Publication No. FHWA-RD-93-119
July 1994

Testing of Small and Large Sign Support Systems FOIL Test Number: 92F038

U.S. Department of Transportation
Federal Highway Administration

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

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.

1. Report No.	2.	3.
FHWA-RD-93-119	PB94-186426	

4. Title and Subtitle	5. Report Date
TESTING OF SMALL AND LARGE SIGN SUPPORT SYSTEMS FOIL TEST NUMBER: 92F038	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, December 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 92F038. 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 steel 2.5-lb/ft (3.7-kg/m), 8-in (203.2-mm) splice, 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 in (101.6 mm), and that there can be no occupant compartment intrusion. The test results indicate that the 2.5-lb/ft (3.7-kg/m) u-channel sign support system meets all of the applicable safety criteria for the high-speed test in strong soil as specified by the FHWA.

17. Key Words	18. Distribution Statement
Acceleration, occupant impact velocity, strong soil, u-channel, 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	19	

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 km/h), test 92F038. 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 was a triple-post 2.5-lb/ft (3.7-kg/m) u-channel sign support with an 8-in (203.2-mm) splice-joint. 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
92F038	12-9-92	'86 Honda Civic	1850 839 kg	60 96.6 km/h	3 leg steel 2.5 lb/ft	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 2.5-lb/ft (3.7-kg/m) steel u-channel posts with a sign blank attached. Each post was constructed from two pieces of u-channel. One section, the stub, was 3 ft 4 in (1.02 m) in length and the other section was 13 ft 4 in (4.1 m) long. The two sections were overlapped 8 in (203.2 mm) and attached with two 3/8-in (9.5-mm) diameter grade-2 bolts. Between the sections of u-channel were 5/8 in (15.9 mm) long spacers (washers). The two pieces of u-channel were connected such that the upper post was behind the stub post. The three two-piece posts were assembled and attached to a 6-ft by 6-ft 3-in (1.8-m by 1.9-m) aluminum sign blank such that the panel was 7 ft (2.1 m) above ground. The three legs were installed

1.7 ft (0.5 m) apart. The whole sign support system was assembled and inserted 3 ft (0.9 m) in NCHRP S-1 strong soil. The hole around the sign support was backfilled in 6-in (152.4-mm) lifts and compacted until the final grade was reached. Figure 1 and figure 2 are drawings of the sign support system.

5. TEST RESULTS - TEST 92F038

The test vehicle was accelerated to 59.2 mi/h (86.8 ft/s (95.3 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 center and left post fail 0.004 s after initial contact. The three splice joints began to fail 0.002 s after the two posts failed. The last post failed 0.008 s into the event. Each of the posts failed at bumper height where initial contact was made. By 0.014 s all the splices had failed and the vehicle continued to pass through the sign system vaulting the sign upwards. The vehicle passed underneath the sign. The vehicle did not make further contact with the sign. The u-posts began to plow through the strong soil; however, the resistive force of the soil did not allow the posts to continue to plow through it. In addition, the speed and energy of the vehicle does not allow sufficient time for the posts to plow through the strong soil.

Damage to the vehicle consisted of minor damage to the bumper and grill and one broken head lamp. The center of the vehicle sustained the maximum crush because it is the softest area on the front end. There was little damage to the bumper, the recorded crush was inflicted on the header panel above the bumper. The center of the vehicle sustained a maximum crush of 1-in (25.2 mm). The occupant compartment was intact after the test.

Damage to the sign system consisted of three broken u-channel posts and six fractured grade-2 bolts. The sign panel and stubs 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 5.0 ft/s (1.5 m/s). The occupant impact velocity was reached 0.497 s into the crash event. The ridedown acceleration was 0.6 g's. The peak acceleration (300 Hz data) for the impact event was 26.0 g's (peak force 48.1 kips (214 kN)). Because the contact between the sign system and the vehicle was less than the time required for an occupant to travel the 2-ft (0.6-m) flail space, the vehicle change in velocity is equal to the occupant impact velocity and was calculated to be 5.0 ft/s (1.5 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 the crush was insignificant, no vehicle crush sketch was included in this report.

6. CONCLUSION

The test results indicate that the small sign support system meets all of the applicable criteria for the high-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 5.0 ft/s (1.5 m/s) which is less than or equal to the 16-ft/s (4.9-m/s) limit specified by the FHWA.

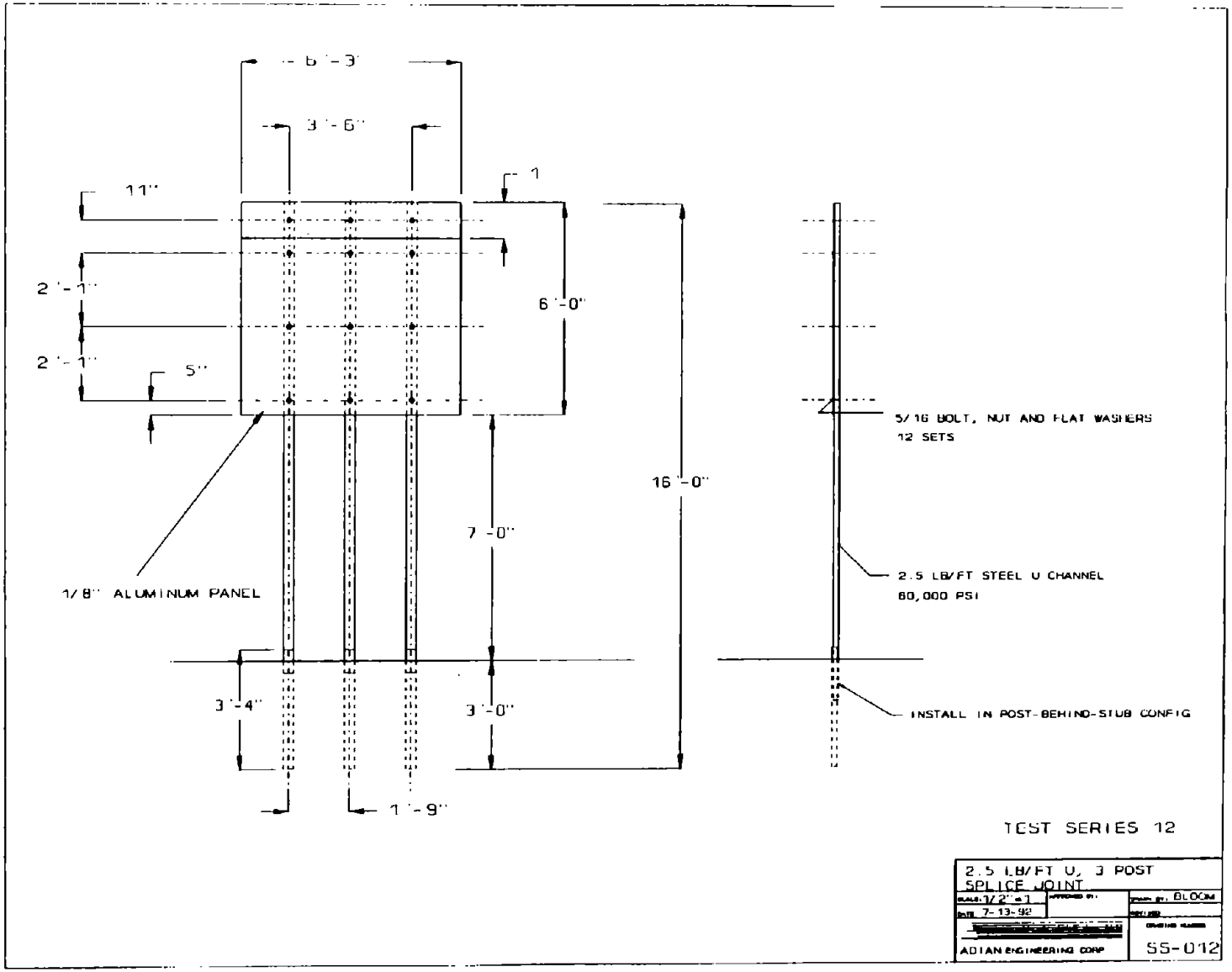


Figure 1. Sketch of small sign support.

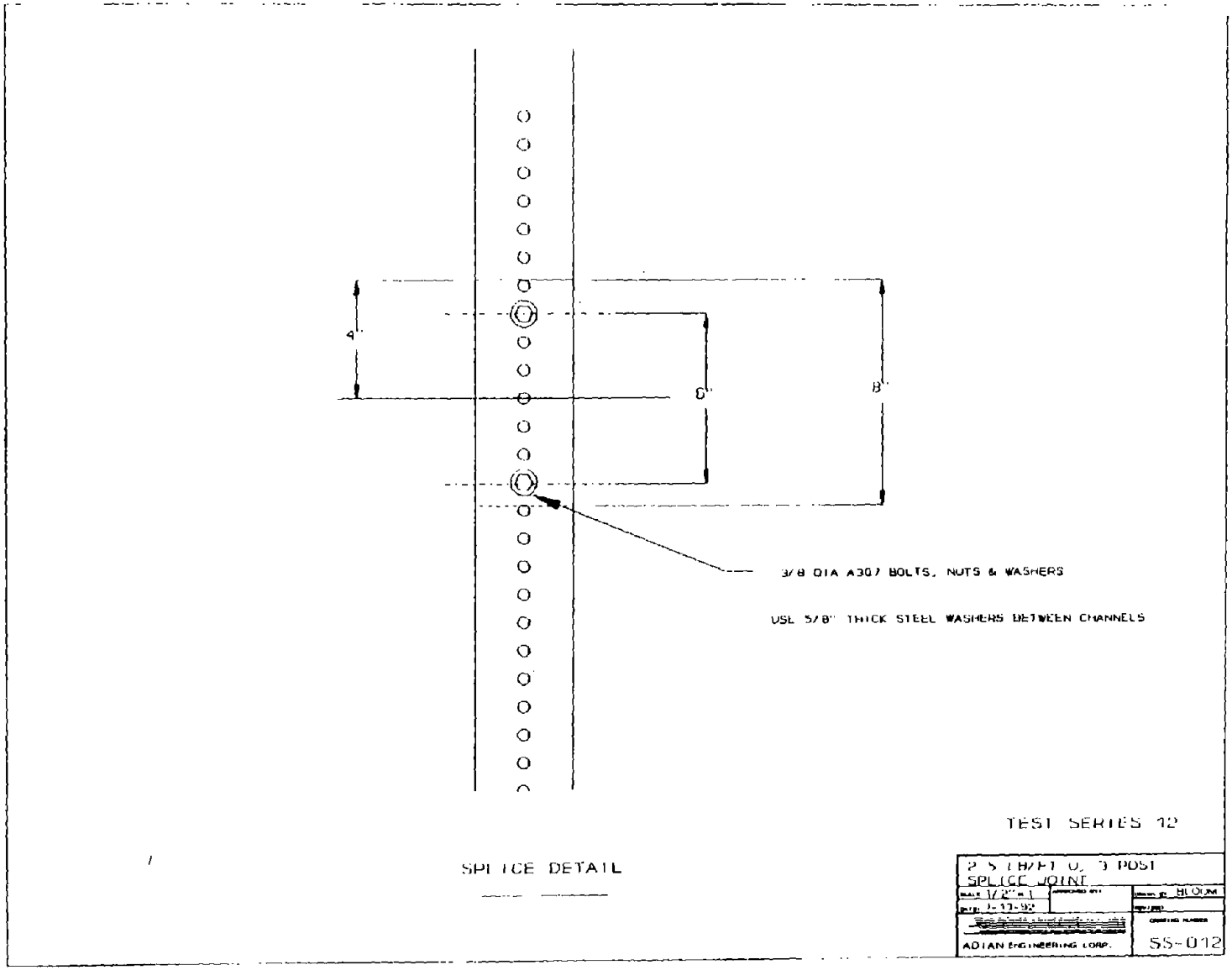
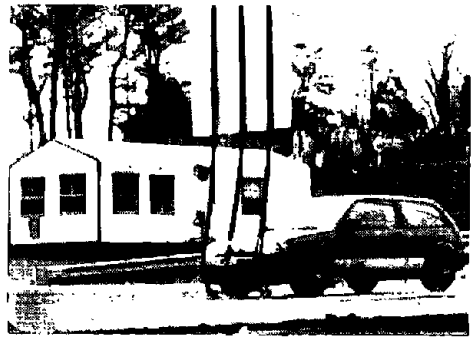
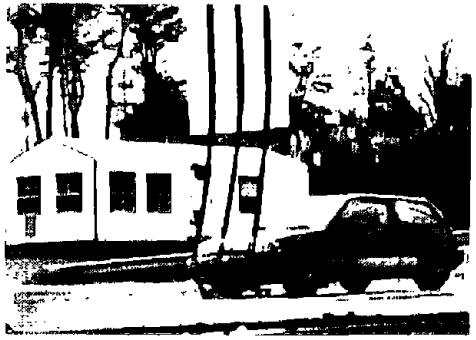


Figure 2. Sketch of small sign, splice detail.

0.006 s

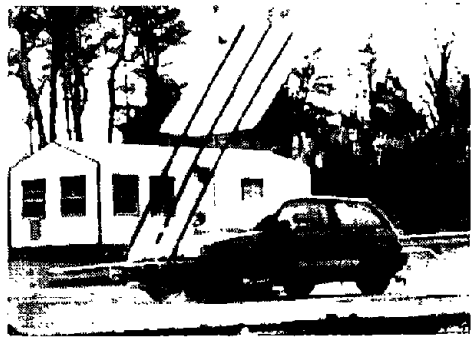


0.010 s

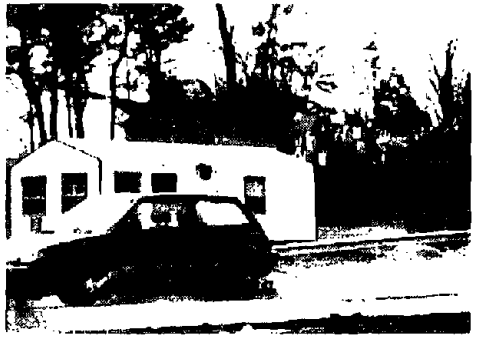


0.014 s

0.030 s

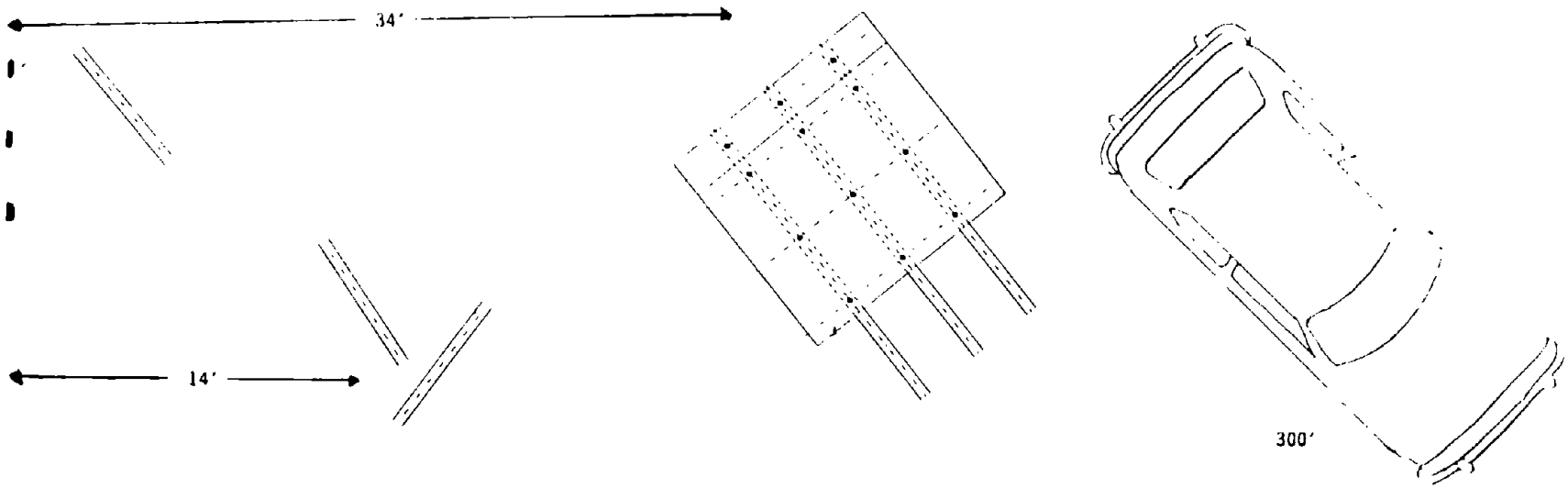


0.060 s



0.156 s

Figure 3. Test photographs during impact, test 92F038.



Test number	92F038
Date	December 9, 1992
Test vehicle	1986 Honda Civic
Vehicle weight	1850 lb (839 kg)
Test article	small sign support
Material	2.5-lb/ft u-channel 3-Leg, 3-Hit
Embedment depth	3 ft
Panel type	6 ft by 6 ft 3 in aluminum sheet
Height	13 ft
Foundation	S-1 strong soil
Impact speed	86.8 ft/s (9.4 m/s)
Impact location	Head-on, centerline

Vehicle analysis:	Observed	Design/Limit
Longitudinal:		
Occupant Delta V at 2 ft	5.0 ft/s	≤16 ft/s
Ridedown Acceleration	0.6 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	2.1 g's	
Lateral	NA	
Vehicle Damage (TAD)	12-FC-1	
(VDI)	12FDEN1	
Vehicle crush	1 in	
Vehicle velocity change	5.0 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 ft/s = 0.305 m/s 1 mi/h = 1.61 km/h

Figure 4. Summary of test 92F038.

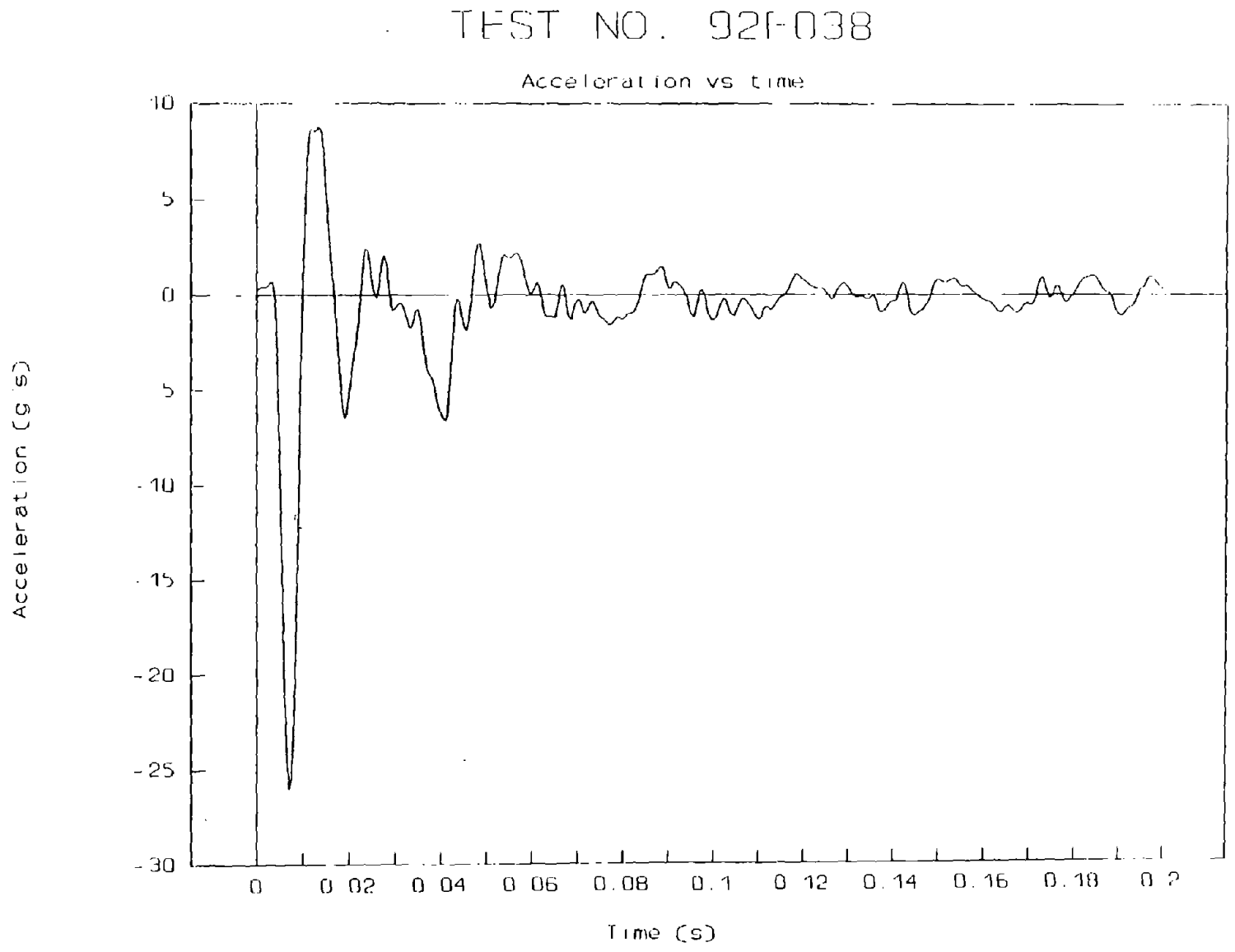
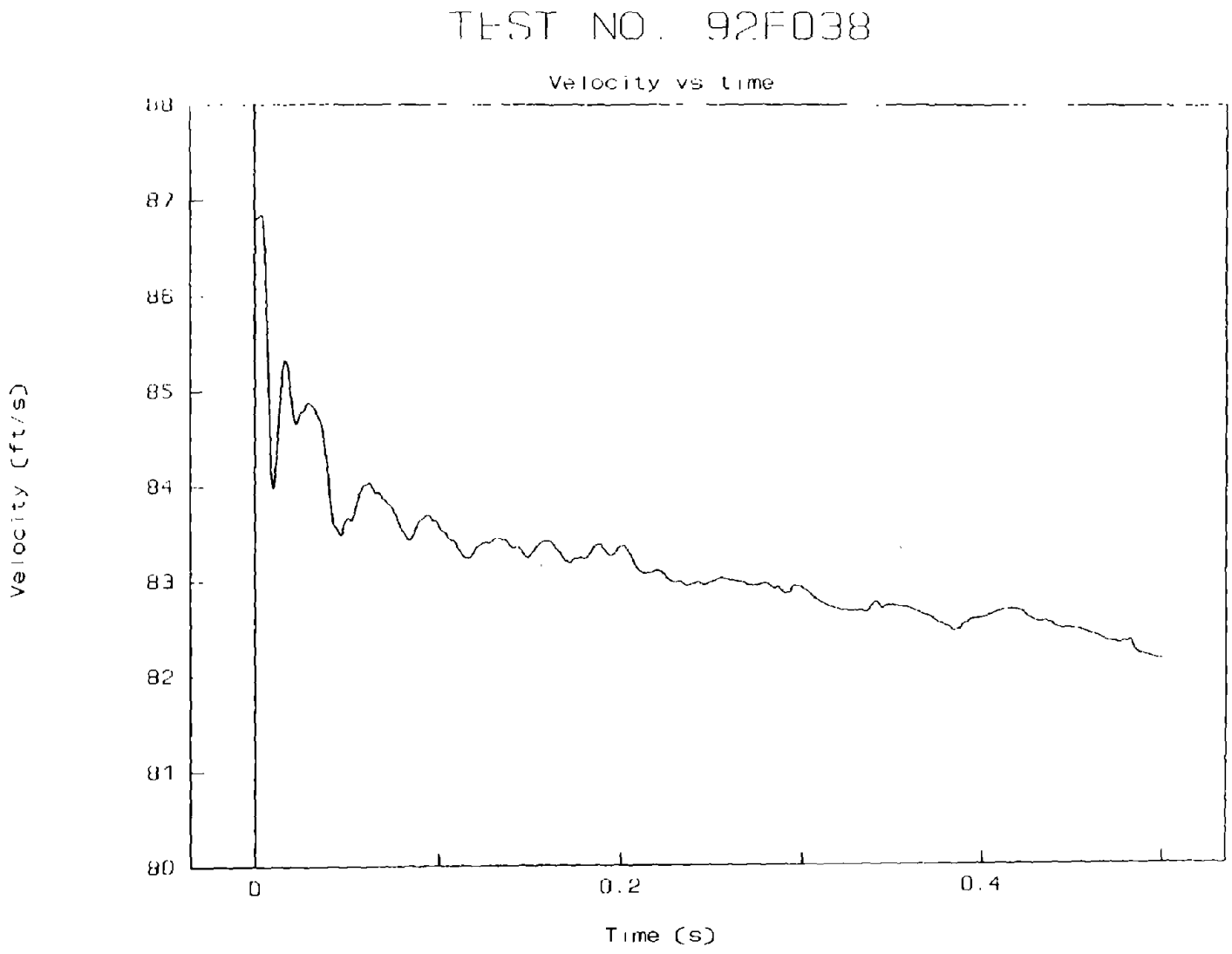
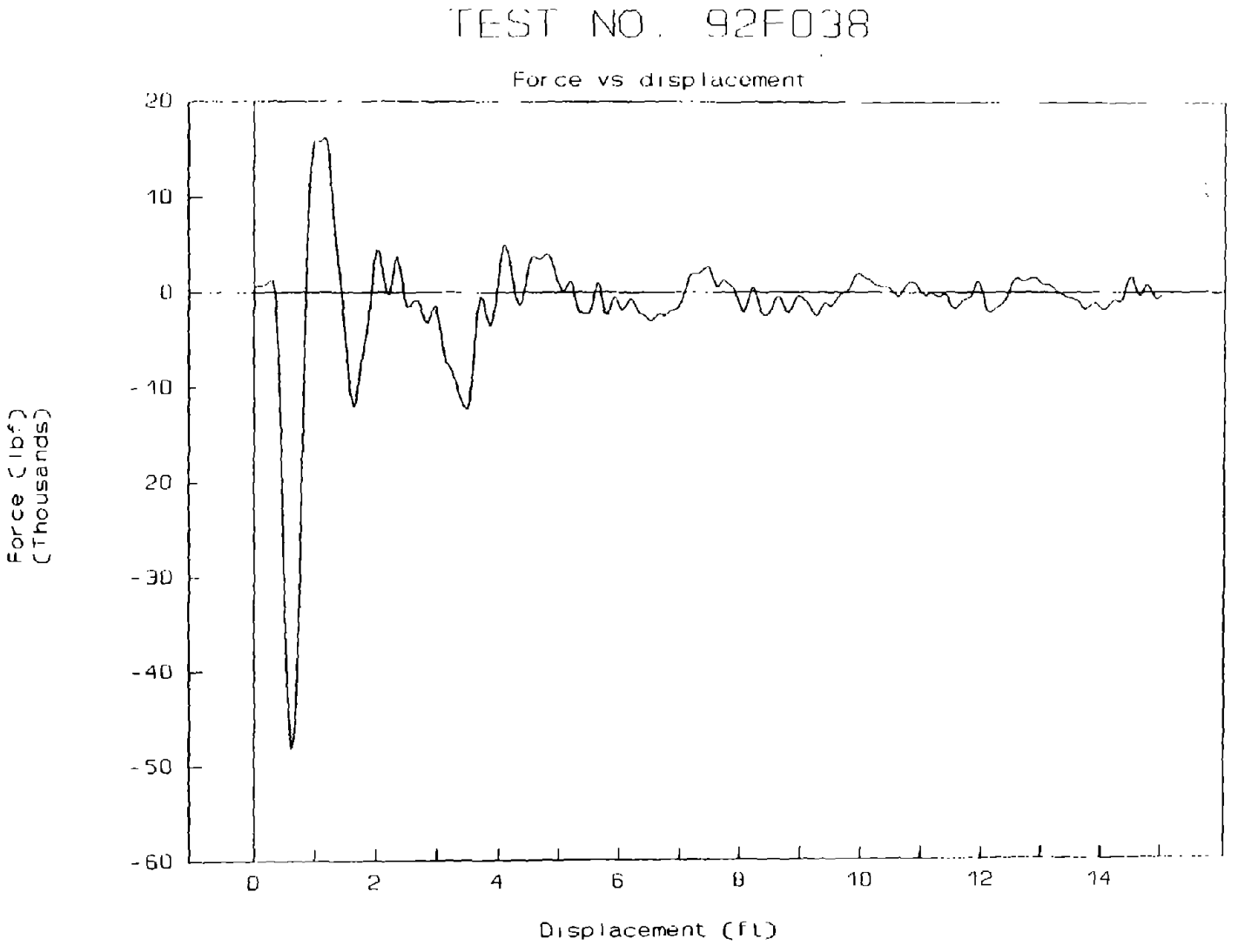


Figure 5. Acceleration versus time, X-axis, test 92F038.



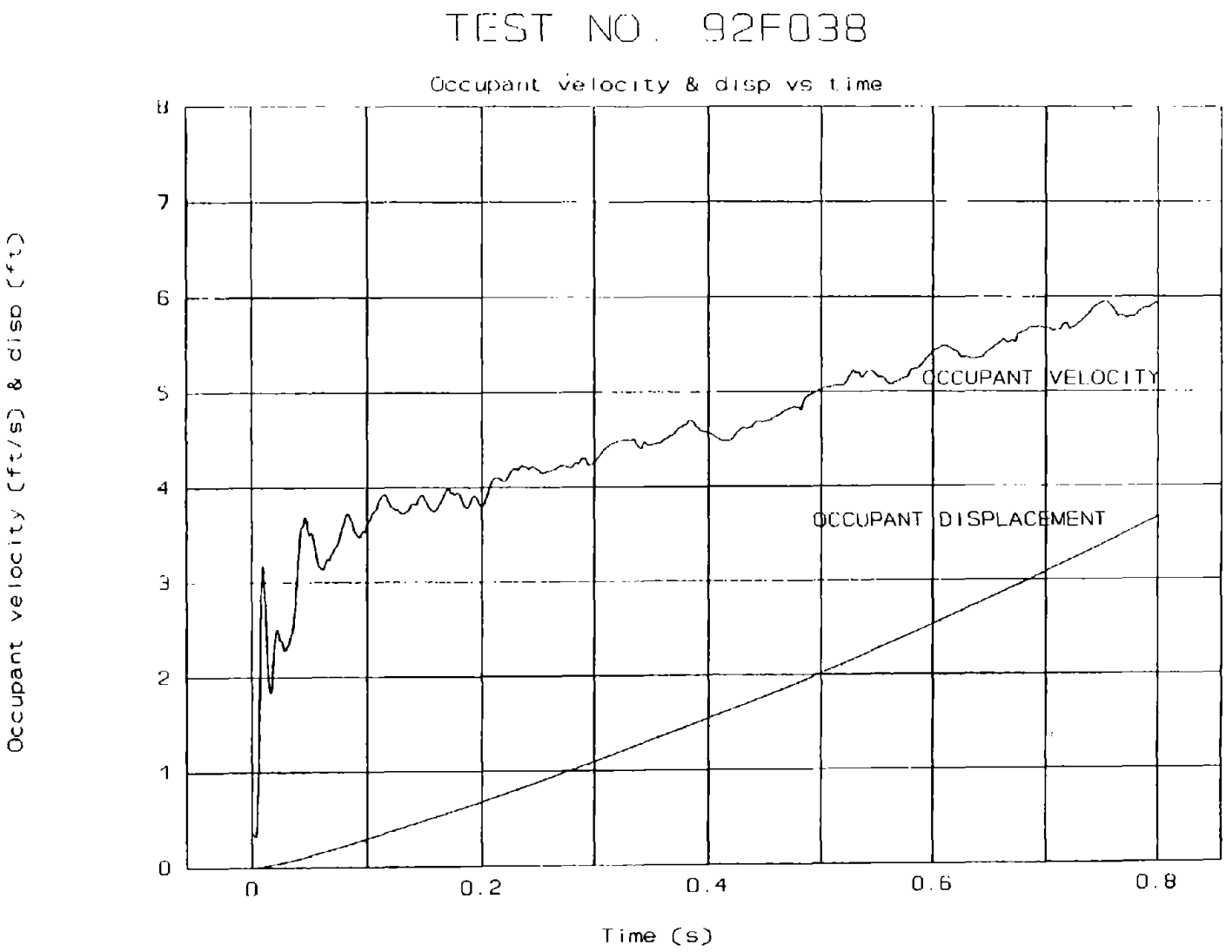
1 ft = 0.305 m

Figure 6. Velocity versus time, X-axis, test 92F038.



1 lbf = 4.45 N 1 ft = 0.305 m

Figure 7. Force versus displacement, X-axis, test 92F038.



1 ft = 0.305 m

Figure 8. Occupant velocity and relative displacement versus time, X-axis, test 92F038.

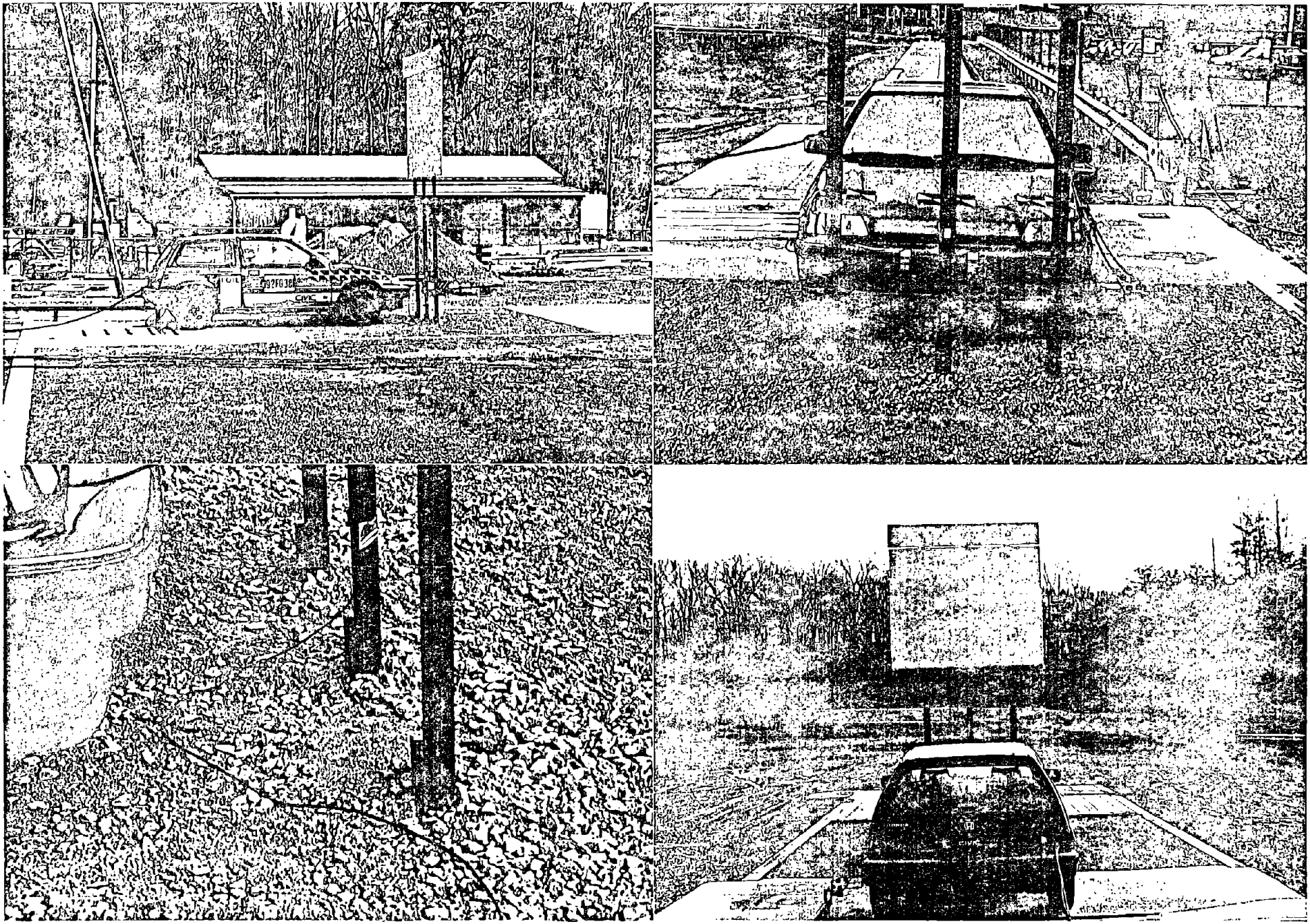


Figure 9. Pretest photographs of test 92F038.

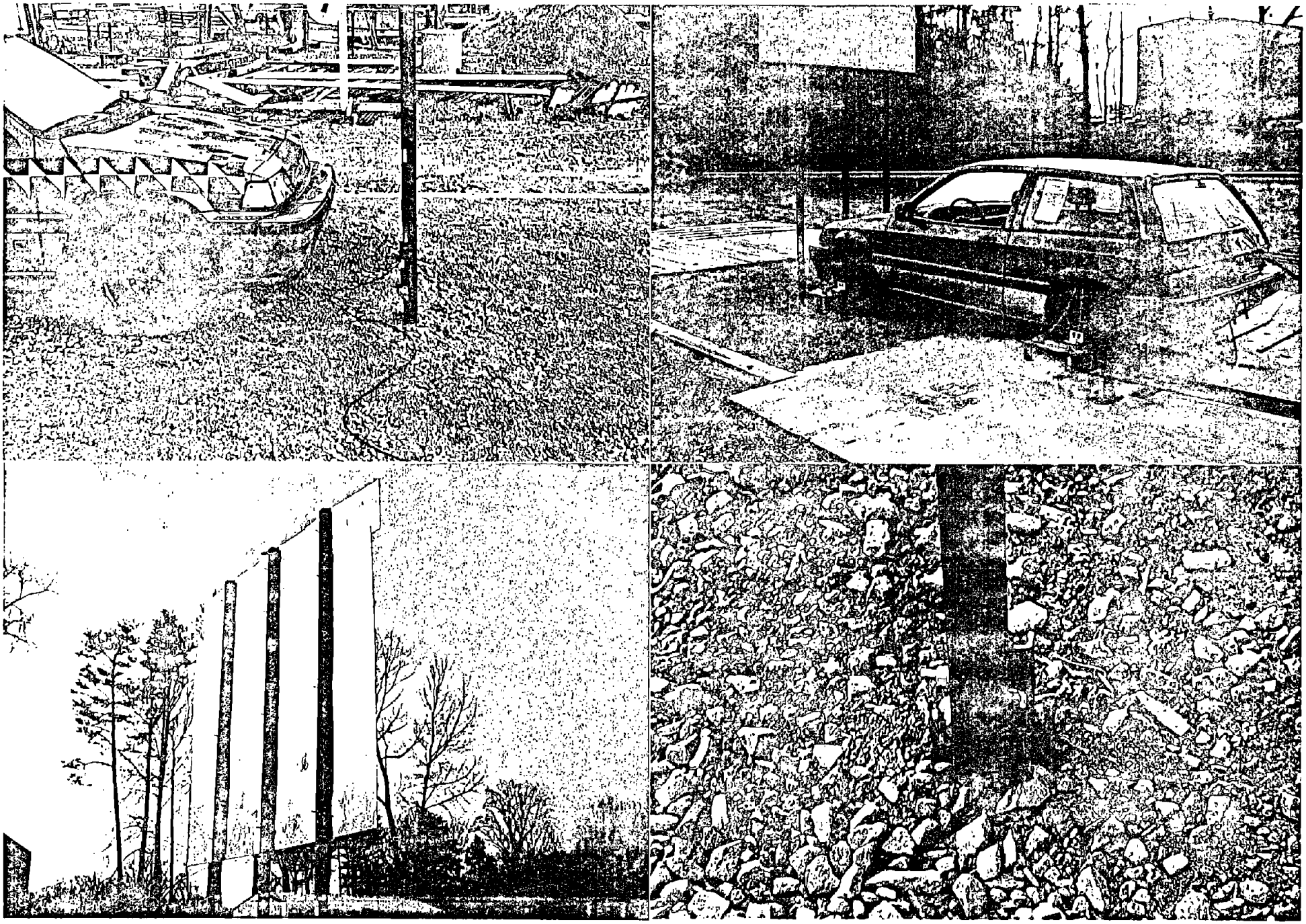


Figure 10. Additional pretest photographs of test 92F038.

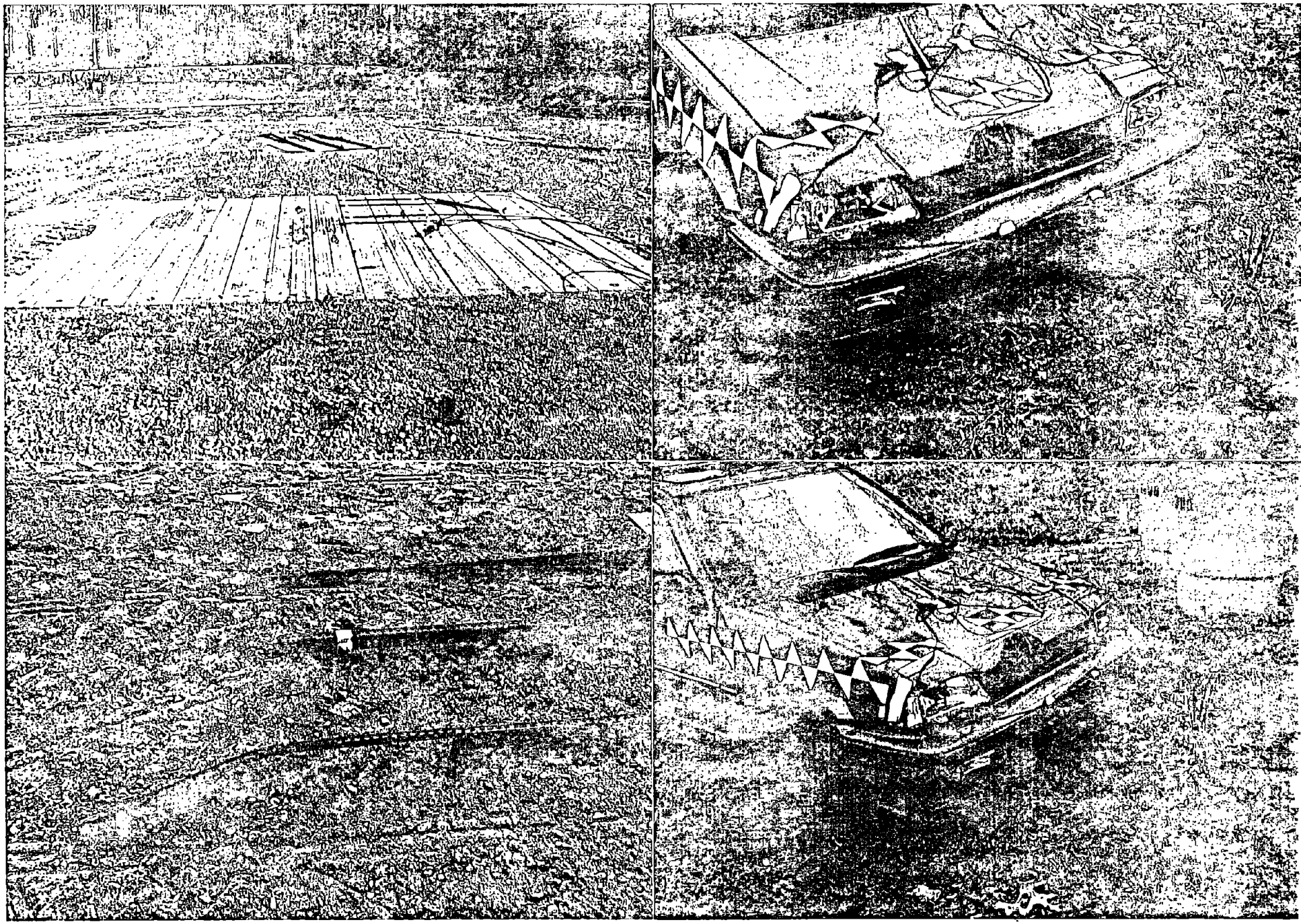


Figure 11. Post-test photographs of test 92F038.

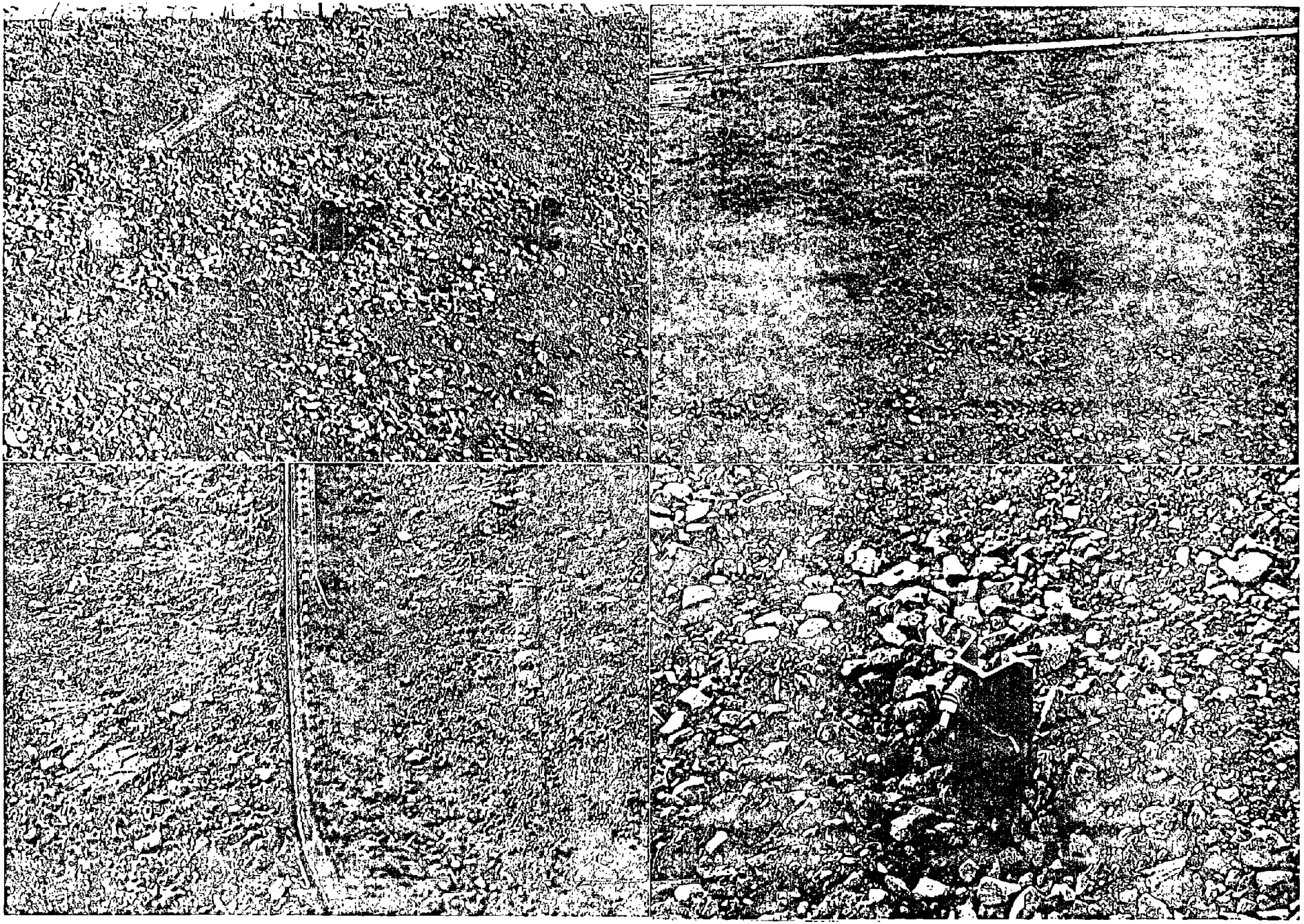


Figure 12. Additional post-test photographs of test 92F038.

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.