Report No. CDH-DTP-R-83-9

SELF-RESTORING BARRIER (SERB) GUARDRAIL DEMONSTRATION PROJECT NO. 939

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Initial Report
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16. Abstract

This initial report covers the construction of Demonstration Project No. 939. The location of guardrail is at MP244.7 on Interstate 70, west of Denver, Colorado. There is a total of 1000' of new guardrail consisting of 300' of modified thriebeam guardrail, 500' of SERB, and 200' of modified thriebeam guardrail on the westbound shoulder. The guardrail site is near the bottom of a 1.9 mile, 6.2% downgrade, on a left curve of 760' radius.

The SERB guardrail was installed using 10" x 10" x 10' wood posts with a post spacing of 6' - 3", and a beam support spacing of 12' - 6".

The modified thriebeam guardrail is used as a transition from the standard w-beam guardrail to the SERB guardrail, and back to the w-beam guardrail.

Problems encountered in the installation was the difficulty in driving the wood posts. The Post Driving Equipment (PDE 1500) was not designed to handle 10' posts, and the soil conditions consisted of large boulders in the fill areas which caused erratic driving of the wood posts.

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INITIAL REPORT
SELF RESTORING BARRIER
(SERB)

INTRODUCTION

The self-restoring barrier (SERB) guardrail was developed by Southwest Research Institute for the Federal Highway Administration (FHWA). The SERB is designed to be a flexible guardrail that will absorb or attenuate the impact forces of most collisions, and will return to its original position with little or no maintenance or repair, yet will be capable of containing and redirecting buses and trucks. Transportation Research Record 796 summarizes the testing of a prototype guardrail.

The FHWA's Demonstration Projects Division initiated a pilot program to install and evaluate SERB barriers under actual highway conditions. Colorado was selected as one of four highway agencies that agreed to participate in the program.

In August 1982 the Colorado Department of Highways (CDOH) entered into an agreement with the FHWA to construct and evaluate a SERB installation on Interstate 70 west of Denver. Under the agreement the FHWA provided 500' of thrie beam guard rail for transitions sections to the SERB, and would reimburse the Colorado Department of Highways for material and construction costs in the amount of $30,000 The CDOH would absorb the cost of design, construction supervision and evaluation of the project.

SITE SELECTION

The CDOH made a survey of several candidate sites and a site at the bottom of Floyd Hill on I-70 west bound was selected and approved for the installation. This site has an accident history of guard rail impacts and one fatality when a tractor trailer tanker went thru the guard rail and into Clear Creek below.

ACCIDENT HISTORY

5-23-81 One fatality, semi-truck at estimated 70 MPH went through guard rail into Clear Creek.

1-21-82 Non-injury guard rail strike, passenger vehicle.

4-22-82 One person injured, runaway truck.

3-26-83 Non-injury guard rail strike.

MAINTENANCE HISTORY

5-23-81 Replacement of approximately 190' of guard rail at $11/ft=$2090
Other minor routine maintenance such as straightening posts and w-beams.

SITE LOCATION

The site of the Self Restoring Barrier (SERB) is approximately 30 miles west of Denver Colorado on Interstate 70. The location is near MP 244.7 on the westbound lanes. This site is on a downhill slope of 6.2% grade, and is at the lower end of a 1.9 mile downhill grade of about 6%. The guardrail is on the outside of a left curve of about 760 foot radius, and with a superelevation of 10° (see figures 1 and 2). The median barrier is a type 4.

The difference in elevation of the ends of the SERB is 31 feet, and the shoulder grading is irregular with the location of the posts usually well below the roadway grade. This causes a loss of up to 15 inches of buried depth on the posts.

The highway is on the east slope of a cut and fill alignment of the road and has exposure to the sun for most of the daytime period. The fill soil consists of very rocky material, including very large boulders.

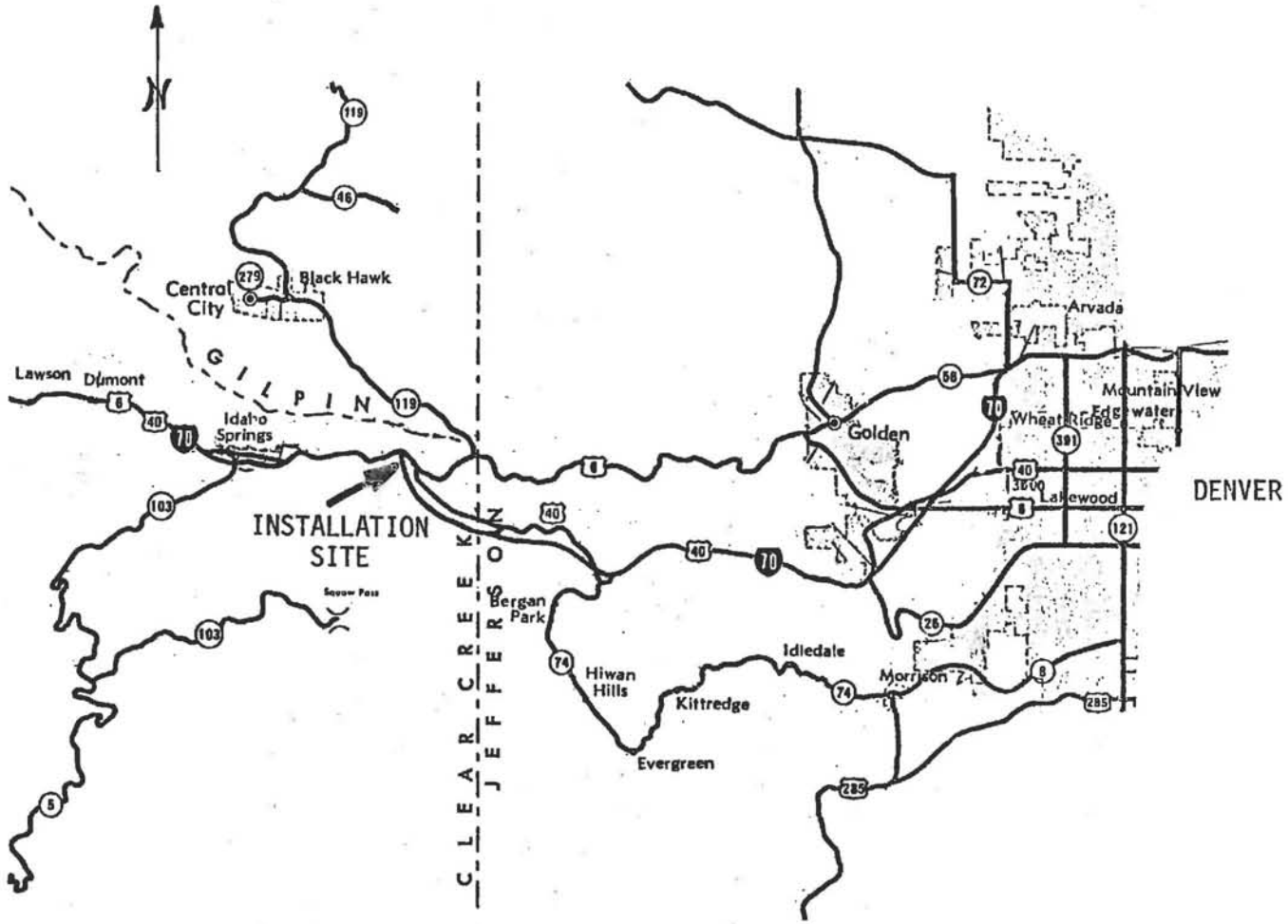
Vehicle Data

Average Daily Traffic:	20,400	
Vehicle Mix:	94.1%	Passenger & Light Trucks
	3.2%	Trucks 2-3 Axle
	2.7%	Trucks, Heavy 3-5 Axle
Speed:		
Passenger & Light Trucks		50-60 mph
Trucks		10-20 mph

Final Barrier Design

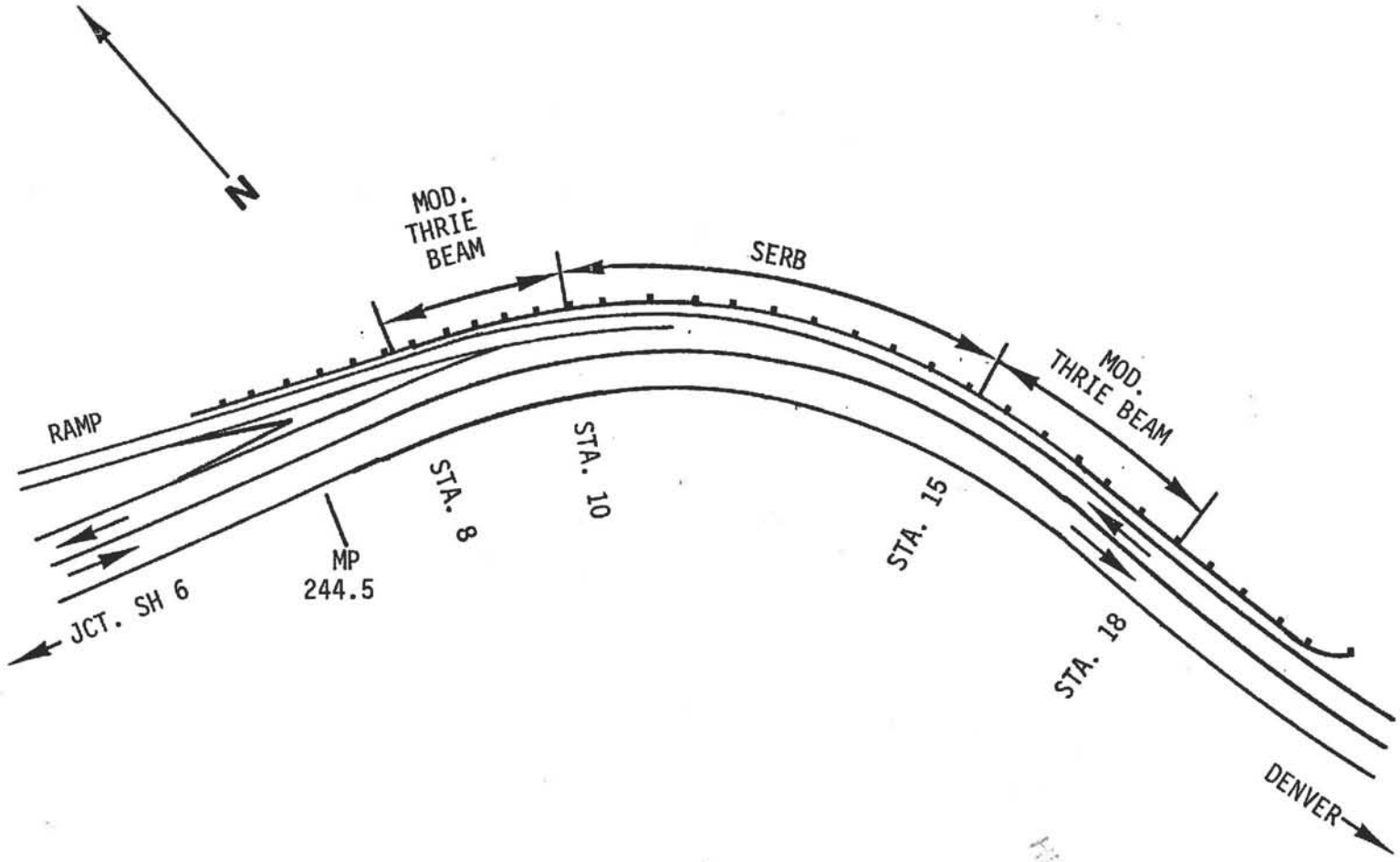
The total installation is 1000' with a 300 foot length of modified thriebeam guardrail to transition from the w-beam guardrail to the SERB, a 500 foot length of tubular thriebeam, SERB, then a 200 foot length of modified thriebeam to transition from the SERB back to the w-beam guardrail, Figure 2.

The SERB installation was constructed using 10" x 10" x 10' wood posts set at 6'-3" spacing. Barrier support hinges are mounted on every other post at 12'-6" spacing. The hinge spacing at the transition ends is 8"-4" spacing, leading to the cable anchoring posts.



COLORADO SELF-RESTORING BARRIER LOCATION

FIGURE 1



I-70 AT FLOYD HILL

SELF RESTORING BARRIER SITE

FIGURE 2

DESIGN MODIFICATIONS

The tubular thrie beam sections received from the supplier, Anderson Safeway Guard Rail, were fabricated for 8'-4" pivot bar spacing. Thus, the supplier provided 19 sections of Type I, and 19 sections of Type II tubular thrie beam guard rail. Each section was 12'-6" in length. Instead of redrilling pivot bar strap mounting holes in 19 sections of the rail, it was decided to cut one section of guard rail to proper length, and drill splice bolt holes in the cut ends. The short piece was inserted at a point where the Type I and Type II guard rail joined. The longer piece was placed at the down hill end of the SERB just before the transition section of tubular guard rail. This arrangement allowed the SERB to fit the post spacing. Photos 17 and 18 show the cut sections installed in the guard rail.

The plans used allowed several post size and spacing options. The 10" x 10" x 10' posts at 6'-3" spacing was selected. In view of the problems encountered in handling and driving the 10" x 10" posts, the use of 8" x 8" x 8' posts at 4'-2" spacing would have facilitated the installation of the barrier and would provide adequate strength to the barrier.

No other design modifications were necessary. The radius of curvature presented no problems using 12'-6" sections of tubular thrie beam and straight section splice pieces.

On recommendation of FHWA the "Local beams" at the transition section were not installed and the steel end posts were not set in concrete.

CONSTRUCTION PROBLEMS

A major installation problem was placing the 10"x10"x10' wood posts. A PDE 1500 post driver was the largest available to the contractor. The fill area where the posts were to be set contained rocks and boulders of various sizes. The PDE hammer was used to pre-punch a pilot hole about 5' deep. Then the post was set under the hammer and the post was pounded down. The initial few posts were driven satisfactorily. Other posts were stopped or skewed when large boulders were encountered when driving the posts. See photo 16 of sample boulder removed from a post hole. Predrilling of the post holes was considered, but because of the large boulders in the soil and the loose fill material this was not attempted. Skewing of posts resulted in alignment offset of up to 4" between post center line and pivot bar mounting holes.

COSTS

The construction of the barrier installation was by the Sanchez Construction Company, Englewood, Colorado, under an open end purchase order.

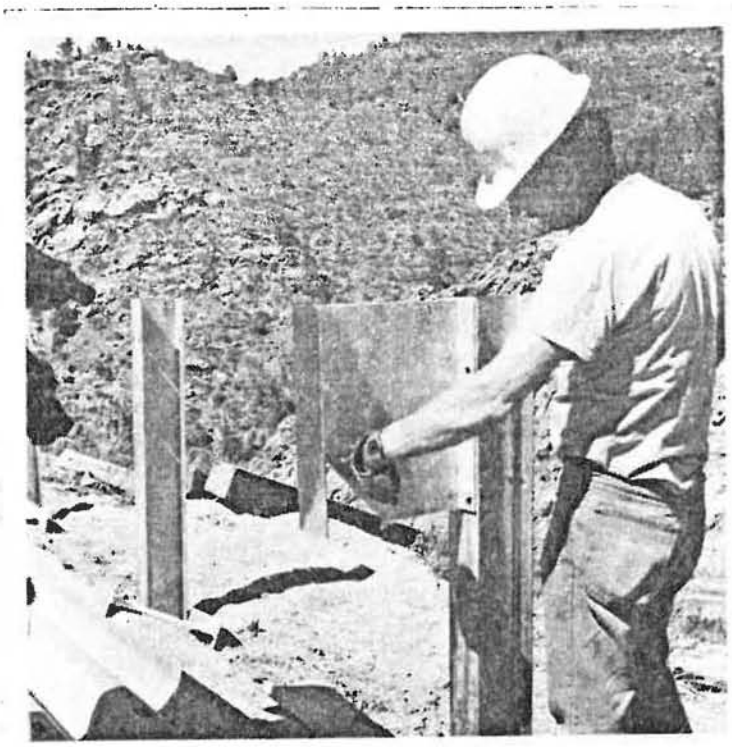
The FHWA provided 500' of thriebeam at no charge.

The cost of material for the SERB includes end anchorages, transition sections and hardware.

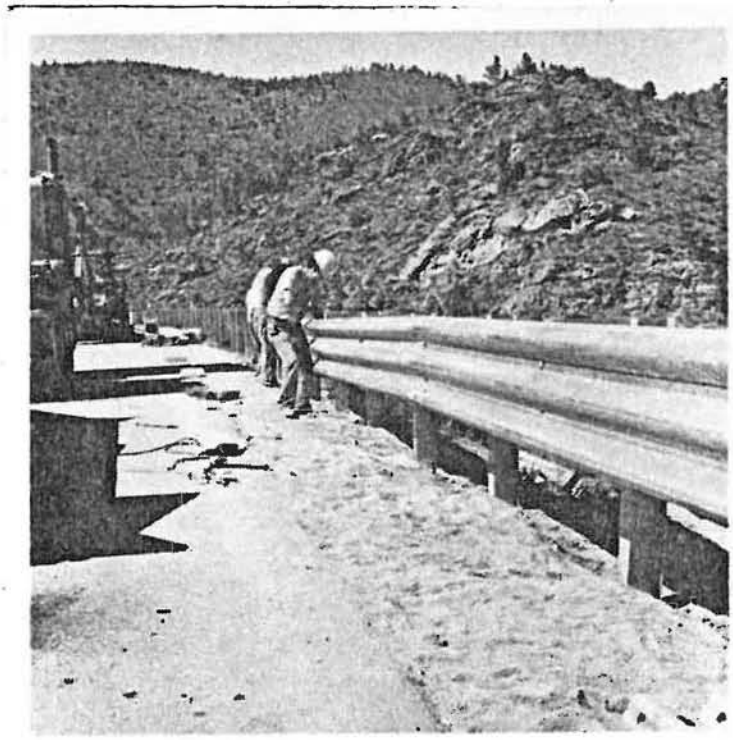
Material:		
SERB, 500'	$17,783	
Modified Thrie Beam, 500'	4,429*	
Total	$22,212	$22,212
*Does not include cost of Thrie beam		
Installation:		
Labor, 455 m/hr. @ 12	$ 5,460	
Hand Equip. 16 days @ 350	5,600	
PDE Post Driver 10 days L.S.	7,195	
Total	$18,255	$18,255
Total Project		$40,467
Project Cost Installed		$40.47/ft.
Project cost including cost of thrie beam		$43.10/ft.
Estimated Cost of 500' SERB		$67.45/ft.
Estimated cost of 500' Modified thrie Beam		$18.80/ft.

APPENDIX A

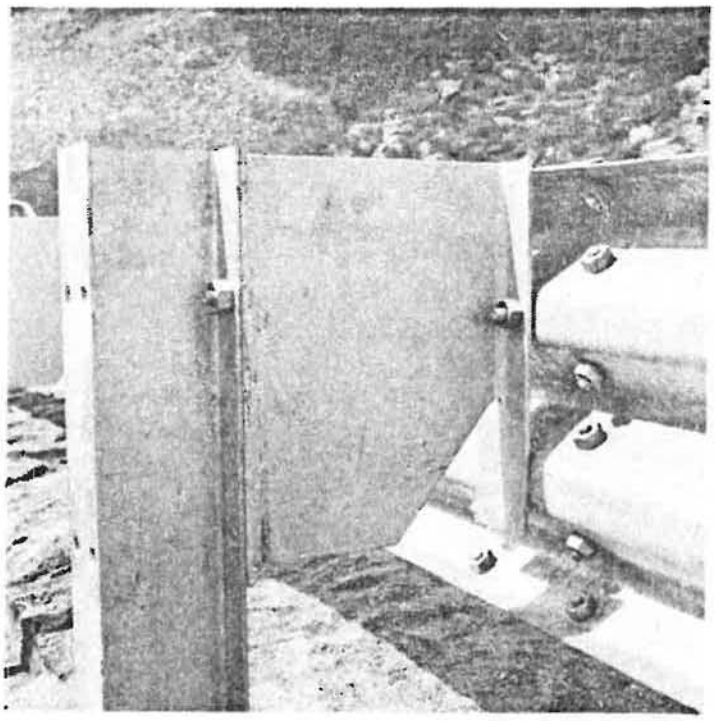
Photographs of the installation of the modified Thrie-beam guard rail and the SERB guard rail.



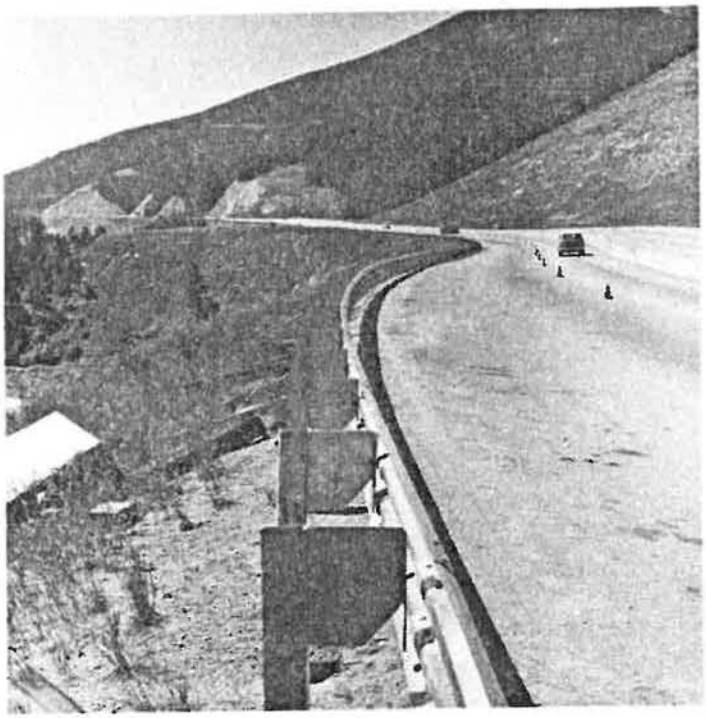
5. M 14 X 17.2 Spacer is attached to the W 6 X 9 steel post for the modified thrie beam guard rail.



6. The thrie beam is attached to the spacer. One 5/8 in. bolt is used.



7. Thrie beam splice and attachments for the modified thrie beam guard rail.



8. Completed 300' portion of the modified thrie beam guard rail.

9. PDE 1500 post driver was used to set the wood posts for the SERB.

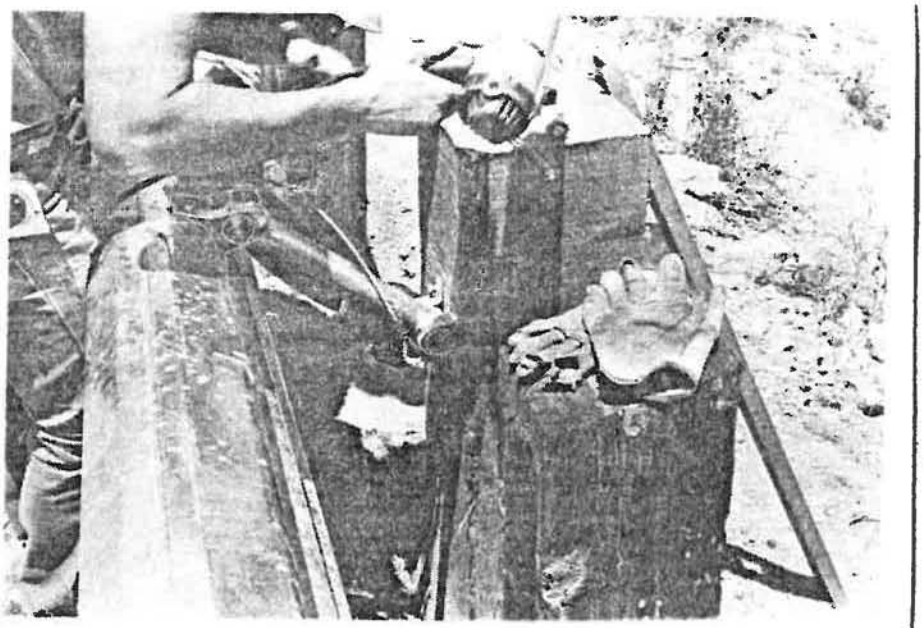
10. The PDE hammer was used to punch a pilot hole about 5' deep to facilitate driving the wood posts.

11. The post driver is shown driving a wood post. Due to damage to top of post, subsequent posts were driven using a steel cap on the top of the post.

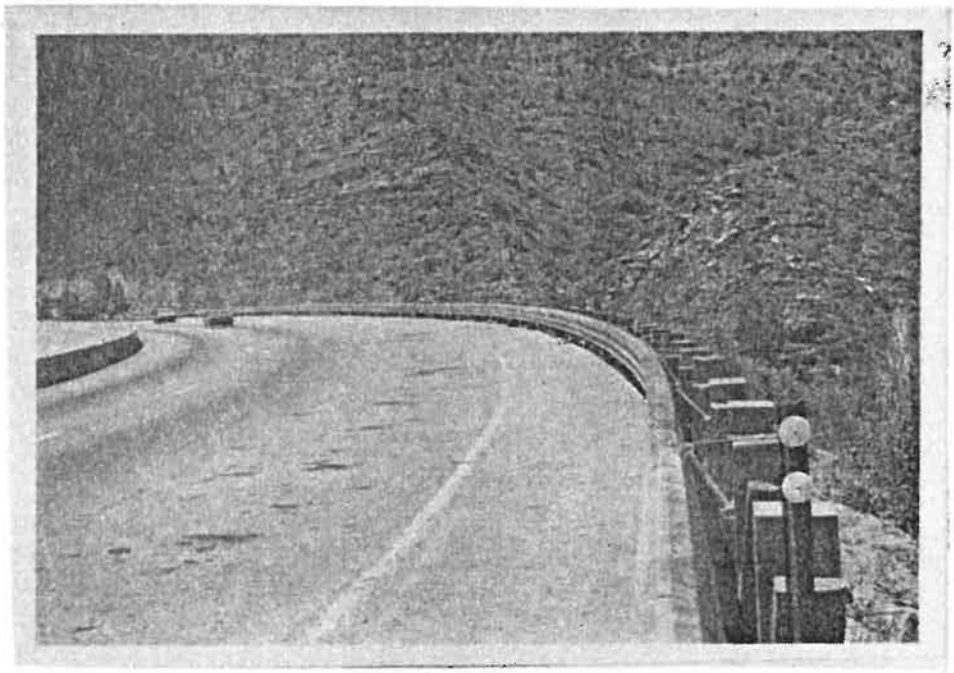
12. View showing equipment in use at site. The back hoe is used to lift the wood posts and position them under the post driver hammer.

13. Back hoe being used to support tubular thrie beam as the beam sections are being joined.

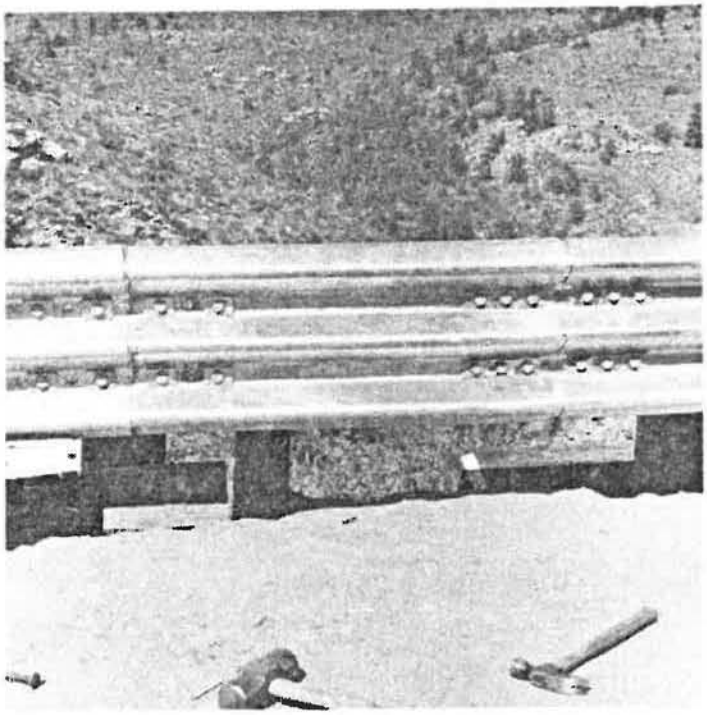
14. Straight internal splice sections were used to connect the tubular thrie beam sections.



15. The pivot bar is shown being attached to the wood post using lag screws. The support cable will be attached last to hold the tubular thrie beam at the proper height.

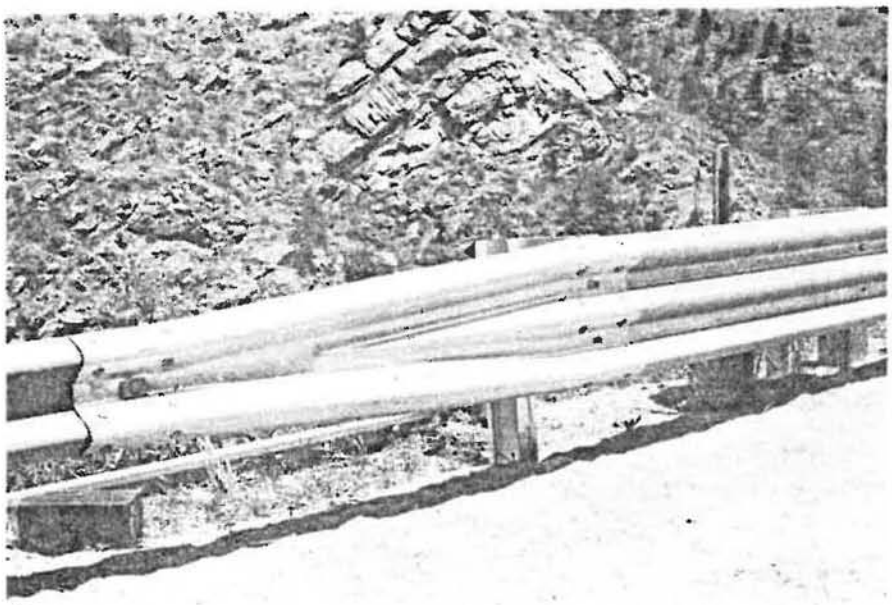


16. The completed SERB portion of the installation. The pivot bars are connected to every other post.

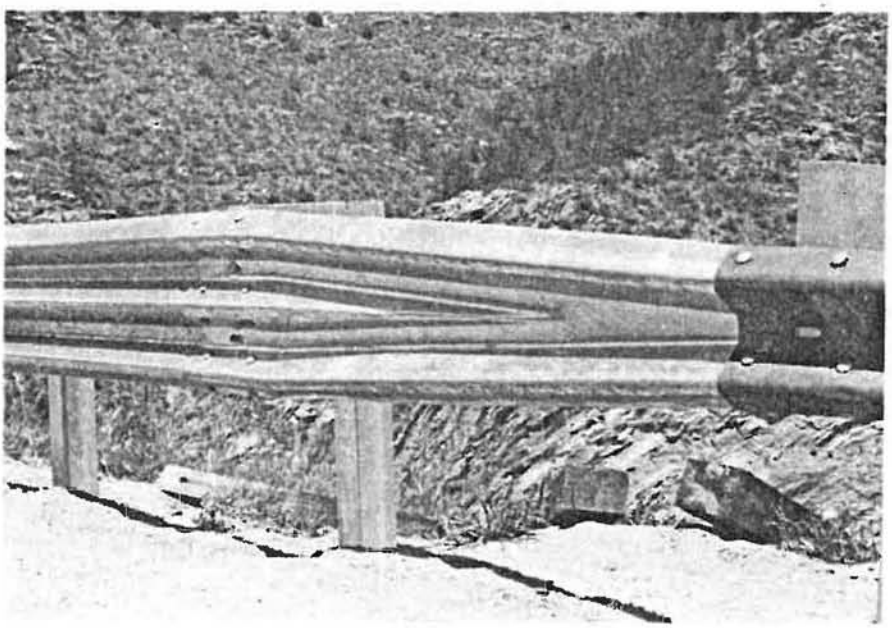


17. This is a 3' 10" section of tubular thrie beam cut to fit the space caused by use of Type I and Type II tubular thrie beam for this installation.

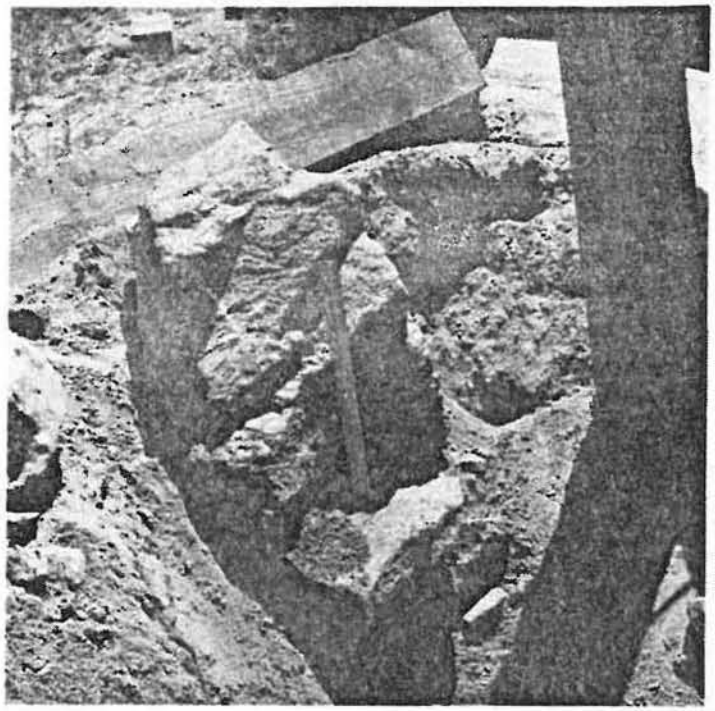
18. This is the 8' 8" piece of the cut section of tubular thrie beam placed at the transition end of the SERB.



19. This is the beginning transition piece from W-beam to thrie beam guard rail.



20. This is the ending transition piece from the thrie beam to W-beam guard rail.



21. A sample boulder occuring in the shoulder area where posts were being driven. The scale shown is 18" long.

REPAIR SPLICE FOR THE SERB

In the initial installation of the SERB, the connection of the tubular thriebeam sections progresses form one end to the other. The insertion of the splice piece into the in-place section and the slipping of the next section over the splice piece makes the installation progress easily.

In the case where a section of tubular thriebeam must be replaced and to eliminate the necessity of dismantling a portion of the SERB, a splice method is shown as used in the installation.

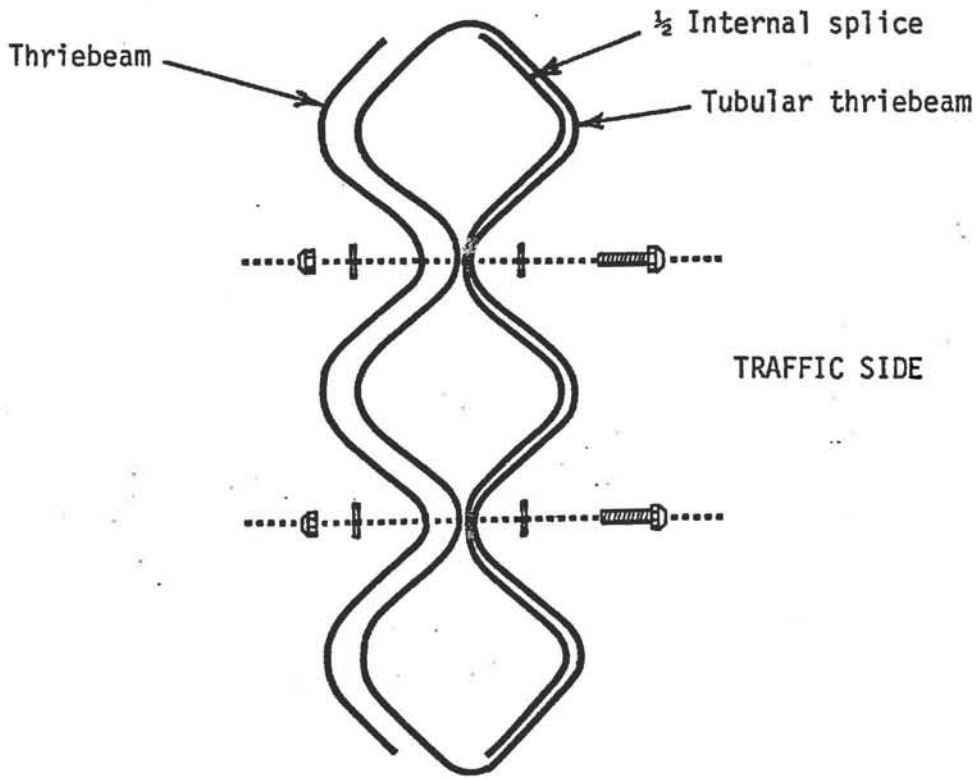
One end of the new tubular thrie beam section is connected in the usual manner using a normal internal splice piece. The remaining connection is made using one-half of an internal splice and a two foot section of thrie beam. The cross section sketch on Page B-3 shows the position of the components in place.

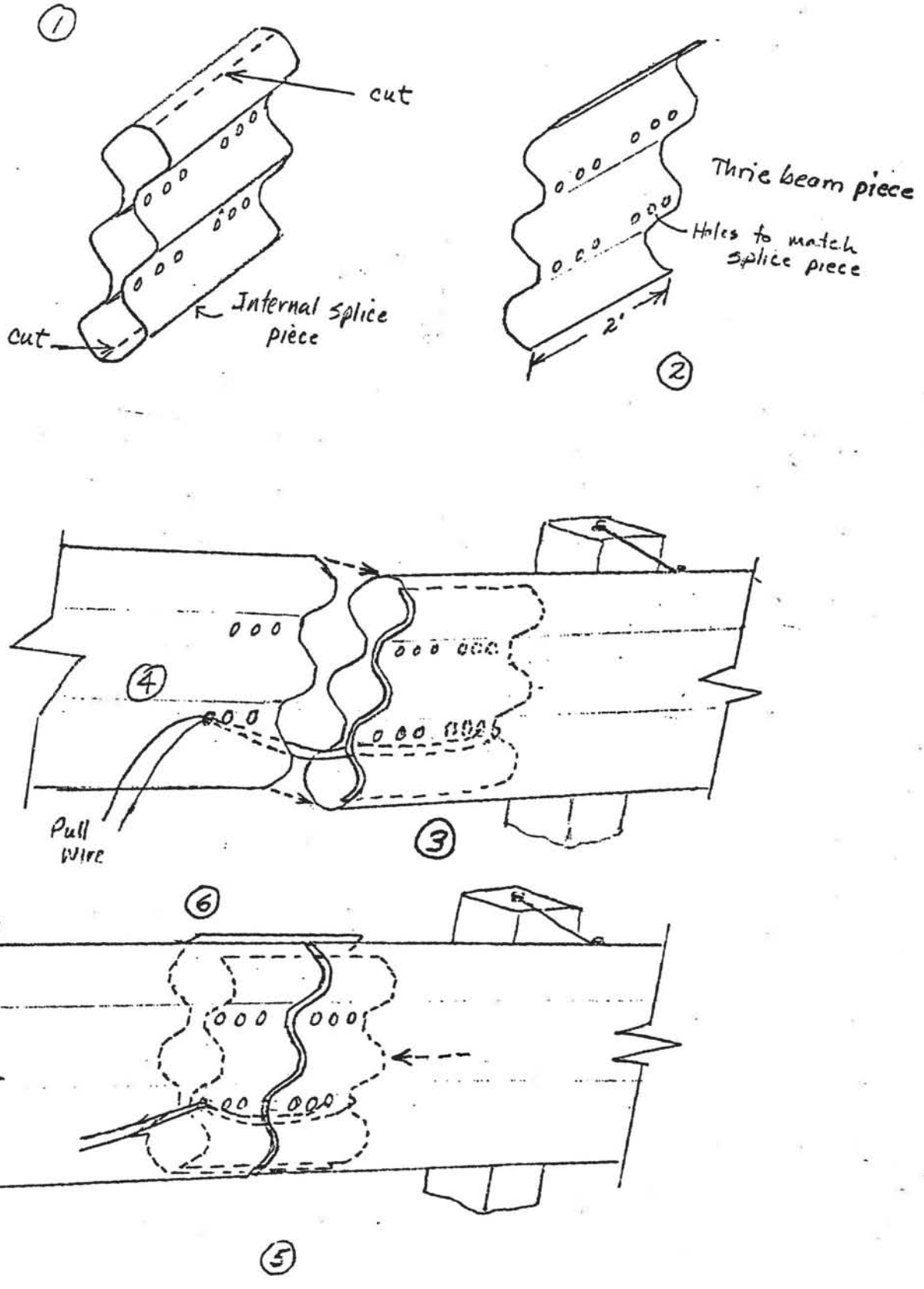
(The circled numbers indicate sequence sketches on page B-4).

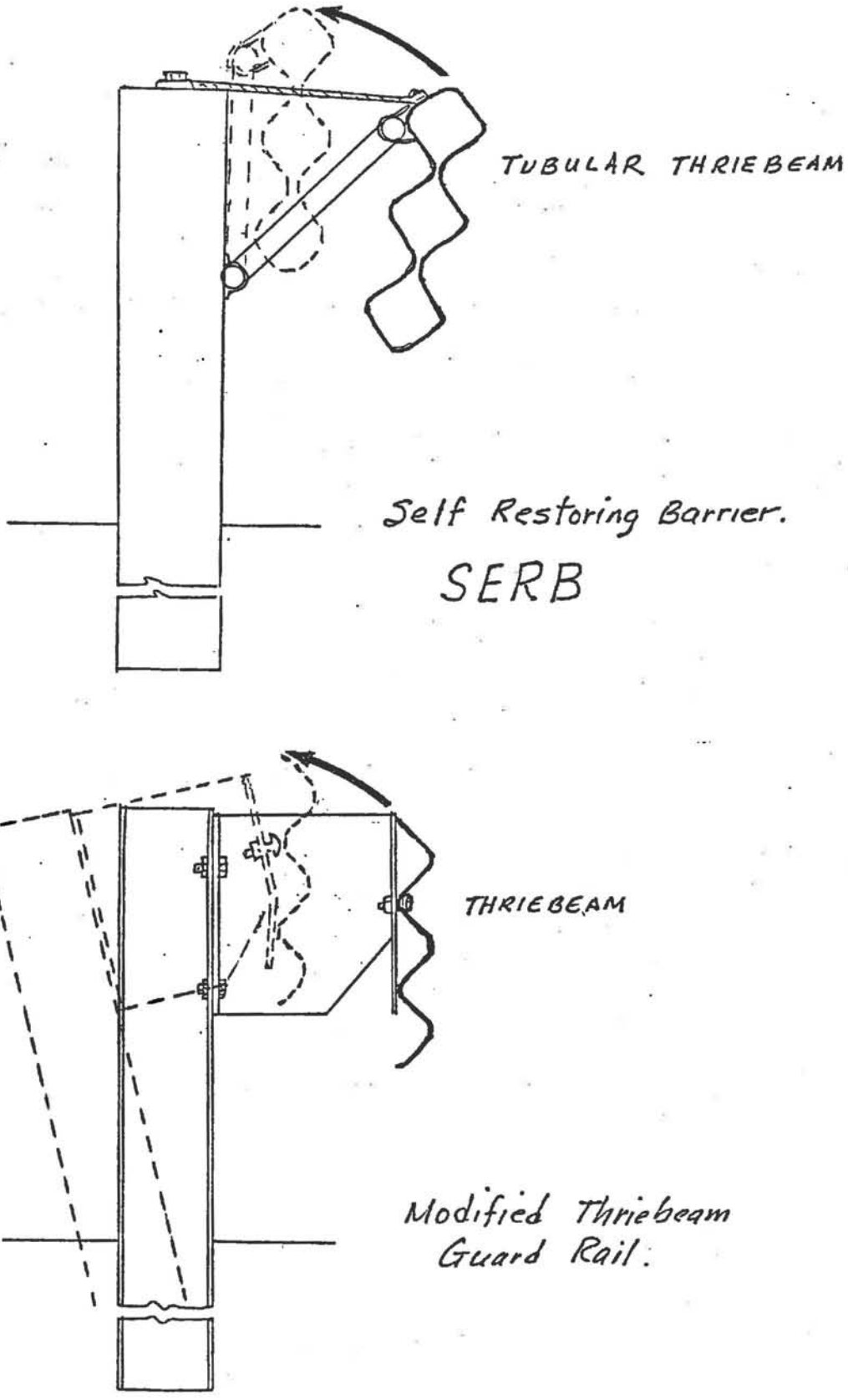
(1) A straight internal splice piece is cut at the top and bottom and one piece (1/2 splice) is used for the internal part of the splice. (2) A two foot section of thrie beam, with connecting bolt holes to match the splice piece is used for the back piece of the splice.

To complete the splice, (3) the internal piece is inserted completely into the fixed section of SERB with a length of wire loop attached. (4) This wire is led back through the new section of tublular thrie beam and out through a connecting

Proposed splice for repair of SERB




1
cut
cut
Internal splice piece
Thrie beam piece
Holes to match splice piece
2'
2
4
Pull Wire
3
6
5



Flexing action of the "Flexable Guardrail installation"