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16. Abstract

Researchers conducted a total of eleven full-scale crash tests. Each test was conducted and evaluated in accordance with nationally recognized guidelines as contained in NCHRP Report 230. The purpose of the first eight tests was to determine the adequacy of a new, universal bracket developed by TxDOT to attach any size mailbox to the support post. Researchers conducted tests with one and two mailboxes of various sizes mounted on single support designs and with multiple mailboxes of different sizes mounted on the Foresight Tubular Support. They conducted the ninth test with multiple mailboxes mounted on a modified version of the Foresight Tubular Support. The modified installation consisted of a "replacement footing" to facilitate use of salvaged parts from damaged supports and to minimize cost of replacement following a vehicular impact. A size no. 2 mailbox supported by two steel winged-channel posts was evaluated in the tenth test. A ¼-in. (0.64 cm) thick steel plate "vandal-proof" mailbox mounted on a single support was evaluated in the final test.

Use of the universal bracket with (a) a 2 lb/ft (3 kg/m) steel winged channel single support with a size no. 1 mailbox, two size no. 1½ mailboxes, and a size no. 2 mailbox, (b) a 2-in. (5.1 cm) O.D. thin-wall steel tube single support with a size no. 2 mailbox, (c) a standard Foresight Tubular Support with five size no. 1 mailboxes, (d) a standard Foresight Tubular Support with three size no. 2 mailboxes, and (e) a modified Foresight Tubular Support with three size no. 2 mailboxes demonstrated acceptable performance. A size no. 2 mailbox supported by two 2 lb/ft (3 kg/m) steel winged channel supports demonstrated acceptable performance. A size no. 1½ vandal-proof mailbox demonstrated unacceptable performance.

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MAILBOX BRACKET CRASH TESTS

by

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Research Report 1945-2F
Research Study No. 7-1945
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Sponsored by the
Texas Department of Transportation

November 1993

TEXAS TRANSPORTATION INSTITUTE
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IMPLEMENTATION STATEMENT

Crash tests described herein verify that the new TxDOT universal mailbox bracket with adjustable extensions meets national impact performance guidelines when used with various supports, provided proper attachment hardware as described herein is used. The three standard size mailboxes can use this bracket. Based on study results, the bracket is ready for immediate use by TxDOT. The researchers anticipate that use of the bracket will reduce costs, simplify mailbox installations, and improve the strength of the connection between the mailbox and the support.

The study also helped to evaluate through crash testing a modified version of the Foresight Tubular Support. It consists of a replacement footing attached to the above-ground support structure. Based on study results, the modified support system is ready for immediate use by TxDOT. The researchers anticipate that use of the modified support will reduce costs since parts of damaged installations are salvageable.

Some TxDOT districts use two winged channel posts to support the larger size no. 2 mailbox. This system was crash tested in the study reported herein. These results indicated the system to be in compliance with national impact performance guidelines.

The researchers evaluated through crash testing a vandal-proof mailbox constructed from ¼-in. (0.64 cm) steel plate. Test results indicate use of this type of mailbox on high-speed roadways is not advisable since it would pose an extreme hazard to motorists. Its use on low-speed roadways is not recommended unless it proves to be acceptable through testing.

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. The engineer in charge of the study was Hayes E. Ross, Jr., P.E. No. 26510.

The Texas Department of Transportation does not endorse products or manufacturers. Trade or manufacturers' names may appear herein only because they are considered essential to the object of this document.

ACKNOWLEDGMENT

The universal mailbox bracket evaluated in this study was designed and developed by Mr. Ken Boehme, P.E., Texas Department of Transportation. The authors are indebted to Mr. Boehme for his valuable input and cooperation during the course of the study. This innovative bracket design will reduce costs and simplify the installation of mailboxes.

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SUMMARY

TxDOT has been the leader in the development and implementation of safe mailbox support systems. These designs have been used throughout the U.S. and have greatly reduced the risks that mailbox installations pose to motorists. To upgrade these designs, TxDOT engineers developed an improved universal mailbox bracket to attach the mailbox to the support structure. The bracket has extensions that permit its use with any of the three standard mailbox sizes. It requires fewer parts and is easier to install than TxDOT's current design.

Researchers conducted the study described herein to evaluate the crashworthiness of the new design when used to attach the three standard size mailboxes to single and multiple support structures. Single supports evaluated included the 2 lb/ft (3 kg/m) steel winged channel support and the 2-in. (5.1 cm) thin walled steel tube. The Foresight Tubular Support was used for multiple mailbox installations. Tests results show that the new bracket is crashworthy, and the bracket is ready for immediate implementation.

Researchers also evaluated through crash tests, in conjunction with the new bracket, a modified version of the Foresight Tubular Support. It consists of a replacement footing attached to the above-ground support structure. Based on successful testing, the modified support system is ready for immediate use by TxDOT. Researchers anticipate that use of the modified support will reduce costs since parts of damaged installations are salvageable.

Some districts in the state use two winged channel supports for the size no. 2 mailbox for added strength. Since this configuration had never been tested, TxDOT engineers decided to examine its crashworthiness in the present study. One test was conducted for this purpose and these results indicated the system to be in compliance with national impact performance guidelines.

A vandal-proof mailbox constructed from ¼-in. (0.64 cm) steel plate was also evaluated through crash testing. Test results indicated that this type of mailbox should not be used on high-speed roadways due to the extreme hazard it poses to motorists. Researchers do not recommend its use on low-speed roadways unless it proves acceptable through testing.

I. INTRODUCTION

The Texas Department of Transportation (TxDOT) continues to be a leader in the design and use of traffic-safe, roadside mailbox installations. The number of serious vehicular accidents with mailboxes have been significantly reduced as a consequence. These designs have been adopted by AASHTO and used throughout the United States. Crash testing of various mailbox installations have been conducted at the Texas Transportation Institute (1,2,3,4,5).

To reduce costs and to simplify installation procedures, TxDOT engineers recently developed a new universal bracket to attach the mailbox to its support structure. As shown in Figure 1, it consists of a main section with two extensions or "wings" that permit its use with any of the three standard mailbox sizes (types 1, 1½, and 2). As shown in Figure 2, no extension is necessary for the size no.1 box, one extension is used for the size no. 1½ box, and both extensions are used for the size no. 2 box. The bracket can be used to attach the box(es) to a single support, such as the winged channel post or the thin-walled tube, or to the Foresight Tubular Support. It is simpler to install than TxDOT's current design and requires fewer parts.

The primary purpose of this study was to examine the crashworthiness of the bracket when used with the various mailbox-support structure configurations used by TxDOT. However, three other mailbox installations were also crash tested.

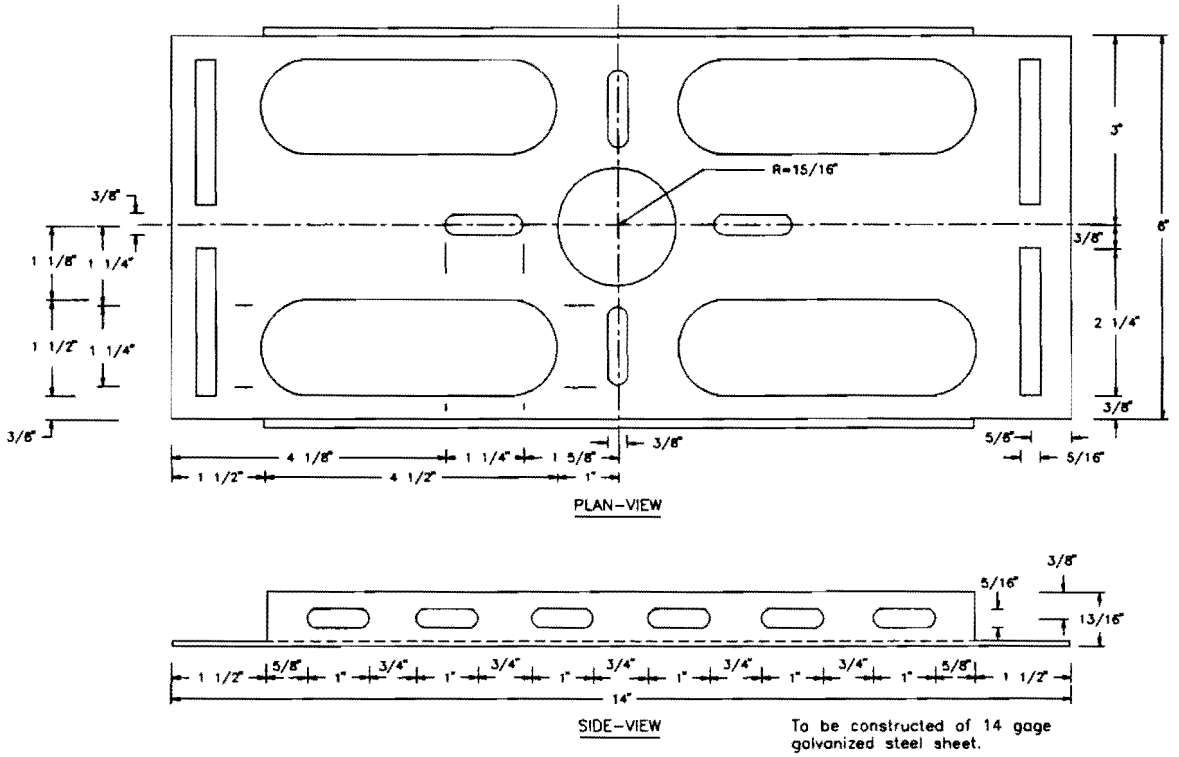
The researchers evaluated a modified version of the Foresight Tubular Support. It consists of a replacement footing attached to the above-ground support structure. In certain "nuisance" hits such as those that occur during mowing operations or low-speed impacts, damage typically consists of a bent section at or near the ground line. With the original design, this type of damage would require replacement of the entire support system since it consisted of one integral pipe section. With the modified design, only the replacement footing needs replacing.

Also evaluated in the study was a single size no. 2 mailbox supported on two winged channel posts. Some TxDOT districts use two supports for added strength. Since this configuration had never been tested, TxDOT engineers decided to examine its crashworthiness in the present study.

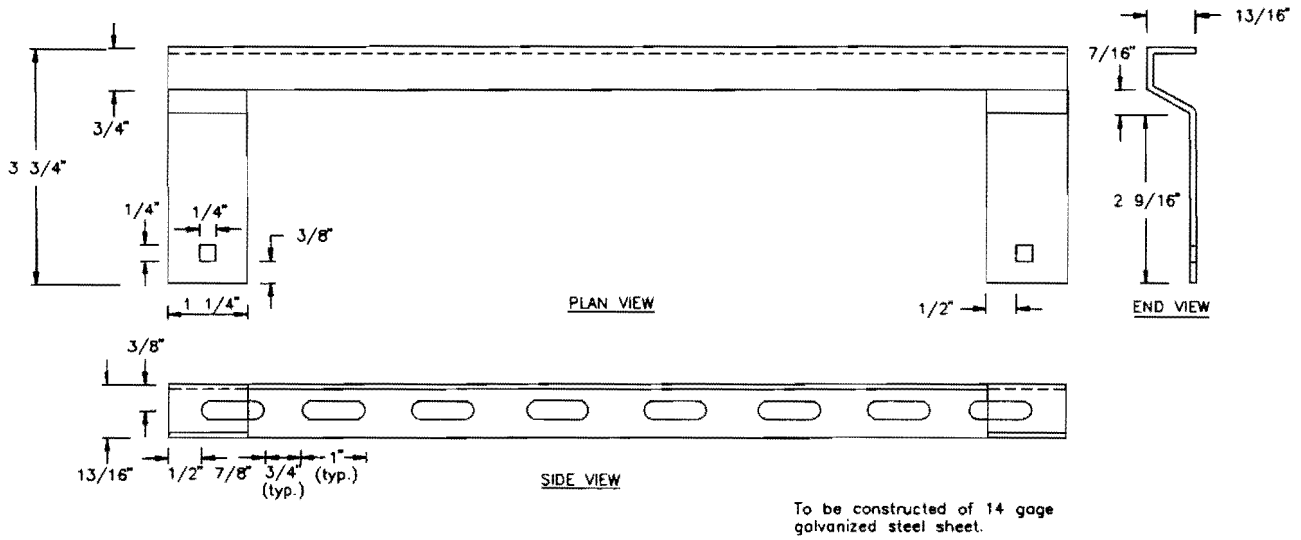
Vandalism is a major concern of owners of roadside mailboxes. Manufacturers are responding to this concern by marketing "vandal-proof" boxes. One such box that has appeared

on the market in Texas is constructed with ¼-in. (0.64 cm) thick steel plate. Due to concerns about the crashworthiness of this design, the decision was made to conduct a crash test. A size no. 1½ box, weighing approximately 55 lb (25.0 kg), supported on a standard winged channel support was tested.

Presented in Chapter II is a description of the crash test program, including detailed drawings of the various mailbox-support configurations examined. Chapter III contains the study conclusions.

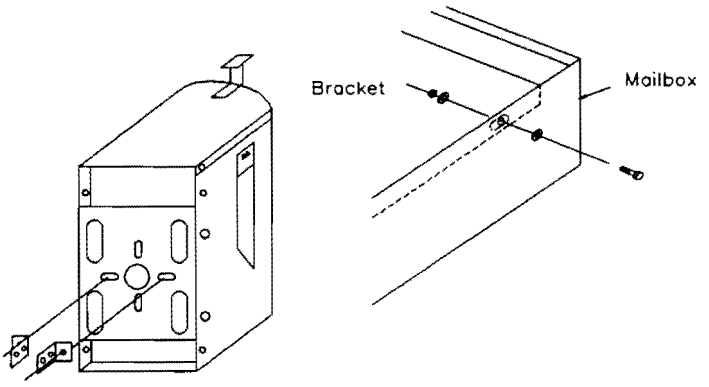


BRACKET

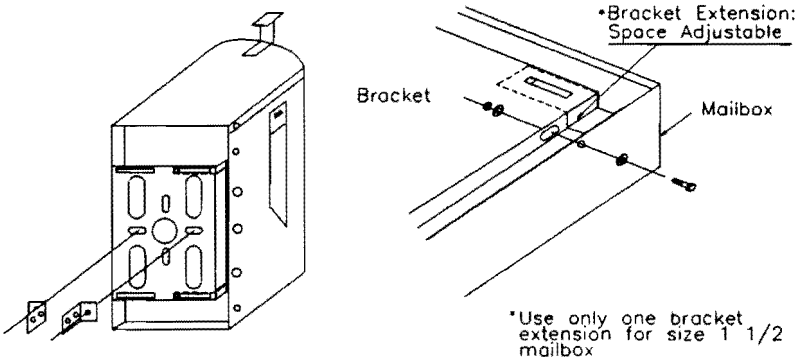


BRACKET EXTENSION

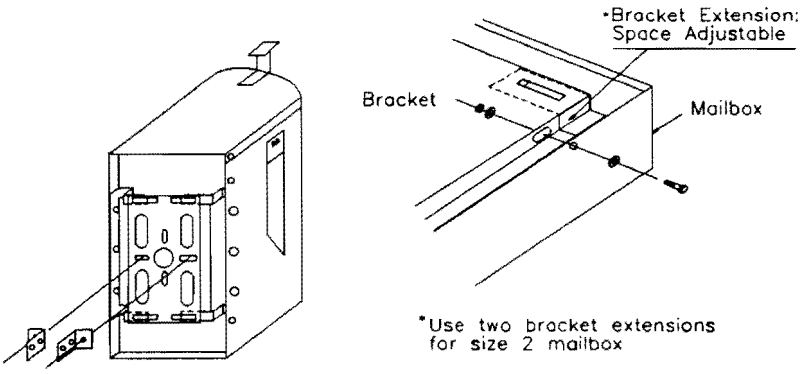
Figure 1. Universal mailbox bracket.



SIZE NO. 1 MAILBOX-TO-BRACKET ATTACHMENT



SIZE NO. 1 1/2 MAILBOX-TO-BRACKET ATTACHMENT



SIZE NO. 2 MAILBOX-TO-BRACKET ATTACHMENT

Figure 2. Mailbox-to-bracket attachment.

II. CRASH TEST PROGRAM

The researchers conducted a total of eleven full-scale crash tests. A summary of these tests is given in Table 1. Each test was conducted and evaluated in accordance with nationally recognized guidelines (6). In each test, a car weighing approximately 1,800 lb (817 kg) impacted the test article at approximately 60 mph (96.6 km/h). Initial impact point of the test article on the vehicle was approximately 15 in. (38.1 cm) to the left or right of the centerline of the vehicle on the front bumper. All test articles were embedded in the S-1 soil described in the guidelines (6). A 50th percentile anthropometric dummy weighing approximately 160 lb was placed in the driver's position and restrained with lap and shoulder belts.

According to Report 230 (6), test results are to be evaluated in terms of three criteria, namely "Structural Adequacy," "Occupant Risk," and "Vehicle Trajectory." Details of these criteria, test procedures, and data analysis procedures are given in Appendix A. As discussed subsequently, in some tests there were questions as to whether item D of the criteria was met. An absolute evaluation of the item D criteria is not always possible, and judgment must therefore be used in assessing results.

The purpose of the first eight tests was to determine the adequacy of a new bracket developed by TxDOT to attach the mailbox to the support post, when the mailbox installation was subjected to recommended crash tests. The researchers conducted tests with one and two mailboxes mounted on a single support and with multiple mailboxes mounted on the Foresight Tubular Support.

The ninth test was conducted with multiple mailboxes mounted on a modified version of the Foresight Tubular Support. The modified installation consisted of a replacement footing to facilitate use of salvaged parts from damaged supports and to minimize cost of replacement following a vehicular impact. The tenth test was conducted to evaluate a size no. 2 box supported on two winged channel posts. The eleventh and last test was conducted to examine the crashworthiness of a vandal-proof mailbox.

Drawings of the test articles for each of the eleven tests are given in Appendix B. These drawings are available on AutoCad files from TTI. Following are summaries of each test. Complete test reports are given in Appendices C through M.

TABLE 1. Summary of Crash Tests

Test No.	Test Article	Results
19452-1	Size no. 1 mailbox mounted with new bracket on a single 2 lb/ft (3 kg/m) channel post.	Test passed all evaluation criteria.
19452-2	Size no. 2 mailbox mounted with new bracket on a single 2 lb/ft (3 kg/m) channel post.	Mailbox struck, dished, but did not penetrate windshield. It was concluded this occurrence could and should be prevented.
19452-3	Same as test 19452-2 except additional fasteners and washers used to attach mailbox to bracket, and additional washers used with bolts that attach bracket to support angle.	Mailbox struck, dished, but did not penetrate windshield. It was concluded this occurrence could and should be prevented.
19452-4	Same as test 19452-3 except larger fasteners used to attach mailbox to bracket.	Test passed all evaluation criteria.
19452-5	Two size no. 1½ mailboxes mounted with new bracket on a single 2 lb/ft (3 kg/m) channel post. Number and size of mailbox-to-bracket fasteners same as test 19452-4.	Test passed all evaluation criteria.
19452-6	Size no. 2 mailbox mounted with new bracket on a single 2.375 in. (6.0 cm) x 0.095 in. (0.24 cm) thin-wall tube. Number and size of mailbox-to-bracket fasteners same as test 19452-4.	Test passed all evaluation criteria.
19452-7	Five size no. 1 mailboxes were mounted with new bracket on a Foresight Tubular Support. Number and size of mailbox-to-bracket fasteners same as test 19452-4.	Test passed all evaluation criteria.
19452-8	Three size no. 2 mailboxes were mounted with new bracket on a Foresight Tubular Support. Number and size of mailbox-to-bracket fasteners same as test 19452-4.	Test passed all evaluation criteria.
19453-9	Same as test 19452-8 except with modified Foresight Tubular Support, having a replacement footing.	Upstream mailbox struck, dished, but did not penetrate windshield. Test judged marginally acceptable (see discussion in Section II-9).
19453-10	Size no. 2 mailbox mounted with TxDOT's current bracket and current fasteners on two 2 lb/ft (3 kg/m) channel posts.	Test passed all evaluation criteria.
19453-11	Size no. 1½ vandal-proof mailbox mounted with new bracket on a single 2 lb/ft (3 kg/m) channel post. Number and size of mailbox-to-bracket fasteners same as test 19452-4.	Test was a failure. Mailbox penetrated occupant compartment.

II-1. Test 19452-1

A size no.1 mailbox was mounted on a single 2 lb/ft (3 kg/m) steel winged channel post. The mailbox was attached to the bracket (no extensions) with four 3/16-in. (0.48 cm) stove bolts. Other details of the installation are given in Appendix B. The test was successful and met all evaluation criteria.

II-2. Test 19452-2

A size no. 2 mailbox was mounted on a single 2 lb/ft (3 kg/m) steel winged channel support. The mailbox was attached to the bracket extensions with four 3/16-in. (0.48 cm) stove bolts. Other details of the installation are given in Appendix B.

The mailbox separated from the bracket extensions and the bracket separated from the angles upon impact, then struck and dished the windshield, although it did not penetrate the windshield. Examination of the test article showed that separation occurred for two reasons: (1) the bolts connecting the angle to the mailbox bracket pulled out of the slot in the bracket, and (2) the bolts connecting the mailbox to the bracket extensions sheared through the mailbox sheet metal. The researchers decided that these problems could and should be corrected.

II-3. Test 19452-3

The installation was the same as test 19452-2 with three exceptions: (1) two flat washers (one between the head and angle and one between the bracket and the lock washer) were added to each of the two bolts attaching the angles to the bracket, (2) two flat washers (one between the head and angle and one between the angle and the lock washer) were added to each of the two bolts attaching the angles to the support, and (3) six 3/16-in. (0.48 cm) stove bolts were used to attach the mailbox to the bracket extensions.

Behavior of the mailbox was similar to that in test 19452-2. However, the bracket and extensions remained with the angles and the support which achieved a partial solution of the problems seen in test 19452-2. Separation of the mailbox occurred when the six bolts connecting the box to the extensions sheared through the mailbox sheet metal. As before, researchers concluded that this problem could and should be corrected.

II-4. Test 19452-4

The installation was the same as test 19452-3 with one exception: the size of the stove bolts connecting the mailbox to the bracket extensions was increased to 1/4 in. (0.64 cm). Although the mailbox again separated from the bracket extensions, the larger stove bolts kept the box attached for a sufficient duration of time to allow the box to obtain a velocity approximately equal to that of the vehicle. Consequently, the box did not hit the windshield, and the test met all evaluation criteria.

II-5. Test 19452-5

Two size no. 1½ mailboxes were mounted on a single 2 lb/ft (3 kg/m) steel winged channel support. Each mailbox was attached to the bracket and one bracket extension with six 1/4-in. (0.64 cm) stove bolts. An adapter plate was used to attach the two brackets to the angles. Other details of the installation are given in Appendix B.

In this test, the boxes remained attached to the support. The test met all evaluation criteria.

II-6. Test 19452-6

One size no. 2 mailbox was mounted on a single 2.375 in. (6.0 cm) O.D. x O.095 in. (0.24 cm) thin-wall steel tube. The tube was mounted in a base socket. Attachment of the mailbox to the bracket extensions, attachment of the bracket to the angles, and attachment of the angles to the support (with the exception of bolt length) were the same as test 19452-4. Other details of the installation are given in Appendix B.

In this test the box and bracket separated from the angles, but only after the vehicle had knocked the installation to the ground and was riding over the installation. The test met all evaluation criteria.

II-7. Test 19452-7

Five size no. 1 mailboxes were mounted on a Foresight Tubular Support. Hardware used to attach each mailbox to the bracket and to attach the bracket to the angles were the same as that used in test 19452-4. Note that in this installation the 2-in. (5.1 cm) leg of the 2 in. (5.1

cm) x 3 in. (7.6 cm) angles was attached to the horizontal member of the Foresight Tubular Support with one 3/8-in. (0.95 cm) bolt. Other details of the installation are given in Appendix B.

Upon impact, all mailboxes remained attached as the support was pulled from the ground socket and projected up and over the car without any windshield contact. The test met all evaluation criteria.

II-8. Test 19452-8

Three size no. 2 mailboxes were mounted on a Foresight Tubular Support. Hardware used to attach each mailbox to the bracket and to attach the bracket to the angles were the same as that used in test 19452-4. Note that in this installation the 2-in. (5.1 cm) leg of the 2 in. (2.54 cm) x 3 in. (7.6 cm) angles was attached to the horizontal member of the Foresight Tubular Support with one 3/8-in. (0.95 cm) bolt. Other details of the installation are given in Appendix B.

Upon impact, all mailboxes remained attached as the support pulled from the ground socket and projected up and over the car without any windshield contact. The test met all evaluation criteria.

II-9. Test 19453-9

The test article was the same as that of test 19452-8 except a modified version of the Foresight Tubular Support was used. The modification consisted of a replacement footing which was attached to the support structure by two 5/16-in. (0.79 cm) bolts at the normal splice and a 3/8-in. (0.95 cm) bolt at the uppermost splice. The lower portion of the replacement footing was inserted in the ground socket. TxDOT standard drawings call for 3/8-in. (0.95 cm) bolts at the normal splice. However, the researchers learned after the test that the support assembly for this test, as provided by TxDOT, as well as those used in tests 19452-7 and -8 contained 5/16-in. (0.79 cm) bolts. Fortunately, none of the splices in tests 19452-7, -8, and 19453-9 failed. Nonetheless, the recommendation is that 3/8-in. (0.95 cm) bolts be used for both splices to insure structural adequacy. The installation was oriented such that the uppermost splice would be subjected to its most critical loading. Other details of the installation are given in Appendix B.

Upon impact, the support structure deformed, pulled from the ground socket, and subsequently the upstream mailbox on the support impacted and dished the windshield. Penetration of the windshield did not occur. Two items were identified as probable causes of the differences in behavior of the installation in this test with the two previous tests. First, and likely the dominant reason, the replacement footing in test 19453-9 was inserted approximately 11 in. (27.9 cm) into the ground socket, whereas the support in tests 19452-7 and -8 were inserted approximately 9 in. (22.9 cm). The 42 in. (106.7 cm) dimension from the top of the horizontal member of the support structure to the ground controlled the insertion depth in all three tests. The researchers believe that the added insertion depth of the replacement footing in test 19453-9 increased the force needed to pull the footing from the socket, which resulted in further deformation of the support structure by the vehicle and, hence, contact of the mailbox with the windshield. Secondly, the horizontal distance from the front bumper to the lower edge of the windshield of the vehicle used in test 19453-9 was approximately 2 in. (5.1 cm) less that the vehicles used in tests 19452-7 and -8.

The primary purpose of this test was to verify the structural adequacy of the modified support structure, primarily the uppermost splice. The test did in fact verify the adequacy of the modified support. It is the researchers' opinions that had the insertion depth of the replacement footing been approximately 9 in. (22.9 cm) or less, the impact behavior of the modified installation would have been essentially the same as that observed in test 19452-8. Thus, the conclusion is that the modified design will meet all impact performance evaluation criteria when the replacement footing is inserted 9 in. (22.9 cm) or less into the ground socket.

Results of test 19453-9 underscore the critical effect that seemingly minor design and installation details can have on the impact behavior of a safety feature. In this case it points to the need to limit the insertion depth, whether it be the standard design or the modified design, to 9 in. (22.9 cm) or less.

II-10. Test 19453-10

A size no. 2 mailbox was mounted on two 2 lb/ft (3 kg/m) steel winged channel posts. The mailbox was attached to TxDOT's current bracket design by six 3/16-in. (0.48 cm) stove

bolts, with 1/2-in. (1.27 cm) pipe spacers being used between the bracket and the mailbox. Details of the installation are given in Appendix B.

The test met all evaluation criteria.

II-11. Test 19453-11

A special size no. 1½ vandal-proof mailbox was mounted on a single 2 lb/ft (3 kg/m) steel winged channel post. The box was fabricated from 1/4-in. (0.64 cm) steel plate and weighed approximately 55 lb (25.0 kg). The mailbox was attached to the bracket and one bracket extension with six 1/4-in. (0.64 cm) stove bolts. Other details of the installation are given in Appendix B.

Upon impact, the support pulled from the ground, the box and support then impacted the windshield; the box penetrated the occupant compartment and struck the dummy placed in the driver's position. This type of performance is clearly unacceptable.

III. CONCLUSIONS

Tests described herein verify that the new TxDOT mailbox bracket with extensions meets national impact performance guidelines when used with various support structures, provided proper attachment hardware (number and sizes of bolts, nuts, and washers) as described herein is used. Acceptable impact performance has been demonstrated for use of the bracket with (a) a 2 lb/ft (3 kg/m) steel winged channel single support with a size no. 1 mailbox, (b) a 2 lb/ft (3 kg/m) steel winged channel single support with a size no. 2 mailbox, (c) a 2 lb/ft (3 kg/m) steel winged channel single support with two size no. 1½ mailboxes, (d) a 2-in. (5.1 cm) O.D. thin wall steel tube single support with a size no. 2 mailbox, (e) a standard Foresight Tubular Support with five size no. 1 mailboxes, (f) a standard Foresight Tubular Support with three size no. 2 mailboxes, and (g) a modified Foresight Tubular Support with three size no. 2 mailboxes.

Researchers judged that, based on test results, the modified Foresight Tubular Support with the replacement footing is acceptable with the following proviso. The replacement footing should not be inserted more than 9 in. (22.9 cm) into the ground socket. Also, the vertical support member of the standard or unmodified Foresight Tubular Support system should not be inserted more than 9 in. (22.9 cm) into the ground socket. Smaller insertion depths enhance impact performance.

A size no. 2 mailbox mounted on two 2 lb/ft (3 kg/m) steel winged channel posts using TxDOT's current bracket design and current attachment fasteners meet national impact performance guidelines.

A vandal-proof size no. 1½ mailbox fabricated from ¼-in. (0.64 cm) steel plate mounted on a 2 lb/ft (3 kg/m) steel winged channel post is unacceptable. Upon impact, the box penetrated the occupant compartment at a high relative speed and would have caused serious or fatal injuries. Use of this box on high-speed roadways should not be permitted. Its use on low-speed roadways is not recommended unless it can be demonstrated to be acceptable through crash testing.

APPENDIX A

NCHRP REPORT 230
EVALUATION CRITERIA, TEST PROCEDURES, AND DATA ANALYSIS PROCEDURES

Evaluation Criteria

Researchers evaluated all crash tests in accordance with the criteria presented in NCHRP Report 230 (6). As stated in NCHRP Report 230, "Safety performance of a highway appurtenance cannot be measured directly but can be judged on the basis of three factors: structural adequacy, occupant risk, and vehicle trajectory after collision." In accordance, the following safety evaluation criteria from Table 6 (NCHRP Report 230) were used:

- Structural Adequacy

  (B) The test article shall readily activate in a predictable manner by breaking away or yielding.
  (D) Detached elements, fragments, or other debris from the test article shall not penetrate or show potential for penetrating the passenger compartment or present undue hazard to other traffic.

- Occupant Risk

  (E) The vehicle shall remain upright during and after collision although moderate roll, pitching, and yawing are acceptable. Integrity of the passenger compartment must be maintained with essentially no deformation or intrusion.
  (F) Impact velocity of a hypothetical front seat passenger against the vehicle interior, calculated from the vehicle accelerations and 24 in. (0.61 m) forward and 12 in. (0.30 m) lateral displacement, shall be less than:

Occupant Impact Velocity - fps	
Longitudinal	Lateral
15	N./A.

  and vehicle highest 10 ms average accelerations subsequent to instant of hypothetical passenger impact should be less than:

Occupant Ridedown Accelerations - g's	
Longitudinal	Lateral
15	N./A.

- Vehicle Trajectory

  (H) After collision, the vehicle trajectory and final stopping position shall intrude a minimum distance, if at all, into adjacent traffic lanes.
  (J) Vehicle trajectory behind the test article is acceptable.

Description of Crash Test Procedures

NCHRP Report 230 guidelines recommend two crash tests for the evaluation of small support yielding installations such as the rural mailbox installation:

> **Modified NCHRP Test Designation 62:** 1,800-lb (816-kg) vehicle impacting the sign support at a speed of 20 mph (32.3 km/h) with the quarter point of the vehicle bumper.
>
> **NCHRP Test Designation 63:** 1,800-lb (816-kg) vehicle impacting the sign support at a speed of 60 mph (96.5 km/h) with the quarter point of the vehicle bumper.

The crash test procedures were in accordance with the guidelines presented in NCHRP Report 230. Instrumentation of the test vehicle included three rate transducers to measure roll, pitch, and yaw rates and a triaxial accelerometer near the vehicle center of gravity to measure acceleration. The electronic signals from the accelerometers and transducers were telemetered to a base station for recording on magnetic tape and for display on a real-time strip chart. There was a provision for transmission of calibration signals before and after the test, and data was simultaneously recorded with an accurate time reference signal. Contact switches on the bumper were actuated just prior to impact by wooden dowels to indicate the elapsed time over a known distance to provide a measurement of impact velocity. The initial contact also produced an "event" mark on the data record to establish the exact instant of impact.

In accordance with NCHRP Report 230, an uninstrumented special-purpose 50th percentile anthropomorphic test dummy was positioned in the front seat of the test vehicle. The dummy was used to create an asymmetrical vehicle mass distribution. The effect of this load configuration was used to evaluate vehicle stability during impact.

Photographic coverage of the tests included two high-speed cameras, one perpendicular to the sign installation and the other located downstream at approximately 45 degrees from the point of impact. The films from these cameras were used to observe phenomena occurring during collision and to obtain time-event, displacement, and angular data. A 3/4-in. (1.91 cm) video camera and 35 mm still cameras were also used for documentary purposes.

Data Analysis Procedures

A microcomputer digitized analog data from the accelerometers and transducers for analysis and evaluation of performance. Two computer programs, DIGITIZE and PLOTANGLE, then analyzed the digitized data. Brief descriptions of these two computer programs follow.

The DIGITIZE program uses digitized data from vehicle-mounted linear accelerometers to compute occupant/compartment impact velocities, time of occupant/compartment impact after vehicle impact, and the highest 0.010-second average ridedown acceleration. The DIGITIZE program also calculates vehicle impact velocity and the change in vehicle velocity at the end of a given impulse period. In addition, maximum average accelerations over 0.050-second intervals in each of three directions are computed. Acceleration versus time curves for the longitudinal, lateral, and vertical directions are then plotted from the digitized data of the vehicle-mounted linear accelerometers using commercially available software (Quattro Pro 4.0).

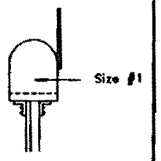
The PLOTANGLE program uses the digitized data from the yaw, pitch, and roll rate transducers to compute angular displacement in degrees at 0.00067-second intervals and then instructs a plotter to draw a reproducible plot: yaw, pitch, and roll versus time. These displacements are in reference to the vehicle-fixed coordinate system with the initial position and orientation of the vehicle-fixed coordinate system being that which existed at initial impact.

APPENDIX B

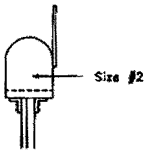
TEST ARTICLE DRAWINGS

TEST MATRIX OF PROJECT 1945

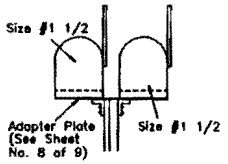
TEST NO.1



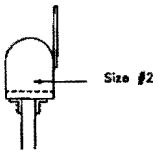
TEST NO.2, NO.3, NO.4



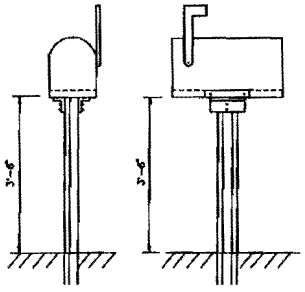
TEST NO.5

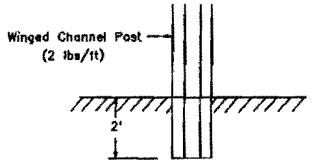


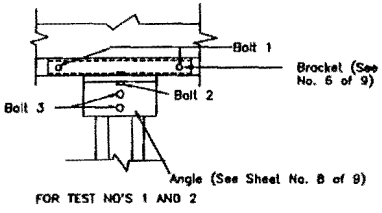
TEST NO.6



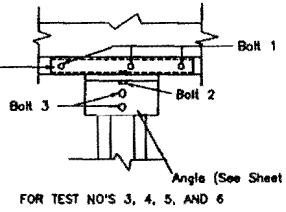
For Bracket/Mailbox Attachment See Sheet No. 5 of 9



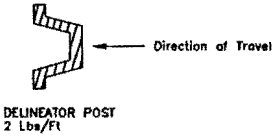




FOR TEST NO'S 1 AND 2



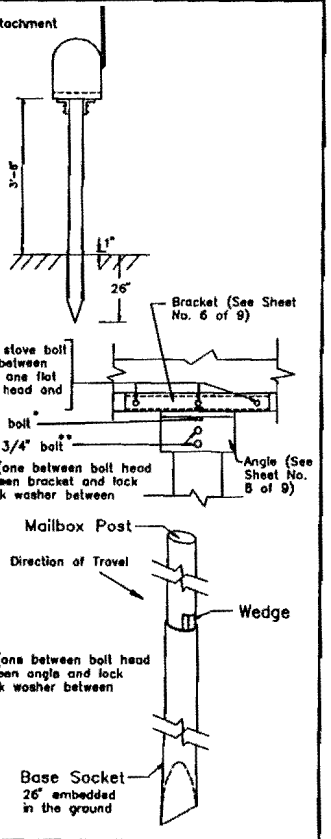
FOR TEST NO'S 3, 4, 5, AND 6



BOLT DESCRIPTION

	TEST NO.1	TEST NO.2	TEST NO.3	TEST NO.4	TEST NO.5
BOLT 1	4 Ea. 3/16" dia.x 1/2" stove bolts w/ 2 washers and 1 nut per bolt	same as TEST NO.1	6 Ea. 3/16" dia.x 1/2" stove bolts w/ 2 washers and 1 nut per bolt	6 Ea. 1/4" dia.x 3/4" bolts w/ 2 washers and 1 nut per bolt	same as TEST NO.4
BOLT 2	2 Ea. 3/8" dia.x 1" bolt w/ 1 lock washer & nut per bolt	same as TEST NO.1	same as test no.1 but two flat washers (one between bolt head and angle, one between bracket and lock washer) are added to each bolt	same as TEST NO.3	same as TEST NO.3
BOLT 3	2 Ea. 3/8" dia.x 2 3/4" bolt w/ 1 lock washer & nut per bolt	same as TEST NO.1	same as test no.1 but two flat washers (one between bolt head and angle, one between angle and lock washer) are added to each bolt	same as TEST NO.3	same as TEST NO.3

For Bracket/Mailbox Attachment See Sheet No. 5 of 9



* w/ two flat washers(one between bolt head and angle, one between bracket and lock washer) and one lock washer between flat washer and nut

** w/ two flat washers(one between bolt head and angle, one between angle and lock washer) and one lock washer between flat washer and nut

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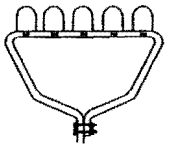
Title: MAILBOX DETAILS

Sheet No. 1 OF 9

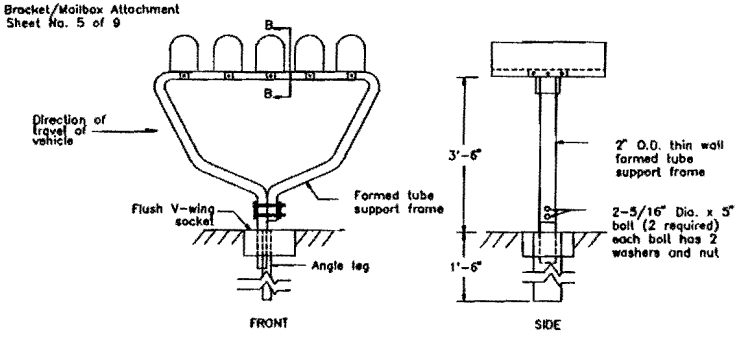
TEST MATRIX OF PROJECT 1945

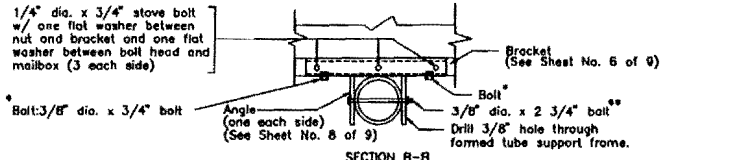
TEST NO.7

FIVE #1 MAILBOXES



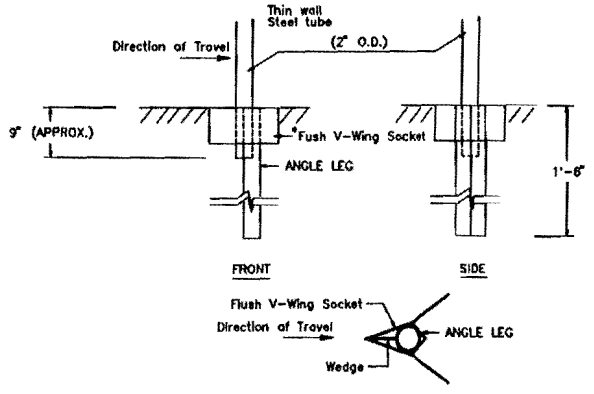
For Bracket/Mailbox Attachment
See Sheet No. 5 of 9





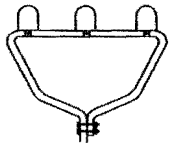
* w/ two flat washers(one between bolt head and angle, one between bracket and lock washer) and one lock washer between flat washer and nut

** w/ two flat washers(one between bolt head and angle, one between angle and lock washer) and one lock washer between flat washer and nut



TEST NO.8

THREE #2 MAILBOXES



For Bracket/Mailbox Attachment
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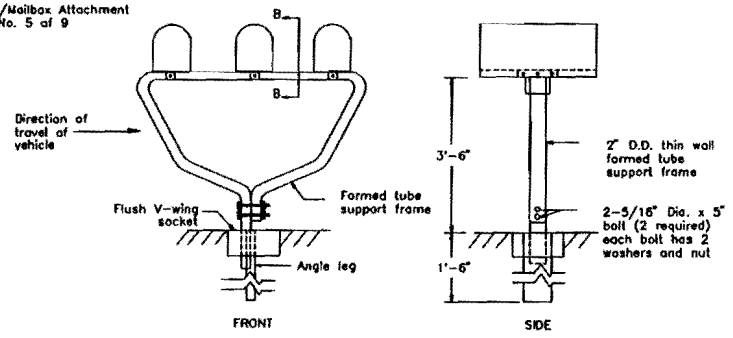
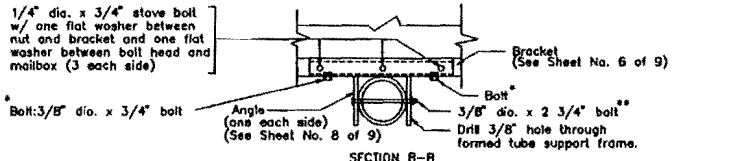
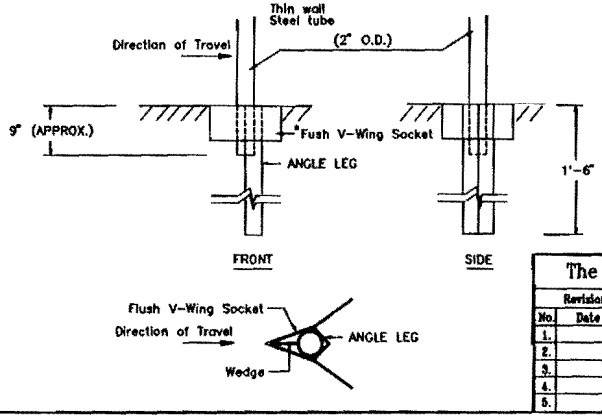




* w/ two flat washers(one between bolt head and angle, one between bracket and lock washer) and one lock washer between flat washer and nut

** w/ two flat washers(one between bolt head and angle, one between angle and lock washer) and one lock washer between flat washer and nut



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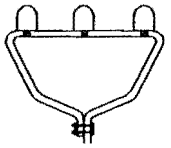
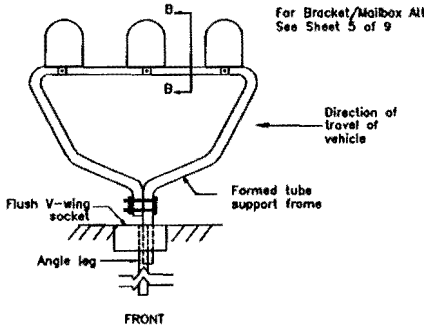
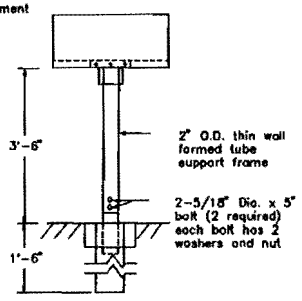
TEST MATRIX OF PROJECT 1945

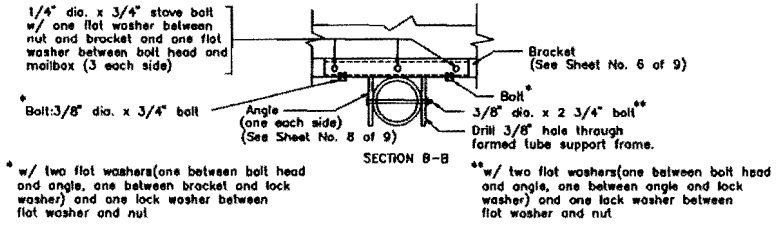
TEST NO.9

THREE #2 MAILBOXES



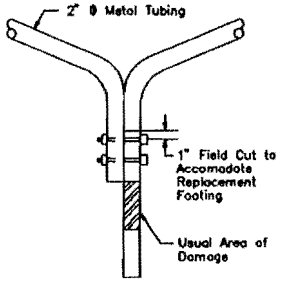




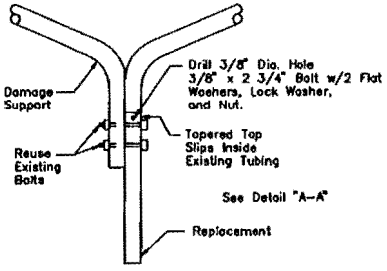


* w/ two flat washers(one between bolt head and angle, one between bracket and lock washer) and one lock washer between flat washer and nut

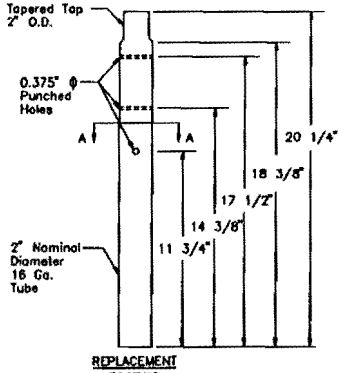
** w/ two flat washers(one between bolt head and angle, one between angle and lock washer) and one lock washer between flat washer and nut



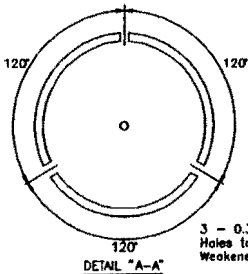
TYPICAL MULTIPLE MAILBOX MOUNT



REPAIR DETAIL



REPLACEMENT FOOTING



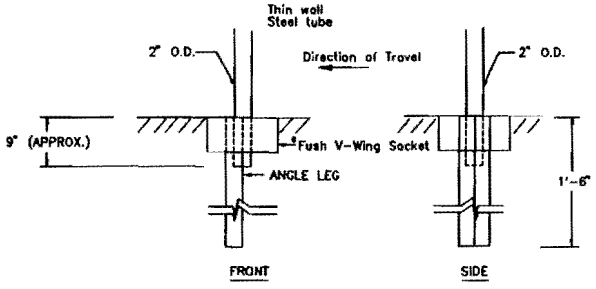
DETAIL "A-A"

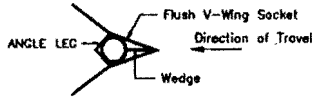
3 - 0.375 Dia. punched Holes to Create Weakened Section

NOTES:

Only damaged multiple mailbox mounts having no visible damage other than to the portion of the footing that is to be discarded may be repaired.

Material for the repair footing is to be AISI-1008 hot rolled carbon steel. The unit shall be galvanized.





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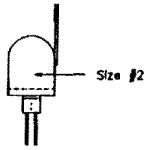
TEST MATRIX OF PROJECT 1945

TEST NO. 10



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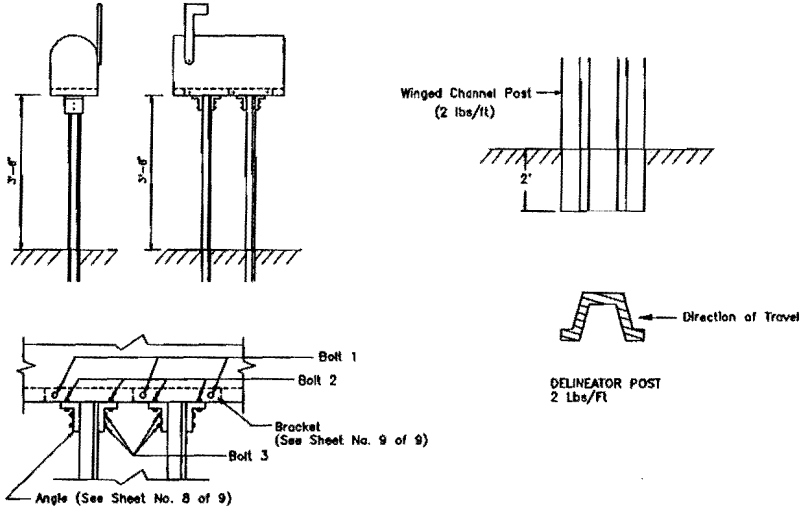
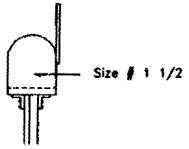
See Sheet No. 5 of 9



TEST NO. 11



For Bracket/Mailbox Attachment
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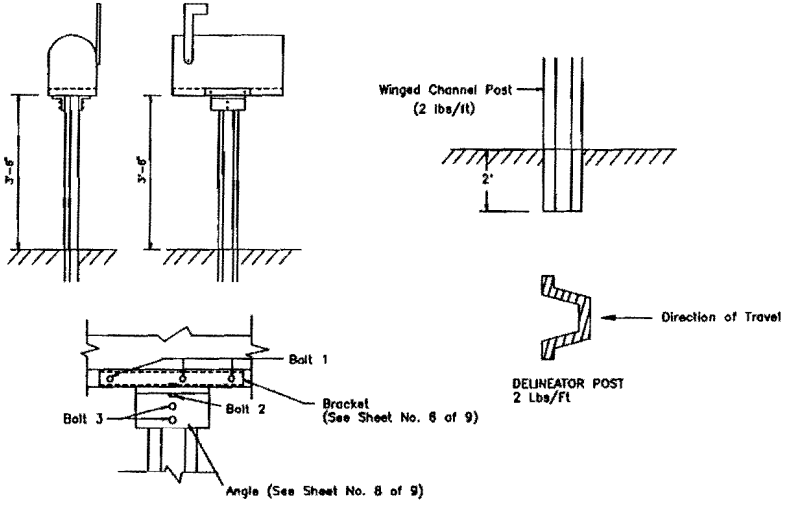

BOLT DESCRIPTION

	TEST NO. 10	TEST NO. 11
BOLT 1	6 Ea. 3/16" dia. x 3" length stove bolt w/ 2 washers and 1 nut per bolt	6 Ea. 1/4" Dia. x 3/4" bolts w/2 flat washers and 1 nut per each bolt
BOLT 2	2 Ea. 3/8" dia. x 3/4" bolt, each bolt has a lock washer and nut	2 Ea. 3/8" dia. x 3/4" bolt w/ 2 flat washers (one between bolt head and angle, one between bracket and and lock washer) and nut per bolt
BOLT 3	2 Ea. 3/8" dia. x 2 1/2" bolt w/ lock washer and nut	2 Ea. 3/8" dia. x 2 1/2" bolt w/2 flat washers (one between bolt head and angle, one between angle and lock washer), lock washer and nut per each bolt

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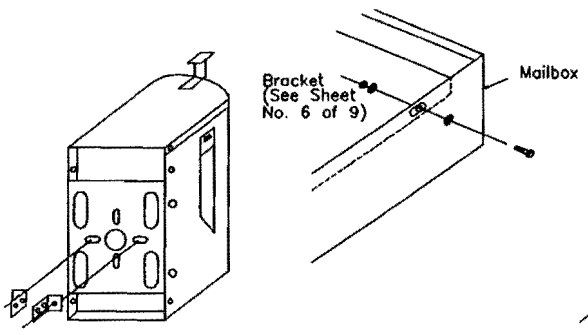
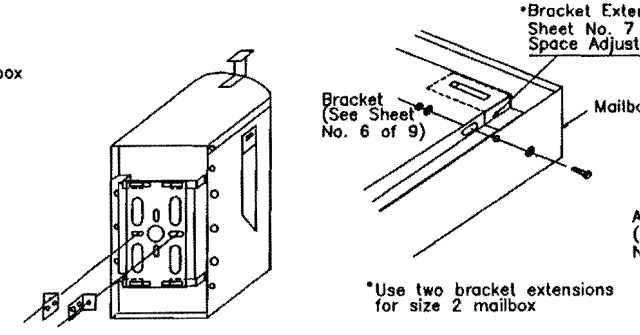
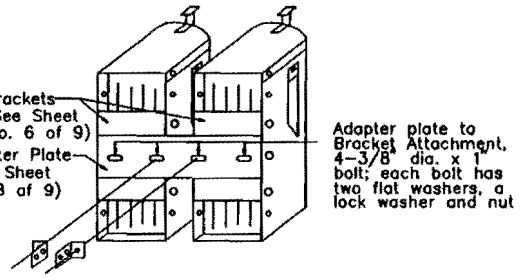


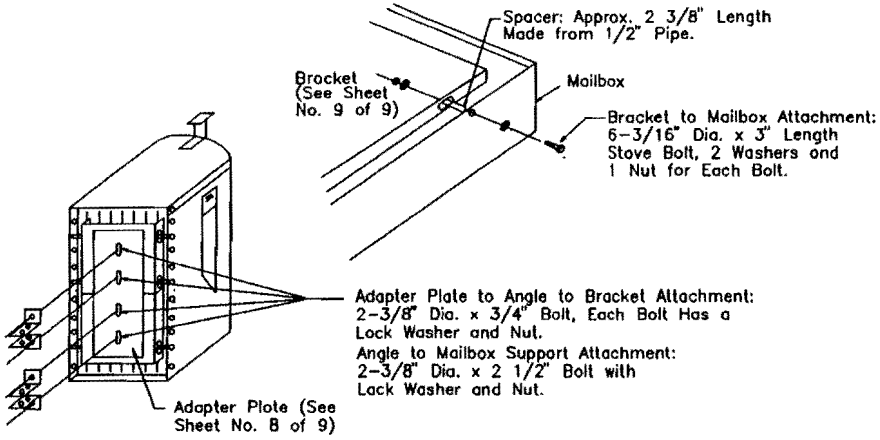
SIZE NO. 1 MAILBOX FOR TEST NO'S 1 AND 7



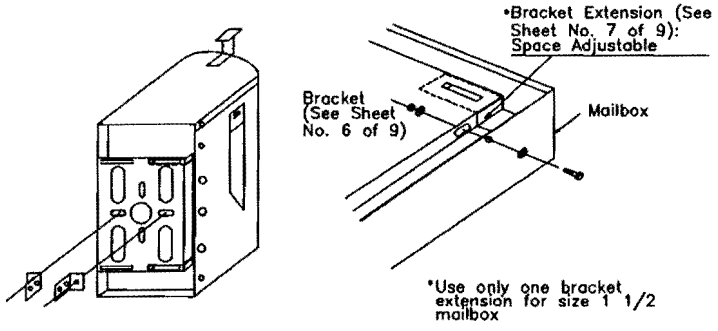
SIZE NO. 2 MAILBOX FOR TEST NO'S 2, 3, 4, 6, 8, AND 9



DOUBLE MAILBOX MOUNT
(Not permitted for No.2 Mailboxes)



SIZE NO. 2 MAILBOX FOR TEST NO. 10



SIZE NO. 1 1/2 MAILBOX FOR TEST NO'S 5 AND 11

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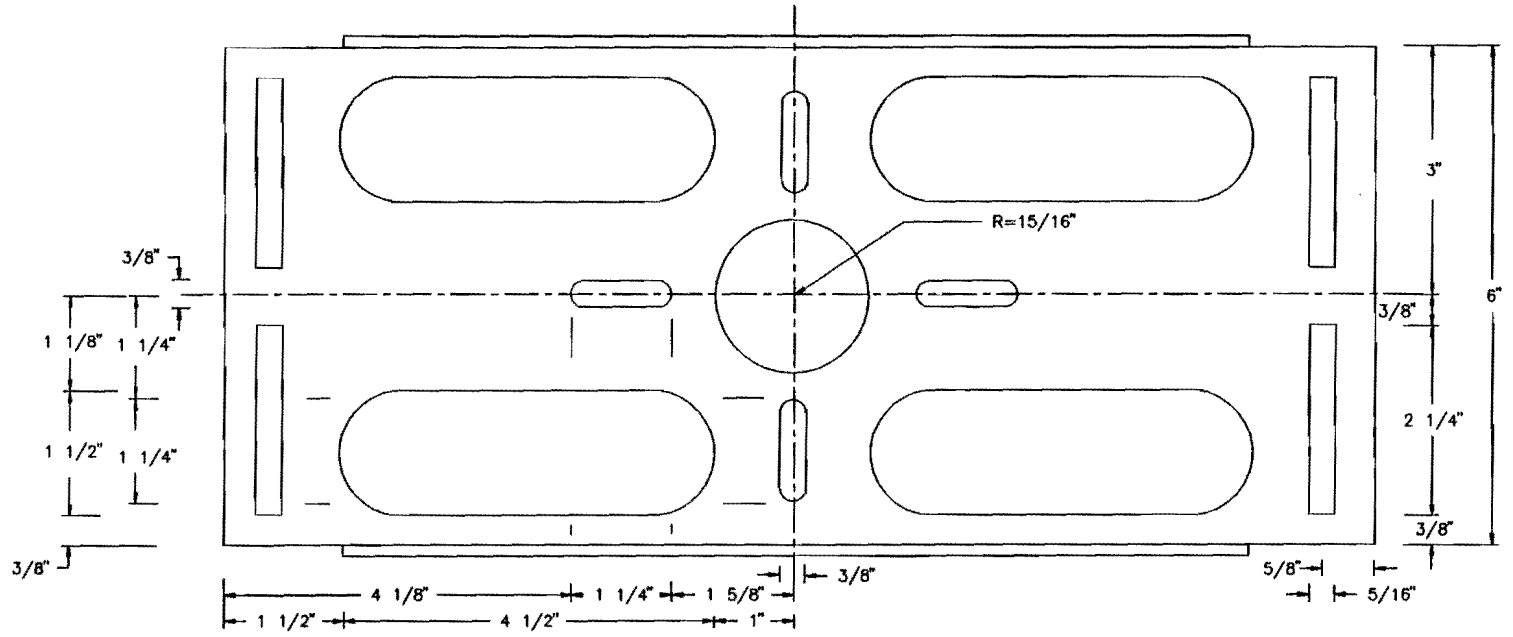
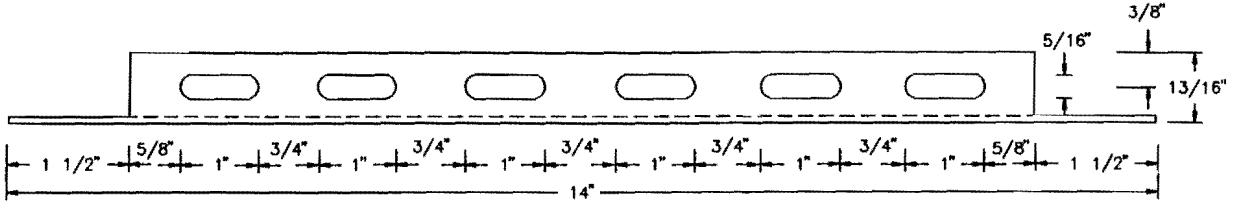
BRACKET FOR TEST NO'S 1, 2, 3, 4, 5, 6, 7, 8, 9, AND 11



PLAN–VIEW



SIDE–VIEW

To be constructed of 14 gage galvanized steel sheet.

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Project No.	Date	Drawn By	Scale
1945	1993		as shown

Title: MAILBOX DETAILS

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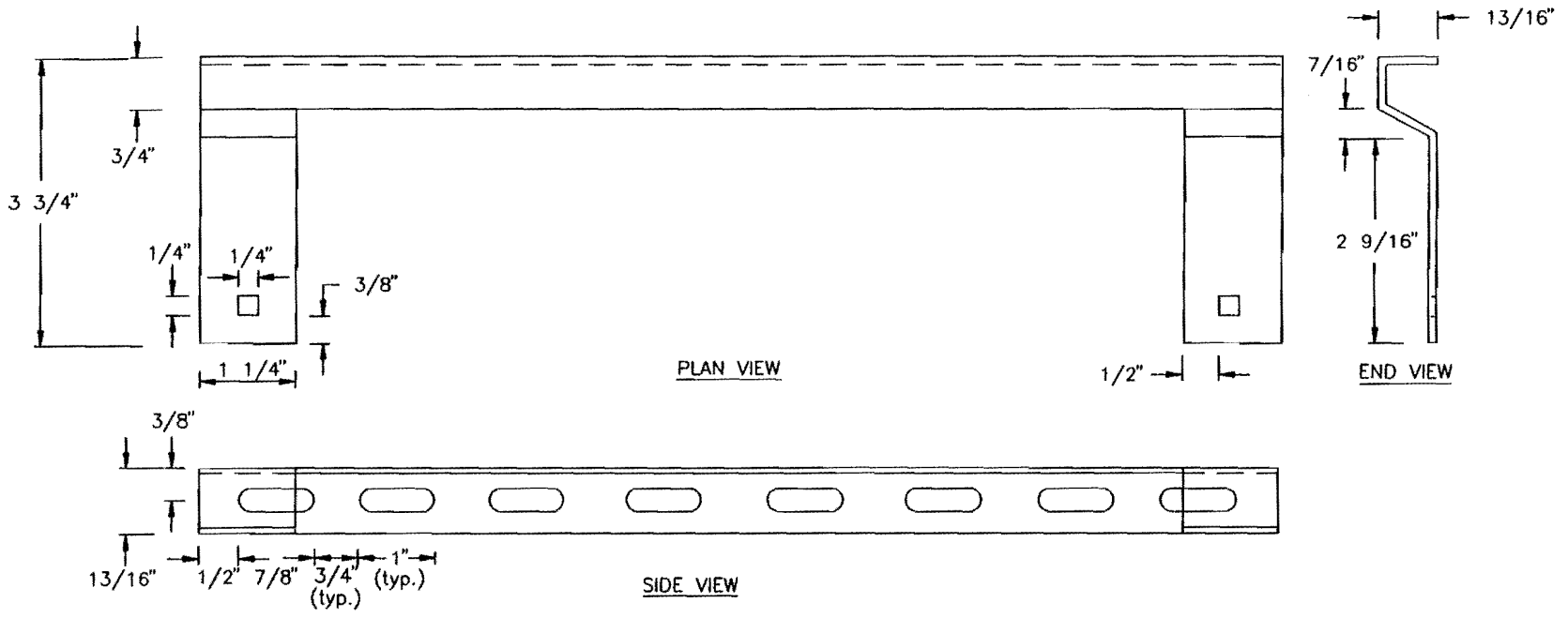

BRACKET EXTENSION FOR TEST NO'S 2, 3, 4, 5, 6, 8, 9, AND 11

To be constructed of 14 gage galvanized steel sheet.

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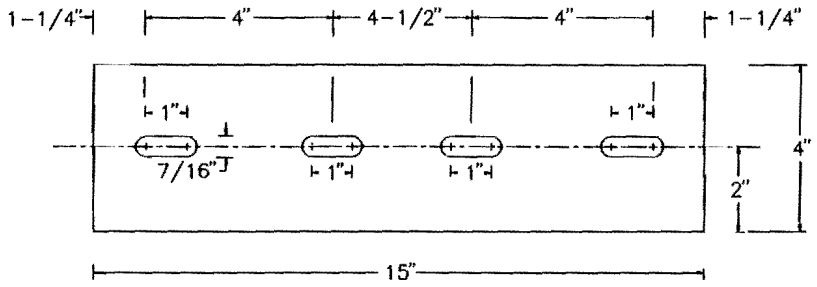
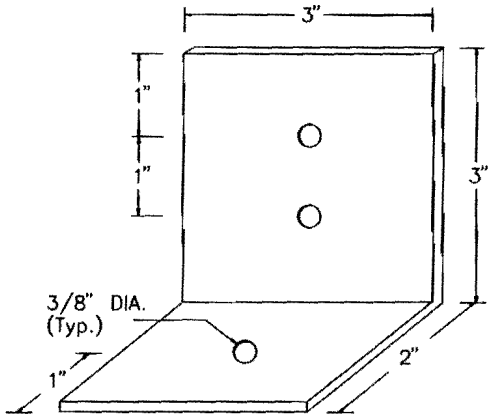
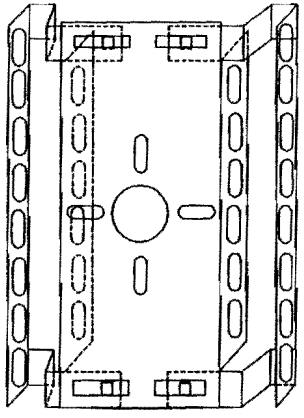


HOLES SHALL HAVE A DIAMETER OF 7/16"

ADAPTER PLATE FOR TEST NO'S 5 AND 10



ANGLE FOR ALL TESTS



BRACKET / BRACKET EXTENSION

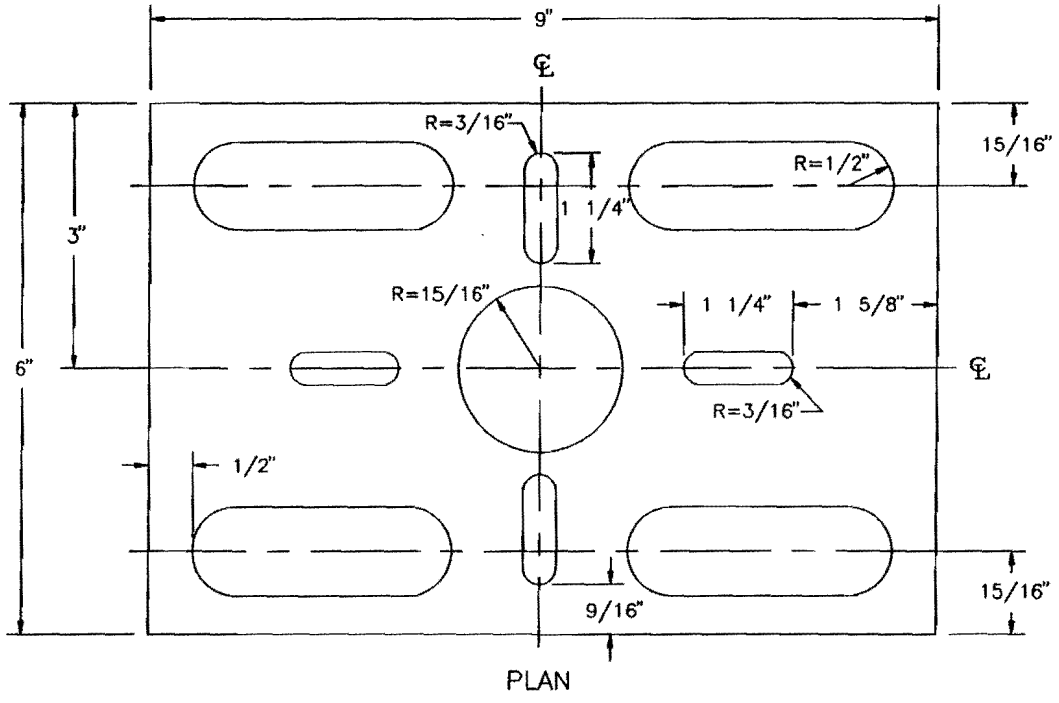
Note: Use 4-1/4"x3/4" Carriage Bolts w/ flat washer and lock washer to attach extension wings to bracket. For dimensions refer to Dwg.4 of 5 and Dwg.5 of 5

Hardware for mounting mailboxes to support/foundation furnished by Foresight Industries or equivalent may be used when approved by the Engineer

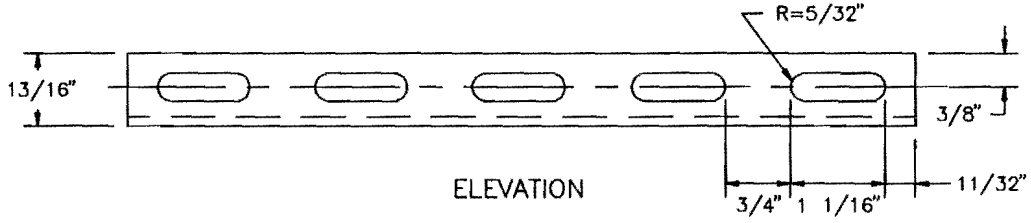
The bracket is to be constructed of 14 gage galvanized steel sheet. The angle is to be constructed of 14 gage galvanized steel sheet. The adapter is to be constructed of 12 gage steel sheet. The angle and adapter may be galvanized before or after fabrication in accordance with ASTM A568. The angle must be formed into the 90 degree bend without damage to the galvanizing coating. The base metal of the angle and adapter plate must have sufficient ductility to be bent flat upon itself without breaking. Items with wet storage stains (white rust) will not be accepted.

The Texas A&M University System						
Revisions			TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843			
No.	Date	By	Project No. 1945	Date 1993	Drawn By	Scale AS SHOWN
1.			Title MAILBOX DETAILS			Sheet No. 8 OF 9
2.						
3.						
4.						
5.						

BRACKET FOR TEST NO. 10



PLAN



ELEVATION

To be constructed of 14 gage galvanized steel sheet.

The Texas A&M University System					
Revisions			TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843		
No.	Date	By	Project No. 1945	Date 1993	Drawn By
1.			Scale As shown		
2.					
3.			Title MAILBOX DETAILS		
4.			Sheet No. 9 OF 9		
5.					

APPENDIX C

TEST 19452-1 REPORT

Test 19452-1

The test article consisted of a size no. 1 mailbox mounted on a single 2 lb/ft (3 kg/m) steel winged channel post. The mailbox was attached to the universal bracket (no extensions) with four 3/16-in. (0.48 cm) stove bolts. Further details of the test article are given in Appendix B. Figures C-1 and C-2 show photos of the test article. Figure C-3 shows the 1988 Yugo GV test vehicle. Figure C-4 shows the position of the vehicle with respect to the test article at impact. Impact speed was 58.7 mph (94.4 km/h). Impact point was the front left quarter point of the vehicle's bumper. Test inertia mass of the vehicle was 1,800 lb (816 kg) and its gross static mass was 1,968 lb (893 kg). Other vehicular dimensions and information are given in Figure C-5.

The vehicle was free wheeling and unrestrained just prior to impact. Upon impact, the support began to yield and pocket around the front of the vehicle. By approximately 0.025 second, the support had yielded sufficiently enough to allow the mailbox to strike the hood of the vehicle. At 0.054 second, the mailbox still attached to the support struck the ground. Shortly thereafter, the mailbox was pulled off of the support and was dragged in front of the vehicle. The vehicle passed over the support, the brakes were applied, and the vehicle came to rest 320 ft (97.6 m) from the point of impact. Figure C-6 shows sequential photographs of the test.

Figures C-7 and C-8 show test article damage. As shown, the support bent at ground level and the mailbox attachment bracket remained attached to the support. The mailbox components came to rest approximately 72.5 ft (22.1 m) from the point of impact. The vehicle sustained only minor damage to the bumper and hood as shown in Figure C-9.

A summary of test results and other pertinent information are given in Figure C-10. The maximum 0.050 second average acceleration experienced by the vehicle was -1.3 g in the longitudinal direction and 0.4 g in the lateral direction. No occupant contact occurred in the longitudinal or lateral direction. Figure C-11 shows the plotted angular displacements of the vehicle and vehicular accelerations are plotted in Figures C-12 through C-14. Change in the velocity of the vehicle was 1.4 mph (2.3 km/h).

In summary, the test was successful and met all evaluation criteria.

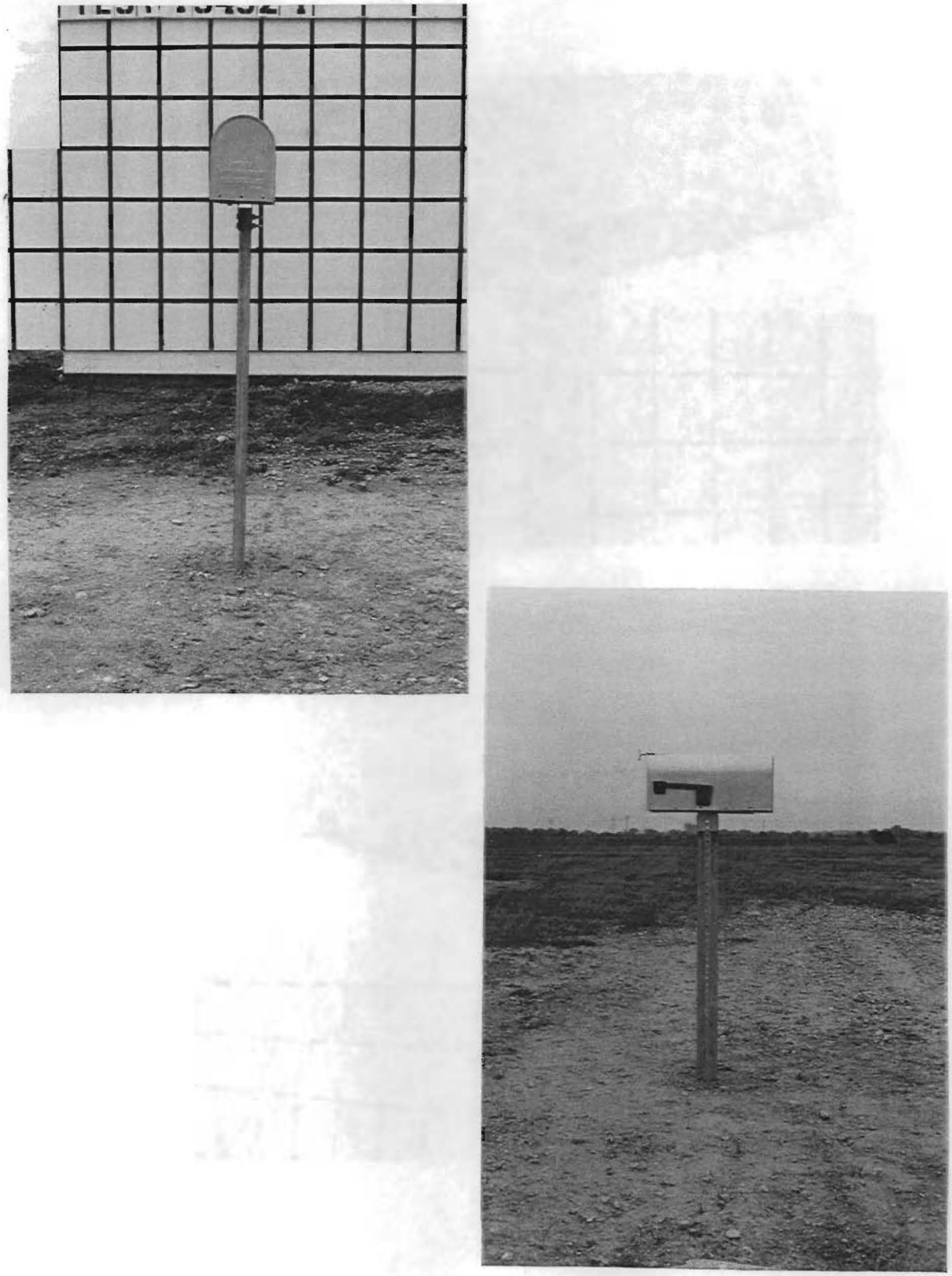


Figure C-1. Mailbox installation for test 19452-1.

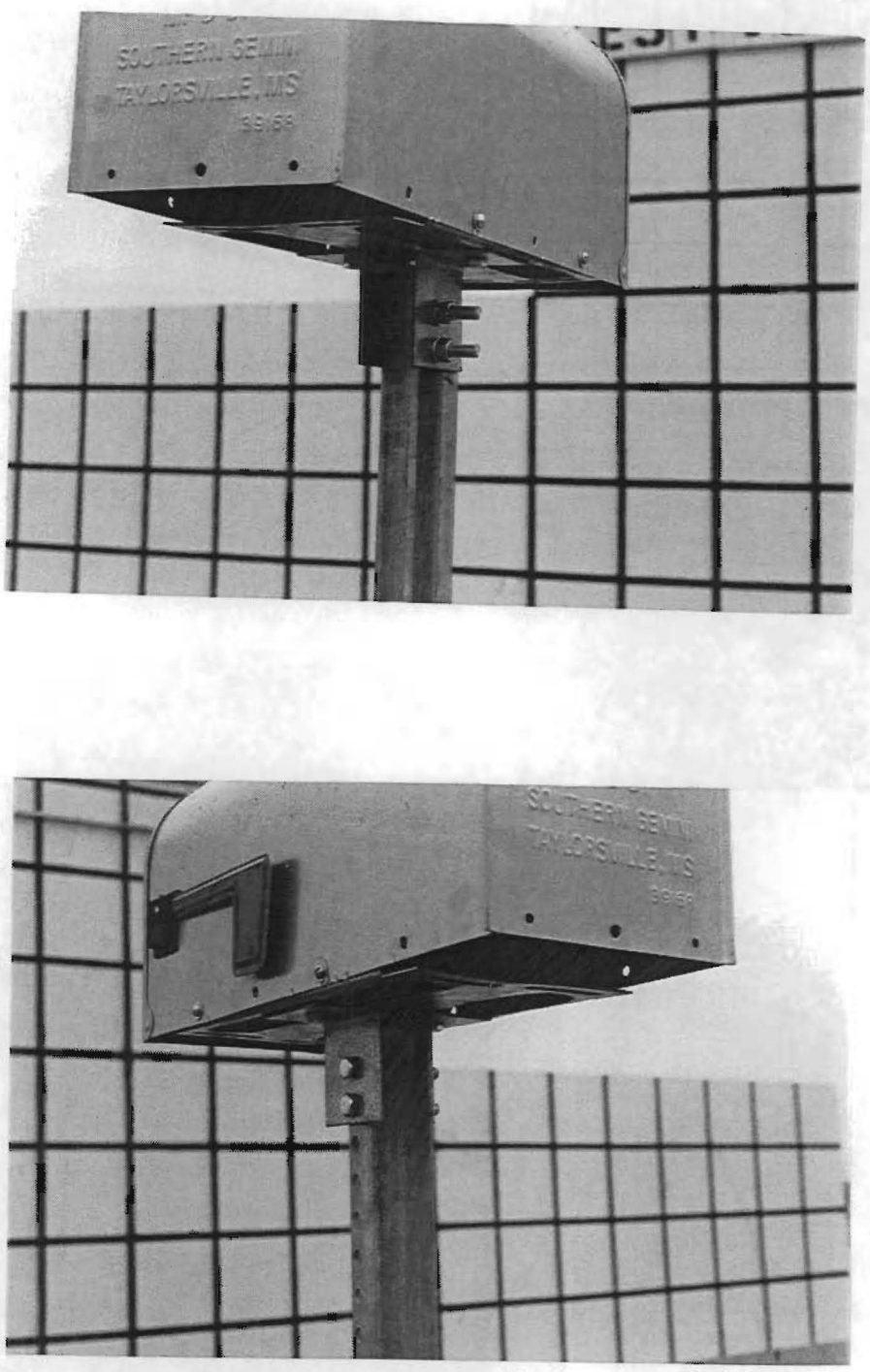


Figure C-2. Mailbox/support connection for installation used in test 19452-1.

Figure C-3. Vehicle before test 19452-1.

Figure C-4. Vehicle/mailbox geometrics for test 19452-1.

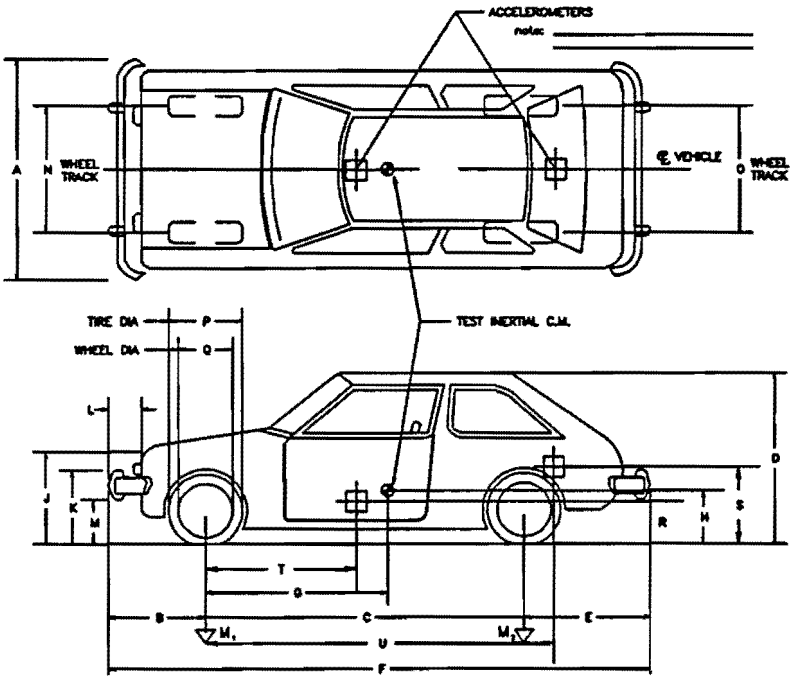
DATE: 7-22-92 TEST NO.: 19452-1 VIN NO.: VX1BA1216JK404378 MAKE: Yugo

MODEL: GV YEAR: 1988 ODOMETER: 48466 TIRE SIZE: 145R13

TIRE INFLATION PRESSURE: _____

MASS DISTRIBUTION (kg) LF 250 RF 252 LR 156 RR 158

DESCRIBE ANY DAMAGE TO VEHICLE PRIOR TO TEST:



ENGINE TYPE: V4 gas

ENGINE CID: 1.1 litre

TRANSMISSION TYPE:

__ AUTO

__ MANUAL

OPTIONAL EQUIPMENT:

DUMMY DATA:

TYPE: _____

MASS: _____

SEAT POSITION: _____

GEOMETRY – (mm)

A	1518	E	610	J	787	N	1283	R	
B	699	F	3473	K	514	O		S	635
C	2165	G	813	L	70	P	578	T	833
D	1435	H	394	M	375	Q	362	U	2292

MASS – (kg)	CURB	TEST INERTIAL	GROSS STATIC
M_1	536	502	541
M_2	284	314	352
M_T	820	816	893

1 mm = 0.039 in
1 kg = 2.202 lb

Figure C-5. Vehicle properties for test 19452-1.

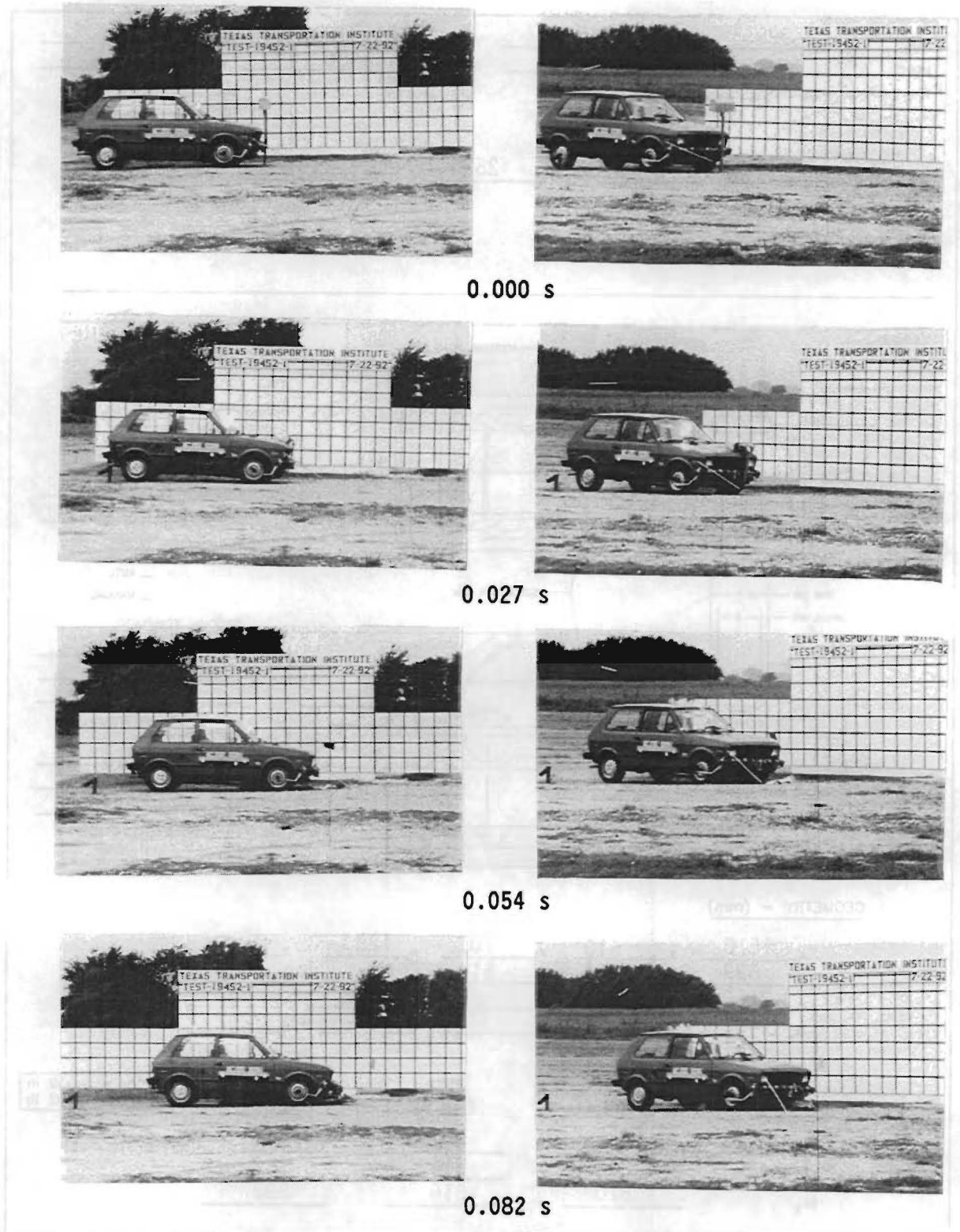
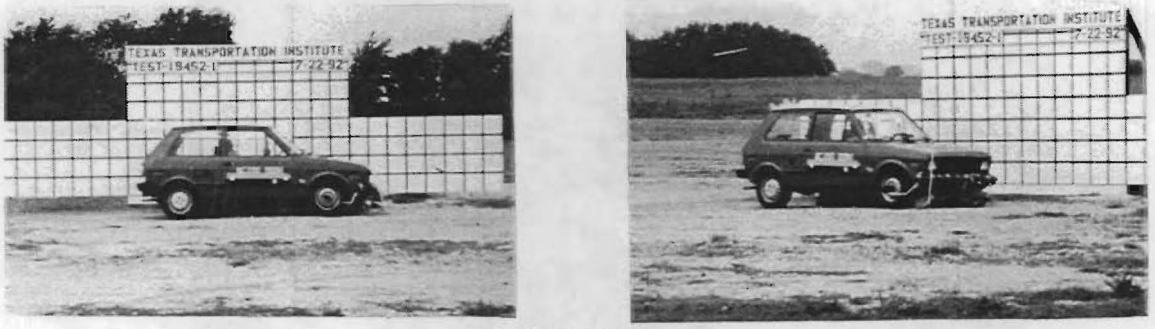
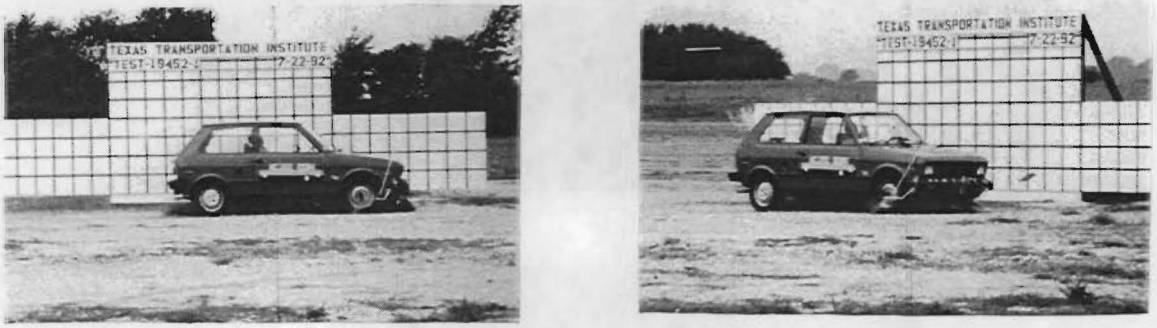


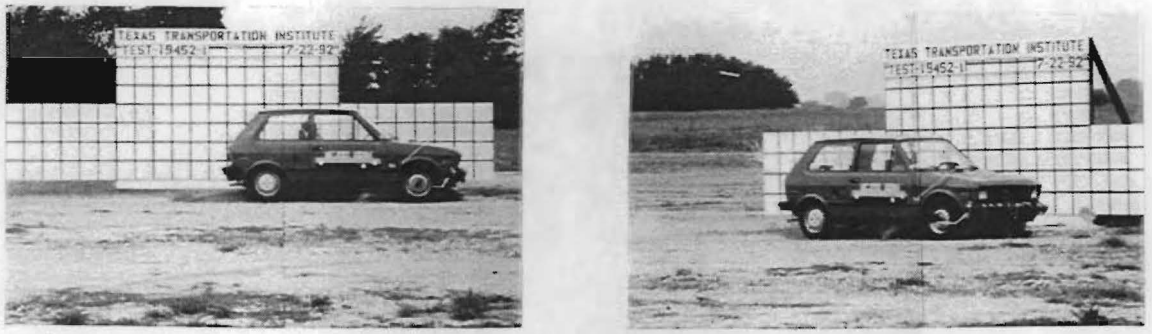
Figure C-6. Sequential photographs for test 19452-1. (perpendicular and side views).



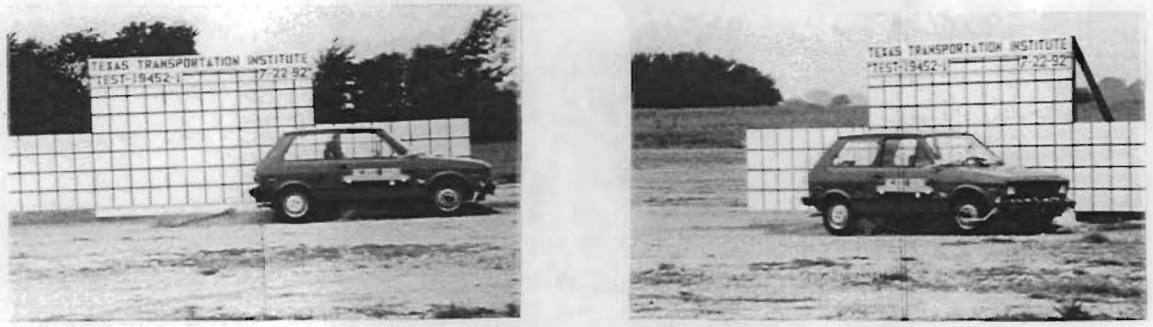
0.109 s



0.136 s

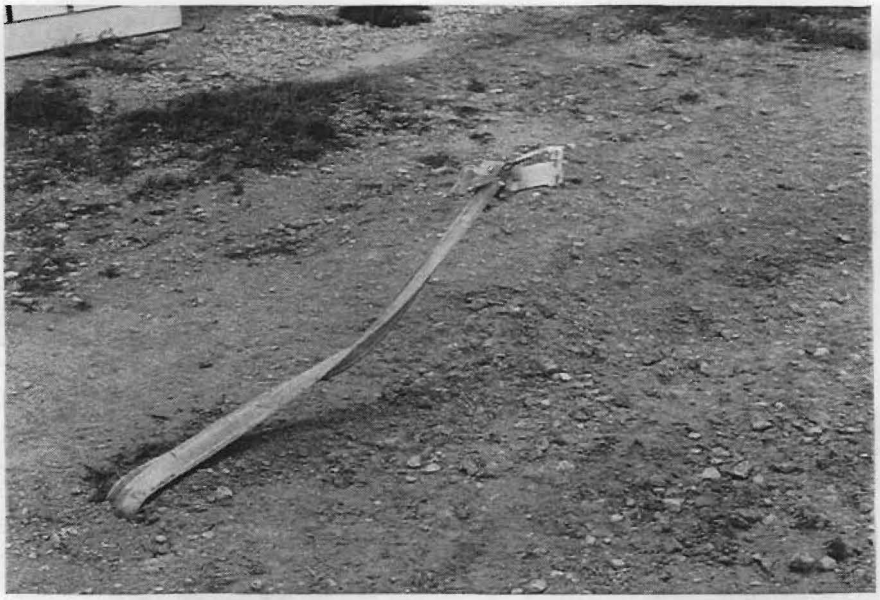


0.163 s



0.191 s

Figure C-6. Sequential photographs for test 19452-1 (perpendicular and side views) continued.



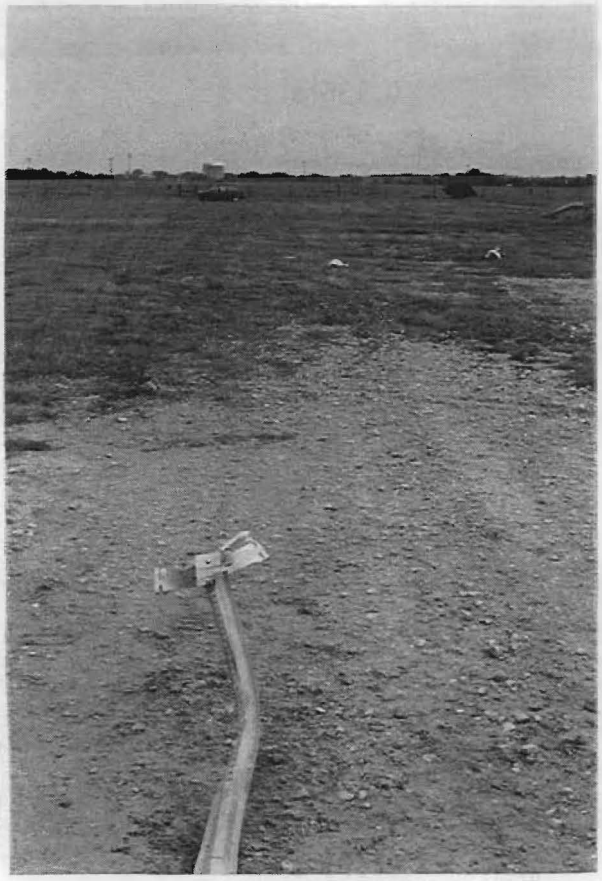
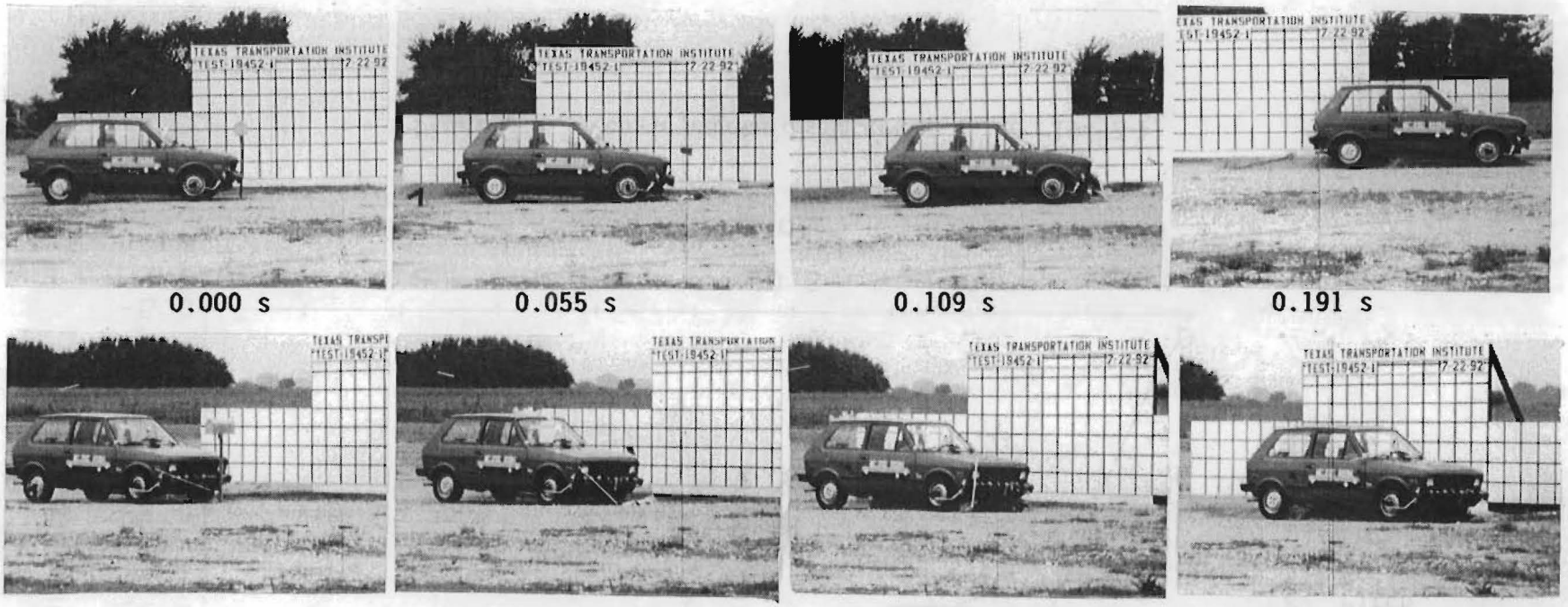


Figure C-7. Test installation after test 19452-1.

Figure C-8. Damage to mailbox after test 19452-1.

Figure C-9. Vehicle after test 19452-1.



Test No	19452-1.	Impact Speed	58.7 mi/h (94.4 km/h)
Date	07/22/92.	Change in Velocity	1.4 mi/h (2.3 km/h)
Test Article	Single mount, Type 1 Mailbox Installation.	Change in Momentum	114.8 lb-s
Support	Type 4 (2 lb/ft winged channel post)	Vehicle Accelerations (Max. 0.050-sec Avg)	
Embedment	2'-0" driven(strong soil)	Longitudinal	-1.3 g
Vehicle	1988 Yugo GV	Lateral	0.4 g
Vehicle Weight		Occupant Impact Velocity	
Test Inertia	1800 lb (816 kg)	Longitudinal	N/A
Gross Static	1968 lb (893 kg)	Lateral	N/A
Vehicle Damage Classification		Occupant Ridedown Accelerations	
TAD	12-FL-1	Longitudinal	No contact
SAE	12FLEN1	Lateral	No contact

Figure C-10. Summary of results for test 19452-1.

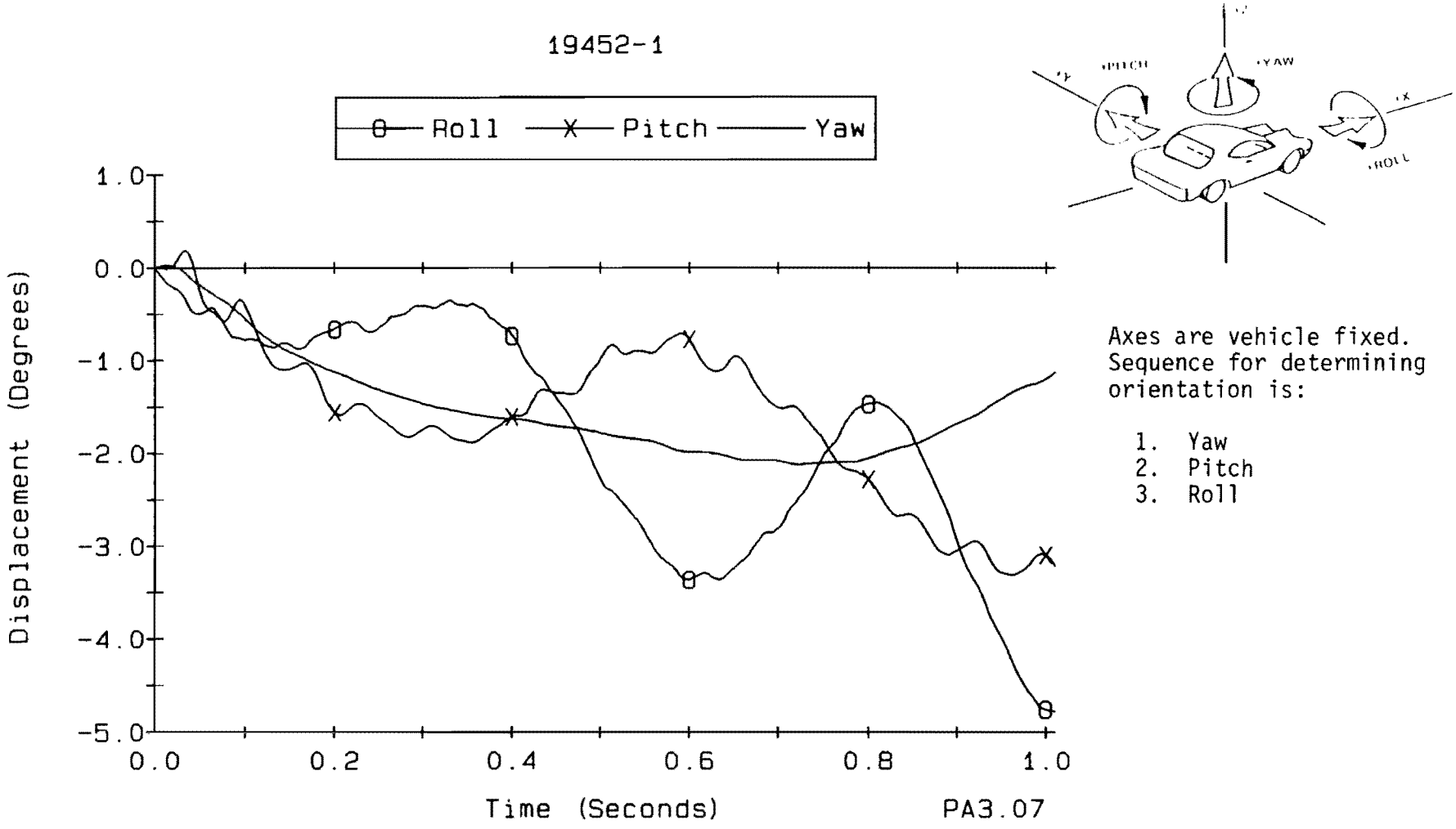


Figure C-11. Vehicle angular displacements for test 19452-1.

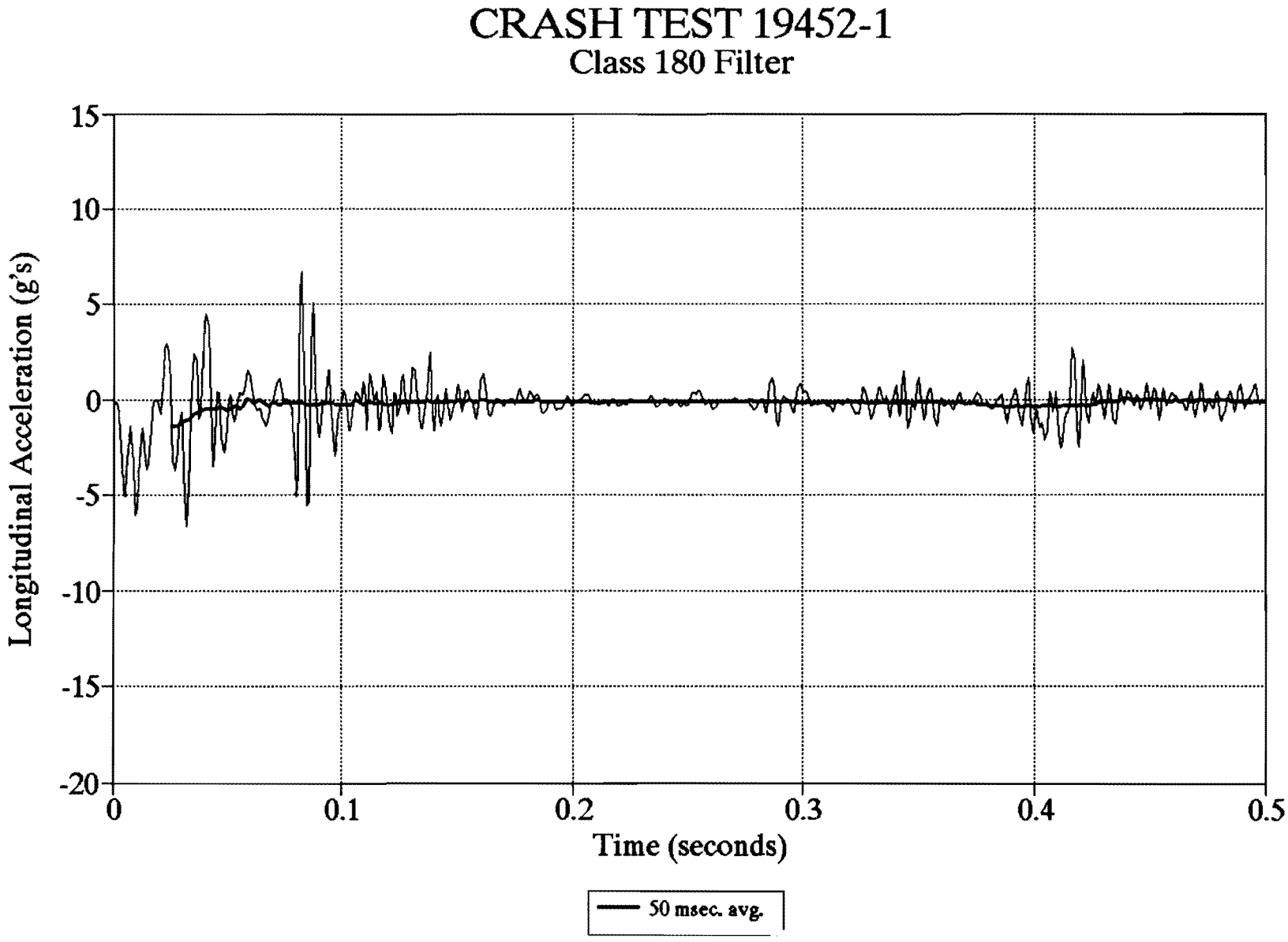


Figure C-12. Longitudinal accelerometer trace for test 19452-1.

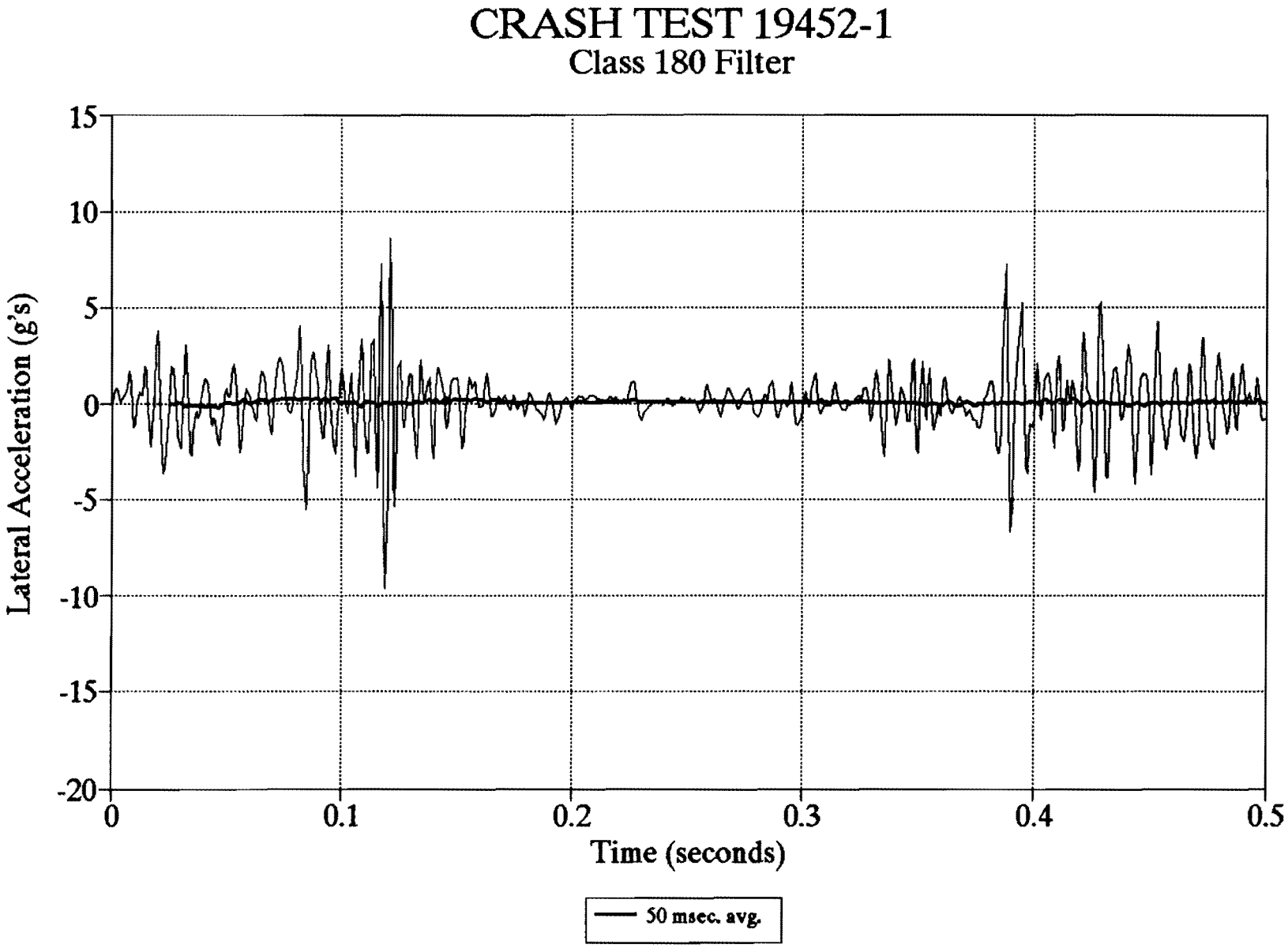


Figure C-13. Lateral accelerometer trace for test 19452-1.

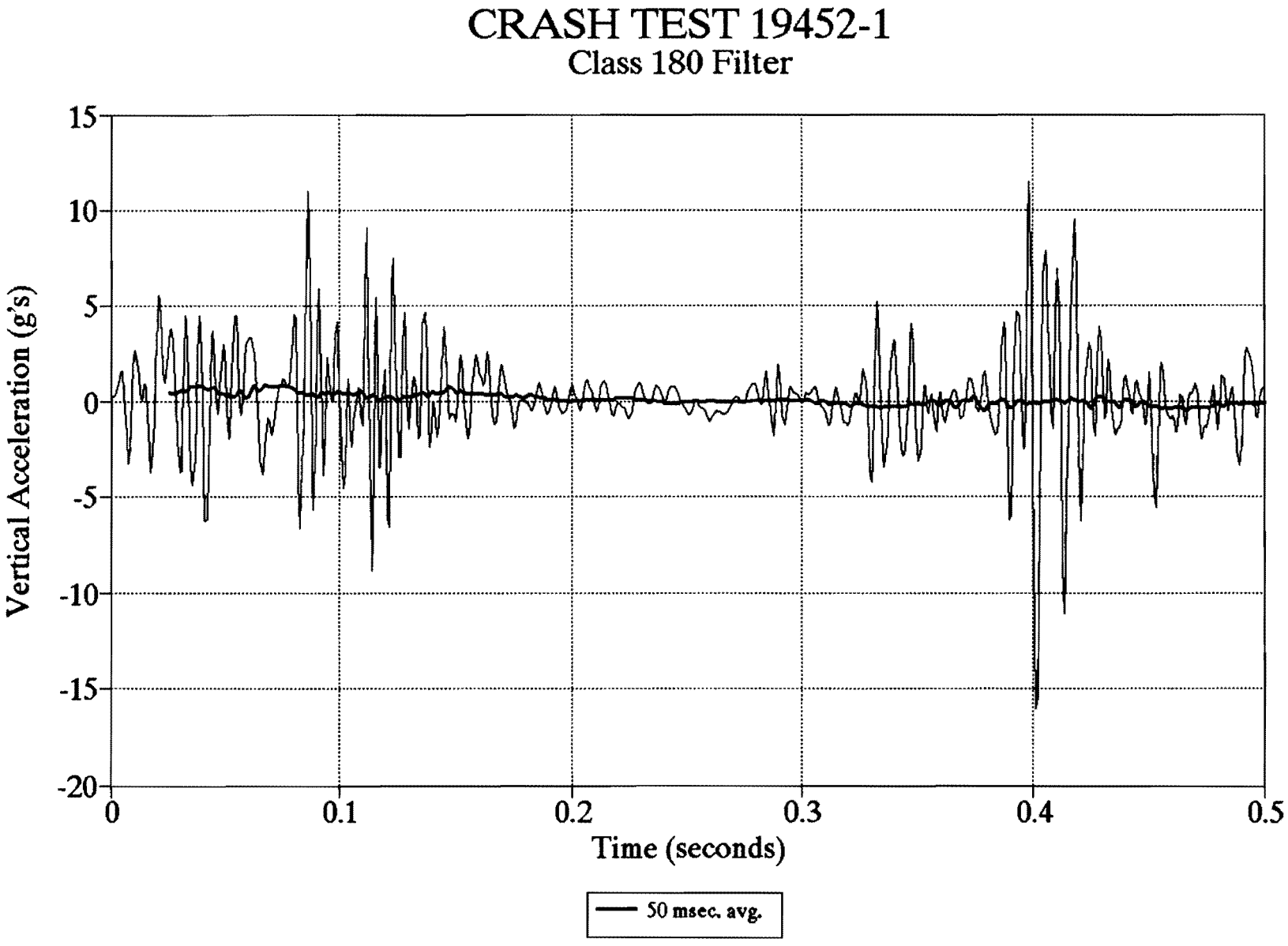


Figure C-14. Vertical accelerometer trace for test 19452-1.

APPENDIX D

TEST 19452-2 REPORT

Test 19452-2

The test article consisted of a size no. 2 mailbox mounted on a single 2 lb/ft (3 kg/m) steel winged channel support. The mailbox was attached to the universal bracket with two extensions, with four 3/16-in. (0.48 cm) stove bolts. Appendix B gives complete details of the test article. Figure D-1 shows photos of the test article are shown. Figure D-2 shows the 1988 Yugo GV test vehicle. Figure D-2 shows the position of the vehicle with respect to the test article at impact. Impact speed was 61.3 mph (98.6 km/h). Impact point was the front right quarter point of the vehicle's bumper. Test inertia mass of the vehicle was 1,800 lb (816 kg) and its gross static mass was 1,968 lb (893 kg). Other vehicular dimensions and information are given in Figure D-4.

The vehicle was free wheeling and unrestrained just prior to impact. Upon impact, the support began to yield and by 0.017 second, the mailbox had detached from the support. At approximately 0.037 second, the mailbox struck the hood of the vehicle, then the windshield, sliding up, over and off the right upper A-pillar. The windshield was dished and broken but none of the test article components entered the occupant compartment. The vehicle lost contact with the installation at approximately 0.184 second, the brakes were applied, and the vehicle came to rest 315 ft (96.0 m) from the point of impact. Figure D-5 shows sequential photographs of the test.

Figures D-6 and D-7 shows the test article damage. As shown, the support bent at ground level and the mailbox attachment bracket became detached from the support, coming to rest approximately 153 ft (46.6 m) from the impact point. Other mailbox components came to rest approximately 101.3 ft (30.9 m) from the impact point. Figure D-8 shows the vehicle sustained only minor damage to the bumper, hood, and windshield.

A summary of test results and other pertinent information are given in Figure D-9. The maximum 0.050 second average acceleration experienced by the vehicle was -1.3 g in the longitudinal direction and -0.3 g in the lateral direction. No occupant contact occurred in the longitudinal or lateral direction. Angular displacements of the vehicle are plotted in Figure D-10 and vehicular accelerations are plotted in Figures D-11 through D-13. Change in the vehicle's velocity was 4.6 mph (7.4 km/h).

In summary, the test was marginally acceptable. The only concern was that the windshield was broken and dished during impact. The researchers concluded that changes could and should be made in the design to eliminate this concern.

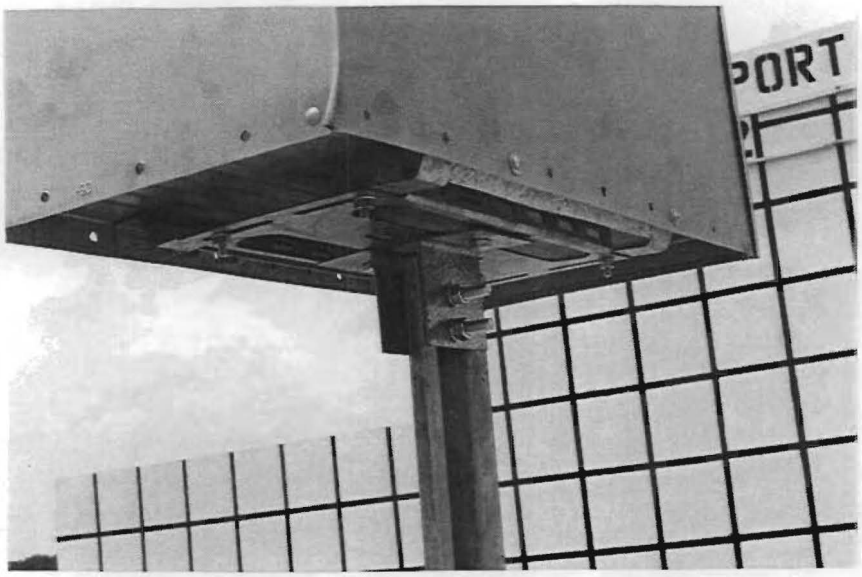


Figure D-1. Mailbox installation for test 19452-2.

Figure D-2. Vehicle before test 19452-2.

Figure D-3. Vehicle/mailbox geometrics for test 19452-2.

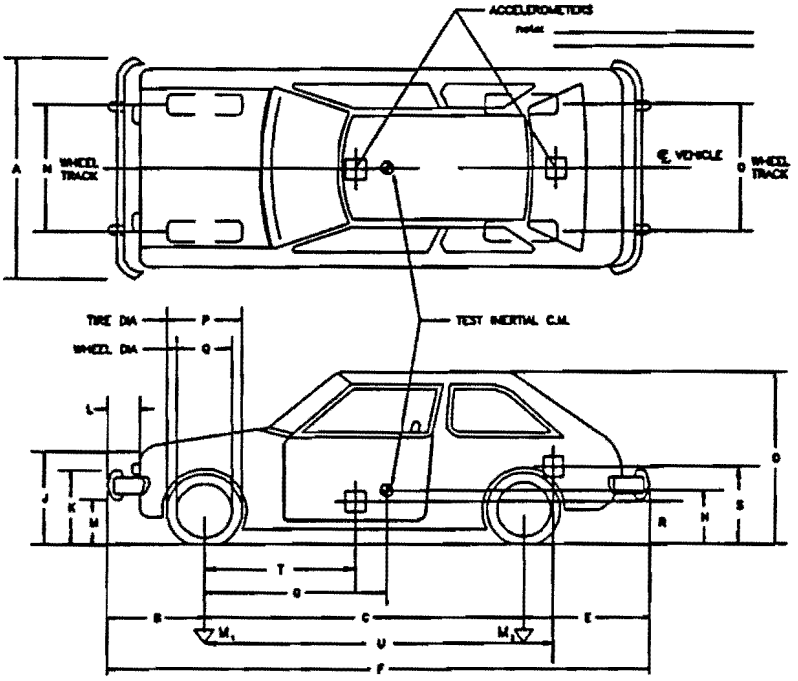
DATE: 7-22-92 TEST NO.: 19452-2 VIN NO.: VX1BA1216JK404378 MAKE: Yugo

MODEL: GV YEAR: 1988 ODOMETER: 48466 TIRE SIZE: 145R13

TIRE INFLATION PRESSURE: _____

MASS DISTRIBUTION (kg) LF 250 RF 252 LR 156 RR 158

DESCRIBE ANY DAMAGE TO VEHICLE PRIOR TO TEST:



ENGINE TYPE: V4 gas

ENGINE CID: 1.1 litre

TRANSMISSION TYPE:

__ AUTO

__ MANUAL

OPTIONAL EQUIPMENT:

DUMMY DATA:

TYPE: _____

MASS: _____

SEAT POSITION: _____

GEOMETRY – (mm)

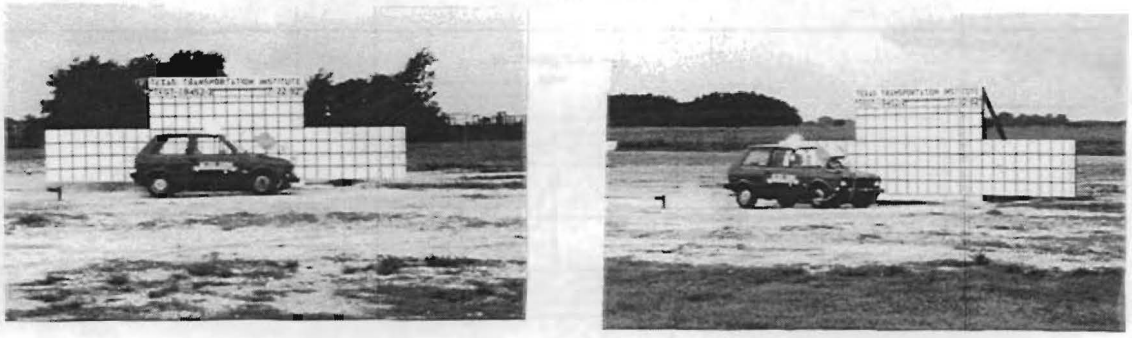
A	1518	E	610	J	787	N	1283	R	
B	699	F	3473	K	514	O		S	635
C	2165	G	813	L	70	P	578	T	833
D	1435	H	394	M	375	Q	362	U	2292

MASS – (kg)	CURB	TEST INERTIAL	GROSS STATIC
M_1	536	502	541
M_2	284	314	352
M_T	820	816	893

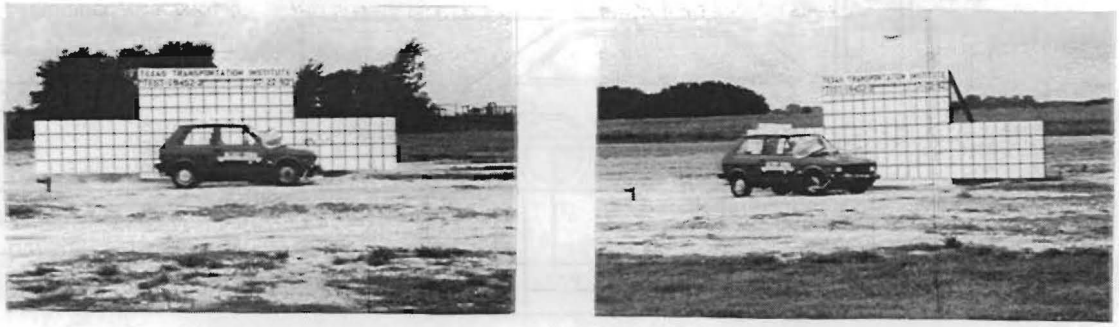
1 mm = 0.039 in
1 kg = 2.202 lb

Figure D-4. Vehicle properties for test 19452-2.

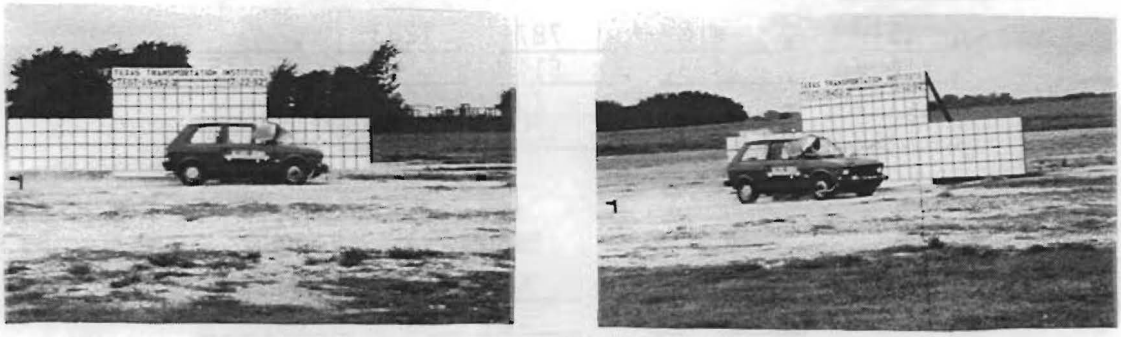
0.000 s



0.027 s



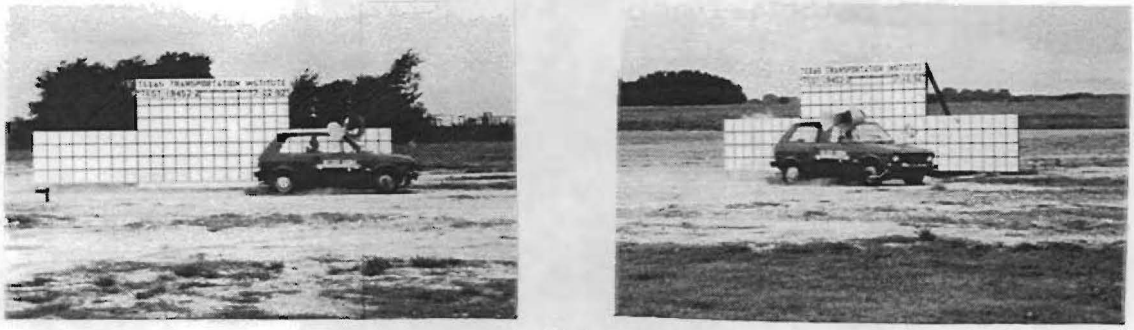
0.055 s



0.082 s

Figure D-5. Sequential photographs for test 19452-2. (perpendicular and side views).

0.109 s



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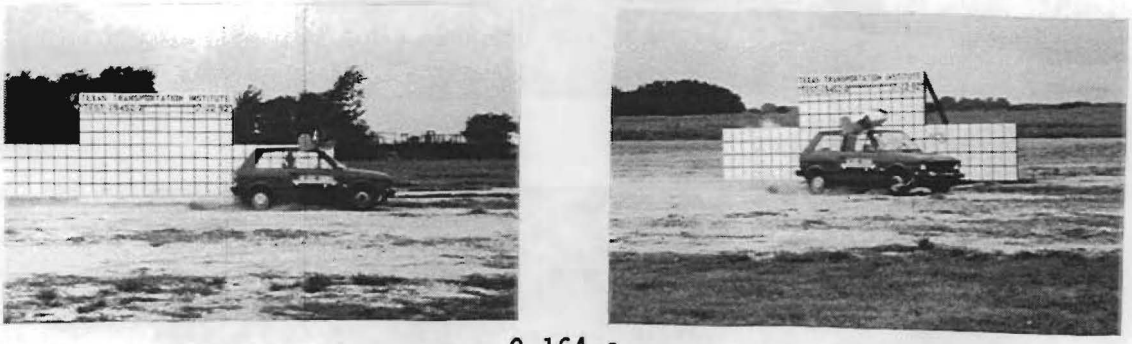
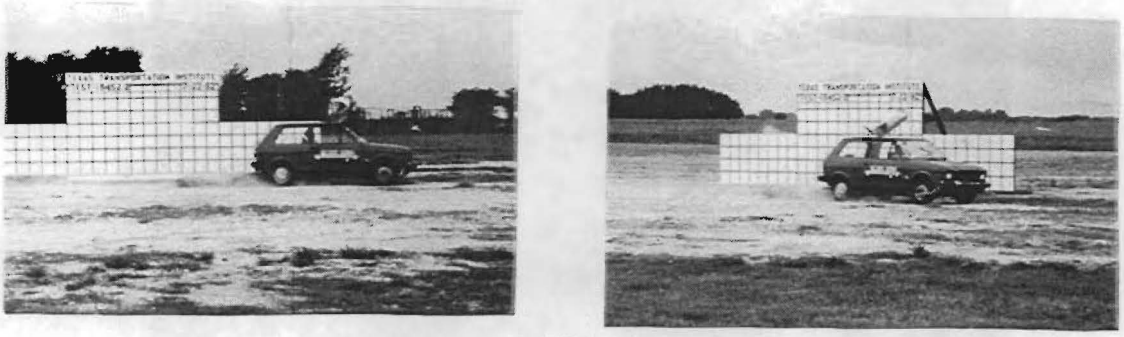


0.164 s



0.191 s

Figure D-5. Sequential photographs for test 19452-2 (perpendicular and side views) continued.

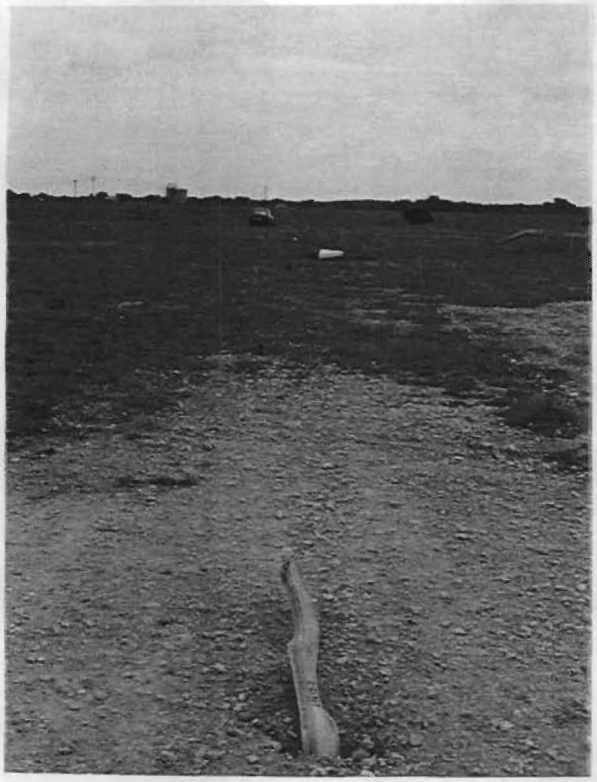
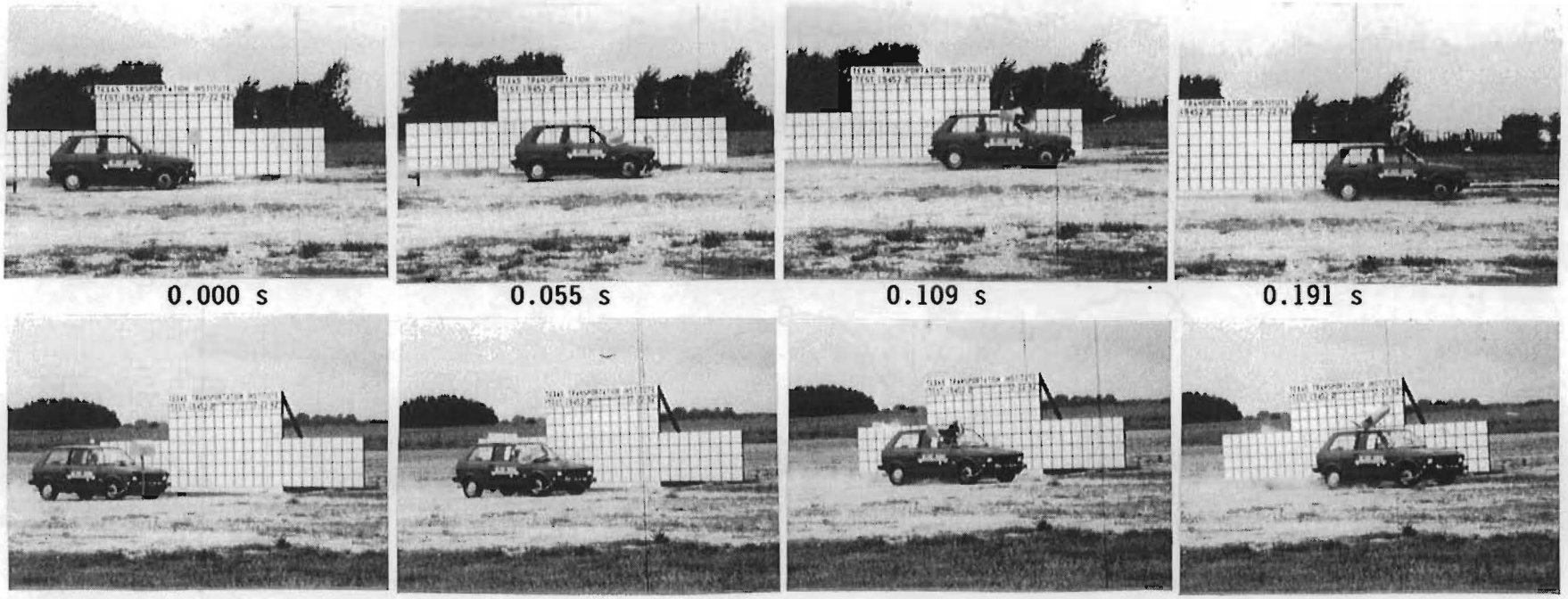


Figure D-6. Test installation after test 19452-2.

Figure D-7. Damage to mailbox and bracket after test 19452-2.

Figure D-8. Vehicle after test 19452-2.



Test No	19452-2.	Impact Speed	61.3 mi/h (98.6 km/h)
Date	07/22/92.	Change in Velocity	4.6 mi/h (7.4 km/h)
Test Article	Single mount, Type 2 Mailbox Installation.	Change in Momentum	377.1 lb-s
Support	Type 4 (2 lb/ft winged channel post)	Vehicle Accelerations (Max. 0.050-sec Avg)	
Embedment	2'-0" driven(strong soil)	Longitudinal	-1.3 g
Vehicle	1988 Yugo GV	Lateral	-0.3 g
Vehicle Weight		Occupant Impact Velocity	
Test Inertia	1800 lb (816 kg)	Longitudinal	N/A
Gross Static	1968 lb (893 kg)	Lateral	N/A
Vehicle Damage Classification		Occupant Ridedown Accelerations	
TAD	12-FR-1	Longitudinal	No contact
SAE	12FRAN1	Lateral	No contact

Figure D-9. Summary of results for test 19452-2.

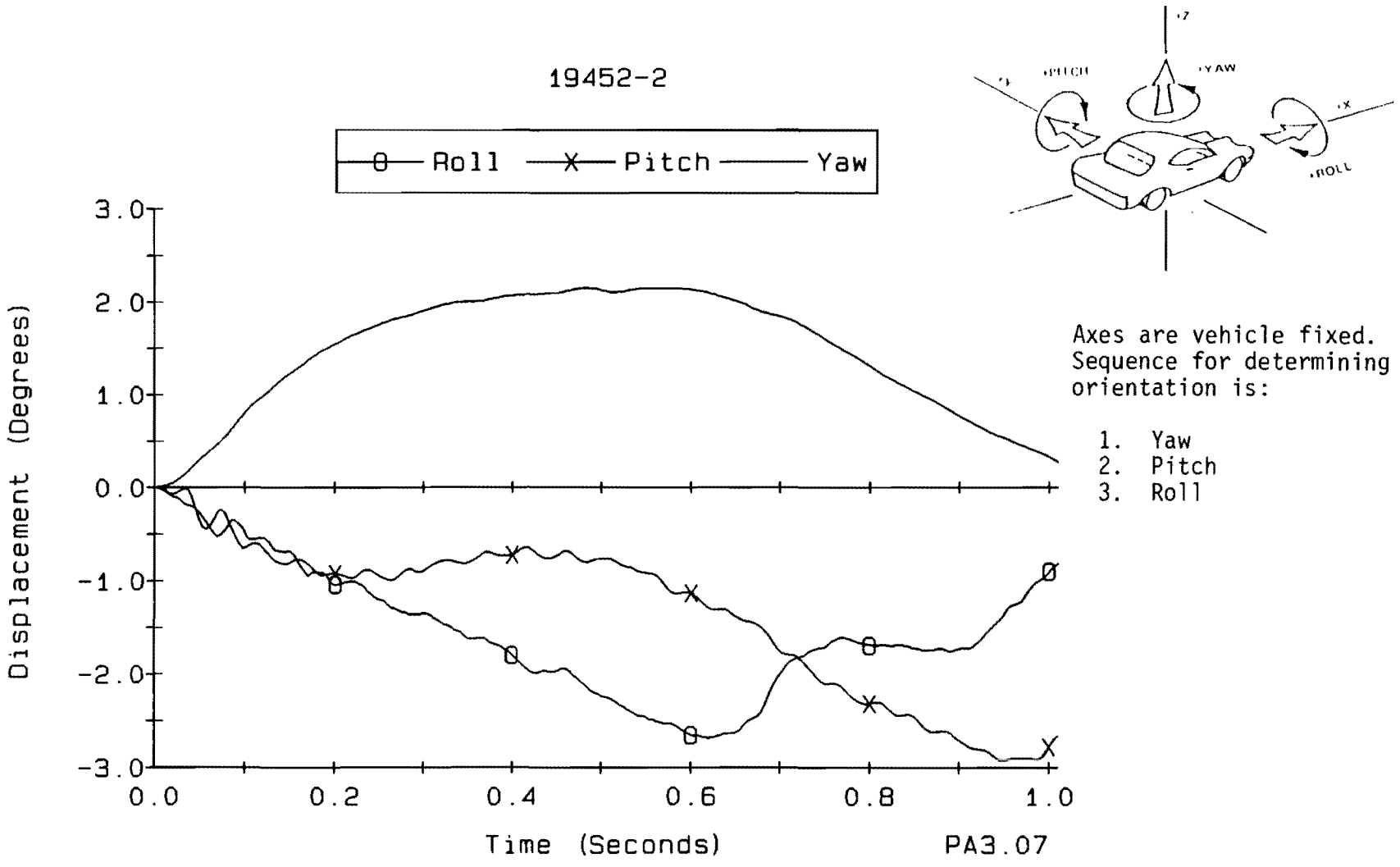


Figure D-10. Vehicle angular displacements for test 19452-2.

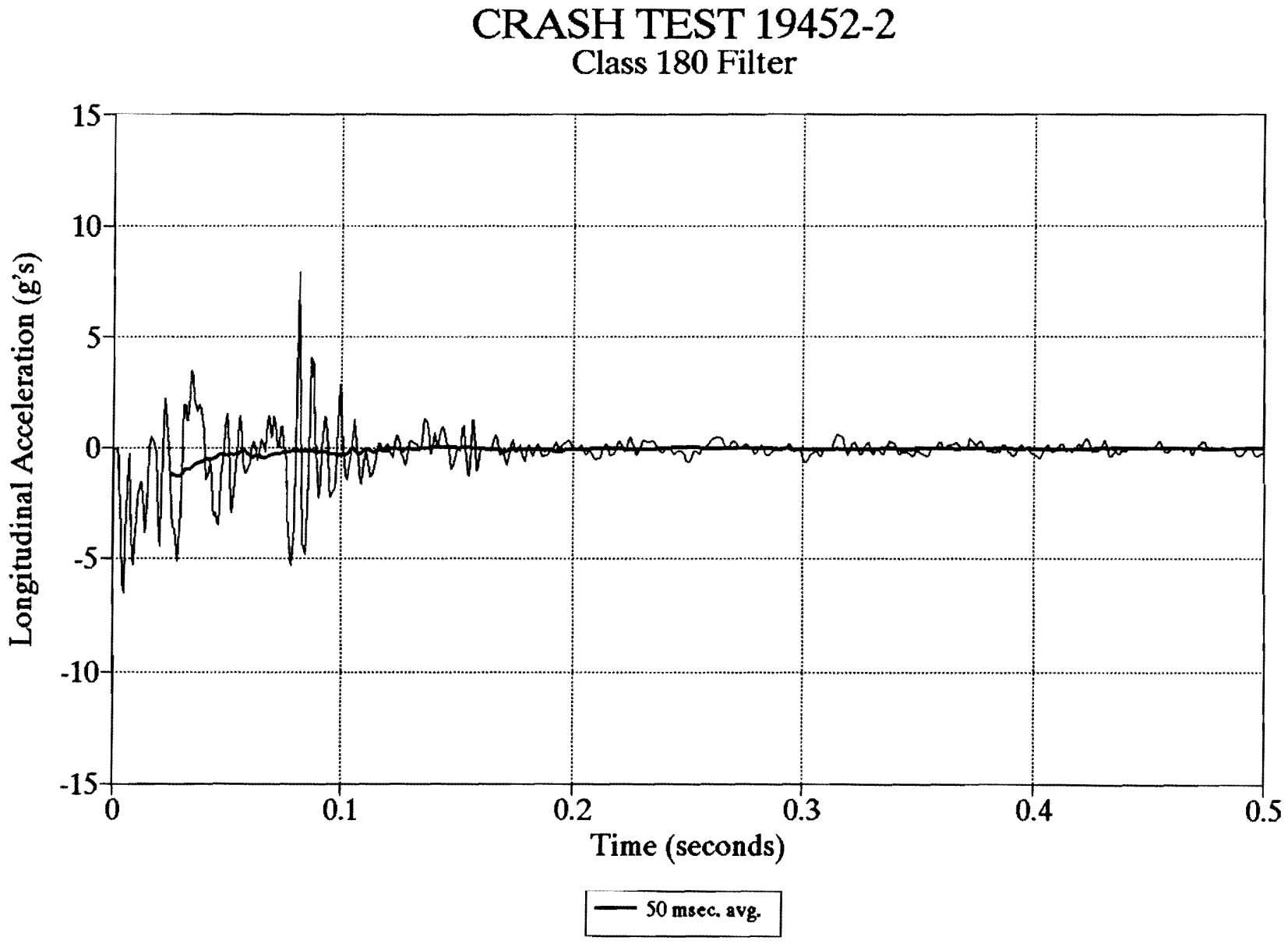


Figure D-11. Longitudinal accelerometer trace for test 19452-2.

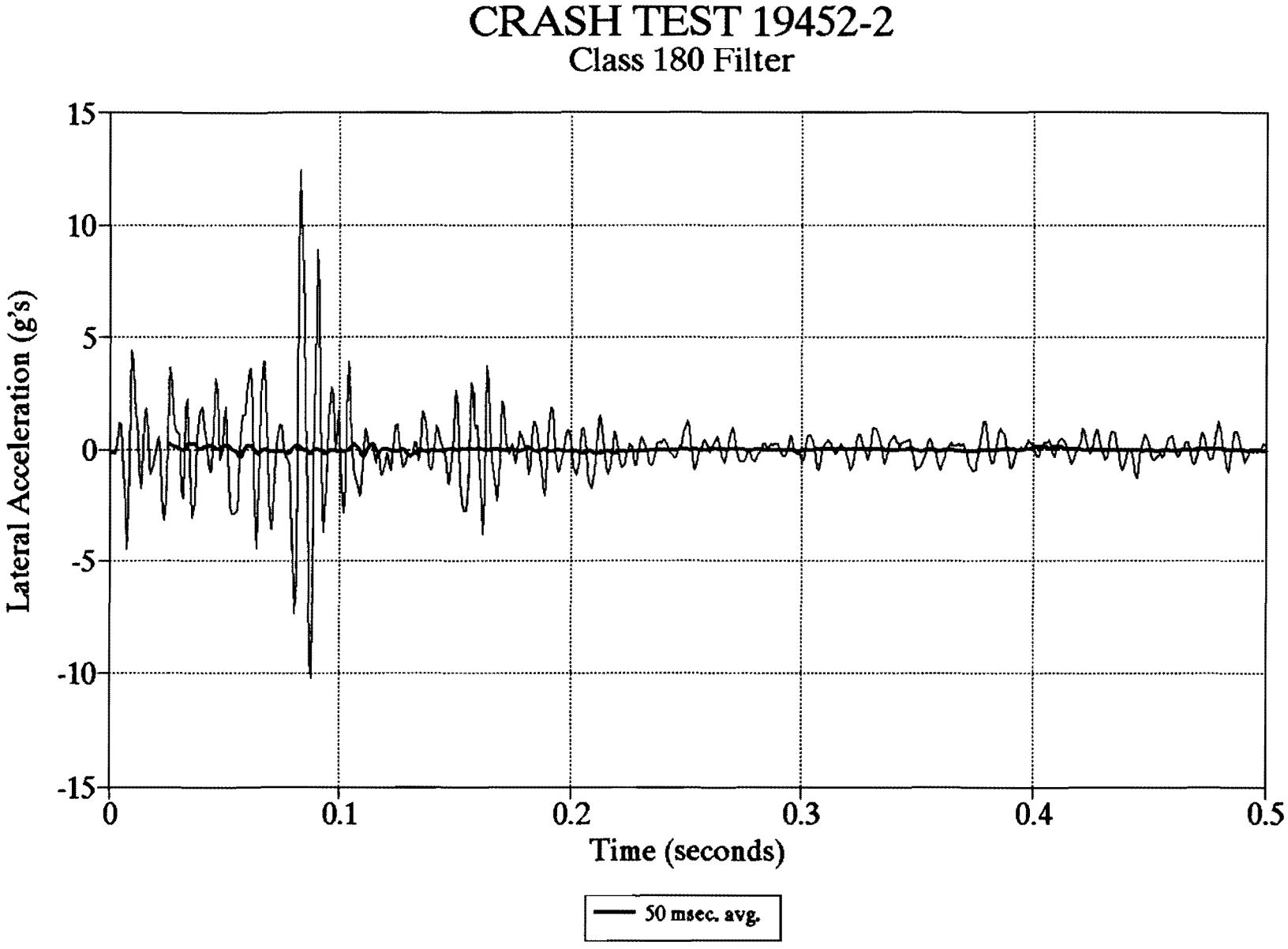


Figure D-12. Lateral accelerometer trace for test 19452-2.

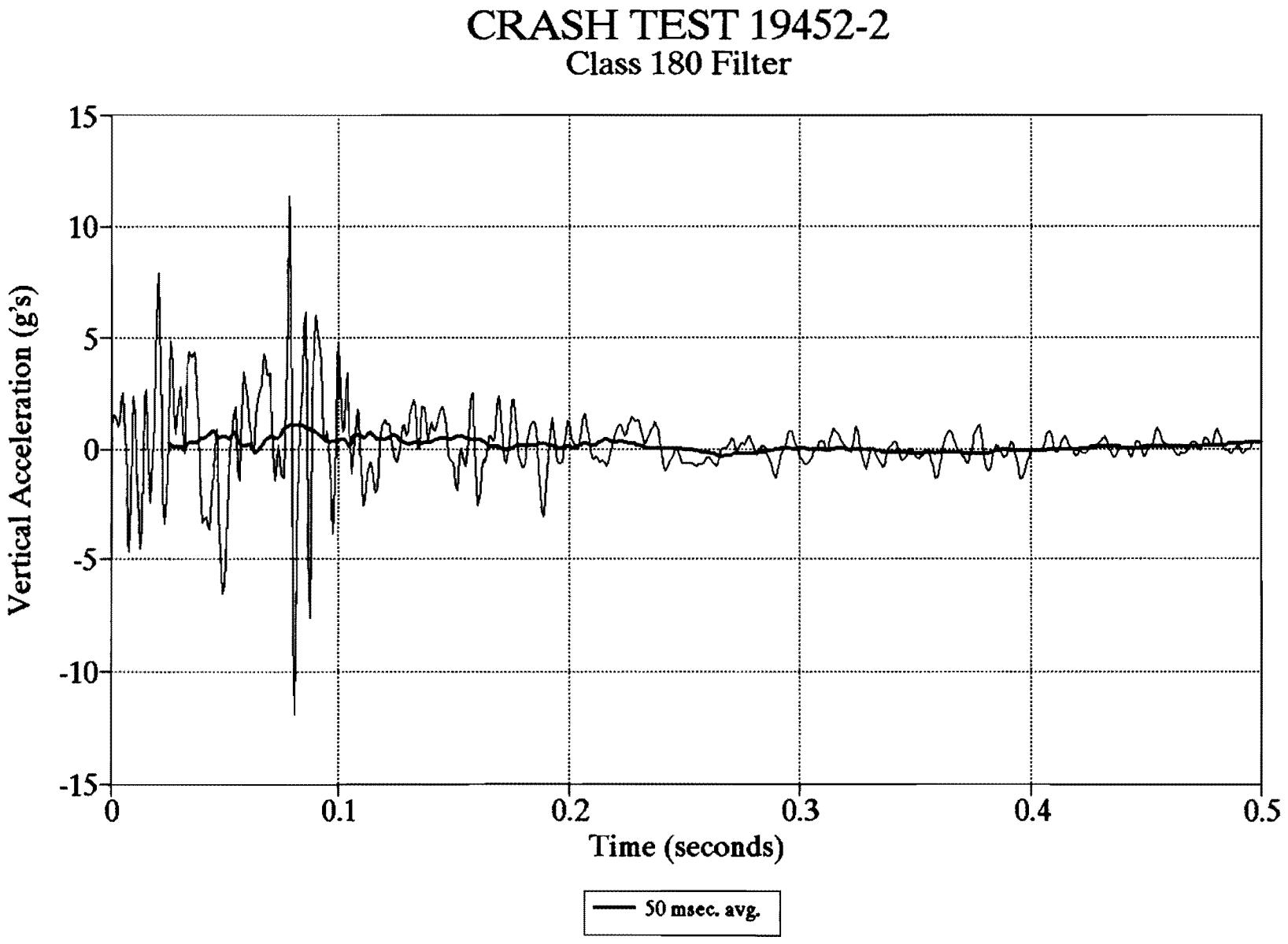


Figure D-13. Vertical accelerometer trace for test 19452-2.

APPENDIX E

TEST 19452-3 REPORT

Test 19452-3

The test article was the same as test 19452-2 with three exceptions: (1) two flat washers (one between the head and angle and one between the bracket and the lock washer) were added to each of the two bolts attaching the angles to the bracket, (2) two flat washers (one between the head and angle and one between the angle and the lock washer) were added to each of the two bolts attaching the angles to the support, and (3) six 3/16-in. (0.48 cm) stove bolts were used to attach the mailbox to the bracket extensions. Complete details of the test article are given in Appendix B. Figures E-1 and E-2 show photos of the test article. Figure E-3 shows the 1987 Yugo GV test vehicle. Figure E-4 shows the position of the vehicle with respect to the test article at impact. Impact speed was 61.2 mph (98.5 km/h). Impact point was the front right quarter point of the bumper of the vehicle. Test inertia mass of the vehicle was 1,800 lb (816 kg) and its gross static mass was 1,968 lb (893 kg). Figure E-5 gives other vehicular dimensions and information.

The vehicle was free wheeling and unrestrained just prior to impact. Upon impact, the support began to yield and by 0.017 second, the mailbox had detached from the support. At approximately 0.035 second, the mailbox struck the hood of the vehicle, then the windshield, sliding up, over and off the right upper A-pillar. The windshield was dished and broken but none of the test article components entered the occupant compartment. The vehicle lost contact with the installation at approximately 0.174 second, the brakes were applied, and the vehicle came to rest 345 ft (105.2 m) from the point of impact. Figure E-6 shows sequential photographs of the test.

Figures E-7 and E-8 show test article damage. As shown, the support bent at ground level and the mailbox attachment bracket remained with the support, but the mailbox itself was torn from the attachment bracket. Other mailbox components came to rest approximately 96.3 ft (29.3 m) from the impact point. The vehicle sustained only minor damage to the bumper, hood, and windshield as shown in Figure E-9.

A summary of test results and other pertinent information are given in Figure E-10. The maximum 0.050 second average acceleration experienced by the vehicle was -1.2 g in the longitudinal direction and -0.3 g in the lateral direction. No occupant contact occurred in the longitudinal or lateral direction. Angular displacements are plotted in Figure E-11 and vehicular

accelerations are plotted in Figures E-12 through E-14. Change in the vehicle's velocity was 1.3 mph (2.1 km/h).

In summary, the test was marginally acceptable. The only concern was that the windshield was broken and dished during impact. Researchers concluded that changes could and should be made in the design to eliminate this concern.

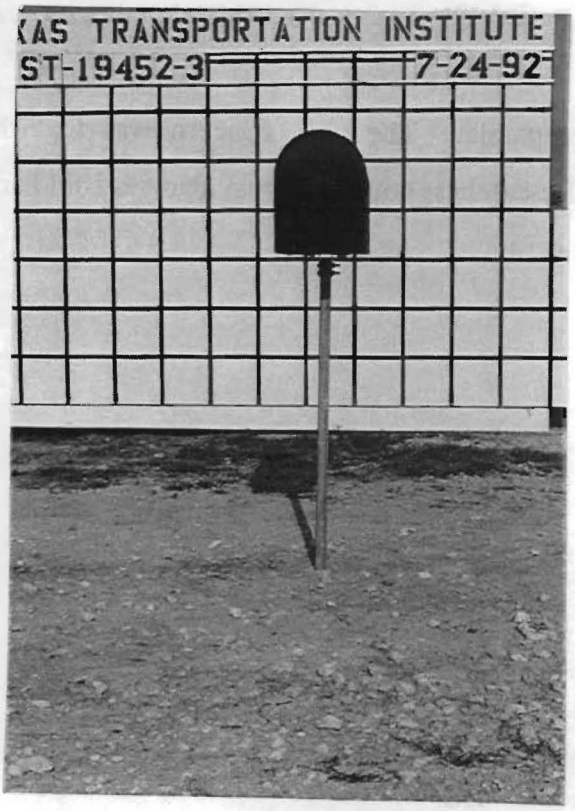


Figure E-1. Mailbox installation for test 19452-3.

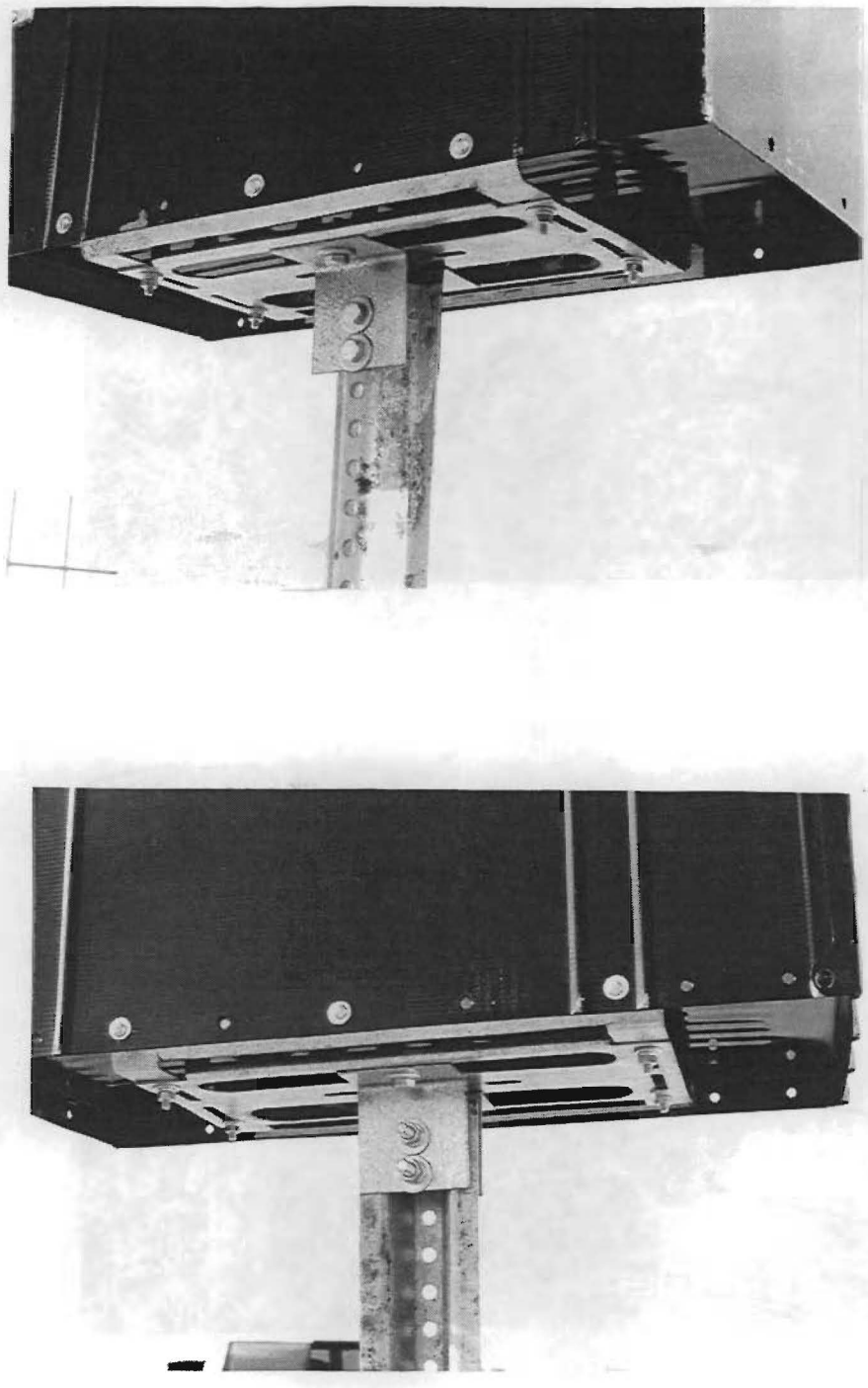


Figure E-2. Mailbox/support connection for installation used in test 19452-3.

Figure E-3. Vehicle before test 19452-3.

Figure E-4. Vehicle/mailbox geometrics for test 19452-3.

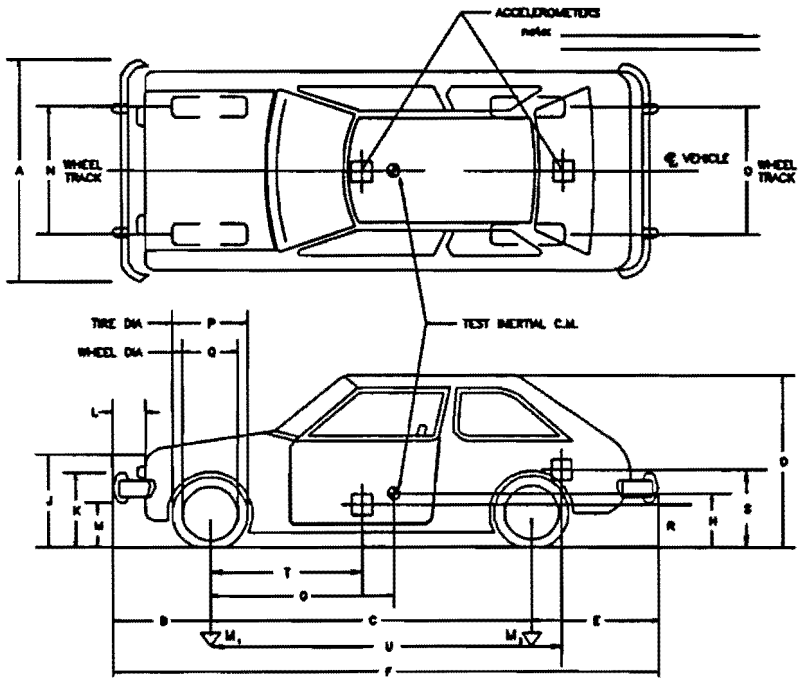
DATE: 7-24-92 TEST NO.: 19452-3 VIN NO.: VX1BA1215H12353059 MAKE: Yugo

MODEL: GV YEAR: 1987 ODOMETER: 51069 TIRE SIZE: 145R13

TIRE INFLATION PRESSURE: _____

MASS DISTRIBUTION (kg) LF 250 RF 269 LR 147 RR 150

DESCRIBE ANY DAMAGE TO VEHICLE PRIOR TO TEST:



ENGINE TYPE: V4 gas

ENGINE CID: 1.1 litre

TRANSMISSION TYPE:

__ AUTO

__ MANUAL

OPTIONAL EQUIPMENT:

DUMMY DATA:

TYPE: _____

MASS: _____

SEAT POSITION: _____

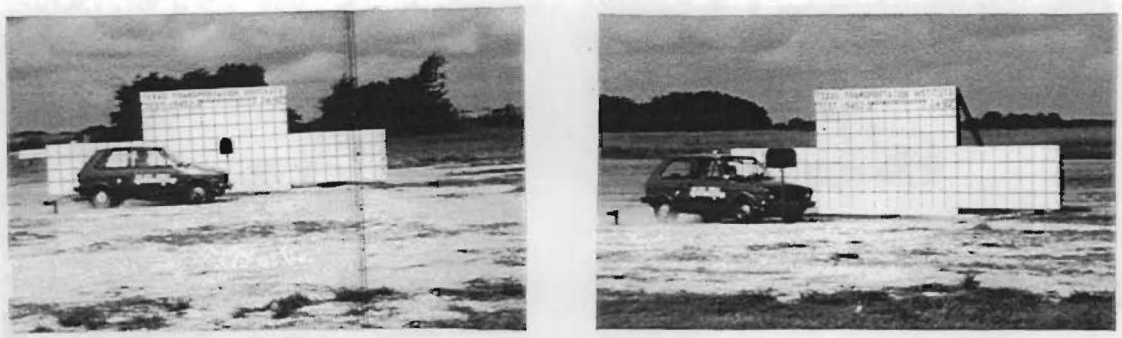
GEOMETRY – (mm)

A	1537	E	635	J	768	N	1327	R	
B	699	F	3473	K	483	O		S	730
C	2140	G	813	L	64	P	559	T	777
D	1410	H	381	M	292	Q	368	U	2451

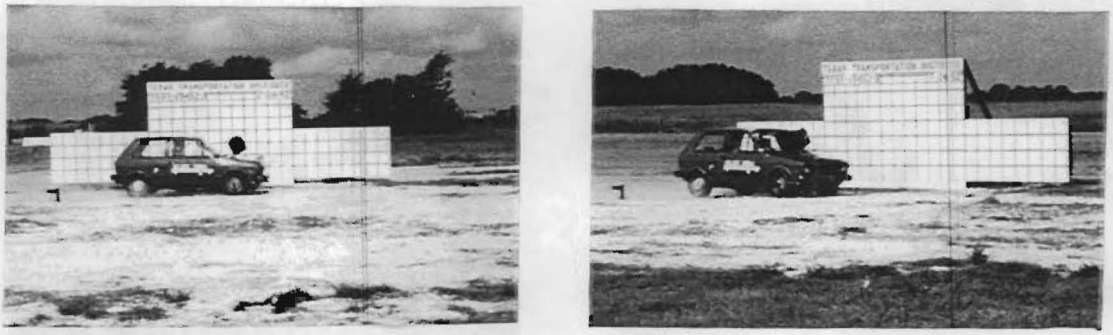
MASS – (kg)	CURB	TEST INERTIAL	GROSS STATIC
M_1	529	520	556
M_2	290	296	337
M_T	819	816	893

1 mm = 0.039 in
1 kg = 2.202 lb

Figure E-5. Vehicle properties for test 19452-3.

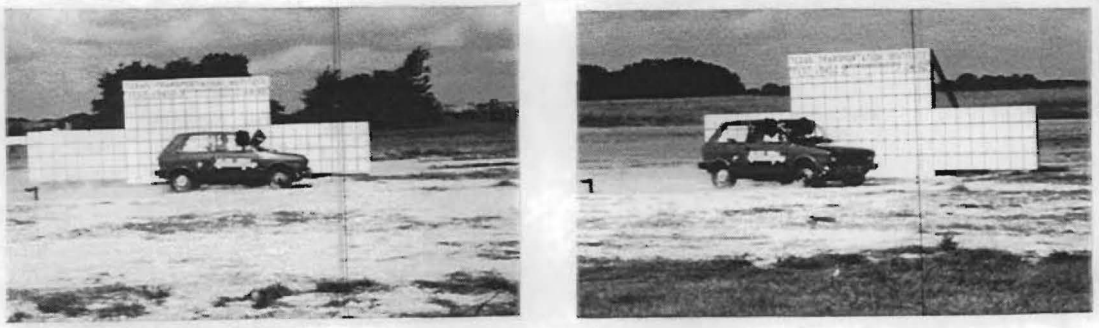


0.000 s



0.027 s

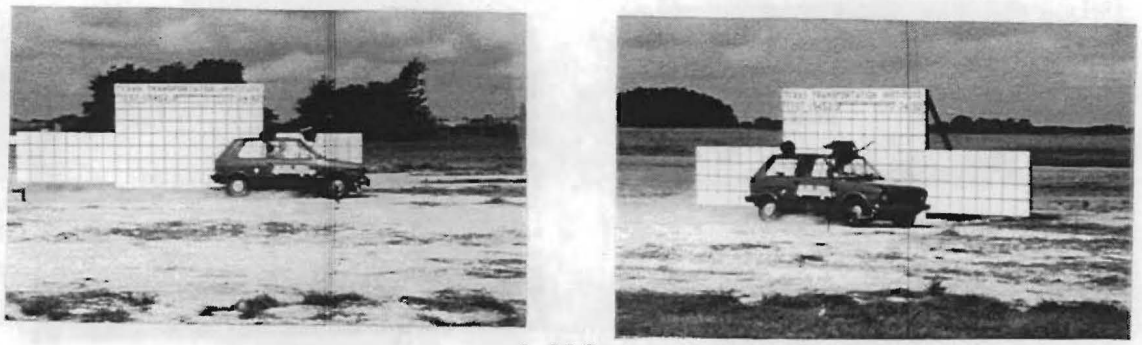
0.055 s



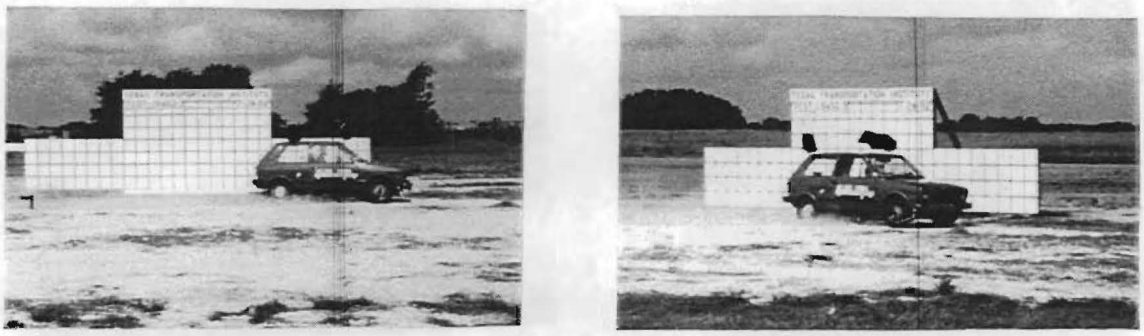
0.082 s

Figure E-6. Sequential photographs for test 19452-3. (perpendicular and side views).

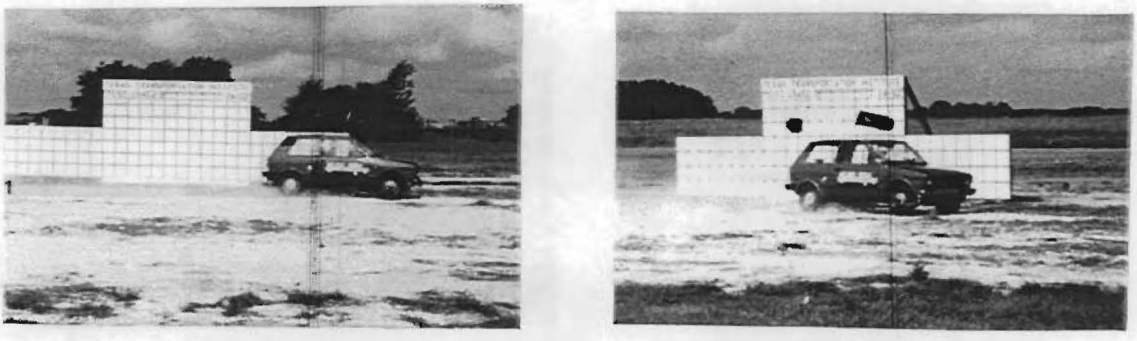
0.109 s



0.136 s



0.164 s



0.191 s

Figure E-6. Sequential photographs for test 19452-3 (perpendicular and side views) continued.

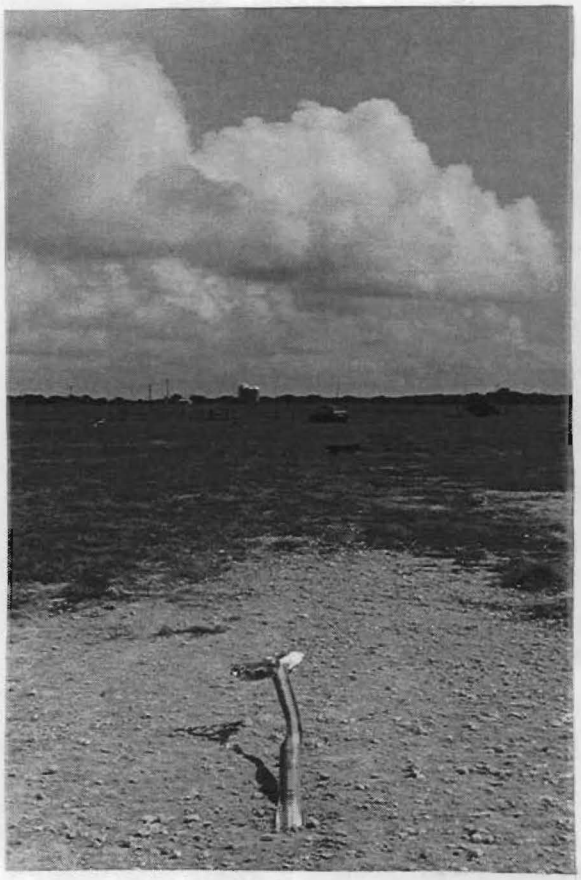


Figure E-7. Test installation after test 19452-3.

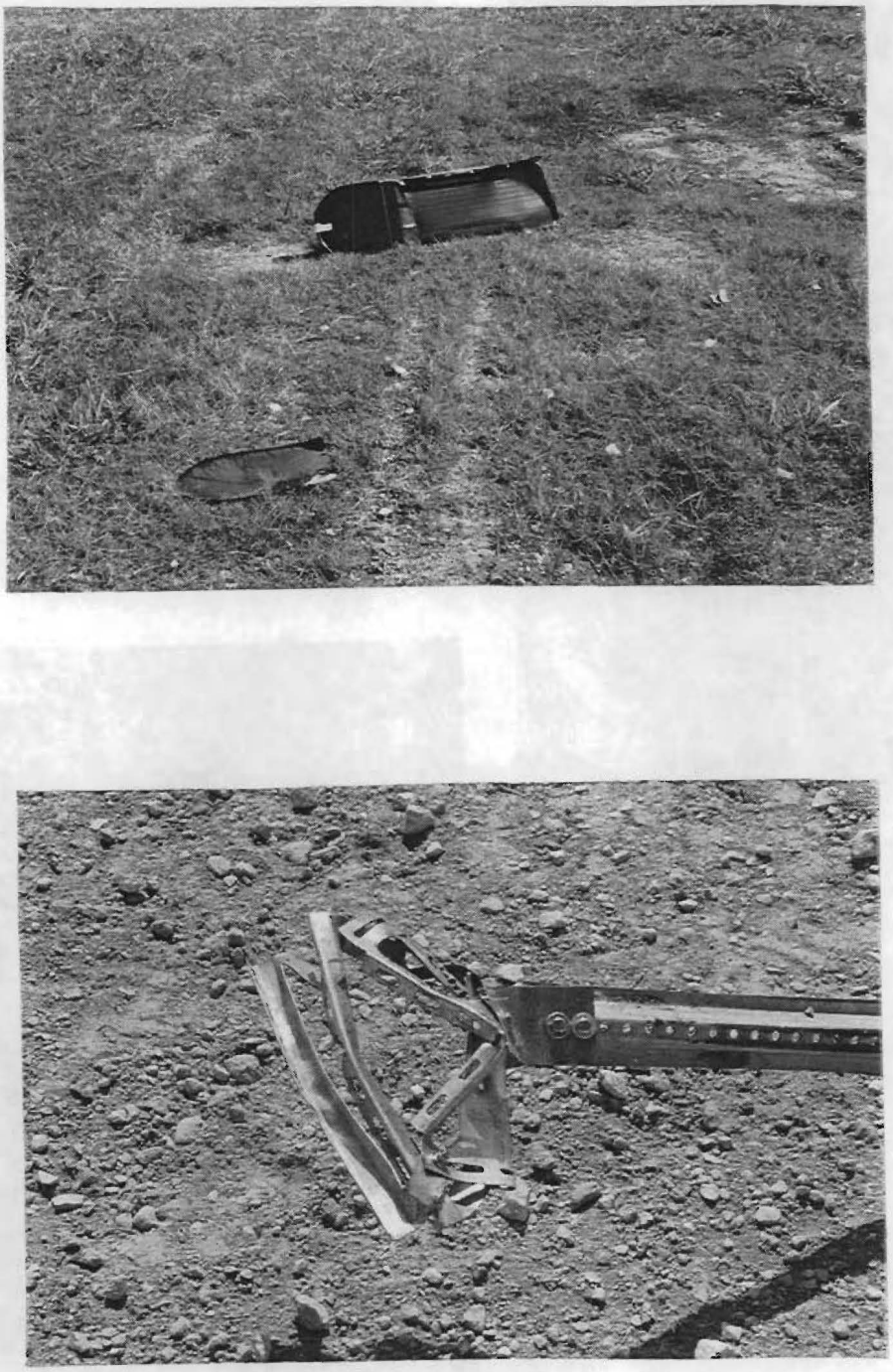
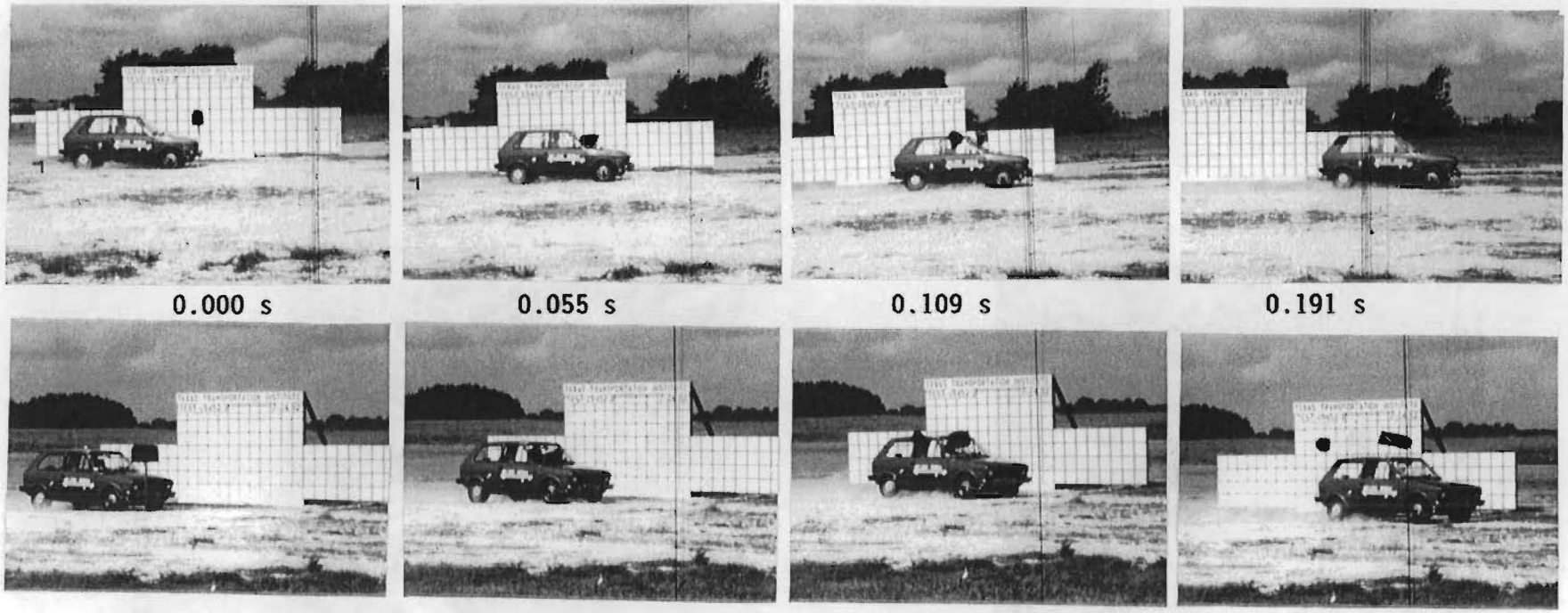


Figure E-8. Damage to mailbox and bracket after test 19452-3.

Figure E-9. Vehicle after test 19452-3.



Test No	19452-3.	Impact Speed	61.2 mi/h (98.4 km/h)
Date	07/24/92.	Change in Velocity	1.3 mi/h (2.1 km/h)
Test Article	Single mount, Type 2 Mailbox Installation.	Change in Momentum	106.6 lb-s
Support	Type 4 (2 lb/ft winged channel post)	Vehicle Accelerations (Max. 0.050-sec Avg)	
Embedment	2'-0" driven(strong soil)	Longitudinal	-1.2 g
Vehicle	1987 Yugo GV	Lateral	-0.3 g
Vehicle Weight		Occupant Impact Velocity	
Test Inertia	1800 lb (816 kg)	Longitudinal	N/A
Gross Static	1968 lb (893 kg)	Lateral	N/A
Vehicle Damage Classification		Occupant Ridedown Accelerations	
TAD	12-FR-1	Longitudinal	No contact
SAE	12FRAN1	Lateral	No contact

Figure E-10. Summary of results for test 19452-3.

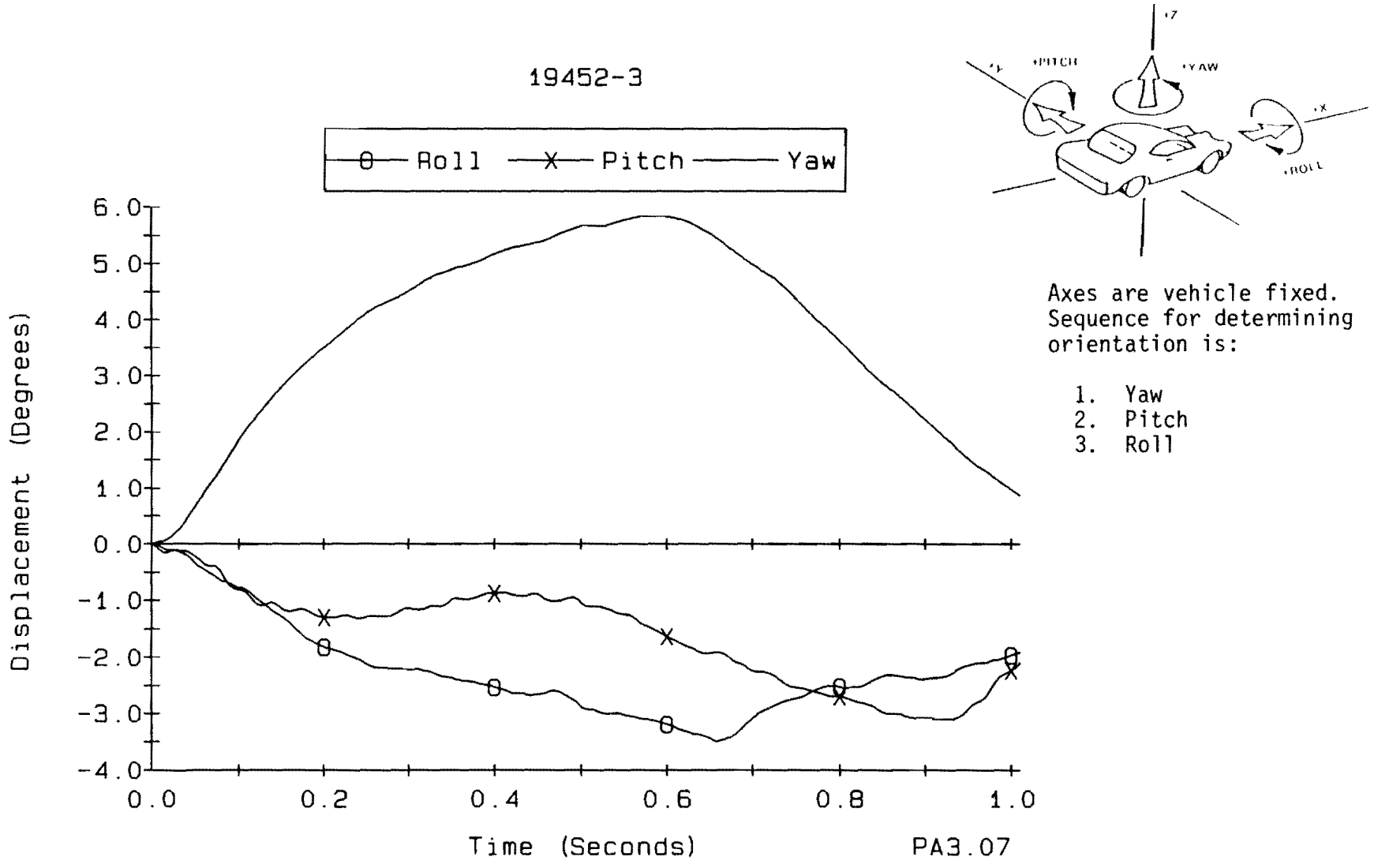


Figure E-11. Vehicle angular displacements for test 19452-3.

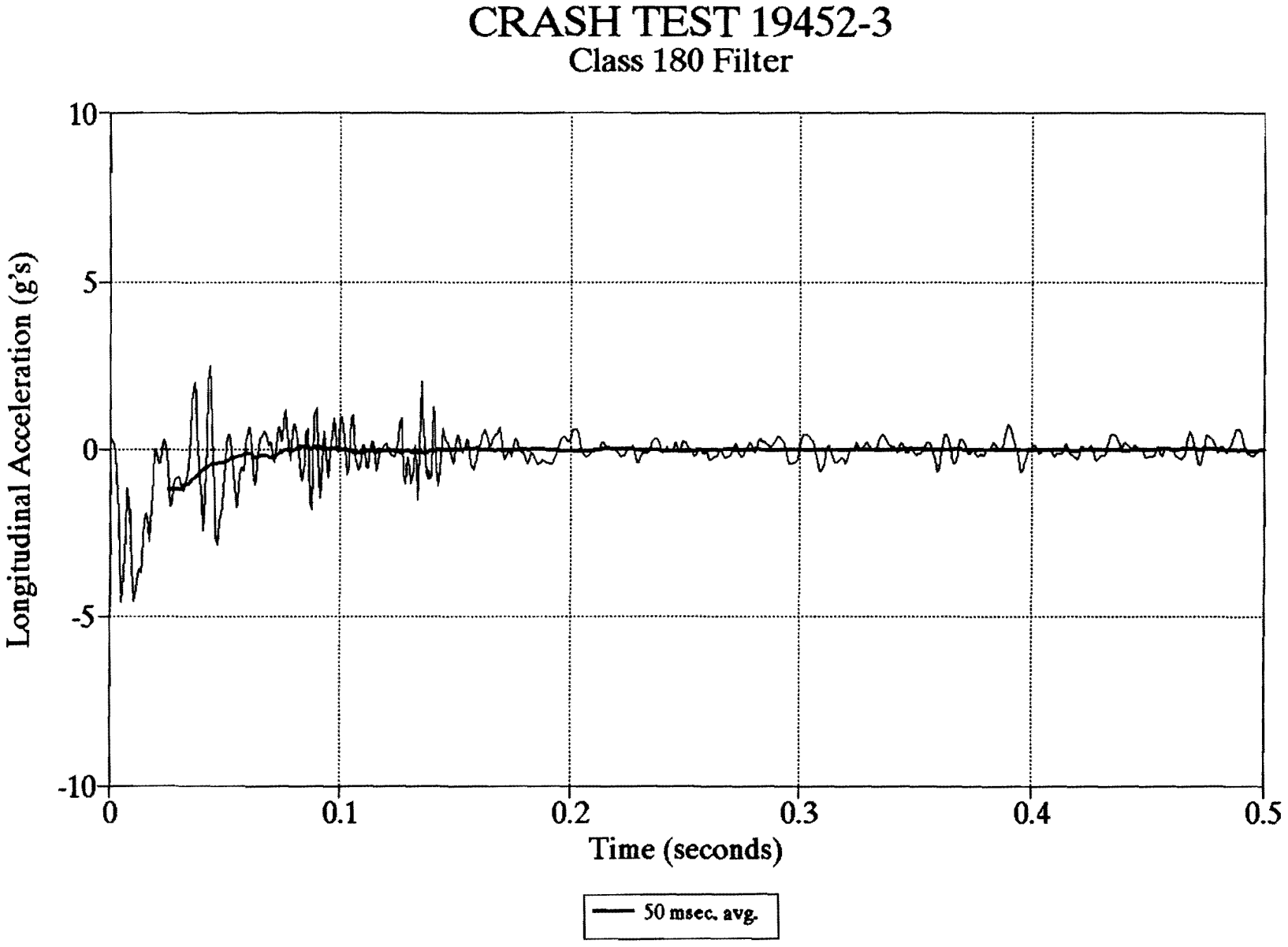


Figure E-12. Longitudinal accelerometer trace for test 19452-3.

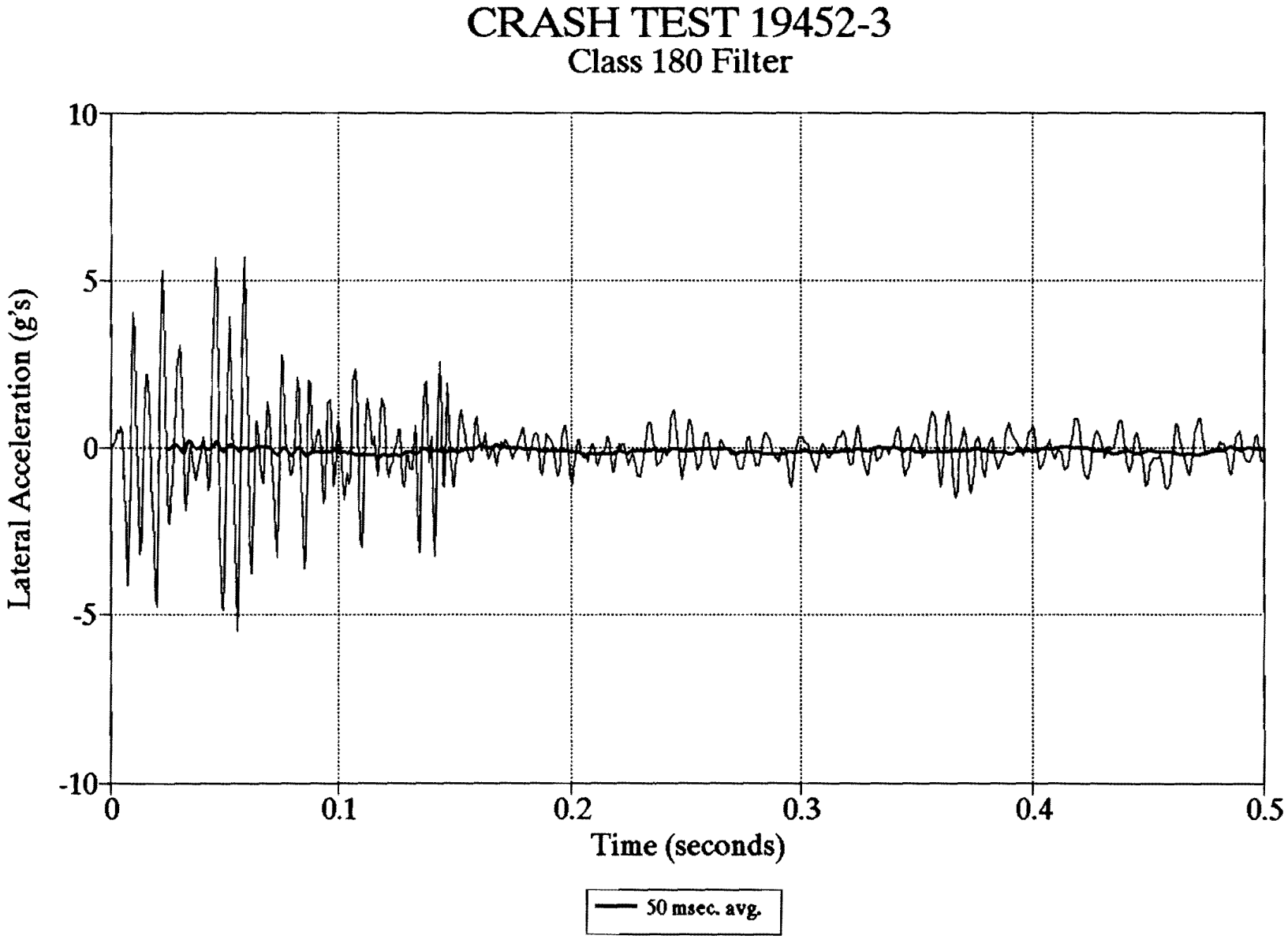


Figure E-13. Lateral accelerometer trace for test 19452-3.

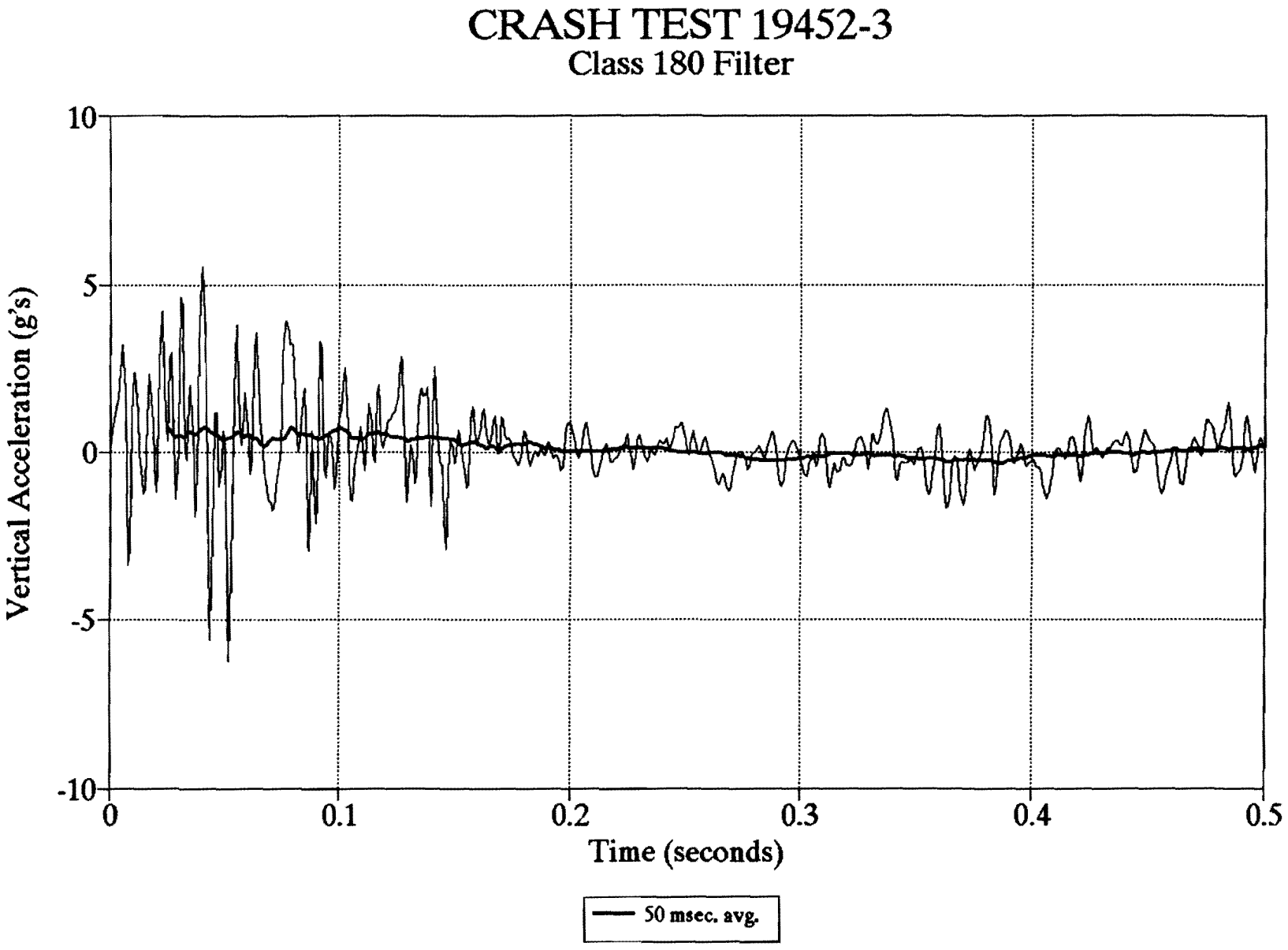


Figure E-14. Vertical accelerometer trace for test 19452-3.

APPENDIX F

TEST 19452-4 REPORT

Test 19452-4

The test article was the same as test 19452-3 with one exception: the size of the stove bolts connecting the mailbox to the bracket extensions was increased to 1/4 in. (0.64 cm). Complete details of the test article are given in Appendix B. Figure F-1 shows photos of the test article. Figure F-2 shows the 1987 Yugo GV test vehicle. Position of the vehicle with respect to the test article at impact is shown in Figure F-3. Impact speed was 61.2 mph (98.5 km/h). Impact point was the front left quarter point of the vehicle's bumper. Test inertia mass of the vehicle was 1,800 lb (816 kg) and its gross static mass was 1,968 lb (893 kg). Other vehicular dimensions and information are given in Figure F-4.

The vehicle was free wheeling and unrestrained just prior to impact. Upon impact, the support began to yield and by 0.025 second, the mailbox had detached from the support. At approximately 0.035 second the mailbox struck the hood of the vehicle, bounced off, and went over the top of the car. Although the mailbox again separated from the bracket extensions, the larger stove bolts kept the box attached for a sufficient duration of time to allow the box to obtain a velocity approximately equal to that of the vehicle. Consequently, the box did not hit the windshield. The vehicle lost contact with the installation at approximately 0.174 second, the brakes were applied, and the vehicle came to rest 300 ft (91.5 m) from the point of impact. Figure F-5 shows sequential photographs of the test.

Figures F-6 and F-7 show the test article damage. As shown, the support bent at ground level and the mailbox attachment bracket remained with the support, but the mailbox itself was torn from the attachment bracket. Other mailbox components came to rest approximately 90 ft (27.4 m) from the impact point. The vehicle sustained only minor damage to the bumper and hood as shown in Figure F-8.

A summary of test results and other pertinent information are given in Figure F-9. The maximum 0.050 second average acceleration experienced by the vehicle was -1.5 g in the longitudinal direction and 0.4 g in the lateral direction. No occupant contact occurred in the longitudinal or lateral direction. Angular displacements of the vehicle are plotted in Figure F-10 and vehicular accelerations are plotted in Figures F-11 through F-13. Change in the vehicle's velocity was 1.5 mph (2.3 km/h).

In summary, the test was successful and met all evaluation criteria.

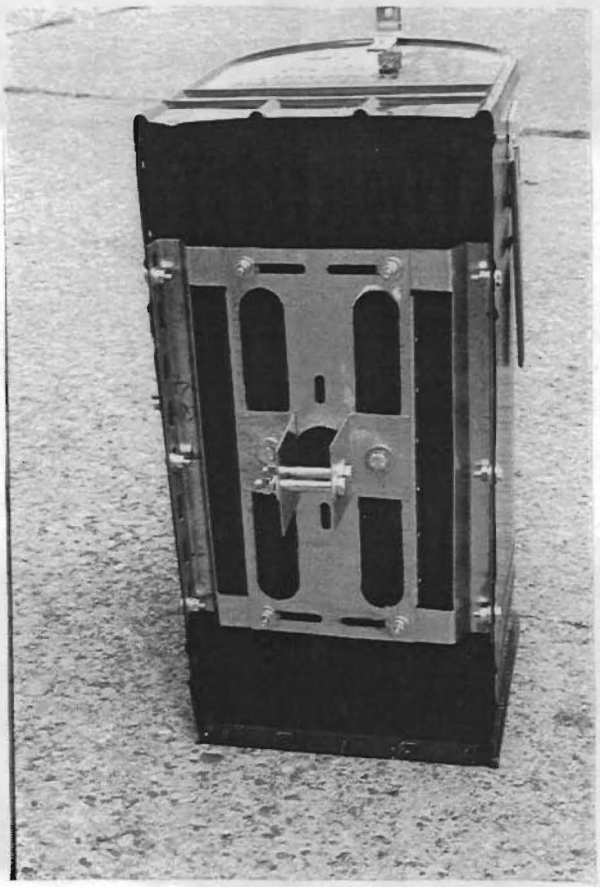


Figure F-1. Mailbox installation for test 19452-4.

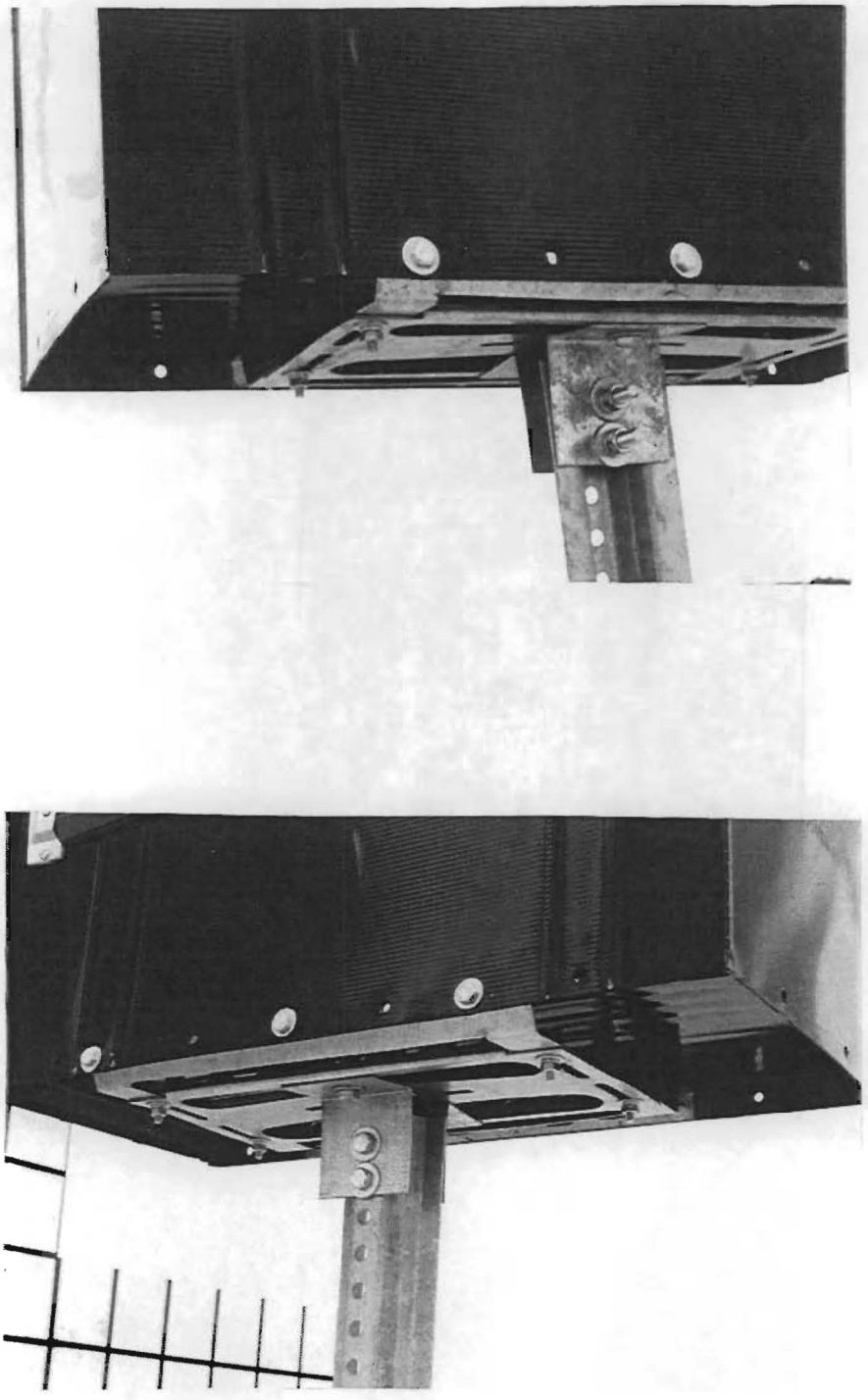


Figure F-1. Mailbox installation for test 19452-4 (continued).

Figure F-2. Vehicle before test 19452-4.

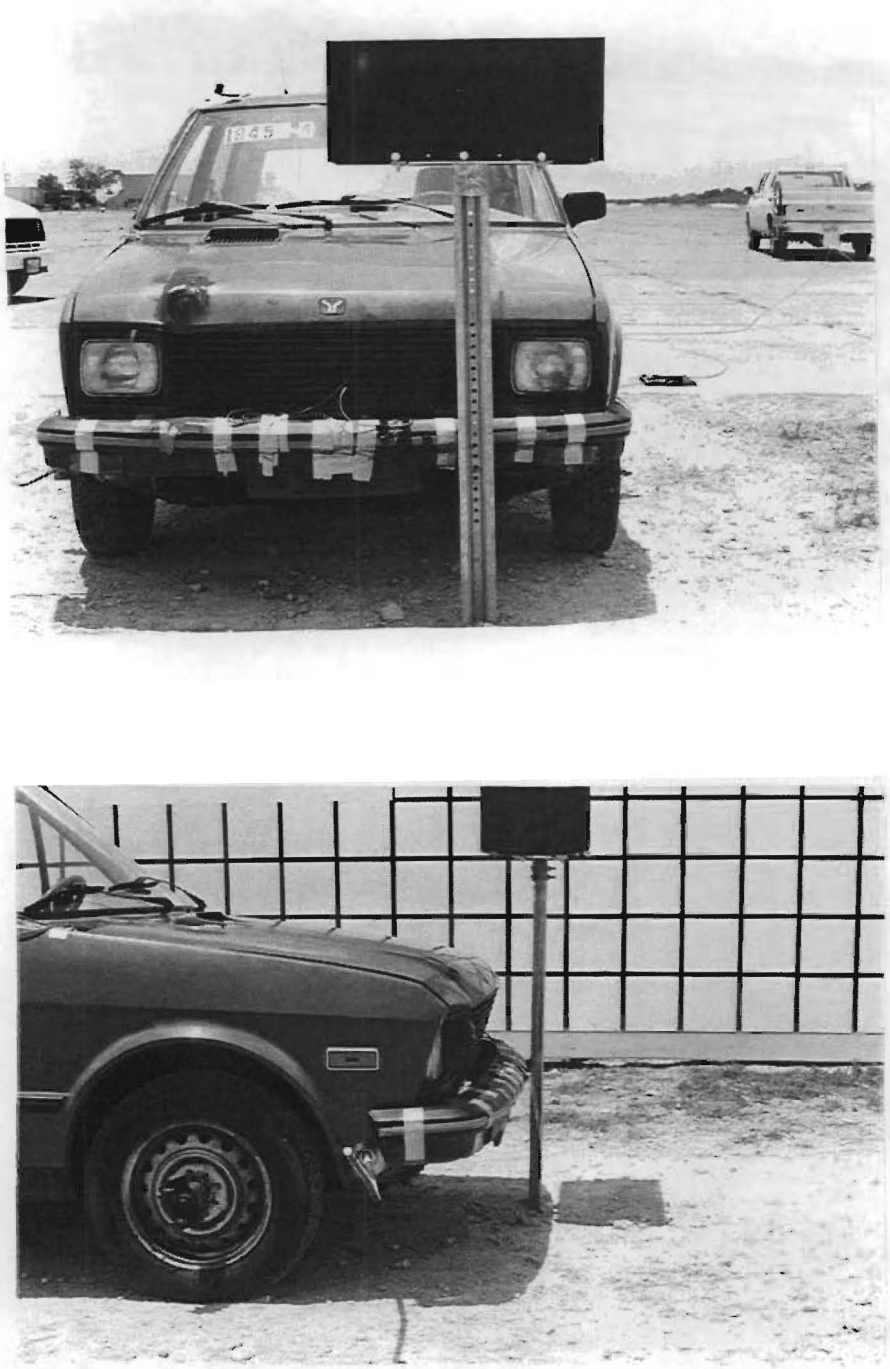


Figure F-3. Vehicle/mailbox geometrics for test 19452-4.

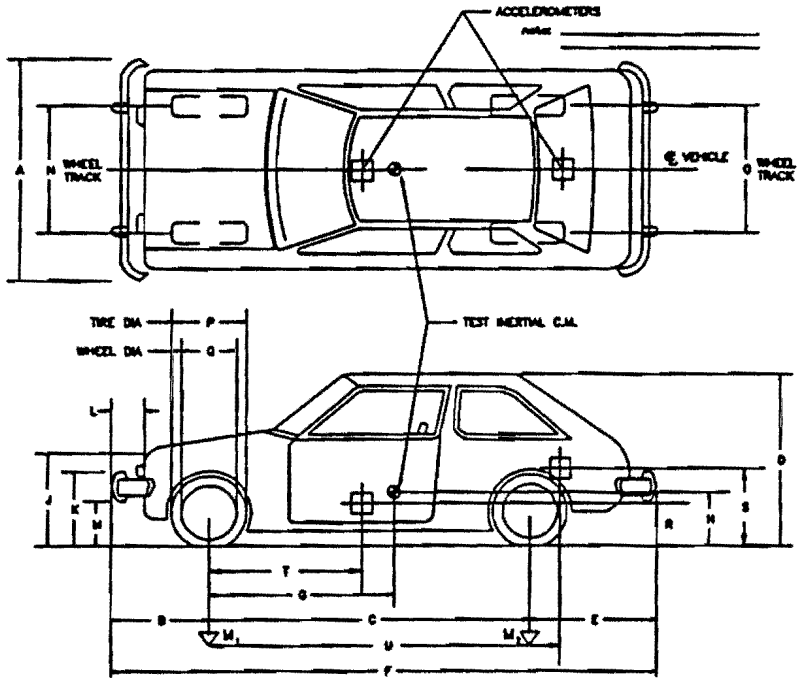
DATE: 7-24-92 TEST NO.: 19452-4 VIN NO: VX1BA1215H12353059 MAKE: Yugo

MODEL: GV YEAR: 1987 ODOMETER: 51069 TIRE SIZE: 145R13

TIRE INFLATION PRESSURE: _____

MASS DISTRIBUTION (kg) LF 250 RF 269 LR 147 RR 150

DESCRIBE ANY DAMAGE TO VEHICLE PRIOR TO TEST:



ENGINE TYPE: V4 gas

ENGINE CID: 1.1 litre

TRANSMISSION TYPE:

__ AUTO

__ MANUAL

OPTIONAL EQUIPMENT:

DUMMY DATA:

TYPE: _____

MASS: _____

SEAT POSITION: _____

GEOMETRY – (mm)

A	1537	E	635	J	768	N	1327	R	
B	699	F	3473	K	483	O		S	730
C	2140	G	813	L	64	P	559	T	777
D	1410	H	381	M	292	Q	368	U	2451

MASS – (kg)	CURB	TEST INERTIAL	GROSS STATIC
M_1	529	520	556
M_2	290	296	337
M_T	819	816	893

1 mm = 0.039 in
1 kg = 2.202 lb

Figure F-4. Vehicle properties for test 19452-4.

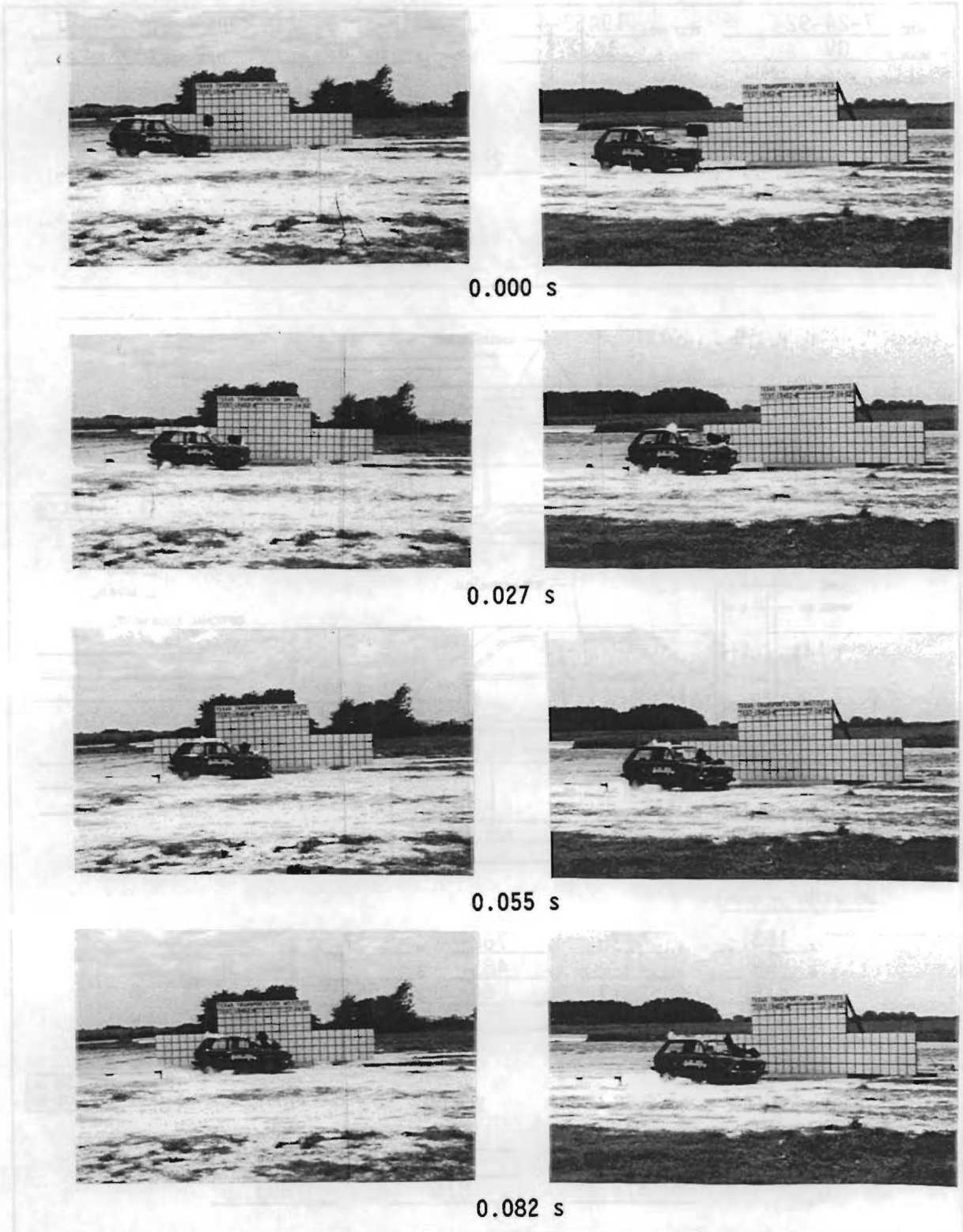
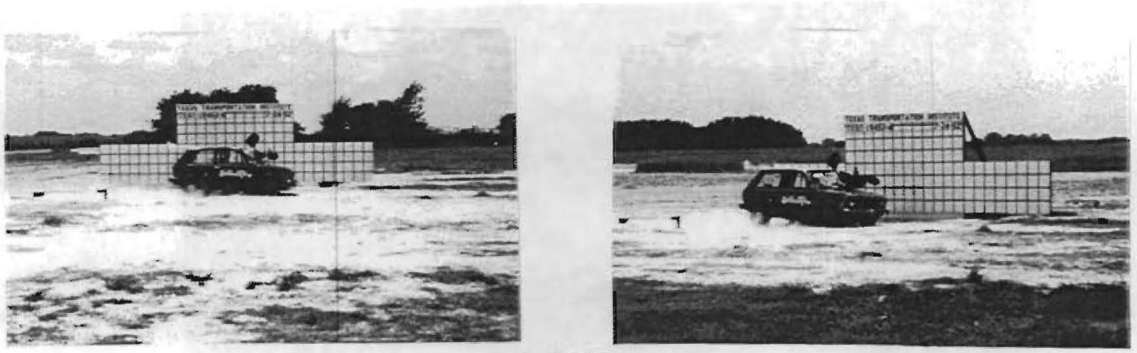
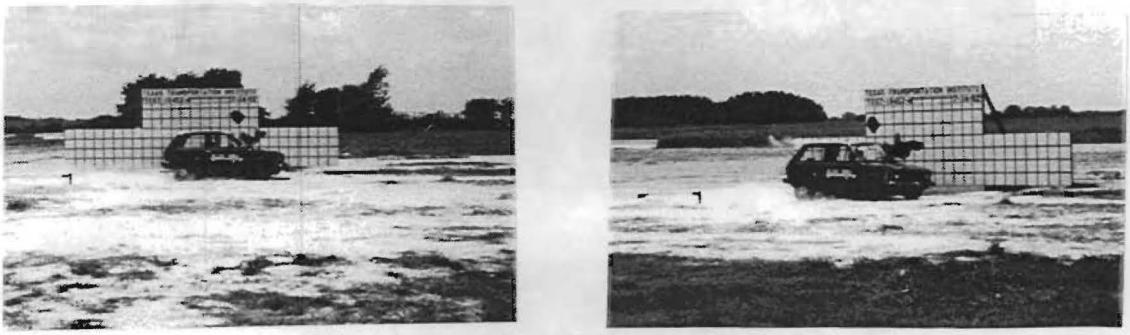


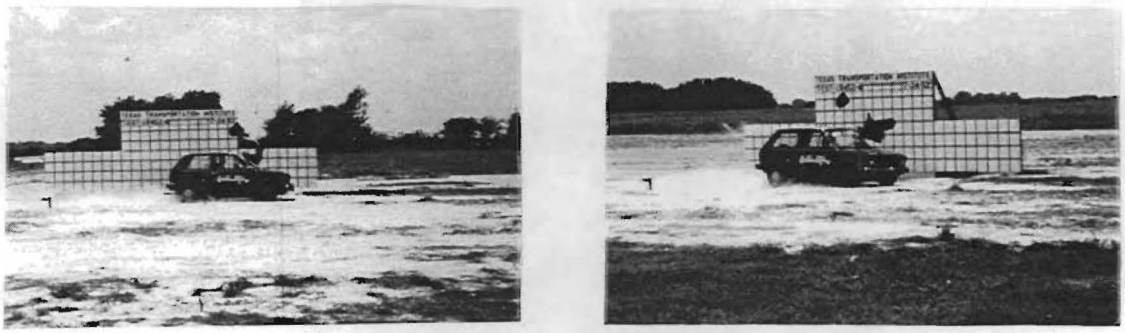
Figure F-5. Sequential photographs for test 19452-4. (perpendicular and side views).



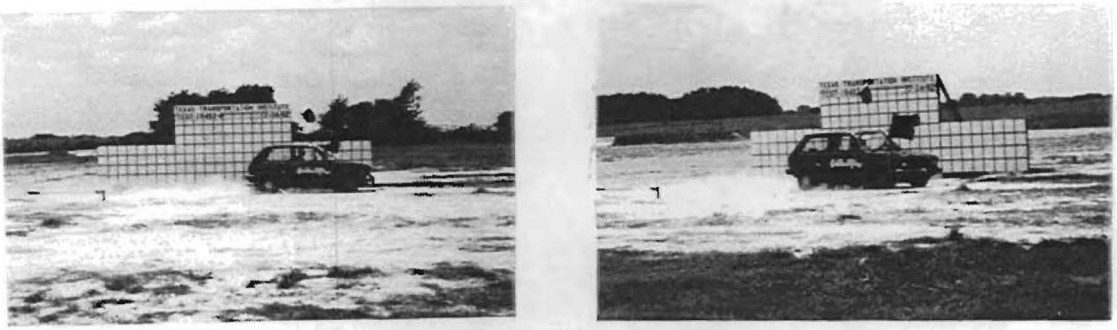
0.109 s



0.137 s

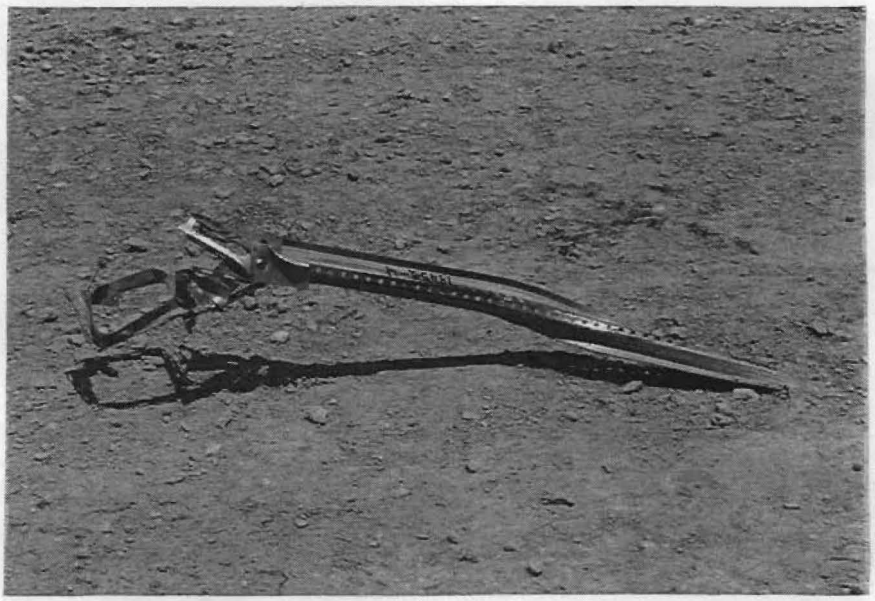


0.164 s



0.191 s

Figure F-5. Sequential photographs for test 19452-4 (perpendicular and side views) continued.



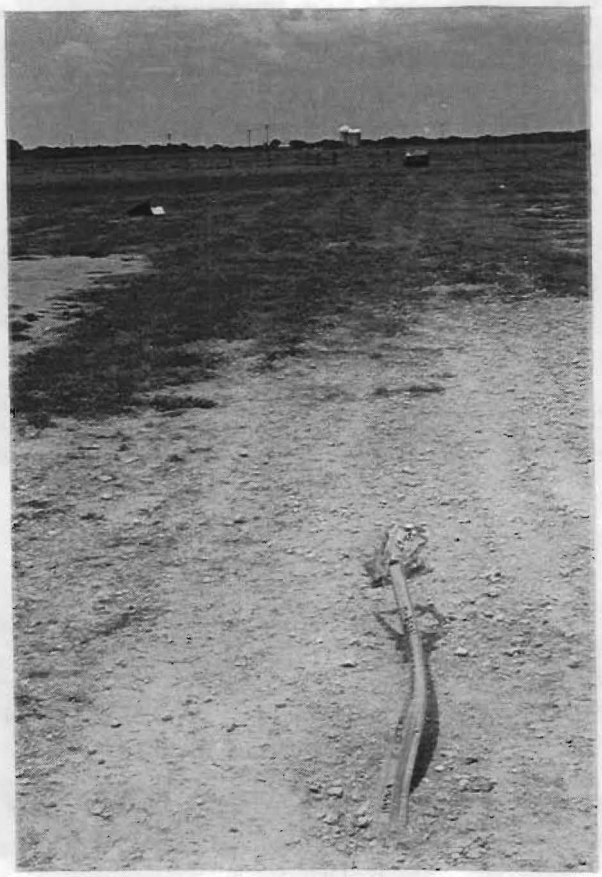
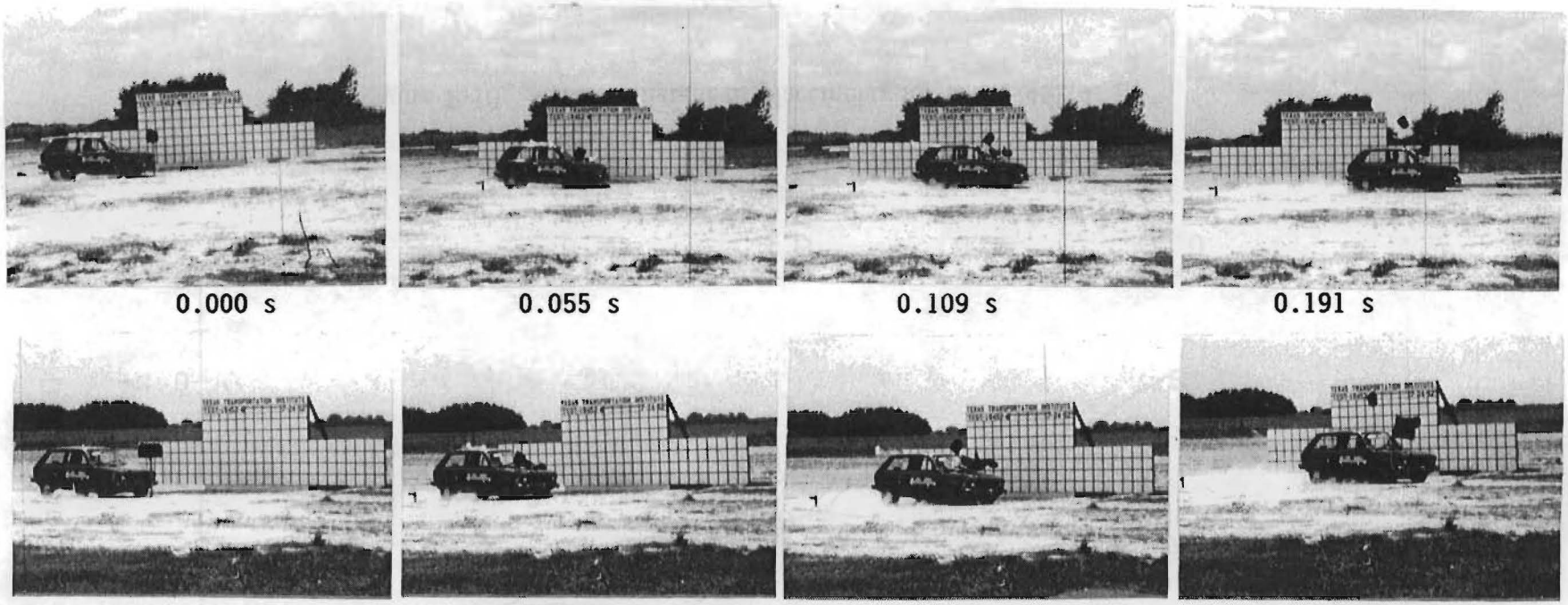


Figure F-6. Test installation after test 19452-4.

Figure F-7. Damage to mailbox after test 19452-4.

Figure F-8. Vehicle after test 19452-4.



Test No	19452-4.	Impact Speed	61.2 mi/h (98.4 km/h)
Date	07/24/92.	Change in Velocity	1.5 mi/h (2.3 km/h)
Test Article	Double mount, Type 1 1/2 Mailbox Installation.	Change in Momentum	123.0 lb-s
Support	Type 4 (2 lb/ft winged channel post)	Vehicle Accelerations (Max. 0.050-sec Avg)	
Embedment	2'-0" driven(strong soil)	Longitudinal	-1.5 g
Vehicle	1987 Yugo GV	Lateral	0.4 g
Vehicle Weight		Occupant Impact Velocity	
Test Inertia	1800 lb (816 kg)	Longitudinal	N/A
Gross Static	1968 lb (893 kg)	Lateral	N/A
Vehicle Damage Classification		Occupant Ridedown Accelerations	
TAD	12-FL-1	Longitudinal	No contact
SAE	12FLEN1	Lateral	No contact

Figure F-9. Summary of results for test 19452-4.

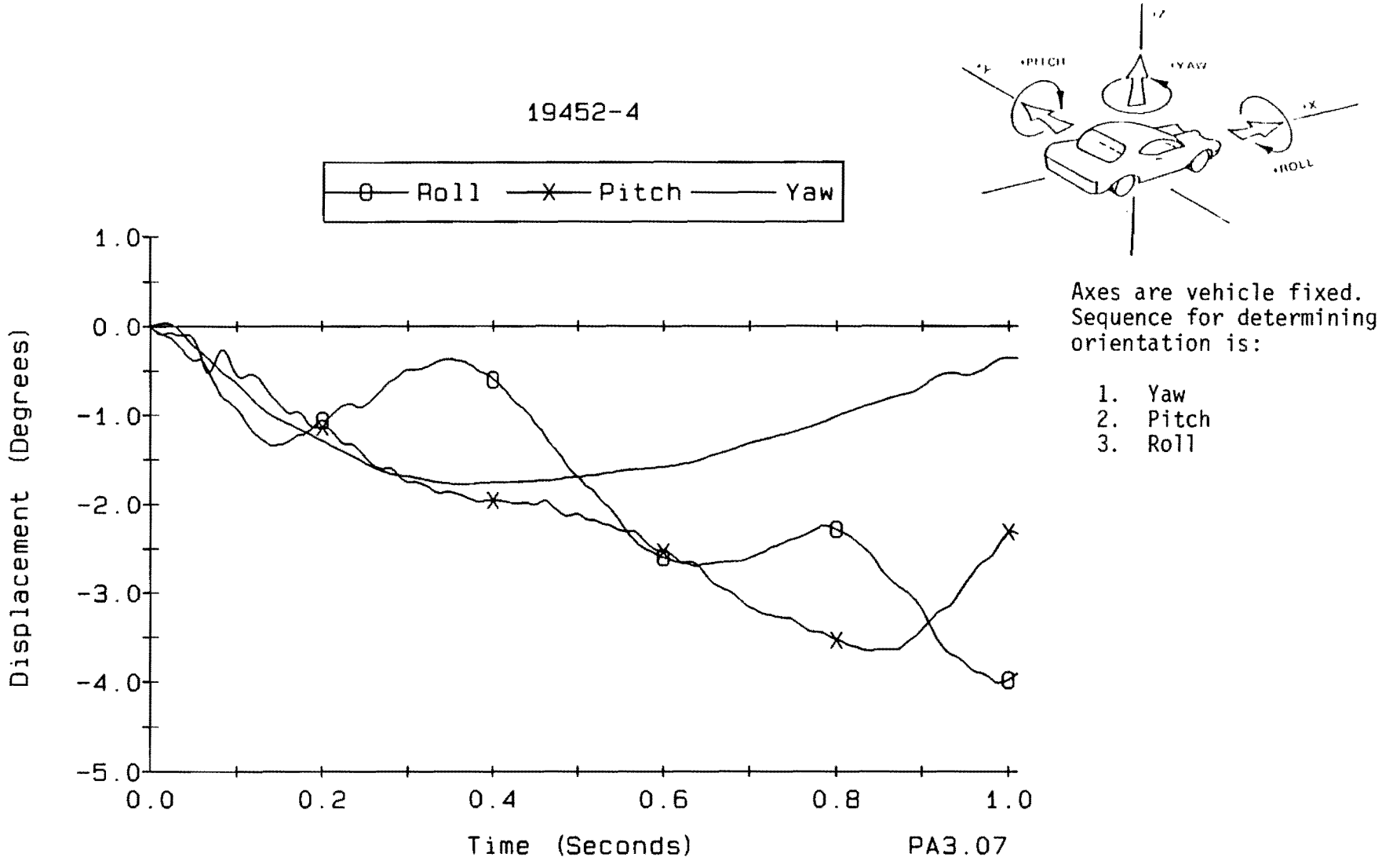


Figure F-10. Vehicle angular displacements for test 19452-4.

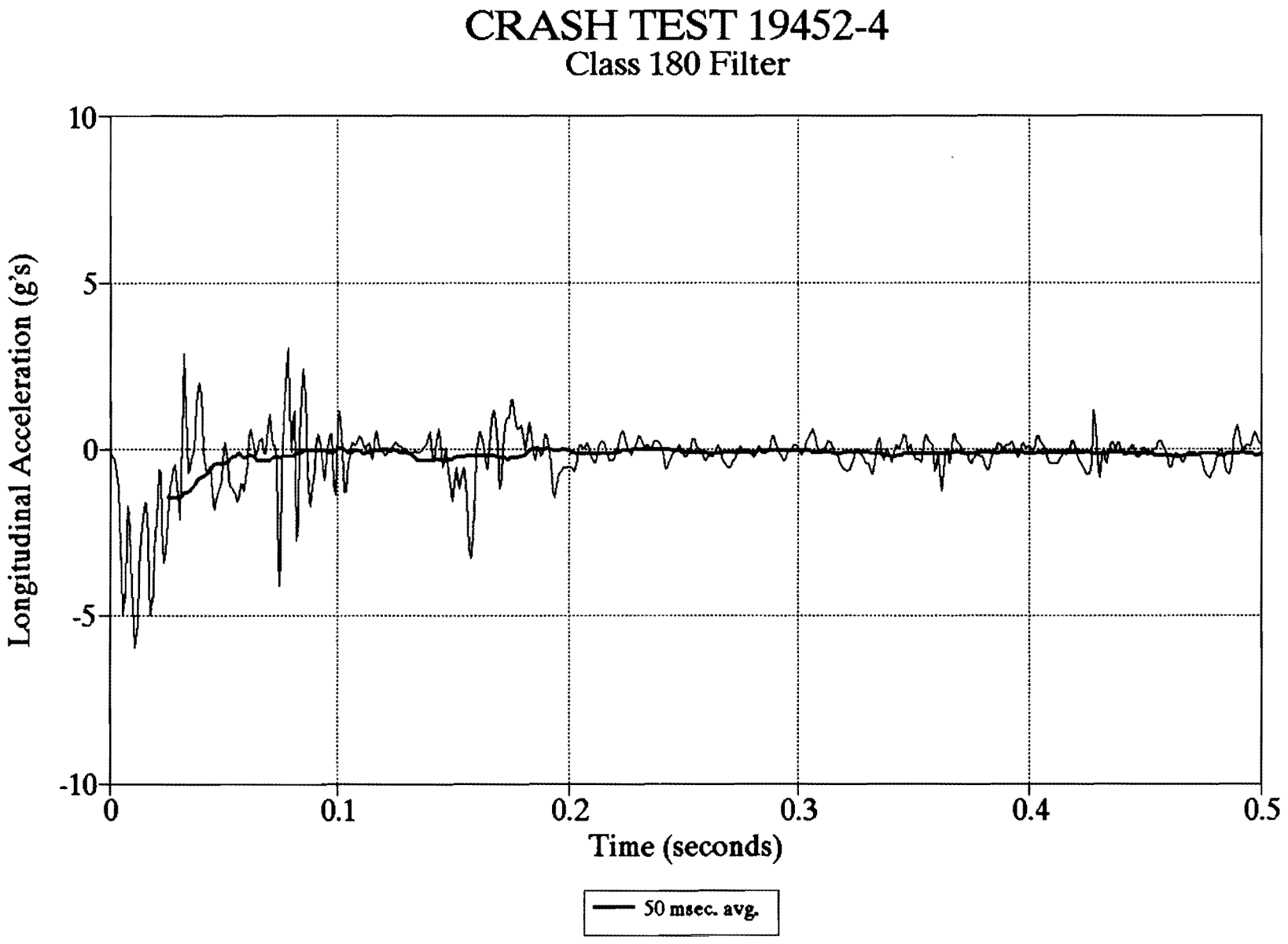


Figure F-11. Longitudinal accelerometer trace for test 19452-4.

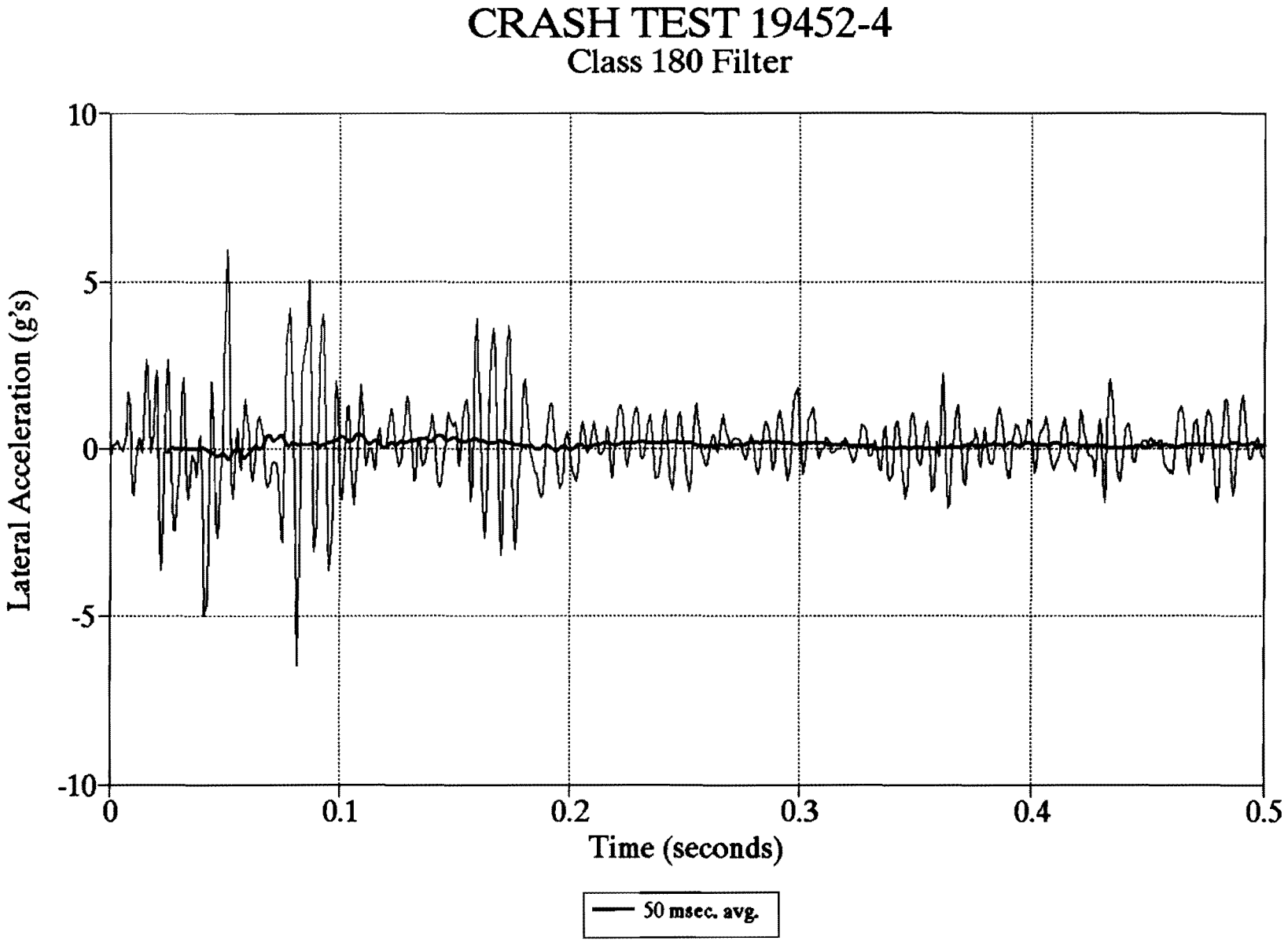


Figure F-12. Lateral accelerometer trace for test 19452-4.

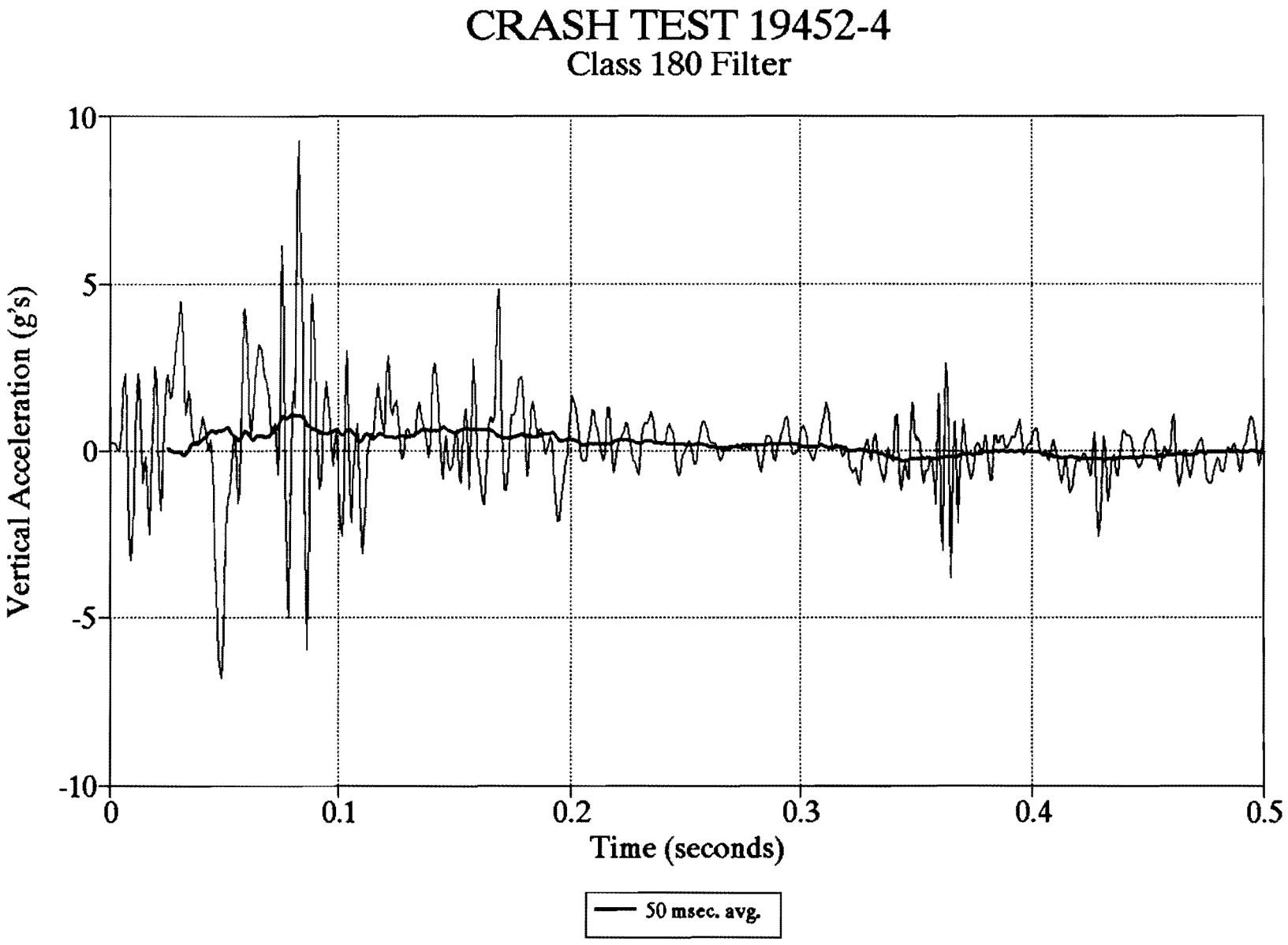


Figure F-13. Vertical accelerometer trace for test 19452-4.

APPENDIX G

TEST 19452-5 REPORT

Test 19452-5

The test article consisted of two size no. 1½ mailboxes mounted on a single 2 lb/ft (3 kg/m) steel winged channel support. Each mailbox was attached to the universal bracket and one bracket extension with six 1/4-in. (0.64 cm) stove bolts. An adapter plate was used to attach the two brackets to the angles. Complete details of the test article are given in Appendix B. Figures G-1 and G-2 show photos of the test article. Figure G-3 shows the 1988 Yugo GV test vehicle. Figure G-4 shows the position of the vehicle with respect to the test article at impact. Impact speed was 62.4 mph (100.4 km/h). Impact point was the front left quarter point of the vehicle's bumper. Test inertia mass of the vehicle was 1,800 lb (816 kg) and its gross static mass was 1,968 lb (893 kg). Other vehicular dimensions and information are given in Figure G-5.

The vehicle was free wheeling and unrestrained just prior to impact. Upon impact, the support began to yield and pocket around the front of the vehicle. By approximately 0.022 second, the support had yielded sufficiently enough to allow the mailboxes to strike the hood of the vehicle. Shortly thereafter, the vehicle exited with the installation pocketed around the front of the vehicle. The brakes were applied and the vehicle came to rest 275 ft (83.8 m) from the point of impact. Figure G-6 shows sequential photographs of the test.

Figures G-7 and G-8 show test article damage. As shown, the support was pulled from the ground. The mailboxes remained attached to the support post. The mailboxes and support came to rest approximately 85 ft (25.9 m) from the impact point. Doors and back sides of the mailboxes were detached and distributed along the vehicle's path. The vehicle sustained only minor damage to the bumper and hood as shown in Figure G-9.

A summary of test results and other pertinent information are given in Figure G-10. The maximum 0.050 second average acceleration experienced by the vehicle was -2.7 g in the longitudinal direction and 0.7 g in the lateral direction. No occupant contact occurred in the longitudinal or lateral direction. Vehicular angular displacements are plotted in Figure G-11 and vehicular accelerations are plotted in Figures G-12 through G-14. Change in vehicle velocity was 4.7 mph (7.6 km/h).

In summary, the test was successful and met all evaluation criteria.

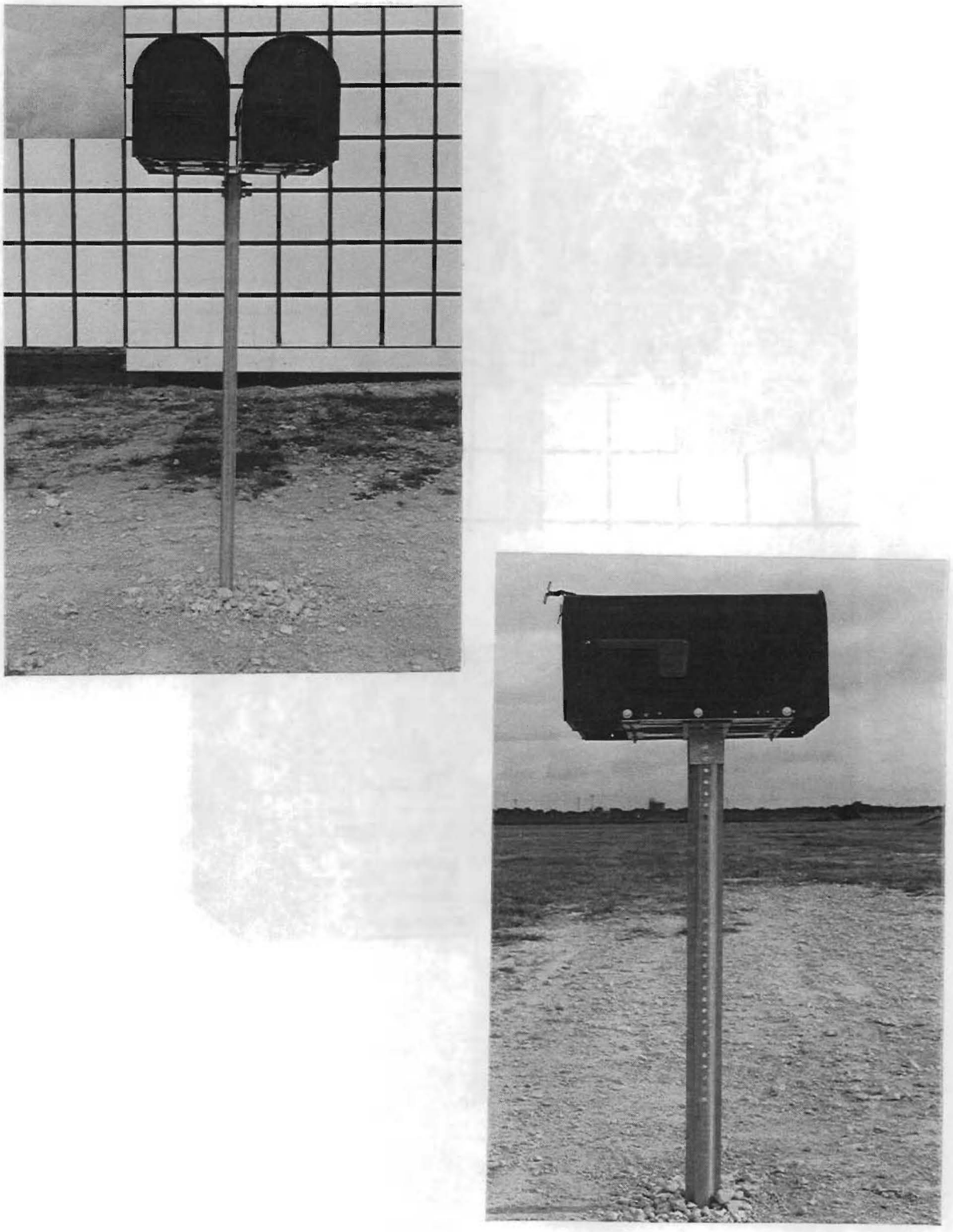


Figure G-1. Mailbox installation for test 19452-5.

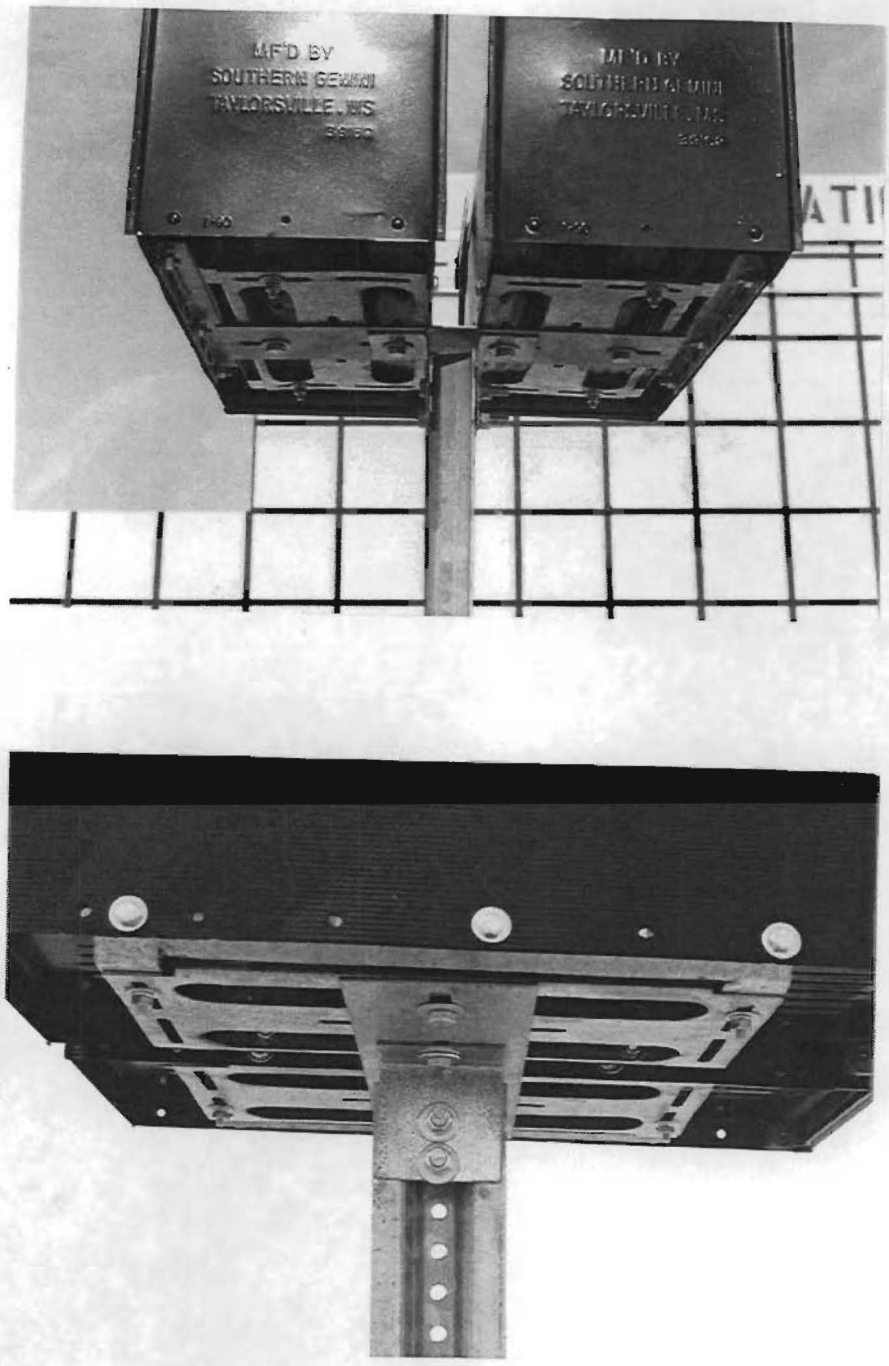


Figure G-2. Mailbox/support connection for installation used in test 19452-5.

Figure G-3. Vehicle before test 19452-5.

Figure G-4. Vehicle/mailbox geometrics for test 19452-5.

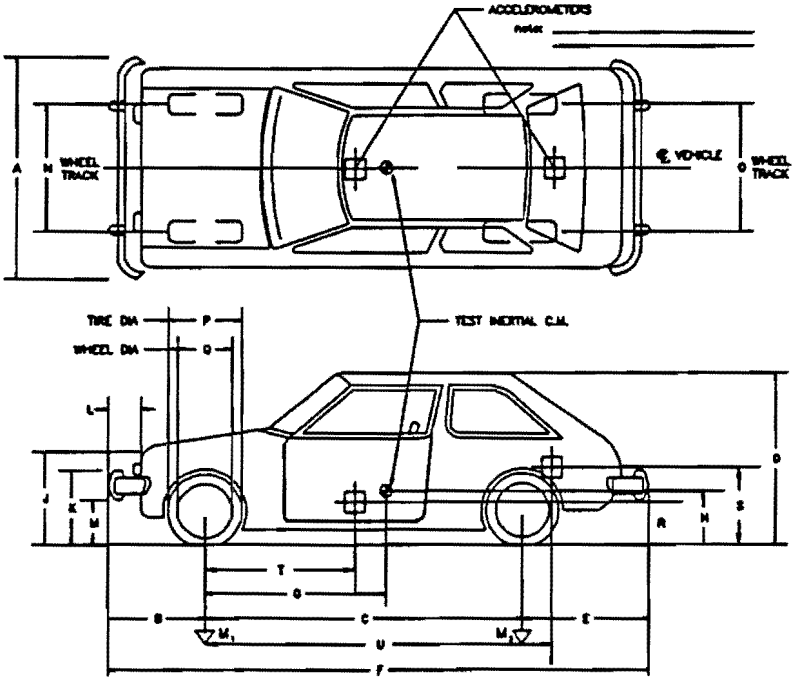
DATE: 7-22-92 TEST NO.: 19452-5 VIN NO.: VX1BA1216JK404378 MAKE: Yugo

MODEL: GV YEAR: 1988 ODOMETER: 48466 TIRE SIZE: 145R13

TIRE INFLATION PRESSURE: _____

MASS DISTRIBUTION (kg) LF 250 RF 252 LR 156 RR 158

DESCRIBE ANY DAMAGE TO VEHICLE PRIOR TO TEST:



ENGINE TYPE: V4 gas

ENGINE CID: 1.1 litre

TRANSMISSION TYPE:

__ AUTO

__ MANUAL

OPTIONAL EQUIPMENT:

DUMMY DATA:

TYPE: _____

MASS: _____

SEAT POSITION: _____

GEOMETRY – (mm)

A	1518	E	610	J	787	N	1283	R	
B	699	F	3473	K	514	O		S	635
C	2165	G	813	L	70	P	578	T	833
D	1435	H	394	M	375	Q	362	U	2292

MASS – (kg)	CURB	TEST INERTIAL	GROSS STATIC
M_1	536	502	541
M_2	284	314	352
M_T	820	816	893

1 mm = 0.039 in
1 kg = 2.202 lb

Figure G-5. Vehicle properties for test 19452-5.

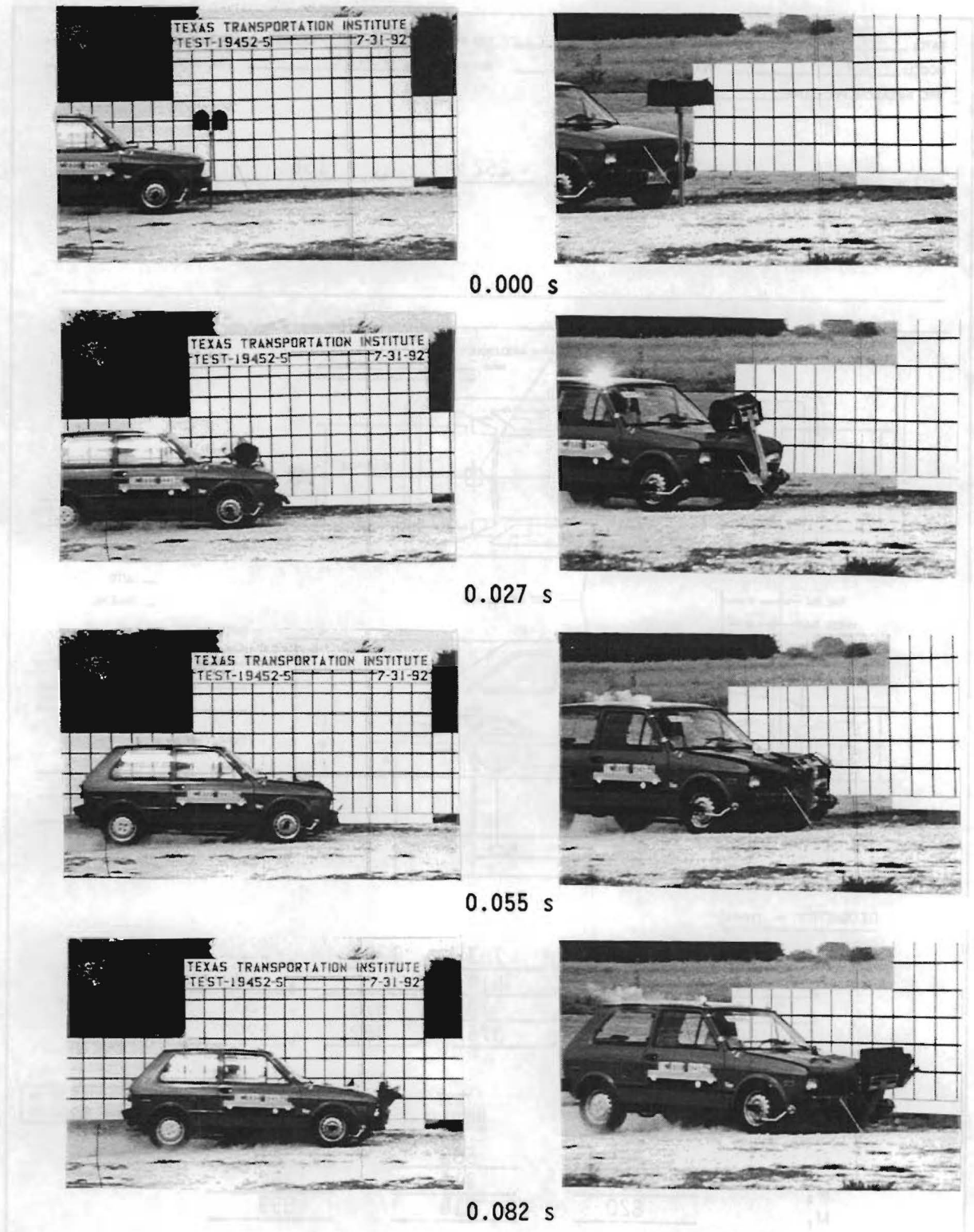
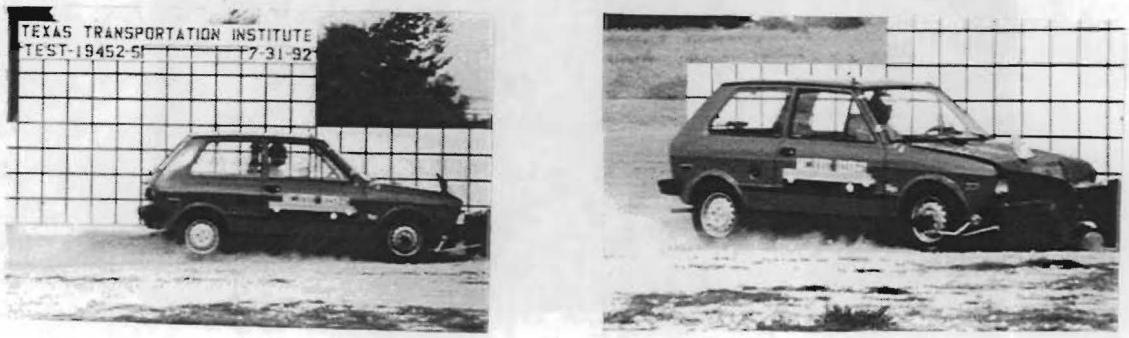


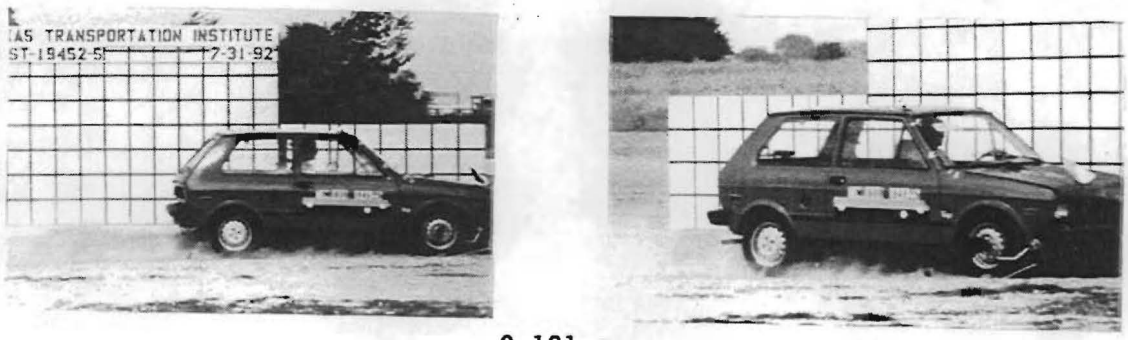
Figure G-6. Sequential photographs for test 19452-5. (perpendicular and side views).

0.109 s

0.136 s



0.164 s



0.191 s

Figure G-6. Sequential photographs for test 19452-5 (perpendicular and side views) continued.

Figure G-7. Test installation after test 19452-5.

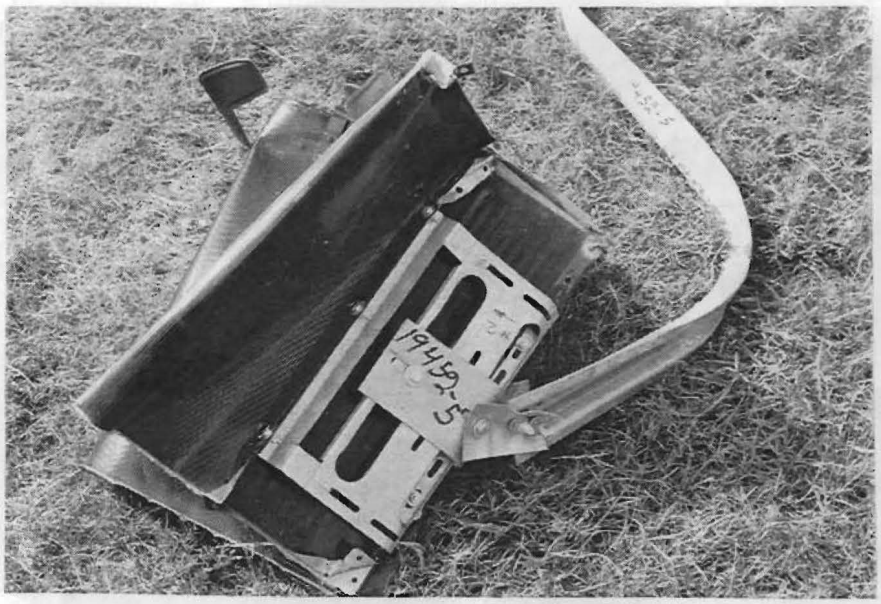
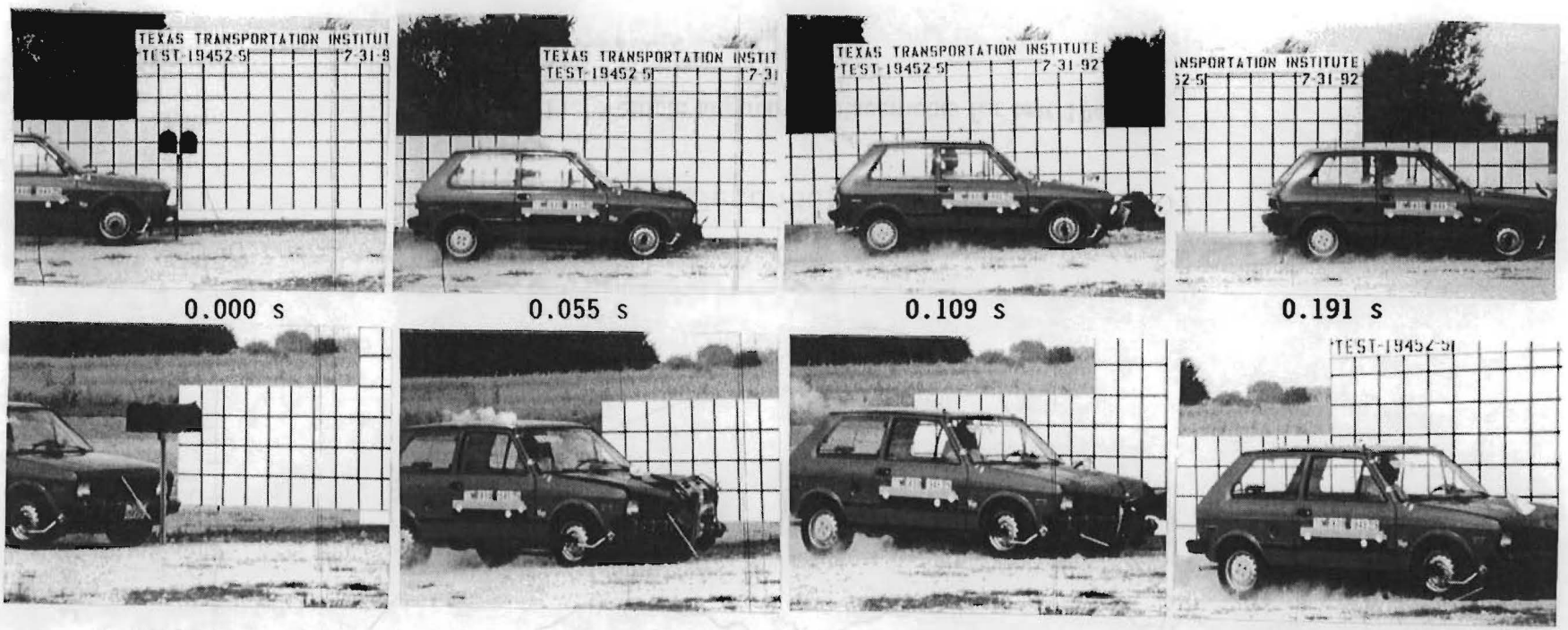


Figure G-8. Damage to installation after test 19452-5.

Figure G-9. Vehicle after test 19452-5.



Test No	19452-5.	Impact Speed	62.4 mi/h (100.4 km/h)
Date	07/31/92	Change in Velocity	4.7 mi/h (7.6 km/h)
Test Article	Double mount, Type 1 1/2 Mailbox Installation.	Change in Momentum	385.3 lb-s
Support	Type 4 (2 lb/ft winged channel post)	Vehicle Accelerations (Max. 0.050-sec Avg)	
Embedment	2'-0" driven(strong soil)	Longitudinal	-2.7 g
Vehicle	1988 Yugo GV	Lateral	0.7 g
Vehicle Weight		Occupant Impact Velocity	
Test Inertia	1800 lb (816 kg)	Longitudinal	N/A
Gross Static	1968 lb (893 kg)	Lateral	N/A
Vehicle Damage Classification		Occupant Ridedown Accelerations	
TAD	12-FL-1	Longitudinal	No contact
SAE	12FLEN1	Lateral	No contact

Figure G-10. Summary of results for test 19452-5.

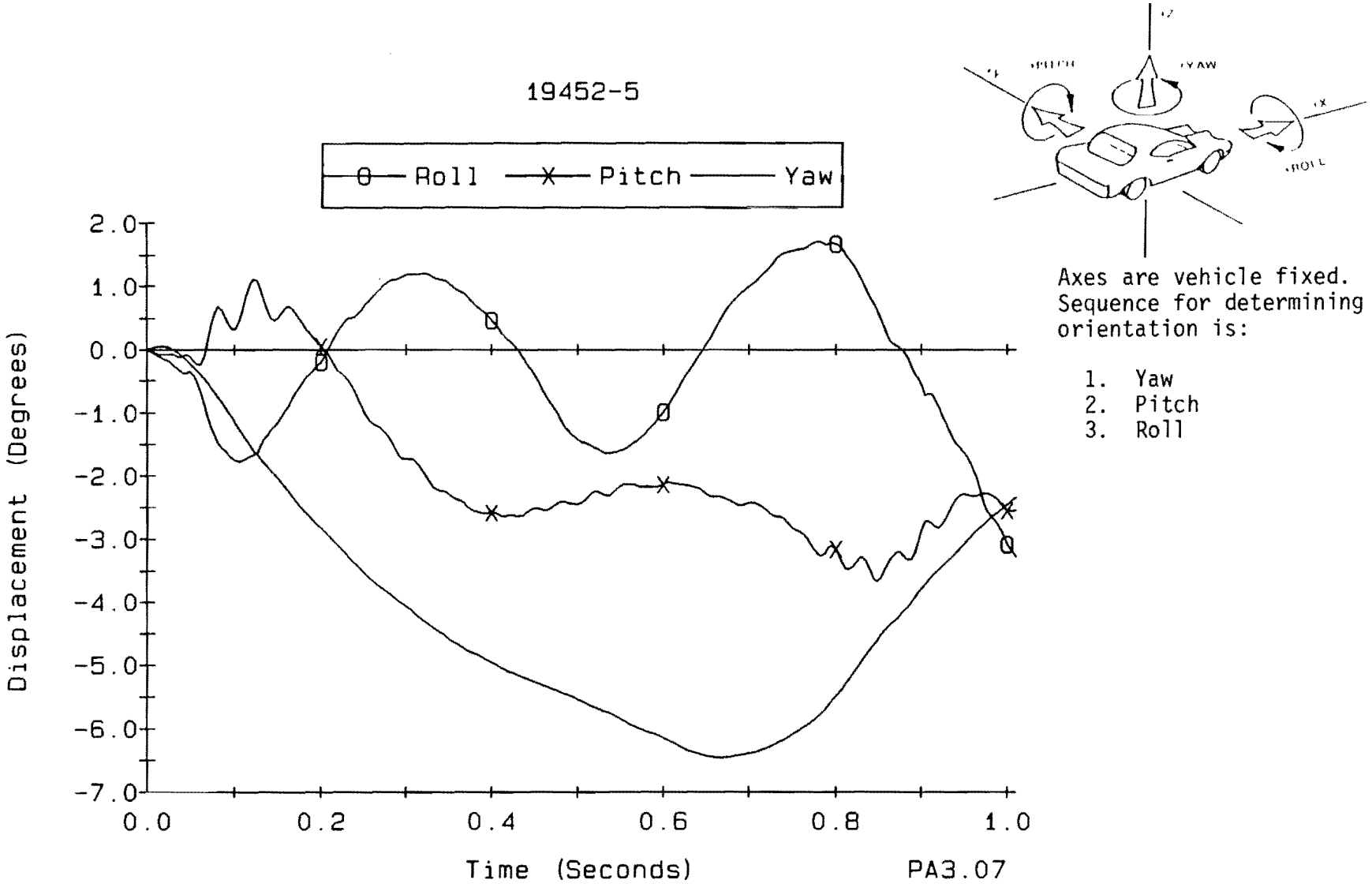


Figure G-11. Vehicle angular displacements for test 19452-5.

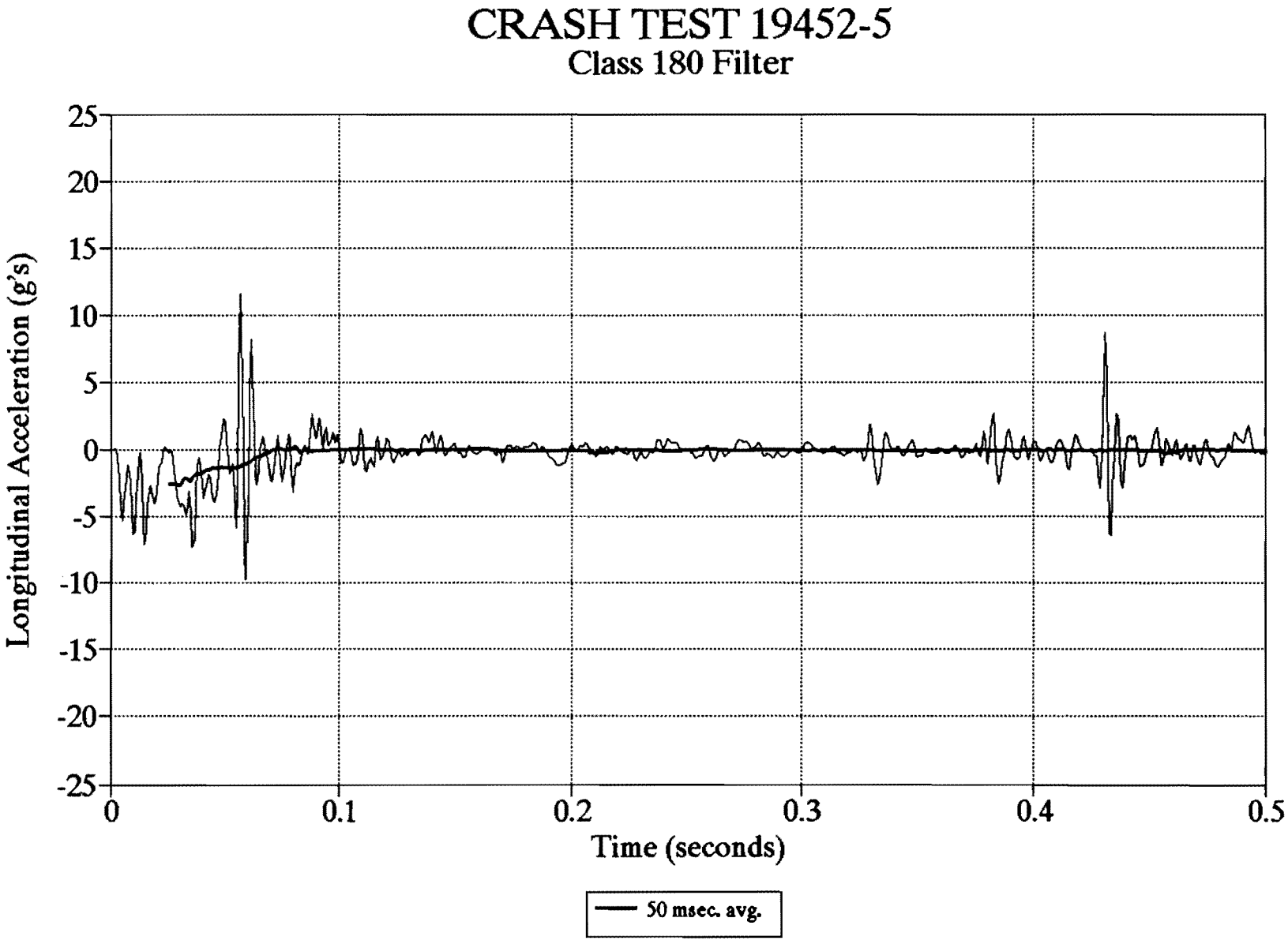


Figure G-12. Longitudinal accelerometer trace for test 19452-5.

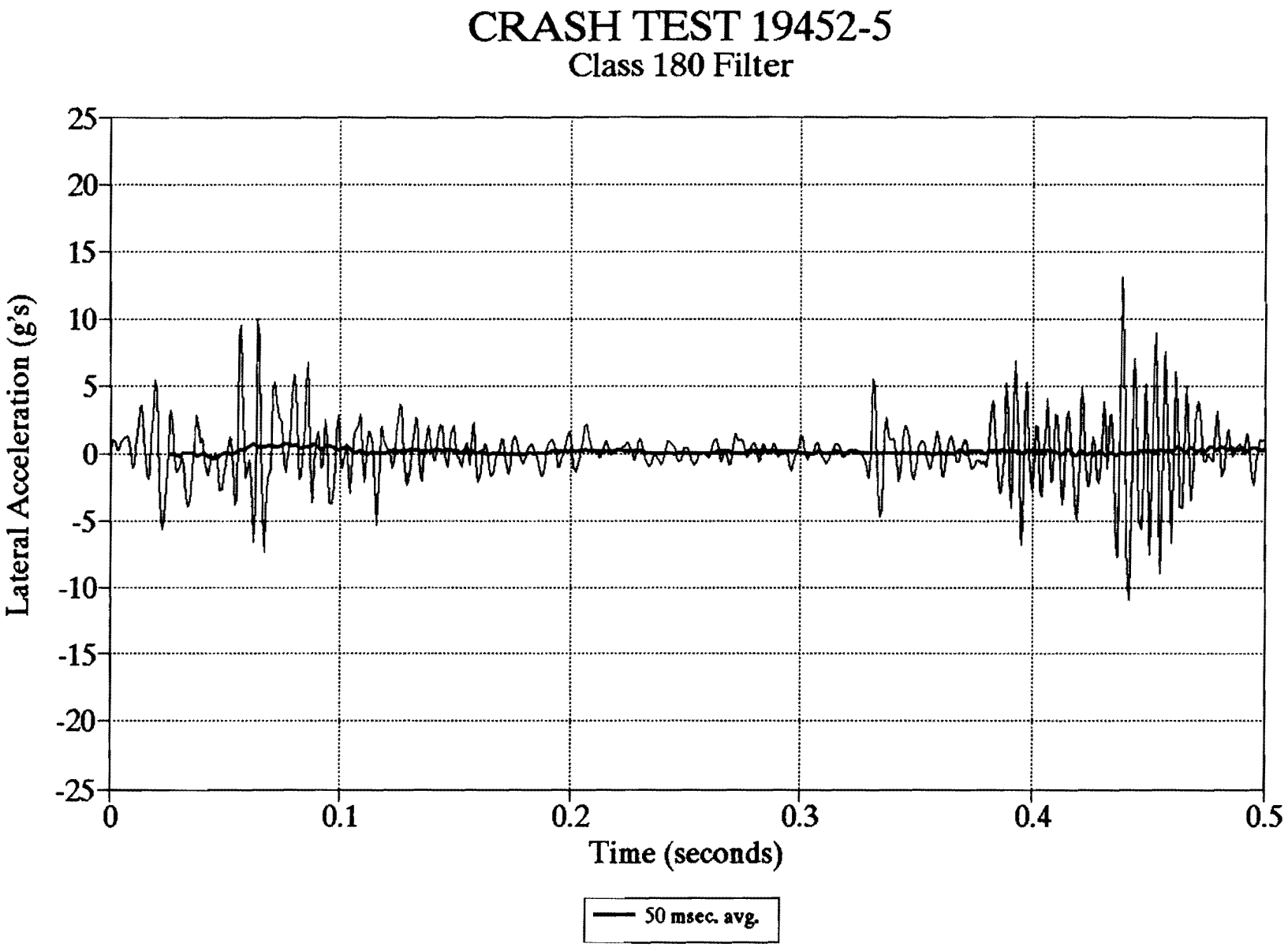


Figure G-13. Lateral accelerometer trace for test 19452-5.

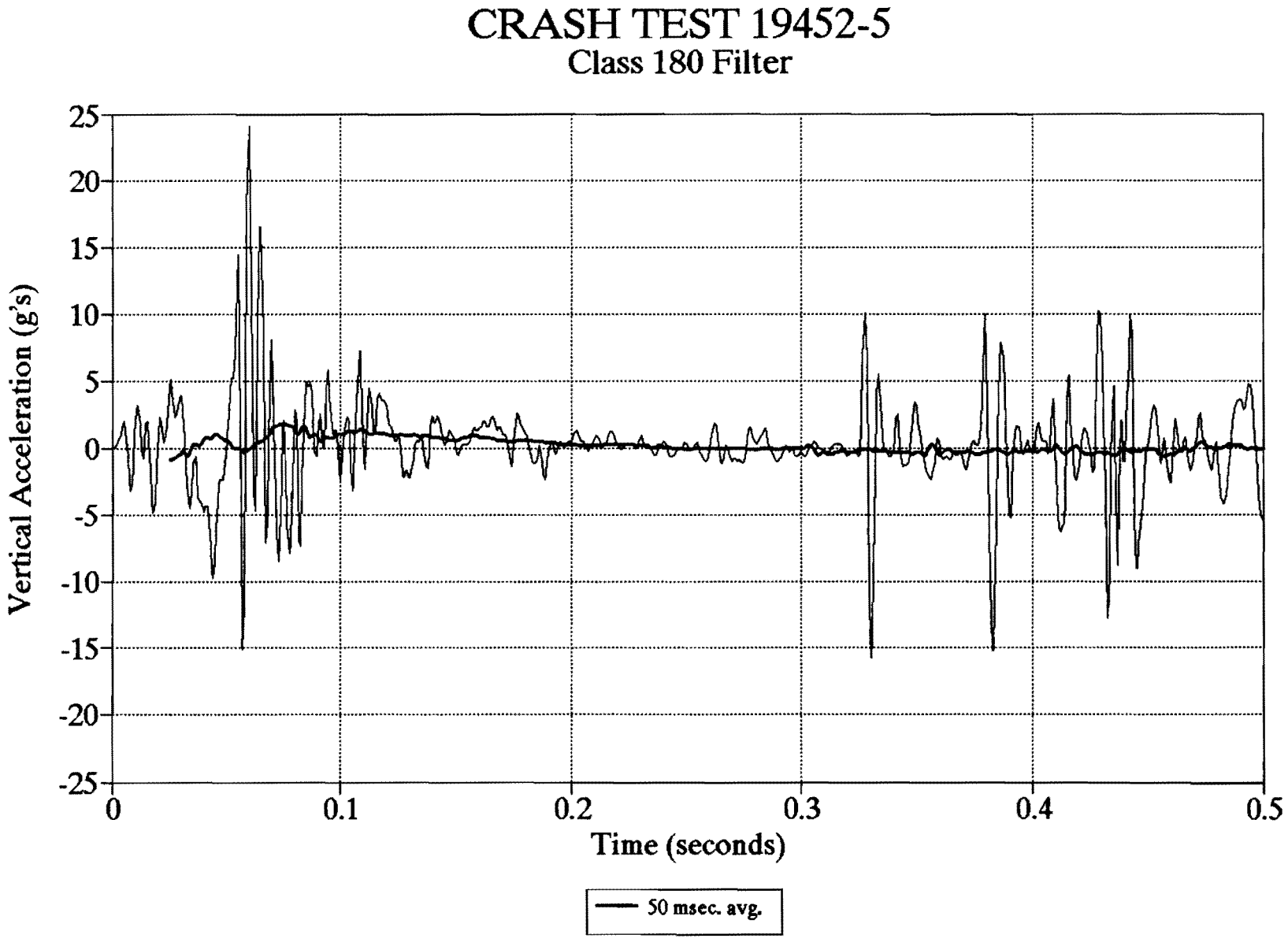


Figure G-14. Vertical accelerometer trace for test 19452-5.

APPENDIX H

TEST 19452-6 REPORT

Test 19452-6

The test article consisted of one size no. 2 mailbox mounted on a single 2.375 in. (6.0 cm) O.D. x O.095 in. (0.24 cm) thin-wall steel tube. The tube was mounted in a base socket. Attachment of the mailbox to the bracket extensions, attachment of the bracket to the angles, and attachment of the angles to the support (with the exception of bolt length) were the same as test 19452-4. Appendix B gives complete details of the test article. Figures H-1 and H-2 show photos of the test article. Figure H-3 shows the 1988 Yugo GV test vehicle. Figure H-4 shows the position of the vehicle with respect to the test article at impact. Impact speed was 60.9 mph (98.0 km/h). Impact point was the front right quarter point of the vehicle's bumper. Test inertia mass of the vehicle was 1,800 lb (816 kg) and its gross static mass was 1,968 lb (893 kg). Other vehicular dimensions and information are given in Figure H-5.

The vehicle was free wheeling and unrestrained just prior to impact. Upon impact, the support began to yield and by 0.020 second, the mailbox had detached from the support. At approximately 0.040 second the mailbox struck the hood of the vehicle, slid up the windshield and up and over the upper A-pillar. As the vehicle lost contact with the installation, the brakes were applied and the vehicle came to rest 295 ft (89.9 m) from the point of impact. Figure H-6 shows sequential photographs of the test.

Figures H-7 through H-9 shows the test article damage. As shown, the support was pulled from the ground socket and came to rest 20 ft (6.1 m) from the impact point. The mailbox came to rest approximately 108 ft (32.9 m) from the impact point. The vehicle sustained only minor damage to the bumper and hood as shown in Figure H-10.

A summary of test results and other pertinent information are given in Figure H-11. The maximum 0.050 second average acceleration experienced by the vehicle was -1.9 g in the longitudinal direction and 0.6 g in the lateral direction. No occupant contact occurred in the longitudinal or lateral direction. Angular displacements of the vehicle are plotted in Figure H-12 and vehicular accelerations are plotted in Figures H-13 through H-15. Change in the vehicle's velocity was 2.3 mph (3.7 km/h).

In summary, the test was successful and met all evaluation criteria.

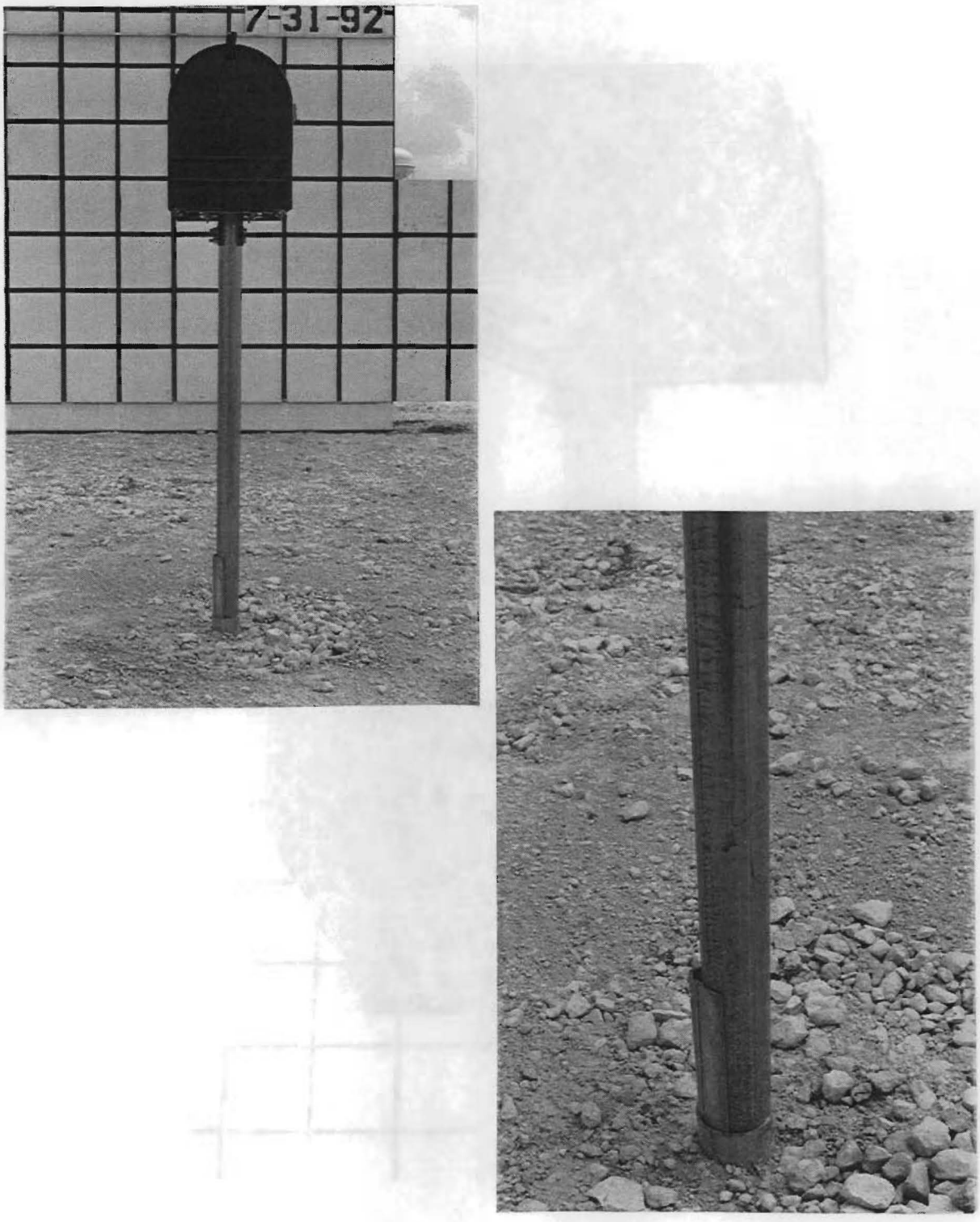


Figure H-1. Mailbox installation for test 19452-6.

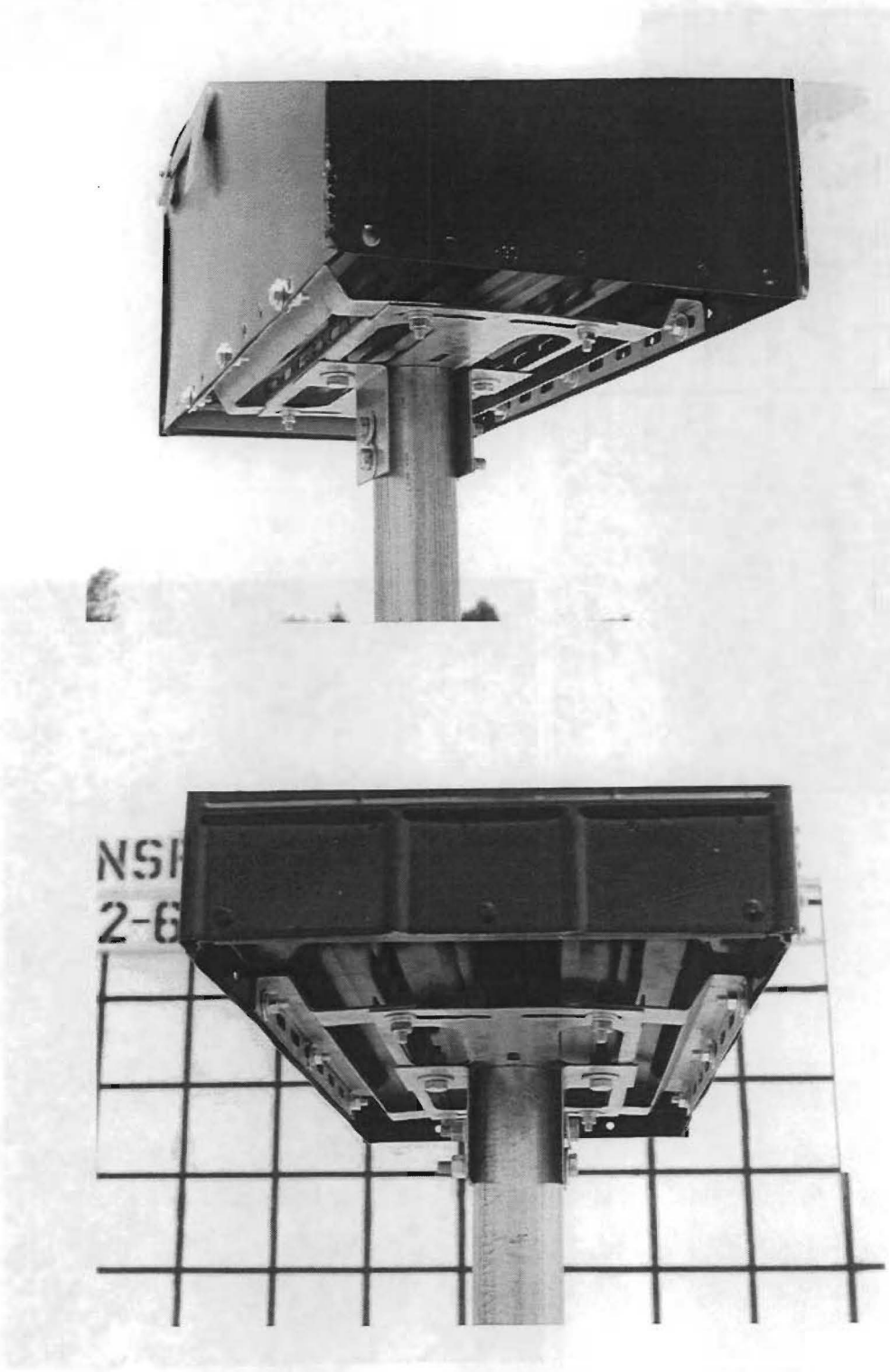


Figure H-2. Mailbox/support connection for installation used in test 19452-6.

Figure H-3. Vehicle before test 19452-6.

Figure H-4. Vehicle/mailbox geometrics for test 19452-6.

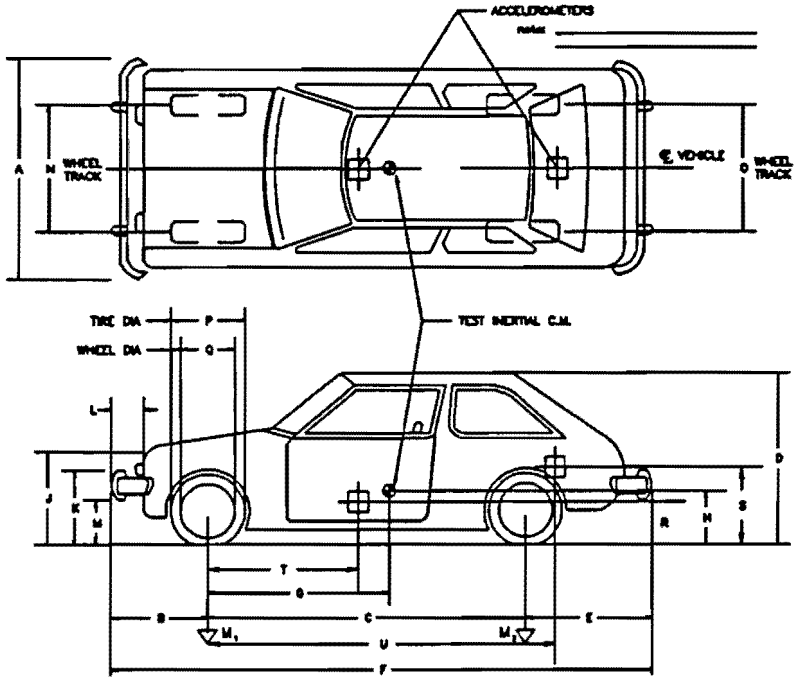
DATE: 7-22-92 TEST NO.: 19452-6 VIN NO.: VX1BA1216JK404378 MAKE: Yugo

MODEL: GV YEAR: 1988 ODOMETER: 48466 TIRE SIZE: 145R13

TIRE INFLATION PRESSURE: _____

MASS DISTRIBUTION (kg) LF 250 RF 252 LR 156 RR 158

DESCRIBE ANY DAMAGE TO VEHICLE PRIOR TO TEST:



ENGINE TYPE: V4 gas

ENGINE CID: 1.1 litre

TRANSMISSION TYPE:

__ AUTO

__ MANUAL

OPTIONAL EQUIPMENT:

DUMMY DATA:

TYPE: _____

MASS: _____

SEAT POSITION: _____

GEOMETRY – (mm)

A	1518	E	610	J	787	N	1283	R	
B	699	F	3473	K	514	O		S	635
C	2165	G	813	L	70	P	578	T	833
D	1435	H	394	M	375	Q	362	U	2292

MASS – (kg)	CURB	TEST INERTIAL	GROSS STATIC
M_1	536	502	541
M_2	284	314	352
M_T	820	816	893

1 mm = 0.039 in
1 kg = 2.202 lb

Figure H-5. Vehicle properties for test 19452-6.

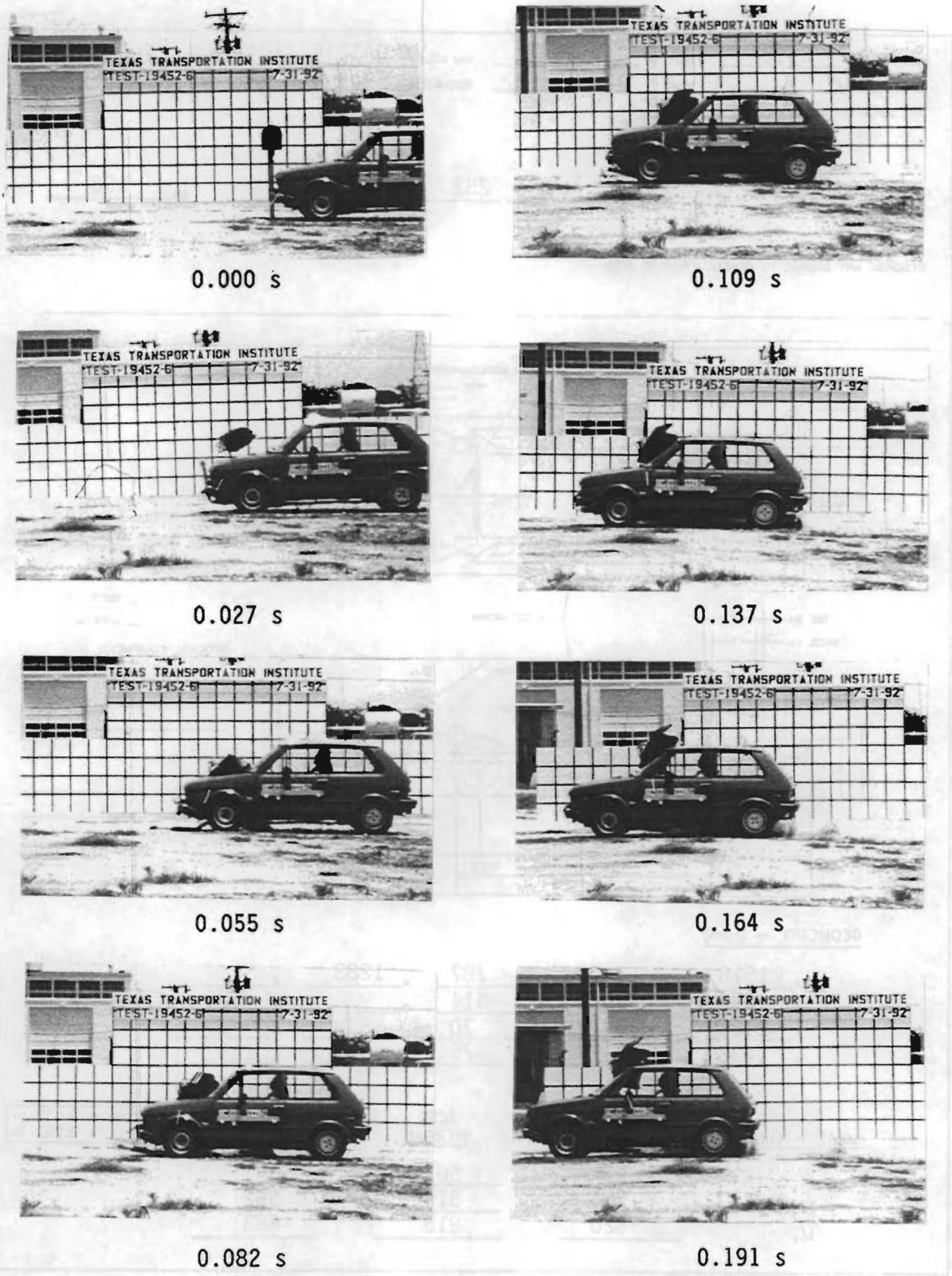


Figure H-6. Sequential photographs for test 19452-6. (perpendicular view).

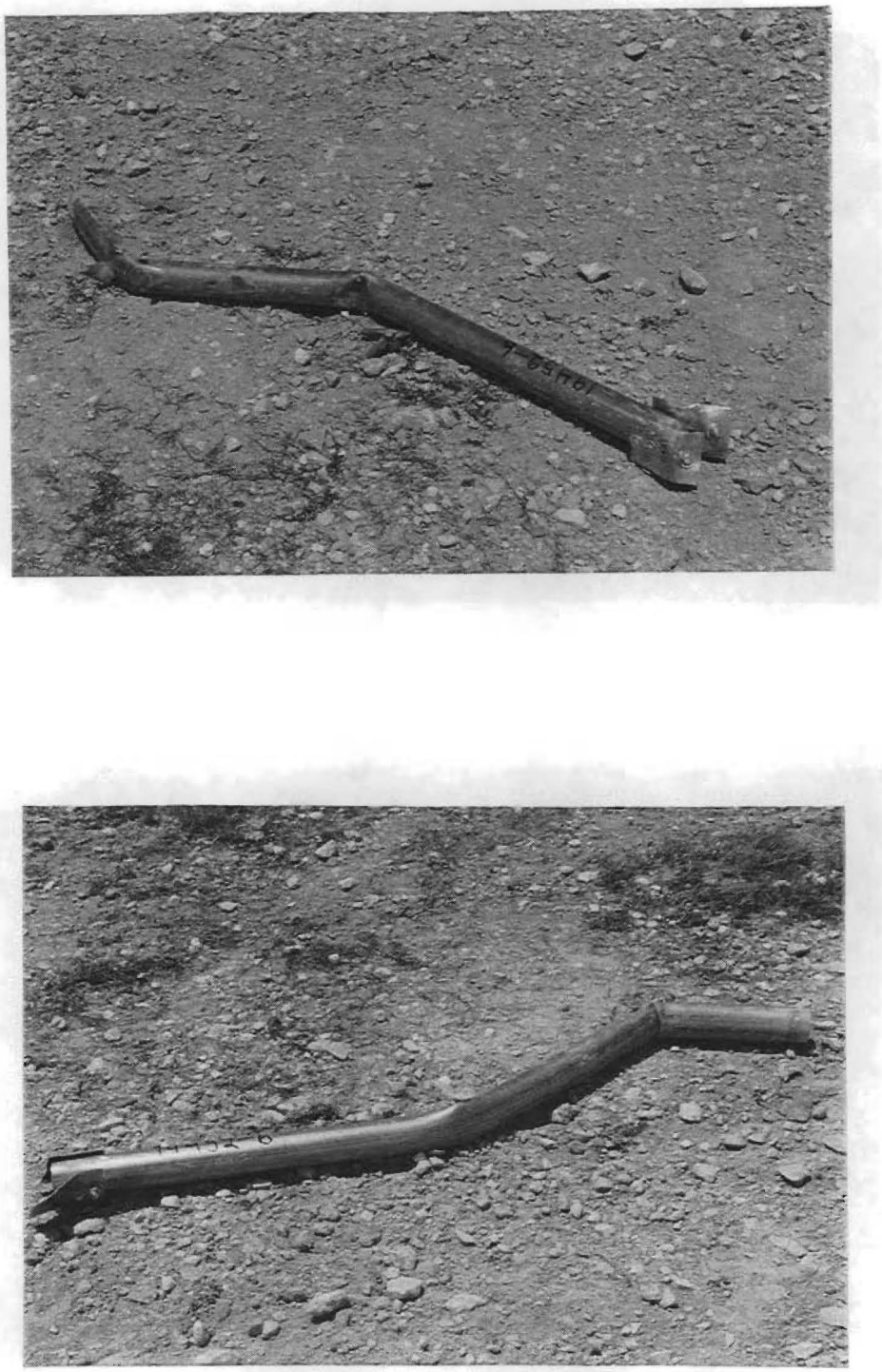


Figure H-7. Damage to support after test 19452-6.

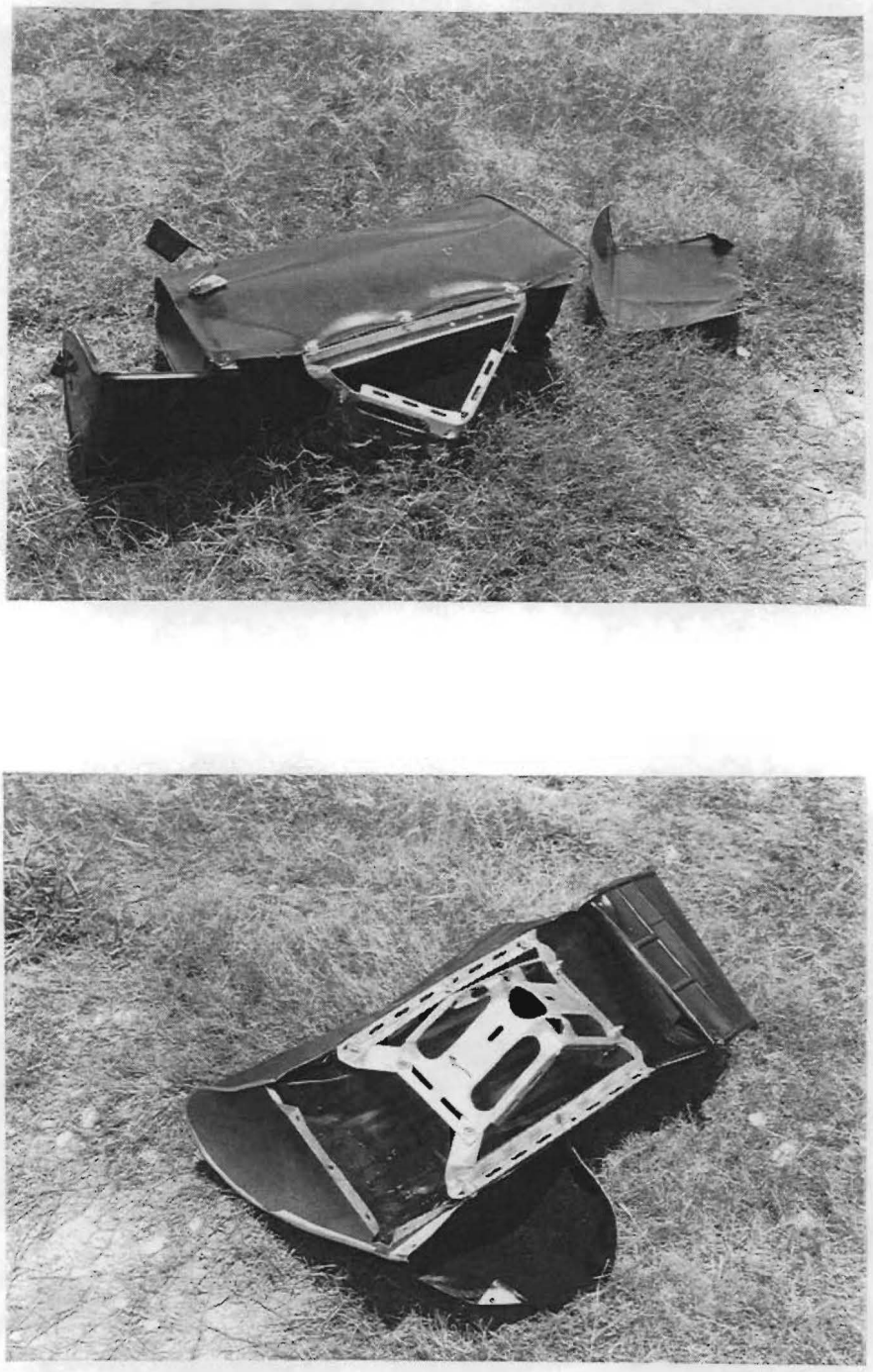


Figure H-8. Damage to mailbox and bracket after test 19452-6.

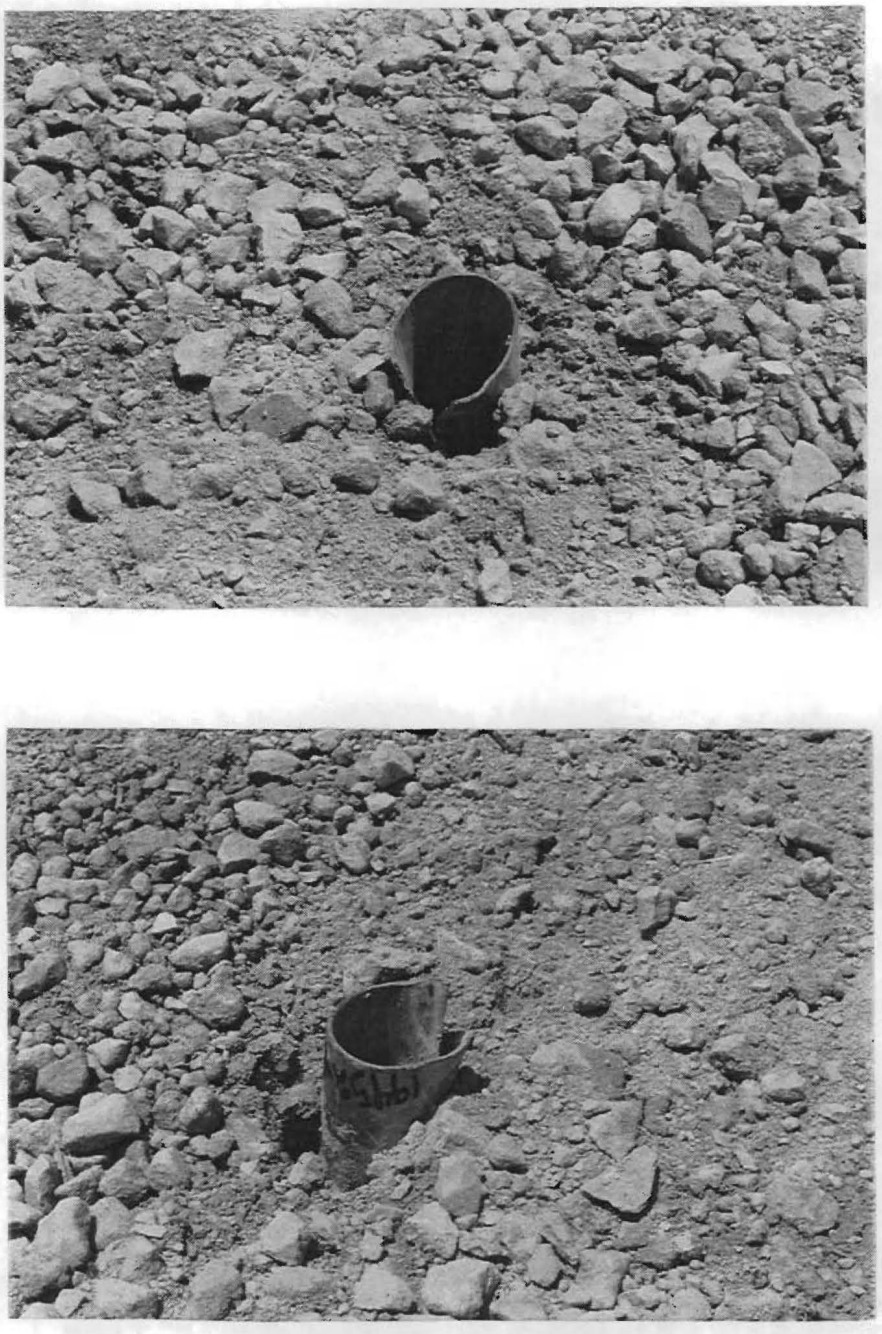


Figure H-9. Damage to base after test 19452-6.

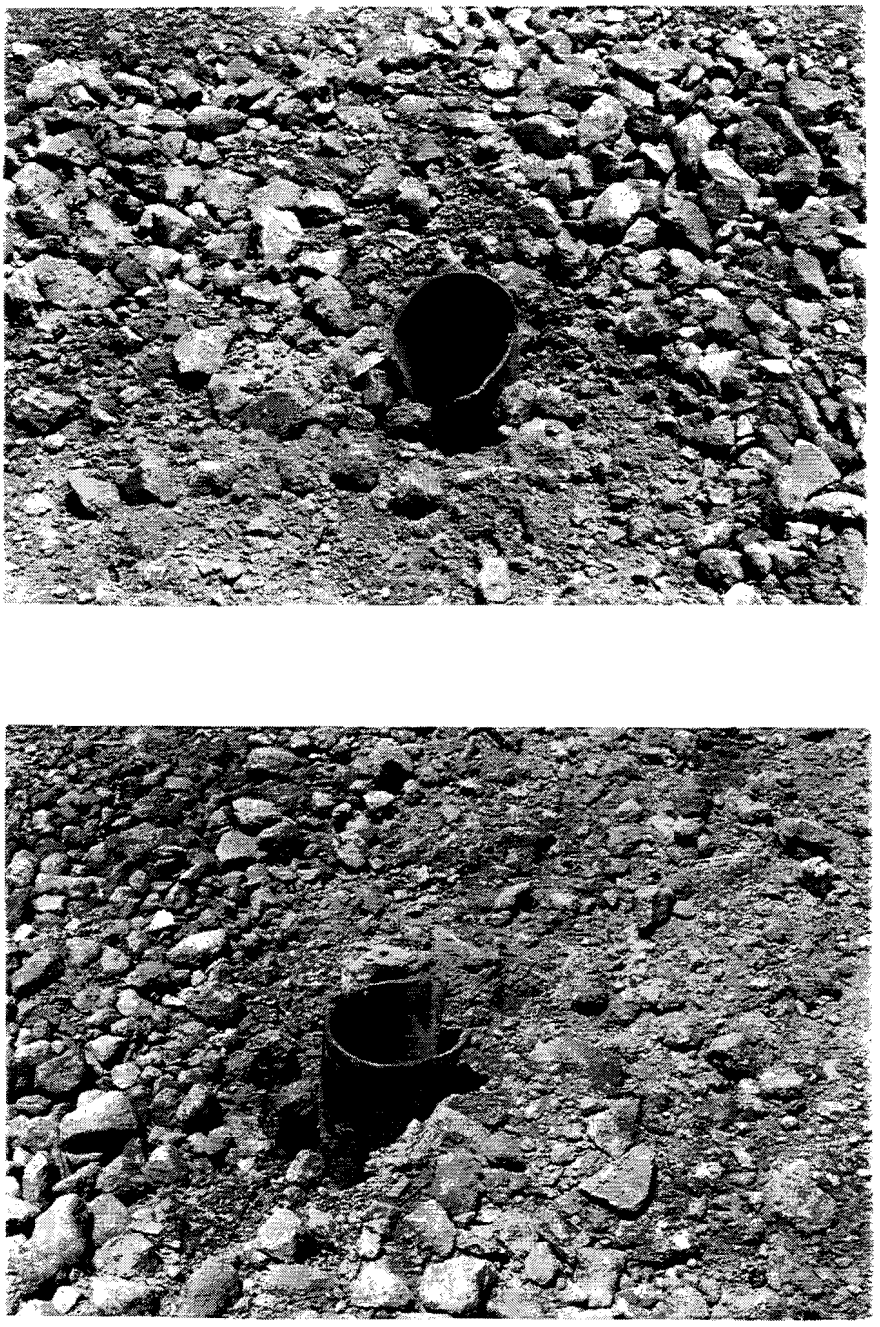


Figure H-9. Damage to base after test 19452-6.

Figure H-10. Vehicle after test 19452-6.

0.000 s 0.055 s 0.109 s 0.191 s

Test No	19452-6.	Impact Speed	60.9 mi/h (98.0 km/h)
Date	07/31/92.	Change in Velocity	2.3 mi/h (3.7 km/h)
Test Article	Single mount, Type 2 Mailbox Installation.	Change in Momentum	190.2 lb-s
Support	Type 2 (2 3/8" thin wall steel tube)	Vehicle Accelerations (Max. 0.050-sec Avg)	
Embedment	26" driven (strong soil)	Longitudinal	-1.9 g
Vehicle	1988 Yugo GV	Lateral	0.6 g
Vehicle Weight		Occupant Impact Velocity	
Test Inertia	1800 lb (816 kg)	Longitudinal	N/A
Gross Static	1968 lb (893 kg)	Lateral	N/A
Vehicle Damage Classification		Occupant Ridedown Accelerations	
TAD	12-FR-1	Longitudinal	No contact
SAE	12FREN1	Lateral	No contact

Figure H-11. Summary of results for test 19452-6.

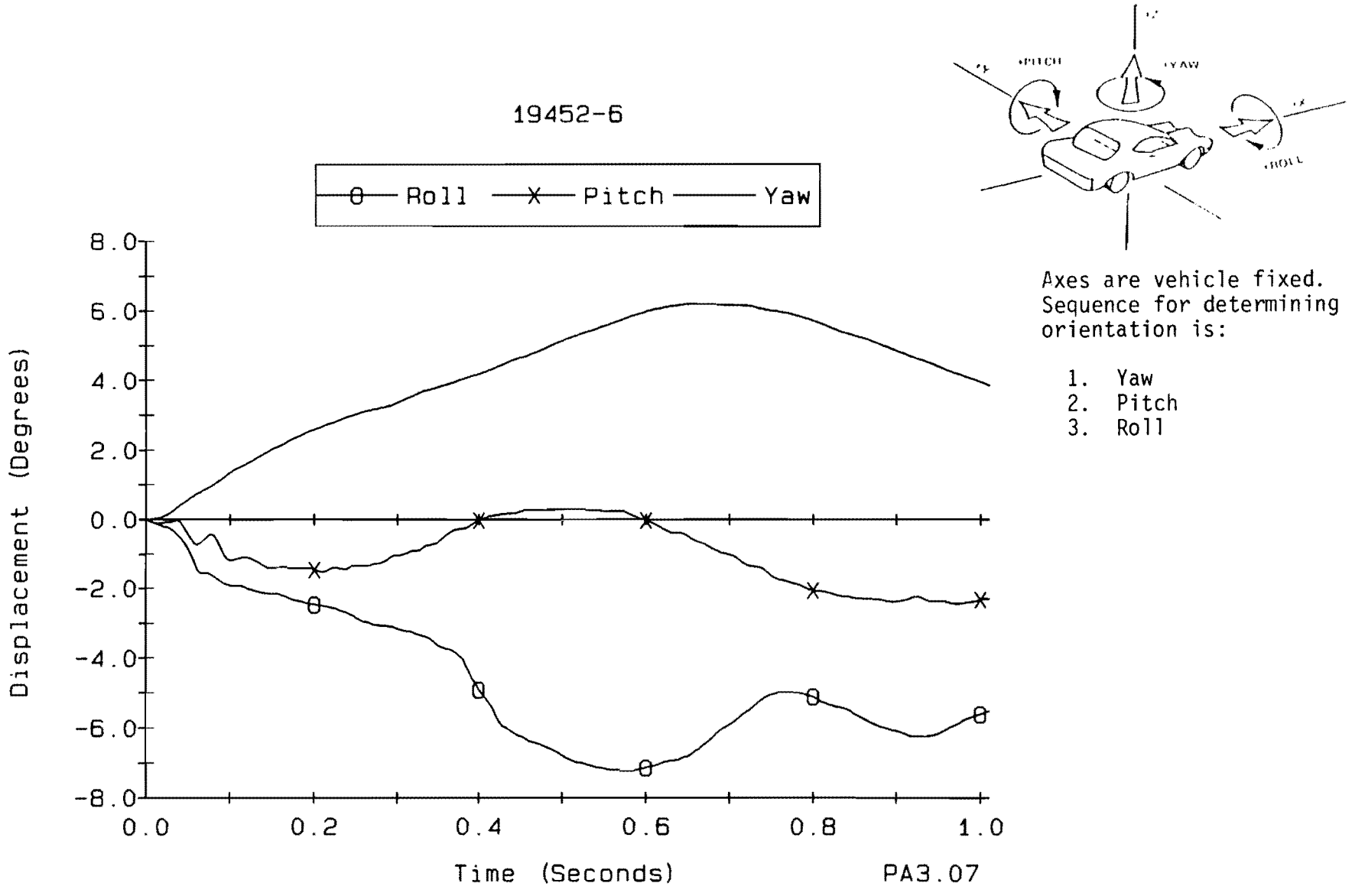


Figure H-12. Vehicle angular displacements for test 19452-6.

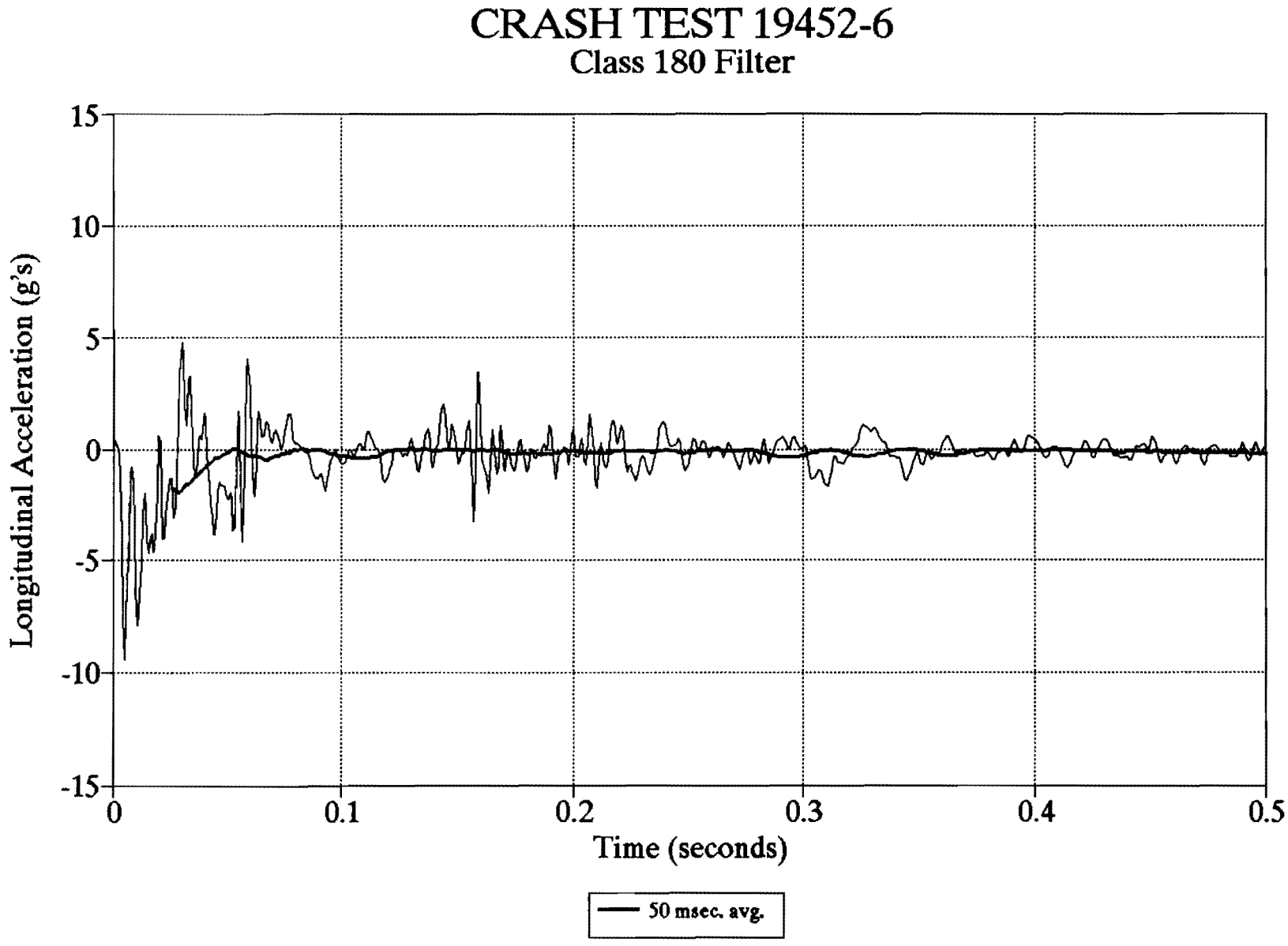


Figure H-13. Longitudinal accelerometer trace for test 19452-6.

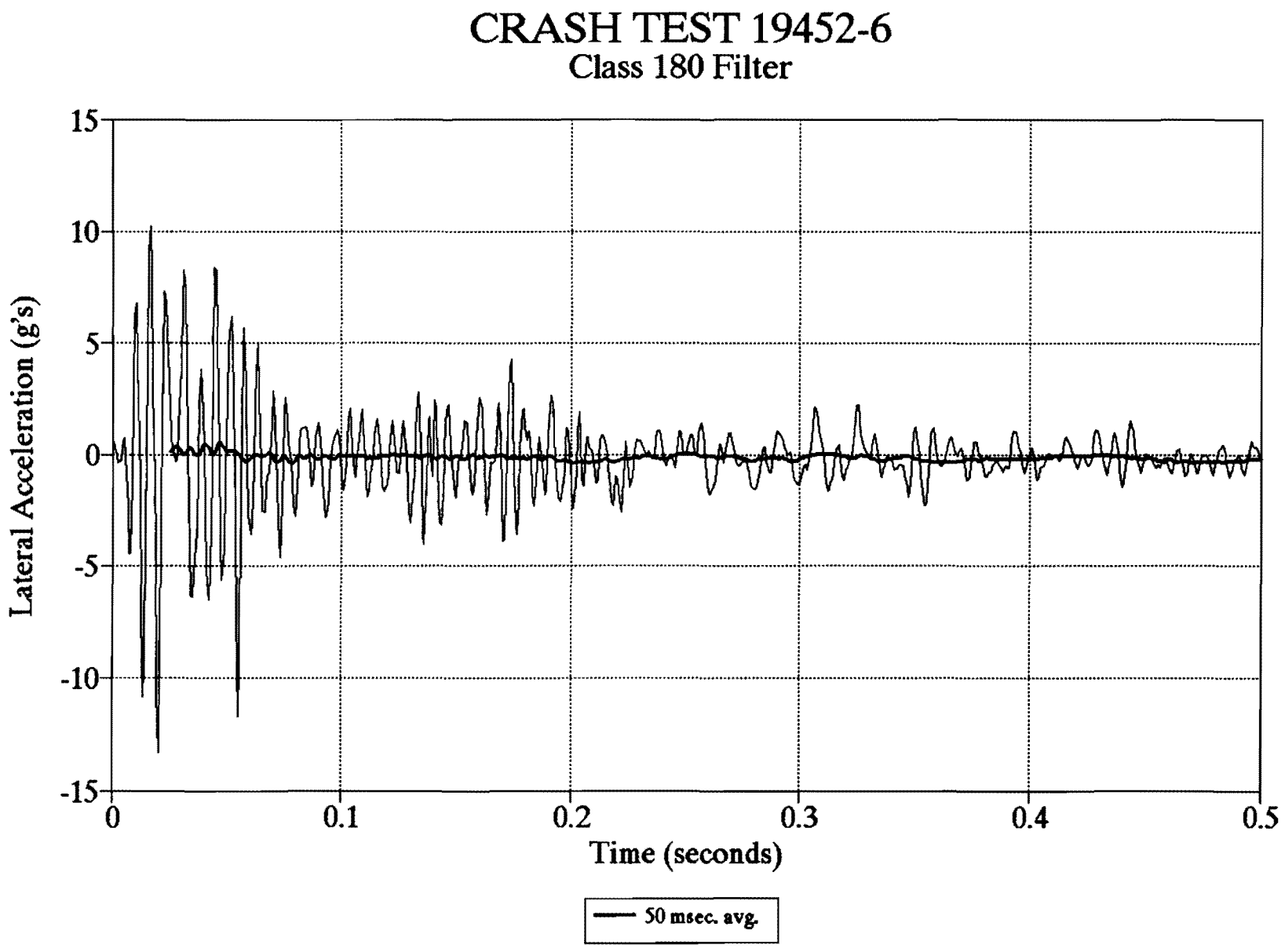


Figure H-14. Lateral accelerometer trace for test 19452-6.

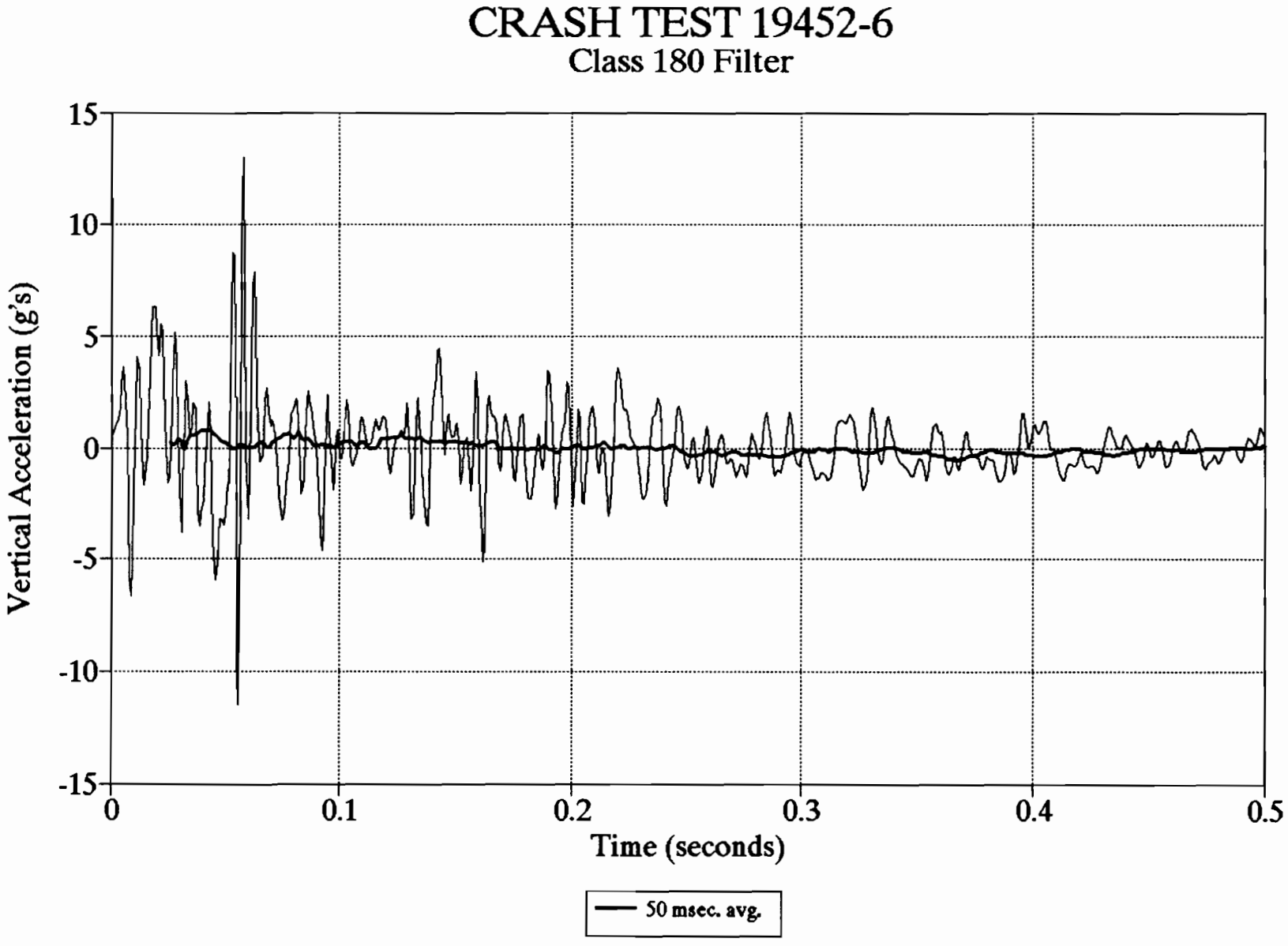


Figure H-15. Vertical accelerometer trace for test 19452-6.

APPENDIX I

TEST 19452-7 REPORT

Test 19452-7

The test article consisted of five size no. 1 mailboxes mounted on a Foresight Tubular Support. Hardware used to attach each mailbox to the bracket and to attach the bracket to the angles were the same as that used in test 19452-4. Note that in this installation the 2-in. (5.1 cm) leg of the 2 in. (5.1 cm) x 3 in. (7.6 cm) angles was attached to the horizontal member of the Foresight Tubular Support with one 3/8-in. (0.95 cm) bolt. Appendix B gives complete details of the installation. Figures I-1 and I-2 show photos of the test article. Figure I-3 shows the 1987 Yugo GV test vehicle. Figure I-4 shows the position of the vehicle with respect to the test article at impact. Impact speed was 63.4 mph (102.0 km/h). Impact point was the front left quarter point of the vehicle's bumper. Test inertia mass of the vehicle was 1,808 lb (820 kg) and its gross static mass was 1,967 lb (892 kg). Figure I-5 shows other vehicular dimensions and information.

The vehicle was free wheeling and unrestrained just prior to impact. Upon impact, the support began to yield and by 0.029 second, the support began to separate from the ground anchor (Flush V-Wing socket). At approximately 0.056 second, the upper section of the support struck the hood of the vehicle. The vehicle lost contact with the support at approximately 0.115 second and the entire assembly went over the top of the vehicle with no subsequent contacts. The brakes were applied at 1.0 second and the vehicle came to rest 339.0 feet (103.3 m) from the point of impact. Figure I-6 shows sequential photographs of the test.

Figure I-7 shows test article damage. As shown, the support was pulled from the ground socket and came to rest approximately 132 ft (40.2 m) from the impact point. All mailboxes remained attached to the support. The vehicle sustained only minor damage to the bumper and hood as shown in Figure I-8.

A summary of test results and other pertinent information are given in Figure I-9. The maximum 0.050 second average acceleration experienced by the vehicle was -1.8 g in the longitudinal direction and -0.6 g in the lateral direction. In the longitudinal direction, the occupant contact velocity was 4.9 ft/s (1.5 m/s) at .546 second and 3.5 ft/s (1.1 m/s) at .655 second in the lateral direction. Angular vehicular displacements are plotted in Figure I-10 and vehicular accelerations are plotted in Figures I-11 through I-13. Change in the vehicle's velocity was 4.8 mph (7.7 km/h).

In summary, the test was successful and met all evaluation criteria.

Figure I-1. Mailbox installation for test 19452-7.

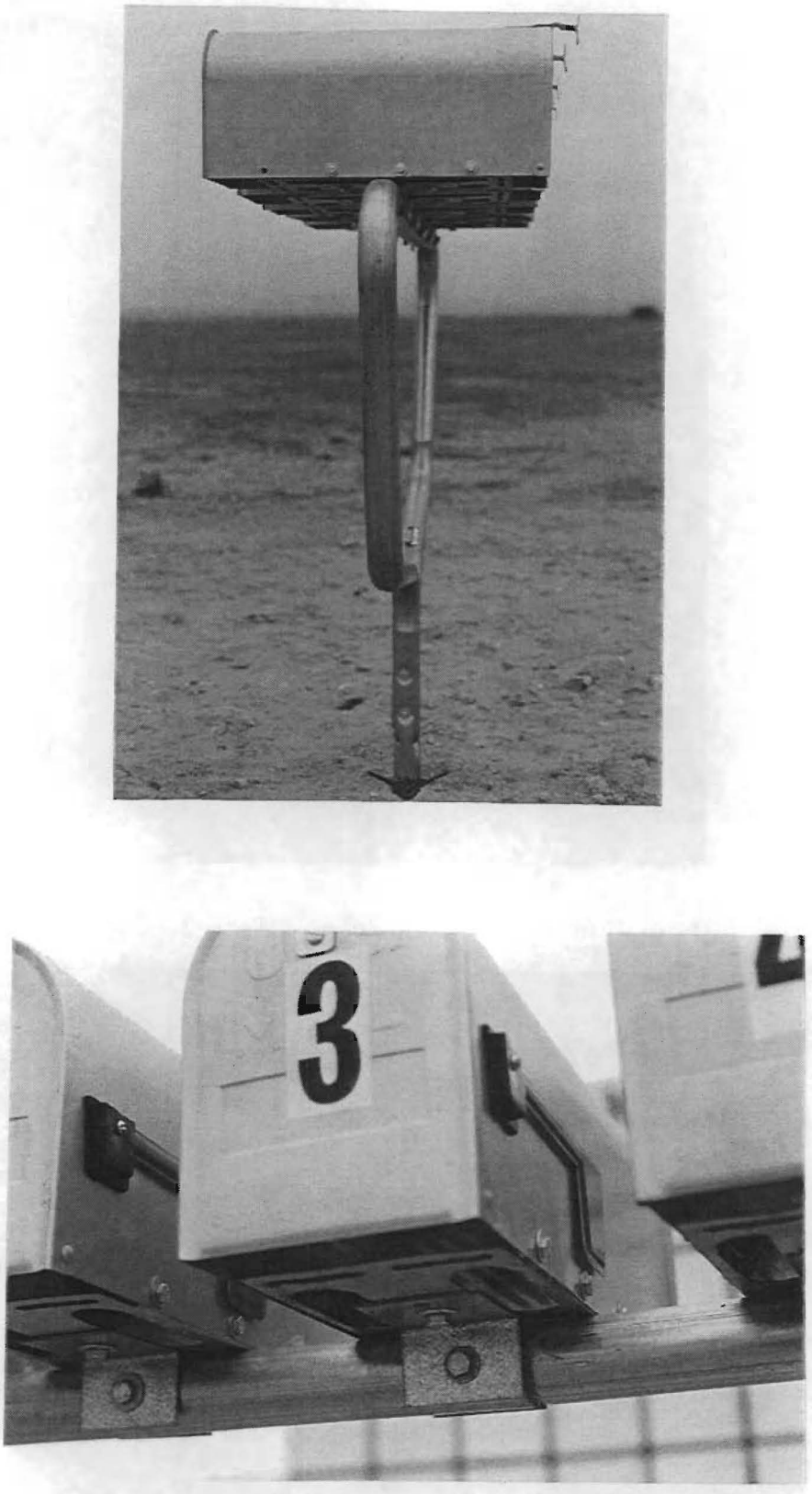


Figure I-2. Mailbox/support connection for installation used in test 19452-7.

Figure I-3. Vehicle before test 19452-7.

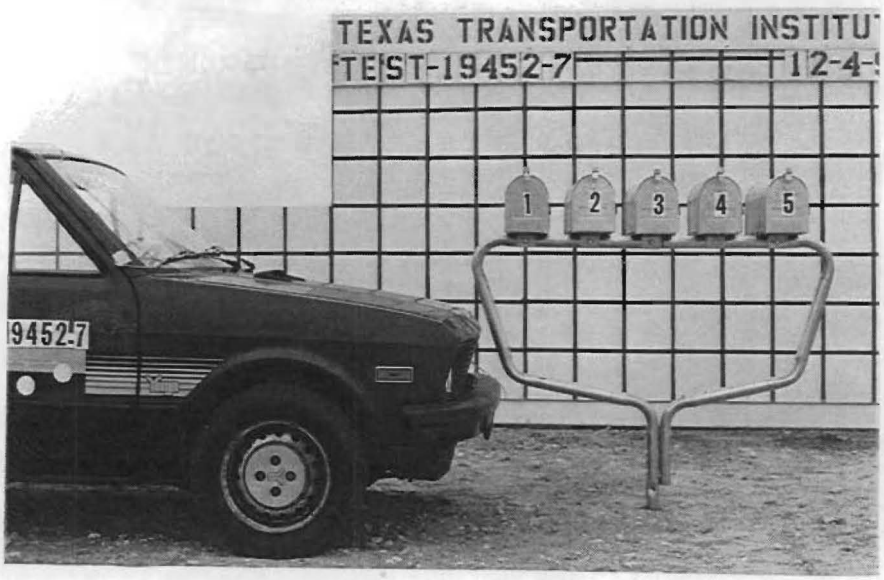


Figure I-4. Vehicle/mailbox geometrics for test 19452-7.

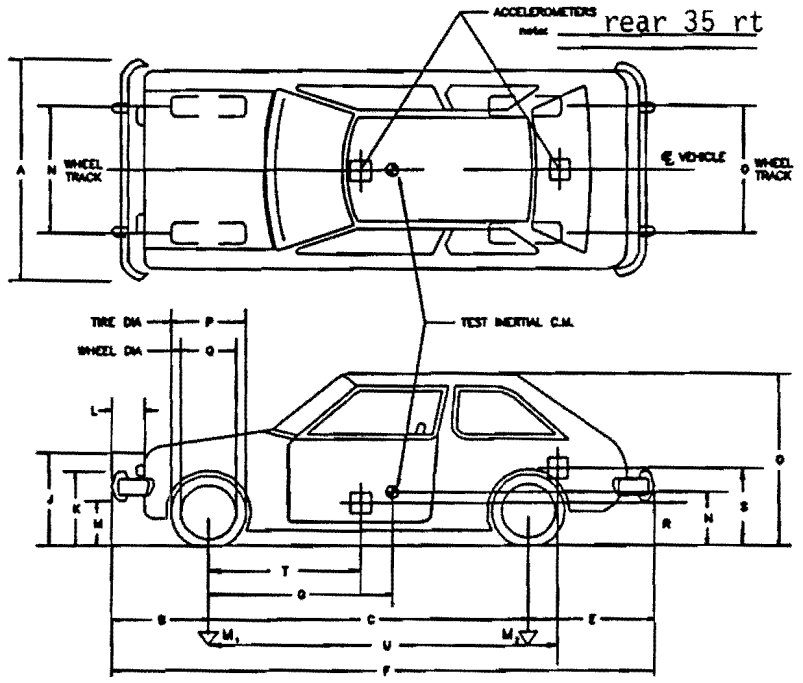
DATE: 12-4-92 TEST NO.: 19453-7 VIN NO.: VX1BA1216JK389865 MAKE: Yugo

MODEL: GV YEAR: 1987 ODOMETER: 42729 TIRE SIZE: P155/80R13

TIRE INFLATION PRESSURE: _____

MASS DISTRIBUTION (kg) LF 258 RF 267 LR 148 RR 147

DESCRIBE ANY DAMAGE TO VEHICLE PRIOR TO TEST:



ENGINE TYPE: 4 cyl

ENGINE CID: 1100 cc

TRANSMISSION TYPE:

_ AUTO

X MANUAL

OPTIONAL EQUIPMENT:

DUMMY DATA:

TYPE: _____

MASS: _____

SEAT POSITION: _____

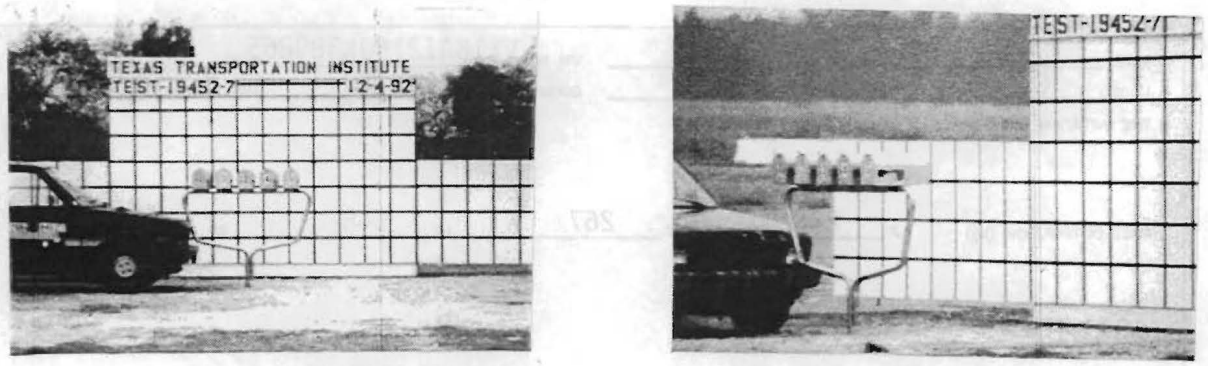
GEOMETRY – (mm)

A	1530	E	610	J	800	N	1320	R	380
B	670	F	3445	K	500	O	1270	S	700
C	2165	G	779	L	65	P	575	T	790
D	1400	H	380	M	370	Q	365	U	2490

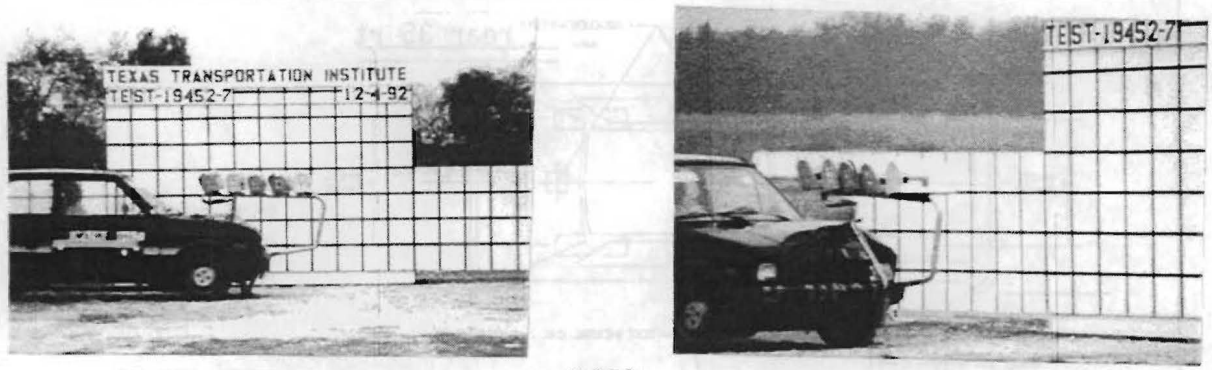
MASS – (kg)	CURB	TEST INERTIAL	GROSS STATIC
M_1	551	525	558
M_2	276	295	334
M_T	827	820	892

1 mm = 0.039 in
1 kg = 2.202 lb

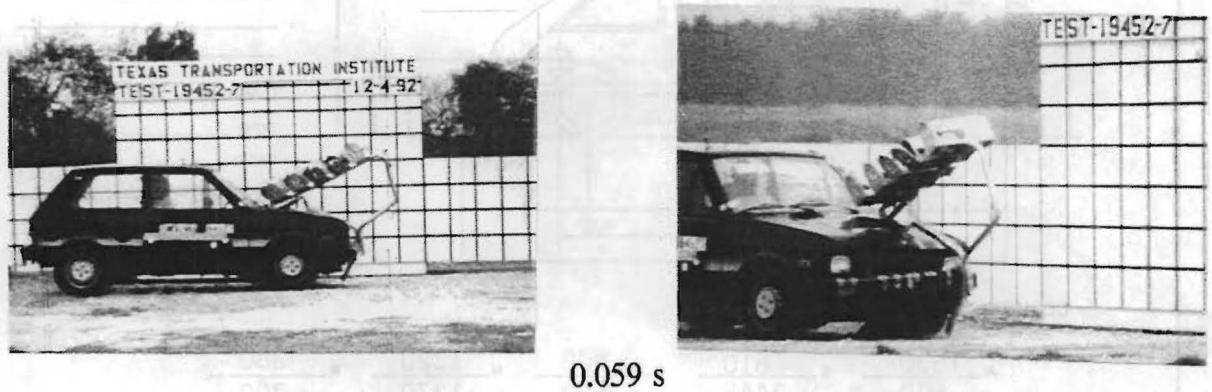
Figure I-5. Vehicle properties for test 19452-7.



0.000 s



0.029 s

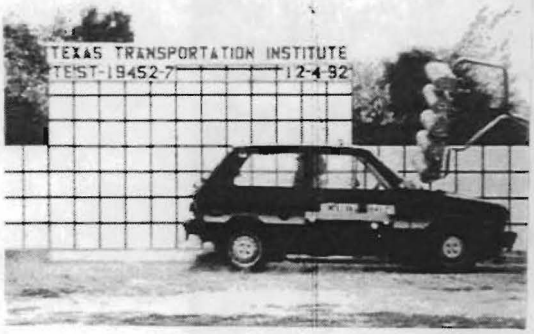


0.059 s

0.088 s

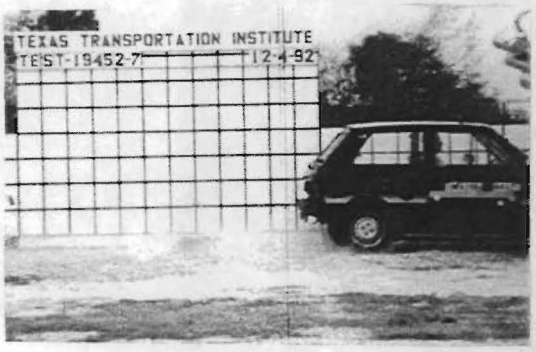
Figure I-6. Sequential photographs for test 19452-7. (perpendicular and side views).

0.117 s



0.147 s

0.176 s



0.205 s

Figure I-6. Sequential photographs for test 19452-7 (perpendicular and side views) continued.

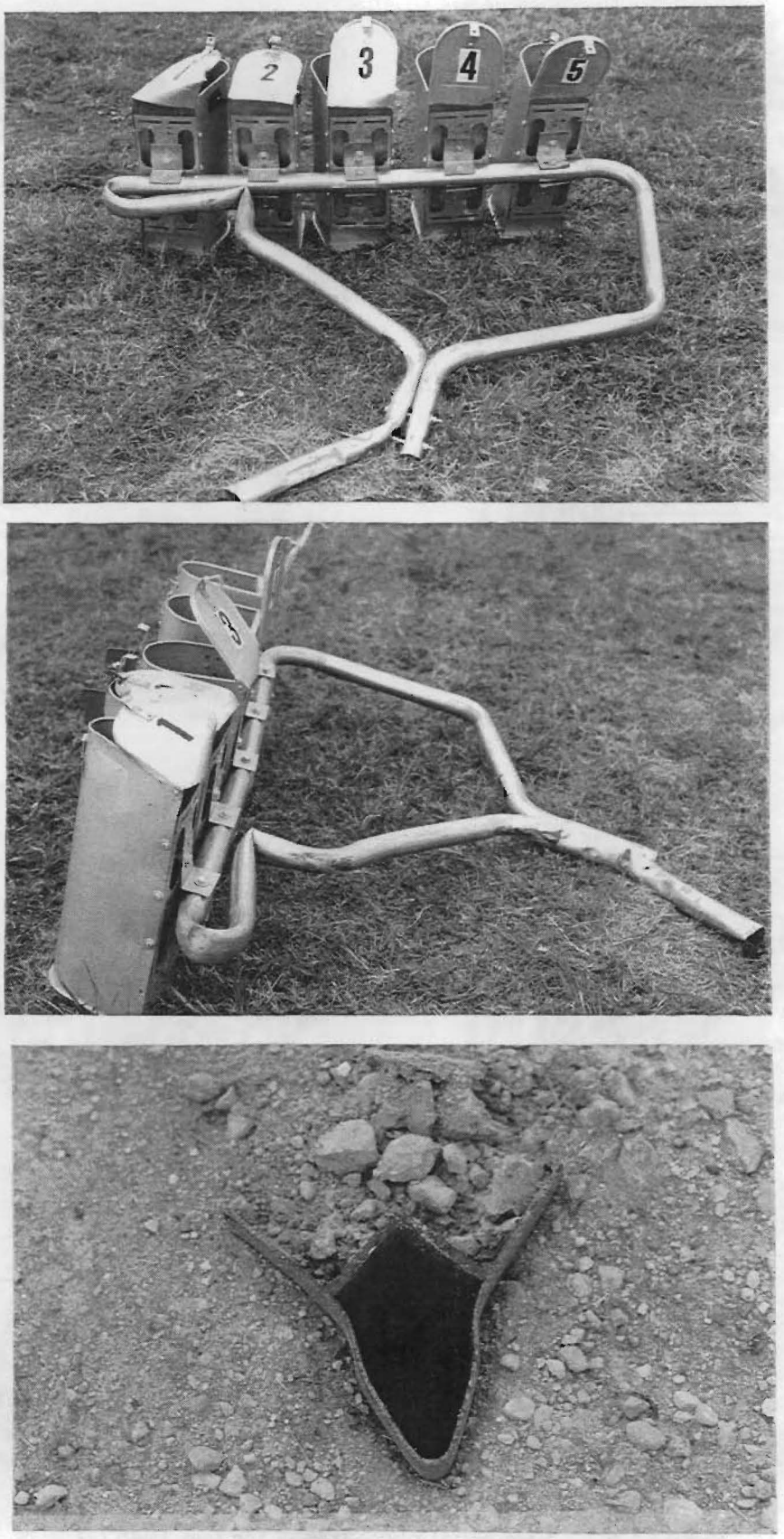
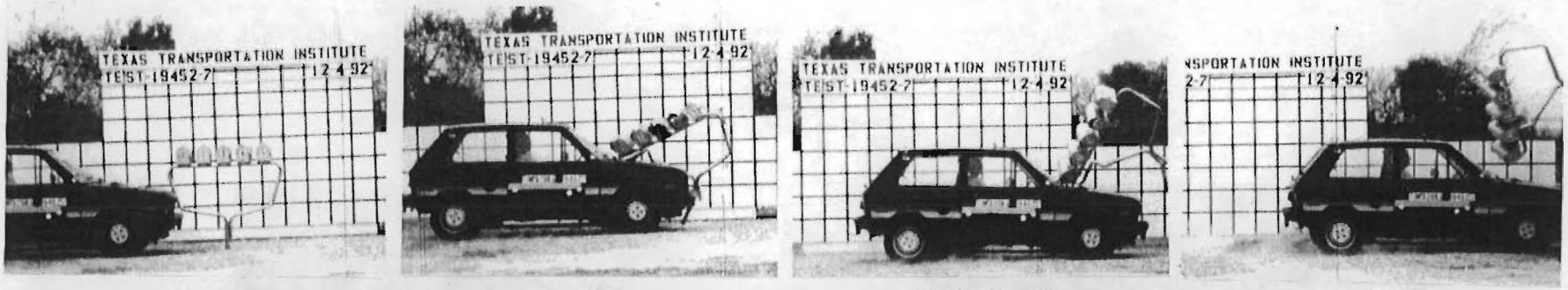


Figure I-7. Mailbox/support and base after test 19452-7.

Figure I-8. Vehicle after test 19452-7.



Test No. 19452-7
Date 12/04/92
Test Installation . . . Mailbox

Installation Length . . N/A
Max. Dynamic Movement . N/A
Max. Perm. Movement . . 132 ft (40.2 m)
Test Vehicle . . . . . 1987 Yugo
Vehicle Weight
  Test Inertia . . . . . 1,808 lb (820 kg)
  Gross Static . . . . . 1,967 lb (892 kg)
Vehicle Damage Classification
  TAD 12FL1
  CDC 12FLEN1
Maximum Vehicle Crush. . 2.0 in (5.0 cm)

Impact Speed. . . . . 63.4 mi/h (102.0 km/h)
Impact Angle. . . . . 0.0 deg
Speed at Parallel . . N/A
Exit Speed . . . . . 58.8 mi/h (94.6 km/h)
Exit Trajectory . . . N/A
Vehicle Accelerations at center-of-gravity
(Max. 0.050-sec Average)
  Longitudinal. . . . -1.8 g
  Lateral . . . . . -0.6 g
  Occupant Impact Velocity at true c.g.
  Longitudinal. . . . 4.9 ft/s (1.5 m/s)
  Lateral . . . . . 3.5 ft/s (1.1 m/s)
Occupant Ridedown Accelerations
  Longitudinal . . . -0.64 g
  Lateral . . . . . 0.64 g

Figure I-9. Summary of results for test 19452-7.

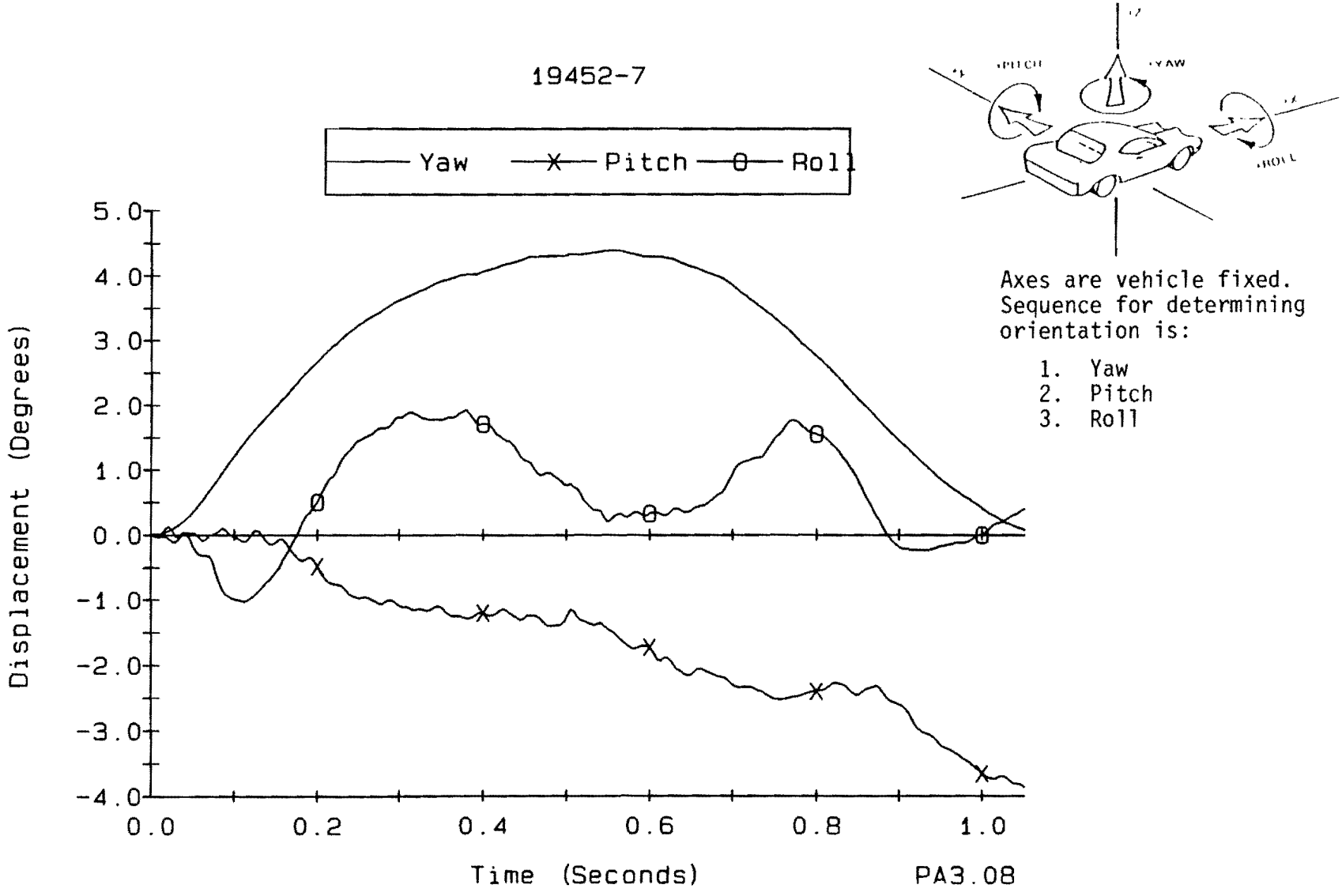


Figure I-10. Vehicle angular displacements for test 19452-7.

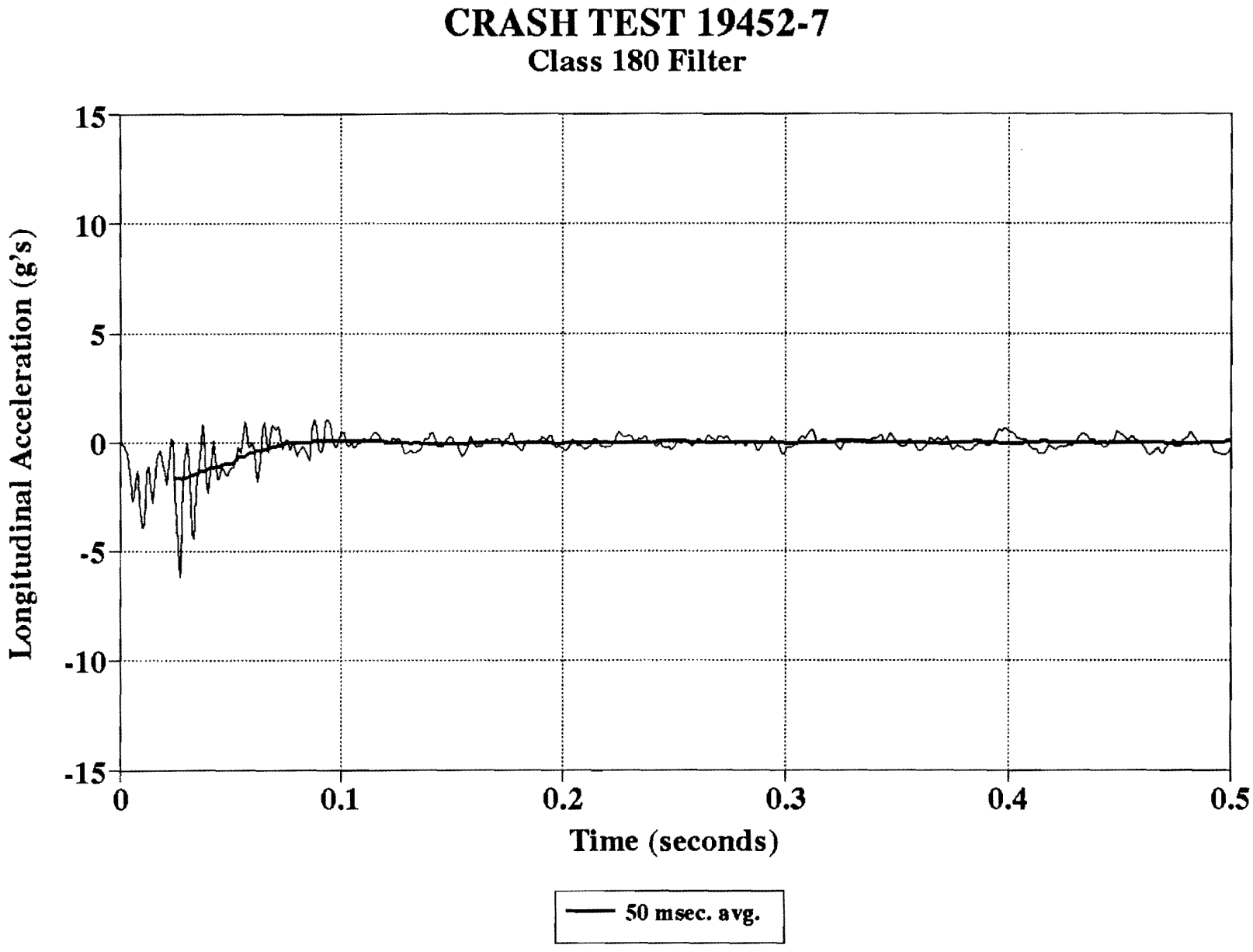


Figure I-11. Longitudinal accelerometer trace for test 19452-7.

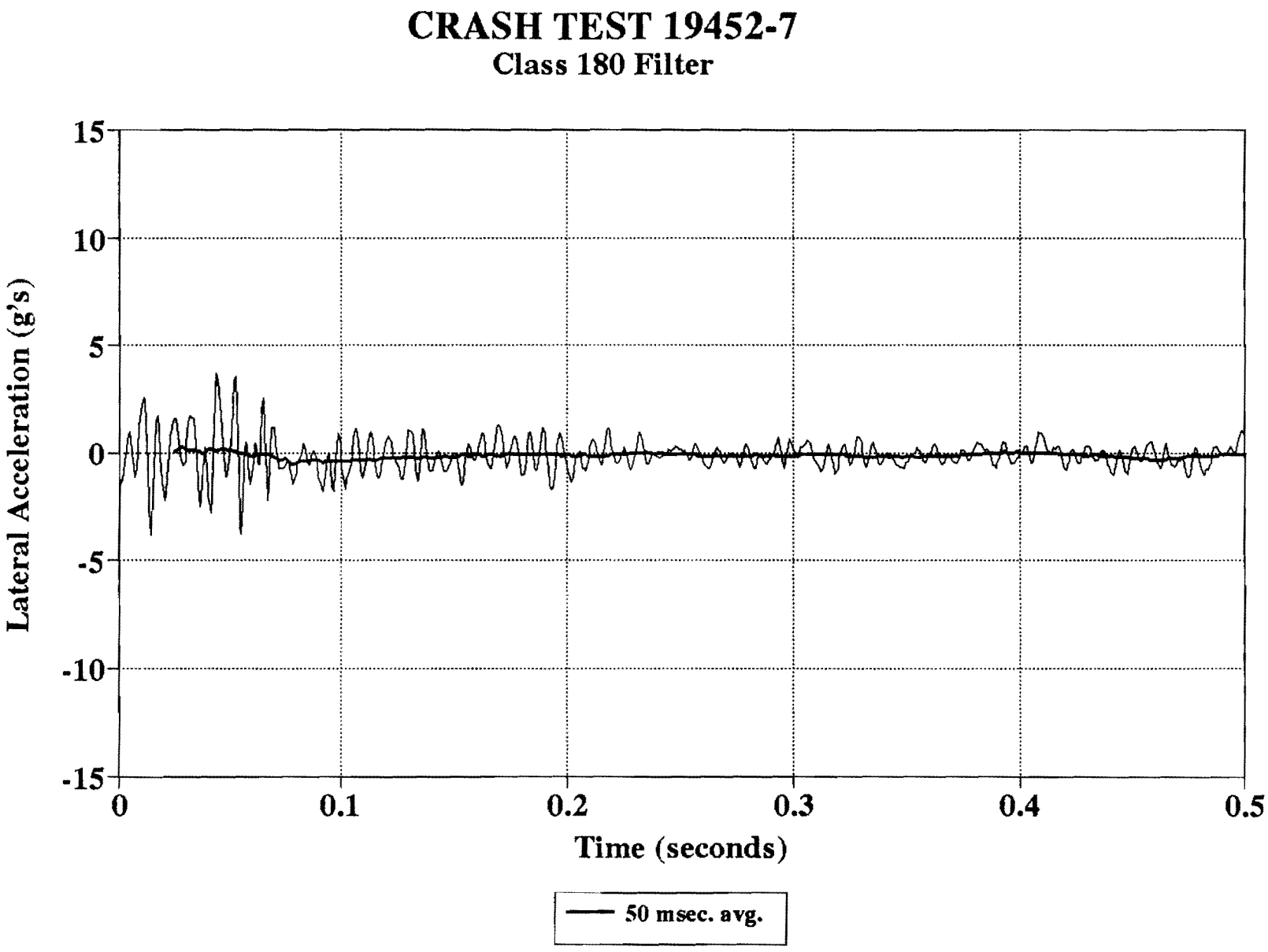


Figure I-12. Lateral accelerometer trace for test 19452-7.

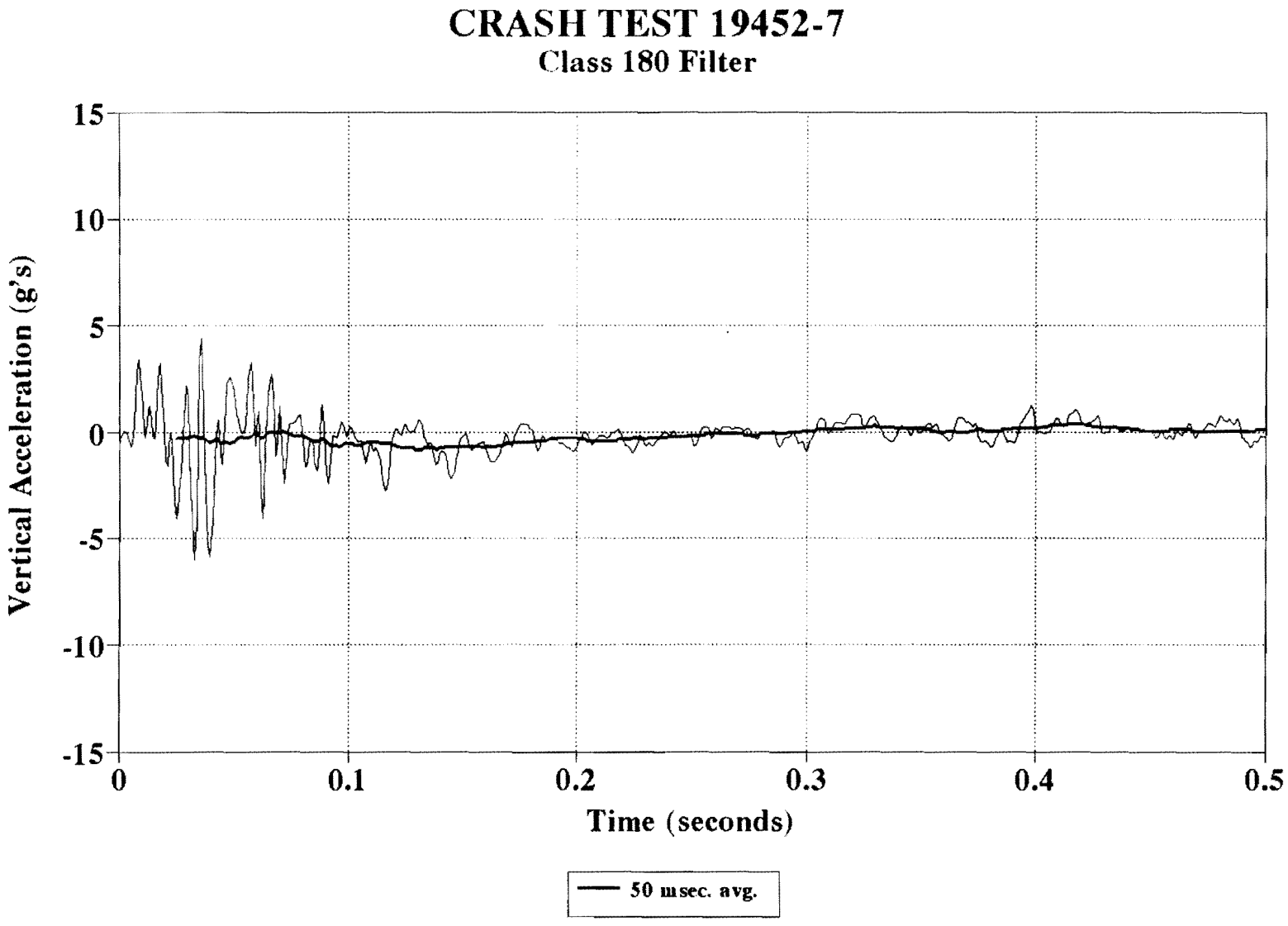


Figure I-13. Vertical accelerometer trace for test 19452-7.

APPENDIX J

TEST 19452-8 REPORT

Test 19452-8

The test article consisted of three size no. 2 mailboxes mounted on a Foresight Tubular Support. Hardware used to attach each mailbox to the bracket and to attach the bracket to the angles were the same as that used in test 19452-4. Note that in this installation the 2-in. (5.1 cm) leg of the 2 in. (5.1 cm) x 3 in. (7.6 cm) angles was attached to the horizontal member of the Foresight Tubular Support with one 3/8-in. (0.95 cm) bolt. Appendix B gives complete details of the installation. Figures J-1 and J-2 show photos of the test article. Figure J-3 shows the 1987 Yugo GV test vehicle. Figure J-4 shows the position of the vehicle with respect to the test article at impact. Impact speed was 61.2 mph (98.5 km/h). Impact point was the front right quarter point of the vehicle's bumper. Test inertia mass of the vehicle was 1,808 lb (820 kg) and its gross static mass was 1,967 lb (892 kg). Other vehicular dimensions and information are given in Figure J-5.

The vehicle was free wheeling and unrestrained just prior to impact. Upon impact, the support began to yield and by 0.027 second, the support began to separate from the ground anchor (Flush V-Wing socket). At approximately 0.034 second the upper section of the support struck the hood of the vehicle. Minor contact with the windshield (no breakage) occurred at 0.063 second. The vehicle lost contact with the installation at approximately 0.121 second and the entire assembly went over the top of the vehicle with no subsequent contacts. The brakes were applied at 1.2 second and the vehicle came to rest 312.0 feet (95.1 m) from the point of impact. Figure J-6 shows sequential photographs of the test.

Figures J-7 and J-8 show test article damage. As shown, the support was pulled from the ground anchor and came to rest approximately 102 ft (31.1 m) from the impact point. All mailboxes remained attached to the support. The vehicle sustained only minor damage to the bumper and hood as shown in Figure J-9.

A summary of test results and other pertinent information are given in Figure J-10. The maximum 0.050 second average acceleration experienced by the vehicle was -2.0 g in the longitudinal direction and 0.4 g in the lateral direction. In the longitudinal direction, the occupant contact velocity was 2.6 ft/s (0.8 m/s) at .694 second and -4.1 ft/s (1.2 m/s) at .599 second in the lateral direction. Angular vehicular displacements are plotted in Figure J-11 and

vehicular accelerations are plotted in Figures J-12 through J-14. Change in the vehicle's velocity was 4.4 mi/h (7.1 km/h).

In summary, the test was successful and met all evaluation criteria.

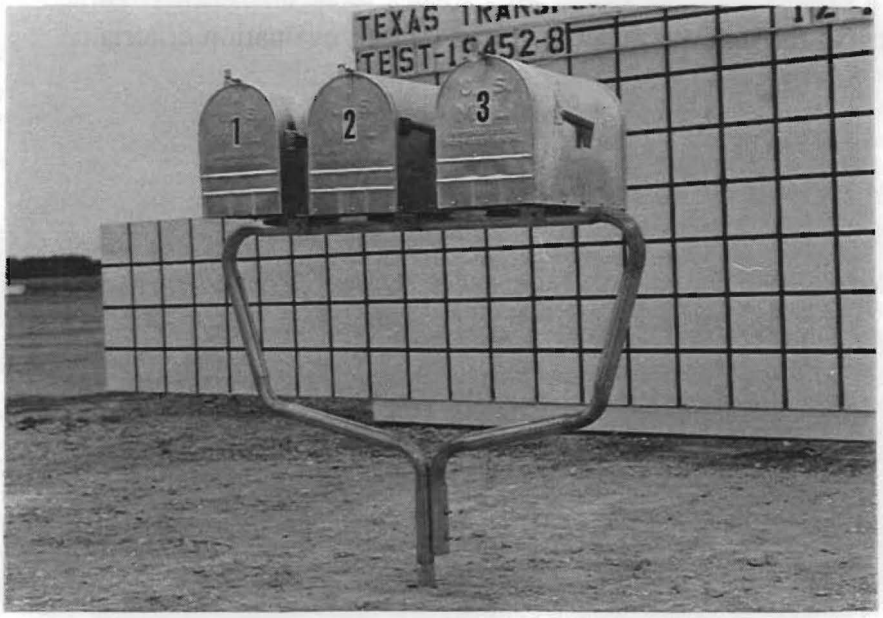


Figure J-1. Mailbox installation for test 19452-8.

Figure J-2. Mailbox/support connection for installation used in test 19452-8.

Figure J-3. Vehicle before test 19452-8.

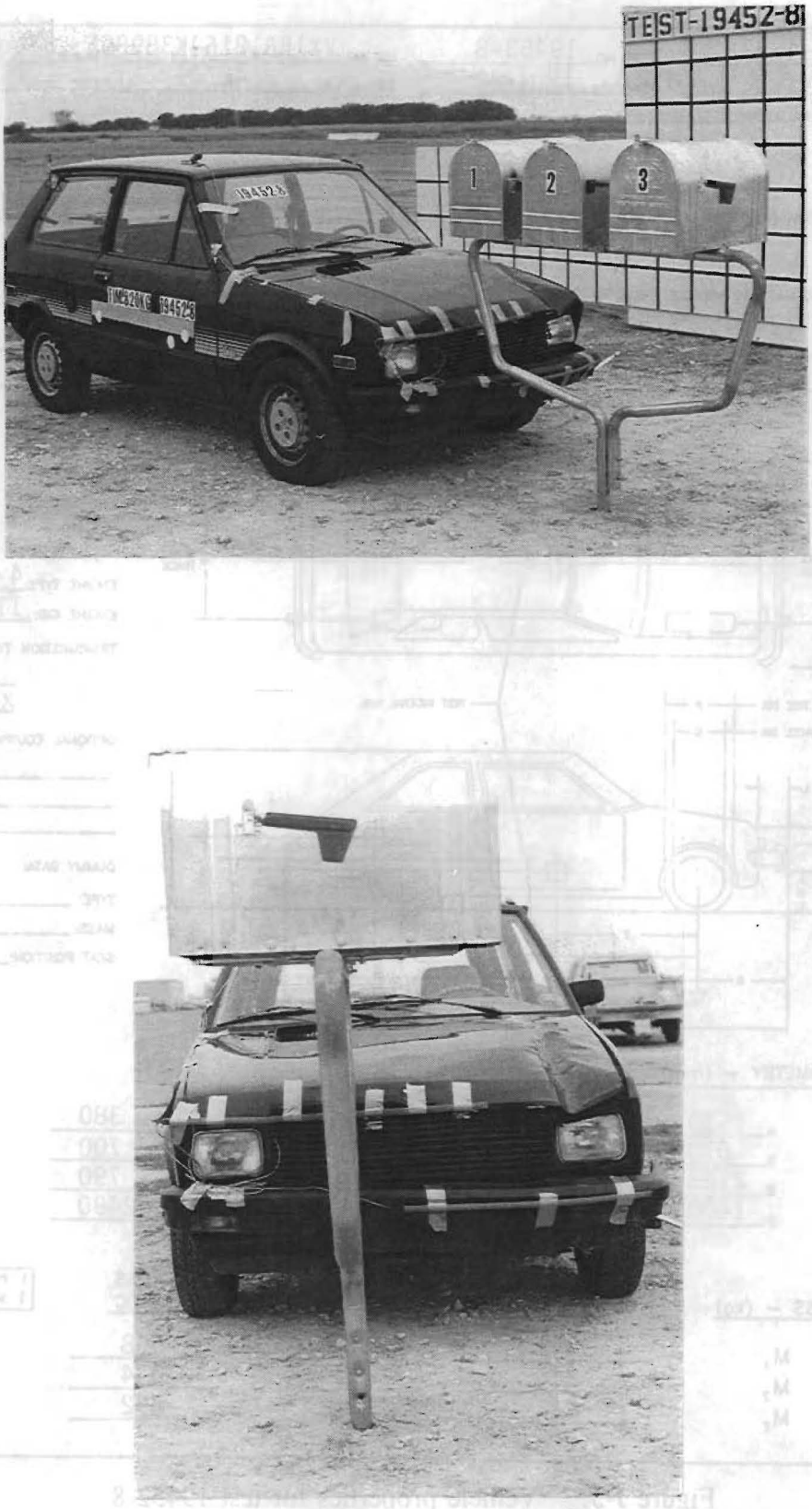


Figure J-4. Vehicle/mailbox geometrics for test 19452-8.

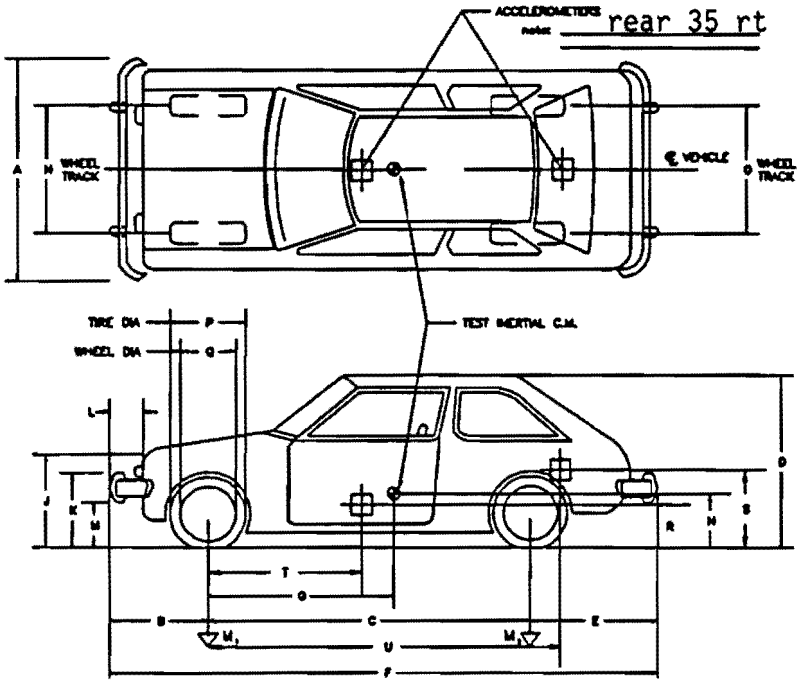
DATE: 12-4-92 TEST NO.: 19453-8 VIN NO.: VX1BA1216JK389865 MAKE: Yugo

MODEL: GV YEAR: 1987 ODOMETER: 42729 TIRE SIZE: P155/80R13

TIRE INFLATION PRESSURE: _____

MASS DISTRIBUTION (kg) LF 258 RF 267 LR 148 RR 147

DESCRIBE ANY DAMAGE TO VEHICLE PRIOR TO TEST:



ENGINE TYPE: 4 cyl

ENGINE CID: 1100 cc

TRANSMISSION TYPE:

_ AUTO

X MANUAL

OPTIONAL EQUIPMENT:

_____

_____

_____

DUMMY DATA:

TYPE: _____

MASS: _____

SEAT POSITION: _____

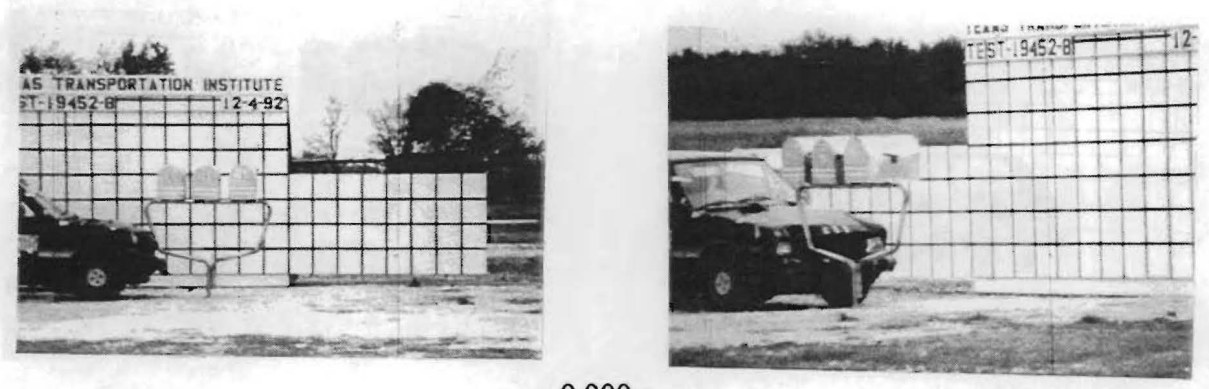
GEOMETRY – (mm)

A	1530	E	610	J	800	N	1320	R	380
B	670	F	3445	K	500	O	1270	S	700
C	2165	G	779	L	65	P	575	T	790
D	1400	H	380	M	370	Q	365	U	2490

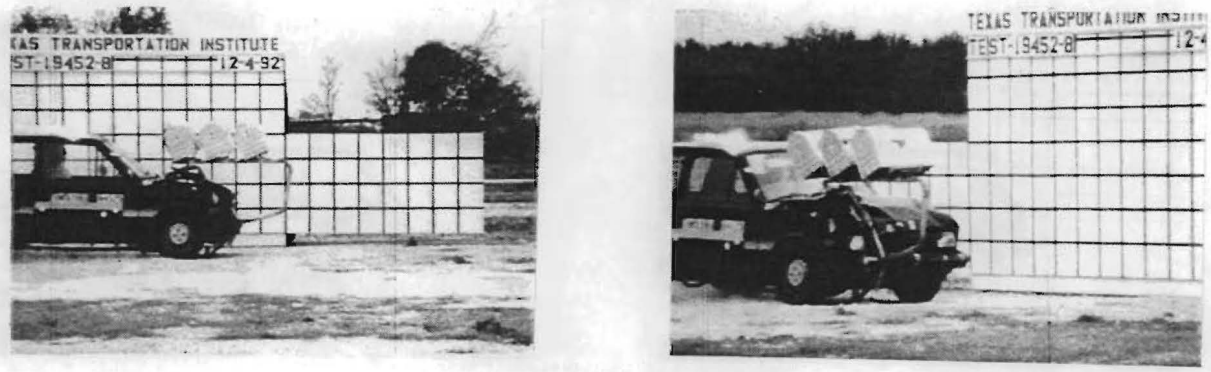
MASS – (kg)	CURB	TEST INERTIAL	GROSS STATIC
M_1	551	525	558
M_2	276	295	334
M_T	827	820	892

1 mm = 0.039 in
1 kg = 2.202 lb

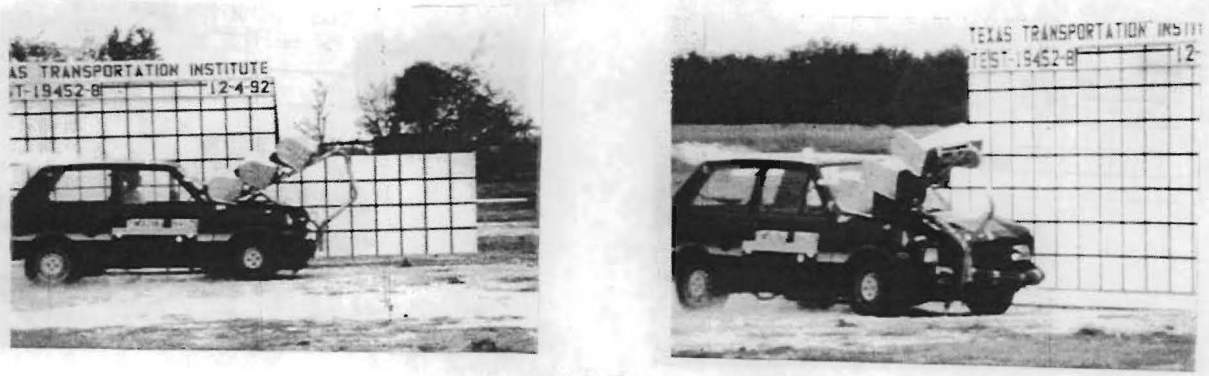
Figure J-5. Vehicle properties for test 19452-8.



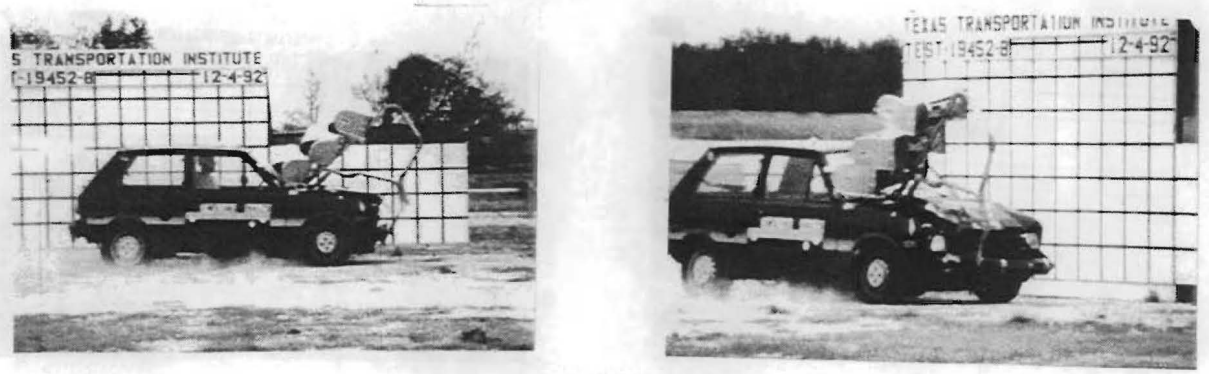
0.000 s



0.034 s

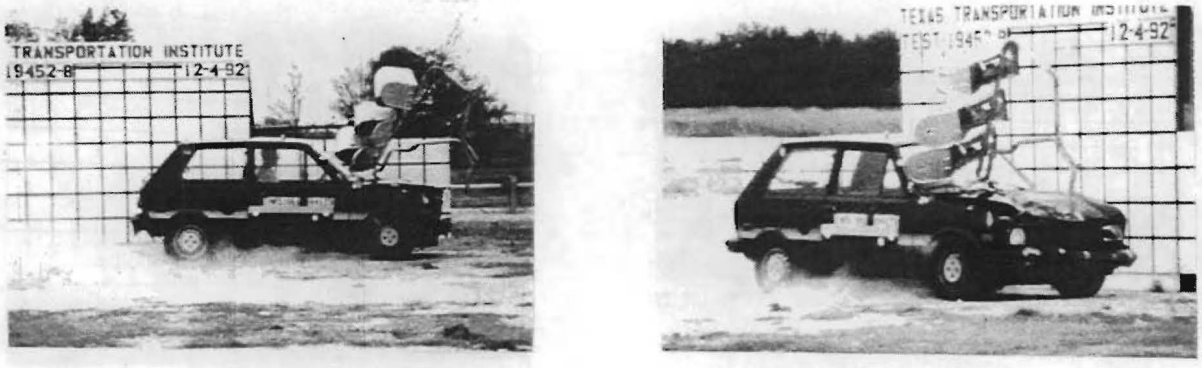


0.068 s

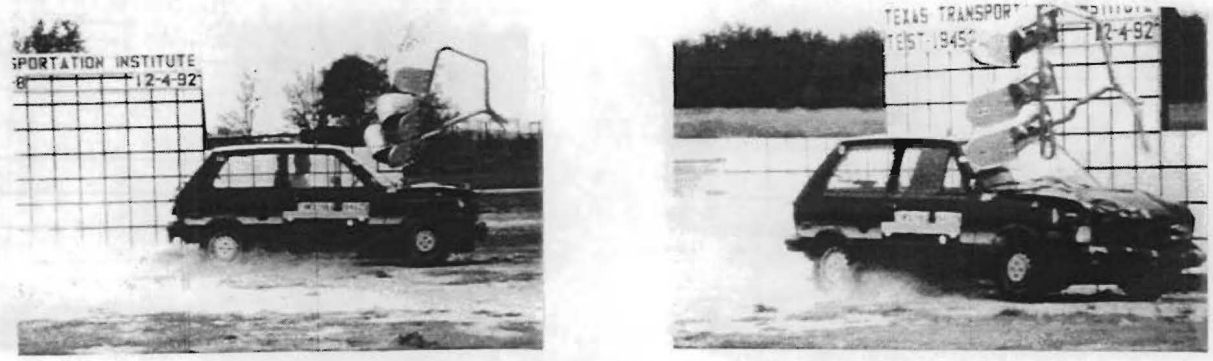


0.102 s

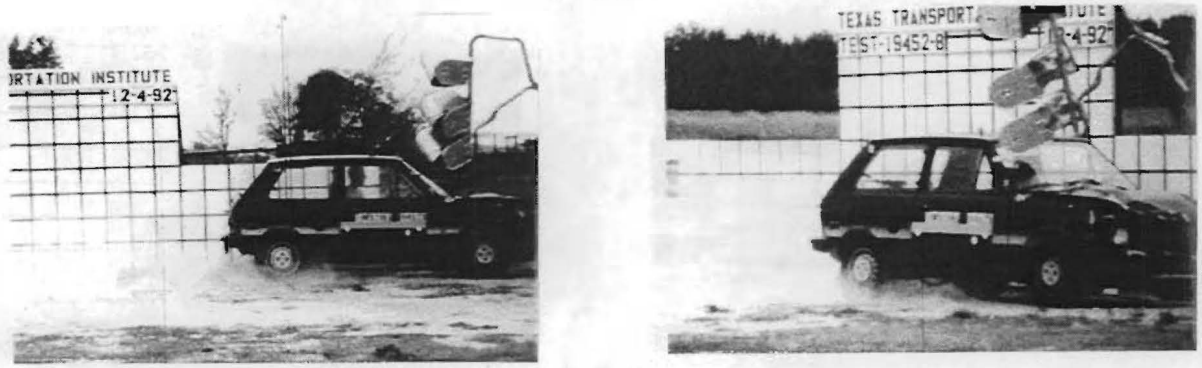
Figure J-6. Sequential photographs for test 19452-8. (perpendicular and side views).



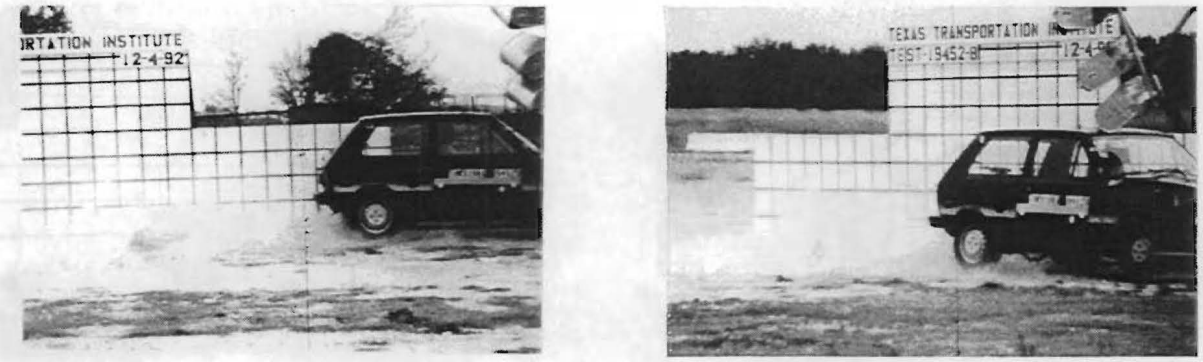
0.136 s



0.170 s



0.204 s



0.238 s

Figure J-6. Sequential photographs for test 19452-8 (perpendicular and side views) continued.

Figure J-7. Mailbox/support after test 19452-8.

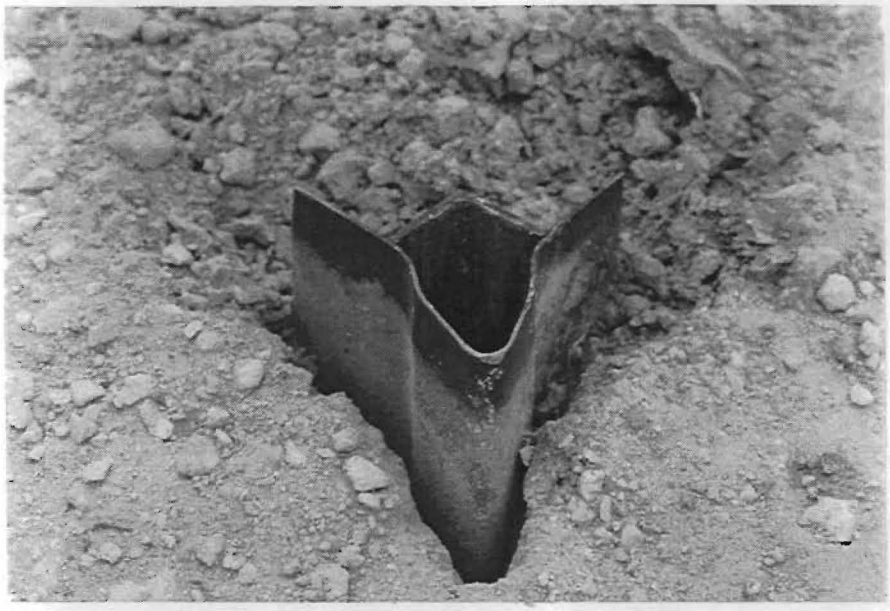
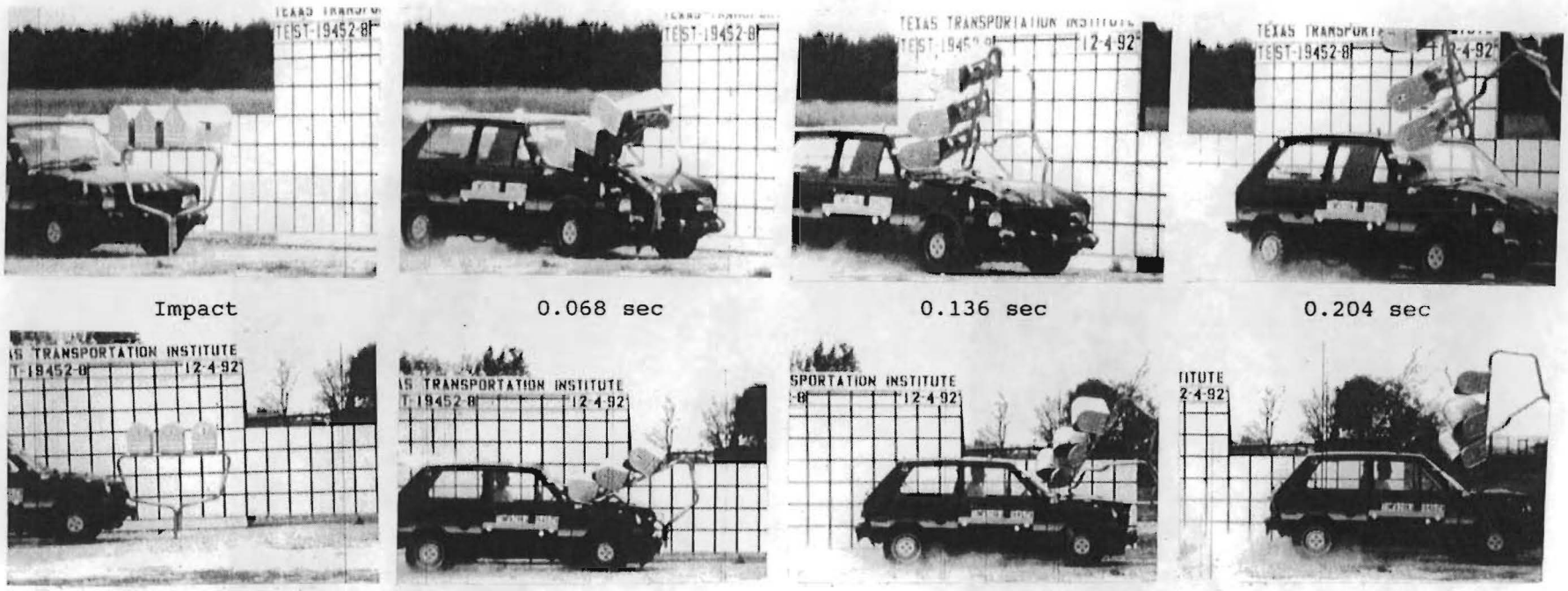


Figure J-8. Support base after test 19452-8.

Figure J-9. Vehicle after test 19452-8.



Test No. 19452-8
Date 12/04/92
Test Installation . . . Mailbox

Installation Length . . N/A
Max. Dynamic Movement . N/A
Max. Perm. Movement . . 102 ft (31.1 m)
Test Vehicle . . . . . 1987 Yugo
Vehicle Weight
  Test Inertia . . . . . 1,808 lb (820 kg)
  Gross Static . . . . . 1,967 lb (892 kg)
Vehicle Damage Classification
  TAD 12FR1
  CDC 12FREN1
Maximum Vehicle Crush. . 5.0 in (12.7 cm)

Impact Speed. . . . . 61.2 mi/h (98.5 km/h)
Impact Angle. . . . . 0.0 deg
Speed at Parallel . . N/A
Exit Speed . . . . . 55.7 mi/h (89.6 km/h)
Exit Trajectory . . . N/A
Vehicle Accelerations at center-of-gravity
(Max. 0.050-sec Average)
  Longitudinal. . . . -2.0 g
  Lateral . . . . . -0.4 g
  Occupant Impact Velocity at true c.g.
  Longitudinal. . . . 2.6 ft/s (0.8 m/s)
  Lateral . . . . . .-4.1 ft/s (1.2 m/s)
Occupant Ridedown Accelerations
  Longitudinal . . . 0.31 g
  Lateral . . . . . 0.78 g

Figure J-10. Summary of results for test 19452-8.

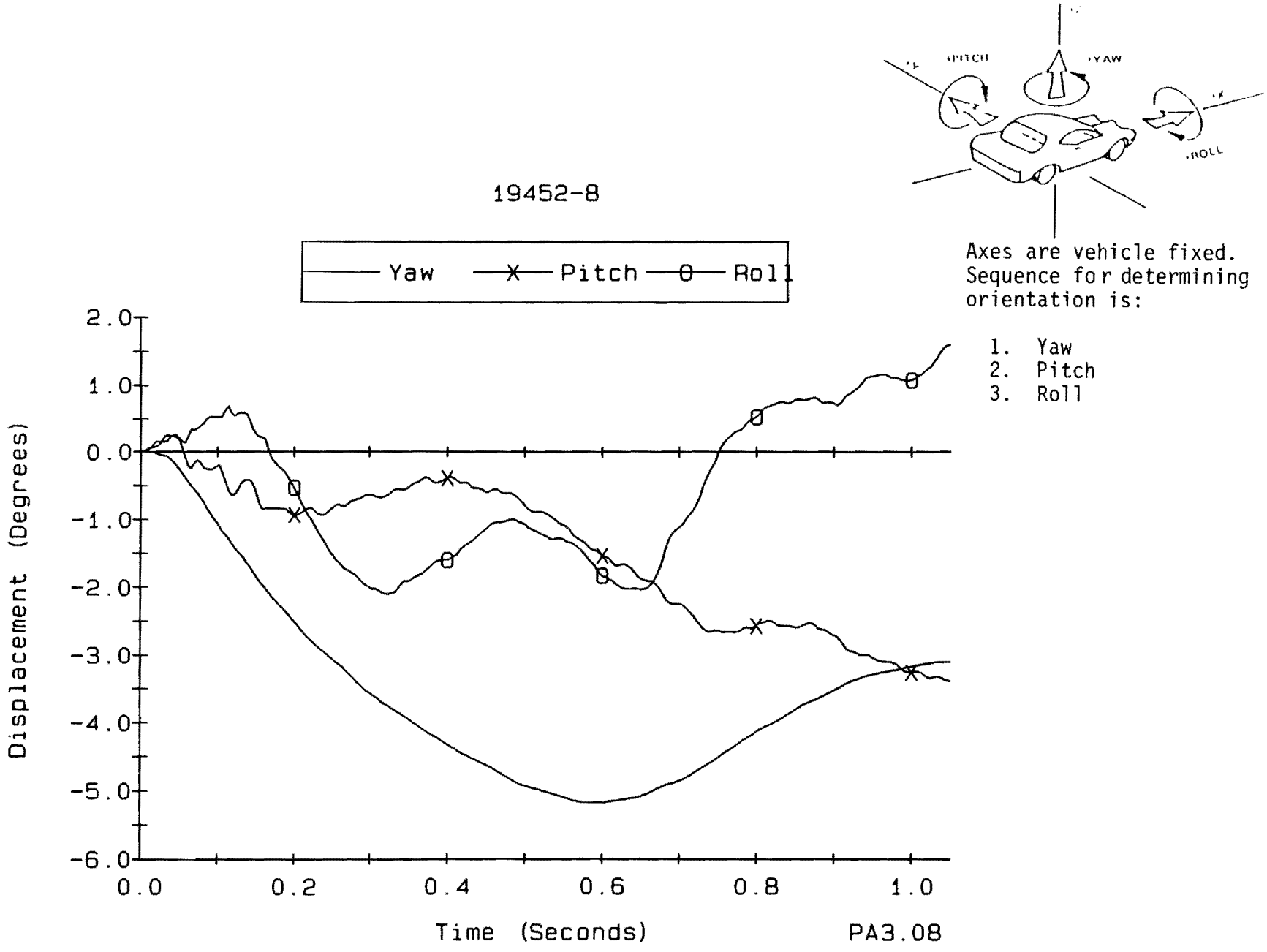


Figure J-11. Vehicle angular displacements for test 19452-8.

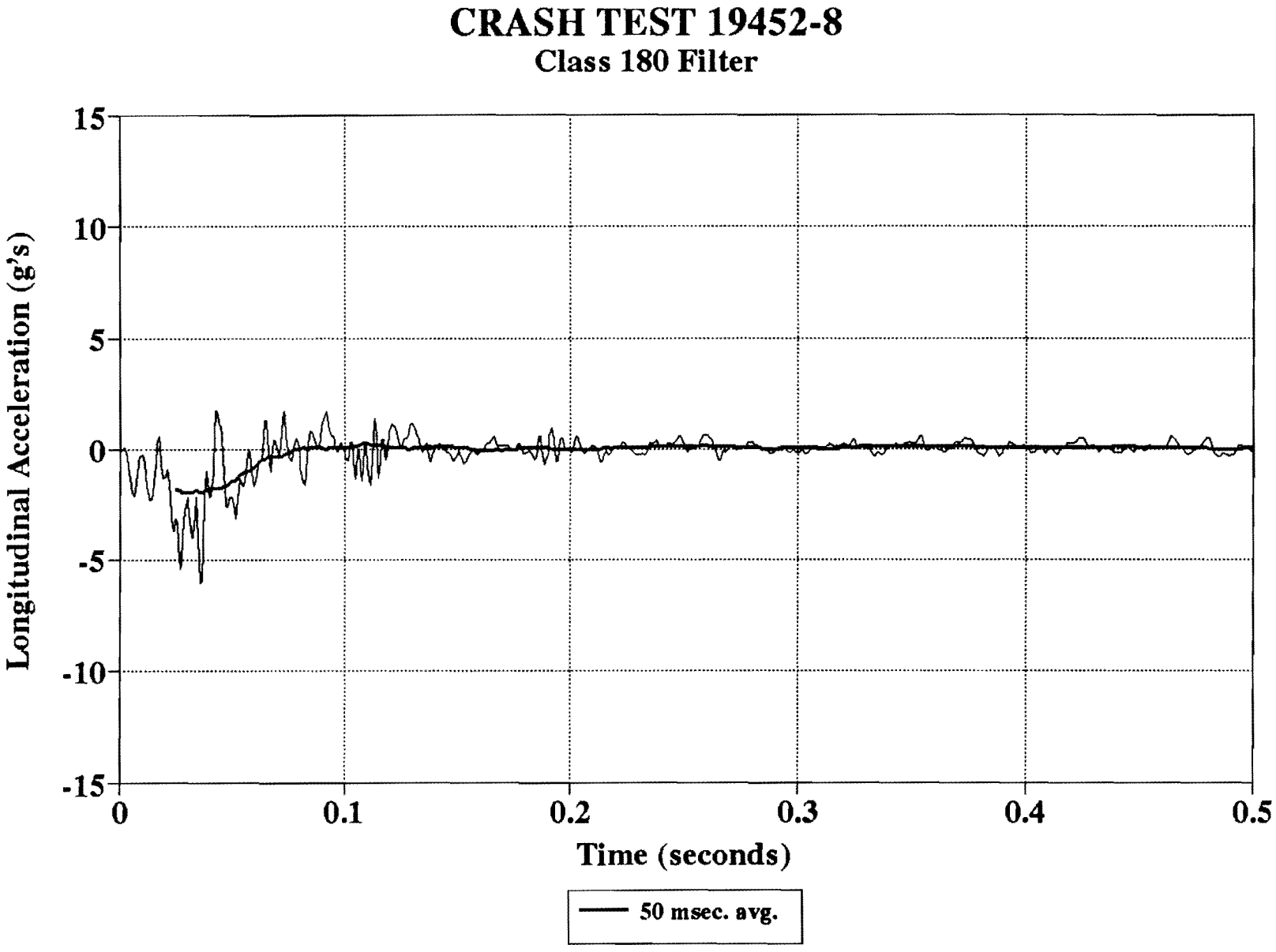


Figure J-12. Longitudinal accelerometer trace for test 19452-8.

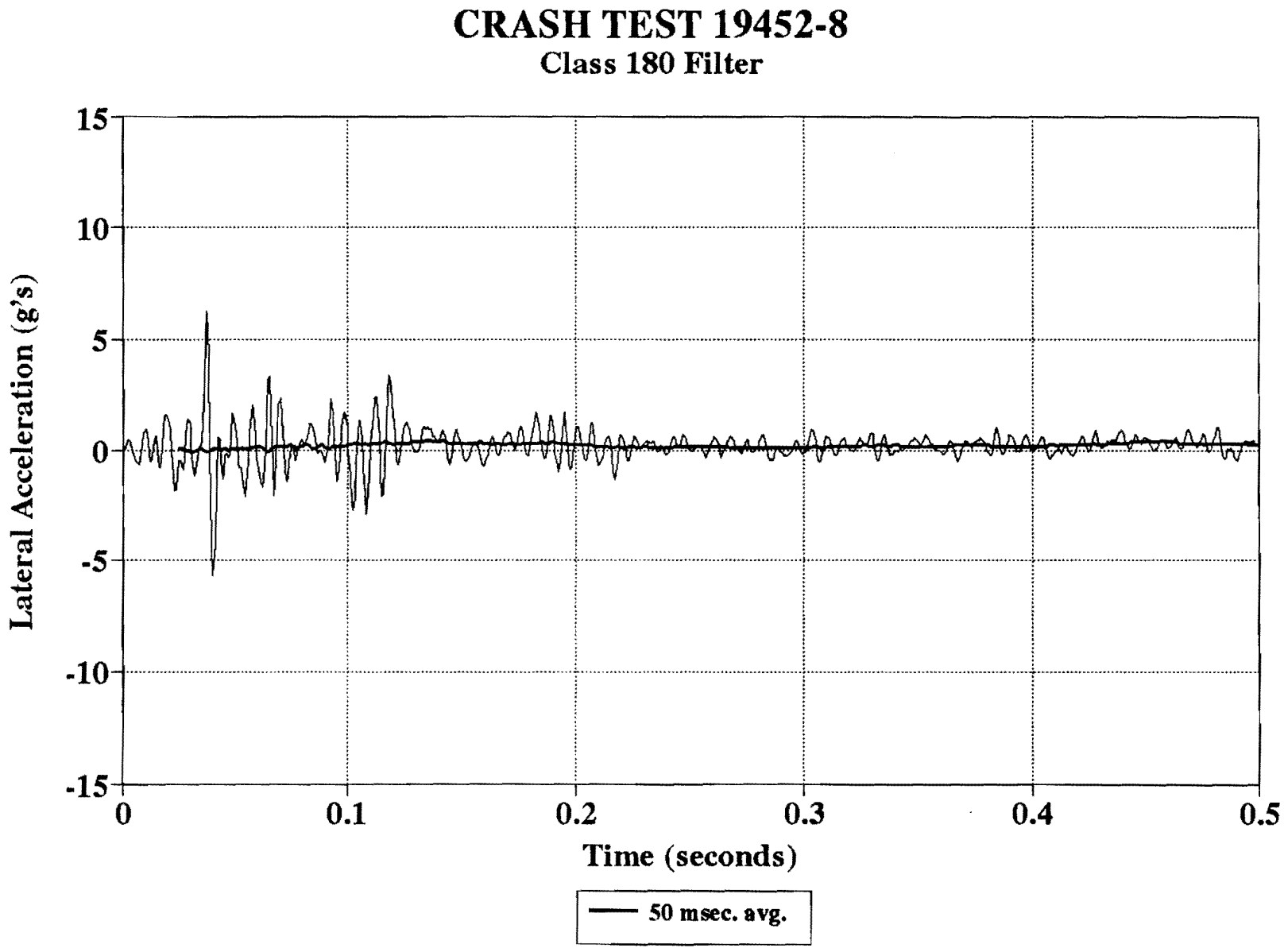


Figure J-13. Lateral accelerometer trace for test 19452-8.

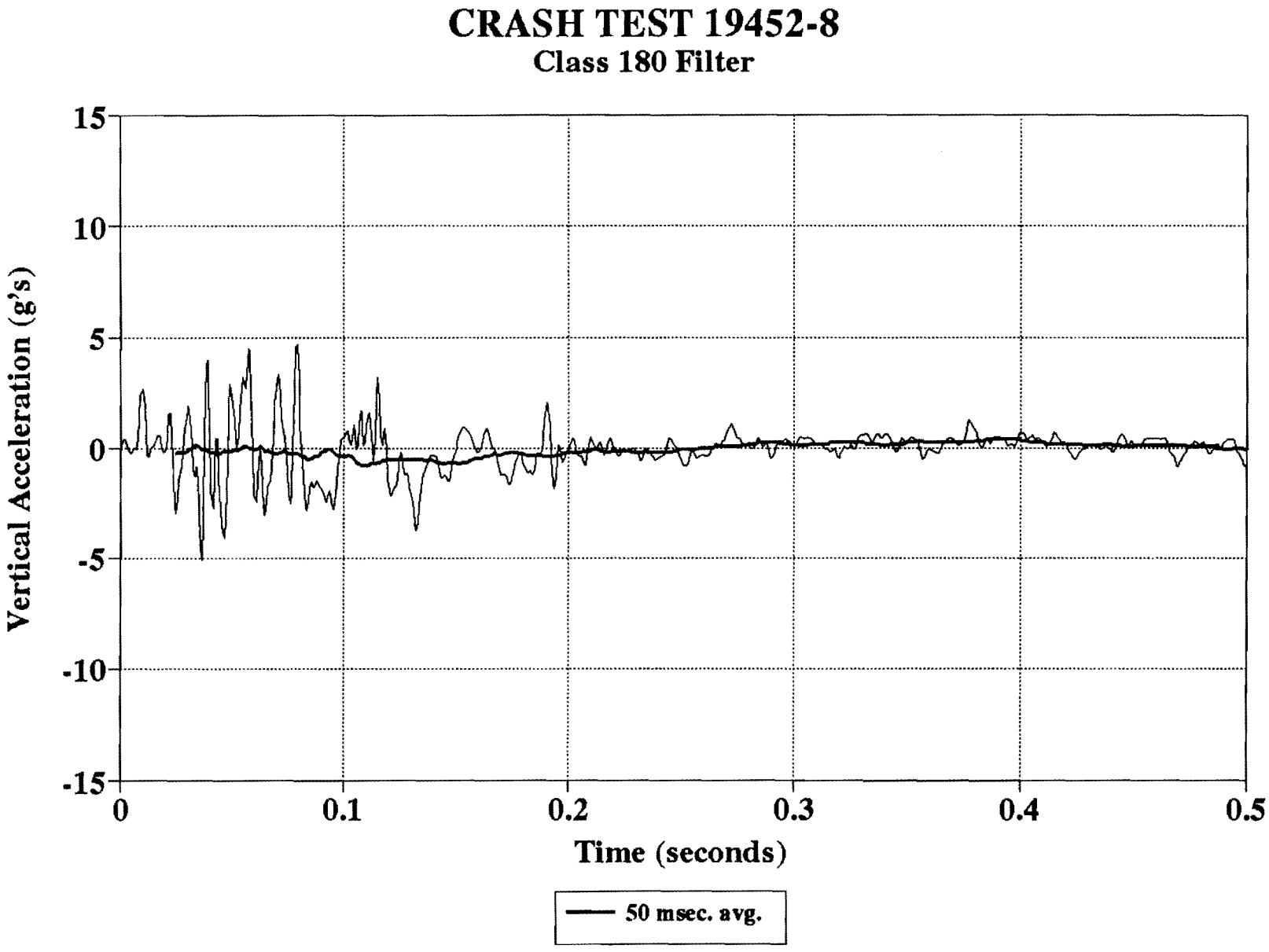


Figure J-14. Vertical accelerometer trace for test 19452-8.

APPENDIX K

TEST 19453-9 REPORT

Test 19453-9

The test article was the same as that of test 19452-8 except a modified version of the Foresight Tubular Support was used. The modification consisted of a replacement footing attached to the support structure by two 5/16-in. (0.79 cm) bolts at the normal splice and a 3/8-in. (0.95 cm) bolt at the uppermost splice. The lower portion of the replacement footing was inserted in the ground socket. TxDOT standard drawings call for 3/8-in. (0.95 cm) bolts at the normal splice. However, researchers learned after the test that the support assembly for this test, as provided by TxDOT, as well as those used in tests 19452-7 and -8 contained 5/16-in. (0.79 cm) bolts. Fortunately, none of the splices in tests 19452-7, -8, and 19453-9 failed. Nonetheless, the researchers recommend that 3/8-in. (0.95 cm) bolts be used for both splices to insure structural adequacy. The installation was oriented such that the uppermost splice would be subjected to its most critical loading. Appendix B gives complete details of the installation. Figures K-1 and K-2 show photos of the test article. Figure K-3 shows the 1989 Ford Festiva test vehicle. Figure K-4 shows the position of the vehicle with respect to the test article at impact. Impact speed was 62.9 mph (101.2 km/h). Impact point was the front left quarter point of the vehicle's bumper. Test inertia mass of the vehicle was 1,808 lb (820 kg) and its gross static mass was 1,967 lb (892 kg). Other vehicular dimensions and information are given in Figure K-5.

The vehicle was free wheeling and unrestrained just prior to impact. Upon impact, the support began to yield and by 0.034 second, the support began to separate from the ground anchor (Flush V-Wing socket). At approximately 0.066 second, the leading mailbox struck, broke, and dished the windshield. It did not penetrate into the occupant compartment. The vehicle lost contact with the support at approximately 0.166 second and the entire assembly went over the top of the vehicle with no subsequent contacts. The brakes were applied at 1.1 second and the vehicle came to rest 282.0 feet (85.0 m) from the point of impact. Figure K-6 shows sequential photographs of the test.

Figures K-7 and K-8 show test article damage. As shown, the support was pulled from the ground anchor and came to rest approximately 132 ft (40.2 m) from the impact point. All mailboxes remained attached to the support. The vehicle sustained moderate damage to the bumper, hood, grill, and windshield as shown in Figure K-9. The fan and radiator also sustained damage.

A summary of test results and other pertinent information are given in Figure K-10. The maximum 0.050 second average acceleration experienced by the vehicle was -2.6 g in the longitudinal direction and -0.6 g in the lateral direction. In the longitudinal direction, the occupant contact velocity was 4.7 ft/s (1.4 m/s) at .470 second and there was no contact in the lateral direction. Angular vehicular displacements are plotted in Figure K-11 and vehicular accelerations are plotted in Figures K-12 through K-14. Change in the vehicle's velocity was 3.9 mph (6.3 km/h).

Researchers identified two items as probable causes of the differences in behavior of the installation in this test with the two previous tests. First, and likely the dominate reason, the replacement footing in test 19453-9 was inserted approximately 11 in. (27.9 cm) into the ground socket; whereas the support in tests 19452-7 and -8 were inserted approximately 9 in. (22.9 cm). In all three tests the insertion depth was controlled by the 42 in. (106.7 cm) dimension from the top of the horizontal member of the support structure to the ground. Researchers believe that the added insertion depth of the replacement footing in test 19453-9 increased the force needed to pull the footing from the socket, which resulted in further deformation of the support structure by the vehicle and, hence, contact of the mailbox with the windshield. Secondly, the horizontal distance from the front bumper to the lower edge of the windshield of the vehicle used in test 19453-9 was approximately 2 in. (5.1 cm) less than was in the vehicles used in tests 19452-7 and -8.

The primary purpose of this test was to verify the structural adequacy of the modified support structure, primarily the uppermost splice. The test did, in fact, verify the adequacy of the modified support. It is the researcher's opinion that had the insertion depth of the replacement footing been approximately 9 in. (22.9 cm) or less, the impact behavior of the modified installation would have been essentially the same as that observed in test 19452-8. Thus, it is concluded that the modified design will meet all impact performance evaluation criteria when the replacement footing is inserted 9 in. (22.9 cm) or less into the ground socket.

Results of test 19453-9 underscore the critical effect that seemingly minor design and installation details can have on the impact behavior of a safety feature. In this case, it points to the need to limit the insertion depth, whether it be the standard design or the modified design, to 9 in. (22.9 cm) or less.

Figure K-1. Mailbox installation for test 19453-9.

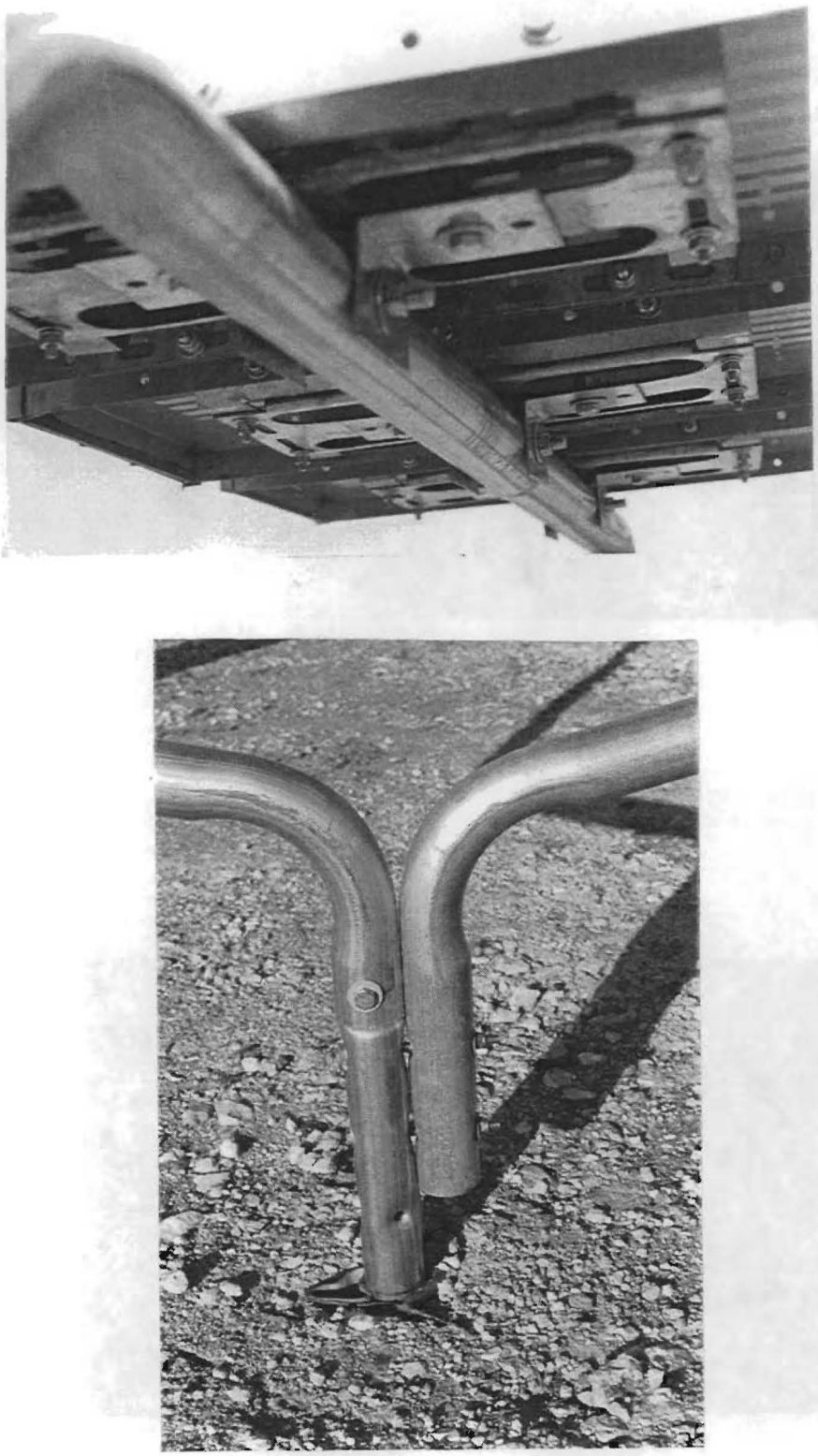


Figure K-2. Support connection for installation used in test 19453-9.

Figure K-3. Vehicle before test 19453-9.

Figure K-4. Vehicle/mailbox geometrics for test 19453-9.

DATE: 12-12-92 TEST NO.: 19453-9 VIN NO.: KNJRT06K4K6144608 MAKE: Ford

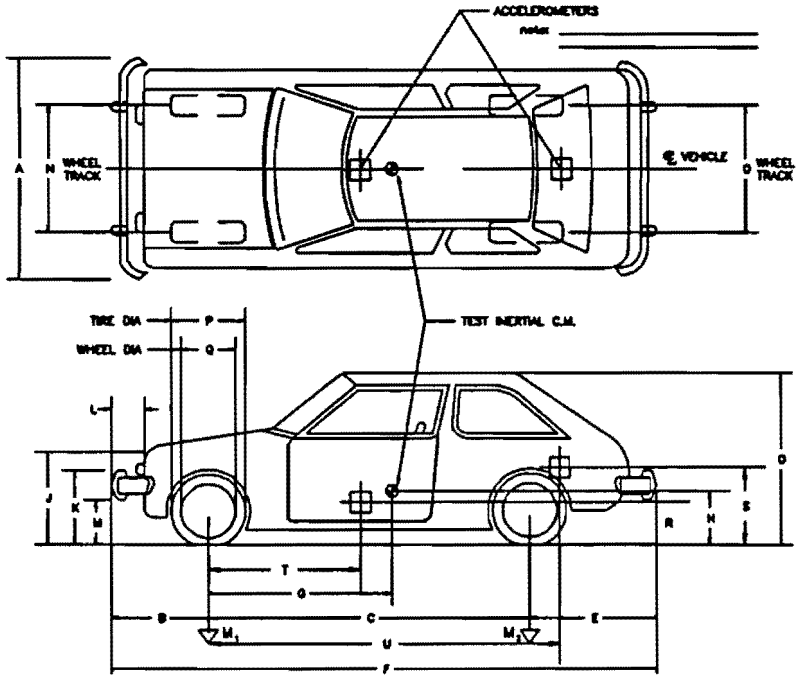
MODEL: Festiva YEAR: 1989 ODOMETER: 60085 TIRE SIZE: 155R12

TIRE INFLATION PRESSURE: _____

MASS DISTRIBUTION (kg) LF 259 RF 266 LR 147 RR 148

DESCRIBE ANY DAMAGE TO VEHICLE PRIOR TO TEST:

dents in roof (marked)



ENGINE TYPE: 4cyl gas

ENGINE CID: 1.3 L (80.8)

TRANSMISSION TYPE:

__ AUTO

X MANUAL

OPTIONAL EQUIPMENT:

DUMMY DATA:

TYPE: _____

MASS: _____

SEAT POSITION: _____

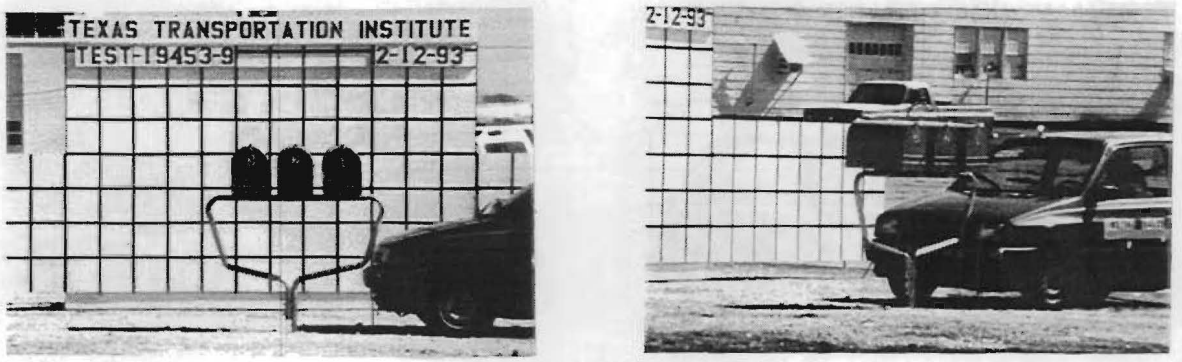
GEOMETRY – (mm)

A	1570	E	540	J	720	N	1390	R	395
B	690	F	3825	K	535	O	1390	S	645
C	2295	G	826	L	130	P	550	T	884
D	1450	H		M	380	Q	330	U	2460

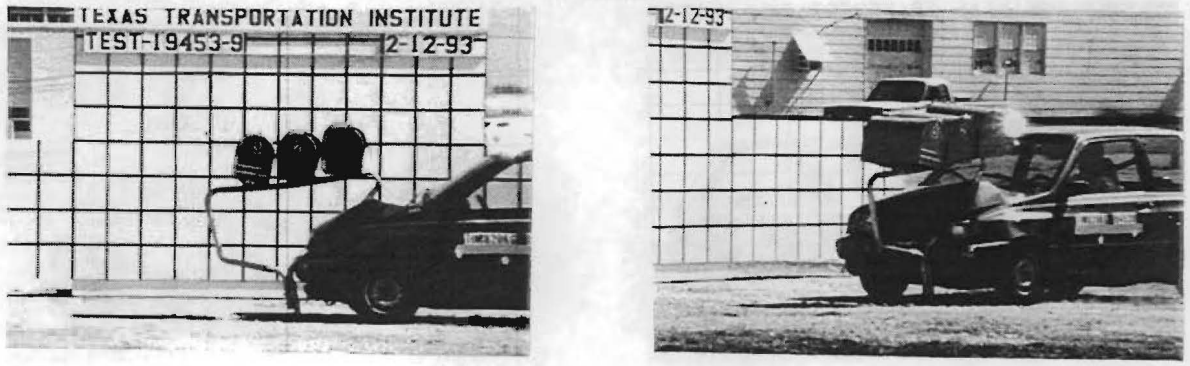
MASS – (kg)	CURB	TEST INERTIAL	GROSS STATIC
M_1	512	525	563
M_2	271	295	330
M_T	783	820	893

1 mm = 0.039 in
1 kg = 2.202 lb

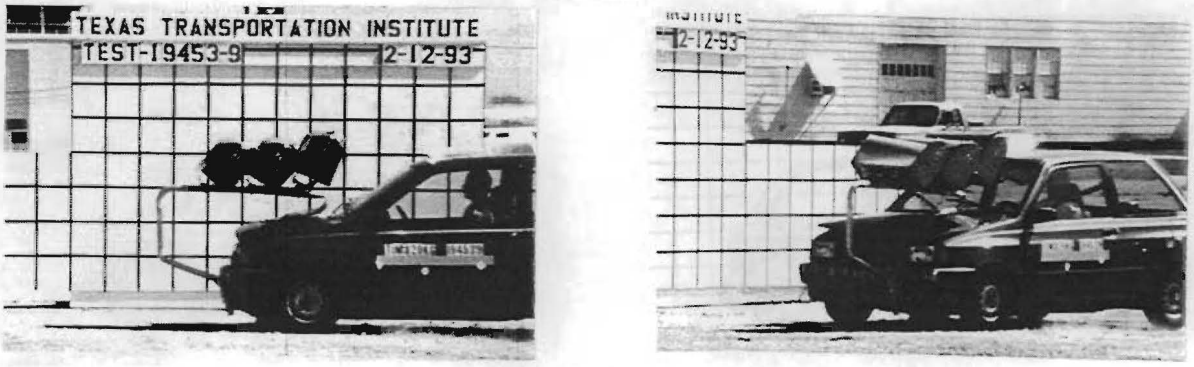
Figure K-5. Vehicle properties for test 19453-9.



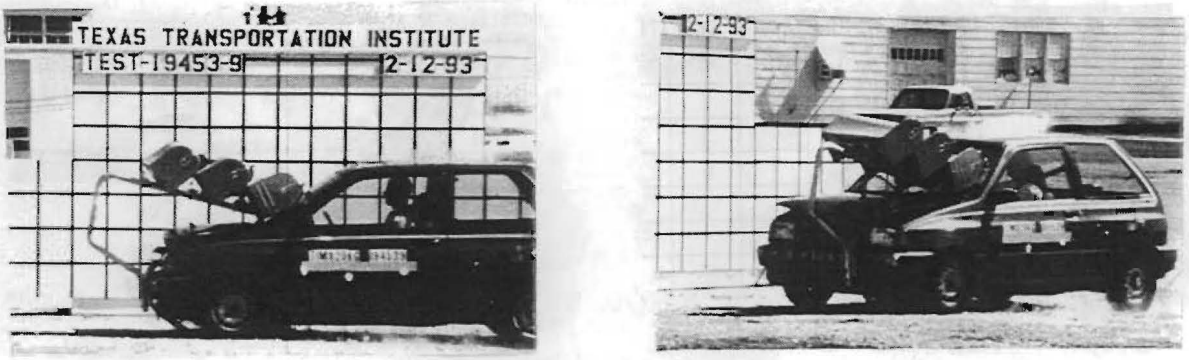
0.000 s



0.022 s



0.044 s



0.066 s

Figure K-6. Sequential photographs for test 19453-9. (perpendicular and side views).

0.088 s

0.110 s

0.132 s

0.154 s

Figure K-6. Sequential photographs for test 19453-9 (perpendicular and side views) continued.

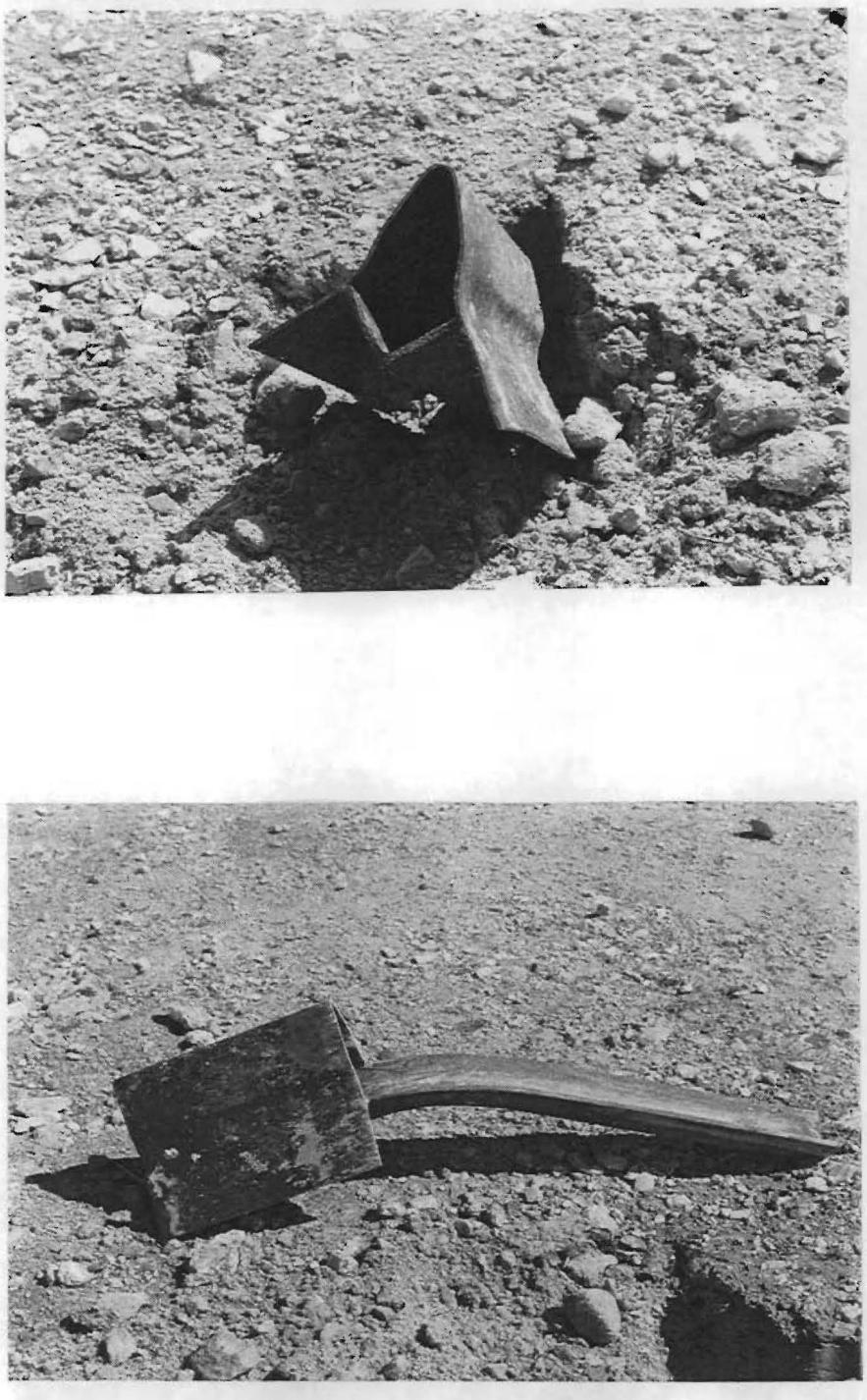


Figure K-7. Flush V-wing socket after test 19453-9.

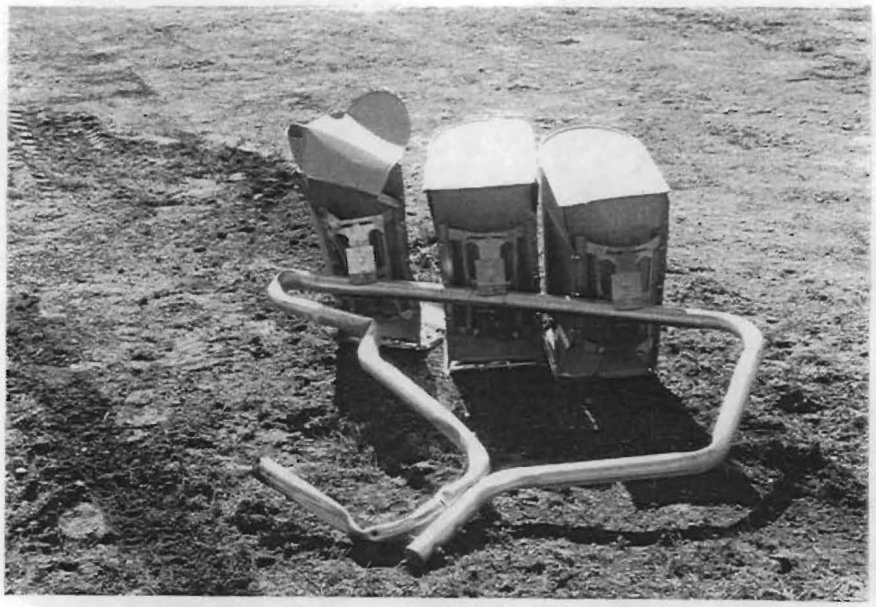
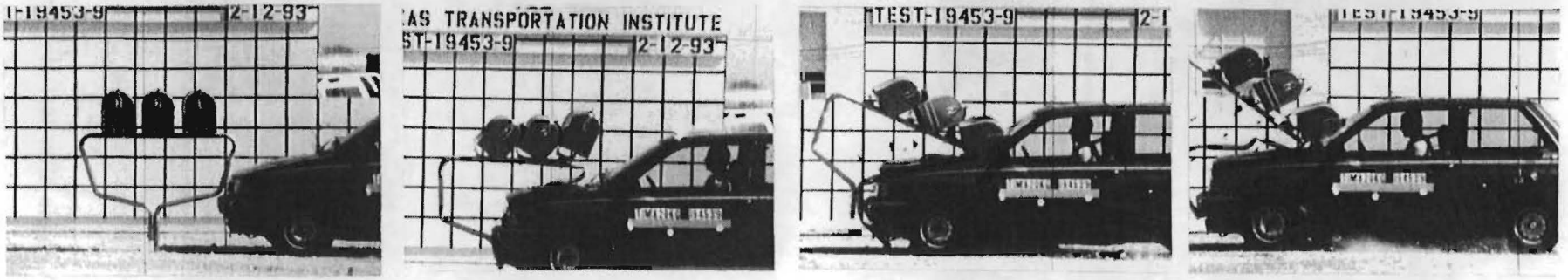


Figure K-8. Mailbox/support after test 19453-9.

Figure K-9. Vehicle after test 19453-9.

Impact 0.044 sec 0.088 sec 0.132 sec



Test No. 19453-9
Date 2/12/93
Test Installation . . . Mailbox

Installation Length . . N/A
Max. Dynamic Movement . N/A
Max. Perm. Movement . . 115 ft (35.1 m)
Test Vehicle . . . . . 1989 Ford Festiva
Vehicle Weight
  Test Inertia . . . . . 1,808 lb (820 kg)
  Gross Static . . . . . 1,969 lb (893 kg)
Vehicle Damage Classification
  TAD 12F11
  CDC 12F1EN1
Maximum Vehicle Crush. . 3.9 in (10.0 cm)

Impact Speed. . . . . 62.9 mi/h (101.2 km/h)
Impact Angle. . . . . 0.0 deg
Speed at Parallel . . N/A
Exit Speed . . . . . 59.0 mi/h (94.5 km/h)
Exit Trajectory . . . N/A
Vehicle Accelerations at center-of-gravity
(Max. 0.050-sec Average)
  Longitudinal. . . . -2.6 g
  Lateral . . . . . -0.6 g
  Occupant Impact Velocity at true c.g.
  Longitudinal. . . . 4.7 ft/s (1.4 m/s)
  Lateral . . . . . N/A
Occupant Ridedown Accelerations
  Longitudinal . . . -0.24 g
  Lateral . . . . . N/A

Figure K-10. Summary of results for test 19453-9.

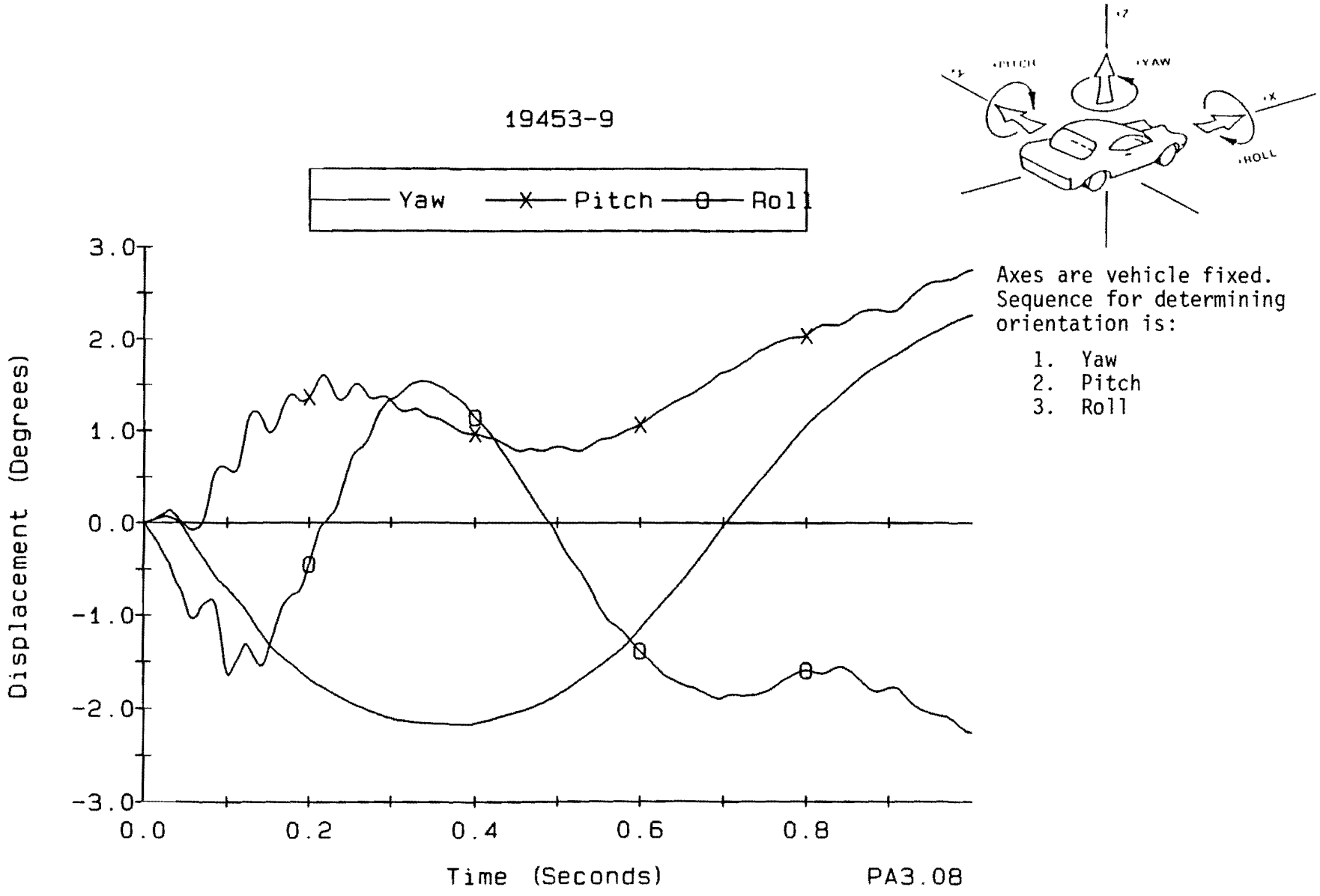


Figure K-11. Vehicle angular displacements for test 19453-9.

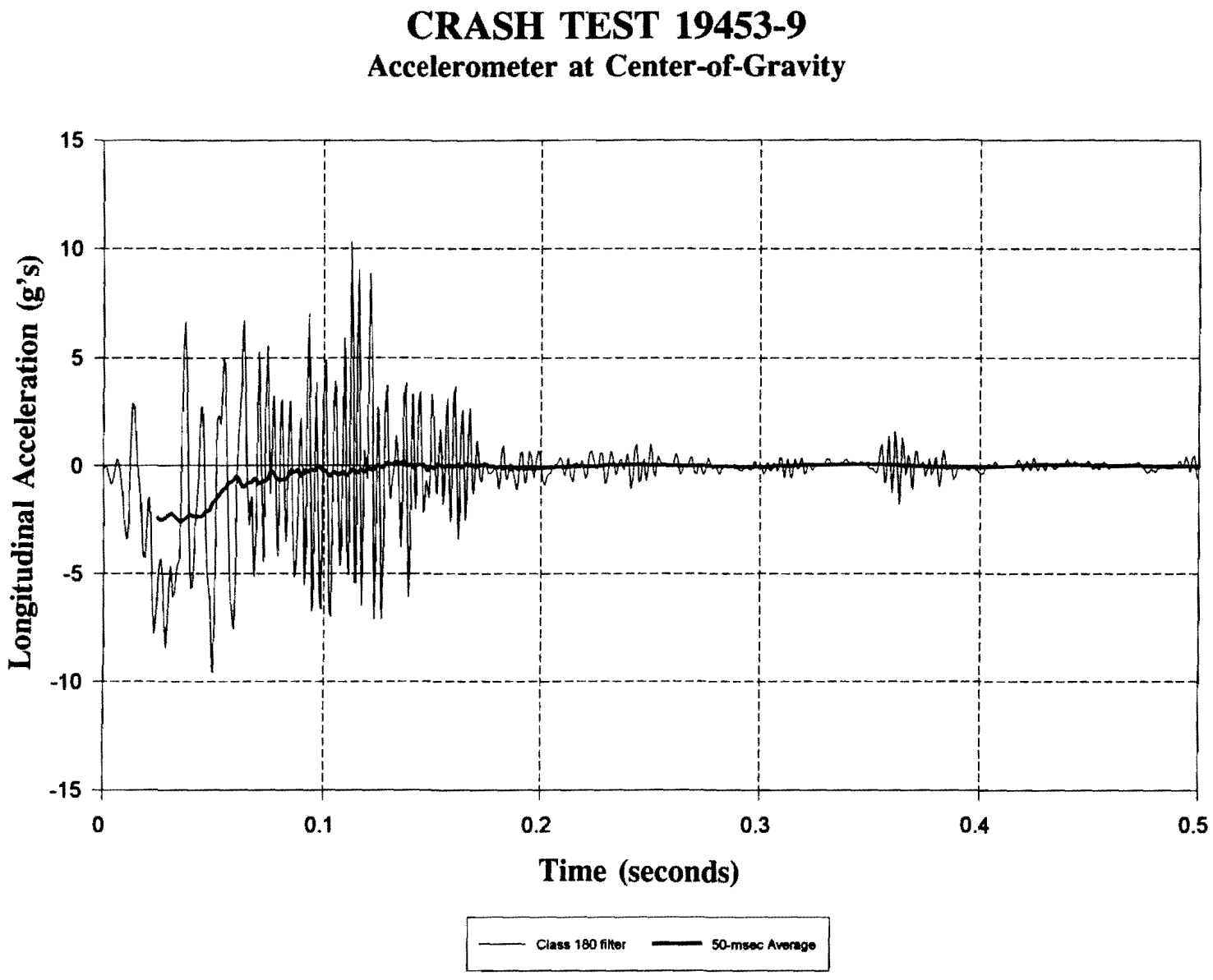


Figure K-12. Longitudinal accelerometer trace for test 19453-9.

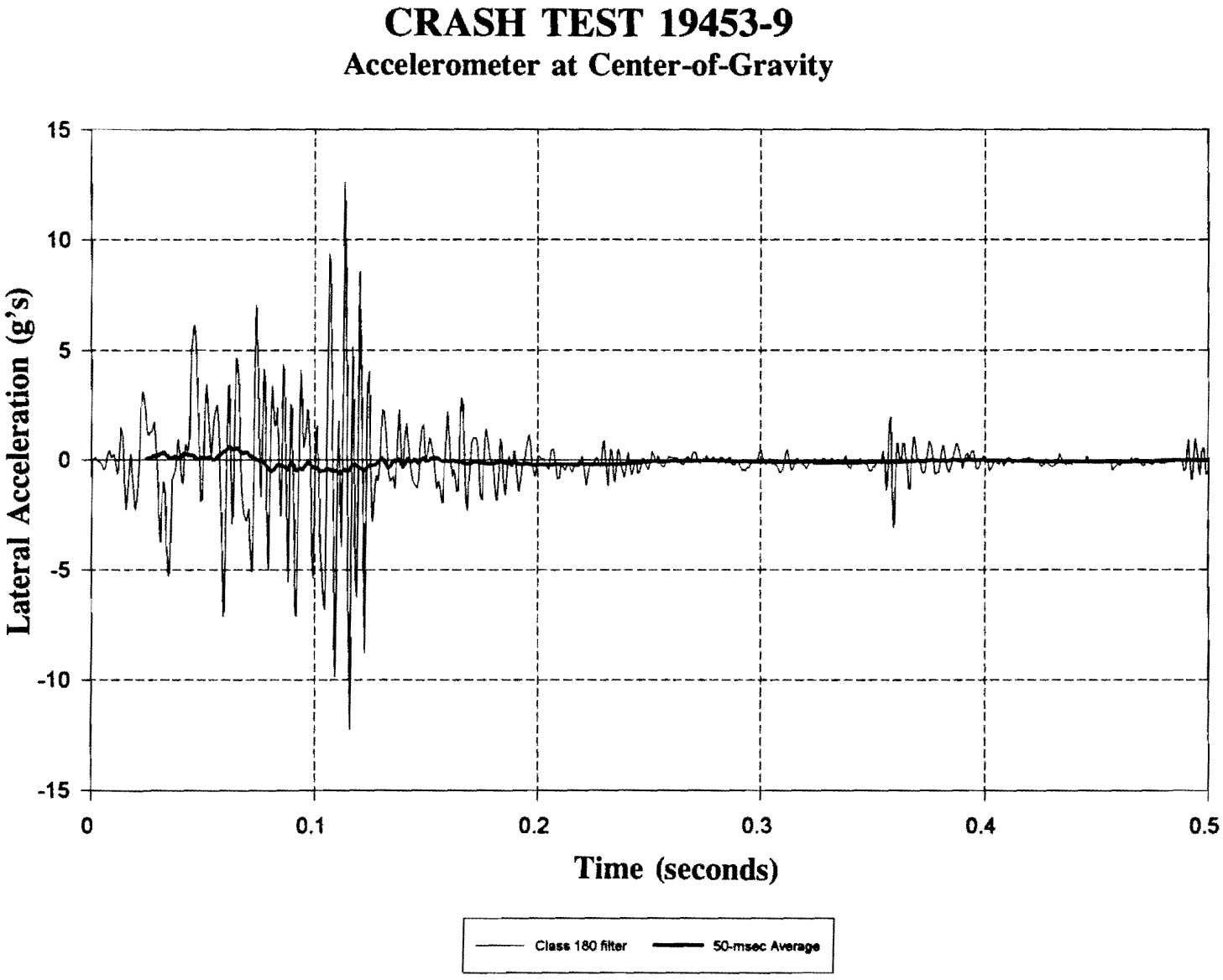


Figure K-13. Lateral accelerometer trace for test 19453-9.

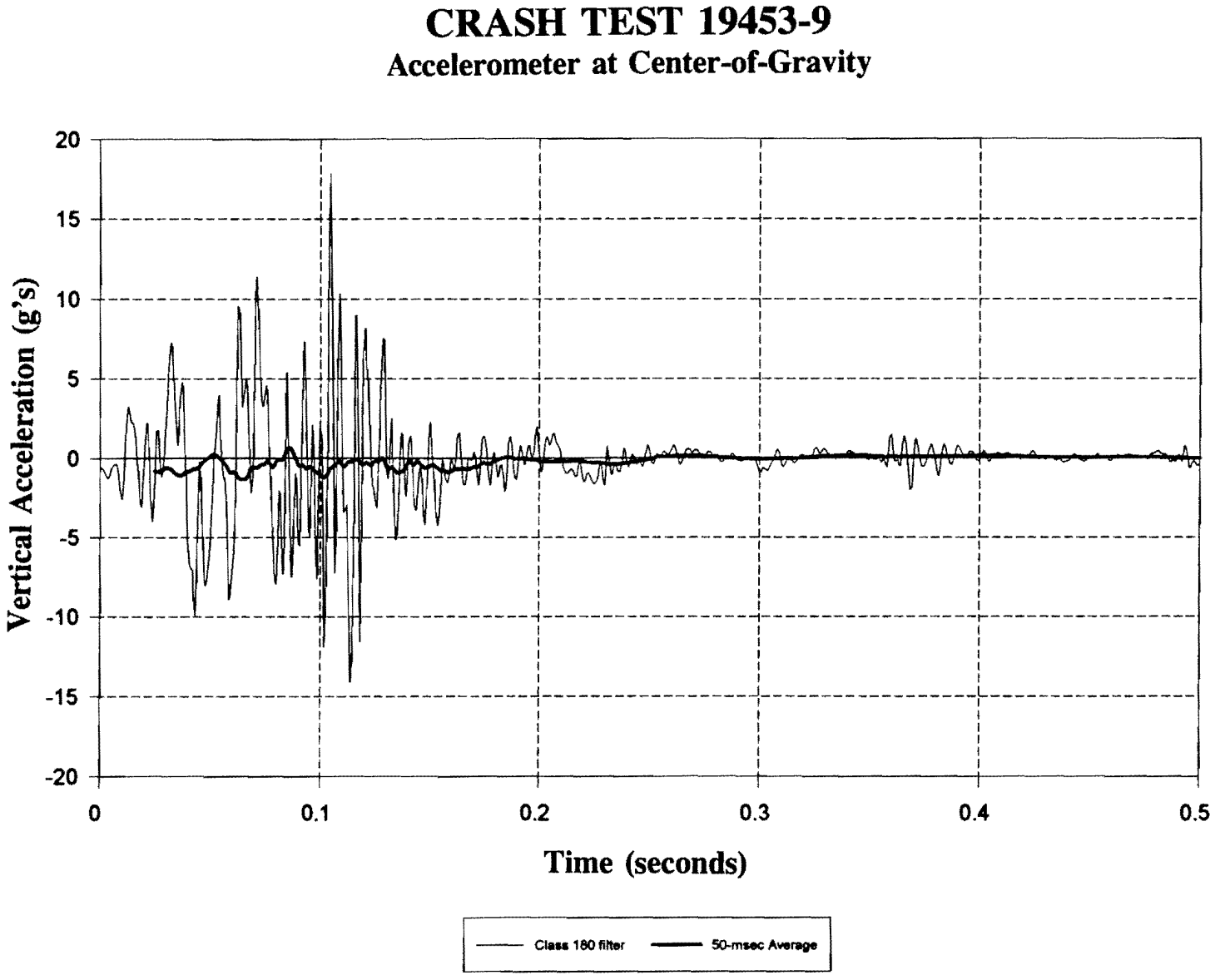


Figure K-14. Vertical accelerometer trace for test 19453-9.

APPENDIX L

TEST 19453-10 REPORT

Test 19453-10

The test article consisted of a size no. 2 mailbox mounted on two 2 lb/ft (3 kg/m) steel winged channel posts. The mailbox was attached to TxDOT's current bracket design by six 3/16-in. (0.48 cm) stove bolts, with 1/2-in. (1.27 cm) pipe spacers being used between the bracket and the mailbox. Appendix B gives complete details of the installation. Figure L-1 shows photos of the test article. Figure L-2 shows the 1989 Ford Festiva test vehicle. Figure L-3 shows the position of the vehicle with respect to the test article at impact. Impact speed was 62.8 mph (101.0 km/h). Impact point was the front left quarter point of the vehicle's bumper. Test inertia mass of the vehicle was 1,808 lb (820 kg) and its gross static mass was 1,969 lb (893 kg). Other vehicular dimensions and information are given in Figure L-4.

The vehicle was free wheeling and unrestrained just prior to impact. Upon impact, the support began to yield and pocket around the front of the vehicle. By approximately 0.017 second, the mailbox became detached from the supports. At 0.030 second, the mailbox struck the hood of the vehicle and rode up. By 0.089 second, the mailbox lost contact with the vehicle as the mailbox passed up and over. The vehicle passed over the fractured support stubs, the brakes were applied at 1.6 seconds, and the vehicle came to rest 323.5 ft (98.6 m) from the point of impact. Figure L-5 shows sequential photographs of the test.

Figures L-6 and L-7 show test article damage. As shown, the support was bent at ground line and fractured about 25 in. (63.5 cm) above ground. The upper portions of the support with mailbox attached came to rest 15.8 ft (4.8 m) from impact point. The vehicle sustained minor damage to the bumper and hood, as shown in Figure L-9.

A summary of test results and other pertinent information are given in Figure L-9. The maximum 0.010 second average acceleration experienced by the vehicle was 1.0 g in the longitudinal direction and 1.2 g in the lateral direction. In the longitudinal direction, the occupant contact velocity was 6.0 ft/s (1.8 m/s) and 5.1 ft/s (1.6 m/s) in the lateral direction. Angular vehicular displacements are plotted in Figure L-10 and vehicular accelerations are plotted in Figures L-11 through L-13. Change in the vehicle's velocity was 6.5 mph (10.5 km/h).

In summary, the test was successful and met all evaluation criteria.

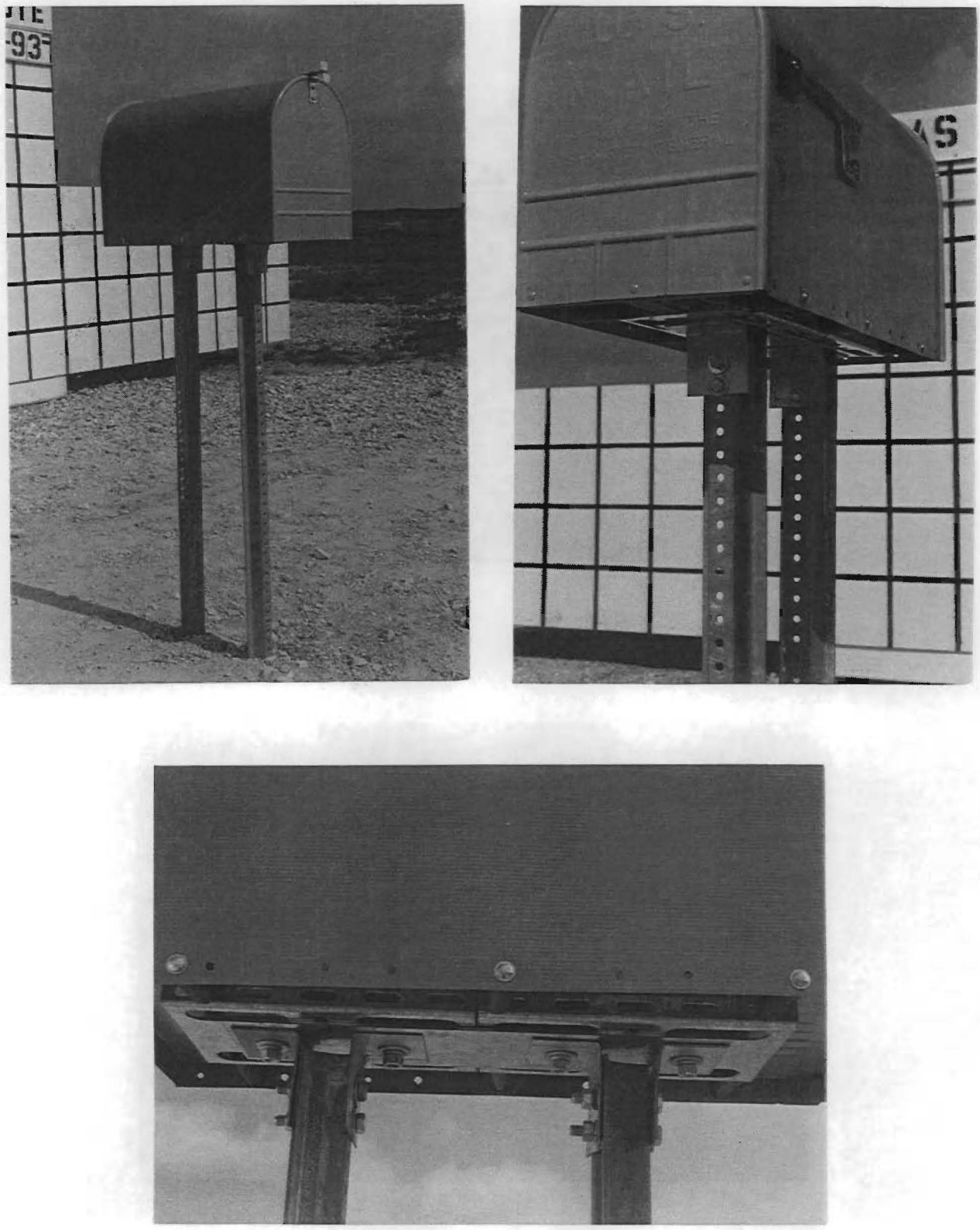


Figure L-1. Type II mailbox installation for test 19453-10.

Figure L-2. Vehicle before test 19453-10.

Figure L-3. Vehicle/mailbox geometrics for test 19453-10.

DATE: 12-12-92 TEST NO.: 19453-10 VIN NO.: KNJRT06K4K6144608 MAKE: Ford

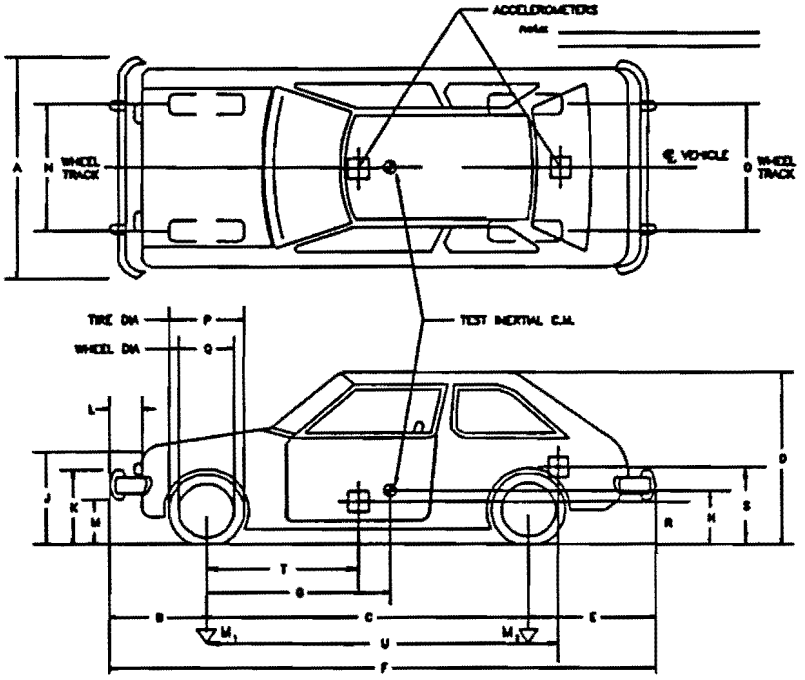
MODEL: Festiva YEAR: 1989 ODOMETER: 60085 TIRE SIZE: 155R12

TIRE INFLATION PRESSURE: _____

MASS DISTRIBUTION (kg) LF 259 RF 266 LR 147 RR 148

DESCRIBE ANY DAMAGE TO VEHICLE PRIOR TO TEST:

dents in roof (marked)



ENGINE TYPE: 4cyl gas

ENGINE CID: 1.3 L (80.8)

TRANSMISSION TYPE:

__ AUTO

X MANUAL

OPTIONAL EQUIPMENT:

DUMMY DATA:

TYPE: _____

MASS: _____

SEAT POSITION: _____

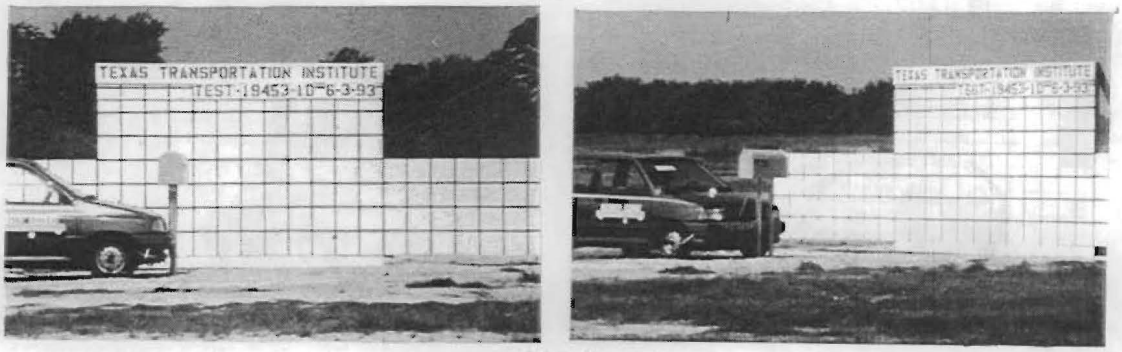
GEOMETRY – (mm)

A 1570	E 540	J 720	N 1390	R 395
B 690	F 3825	K 535	O 1390	S 645
C 2295	G 826	L 130	P 550	T 884
D 1450	H	M 380	Q 330	U 2460

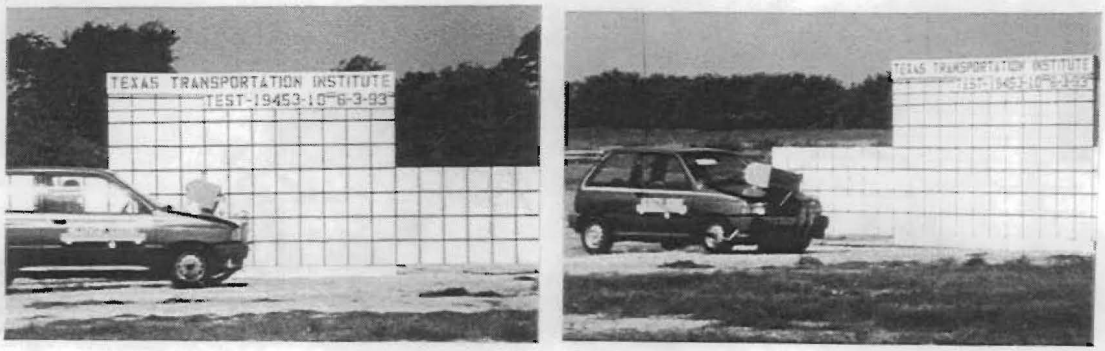
MASS – (kg)	CURB	TEST INERTIAL	GROSS STATIC
M_1	512	525	563
M_2	271	295	330
M_T	783	820	893

1 mm = 0.039 in
1 kg = 2.202 lb

Figure L-4. Vehicle properties for test 19453-10.

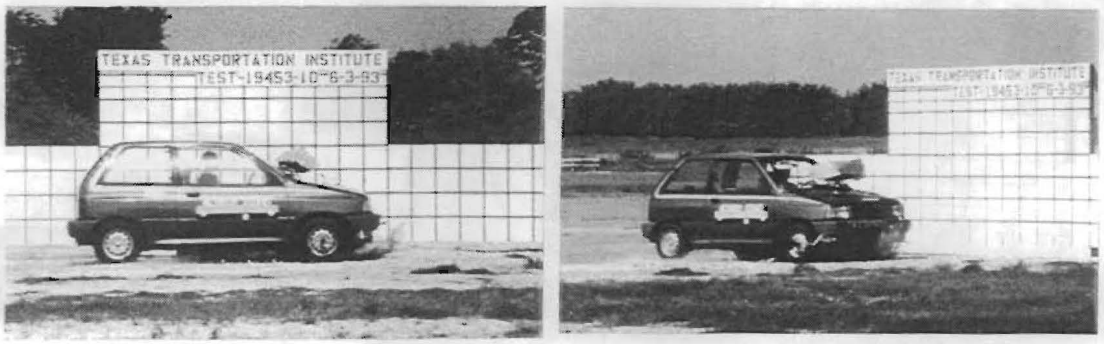


0.000 s



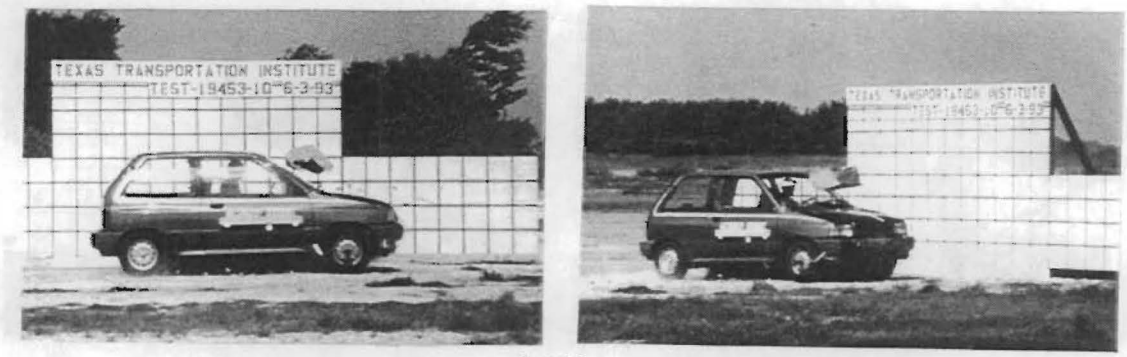
0.030 s

0.059 s

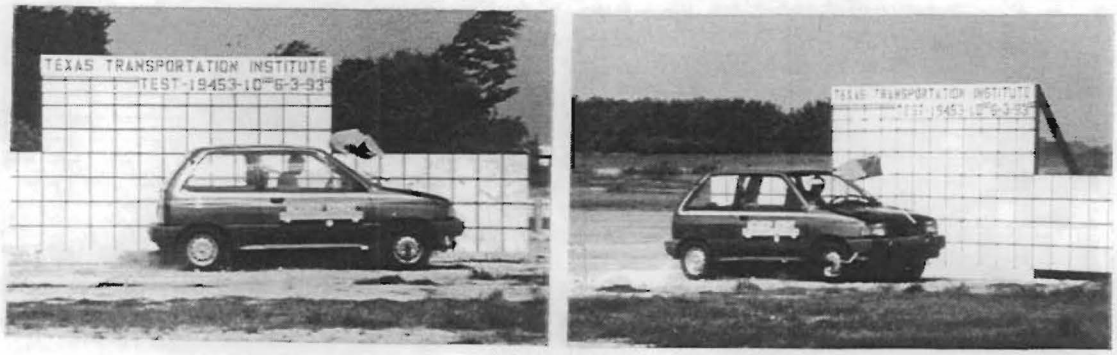


0.089 s

Figure L-5. Sequential photographs for test 19453-10. (perpendicular and side views).

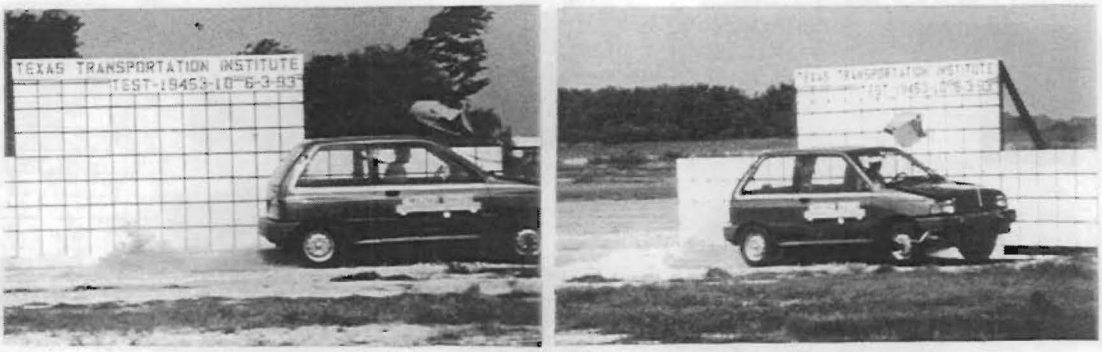


0.119 s



0.148 s

0.178 s



0.208 s

Figure L-5. Sequential photographs for test 19453-10 (perpendicular and side views) continued.

Figure L-6. Type II mailbox installation after test 19453-10.

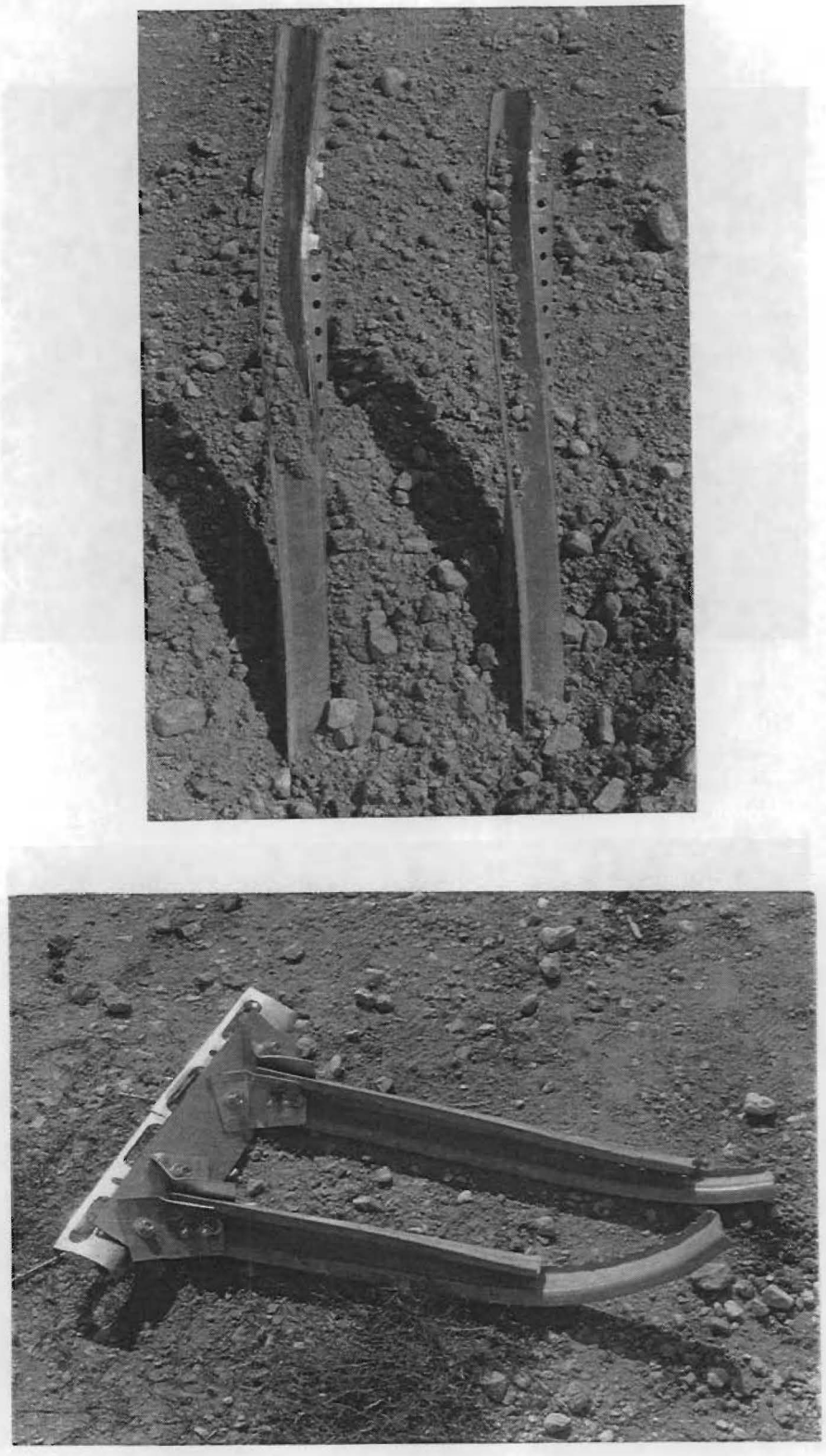


Figure L-6. Type II mailbox installation after test 19453-10 (continued).

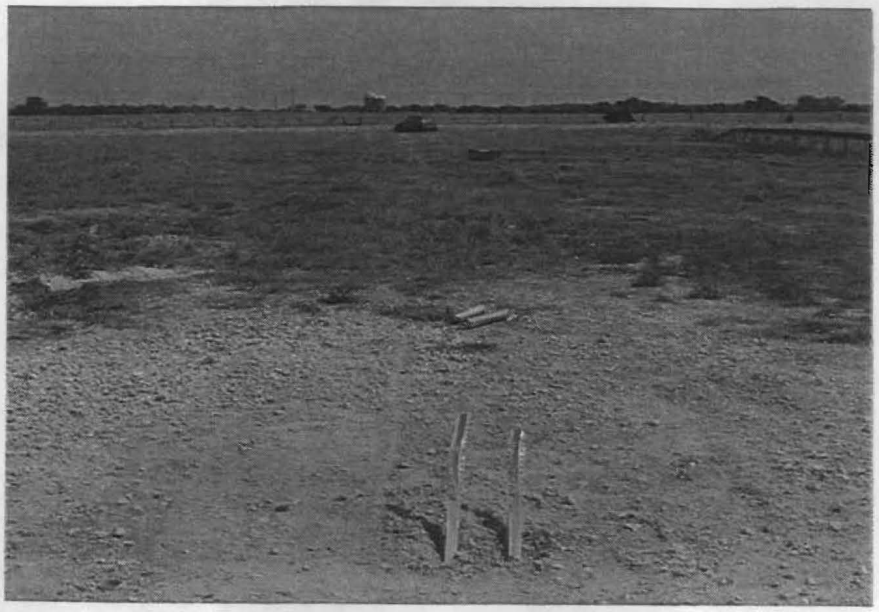


Figure L-7. Debris pattern and final rest position of vehicle after test 19453-10.

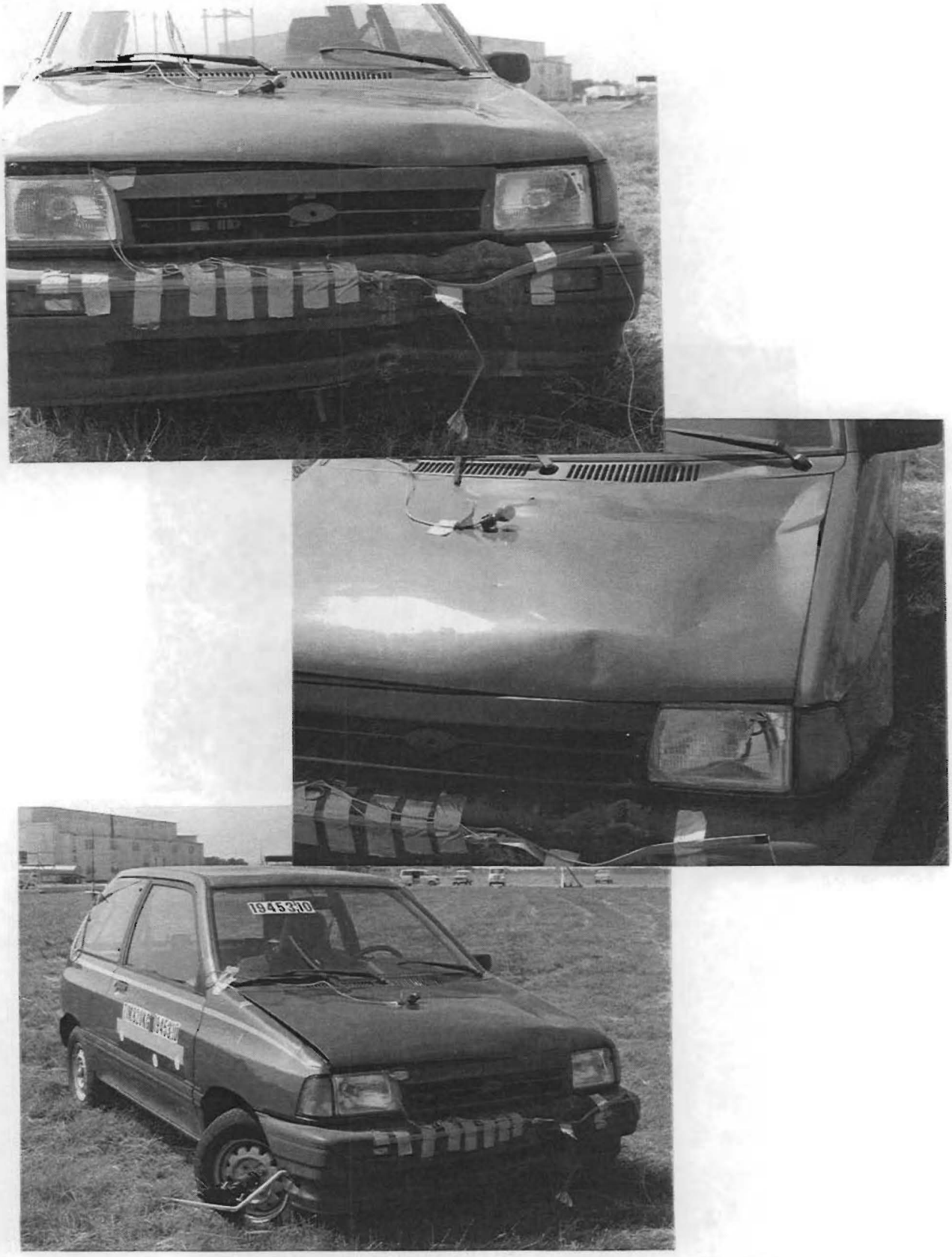
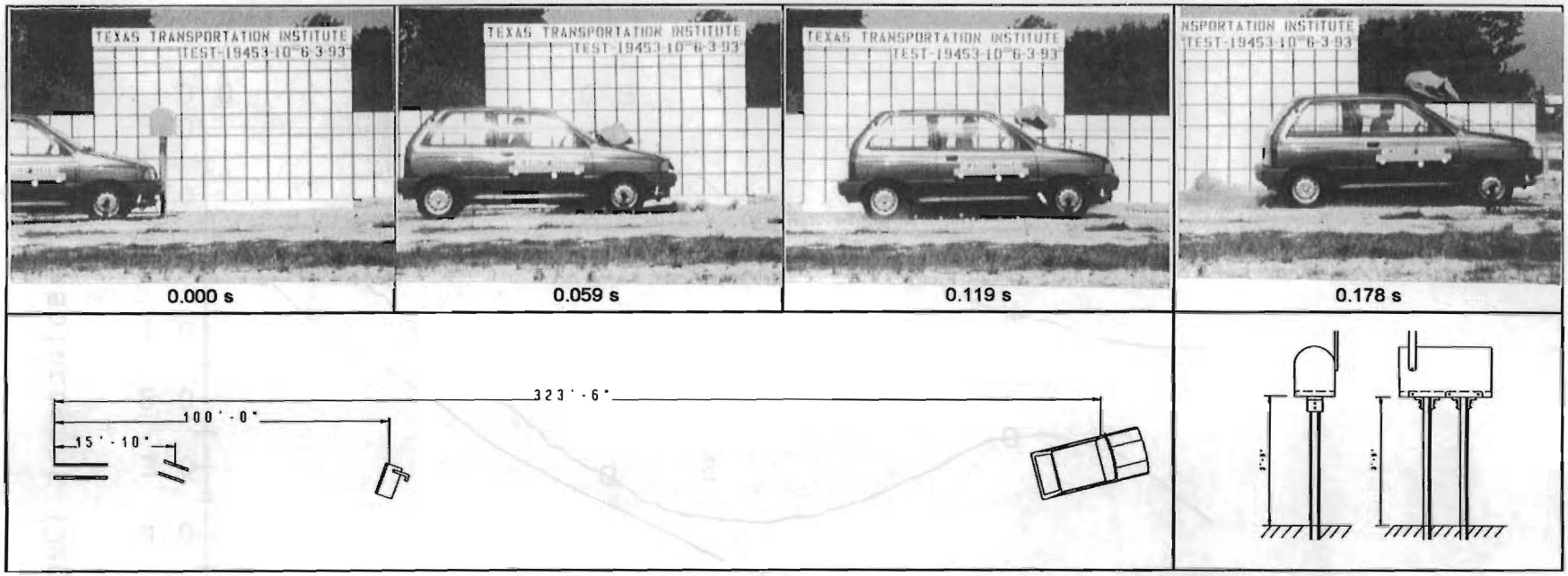


Figure L-8. Vehicle after test 19453-10.



General Information
- Test Agency ..... Texas Transportation Institute
- Test No. 19453-10
- Date 06/03/93

Test Article
- Type ..... Type II mailbox mounted w/ 2-steel U-channel supports
- Height to bottom of mailbox (cm). ..... 106.7 (42.0 in)
- Size and/or dimension and material of key elements ..... 22.9 cm (9 in) post spacing

Soil Type and Condition ... Strong soil

Test Vehicle
- Type ..... 1989 Ford
- Designation 820C
- Model ..... Festiva
- Mass (kg) Curb ..... 783 (1,726 lb)
  - Test Inertial . 820 (1,808 lb)
  - Dummy .... 73 (161 lb)
  - Gross Static . 893 (1,969 lb)

Impact Conditions
- Speed (km/h) ..... 101.0(62.8 mi/h)
- Angle (deg) ..... 0 (15" offset)

Exit Conditions
- Speed (km/h) ..... 90.7 (56.3 mi/h)
- Angle (deg) ..... N.A.

Occupant Risk Values
- Impact Velocity (m/s)
  - x-direction ..... 1.8 (6.0 ft/s)
  - y-direction ..... 1.6 (5.1 ft/s)
- THIV (optional) .....
- Ridedown Accelerations (g's)
  - x-direction 1.0
  - y-direction 1.2
- PHD (optional) .....
- ASI (optional) .....

Test Article Deflections (m)
- Dynamic ..... {Sign supports-
- Permanent ..... fractured}

Vehicle Damage
- Exterior
  - VDS 11FL-1
  - CDC 12FLEN1
- Interior
  - OCDI .....

Post-Impact Behavior
- Max. Roll Angle (deg) .. 3.8
- Max. Pitch Angle (deg) . -1.8
- Max. Yaw Angle (deg) .. 7.7

Figure L-9. Summary of results for test 19453-10.

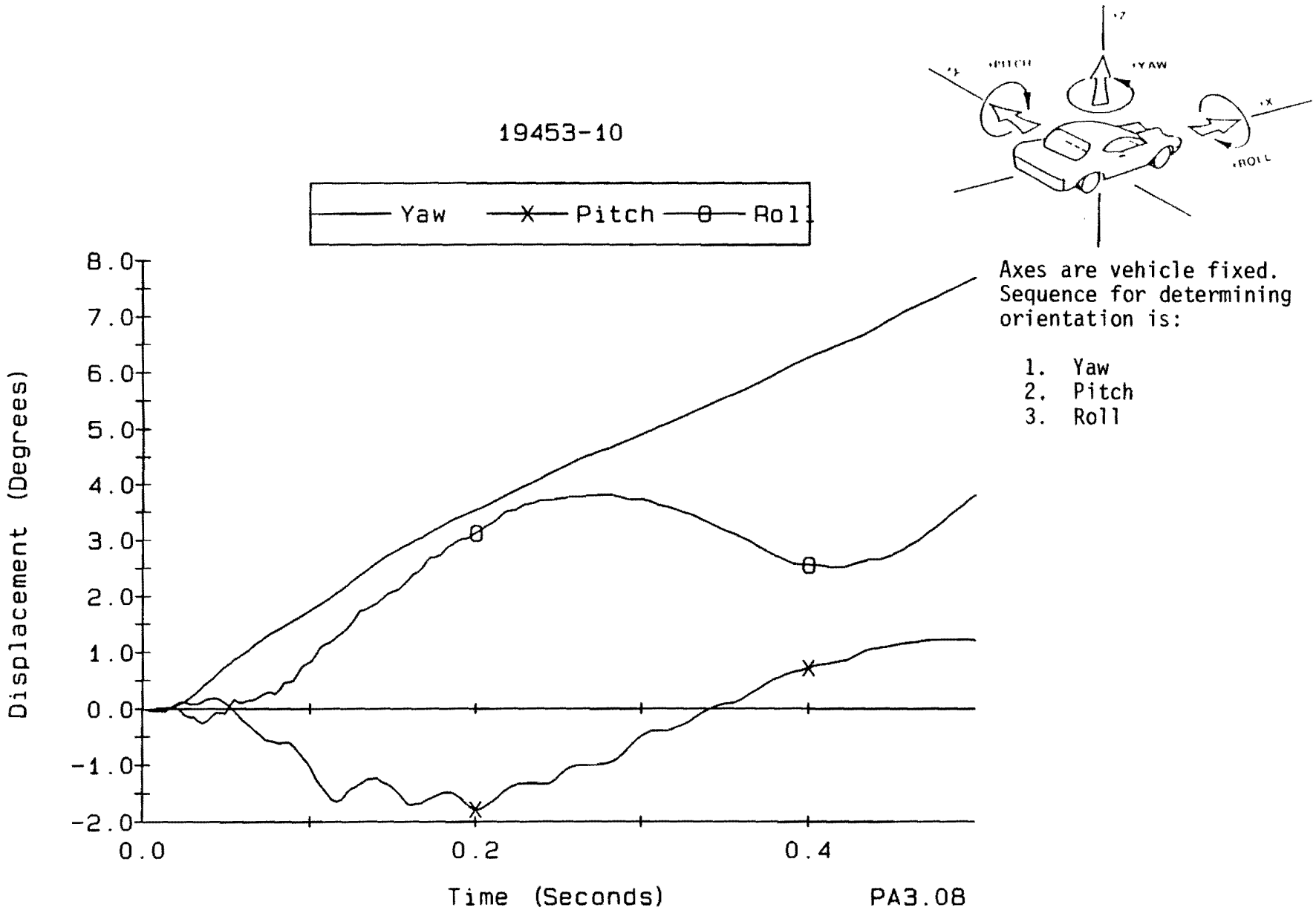


Figure L-10. Vehicle angular displacements for test 19453-10.

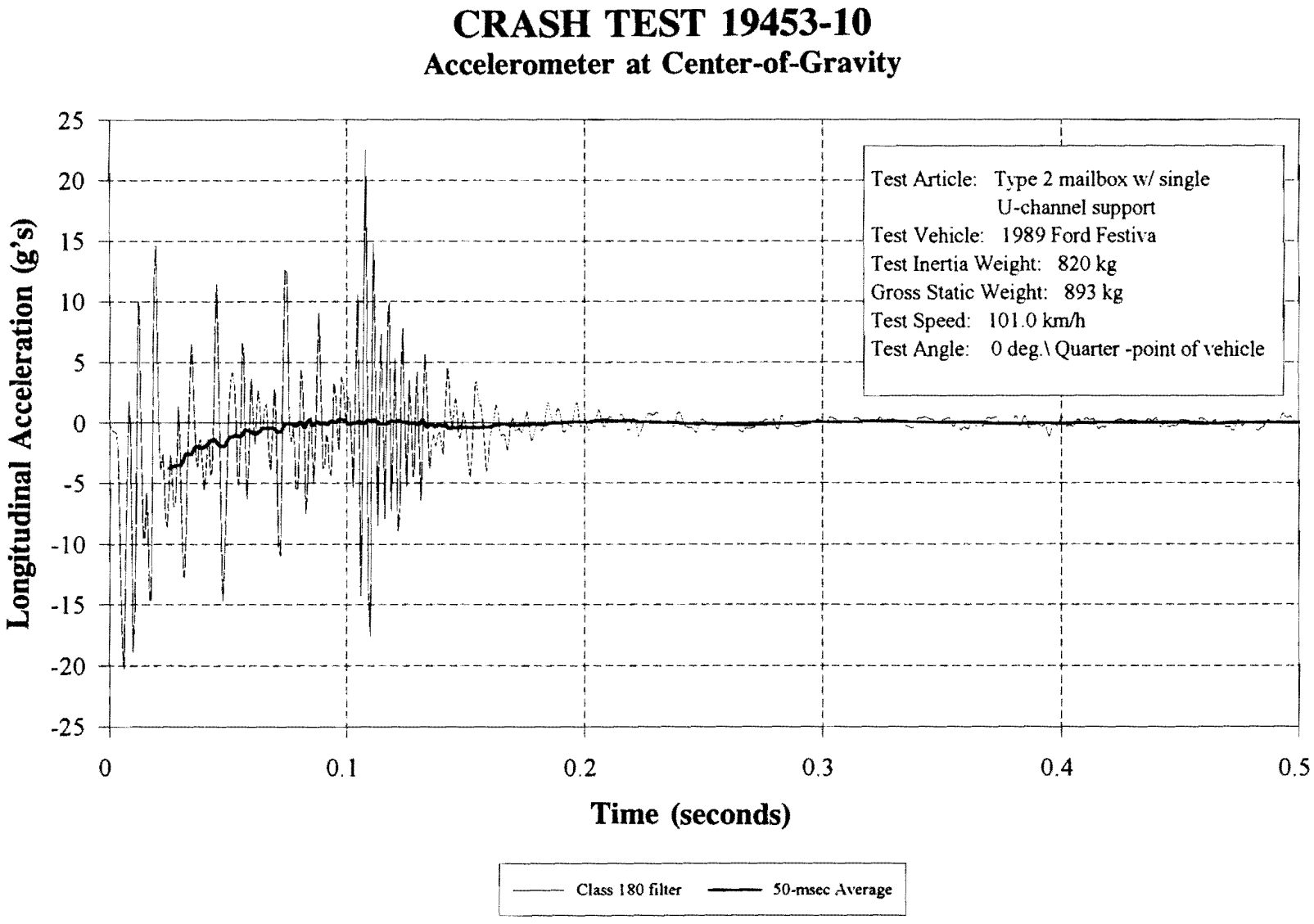


Figure L-11. Longitudinal accelerometer trace for test 19453-10.

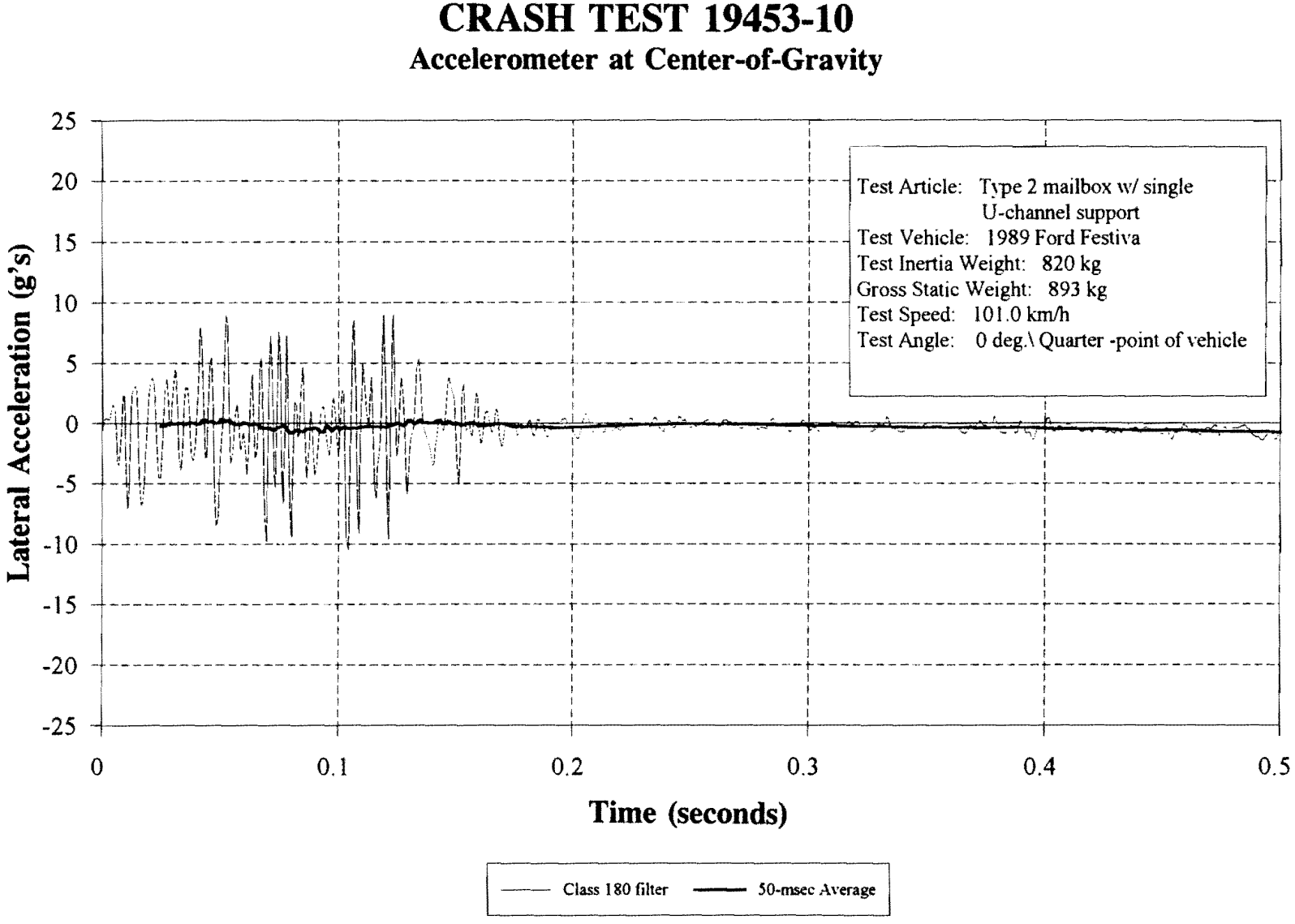


Figure L-12. Lateral accelerometer trace for test 19453-10.

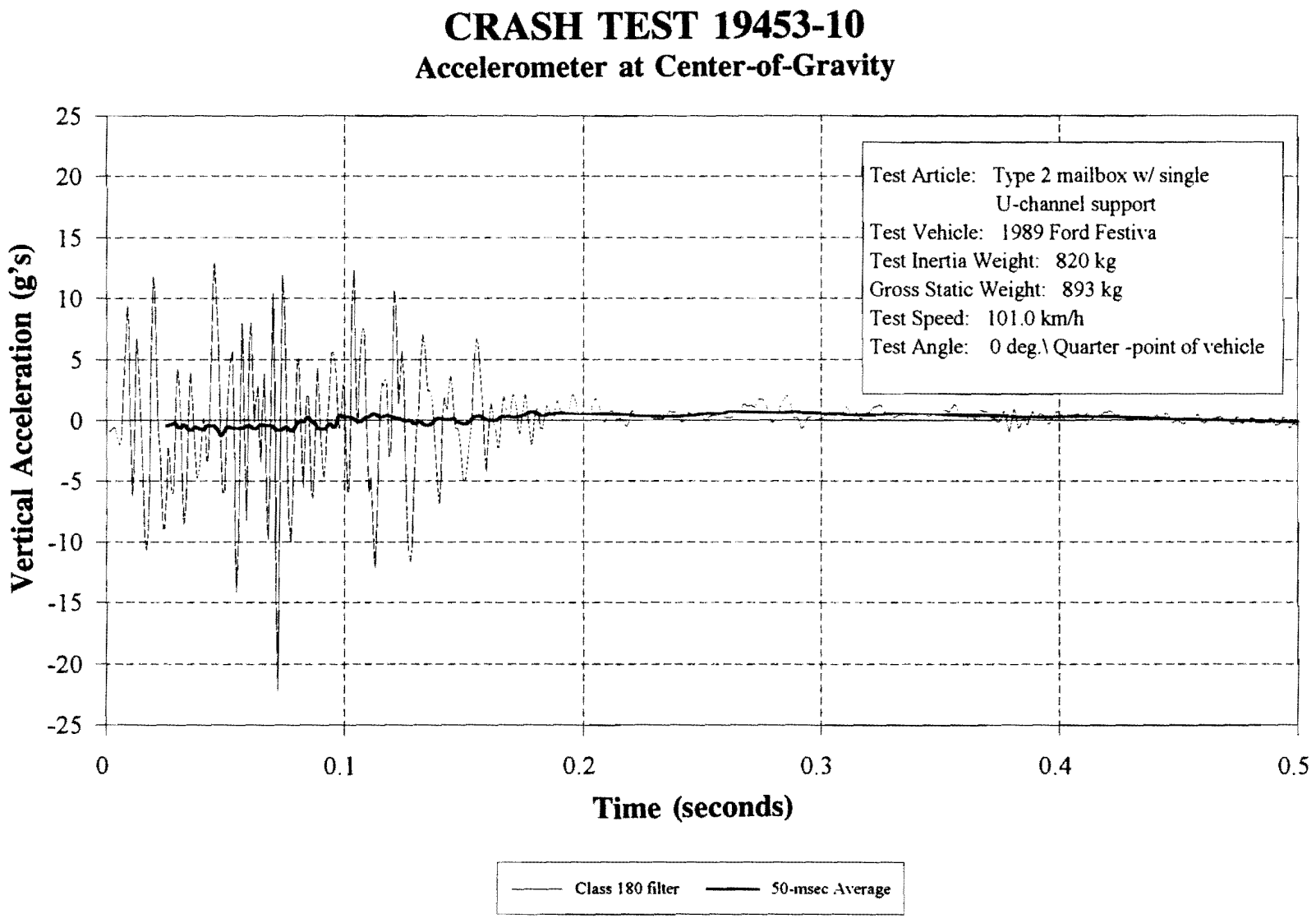


Figure L-13. Vertical accelerometer trace for test 19453-10.

APPENDIX M

TEST 19453-11 REPORT

Test 19453-11

The test article consisted of a special size no. 1½ vandal-proof mailbox mounted on a single 2 lb/ft (3 kg/m) steel winged channel post. The box was fabricated from 1/4-in. (0.64 cm) steel plate and weighed approximately 55 lb (25.0 kg). The mailbox was attached to the bracket and one bracket extension with six 1/4-in. (0.64 cm) stove bolts. Appendix B gives complete details of the installation. Figures M-1 and M-2 show photos of the test article. Figure M-3 shows the 1989 Ford Festiva test vehicle. Figure M-4 shows the position of the vehicle with respect to the test article at impact. Impact speed was 59.7 mph (96.1 km/h). Impact point was the front left quarter point of the vehicle's bumper. Test inertia mass of the vehicle was 1,808 lb (820 kg) and its gross static mass was 1,969 lb (893 kg). Other vehicular dimensions and information are given in Figure M-5.

The vehicle was free wheeling and unrestrained just prior to impact. Upon impact, the support began to yield and pocket around the front of the vehicle. By 0.037 second, the mailbox support had pulled from the ground. At 0.047 second, the mailbox struck the windshield and penetrated into the occupant compartment. The installation was rotating in a manner such that shortly after the mailbox penetrated the occupant compartment, the support struck the top of the windshield channel/roof intersection and detached from the mailbox. The mailbox struck the dummy driver shortly thereafter at approximately 0.114 second. The mailbox made many contact points with the interior of the vehicle prior to coming to rest directly behind the driver's seat. The vehicle lost contact with the installation, the brakes were applied at 1.6 second, and the vehicle came to rest 287.5 ft (87.7 m) from the point of impact. Figure M-6 shows sequential photographs of the test.

Figure M-7 shows test article damage. Note that the mailbox itself was essentially undamaged. Remnants of the support came to rest 57 ft (17.4 m) from the impact point. The vehicle sustained damage to the bumper, hood, A-pillar, windshield, and steering wheel as shown in Figures M-8 and M-9.

A summary of test results and other pertinent information are given in Figure M-10. The maximum 0.010 second average acceleration experienced by the vehicle was 1.0 g in the longitudinal direction and 1.4 g in the lateral direction. In the longitudinal direction, the occupant contact velocity was 3.9 ft/s (1.2 m/s) and 5.4 ft/s (1.6 m/s) in the lateral direction. Angular vehicular displacements are plotted in Figure M-11 and vehicular accelerations are

plotted in Figures M-12 through ML-14. Change in the vehicle's velocity was 3.2 mph (5.2 km/h).

Results of this test were unacceptable. Use of this box on high-speed roadways clearly should not be permitted. Its use on low-speed roadways is not recommended unless it can be demonstrated to be acceptable through crash testing.

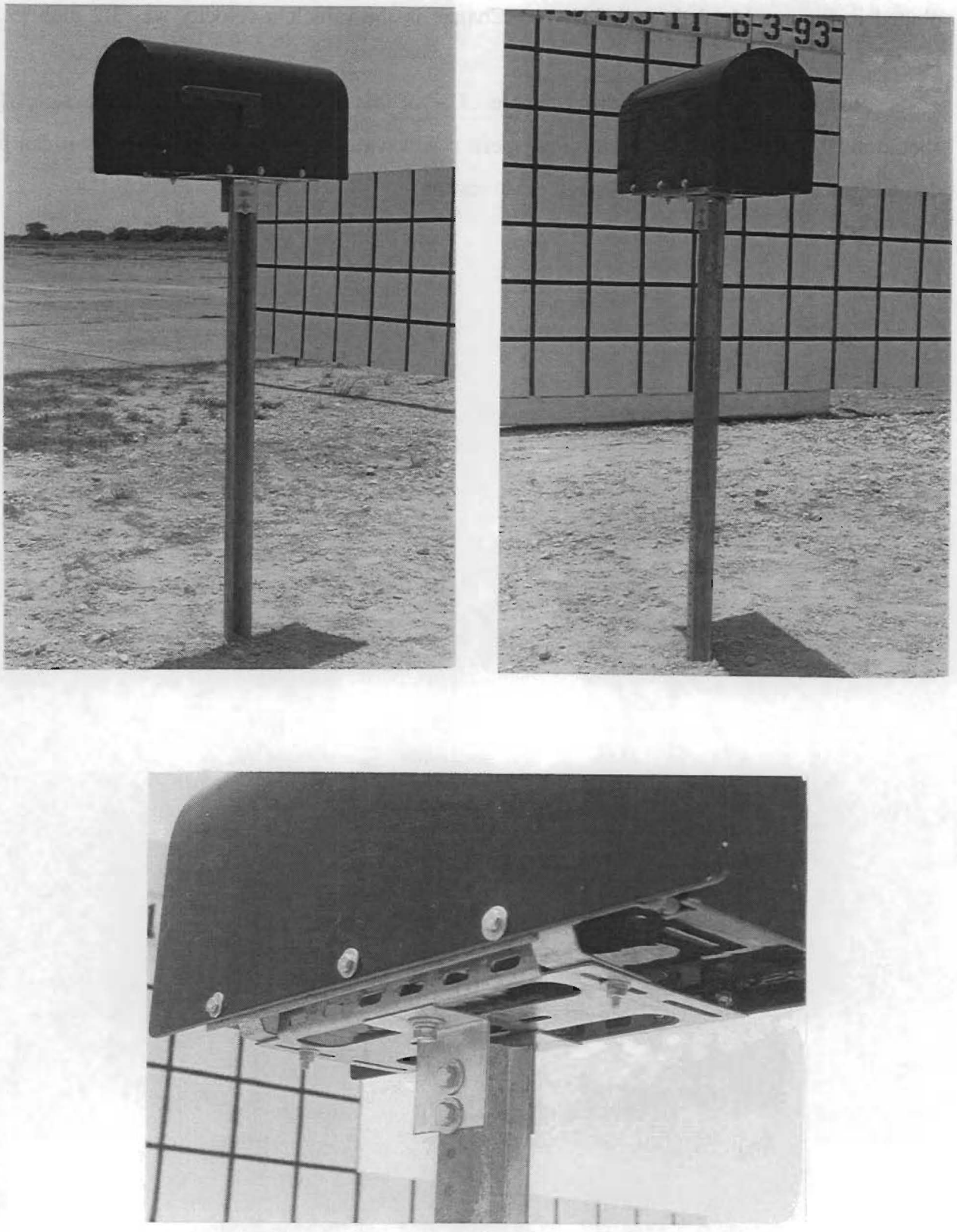
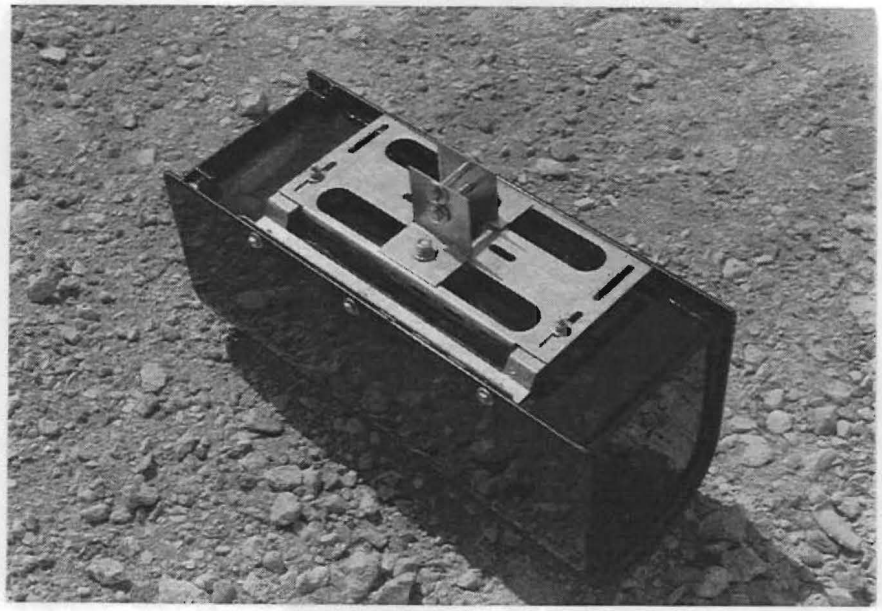


Figure M-1. 55 pound, steel mailbox installation for test 19453-11.



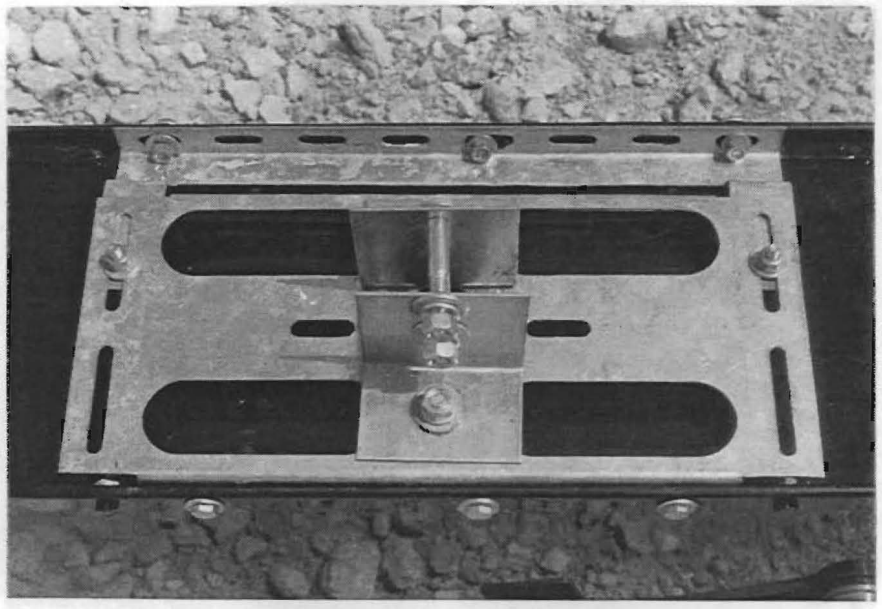


Figure M-2. Details of mounting hardware for test 19453-11.

Figure M-3. Vehicle before test 19453-11.

Figure M-4. Vehicle/mailbox geometrics for test 19453-11.

DATE: 12-12-92 TEST NO.: 19453-11 VIN NO.KNJRT06K4K6144608 MAKE: Ford

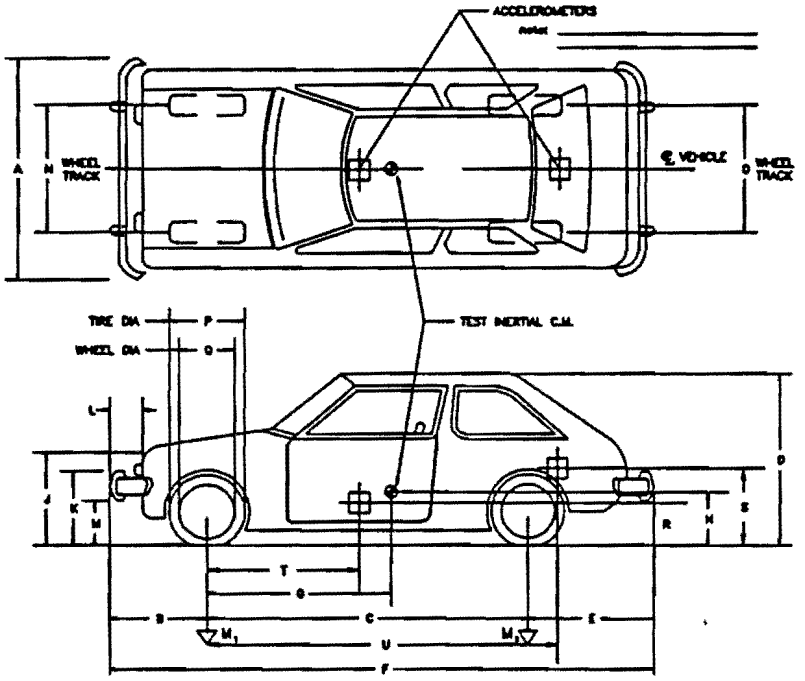
MODEL: Festiva YEAR: 1989 ODOMETER: 60085 TIRE SIZE: 155R12

TIRE INFLATION PRESSURE:

MASS DISTRIBUTION (kg) LF 259 RF 266 LR 147 RR 148

DESCRIBE ANY DAMAGE TO VEHICLE PRIOR TO TEST:

dents in roof (marked)



ENGINE TYPE: 4cyl gas

ENGINE CID: 1.3 L (80.8)

TRANSMISSION TYPE:

— AUTO

X MANUAL

OPTIONAL EQUIPMENT:

DUMMY DATA:

TYPE:

MASS:

SEAT POSITION:

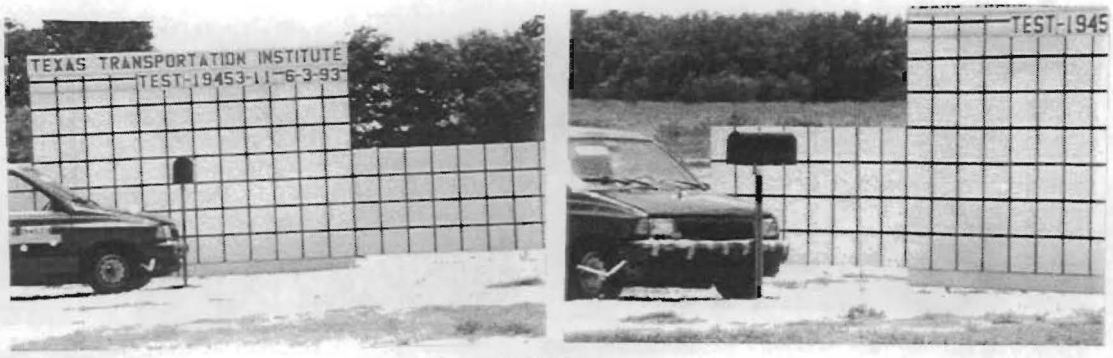
GEOMETRY – (mm)

A	1570	E	540	J	720	N	1390	R	395
B	690	F	3825	K	535	O	1390	S	645
C	2295	G	826	L	130	P	550	T	884
D	1450	H		M	380	Q	330	U	2460

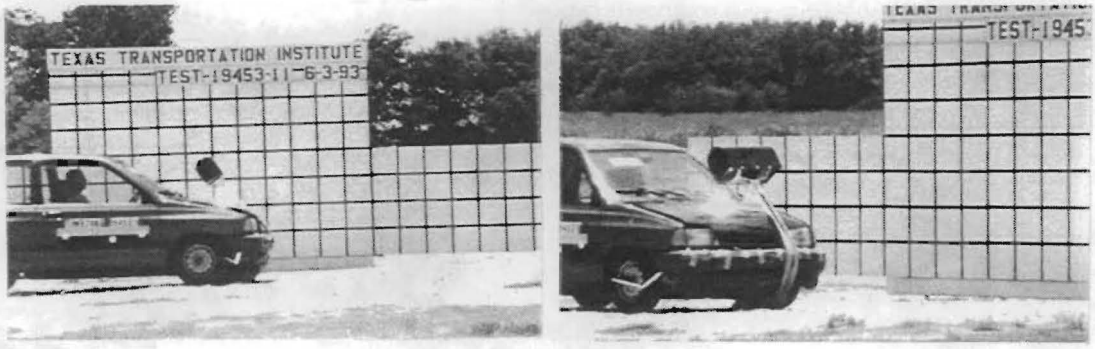
MASS – (kg)	CURB	TEST INERTIAL	GROSS STATIC
M_1	512	525	563
M_2	271	295	330
M_T	783	820	893

1 mm = 0.039 in
1 kg = 2.202 lb

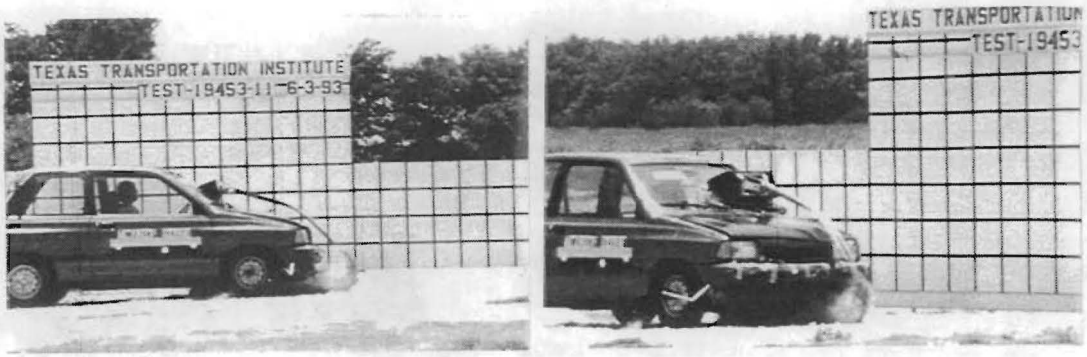
Figure M-5. Vehicle properties for test 19453-11.



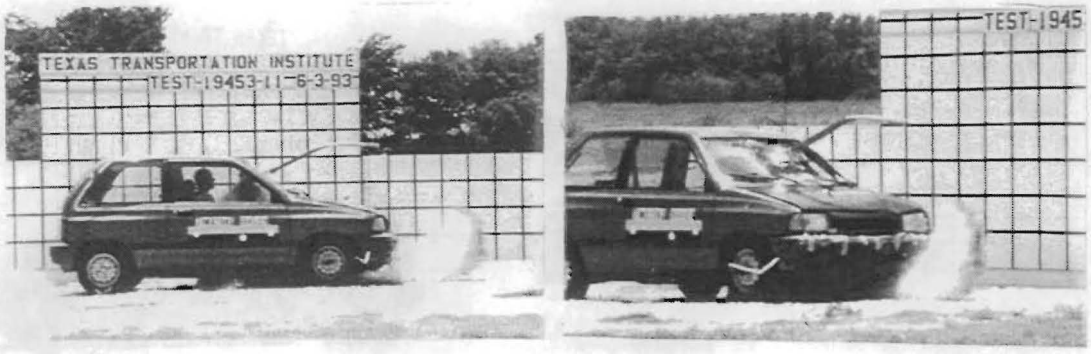
0.000 s



0.027 s



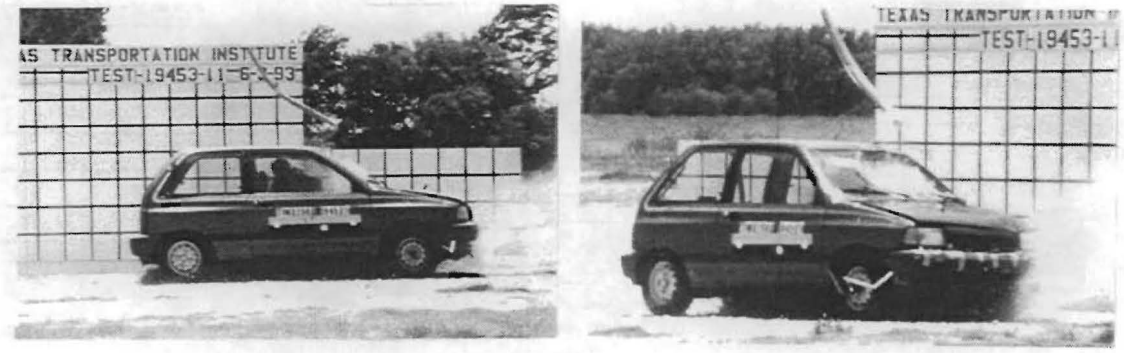
0.055 s



0.082 s

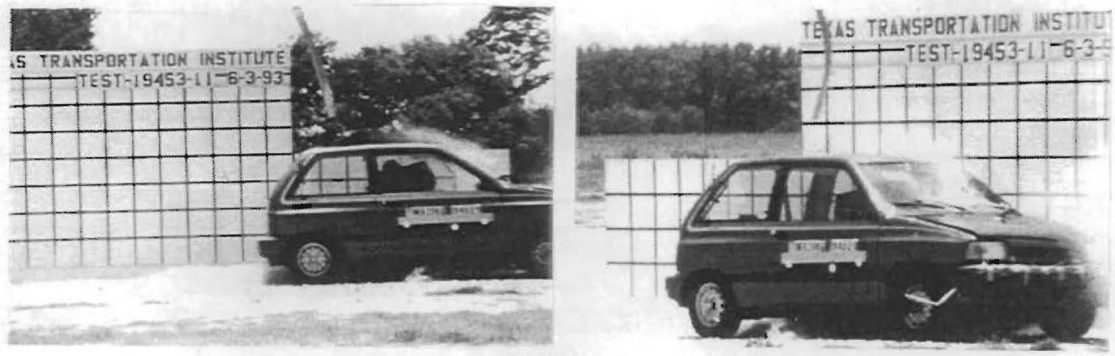
Figure M-6. Sequential photographs for test 19453-11. (perpendicular and side views).

0.109 s



0.136 s

0.164 s



0.191 s

Figure M-6. Sequential photographs for test 19453-11 (perpendicular and side views) continued.

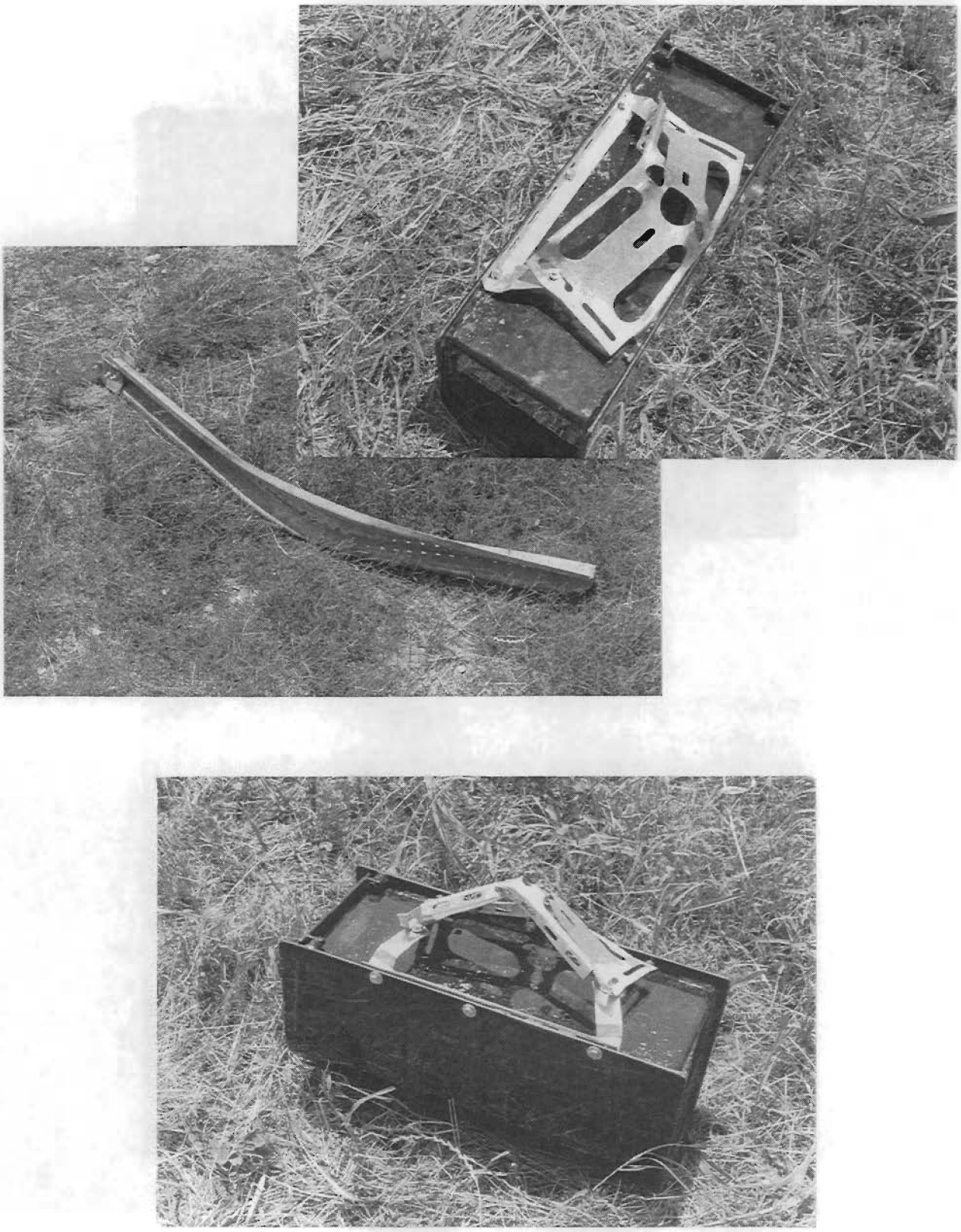


Figure M-7. Mailbox installation after test 19453-11.

Figure M-8. Vehicle after test 19453-11.

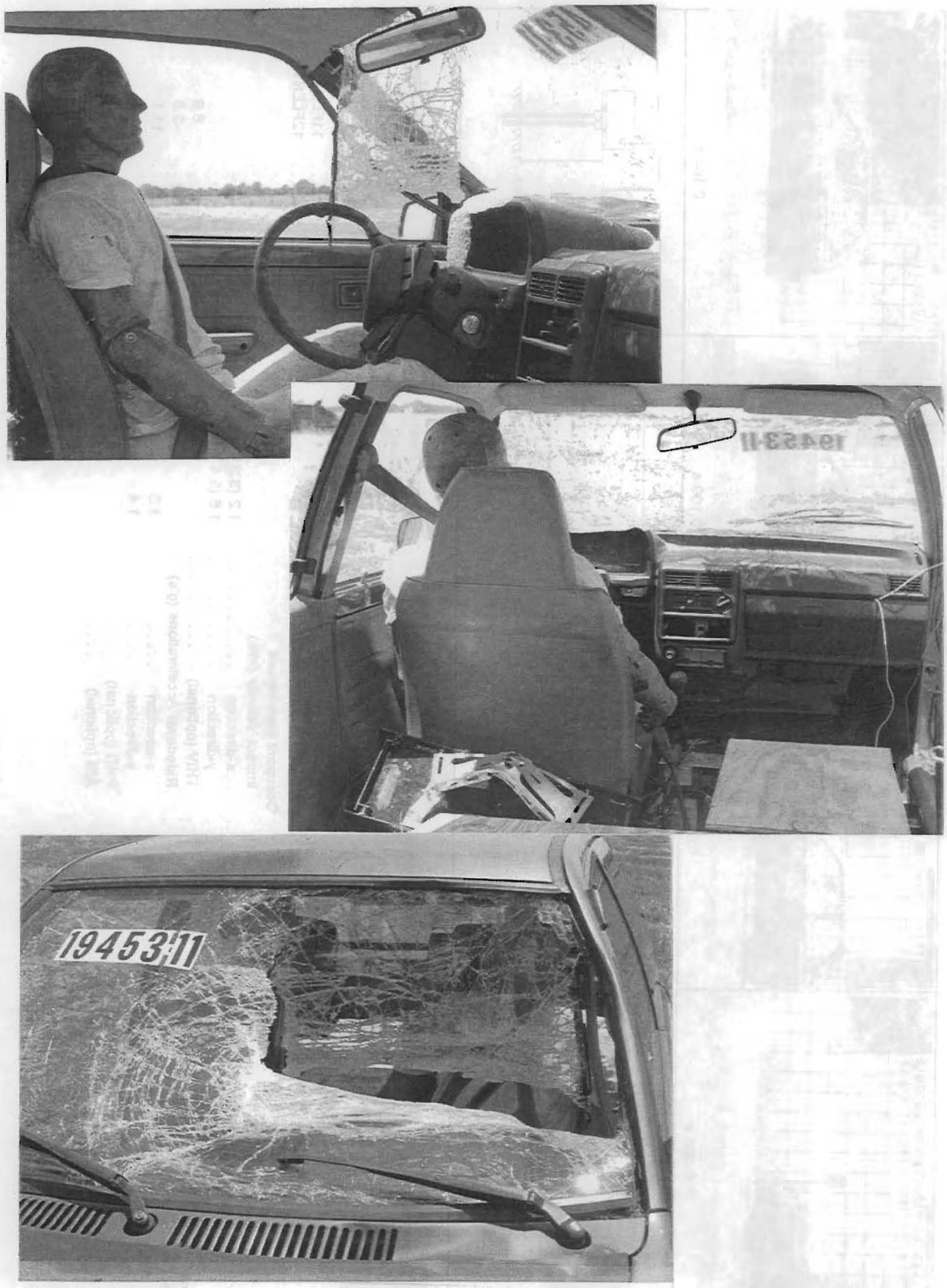
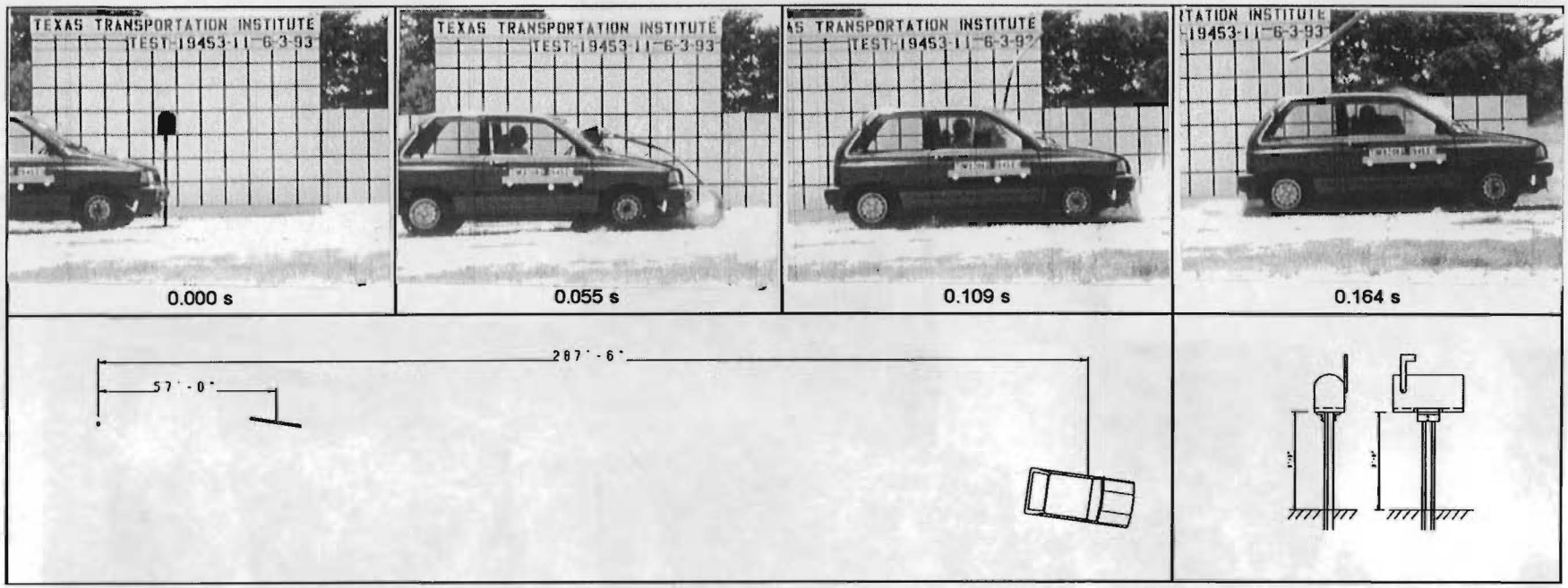


Figure M-9. Details of occupant compartment intrusion after test 19543-11.



General Information		**Impact Conditions**		**Test Article Deflections (m)**	
Test Agency	Texas Transportation Institute	Speed (km/h)	96.1(59.7 mi/h)	Dynamic	{Sign support
Test No.	19453-11	Angle (deg)	0 (15" offset)	Permanent	pulled}
Date	06/03/93				
Test Article		**Exit Conditions**		**Vehicle Damage**	
Type	24.9 kg (55 lb) steel mailbox	Speed (km/h)	90.9 (56.5 mi/h)	Exterior	
	mounted on a steel U-channel	Angle (deg)	N.A.	VDS	11FL-1
Height to bottom of mailbox (cm)	106.7 (42.0 in)			CDC	12FLEN1
Size and/or dimension and material of key elements	2-lb/ft U-channel support	**Occupant Risk Values**		Interior	
Soil Type and Condition	Strong soil	Impact Velocity (m/s)		OCDI	
Test Vehicle		x-direction	1.2 (3.9 ft/s)		
Type	1989 Ford	y-direction	1.6 (5.4 ft/s)	**Post-Impact Behavior**	
Designation	820C	THIV (optional)		Max. Roll Angle (deg)	6.6
Model	Festiva	Ridedown Accelerations (g's)		Max. Pitch Angle (deg)	-2.8
Mass (kg) Curb	783 (1,726 lb)	x-direction	1.0	Max. Yaw Angle (deg)	-11.1
Test Inertial	820 (1,808 lb)	y-direction	1.4		
Dummy	73 (161 lb)	PHD (optional)			
Gross Static	893 (1,969 lb)	ASI (optional)			

Figure M-10. Summary of results for test 19453-11.

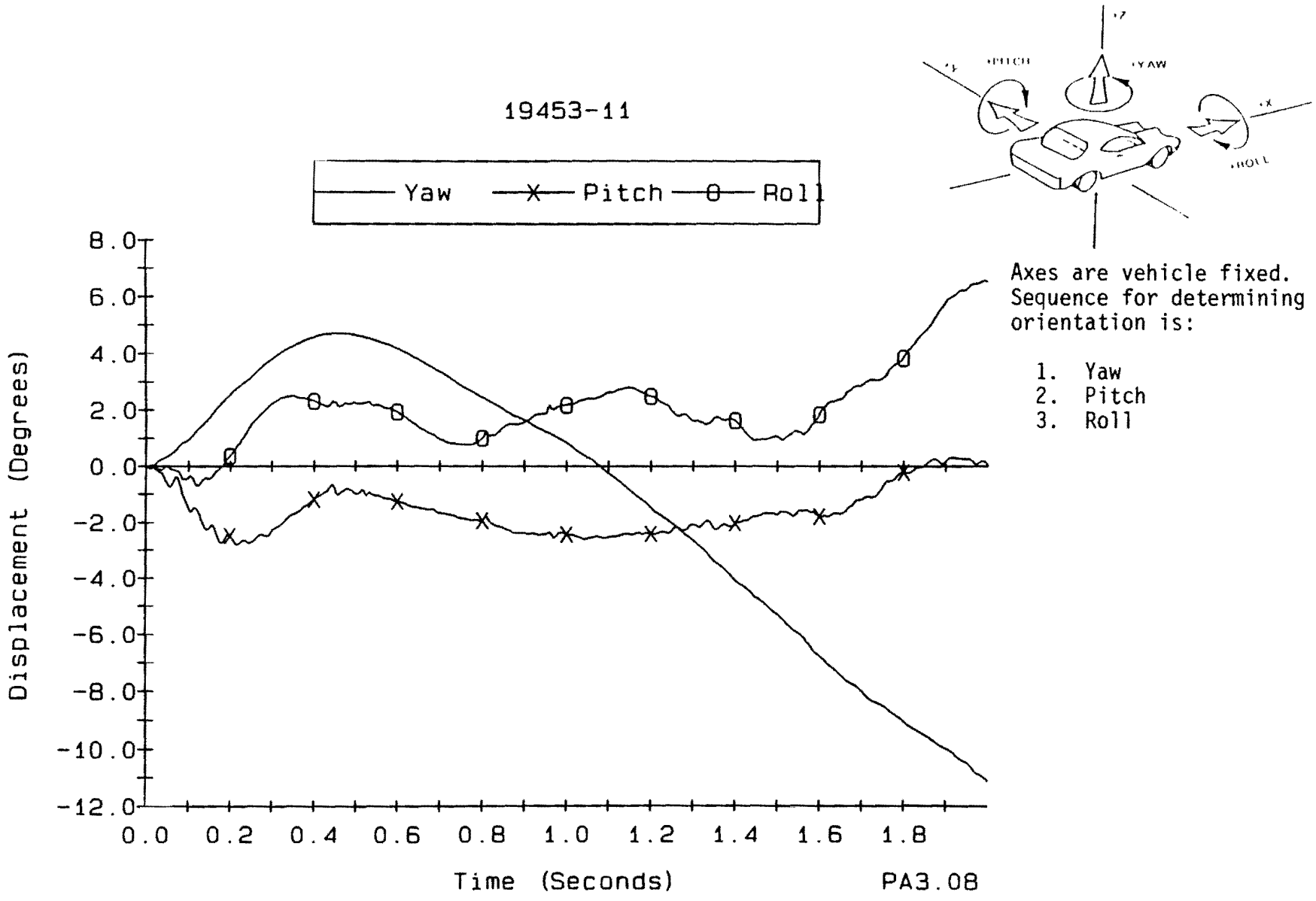


Figure M-11. Vehicle angular displacements for test 19453-11.

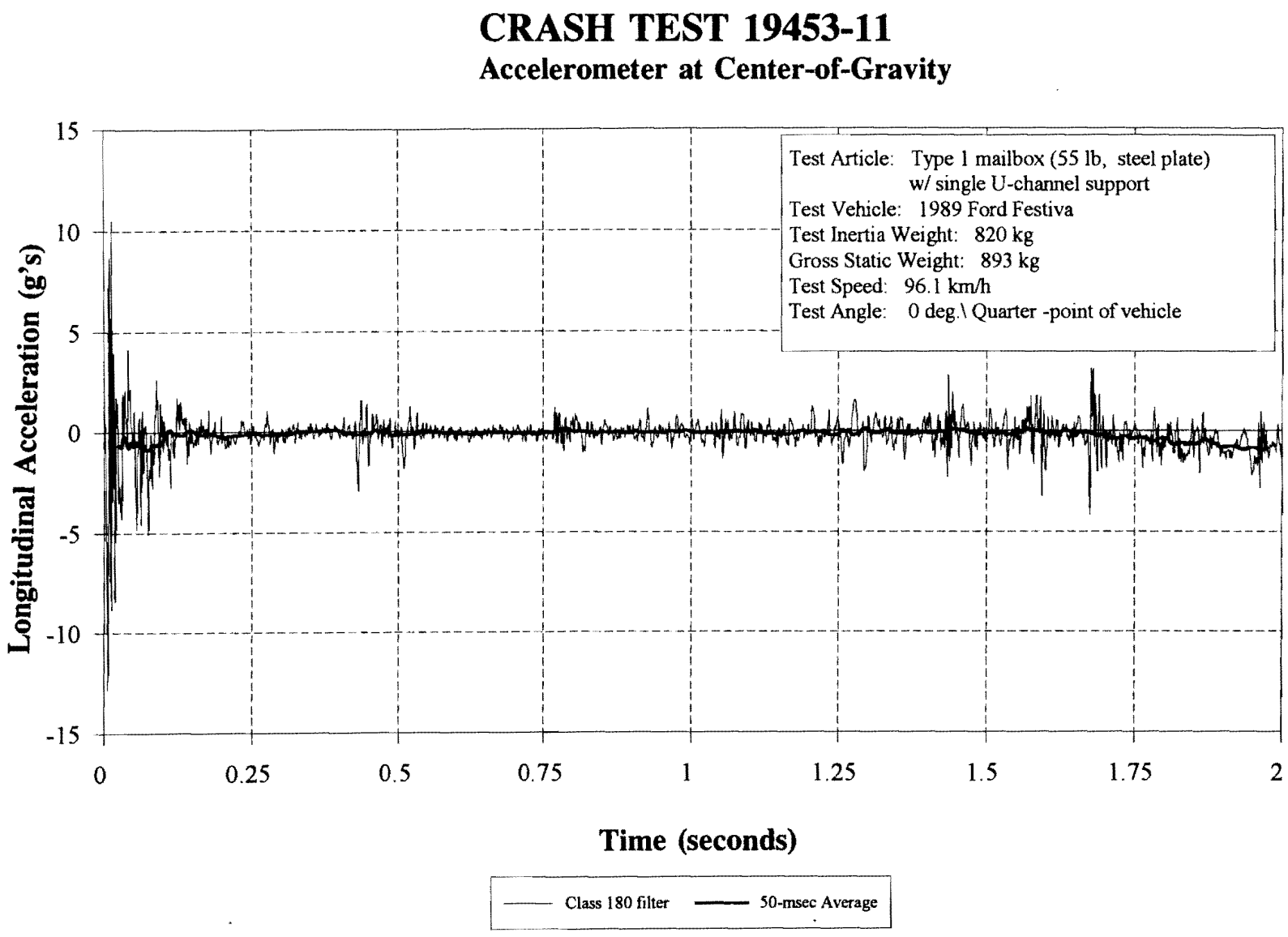


Figure M-12. Longitudinal accelerometer trace for test 19453-11.

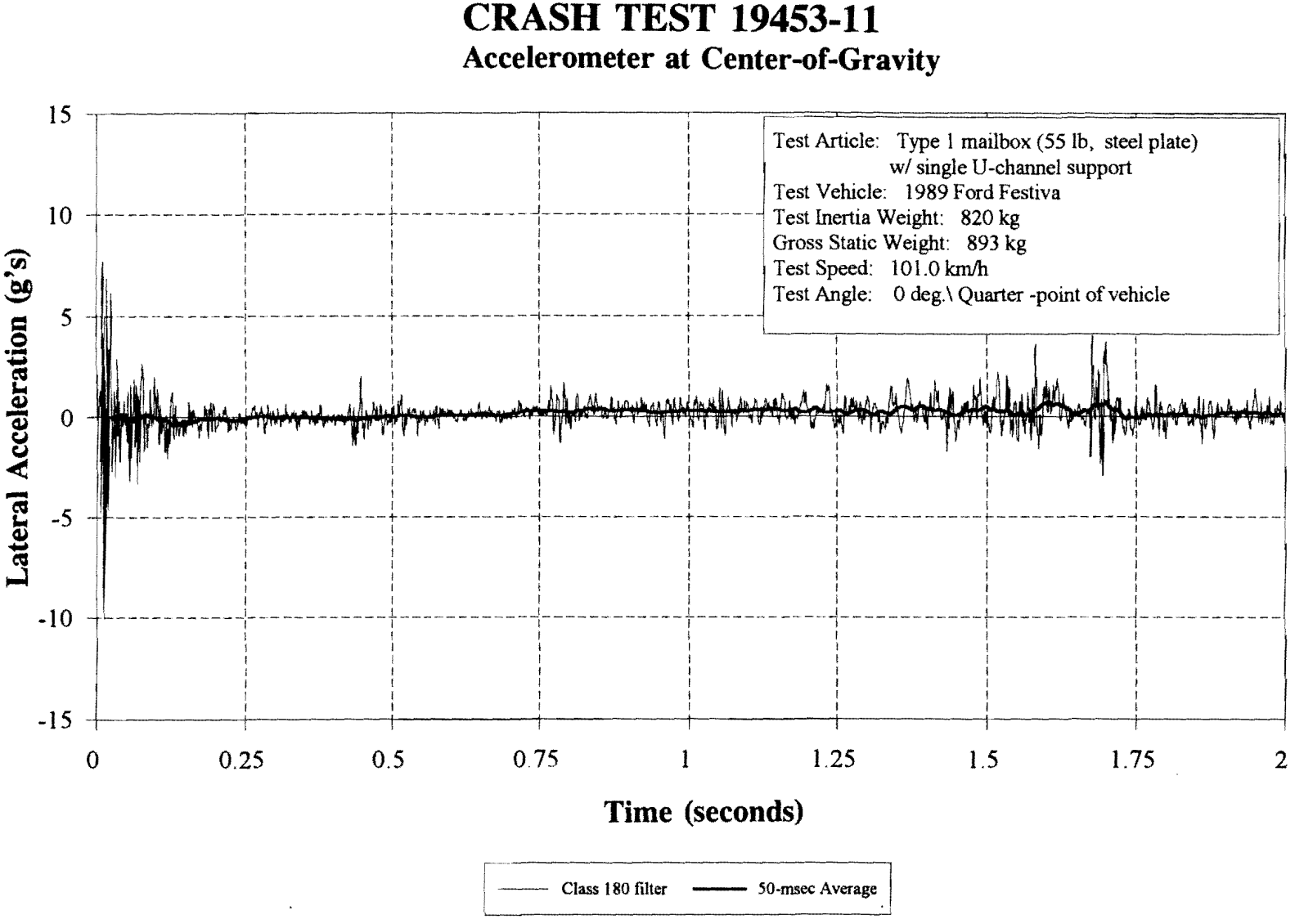


Figure M-13. Lateral accelerometer trace for test 19453-11.

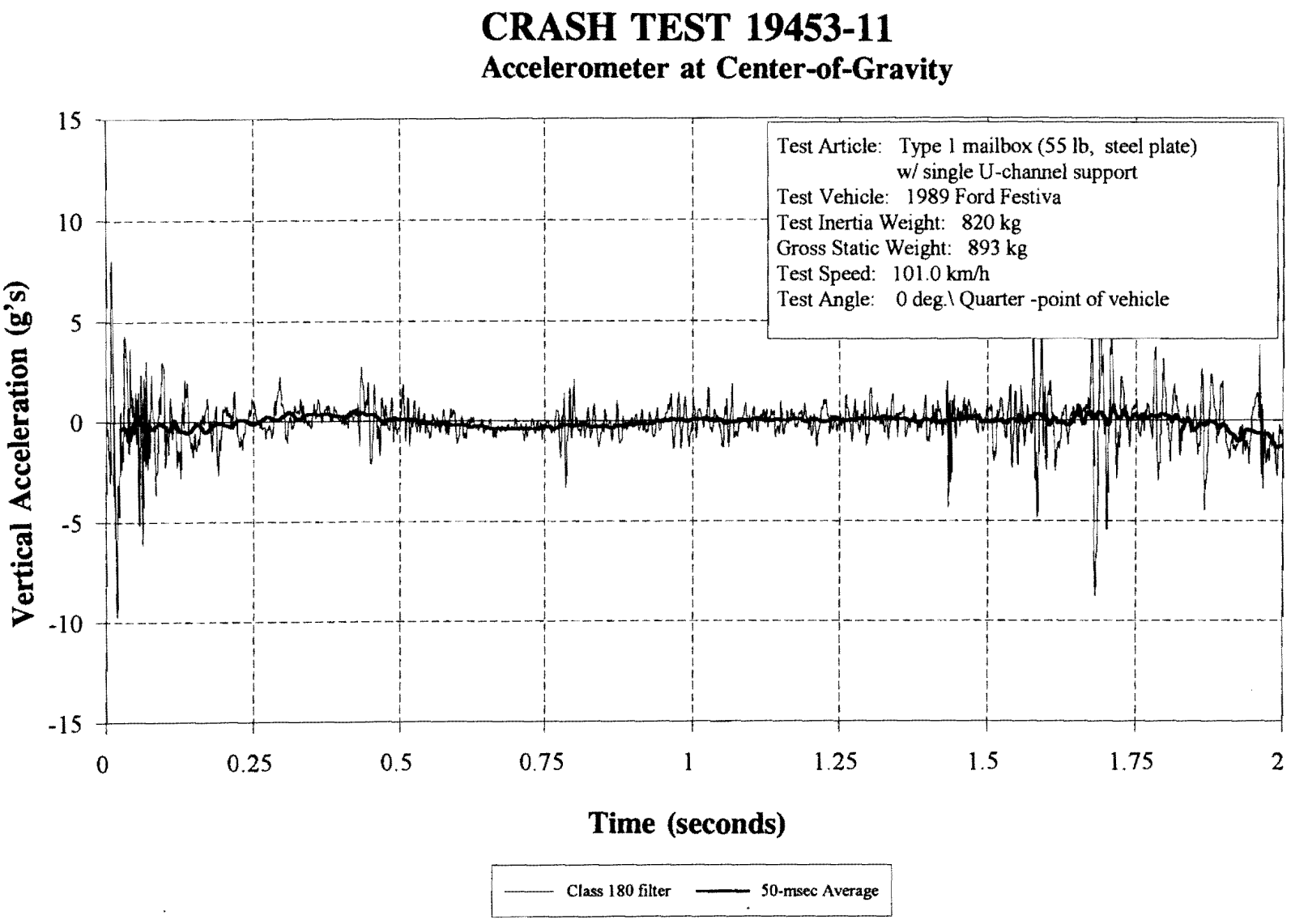


Figure M-14. Vertical accelerometer trace for test 19453-11.

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