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Testing of Small and Large Sign Support Systems FOIL Test Number: 92F011

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Research and Development
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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 20 mi/h (8.9 m/s), test 92F011. The vehicle used for these test was a 1985 Honda Civic. The purpose of this test was to evaluate the low-speed safety performance of a dual 4-lb/ft (6-kg/m) u-channel sign support with a 5-in (127-mm) overlap splice 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 (102 mm), and that there can be no occupant compartment intrusion. The test results indicate that the dual 4-lb/ft (6-kg/m) u-channel sign support with a 5-in (127-mm) overlap splice does not meet all of the applicable performance criteria for roadside safety appurtenances in weak soil specified by the FHWA.

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

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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 Appropnate rounding should be made to comply with Section 4 of ASTM E380

(Revised August 1992)

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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 20 mi/h (8.9 m/s), test 92FOll. The vehicle used for this test was a 1984 Honda Civic. The purpose of this test was to evaluate the low- speed safety performance of a dual legged steel 4 lb/ft (5.95 kg/m) u-channel sign support. 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 inches (102 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 20 mi/h (8.9 m/s). 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
92FOll	'84 Honda Civic	1850	20	2 leg steel 4 lb/ft	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 pounds (839 kg). The actual weight of the test vehicle was 1850 pounds (839 kg). After ballasting, the vehicles' inertial properties were remeasured.

4. SIGN SUPPORT

The sign support system consisted of two 4 lb/ft (5.95 kg/m) u-channel steel posts 12 ft, 1 in (3.7 m) long. Attached to each leg was an additional 3 ft-1 in (0.9 m) section of 4 lb/ft (5.95 kg/m) u-channel. The two sections were spliced such that a 5 in (0.127 m) overlap was obtained. The splice was bolted together using two 5/16 in (8 mm) diameter grade 9 bolts. Each bolt was passed through the lower u-channel first then through the upper u-channel. A threaded spacer (washer) was installed between the two sections of u-channel. The legs were buried in NCHRP Report 230 S-2 weak soil (sand) such that 1 in (25 mm) of the splice was below ground level. Attached to the 2 legs was a 5-ft high by 6.5-ft (1.5-m by 2.0-m) wide aluminum sign panel. The aluminum panel was 0.125 in (3 mm) thick and was fastened to the u-channel using four 5/16 in (8 mm) bolts with a nut and washer and was installed 7 ft

(2.1 m) above ground. The two legs were installed 3.5 ft (1.1 m) apart. The whole sign support system was assembled and inserted in a hole in the weak soil. The hole was backfilled in 6-in (0.152-m) lifts and compacted until the final grade was reached. Figure 1 is a drawing of the sign support system. Figure 2 is a copy of the splice joint instructions followed for installation of the sign system.

5. TEST RESULTS - 20 MI/H (8.9 M/S), TEST 92F011

The test vehicle was accelerated to 20.3 mi/h (29.7 ft/s (9.1 m/s)) prior to impacting the sign support. The centerline of the test vehicle was aligned with the mid point between the two sign legs.

The bumper made contact with both sign legs and began to collapse and the u-channel legs began to bend away from the vehicle. The force required to break the four grade nine splice bolts was higher than the resistive force the weak soil could maintain. The u-channel began to plow through the weak soil. Additional energy was consumed pushing the u-channel through the weak soil and bending each sign leg. The breakaway mechanism, breaking the splice bolts, activated too late in the impact event for the vehicle to pass through the sign system. The splice bolts failed while the vehicle climbed the sign legs pushing the sign over backwards. Two grade 9 bolts, the upper bolt of each leg failed in tension while the lower two bolts failed in shear.

The brunt of the impact occurred to outside edges of each bumper support. The bumper was much softer than the bumper supports therefore damage to the vehicle consisted of damage to the bumper and other plastic elements but no structural damage. Both head light sockets were damaged. The maximum deflection of 9.5 in (0.241 m) was recorded at the left head light cavity. None of the sign components impaled the occupant compartment.

The sign damage consisted of bent and twisted u-channel and four broken grade 9 bolts. The upper and lower sections of the spliced leg were bent and not reusable. The lower sections bent approximately 1 ft (0.3 m) below the groundline. The aluminum sheet panel was in good condition after the test.

The occupant impact velocity using the 2 ft (0.6 m) flail space model outlined in NCHRP Report Number 230, was determined to be 21.4 ft/s (6.5 m/s). The occupant impact velocity was reached 0.184 s into the crash event. The ridedown acceleration was 3.0 g's. The peak force (300 Hz data) for the impact event was 12.3 g's (22.7 kips (101 kN)). Because the sign stopped the vehicle before the vehicle could exit the sign system, the vehicle change in velocity was equal to the impact speed. The actual vehicle change in velocity was calculated to be 28.4 ft/s (8.7 m/s).

Photographs during the impact event are presented in figure 3. A summary of the impact conditions and the test results is presented in figure 4. Figures 5 through 8 are plots of data collected during the test. Pre and post-test photographs of the vehicle and sign support system are presented in figures 9 through 12. The measured crush was confined to outside of each bumper support. A sketch depicting the crush is presented in figure 13.

6. CONCLUSION

The test results indicate that the small sign support system does not meet all of the applicable criteria for the low speed test in weak soil. There was no occupant compartment intrusion and no significant stub remaining after the test, however the occupant impact velocity was 21.4 ft/s (6.5 m/s) which is not less than or equal to the 16 ft/s (4.9 m/s) limit specified by the FHWA.

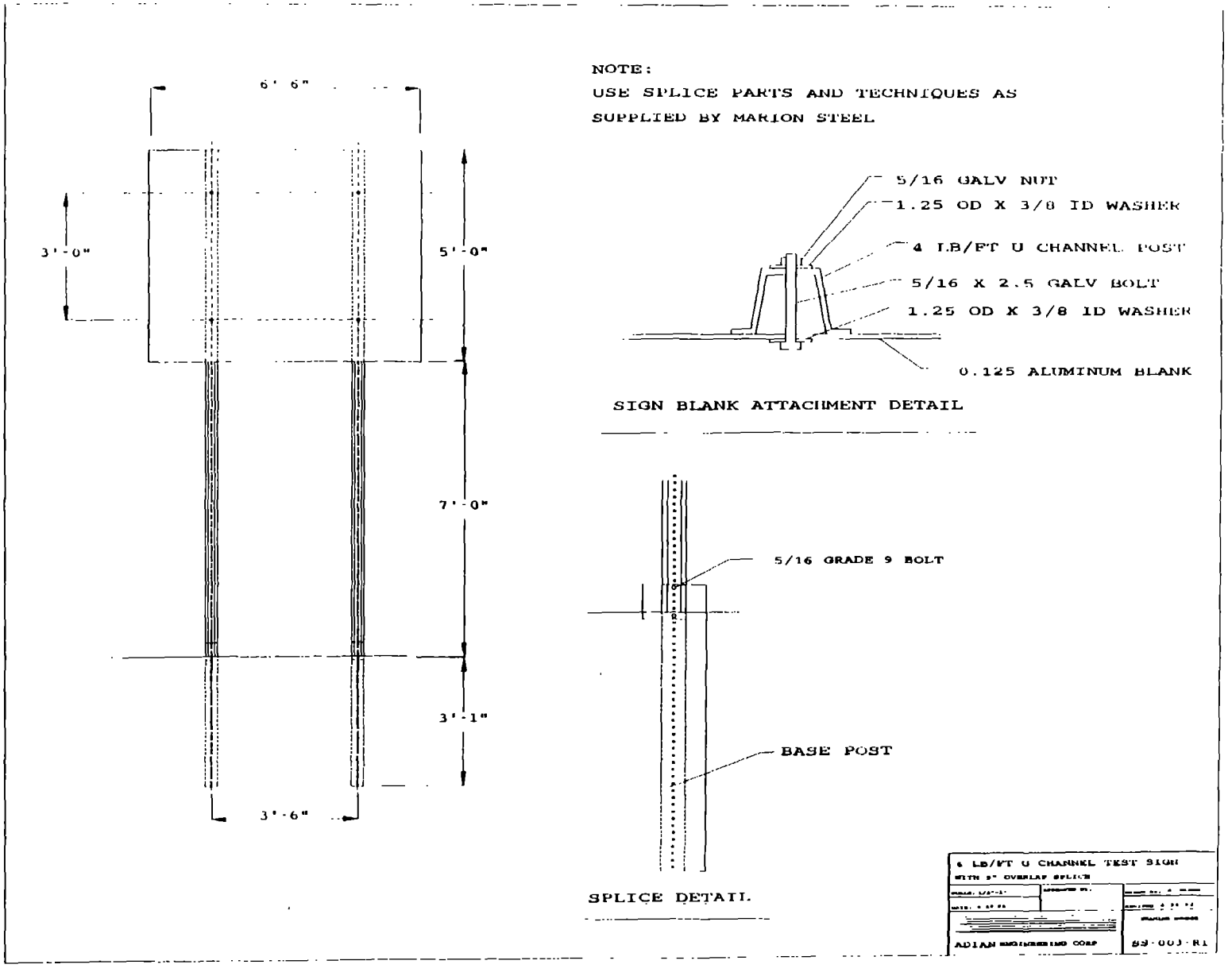


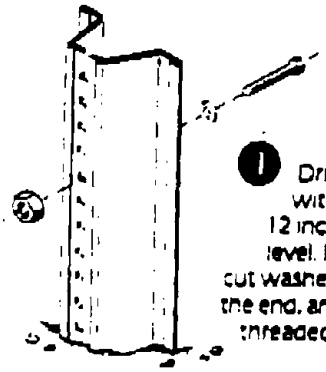
Figure 1. Sketch of small sign support.

THE LAP SPLICE™ U-CHANNEL BREAKAWAY SYSTEM

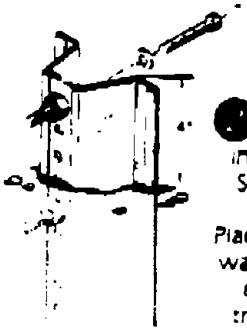
Patent Pending

Installation

The LAP SPLICE system consists of four washers and two specially designed Grade 9 bolts, nuts and threaded spacers. This system is FHWA approved *only* when used to lap splice Marion Steel RIB-BAK® u-channel sign and ground posts.

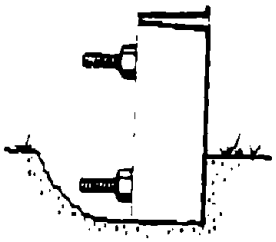


1. Drive ground post to within approximately 12 inches above ground level. Place one bolt and cut washer in fifth hole from the end, and securely tighten threaded spacer onto bolt.

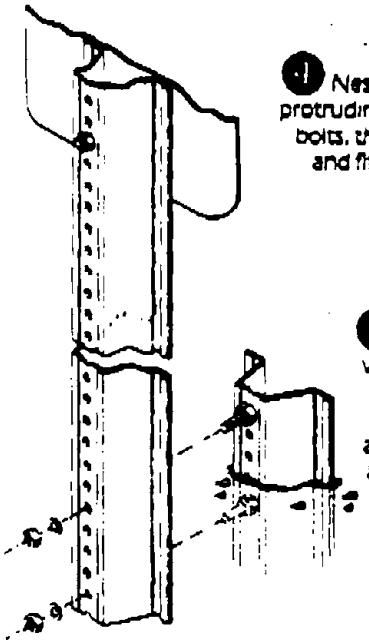


2. Drive ground post to 4 inches above ground level. Some loosening of top soil may make driving easier. Place remaining bolt and cut washer in first hole from the end, and securely tighten threaded spacer onto bolt.

MARION STEEL CO.



3. Dig out approximately 2 inches from around back of ground post to allow room for top post to be attached.



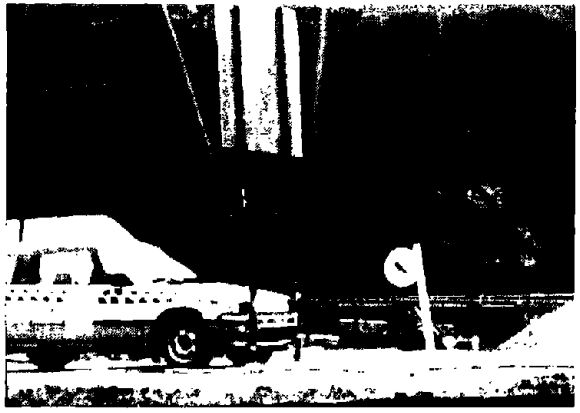
4. Nest top post over protruding ground post bolts, through the first and fifth holes of the top post.

5. Place a lock washer and nut on each bolt. Tighten nuts and tamp earth around ground post firmly.

MARION STEEL CO.

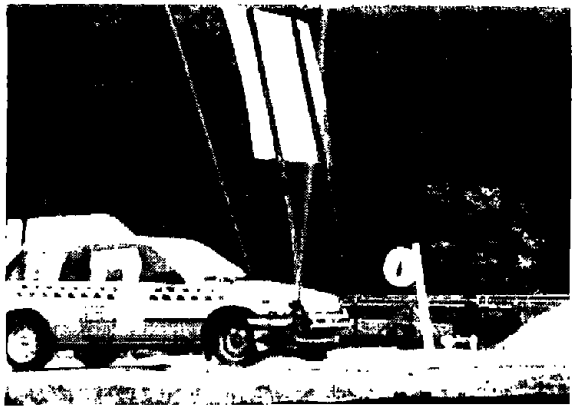
912 Cheney Avenue
Marion, Ohio 43302
614/383-4011

Figure 2. U-channel splice detail, supplied by Marion Steel.



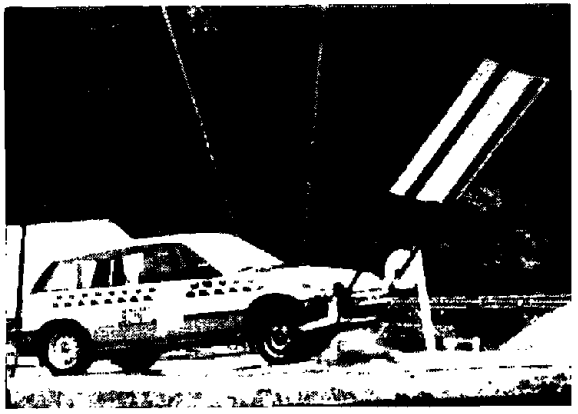
0.016 s

0.052 s

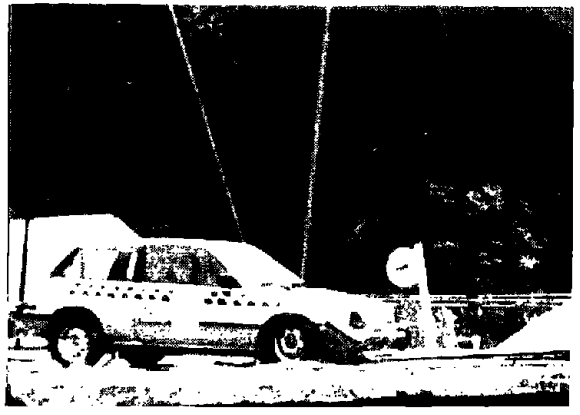


0.100 s

0.150 s

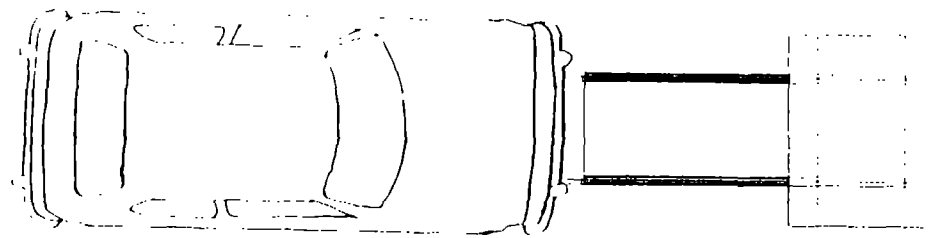


0.310 s



0.690 s

Figure 3. Test photographs during impact, test 92F011.



Test number..... 92F011

Date..... May 19, 1992

Test vehicle.....1984 Honda Civic

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

Test article.....Small Sign Support

Material.....4 lb/ft u-channel 5 inch splice 2-Leg, 2-Hit

Embedment depth.....3 feet

Panel type...5 foot by 6.5 foot by 0.125 thick aluminum sheet

Height.....11 feet

Foundation.....S-2 Weak Soil

Impact speed.....29.7 ft/s (9.1 m/s)

Impact angle.....0 degrees

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

Vehicle analysis:	Observed	Design/Limit
Longitudinal:		
Occupant Delta V at 2 ft	21.4 ft/s	≤16 ft/s
Ridedown Acceleration	3.0 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.....4.2 g's
Lateral.....NA

Vehicle Damage (TAD).....12-FC-2
(VDI).....12FDEN1

Vehicle crush.....9.5 inches

Vehicle velocity change.....28.4 ft/s

Exit angle.....no exit

Figure 4. Summary of test 92F011.

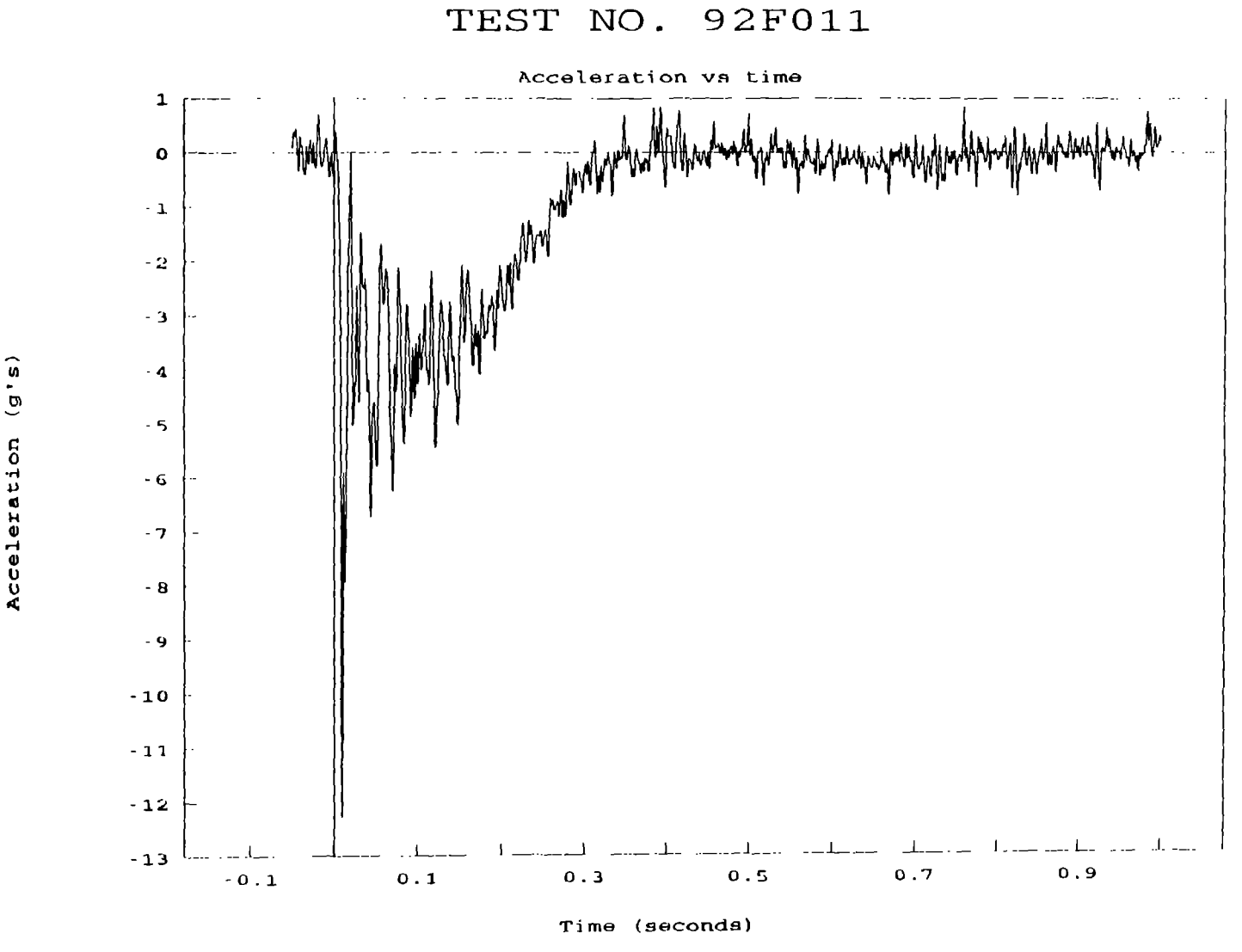


Figure 5. Acceleration versus time, X-axis, test 92F011.

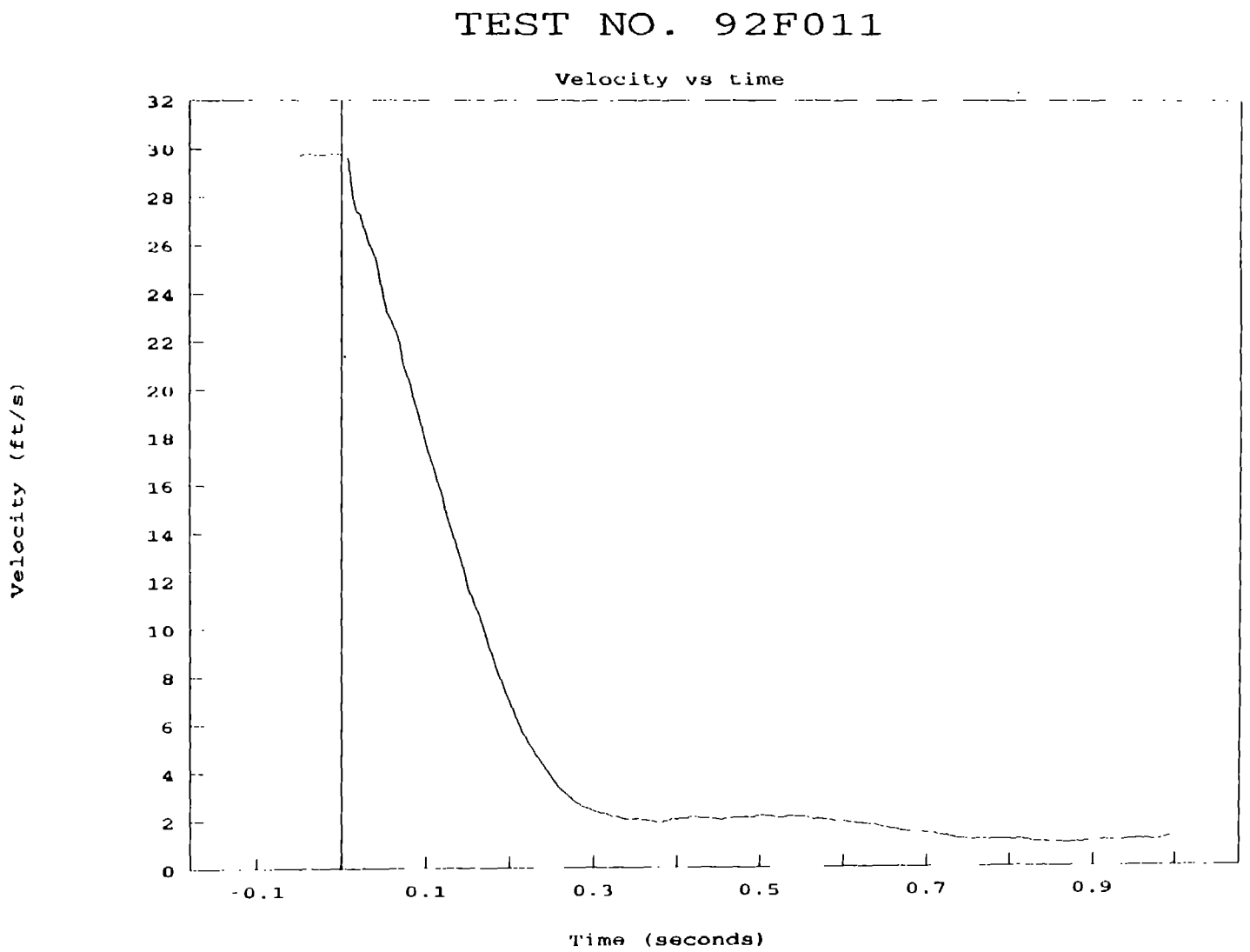


Figure 6. Velocity versus time, X-axis, test 92F011.

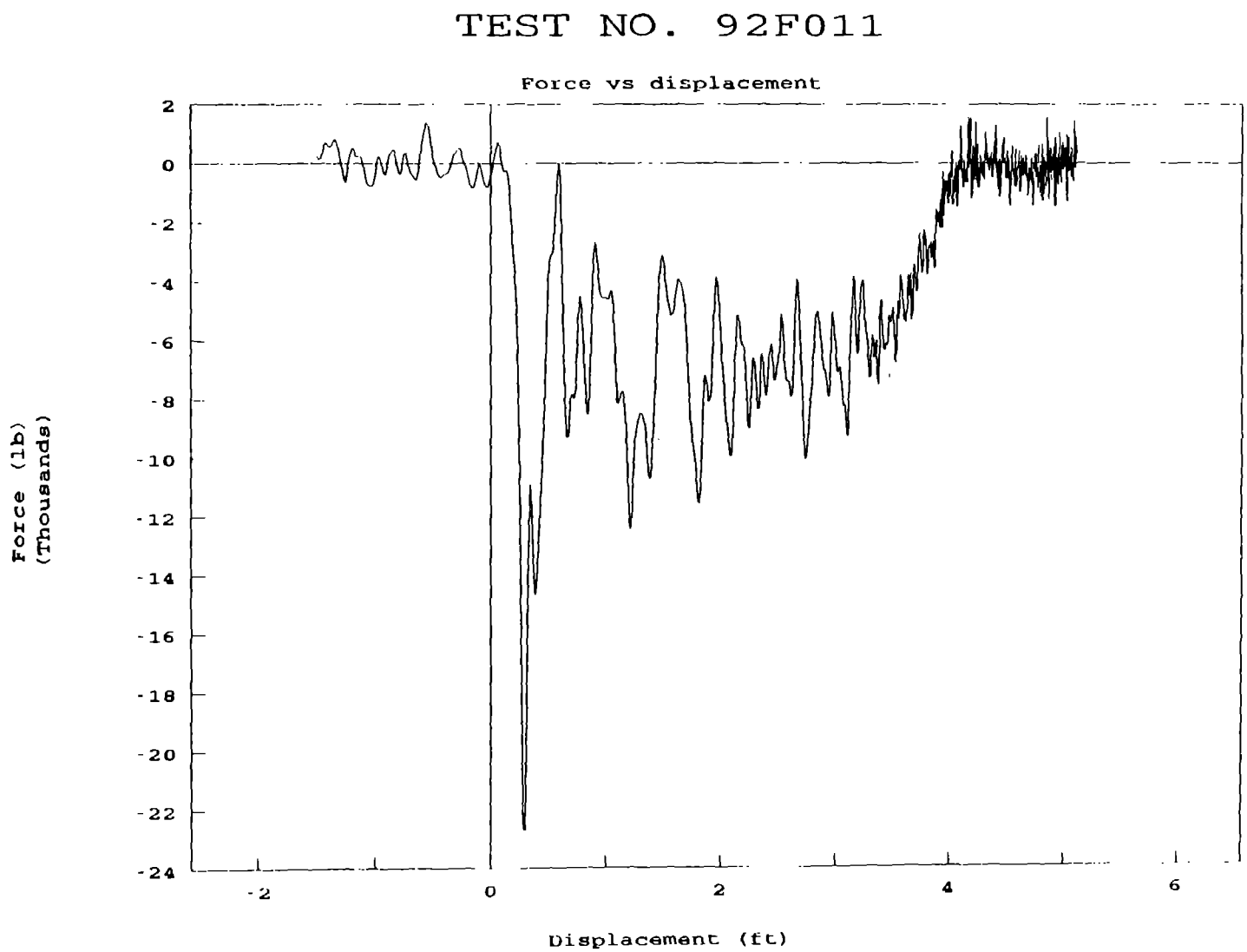


Figure 7. Force versus displacement, X-axis, test 92F011.

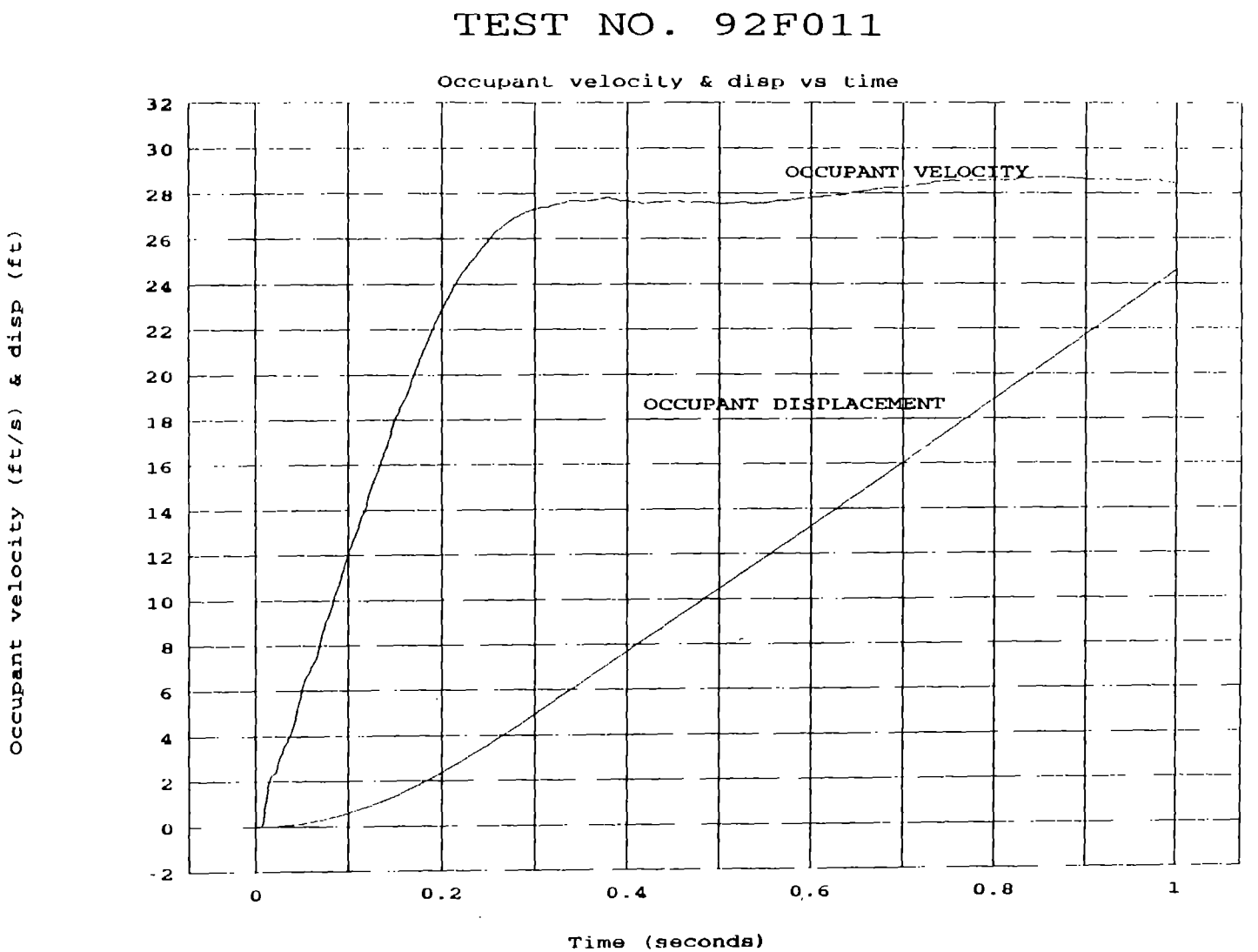


Figure 8. Occupant velocity and relative displacement versus time, X-axis, test 92F011.

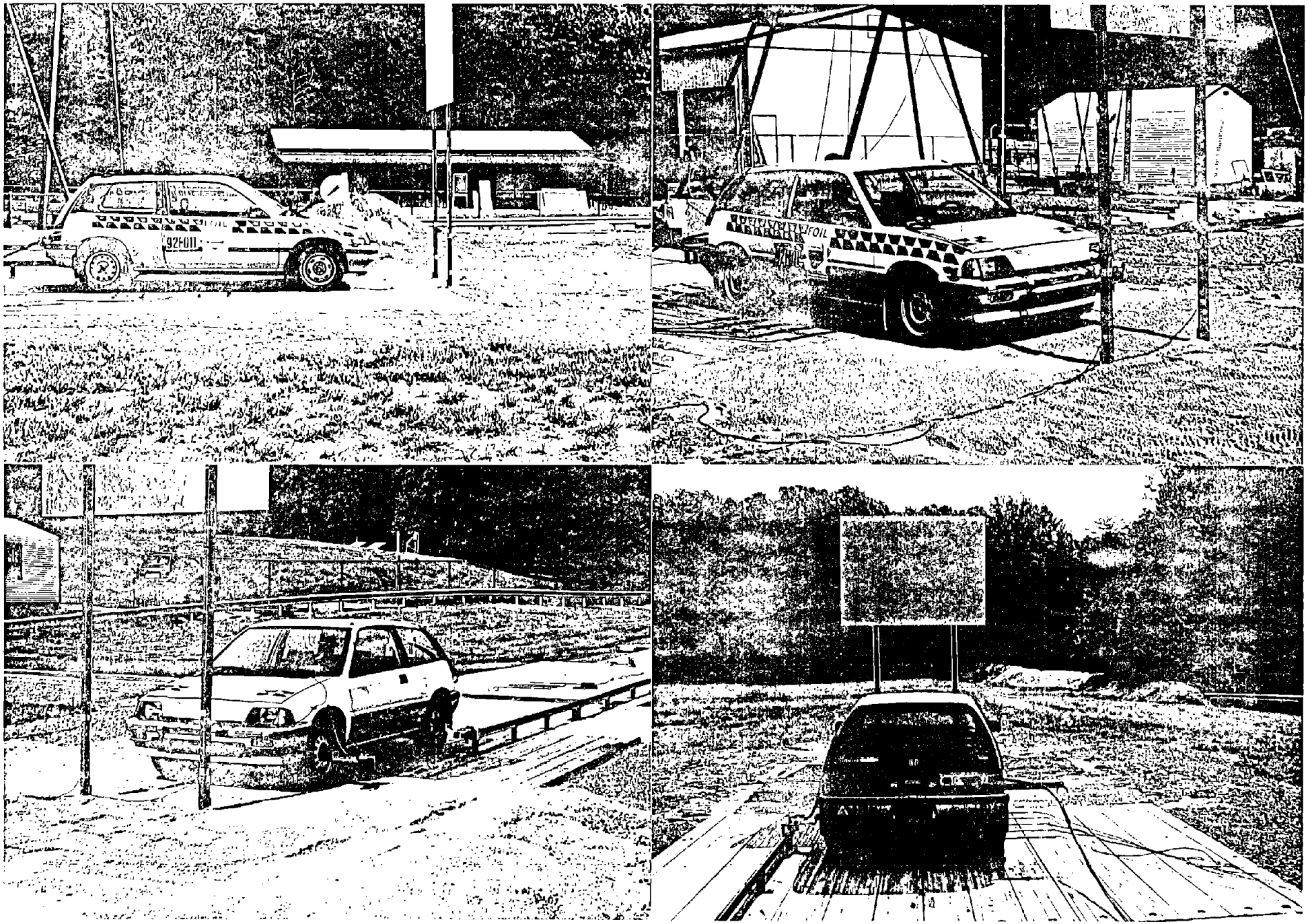


Figure 9. Pretest photographs of test 92F011.

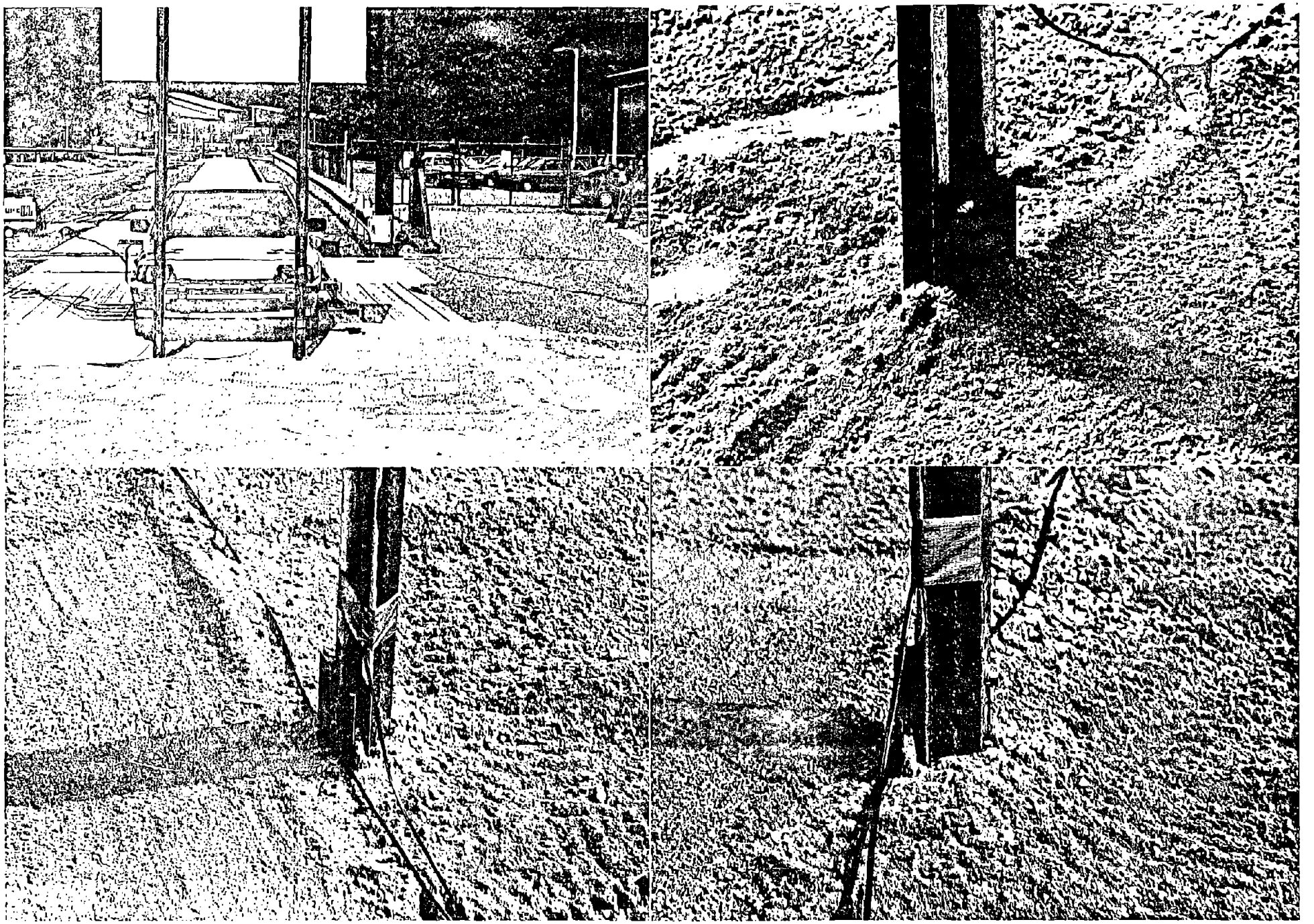


Figure 10. Additional pretest photographs of test 92F011.

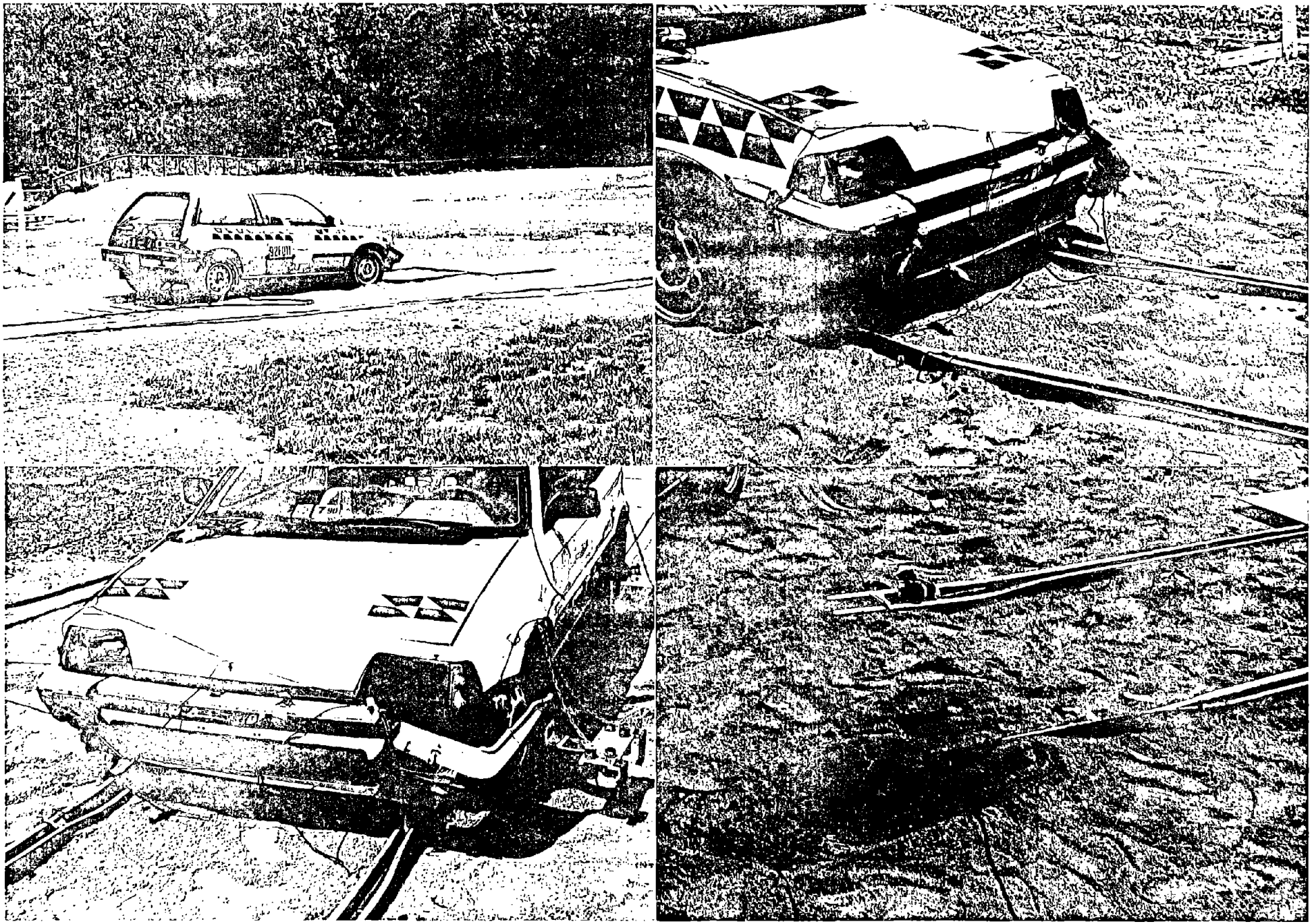


Figure 11. Post-test photographs of test 92F011.

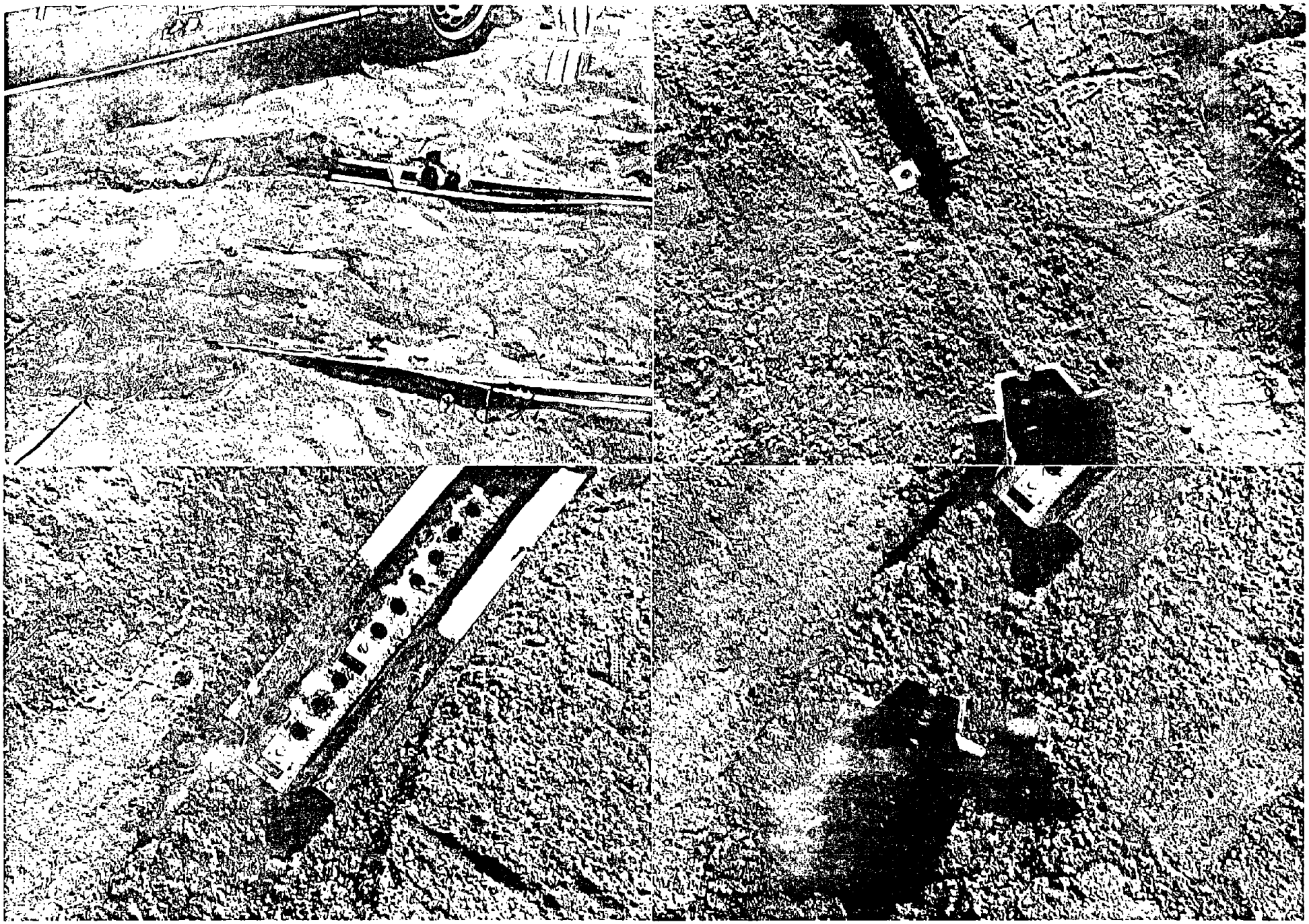
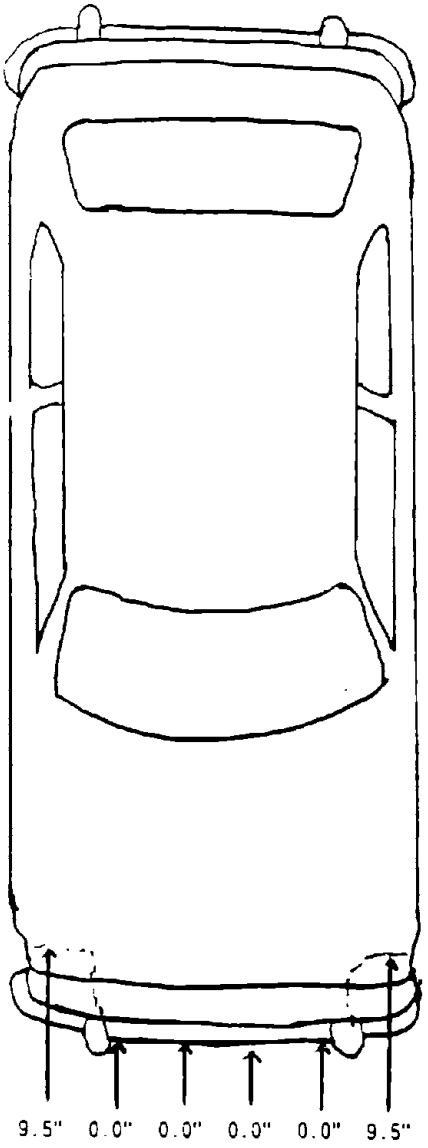


Figure 12. Additional post-test photographs of test 92F011.



------- Post test

1 in = 2.54 cm

Figure 13. Sketch of vehicle crush, test 92F011.

8. REFERENCES

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