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Testing of Small and Large Sign Support Systems FOIL Test Number: 92F018

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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 92F018. 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 triple 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 in (102 mm), and that there can be no occupant compartment intrusion. The test results indicate that the 4 lb/ft (5.95 kg/m) u-channel sign support system does not meet all of the applicable criteria for roadside safety appurtenances specified by the FHWA.

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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	mogagrams	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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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 Date	Test Vehicle	Test Weight (lb)	Test Speed (mi/h)	Test Article Description	Impact Location
92F018	7-8-92	'84 Honda Civic	1850	20	3 leg steel 4 lb/ft	2 leg hit

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 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 4 lb/ft (5.95 kg/m) steel u-channel legs 15 ft (4.6 m) long. Three feet (0.9 m) of each leg was buried in NCHRP Report 230 S-2 weak soil (sand). Attached to the three legs was a 5-ft high by 12-ft wide (1.5-m by 3.7-m) aluminum sign panel. The panel was a 0.125-in (3-mm) thick aluminum sheet and was installed 7 ft (2.1 m) above ground. The three 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. The centerline of the vehicle was aligned with the

midpoint between the center post and the right post. Figure 1 is a drawing of the sign support system.

5. TEST RESULTS - TEST 92F018

The test vehicle was accelerated to 21.5 mi/h (31.5 ft/s (9.6 m/s)) prior to impacting the sign support. The centerline of the test vehicle was aligned with the midpoint between the center and right sign post.

The bumper made contact with two of the three sign legs and began to collapse. The bumper collapsed to the outside edge of the left bumper support and at the right bumper support. The u-channel legs began to bow away from the vehicle and push through the weak soil. Because two out of three sign posts were struck, the sign system was unable or unintended to be a base-bending sign system. The required force to break the two u-channel posts was higher than the resisting force of the weak soil therefore the weak soil gave way before the u-channel and the vehicle forced the u-channel to plow through the sand. Contact was not made with the left sign post and therefore the sign pivoted counter-clockwise around the left sign post. The vehicle continued to force the two u-channel legs through the sand. The rotation around the left post causes the vehicle to turn to the left and consequently forces the right post through a greater distance than the center post. The induced moment on the right post causes the right u-channel to break. The vehicle passed over the remaining u-channel stub and yawed around the center post. The vehicle came to rest on top of the right posts' stub. The vehicle did not pass completely through the sign system. After the test, the stub was measured to be 21 in (0.533 m).

Damage to the vehicle consisted of damage to the bumper and grill. The majority of the damage occurred to the outside edge of the left bumper support where there was little structural support. The bumper collapsed to the left head-light socket and damaged plastic components. The right side of the vehicle was intact with the exception of one parking light. The occupant compartment was intact after the test.

Damage to the sign system consisted of three bent and twisted u-channel legs with one u-channel broken 21 in (0.533 m) above ground. Each of the two struck posts bent 12 in (0.305 m) below the ground line. The panel was in good condition after the test.

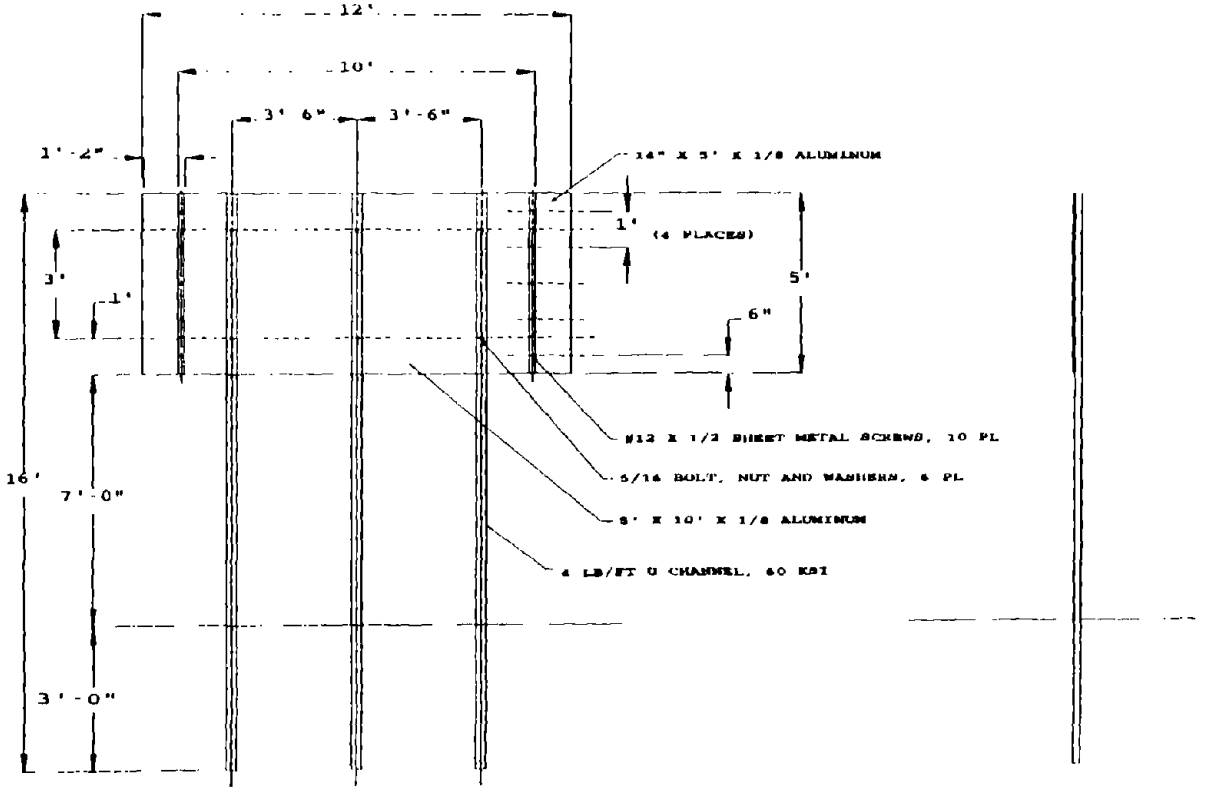
The occupant impact velocity using the 2-ft (0.6-m) flail space model outlined in NCHRP Report Number 230, was determined to be 20.2 ft/s (6.2 m/s). The occupant impact velocity was reached 0.182 s into the crash event. The ridedown acceleration was 2.7 g's. The peak force (300 Hz data) for the impact event was 8.1 g's (15.0 kips (66.6 kN)). Because the sign system stopped the vehicle, the vehicle change in velocity is equal to the impact velocity. The actual vehicle velocity change calculated by integration of the on-board accelerometers was 29.5 ft/s (9.0 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. Pretest and post-test photographs of the vehicle and sign support system are presented in figures 8 through 11. Figure 12 is a sketch of the measured vehicle crush.

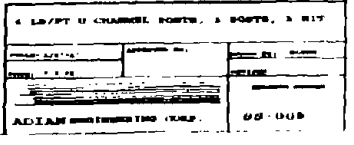
6. CONCLUSION

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, however the stub remaining after the test was measured to be 21 in (0.533 m) which is not less than or equal to the 4-in (0.102-m) limit specified by the FHWA. In addition, the occupant impact velocity was 20.2 ft/s (6.2 m/s) which is not less than or equal to the 16 ft/s (4.9 m/s) limit specified by the FHWA.



Total weight = 285 lb



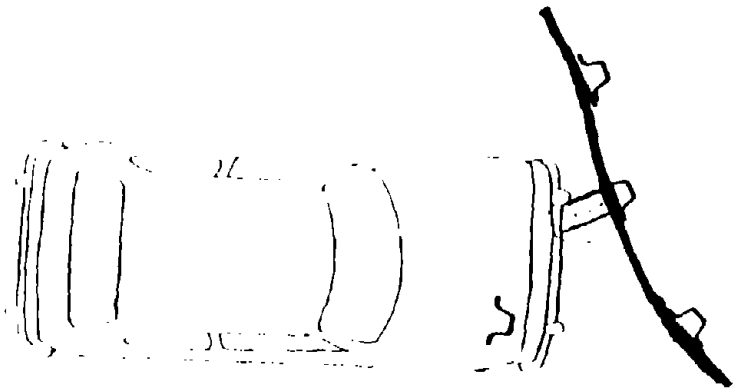
1 in = 25.4 mm 1 ft = 0.305 m 1 lb = 0.454 kg

Figure 1. Sketch of small sign support.

0.022 s 0.046 s 0.134 s

0.242 s 0.400 s 0.984 s

Figure 2. Test photographs during impact, test 92F018.



SIGN REMAINED UPRIGHT

STUB UNDER VEHICLE

Test number	92F018
Date	July 8, 1992
Test vehicle	1984 Honda Civic
Vehicle weight	1850 lb (839 kg)
Test article	Small Sign Support
Material	4 lb/ft u-channel 3-Leg, 2-Hit
Embedment depth	3 ft
Panel type	5 ft by 12 ft aluminum sheet
Height	12 ft
Foundation	S-2 Weak Soil
Impact speed	31.5 ft/s (9.6 m/s)
Impact angle	0 degrees
Impact location	Head-on, centerline

Vehicle analysis:	Observed	Design/Limit
Longitudinal:		
Occupant Delta V at 2 ft	20.2 ft/s	≤16 ft/s
Ridedown Acceleration	2.7 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	4.5 g's	
Lateral	NA	
Vehicle Damage (TAD)	12-FC-2	
(VDI)	12FDEN2	
Vehicle crush	12.5 in	
Vehicle velocity change	29.5 ft/s	
Exit angle	no exit	

1 in = 25.4 mm 1 ft = 0.305 m 1 lb = 0.454 kg

Figure 3. Summary of test 92F018.

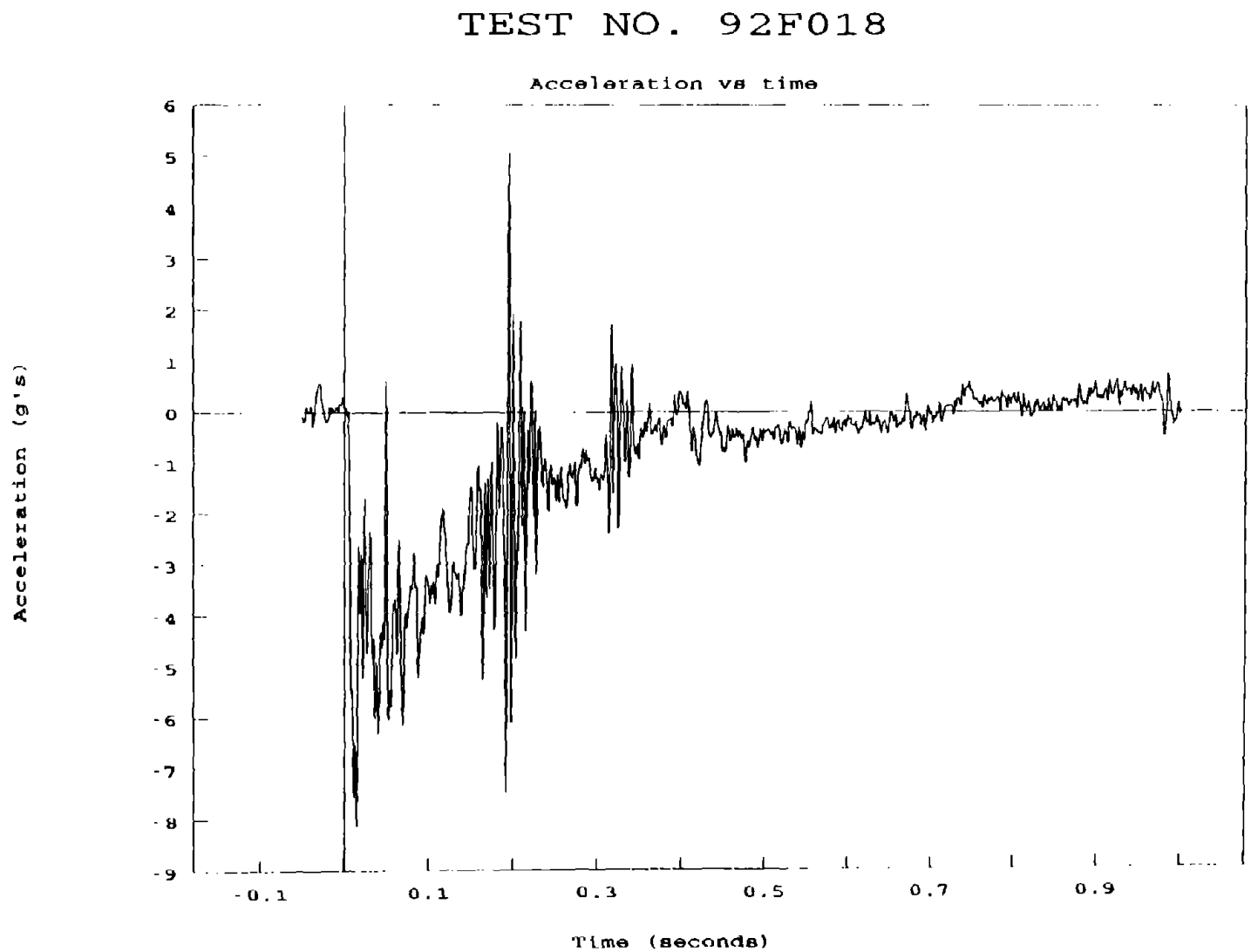
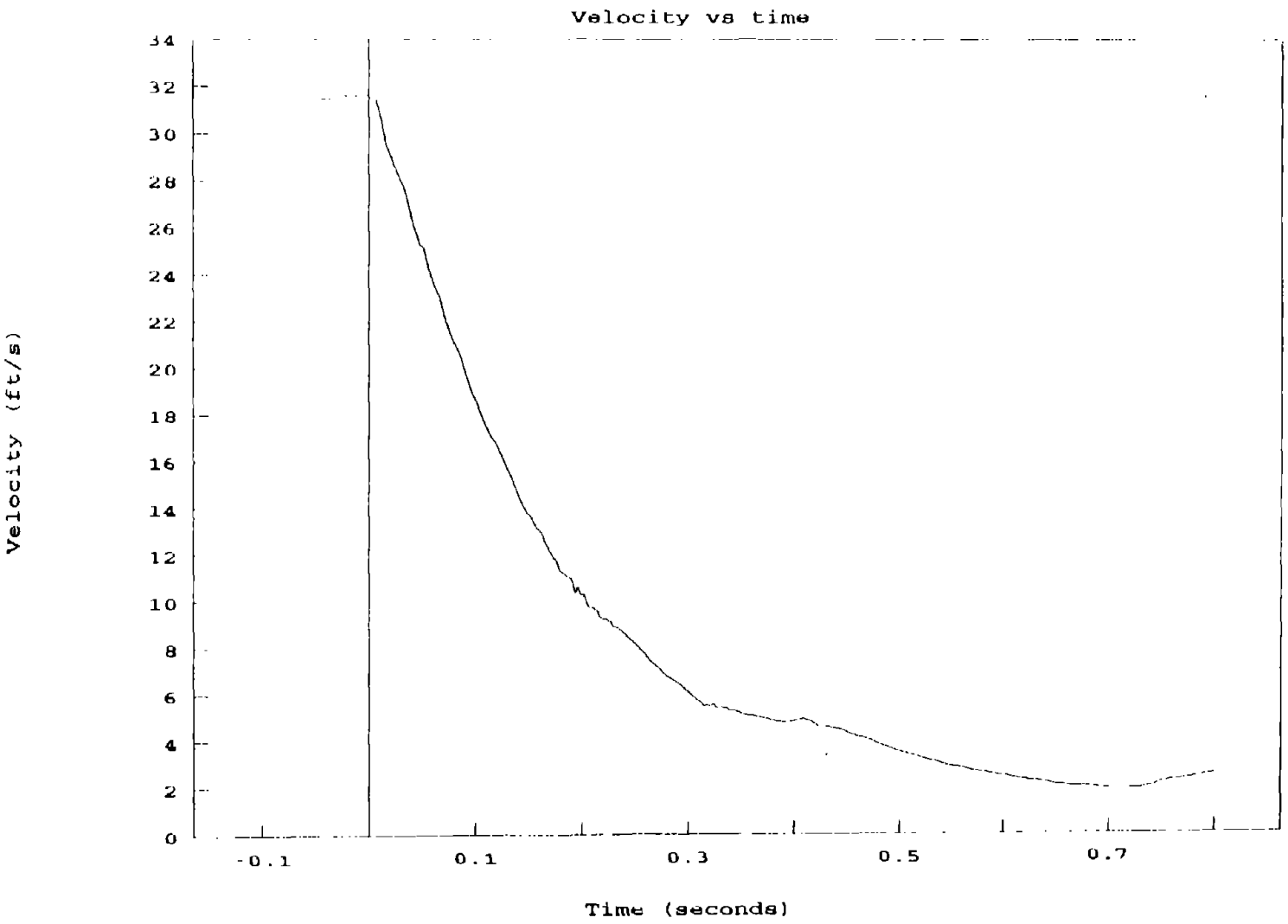


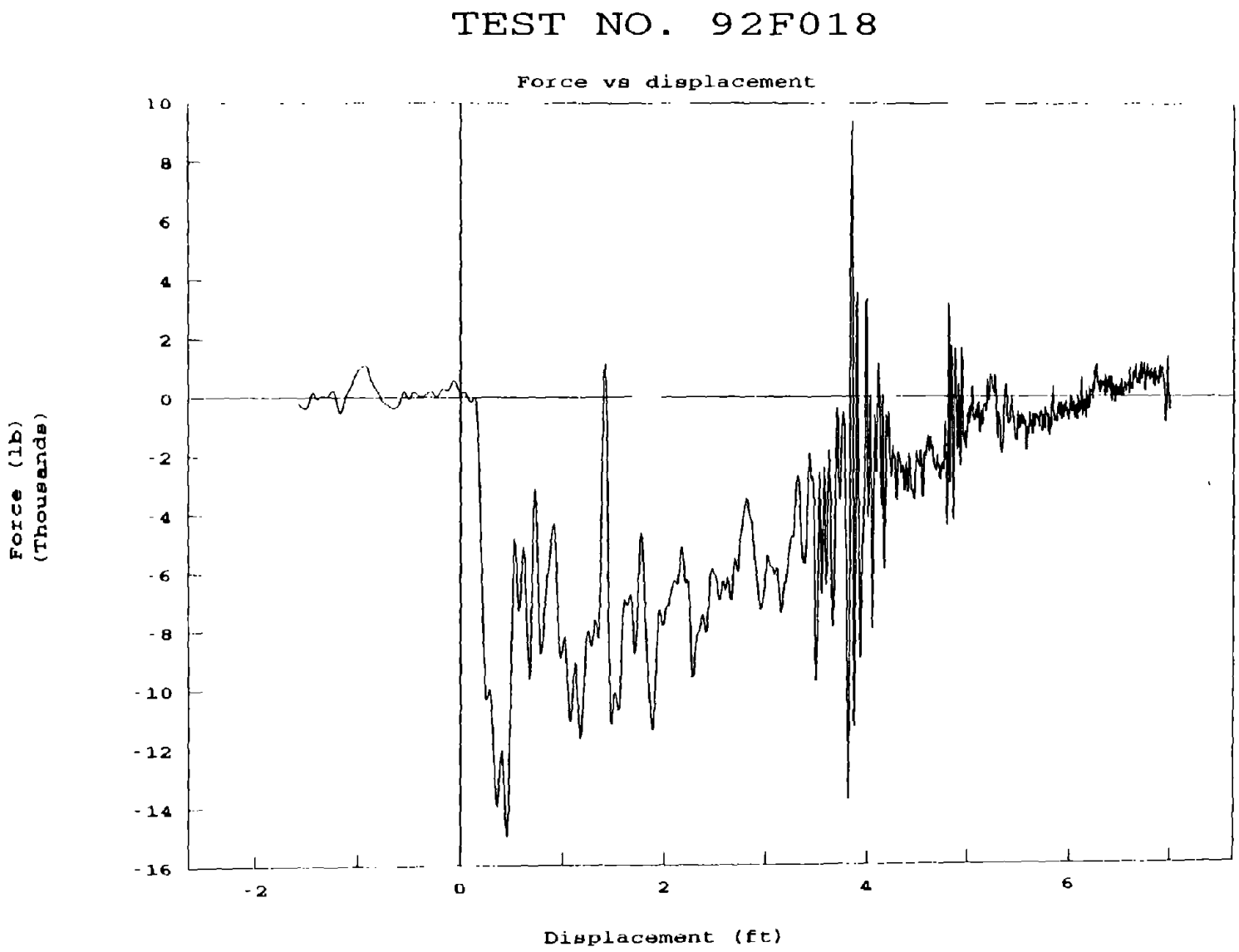
Figure 4. Acceleration versus time, X-axis, test 92F018.

TEST NO. 92F018



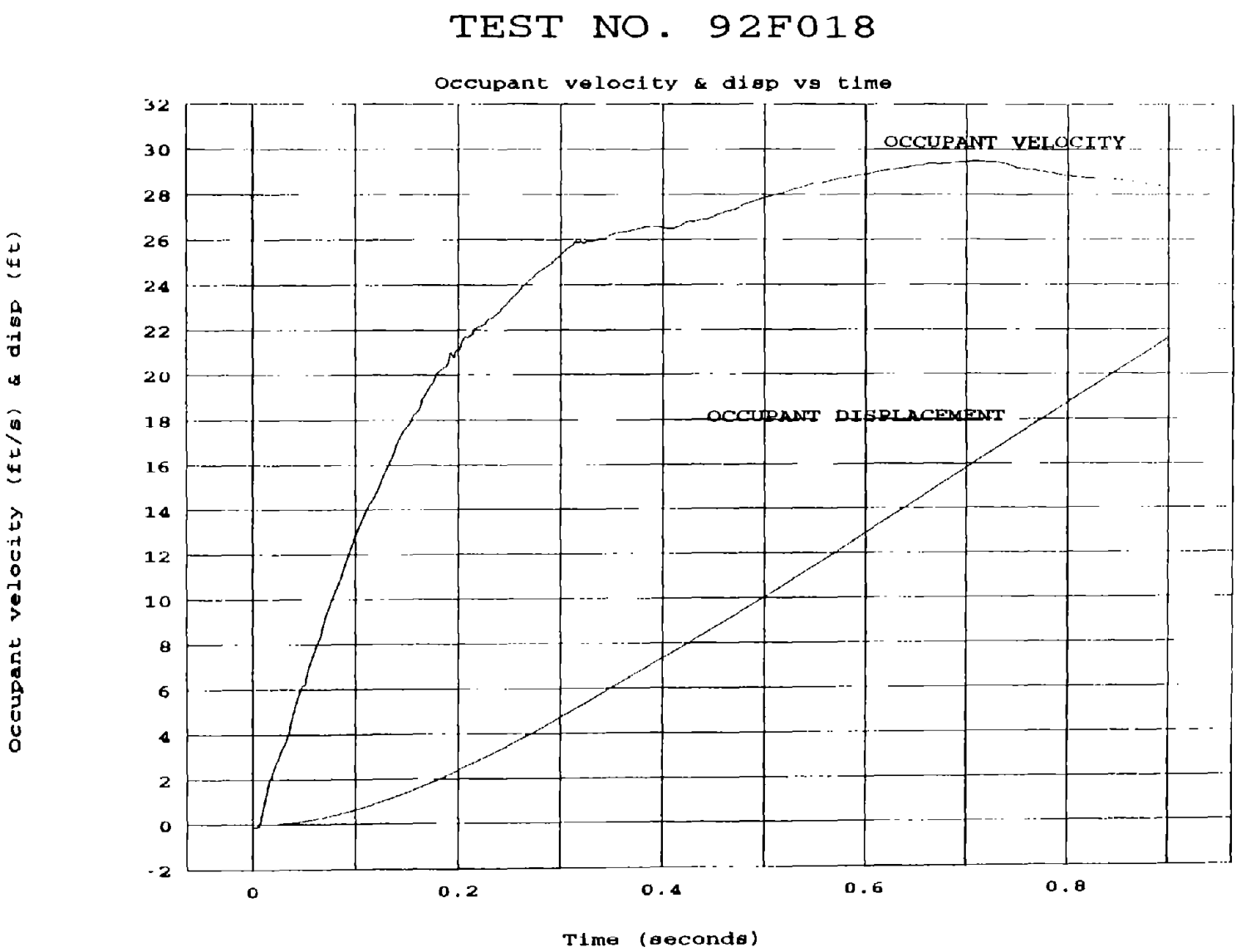
1 ft = 0.305 m

Figure 5. Velocity versus time, X-axis, test 92F018.



1 lbf = 4.45 N 1 ft = 0.305 m

Figure 6. Force versus displacement, X-axis, test 92F018.



1 ft = 0.305 m

Figure 7. Occupant velocity and relative displacement versus time, X-axis, test 92F018.

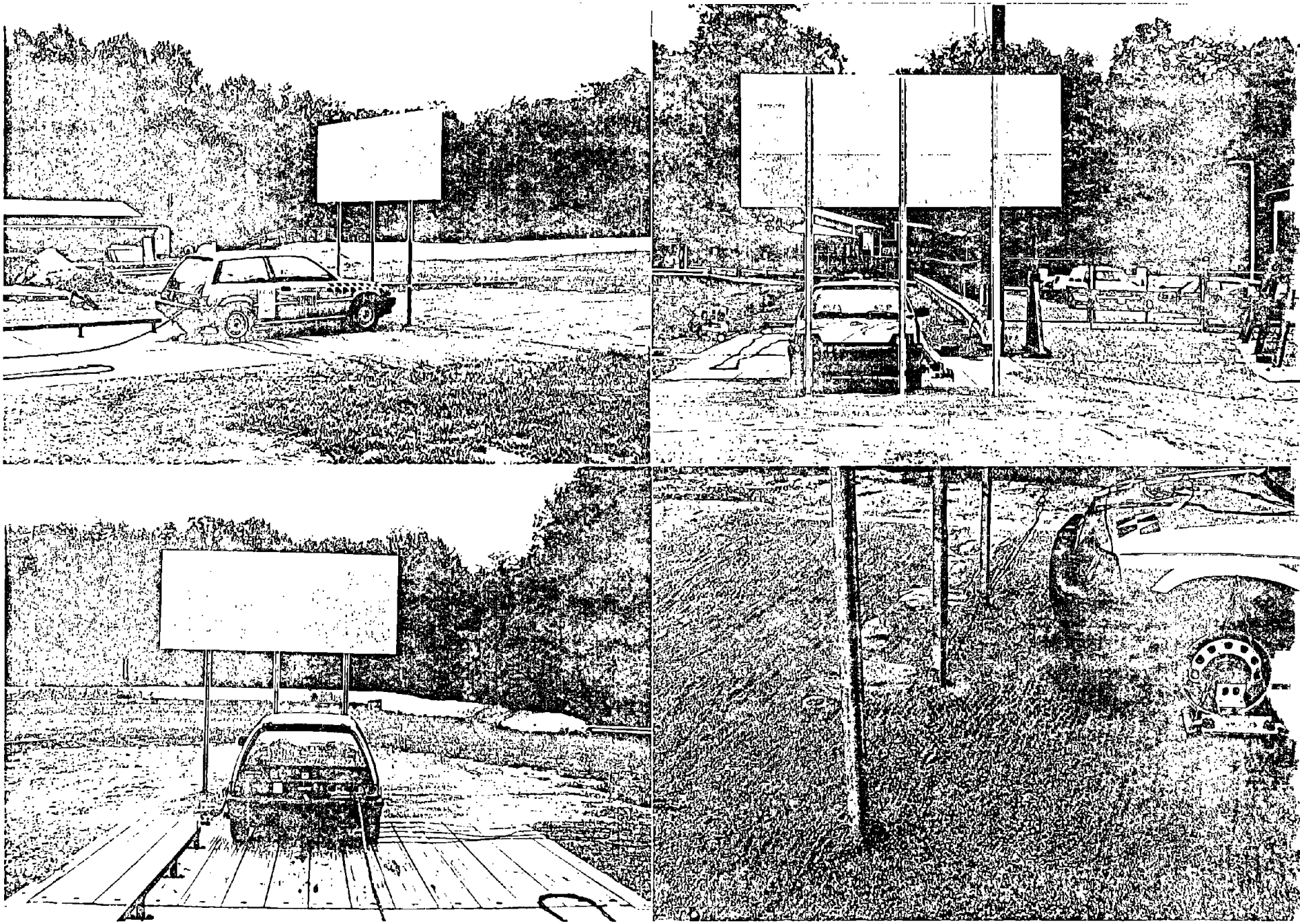


Figure 8. Pretest photographs of test 92F018.

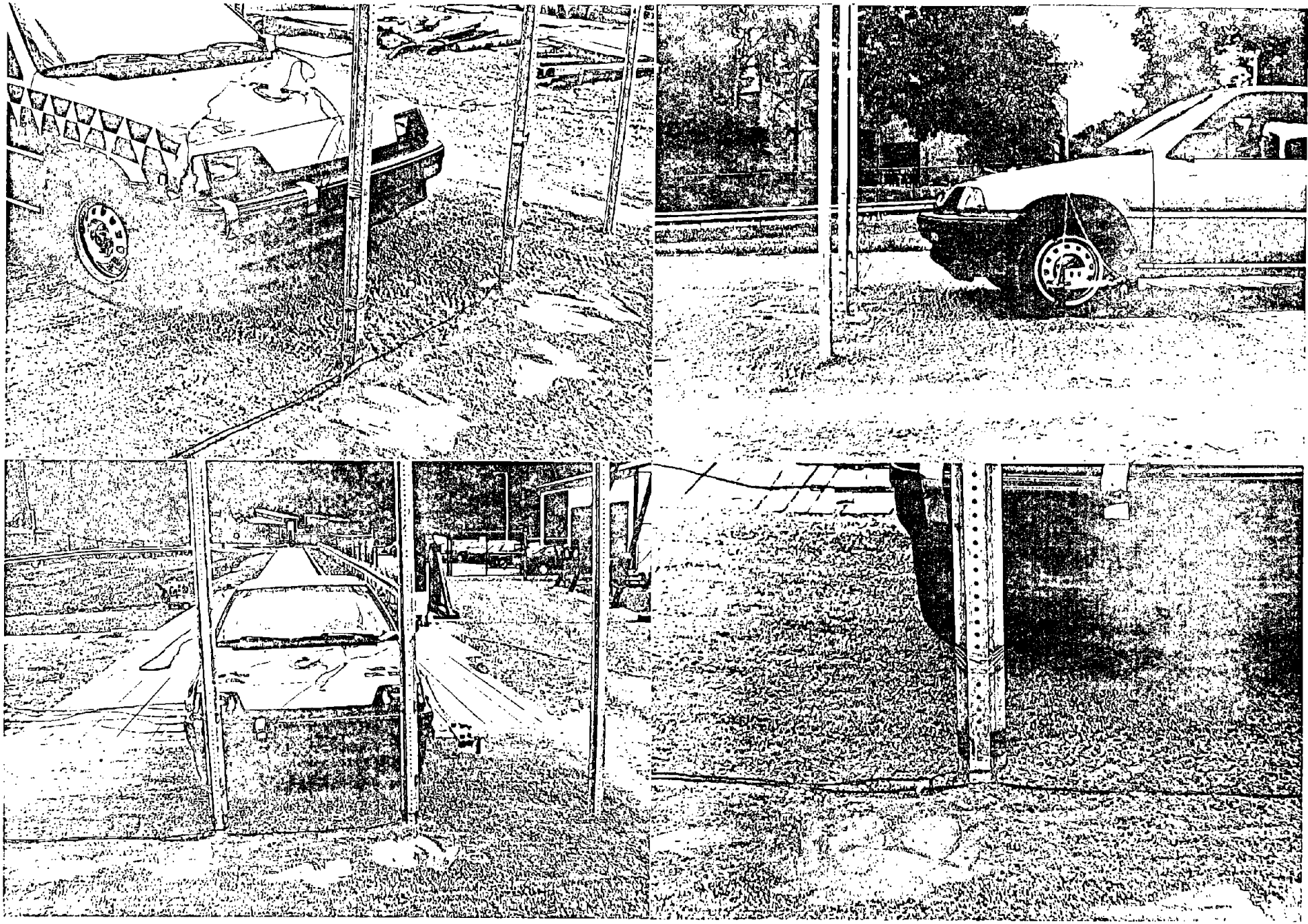


Figure 9. Additional pretest photographs of test 92F018.

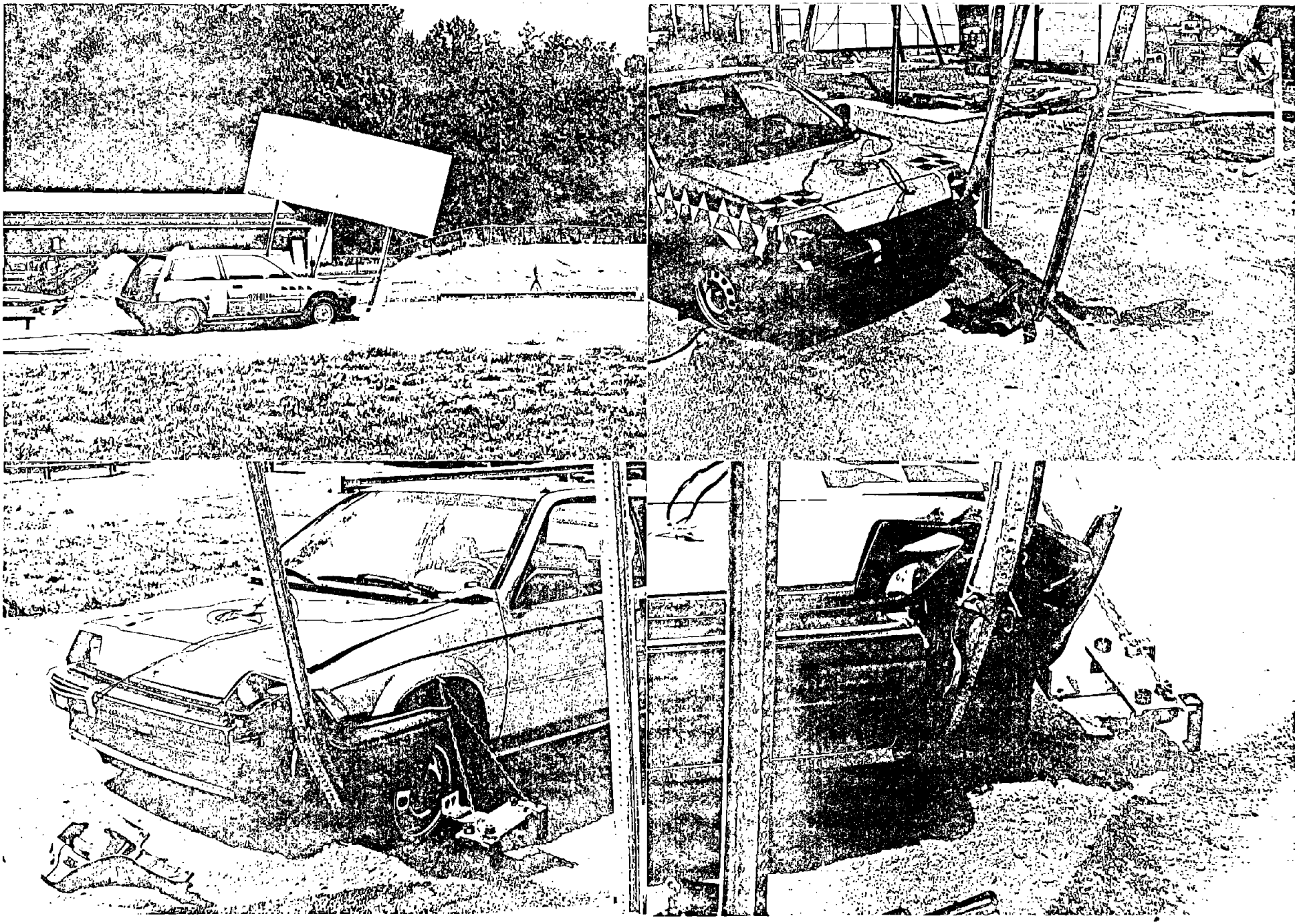


Figure 10. Post-test photographs of test 92F018.

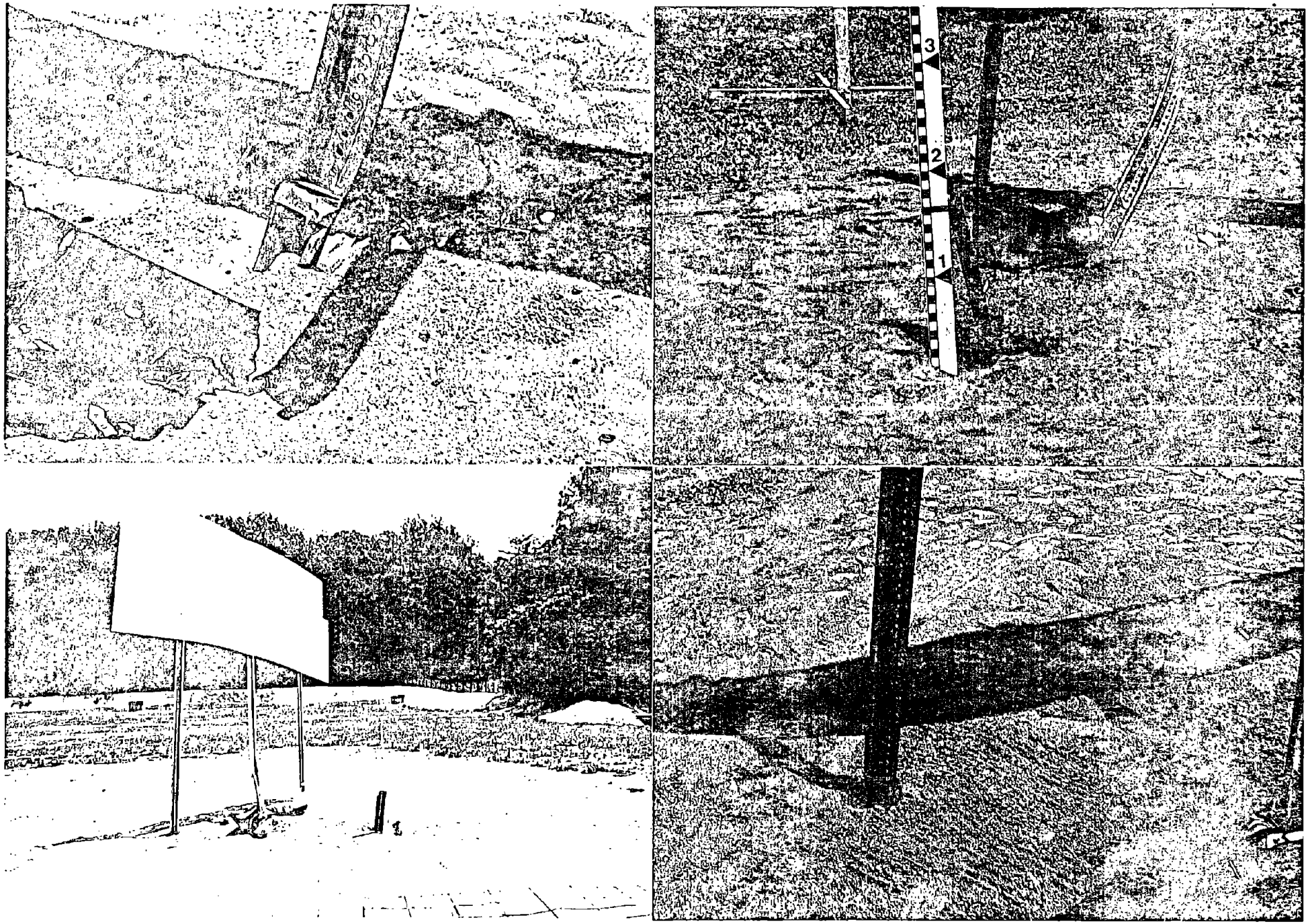
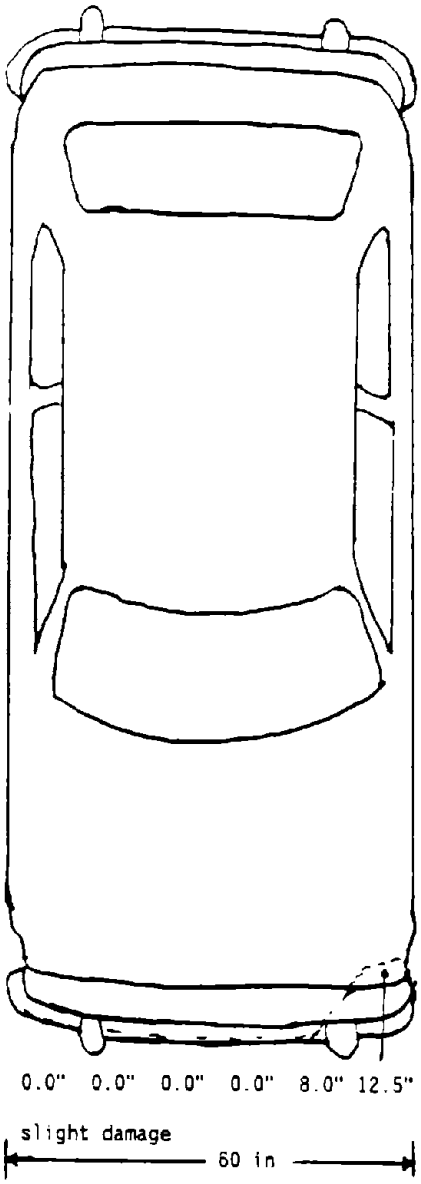


Figure 11. Additional post-test photographs of test 92F018.



Max Crush = 12.5 in

------- Post test

1 in = 25.4 mm

Figure 12. Sketch of vehicle crush, test 92F018.

8. 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.