A-3-7. Test 7

A 1979 Honda Civic, pictured in Figure A-60, was directed into the sign installation at 60.5 mph. Test inertia mass of the test vehicle was 1,800 lb and its gross static mass was 1,965 lb. Impact point was 15 in. to the left of the vehicle centerline. Relative positions of the test vehicle and sign installation are shown in Figure A-61.

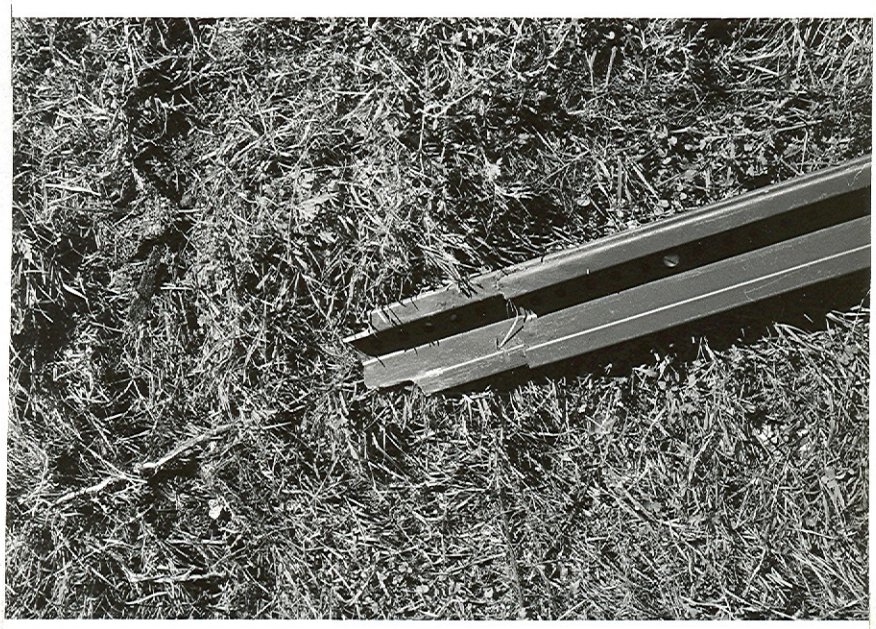
Approximately 0.015 sec after the impact the support began to fracture at bumper height. At 0.025 sec the support lost contact with the front of the vehicle and the sign and part of the support began rising upward. The sign panel then impacted the roof of the vehicle at 0.072 sec. The sign lost contact with the vehicle at 0.097 sec and subsequently came to rest 72 ft behind and 16 ft to the left of the impact point. The vehicle came to a stop approximately 228 ft behind and 60 ft to the left of the impact point.

The support was split from ground level to 14 in. above the ground. At this point the support was fractured as shown in Figure A-62. The vehicle received a maximum crush of 3.5 in. at bumper height and the left front corner of the bumper was bent forward. The roof was dented about 2 in. where the sign impacted. Photographs of the vehicle after the test are shown in Figure A-63 and sequentials of the crash are presented in Figure A-64.

Test results are given in Figure A-65. Change in the vehicle's velocity during the impulse period was 2.1 mph and change in momentum was 169 lb-sec. There was no occupant impact during the impulse period.

FIGURE A-60. TEST VEHICLE BEFORE TEST 7.

FIGURE A-61. RELATIVE POSITIONS OF TEST VEHICLE AND SIGN INSTALLATION FOR TEST 7.



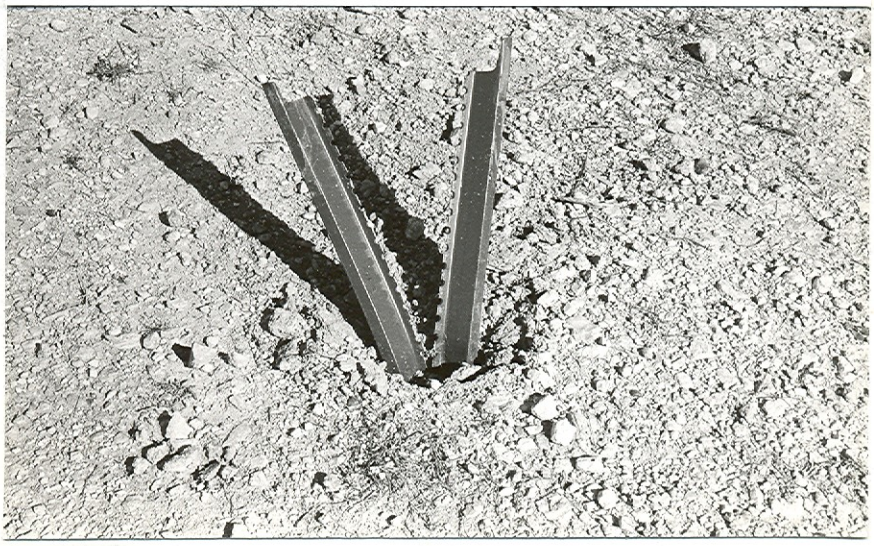
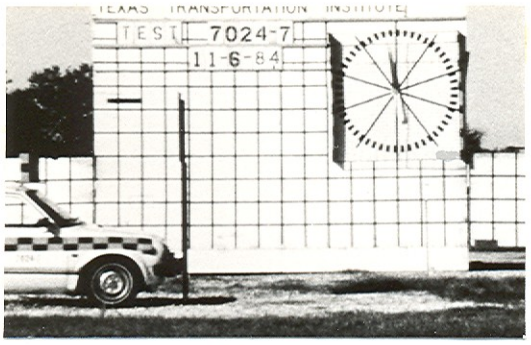
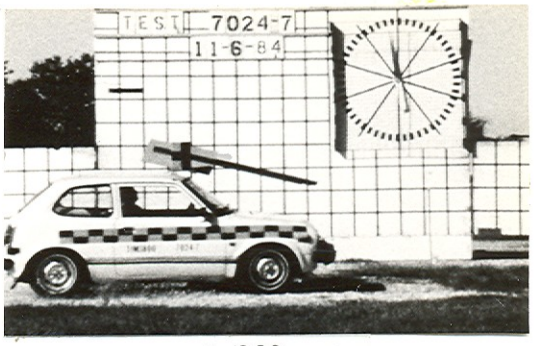


FIGURE A-62. SIGN INSTALLATION AFTER TEST 7.

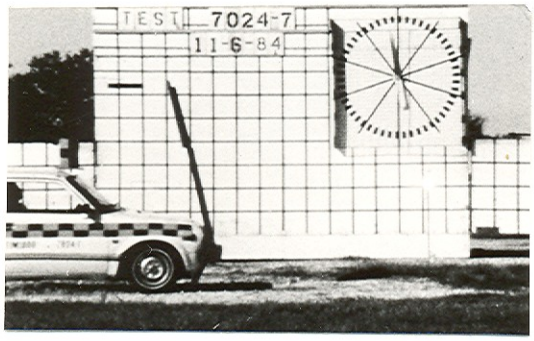
FIGURE A-63. TEST VEHICLE AFTER TEST 7.



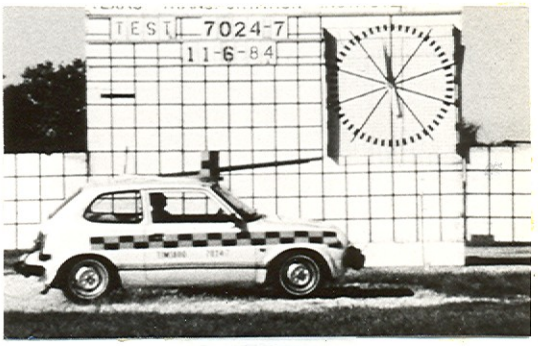
0.000 sec



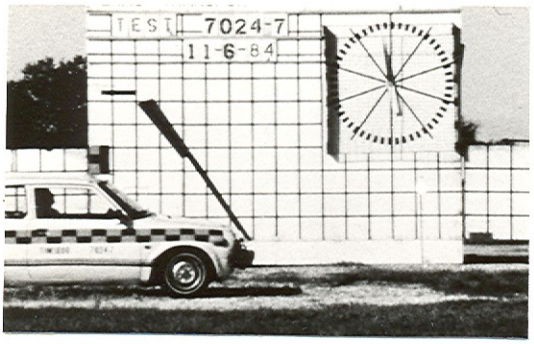
0.060 sec



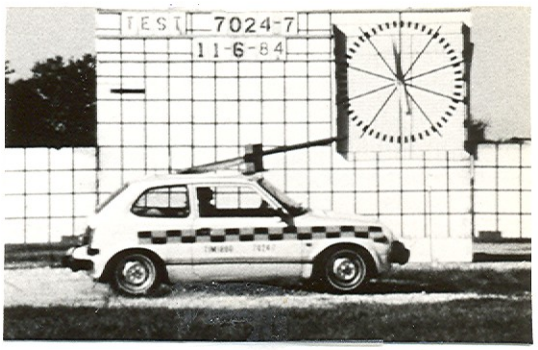
0.015 sec



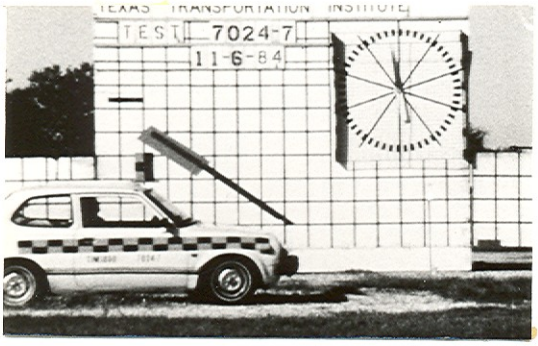
0.075 sec



0.030 sec



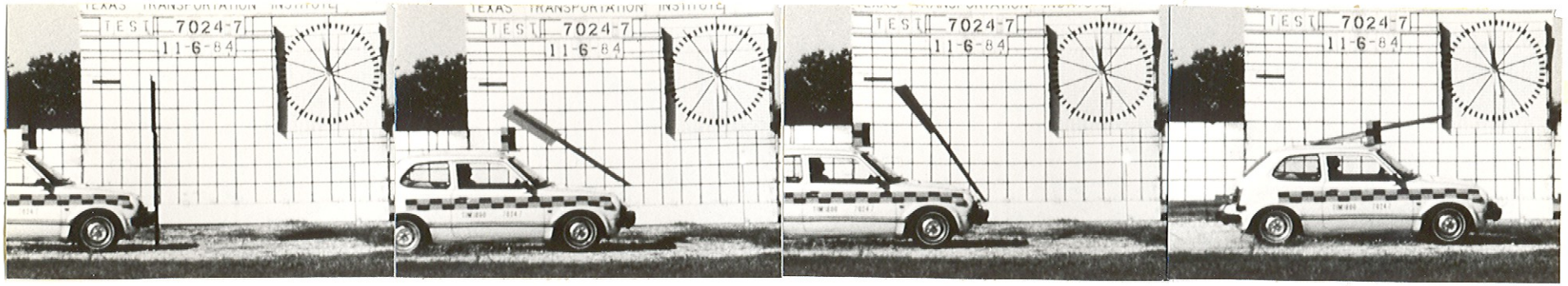
0.090 sec



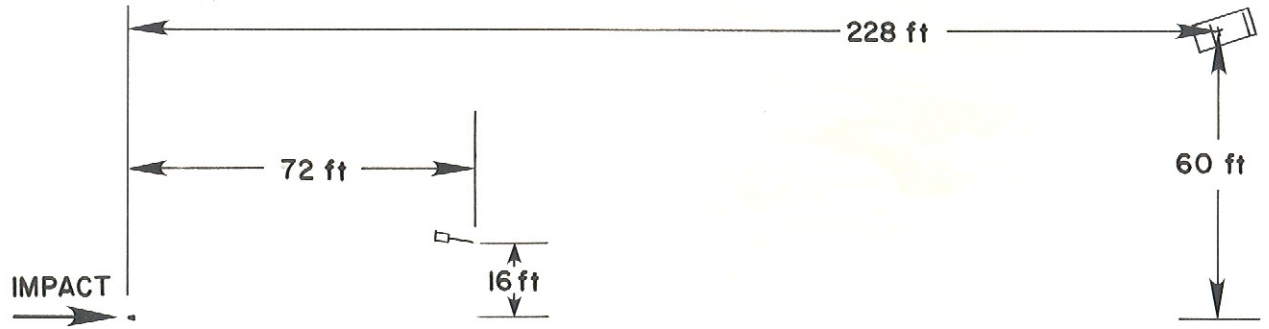
0.045 sec

0.105 sec

FIGURE A-64. SEQUENTIAL PHOTOGRAPHS FOR TEST 7.



0.000 sec 0.030 sec 0.060 sec 0.090 sec



Test No.	7024-7
Date	11/6/84
Test Article	Single-leg Sign Support of 3 lb H.C. Billet Steel U-Channel
Vehicle	1979 Honda Civic
Vehicle Weight	
Test Inertia	1,800 lb (817 kg)
Gross Static	1,965 lb (892 kg)
Vehicle Damage Classification	
TAD	12FL1
SAE	12FLEE1

Impact Speed	60.5 mph (97.3 kph)
Change in Velocity	2.1 mph (3.4 kph)
Change in Momentum	169 lb-sec
Occupant Impact Velocity	
Longitudinal	No Contact
Lateral	No Contact
Occupant Ridedown Accelerations	
Longitudinal	N/A
Lateral	N/A
Vehicle Crush	
Bumper Height	3.5 in. (8.9 cm)
Hood Height	None

FIGURE A-65. SUMMARY OF RESULTS FOR TEST 7.

A-3-8. Test 8

A 1979 Honda Civic, pictured in Figure A-66, was directed into the sign installation at 19.9 mph. Test inertia mass of the test vehicle was 1,800 lb and its gross static mass was 1,965 lb. Impact point was 15 in. to the right of the vehicle centerline. Relative positions of the test vehicle and sign installation are shown in Figure A-67.

Approximately 0.015 sec after impact the support began to fracture at bumper height. At 0.095 sec the support lost contact with the front of the vehicle and the sign and a portion of the support began rising upward. As the vehicle continued forward the sign panel grazed the right front corner of the vehicle at roof height (just above and to the right of the windshield) and bounced away leaving no deformation. The sign panel and support subsequently came to rest 21 ft behind the impact point as shown in Figure A-68. The vehicle came to a stop approximately 60 ft directly behind the impact point.

The support was split from ground level to 16.5 in. above the ground. At this point the support was fractured as shown in Figure A-68. The vehicle received a minimal amount of damage. As shown in Figure A-69 there was a slight indentation in the bumper and the parking light was also broken. (Damage to the left side was due to the previous test.) Sequentials of the test are presented in Figure A-70.

Test results are given in Figure A-71. Change in the vehicle's velocity during the impulse period was 4.1 mph and change in momentum was 339 lb-sec. There was no occupant impact during the impulse period.

FIGURE A-66. TEST VEHICLE BEFORE TEST 8.

FIGURE A-67. RELATIVE POSITIONS OF TEST VEHICLE AND SIGN INSTALLATION FOR TEST 8.

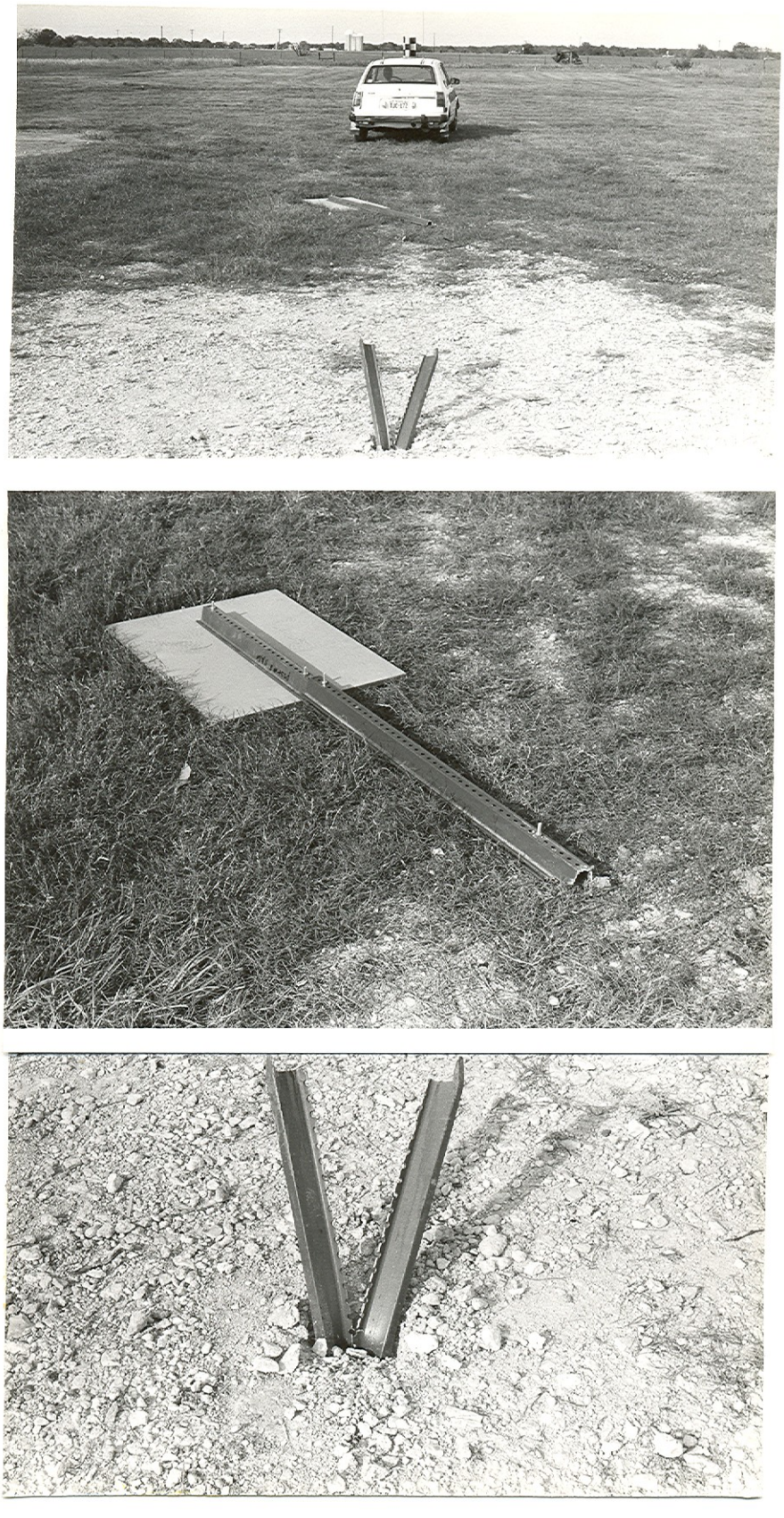


FIGURE A-68. SIGN INSTALLATION AFTER TEST 8.

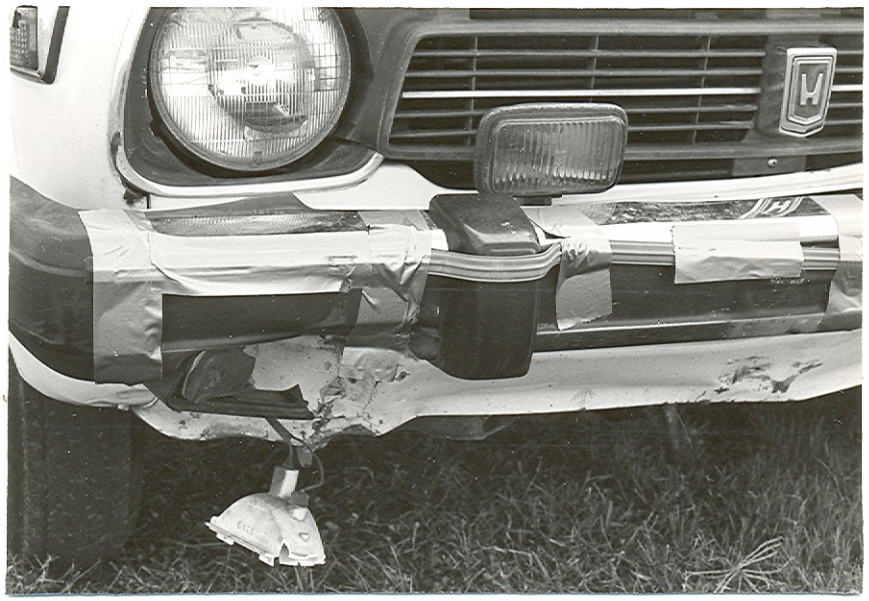
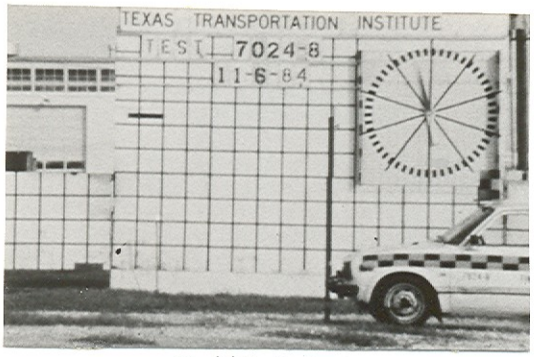
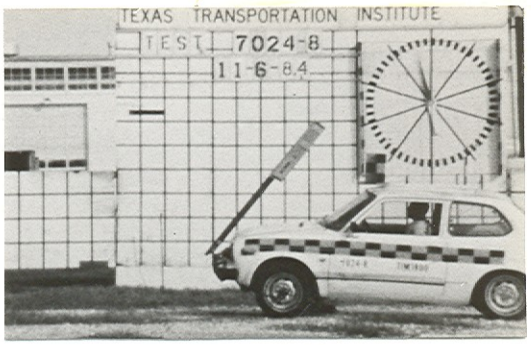


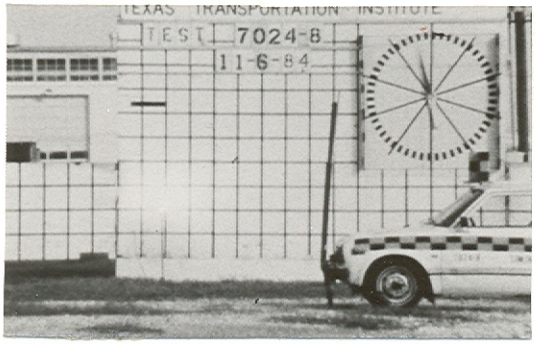
FIGURE A-69. TEST VEHICLE AFTER TEST 8.



0.000 sec

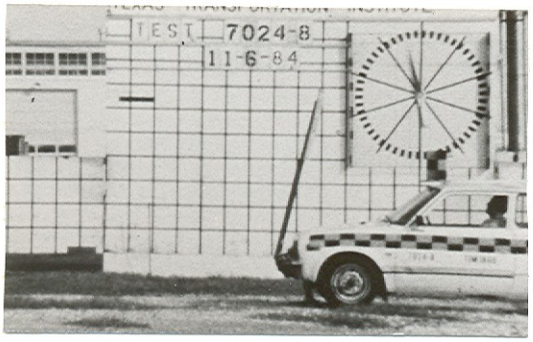


0.163 sec



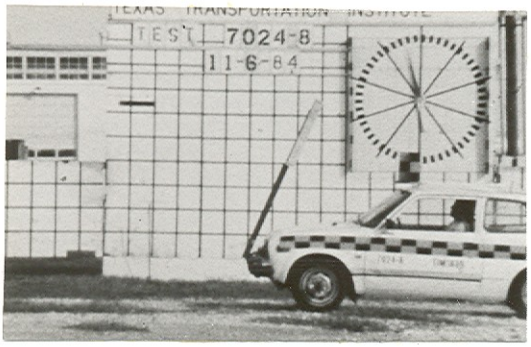
0.015 sec

0.231 sec



0.055 sec

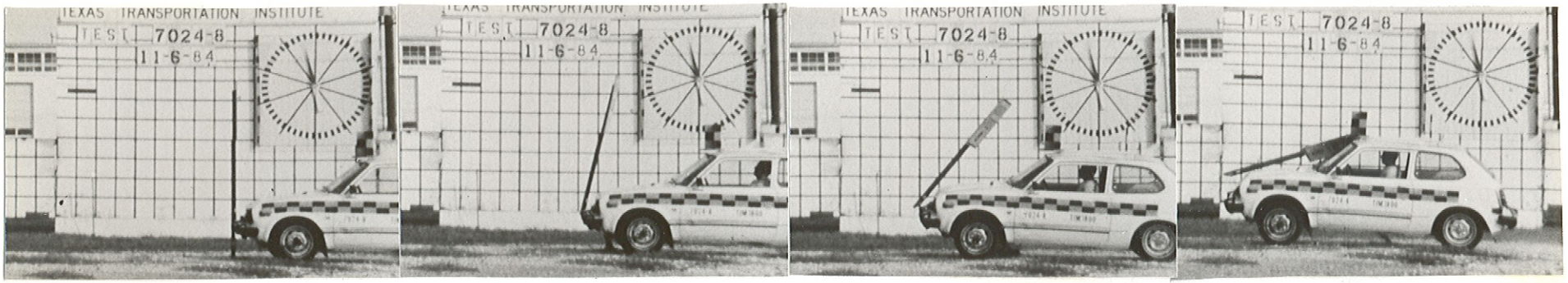
0.296 sec



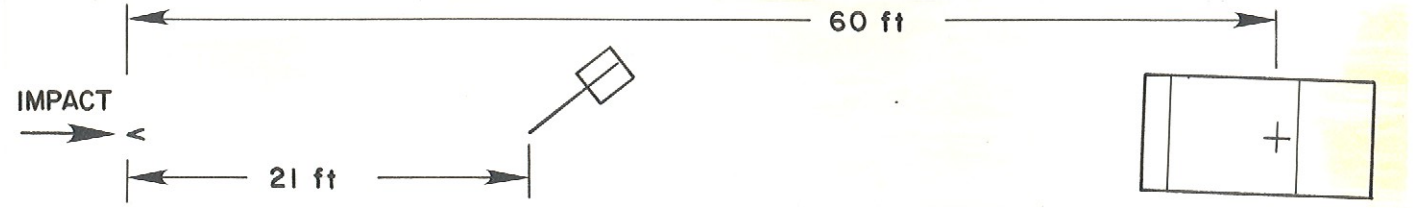
0.095 sec

0.366 sec

FIGURE A-70. SEQUENTIAL PHOTOGRAPHS FOR TEST 8.



0.000 sec 0.055 sec 0.163 sec 0.296 sec



Test No.	7024-8
Date	11/6/84
Test Article	Single-leg Sign Support of 3 lb H.C. Billet Steel U-Channel
Vehicle	1979 Honda Civic
Vehicle Weight	
Test Inertia	1,800 lb (817 kg)
Gross Static	1,965 lb (892 kg)
Vehicle Damage Classification	
TAD	12FR1
CDC	12FLEE1

Impact Speed	19.9 mph (32.0 kph)
Change in Velocity	4.1 mph (6.6 kph)
Change in Momentum	339 lb-sec
Occupant Impact Velocity	
Longitudinal	No Contact
Lateral	No Contact
Occupant Ridedown Accelerations	
Longitudinal	N/A
Lateral	N/A
Vehicle Crush	
Bumper Height	Negligible
Hood Height	None

FIGURE A-71. SUMMARY OF RESULTS FOR TEST 8.

A-3-9. Test 9

A 1979 Honda Civic, pictured in Figure A-72, was directed into the sign installation at 59.3 mph. Test inertia mass of the test vehicle was 1,800 lb and its gross static mass was 1,970 lb. Impact point was such that the vehicle impacted all three supports of the installation. Relative positions of the test vehicle and sign installation are shown in Figure A-73.

Approximately 0.017 sec after impact the lower section of the left support began to fracture at bumper height and by 0.027 sec the remaining supports had fractured. At 0.055 sec the supports lost contact with the front of the vehicle and the sign panel and supports began rising upward. The sign subsequently came to rest 6 ft directly behind the impact point. The vehicle came to a stop approximately 270 ft behind and 30 ft to the left of the impact point.

The lower section of the left support was split longitudinally from ground level to 16.5 in. above the ground where it had fractured. The lower section of the center support was split from ground level to its fracture point of 12 in. As shown in Figure A-74 the right support split from ground level to 20 in. above the ground where only the right half fractured. The upper sections were relatively undamaged.

The front of the vehicle was deformed as shown in Figure A-75. The right front quarter received 12.0 in. crush at bumper height. The center was crushed 6.5 in. at bumper height and 1.5 in. at hood height. Sequential photographs of the test are shown in Figure A-76.

Test results are given in Figure A-77. Change in the vehicle's velocity during the impulse period was 7.2 mph and change in momentum was 590 lb-sec. There was no occupant impact during the impulse period.

FIGURE A-72. TEST VEHICLE BEFORE TEST 9.

FIGURE A-73. RELATIVE POSITIONS OF TEST VEHICLE AND SIGN INSTALLATION FOR TEST 9.

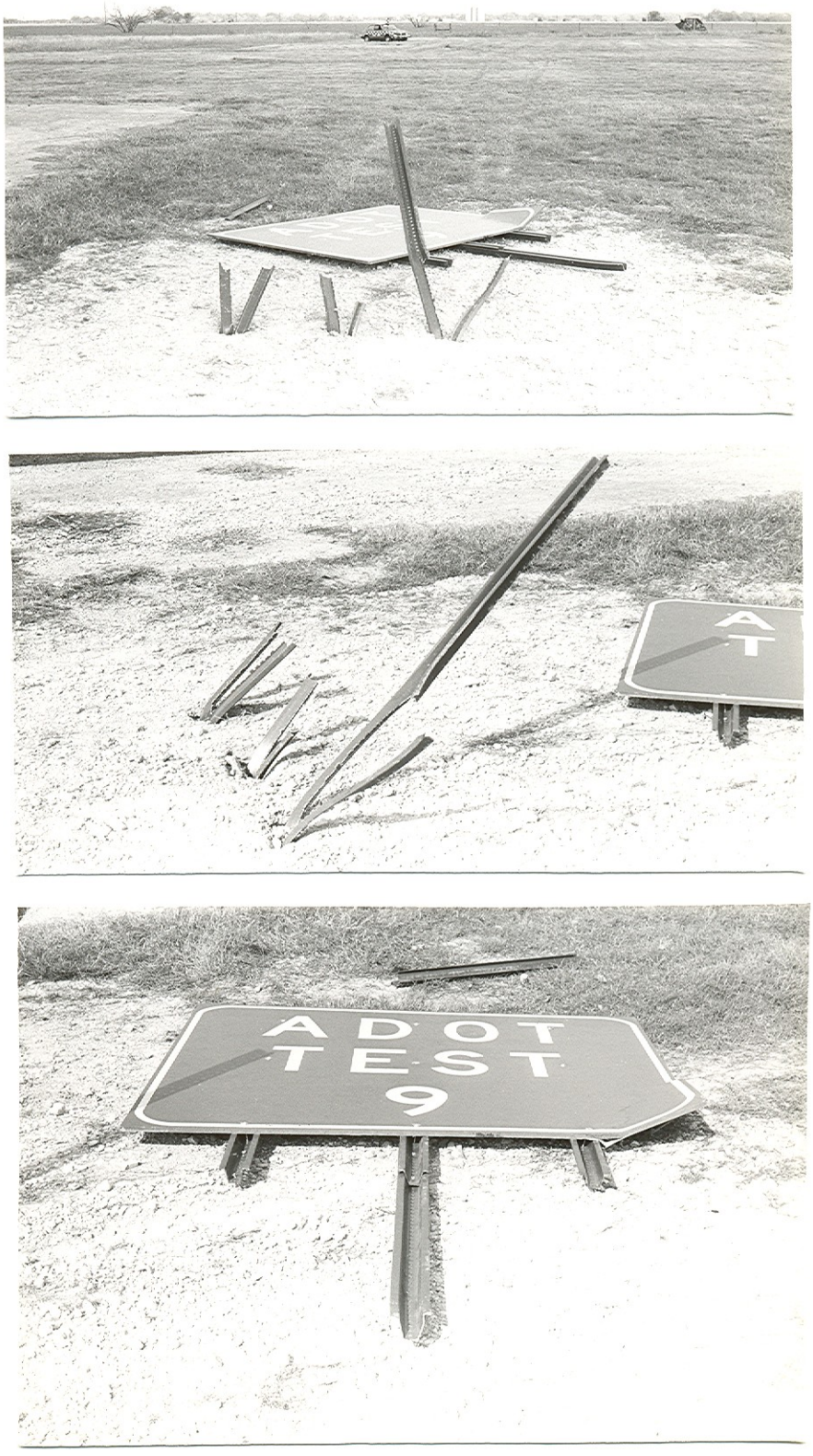
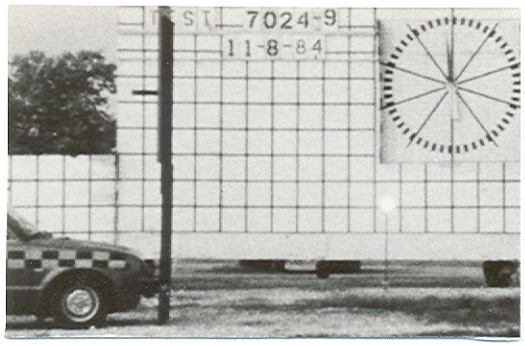
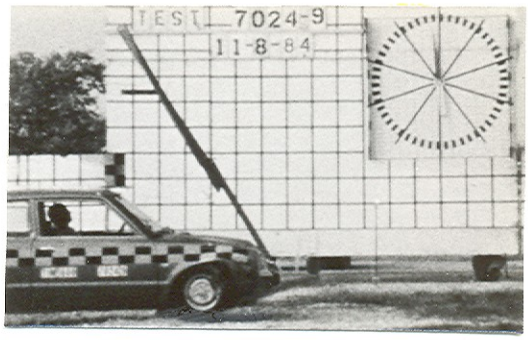


FIGURE A-74. SIGN INSTALLATION AFTER TEST 9.

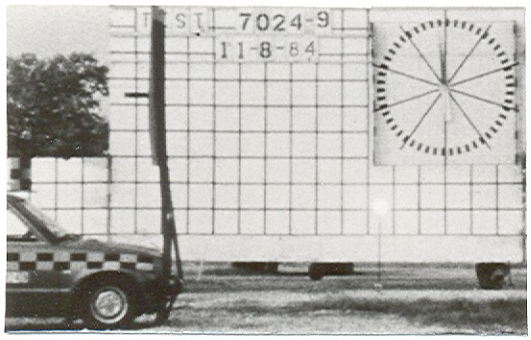
FIGURE A-75. TEST VEHICLE AFTER TEST 9.



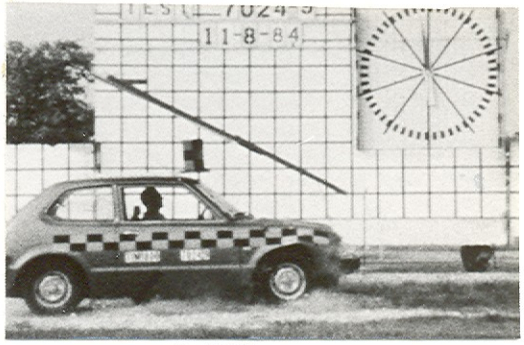
0.000 sec



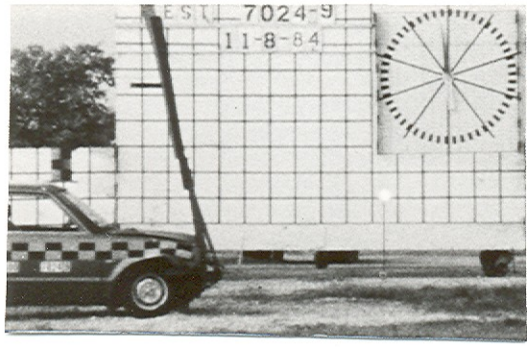
0.050 sec



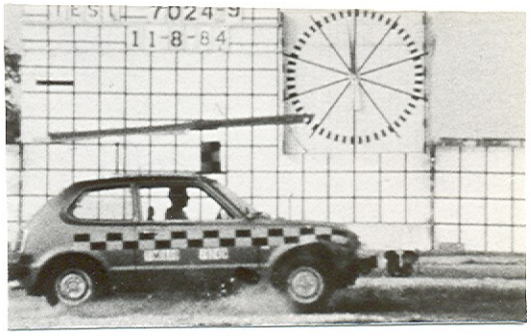
0.012 sec



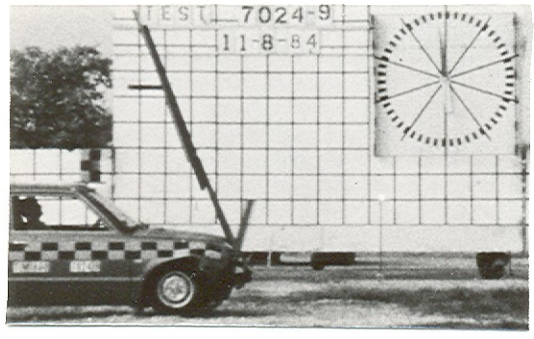
0.087 sec



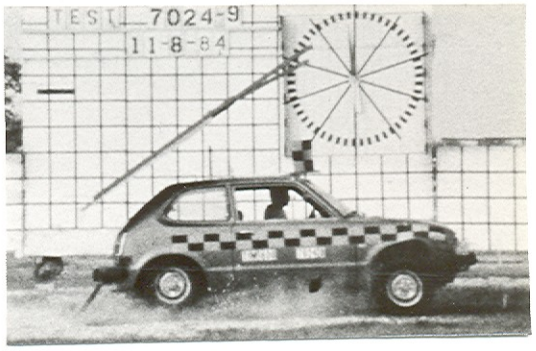
0.025 sec



0.125 sec

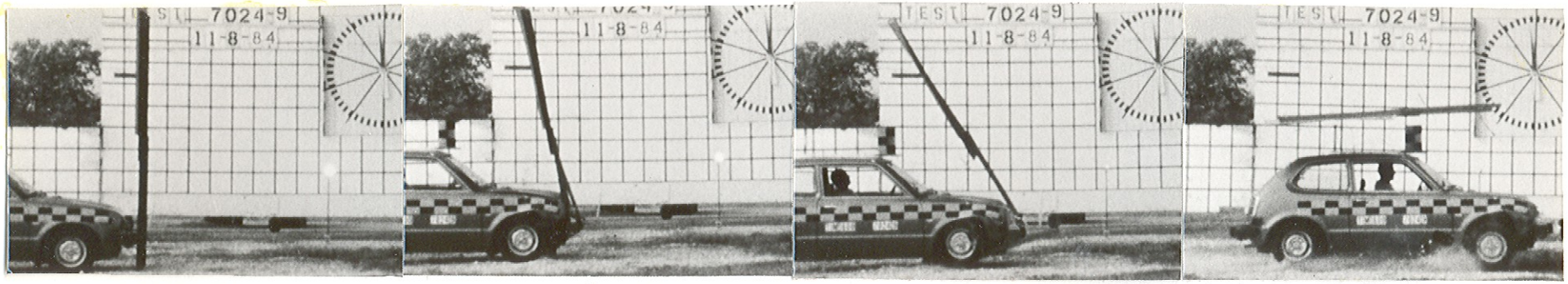


0.037 sec

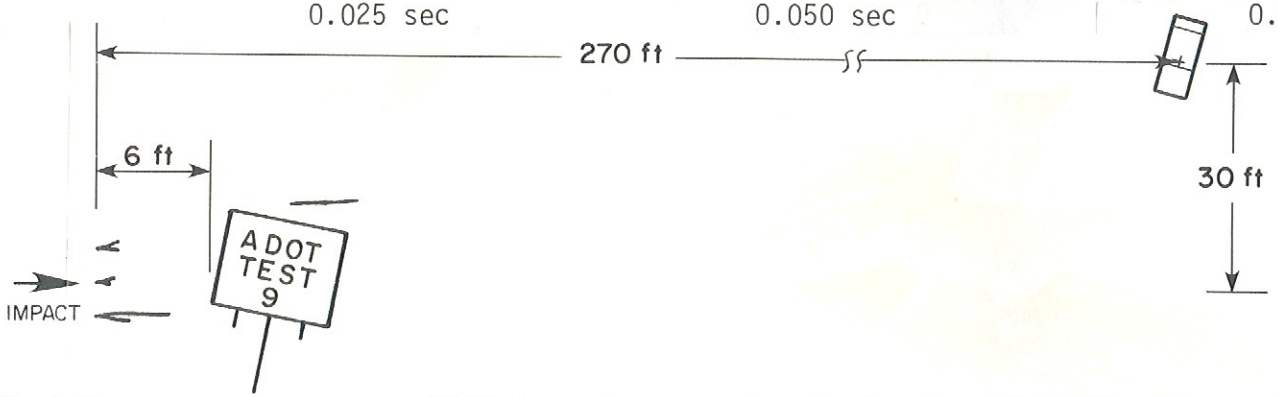


0.162 sec

FIGURE A-76. SEQUENTIAL PHOTOGRAPHS FOR TEST 9.



0.000 sec 0.025 sec 0.050 sec 0.125 sec



A-96

Test No.	7024-9
Date	11/8/84
Test Article	Multi-leg Sign Support of 3 lb H.C. Billet Steel U-Channel
Vehicle	1979 Honda Civic
Vehicle Weight	
Test Inertia	1,800 lb (817 kg)
Gross Static	1,970 lb (894 kg)
Vehicle Damage Classification	
TAD	12FD1
SAE	12FDEW2

Impact Speed	59.3 mph (95.4 kph)
Change in Velocity	7.2 mph (11.6 kph)
Change in Momentum	590 lb-sec
Occupant Impact Velocity	
Longitudinal	No Contact
Lateral	No Contact
Occupant Ridedown Accelerations	
Longitudinal	N/A
Lateral	N/A
Maximum Vehicle Crush	
Bumper Height	12.0 in. (30.5 cm)
Hood Height	1.5 in. (3.8 cm)

FIGURE A-77. SUMMARY OF RESULTS FOR TEST 9.

A-3-10. Test 10

A 1979 Honda Civic was directed into the sign installation at 19.4 mph. Test inertia mass of the test vehicle was 1,800 lb and its gross static mass was 1,970 lb. Impact point was such that the vehicle impacted all three supports of the installation. Relative positions of the test vehicle and sign installation are shown in Figure A-78.

Approximately 0.013 sec after impact the lower sections of the supports between ground level and the upper connection were bending and causing bending deformations at the upper connection. By 0.028 sec the top bolts in the connection failed and by 0.038 sec the lower bolts also failed. At 0.108 sec the vehicle began to ride up on the supports. The dummy's head hit the windshield just below the visor at 0.170 sec and at 0.210 sec the vehicle impacted the sign panel which had remained connected to the upper sections of the supports. Subsequently, the vehicle tilted to the left and came to rest directly over the left and center supports as shown in Figure A-79. The sign came to rest about 6 ft in front of the vehicle.

The lower section of the left support was split longitudinally from just below ground level to 24.0 in. above the ground. The lower section of the center support was split from about 1.5 in. below ground level to 16.0 in. above. The right support was scratched and bent back slightly. The upper sections were relatively undamaged.

The front of the vehicle was deformed as shown in Figure A-80. The right front quarter received 6.0 in. crush at bumper height. The center was crushed 2.0 in. at bumper height. The windshield was slightly cracked just below the visor and the visor was bent. Sequential photographs of the test are shown in Figure A-81.

A summary of the test results is given in Figure A-82. Change in the vehicle's velocity during the impulse period (0.600 sec) was 16.3 mph and change in momentum at 0.600 sec was 1,335 lb-sec. Occupant impact velocity in the longitudinal direction was 19.3 fps and the highest 0.010-second occupant ridedown acceleration was -1.6 g.

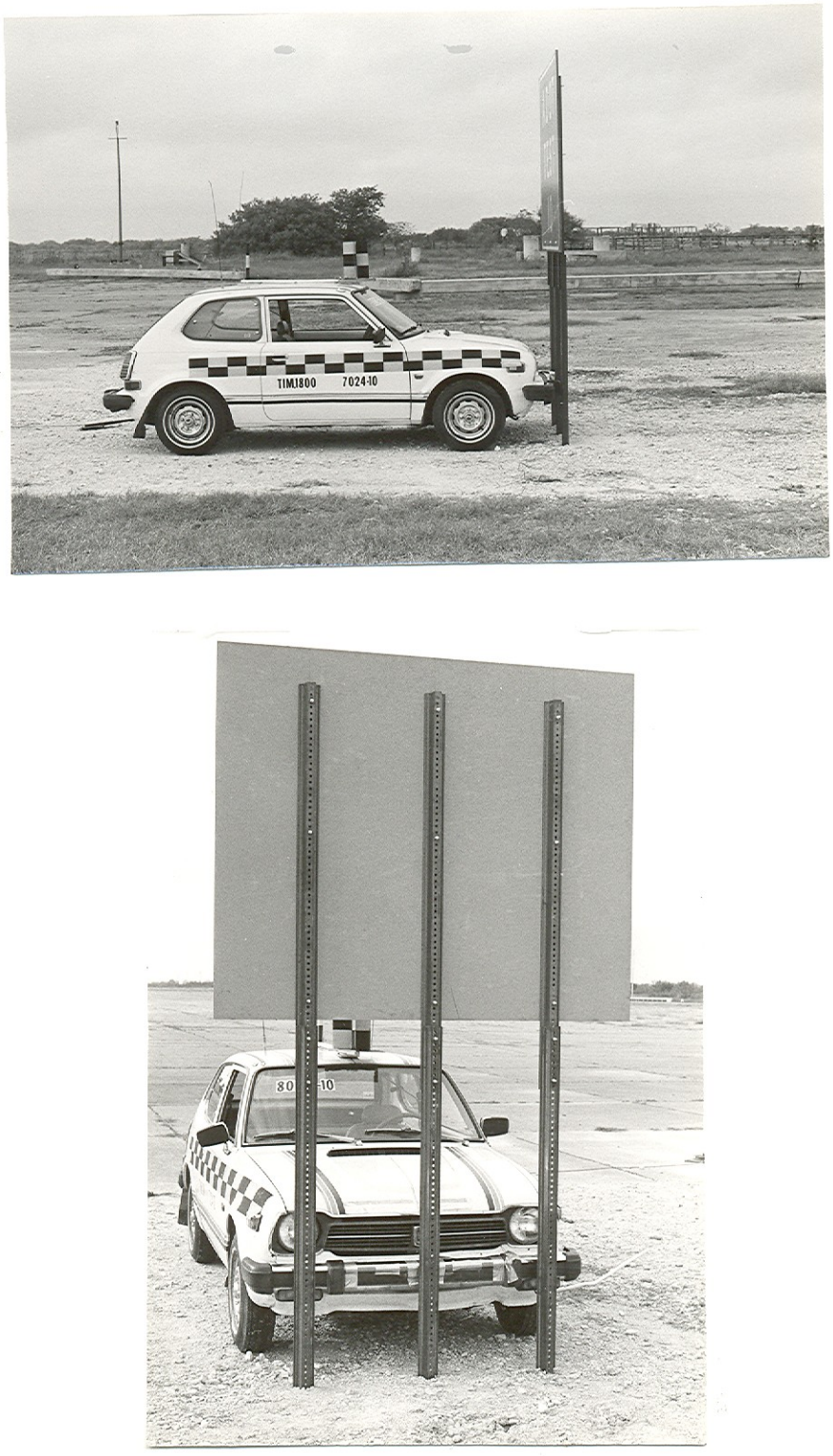
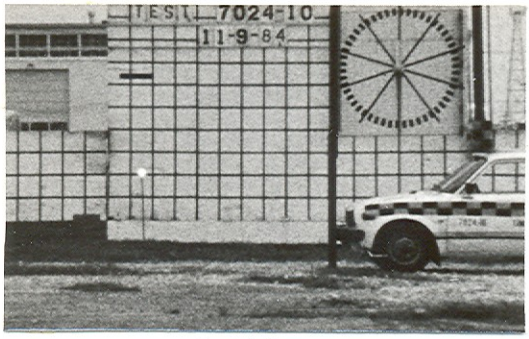


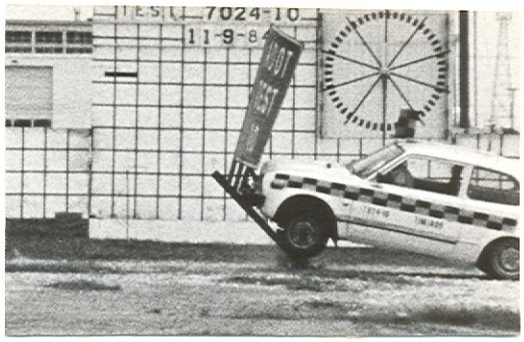
FIGURE A-78. RELATIVE POSITIONS OF TEST VEHICLE AND SIGN INSTALLATION FOR TEST 10.

FIGURE A-79. SIGN INSTALLATION AFTER TEST 10.

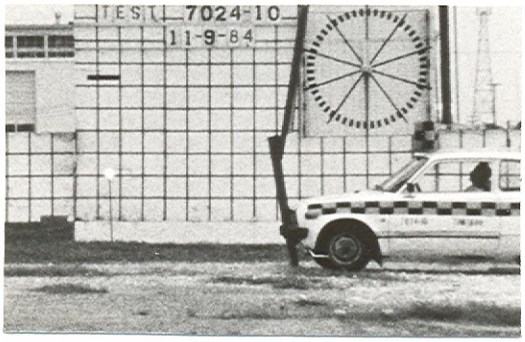
FIGURE A-80. TEST VEHICLE AFTER TEST 10.



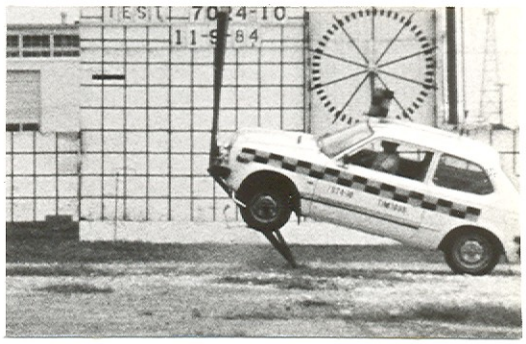
0.000 sec



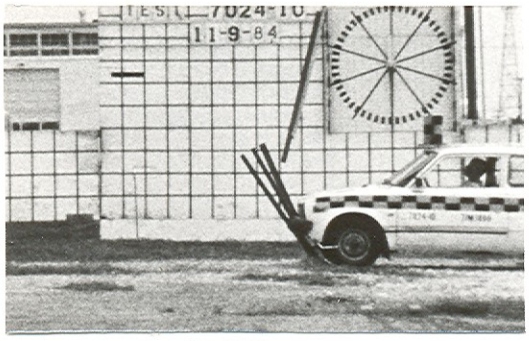
0.200 sec



0.038 sec

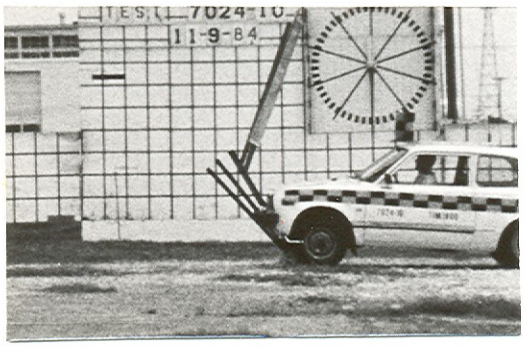


0.338 sec



0.075 sec

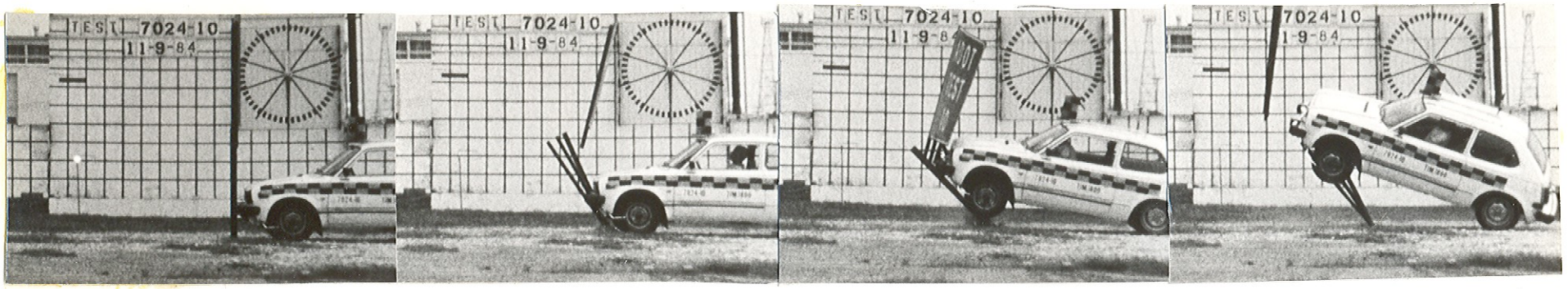
0.475 sec



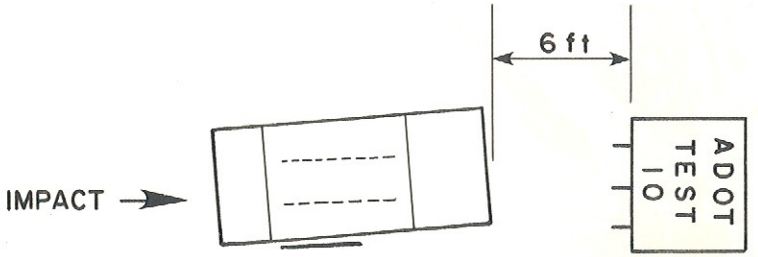
0.113 sec

0.613 sec

FIGURE A-81. SEQUENTIAL PHOTOGRAPHS FOR TEST 10.



0.000 sec 0.075 sec 0.200 sec 0.475 sec



Vehicle subsequently came to rest over left and center supports.

Test No.	7024-10
Date	11/9/84
Test Article	Multi-leg Sign Support of 3 lb H.C. Billet Steel U-Channel
Vehicle	1979 Honda Civic
Vehicle Weight	
Test Inertia	1,800 lb (817 kg)
Gross Static	1,970 lb (894 kg)
Vehicle Damage Classification	
TAD	12FD1
SAE	12FDEW1
Impact Speed	19.4 mph (31.2 kph)
Change in Velocity*	16.3 mph (26.2 kph)
Change in Momentum*	1335 lb-sec
Occupant Impact Velocity	
Longitudinal	19.3 fps (5.9 m/s)
Lateral	No Contact
Occupant Ridedown Accelerations	
Longitudinal	-1.6 g
Lateral	N/A
Maximum Vehicle Crush	
Bumper Height	6.0 in. (30.5 cm)
Hood Height	None

*Impulse period computed from 0.000 to 0.600 sec.

FIGURE A-82. SUMMARY OF RESULTS FOR TEST 10.

A-3-11. Test 11

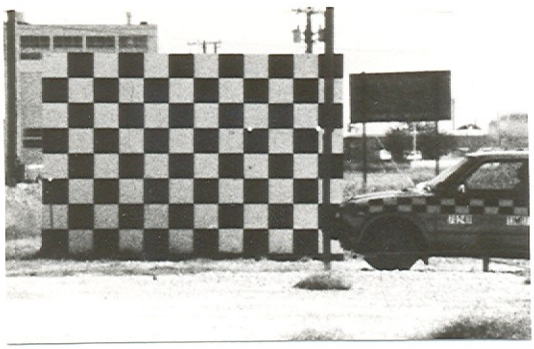
The 1979 Honda, shown in Figure A-83, was directed into the sign installation at 20.2 mph. The test inertia mass of the vehicle was 1,770 lb and its gross static mass was 1,940 lb. Impact point was such that the vehicle bumper contacted both supports of the sign installation.

Approximately 0.029 sec after impact the right support fractured, and at 0.044 sec the left support fractured. The vehicle lost contact with the upper portion of the sign installation at 0.112 sec. However, the vehicle came to rest over the lower section of the sign installation. One of the lower sections penetrated the floorboard of the vehicle approximately 3 in. Sequential photographs of the test are shown in Figure A-84.

The right support was fractured 19 in. above the ground and the left support was fractured 20 in. above the ground, as shown in Figure A-85. As shown in Figure A-86, the vehicle was elevated by the fractured supports. The front of the vehicle sustained minor scrapes and dents.

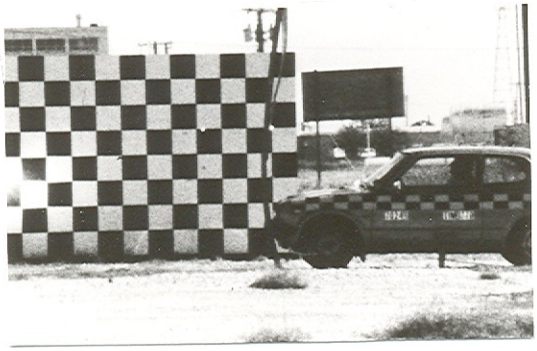
Results of the test are summarized in Figure A-87. Change in the vehicle's velocity at 0.500 sec was 8.1 mph and change in momentum was 653 lb-sec. Longitudinal occupant impact velocity was 14.2 fps and the maximum 0.010-second average occupant ridedown acceleration was -1.6 g.

FIGURE A-83. VEHICLE BEFORE TEST 11.



0.000 sec

0.104 sec



0.026 sec

0.157 sec

0.052 sec

0.209 sec

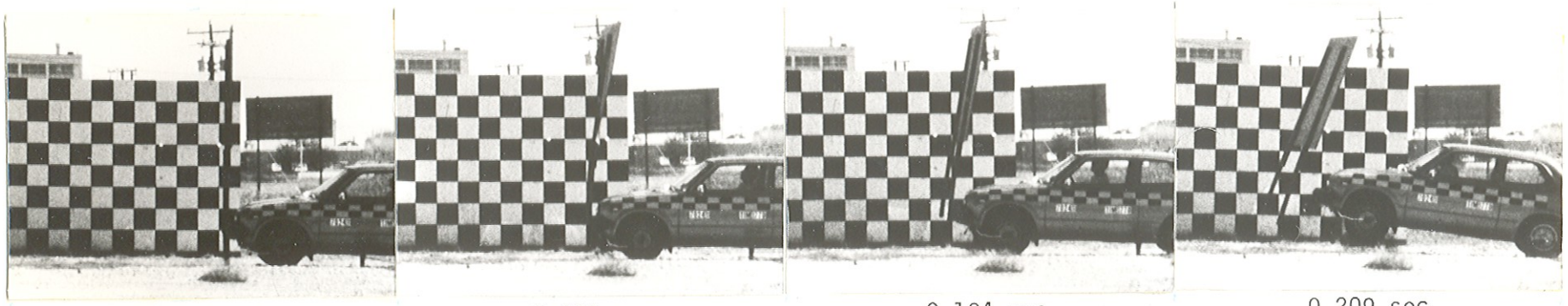
0.078 sec

0.261 sec

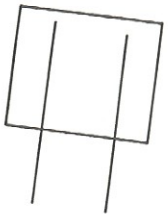
FIGURE A-84. SEQUENTIAL PHOTOGRAPHS FOR TEST 11.

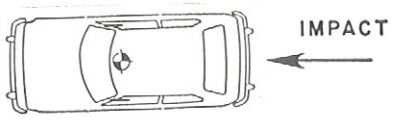
FIGURE A-85. SIGN INSTALLATION AFTER TEST 11.

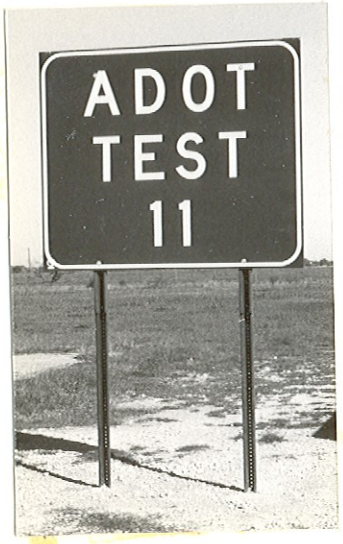
FIGURE A-86. VEHICLE AFTER TEST 11.



0.000 sec 0.052 sec 0.104 sec 0.209 sec







Test No.	7024-11
Date	11/05/85
Test Article	Sign installation
Support	Two posts of 4 lb High Carbon Billet Steel
Vehicle	1979 Honda Civic
Vehicle Weight	
Test Inertia	1,770 lb (804 kg)
Gross Static	1,940 lb (881 kg)
Vehicle Damage Classification	
TAD	12FD1
SAE	12FDEW1
Impact Speed	20.2 mph (32.5 kph)
Change in Velocity	8.1 mph (13.0 kph)
Change in Momentum	653 lb-sec
Occupant Impact Velocity	
Longitudinal	14.2 fps (4.3 m/s)
Lateral	None
Occupant Ridedown Accelerations	
Longitudinal	-1.6 g
Lateral	N/A
Maximum Vehicle Crush	
Bumper Height	0.0 in. (0.0 cm)

FIGURE A-87. SUMMARY OF RESULTS FOR TEST 11.

A-3-12. Test 12

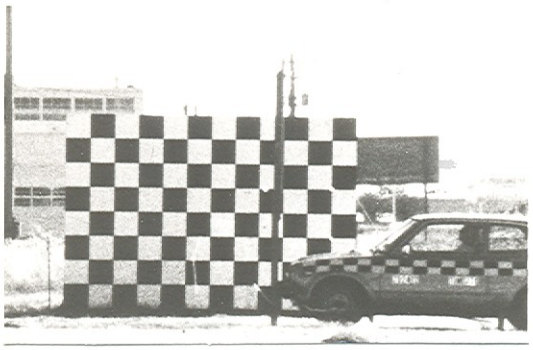
A 1979 Honda Civic, shown in Figure A-88, was directed into the sign at 60.9 mph. Test inertia mass of the vehicle was 1,770 lb and its gross static mass was 1,940 lb. Impact point was such that the vehicle bumper contacted both supports of the installation. Relative positions of the test vehicle and sign installation are shown in Figure A-88.

Approximately 0.010 sec after impact the supports began to fracture. At 0.039 sec the vehicle lost contact with the sign. Shortly thereafter the upper portion of the sign installation went up and over the vehicle and at 0.183 sec the sign panel struck the rear of the vehicle. Sequential photographs of the test are presented in Figure A-89.

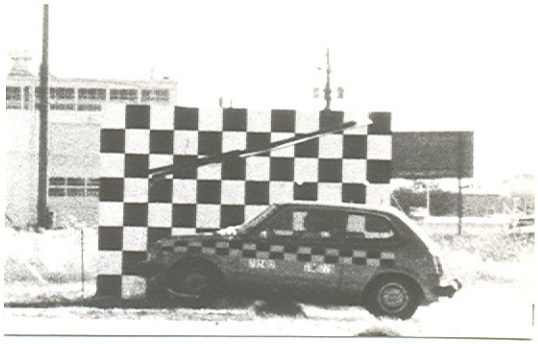
The lower sections of the left and right supports fractured 17 in. above the ground. Damage to the sign supports is shown in Figure A-90. The front of the vehicle was deformed as shown in Figure A-91. The vehicle sustained minor dents. It remained upright and stable after impact.

Test results are shown in Figure A-92. Change in the vehicle's velocity was 7.3 mph and change in momentum was 589 lb-sec. Longitudinal occupant impact velocity was 10.5 fps and the maximum 0.010-second average ridedown acceleration was -0.5 g.

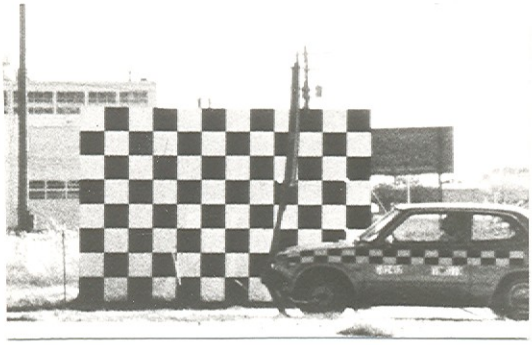
FIGURE A-88. VEHICLE BEFORE TEST 12.



0.000 sec

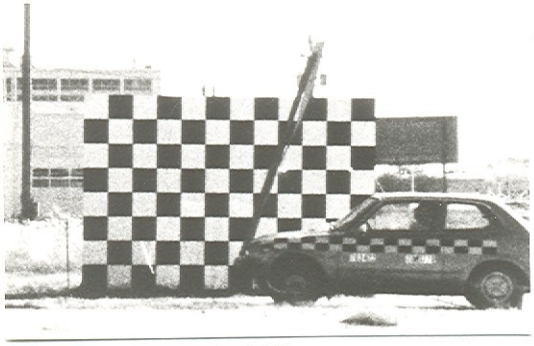


0.080 sec

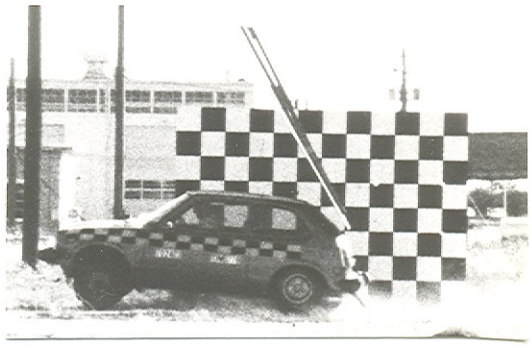


0.013 sec

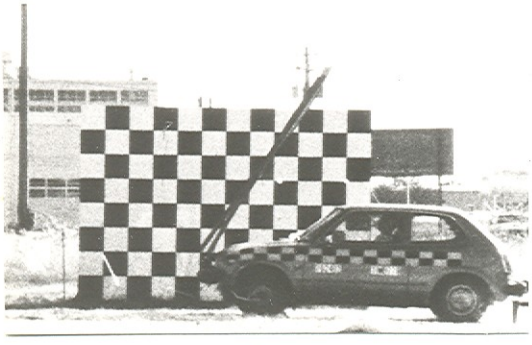
0.120 sec



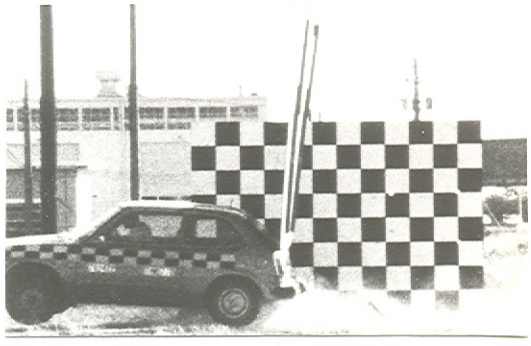
0.027 sec



0.160 sec



0.040 sec



0.200 sec

FIGURE A-89. SEQUENTIAL PHOTOGRAPHS FOR TEST 12.

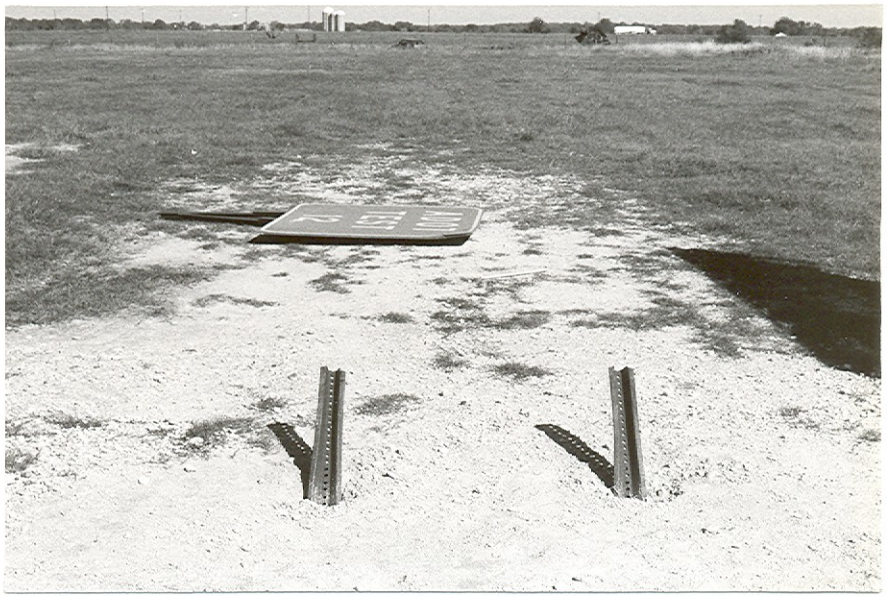
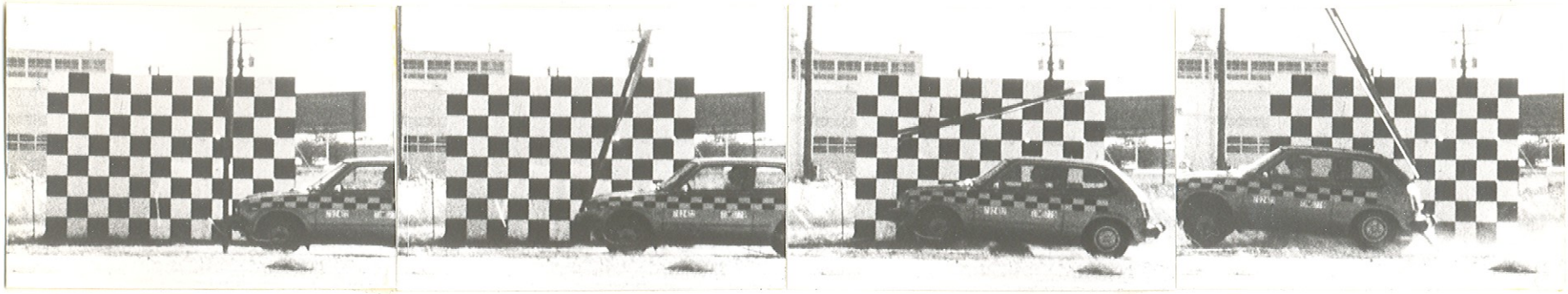
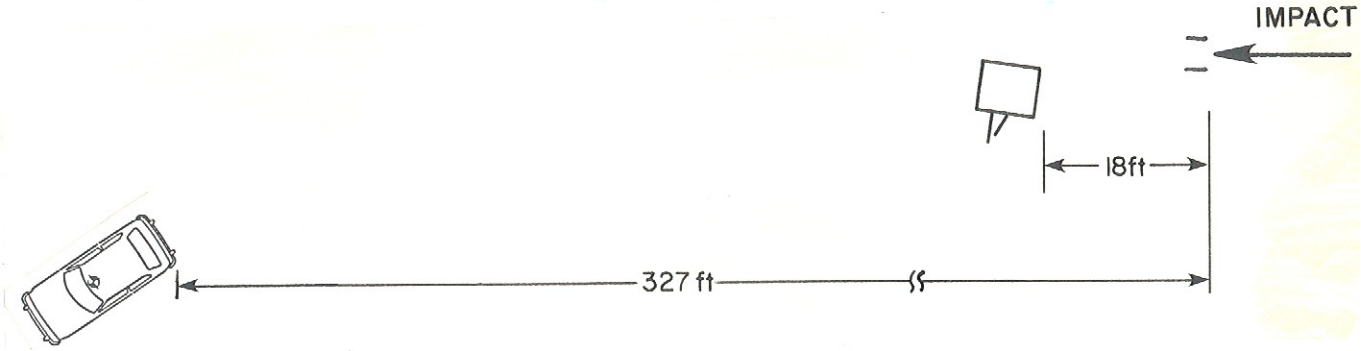


FIGURE A-90. SIGN INSTALLATION AFTER TEST 12.

FIGURE A-91. VEHICLE AFTER TEST 12.



0.000 sec 0.027 sec 0.080 sec 0.160 sec



Test No.	7024-12
Date	11/06/85
Test Article	Sign Installation
Support	Two posts of 4 lb High Carbon Billet Steel
Vehicle	1979 Honda Civic
Vehicle Weight	
Test Inertia	1770 lb (804 kg)
Gross Static	1940 lb (881 kg)
Vehicle Damage Classification	
TAD	12FD1
SAE	12FDEW1

Impact Speed	60.9 mph (98.0 kph)
Change in Velocity	7.3 mph (11.7 kph)
Change in Momentum	589 lb-sec
Occupant Impact Velocity	
Longitudinal	10.5 fps (3.2 m/s)
Lateral	None
Occupant Ridedown Accelerations	
Longitudinal	-0.5 g
Lateral	N/A
Maximum Vehicle Crush	
Bumper Height	0.0 in. (0.0 cm)

FIGURE A-92. SUMMARY OF RESULTS FOR TEST 12.

A-3-13. Test 13

A 1979 Honda Civic, pictured in Figure A-93, was directed into the sign installation at 61.3 mph. Test inertia mass of the test vehicle was 1,795 lb and its gross static mass was 1,961 lb. Impact point was 15 in. to the left of the vehicle centerline. Relative positions of the test vehicle and sign installation are shown in Figure A-94.

Approximately 0.015 sec after impact the lower section of the support began to fracture at bumper height. At 0.040 sec the support lost contact with the front of the vehicle and the sign panel and part of the support began rising upward. The sign panel then impacted the left side of the roof of the vehicle at 0.077 sec. The sign lost contact with the vehicle at 0.125 sec and subsequently came to rest 90 ft behind and 30 ft to the left of the impact point. The vehicle left the test area in a stable mode yawing counterclockwise at 15 deg/sec (8 deg at 0.550 sec). Post-test brake application caused the vehicle to yaw violently in clockwise rotation and subsequently rolled one revolution.

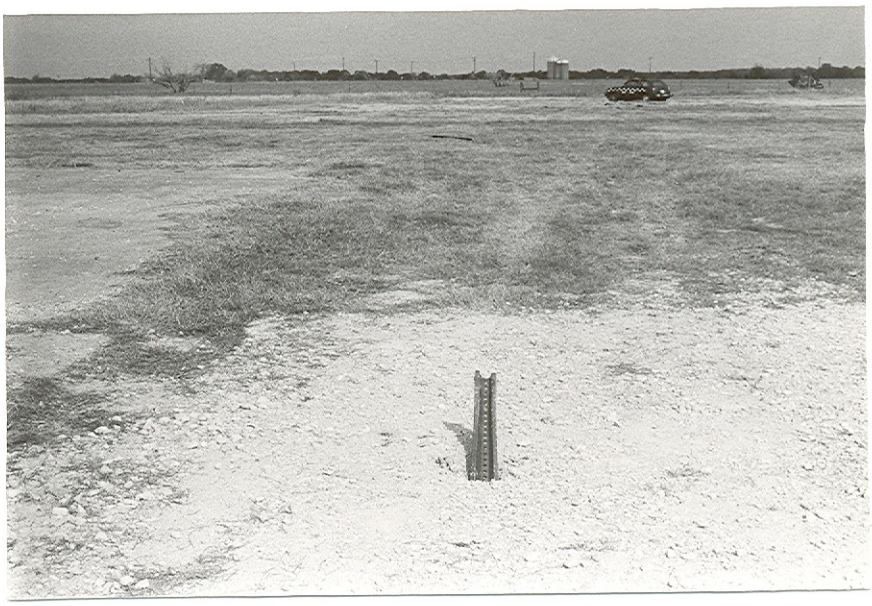
The lower section of the support was fractured 18 in. above the ground as shown in Figures A-95 and A-96. The vehicle received a maximum crush of 6.0 in. at bumper height and 2 in. at hood height. Photographs of the vehicle after the test are shown in Figure A-97 and sequentials of the test are presented in Figure A-98.

Test results are shown in Figure A-99. Change in the vehicle's velocity during the impulse period was 4.3 mph and change in momentum was 352 lb-sec. There was no occupant impact during the impulse period.

The vehicle remained upright and stable throughout the initial test period. Post-test roll was attributed to unsymmetrical brake application and subsequent tipping of the vehicle when the tires rutted the grassy sod.

FIGURE A-93. VEHICLE BEFORE TEST 13.

FIGURE A-94. RELATIVE POSITIONS OF SIGN INSTALLATION AND TEST VEHICLE FOR TEST 13.



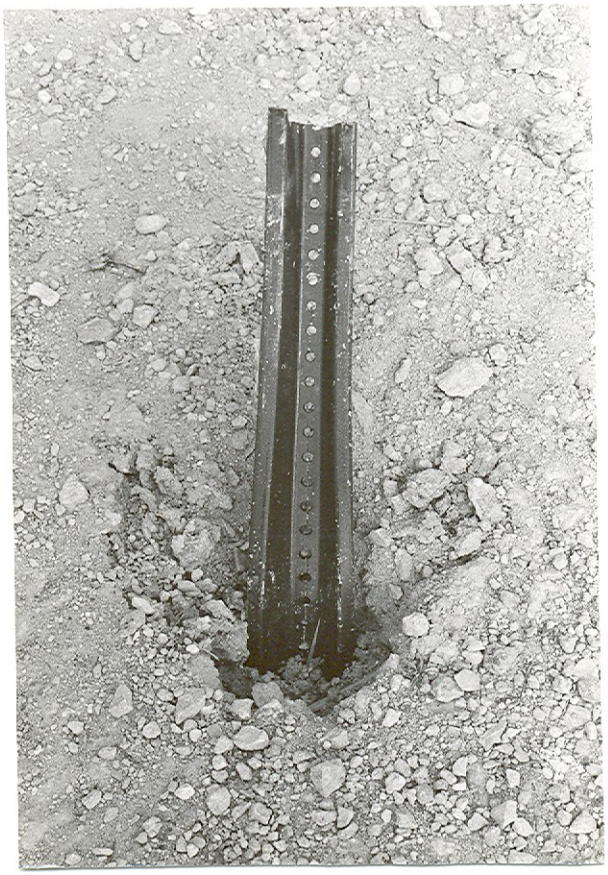


FIGURE A-95. TEST SITE AFTER TEST 13.

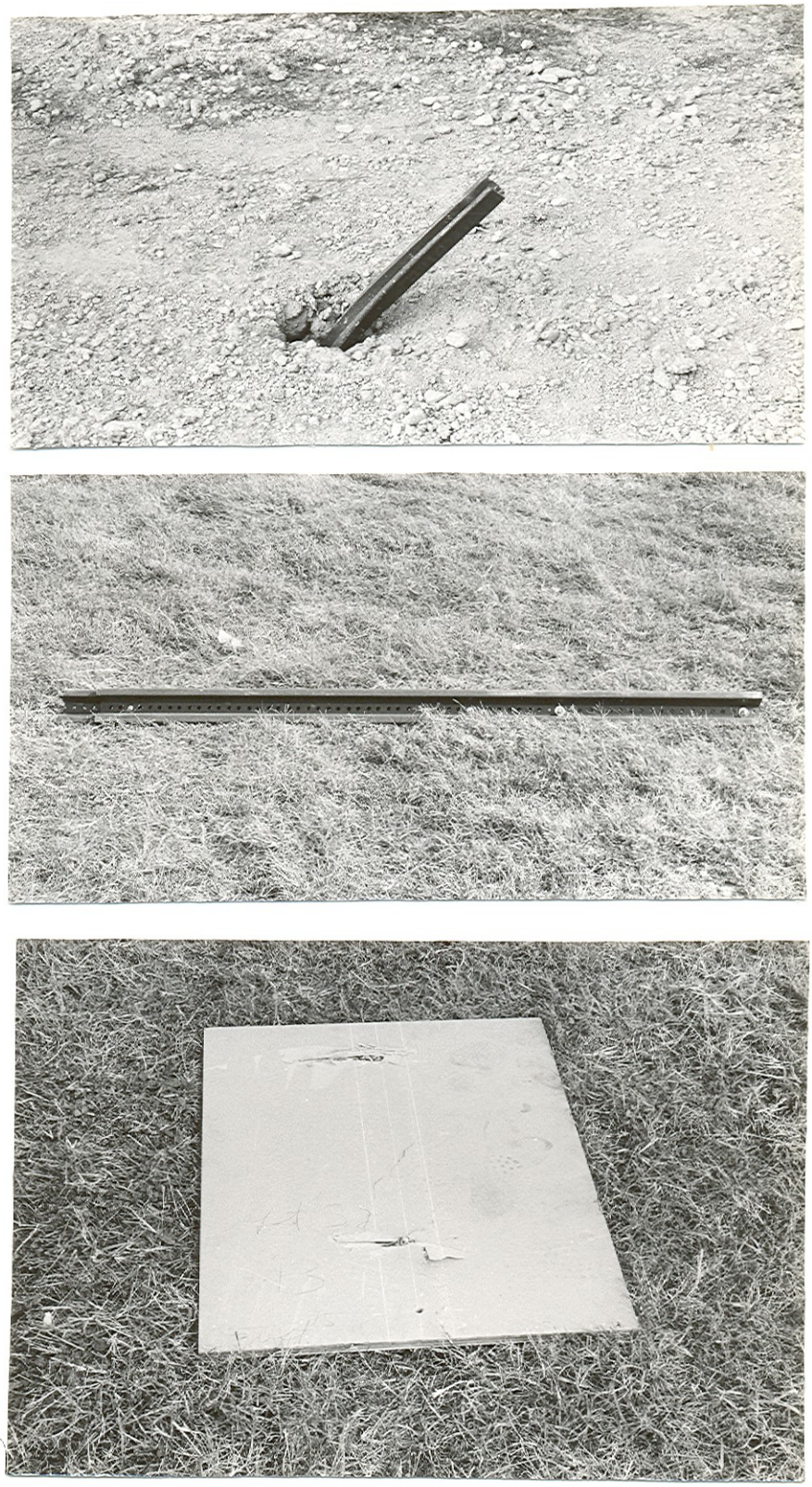
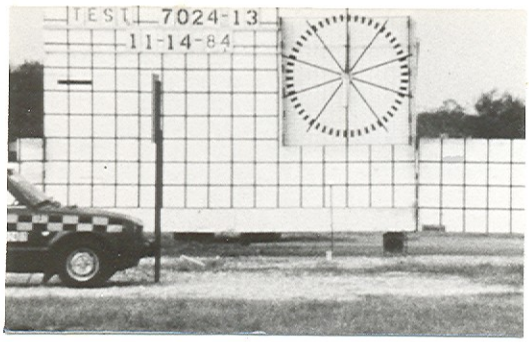


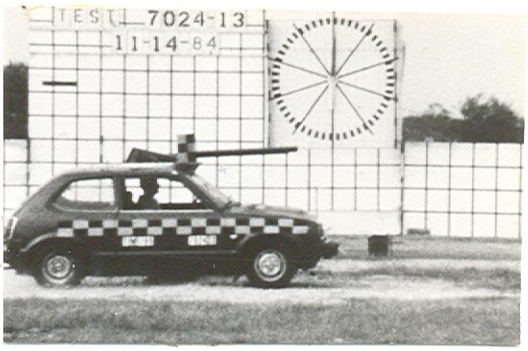
FIGURE A-96. SIGN INSTALLATION AFTER TEST 13.

Post-test roll attributed to
unsymmetrical brake application
and soil condition.

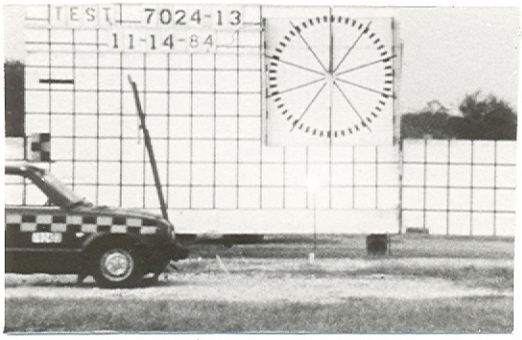
FIGURE A-97. TEST VEHICLE AFTER TEST 13.



0.000 sec

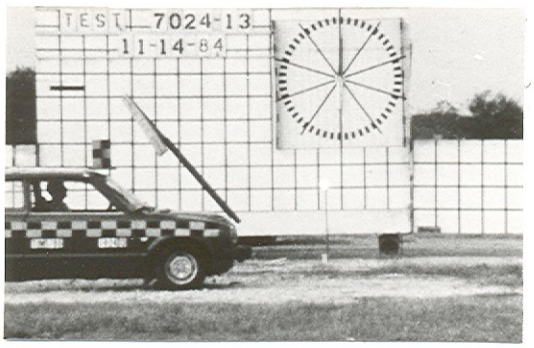


0.080 sec

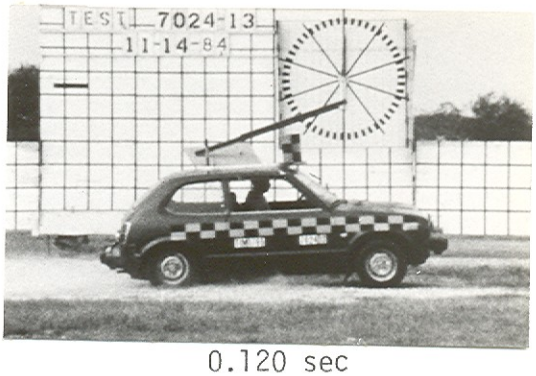


0.020 sec

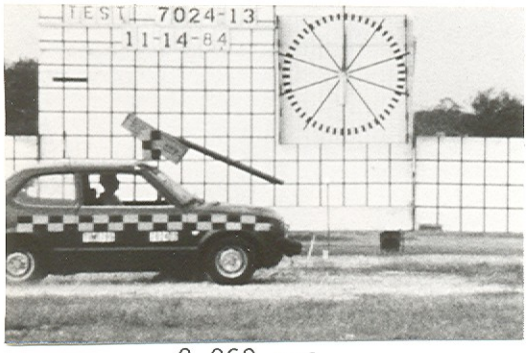
0.100 sec



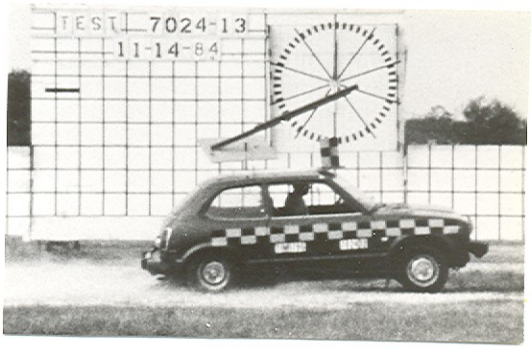
0.040 sec



0.120 sec

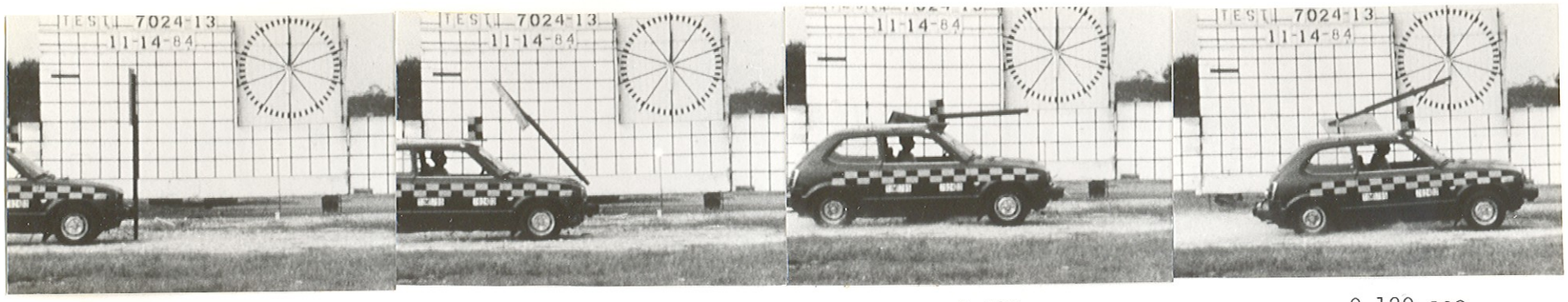


0.060 sec

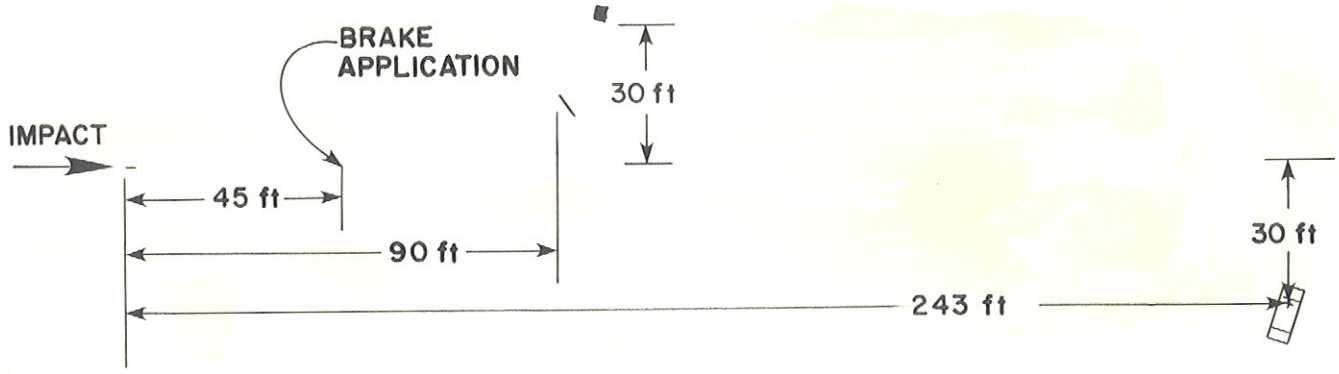


0.140 sec

FIGURE A-98. SEQUENTIAL PHOTOGRAPHS FOR TEST 13.



0.000 sec 0.040 sec 0.080 sec 0.120 sec



Test No.	7024-13
Date	11/14/84
Test Article	Single-leg Sign Support of 4 lb H.C. Billet Steel U-Channel
Vehicle	1979 Honda Civic
Vehicle Weight	
Test Inertia	1,795 lb (815 kg)
Gross Static	1,961 lb (890 kg)
Vehicle Damage Classification	
TAD	12FL2
SAE	12FLEE1

Impact Speed	61.3 mph (98.6 kph)
Change in Velocity	4.3 mph (6.9 kph)
Change in Momentum	352 lb-sec
Occupant Impact Velocity	
Longitudinal	No Contact
Lateral	No Contact
Occupant Ridedown Accelerations	
Longitudinal	N/A
Lateral	N/A
Vehicle Crush	
Bumper Height	6.0 in. (15.2 cm)
Hood Height	2.0 in. (5.1 cm)

FIGURE A-99. SUMMARY OF RESULTS FOR TEST 13.

A-3-14. Test 14

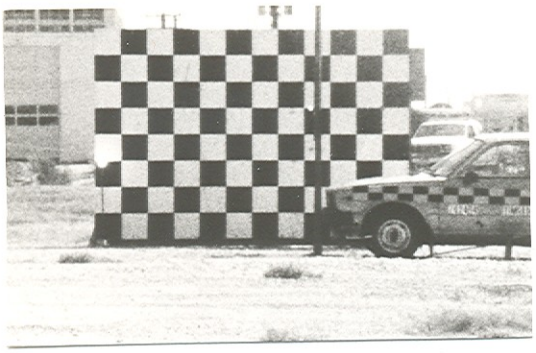
The 1980 Honda Civic, shown in Figure A-100, was directed into the sign at 20.3 mph. The test inertia mass of the vehicle was 1,800 lb and its gross static mass was 1,970 lb. Impact point was such that the vehicle bumper contacted all three supports of the sign installation. Relative positions of the vehicle and sign installation are shown in Figure A-100.

Approximately 0.123 sec after impact the vehicle began to ride up on the supports, and at 0.128 sec the dummy hit the windshield. The vehicle lost contact with the sign installation at 0.212 sec and began to rebound. Sequential photographs of the test are shown in Figure A-101.

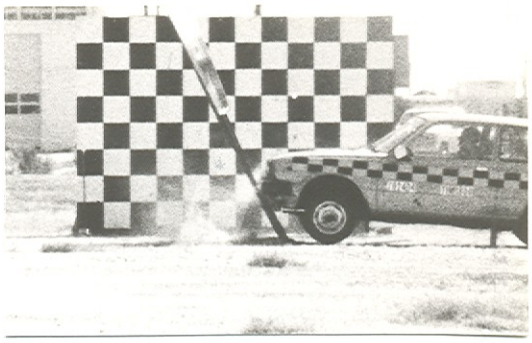
The sign installation was pushed back about 6.5 in. and was scratched and bent about 16 in. above the ground as shown in Figure A-102. As shown in Figure A-103, the vehicle sustained minor scrapes to the bumper with a maximum 1.5 in. crush at bumper height. Also the windshield was cracked.

The results of the test are summarized in Figure A-104. Change in the vehicle's velocity was 18.8 mph and change in momentum was 1,541 lb-sec. Longitudinal occupant impact velocity was 26.9 fps and the maximum 0.010-second average occupant ridedown acceleration was -1.6 g.

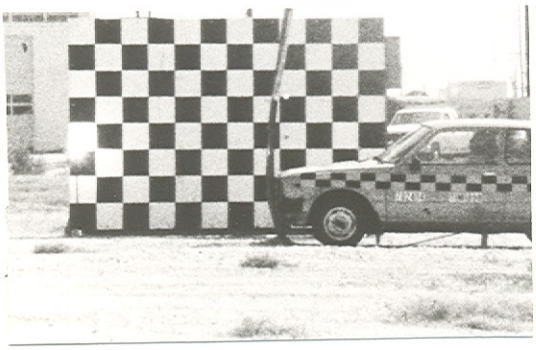
FIGURE A-100. VEHICLE BEFORE TEST 14.



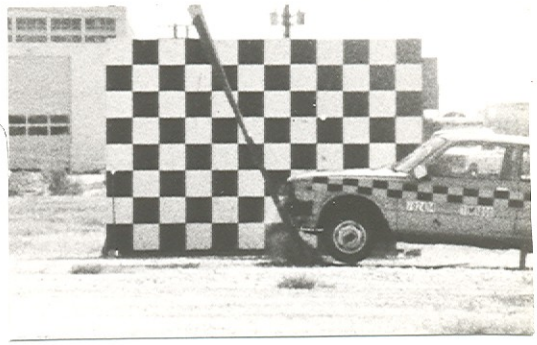
0.000 sec



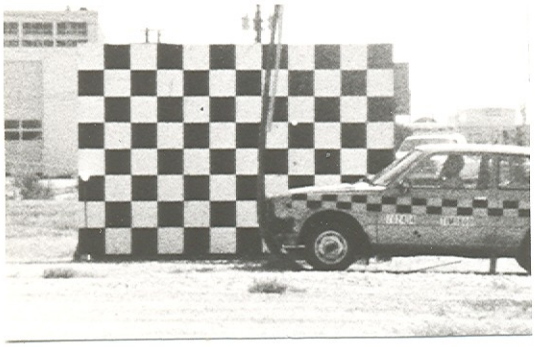
0.166 sec



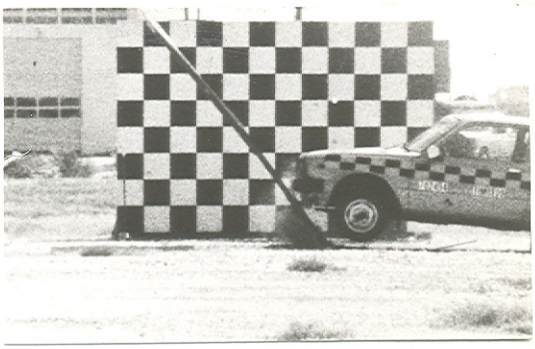
0.040 sec



0.211 sec



0.081 sec



0.335 sec

0.121 sec

0.461 sec

FIGURE A-101. SEQUENTIAL PHOTOGRAPHS FOR TEST 14.

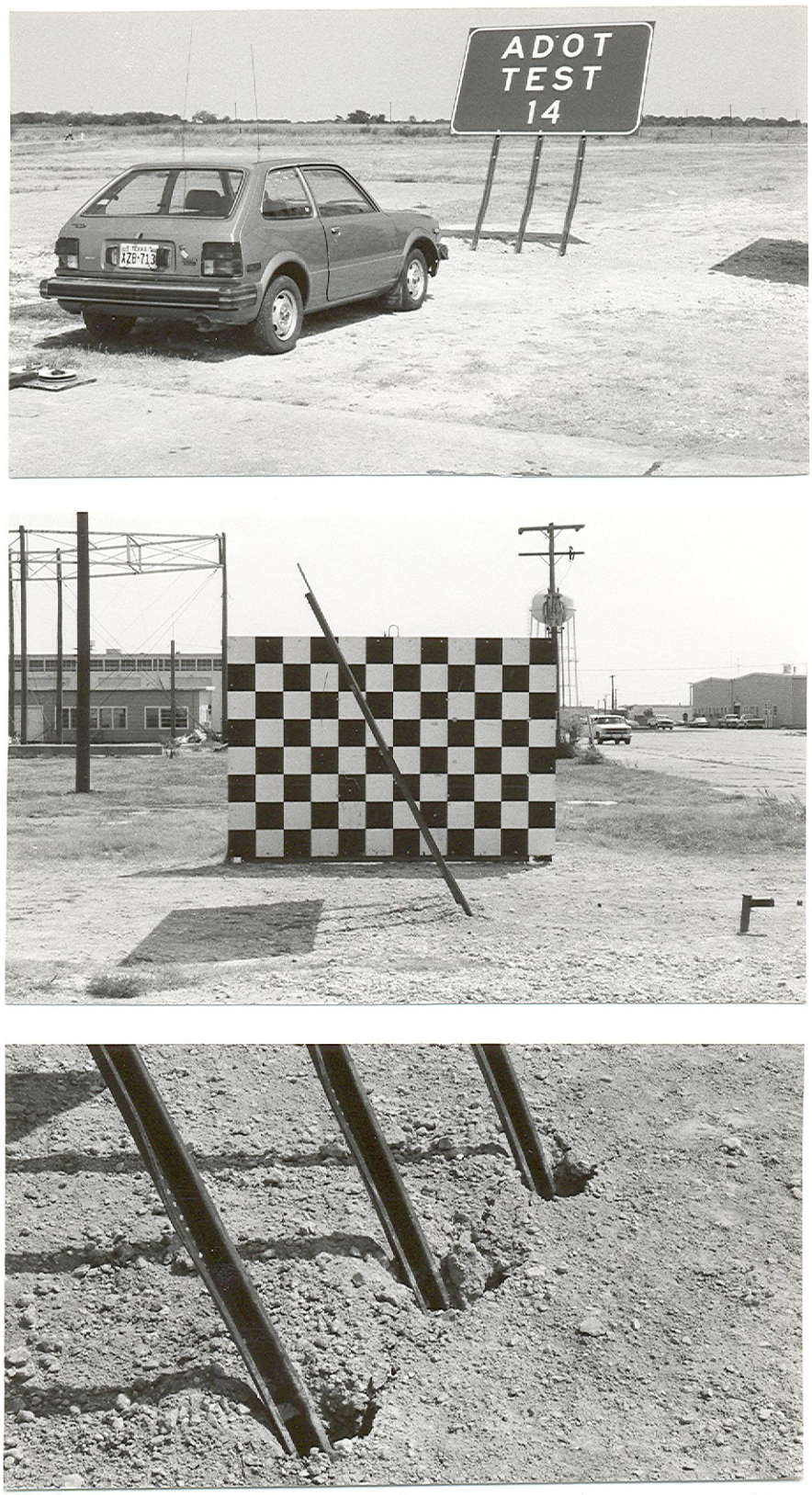


FIGURE A-102. TEST INSTALLATION AFTER TEST 14.

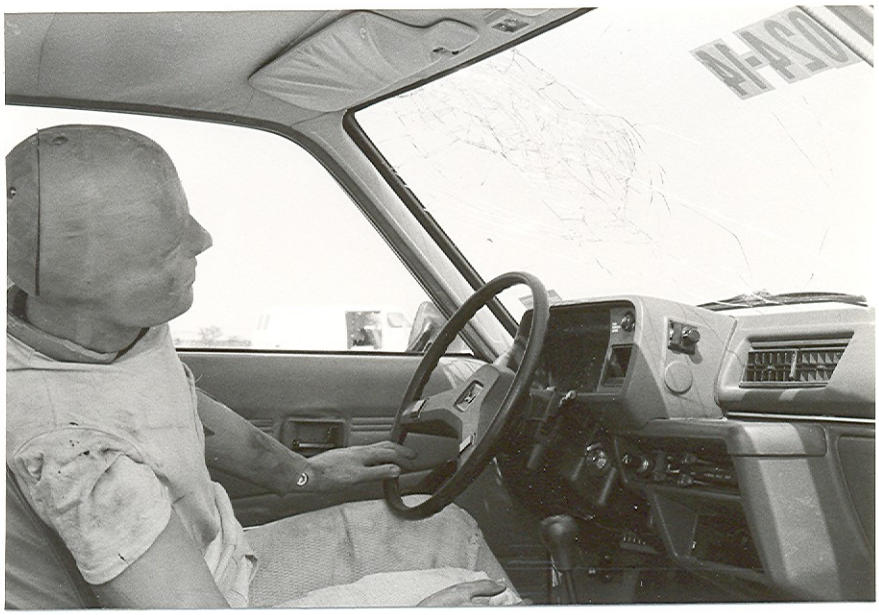
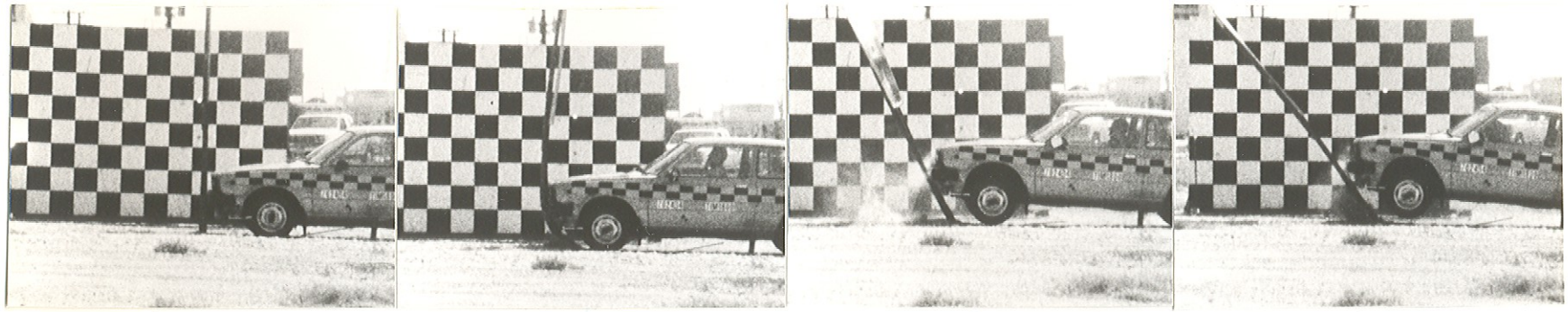
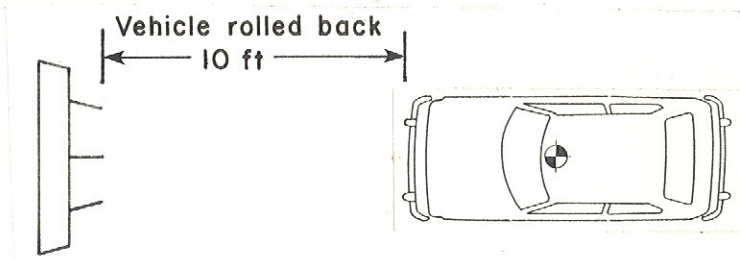


FIGURE A-103. VEHICLE AFTER TEST 14.



0.000 sec 0.081 sec 0.166 sec 0.335 sec



Test No.	7024-14	Impact Speed.	20.3 mph (32.7 kph)
Date	9/03/85	Change in Velocity.	18.8 mph (30.2 kph)
Test Article	Sign installation	Change in Momentum.	1,541 lb-sec
Support.	Three 3 lb Rail Steel Channel Supports	Occupant Impact Velocity	
		Longitudinal.	26.9 ft/s (8.2 m/s)
		Lateral	None
Vehicle.	1980 Honda Civic	Occupant Ridedown Accelerations	
Vehicle Weight		Longitudinal.	-1.6 g
Test Inertia	1,800 lb (817 kg)	Lateral	N/A
Gross Static	1,970 lb (894 kg)	Maximum Vehicle Crush	
Vehicle Damage Classification		Bumper Height	1.5 in. (3.8 cm)
TAD.	12FD1		
SAE.	12FDLW1		

FIGURE A-104. SUMMARY OF RESULTS FOR TEST 14.

A-3-15. Test 15

A 1980 Honda Civic, shown in Figure A-105, was directed into the sign at 62.0 mph. Test inertia mass of the vehicle was 1,800 lb and its gross static mass was 1,970 lb. Impact point was such that the vehicle bumper contacted all three supports of the installation. Relative positions of the test vehicle and sign installation are shown in Figure A-105.

Approximately 0.008 sec after impact the supports began to bend. At 0.060 sec the lower section of the left and right supports began to fracture. Shortly thereafter the dummy hit the windshield and the sign panel which had separated from the supports hit the hood and windshield. The sign panel rode with the vehicle which traveled 105 ft directly behind the impact point.

The lower sections of the left and right supports fractured 54 in. above the ground. The center support was pulled completely out of the ground. Damage to the sign supports is shown in Figure A-106.

The front of the vehicle was deformed as shown in Figure A-107. The right front quarter received 10.0 in. crush at bumper height. The center was crushed 3.0 in. at bumper height and 1.0 in. on the left side. The windshield was also broken. Sequential photographs of the test are shown in Figure A-108.

Test results are given in Figure A-109. Change in the vehicle's velocity at 0.350 seconds was 23.5 mph and change in momentum was 1,927 lb-sec. Longitudinal occupant impact velocity was 31.2 fps and the maximum 0.010-second average ridedown acceleration was 4.6 g.

FIGURE A-105. VEHICLE BEFORE TEST 15.

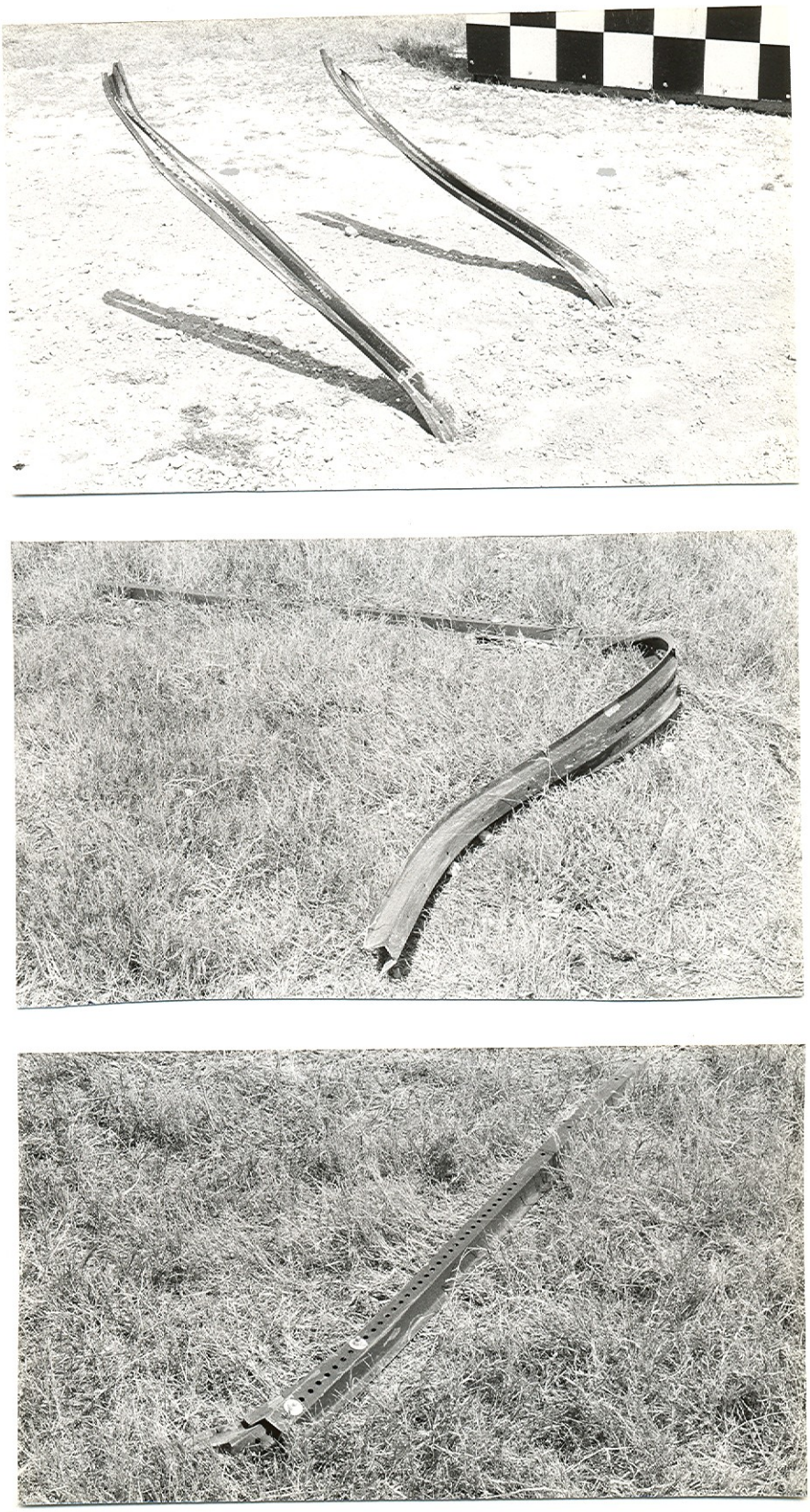
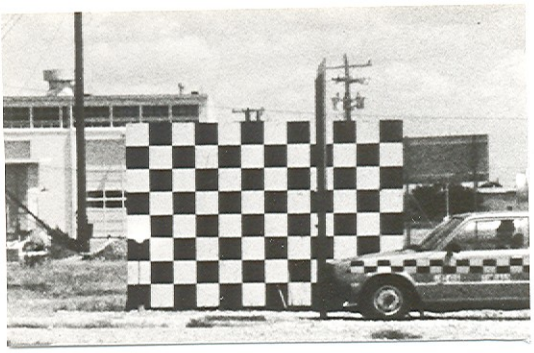


FIGURE A-106. TEST INSTALLATION AFTER TEST 15.

FIGURE A-107. VEHICLE AFTER TEST 15.



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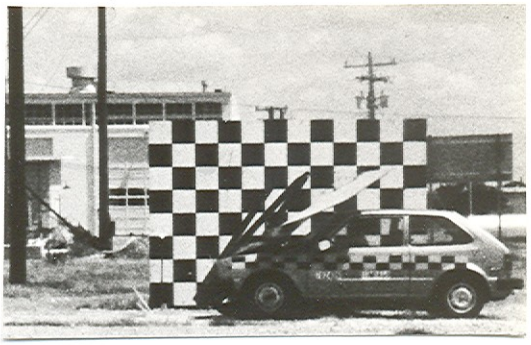
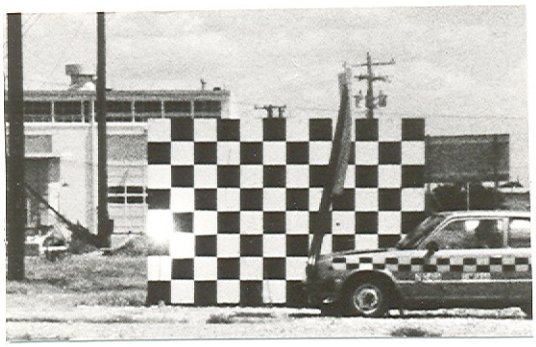


0.073 sec



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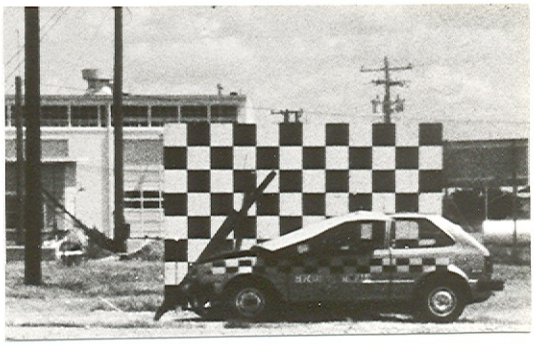
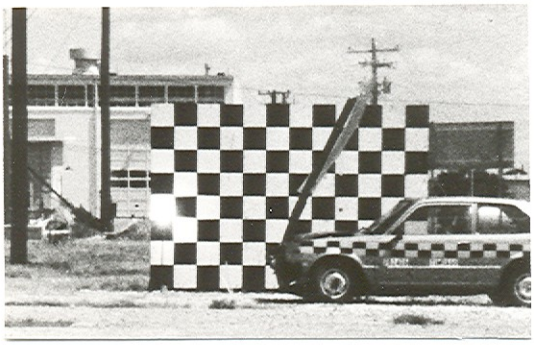
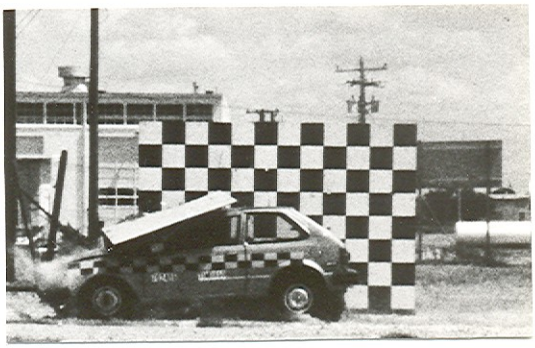


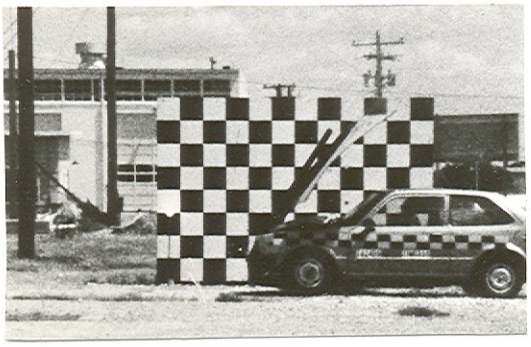
0.093 sec



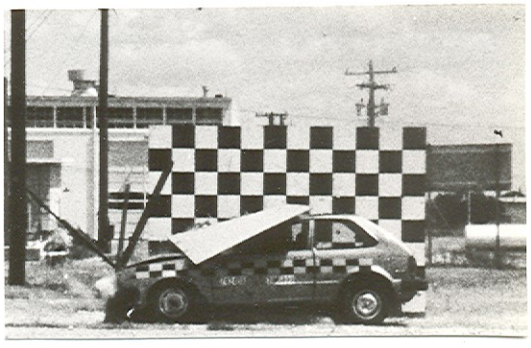
0.035 sec



0.131 sec

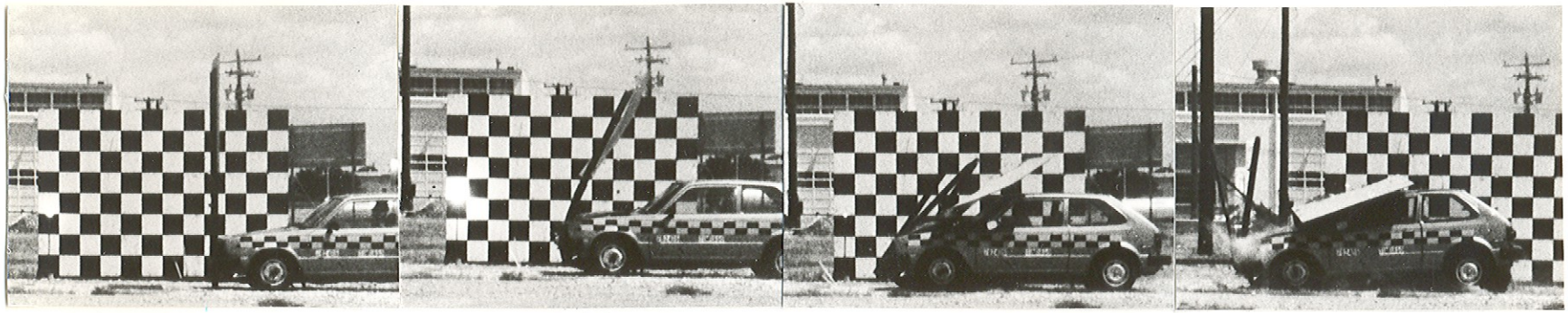


0.053 sec

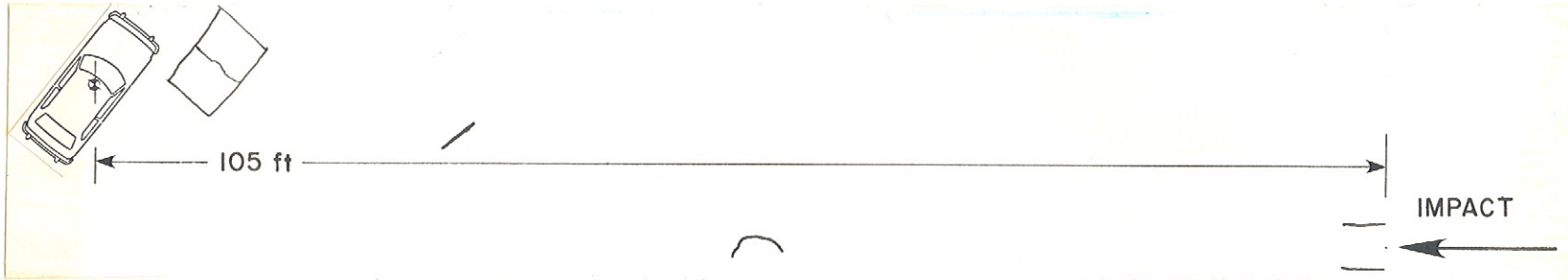


0.169 sec

FIGURE A-108. SEQUENTIAL PHOTOGRAPHS FOR TEST 15.



0.000 sec 0.035 sec 0.073 sec 0.131 sec



Test No.	7024-15
Date	9/9/85
Test Article	Sign Installation
Support	Three 3 lb Rail Steel Channel Supports
Vehicle	1980 Honda Civic
Vehicle Weight	
Test Inertia	1,800 lb (817 kg)
Gross Static	1,970 lb (894 kg)
Vehicle Damage Classification	
TAD	12FD3
SAE	12FDAW7

Impact Speed	62.0 mph (99.8 kph)
Change in Velocity	23.5 mph (37.8 kph)
Change in Momentum	1,927 lb-sec
Occupant Impact Velocity	
Longitudinal	31.2 fps (9.5 m/s)
Lateral	No Contact
Occupant Ridedown Accelerations	
Longitudinal	4.6 g
Lateral	N/A
Maximum Vehicle Crush	
Bumper Height	10.0 in. (25.4 cm)

FIGURE A-109. SUMMARY OF RESULTS FOR TEST 15.

A-3-16. Test 16

The 1979 Honda Civic, shown in Figure A-110, was directed into the sign at 20.0 mph. The test inertia mass of the vehicle was 1,772 lb and its gross static mass was 1,955 lb. Impact point was such that the vehicle bumper contacted all three supports of the sign installation. Relative positions of the vehicle and sign installation are shown in Figure A-110.

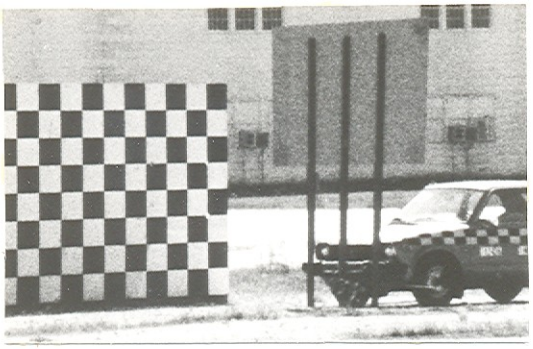
Approximately 0.035 sec after impact the lower section of the right support fractured at bumper height and at 0.169 sec the dummy hit the visor. The vehicle lost contact with the sign installation at 0.538 sec. Sequential photographs of the test are shown in Figure A-111.

The sign installation was pushed to the ground as shown in Figure A-112. The lower section of the right support was split longitudinally and was fractured 19 in. above the ground. The lower sections of the center and left supports were split longitudinally.

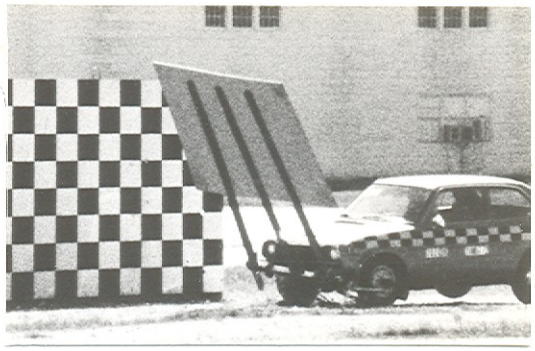
The vehicle received minor damage as shown in Figure A-113. There was a maximum vehicle crush of 4 in. at bumper height.

The results of the test are summarized in Figure A-114. Change in the vehicle's velocity was 19.0 mph and change in momentum was 1,534 lb-sec. Longitudinal occupant impact velocity was 22.4 fps and the maximum 0.010-second average occupant ridedown acceleration was -3.6 g.

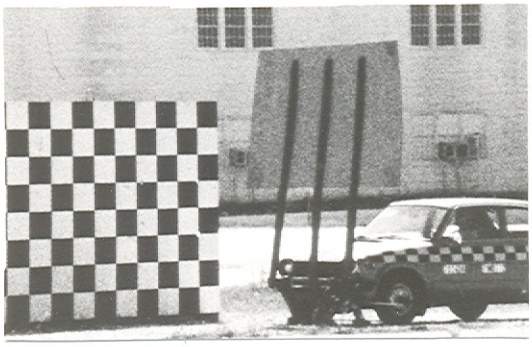
FIGURE A-110. VEHICLE BEFORE TEST 16.



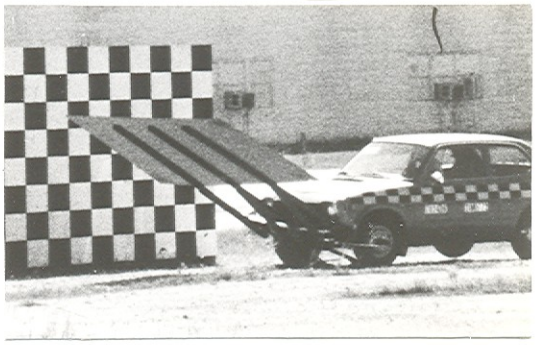
0.000 sec



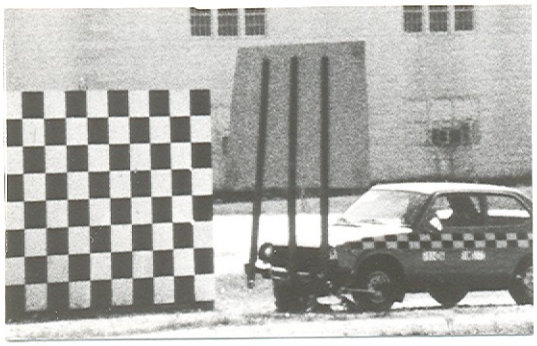
0.251 sec



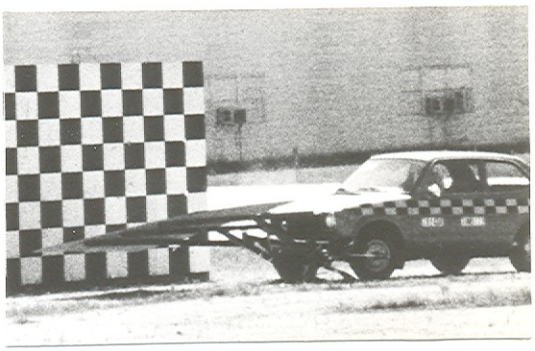
0.063 sec



0.347 sec

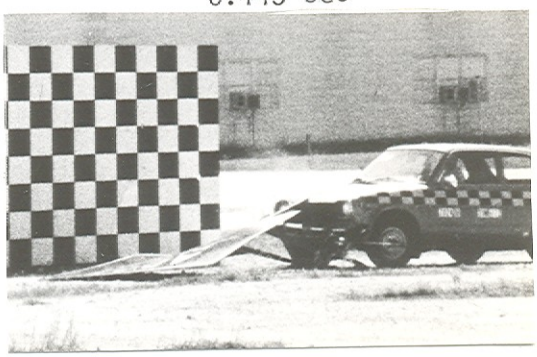


0.126 sec



0.443 sec

0.189 sec



0.538 sec

FIGURE A-111. SEQUENTIAL PHOTOGRAPHS FOR TEST 16.

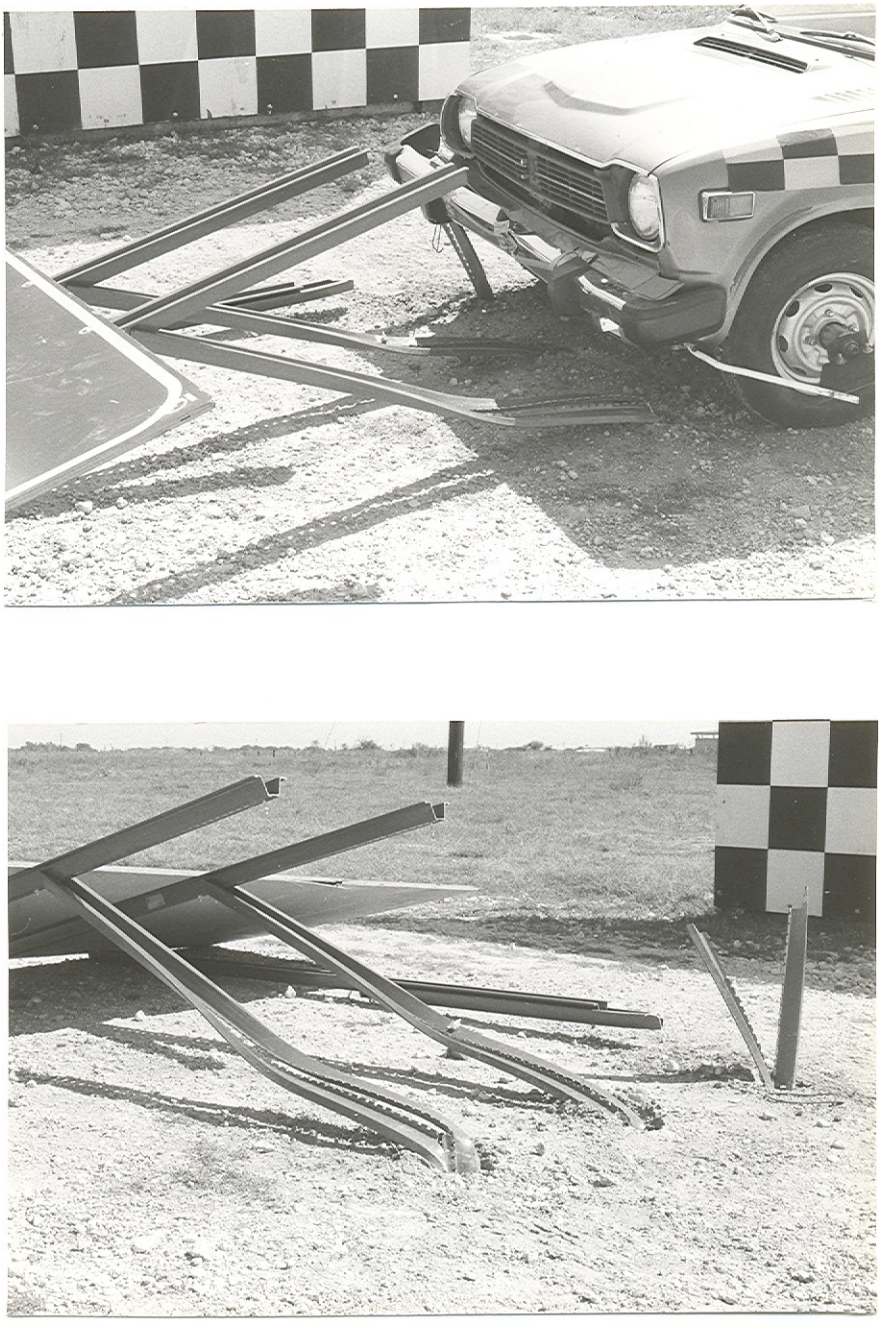
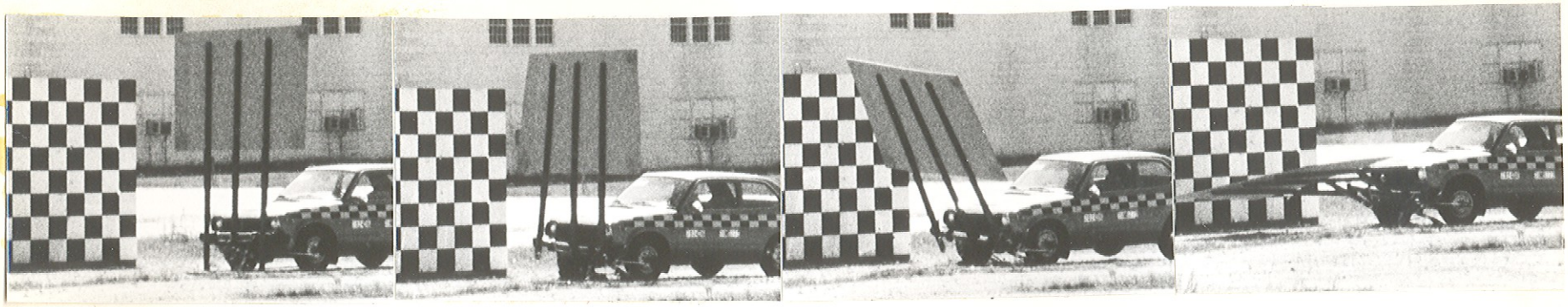
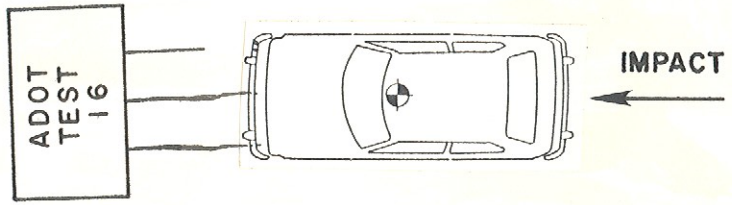


FIGURE A-112. TEST INSTALLATION AFTER TEST 16.

FIGURE A-113. VEHICLE AFTER TEST 16.



0.000 sec 0.126 sec 0.251 sec 0.443 sec



Test No.	7024-16
Date	9/24/85
Test Article	Sign installation
Support	Three 3 lb High Carbon Billet Steel Supports
Vehicle	1979 Honda Civic
Vehicle Weight	
Test Inertia	1,772 lb (804 kg)
Gross Static	1,955 lb (888 kg)
Vehicle Damage Classification	
TAD	12FD1
SAE	12FDLW1

Impact Speed	20.0 mph (32.2 kph)
Change in Velocity	19.0 mph (30.6 kph)
Change in Momentum	1,534 lb-sec
Occupant Impact Velocity	
Longitudinal	22.4 fps (6.8 m/s)
Lateral	None
Occupant Ridedown Accelerations	
Longitudinal	-3.6 g
Lateral	N/A
Maximum Vehicle Crush	
Bumper Height	4.0 in. (10.2 cm)

FIGURE A-114. SUMMARY OF RESULTS FOR TEST 16.

A-3-17. Test 17

A 1979 Honda Civic, shown in Figure A-115, was directed into the sign at 62.0 mph. Test inertia mass of the vehicle was 1,800 lb and its gross static mass was 1,965 lb. Impact point was such that the vehicle bumper contacted all three supports of the installation. Relative positions of the test vehicle and sign installation are shown in Figure A-115.

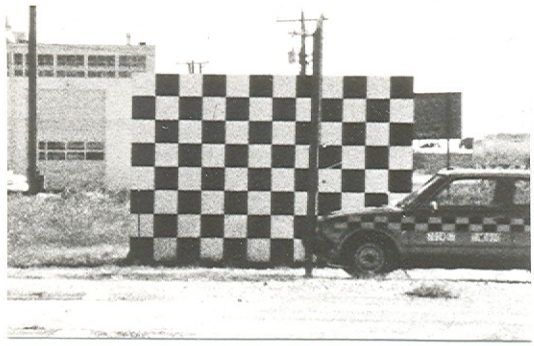
Approximately 0.021 sec after impact, the lower section of the center and right supports began to fracture. Shortly thereafter the sign panel which had separated from the left support hit the roof. The left support pulled out of the ground and rode with the vehicle which traveled 207 ft directly behind the impact point. Sequential photographs of the test are presented in Figure A-116.

The lower section of the center support fractured at 17 in. and the right support fractured 33 in. above the ground. The left support was pulled completely out of the ground. Damage to the sign supports is shown in Figure A-117.

The front of the vehicle was deformed as shown in Figure A-118. The right front quarter received 5.0 in. crush at bumper height. The center was crushed 5.5 in. at bumper height, and 10.0 in. on the left side.

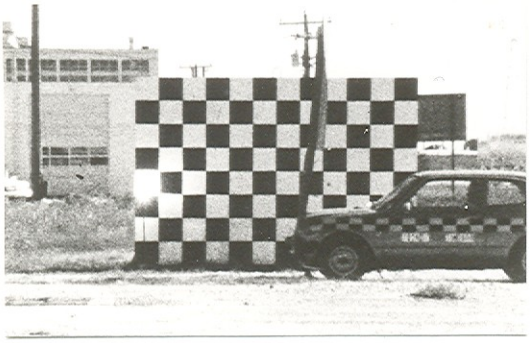
Test results are shown in Figure A-119. Change in the vehicle's velocity was 12.9 mph and change in momentum was 1,058 lb-sec. Longitudinal occupant impact velocity was 12.8 fps and the maximum 0.010-second average ridedown acceleration was -2.0 g.

FIGURE A-115. VEHICLE BEFORE TEST 17.



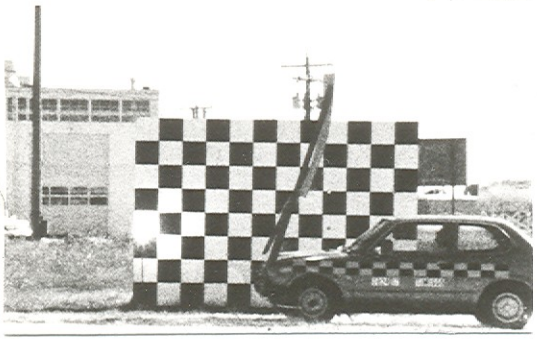
0.000 sec

0.078 sec

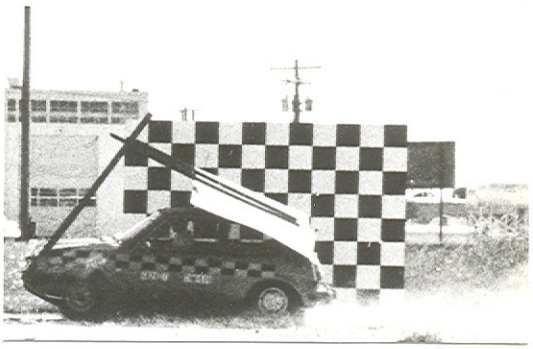


0.013 sec

0.117 sec



0.026 sec



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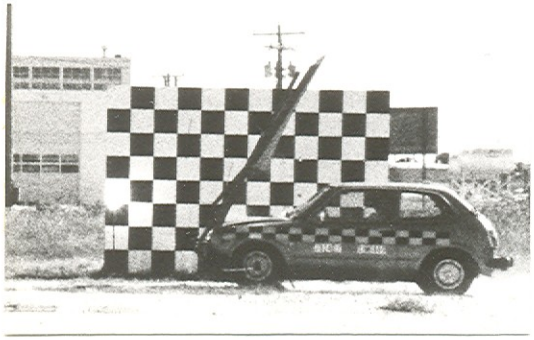
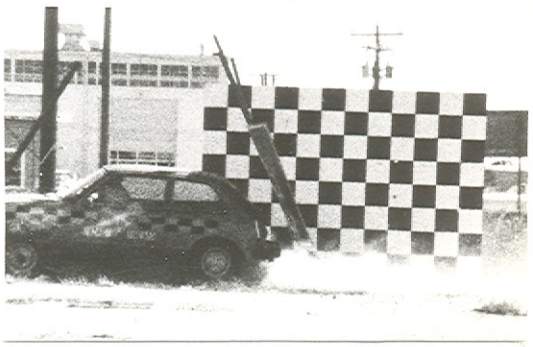


0.039 sec



0.196 sec

FIGURE A-116. SEQUENTIAL PHOTOGRAPHS FOR TEST 17.

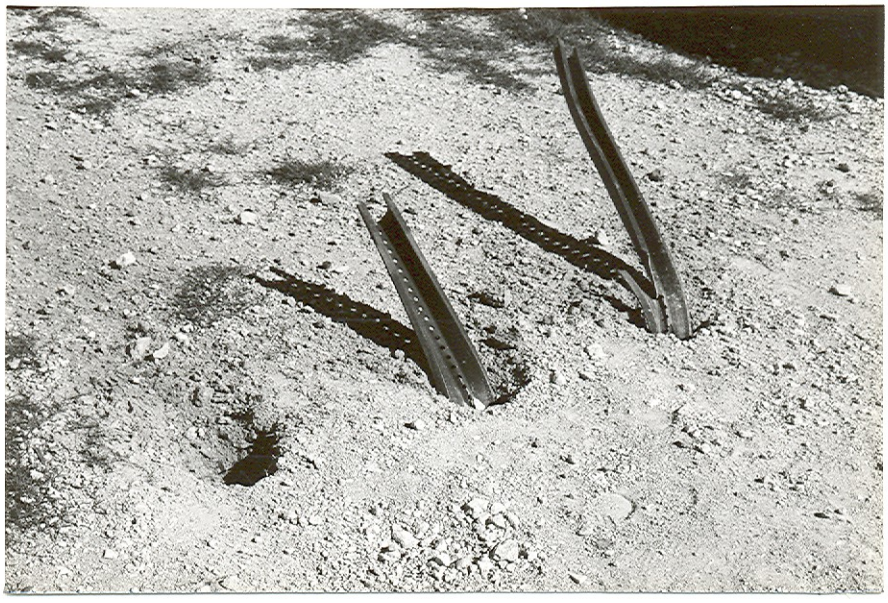
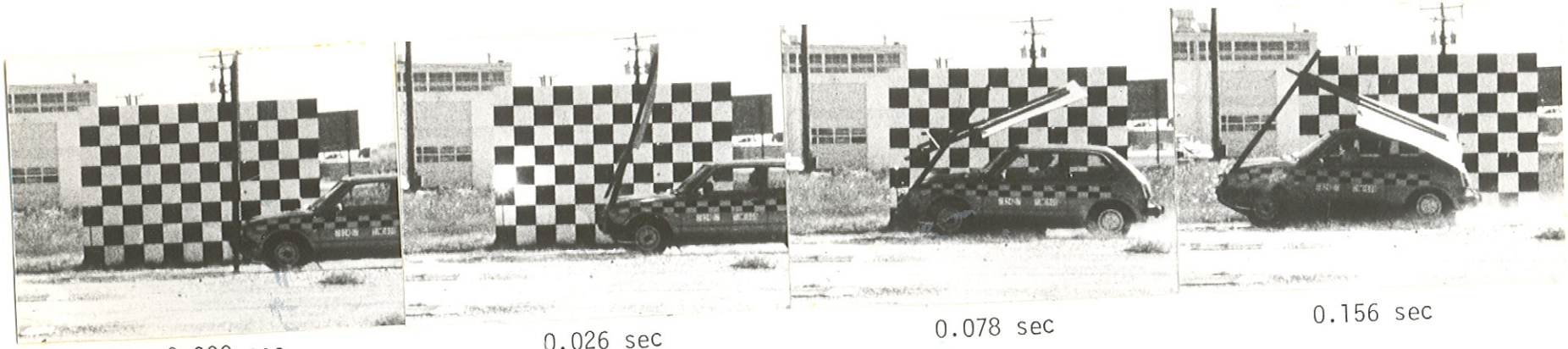
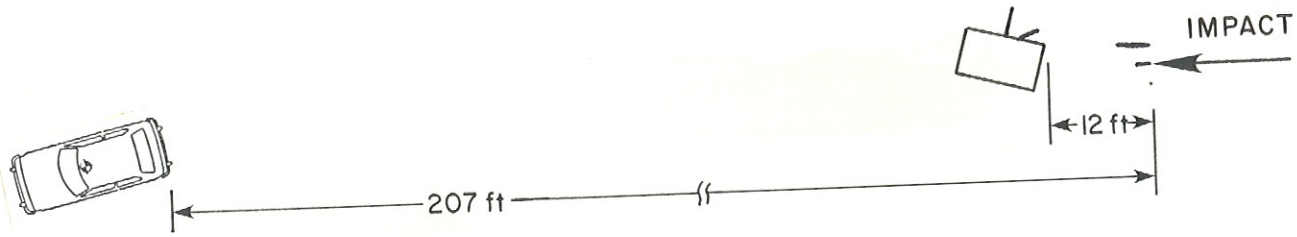
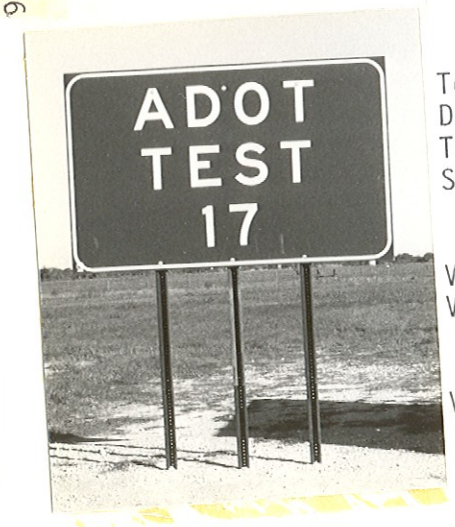


FIGURE A-117. SIGN INSTALLATION AFTER TEST 17.

FIGURE A-118. VEHICLE AFTER TEST 17.







Test No.	7024-17
Date	11/07/85
Test Article	Sign Installation
Support	Three posts of 3 lb High Carbon Billet Steel
Vehicle	1979 Honda Civic
Vehicle Weight	
Test Inertia	1,800 lb (817 kg)
Gross Static	1,965 lb (892 kg)
Vehicle Damage Classification	
TAD	12FD1
SAE	12FDEW1

Impact Speed	62.0 mph (99.8 kph)
Change in Velocity	12.9 mph (20.8 kph)
Change in Momentum	1,058 lb-sec
Occupant Impact Velocity	
Longitudinal	12.8 fps (3.9 m/s)
Lateral	None
Occupant Ridedown Accelerations	
Longitudinal	-2.0 g
Lateral	N/A
Maximum Vehicle Crush	
Bumper Height	10.0 in. (25.4 cm)

FIGURE A-119. SUMMARY OF RESULTS FOR TEST 17.

A-3-18. Test 18

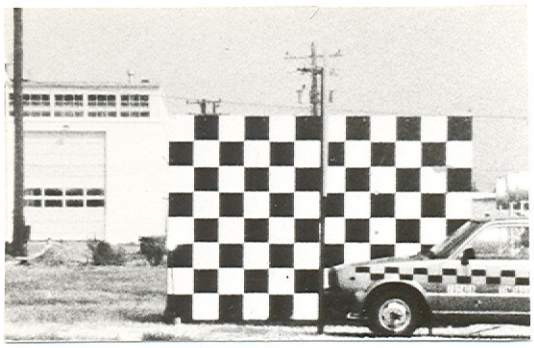
A 1980 Honda Civic, shown in Figure A-120, was directed into the sign at 19.5 mph. The test inertia mass of the vehicle was 1,800 lb and its gross static mass was 1,970 lb. Impact was such that the vehicle bumper contacted all three supports of the installation.

Approximately 0.008 sec after impact the supports began to bend. The dummy hit the windshield at 0.123 sec and at 0.217 sec the left support fractured. The vehicle lost contact with the sign installation at 0.262 sec but snagged on the lower section of the broken support as it rolled back. Sequential photographs of the test are shown in Figure A-121.

The left support was fractured 19.5 in. above the ground as shown in Figure A-122. The center and right supports were split longitudinally but did not fracture. As shown in Figure A-123, the vehicle sustained minor scrapes to the bumper and a broken windshield.

The results of the test are summarized in Figure A-124. Change in the vehicle's velocity was 17.0 mph and change in momentum was 1,394 lb-sec. Longitudinal occupant impact velocity was 22.5 fps and the maximum 0.010-second average ridedown acceleration was -1.3 g.

FIGURE A-120. VEHICLE BEFORE TEST 18.



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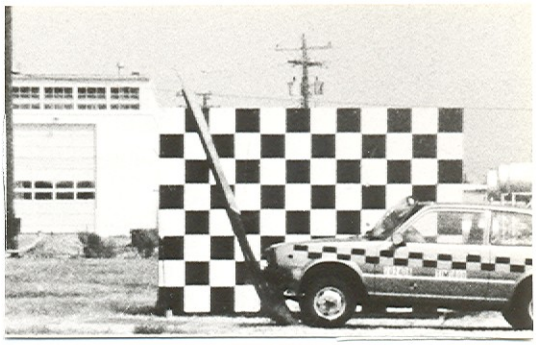
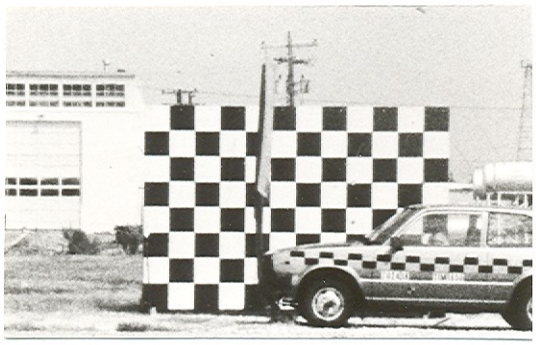
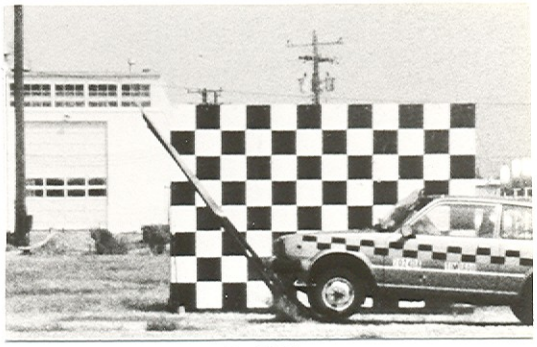


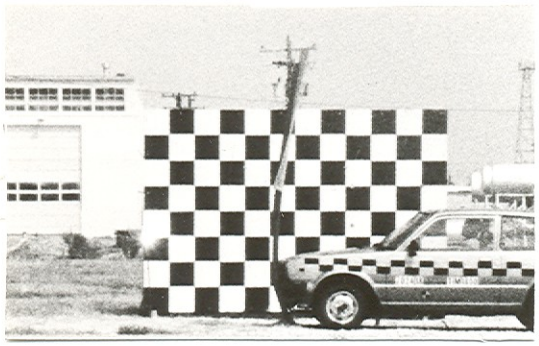
0.171 sec



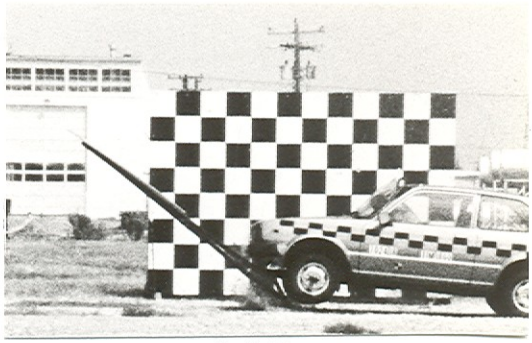
0.043 sec



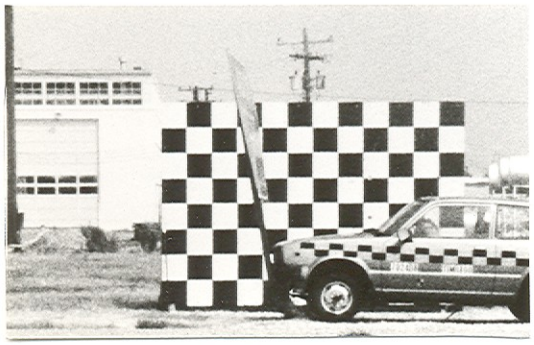
0.217 sec



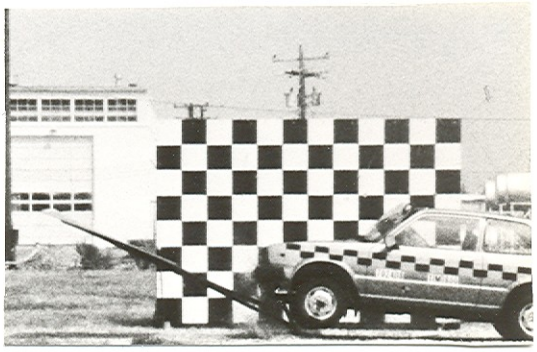
0.086 sec



0.262 sec



0.129 sec



0.313 sec

FIGURE A-121. SEQUENTIAL PHOTOGRAPHS FOR TEST 18.

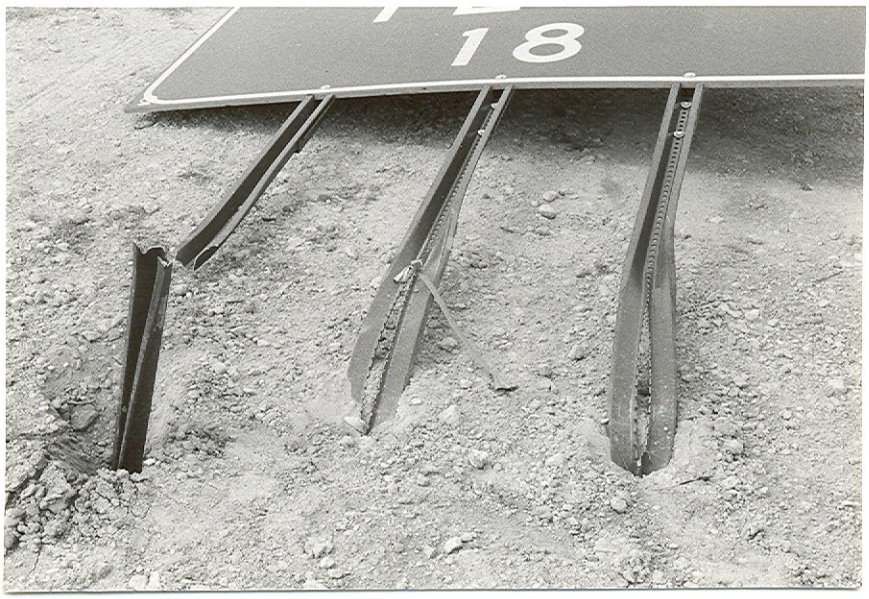
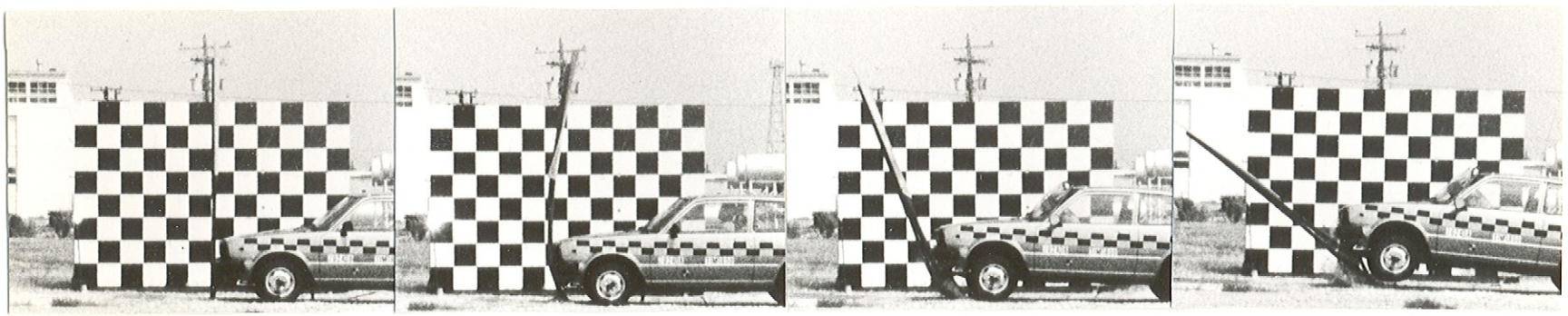
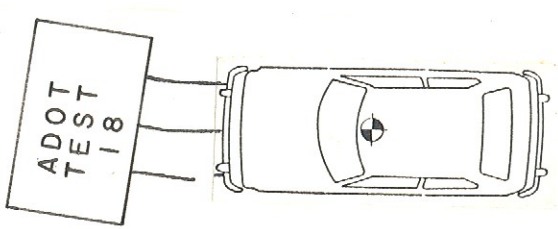


FIGURE A-122. TEST INSTALLATION AFTER TEST 18.

FIGURE A-123. VEHICLE AFTER TEST 18.



0.000 sec 0.086 sec 0.171 sec 0.262 sec



Test No.	7024-18
Date	9/03/85
Test Article	Sign installation
Support	Three 3 lb H.C Billet Steel Supports
Vehicle	1980 Honda Civic
Vehicle Weight	
Test Inertia	1,800 lb (817 kg)
Gross Static	1,970 lb (894 kg)
Vehicle Damage Classification	
TAD	12FD1
SAE	12FDAW6
Impact Speed	19.5 mph (31.4 kph)
Change in Velocity	17.0 mph (27.4 kph)
Change in Momentum	1,394 lb-sec
Occupant Impact Velocity	
Longitudinal	22.5 fps (6.9 m/s)
Lateral	None
Occupant Ridedown Accelerations	
Longitudinal	-1.3 g
Lateral	N/A
Maximum Vehicle Crush	
Bumper Height	1.5 in. (3.8 cm)

FIGURE A-124. SUMMARY OF RESULTS FOR TEST 18.

A-3-19. Test 19

A 1979 Honda Civic, shown in Figure A-125, was directed into the sign at 18.9 mph. The test inertia mass of the vehicle was 1,808 lb and its gross static mass was 1,980 lb. Impact was such that the vehicle bumper contacted both supports.

At approximately 0.015 sec after impact the left support of the installation began to bend. Shortly thereafter the right support began to bend and at 0.045 sec the left support fractured. At 0.171 sec the dummy hit and cracked the windshield. The vehicle continued to roll forward and subsequently came to rest over the sign as shown in Figure A-126. Sequential photographs of the test are shown in Figure A-127.

As shown in Figure A-128, the supports were fractured at the base. The left support also had a slight fracture about 16.0 in. above the ground. The vehicle (see Figure A-126) received minor scrapes on the bumper with a maximum crush of 4.5 in. on the right side at bumper height. The windshield was also cracked.

The results of this test are summarized in Figure A-129. Change in the vehicle's velocity at 0.300 seconds was 10.0 mph and change in momentum was 825 lb-sec. Occupant impact velocity in the longitudinal direction was 14.1 fps and the highest 0.010-second longitudinal occupant ridedown acceleration was -2.5 g.

FIGURE A-125. TEST VEHICLE BEFORE TEST 19.

FIGURE A-126. TEST VEHICLE AFTER TEST 19.

0.000 sec

0.101 sec

0.025 sec

0.151 sec

0.050 sec

0.201 sec

0.075 sec

0.252 sec

FIGURE A-127. SEQUENTIAL PHOTOGRAPHS FOR TEST 19.

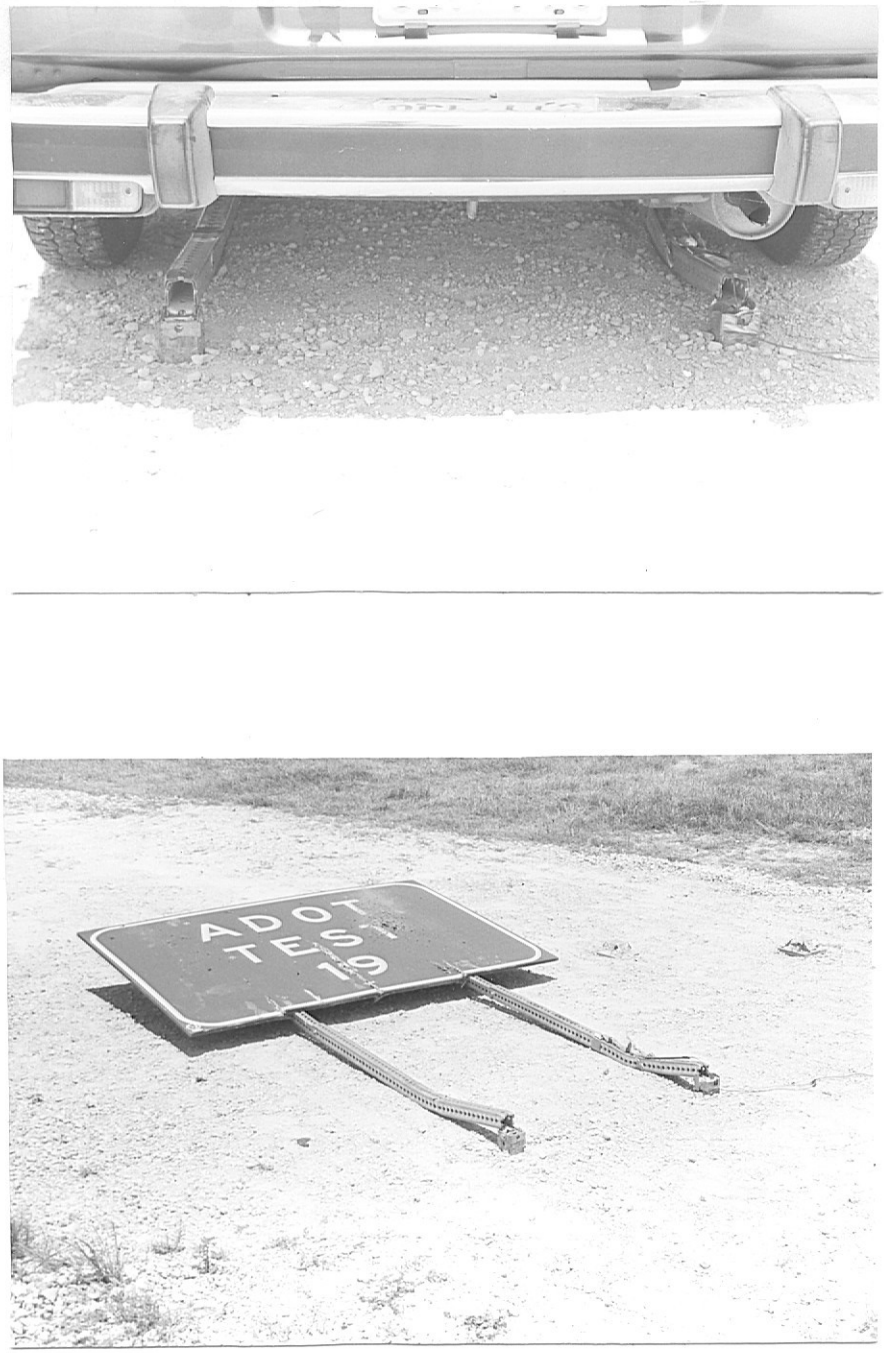
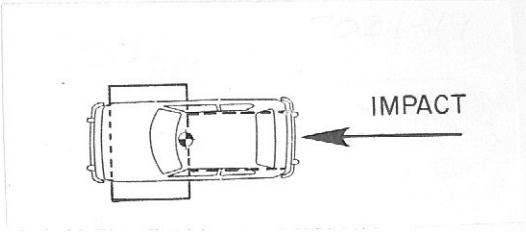


FIGURE A-128. TEST INSTALLATION AFTER TEST 19.

0.000 sec | 0.050 sec | 0.101 sec | 0.201 sec



Test No.	7024-19
Date	5/31/85
Test Article	Sign Installation
Support	Two square tube (Unistrut) P2 posts
Vehicle	1979 Honda Civic
Vehicle Weight	
Test Inertia	1,808 lb (821 kg)
Gross Static	1,980 lb (899 kg)
Vehicle Damage Classification	
TAD	12FD1
SAE	12FDLN1
Impact Speed	18.9 mph (30.4 kph)
Change in Velocity	10.0 mph (16.1 kph)
Change in Momentum	825 lb-sec
Occupant Impact Velocity	
Longitudinal	14.1 fps (4.3 m/s)
Lateral	None
Occupant Ridedown Accelerations	
Longitudinal	-2.5 g
Lateral	N/A
Maximum Vehicle Crush	
Bumper Height	4.5 in. (11.4 cm)
Hood Height	0.0 in. (0.0 cm)

FIGURE A-129. SUMMARY OF RESULTS FOR TEST 19.

A-3-20. Test 20

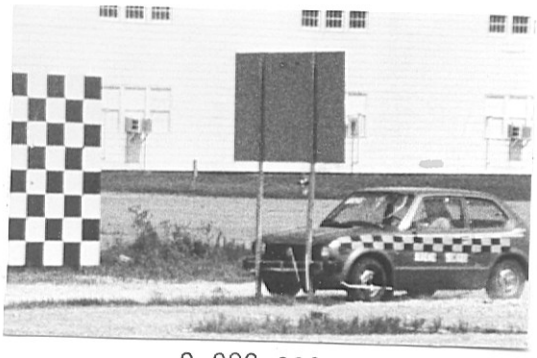
A 1979 Honda Civic, shown in Figure A-130, was directed into the sign at 57.5 mph. The test inertia mass of the vehicle was 1,808 lb and its gross static mass was 1,980 lb. Impact was such that the vehicle bumper contacted both supports.

The left support of the sign installation fractured at bumper height approximately 0.010 sec after impact. Both supports then began to deform around the front of the vehicle and at 0.045 sec the right support fractured at hood height. At 0.056 sec the sign panel impacted the windshield. As the vehicle continued forward, it carried the whole installation with it. Sequential photographs of the test are shown in Figure A-131.

As shown in Figure A-132 (two sheets), the left support separated about 10 in. above the ground and the right support separated at the base. The vehicle sustained a maximum crush of 3 in. at bumper height on the right side. The hood was scraped and dented, and the windshield was knocked out. Photographs of the vehicle after the test are shown in Figure A-133.

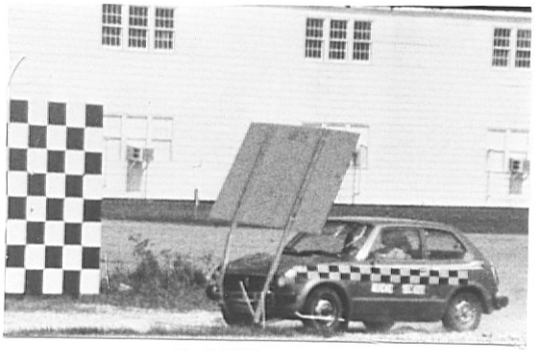
The results from this test are summarized in Figure A-134. The change in the vehicle's velocity was 12.2 mph and change in momentum was 1,005 lb-sec. Occupant impact velocity in the longitudinal direction was 17.4 fps and the highest 0.010-second longitudinal occupant ridedown acceleration was 1.7 g.

FIGURE A-130. TEST VEHICLE BEFORE TEST 20.



0.000 sec

0.111 sec



0.028 sec

0.141 sec

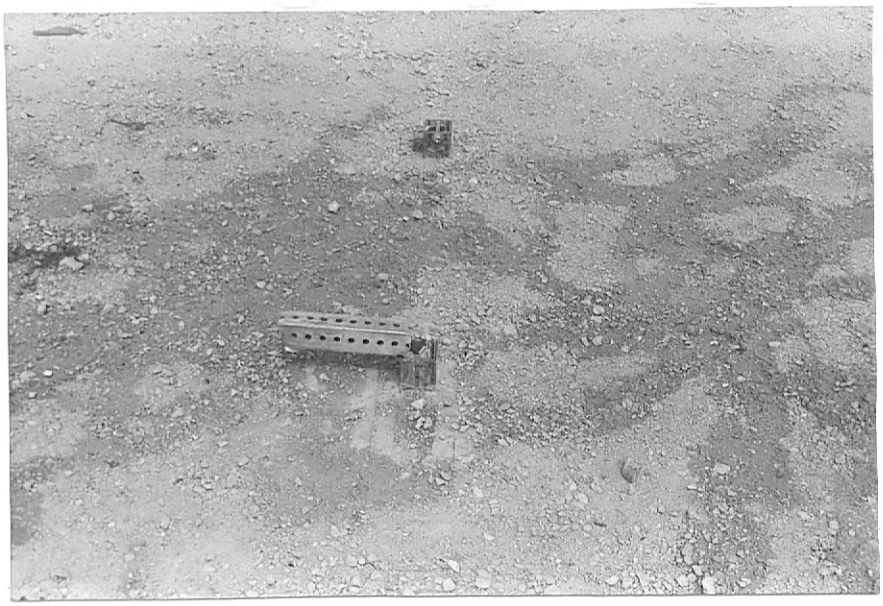
0.056 sec

0.172 sec

0.083 sec

0.202 sec

FIGURE A-131. SEQUENTIAL PHOTOGRAPHS FOR TEST 20.



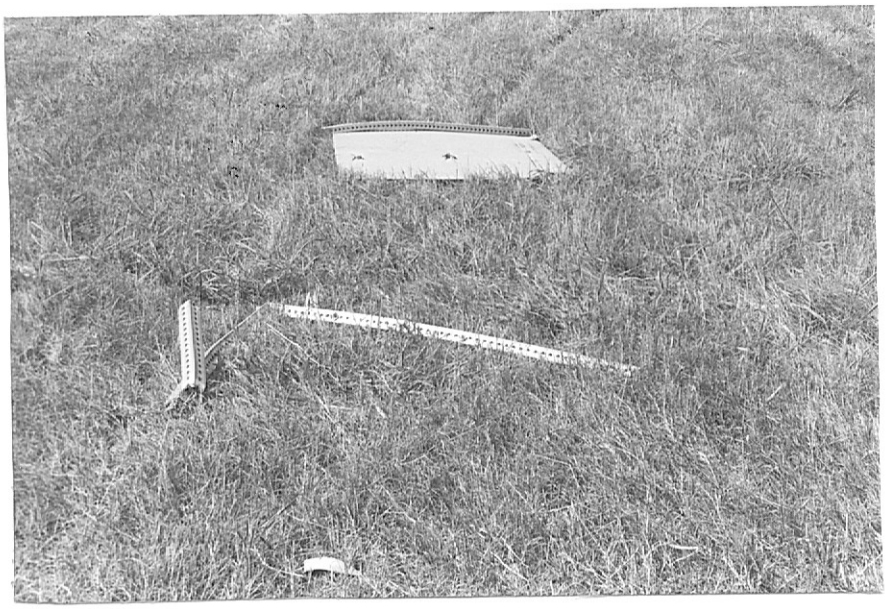


FIGURE A-132. SIGN INSTALLATION AFTER TEST 20.

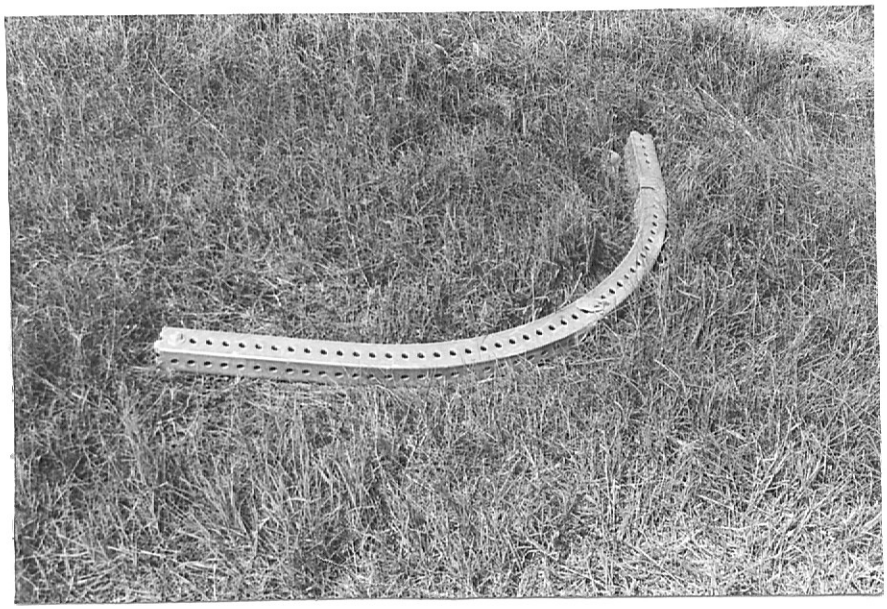
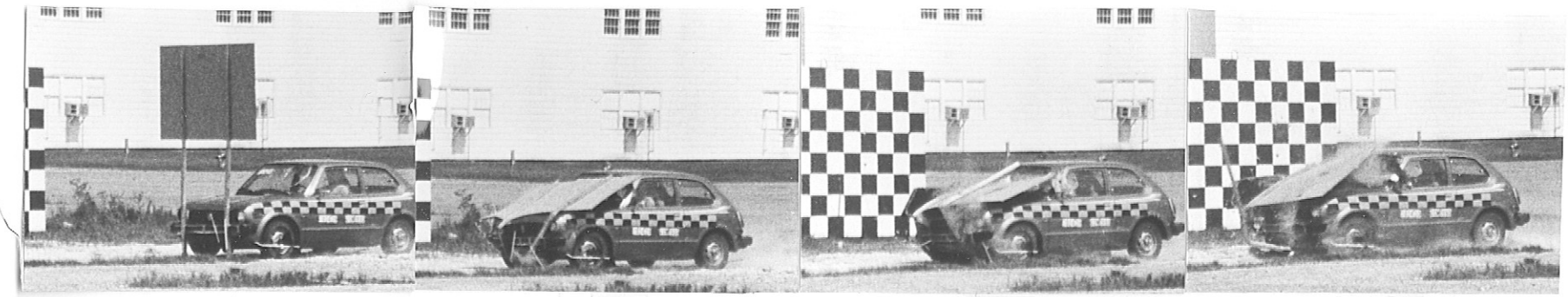
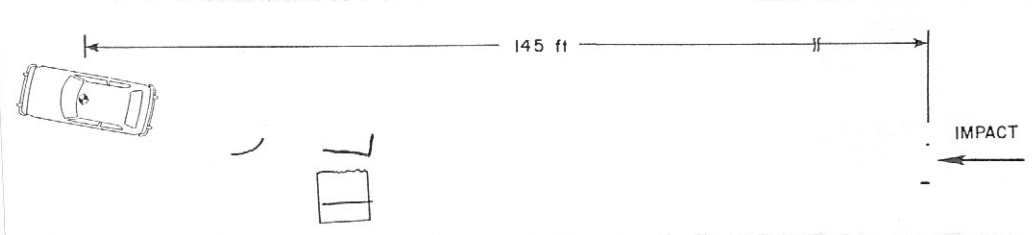


FIGURE A-132. SIGN INSTALLATION AFTER TEST 20 (continued).

FIGURE A-133. TEST VEHICLE AFTER TEST 20.



0.000 sec 0.056 sec 0.111 sec 0.172 sec



Test No.	7024-20
Date	5/31/85
Test Article	Sign installation
Support	Two square tube (Unistrut) P2 posts
Vehicle	1979 Honda Civic
Vehicle Weight	
Test Inertia	1,808 lb (821 kg)
Gross Static	1,980 lb (899 kg)
Vehicle Damage Classification	
TAD	12FD1
SAE	12FDEW1
Impact Speed	57.5 mph (92.5 kph)
Change in Velocity	12.2 mph (19.6 kph)
Change in Momentum	1,005 lb-sec
Occupant Impact Velocity	
Longitudinal	17.4 fps (5.3 m/s)
Lateral	None
Occupant Ridedown Accelerations	
Longitudinal	1.7 g
Lateral	N/A
Maximum Vehicle Crush	
Bumper Height	3.0 in. (7.6 cm)
Hood Height	None

FIGURE A-134. SUMMARY OF RESULTS FOR TEST 20.

A-3-21. Test 21

A 1979 Honda Civic, shown in Figure A-135, was directed into the sign at 61.5 mph. Test inertia mass of the vehicle was 1,772 lb and its gross static mass was 1,955 lb. Impact point was such that the vehicle bumper contacted all three supports of the installation.

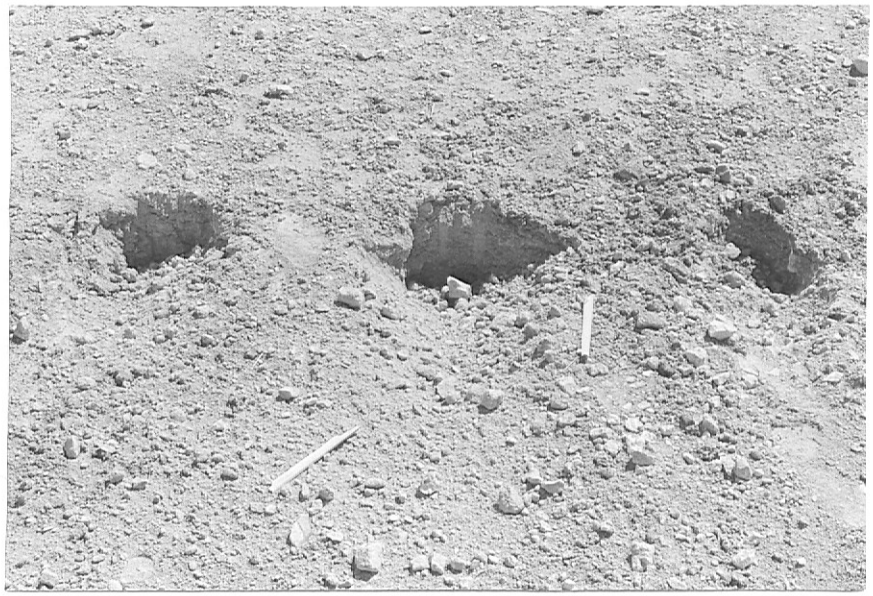
Shortly after impact the supports began to deform around the front of the vehicle and by 0.063 sec the front wheels left the ground. By 0.089 sec the supports had bent sufficiently to cause the sign panel to hit the hood and windshield. The whole sign installation pulled out of the ground and rode with the vehicle which traveled 175 ft directly behind the impact point.

The sign installation was pulled out of the ground. The supports were split and twisted. Damage to the sign supports is shown in Figure A-136.

The front of the vehicle was deformed as shown in Figure A-137. The left front quarter received 6.0 in. crush at bumper height. The center and right side was crushed 3.0 in. at bumper height. The windshield also was broken. Sequential photographs of the test are shown in Figure A-138.

The results are shown in Figure A-139. Change in the vehicle's velocity at 0.300 seconds was 15.3 mph and change in momentum was 1,235 lb-sec. Longitudinal occupant impact velocity was 19.0 fps and the maximum 0.010-second ridedown acceleration was -1.9 g.

FIGURE A-135. VEHICLE BEFORE TEST 21.



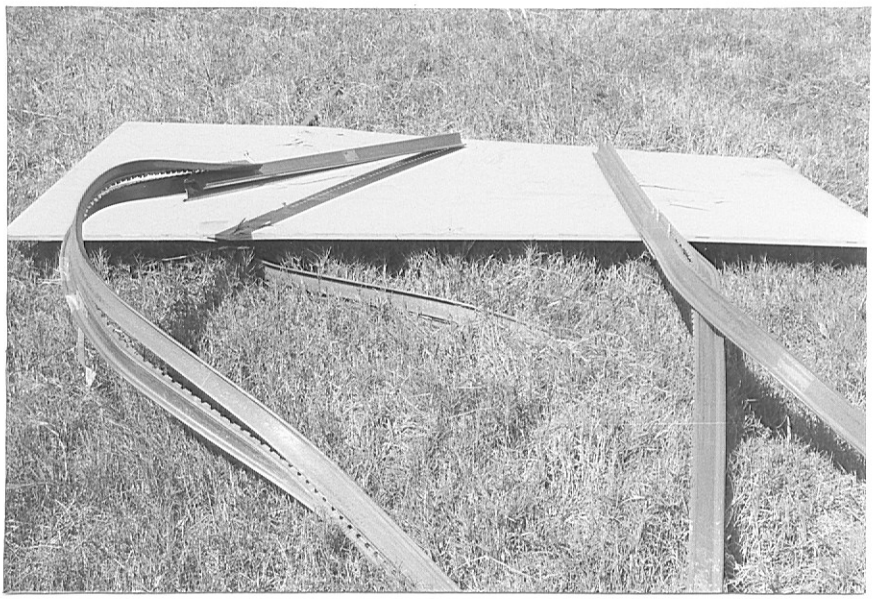


FIGURE A-136. SIGN INSTALLATION AFTER TEST 21.

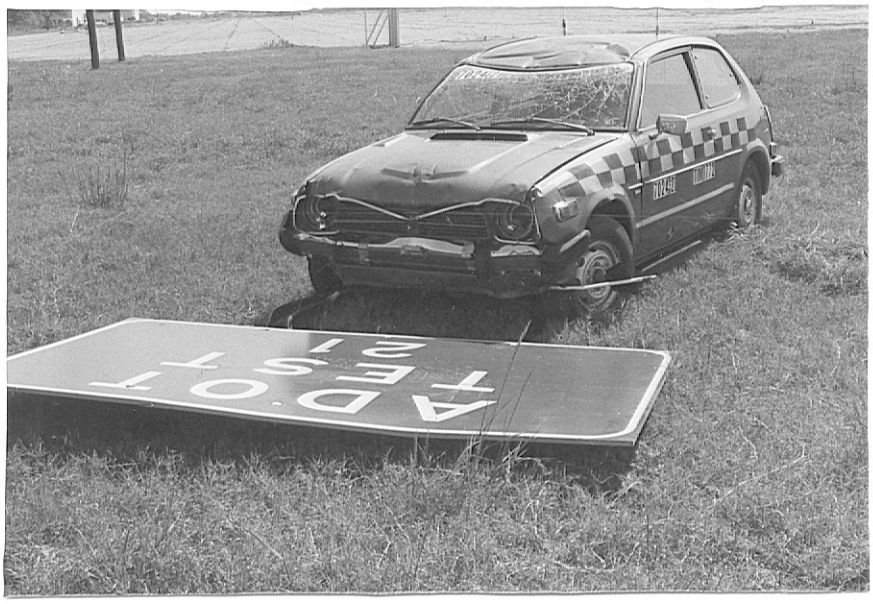
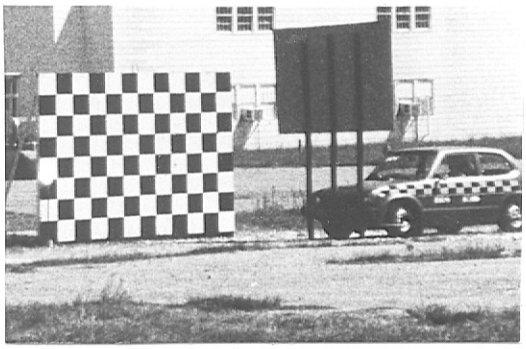
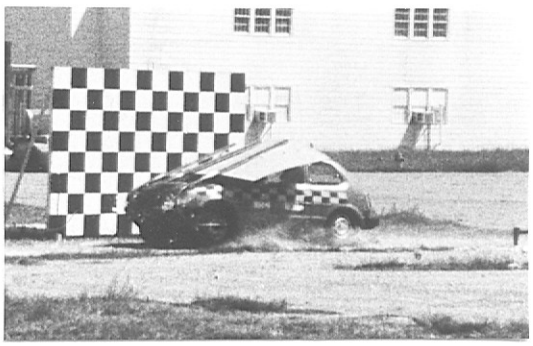


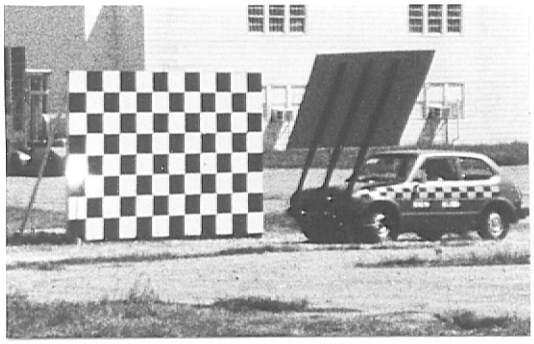
FIGURE A-137. VEHICLE AFTER TEST 21.



0.000 sec

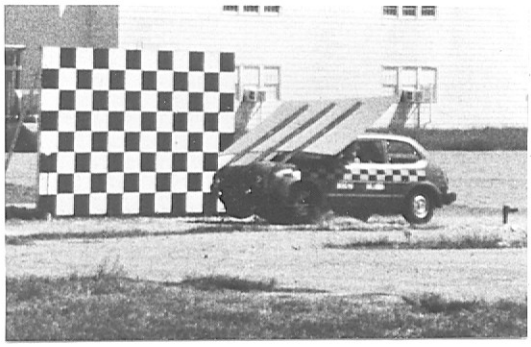


0.152 sec

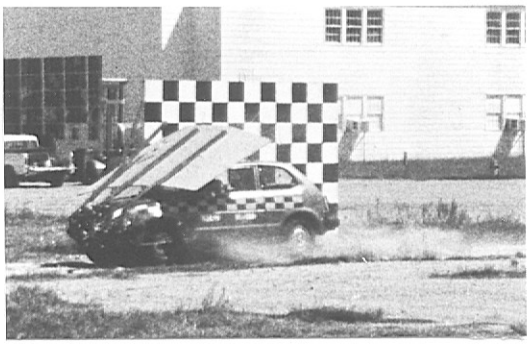


0.038 sec

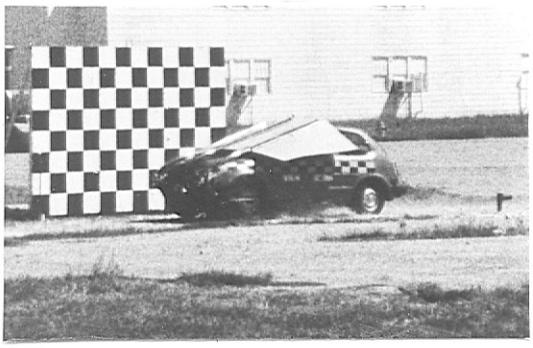
0.190 sec



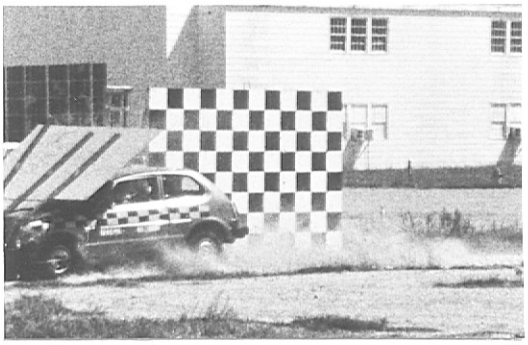
0.076 sec



0.266 sec

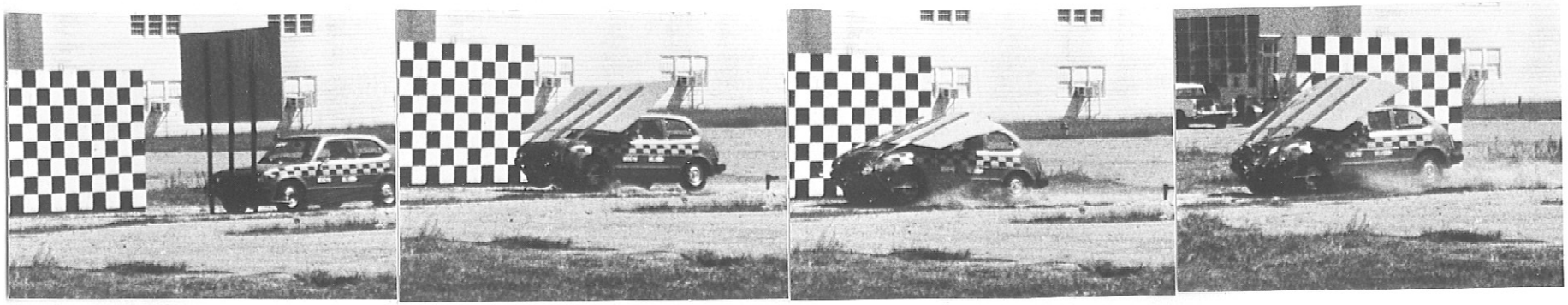


0.114 sec



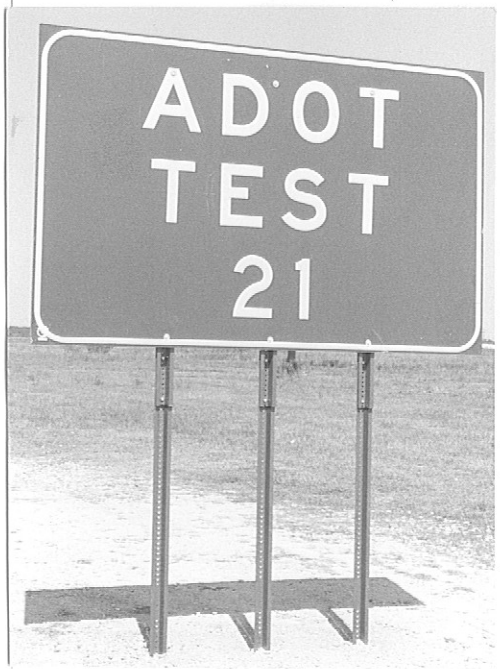
0.342 sec

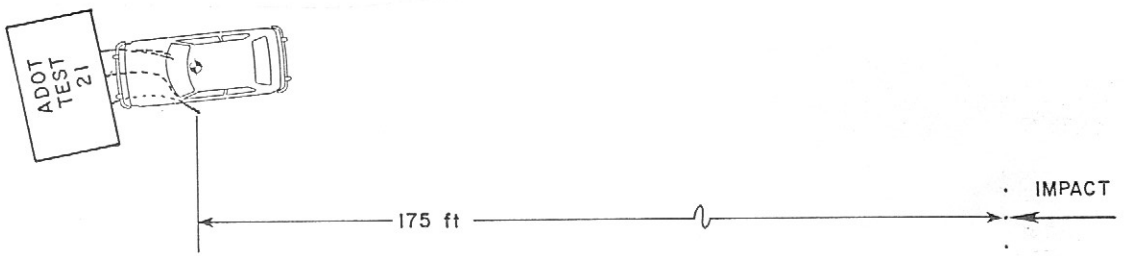
FIGURE A-138. SEQUENTIAL PHOTOGRAPHS FOR TEST 21.



0.000 sec | 0.076 sec | 0.152 sec | 0.266 sec

A-171





Test No.	7024-21
Date	9/24/85
Test Article	Sign Installation
Support	Three 3 lb High Carbon Billet Steel Supports
Vehicle	1979 Honda Civic
Vehicle Weight	
Test Inertia	1,772 lb (804 kg)
Gross Static	1,955 lb (888 kg)
Vehicle Damage Classification	
TAD	12FD3
SAE	12FDAW7

Impact Speed	61.5 mph (99.0 kph)
Change in Velocity	15.3 mph (24.6 kph)
Change in Momentum	1,235 lb-sec
Occupant Impact Velocity	
Longitudinal	19.0 fps (5.8 m/s)
Lateral	No Contact
Occupant Ridedown Accelerations	
Longitudinal	-1.9 g
Lateral	N/A
Maximum Vehicle Crush	
Bumper Height	6.0 in. (15.2 cm)

FIGURE A-139. SUMMARY OF RESULTS FOR TEST 21.

A-3-22. Test 22

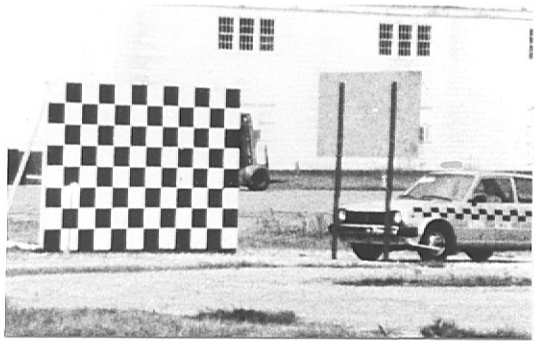
A 1980 Honda, shown in Figure A-140, was directed into the sign at 20.0 mph. The test inertia mass of the vehicle was 1,833 lb and its gross static mass was 2,003 lb. Impact point was such that the vehicle bumper contacted both supports of the sign installation.

Approximately 0.054 sec after impact the right support fractured, and at 0.077 sec the left support fractured. The vehicle lost contact with the sign installation at 0.197 sec. Shortly thereafter the sign panel fell on the hood and slid to the ground. Sequential photographs of the test are shown in Figure A-141.

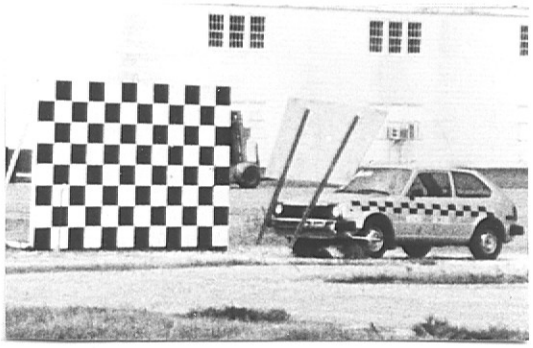
The right support was fractured 19 in. above the ground and the left support was fractured 20 in. above the ground as shown in Figure A-142. As shown in Figure A-143, the vehicle sustained minor scrapes to the bumper and hood.

The results of the test are summarized in Figure A-144. Change in the vehicle's velocity was 6.4 mph and change in momentum was 534 lb-sec. Longitudinal occupant impact velocity was 10.1 fps and the maximum 0.010-second average occupant ridedown acceleration was -1.9 g.

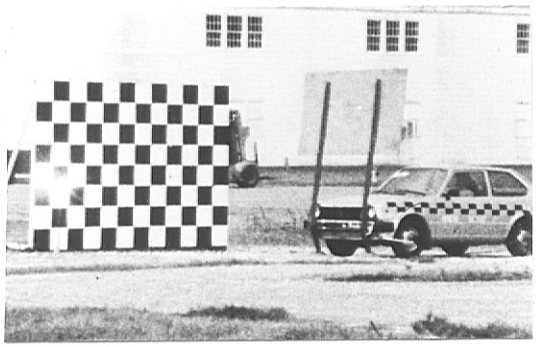
FIGURE A-140. VEHICLE BEFORE TEST 22.



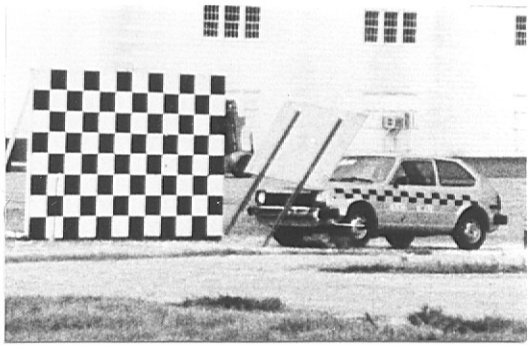
0.00 sec



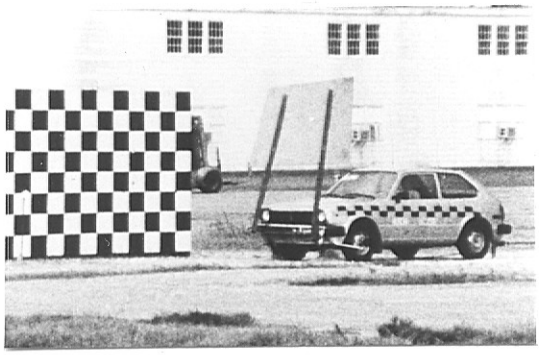
0.163 sec



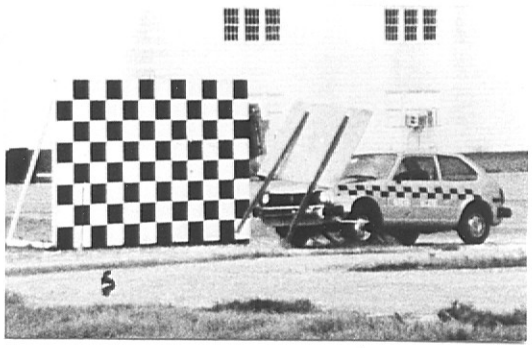
0.041 sec



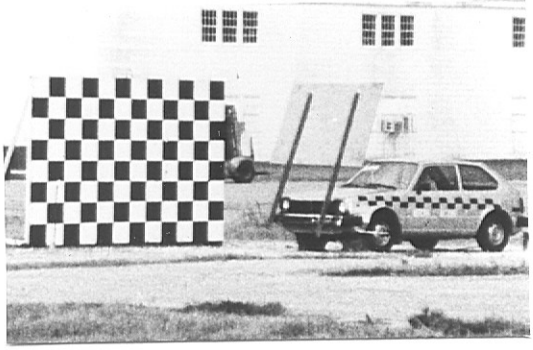
0.204



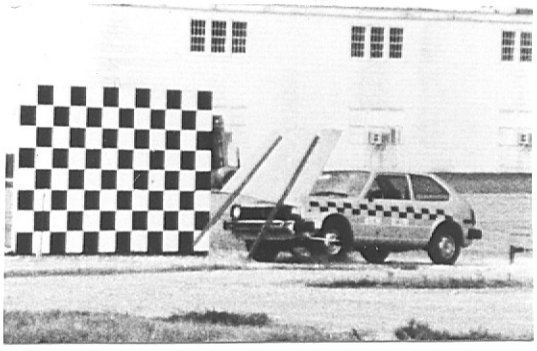
0.082 sec



0.245 sec



0.123 sec



0.286 sec

FIGURE A-141. SEQUENTIAL PHOTOGRAPHS FOR TEST 22.

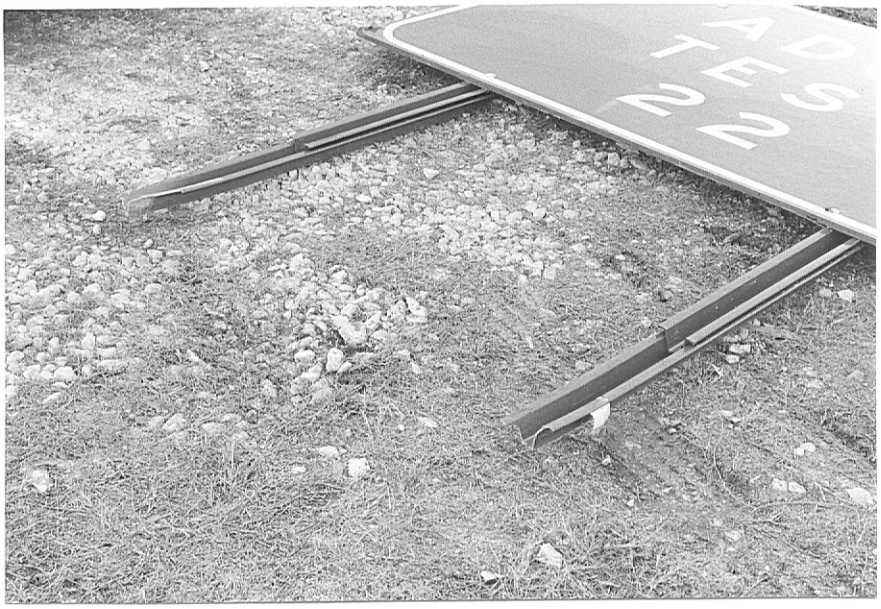
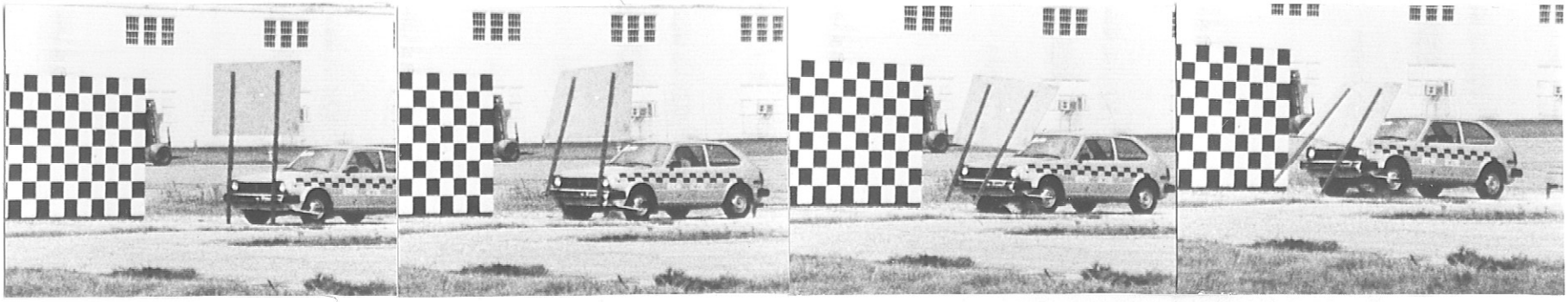
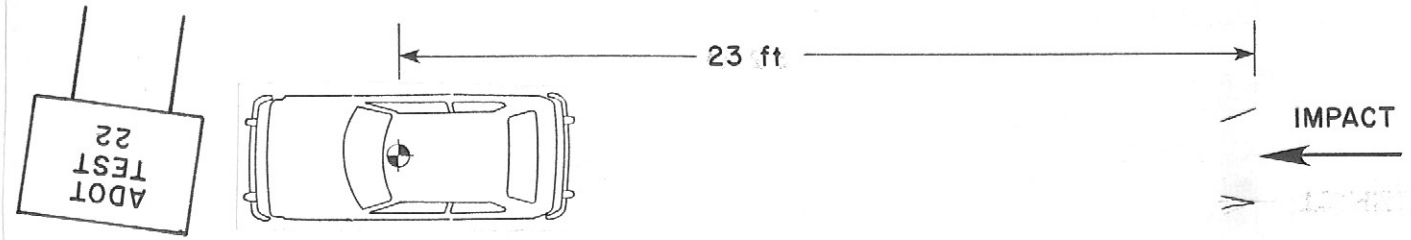


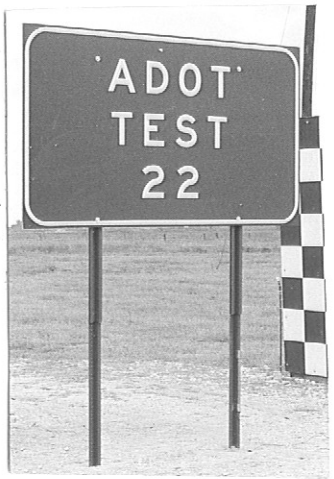
FIGURE A-142. SIGN INSTALLATION AFTER TEST 22.

FIGURE A-143. VEHICLE AFTER TEST 22.



0.000 sec 0.082 sec 0.163 sec 0.286 sec





Test No.	7024-22
Date	9/12/85
Test Article	Sign installation
Support	Two 3 lb High Carbon Billet Steel Supports
Vehicle	1980 Honda
Vehicle Weight	
Test Inertia	1,833 lb (832 kg)
Gross Static	2,003 lb (909 kg)
Vehicle Damage Classification	
TAD	12FD1
SAE	12FDEW1

Impact Speed	20.0 mph (32.2 kph)
Change in Velocity	6.4 mph (10.3 kph)
Change in Momentum	534 lb-sec
Occupant Impact Velocity	
Longitudinal	10.1 fps (3.1 m/s)
Lateral	None
Occupant Ridedown Accelerations	
Longitudinal	-1.9 g
Lateral	N/A
Maximum Vehicle Crush	
Bumper Height	0.0 in. (0.0 cm)

FIGURE A-144. SUMMARY OF RESULTS FOR TEST 22.

A-3-23. Test 23

A 1980 Honda, shown in Figure A-145, was directed into the sign at 62.8 mph. Test inertia mass of the vehicle was 1,833 lb and its gross static mass was 2,003 lb. Impact point was such that the vehicle bumper contacted both supports of the installation. Relative positions of the test vehicle and sign installation are shown in Figure A-145.

Approximately 0.010 sec after impact the supports began to split longitudinally and the sign panel separated from the supports. At 0.045 sec the lower sections of the supports began to fracture. By 0.096 sec the panel was on the roof and the supports were riding horizontally on the hood of the vehicle as shown in Figure A-146. The vehicle continued to travel 198 ft before coming to a stop.

The lower section of the left support fractured 35 in. above the ground and the right support fractured 38 in. above the ground. The upper sections of the supports rode with the vehicle for approximately 145 ft. Damage to the sign installation is shown in Figure A-147.

The front of the vehicle was deformed as shown in Figure A-148. The right front quarter received 1.0 in. crush at bumper height and 5.0 in. on the left side. The roof was scratched from the sign panel.

The results of this test are summarized in Figure A-149. Change in the vehicle's velocity at 0.300 seconds was 8.0 mph and change in momentum was 668 lb-sec. Longitudinal occupant velocity was 11.8 fps and the maximum 0.010-second average ridedown acceleration was -0.8 g.

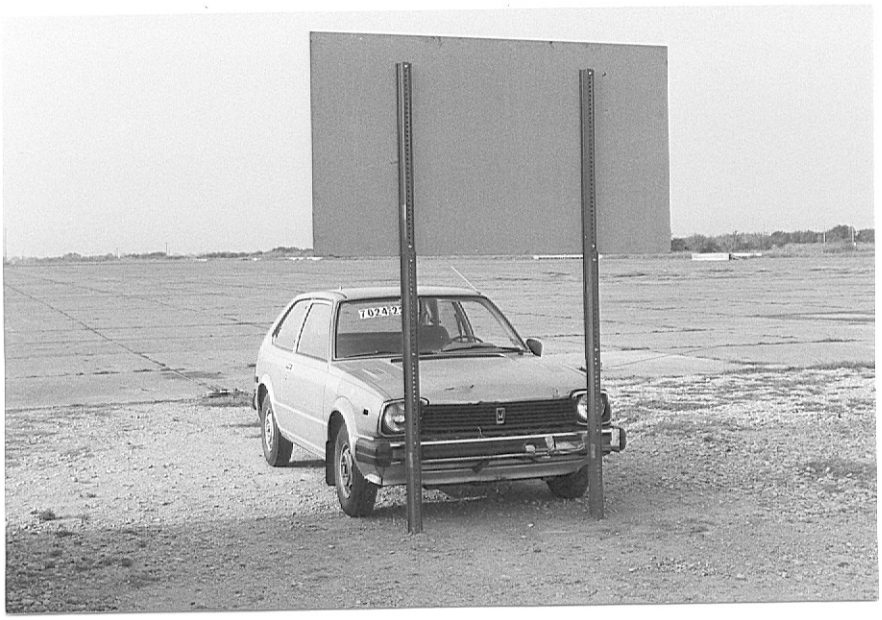
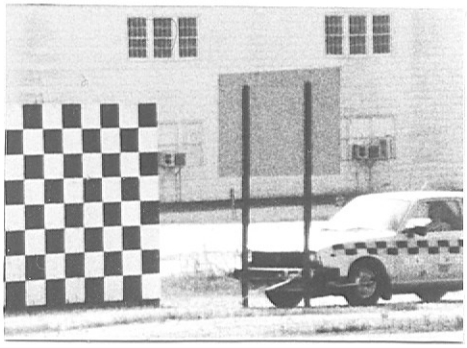
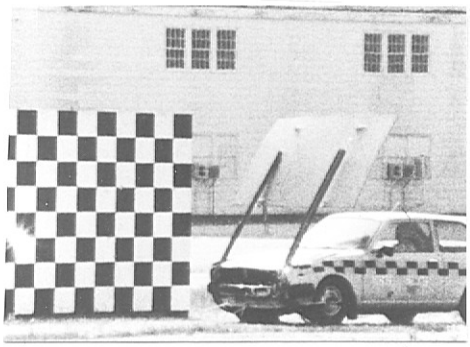


FIGURE A-145. VEHICLE BEFORE TEST 23.



0.000 sec

0.141 sec



0.035 sec

0.177 sec

0.071 sec

0.212 sec

0.106 sec

0.248 sec

FIGURE A-146. SEQUENTIAL PHOTOGRAPHS FOR TEST 23.

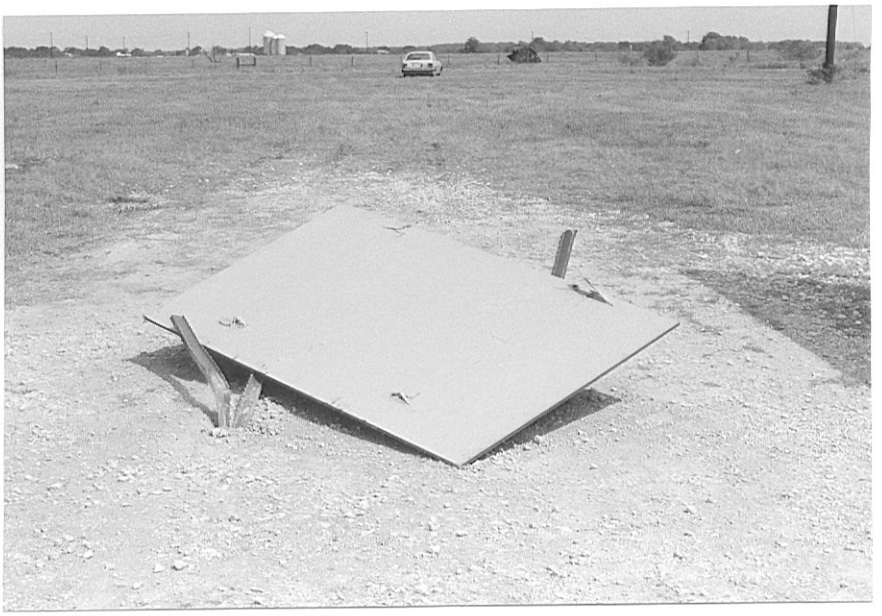


FIGURE A-147. SIGN INSTALLATION AFTER TEST 23.

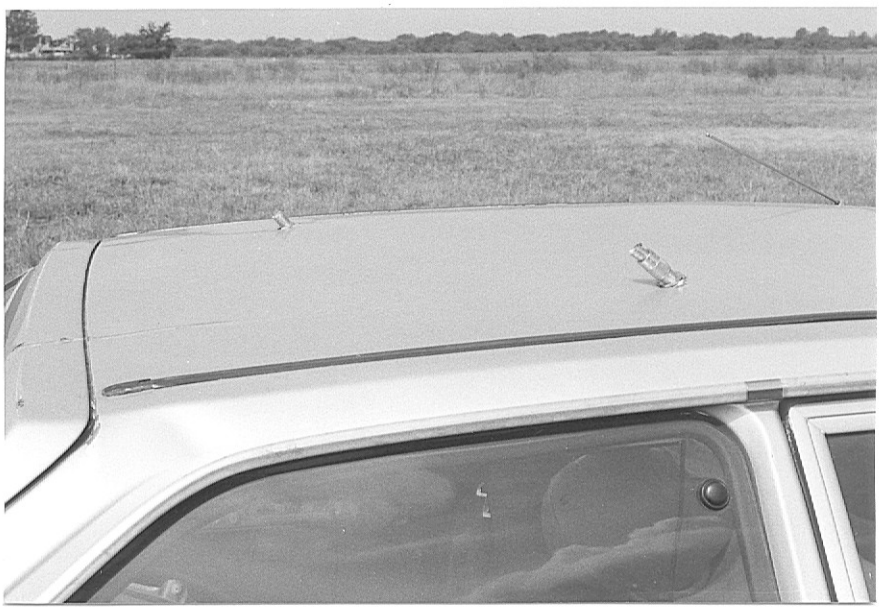
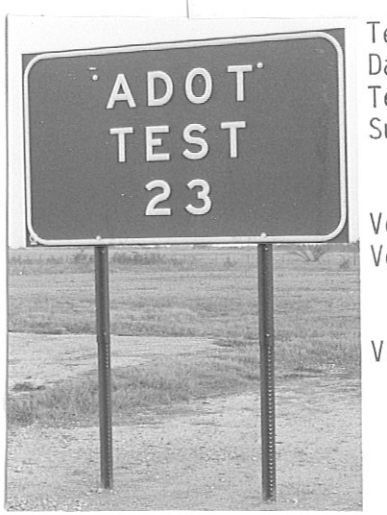


FIGURE A-148. VEHICLE AFTER TEST 23.

0.000 sec 0.071 sec 0.141 sec 0.212 sec

198 ft

IMPACT



Test No.	7024-23
Date	9/13/85
Test Article	Sign Installation
Support	Two 3 lb High Carbon Billet Steel Supports
Vehicle	1980 Honda
Vehicle Weight	
Test Inertia	1,833 lb (832 kg)
Gross Static	2,003 lb (909 kg)
Vehicle Damage Classification	
TAD	12FD2
SAE	12FDAW1

Impact Speed	62.8 mph (101.0 kph)
Change in Velocity	8.0 mph (12.9 kph)
Change in Momentum	668 lb-sec
Occupant Impact Velocity	
Longitudinal	11.8 fps (3.6 m/s)
Lateral	No Contact
Occupant Ridedown Accelerations	
Longitudinal	-0.8 g
Lateral	N/A
Maximum Vehicle Crush	
Bumper Height	5.0 in. (2.5 cm)

FIGURE A-149. SUMMARY OF RESULTS FOR TEST 23.

APPENDIX B. PROPERTIES OF SIGN POSTS

B. PROPERTIES OF SIGN POSTS

Tests were conducted by an independent materials laboratory in Houston, Texas to determine the chemical, physical, and impact properties of each of the base-bending sign supports, which included supports in tests 3 through 23. A specimen was taken from the above-ground portion of the support system for analysis. The specimen was taken from an undeformed section. For tests in which multiple supports were used, the specimen was taken at random from one of the posts. Chemical and physical properties are given in Table B-1 and impact properties are given in Table B-2.

Charpy tests were conducted at both the ambient temperature at the time of the full-scale crash test and at 150°F. The latter value was selected as an "upper temperature limit" for a post in the field. In general, the fracture energy of a metal post increases as its temperature increases. Hence, if the post exhibits brittle fracture at 150°F it follows that it would do so at lower temperatures.

For each post evaluated, four Charpy tests were conducted -- two at the ambient temperature and two at 150°F. The thickness of the specimen cross section was that of the post, and the depth of the cross section (at the notch) was held constant at 0.314 -0.000 in. Results of the Charpy tests were normalized in terms of fracture energy per square inch of cross section at the notch.

TABLE B-1. CHEMICAL AND MECHANICAL PROPERTIES OF SIGN POSTS

CRASH TEST NO.	POST TYPE AND SIZE	CHEMICAL ANALYSIS (PERCENT BY WEIGHT)														MECHANICAL PROPERTIES		ELONGATION (%)
		C	Mn	P	S	Si	Ni	Cr	Mo	Cu	A	Ti	Zn	Sn	Mg	YIELD STRENGTH (psi)	ULTIMATE STRENGTH (psi)	
3	Square Steel Tube 2" x 2" x 0.105"	0.100	0.35	0.005	0.019	(a)	0.01	(a)	(a)	0.02	0.013	(a)	(a)	(a)	(a)	55,400	58,100	25
4	Same as Test 3	0.099	0.36	0.006	0.020	(a)	(a)	(a)	(a)	(a)	0.04	(a)	(a)	(a)	(a)	50,700	57,600	25
5	Square Steel Tube 1 3/4" x 1 3/4" x 0.105	0.054	0.25	0.012	0.021	0.06	0.02	0.03	(a)	0.06	0.09	(a)	(a)	(a)	(a)	50,000	56,500	21
6	Same as Test 5	0.053	0.25	0.008	0.022	0.05	0.04	0.03	(a)	0.08	0.08	(a)	(a)	(a)	(a)	45,600	55,000	24
7	Billet Steel U-Post 3 lb/ft	0.75	0.94	0.020	0.023	0.27	0.08	0.16	0.01	0.40	0.02	(a)	(a)	0.03	(a)	102,000	162,000	7
8	Same as Test 7	0.74	1.02	0.019	0.020	0.38	0.10	0.16	0.01	0.41	0.03	(a)	(a)	0.03	(a)	104,000	162,000	10
9	Same as Test 7	0.75	0.93	0.018	0.020	0.26	0.09	0.17	0.02	0.40	0.03	(a)	(a)	0.04	(a)	105,000	163,000	10
10	Same as Test 7	0.74	0.95	0.022	0.030	0.20	0.11	0.15	0.03	0.36	0.02	(a)	(a)	0.02	(a)	100,000	159,000	9
11	Billet Steel U-Post 4 lb/ft	0.75	0.81	0.011	0.028	0.13	0.12	0.16	0.02	0.34	(a)	(a)	(a)	0.02	(a)	84,100	147,200	11
12	Same as Test 11	0.74	0.81	0.012	0.031	0.14	0.11	0.16	0.02	0.34	(a)	(a)	(a)	0.02	(a)	86,700	147,400	12
13	Same as Test 11	0.73	0.81	0.028	0.034	0.15	0.10	0.15	0.02	0.34	0.03	(a)	(a)	0.02	(a)	98,000	156,000	12
14	Rail Steel U-Post 3 lb/ft	0.69	0.84	0.038	0.015	0.16	0.02	0.01	(a)	0.18	0.04	(a)	(a)	--	(a)	72,200	133,200	14
15	Same as Test 14	0.74	0.82	0.005	0.020	0.16	0.07	0.04	0.01	0.07	0.06	(a)	(a)	--	(a)	78,300	137,400	12
16	Same as Test 7	0.75	0.70	0.006	0.017	0.08	0.11	0.08	0.02	0.24	0.04	(a)	(a)	--	(a)	85,100	147,300	12
17	Same as Test 7	0.69	0.83	0.018	0.021	0.22	0.15	0.14	0.02	0.46	(a)	(a)	(a)	0.02	(a)	88,700	146,600	14
18	Same as Test 7	0.76	0.76	0.008	0.017	0.10	0.10	0.10	0.02	0.31	0.04	(a)	(a)	--	(a)	84,700	146,700	12
19	Same as Test 5	0.098	0.41	0.006	0.015	(a)	0.01	(a)	(a)	(a)	0.05	(a)	(a)	(a)	(a)	41,500	49,200	44
20	Same as Test 5	0.097	0.42	0.013	0.017	(a)	(a)	(a)	(a)	(a)	0.05	(a)	(a)	(a)	(a)	39,200	49,200	43
21	Same as Test 7	0.74	0.70	0.010	0.020	0.08	0.11	0.10	0.03	0.25	0.06	(a)	(a)	--	(a)	87,900	149,100	10
22	Same as Test 7	0.75	0.73	0.010	0.022	0.11	0.10	0.09	0.02	0.24	0.06	(a)	(a)	--	(a)	81,300	139,800	10
23	Same as Test 7	0.75	0.71	0.009	0.020	0.11	0.11	0.09	0.03	0.25	0.06	(a)	(a)	--	(a)	86,200	147,400	12

(a)Less than 0.01

TABLE B-2. IMPACT PROPERTIES OF SIGN POSTS

CRASH TEST NO.	POST TYPE AND SIZE	CHARPY FRACTURE ENERGY (in.-lb/in.^{2})		ROCKWELL HARDNESS
		AMBIENT TEMP. (°F)[a]	AT 150°F	
3	Square Steel Tube 2" x 2" x 0.105"	6560 (85) 6560 (85)	6560 6950	74.7[b] 76.1[b] 76.5[b]
4	Same as Test 3	6950 (85) 6560 (85)	6560 6180	76.4[b] 72.6[b] 74.6[b]
5	Square Steel Tube 1 3/4" x 1 3/4" x 0.105"	6348 (57) 6732 (57)	6732 6348	N/A
6	Same as Test 5	6348 (72) 6540 (72)	6732 6348	N/A
7	Billet Steel U-Post 3 lb/ft	768 (65) 576 (65)	576 960	N/A
8	Same as Test 7	576 (73) 384 (73)	960 768	N/A
9	Same as Test 7	576 (79) 576 (79)	768 768	N/A
10	Same as Test 7	768 (77) 768 (77)	960 960	N/A
11	Billet Steel U-Post 4 lb/ft	293 (68) 586 (68)	732 732	29.3[c] 30.3[c] 30.0[c]
12	Same as Test 11	290 (72) 140 (72)	436 581	30.5[c] 30.5[c] 30.5[c]
13	Same as Test 11	432 (67) 288 (67)	432 576	N/A
14	Rail Steel U-Post 3 lb/ft	650 (92) 810 (92)	485 650	27.0[c] 25.0[c] 30.1[c]
15	Same as Test 14	440 (94) 585 (94)	730 585	27.9[c] 27.8[c] 28.0[c]

[a]Number in parenthesis is temperature in degrees Fahrenheit; [b]Hardness "B"; [c]Hardness "C"

TABLE B-2. IMPACT PROPERTIES OF SIGN POSTS (concluded)

CRASH TEST NO.	POST TYPE AND SIZE	CHARPY FRACTURE ENERGY (in.-lb/in.^{2})		ROCKWELL HARDNESS
		AMBIENT TEMP. (°F)[a]	AT 150°F	
16	Same as Test 7	325 (73) 485 (73)	670 485	29.8[c] 30.1[c] 29.9[c]
17	Same as Test 7	488 (59) 651 (59)	976 976	30.2[c] 31.2[c] 31.3[c]
18	Same as Test 7	485 (102) 485 (102)	650 650	29.6[c] 26.4[c] 25.9[c]
19	Same as Test 5	10040 (89) 9650 (89)	9650 10040	65.4[b] 65.1[b] 69.8[b]
20	Same as Test 5	9650 (89) 9650 (89)	9260 9260	58.3[b] 63.5[b] 59.2[b]
21	Same as Test 7	325 (84) 655 (84)	655 815	30.3[c] 30.2[c] 30.4[c]
22	Same as Test 7	645 (72) 645 (72)	645 645	29.1[c] 29.3[c] 29.4[c]
23	Same as Test 7	655 (85) 490 (85)	655 655	30.2[c] 30.2[c] 30.5[c]

[a]Number in parenthesis is temperature in degrees Fahrenheit; [b]Hardness "B"; [c]Hardness "C"

APPENDIX C. SOIL PROPERTIES AT TEST SITE

C. SOIL PROPERTIES AT TEST SITE

With the exception of tests 1 and 2, all sign posts were embedded in a test pit composed of a crushed limestone base material. The pit was 6 ft deep, 12 ft long, and 15 ft wide. The 12 ft dimension was in a direction parallel to the direction of the test vehicle's travel at impact. The soil and test pit dimensions were in accordance with recommended criteria of NCHRP 230 (1). The pit was filled with the "strong soil (S-1)" described in NCHRP 230.

Gradation of the test site soil, determined from previous research (6), is shown in Figure C-1 together with recommended limits. The soil was compacted and the density was determined by AASHTO T99-70, Method C. The maximum soil density was 142 lb/ft^3 at a moisture content of 7.8%. The moisture-density curve is shown in Figure C-2. The soil can be seen in photos presented in Section A-3; for example, see Figure A-38.

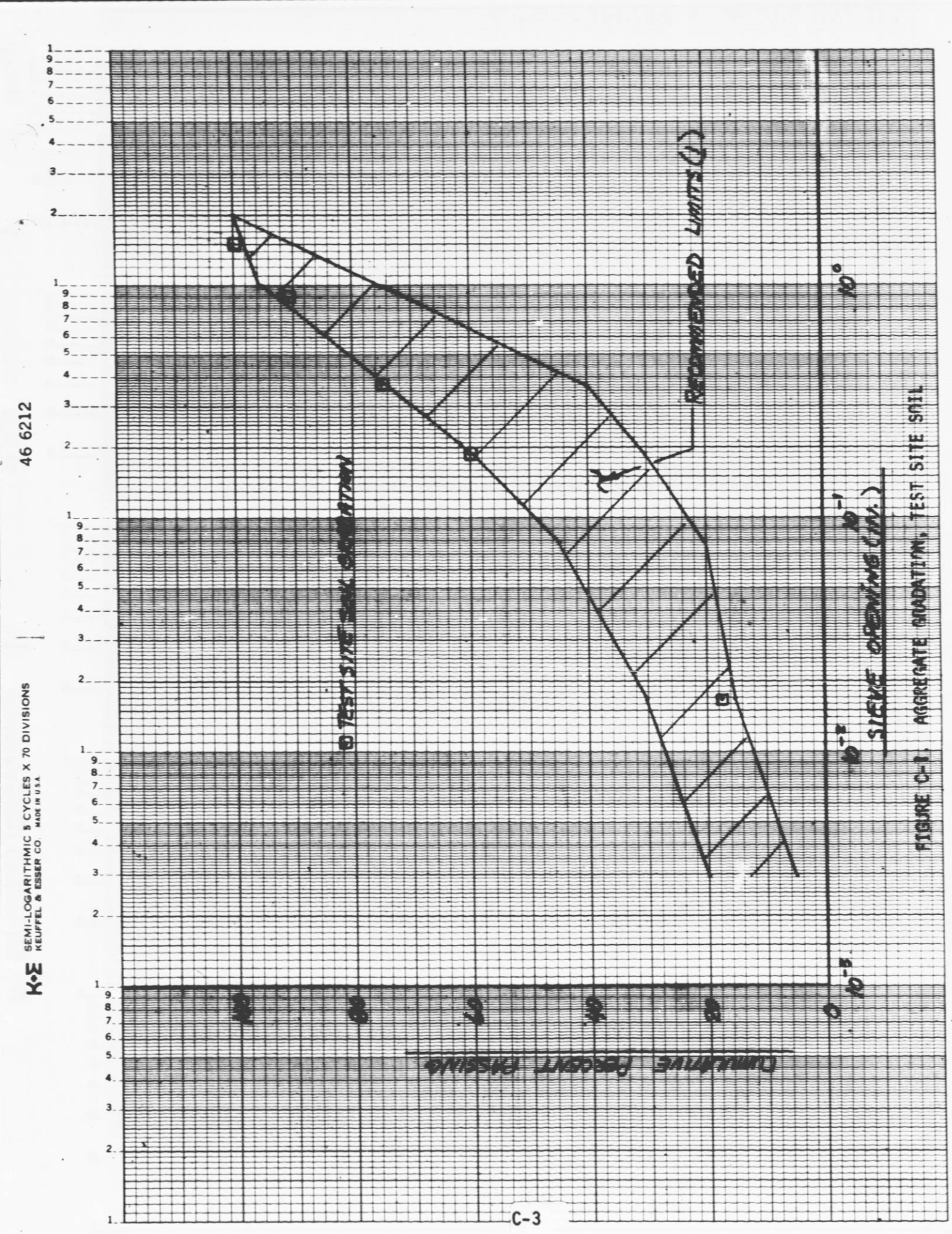


FIGURE C-1. AGGREGATE GRADATION, TEST SITE SOIL

46 6212

K·E SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

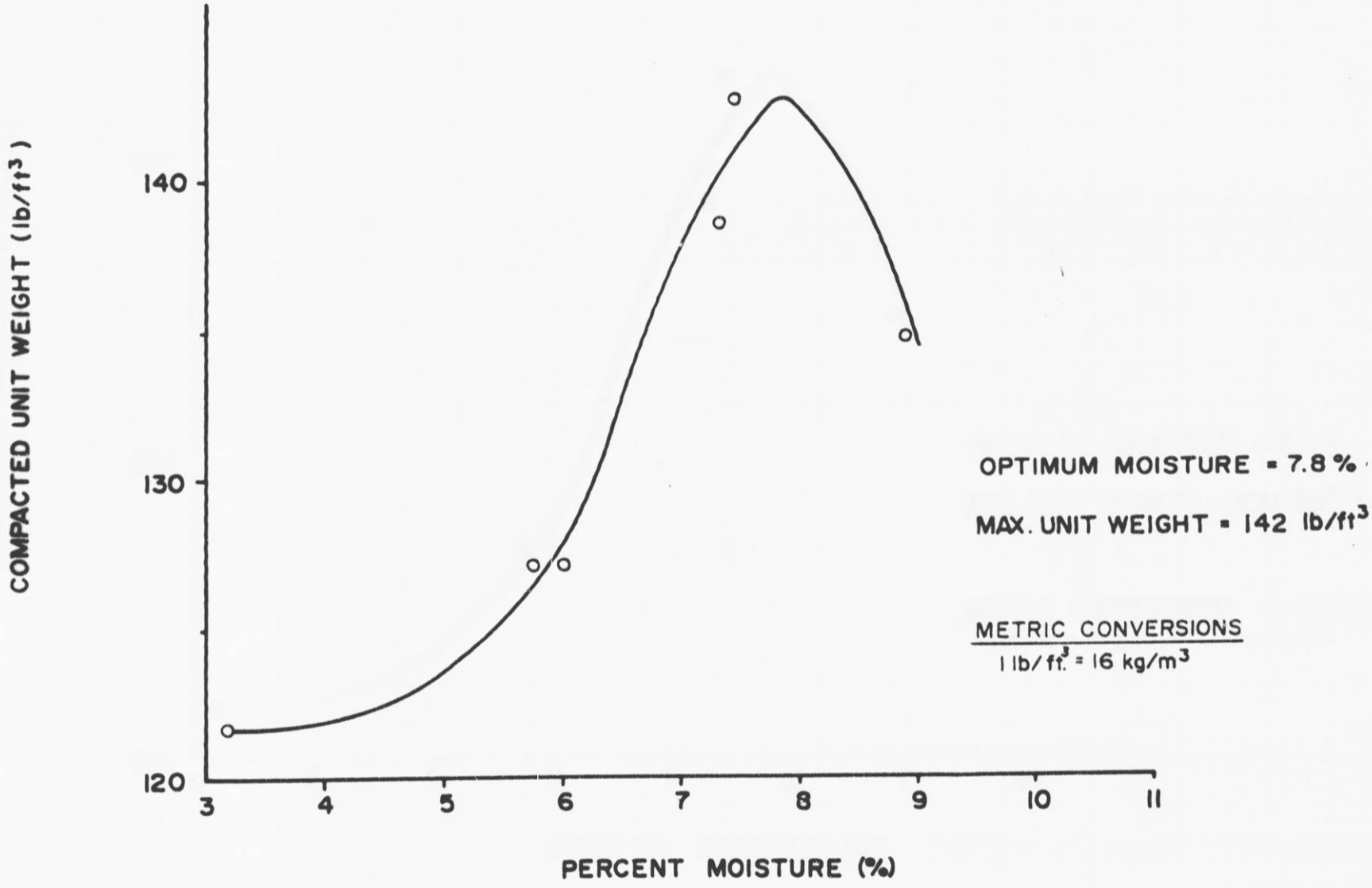


FIGURE C-2. COMPACTED UNIT WEIGHT OF TEST SOIL (6)

APPENDIX D. DATA ACQUISITION SYSTEMS

D. DATA ACQUISITION SYSTEMS

D-1. Deceleration Measurements

Vehicle acceleration measurements were made by means of two longitudinally and one transversely oriented strain gage linear accelerometers attached to the floor of the vehicle. Each accelerometer was placed near the vehicle's center of mass, as shown in Figure A-1. The vertical position of the accelerometers was approximately 13.5 in. above ground. These accelerometers incorporate a balanced, fully active strain gage bridge which features rugged construction, low response to transverse accelerations, and high overload capacity. The particular units used had a measurement range of ±50 g's with a bandwidth of 0 to 250 Hz. The nonlinearity and hysteresis is less than ±1% full scale with infinite resolution.

The accelerometers were physically calibrated by means of a Genisco 1074 precision centrifuge at various input levels. These calibration values were used to establish an 'R' cal value which was transmitted just prior to a test as required in final data reduction. Signals from the accelerometers were transmitted via a telemetry system to the base station for recording on analog tape.

D.2. High-Speed Cine

Three high-speed, ground mounted cameras were used to record the impact behavior of the test article and the vehicle. A fourth movie camera was used for documentary purposes, including real-time behavior of test vehicle and pre an postimpact scenes. Details of these cameras are given in Figure D-1 and Table D-1. The tests were also recorded on videotape for quick examination.

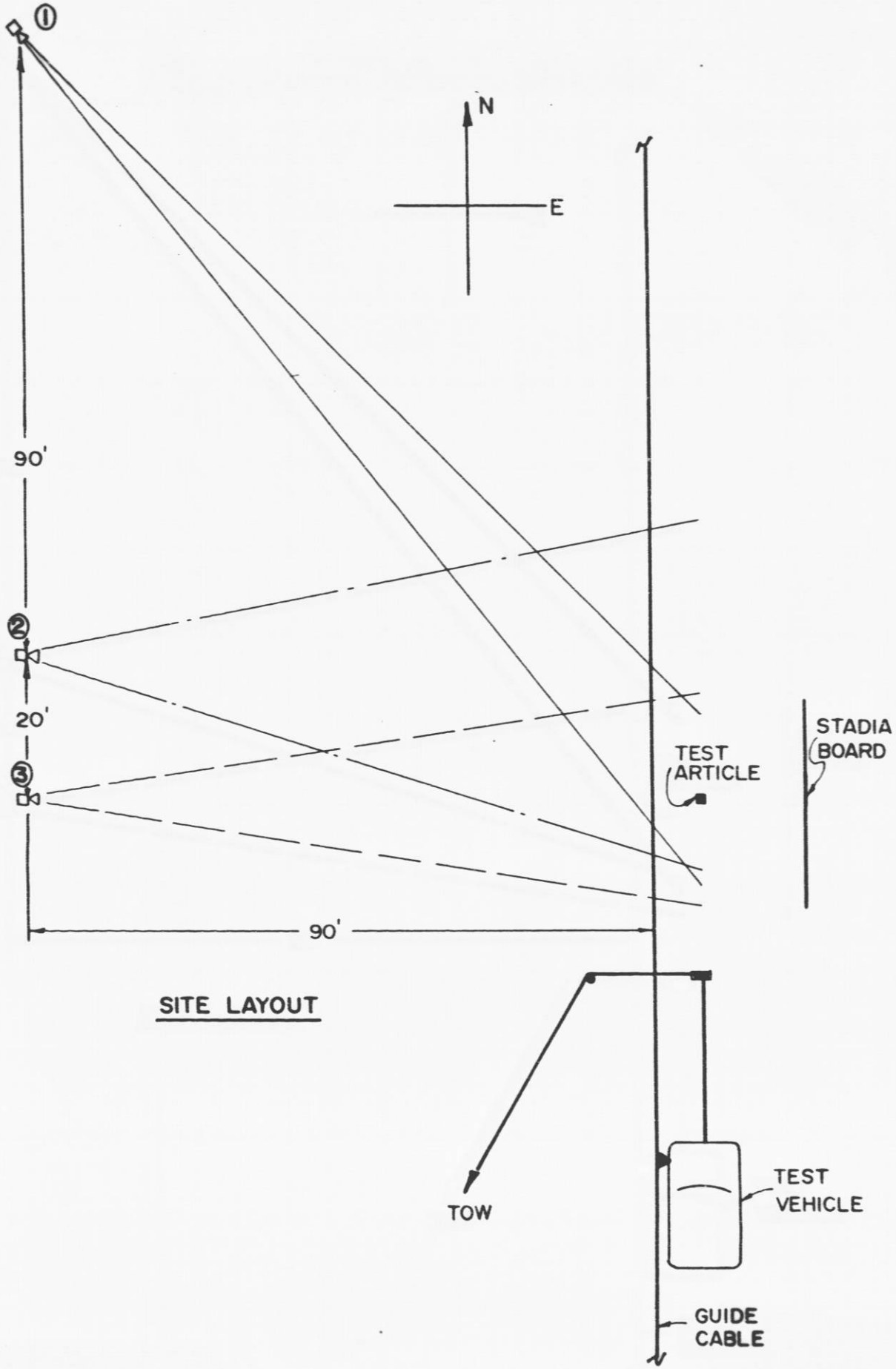


FIGURE D-1. CAMERA POSITIONS

TABLE D-1. CAMERA DETAILS

CAMERA NO.	TYPE	TYPICAL SPEED (Frames/sec)	BOUNDARIES OF SCENE	LENS
1[a]	Redlakes Hycam	1000	12 ft before and after impact	74 mm Wollensak
2[a]	Redlakes Locam	500	10 ft before and 40 ft after impact	12-120 mm Zoom Angeneaux
3[a]	Photosonics 1P	500	15 ft before and after impact	12-120 mm Zoom Angeneaux
4	Arriflex-M	24	Documentary	17-70 mm Zoom Angeneaux

[a]See Figure D-1.

APPENDIX E. REFERENCES

REFERENCES

1. Michie, Jarvis D., "Recommended Procedures for the Safety Performance Evaluation of Highway Appurtenances," National Cooperative Highway Research Program Report 230, March 1981.

2. "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals," American Association of State Highway and Transportation Officials, 1975.

3. "Recommended Procedures for Vehicle Crash Testing of Highway Appurtenances," Transportation Research Circular No. 191, Transportation Research Board, February 1978.

4. "Vehicle Damage Scale for Traffic Accident Investigators," Traffic Accident Data Project Bulletin No. 1, National Safety Council, 1971.

5. "Collision Deformation Classification, Recommended Practice J224a," Society of Automotive Engineers, New York, 1973.

6. Ross, H. E., Jr., et al., "Crash Tests of Small Highway Sign Supports," Report No. FHWA/RD-80/502, Federal Highway Administration, Washington, D.C., May 1980.