brifen. Tensioned to 3600 lbs.



Figure 1 – Brifen Wire Rope Installation

**COSTS:**

The total bid price for this project was \$76,500.00. An amount of \$26,550 was allocated to Traffic officers, traffic control, message signs, aggregate, testing equipment, flaggers and mobilization/demobilization. The remaining \$40,750 was dedicated to the wire



safety fence and the two end terminals. The cost of the cable guard rail was \$25 a linear foot for 1630 LF equaling \$40,750, plus 2 end terminals at \$4600 each.

**OBSERVATIONS:**

During the initial post installation site visit conducted on June 21<sup>st</sup>, the fence appeared to be very highly tensioned and visibly stronger than the standard three rope safety fence which seemed to sag in the middle between posts(See Figures 2 and 3). The referenced three cable barrier is located on the shoulder of the break down lane of I-89 northbound diagonally across from the brifen test site and end at MM 56.53. It was also observed that all four wire ropes were secured at the end terminals. While the three cable wire fence is hung on the front face of the post, the Brifen system weaves two wires around both sides of the posts as shown in Figures 2 and 3.

There were no visible signs of vehicular collisions to the date of this report. Research personnel will continue to monitor the Brifen fence and any reports pertaining to vehicular impacts will be noted and included in the associated report.



Figure 2 - Three Rope Fence



Figure 3 - Brifen Wire Rope

**FUTURE RECOMMENDATIONS:**

Research personnel will observe any future repairs to examine the time and effort required for associated maintenance activities. According to the manufacturer, it will only take 30 minutes to repair an average of five post and reattach pretensioned wires. Additionally, the manufacturer states that the wire rope can sustain multiple collisions prior to repair even if several posts are impacted. The District has been asked to inform Research and Development personnel when vehicle collisions occur. District personnel will be polled as to their observations concerning ease of repair. There is some concern that the metal sleeves will fill with ice making it difficult to remove a damaged post during the winter season. Any problems encountered will be noted and documented. To further assess the performance of the fence, an inspection will occur during 2006 and again in 2007, to examine any damage, including loose wires and breakage to the housing. Manufacturer's claims, any other concerns or problems that may arise will be evaluated during inspections and repairs.

**SUMMARY:**

The Brifen system required an increased level of effort during initial installation when compared with a standard three-cable wire rope fence. The resulting system appeared to be stronger, with less deflection in the cable along its entire length. The initial installation encountered no difficulties, as observed by Construction, Operations or Research staff. A final report to address the performance of the system is scheduled for November 2007.

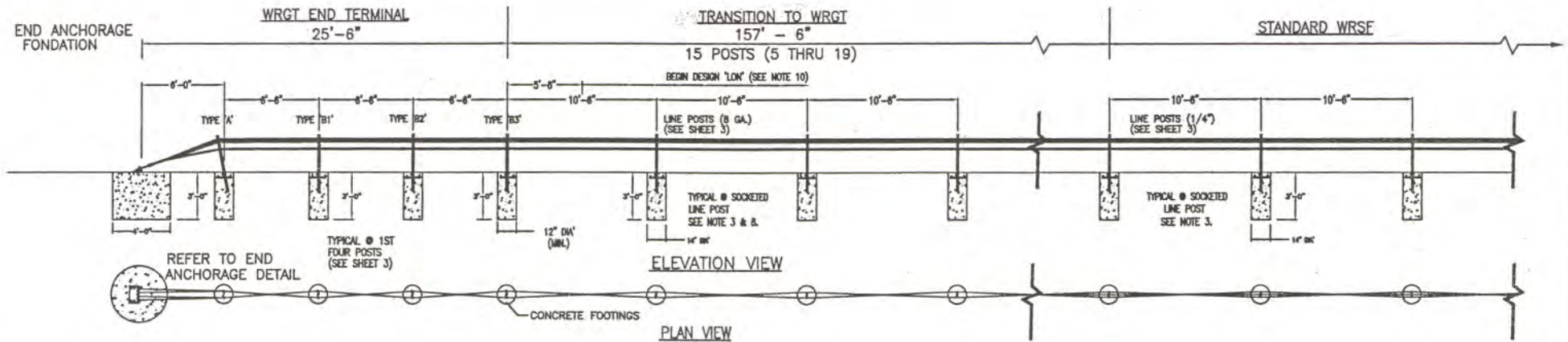
Disclaimer

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“The information contained in this report was compiled for the use of the Vermont Agency of Transportation. Conclusions and recommendations contained herein are based upon the research data obtained and the expertise of the researchers, and are not necessarily to be construed as Agency policy. This report does not constitute a standard, specification, or regulation. The Vermont Agency of Transportation assumes no liability for its contents or the use thereof.”

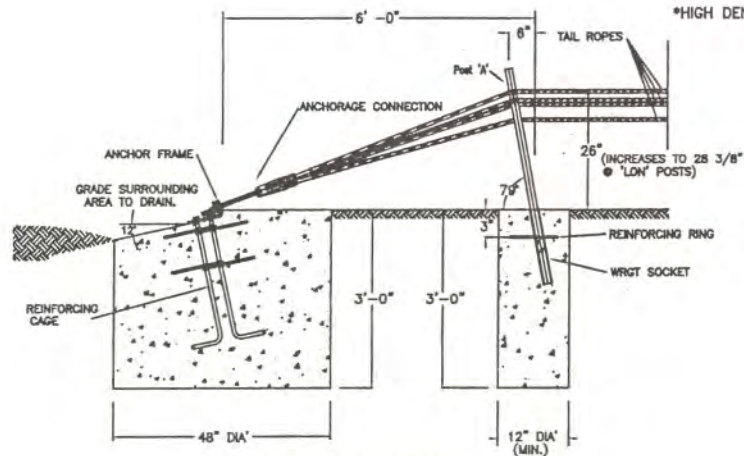
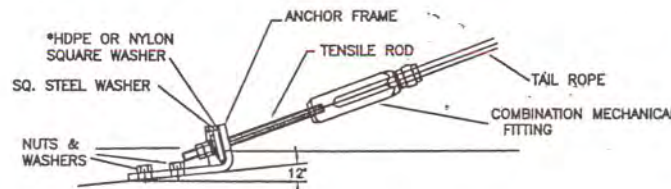
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# Appendix A

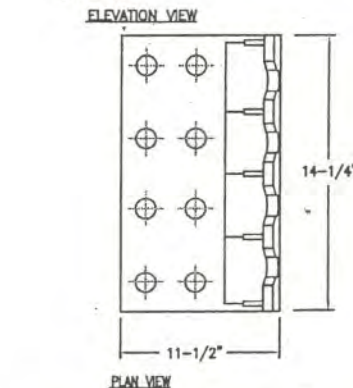


**GENERAL NOTES:**

- WRGT End Terminal meets NCHRP 350, TL 3.
- No maximum limit to length between end terminals.
- All posts are set in concrete sockets unless otherwise specified. If driven posts are specified, see sheet 4.
- Line post spacing may be decreased. For additional information see the manufacturer's product manual.
- End Terminal is NCHRP 350 approved and may be located within the Horizontal Clear Zone. End Terminal flare rate may not exceed 25:1; 50:1 or less is preferred.
- Wire Rope Safety Fence (WRSF) is recommended for installations on slopes of 6:1 or flatter, placed where an errant vehicle can approach on a relatively smooth surface. Some filling and grading may be required.
- WRSF may be installed on either side of the roadway. The radius edge of posts shall be on the approach side of traffic. Line posts shall be ecketed design unless otherwise specified. Also see sheet 3.
- The 15 transition line posts adjacent to WRGT End Terminal do not have top rope slot. All the ropes weave on either side of the posts until the first line post with a slot (post 20). See sheet 3.
- Anchor Frame, Reinforcing Cage, Connection Hardware, Combination Mechanical Fitting, posts type A and B, WRGT Sockets, Pags, Excluders, plus tail rope lengths are supplied as a package. Reflective sheeting can be supplied if specified.
- 'LON' begins 5' -6" from post 4 for calculating design length of need.



**END ANCHORAGE DETAIL**  
SEE NOTE 9.



**ANCHORAGE CONNECTION DETAILS**

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

<b>BRIFEN★USA INC.</b>			Customer:		
Revisions		Date			
No.	Date	By	Drawn By		Scale
1.	4.30.04	AW	Aaron Wells		None
2.	5.03.04	AW	Date 4.16.04		
3.	5.05.04	AW	General Layout		
4.			using WRGT (NCHRP 350) Anchors		Sheet No.
5.			Dwg. No. WRSF-04-001e		1 of 5