



U.S. Department  
of Transportation  
**Federal Highway  
Administration**

July 24, 2023

1200 New Jersey Ave., SE  
Washington, D.C. 20590

In Reply Refer To:  
HSST-1/B-372

Nina Ertel  
Pennsylvania Department of Transportation  
400 North St., 7<sup>th</sup> Floor  
Harrisburg, Pennsylvania 17120  
USA

Dear Ms. Ertel:

We received your correspondence of November 10, 2021 requesting issuance of a reimbursement eligibility letter under the Federal-aid highway program for the roadside safety system, device, design, product, or hardware (collectively “device”) described below. This letter is assigned Federal Highway Administration (FHWA) control number B-372.

#### **ELIGIBILITY LETTERS**

The FHWA issues Federal-aid reimbursement eligibility letters for new roadside safety devices that are crash tested in accordance with the industry standard of the American Association of State Highway and Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH).

FHWA, the Department of Transportation, and the United States (government) do not regulate roadside safety devices, crash test facilities, or the manufacturing industry. Issuance of eligibility letters is discretionary and provided only as a service to the states. FHWA may, at its discretion, decline to issue, revise, or rescind an eligibility letter. Eligibility letters are only issued by the FHWA headquarters Office of Safety.

Eligibility letters are issued only as notice to the states that a device is eligible for reimbursement under the Federal-aid highway program. They do not establish approval or certification for any other purpose. Issuance of an eligibility letter is not a prerequisite or requirement for state transportation agencies seeking to use Federal-aid funds for roadside safety devices. State agencies may use a device for which an eligibility letter has not been issued and seek Federal-aid reimbursement.

#### **FEDERAL-AID REIMBURSEMENT**

The request for issuance of this letter certified the device was crash tested in accordance with the industry standard of AASHTO’s MASH. This eligibility letter is based on that certification and the material offered in support of its issuance. The device described below is eligible for reimbursement under the Federal-aid highway program.

Name of system: PennDOT 50-inch Tall Precast F-shape Concrete Barrier Keyed in 4-inches of Asphalt  
Type of system: Longitudinal Barrier  
Test Level: Test Level 4  
Testing conducted by: Texas A&M Transportation Institute  
Date of request: November 10, 2021

Information about the device, including material such as the eligibility request, crash test reports, drawings, or images are included in one or more attachment(s) to this letter.

In accordance with FHWA's Memo "Federal-aid Reimbursement Eligibility Process for Safety Hardware Devices" dated November 12, 2015, FHWA will make note of any reported damage to a test vehicle's fuel tank, oil pan, or other feature that might serve as a surrogate of the fuel tank. AASHTO's MASH states "Although not a specific factor in assessing test results, integrity of a test vehicle's fuel tank is a potential concern. It is preferable that the fuel tank remains intact and not be punctured. Damage or rupture of the fuel tank, oil pan, or other feature that might serve as a surrogate of the fuel tank should be reported". A test report included in the submittal documents states that there was damage to the right fuel tank in Test 4-12.

Eligibility letter B-372 is inapplicable to devices, optional equipment, alternate materials, or other features that were not crash tested in accordance with AASHTO's MASH.

This letter is issued only for the subject device as crash tested under AASHTO's MASH. Later modification(s) of the device are not eligible for Federal-aid reimbursement under this letter. Notice of later modification(s) should be given to transportation agencies, facility owners, and operators (collectively "agencies").

Agencies should be provided appropriate information about the device's design, installation, maintenance, materials, and mechanical properties.

Issuance of this letter is discretionary, and it may be revised or rescinded at FHWA's discretion. This letter is not a determination of compliance with the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) or ownership of any intellectual property rights.

This eligibility letter is not a determination by the government that a crash involving the subject device will result in any particular outcome. It is limited to only the device's eligibility for Federal-aid reimbursement.

### **INTELLECTUAL PROPERTY**

Issuance of this eligibility letter does not convey property rights of any sort nor any exclusive privilege. This letter is not authorization or consent by the government for the use, manufacture, or sale of any patented or proprietary system, device, design, product, or hardware for which the requester is not the patent owner. Eligibility letters are not an expression of any view, position, or determination by the government as to the validity, scope, or ownership of any intellectual property rights to a specific device. These letters do not grant, impute, suggest, or otherwise

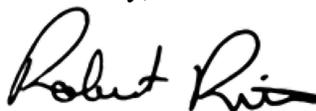
establish any ownership, distribution, or licensing rights to the requester. The government expresses no opinion about the intellectual property rights relating to any device for which this or any other eligibility letter is issued.

**PUBLIC DISCLOSURE**

To prevent any misunderstanding, and as discussed above, this eligibility letter is assigned FHWA control number B-372. It should only be reproduced in full with its attachment(s). This letter and the material offered by the requester supporting its issuance is public information. All eligibility letters and supporting material are subject to public disclosure under the Freedom of Information Act (FOIA). Eligibility letters are available to the public at [https://safety.fhwa.dot.gov/roadway\\_dept/countermeasures/reduce\\_crash\\_severity/](https://safety.fhwa.dot.gov/roadway_dept/countermeasures/reduce_crash_severity/).

If you have any questions please contact Aimee Zhang at [Aimee.Zhang@dot.gov](mailto:Aimee.Zhang@dot.gov).

Sincerely,

A handwritten signature in black ink that reads "Robert Ritter". The signature is written in a cursive style with a large, prominent initial "R".

Robert Ritter  
Director, Office of Safety Technologies  
Office of Safety

Enclosures

## Request for Federal Aid Reimbursement Eligibility of Highway Safety Hardware

|                  |  |  |   |
|------------------|--|--|---|
| <b>Submitter</b> | Date of Request:   | November 10, 2021  | <input checked="" type="radio"/> New <input type="radio"/> Resubmission |
|                  | Name:  | Nina Ertel, P.E.   | {{March 6, 2023 Rev #2 to Orig'l Request }}                             |
|                  | Company:   | Pennsylvania Department of Transportation                |   |
|                  | Address:   | 400 North St., 7th Floor, Harrisburg, Pennsylvania 17120 |   |
|                  | Country:   | USA  |   |
| To:              | Michael S. Griffith, Director<br>FHWA, Office of Safety Technologies |  |   |

I request the following devices be considered eligible for reimbursement under the Federal-aid highway program.

**Device & Testing Criterion** - Enter from right to left starting with Test Level

!-!-!

| System Type  | Submission Type   | Device Name / Variant  | Testing Criterion | Test Level |
|--|---|--|-------------------|------------|
| 'B': Rigid/Semi-Rigid Barriers (Roadside, Median, Bridge Railings) | <input checked="" type="radio"/> Physical Crash Testing<br><input type="radio"/> Engineering Analysis | PennDOT 50-inch Tall Precast F-shape Concrete Barrier Keyed in 4-inches of Asphalt | AASHTO MASH       | TL4        |

By submitting this request for review and evaluation by the Federal Highway Administration, I certify that the product(s) was (were) tested in conformity with the AASHTO Manual for Assessing Safety Hardware and that the evaluation results meet the appropriate evaluation criteria in the MASH.

**Individual or Organization responsible for the product:**

|               |  |  |
|---------------|--|--|
| Contact Name: | Nina Ertel, P.E.   | Same as Submitter <input type="checkbox"/> |
| Company Name: | Pennsylvania Department of Transportation                | Same as Submitter <input type="checkbox"/> |
| Address:      | 400 North St., 7th Floor, Harrisburg, Pennsylvania 17120 | Same as Submitter <input type="checkbox"/> |
| Country:      | USA  | Same as Submitter <input type="checkbox"/> |

Enter below all disclosures of financial interests as required by the FHWA 'Federal-Aid Reimbursement Eligibility Process for Safety Hardware Devices' document.

Texas A&M Transportation Institute (TTI) was contracted by Gannett Fleming, Inc. to perform full-scale crash testing of the PennDOT 50-inch Tall Precast F-shape Concrete Barrier Keyed in Asphalt. There are no shared financial interests in the PennDOT 50-inch Tall Precast F-shape Concrete Barrier Keyed in Asphalt by TTI, or between PennDOT and TTI, or between Gannett Fleming, Inc. and TTI other than the costs involved in the actual crash tests and reports for this submission to FHWA.

TTI 611851 -1-2-3 &-4

## PRODUCT DESCRIPTION

New Hardware or Significant Modification       Modification to Existing Hardware

The test installation was comprised of 8 precast, steel reinforced concrete barrier segments keyed in 4-inches of asphalt. Each barrier segment was 12 ft long, and adjacent barrier segments were connected to each other with drop-in pins through loops that were cast into the barriers. There was an approximately 2 inch space between the barriers, for a total length of approximately 97 ft-2 inches. Each barrier was 54 inches tall, 5 inches wide at top, and 24 inches wide at bottom. A 4-inch thick layer of asphalt, 9 ft wide, was placed on the traffic and field sides of the barriers, resulting in a 50-inch height from grade to the top of the barriers.

### CRASH TESTING

By signature below, the Engineer affiliated with the testing laboratory, agrees in support of this submission that all of the critical and relevant crash tests for this device listed above were conducted to meet the MASH test criteria. The Engineer has determined that no other crash tests are necessary to determine the device meets the MASH criteria.

|                     |   |  |
|---------------------|---|--|
| Engineer Name:      | D. Lance Bullard, Jr. P.E.  |  |
| Engineer Signature: | <b>D. Lance Bullard, Jr.</b> Digitally signed by D. Lance Bullard, Jr.<br>Date: 2021.11.18 08:53:03 -06'00' |  |
| Address:            | 1254 Avenue A, Bldg. 7091, Bryan, Texas 77807   | Same as Submitter <input type="checkbox"/> |
| Country:            | USA   | Same as Submitter <input type="checkbox"/> |

A brief description of each crash test and its result:

| Required Test Number | Narrative Description   | Evaluation Results |
|----------------------|---|--------------------|
| 4-10 (1100C)         | <p>====This 4-10 Test in 4-inches of Asphalt====</p> <p>Test 4-10 involves an 1100C vehicle impacting the test article at a target impact speed of 62 mi/h and target angle of 25°. The target CIP for the right corner of the front bumper was 3.6 ft upstream of the centerline of the joint between segs 4 and 5. The results of the re-test conducted on November 13, 2020, are found in TTI Test Report No. 611851-4. The test vehicle was traveling at a speed of 61.7 mi/h as it contacted the PennDOT 50-inch Tall Precast F-shape Concrete Barrier Keyed in 4 inches of Asphalt 3.5 ft upstream of the centerline of the joint between barriers 4 and 5 and at an impact angle of 25.2°. After loss of contact with the barrier, the vehicle came to rest 194 ft downstream of the impact point and 23 ft toward the field side. PennDOT 50-inch Tall Precast F-shape Concrete Barrier Keyed in 4 inches of Asphalt contained and redirected the 1100C vehicle. The vehicle did not penetrate, underride, or override the installation. The vehicle exited within the exit box criteria defined in MASH.</p> <p>Maximum dynamic deflection of the barrier during the test was 1.6 inches at the top of the barrier. No permanent deformation was observed. Working width was 24.0 inches. No detached elements, fragments, or other debris were present to penetrate, or to show potential for penetrating, the occupant compartment, or to present undue hazard for others in the area. The 1100C vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 7° and 10°, respectively.</p> <p>Longitudinal OIV was 20.3 ft/s and lateral OIV was 30.2 ft/s. Maximum longitudinal occupant ridedown acceleration was 3.1 g, and maximum lateral occupant ridedown acceleration was 7.8 g. Occupant risk factors were within the allowable limits specified in MASH.</p> <p>Maximum exterior crush to the vehicle was 9.0 inches in the side plane at the right front corner at bumper height. Maximum occupant compartment deformation was 2.5 inches in the right front kick panel laterally across the front of the inside of the vehicle.</p> <p>The PennDOT 50-inch Tall Precast F-shape Concrete Barrier Keyed in 4-inches of Asphalt performed acceptably for MASH Test 4-10.</p> | PASS               |

| Required Test Number | Narrative Description   | Evaluation Results |
|----------------------|---|--------------------|
| 4-11 (2270P)         | <p>====This 4-11 Test in 2-inches of Asphalt====</p> <p>Test 4-11 involves a 2270P vehicle impacting the test article at a target impact speed of 62 mi/h and target angle of 25°. The target CIP for the right corner of the front bumper was 4.3 ft upstream of the centerline of the joint between segment 9 and 10. The results of the test conducted on July 17, 2019, are found in TTI Test Report No. 611851-2. The test vehicle was traveling at a speed of 63.4 mi/h as it contacted the PennDOT 50-inch Tall Precast F-shape Concrete Barrier Keyed in 2 inches of Asphalt 4.2 ft upstream of the centerline of the joint between segments 9 and 10 and at an impact angle of 24.5°. After loss of contact with the barrier, the vehicle came to rest 187 ft downstream of the impact point and 7 ft toward the field side. The PennDOT 50-inch Tall Precast F-shape Concrete Barrier Keyed in 2 inches of Asphalt contained and redirected the 2270P vehicle. The vehicle did not penetrate, underride, or override the installation. The vehicle exited within the exit box criteria defined in MASH.</p> <p>Maximum dynamic deflection during the test was 13.2 inches at the top of the barrier. Maximum permanent deformation was 4.0 inches. Working width was 26.75 inches. Although some gouging of the concrete occurred on the barrier face, no detached elements, fragments, or other debris were present to penetrate, or to show potential for penetrating, the occupant compartment, or to present undue hazard for others in the area.</p> <p>The 2270P vehicle remained upright during and after the collision event. Maximum roll angle was 13° and max pitch was 16°. Longitudinal OIV was 19.4 ft/s and lateral OIV was 23.3 ft/s. Maximum longitudinal occupant ridedown acceleration was 6.4 g and maximum lateral occupant ridedown acceleration was 6.2 g. Occupant risk factors were within the preferred limits specified in MASH.</p> <p>Maximum exterior crush to the vehicle was 16.0 inches in the side plane at the right front corner at bumper height. Maximum occupant compartment deformation was 3.0 inch in the right side firewall area. The PennDOT 50-inch Tall Precast F-shape Concrete Barrier Keyed in 2-inches of Asphalt performed acceptably for MASH Test 4-11.</p> | PASS               |

|              |  |                                  |
|--------------|--|----------------------------------|
| 4-12 (1000S) | <p>====This 4-12 Test in 2-inches of Asphalt====</p> <p>Test 4-12 involves a 1000S vehicle impacting the test article at a target impact speed of 56 mi/h and target angle of 15°. The target CIP for the right corner of the front bumper was 5.0 ft upstream of centerline of the joint between segs 4 and 5. The results of the test conducted on July 15, 2019, are found in TTI Test Report No. 611851-3. The test vehicle was traveling at a speed of 56.6 mi/h as it contacted the PennDOT 50-inch Tall Precast F-shape Concrete Barrier Keyed in 2 inches of Asphalt 4.4 ft upstream of the centerline of the joint between segments 4 and 5 and at an impact angle of 14.8°. After loss of contact with the barrier, the vehicle came to rest 280 ft downstream of the impact point and 2 ft toward the traffic side. The PennDOT 50-inch Tall Precast F-shape Concrete Barrier Keyed in 2 inches of Asphalt contained and redirected the 1000S vehicle. The vehicle did not penetrate, underide, or override the installation. The vehicle exited within the exit box criteria defined in MASH. Maximum dynamic deflection during the test was 21.8 inches at the top of the barrier. Maximum permanent deformation was 6.75 inches. Working width was 69.3 inches. No detached elements, fragments, or other debris were present to penetrate or to show potential for penetrating the occupant compartment, or to present undue hazard for others in the area. The 1000S vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 36° and 10°, respectively. Longitudinal OIV was 5.6 ft/s, and lateral OIV was 13.1 ft/s. Maximum longitudinal occupant ridedown acceleration was 4.7 g, and maximum lateral occupant ridedown acceleration was 12.6 g. Maximum exterior crush to the vehicle was 14.0 inches in the side plane at the right front corner at bumper height. Maximum occupant compartment deformation was 4.0 inches in the right side firewall/floor pan area. The PennDOT 50-inch Tall Precast F-shape Concrete Barrier Keyed in 2-inches of Asphalt performed acceptably for MASH Test 4-12.</p> | PASS                             |
| 4-20 (1100C) | Test 4-20 for transition is not applicable for this median barrier system  | Non-Relevant Test, not conducted |

|               |   |                                  |
|---------------|---|----------------------------------|
| 4-21 (2270P)  | Test 4-21 for transition is not applicable for this median barrier system | Non-Relevant Test, not conducted |
| 4-22 (10000S) | Test 4-22 for transition is not applicable for this median barrier system | Non-Relevant Test, not conducted |

Full Scale Crash Testing was done in compliance with MASH by the following accredited crash test laboratory (cite the laboratory's accreditation status as noted in the crash test reports.):

|  |  |  |
|--|--|--|
| Laboratory Name:   | Texas AM Transportation Institute  |  |
| Laboratory Signature:  | Digitally signed by Darrell L. Kuhn<br>'Date: 2023.03.06 10:40:14 -06'00  |  |
| Address:   | 1254 Avenue A, Bldg. 7091, Bryan, Texas 77807  | Same as Submitter <input type="checkbox"/> |
| Country:   | USA  | Same as Submitter <input type="checkbox"/> |
| Accreditation Certificate Number and Dates of current Accreditation period : | ISO 17025-2017 Laboratory<br>A2LA Certificate Number: 2821.01<br>Valid To: April 30, 2023  |  |

Submitter Signature\*:

Submit Form

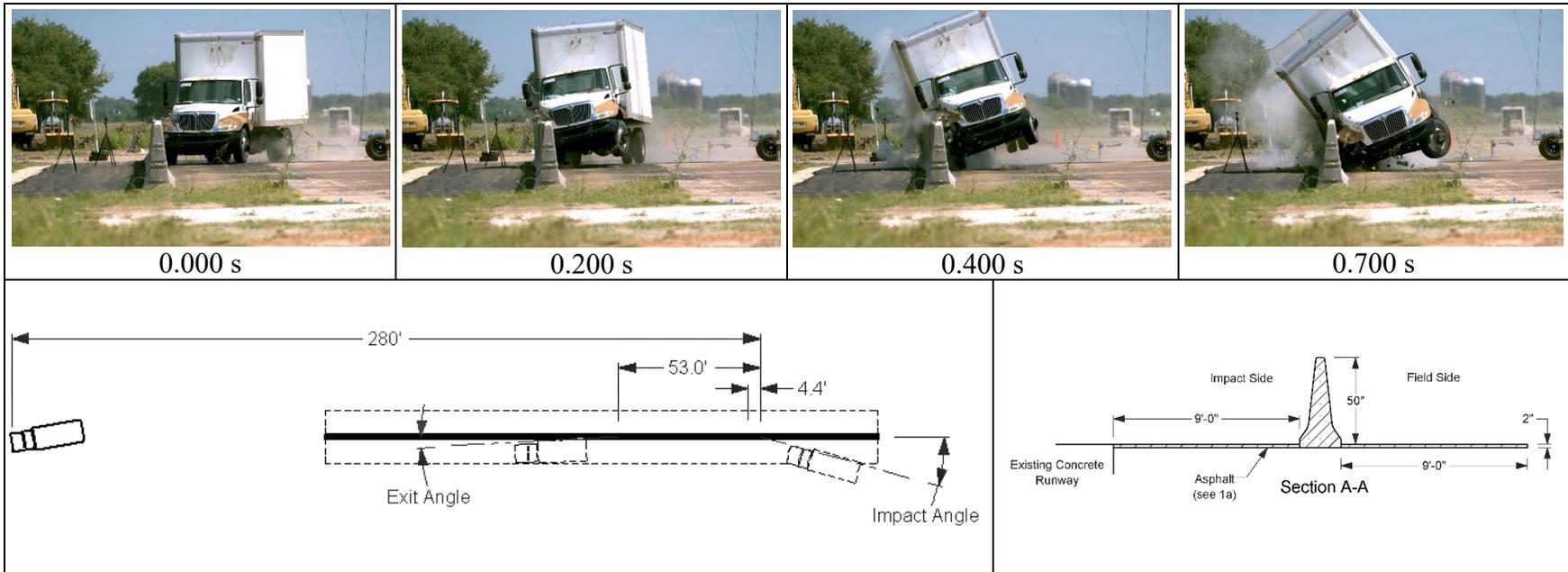
## ATTACHMENTS

Attach to this form:

- 1) Additional disclosures of related financial interest as indicated above.
- 2) A copy of the full test report, video, and a Test Data Summary Sheet for each test conducted in support of this request.
- 3) A drawing or drawings of the device(s) that conform to the Task Force-13 Drawing Specifications [[Hardware Guide Drawing Standards](#)]. For proprietary products, a single isometric line drawing is usually acceptable to illustrate the product, with detailed specifications, intended use, and contact information provided on the reverse. Additional drawings (not in TF-13 format) showing details that are relevant to understanding the dimensions and performance of the device should also be submitted to facilitate our review.

FHWA Official Business Only:

| Eligibility Letter |      |           |
|--------------------|------|-----------|
| Number             | Date | Key Words |
|                    |      |           |



**General Information**

Test Agency..... Texas A&M Transportation Institute (TTI)  
 Test Standard Test No..... MASH Test 4-12  
 TTI Test No. .... 611851-3  
 Test Date ..... 2019-07-15

**Test Article**

Type ..... Longitudinal Barrier – Concrete Barrier  
 Name..... 50-inch tall precast F-shape concrete barrier  
 Installation Length..... 206 ft-8 inches  
 Material or Key Elements .... 17 precast reinforced F-shape concrete barriers 12 ft long, 52 inches tall, 5 inches wide at top, and 24 inches wide at bottom connected with drop-in pins through loops

**Soil Type and Condition**

Keyed in with 2 inches of asphalt

**Test Vehicle**

Type/Designation ..... 10000S  
 Make and Model ..... 2011 International 4300 single-unit truck  
 Curb..... 14,170 lb  
 Test Inertial..... 22,240 lb  
 Dummy ..... No dummy  
 Gross Static ..... 22,240 lb

**Impact Conditions**

Speed..... 56.6 mi/h  
 Angle..... 14.8°  
 Location/Orientation ..... 4.4 ft upstream of joint 4-5

**Impact Severity**

155 kip-ft

**Exit Conditions**

Speed..... Not obtainable  
 Angle..... Not obtainable

**Occupant Risk Values**

Longitudinal OIV ..... 5.6 ft/s  
 Lateral OIV ..... 13.1 ft/s  
 Longitudinal Ridedown ..... 4.7 g  
 Lateral Ridedown ..... 12.6 g  
 THIV ..... 15.5 km/h  
 PHD ..... 12.6 g  
 ASI ..... 0.52  
 Max. 0.050-s Average  
 Longitudinal..... -1.5 g  
 Lateral ..... -4.5 g  
 Vertical ..... -2.6 g

**Post-Impact Trajectory**

Stopping Distance..... 280 ft downstream  
 2 ft twd traffic lanes

**Vehicle Stability**

Maximum Yaw Angle ..... 22°  
 Maximum Pitch Angle ..... 10°  
 Maximum Roll Angle ..... 36°  
 Vehicle Snagging ..... No  
 Vehicle Pocketing ..... No

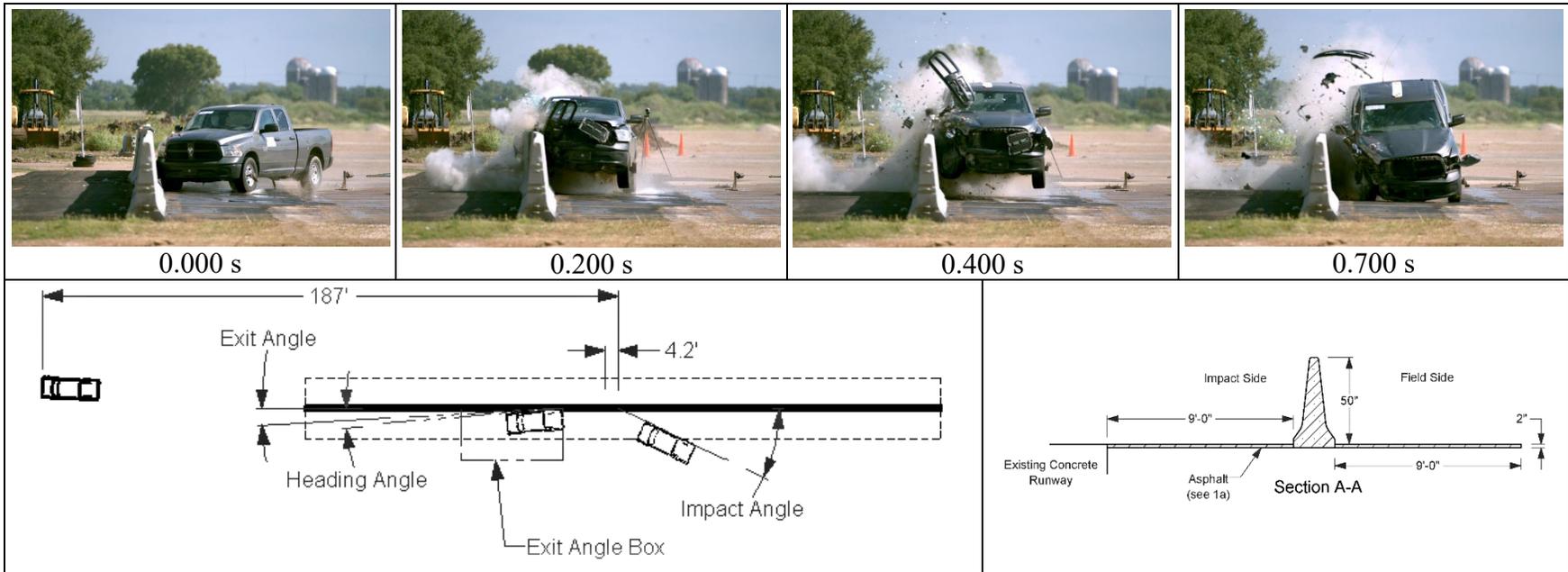
**Test Article Deflections**

Dynamic.....at Top ..... 21.8 inches  
 Permanent.....at Bottom ..... 6.75 inches  
 Working Width ..... 69.3 inches  
 Height of Working Width ..... 120.4 inches

**Vehicle Damage**

VDS ..... NA  
 CDC ..... 01RFQ4  
 Max. Exterior Deformation..... 14.0 inches  
 OCDI ..... NA  
 Max. Occupant Compartment Deformation ..... 4.0 inches in the right firewall/floor pan

**Figure 5.6. Summary of Results for MASH Test 4-12 on 50-inch Tall Precast F-Shape Concrete Barrier.**



**General Information**

Test Agency ..... Texas A&M Transportation Institute (TTI)  
 Test Standard Test No. .... MASH Test 4-11  
 TTI Test No. .... 611851-2  
 Test Date ..... 2019-07-17

**Test Article**

Type..... Longitudinal Barrier – Concrete Barrier  
 Name ..... 50-inch tall precast F-shape concrete barrier  
 Installation Length ..... 206 ft-8 inches  
 Material or Key Elements ... 17 precast reinforced F-shape concrete barriers  
 12 ft long, 52 inches tall, 5 inches wide at top, and  
 24 inches wide at bottom connected with drop-in  
 pins through loops  
 Keyed in with 2 inches of asphalt

**Soil Type and Condition .....**

**Test Vehicle**

Type/Designation ..... 2270P  
 Make and Model ..... 2013 RAM 1500 pickup  
 Curb ..... 4976 lb  
 Test Inertial ..... 5010 lb  
 Dummy ..... 165 lb  
 Gross Static ..... 5175 lb

**Impact Conditions**

Speed .....63.4 mi/h  
 Angle .....24.5°  
 Location/Orientation .....4.2 ft upstream  
 of joint 9 and 10

**Impact Severity** .....116 kip-ft

**Exit Conditions**

Speed .....50.4 mi/h  
 Trajectory/Heading Angle...4.1° / 1.9°

**Occupant Risk Values**

Longitudinal OIV .....19.4 ft/s  
 Lateral OIV .....23.3 ft/s  
 Longitudinal Ridedown.....6.4 g  
 Lateral Ridedown.....6.2 g  
 THIV .....34.9 km/h  
 PHD .....6.8 g  
 ASI .....1.79

**Max. 0.050-s Average**

Longitudinal .....-9.9 g  
 Lateral .....-13.2 g  
 Vertical .....-4.0 g

**Post-Impact Trajectory**

Stopping Distance..... 187 ft downstream  
 7 ft twd field side

**Vehicle Stability**

Maximum Yaw Angle ..... 27°  
 Maximum Pitch Angle ..... 16°  
 Maximum Roll Angle ..... 13°  
 Vehicle Snagging ..... No  
 Vehicle Pocketing ..... No

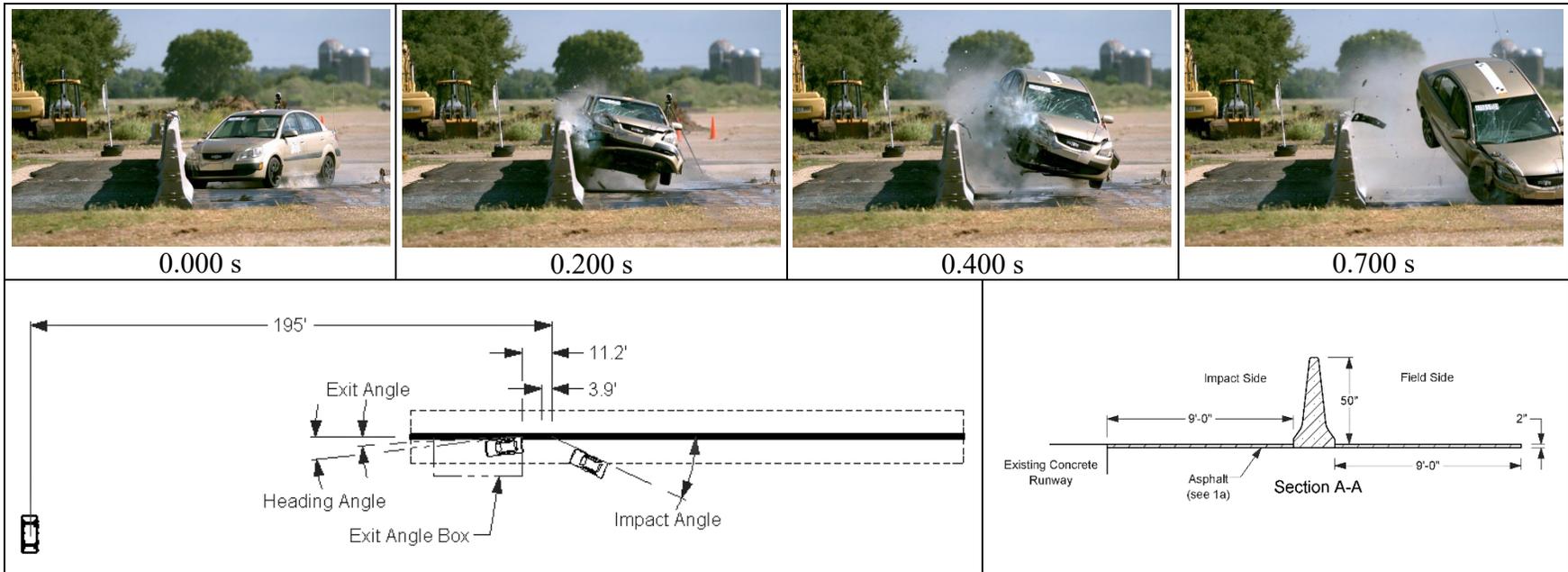
**Test Article Deflections**

Dynamic.....at Top ..... 13.2 inches  
 Permanent...at Bottom ..... 4.0 inches  
 Working Width ..... 26.75 inches  
 Height of Working Width ..... 50.0 inches

**Vehicle Damage**

VDS ..... 01RFQ5  
 CDC ..... 01FREW4  
 Max. Exterior Deformation ..... 16.0 inches  
 OCDI ..... RF0010000  
 Max. Occupant Compartment  
 Deformation..... 3.0 inches in the  
 right side firewall

**Figure 6.6. Summary of Results for MASH Test 4-11 on 50-inch Tall Precast F-Shape Concrete Barrier.**



**General Information**

Test Agency..... Texas A&M Transportation Institute (TTI)  
 Test Standard Test No..... MASH Test 4-10  
 TTI Test No. .... 611851-1  
 Test Date ..... 2019-07-19

**Test Article**

Type ..... Longitudinal Barrier – Concrete Barrier  
 Name ..... 50-inch tall precast F-shape concrete barrier  
 Installation Length..... barrier  
 Material or Key Elements .... 206 ft-8 inches  
 17 precast reinforced F-shape concrete barriers 12 ft long, 52 inches tall, 5 inches wide at top, and 24 inches wide at bottom connected with drop-in pins through loops

**Soil Type and Condition**

Keyed in with 2 inches of asphalt

**Test Vehicle**

Type/Designation ..... 1100C  
 Make and Model ..... 2009 Kia Rio  
 Curb ..... 2529 lb  
 Test Inertial ..... 2418 lb  
 Dummy ..... 165 lb  
 Gross Static ..... 2583 lb

**Impact Conditions**

Speed ..... 62.4 mi/h  
 Angle ..... 25.6°  
 Location/Orientation ..... 3.9 ft upstream of Joint 13 and 14

**Impact Severity**

59 kip-ft

**Exit Conditions**

Speed ..... 53.9 mi/h  
 Trajectory/Heading Angle... 7.2° / 6.8°

**Occupant Risk Values**

Longitudinal OIV ..... 18.7 ft/s  
 Lateral OIV..... 31.2ft/s  
 Longitudinal Ridedown ..... 5.7 g  
 Lateral Ridedown ..... 13.0 g  
 THIV ..... 39.7 km/h  
 PHD ..... 13.0 g  
 ASI..... 2.34

**Max. 0.050-s Average**

Longitudinal ..... -9.7 g  
 Lateral ..... -17.6 g  
 Vertical..... 4.9 g

**Post-Impact Trajectory**

Stopping Distance..... 195 ft downstream  
 43 ft twd traffic lanes

**Vehicle Stability**

Maximum Yaw Angle ..... 124°  
 Maximum Pitch Angle ..... 29°  
 Maximum Roll Angle ..... 649°  
 Vehicle Snagging ..... No  
 Vehicle Pocketing ..... No

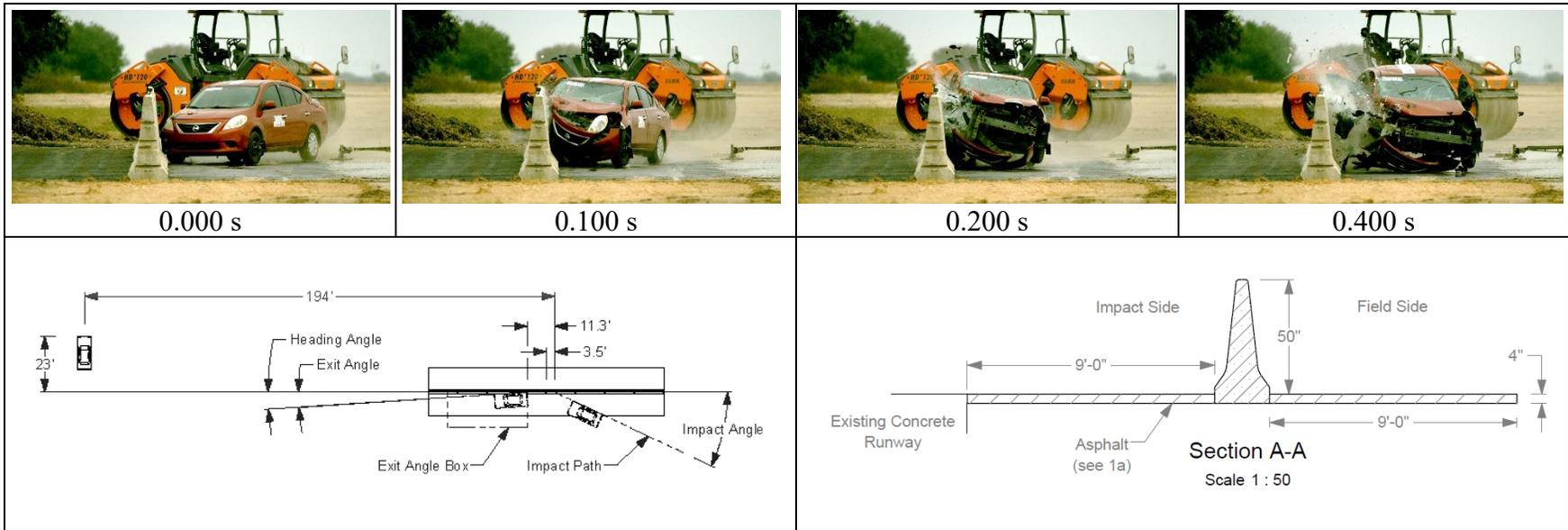
**Test Article Deflections**

Dynamic..... at Top ..... 2.9 inches  
 Permanent.....at Bottom ..... 0.125 inch  
 Working Width ..... 24.0 inches  
 Height of Working Width ..... Ground level

**Vehicle Damage**

VDS ..... 01R&T5  
 CDC ..... 01FRAW5  
 Max. Exterior Deformation..... 9.0 inches  
 OCDI ..... AS0010000  
 Max. Occupant Compartment Deformation ..... 2.0 inches in the right front passenger roof

**Figure 7.6. Summary of Results for MASH Test 4-10 on 50-inch Tall Precast F-Shape Concrete Barrier.**



**General Information**

Test Agency ..... Texas A&M Transportation Institute (TTI)  
 Test Standard Test No. .... MASH Test 4-10  
 TTI Test No. .... 611851-4  
 Test Date ..... 2020-11-13

**Test Article**

Type ..... Longitudinal Barrier—Concrete Barrier  
 Name ..... 50-inch tall precast F-shape concrete barrier keyed in 4 inches of asphalt  
 Installation Length ..... 97 ft-2 inches  
 Material or Key Elements ... Concrete, steel rebar and pins, and asphalt.

**Soil Type and Condition** .... Keyed in with 4 inches of asphalt

**Test Vehicle**

Type/Designation ..... 1100C  
 Make and Model ..... 2014 Nissan Versa  
 Curb ..... 2415 lb  
 Test Inertial ..... 2429 lb  
 Dummy ..... 165 lb  
 Gross Static ..... 2594 lb

**Impact Conditions**

Speed ..... 61.7 mi/h  
 Angle ..... 25.2°  
 Location/Orientation ..... 3.5 ft upstream joint 4 – 5

**Impact Severity** ..... 56 kip-ft

**Exit Conditions**

Speed ..... 50.7 mi/h  
 Trajectory/Heading Angle... 3.8°/3.7°

**Occupant Risk Values**

Longitudinal OIV ..... 20.3 ft/s  
 Lateral OIV ..... 30.2 ft/s  
 Longitudinal Ridedown ..... 3.1 g  
 Lateral Ridedown ..... 7.8 g  
 THIV ..... 10.8 m/s  
 ASI ..... 2.4  
 Max. 0.050-s Average  
 Longitudinal ..... -11.4 g  
 Lateral ..... -18.7 g  
 Vertical ..... -7.5 g

**Post-Impact Trajectory**

Stopping Distance ..... 194 ft downstream  
 23 ft twd field side

**Vehicle Stability**

Maximum Roll Angle ..... 7°  
 Maximum Pitch Angle ..... 10°  
 Maximum Yaw Angle ..... 75°  
 Vehicle Snagging ..... No  
 Vehicle Pocketing ..... No

**Test Article Deflections**

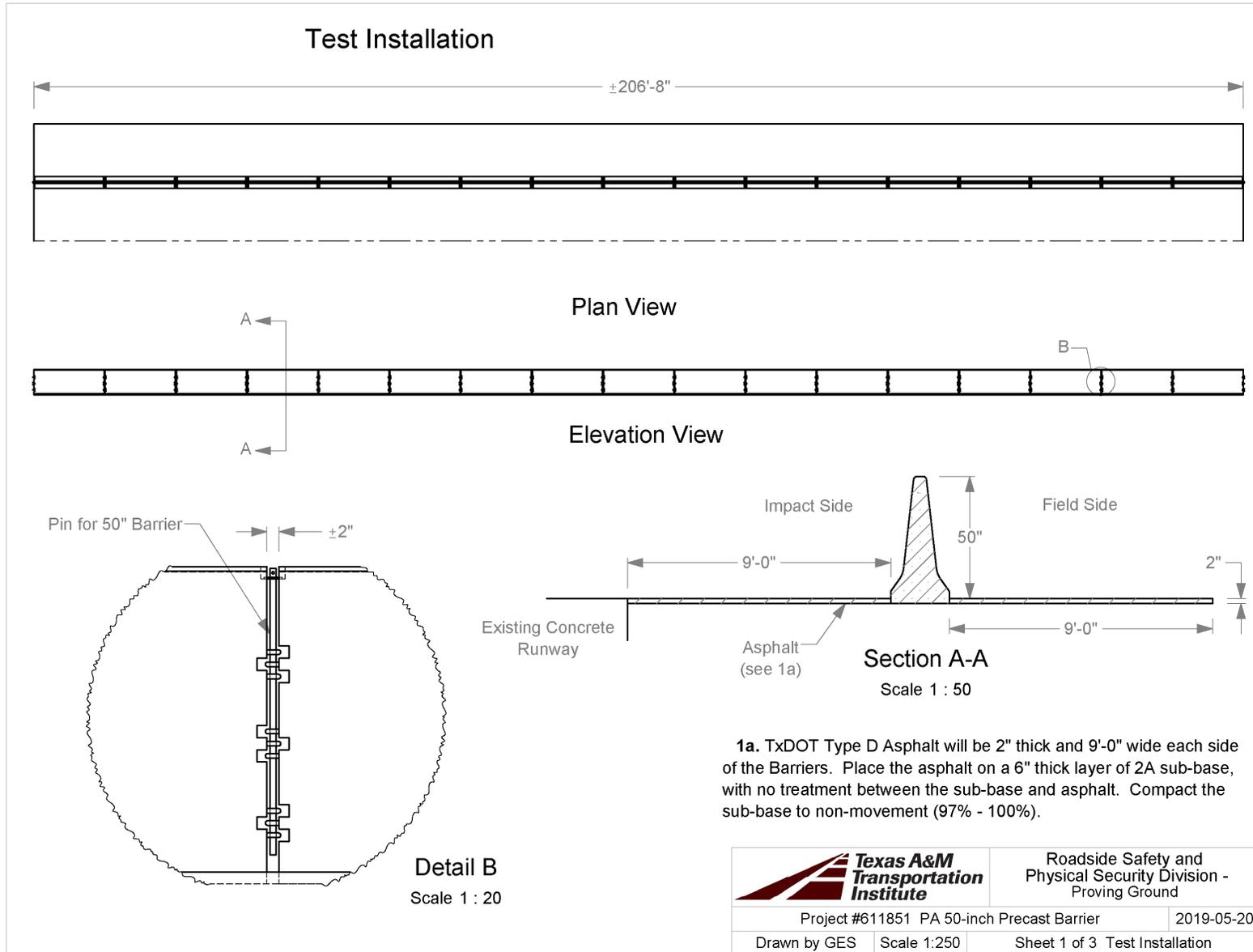
Dynamic ..... 1.6 inches  
 Permanent ..... None observed  
 Working Width ..... 24.0 inches  
 Height of Working Width ..... 50.0 inches

**Vehicle Damage**

VDS ..... 01RFQ6  
 CDC ..... 01FREW4  
 Max. Exterior Deformation ..... 9.0 inches  
 OCDI ..... RF0000000  
 Max. Occupant Compartment Deformation ..... 2.5 inches in the right front kick panel

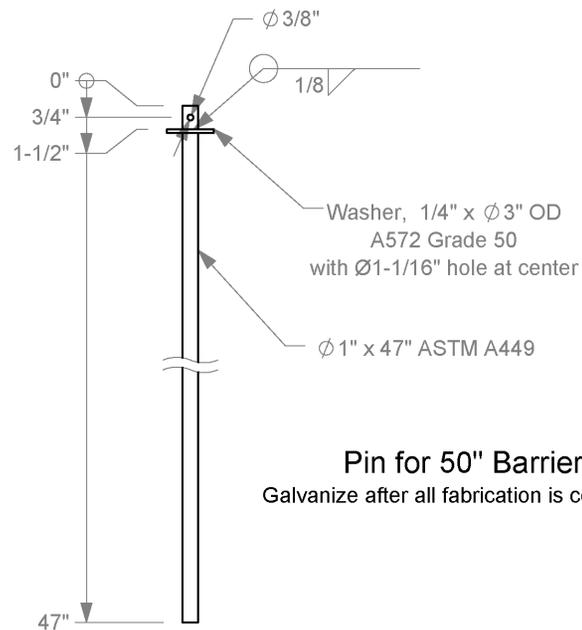
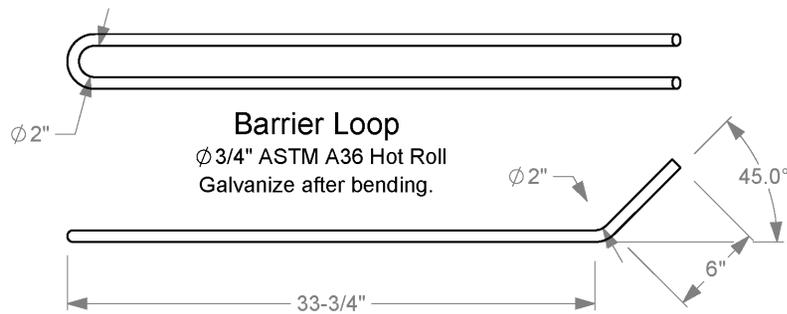
**Figure 8.6. Summary of Results for MASH Test 4-10 on 50-inch Tall Precast F-Shape Concrete Barrier Keyed in 4 inches of Asphalt.**

**A.1 DETAILS OF 50-INCH TALL PRECAST F-SHAPE CONCRETE BARRIER  
KEYED IN 2 INCHES OF ASPHALT**

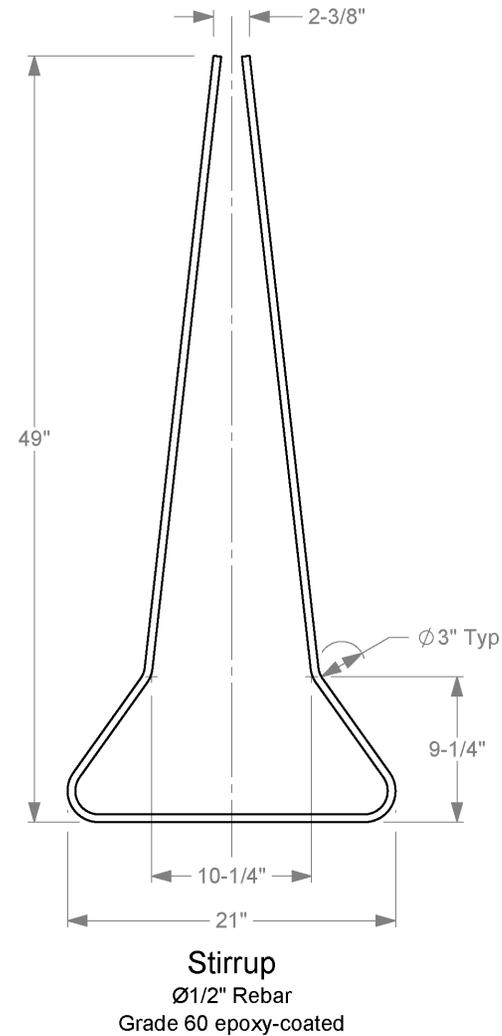


T:\1-ProjectFiles\611851 - 50 in. F-Shape Barrier-Bullard\Drafting, 611851\611851 Drawing





**Parts**



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Project #611851 PA 50-inch Precast Barrier

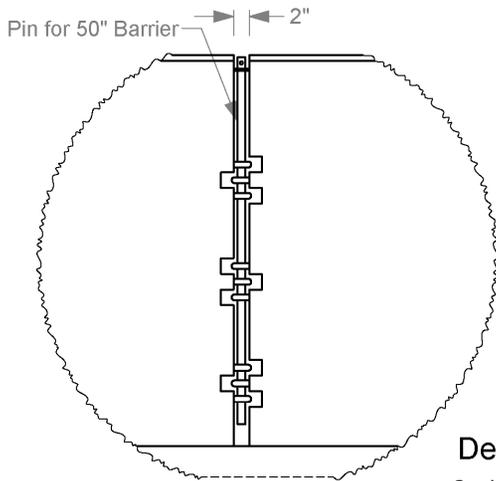
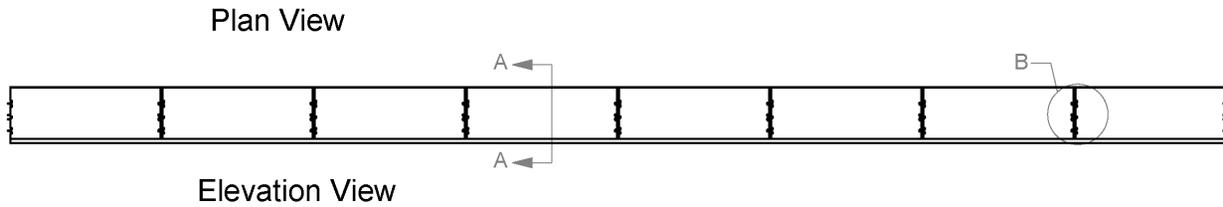
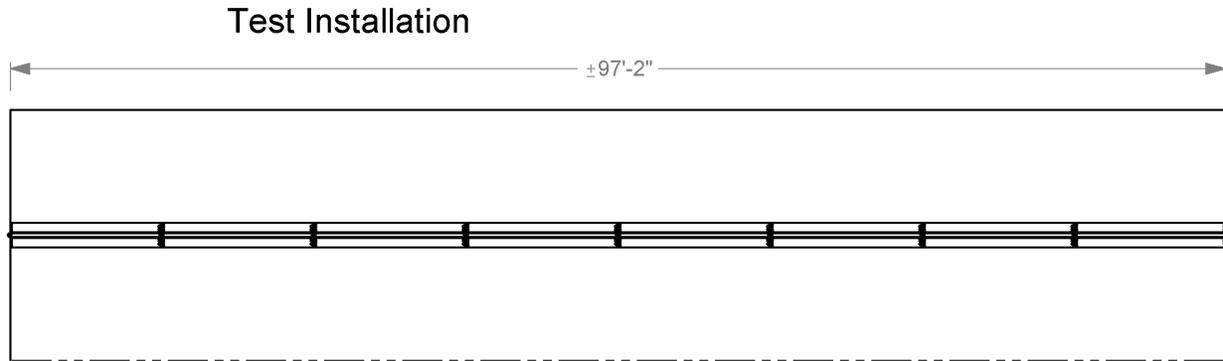
2019-05-20

Drawn by GES

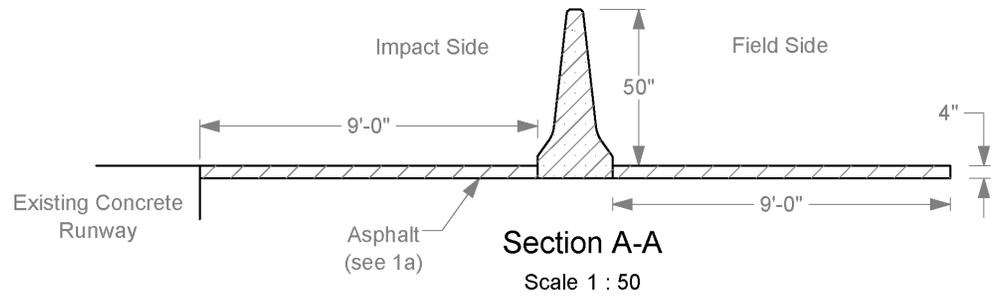
Scale 1:10

Sheet 3 of 3 Parts

**A.2 DETAILS OF 50-INCH TALL PRECAST F-SHAPE CONCRETE BARRIER  
KEYED IN 4 INCHES OF ASPHALT**



Scale 1 : 20



**1a.** TxDOT Type D Asphalt will be 4" thick and 9'-0" wide each side of the Barriers. Place the asphalt on a 6" thick layer of 2A sub-base, with no treatment between the sub-base and asphalt. Compact the sub-base to non-movement (97% - 100%).



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Project #611851-4 PA 50-inch Precast Barrier

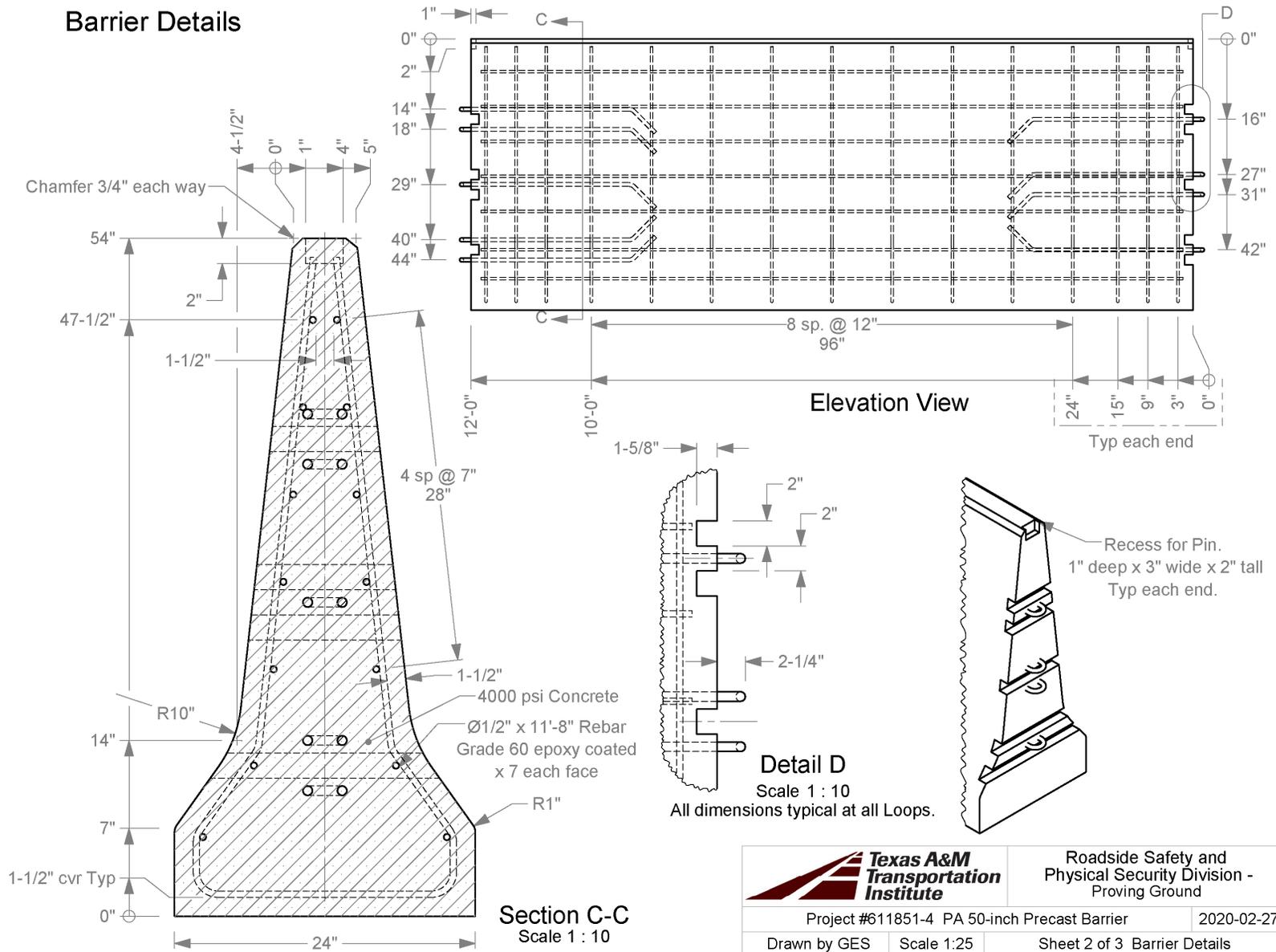
2020-02-27

Drawn by GES

Scale 1:150

Sheet 1 of 3 Test Installation

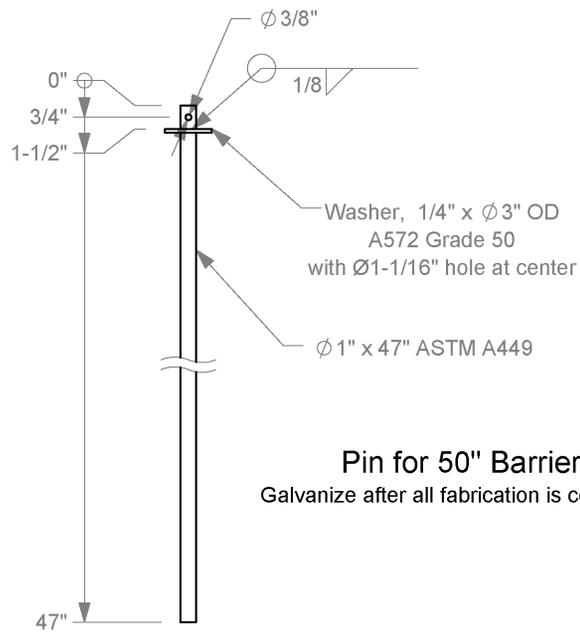
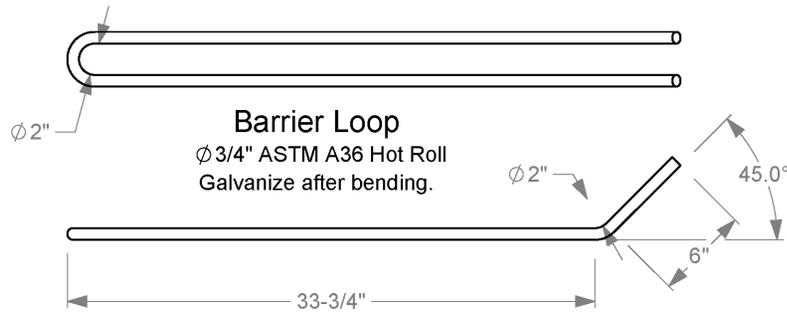
# Barrier Details



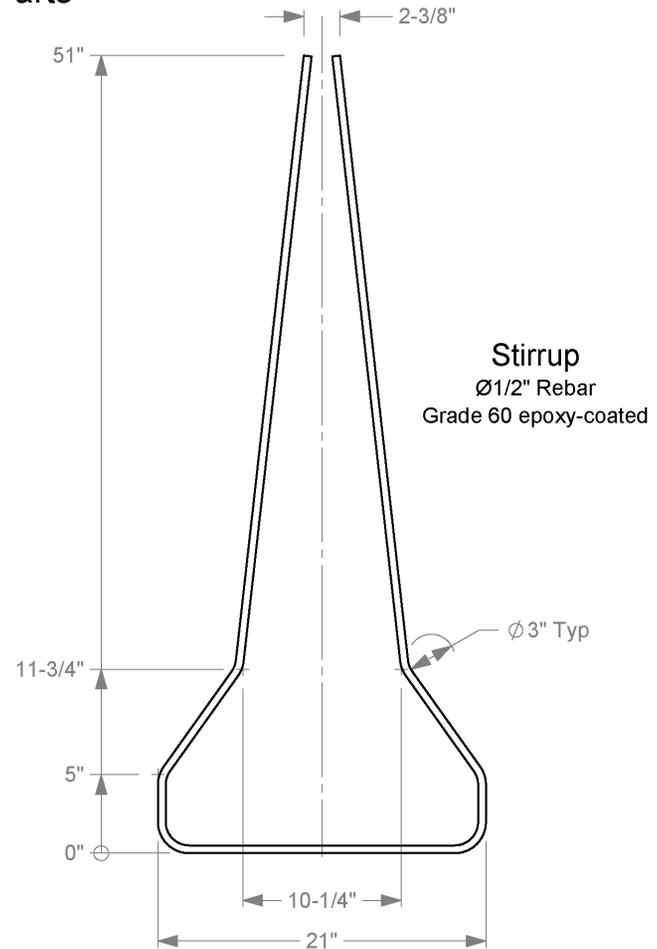
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|  |            |                              |
|--|------------|------------------------------|
| Project #611851-4 PA 50-inch Precast Barrier |            | 2020-02-27                   |
| Drawn by GES                                 | Scale 1:25 | Sheet 2 of 3 Barrier Details |

Q:\Accreditation-17025-2017\EIR-000 Project Files\611851-1-F-Shape Median Barrier -Bullard\_Moran\Drafting\_611851-2020-02-27\611851-4 Drawing



**Parts**



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|  |            |                    |
|--|------------|--------------------|
| Project #611851-4 PA 50-inch Precast Barrier |            | 2020-02-27         |
| Drawn by GES                                 | Scale 1:10 | Sheet 3 of 3 Parts |