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Testing of Small and Large Sign Support Systems FOIL Test Number: 92F022

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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 92F022. 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 (3.72 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 (3.72 kg/m) u-channel sign support system does not meet all of the applicable criteria for roadside safety appurtenances in weak soil specified by the FHWA.

17. Key Words	18. Distribution Statement
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	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 (8.9 m/s), test 92F022. 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 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 (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
92F022	8-06-92	'84 Honda Civic	1850	20	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 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 (3.72 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-2 weak 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 92F022

The test vehicle was accelerated to 21.8 mi/h (32 ft/s (9.8 m/s)) 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 u-channel legs began to bow away from the vehicle and wrap around the front end of the vehicle. The vehicle continued forward, pushing the u-channel legs through the weak soil. The required force to break the six grade-2 splice bolts or flatten the u-channel was higher than the resisting force of the weak soil therefore the weak soil gave way before the bolts and the vehicle forced the u-channel to plow through the sand. Once the u-channel had pushed through the sand as far as possible the flattening or breakaway force required still could not be obtained because to much energy was consumed plowing through the weak soil. The splice bolts did not break, however the left post did break approximately 15 in (381.0 mm) above ground. The post 0.054 s into the crash event. Two posts bent backwards but never flattened or broke. The u-channel legs pushed through the sand approximately 2.7 ft (0.8 m). The u-channel began pushing through the weak soil upon impact and continued to push through the weak until the vehicle had come to a stop 0.834 s after impact. The sign system remained in the weak soil leaning back 60 degrees. The vehicle came to rest on the broken post's stub and the other two leaning posts. The u-channel was later pulled from the ground and a bend in each u-channel post was recorded 12 in (304.8 mm) below the ground line.

Damage to the vehicle consisted of damage to the bumper and grill. The right side of the vehicle sustained the maximum crush due to the superficial plastic parts which were damaged. The center of the bumper sustained a 4-in (101.6-mm) dent. The occupant compartment was intact after the test.

Damage to the sign system consisted of two bent and twisted u-channel posts. The third post broke 15 in (381.0 mm) above ground during the test. The three splice joints were intact after the test. The sign posts were removed from the ground after the test and a bend was recorded 12 in (304.8 mm) below the ground-line. The panel was in good 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 20.9 ft/s (6.4 m/s). The occupant impact velocity was reached 0.172 s into the crash event. The ridedown acceleration was 2.2 g's. The peak acceleration (300 Hz data) for the impact event was 9.4 g's (peak force 17.5 kips (77.7 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 29.4 ft/s (9.0 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 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 from the left sign post remaining after the test was 15 in (381.0 mm) high which is higher than the 4-in (101.6-mm) limit specified by the FHWA. In addition to the stub height, the occupant impact velocity was 20.9 ft/s (6.4 m/s) which is not less than or equal to the 16 ft/s (4.9 m/s) limit specified by the FHWA.

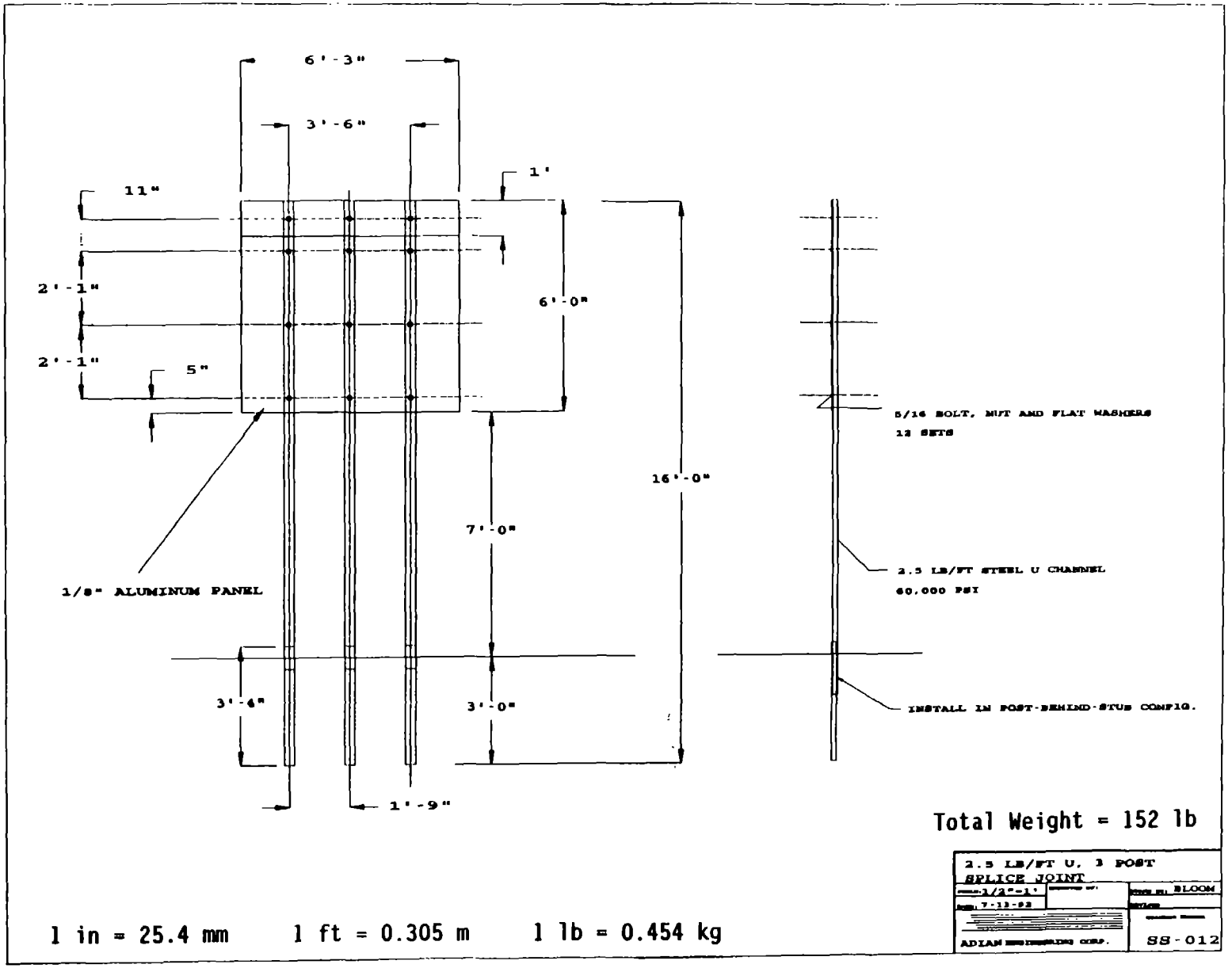


Figure 1. Sketch of small sign support.

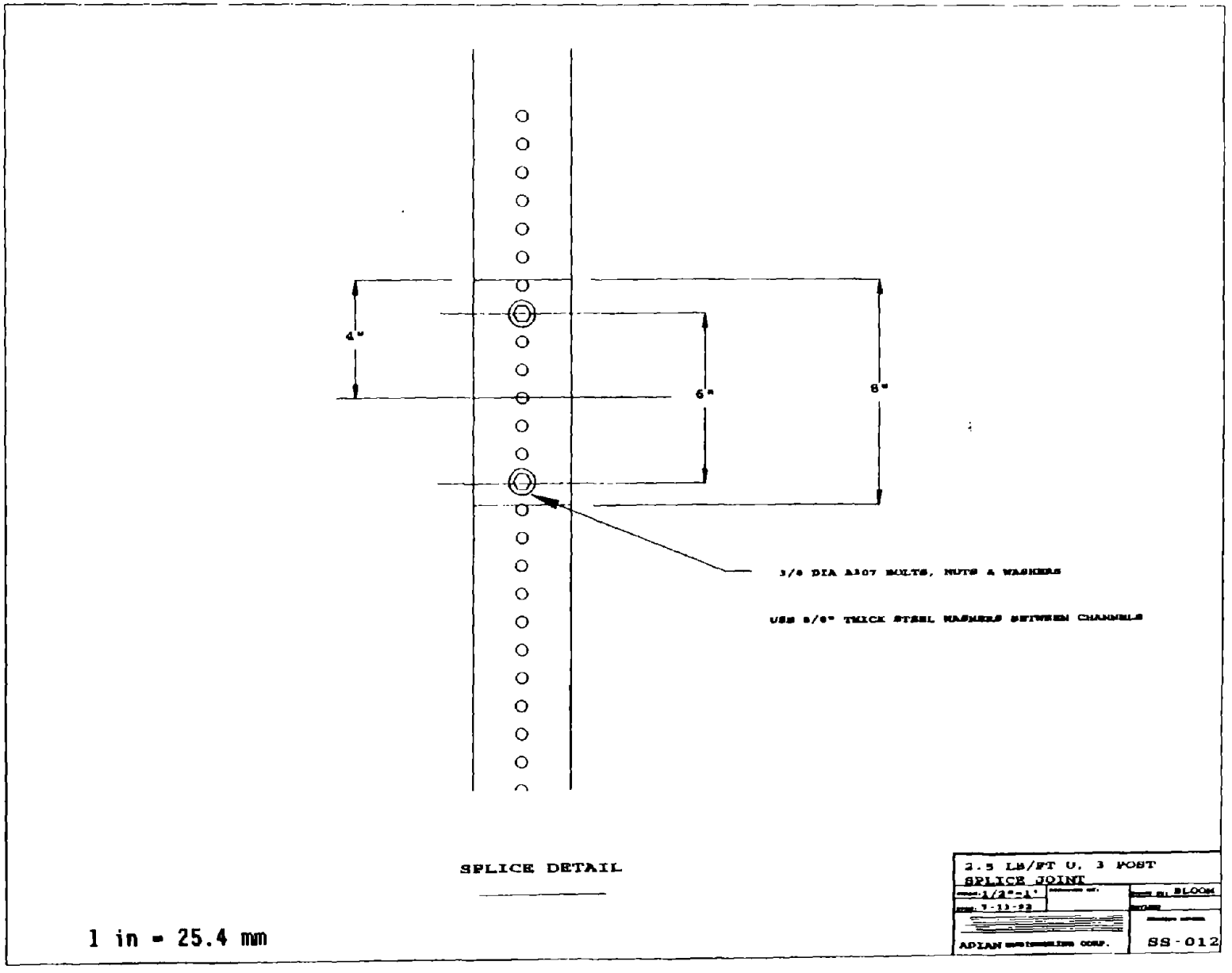
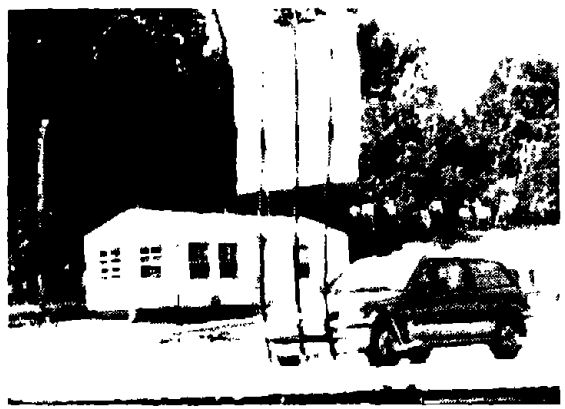
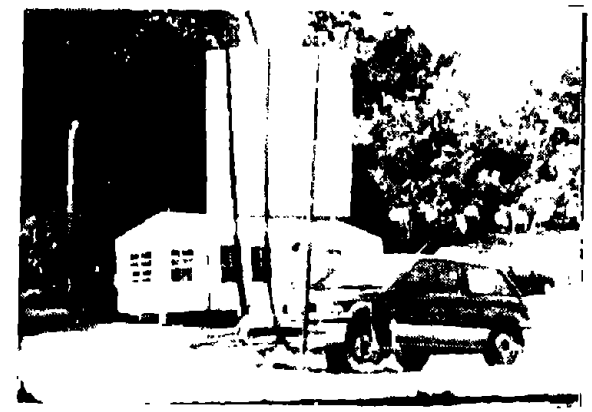


Figure 2. Sketch of small sign, splice detail.

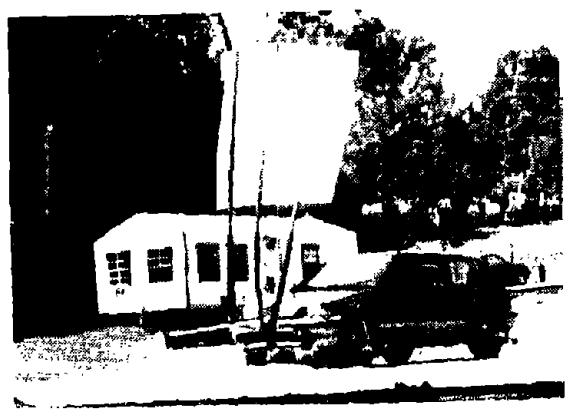


0.030 s

0.056 s



0.150 s



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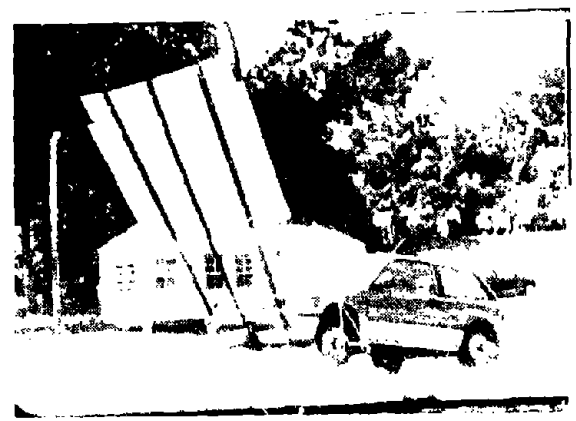
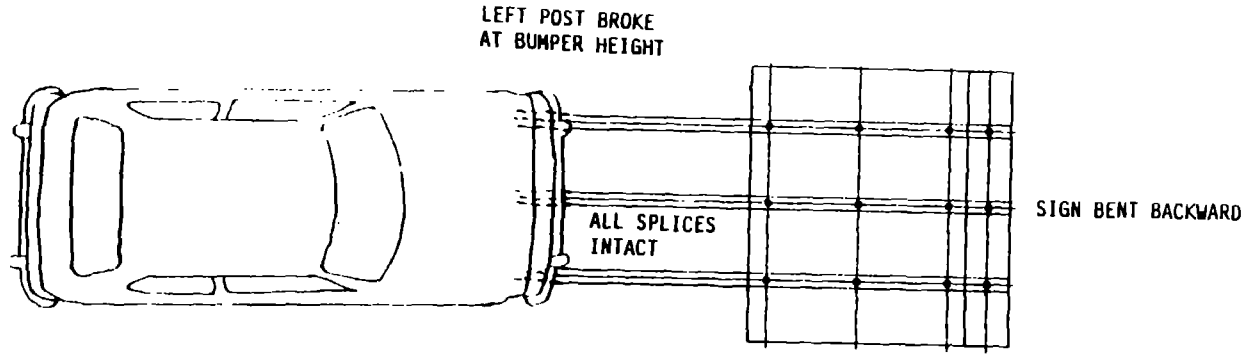


0.300 s

0.564 s

Figure 3. Test photographs during impact, test 92F022.



Test number..... 92F022

Date..... August 6, 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 feet

Panel type.....6 ft by 6 ft 3 in aluminum sheet

Height.....16 ft

Foundation.....S-2 Weak Soil

Impact speed.....32 ft/s (9.8 m/s)

Impact angle.....0 degrees

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

Vehicle analysis:	Observed	Design/Limit
Longitudinal:		
Occupant Delta V at 2 ft	20.9 ft/s	≤16 ft/s
Ridedown Acceleration	2.2 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.....5.0 g's
Lateral.....NA

Vehicle Damage (TAD).....12-FC-2
(VDI).....12FDEN2

Vehicle crush.....10 in

Vehicle velocity change.....29.4 ft/s

Exit angle.....no exit

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

Figure 4. Summary of test 92F022.

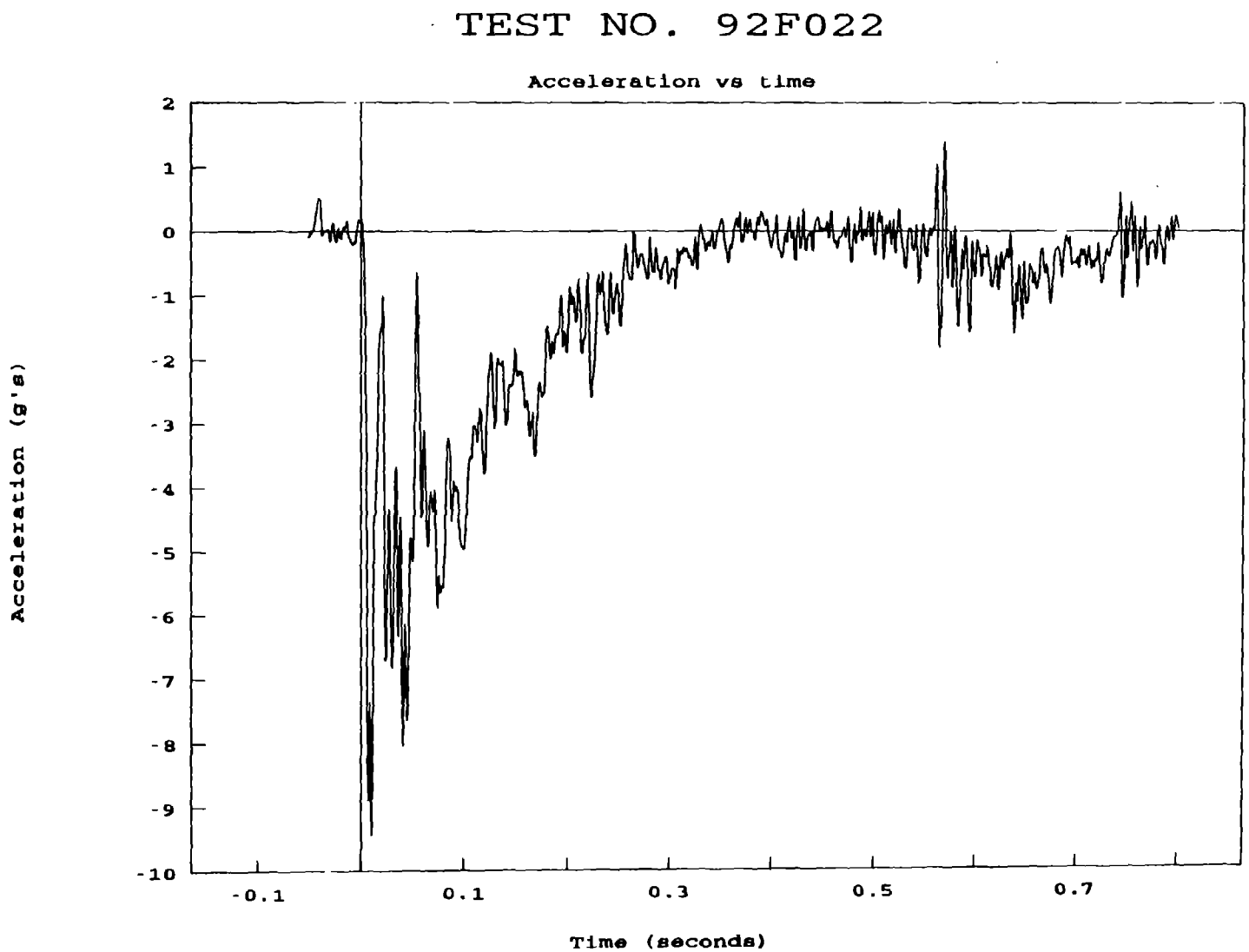
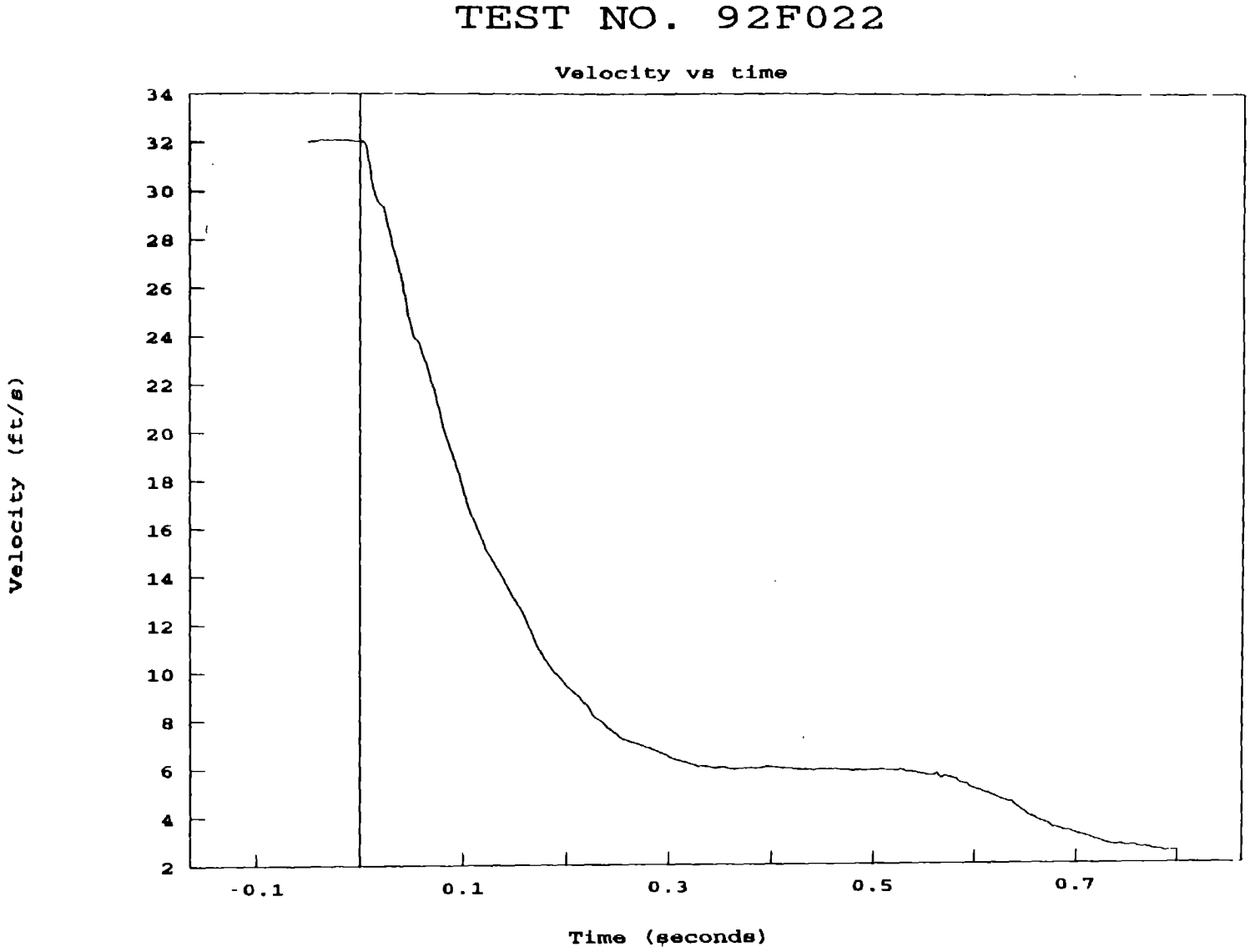
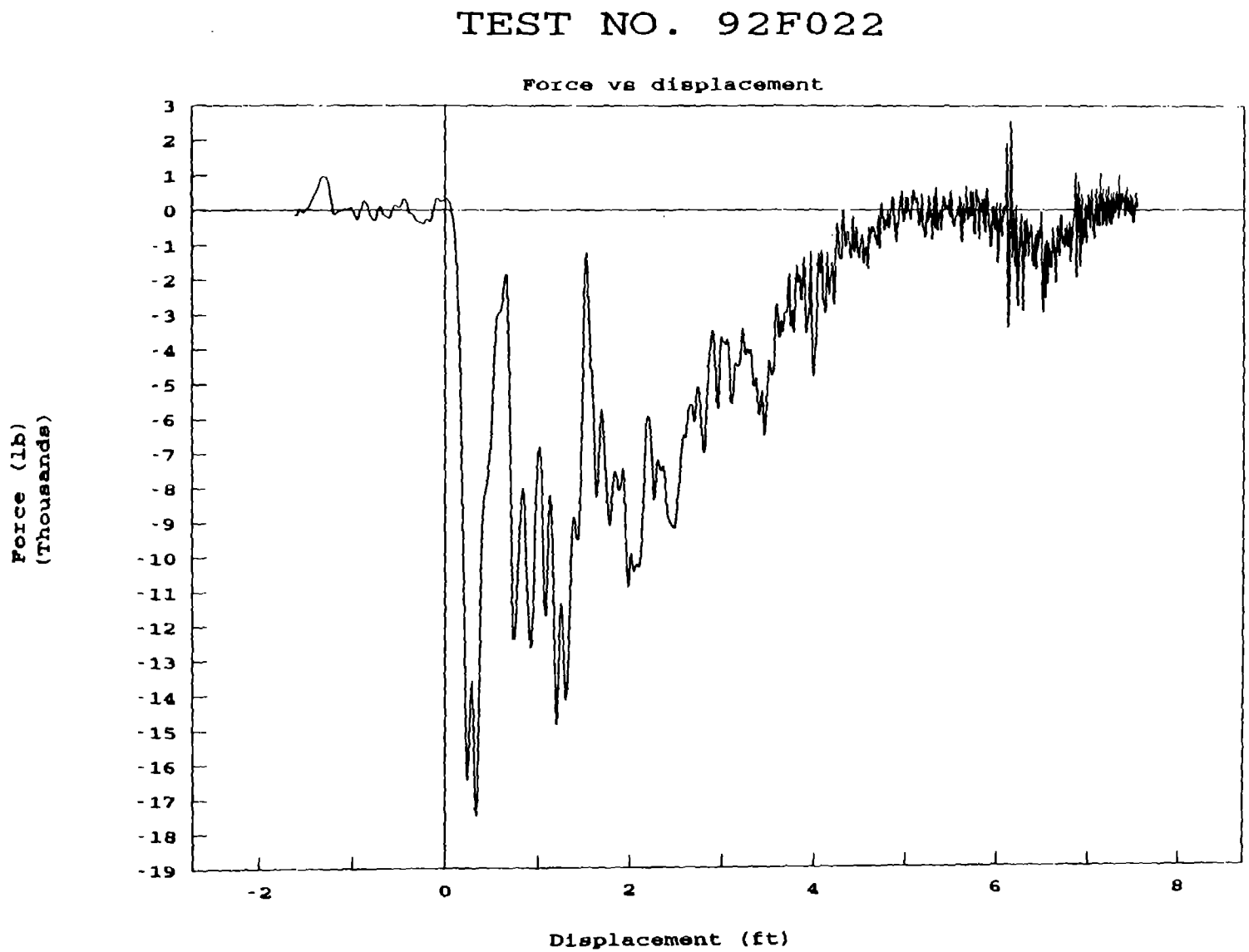


Figure 5. Acceleration versus time, X-axis, test 92F022.



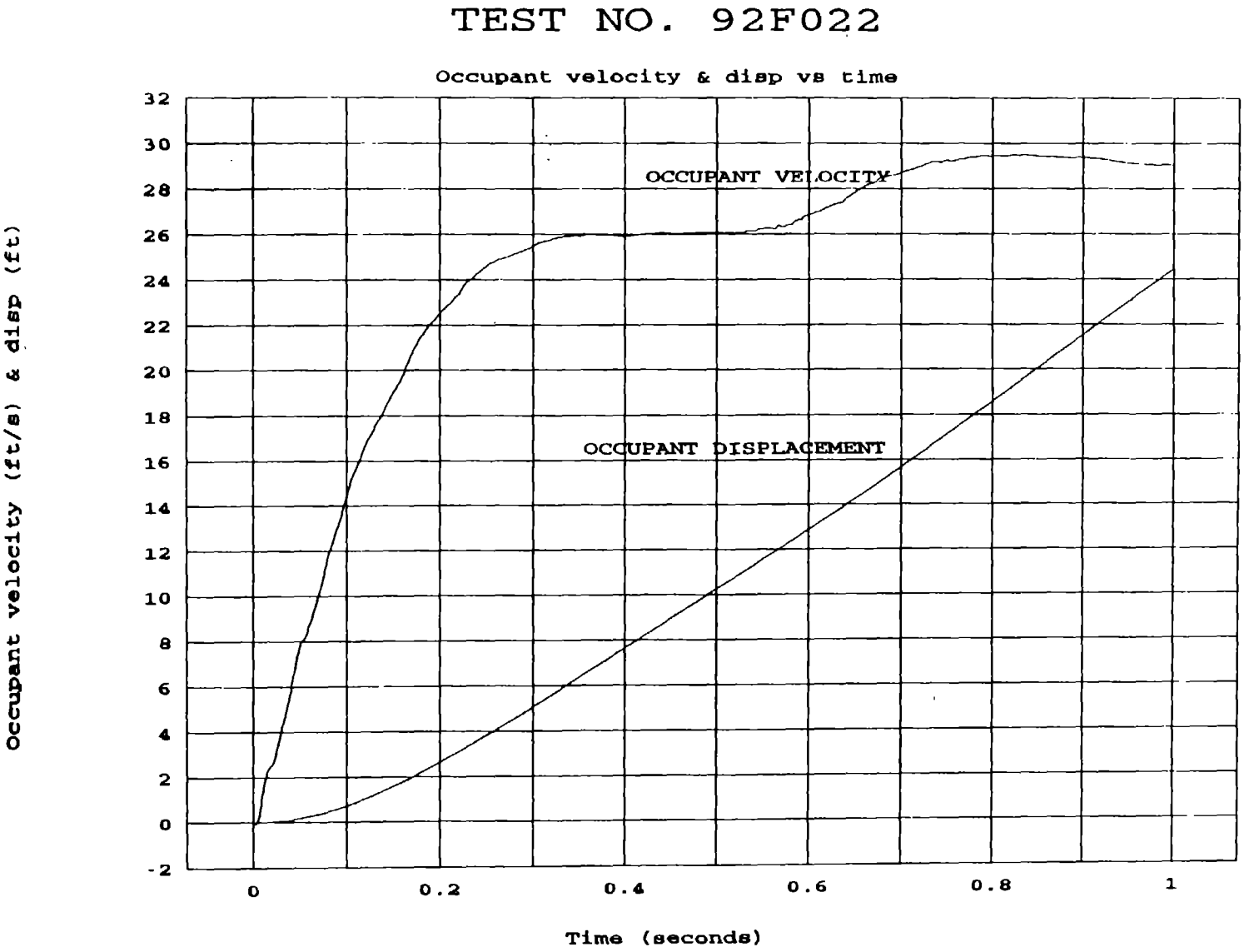
1 ft = 0.305 m

Figure 6. Velocity versus time, X-axis, test 92F022.



1 lbf = 4.45 N 1 ft = 0.305 m

Figure 7. Force versus displacement, X-axis, test 92F022.



1 ft = 0.305 m

Figure 8. Occupant velocity and relative displacement versus time, X-axis, test 92F022.

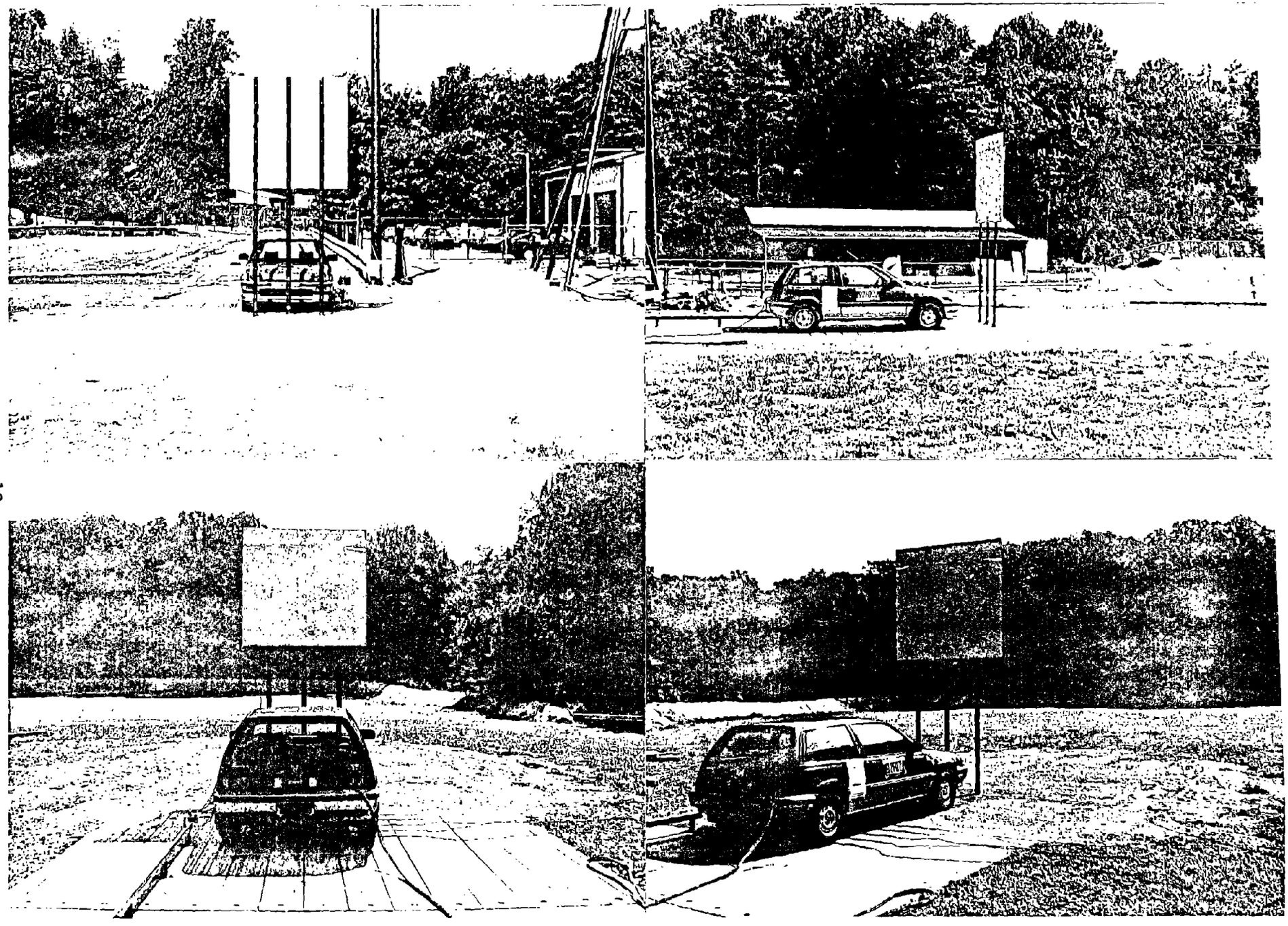


Figure 9. Pretest photographs of test 92F022.

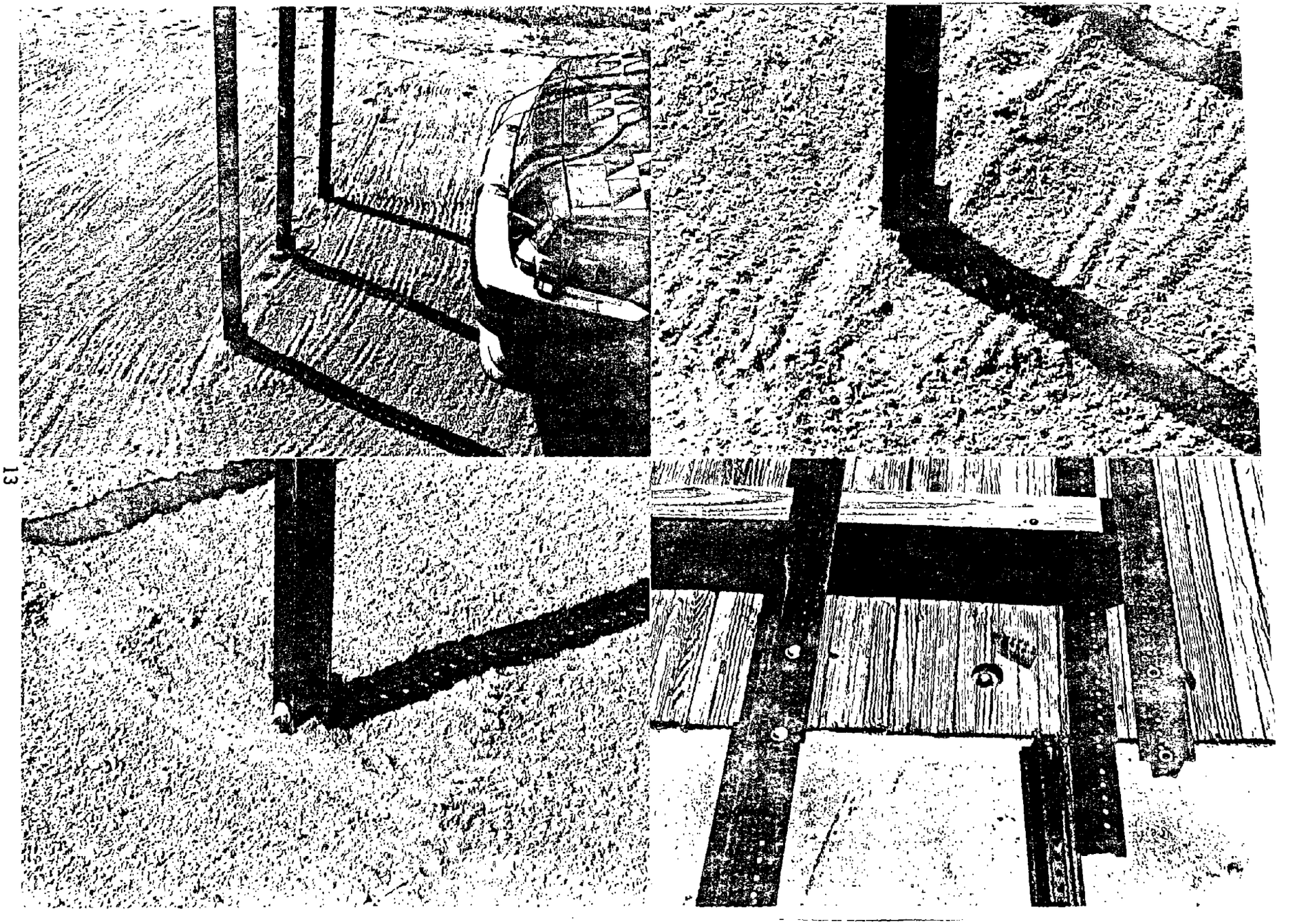


Figure 10. Additional pretest photographs of test 92F022.

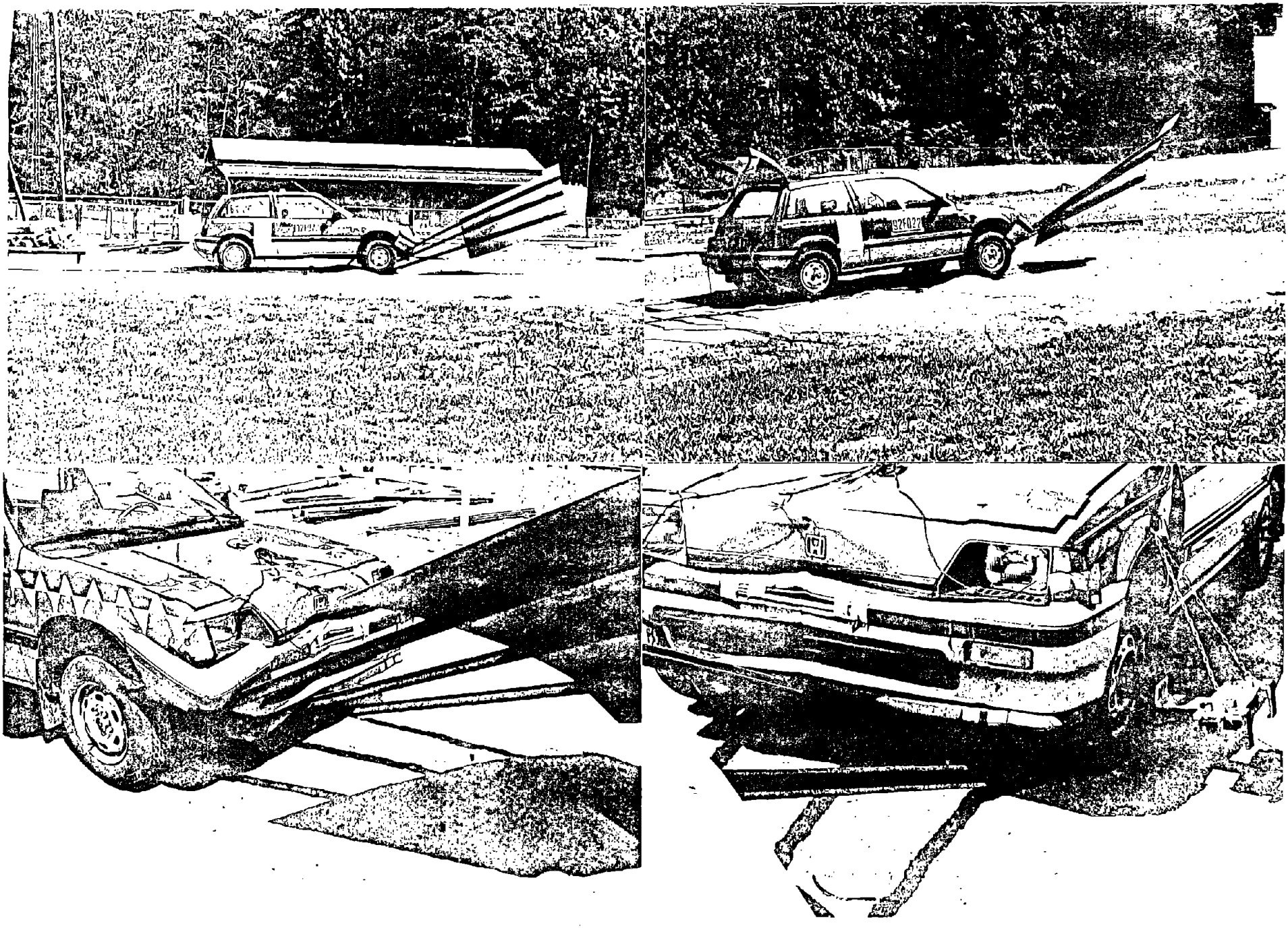


Figure 11. Post-test photographs of test 92F022.

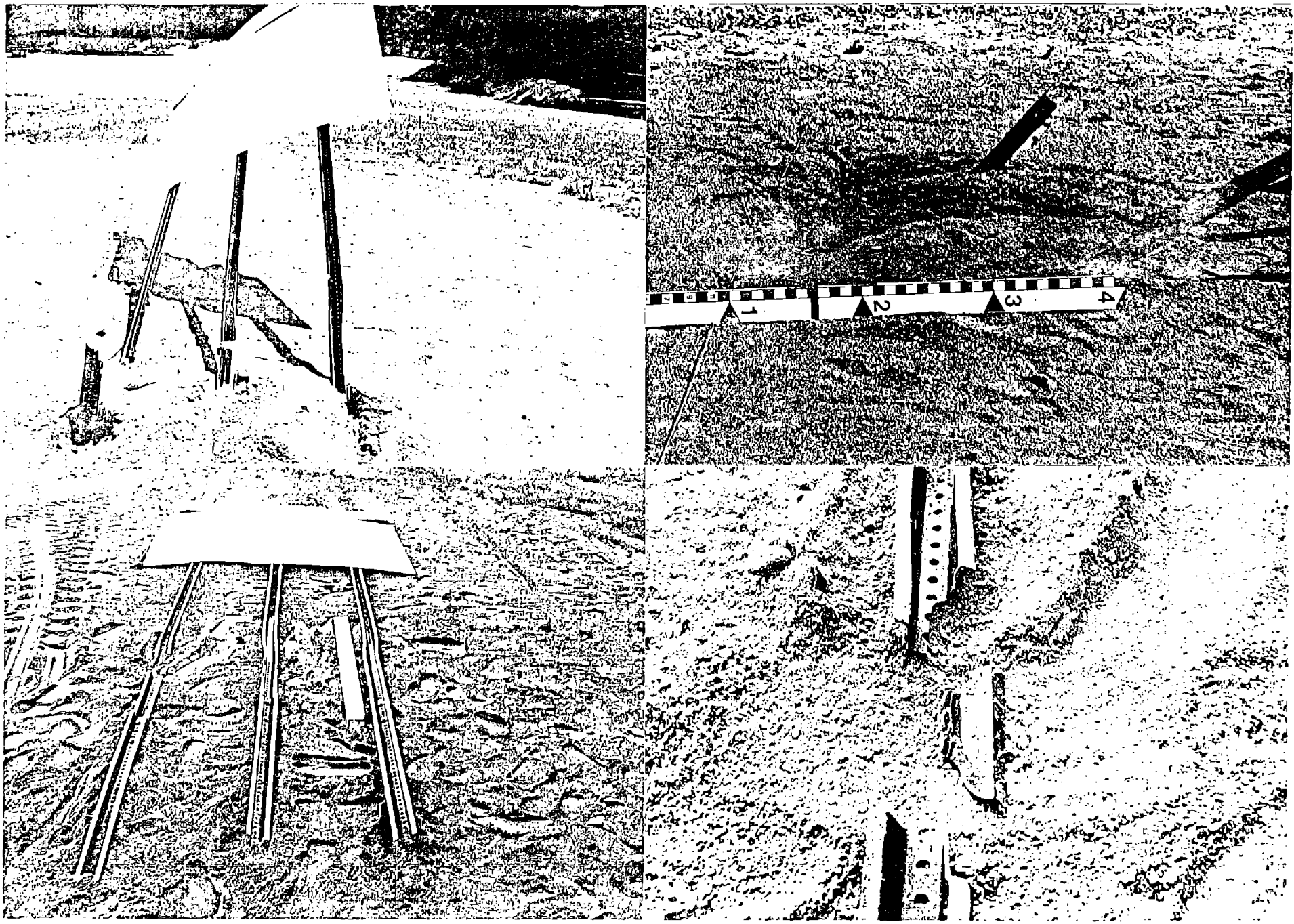


Figure 12. Additional post-test photographs of test 92F022.

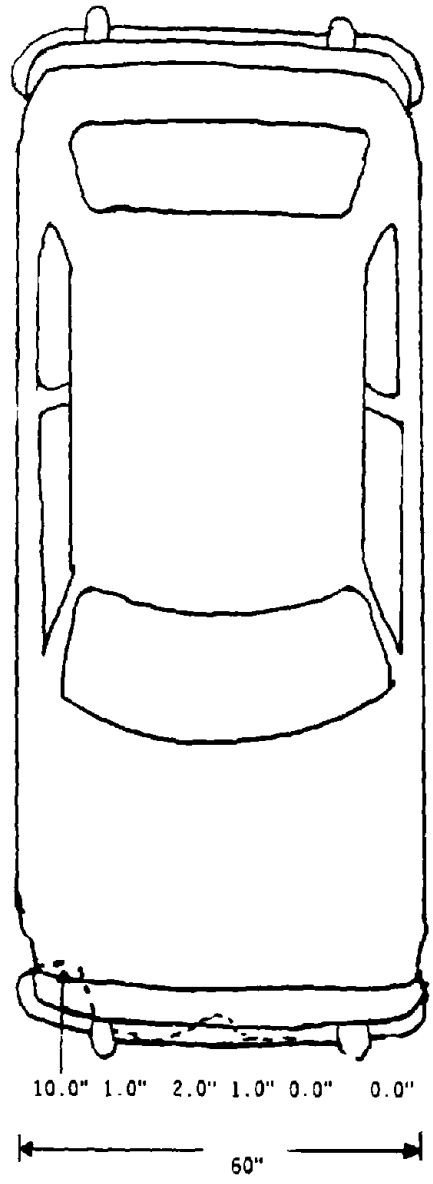


Figure 13. Sketch of vehicle crush, test 92F022.

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.