5124

NEVADA

DEPARTMENT OF TRANSPORTATION

MATERIALS

DIVISION

HEADLIGHT GLARE SCREEN PANELS
COLD TEMPERATURE PERFORMANCE
IMPACT TEST

by

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I. OBJECTIVE:

The objective of this study was to examine and evaluate the material properties performance of various weathered glare screen panels, when impacted at low temperatures. The various materials tested were fiberglass, a glass fiber with marble reinforced thermosetting composite, polyurethane and styrene.

The intention of this impact test is to examine the physical reaction, in cold temperatures, of various climatic exposed materials. Material characteristics examined were flexibility, durability, brittleness, and the affects of ultraviolet exposure, if any, on material performance. Other areas of examination were installation or replacement time and necessary equipment. Reducing traffic exposure time to installation crews, increases worker safety and saves manhours.

II. BACKGROUND:

The Materials Division received a request, from management, to design and conduct an impact test of selected glare screen products. The test was to include high speed impacts, low temperatures, on climatic conditioned "in-service" products.

An evaluation team was formed to observe, inspect and record all data after each impact. The evaluation team consisted of Joe Crowdis of the Maintenance Division in District II and Dick Moore of the Materials Division and the author served as Principal Investigator.

A literature search revealed several studies have been

conducted on glare screen panels. But in most of the studies, the objective was to evaluate the effectiveness of the panels in reducing glare from oncoming traffic. An impact test was conducted in New Mexico; however, the criteria, in the New Mexico impact test, was at lower speeds and no temperature factor was included.

The four products tested were Carsonite, Safe-Hit, Glasform, and Syro Steel. Following is a brief description of each product impacted:

III. PRODUCT DESCRIPTION:

CARSONITE

The **Carsonite** Modular Guidance System consists of eight, 6" wide factory installed blades, manufactured from a glass fiber and marble reinforced thermosetting composite. The blades are attached perpendicular to a 10′ rail. The pre-assembled 10′ sections are mounted to the concrete barrier rail with three stud-type expansion anchors. The 10′ sections are installed according to the following manufacturers instructions, as shown below in Figure 1.

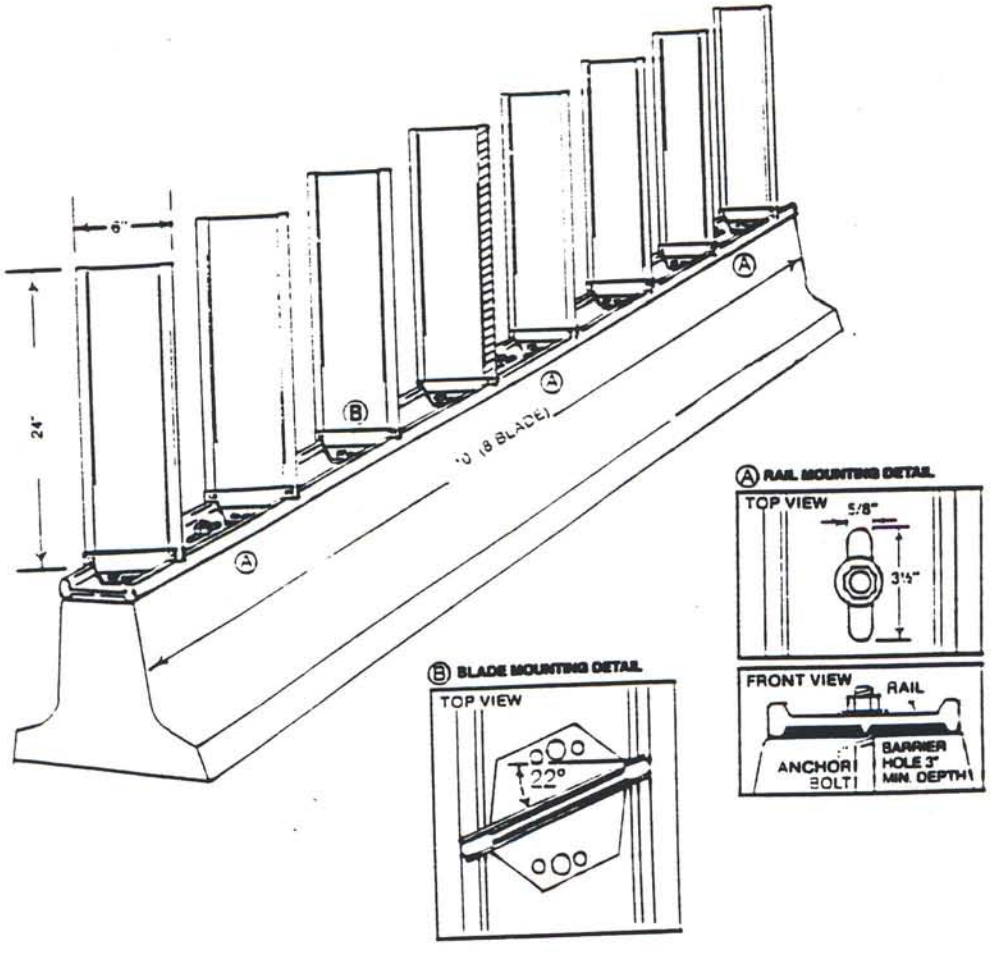

Figure 1

SYRO STEEL

The **Syro Steel** product, the Glarefoil Runner System has five Glarefoil blades, constructed of polyurethane. The cross section of the blades are an ellipsoid, 8.7" long by 2.5" wide. The blades are pre-mounted on a 9.67' runner with two 3" long by 1" wide carriage bolts, that sandwich the panel base to the mounting surface. The individual blades are mounted perpendicular to the surface, at a 45° angle, with 24" center to center blade spacing, as shown in Figure 2 below. The pre-assembled runner is attached to the concrete barrier rail with 4 expansion anchor studs.

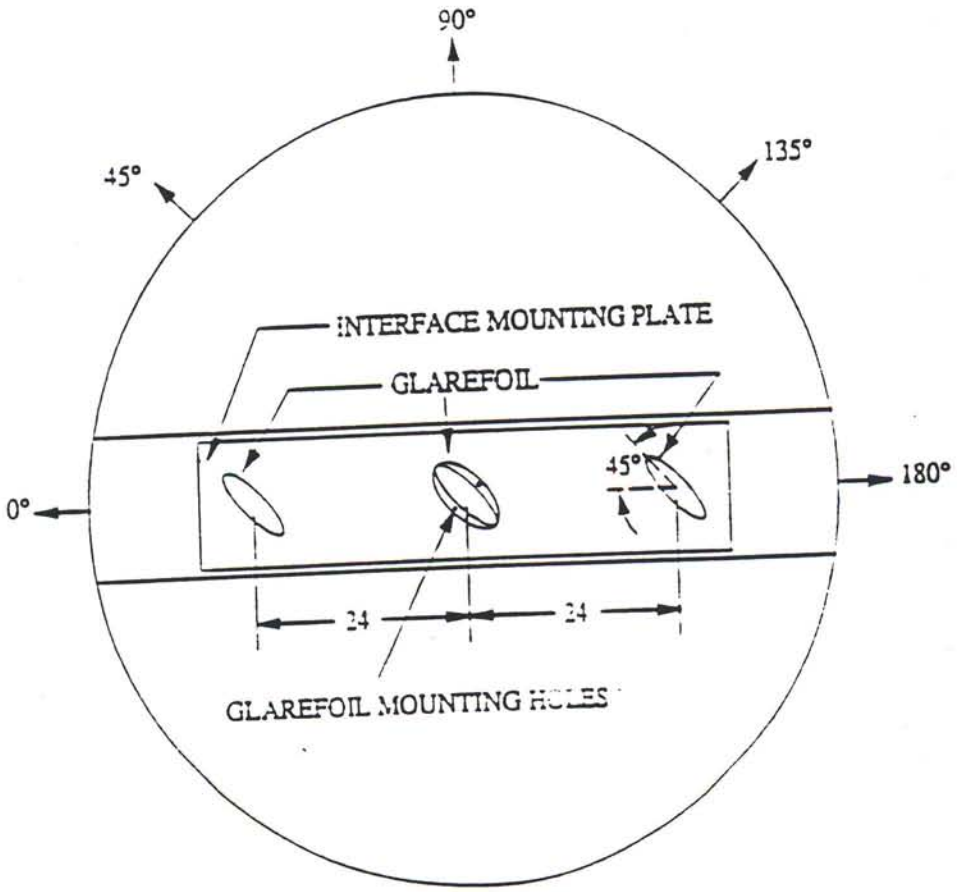

Figure 2

GLASFORM

Glasform's Glareform Screen System is a modular design with individual 6" wide vertical fiberglass blades, mounted in a cantilever fashion, to a singular continuous 9.83' base rail. Each 9.83' base rail is pre-assembled with 10 blades, and has 3 stud type anchors for concrete barrier rail attachment, as shown in Figure 3 below. The blades are perpendicular and are mounted at a 90° angle, to the base rail.

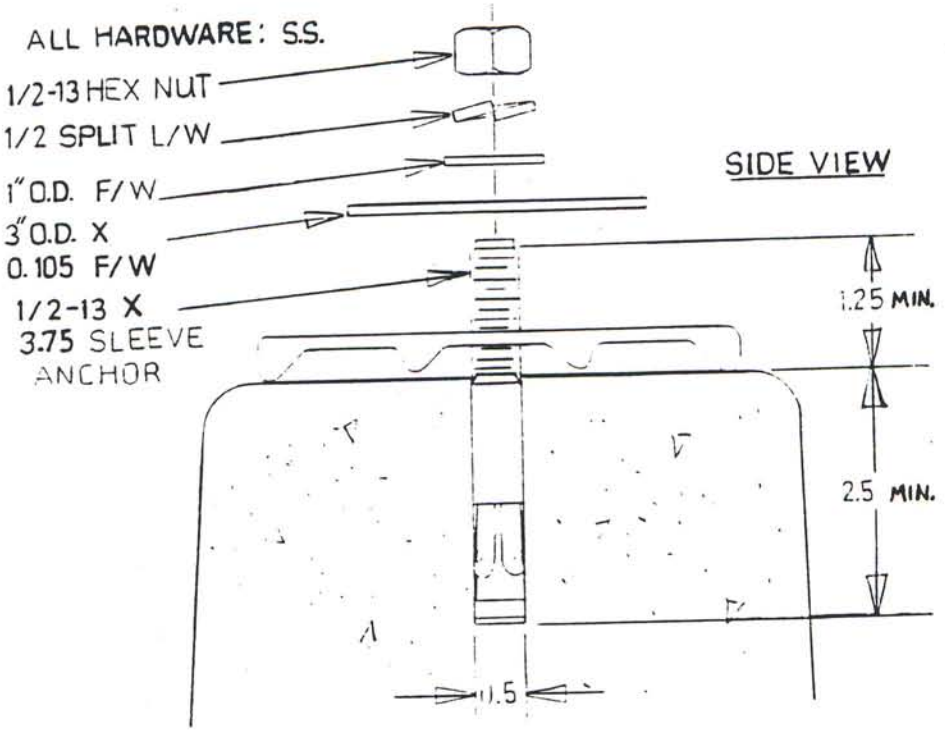

Figure 3

SAFE-HIT

Safe-Hit's Anti-Glare Shield System consists of 24" sub-modules, that join together to make up the desired length, a 4 3/4" diameter blade base, and five, 9" wide styrene blades, with flared corners. The recommended anchor system consists of five anchor bolts, one for each blade, per 10' section. The blades are perpendicular to the base, as shown below in Figure 4.

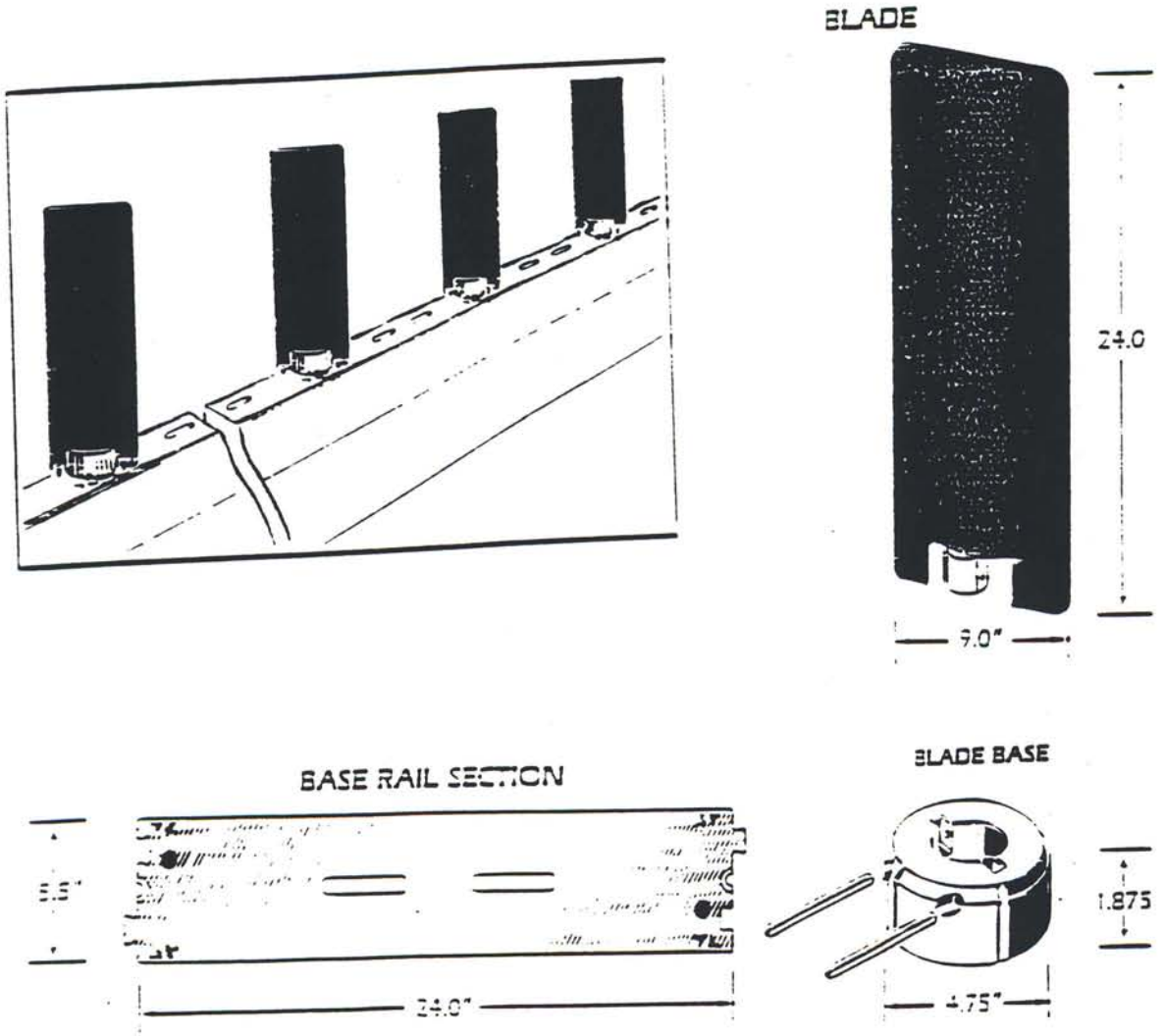

Figure 4

IV. THE TESTING PROGRAM:

The intention of this test was to evaluate the reaction and performance of the individual panel materials, when subjected to impacts, at low temperatures. The test procedure was not designed to simulate possible major impacts, that may occur under normal "in-service" conditions. No attempt was made to reflect the performance of the products, in their intended function for reducing headlight glare.

The impact test was prepared and designed by Materials Division personnel after discussion of objectives, criteria for performance, and with the approval of management.

A. PREPARATION:

Preparation for the test required a joint effort between the Materials Division and District II, utilizing the efforts of Maintenance Crew No. 253, to remove and re-install four glare screen products. To insure there were no fractures or damage, which would adversely affect a fair test, an examination of the condition of the in-service products was conducted by the Principal Investigator.

The selection and removal of the "in-service" product units required traffic control, for a typical one lane closure, in three locations. Three of the products were in-place in Reno; Syro Steel and Glasform were in-place on I-580 and Safe-Hit was on I-80. The Carsonite product was on US-395, between Reno and Carson City. Prior to the February 17th impact test, all four products had been in service and exposed to climatic conditions, typical to the Reno

area, from 9 to 16 months.

In the March 5th impact test, the Safe-Hit, Syro Steel and Glasform products were all removed from the same locations mentioned above. However, one of the 10' sections of Glasform was damaged on route to the test site. The maintaners replaced the section with one from the Reno yard that had been stored for over a year. There were no Carsonite products available from the same location, so Carsonite supplied NDOT with test samples and documentation for 12-15 month climatic exposure time.

Portable concrete barrier rail was placed at the south end of Washoe Valley, on the frontage road, adjacent to US-395. Placement of the barrier rail was on the paved shoulder, to prevent any rotation or displacement of the barrier rail. On February 11, 1993, all the products were removed from the locations mentioned above, and re-installed on the barrier rail at the test site.

B. INSTALLATION:

Safe-Hit's 24" sub-modules were joined together, to the desired twenty foot length and used as a template to mark locations for drilling of the anchor holes. With this system, it is necessary to drill the exact location of the ten blade base rail connections. The joined sub-module sections, forming the base rail, are then placed on top of the barrier rail. The blade base assembly is placed onto the base rail and is aligned for proper bolt insertion through base and rail. After anchoring the blade base and the rail, the blades are then placed into the proper orientation grooves on the base rail. Roll pins on the blade base

assembly are then driven through aligned holes on the blades.

The installation of Carsonite and Glasform, per each nominal 10′ section, requires <u>three</u> holes drilled in the concrete barrier rail and Syro Steel requires <u>four</u>. The base rail of these three products are pre-formed with slots for the anchor mounting and no additional assembly is required.

All the products were installed at the calculated sight cut-off angle of 22°, required in NDOT specifications. For the blade placement formula, see Figure 5.

O_s = 22°

O_b = Angle of Blade Placement on Barrier (0° - 52°)

W_b = Width of Glare Blade

D = Distance between glare blades to maintain cut-off angle.

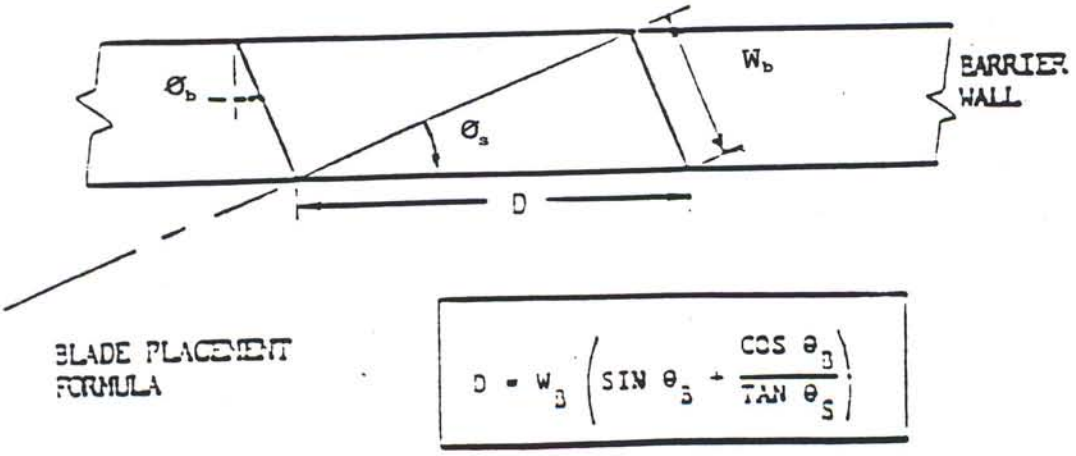

Figure 5

V. TEST CRITERIA:

Twenty feet of each product was installed in consecutive sections on portable concrete barrier rail. A 2 1/2 ton testing vehicle was equipped with a retractable 3 inch diameter metal rod, 12 inches above the top of the barrier rail (See Figures 6 and 7). This size truck was selected to insure the continuous momentum of 45 miles per hour impact speed, throughout the entire length of the test. (See pictures 1 and 2) The material properties of the panels may perform differently in cold temperatures; therefore, the target temperature was set at 25° F, or below. The number of impacts was to be determined by the evaluation team, based on the results of the initial impact.

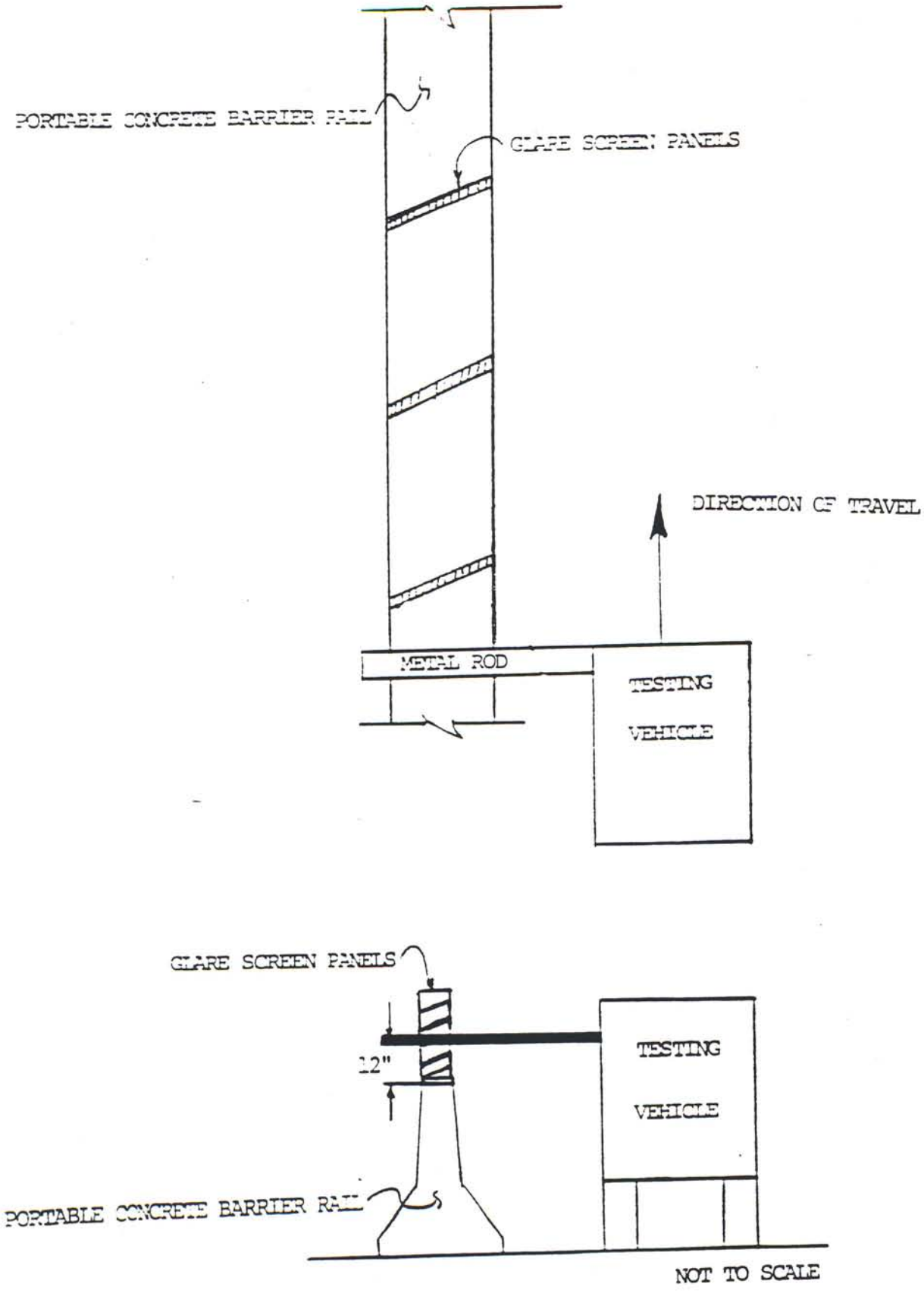
PORTABLE CONCRETE BARRIER RAIL
GLARE SCREEN PANELS
DIRECTION OF TRAVEL
METAL ROD
TESTING
VEHICLE
GLARE SCREEN PANELS
12"
TESTING
VEHICLE
PORTABLE CONCRETE BARRIER RAIL
NOT TO SCALE

Figure 6

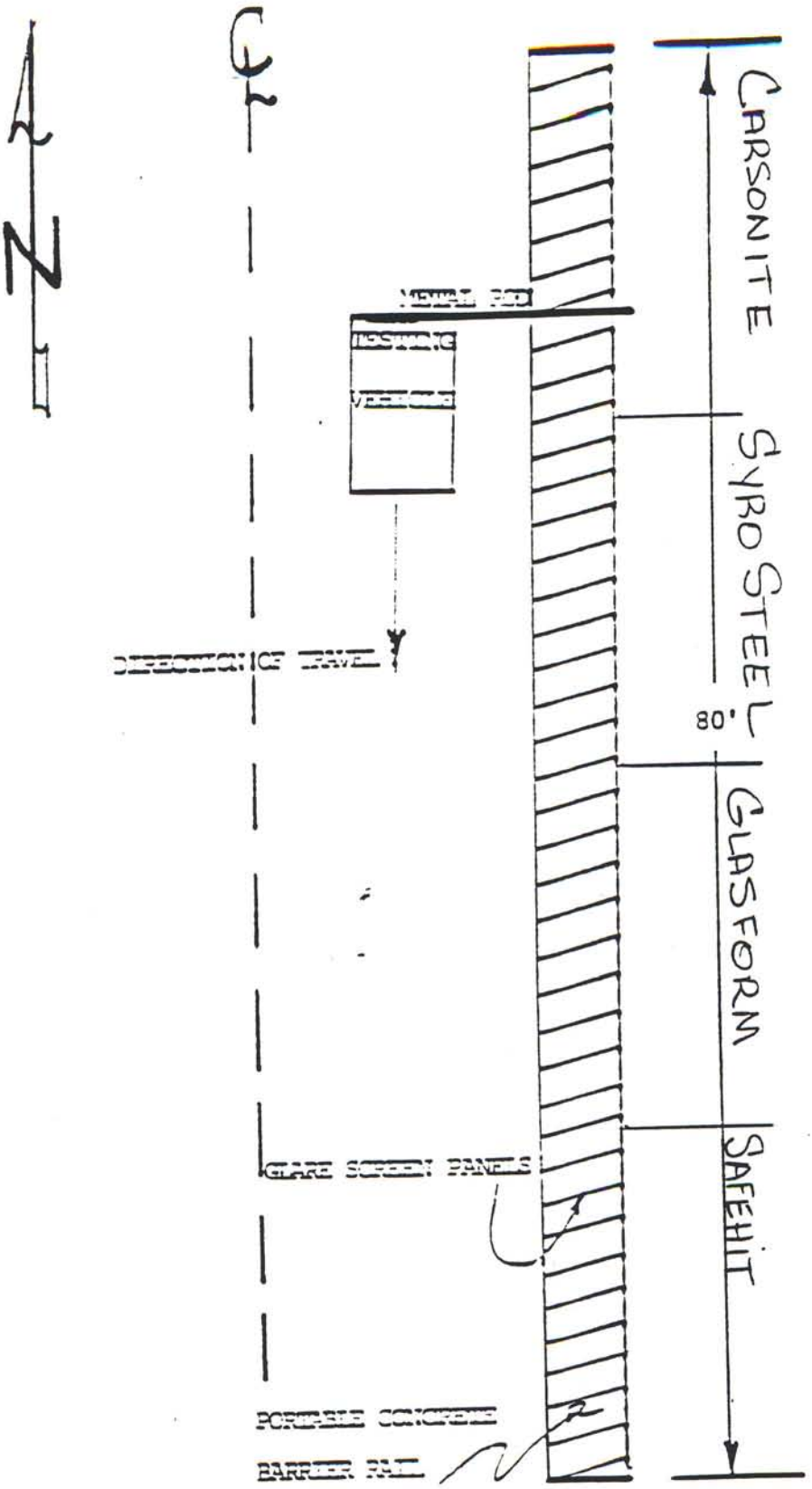
N
CARSONITE
SYRO STEEL
80'
GLASFORM
SAFEHIT
GLARE SCREEN PANELS
PORTABLE CONCRETE
BARRIER RAIL
NOT TO SCALE

Figure 7

VI. EVALUATION CRITERIA:

The criteria selected for evaluation of performance of the panel material included, but was not limited to, blade rotation, dislocation, fracture, failure to self erect or shear failure.

Due to the different material composition of the four products, the performance of the individual products had to be evaluated independently. Therefore, criteria for Carsonite and Glasform was established for "measure of lean" and fracture, while Safe-Hit and Syro Steel's performance was measured by dislocation and fracture.

The angle of lean was measured, from perpendicular to the base rail, after the second impact, in both tests. This was used as a means of determining if the products could be considered functional or non-functional. The angle of lean is defined as follows:

"Slight" =	5° to 10°
"Moderate" =	10° to 20°
"Substantial" =	20° to 30°
"Severe" =	Over 30°, Non-functional

VII. TEST RESULTS for FEBRUARY 17, 1993:

The initial impact test was scheduled for February 17, 1993 at 7:00 a.m. The test was slightly delayed, due to a light snow fall from the previous night. A snow removal truck was dispatched to the site and the first impact began at 7:50 a.m. with a recorded temperature of 27° F and the second impact at 8:10 a.m. at 30° F.

CARSONITE

SUMMARY OF RESULTS AFTER IMPACT #1, FEBRUARY 17, 1993

IMPACT NUMBER 1

Panel No. and Results	Panel No. and Results
1. Shear to panel	9. Shear to panel
2. Shear to panel	10. Shear to panel
3. Shear to panel	11. Shear to panel
4. Shear to panel	12. Shear to panel
5. Shear to panel	13. Shear to panel
6. Shear to panel	14. Shear to panel
7. Shear to panel	15. Shear to panel
8. Shear to panel	16. No shear, moderate lean

Impact Number 1: The panels split, or sheared, from the top down, 2 to 6 inches. All the panels remained in place and standing, but the bracket-base rail connection bent, causing the panels to lean, slight to moderate. See picture #3.

CARSONITE

SUMMARY OF RESULTS AFTER IMPACT #2, FEBRUARY 17, 1993

IMPACT NUMBER 2

Panel No. and Results	Panel No. and Results
1. Split 24", 11° lean	9. Split 20", 11° lean
2. Split 13", 12° lean	10. Split 14", 7° lean
3. Split 20", 15° lean	11. Split 24", 9° lean
4. Split 24", 17° lean	12. Split 17", 11° lean
5. Split 18", 13° lean	13. Split 20", 12° lean
6. Split 16", 12° lean	14. Split 15", 12° lean
7. Split 5", 12° lean	15. Split 18", 15° lean
8. Split 14", 19° lean	16. 2.5" split at bracket, 18° lean

Impact Number 2: The splits or shear failure on the panels lengthened, from the top down, as shown in picture #4. Three of the panels split to full length. A small split developed at the bracket of panel #16. Although the panels remained attached, the bracket bent, causing them to lean. It must be noted that although the panel material split, the product remained attached and could be considered functional, until replaced, if it were in an "in-service" situation.

SYRO STEEL

SUMMARY OF RESULTS AFTER IMPACT #1, FEBRUARY 17, 1993

IMPACT NUMBER 1

Panel No. and Results	Panel No. and Results
1. Dislocated	6. Tore at bolt
2. Split top/tore at bolt	7. Split top/tore at bolt
3. Tore at bolt	8. Split top/tore at bolt
4. Split top/tore at bolt	9. Split top/tore at bolt
5. Tore at bolt	10. Tore at bolt

Impact Number 1: Of the two carriage anchor bolts attaching the panel to the base rail, nine panels tore at this bolt, on the impact side. Additionally, five of those nine panels also split at the top and panel #1 was dislocated. See pictures 5 and 6.

SYRO STEEL

SUMMARY OF RESULTS AFTER IMPACT #2, FEBRUARY 17, 1993

IMPACT NUMBER 2

Panel No. and Results	Panel No. and Results
1. Dislocated	6. Split top, loose
2. Top shattered, panel loose	7. Dislocated
3. Dislocated	8. Top shattered, panel loose
4. Split top, panel loose	9. Dislocated
5. Dislocated	10. Dislocated

Impact Number 2: An additional five panels were dislocated after the second impact. The four remaining panels tore, on the impact side, at the anchor bolt, leaving the panels loose and falling over. The angle of lean was not measured, however, because with no rigidity to the panels, they were evaluated as non-functional.

GLASFORM

SUMMARY OF RESULTS AFTER IMPACT #1, FEBRUARY 17, 1993

IMPACT NUMBER 1

Panel Number and Results	Panel Number and Results
1. Panel OK, bolt pull out	11. **
2. **	12. **
3. **	13. **
4. **	14. **
5. **	15. **
6. **	16. **
7. **	17. **
8. **	18. **
9. **	19. **
10. **	20. 3" Split at bracket

** bent bracket, slight lean.

Impact Number 1: Panels #1 through #19 were still standing, with no damage to the panel material, however the bracket bent, causing them to lean slight to moderate. See picture #7 A small split, on panel #20, developed at the bracket. The panel material of #1 sustained no damage, but the bolt started pulling through the base rail, see picture #8.

GLASFORM

SUMMARY OF RESULTS AFTER IMPACT #2, FEBRUARY 17, 1993

IMPACT NUMBER 2

Panel Number and Results	Panel Number and Results
1. Dislocated	11. Bolt pull out, severe lean
2. Panel OK, 22° lean	12. Panel OK, 12° lean
3. 4.5" split at bracket, 15° lean	13. 7" split, 10° lean
4. Panel OK, 13° lean	14. 5" split, bolt pull out
5. Panel OK, 17° lean	15. Panel OK, 14° lean
6. Bolt pull out, 42° lean	16. 9" split, 15° lean
7. 4" split at bracket, 19° lean	17. 3" split at bracket, 14° lean
8. Panel OK, 15° lean	18. 8" split, 12° lean
9. 1" split at bracket, 14° lean	19. Panel OK, 16° lean
10. Panel OK, 18° lean	20. 3" split at bracket, 9° lean split

Impact Number 2: All the panels were leaning due to the split running through the entire length of the base rail. Panel #1 was dislocated due to the bolt pulling through the base rail. Panels #6 and #14 remained attached, but were leaning severely due to the bolt pulling through the base rail, see picture #9. Sixteen of the twenty panels remained fully functional

SAFE-HIT

SUMMARY OF RESULTS AFTER IMPACT #1, FEBRUARY 17, 1993

IMPACT NUMBER 1

Panel No. and Results	Panel No. and Results
1. Dislocated, blade base sheared	6. Dislocated, blade base sheared
2. Dislocated, blade base sheared	7. Shear at top of base, fallen over
3. No Damage	8. Dislocated, blade base sheared
4. Dislocated, shear at top of base	9. Dislocated, blade base sheared
5. Dislocated, shear at top of base	10. Dislocated, blade base sheared

Impact Number 1: Out of 10 panels, 6 were dislocated due to the blade base shearing off at the base rail. Three were dislocated due to the panel shearing off at the top of the blade-base. Panel #7 was barely attached and fallen over and was non-functional, see picture #10. Panel #3 was still in place with no damage to any part of the assembly. See pictures #11.

SAFE-HIT

SUMMARY OF RESULTS AFTER IMPACT #2, FEBRUARY 17, 1993

IMPACT NUMBER 2

Panel No. and Results	Panel No. and Results
1. Dislocated, blade base sheared	6. Dislocated, blade base sheared
2. Dislocated, blade base sheared	7. Dislocated, shear at top of base
3. Dislocated, blade base sheared	8. Dislocated, blade base sheared
4. Dislocated, shear at top of base	9. Dislocated, blade base sheared
5. Dislocated, shear at top of base	10. Dislocated, blade base sheared

Impact Number 2: Panel #3 was dislocated due to the blade base shearing off. The product, as a whole, became non-functional when dislocated, however; the durability of the panel material was apparent, with no sign of splitting.

VIII. TEST RESULTS for MARCH 5, 1993:

The second test was conducted on March 5, 1993 and the first impact began at 6:30 a.m., with a temperature of 30° F, the second impact was conducted at 7:05, with a 31.5° F temperature recorded.

CARSONITE

SUMMARY OF RESULTS AFTER IMPACT #1, MARCH 5, 1993

IMPACT NUMBER 1

Panel No. and Results	Panel No. and Results
1. Split to panel	9. Split to panel
2. Split to panel	10. Split to panel
3. Split to panel	11. Split to panel
4. Split to panel	12. Split to panel
5. Split to panel	13. Split to panel
6. Split to panel	14. Split to panel
7. Split to panel	15. Split to panel
8. Split to panel	16. No split, substantial lean

Impact Number 1: The panel material began to split, or shear, from the top down, 2 to 8 inches. All of the panels remain in-place and standing, but bent at the bracket, causing the panels to lean, slight to substantial.

SUMMARY OF RESULTS AFTER IMPACT #2, MARCH 5, 1993

IMPACT NUMBER 2

Panel No. and Results	Panel No. and Results
1. Split 8", 18° lean	9. Split 3", 16° lean
2. Split 8", 18° lean	10. Split 3", 12° lean
3. Split 2", 19° lean	11. Split 5", 16° lean
4. Split 5", 20° lean	12. Split 3", 17° lean
5. Split 2", 21° lean	13. Split 2", 17° lean
6. Split 4", 19° lean	14. Split 4", 16° lean
7. Split 3", 19° lean	15. Split 2", 19° lean
8. Split 3", 22° lean	16. Split 1", 28° lean

Impact Number 2: All panels remain in-place and functional The bracket to base rail connection bent, causing the panels to lean. The angle of lean is more severe and the shearing (splitting) of the panels lengthened after the second impact. The damage to the panels was not as severe as the February test. (See pictures 12 and 13)

SYRO STEEL

SUMMARY OF RESULTS AFTER IMPACT #1, MARCH 5, 1993

IMPACT NUMBER 1

Panel No. and Results	Panel No. and Results
1. Panel shattered, tore at bolt	6. Shattered top, tore at bolt
2. Tore at bolt	7. Split top and bottom
3. Dislocated	8. Tore at bolt
4. Split top and bottom	9. Shattered top, tore at bolt
5. Panel shattered, tore at bolt	10. Shattered top, tore at bolt

Impact Number 1: The panels sustained splitting or shear failure to both the top and bottom. At the mounting anchor bolt, on the impact side, seven panels tore at this bolt and #3 was dislocated.

SYRO STEEL

SUMMARY OF RESULTS AFTER IMPACT #2, MARCH 5, 1993

IMPACT NUMBER 2

Panel No. and Results	Panel No. and Results
1. Dislocated, shattered panel	6. Shattered 8" at top, loose
2. Shattered 9" at top	7. Shattered 12" at top, tore at bolt
3. Dislocated	8. Dislocated and shattered
4. Shattered, loose	9. Shattered 10" at top, loose
5. Shattered, loose	10. Shattered 11" at top, fallen over

Impact Number 2: Three additional panels were dislocated. All the panels were cracked and torn, five were shattered. The impact side of the anchor bolts tore and the panels were loose and falling over. This product was evaluated as non-functional, due to the dislocation of the panels and failure to self erect. See pictures 14 and 15.

GLASFORM

SUMMARY OF RESULTS AFTER IMPACT #1, MARCH 5, 1993

IMPACT NUMBER 1

Panel Number and Results	Panel Number and Results
1. Base rail split	11. Slight lean
2. Substantial lean	12. Slight lean
3. Moderate lean	13. Slight lean
4. Bolt pull out, severe lean	14. Slight lean
5. Slight lean	15. Slight lean
6. Slight lean	16. Slight lean
7. Slight lean	17. Slight lean
8. Slight lean	18. Slight lean
9. Bolt pull out, severe lean	19. Slight lean
10. Slight lean	20. Slight lean, 3" split at bracket

Impact Number 1: All panels remained attached, but the anchor bolts pulled through the base rail on panels #4 and #9. All the panels were bent at the bracket-base rail connection. Panel #20 was split 3 to 4 inches at the bracket, in two places. The base rail split the full length on both 10' sections.

GLASFORM

SUMMARY OF RESULTS AFTER IMPACT #2, MARCH 5, 1993

IMPACT NUMBER 2

Panel Number and Results	Panel Number and Results
1. Dislocated, bolt pull out	11. Panel OK, 11°, bolt pull out
2. Panel OK, 49° lean, bolt pull out	12. Panel OK, 14° lean
3. Panel OK, 47° lean, bolt pull out	13. 2" split at , 12° lean
4. Panel OK, 47° lean, bolt pull out	14. Panel OK, 12° lean
5. Panel OK, 18° lean	15. 6.5" split at top, 12° lean
6. Panel OK, 18° lean	16. 3" split at bracket, 13° lean
7. 3" split at bracket, 51° lean, bolt pull out	17. 1" split at top, 13° lean
	18. 2.5" split at top, 12° lean
8. Panel OK, 50° lean, bolt pull out	19. 2" split at top, 13° lean
9. Panel OK, 42° lean, bolt pull out	20. 5" split at bracket, 10° lean
10. Dislocated, bolt pull out	

Impact Number 2: Panels #1 and #10 were dislocated due to the bracket anchor bolt pulling through the base rail. Due to the dislocation and the severe lean of panels, this product was evaluated as non-functional. See pictures 16 and 17.

SAFE-HIT

SUMMARY OF RESULTS AFTER IMPACT #1, MARCH 5, 1993

IMPACT NUMBER 1

Panel No. and Results	Panel No. and Results
1. Dislocated, blade base sheared	6. Dislocated, blade base sheared
2. Dislocated, blade base sheared	7. No damage, slight lean
3. No damage, slight lean	8. Dislocated, blade base sheared
4. No damage, slight lean	9. Dislocated, blade base sheared
5. Dislocated, blade base sheared	10. Dislocated, blade base sheared

Impact Number 1: Seven of the ten panels were dislocated due to blade base shear failure. Panels 3, 4 and 7 remained attached with a slight lean. Panel #9 was dislocated and carried by the impacting vehicle but the panel material did not suffer any damage, such as splits.

SAFE-HIT

SUMMARY OF RESULTS AFTER IMPACT #2, MARCH 5, 1993

IMPACT NUMBER 2

Panel No. and Results	Panel No. and Results
1. Dislocated, blade base sheared	6. Dislocated, blade base sheared
2. Dislocated, blade base sheared	7. Dislocated, blade base sheared
3. Dislocated, blade base sheared	8. Dislocated, blade base sheared
4. Panel Ok, 5° lean	9. Dislocated, blade base sheared
5. Dislocated, blade base sheared	10. Dislocated, blade base sheared

Impact Number 2: Panel #4 was still attached with no damage to any part of the assembly. See pictures 18 and 19. Due to the dislocation of the panels, this product was evaluated as non-functional. The panel material proved to be very durable, with no evidence of splitting.

APPENDIX A

PHOTOGRAPHS

PHOTO #1

The retractable, 3 inch metal rod and method of measurement for the impact device, set at 12 inches above the portable concrete barrier rail.

PHOTO #2

The 2 1/2 ton testing vehicle at 45 MPH, right before impact.

PHOTO #3

CARSONITE 2-17-1993

The split of the panels and the lean, due to the bend in the bracket

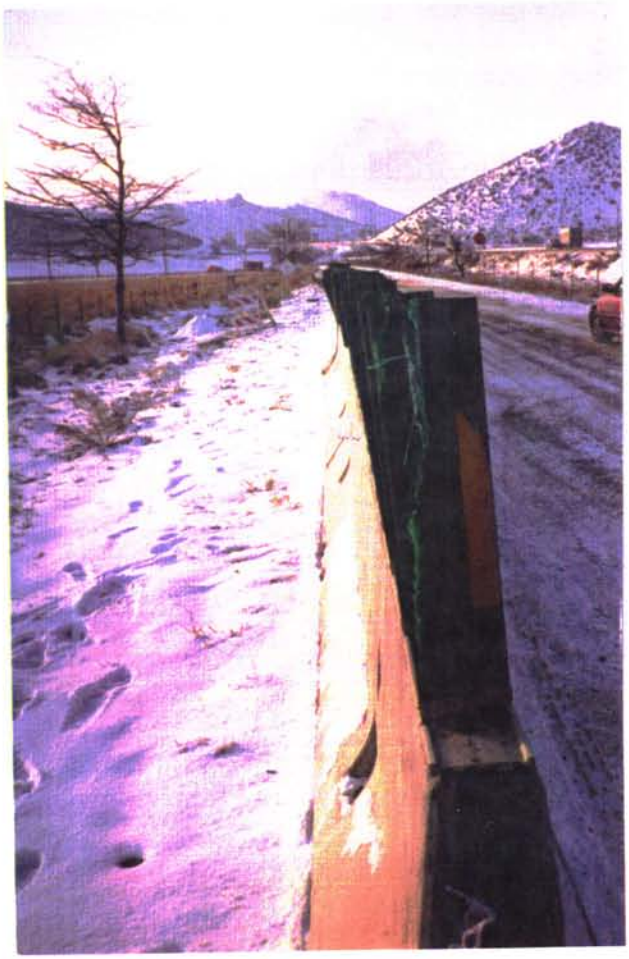

PHOTO #4

CARONITE 2-17-1993

The split of the panels and the lean, due to the bend in the bracket

PHOTO #5

SYRO STEEL 2-17-1993

The detachment and looseness of the panels after one impact.

PHOTO #6

SYRO STEEL 2-17-1993

The tear in the panels, at the anchor bolt, on the impact side.

PHOTO #7

GLASFORM 2-17-1993

The lean of the panels, due to the bend in the bracket.

PHOTO #8

GLASFORM 2-17-1993

The base rail delaminating, causing the bolt to pull through.

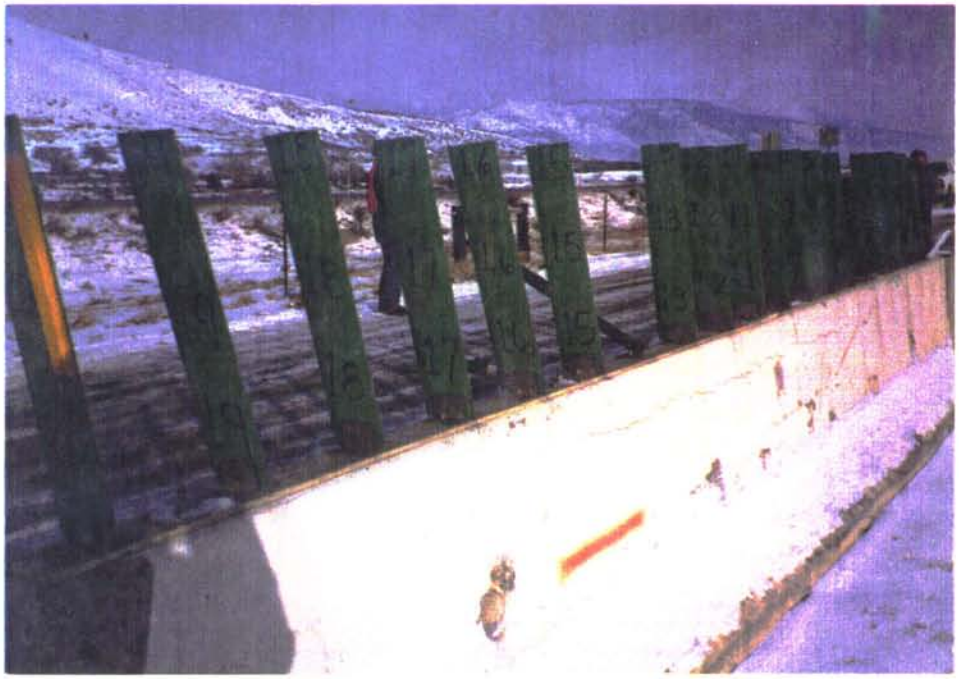

PHOTO #9

GLASFORM 2-17-1993

Panels #6 and #14 leaning, due to the bolt pulling through the base rail.

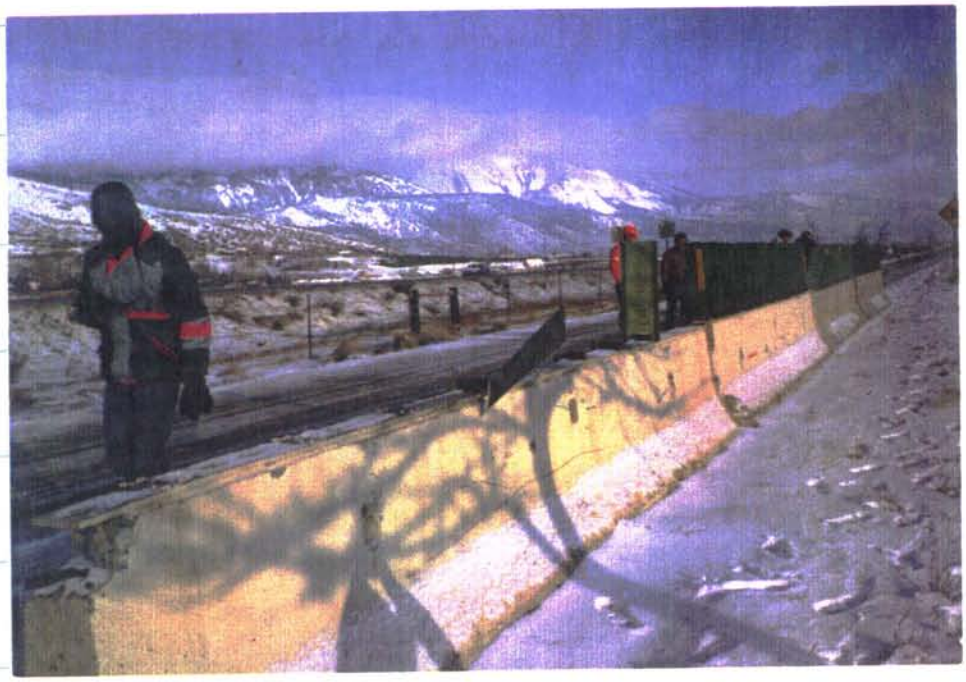

PHOTO #10

SAFE-HIT 2-17-1993

Broken blade base and panel #7 sheared at the top of the blade base.

PHOTO #11

SAFE-HIT 2-17-1993

Panel #3 is undamaged and intact.

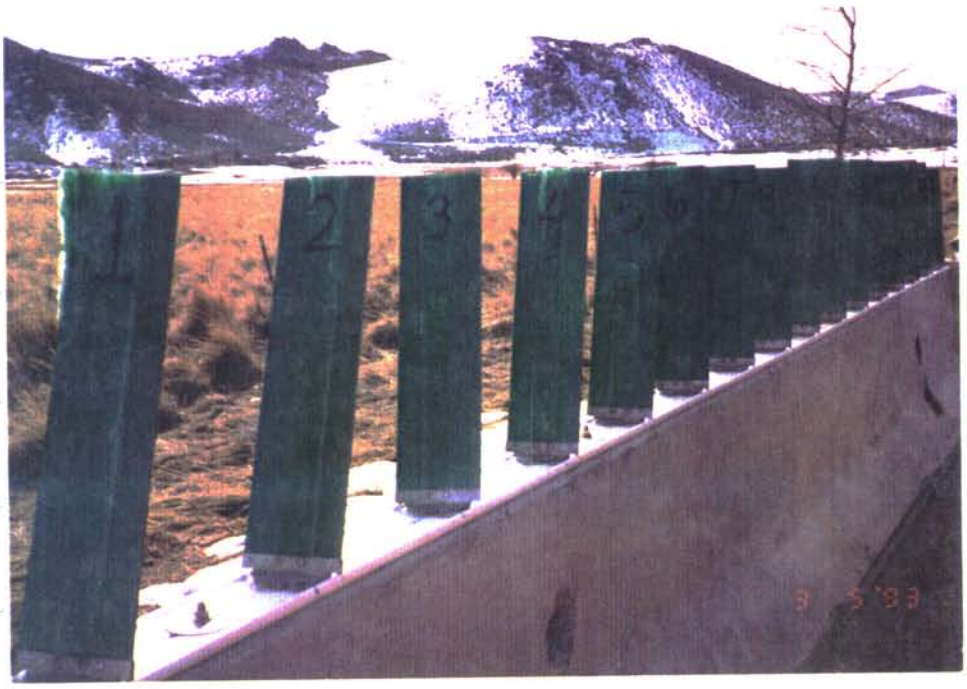

PHOTO #12

CARSONITE 3-05-1993

The split of the panels and the lean, due to the bend in the bracket

PHOTO #13

CARONITE 3-05-1993

The split of the panels and the lean, due to the bend in the bracket

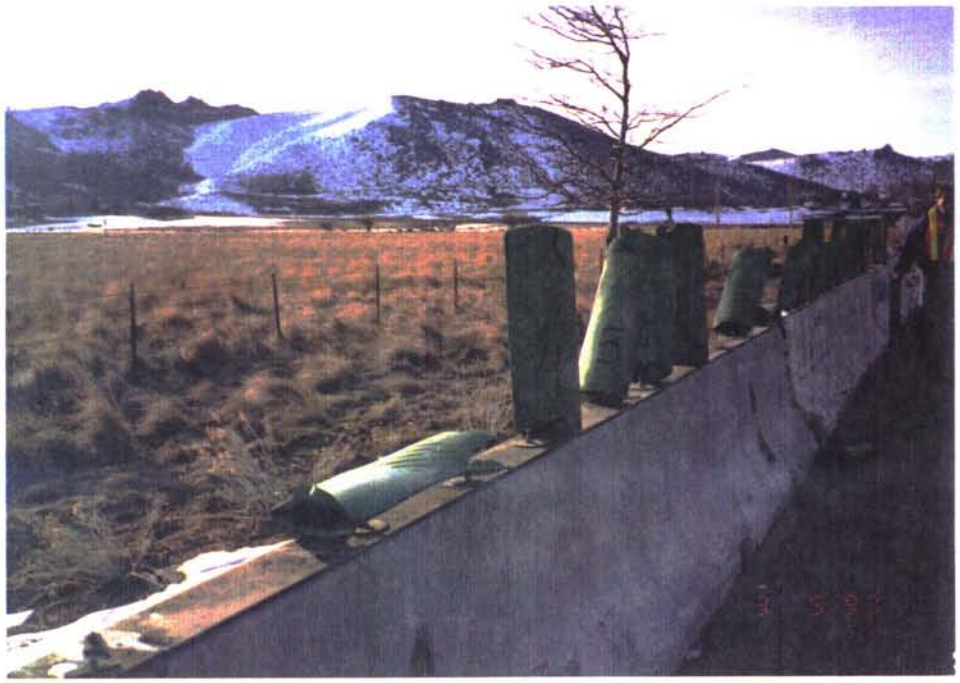

PHOTO #14

SYRO STEEL 3-05-1993

The shattered top of the panels and the tear at the anchor bolt.

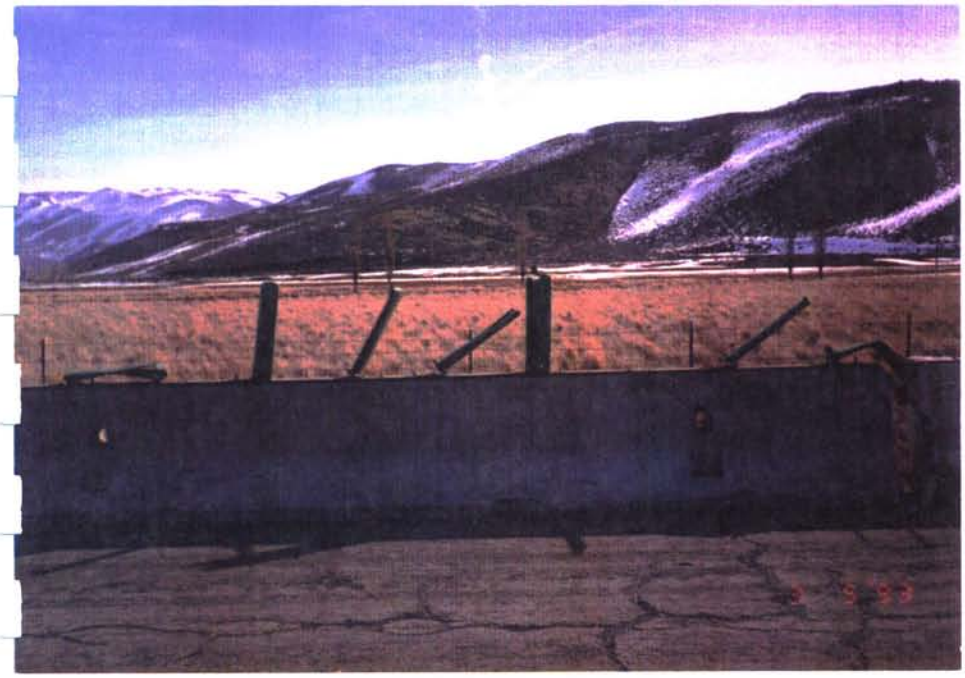

PHOTO #15

SYRO STEEL 3-05-1993

The looseness of the panels, due to the panel tearing at the anchor bolt

PHOTO #16

GLASFORM 3-05-1993

The bolt pulling through the base rail, causing the panels to lean.

PHOTO #17

GLASFORM 3-05-1993

The base rail delaminating and the bolt pulling through.

PHOTO #18

SAFE-HIT 3-05-1993

Broken blade base, panel #4 undamaged and intact.

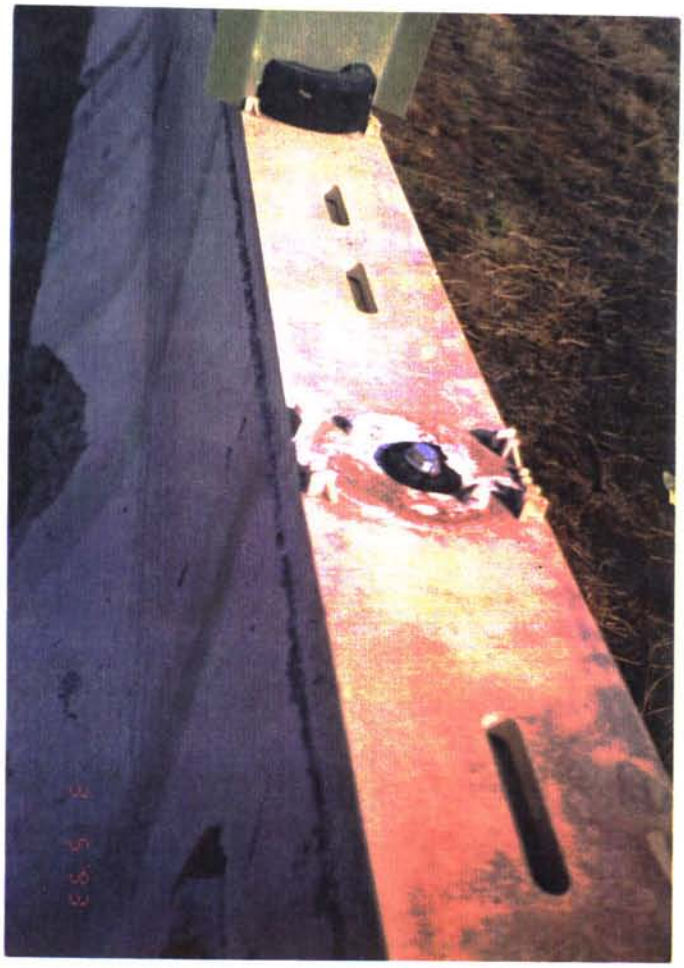

PHOTO #19

SAFE-HIT 3-05-1993

Broken blade base.