May 27, 2020

Mr. Ahmad Hammad
WSP USA Inc.
2200 Western Court, Suite 120
Lisle, IL 60532
USA

Dear Mr. Hammad:

This letter is in response to your February 7, 2020 request for the Federal Highway Administration (FHWA) to review a roadside safety device, hardware, or system for eligibility for reimbursement under the Federal-aid highway program. This FHWA letter of eligibility is assigned FHWA control number B-339 and is valid until a subsequent letter is issued by FHWA that expressly references this device.

Decision

The following device is eligible within the length-of-need, with details provided in the form which is attached as an integral part of this letter:

- F-Shape Barrier on Cantilevered Bridge Deck with Noise Wall Panels

Scope of this Letter

To be found eligible for Federal-aid funding, new roadside safety devices should meet the crash test and evaluation criteria contained in the American Association of State Highway and Transportation Officials’ (AASHTO) Manual for Assessing Safety Hardware (MASH). However, the FHWA, the Department of Transportation, and the United States Government do not regulate the manufacture of roadside safety devices. Eligibility for reimbursement under the Federal-aid highway program does not establish approval, certification or endorsement of the device for any particular purpose or use.

This letter is not a determination by the FHWA, the Department of Transportation, or the United States Government that a vehicle crash involving the device will result in any particular outcome, nor is it a guarantee of the in-service performance of this device. Proper manufacturing, installation, and maintenance are required in order for this device to function as tested.

This finding of eligibility is limited to the crashworthiness of the system and does not cover other structural features, nor conformity with the Manual on Uniform Traffic Control Devices.
Eligibility for Reimbursement

Based solely on a review of crash test results and certifications submitted by the manufacturer, and the crash test laboratory, FHWA agrees that the device described herein meets the crash test and evaluation criteria of the AASHTO’s MASH. Therefore, the device is eligible for reimbursement under the Federal-aid highway program if installed under the range of tested conditions.

Name of system: F-Shape Barrier on Cantilevered Bridge Deck with Noise Wall Panels
Type of system: Bridge Barrier
Test Level: MASH Test Level 5 (TL5)
Testing conducted by: Texas A&M Transportation Institute.
Date of request: February 7, 2020

FHWA concurs with the recommendation of the accredited crash testing laboratory on the attached form.

Full Description of the Eligible Device

The device and supporting documentation, including reports of the crash tests or other testing done, videos of any crash testing, and/or drawings of the device, are described in the attached form.

Notice

This eligibility letter is issued for the subject device as tested. Modifications made to the device are not covered by this letter. Any modifications to this device should be submitted to the user (i.e., state DOT) as per their requirements.

You are expected to supply potential users with sufficient information on design, installation and maintenance requirements to ensure proper performance.

You are expected to certify to potential users that the hardware furnished has the same chemistry, mechanical properties, and geometry as that submitted for review, and that it will meet the test and evaluation criteria of AASHTO’s MASH.

Issuance of this letter does not convey property rights of any sort or any exclusive privilege. This letter is based on the premise that information and reports submitted by you are accurate and correct. We reserve the right to modify or revoke this letter if: (1) there are any inaccuracies in the information submitted in support of your request for this letter, (2) the qualification testing was flawed, (3) in-service performance or other information reveals safety problems, (4) the system is significantly different from the version that was crash tested, or (5) any other information indicates that the letter was issued in error or otherwise does not reflect full and complete information about the crashworthiness of the system.
Standard Provisions

- To prevent misunderstanding by others, this letter of eligibility designated as FHWA control number B-339 shall not be reproduced except in full. This letter and the test documentation upon which it is based are public information. All such letters and documentation may be reviewed upon request.

- This letter shall not be construed as authorization or consent by the FHWA to use, manufacture, or sell any patented system for which the applicant is not the patent holder.

- This FHWA eligibility letter is not an expression of any Agency view, position, or determination of validity, scope, or ownership of any intellectual property rights to a specific device or design. Further, this letter does not impute any distribution or licensing rights to the requester. This FHWA eligibility letter determination is made based solely on the crash-testing information submitted by the requester. The FHWA reserves the right to review and revoke an earlier eligibility determination after receipt of subsequent information related to crash testing.

Sincerely,

Michael S. Griffith
Director, Office of Safety Technologies
Office of Safety

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

<table>
<thead>
<tr>
<th>System Type</th>
<th>Submission Type</th>
<th>Device Name / Variant</th>
<th>Testing Criterion</th>
<th>Test Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>'B': Rigid/Semi-Rigid Barriers</td>
<td>Physical Crash Testing</td>
<td>F-Shape Barrier on Cantilevered Bridge Deck with Noise Wall Panels</td>
<td>AASHTO MASH</td>
<td>TL5</td>
</tr>
<tr>
<td></td>
<td>Engineering Analysis</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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:**

<table>
<thead>
<tr>
<th>Contact Name</th>
<th>Company Name</th>
<th>Address</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahmad Hammad, PhD, PE, SE</td>
<td>WSP USA Inc.</td>
<td>2200 Western Court, Suite 120, Lisle, IL 60532</td>
<td>USA</td>
</tr>
</tbody>
</table>

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 WSP USA Inc. (WSP) to perform full-scale crash testing of the 6-ft Tall Illinois Tollway F-Shape Barrier on Cantilevered Bridge Deck with Noise Abatement Wall Panels. There are no shared financial interests in the 6-ft Tall Illinois Tollway F-Shape Barrier on Cantilevered Bridge Deck with Noise Abatement Wall Panels by TTI, or between WSP and TTI, other than costs involved in the actual crash test and reports for this submission to FHWA.

**690900-ITG1-3**
PRODUCT DESCRIPTION

<table>
<thead>
<tr>
<th>New Hardware or Modification to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant Modification</td>
</tr>
<tr>
<td>Existing Hardware</td>
</tr>
</tbody>
</table>

The installation was 90 ft-½ inch long and consisted of a 6-ft tall reinforced concrete F-shape concrete parapet anchored to a cantilevered reinforced concrete deck. A ½-inch joint in the deck and parapet was located 30 ft from the upstream end of the installation. W8×48 posts were secured to the back of the parapet, spaced at 11 ft-8 inches on center. These posts supported noise abatement panels that extended 18 ft above grade.

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.

<table>
<thead>
<tr>
<th>Engineer Name:</th>
<th>D. Lance Bullard, Jr. P.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineer Signature:</td>
<td>D. Lance Bullard, Jr. Digitally signed by D. Lance Bullard, Jr.</td>
</tr>
<tr>
<td>Date:</td>
<td>2020.02.07 13:07:50-06'00'</td>
</tr>
<tr>
<td>Address:</td>
<td>3100 SH47, Bldg 7091, Bryan TX 77807</td>
</tr>
<tr>
<td>Country:</td>
<td>USA</td>
</tr>
</tbody>
</table>

A brief description of each crash test and its result: Help
Test 5-10 involves an 1100C vehicle impacting the test article at a target impact speed of 62 mi/h ±2.5 mi/h and a target impact angle of 25° ±1.5°. The target CIP was determined using the information provided in MASH Section 2.2.1, Section 2.3.2, and Table 2-7 and was for the left corner of the front bumper to impact at 3.6 ft upstream of the barrier joint.

The results of the test conducted on September 26, 2019, are found in TTITest Report number 690900-ITG1-3. The test vehicle was traveling at an impact speed of 62.2 mi/h as it made contact with the barrier 3.9 ft upstream of the barrier joint at an impact angle of 25.1°. After loss of contact with the barrier, the vehicle came to rest 242 ft downstream of the impact point and 50 ft towards the traffic side.

The barrier contained and redirected the 1100C vehicle. The vehicle did not penetrate, underride, or override the installation. The 1100C vehicle exited within the exit box criteria.

Working width was 43.0 inches to the field side of post support protrusions. There was no measurable dynamic deflection during the test, or permanent deformation observed afterwards, for either the barrier or the wall.

No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or present hazard to others in the area.

Maximum exterior crush to the vehicle was 9.5 inches in the front plane at the left front corner at bumper height. Maximum occupant compartment deformation was 2.5 inches in the left floor pan area.

The 1100C vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 10° and 9°, respectively. Longitudinal OIV was 21.0 ft/s, and lateral OIV was 30.8 ft/s. Longitudinal occupant ridedown acceleration was 3.2 g, and lateral occupant ridedown acceleration 9.6 g. The occupant risk factors were within the MASH preferred limits.

The 6-ft tall Illinois Tollway F-Shape Barrier with Noise Abatement Wall Panels performed acceptably for MASH test 5-10.

Pass
<table>
<thead>
<tr>
<th>Required Test Number</th>
<th>Narrative Description</th>
<th>Evaluation Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 5-11 involves a 2270P vehicle impacting the test article at a target impact speed of 62 mi/h ±2.5 mi/h and a target impact angle of 25° ±1.5°. The target CIP was determined using the information provided in MASH Section 2.2.1, Section 2.3.2, and Table 2-7 and was for the left corner of the front bumper to impact at 4.3 ft upstream of the barrier joint. The results of the test conducted on September 27, 2019 are found in TTI Test Report number 690900-ITG1-3. The test vehicle was traveling at an impact speed of 61.7 mi/h as it made contact with the barrier 5.2 ft upstream of the barrier joint at an angle of 26.7°. After loss of contact with the barrier, the vehicle came to rest 186 ft downstream of the impact point and 2 ft towards the traffic side. The barrier contained and redirected the 2270P vehicle. The vehicle did not penetrate, underride, or override the installation. The 2270P vehicle exited within the exit box criteria. Working width was 43.0-inches to the field side of post support protrusions. There was no measurable dynamic deflection during the test, or permanent deformation observed afterwards, for either the barrier or the wall. No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or present hazard to others in the area. Maximum exterior crush to the vehicle was 15.0 inches in the front plane at the left front corner at bumper height. Maximum occupant compartment deformation was 4.0 inches in the left front firewall area. The 2270P vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 9° and 15°, respectively. Longitudinal OIV was 20.0 ft/s, and lateral OIV was 29.2 ft/s. Longitudinal occupant ridedown acceleration was 3.7 g, and lateral occupant ridedown acceleration 9.8 g. The occupant risk factors were within the MASH preferred limits. The 6-ft tall Illinois Tollway F-Shape Barrier with Noise Abatement Wall Panels performed acceptably for MASH test 5-11.</td>
<td>PASS</td>
<td></td>
</tr>
</tbody>
</table>
Test 5-12 involves a 36000V vehicle impacting the test article at a target impact speed of 50 mi/h ±2.5 mi/h and a target impact angle of 15° ±1.5°. The target CIP was determined using the information provided in MASH Section 2.2.1, Section 2.3.2, and Table 2-7 and was for the left corner of the front bumper to impact at 1 ft downstream of the barrier joint.

The results of the test conducted on October 2, 2019 are found in TTI Test Report number 690900-ITG1-3. The test vehicle was traveling at an impact speed of 50.5 mi/h as it made contact with the barrier 0.9 ft downstream of the barrier joint at an angle of 15.2°. After loss of contact with the barrier, the vehicle came to rest 279 ft downstream of the impact point and 16 ft towards the field side.

The barrier contained and redirected the 36000V vehicle. The vehicle did not penetrate, underride, or override the installation. The 36000V vehicle exited within the exit box criteria. The trailer broke at its ⅓rd point. Working width was 47.1 inches to the field side of the wall posts at the top of the posts. The maximum dynamic deflection during the test was 9.6 inches at the top of the noise abatement wall panel, and 3.3 inches at the top of the F-Shape barrier. The maximum permanent deformation was 0.5 inch at the top of the wall panel, and 0.4 inch at the top of the barrier just downstream of the joint.

No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or present hazard to others in the area.

Maximum exterior crush to the vehicle was 12.0 inches in the front plane at the left front corner at bumper height. No occupant compartment deformation or intrusion was observed.

The 36000V vehicle remained upright during and after the collision event. Maximum roll was 11°. Longitudinal OIV was 4.3 ft/s, and lateral OIV was 17.1 ft/s. Longitudinal occupant ridedown acceleration was 10.2 g, and lateral occupant ridedown acceleration 5.6 g. The occupant risk factors were within the MASH preferred limits.

The 6-ft tall Illinois Tollway F-Shape Barrier with Noise Abatement Wall Panels performed acceptably for MASH test 5-12.
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:

<table>
<thead>
<tr>
<th>Eligibility Letter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Figure 5.6. Summary of Results for MASH Test 5-10 on 6-ft Tall Illinois Tollway F-Shape Barrier on Cantilevered Bridge Deck with Noise Abatement Panels.
Figure 6.6. Summary of Results for MASH Test 5-11 on 6-ft Tall Illinois Tollway F-Shape Barrier on Cantilevered Bridge Deck with Noise Abatement Panels.
**General Information**

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Agency</td>
<td>Texas A&amp;M Transportation Institute (TTI)</td>
</tr>
<tr>
<td>Test Standard Test No.</td>
<td>MASH Test 5-12</td>
</tr>
<tr>
<td>TTI Test No.</td>
<td>600000-ITG3</td>
</tr>
<tr>
<td>Test Date</td>
<td>2019-10-02</td>
</tr>
</tbody>
</table>

**Test Article**

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Longitudinal Barrier - Concrete Bridge Rail</td>
</tr>
<tr>
<td>Name</td>
<td>6-ft Tall Illinois Tollway F-Shape Barrier on cantilevered bridge</td>
</tr>
<tr>
<td></td>
<td>deck with noise abatement panels</td>
</tr>
<tr>
<td>Installation Length</td>
<td>90 ft-½ inch</td>
</tr>
<tr>
<td>Material or Key Elements</td>
<td>6-ft tall F-Shape reinforced concrete barrier anchored to</td>
</tr>
<tr>
<td></td>
<td>cantilevered reinforced concrete deck with noise abatement</td>
</tr>
<tr>
<td></td>
<td>panels that extended to 18 ft above grade</td>
</tr>
<tr>
<td>Soil Type and Condition</td>
<td>Concrete Deck, Dry</td>
</tr>
</tbody>
</table>

**Impact Conditions**

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>50.5 mi/h</td>
</tr>
<tr>
<td>Angle</td>
<td>15.2°</td>
</tr>
<tr>
<td>Location/Orientation</td>
<td>11 inches downstream of joint</td>
</tr>
</tbody>
</table>

**Impact Severity**

- 469 kip-ft

**Occupant Risk Values**

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal OIV</td>
<td>4.3 ft/s</td>
</tr>
<tr>
<td>Lateral OIV</td>
<td>17.1 ft/s</td>
</tr>
<tr>
<td>Longitudinal Ridedown</td>
<td>10.2 g</td>
</tr>
<tr>
<td>Lateral Ridedown</td>
<td>5.6 g</td>
</tr>
<tr>
<td>THIV</td>
<td>16.4 km/h</td>
</tr>
<tr>
<td>ASI</td>
<td>0.84</td>
</tr>
<tr>
<td>Max. 0.050-s Average Longitudinal</td>
<td>2.8 g</td>
</tr>
<tr>
<td></td>
<td>Lateral</td>
</tr>
<tr>
<td></td>
<td>Vertical</td>
</tr>
</tbody>
</table>

**Vehicle Stability**

- Maximum Yaw Angle: 25°
- Maximum Pitch Angle: 5°
- Maximum Roll Angle: 11°
- Vehicle Snagging: No
- Vehicle Pocketing: No

**Test Article Deflections**

- Dynamic: 3.3 inches (barrier)
- Permanent: 9.6 inches (wall)
- Working Width, Top of Wall: 47.1 inches
- Height of Working Width, Wall: 18 ft

**Test Vehicle**

- Type/Model: 2004 Freightliner w1998 Lufkin 53-ft trailer
- Curb: 30,270 lb
- Test Inertial: 80,000 lb
- Dummy: No dummy
- Gross Static: 80,000 lb

**Vehicle Damage**

- VDS: NA
- CDC: 11FLEW3
- Max. Exterior Deformation: 12.0 inches
- OCDI: NA
- Max. Occupant Compartment Deformation: None

**Post-Impact Trajectory**

- Stopping Distance: 279 ft downstream
- Vehicle Stability:
  - 16 ft to field side
- Vehicle Snagging: No
- Vehicle Pocketing: No

**Test Article Deflections**

- Dynamic: 3.3 inches (barrier)
- Permanent: 9.6 inches (wall)
- Working Width, Top of Wall: 47.1 inches
- Height of Working Width, Wall: 18 ft

**Vehicle Damage**

- VDS: NA
- CDC: 11FLEW3
- Max. Exterior Deformation: 12.0 inches
- OCDI: NA
- Max. Occupant Compartment Deformation: None

**Figure 7.12. Summary of Results for MASH Test 5-12 on 6-ft Tall Illinois Tollway F-Shape Barrier on Cantilevered Bridge Deck with Noise Abatement Panels.**
REINFORCEMENT BARS
REINFORCEMENT BARS, INCLUDING EPOXY-COATED REINFORCEMENT BARS, SHALL CONFORM TO THE REQUIREMENTS OF AASHTO M-31 (ASTM A706), GRADE 60, DEFORMED BARS.

CAST-IN-PLACE CONCRETE
ALL EXPOSED CONCRETE EDGES SHALL HAVE A ⅜" X 45° CHAMFER, EXCEPT WHERE SHOWN OTHERWISE.
ALL CONCRETE = 4,000 PSI

Roadside Safety and Physical Security Division - Proving Ground

Project #690900-ITG F-Shape and Single Slope 2019-08-22
Drawn by BLG Scale 1:225 Sheet 1 of 35 Test Installation
10" Deep Built Up Shape
See details on page 11

Custom Right Angle Anchor Bolts
1" Diameter, F1554 Grd105
1" Heavy Hex Nut x 2
1" Hardened Flat Washer
4 Places

DCKA(E), #8 bar at End Region
10" Spacing

a(E), #6 bar at Interior Region
5" Spacing

SS(E), #5 bar for Single Slope
5" Spacing

SSA(E), #5 bar only at
Post Anchor Bolt Location
5" Spacing

#6 Longitudinal Bar
16 In Single Slope Barrier

SS1A(E), #6 Bar at End Region (15' from ends)

SS1(E), #5 Bar at Interior Region
5" Spacing

#8 Longitudinal Bar

SS2A(E), #6 Bar at End Region (15' from ends)

SS2(E), #5 Bar at Interior Region
5" Spacing

DCKA(E), #8 bar at End Region

a1(E), #5 Bar
10" Spacing

a2(E), #5 Bar
10" Spacing

#5 Longitudinal Bar
12" Spacing, 13 Places

#8 Longitudinal Bar

5" Spacing

#5 Longitudinal Bar
12" Spacing, 13 Places

#8 Longitudinal Bar

5" Spacing

#5 Longitudinal Bar
15" Spacing, 11 places

#8 Longitudinal Bar

5" Spacing

#4 Longitudinal Bar
16 in Wall

#4 Longitudinal Bar
56 in Slab

#4 Tranverse Bar, 14’ 2" Long
10" Spacing

3a. All Rebar is 60 ksi rated
3b. All Epoxy Coated Rebar is designated with (E)
Section A-A
Single Slope
Away from NAW Posts

4a. All Rebar is 60 ksi rated
4b. All Epoxy Coated Rebar is designated with (E)
Detail E

1-1/2" Cover (Minimum)

70-1/2"
66-7/8"
58-7/8"
50-1/2"
47-1/2"
40-7/8"
38-7/8"
33"
25-7/8"
24-1/4"
20-1/8"
18-3/8"
12-3/4"
10-7/8"
5-3/8"
3-3/8"
0"
8-1/2"
9-1/8"

2-5/8" (Cover)
1-1/4" (Cover)
5-1/4" Typ.
6"

1-1/2" Cover (Minimum)
Section B-B
Single Slope

6a. All Rebar is 60 ksi rated
6b. All Epoxy Coated Rebar is designated with (E)

SSA(E), #5 bar
Only at Post to accommodate Custom Anchors for Post

9" Embedment Depth for Custom Anchors

SSA(E), #5 bars used where Custom Anchors are

F
9-1/4"
16"

5" 2-1/4"
Typ.

2-3/4"

Section F-F

Centerline of Post
**Detail G**
Single Slope at Expansion Joint

4-1/2" Cover to DCKA(E) bar

5" Typ. for DCKA (E) and a(E) bars

10" Typ. for a1(E) and a2(E) bars

5-5/8" Cover for a1(E) and a2(E) bars

---

**Detail H**
Single Slope at End Region transition to Interior Region

a1(E), #5 Bar, Interior Region

DCKA(E), #8 bar End Region

End Region stops 15' from ends

Interior Region Starts 15' from ends

---

8a. All Rebar is 60 ksi rated
8b. All Epoxy Coated Rebar is designated with (E)
9a. All Rebar is 60 ksi rated
9b. All Epoxy Coated Rebar is designated with (E)
10a. All Steel plate, beams and angles shall be A36 (minimum 36 ksi yield) material.
11a. All Steel plate, beams and angles shall be A36 (minimum 36 ksi yield) material.
13a. All Rebar is 60 ksi rated
13b. All Epoxy Coated Rebar is designated with (E)

See next page for blown up view

End View
F-Shape

#5 Longitudinal Bar
12" Spacing, 13 places

a1(E), #5 Bar
10" Spacing

a2(E), #5 Bar
10" Spacing

Wall to Slab, #5 bar
5" Spacing

#5 Longitudinal Bar
15" Spacing, 11 places

#5 Longitudinal Bar
16 Places in Wall

#4 Longitudinal Bar
28 places in slab

#4 Longitudinal Bar
16 Places in Wall
14a. All Rebar is 60 ksi rated
14b. All Epoxy Coated Rebar is designated with (E)
Section C-C
F-Shape at Extension

15a. All Rebar is 60 ksi rated
15b. All Epoxy Coated Rebar is designated with (E)
16a. All Rebar is 60 ksi rated
16b. All Epoxy Coated Rebar is designated with (E)
17a. All Rebar is 60 ksi rated
17b. All Epoxy Coated Rebar is designated with (E)
19a. All Rebar is 60 ksi rated
19b. All Epoxy Coated Rebar is designated with (E)
20a. All Rebar is 60 ksi rated
20b. All Epoxy Coated Rebar is designated with (E)
21a. All Rebar is 60 ksi rated
21b. All Epoxy Coated Rebar is designated with (E)
22a. All Rebar is 60 ksi rated
22b. All Epoxy Coated Rebar is designated with (E)
**Detail P**
Deck Expansion Joint

- Wall to Slab, #5 bar
- DCKA(E), #8 bar
- Cover 4-1/2"

**Detail Q**
Deck End to Interior Region Transition

- End Region
  - Stops 15' from end
  - Interior Region begins 15' from end
- DCKA(E), #8 bar
- DCK(E), #6 Bar
- 4-1/2" Cover
- 10" Typ.
- 5" Typ.

---

24a. All Rebar is 60 ksi rated
24b. All Epoxy Coated Rebar is designated with (E)
25a. All Rebar is 60 ksi rated
25b. All Epoxy Coated Rebar is designated with (E)
26a. All steel plate, beams and angles shall be A36 (minimum 36 ksi yield) material.
27a. All steel plate, beams and angles shall be A36 (minimum 36 ksi yield) material.
Go-Pro Cameras:
Camera to be mounted on top of NAW post, facing
along the front of the NAW toward the impact zone near
the full joint in the barrier and deck
#6 FSA2-SG rebar for F-Shape
Every Other Rebar starting from Joint as shown below
9 Total Strain Guages needed

Detail AB
Scale 1 : 35

Elevation view of Fshape deck
#8 F-Shape deck
DCKA-SG-(E) rebar
7 needed

Strain Gauge as shown

#6 FShape deck
a2-SG-(E) rebar
2 needed (2 Total)

Strain Gauge as shown

Strain Guages on every other a3-SG (E) rebar as shown
Strain Guages on every other DCKA(E) rebar as shown

Detail AC
Scale 1 : 30

Plan view of Fshape deck

Roadside Safety and Physical Security Division - Proving Ground
Project #690900-ITG  FShape and Single Slope  2019-08-22
Drawn by BLG  Scale 1:250  Sheet 31 of 35  Strain Gauges, FShape Deck
Expansion Joint

#6 SS2A-SG rebar for Single Slope
Every Other Rebar starting from Joint as shown below
9 Total Strain Guages needed

Detail AD
Scale 1 : 30

AD

Elevation View of Single Slope

#6 Single Slope
SS2A-SG-(E)
9 Needed

Roadside Safety and Physical Security Division - Proving Ground

Project #690900-ITG FShape and Single Slope 2019-08-22
Drawn by BLG  Scale 1:220  Sheet 32 of 35  Strain Gauges, SS Barrier
#8 Single Slope deck
DCKA-SG-(E) rebar
9 needed

Strain Gauge as shown

Expansion Joint

Strain Gauges on every other DCKA(E) rebar starting from the expansion Joint as shown
9 Strain Gauges in total

Detail AE
Scale 1:20

Plan view of Single Slope deck

Roadside Safety and Physical Security Division - Proving Ground

Project #690900-ITG FShape and Single Slope 2019-08-22

Drawn by BLG Scale 1:250 Sheet 33 of 35 Strain Gauges, SS Deck
Single Slope Plan View

5/8" OD Dowels, 24" Long, 8" embedment into 60 deck, 4 places 12" spacing on centers, center in deck

F-Shape Plan View

5/8" OD Dowels, 24" Long, 8" embedment into 60 deck, 4 places 12" spacing on centers, center in deck
F-Shape End View

Single Slope End View

Barrier Concrete

Deck Concrete

Wall Concrete

Slab Concrete

Dowels only between 30' and 60' sections

Dowels, only between 30' and 60' sections

Roadside Safety and Physical Security Division - Proving Ground

Project #690900-ITG F-Shape and Single Slope 2019-08-22

Drawn by BLG | Scale 1:250 | Sheet 35 of 35 Concrete Location