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Testing of Small and Large Sign Support Systems FOIL Test Number: 92F037

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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 92F037. 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 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 criteria for roadside safety appurtenances in strong soil 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
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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 92F037. 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 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 20 mi/h (32 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
92F037	12-3-92	'84 Honda Civic	1850 839 kg	20 32 km/h	3 leg steel 2.5 lb/ft	center

3. VEHICLE

The test vehicle was a 1984 Honda Civic two-door hatchback with a manual transmission. Prior to the test, the vehicle's 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 vehicle's 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) into 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 92F037

The test vehicle was accelerated to 21.1 mi/h (31.0 ft/s (34 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 they began to collapse. The u-channel legs began to bow away from the vehicle. 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. The force builds at the point of contact and the left post failed at 0.016 s. Left post failure was followed by the left post's grade-2 splice bolts failing at 0.024 s. The left post was aligned with the left bumper support of the vehicle which caused the post failure. Crush of the vehicle did not allow failure of the center or right u-post early in the impact event. The right post failed approximately 38 in (965.2 mm) above ground and at 0.038 s. Failure above the bumper level was due to sign post being fastened to the anchor at the bottom and the mass of the large sign panel on the top. The sign post bent as far as possible then broke about half way up the sign post. The vehicle continued to flatten the right stub and the grade-2 bolts failed at 0.042 s. The center post began to wrap around the front end of the vehicle and the center post splice bolts failed as the vehicle tried to force the sign post through the soil. The center post was wrapped around the front end of the vehicle and eventually fractured at 0.090 s. The remainder of the sign system fell on top of the vehicle making contact with the hood, windshield and roof. The contact cracked the windshield along the roof-windshield joint. The contact occurred at 0.430 s.

Damage to the vehicle consisted of damage to the bumper and grill. The center of the vehicle sustained the maximum crush because it is the softest area on the front end. The center of the vehicle sustained a maximum crush of 3.5-in (88.9 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 8.0 ft/s (2.4 m/s). The occupant impact velocity was reached 0.294 s into the crash event. The ridedown acceleration was 1.6 g's. The peak acceleration (300 Hz data) for the impact event was 7.8 g's (peak force 14.4 kips (64.1 kN)). Because the sign system remained in contact with the vehicle longer than the time required for an occupant to travel the 2-ft (0.6-m) flail space, the vehicle change in velocity is higher than the occupant impact velocity and was calculated to be 9.7 ft/s (2.9 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. Figure 13 depicts a sketch of the measured vehicle crush.

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 8.0 ft/s (2.4 m/s) which is less than or equal to the 16-ft/s (4.9-m/s) limit specified by the FHWA.

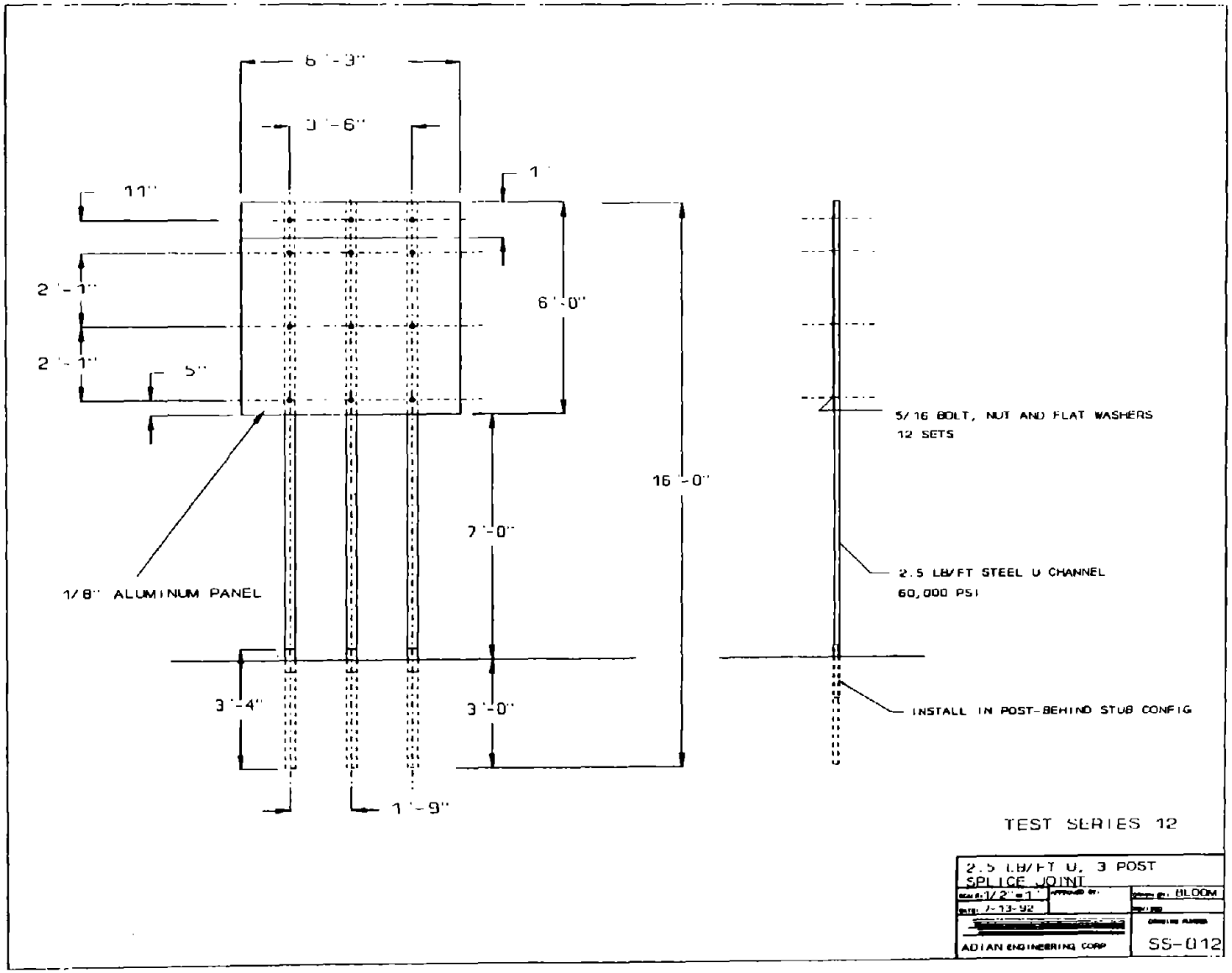


Figure 1. Sketch of small sign support.

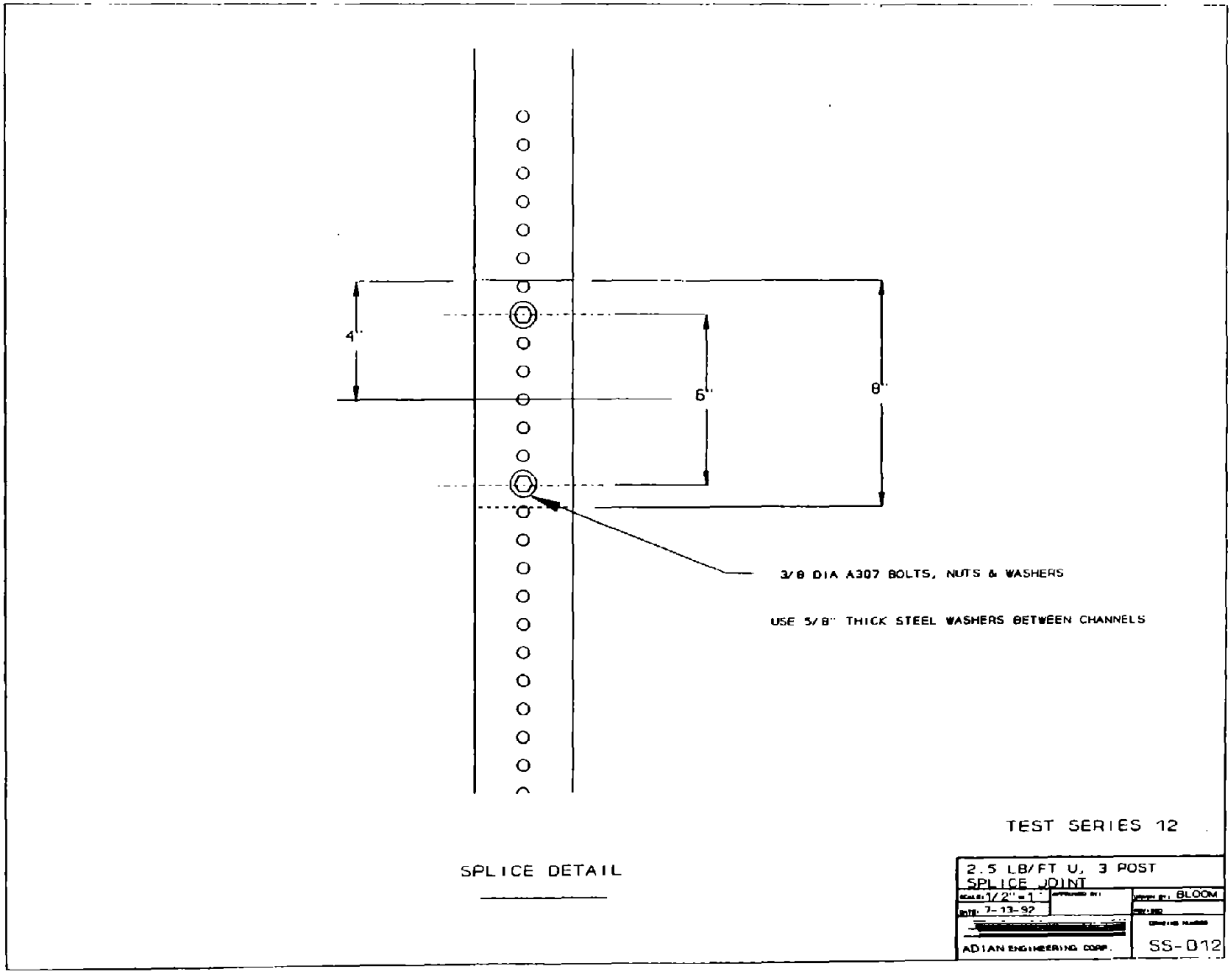
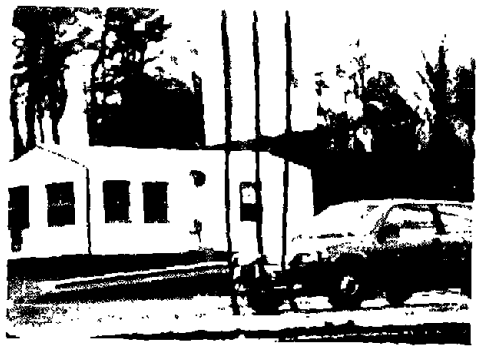
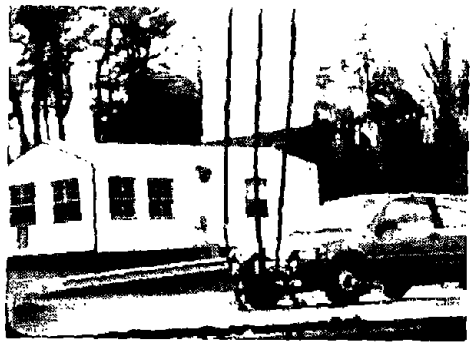


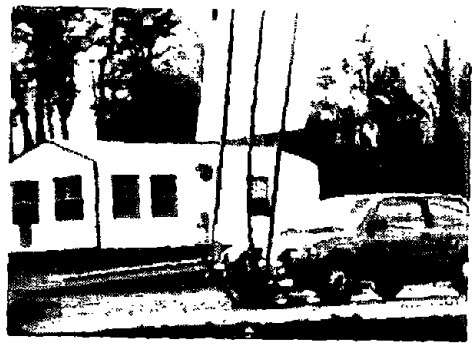
Figure 2. Sketch of small sign, splice detail.



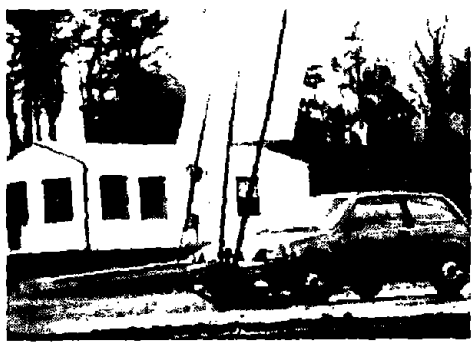
0.022 s



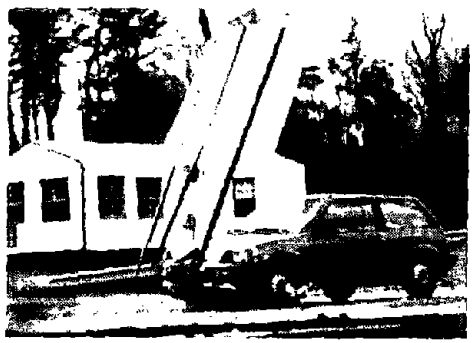
0.040 s



0.060 s



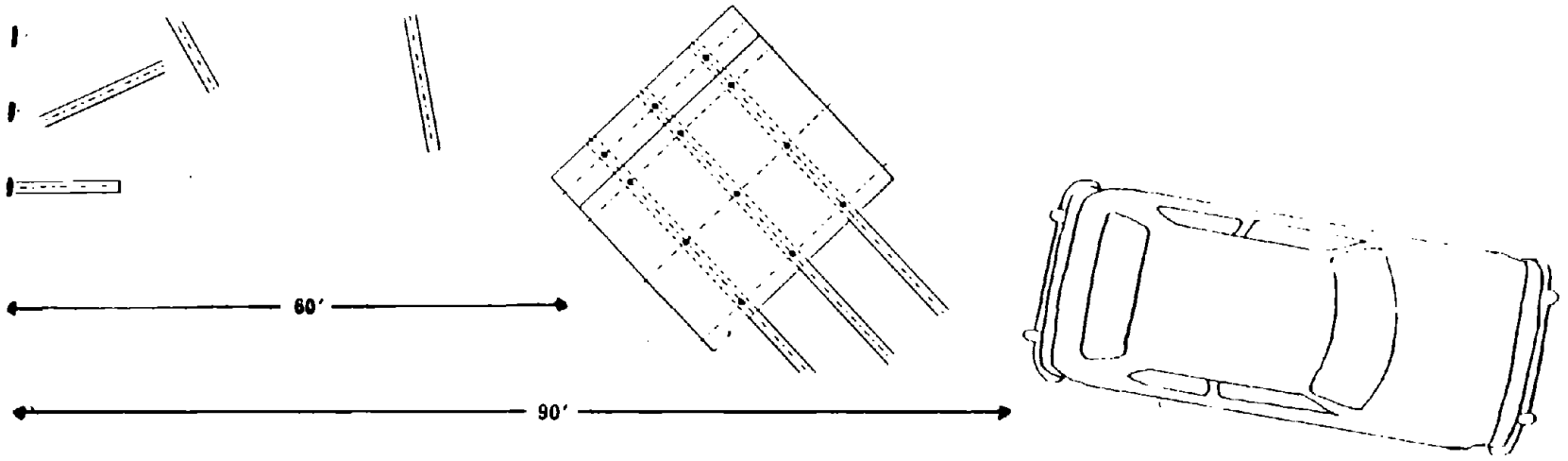
0.096 s



0.164 s

0.432 s

Figure 3. Test photographs during impact, test 92F037.



Test number..... 92F037

Date..... December 3, 1992

Test vehicle..... 1984 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..... 31.0 ft/s (9.4 m/s)

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

Vehicle analysis:	Observed	Design/Limit
Longitudinal:		
Occupant Delta V at 2 ft	8.0 ft/s	≤16 ft/s
Ridedown Acceleration	1.6 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..... 3.4 g's
Lateral..... NA

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

Vehicle crush..... 3.5 in

Vehicle velocity change..... 9.7 ft/s

Impact angle..... 0 degrees

Exit angle..... 5 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 4. Summary of test 92F037.

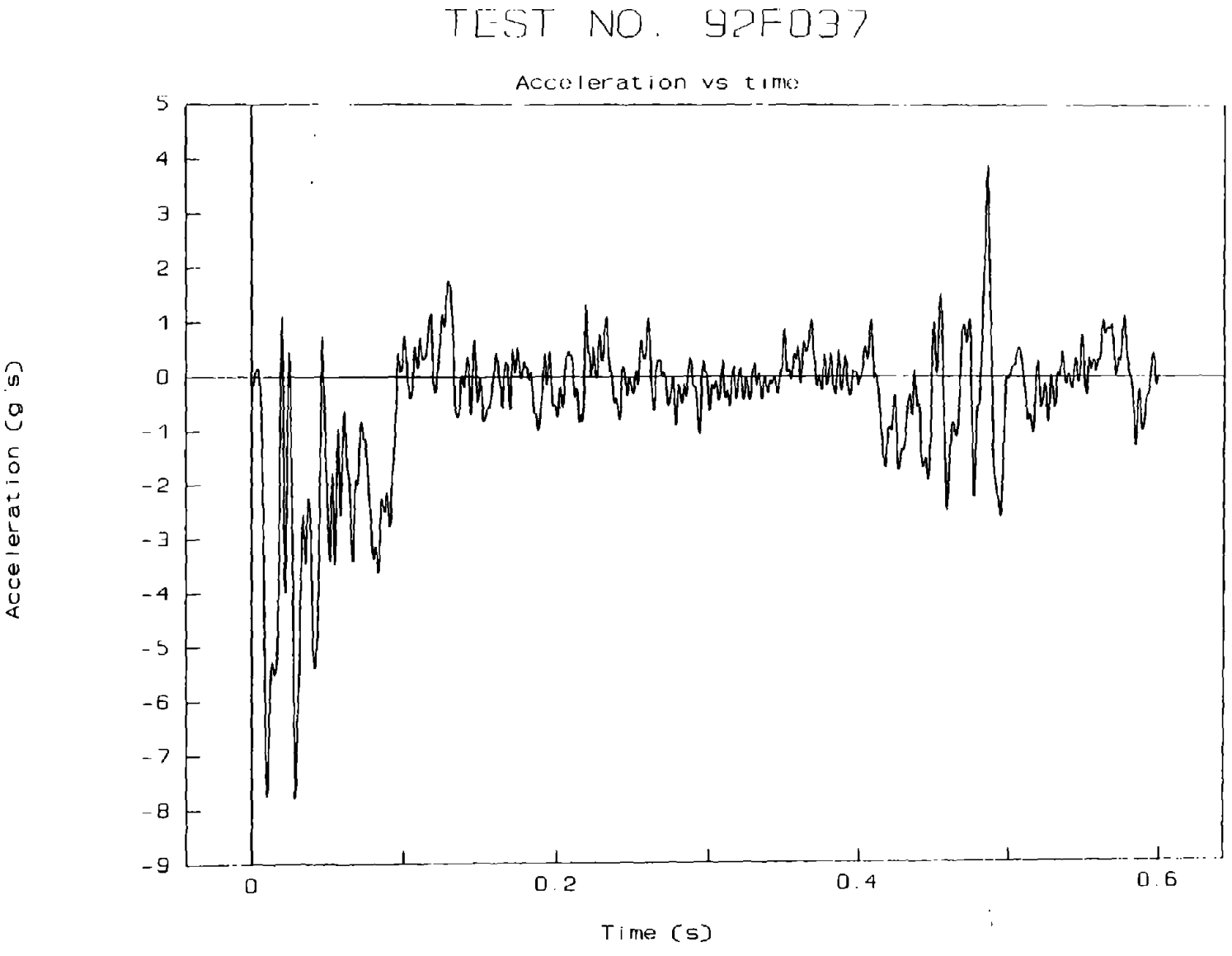
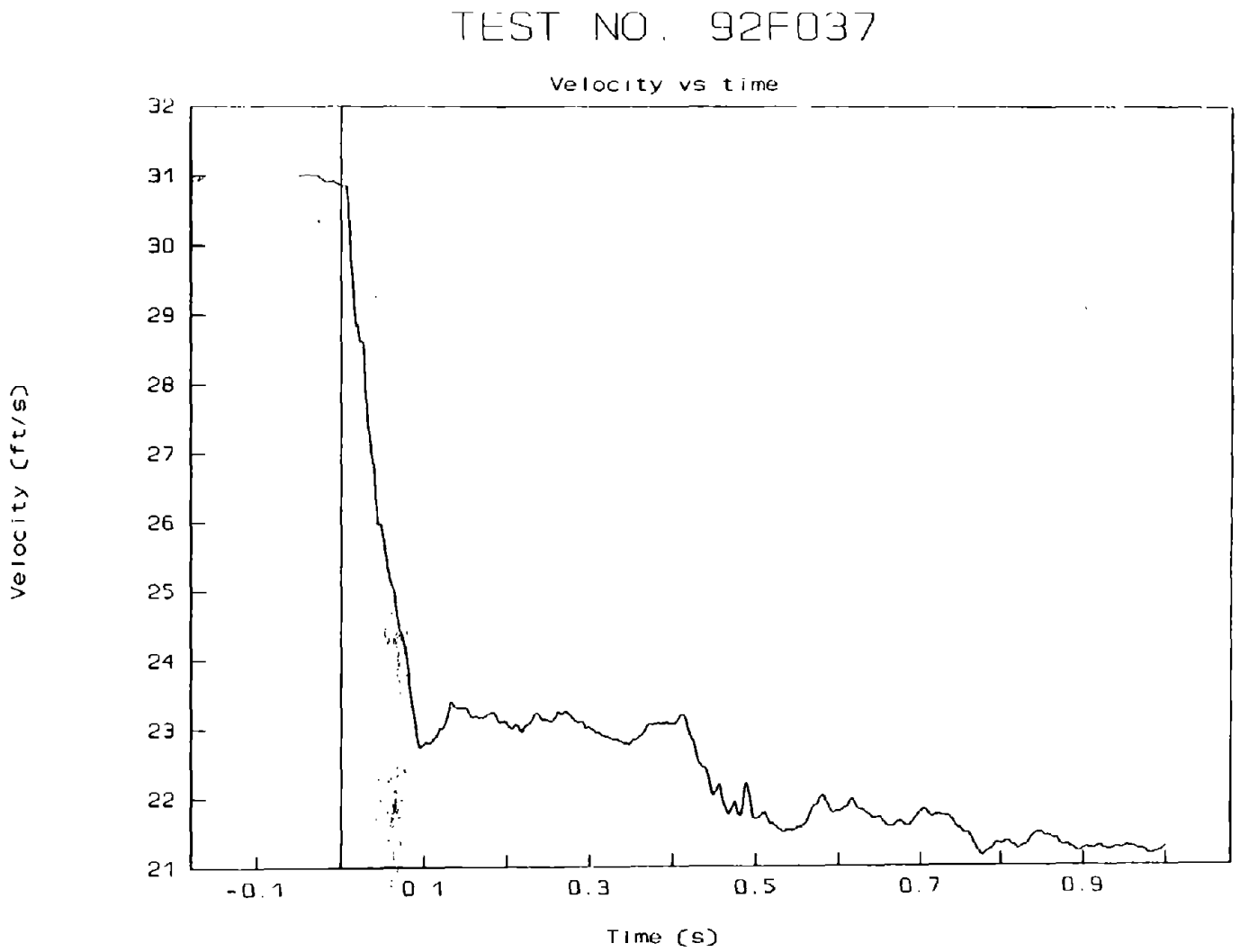
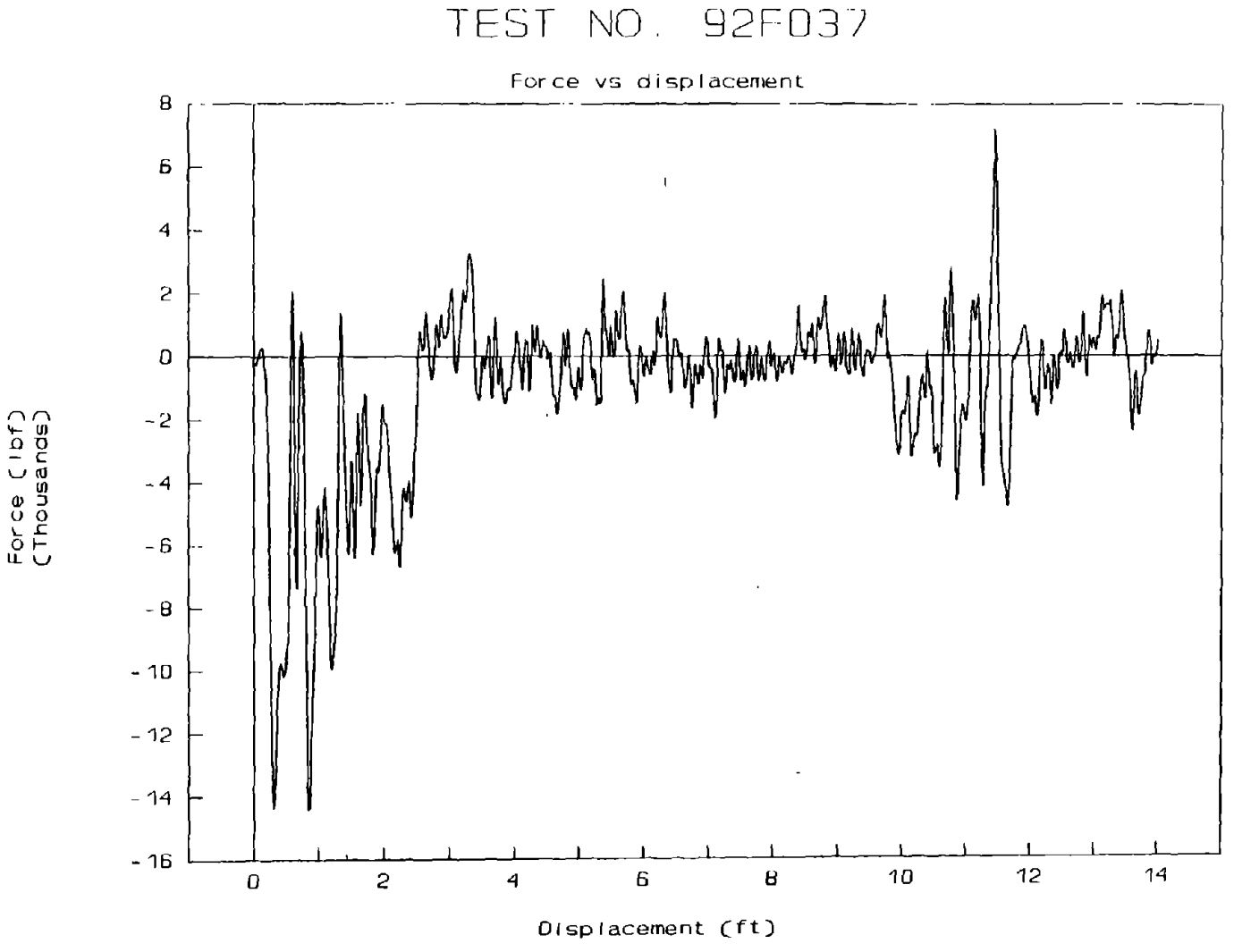


Figure 5. Acceleration versus time, X-axis, test 92F037.



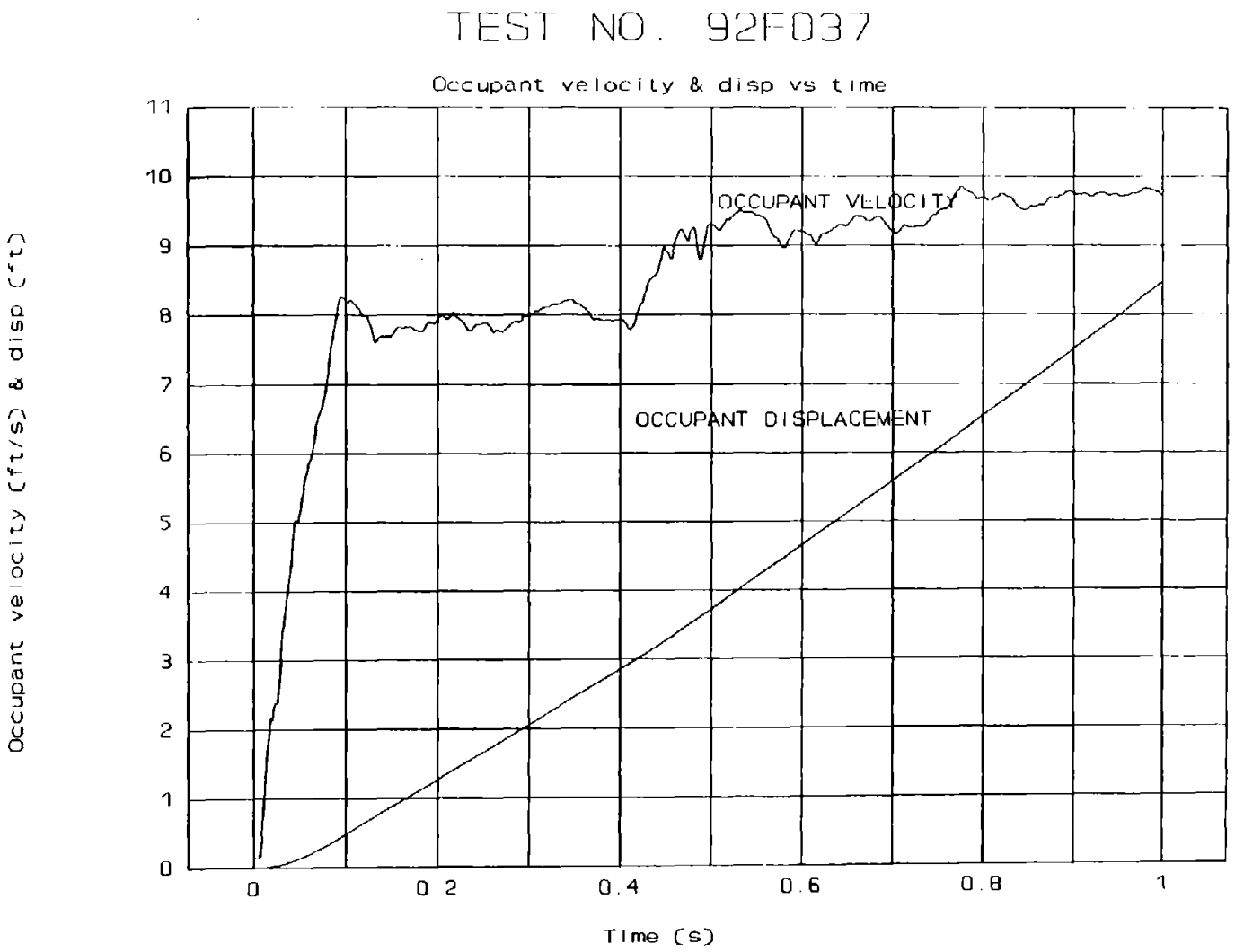
1 ft = 0.305 m

Figure 6. Velocity versus time, X-axis, test 92F037.



1 lbf = 4.45 N 1 ft = 0.305 m

Figure 7. Force versus displacement, X-axis, test 92F037.



1 ft = 0.305 m

Figure 8. Occupant velocity and relative displacement versus time, X-axis, test 92F037.

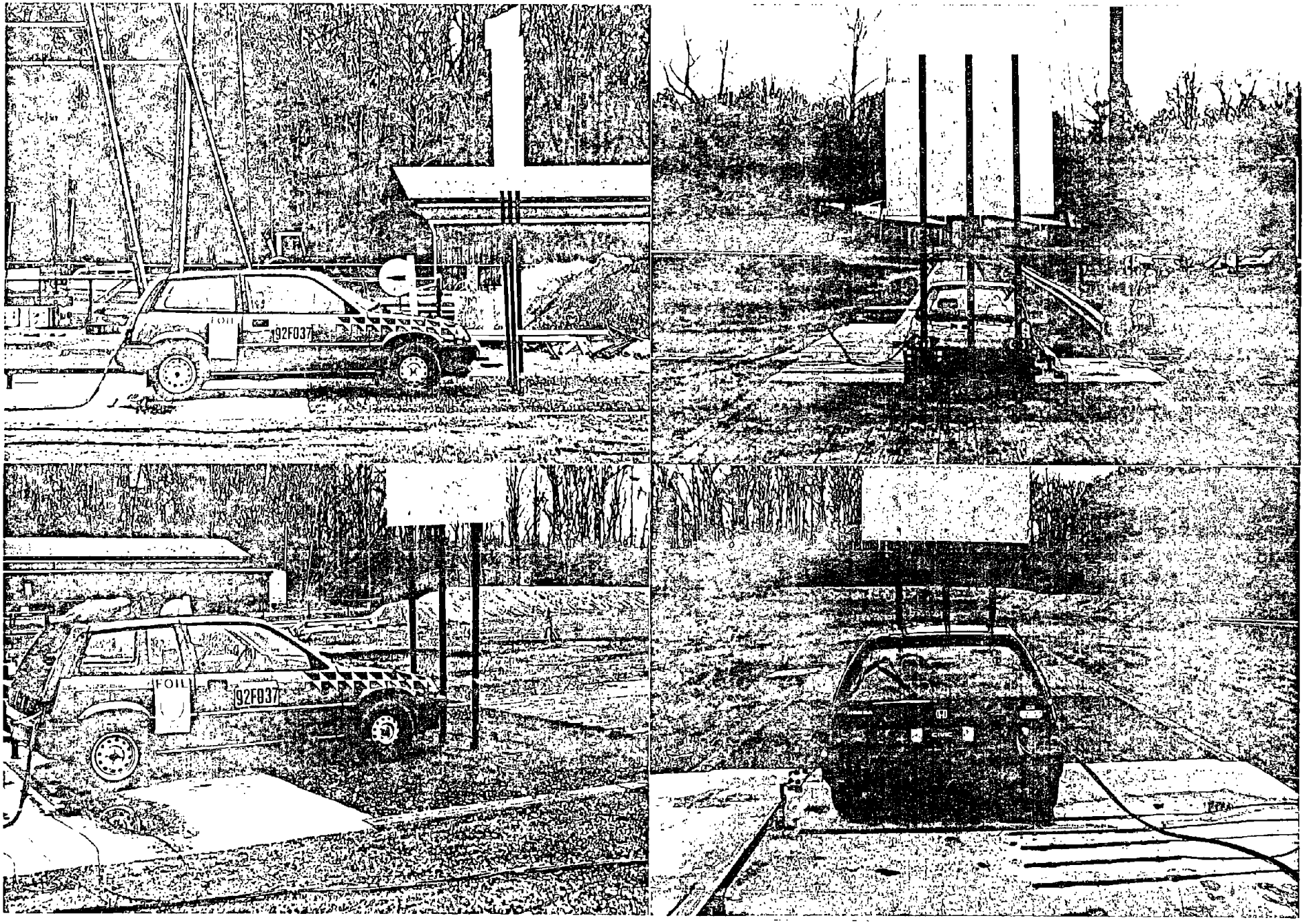


Figure 9. Pretest photographs of test 92F037.

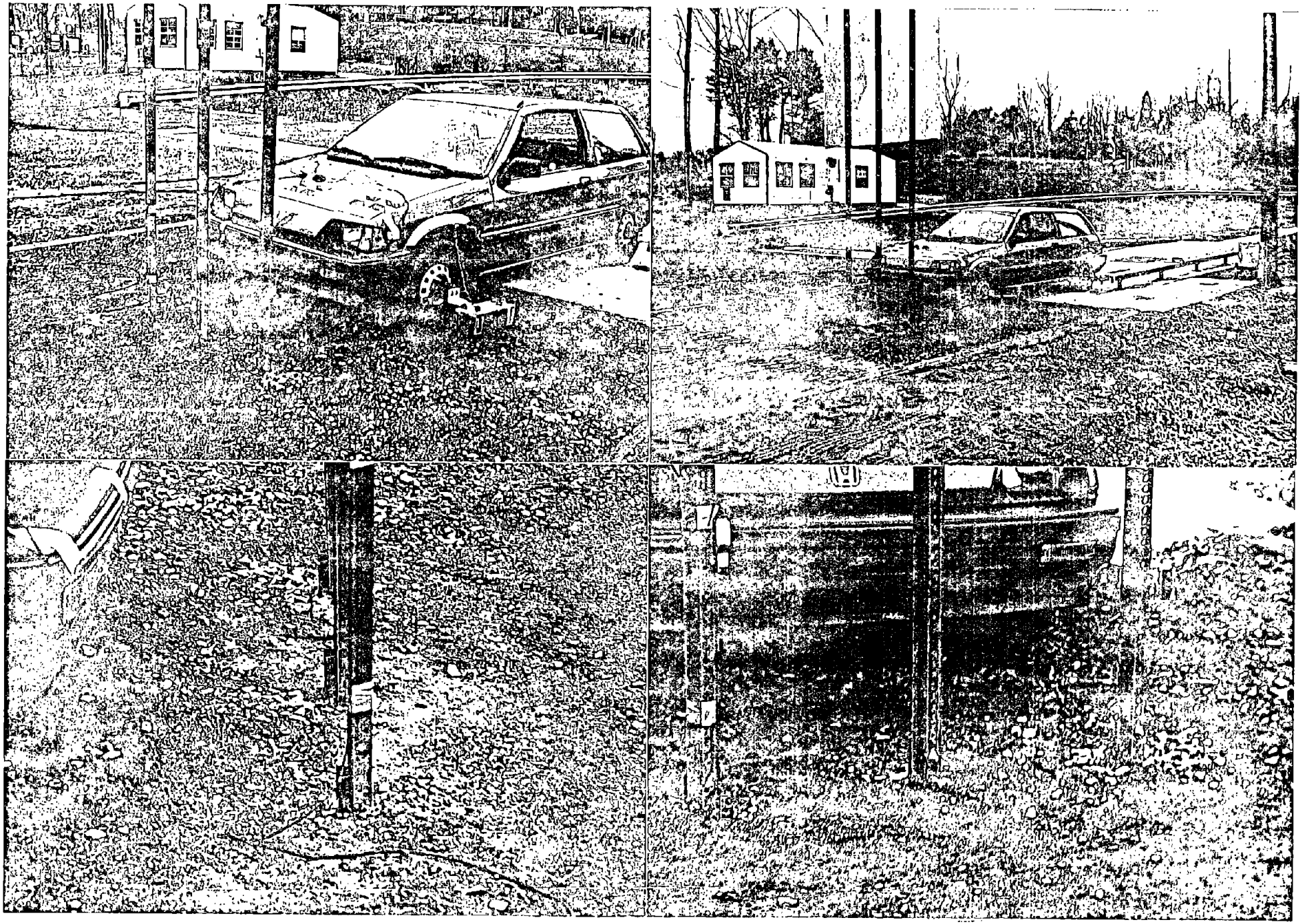


Figure 10. Additional pretest photographs of test 92F037.

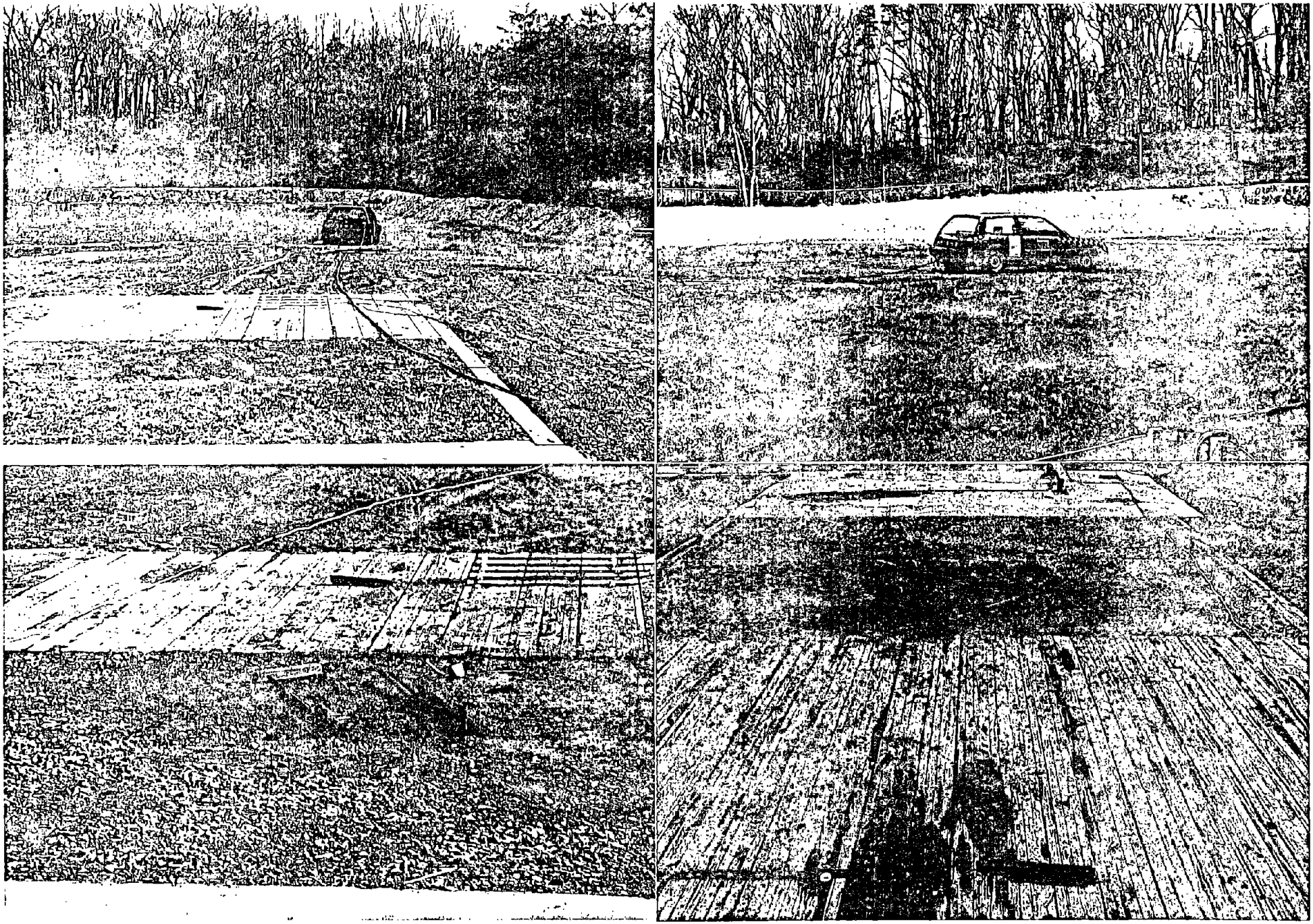


Figure 11. Post-test photographs of test 92F037.

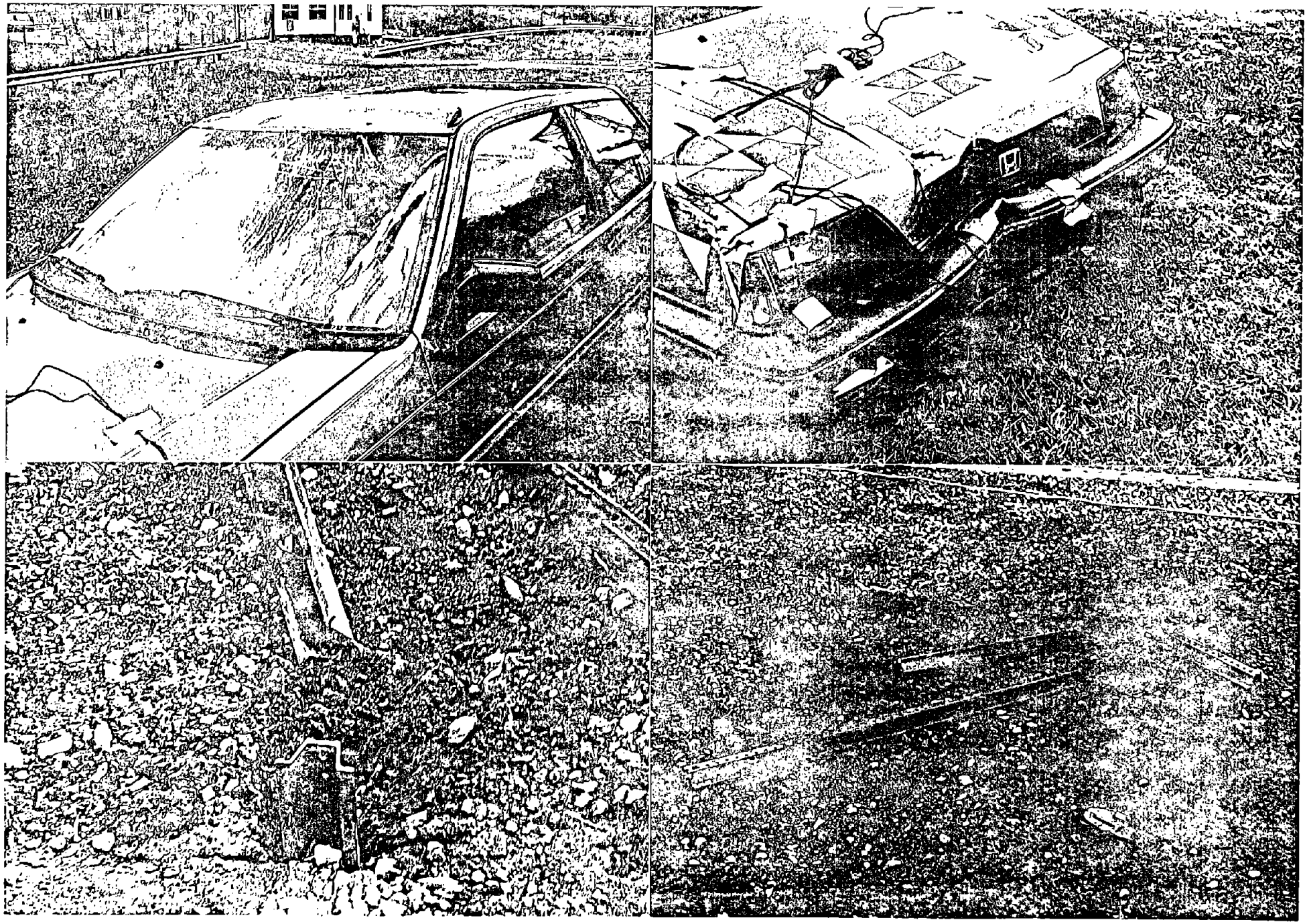
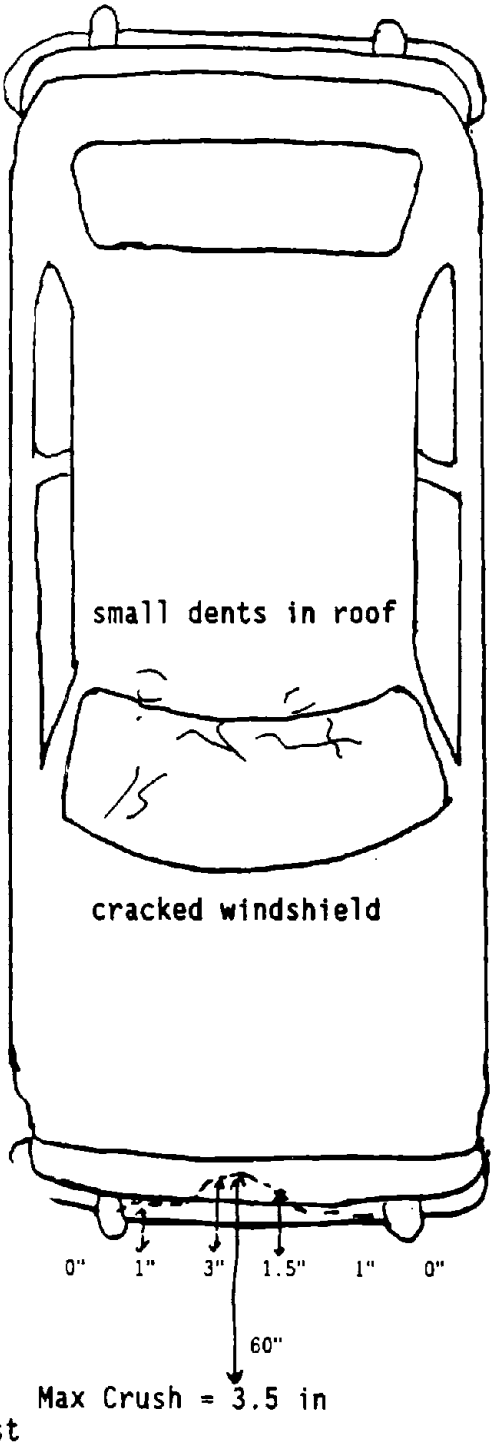


Figure 12. Additional post-test photographs of test 92F037.



------- Post test

1 in = 25.4 mm

Figure 13. Sketch of vehicle crush, test 92F037.

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.