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Testing of Small and Large Sign Support Systems FOIL Test Number: 92F039

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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 (32.2 km/h), test 92F039. The vehicle used for this test was a 1986 Honda Civic. The purpose of this test was to evaluate the low-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 meets all of the applicable safety criteria for the low-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 20 mi/h (32.2 km/h), test 92F039. The vehicle used for this test was a 1986 Honda Civic. The purpose of this test was to evaluate the low-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 20 mi/h (32.2 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
92F039	12-15-92	'86 Honda Civic	1850 839 kg	20 32.2 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 92F039

The test vehicle was accelerated to 20.4 mi/h (29.9 ft/s (32.8 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 and began to collapse. The three square tube sign posts bent around the front end of the test vehicle. The square tube did not fracture and the vehicle continued forward and began to pull the anchors up out of the ground at 0.060 s. The square tube anchors did not plow through the strong soil during impact. The center and left post buckle 0.080 s after initial contact while the right post continued to bend. The buckling causes the posts to further wrap around the front end of the vehicle causing the continued pull-out on the square tube anchors. The sign panel and posts did not strike the vehicle during the impact event. The posts rebounded away from the vehicle and laid over backwards without further contact with the vehicle. The stubs consisting of the protruding anchor tubes were high enough to snag on the test vehicle's undercarriage. Occupant compartment penetration did not occur as a result of the snagging. The undercarriage of the vehicle remained in contact with the sign stubs while coming to a complete stop, and the vehicle stopped on top of the three sign stubs. While the anchors were being pulled from the ground, the 2-in (50.8-mm) square tube anchors fractured at the bottom of the 1.75-in (44.4-mm) square tube splice-insert. The six corner bolts did not fail or tear through the perforated square tube during impact.

Damage to the vehicle consisted of damage to the parking lights. No residual crush was recorded after the test. The bumper, grill, header panel and headlights were all intact after the test. Some tearing of the undercarriage metal was visible but not significant. The occupant compartment was 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. No sign components impaled 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 14.4 ft/s (4.4 m/s). The occupant impact velocity was reached 0.2155 s into the crash event. The ridedown acceleration was 6.9 g's. The peak acceleration (300 Hz data) for the impact event was 13.6 g's (peak force 25.2 kips (112.1 kN)). Because the sign system caused the vehicle to come to a complete stop the vehicle change in velocity is equal to the impact speed. The calculated vehicle change in velocity by integration of the acceleration trace was 28.5 ft/s (8.7 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. Because no residual crush was recorded after the test, the vehicle crush sketch was omitted from this report.

6. CONCLUSION

The test results indicate that the small sign support system meets all of the applicable criteria for the low-speed test in strong soil. There was no occupant compartment intrusion and the stub remaining after the test was 4.0 in (101.6 mm) which is less than or equal to the 4-in (101.6-mm) limit specified by the FHWA. The occupant impact velocity was 14.4 ft/s (4.4 m/s) which is less than or equal to the 16-ft/s (4.9-m/s) limit specified by the FHWA.

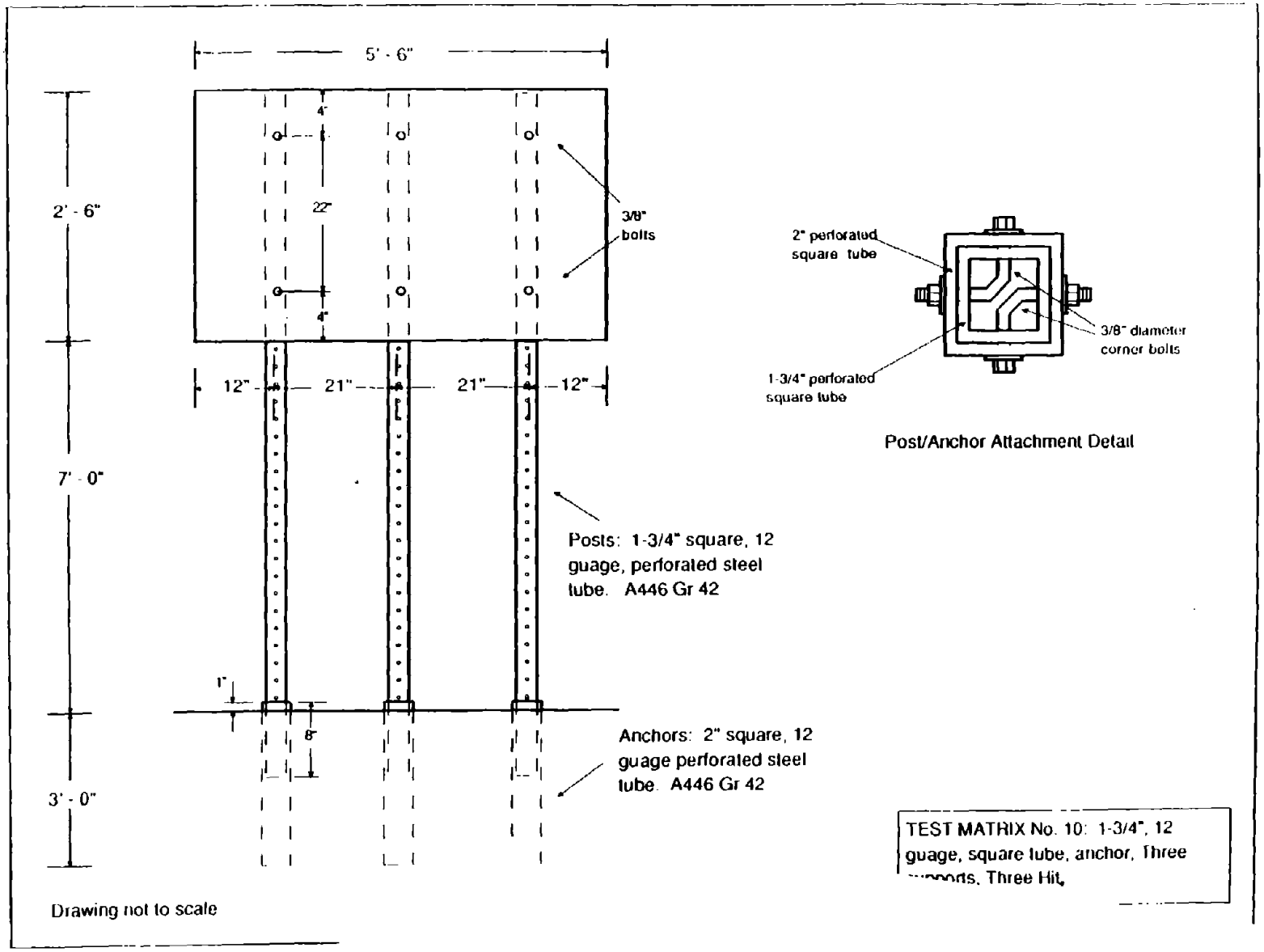
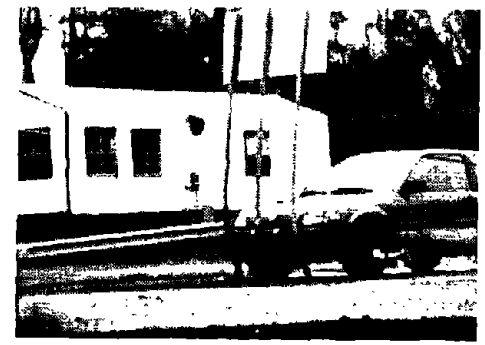


Figure 1. Sketch of small sign support.

0.024 s



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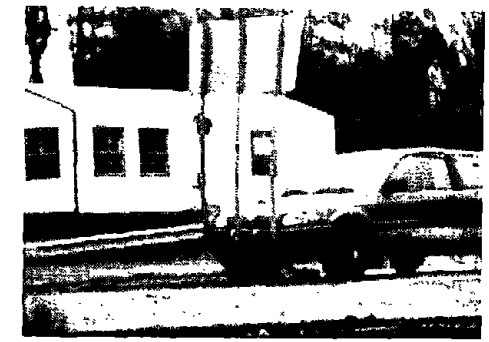
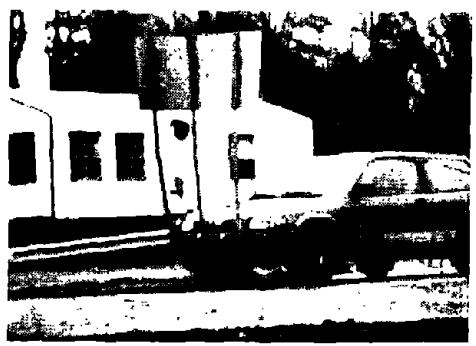


0.096 s



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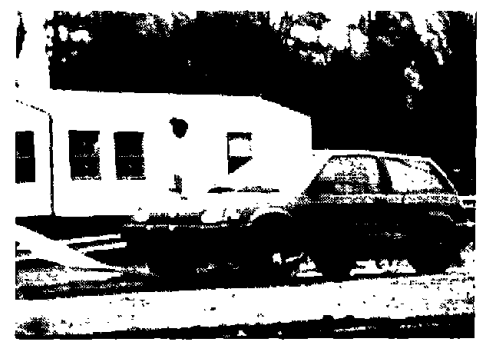
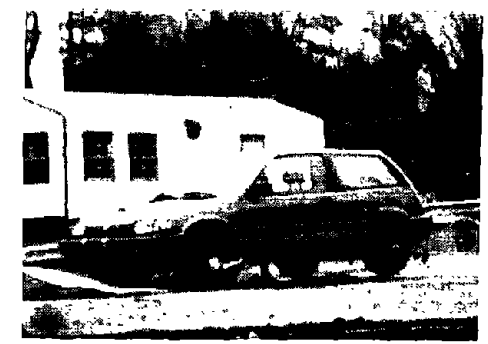
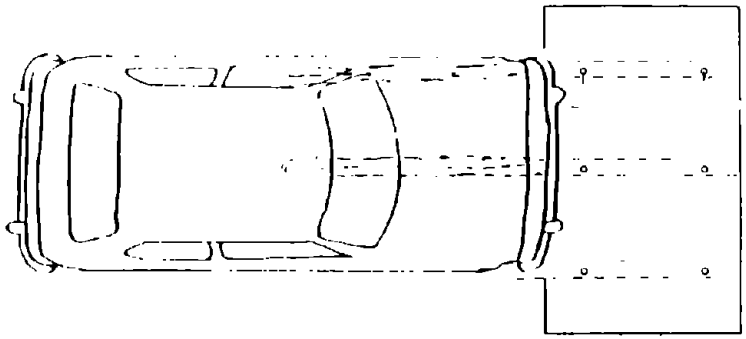


0.256 s



0.550 s

Figure 2. Test photographs during impact, test 92F039.



Test number..... 92F039

Date..... December 15, 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..... 29.9 ft/s (9.1 m/s)

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

Vehicle analysis:	Observed	Design/Limit
Longitudinal:		
Occupant Delta V at 2 ft	14.4 ft/s	≤16 ft/s
Ridedown Acceleration	6.9 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	4.1 g's	
Lateral	NA	
Vehicle Damage (TAD)	12-FC-1	
(VDI)	12FDEN1	
Vehicle crush	no residual crush	
Vehicle velocity change	28.5 ft/s	
Impact angle	0 degrees	
Exit angle	no exit	

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 92F039.

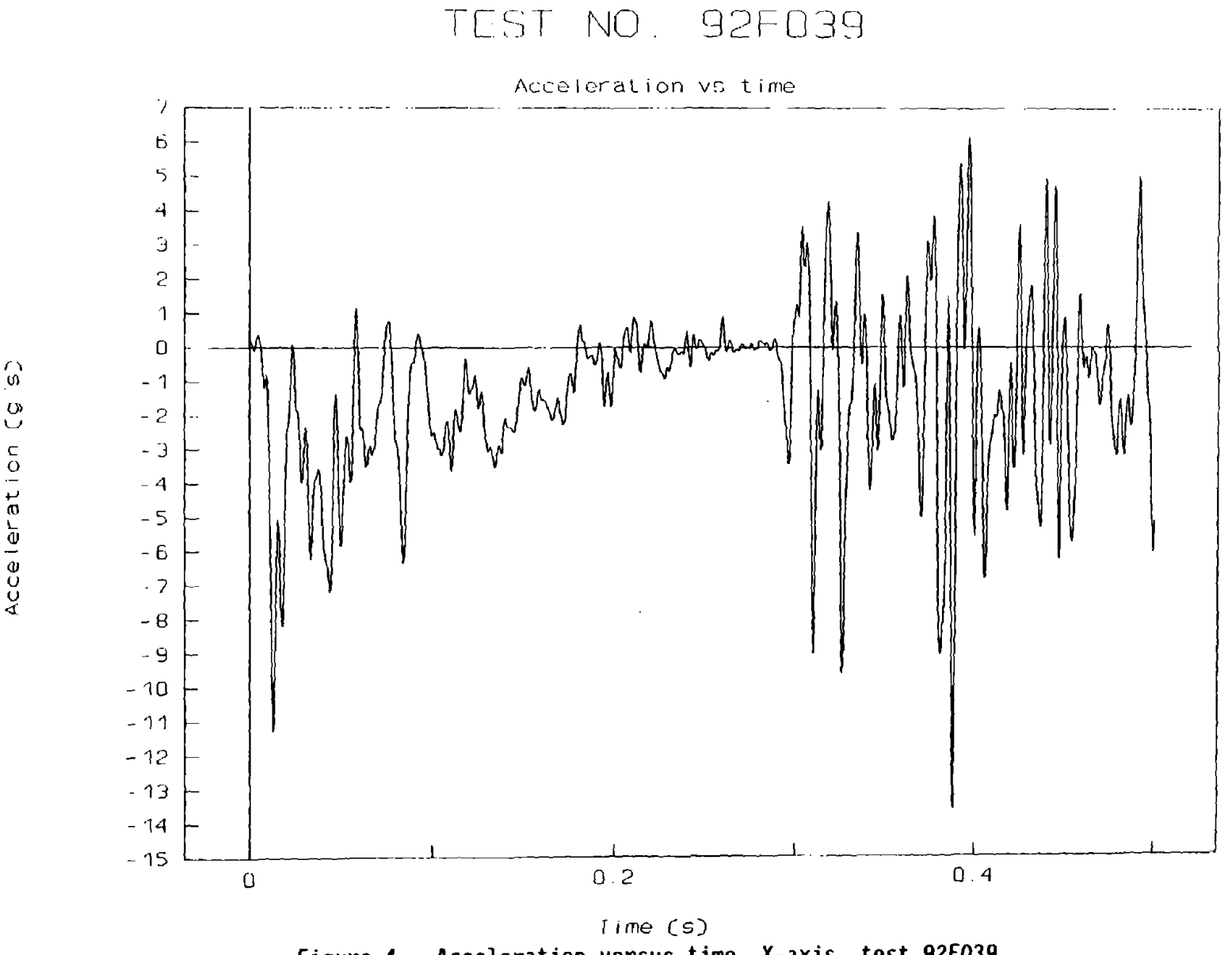
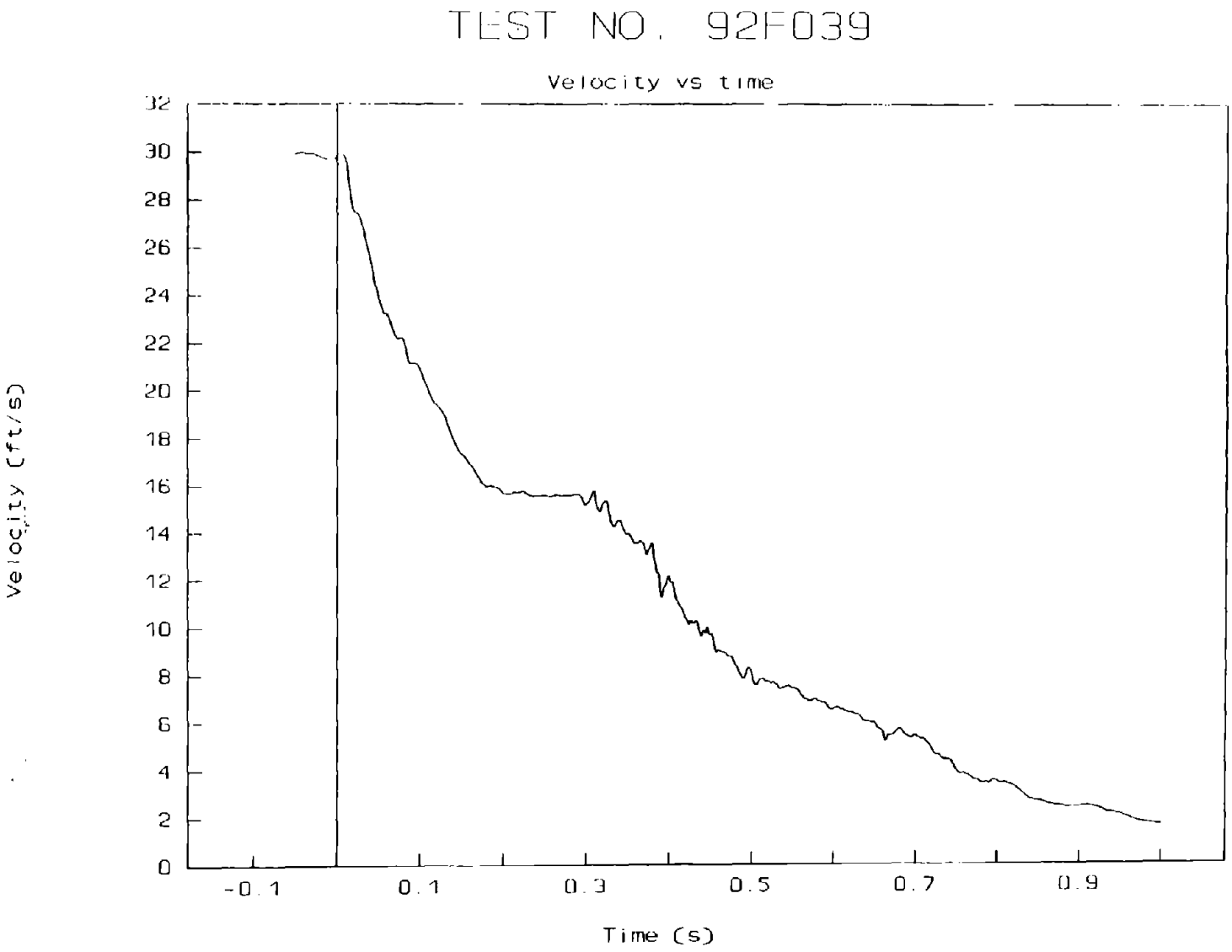
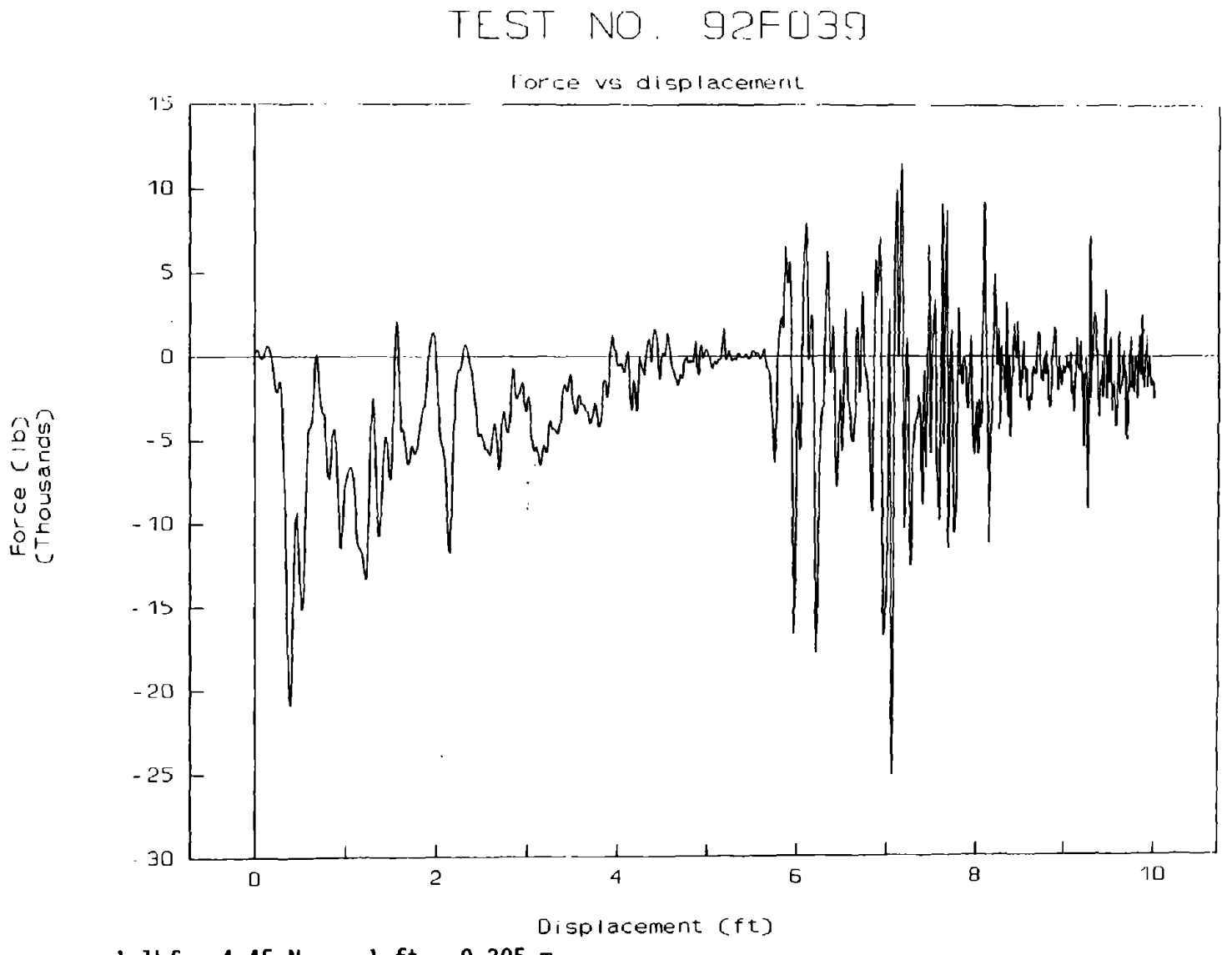


Figure 4. Acceleration versus time, X-axis, test 92F039.



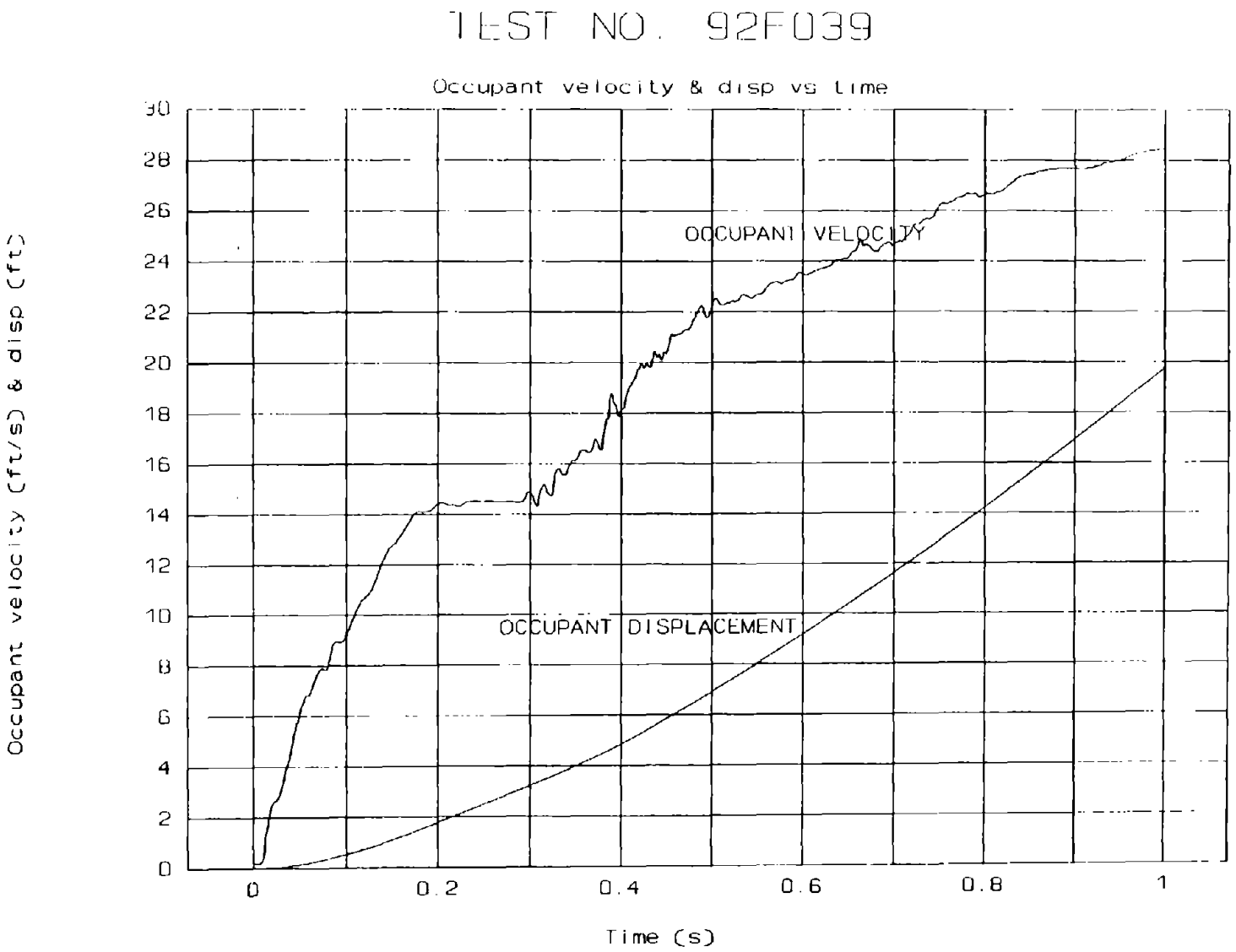
1 ft = 0.305 m

Figure 5. Velocity versus time, X-axis, test 92F039.



1 lbf = 4.45 N 1 ft = 0.305 m

Figure 6. Force versus displacement, X-axis, test 92F039.



1 ft = 0.305 m

Figure 7. Occupant velocity and relative displacement versus time, X-axis, test 92F039.

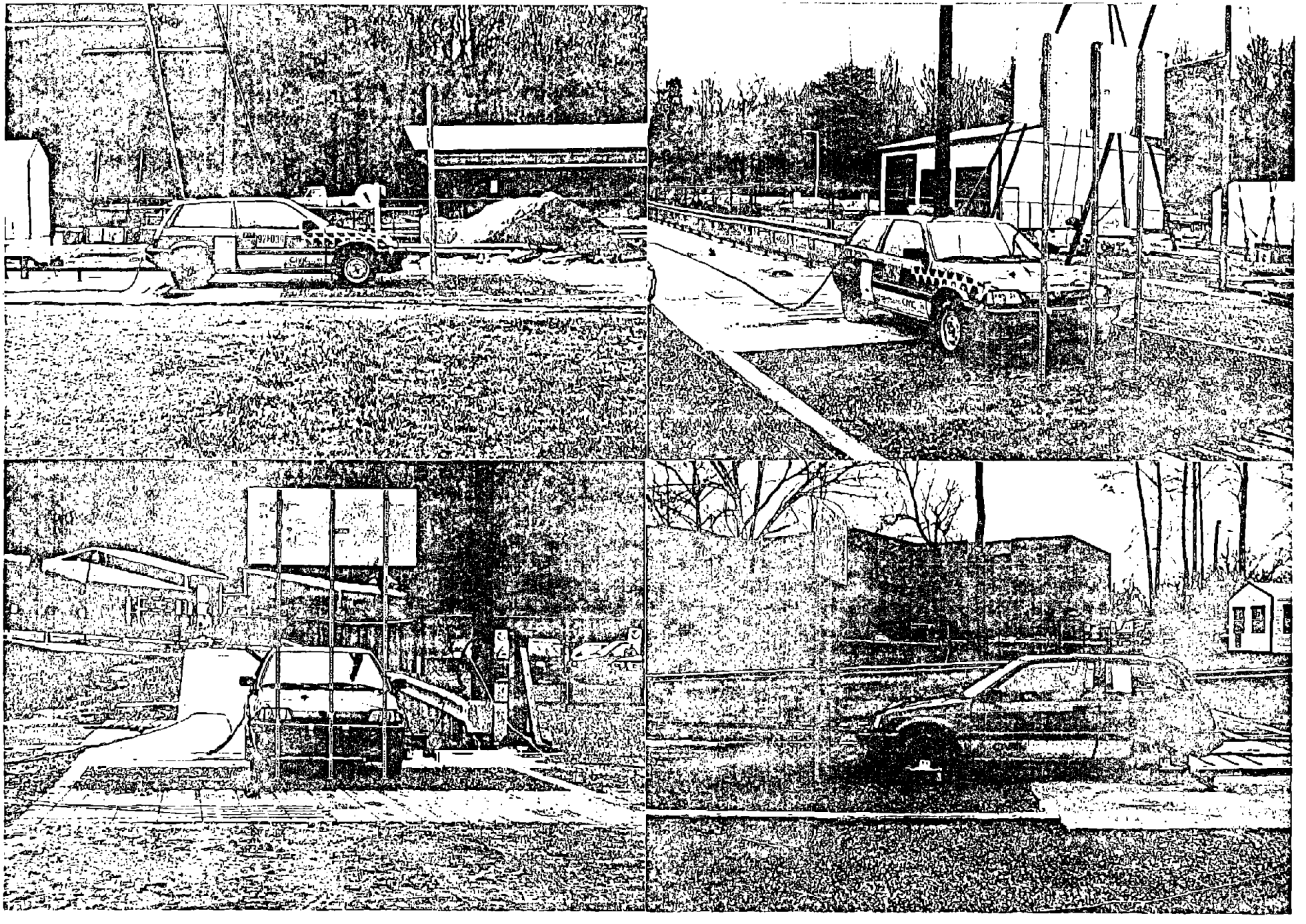


Figure 8. Pretest photographs of test 92F039.

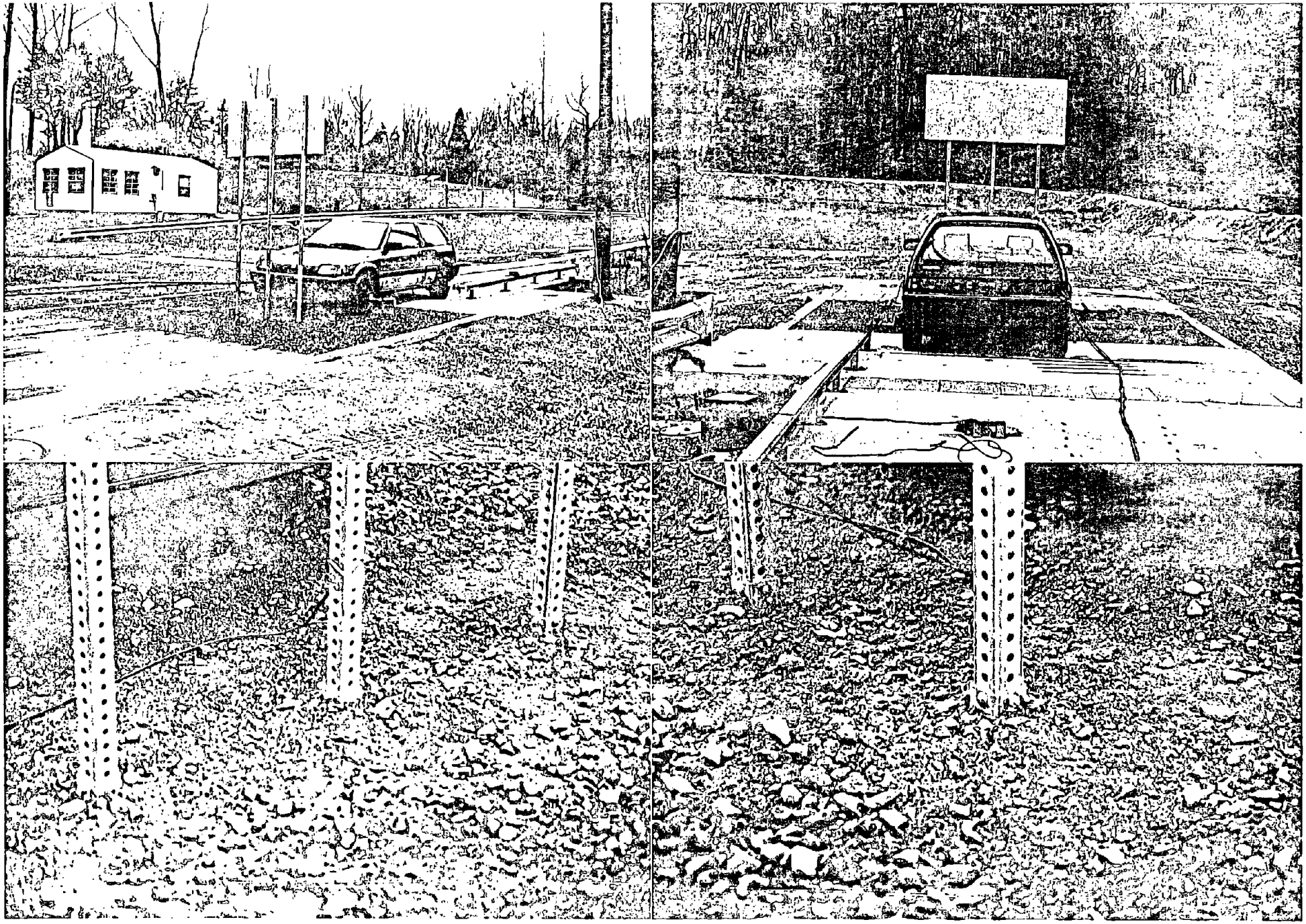


Figure 9. Additional pretest photographs of test 92F039.

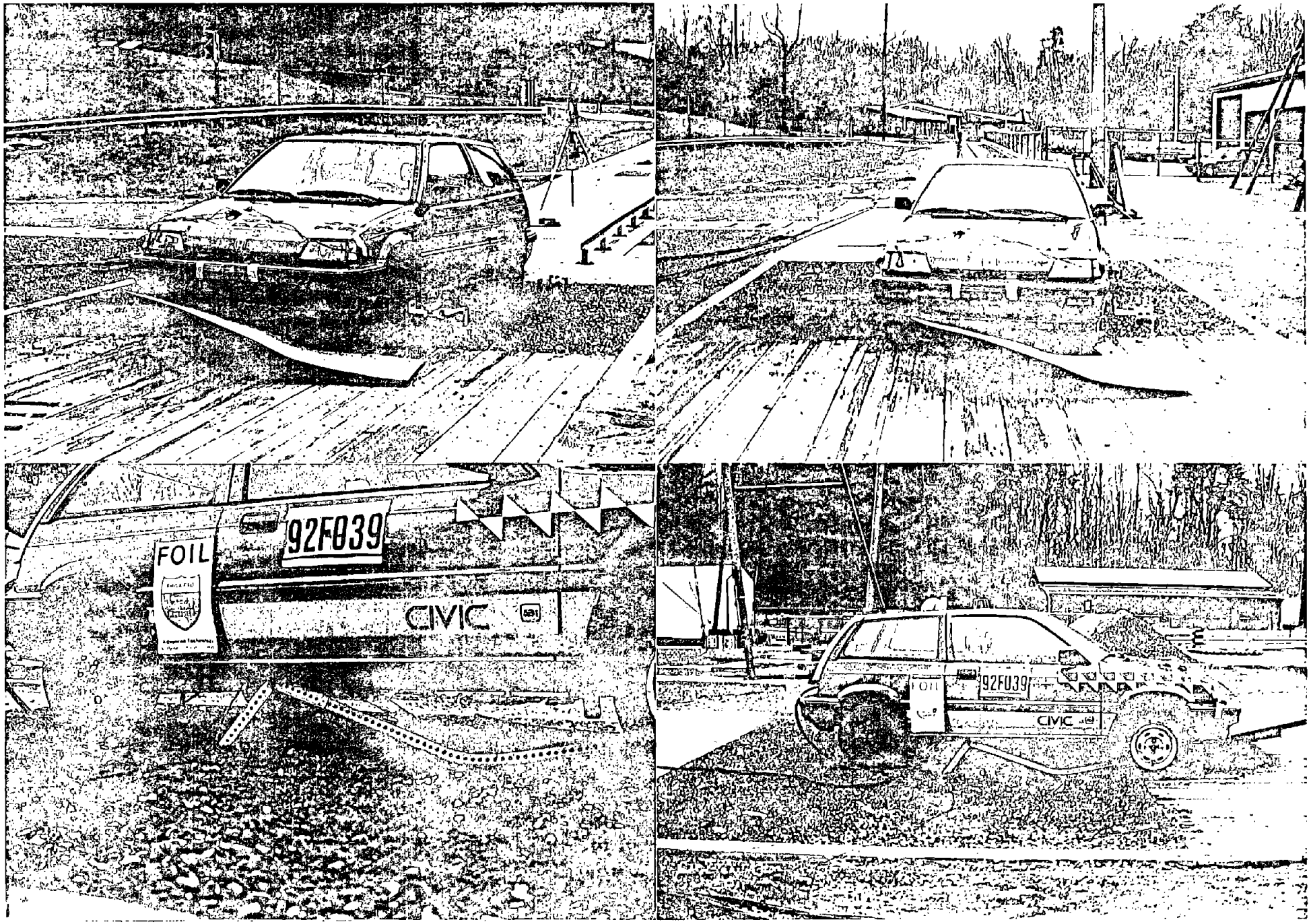


Figure 10. Post-test photographs of test 92F039.

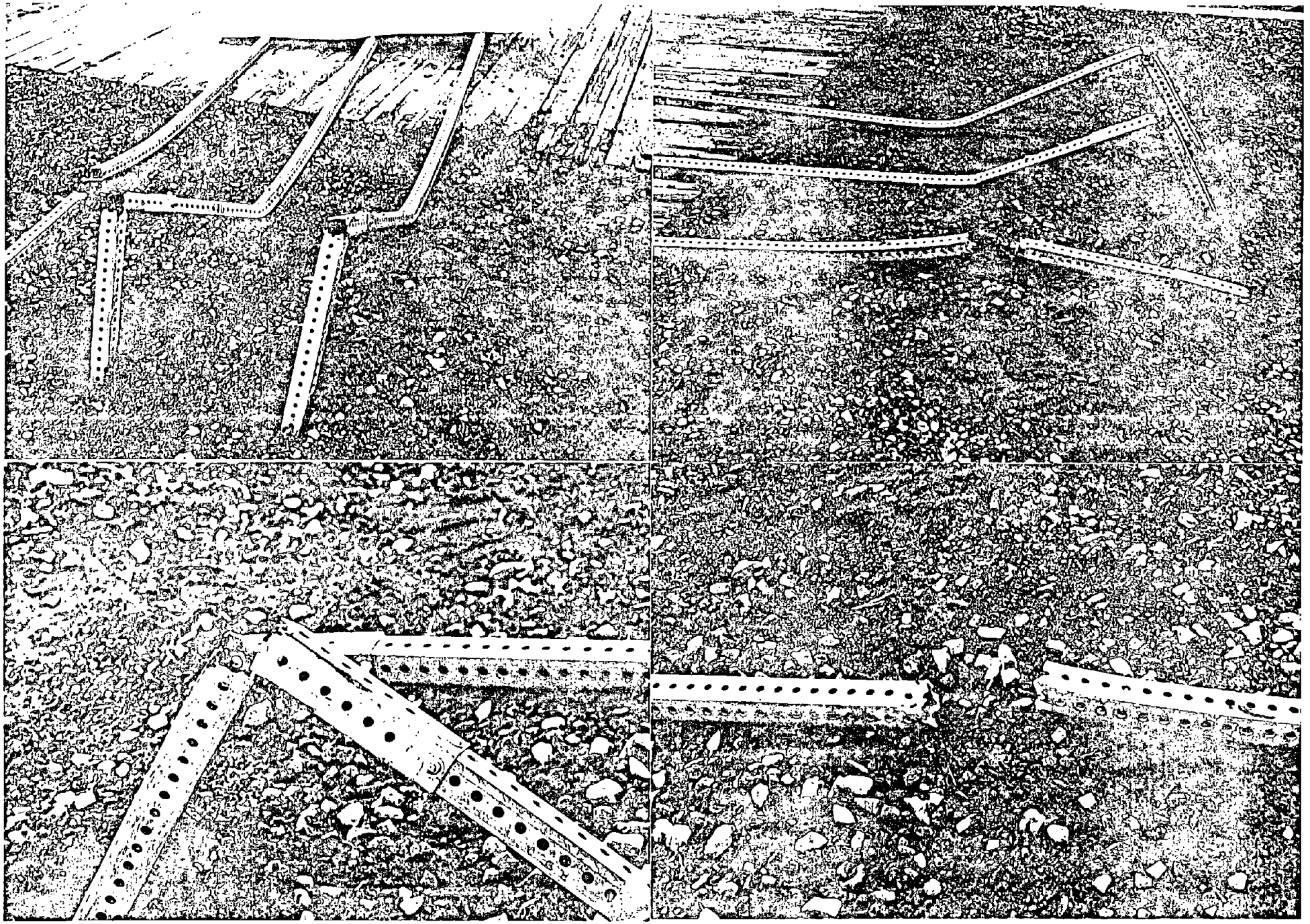


Figure 11. Additional post-test photographs of test 92F039.

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.