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Testing of Small and Large Sign Support Systems FOIL Test Numbers: 92F040

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Christopher M. Brown

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Advanced Technology & Research Corp.
14900 Sweitzer Lane
Laurel, MD 20707

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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 60 mi/h (96.6 km/h), test 92F040. The vehicle used for this test was a 1986 Honda Civic. The purpose of this test was to evaluate the high-speed safety performance of a triple-legged 12-gauge 1.75-in (44.4-mm) square tube 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 (101.6 mm), and that there can be no occupant compartment intrusion. The test results indicate that the square tube sign support system does not meet all of the applicable safety criteria for the high-speed test in strong soil as specified by the FHWA.

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Acceleration, occupant impact velocity, strong soil, square tube, 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 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 92F040. The vehicle used for this test was a 1986 Honda Civic. The purpose of this test was to evaluate the high-speed safety performance of the sign support system. The sign support system consisted of three small square tube posts inserted in three larger square tube anchors. The sign posts were 1-3/4-in (44.4-mm) square tube inserted into 2-in (50.8-mm) square tube anchors. The anchors were installed in strong 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-1 strong soil[1]. A summary of the test conditions is presented in table 1.

Table 1. Test matrix.

Test Number	Test Date	Test Vehicle	Test Weight (lb)	Test Speed (mi/h)	Test Article Description	Impact Location
92F040	12-16-92	'86 Honda Civic	1850 839 kg	60 96.6 km/h	3 leg steel square tube	center

3. VEHICLE

The test vehicle was a 1986 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 three square tube posts embedded 3 ft (0.9 m) in NCHRP Report 230 S-1 strong soil. Each leg consisted of a 1-3/4-in (44.4-mm) 12-gauge perforated square tube inserted into a 2-in (50.8-mm) 12-gauge perforated square tube anchor. The splice was 9 in (228.6 mm) long with 8 in (203.2 mm) below ground. The square tubes were spliced using two 3/8-in (9.5-mm) diameter corner bolts at ground level. The posts were spaced 1.75 ft (0.53 m) apart with a 2.5-ft by 5.5-ft (0.76-m by 1.68-m) aluminum sign blank attached. Figure 1 presents a sketch

of the sign support system. The sign system was assembled then placed in a trench in the strong soil. Soil was placed in the trench around the sign posts in 6-in (152.4-mm) lifts. During each lift the soil was moistened and compacted. This procedure was repeated until the final grade was reached.

5. TEST RESULTS - TEST 92F040

The test vehicle was accelerated to 59.2 mi/h (86.8 ft/s (95.5 km/h)) prior to impacting the sign support. The centerline of the test vehicle was aligned with the center sign post.

The bumper made contact with all three sign posts but did not significantly collapse. The three square tube sign posts bent around the front end of the test vehicle. The three square tube posts buckled 0.014 s after contact. The vehicle begins to ridedown the sign posts but the square tube fractured at the impact point on the posts approximately 0.028 s into the impact event. The square tube anchors did not plow through the strong soil during impact. The square tube anchors were pulled up slightly by the vehicle. The anchors of the center and right posts fractured at the bottom of the splice, where the inserted smaller tube ends inside the larger anchor. The left post fractured 1 in (25.4 mm) above ground just above the corner bolts that spliced the two pieces of square tube. The vehicle broke through the square tube posts and pushed on the remaining sign posts rotating the top of the sign down towards the vehicle. The sign made contact with the roof-windshield joint at 0.080 s. The impact of the sign on the roof and windshield caused severe denting of the roof and shattered the windshield. The roof attained its maximum crush at approximately 0.108 s. The sign rebounded off the roof and slid down off the front end of the vehicle and briefly impaled the ground in front of the test vehicle. The vehicle struck the sign again and launched it up and away from the test vehicle. The vehicle's brakes were applied and the vehicle came to a stop prior to colliding with the FOIL catch fence. The sign stub remaining at the location of impact consisted of three 24-in (609.6-mm) square tube sections bent over, laying flat on the ground. The six corner bolts did not fracture or tear through the perforated square tube during impact.

Damage to the vehicle consisted of damage to the parking lights and a small dent in the front end header panel. No damage to the bumper or headlights was recorded after the test. The most damage was imparted to the windshield and roof of the vehicle. The roof dented in approximately 6 in (152.4 mm) and the windshield was shattered. The occupant compartment was not intact after the test.

Damage to the sign system consisted of three collapsed 1.75-in (44.4-mm) square tube posts and three fractured 2-in (50.8-mm) square tube anchors. None of the square tube sign material could be reused. The sign panel and six corner bolts were in usable condition after the test. The sign panel and top of the posts collapsed the occupant compartment.

The occupant impact velocity using the 2-ft (0.6-m) flail space model outlined in NCHRP Report Number 230, was determined to be 8.1 ft/s (2.5 m/s). The occupant impact velocity was reached 0.2805 s into the crash event. The ridedown acceleration was 2.5 g's. The peak acceleration (300 Hz data) for the impact event was 25.4 g's (peak force 47.0 kips (209.1 kN)). Because the sign system had secondary impact with the vehicle after the occupant had traversed the flail space, the vehicle change in velocity is greater than the occupant impact velocity. The calculated vehicle change in velocity by integration of the acceleration trace was 10.6 ft/s (3.2 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 10.

6. CONCLUSION

The test results indicate that the small sign support system does not meet all of the applicable criteria for the high-speed test in strong soil. The occupant impact velocity was 8.1 ft/s (2.5 m/s) which is less than or equal to the 16-ft/s (4.9-m/s) limit specified by the FHWA and the significant test article stub height remaining after the test was 1.75 in (44.4 mm) which is less than or equal to the 4-in (101.6-mm) limit. However the impact between the sign panel/posts and the roof and windshield, caused severe collapse of the vehicle's roof and shattered the windshield. The occupant compartment was severely damaged and could put an occupant at a higher risk of injury.

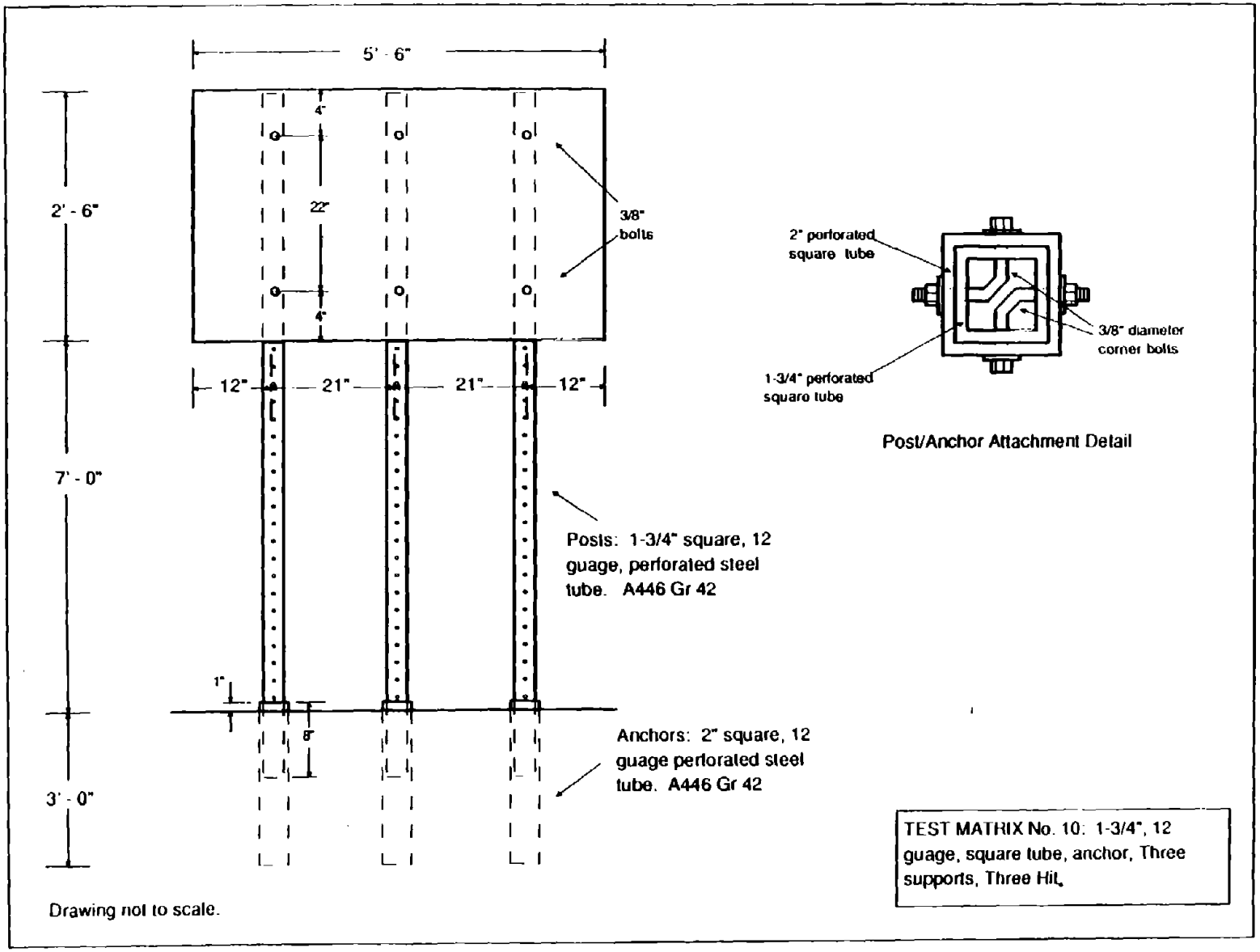
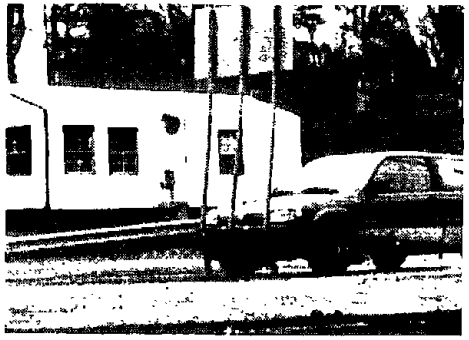


Figure 1. Sketch of small sign support.



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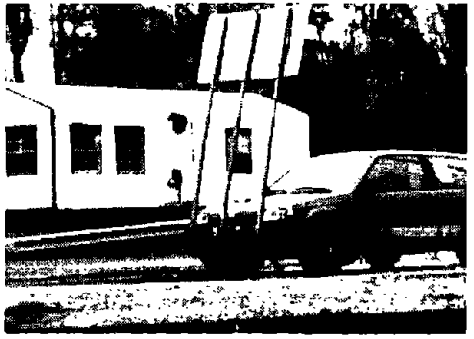

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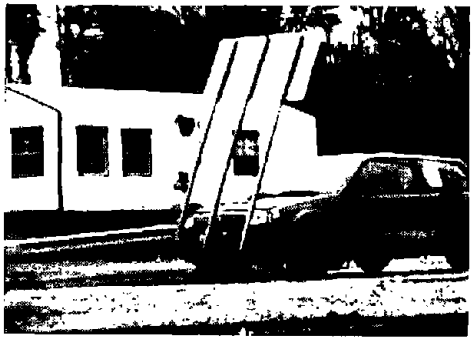

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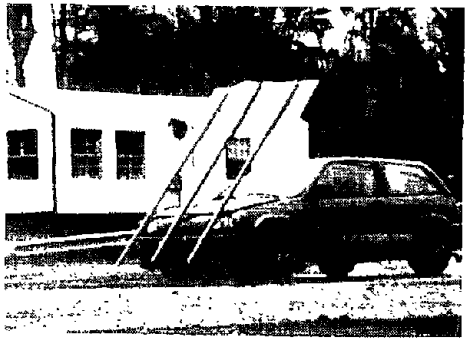

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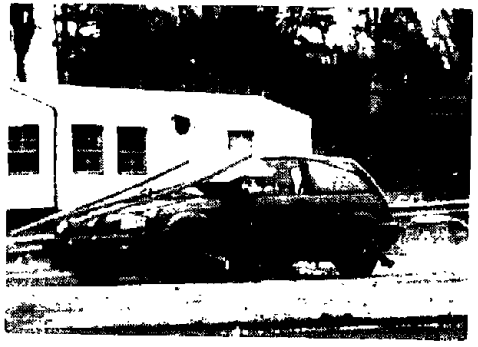
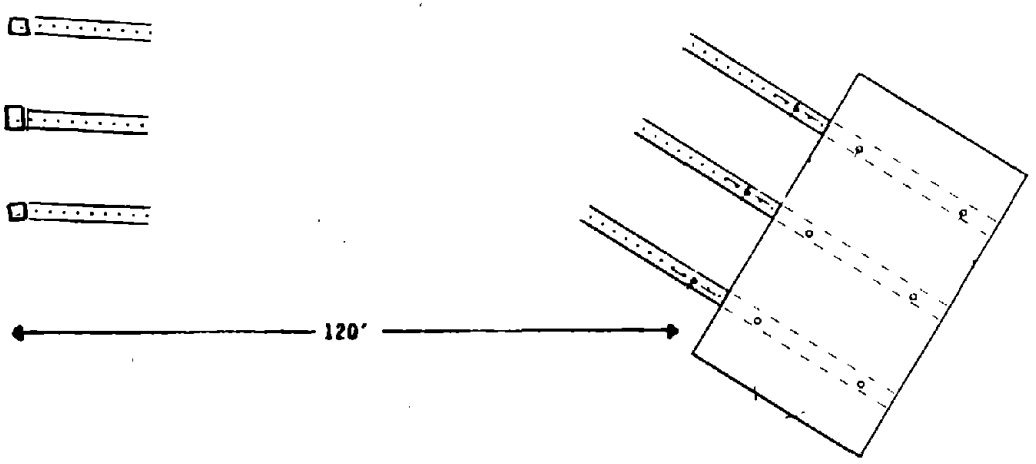
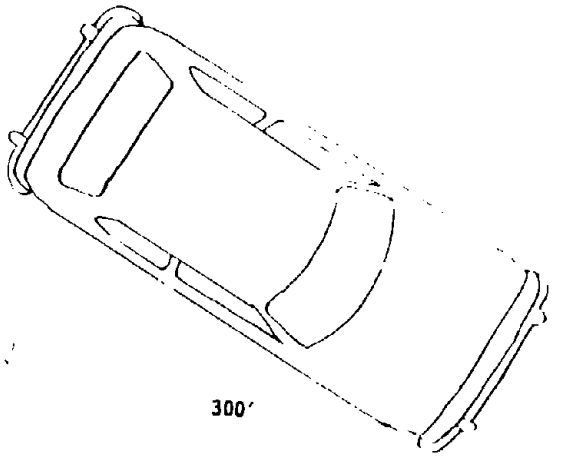


0.100 s

Figure 2. Test photographs during impact, test 92F040.





Test number..... 92F040

Date..... December 16, 1992

Test vehicle..... 1986 Honda Civic

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

Test article..... small sign support

Material..... 1.75-in steel square tube 3-Leg, 3-Hit

Embedment depth..... 3 ft

Panel type..... 2.5-ft by 5.5-ft aluminum sheet

Height..... 9.5 ft

Foundation..... 2-in square tube anchors in S-1 Strong Soil

Impact speed..... 86.8 ft/s (26.5 m/s)

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

Vehicle analysis:	Observed	Design/Limit
Longitudinal:		
Occupant Delta V at 2 ft	8.1 ft/s	≤16 ft/s
Ridedown Acceleration	2.5 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..... 3.9 g's
Lateral..... NA

Vehicle Damage (TAD)..... 12-FC-1
(VDI)..... 12TDCW3

Vehicle crush (roof deflection)..... 6 in

Vehicle velocity change..... 10.6 ft/s

Impact angle..... 0 degrees

Exit angle..... 0 degrees

1 in = 25.4 mm 1 ft = 0.305 m 1 lb = 0.454 kg 1 mi/h = 1.61 km/h 1 ft/s = 0.305 m/s

Figure 3. Summary of test 92F040.

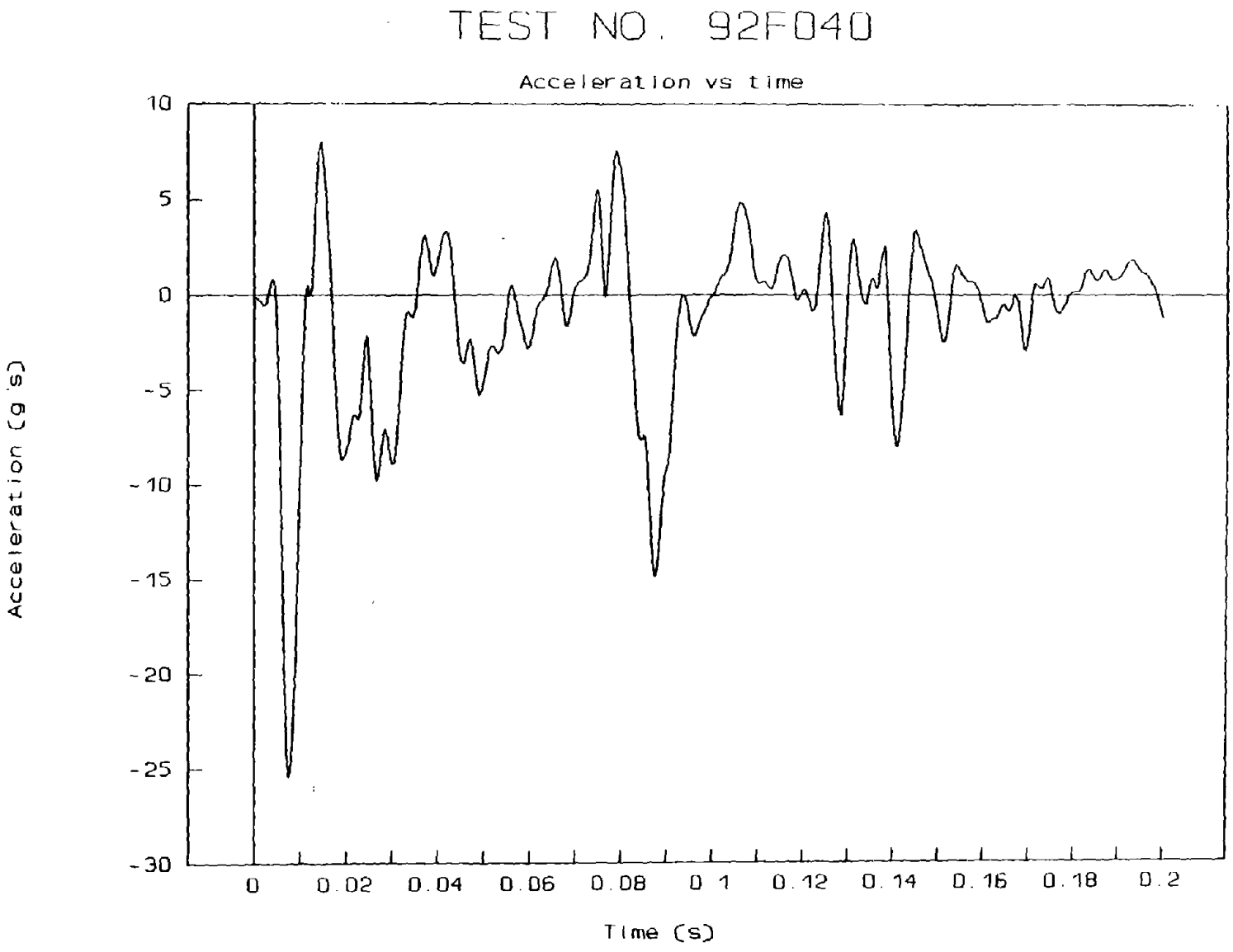
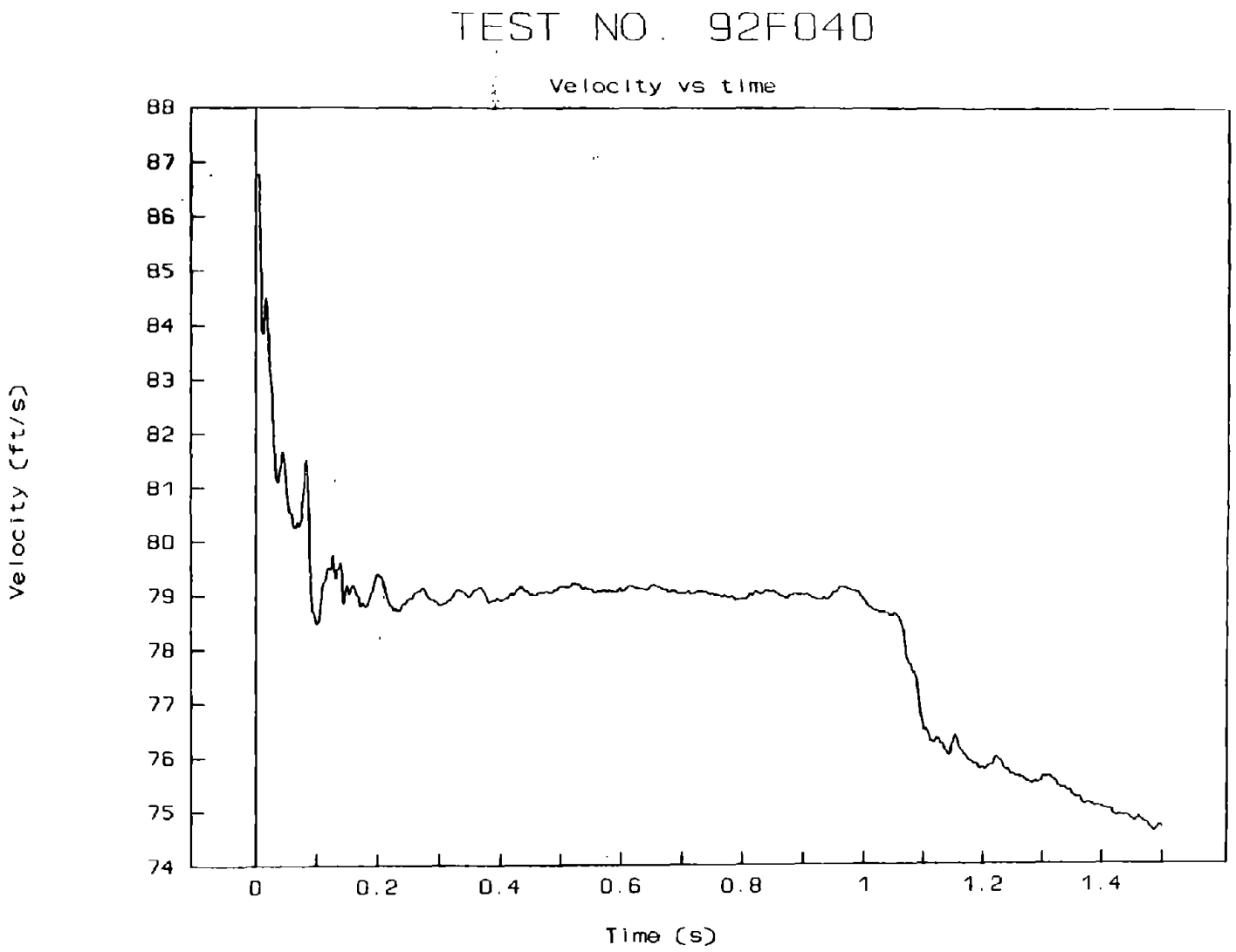
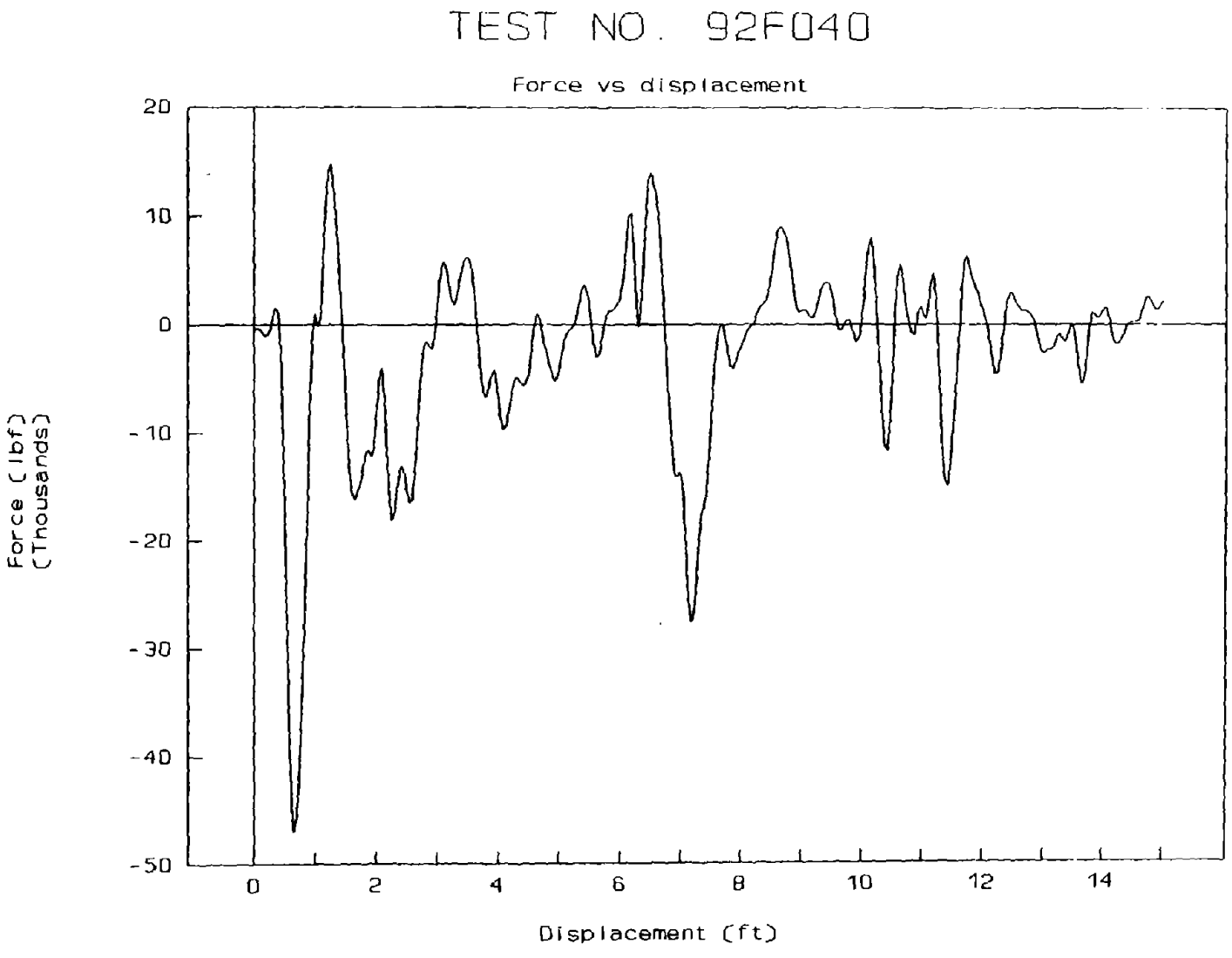


Figure 4. Acceleration versus time, X-axis, test 92F040.



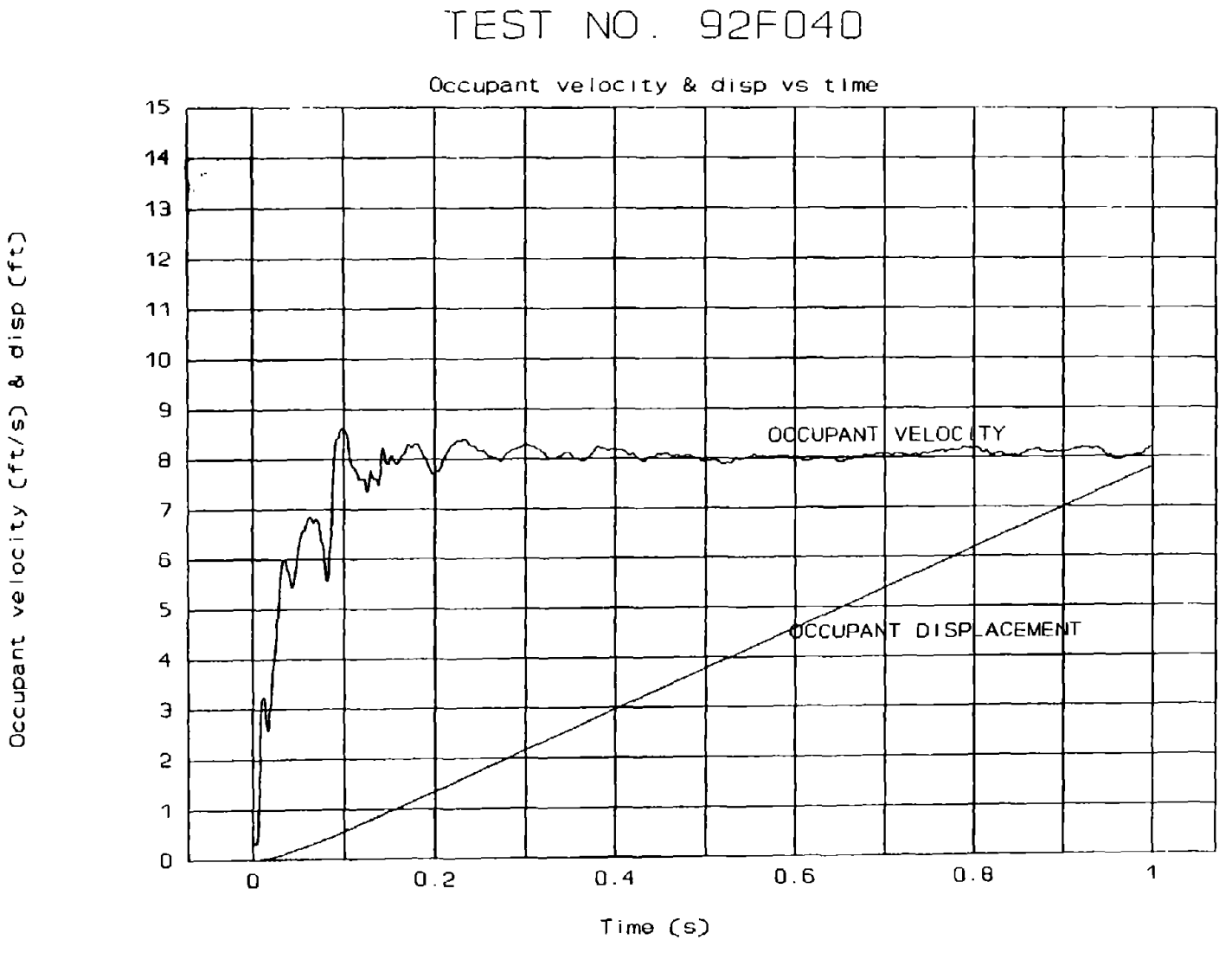
1 ft = 0.305 m

Figure 5. Velocity versus time, X-axis, test 92F040.



1 lbf = 4.45 N 1 ft = 0.305 m

Figure 6. Force versus displacement, X-axis, test 92F040.



1 ft = 0.305 m

Figure 7. Occupant velocity and relative displacement versus time, X-axis, test 92F040.

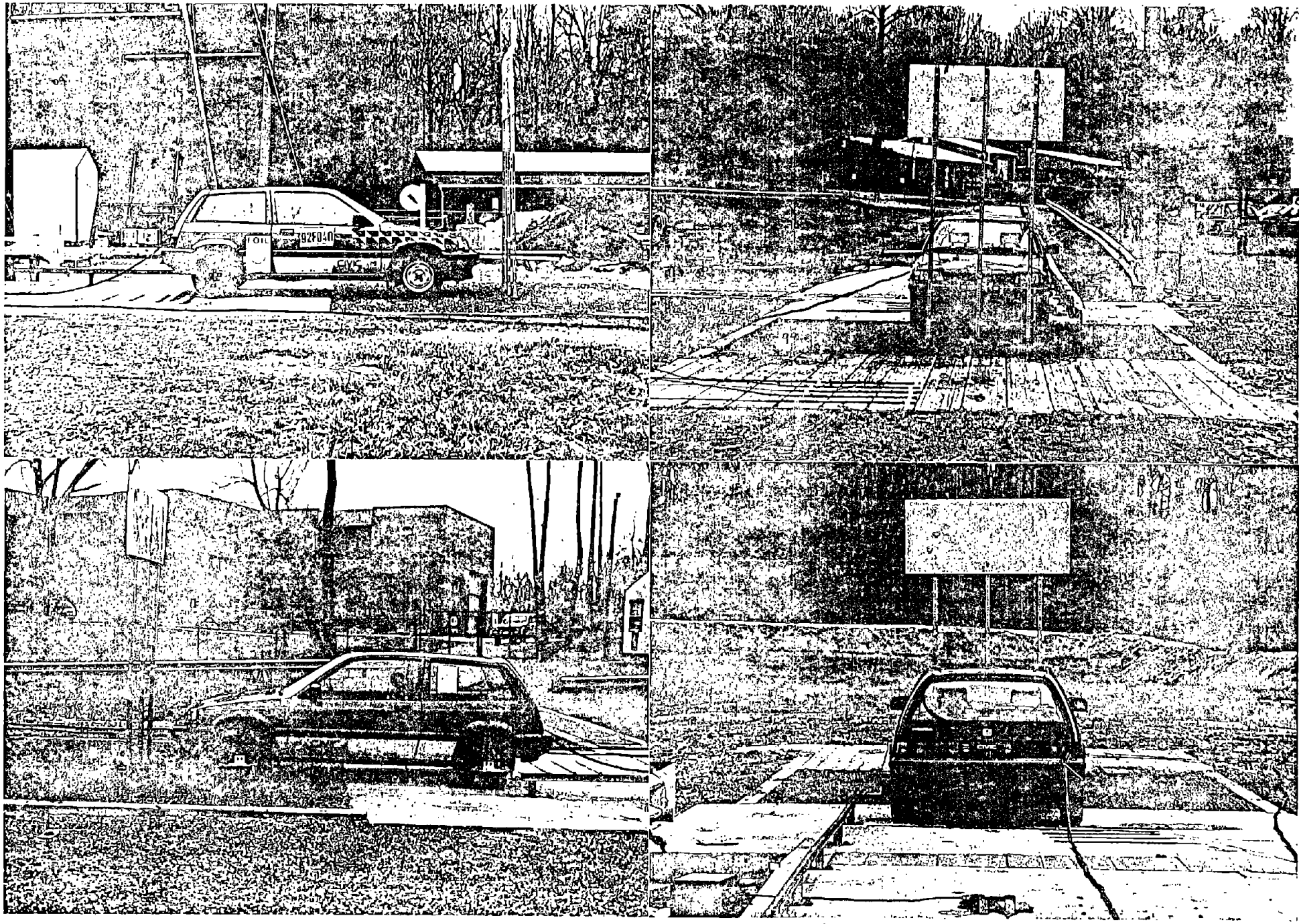


Figure 8. Pretest photographs of test 92F040.

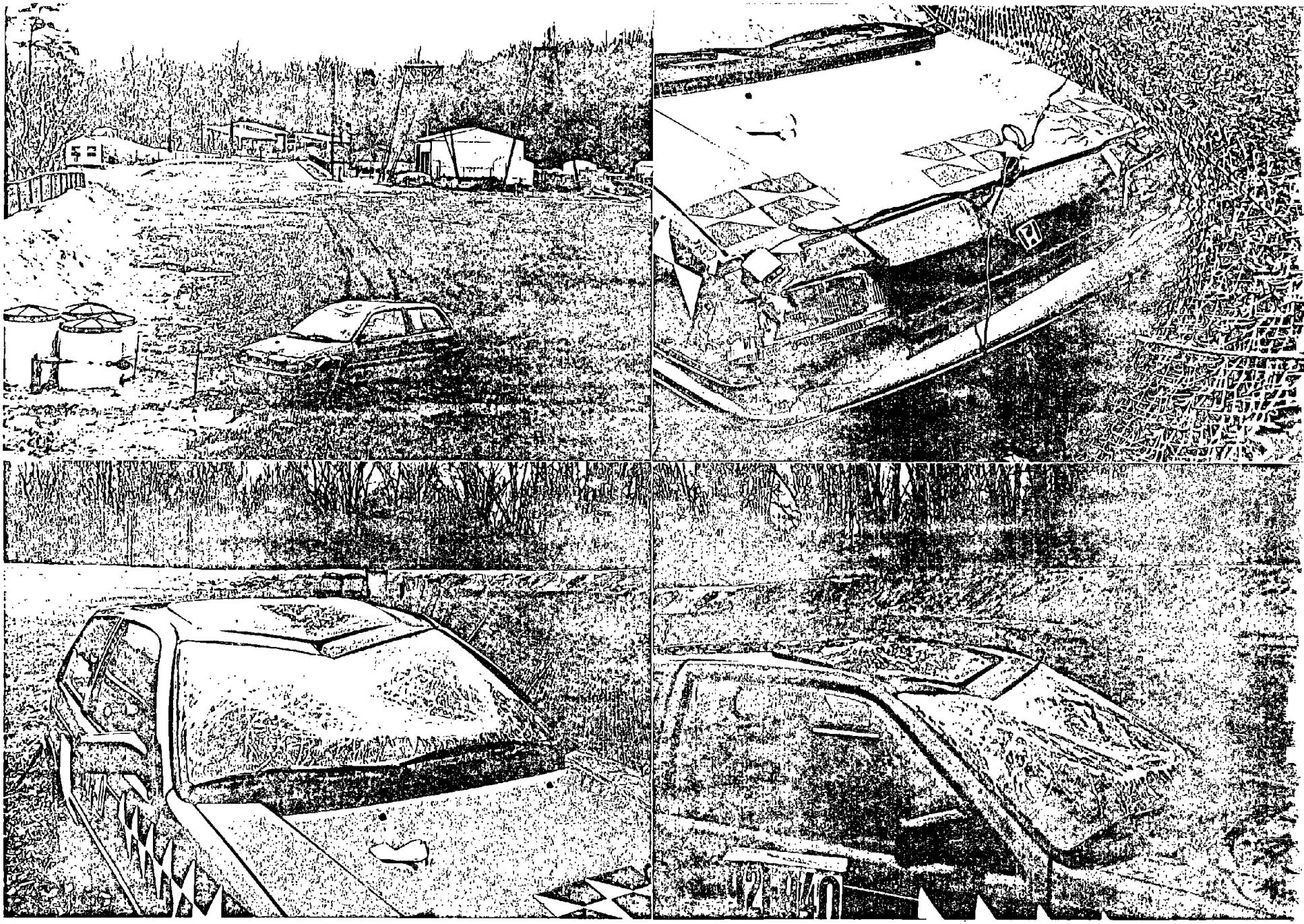


Figure 9. Post-test photographs of test 92F040.

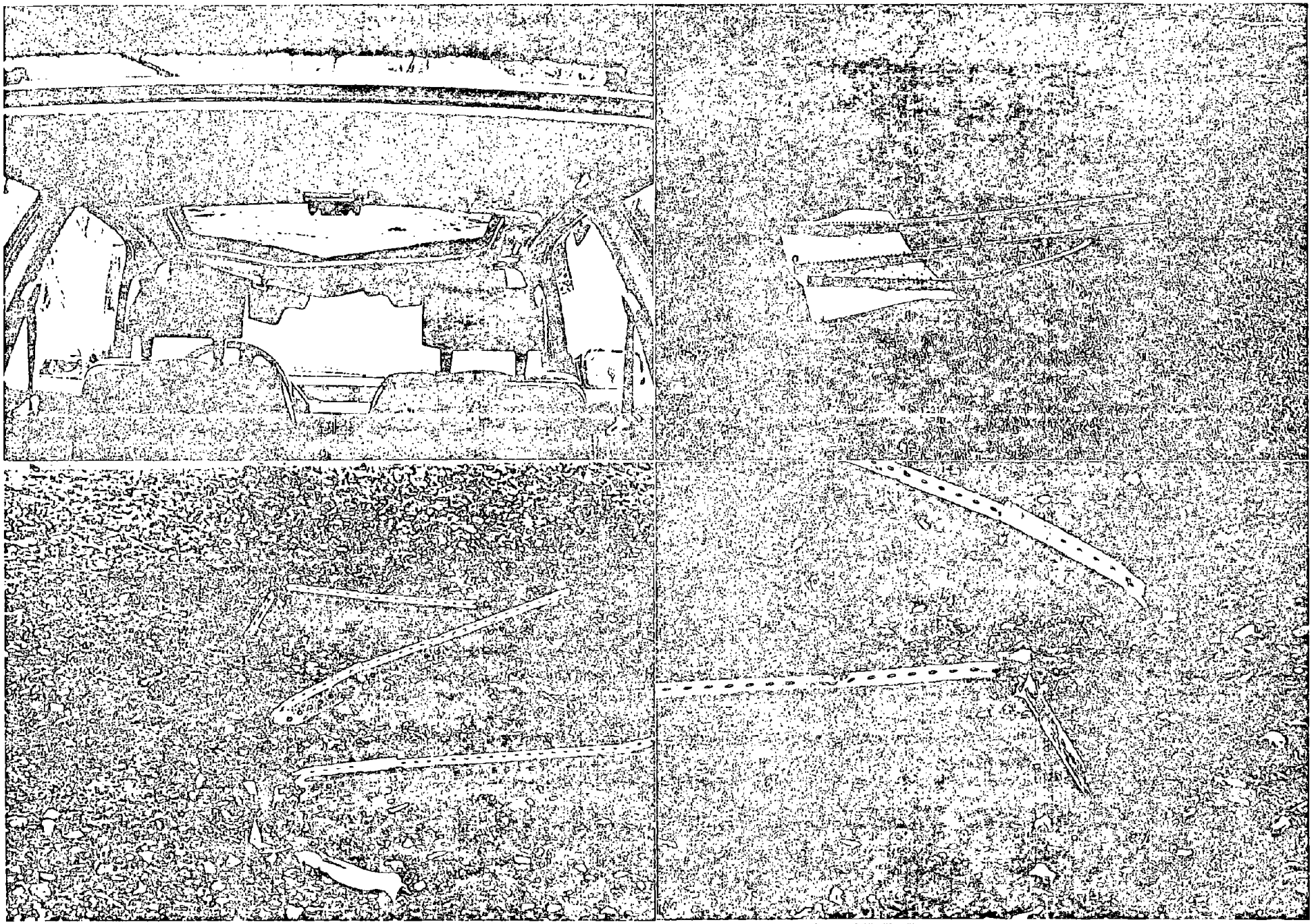


Figure 10. Additional post-test photographs of test 92F040.

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.