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Testing of Small and Large Sign Support Systems FOIL Test Numbers: 92F009 and 92F010

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15. Supplementary Notes

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16. Abstract

This test report contains the results of two crash tests performed at the Federal Outdoor Impact Laboratory (FOIL) in McLean, Virginia. The tests were performed on a small sign support system at 20 mi/h (8.9 m/s), test 92F009 and 60 mi/h (26.8 m/s), test 92F010. The vehicles used for these tests were 1985 Honda Civics. The purpose of these tests was to evaluate the low- and high-speed safety performance of a dual 4-in by 6-in (102-mm by 152-mm) pressure treated wood post 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 in (102 mm), and that there can be no occupant compartment intrusion. The test results indicate that the dual 4-in by 6-in (102-mm by 152-mm) wood post sign support system meets all of the applicable performance criteria for roadside safety appurtenances specified by the FHWA.

17. Key Words	18. Distribution Statement
Acceleration, occupant impact velocity, weak soil, 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. Appropriate 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 two crash tests performed at the Federal Outdoor Impact Laboratory (FOIL) in McLean, Virginia. The tests were performed on a small sign support system, one at 20 mi/h (8.9 m/s), test 92F009, and one at 60 mi/h (26.8 m/s), test 92F010. The vehicle used for these tests were Honda Civics. The purpose of these tests was to evaluate the low-speed and high-speed safety performance of a dual-legged wooden 4-by-6 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 in (102 mm), and that there can be no occupant compartment intrusion.

2. TEST MATRIX

Two tests were performed on a small sign support system. The test speeds for the tests were 20 mi/h (8.9 m/s) and 60 mi/h (26.8 m/s). The sign was buried in NCHRP Report Number 230, S-2 weak soil.[1] A summary of the test conditions are presented in table 1.

Table 1. Test matrix.

Test Number	Test Vehicle	Test Weight (lb)	Test Speed (mi/h)	Test Article Description	Impact Location
92F009	'86 Honda Civic	1850	20	2 leg wood 4x6	center
92F010	'85 Honda Civic	1860	60	2 leg wood 4x6	center

3. VEHICLE

The test vehicles were a 1986 and a 1985 Honda Civic two door hatchbacks with manual transmissions. Prior to the tests, the vehicles' fluids were drained and their inertial measurements measured. The vehicles were stripped of certain components which made space for the installation of test equipment. The vehicles were ballasted with data acquisitions systems, transducers, a brake system and weight plates (if necessary) to bring their inertial weights to approximately 1850 lb (839 kg). The actual weights of the test vehicles were 1850 lb (839 kg) and 1860 lb (844 kg). After ballasting, the vehicles' inertial properties were remeasured.

4. SIGN SUPPORT

The sign support system consisted of two 4-in by 6-in (102-mm by 152-mm) wooden legs 15 ft (4.6 m) long. The actual dimensions of the sign legs were 3.5 in by 5.5 in (89 mm by 140 mm). Three feet (0.9 m) of each leg was buried in NCHRP Report 230 S-2 weak soil (sand). Attached to the 2 legs was a 4-ft high by 10-ft (1.2-m by 3.0-m) wide aluminum sign panel. The final panel was assembled from four 1-ft by 10-ft (0.3-m by 3.0 m) extruded aluminum panels and was installed 7 ft (2.1 m) above ground. Two 1.5-in (30-mm) holes were drilled in each sign leg. The holes were drilled 4 in (0.102 m) and 18 in (0.457 m) above ground level. 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 the attachment detail for the sign panel.

5. TEST RESULTS - 20 MI/H (8.9 M/S), TEST 92F009

The test vehicle was accelerated to 20.1 mi/h (29.5 ft/s (9.0 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. The bumper did not crush significantly during the impact event. The breakaway force was low enough not to cause severe damage to the front end of the vehicle. The left leg of the sign fractured at the hole 4 in (0.102 m) above ground 0.016 s after initial contact. The left leg never fractured at the hole 18 in (0.457 m) above ground level. The right leg fractured 0.036 s after impact. The fracture occurred at the upper hole and not the lower hole. Because the right leg took longer to fracture than the left leg, the vehicle yawed clockwise approximately 15 degrees. The vehicle continued to pass over the remaining section of the right leg. The remaining piece broke 12 in (0.305 m) below ground level as the vehicle passed over. A second significant impact occurred at 0.412 s, as the sign fell on top of the vehicle with the center of the panel striking the roof/windshield sill. The impact was enough to dent the roof and cause the windshield to crack. The sign panel with the broken legs attached remained on the hood of the vehicle for the remainder of the runout time. The brakes were applied and the sign slid off the vehicle as the vehicle came to rest.

Damage to the vehicle consisted of minor damage to the bumper and a dent approximately 0.5 in (13 mm) deep along the roof/windshield sill. Since no considerable damage was inflicted on the front end of the vehicle no crush measurements were recorded. The damage to the roof was slight and the windshield was cracked but did not shatter. None of the sign components impaled the occupant compartment.

Damage to the sign support consisted of two fractured wooden legs. The upper portions remained attached to the sign panel. The embedded 3-ft (0.9-m) sections of the sign legs remained buried in the weak soil. Strands of wood fibers remained intact on the right leg between the buried section and length of leg up to the upper hole. The panel was in good condition after the test.

The occupant impact velocity using the 2-ft (0.6-m) flail space model outlined NCHRP Report Number 230, was determined to be 8.6 ft/s (2.6 m/s). The occupant impact velocity was reached 0.286 s into the crash event. The ridedown acceleration was 3.4 g's. The ridedown acceleration was attributed to the secondary impact between vehicle and sign panel as the sign fell on top of the vehicle. The peak force (300 Hz data) for the impact event was 16.5 g's (30.7 kips (136 kN)). Because the sign remained in contact with vehicle the vehicle change in velocity was calculated to be 14.3 ft/s (4.4 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. Because no residual crush was recorded a sketch depicting the crush was omitted from this report.

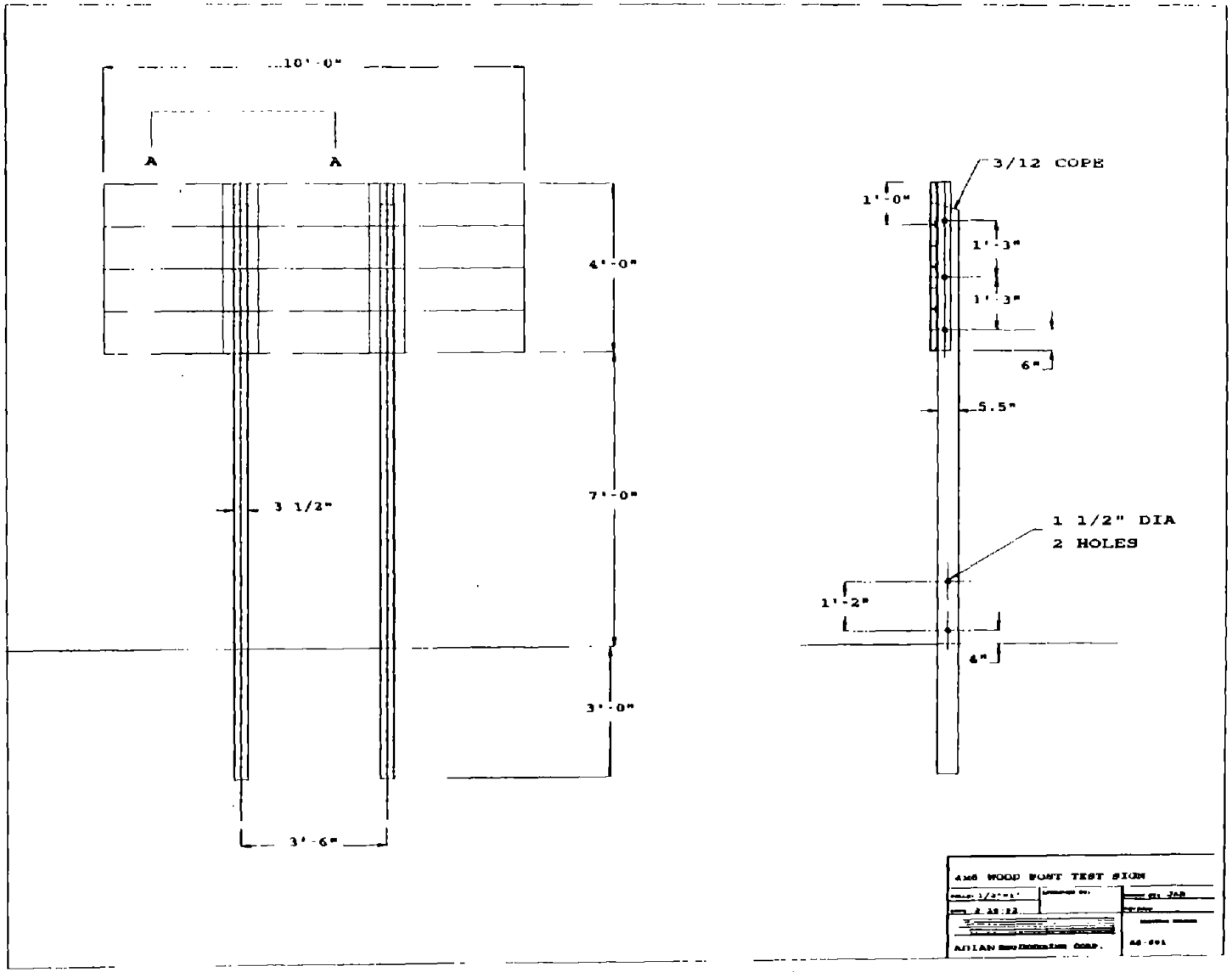
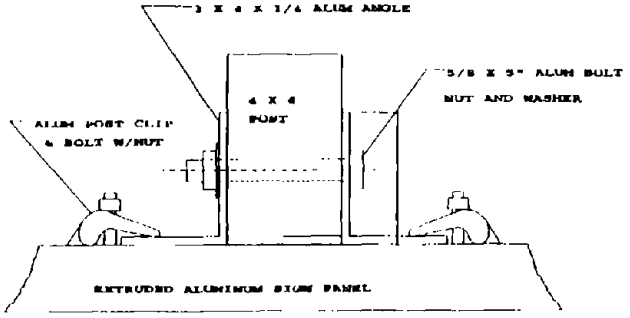


Figure 1. Sketch of small sign support.



VIEW A-A

Figure 2. Sketch of small sign support attachment detail.

0.016 s

0.038 s

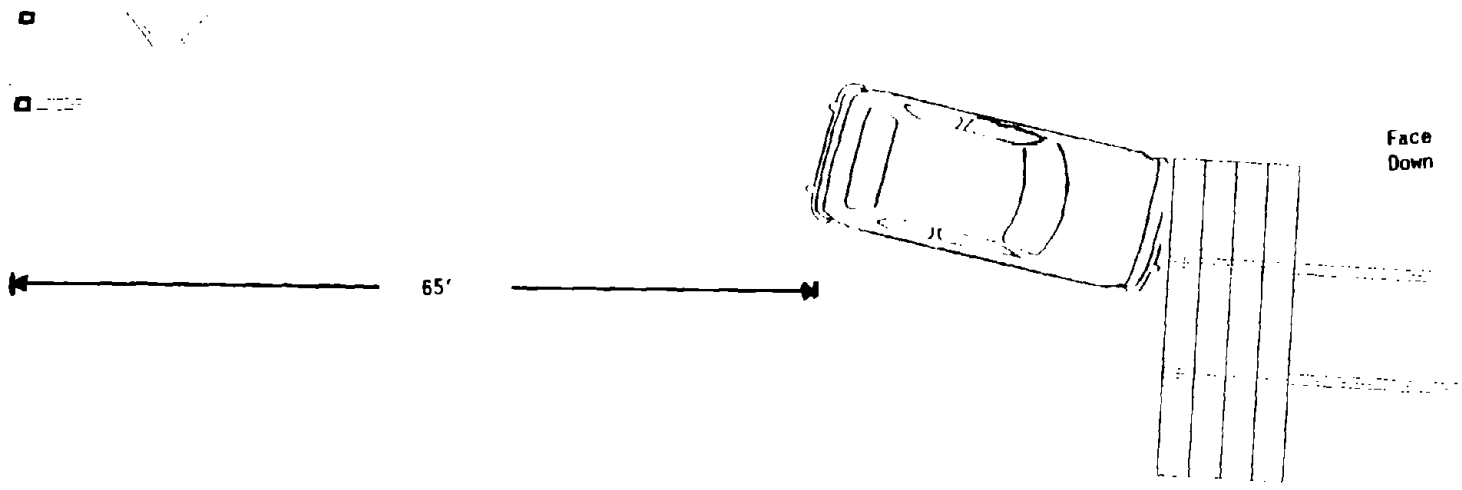
0.104 s

0.416 s

0.546 s

0.870 s

Figure 3. Test photographs during impact, test 92F009.



Test number..... 92F009

Date..... May 1, 1992

Test vehicle.....1986 Honda Civic

Vehicle weight.....1860 lb (844 kg)

Test article.....Small Sign Support

Material.....4 by 6 wood, two 1.5" holes
2-Leg, 2-Hit

Embedment depth.....3 feet

Panel type.....4 foot by 10 feet extruded aluminum

Height.....11 feet

Foundation.....S-2 Weak Soil

Impact speed.....29.5 ft/s (8.9 m/s)

Impact angle.....0 degrees

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

Vehicle analysis:	Observed	Design/Limit
Longitudinal:		
Occupant Delta V at 2 ft	8.6 ft/s	≤16 ft/s
Ridedown Acceleration	3.4 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.....3.4 g's
Lateral.....NA

Vehicle Damage (TAD).....12-FC-1
(VDI).....12FDAU1

Vehicle crush.....no residual crush

Vehicle velocity change.....14.3 ft/s

Exit angle.....15 degrees

Figure 4. Summary of test 92F009.

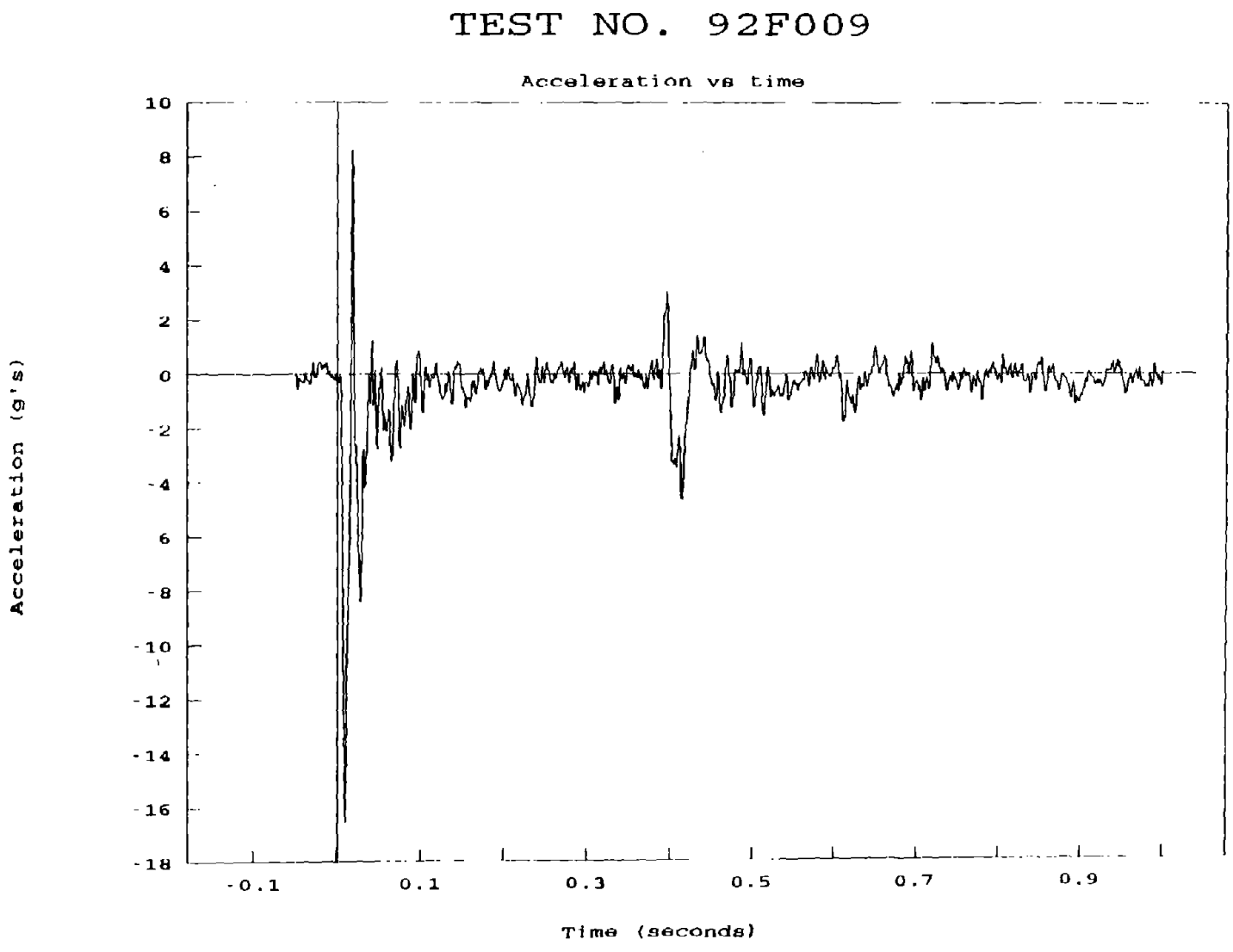


Figure 5. Acceleration versus time, X-axis, test 92F009.

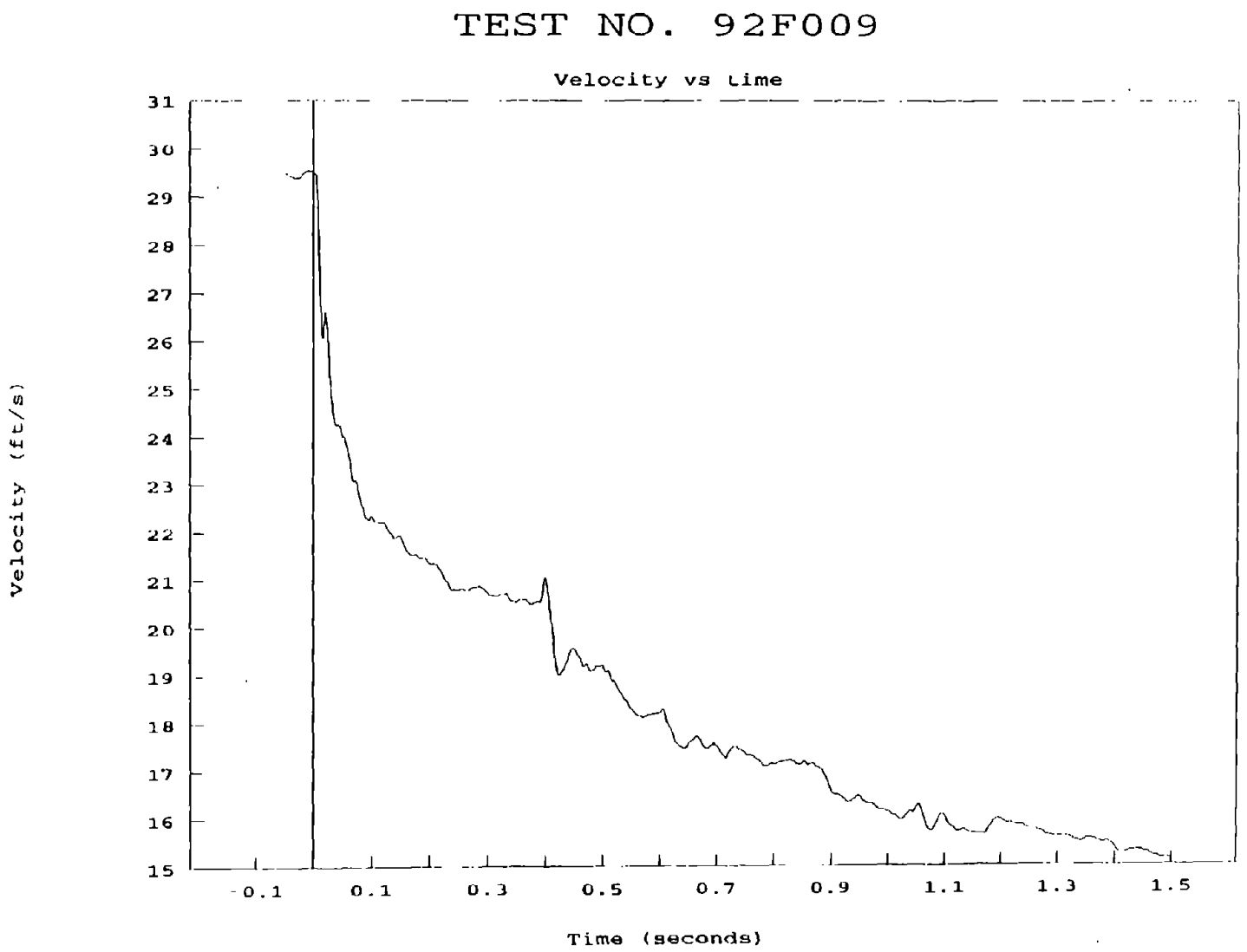


Figure 6. Velocity versus time, X-axis, test 92F009.

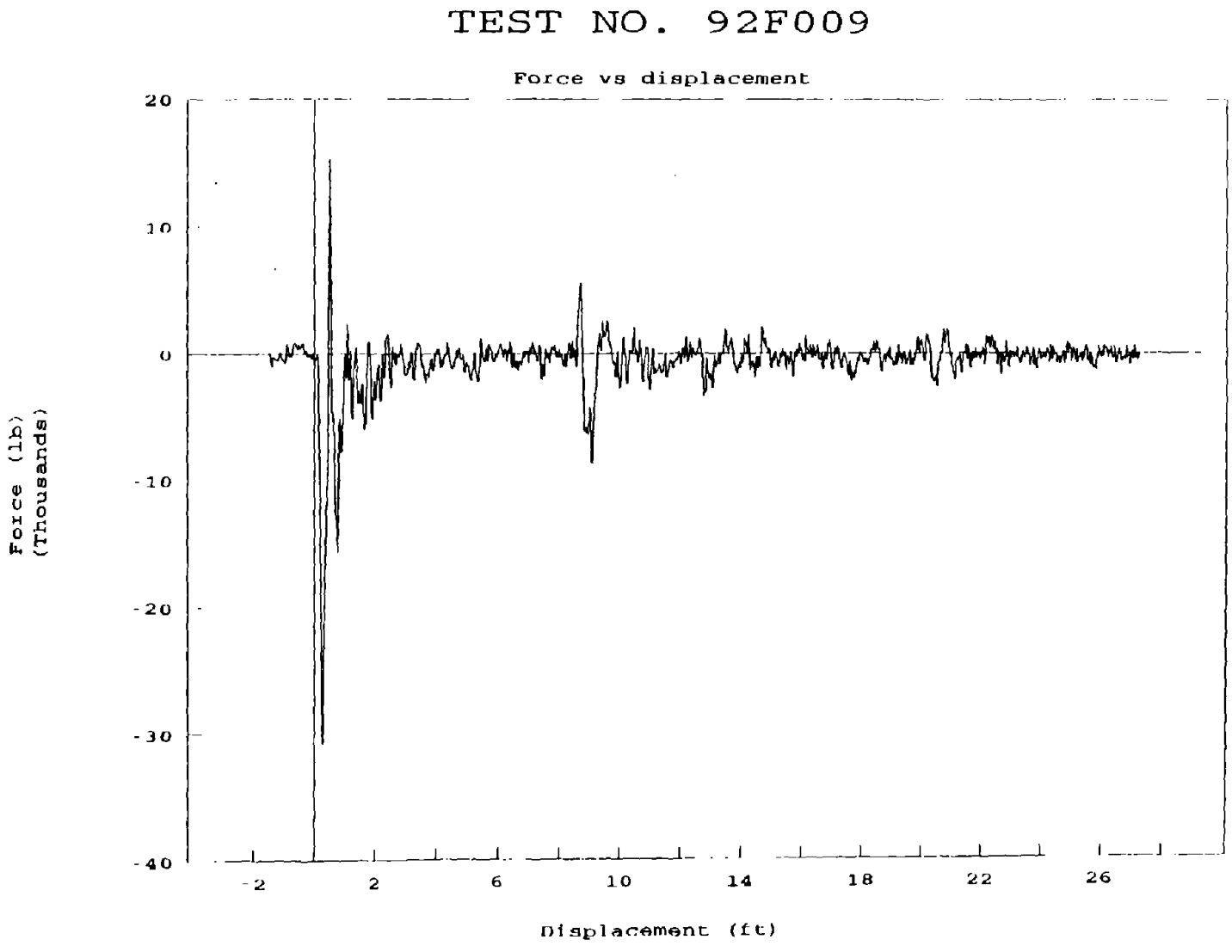


Figure 7. Force versus displacement, X-axis, test 92F009.

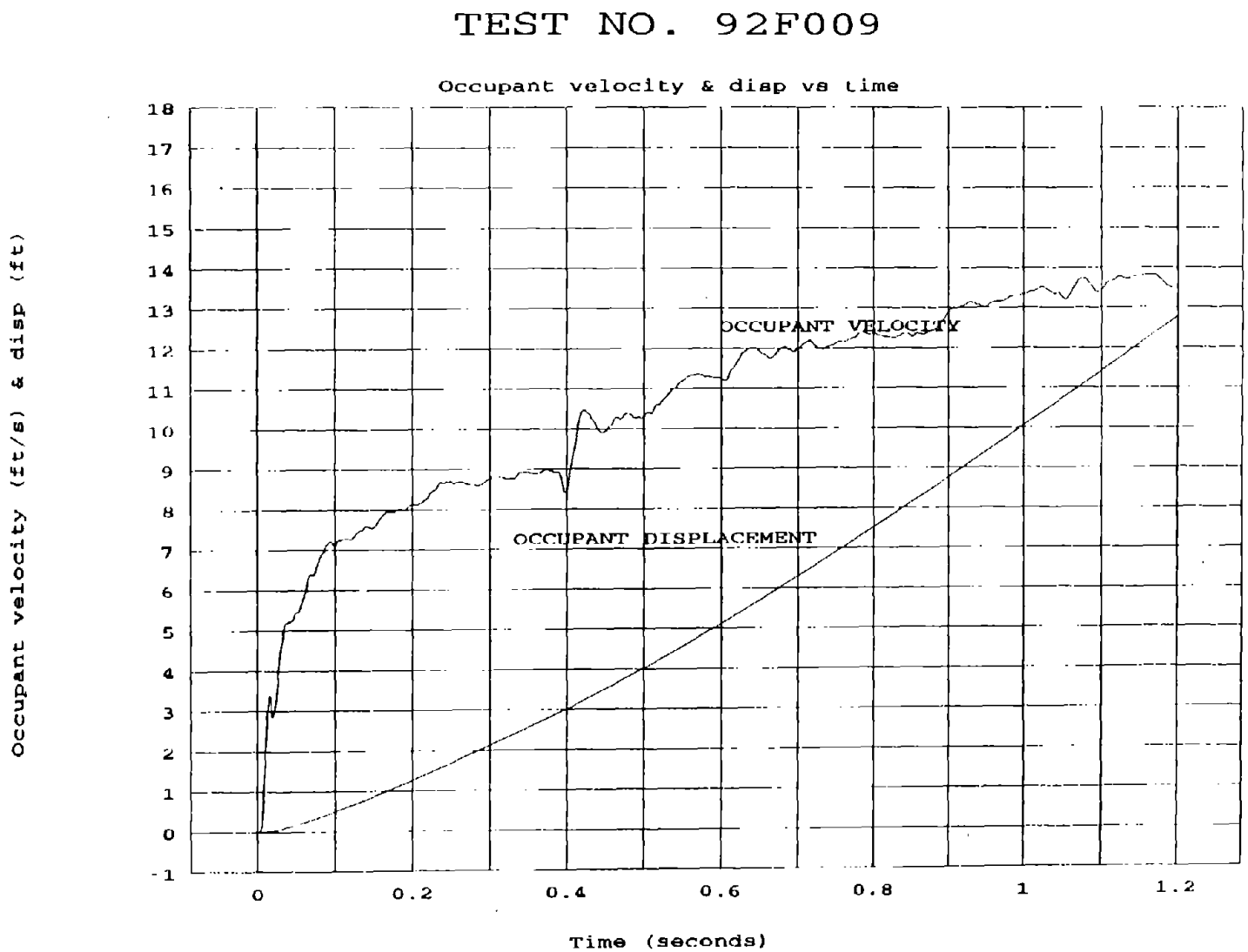


Figure 8. Occupant velocity and relative displacement versus time, X-axis, test 92F009.

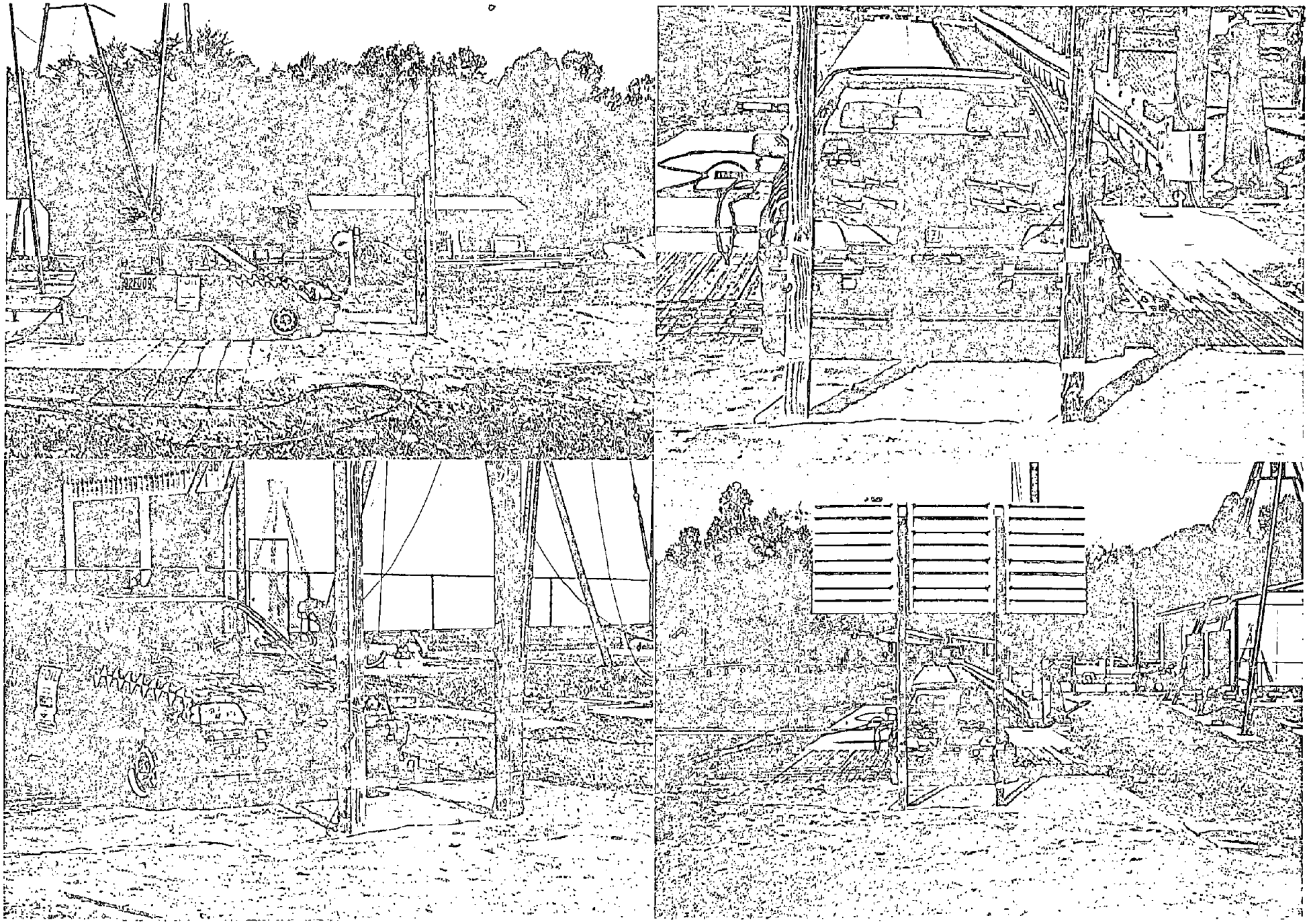


Figure 9. Pretest photographs of test 92F009.

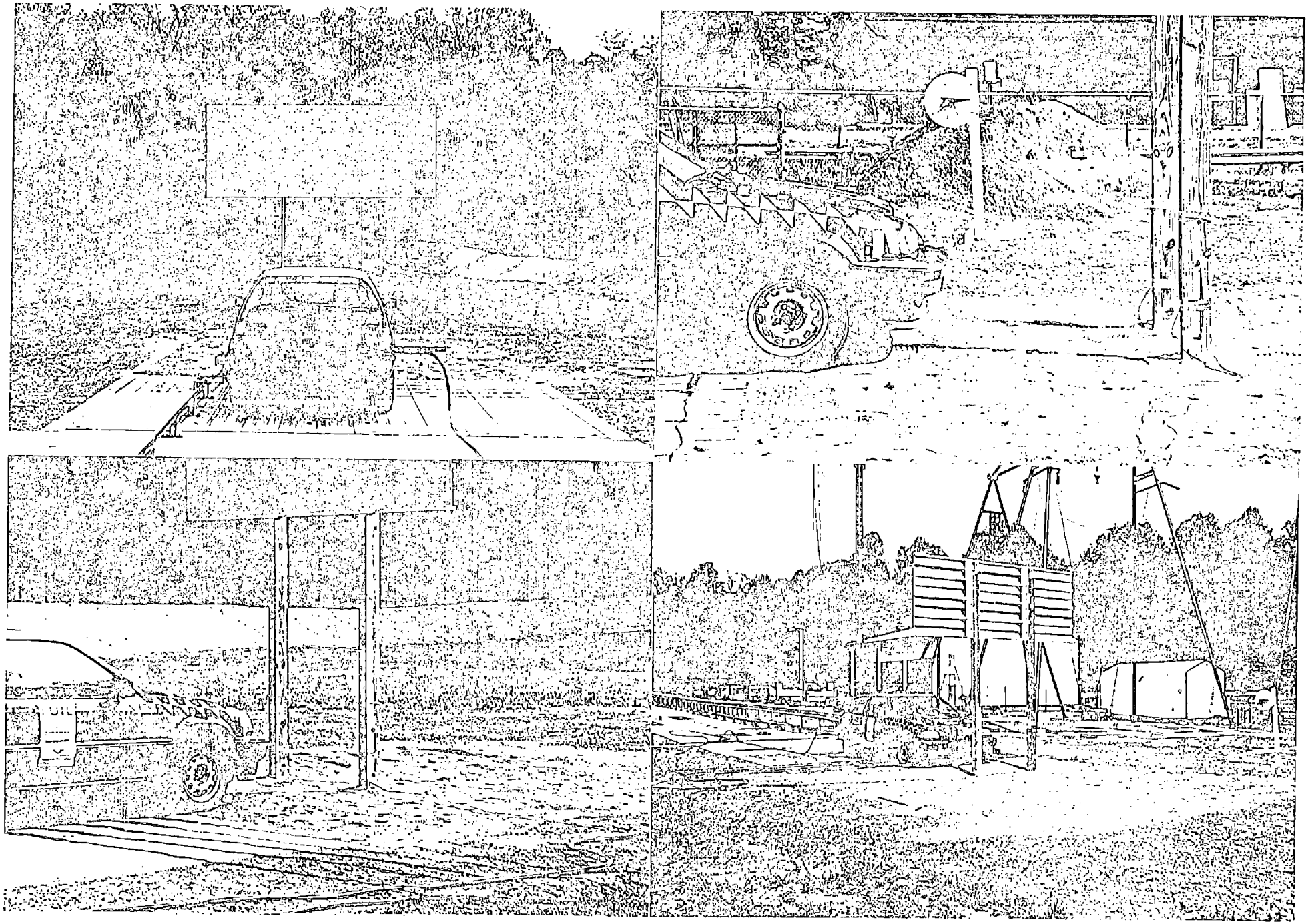


Figure 9. Pretest photographs of test 92F009 (continued).

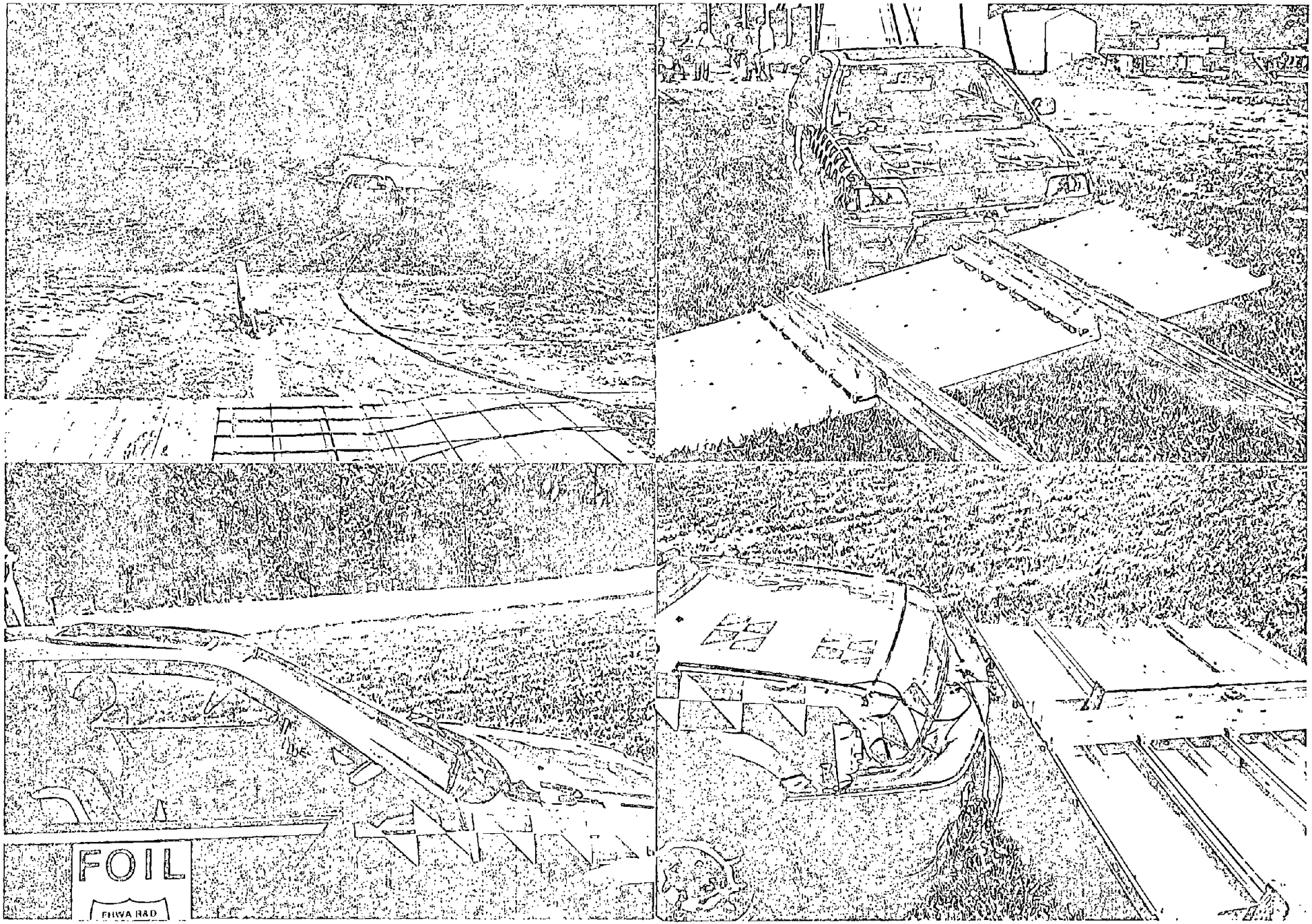


Figure 10. Post-test photographs of test 92F009.

Figure 10. Post-test photographs of test 92F009 (continued).

6. TEST RESULTS - 60 MI/H (26.8 M/S), TEST 92F010

The test vehicle was accelerated to 58.6 mi/h (85.9 ft/s (26.2 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. The contact between bumper and sign legs occurred to the outside edge of each bumper support. Damage was significant to the bumper and headlights only, the majority of the front end elements remained in good condition. The vehicle contacted both sign legs simultaneously and the legs fractured at the hole 18 in (0.457 m) above ground 0.016 s after initial contact. Both legs never fractured at the lower hole 4 in (0.102 m) above ground level. Instead each leg fractured 12 in (0.305 m) below ground level while the vehicle rolled over the remnants of each leg. The vehicle continued underneath the sign support, inducing a rotation in the sign support and vaulting the sign support upward. The vehicle passed underneath the sign support without making secondary contact. The sign support rotated 360 degrees and re-impaled itself in the weak soil briefly then fell backward with the sign panel facing up. The brakes were applied and the vehicle came to rest before making contact with the FOIL catch fence.

Damage to the vehicle consisted of damage to the bumper and other minor front end components (plastic parts). The contact between the legs and vehicle occurred outside of each bumper support. This area of the bumper was not as stiff as bumper supports. The legs caused damage to both headlights and light damage to each fender. The maximum residual crush was measured and recorded as 7.3 in (0.185 m). None of the sign components impaled the occupant compartment.

Damage to the sign support consisted of two fractured wooden legs with the fracture occurring at the upper hole. The upper portions above the upper hole remained attached to the sign panel. The embedded 3-ft (0.9-m) sections of the sign legs remained buried in the weak soil. A segment containing the lower drilled hole (not fractured) and approximately 18 in (0.457 m) in length was broken off each leg. The panel was in good condition after the test.

The occupant impact velocity using the 2 ft (0.6-m) flail space model outlined NCHRP Report Number 230, was determined to be 7.5 ft/s (2.3 m/s). The occupant impact velocity was reached 0.309 s into the crash event. The ridedown acceleration was 0.5 g's. The peak force (300 Hz data) for the impact event was 14.9 g's (27.5 kips (122 kN)). Because the sign/vehicle contact was brief the vehicle change in velocity was equal to the occupant impact velocity, 7.5 ft/s (2.3 m/s).

Photographs during the impact event are presented in figure 13. A summary of the impact conditions and the test results is presented in figure 14. Figures 15 through 18 are data plots of data collected during the test. Pre and post-test photographs of the vehicle and sign support system are shown in figures 19 through 22. Figure 23 depicts the measured vehicle crush for test 92F010.

7. CONCLUSION

The test results show that the occupant impact velocities of 8.6 ft/s (2.6 m/s) and 7.5 ft/s (2.3 m/s) for the low- and high-speed test respectively, are below the 16 ft/s (4.9 m/s) criteria as specified by the FHWA. There was no occupant compartment intrusion and no significant stub remaining after the test. Therefore the dual legged 4-by-6 wood sign support system in weak soil meets all of the applicable criteria for the low- and high- speed tests.

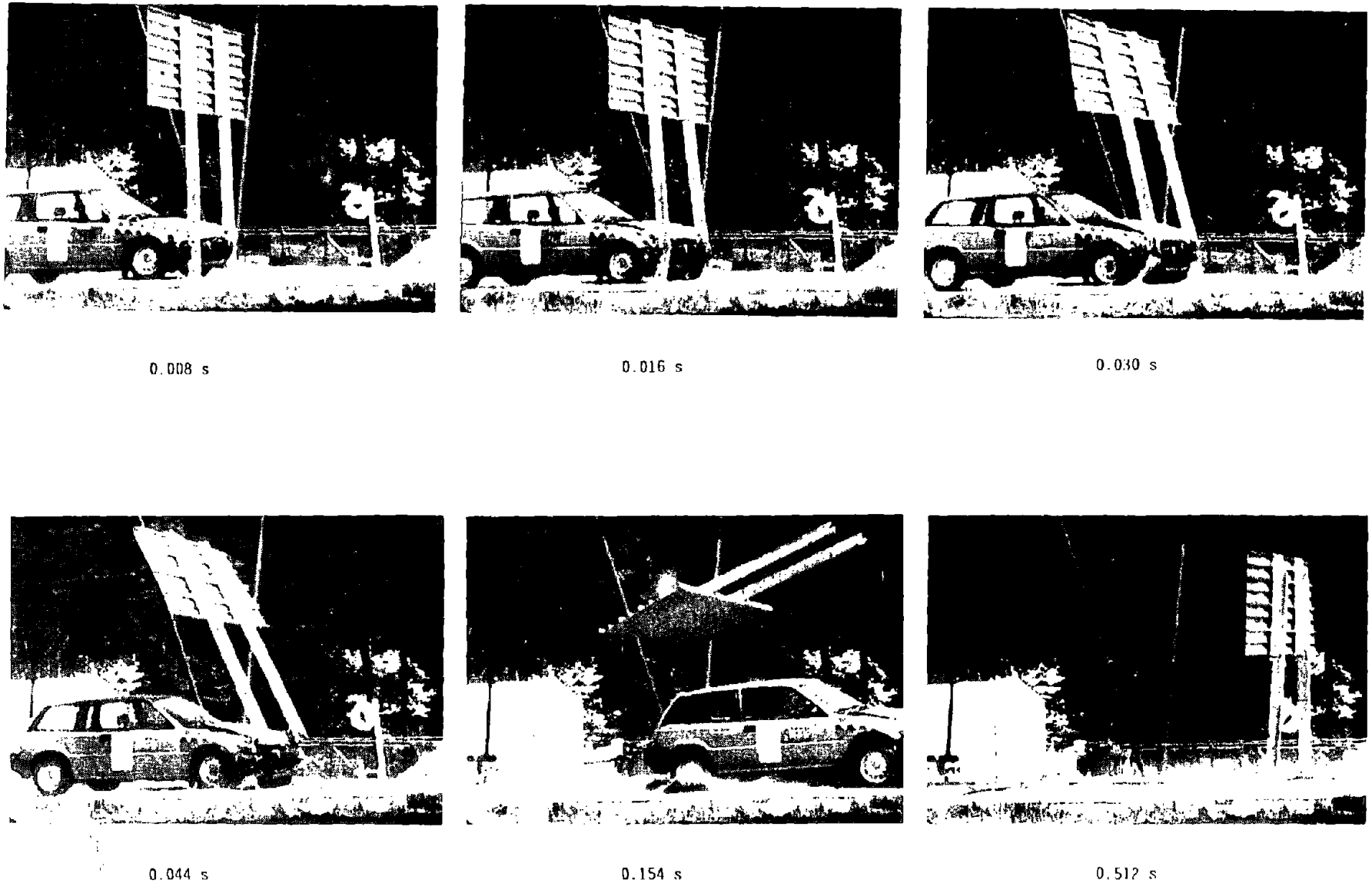
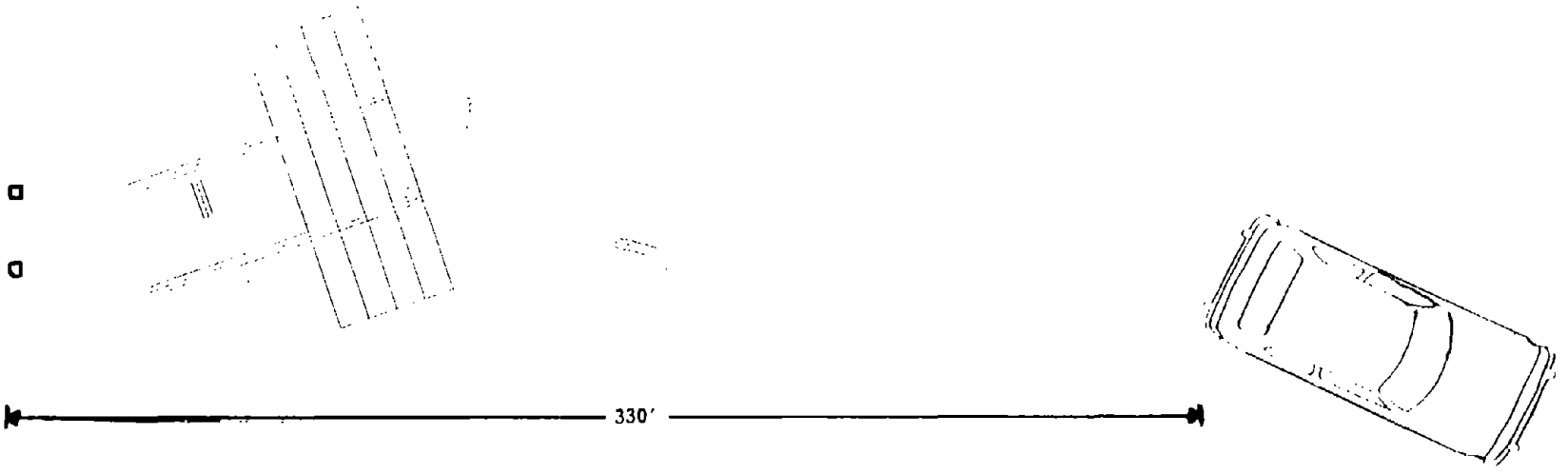


Figure 11. Test photographs during impact, test 92FOIO.



Test number..... 92F010

Date..... May 6, 1992

Test vehicle.....1985 Honda Civic

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

Test article.....Small Sign Support

Material.....4 by 6 wood, two 1.5" holes
2-Leg, 2-Hit

Embedment depth.....3 feet

Panel type.....4 foot by 10 feet extruded aluminum

Height.....11 feet

Foundation.....S-2 Weak Soil

Impact speed.....85.9 ft/s (26.2 m/s)

Impact angle.....0 degrees

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

Vehicle analysis:	Observed	Design/Limit
Longitudinal:		
Occupant Delta V at 2 ft	7.5 ft/s	≤16 ft/s
Ridedown Acceleration	0.5 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.....3.1 g's
Lateral.....NA

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

Vehicle crush.....7.3 inches

Vehicle velocity change.....7.5 ft/s

Exit angle.....0 degrees

Figure 12. Summary of test 92F010.

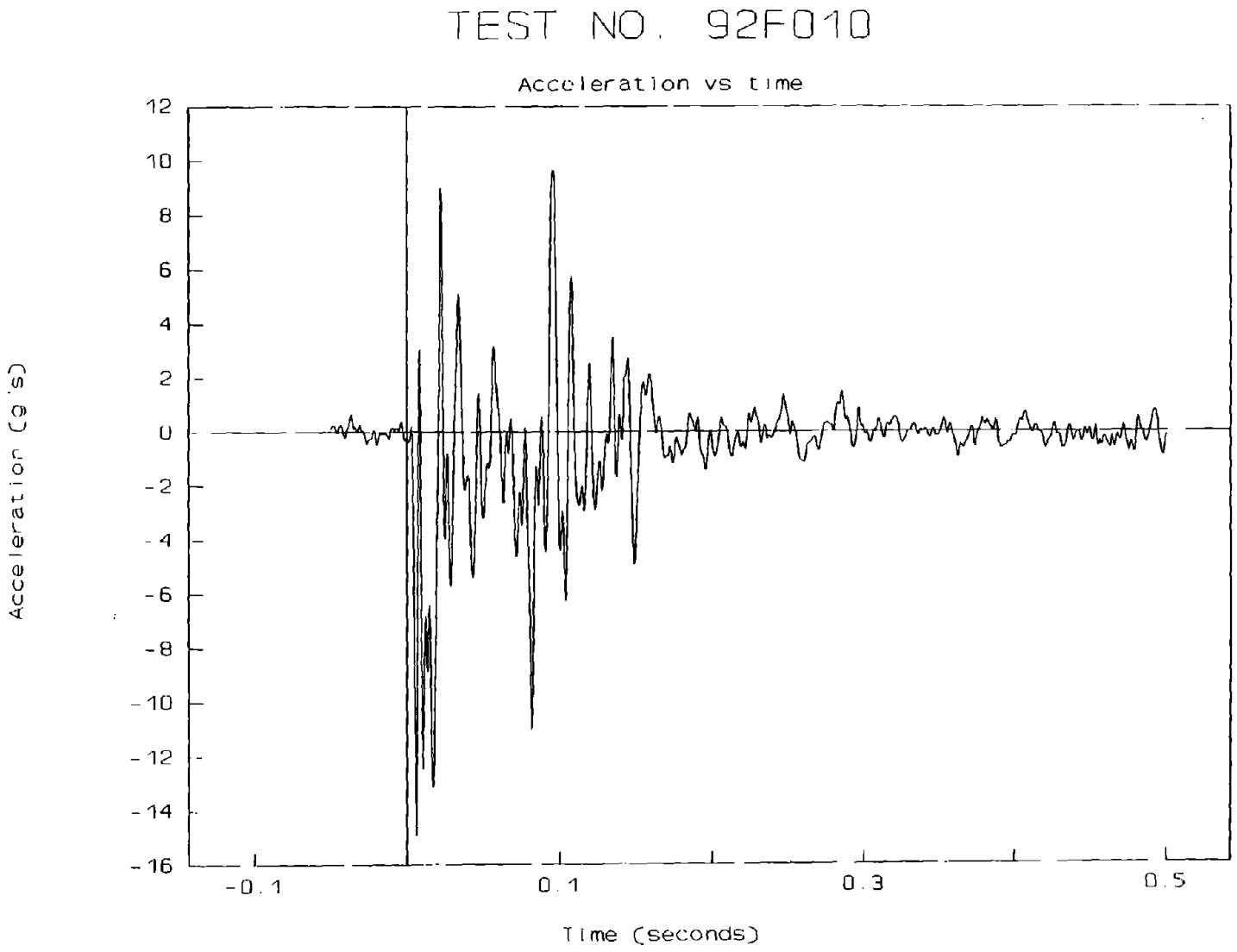


Figure 13. Acceleration versus time, X-axis, test 92F010.

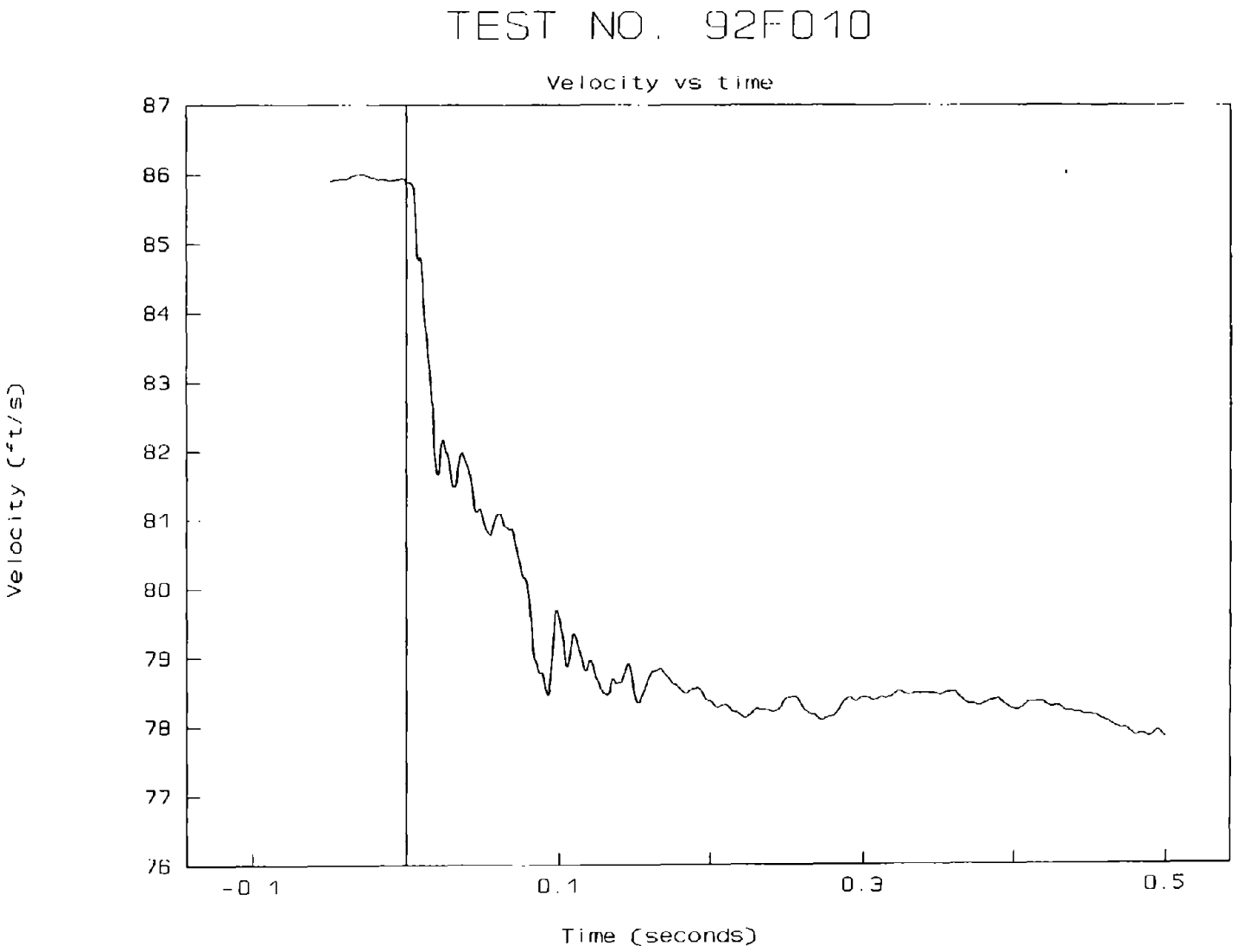


Figure 14. Velocity versus time, X-axis, test 92F010.

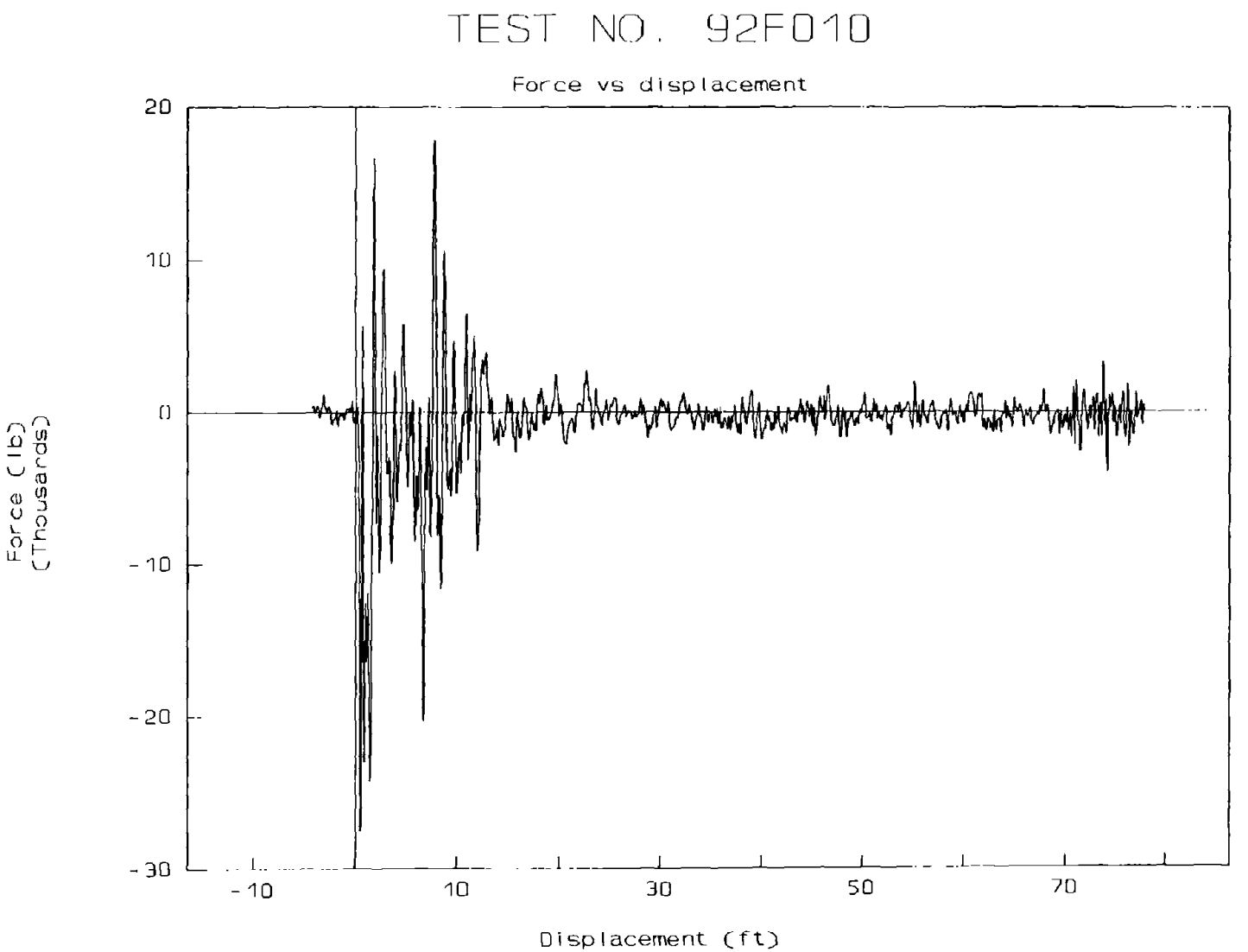


Figure 15. Force versus displacement, X-axis, test 92F010.

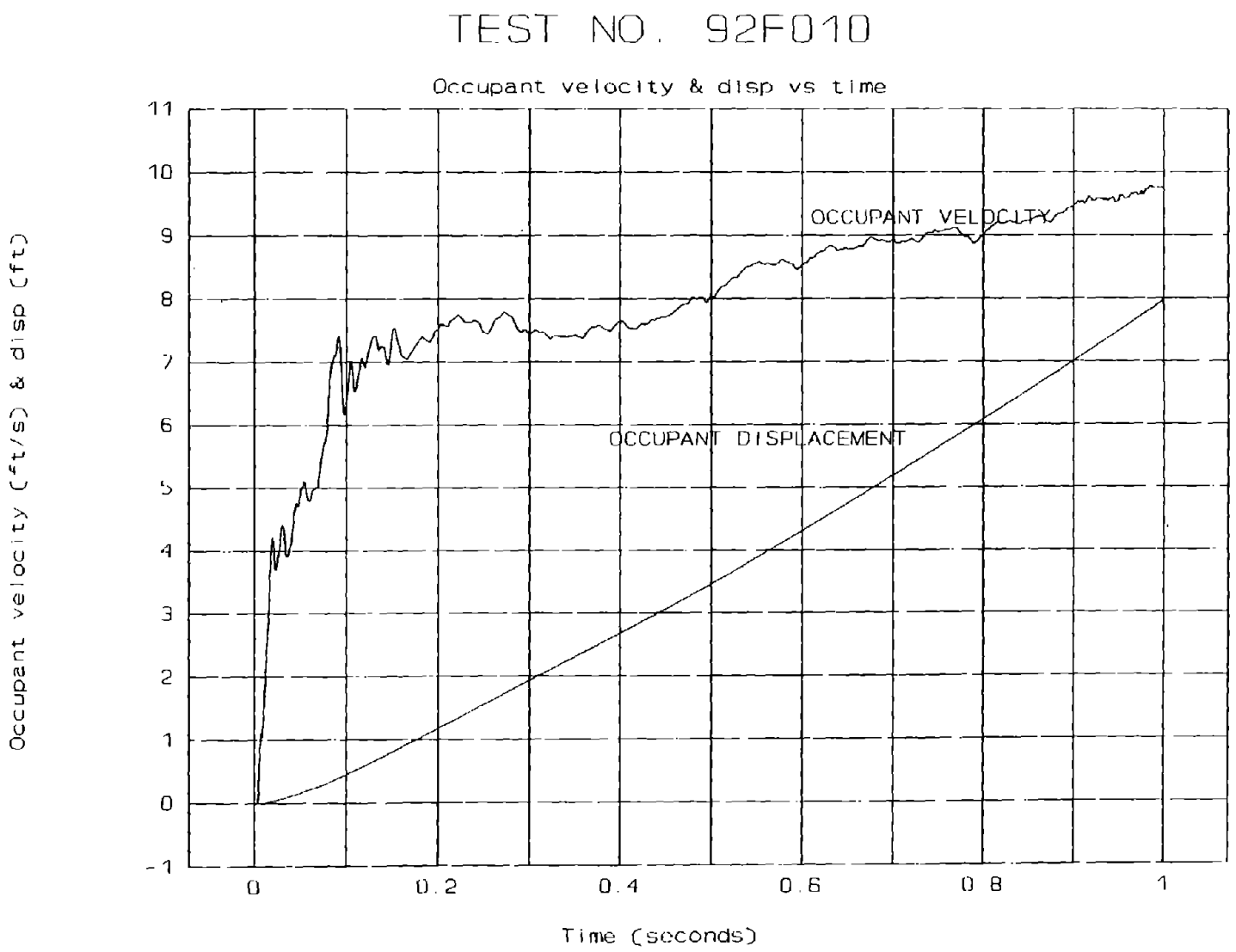


Figure 16. Occupant velocity and relative displacement versus time, test 92F010.

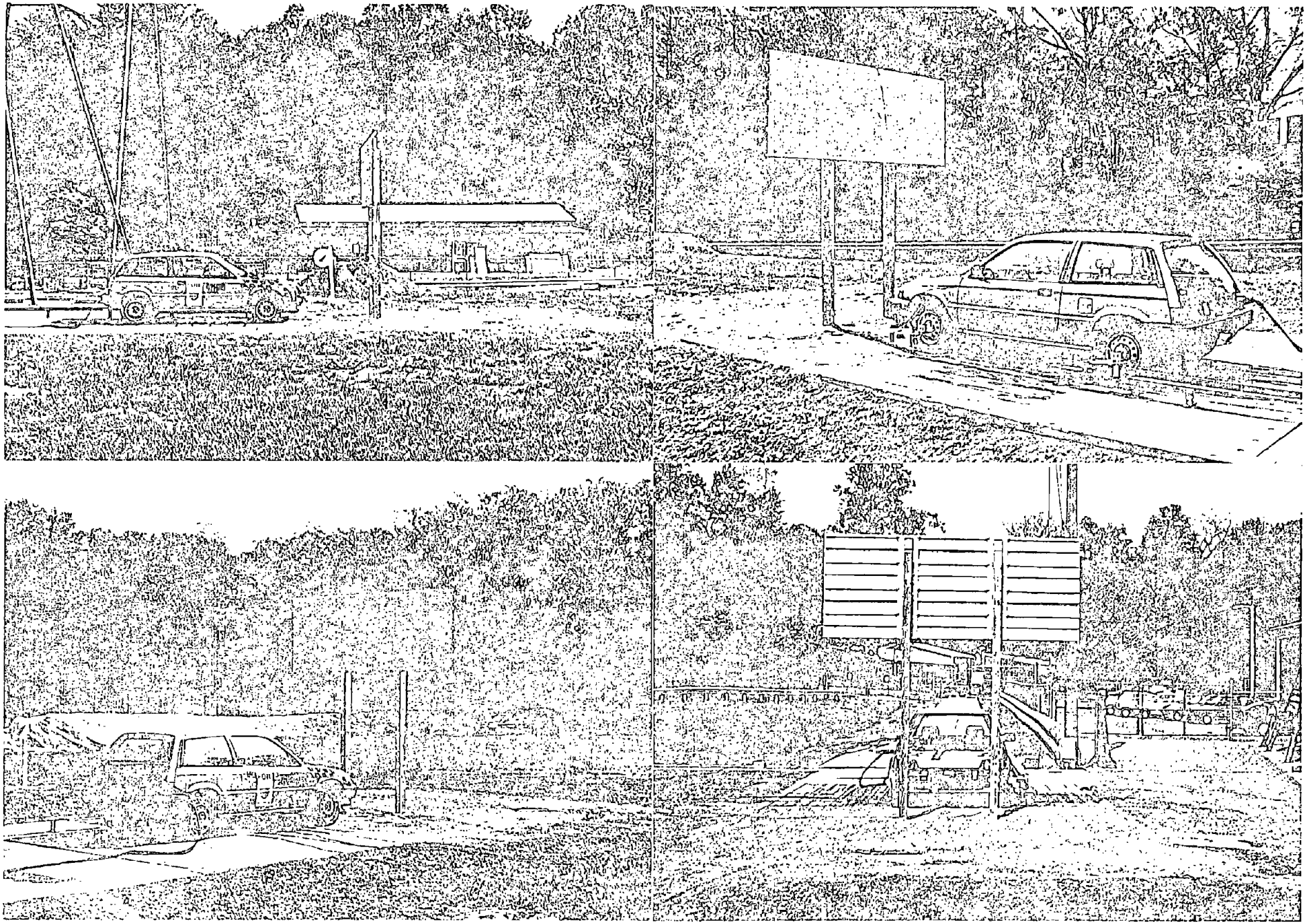


Figure 17. Pretest photographs of test 92F010.

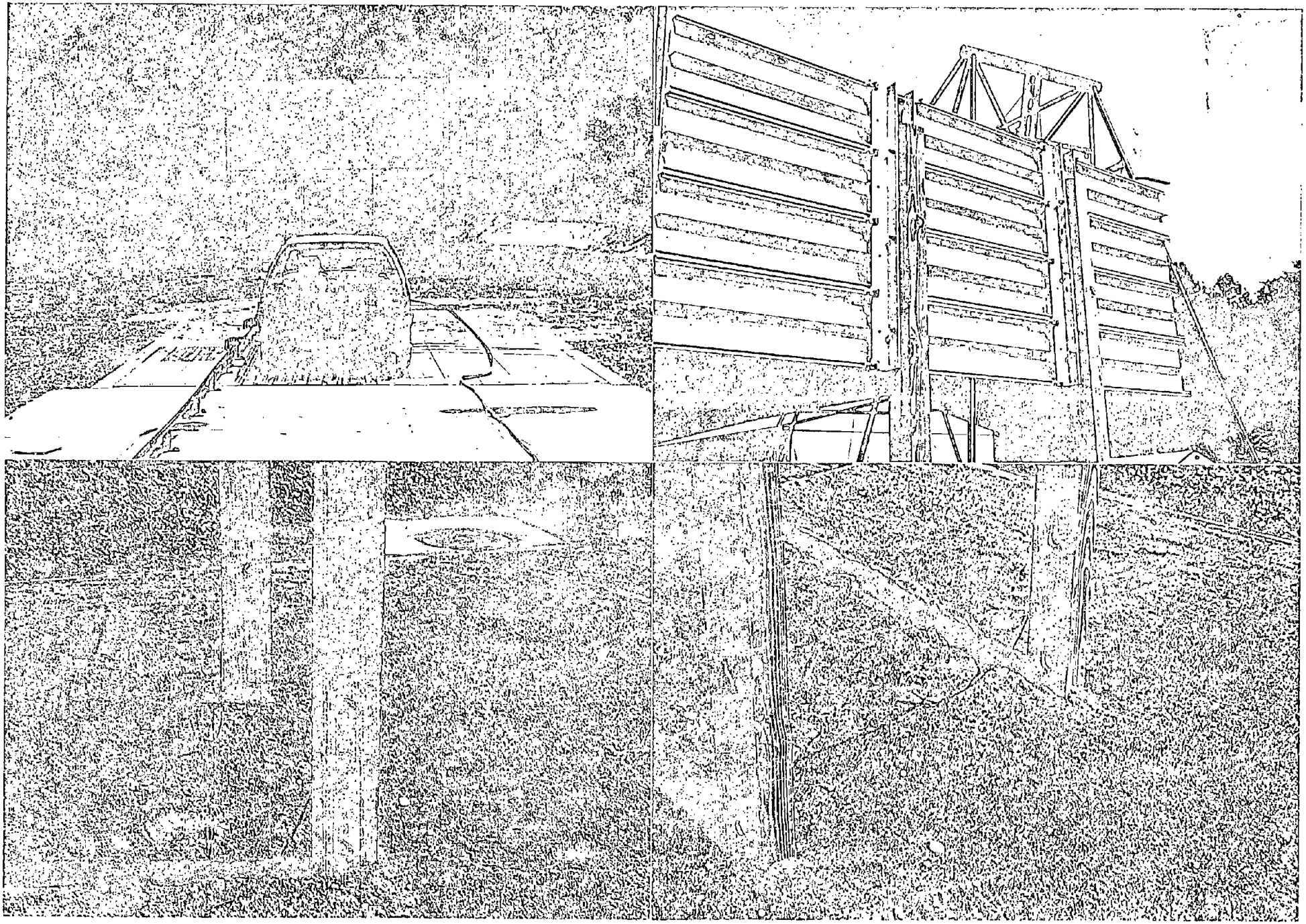


Figure 17. Pretest photographs of test 92F010 (continued).

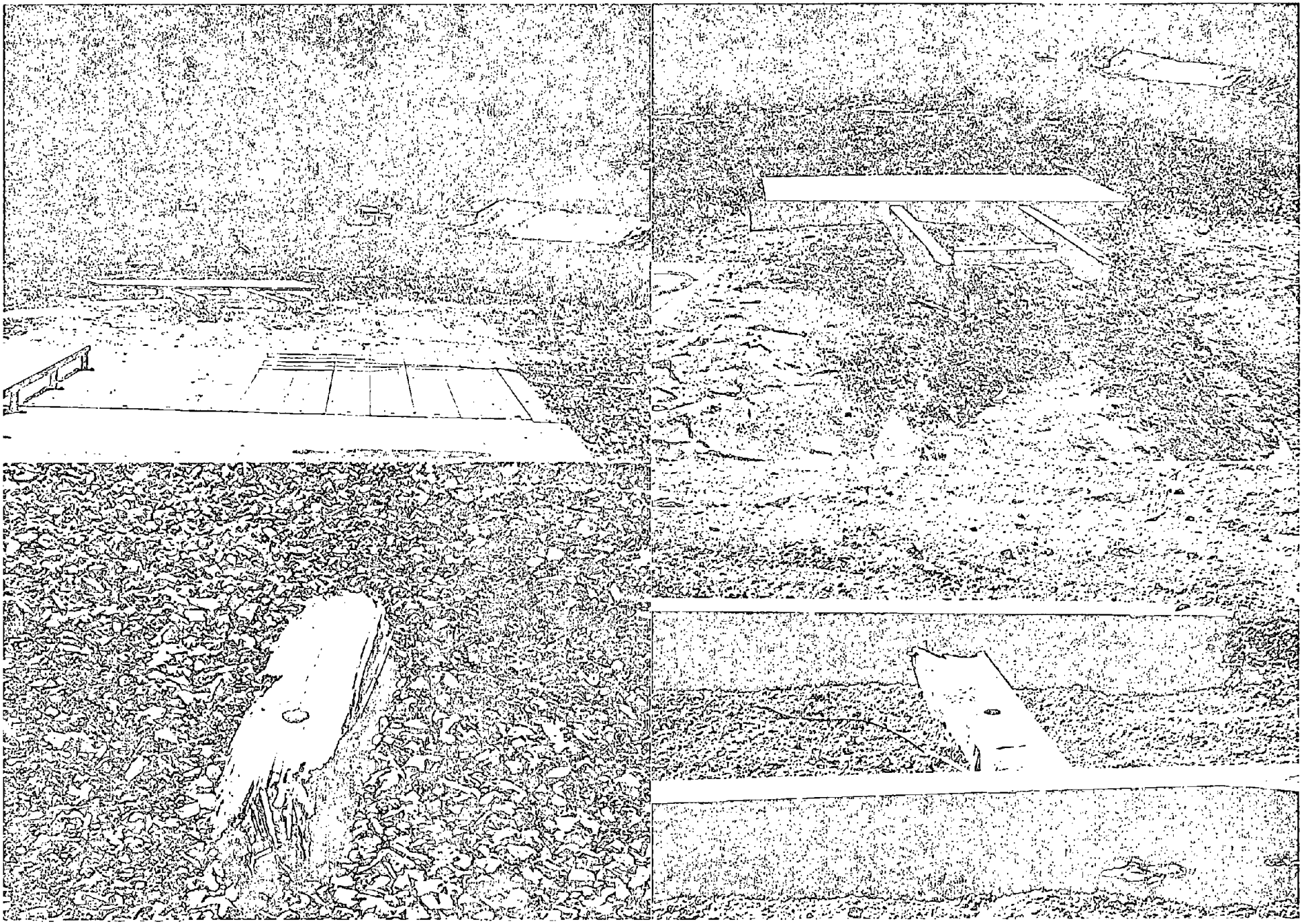


Figure 18. Post-test photographs of test 92F010.

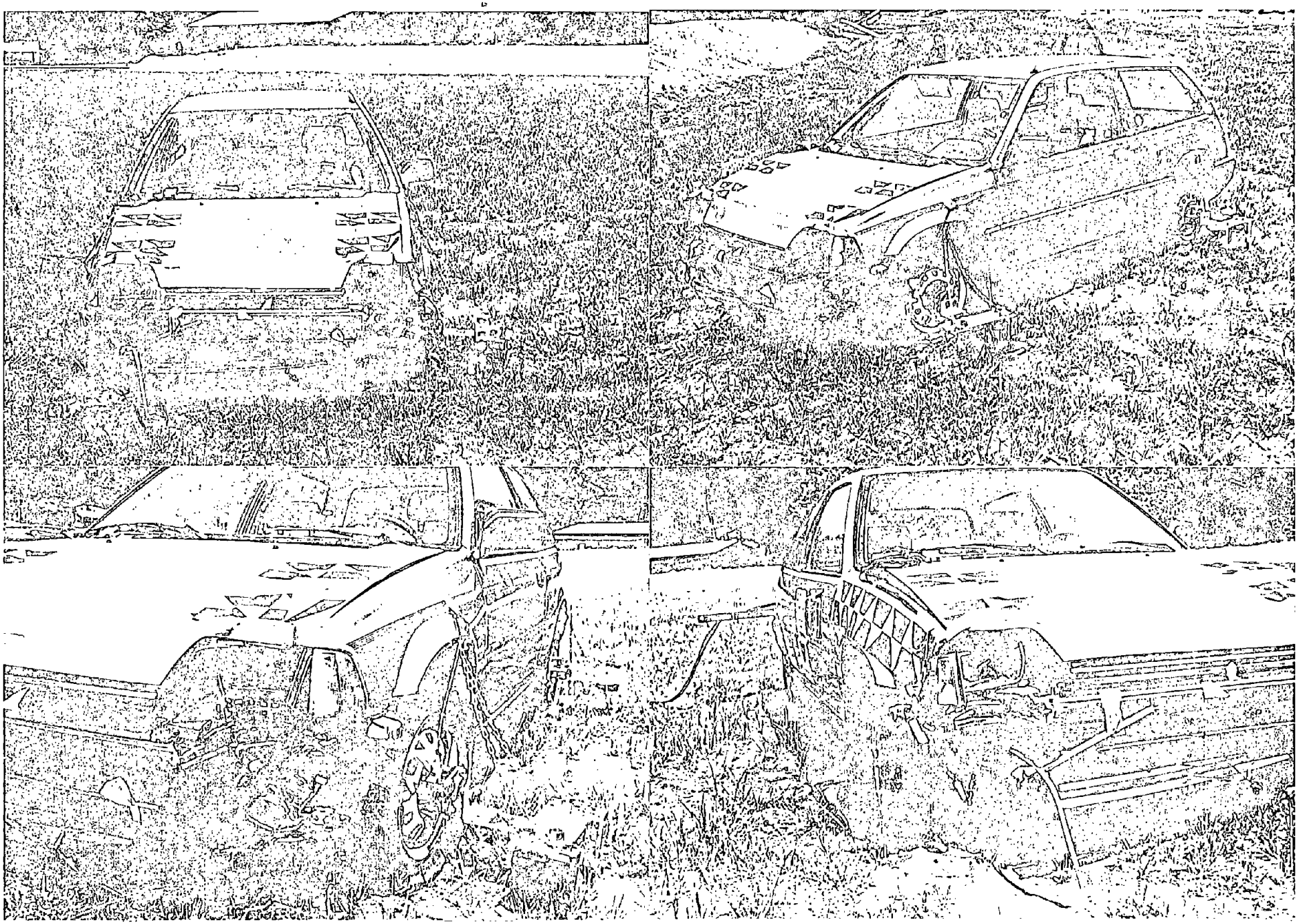
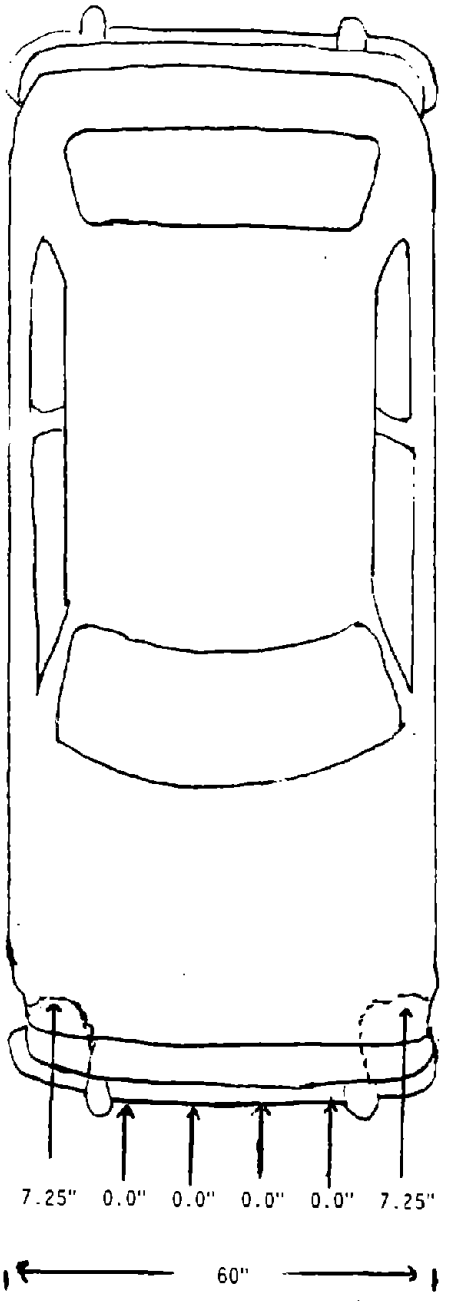


Figure 18. Post-test photographs of test 92F010 (continued).



Max = 7.25"

------- Post test

1 in = 2.54 cm

Figure 19. Sketch of vehicle crush, test 92F010.

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.