Publication No. FHWA-RD-93-117
July 1994

Testing of Small and Large Sign Support Systems FOIL Test Number: 92F036

U.S. Department of Transportation
Federal Highway Administration

Research and Development
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, Virginia 22101-2296

1. Report No.	2.	3.
FHWA-RD-93-117	PB94-186384	

4. Title and Subtitle	5. Report Date
TESTING OF SMALL AND LARGE SIGN SUPPORT SYSTEMS FOIL TEST NUMBER: 92F036	July 1994
	6. Performing Organization Code
7. Author(s) Christopher M. Brown	8. Performing Organization Report No.
9. Performing Organization Name and Address Advanced Technology & Research Corp. 14900 Sweitzer Lane Laurel, MD 20707	10. Work Unit No. (TRAIS) 3A5f3142
	11. Contract or Grant No. DTFH61-91-Z-00002
12. Sponsoring Agency Name and Address Office of Safety and Traffic Operations R&D Federal Highway Administration 6300 Georgetown Pike McLean, VA 22101-2296	13. Type of Report and Period Covered Test Report, November 1992
	14. Sponsoring Agency Code

15. Supplementary Notes

Contracting Officer's Technical Representative (COTR) - Richard King, HSR-20

16. Abstract

This test report contains the results of a crash test performed at the Federal Outdoor Impact Laboratory (FOIL) in McLean, Virginia. The test was performed on a small sign support system at 60 mi/h (96.6 km/h), test 92F036. The vehicle used for this test was a 1984 Honda Civic. The purpose of this test was to evaluate the high-speed safety performance of a dual-leg 3-in (76.2-mm) diameter fiberglass sign support with concrete foundations. The performance evaluation was based on the latest requirements for breakaway supports as specified in Volume 54, Number 3 of the Federal Register dated January 5, 1989. These criteria specify, in part, that the occupant change in velocity must be 16 ft/s (4.9 m/s) or less, that the significant test article stub height remaining after impact be no more than 4 in (101.6 mm), and that there can be no occupant compartment intrusion. The test results indicate that the 3-in (76.2-mm) diameter fiberglass sign support with concrete foundations in weak soil meets all of the applicable high-speed safety performance criteria specified by the FHWA.

17. Key Words	18. Distribution Statement
Acceleration, occupant impact velocity, weak soil, fiberglass, vehicle, FOIL.	No restrictions. This document is available to the public through the National Technical Information Service Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	20	

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof. This report does not constitute a standard, specification, or regulation.

The United States Government does not endorse products or manufacturers. Trade and manufacturers' names appear in this report only because they are considered essential to the object of the document.

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
	AREA			
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
	VOLUME			
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	l
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: Volumes greater than 1000 l shall be shown in m^3.				
	MASS			
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C
	ILLUMINATION			
fc	foot-candles	10.76	lux	l
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
	FORCE and PRESSURE or STRESS			
lbf	poundforce	4.45	newtons	N
psi	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
	AREA			
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	ac
ha	hectares	2.47	acres	mi^2
km^2	square kilometers	0.386	square miles	
	VOLUME			
ml	milliliters	0.034	fluid ounces	fl oz
l	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
	MASS			
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg	megagrams	1.103	short tons (2000 lb)	T
	TEMPERATURE (exact)			
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F
	ILLUMINATION			
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
	FORCE and PRESSURE or STRESS			
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	psi

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised August 1992)

Table of Contents.

List of Figures.

List of Tables.

1. SCOPE

This test report contains the results of a crash test performed at the Federal Outdoor Impact Laboratory (FOIL) in McLean, Virginia. The test was performed on a small sign support system at 60 mi/h (96.6 km/h), test 92F036. The vehicle used for this test was a 1984 Honda Civic. The purpose of this test was to evaluate the high-speed safety performance of a dual-post fiberglass sign support with concrete foundations in weak soil. The performance evaluation was based on the latest requirements for breakaway supports as specified in Volume 54, Number 3 of the Federal Register dated January 5, 1989. These criteria specify, in part, that the occupant change in velocity must be 16 ft/s (4.9 m/s) or less, that the significant test article stub height remaining after impact be no more than 4 in (101.6 mm), and that there can be no occupant compartment intrusion.

2. TEST MATRIX

The test was performed on a small sign support system. The test speed was 60 mi/h (96.6 km/h). The sign was buried in NCHRP Report Number 230, S-2 weak soil[1]. A summary of the test conditions is presented in table 1.

Table 1. Test matrix.

Test Number	Test Vehicle	Test Weight (lb)	Test Speed (mi/h)	Test Article Description	Impact Location
92F036	'84 Honda Civic	1850 839 kg	60 96 km/h	2 leg fiberglass in concrete	center

3. VEHICLE

The test vehicle was a 1984 Honda Civic two door hatchback with a manual transmission. Prior to the test, the vehicles' fluids were drained and its inertial properties measured. The vehicle was stripped of certain components which made space for the installation of test equipment. The vehicle was ballasted with a data acquisitions system, transducers, a brake system and weight plates (if necessary) to bring its inertial weight to approximately 1850 lb (839 kg). The actual weight of the test vehicle was 1850 lb (839 kg). After ballasting, the vehicles' inertial properties were remeasured.

4. SIGN SUPPORT

The sign support system consisted of two 3-in (76.2-mm) diameter fiberglass posts 13 ft (4.0 m) long. Attached to the two fiberglass posts was a 6-ft high by 5.5-ft wide (1.2-m by 1.7-m) aluminum sign panel. The posts were cut to length and the panel attached before installation. Two 12-in (304.8-mm) diameter by 2.5 ft (0.8 m) deep concrete foundations were poured with a 3-in (76.2-mm) diameter by 2-ft (0.6-m) long steel sleeve cast inside. The sleeve was cast in the concrete such that 2 in (50.8 mm) of the sleeve protruded out of the foundation. A trench 2.5 ft (0.8 m) deep was dug in the S-2 weak soil. The foundations were set in the hole 3.5 ft (1.1 m) apart on center and the hole was backfilled with weak soil. The weak soil was added to the hole in 6-in (152.4-mm) lifts and compacted until the final grade was

reached. After installation of the foundations, the assemble fiberglass sign support was inserted inside the steel sleeves. One 1/4-in (6.4-mm) bolt per post was used to couple the fiberglass posts to the steel sleeve. Figure 1 presents a drawing of the sign support system.

5. TEST RESULTS - TEST 92F036

The test vehicle was accelerated to 60.4 mi/h (88.6 ft/s (97.2 km/h)) prior to impacting the sign support. The centerline of the test vehicle was aligned with the mid point between the two sign posts.

The bumper made contact with both sign legs and the fiberglass posts began to collapse. The vehicles left bumper support made contact with the left sign post while the right sign posts was struck by the vehicle's bumper at the right head lamp. The left sign post collapsed 0.006 s after contact. The right post had collapsed by 0.012 s. The vehicle continued forward riding down the sign posts. From 0.014 s to 0.044 s, the sign panel bolts had pulled through the aluminum panel separating the panel from the fiberglass posts. The vehicle rides downs the two posts, causing them to wrap around the vehicle's front end. The tips of each post came down and struck the vehicle at each outside edge of the windshield, slid off and struck the side-view mirrors. The tip of the posts made contact at 0.080 s. The impact with the windshield was not significant enough to penetrate the occupant compartment. The free falling sign panel grazed the roof of the vehicle at 0.112 s. The sign panel was not a hazard to the test vehicle, it landed on top of the foundations in the weak soil. The vehicle completely flatten and tore the fiberglass posts as it rode down the sign system. The vehicle passed through without difficulty. The brakes were applied and the vehicle yawed slightly clockwise and skidded to a stop prior to impacting the FOIL catch fence.

Damage to the vehicle consisted of light damage to the bumper and header panel. The damage was to plastic bumper parts and not to any structural members. The maximum crush measured after the test was recorded to be 1 in (25.4 mm). None of the sign components impaled the occupant compartment, although the tip of the sign posts did crack the windshield on the passenger side of the vehicle.

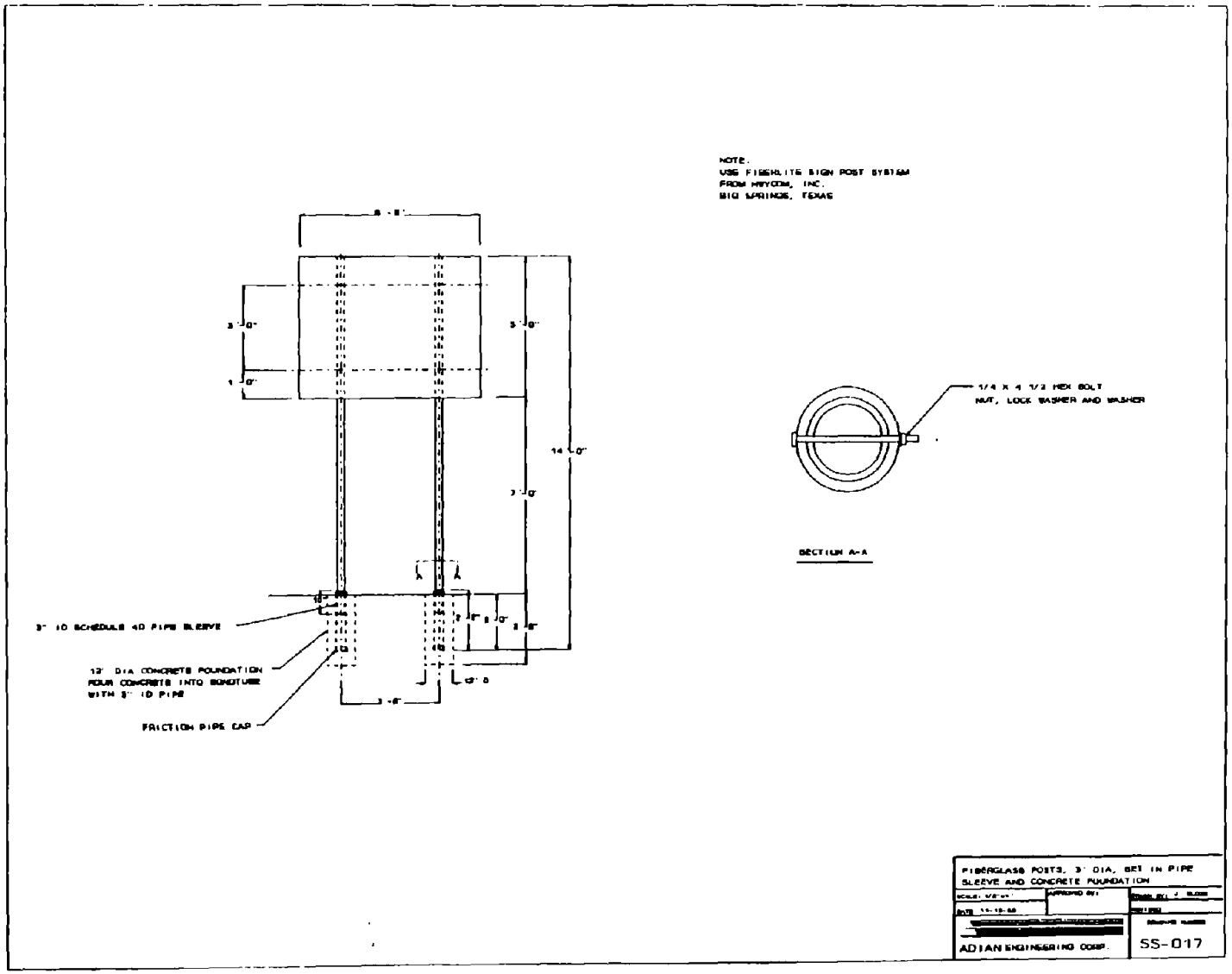
Damage to the sign consisted of two ripped and frayed fiberglass posts. The sign panel and all hardware were in usable condition after the test. The concrete foundations did not move during the impact event. New posts could be installed in the foundations with no complication.

The occupant impact velocity using the 2-ft (0.6-m) flail space model outlined in NCHRP Report Number 230, was determined to be 8.0 ft/s (2.4 m/s). The occupant impact velocity was reached 0.312 s into the crash event. The 10-ms ridedown acceleration was determined to be 1.0 g's. The peak acceleration (300 Hz data) for the impact event was 9.1 g's (peak force 16.8 kips (74.8 kN)). Because the time needed for the occupant to traverse the flail space was equal to the sign-vehicle interaction, the vehicle change in velocity was equal to the occupant impact velocity. The vehicle change in velocity was calculated to be 8.0 ft/s (2.4 m/s).

Photographs during the impact event are presented in figure 2. A summary of the impact conditions and the test results is presented in figure 3. Figures 4 through 7 are plots of data collected during the test. Pre- and post-test photographs of the vehicle and sign support system are presented in figures 8 through 11. Figure 12 is sketch of the vehicle static crush recorded after the test.

6. CONCLUSION

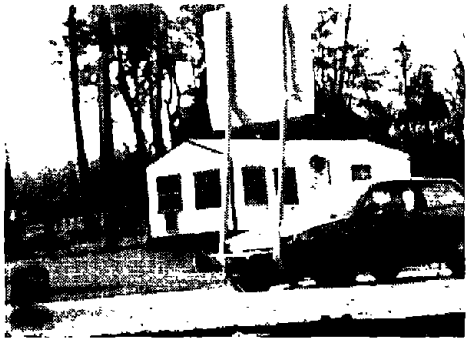
The test results indicate that the small sign support system meets all of the applicable criteria for the high-speed test in weak soil. There was no occupant compartment intrusion, no significant stub remaining after the test, and the occupant impact velocity was 8.0 ft/s (2.4 m/s) which is less than or equal to the 16 ft/s (4.9 m/s) limit specified by the FHWA.



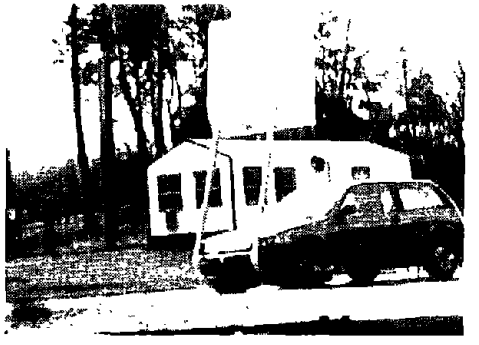
1 in = 25.4 mm 1 ft = 0.305 m

Figure 1. Sketch of small sign support.

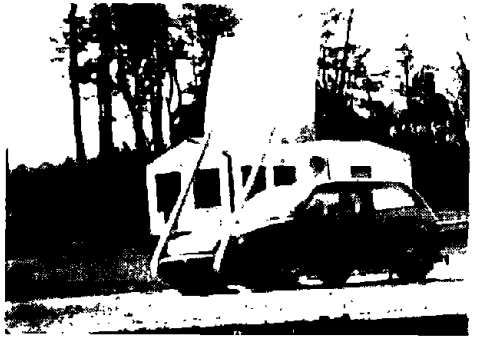
0.006 s



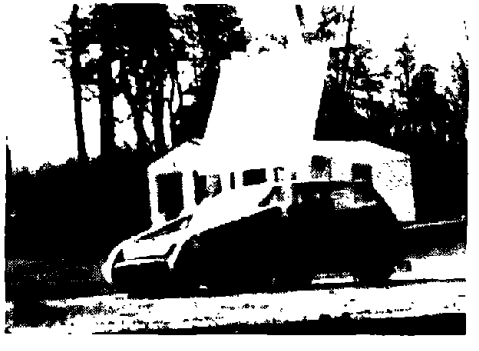
0.014 s



0.030 s



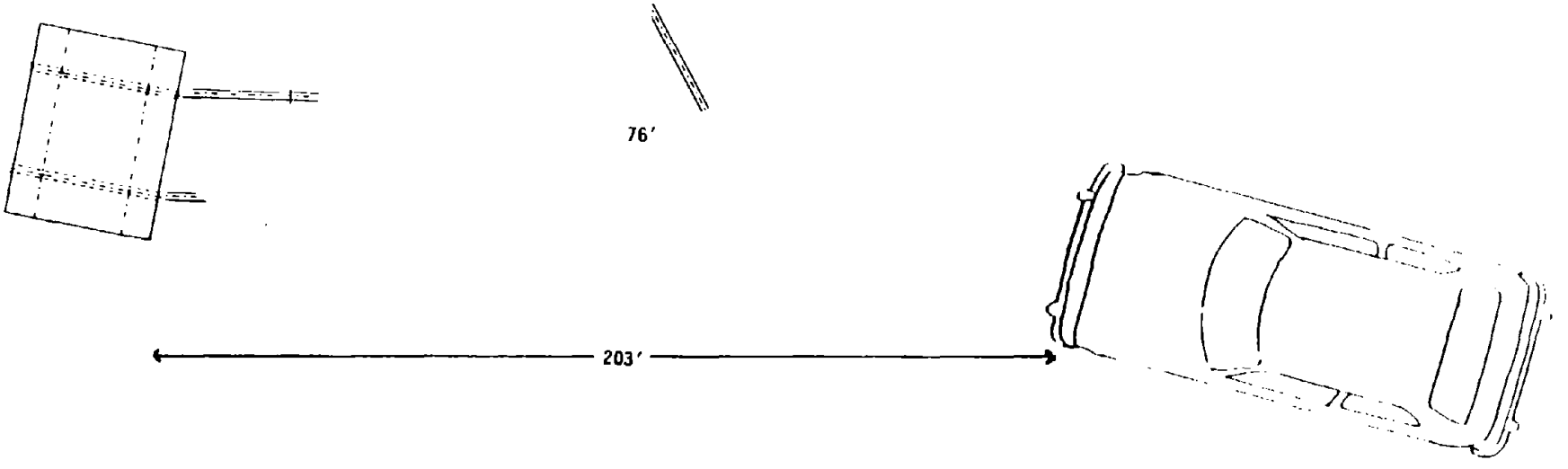
0.052 s



0.080 s

0.120 s

Figure 2. Test photographs during impact, test 92F036.



Test number..... 92F036

Date..... November 24, 1992

Test vehicle..... 1984 Honda Civic

Vehicle weight..... 1850 lb (839 kg)

Test article..... small sign support

Material..... 3-in diameter fiberglass posts 2-Leg, 2-Hit

Embedment depth..... 2 ft

Panel type..... 4-ft by 10-ft extruded aluminum

Height..... 11 ft

Foundation..... 12-in dia. concrete footers in S-2 Weak Soil

Impact speed..... 88.6 ft/s (27.0 m/s)

Impact location..... Head-on, centerline

Vehicle analysis:	Observed	Design/Limit
Longitudinal:		
Occupant Delta V at 2 ft	8.0 ft/s	≤16 ft/s
Ridedown Acceleration	1.0 g's	15/20 g's
Lateral:		
Occupant Delta V at 1 ft	no contact	no spec
Ridedown Acceleration	no contact	no spec

Peak 50 msec acceleration
Longitudinal..... 2.6 g's
Lateral..... NA

Vehicle Damage (TAD)..... 12-FC-1
(VDI)..... 12FDEN1

Vehicle crush..... 1 in

Vehicle velocity change..... 8.0 ft/s

Impact angle..... 0 degrees

Exit angle..... 5 degrees

1 in = 25.4 mm 1 ft = 0.305 m 1 ft/s = 0.305 m/s 1 lb = 0.454 kg

Figure 3. Summary of test 92F036.

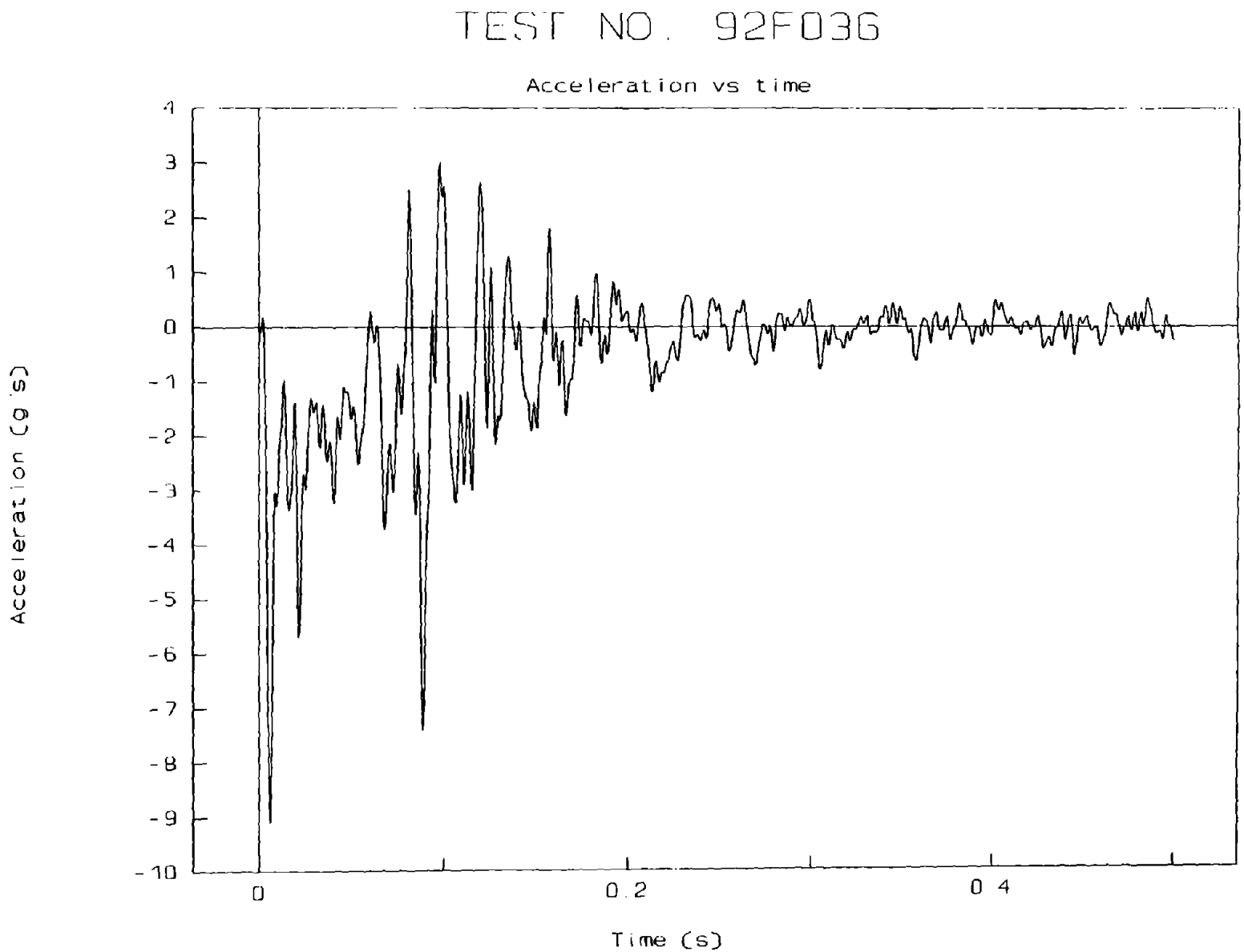
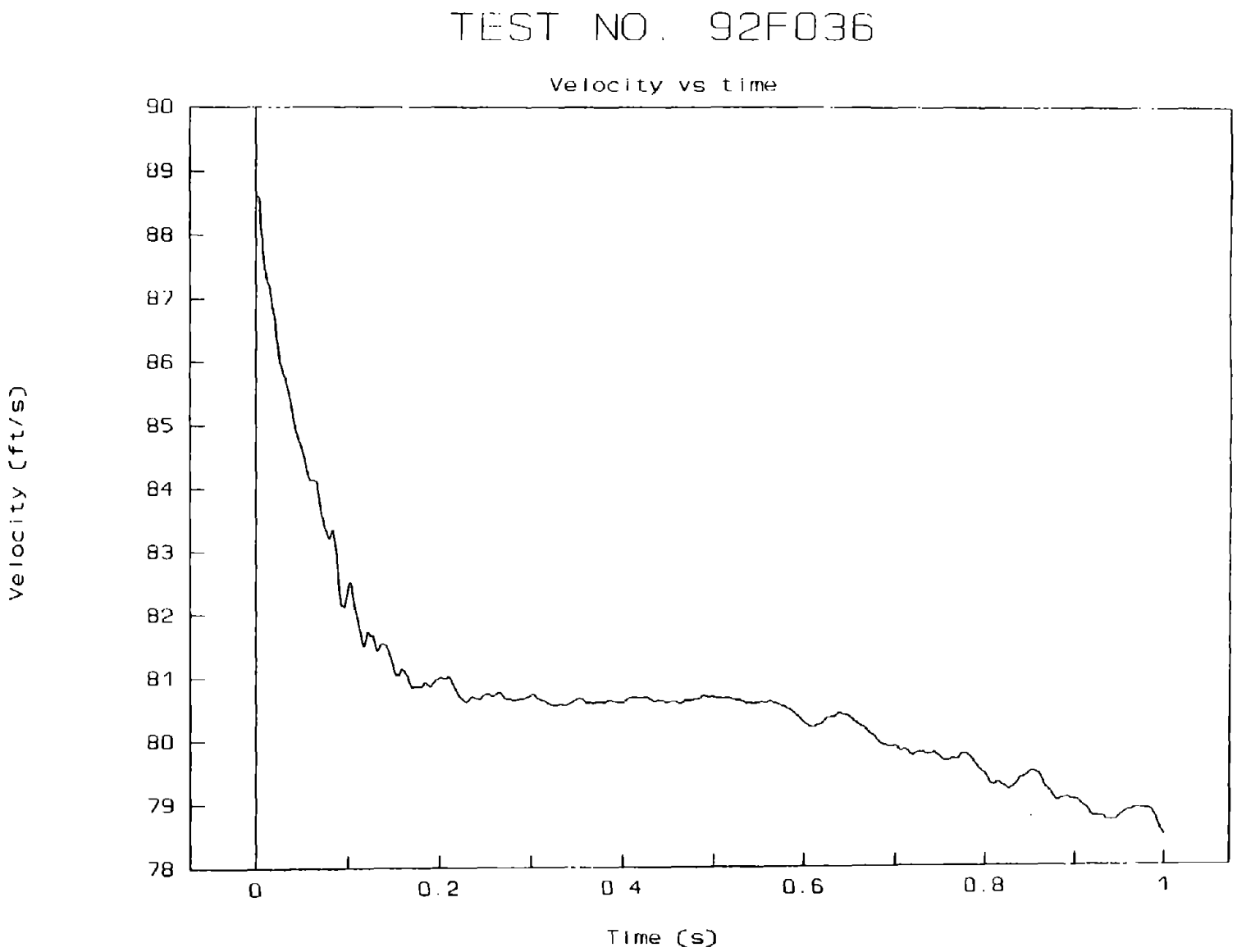
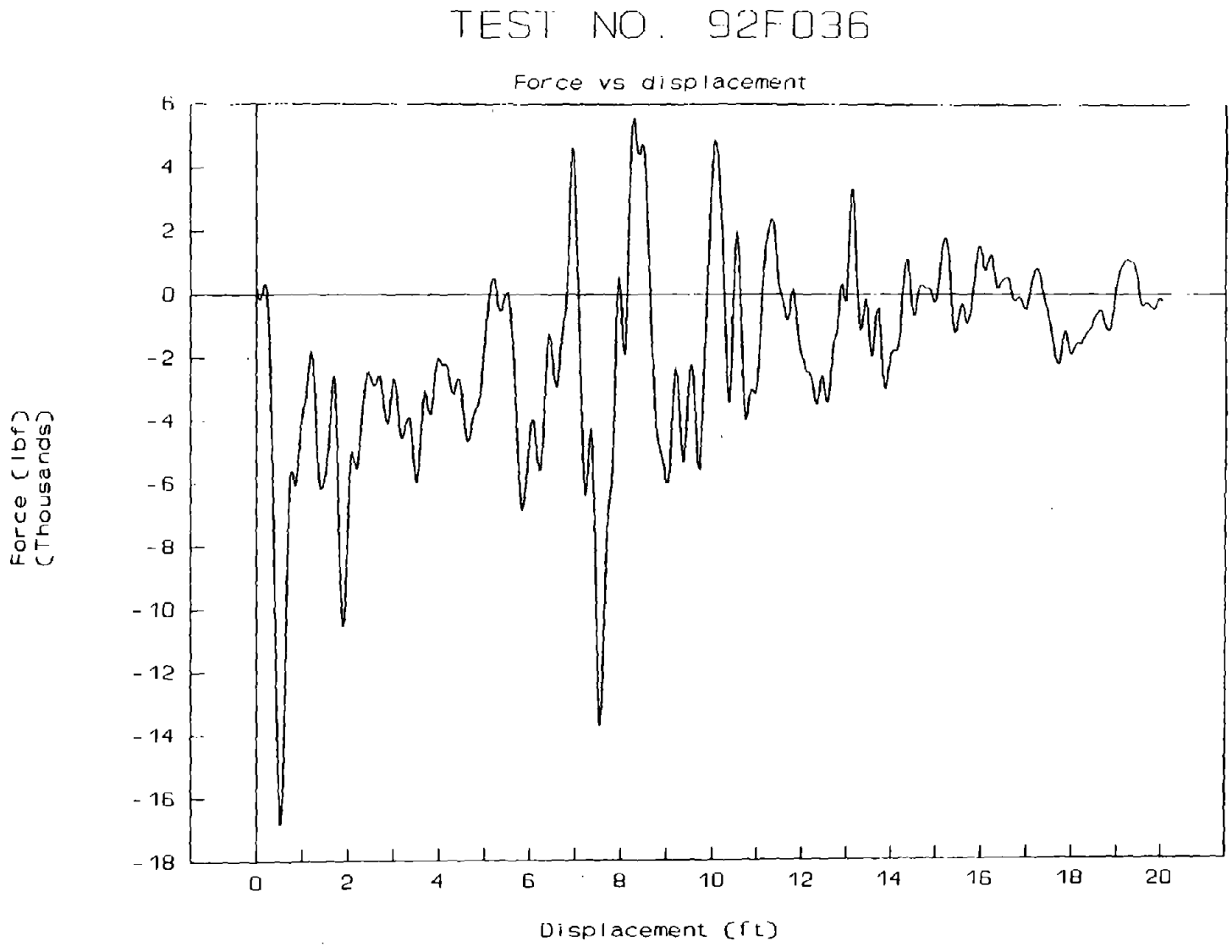


Figure 4. Acceleration versus time, X-axis, test 92F036.



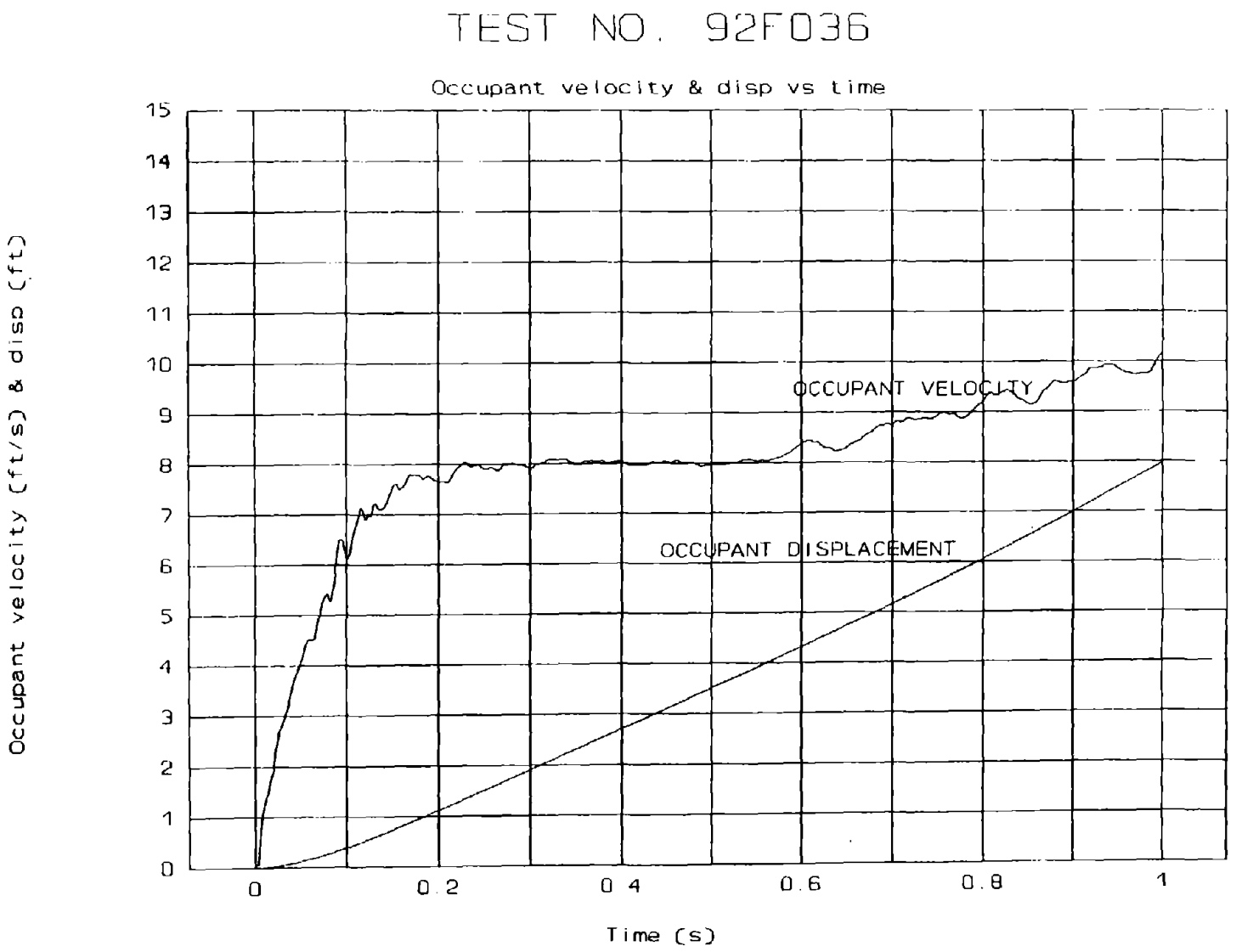
1 ft/s = 0.305 m/s

Figure 5. Velocity versus time, X-axis, test 92F036.



1 ft = 0.305 m 1 lbf = 0.454 kg

Figure 6. Force versus displacement, X-axis, test 92F036.



1 ft = 0.305 m 1 ft/s = 0.305 m/s

Figure 7. Occupant velocity and relative displacement versus time, X-axis, test 92F036.

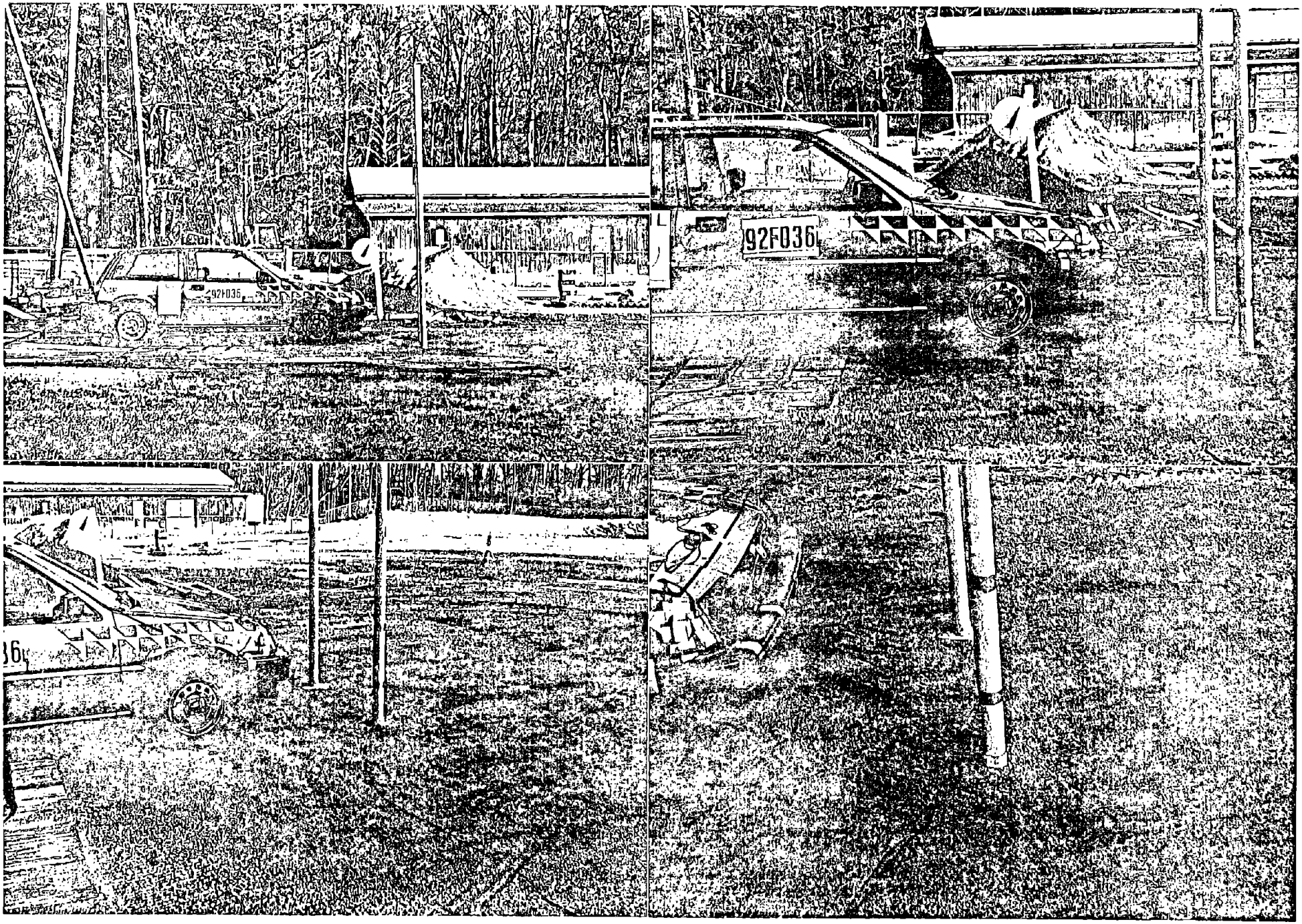


Figure 8. Pretest photographs of test 92F036.

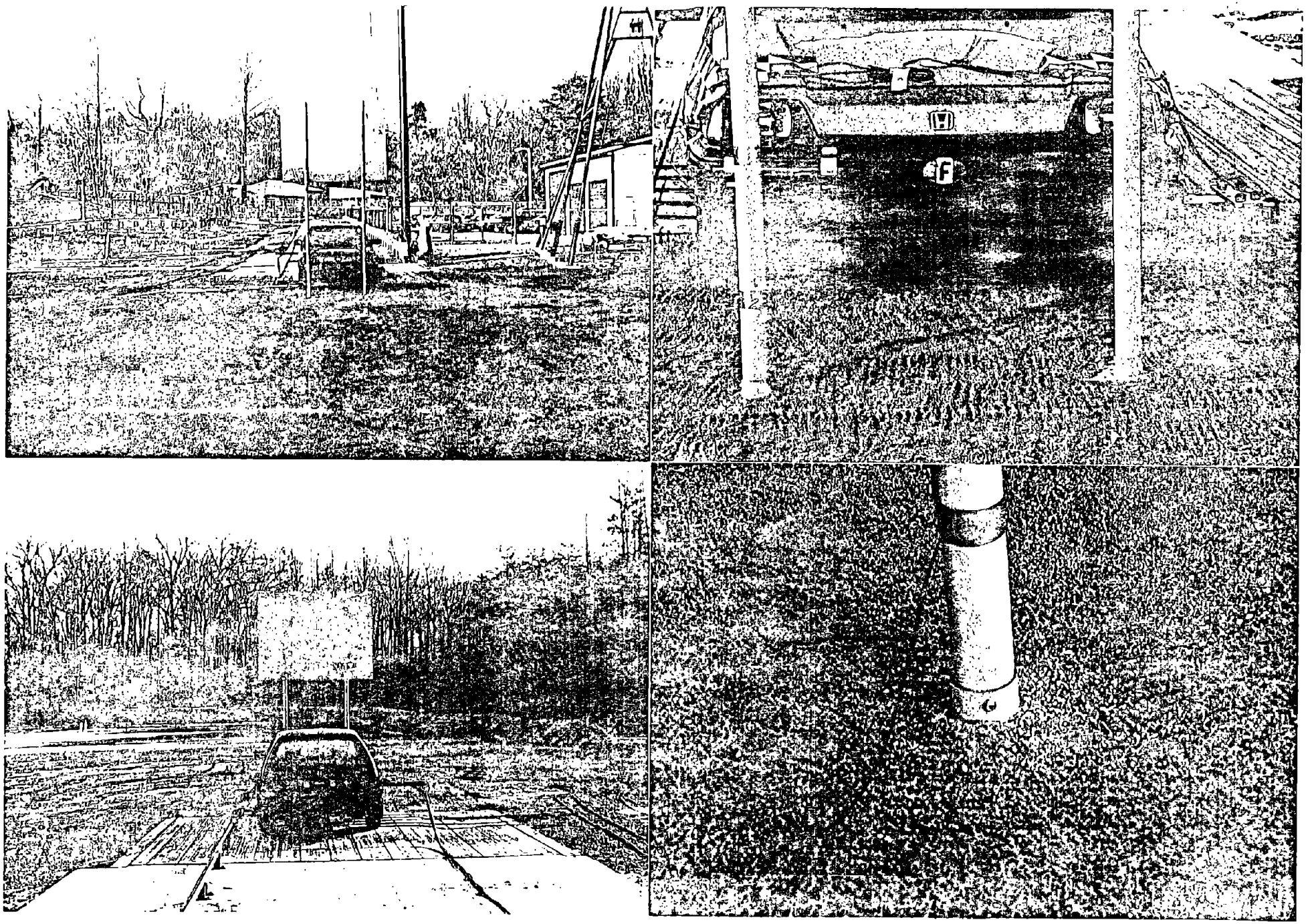


Figure 9. Additional pretest photographs of test 92F036.

Figure 10. Post-test photographs of test 92F036.

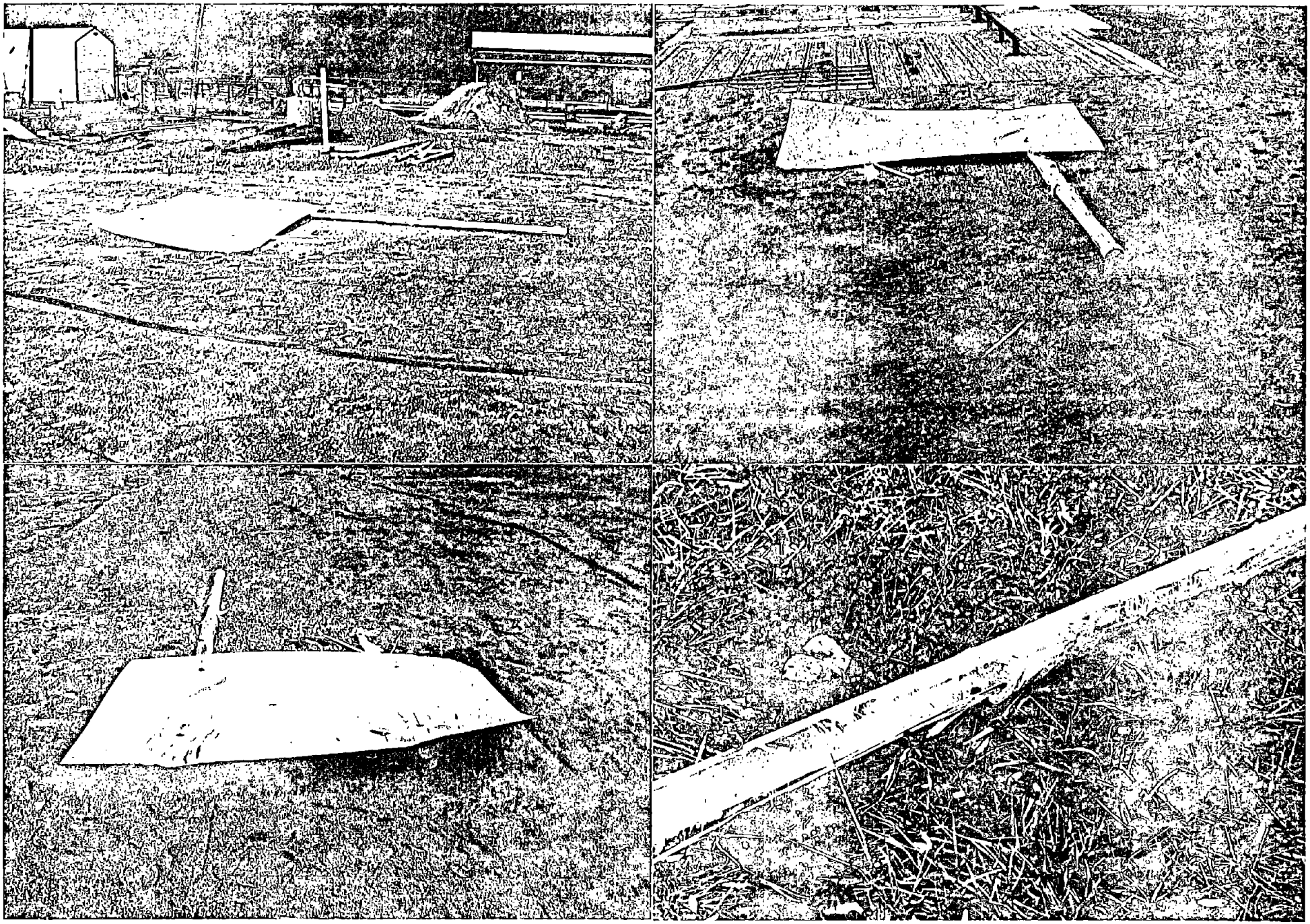
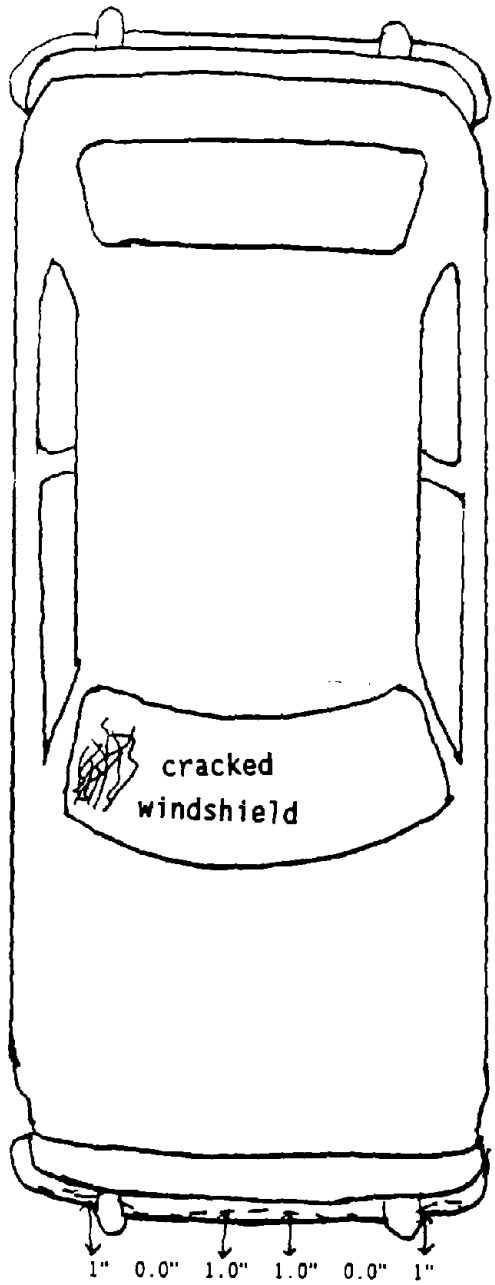


Figure 11. Additional post-test photographs of test 92F036.



------- Post test

1 in = 25.4 mm

Figure 12. Sketch of vehicle crush, test 92F036.

7. REFERENCES

(1) Jarvis D. Michie, *Recommended Procedures for the Safety Performance Evaluation of Highway Appurtenances*, National Cooperative Highway Research Program Report Number 230, March 1981.