Ms. Karla Lechtenberg  
Midwest Roadside Safety Facility  
130 Whittier Research Center  
2200 Vine Street  
Lincoln, NE 68583-0853  

Dear Ms. Lechtenberg:

This letter is in response to your May 11, 2015 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-255A and is valid until a subsequent letter is issued by FHWA that expressly references this device.

**Decision**

The following devices are eligible, with details provided in the form which is attached as an integral part of this letter:

- Low-Deflection Portable Concrete Barrier Version 2

**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' 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 American Association of State Highway and Transportation Officials’ Manual for Assessing Safety Hardware (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: Retrofit, Low-Deflection Portable Concrete Barrier Version 2  
Type of system: Longitudinal Barrier  
Test Level: MASH Test Level 3  
Testing conducted by: Midwest Roadside Safety Facility  
Task Force 13 Designator: SWC20a-b  
Date of request: May 11, 2015  
Date initially acknowledged: May 28, 2015  
Date of completed package: August 21, 2015

**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**

If a manufacturer makes any modification to any of their roadside safety hardware that has an existing eligibility letter from FHWA, the manufacturer must notify FHWA of such modification with a request for continued eligibility for reimbursement. The notice of all modifications to a device must be accompanied by:

- Significant modifications – For these modifications, crash test results must be submitted with accompanying documentation and videos.
- Non-signification modifications – For these modifications, a statement from the crash test laboratory on the potential effect of the modification on the ability of the device to meet the relevant crash test criteria.

FHWA's determination of continued eligibility for the modified hardware will be based on whether the modified hardware will continue to meet the relevant crash test criteria.

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 the 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**

- This letter provides a AASHTO/ARTBA/AGC Task Force 13 designator that should be used for the purpose of the creation of a new and/or the update of an existing Task Force 13 drawing for posting on the on-line ‘Guide to Standardized Highway Barrier Hardware’ currently referenced in AASHTO Roadside Design Guide.

- To prevent misunderstanding by others, this letter of eligibility designated as FHWA control number B-255A 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.

- If the subject device is a patented product it may be considered to be proprietary. If proprietary systems are specified by a highway agency for use on Federal-aid projects: (a) they must be supplied through competitive bidding with equally suitable unpatented items; (b) the highway agency must certify that they are essential for synchronization with the existing highway facilities or that no equally suitable alternative exists; or (c) they must be used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes.
Our regulations concerning proprietary products are contained in Title 23, Code of Federal Regulations, Section 635.411.

Sincerely yours,

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

Enclosures
# Request for Federal Aid Reimbursement Eligibility
## Of Highway Safety Hardware

**Date of Request:** May 11, 2015  
**Name:** Karla Lechtenberg  
**Company:** Midwest Roadside Safety Facility  
**Address:** 130 Whittier Research Center, 2200 Vine Street, Lincoln, NE 68583-0853  
**Country:** USA  
**To:** Michael S. Griffith, Director  
FHWA, Office of Safety Technologies

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>
</table>
| ‘B’: Barriers (Roadside, Median, Bridge Railings) | ☑ Physical Crash Testing  
☐ FEA & V&V Analysis  
☐ Engineering Analysis | Retrofit, Low-Deflection Portable Concrete Barrier Version 2 | AASHTO MASH | TL3 |

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.

**Identification of the individual or organization responsible for the product:**

| Contact Name: | Karla Lechtenberg | Same as Submitter | ☒ |
| Company Name: | Midwest Roadside Safety Facility | Same as Submitter | ☒ |
| Address: | 130 Whittier Research Center, 2200 Vine Street, Lincoln, NE 68583-0853 | Same as Submitter | ☒ |
| Country: | USA | Same as Submitter | ☒ |
PRODUCT DESCRIPTION

The Low-Deflection Portable Concrete Barrier Version 2 system (SWC20b) is comprised of Portable F-shape Concrete Barrier Element (SWC09) joined with the Portable Concrete Barrier Connector Pins with or without the retainer bolt (FMW02 or FMW03) and stiffened by attachment of a steel cap across each joint of the barrier system and the addition of tubular beams on both faces of the barrier. The system is not anchored to the roadway surface and is designed for use with PCB segments (SWC09) placed in a straight line or large-radius curves where the design tolerances can accommodate the small angles between adjacent barrier segments. A 42-in. long, 10-gauge, ASTM A1011 Grade 50 bent steel cap was centered across each joint and through-bolted to the barriers with either four 12 3/4-in. long, ASTM A449 bolts with nuts (FBX24b) and washers (FWC24a) on both sides of the barrier or four 14-in. long, ASTM A449 threaded straight anchor studs with nuts (FRS24b) and washers (FWC24a) on both sides of the barrier. A 153 3/8-in. long, 5-in. x 5-in. x 3/16-in. ASTM A500 Grade B steel tube was welded to the steel cap on both sides of the barrier. The steel tubes were spliced at the center of each Portable F-shape Concrete Barrier Element (SWC09). Each splice contained a 22-in. long, 4 1/2-in. x 4 1/2-in. x 1/2-in. U-shape bent ASTM A572 Grade 50 steel splice insert which was placed inside the end of each of the adjoining tubes. The tube splices were bolted together on both the front and back sides with four 6 1/2-in. long, 3/4-in. diameter Grade 5 bolts with nuts (FBX20a) and washers (FWC20a) under the head of the bolt and the nut. A 12-in. long, 4-in. x 3-in. x 3/8-in., ASTM A529 Grade 50 L-bracket was welded to the bottom side of the steel tubes at 13 1/2-in. from the each end of the steel tubes. The L-brackets were through-bolted to the barriers with either two 13-in. long, ASTM A449 bolts with nuts (FBX20b) and washers (FWC20a) on both sides of the barrier or two 14 1/4-in. long, ASTM A449 threaded straight anchor studs with nuts (FRS20b) and washers (FWC20a) on both sides of the barrier. The bolts and threaded anchor studs should not have more than 1/2 in. of length exposed past the end of the nut.

CRASH TESTING

A brief description of each crash test and its result:

<table>
<thead>
<tr>
<th>Required Test Number</th>
<th>Narrative Description</th>
<th>Evaluation Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-10 (1100C)</td>
<td>In test no. 7069-3 found in FHWA report nos. FHWA-RD-93-058 and FHWA-RD-93-064, a rigid, F-shape bridge rail was successfully impacted by a small car weighing 1,800 lb at 60.1 mph and 21.4 degrees according to the American Association of State Highway and Transportation Officials (AASHTO) Guide Specifications for Bridge Railings. Rigid New Jersey safety shape barriers struck by small cars have been shown to meet safety performance standards. In test no. 2214NJ-1 found In MwRSF report no. TRP-03-177-06, a New Jersey safety shape barrier was impacted by a passenger car weighing 2,579 lb at 60.8 mph and 26.1 degrees according to the TL-3 standards set forth in MASH. Temporary New Jersey safety shape concrete median barriers have experienced only slight barrier deflections when impacted by small cars and behave similarly to rigid barriers. Therefore, the 1100C passenger car test was deemed unnecessary for this system.</td>
<td>WAIVER REQUESTED</td>
</tr>
</tbody>
</table>
The results of test no. RDTCB-2 conducted on August 9, 2013 are found in MwRSF report no. TRP-03-295-14. A 4,978-lb pickup truck with a simulated occupant seated in the right-front seat, impacted the low-deflection PCB version 2 system offset 24 in. from the edge of a simulated bridge deck at a speed of 64.8 mph and at an angle of 25.4 degrees. At 0.192 sec after impact, the vehicle became parallel to the system with a speed of 58.4 mph. At 0.684 sec, the vehicle exited the barrier system at a speed of 47.9 mph and at an angle of 7.2 degrees. The vehicle was smoothly redirected. After exiting the system, the vehicle yawed back toward the system and came to rest in contact with the barrier.

Exterior vehicle damage was moderate. Interior occupant compartment deformations were minimal with a maximum of 1 in., consequently not violating the limits established in MASH. Damage to the barrier was also moderate, consisting of vehicle contact marks on the front face of the PCB segments and steel tubes, concrete spalling, concrete cracking, and permanent deformation of the steel tube rails. The additional attachment points for the steel tubes successfully stiffened the PCB system and transmitted the impact loads more effectively to adjacent barrier segments to engage more of the barrier system. However, due to the amount of flexural cracking and damage to the PCB segments, the flexural capacity of the PCB segments was exceeded which limited the system's effectiveness in reducing barrier deflections. The maximum lateral dynamic barrier deflection was 40.7 in., which included tipping of the barrier at the top surface. The working width of the system was 51.9 in. All barrier segments were safely retained on the edge of the bridge deck. All occupant risk measures were within the recommended limits, and the test vehicle showed no tendency to roll over.

Exterior vehicle damage was moderate. Interior occupant compartment deformations were minimal with a maximum of 1 in., consequently not violating the limits established in MASH. Damage to the barrier was also moderate, consisting of vehicle contact marks on the front face of the PCB segments and steel tubes, concrete spalling, concrete cracking, and permanent deformation of the steel tube rails. The additional attachment points for the steel tubes successfully stiffened the PCB system and transmitted the impact loads more effectively to adjacent barrier segments to engage more of the barrier system. However, due to the amount of flexural cracking and damage to the PCB segments, the flexural capacity of the PCB segments was exceeded which limited the system’s effectiveness in reducing barrier deflections. The maximum lateral dynamic barrier deflection was 40.7 in., which included tipping of the barrier at the top surface. The working width of the system was 51.9 in. All barrier segments were safely retained on the edge of the bridge deck. All occupant risk measures were within the recommended limits, and the test vehicle showed no tendency to roll over.

3-11 (2270P)
PASS

3-20 (1100C) Not Applicable WAIVER REQUESTED
3-21 (2270P) Not Applicable WAIVER REQUESTED

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: | Midwest Roadside Safety Facility |
| Laboratory Contact: | Karla Lechtenberg |
| Address: | 130 Whittier Research Center, 2200 Vine Street, Lincoln, NE 68583-0853 |
| Country: | USA |
| Accreditation Certificate Number and Date: | A2LA Certificate Number: 2937.01, Valid to November 30, 2015 |

Submit Form
ATTACHMENTS

Attach to this form:

1) A copy of the full test report, video, and a Test Data Summary Sheet for each test conducted in support of this request.

2) 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 key to understanding the performance of the device should also be submitted to facilitate our review.

FHWA Official Business Only:

<table>
<thead>
<tr>
<th>Eligibility Letter</th>
<th>AASHTO TF13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Date</td>
</tr>
<tr>
<td>Designator</td>
<td>Key Words</td>
</tr>
</tbody>
</table>
SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

MIDWEST ROADSIDE SAFETY FACILITY (MwRSF)¹
University of Nebraska-Lincoln
4800 NW 35th Street
Lincoln, NE 68524
Ms. Karla Lechtenberg Phone: 402 472 9070

MECHANICAL

Valid To: December 31, 2015
Certificate Number: 2937.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following tests:

<table>
<thead>
<tr>
<th>Tests</th>
<th>Test Methods²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-Scale Vehicle Crash Tests of Highway Safety Features</td>
<td>NCHRP Report 350; MASH; EN 1317</td>
</tr>
<tr>
<td>Full-Scale Vehicle Crash Tests of Perimeter Protection Systems and Access Control Devices</td>
<td>ASTM F2656; SD-STD-02.01 Revision A</td>
</tr>
</tbody>
</table>

On the following types of products, materials, and/or structures: Metal, Wood, Concrete and Plastic Structures, Components of Structures, Fasteners, and Roadway Pavements.

¹ Administrative office located at: 2200 Vine Street, 130 Whittier Building, Lincoln, NE 68583-0853.

² This laboratory meets A2LA R104 – General Requirements: Accreditation of Field Testing and Field Calibration Laboratories for these tests.
Accredited Laboratory

A2LA has accredited

MIDWEST ROADSIDE SAFETY FACILITY (MWRSF)
Lincoln, NE

for technical competence in the field of

Mechanical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005
General requirements for the competence of testing and calibration laboratories. This accreditation demonstrates
technical competence for a defined scope and the operation of a laboratory quality management system
(refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Presented this 31st day of December 2013.

[Signature]
President & CEO
For the Accreditation Council
Certificate Number 2937.01
Valid to December 31, 2015

For the tests to which this accreditation applies, please refer to the laboratory’s Mechanical Scope of Accreditation.
August 27, 2015

Subject: Financial Interest Statement

Dear Will:

This letter is intended to be a disclosure of any financial interest that the Midwest Roadside Safety Facility (MwRSF) and its employees have in the Retrofit, Low-Deflection Portable Concrete Barrier Version 1 and Version 2 for which we are requesting a letter of eligibility on behalf of the state departments of transportation participating in the Midwest States Regional Pooled Fund Program, specifically Wisconsin Department of Transportation.

MwRSF’s financial interests are as follows:
(i) No compensation, including wages, salaries, commissions, professional fees, or fees for business referrals;
(ii) Consulting relationships consist of answering design and implementation questions from the member states;
(iii) Research funding or other forms of research support include continuing to fund the Midwest States Regional Pooled Fund Program as well as state departments of transportation funding individual research projects with MwRSF;
(iv) No patents, copyrights, or other intellectual property interests for this system;
(v) No licenses or contractual relationships for this system; and
(vi) No business ownership and investment interests for this system.

If you need any further information or clarification, please feel free to contact Dr. Ron Faller or myself.

Sincerely,

Karla A. Lechtenberg
Research Associate Engineer

cc: Ronald K. Faller, Ph.D., Director and Research Associate Professor
December 21, 2015

Subject: Small Car Test Waiver Information

Dear Will:

This letter is intended to address the request by FHWA for additional information pertaining to vehicle stability of the small car in regards to the Retrofit, Low-Deflection Portable Concrete Barrier Version 2 for which we are requesting a letter of eligibility on behalf of the state departments of transportation participating in the Midwest States Regional Pooled Fund Program, specifically Wisconsin Department of Transportation.

In test no. 7043-2 found in Volume II – Appendices of NCHRP Project 22-6 (final report NCHRP 318), a rigid, New Jersey shape concrete barrier was successfully impacted by a small car weighing 1,722 lb at 59.9 mph and 21.9 degrees similar to the standards set forth in NCHRP 350. In test no. 7043-12 found in Volume II – Appendices of NCHRP Project 22-6 (final report NCHRP 318), a rigid, New Jersey shape concrete barrier was successfully impacted by a small car weighing 1,695 lb at 61.6 mph and 20.1 degrees similar to the standards set forth in NCHRP 350. In test no. 7069-3 found in FHWA report nos. FHWA-RD-93-058 and FHWA-RD-93-064, a rigid, F-shape bridge rail was successfully impacted by a small car weighing 1,800 lb at 60.1 mph and 21.4 degrees according to the American Association of State Highway and Transportation Officials (AASHTO) Guide Specifications for Bridge Railings.

During all three tests, the small car climbed the face of the barrier and became airborne. Although the small cars were airborne for a brief period, the vehicle remained upright and was smoothly redirected. The geometry of the F-shape exhibited improved vehicle stability characteristics when compared to the New Jersey shape even though both barrier shapes allow the small car to climb the face of the barrier.

Further, in test no. 2214NJ-1 found in MwRSF report no. TRP-03-177-06, a rigid, New Jersey safety shape barrier was successfully impacted by a passenger car weighing 2,579 lb at 60.8 mph and 26.1 degrees according to the TL-3 standards set forth in MASH. The 1100C vehicle once again climbed the face of the barrier and became airborne, but remained upright and was smoothly redirected. Therefore, based on the above noted tests, the 1100C passenger car test was believed to be unnecessary for this system.
If you need any further information or clarification, please feel free to contact Dr. Ron Faller, Bob Bielenberg, or myself.

Sincerely,

Kara A. Lechtenberg
Research Associate Engineer

cc: Ronald K. Faller, Ph.D., Director and Research Associate Professor
Bob Bielenberg, Research Associate Engineer
December 14, 2015

Subject: Small Car Test

Dear Will:

This letter is intended to address the question pertaining to concerns for occupant compartment intrusion with the 1100C vehicle raised by FHWA in regards to the Retrofit, Low-Deflection Portable Concrete Barrier Version 1 and Version 2 for which we are requesting a letter of eligibility on behalf of the state departments of transportation participating in the Midwest States Regional Pooled Fund Program, specifically Wisconsin Department of Transportation.

The top rail height for the low-deflection PCB system is 29". This height was based on the 27" and 28" heights of the previously tested box beam roadside and median barrier systems, respectively. The height was adjusted to 29" due on connection and interference issues with the PCB reinforcement. This height was not believed to be an issue as the height of the small car (1100C) vehicle window is generally over 31". Thus, the height of the box beam rail is lower than the A-pillar, windshield, and side-window structures, and the potential for the box beam to intrude or cause excessive damage in these areas is minimal.

Additionally, the box beam is mounted on an F-shape PCB. Typically, small cars that interact with the toes of F-shape barriers tend to climb the barrier and roll away from the face of the barrier. This motion would further reduce the potential for damage to the A-pillar or other areas above the door frame by the box beam. The box beam railing used in the system is a continuous element that is spliced longitudinally similar to other box beam and tubular bridge rail designs. The box beam is anchored to the PCB at the cap over the PCB joint and at the mid-section of the barrier. This prevents the tubes from disengaging from the PCB and becoming an intrusion hazard. The increased impact loading of the 2270P impacts would have indicated any potential for the tubes to disengage or separate.

Previous testing with small cars on an identically similar system does not exist, but similar testing appears to indicate that it is not a safety concern. Previous testing of box-beam systems or tubular bridge rails, as summarized below, has not indicated that occupant compartment deformation of the small cars due to the tubes is an issue.

1. In test no. 473160-8, a box-beam transition to two tube bridge rail was evaluated according to NCHRP 350 Test Level 3 (TL-3) with the 820C vehicle. The transition had a top rail height of 29". This test passed NCHRP 350 with a
similar rail height and a much stiffer tubular rail configuration than the low-deflection PCB system which deflects approximately 40". While the angle of the NCHRP 350 test was 20 degrees rather than the 25 degrees required by MASH, this test would suggest that there is minimal concern for occupant compartment deformation for MASH test designation no. 3-10.

2. In test no. 7202-5, a box beam median barrier terminal was evaluated according to NCHRP 350 TL-3 with the 820C vehicle. The box beam median terminal had a rail height of 28". The small car was safely redirected and no occupant compartment concerns arose. Again, the tests were not identical to the low-deflection PCB system in terms of impact conditions and the rail height is slightly lower by 1". However, it further indicates that occupant compartment intrusion would be a concern.

Therefore, based on a comparison of similar previous testing and engineering analysis of the box-beam rail height mounted on the low-deflection PCB system relative to the vehicle structure, we do not believe that occupant compartment deformation or intrusion concerns warranted conducting MASH test designation no. 3-10, the 1100C small car vehicle.

Lastly, this letter is intended to further clarify the Not Applicable statement in the Narrative Description for Required Test Number 3-20 and 3-21 in the Request for Federal Aid Reimbursement Eligibility of Highway Safety Hardware form submitted. Not Applicable means that test numbers 3-20 and 3-21 are not applicable for this type of system.

If you need any further information or clarification, please feel free to contact Dr. Ron Faller, Bob Bielenberg, or myself.

Sincerely,

Karla A. Lechtenberg
Research Associate Engineer

cc: Ronald K. Faller, Ph.D., Director and Research Associate Professor
    Bob Bielenberg, Research Associate Engineer
Figure 141. Summary of Test Results and Sequential Photographs. Test No. RDTCB-2
Note: (1) Impact location is 51 3/16" [1300] upstream of joint between barrier nos. 8 and 9.
Note: (1) Bridge deck omitted.
Notes: (1) ASTM A449 or ASTM A193 B7 threaded rod may be used in lieu of bolts (Parts b9 and b6).

(2) If threaded rod is used in lieu of cup or L-Bracket bolts, limit thread extension beyond nut to 1/4 - 1/2 (6 - 13).
DETAIL C (PLAN VIEW)

Notes: (1) Shown with nominal gap, but variations in gap width will change overlap of cap.
(2) Cap shall be centered over joint.

DETAIL D (ELEVATION VIEW)
DETAIL E (PLAN VIEW)

1/2" [13] nominal gap
Note: (1) Parts shall be galvanized after assembly and welding.
PROFILE VIEW
SCALE 1:3

Wisconsin DOT Low Deflection Portable Concrete Barrier

Midwest Roadside Safety Facility

Mounting Bracket Weld Locations

Sheet: B of 12
Date: 8/11/2014
Drawing No: 600/2003
Notes:

1. Holes for barrier joint are prefabricated using 1 1/4" [32] schedule 40 PVC with inner diameter of 1.3635 [35].

2. The nominal hole size of 1 3/8" [35] should be used for actual installations.

3. Due to prototype fabrication issues, hole location tolerances were 1/4" - 1/2" [6 - 13] off in vertical and longitudinal direction. Thus, for testing, PVC was removed to increase hole diameter to 1.6642 [42] and allow for bolt installation. This would represent a worse case scenario for bolt hole tolerances.
Note: (1) 2" [51] clear cover used for all reinforcement.
Part b1

Wisconsin DOT Low Deflection Portable Concrete Barrier
Midwest Roadside Safety Facility
Splice Main Tube
<table>
<thead>
<tr>
<th>Item No.</th>
<th>QTY.</th>
<th>Description</th>
<th>Material Specifications</th>
<th>Hardware</th>
</tr>
</thead>
<tbody>
<tr>
<td>a1</td>
<td>16</td>
<td>Portable Concrete Barrier</td>
<td>( f_c = 5000 ) psi ( (34.5 \text{ MPa}) )</td>
<td>SWC09</td>
</tr>
<tr>
<td>a2</td>
<td>192</td>
<td>( 1/2'' ) Dia., 72'' [1829] Long Form Bar</td>
<td>ASTM A615 Grade 60</td>
<td>SWC09</td>
</tr>
<tr>
<td>a3</td>
<td>32</td>
<td>( 1/2'' ) Dia., 146'' [3708] Long Longitudinal Bar</td>
<td>ASTM A615 Grade 60</td>
<td>SWC09</td>
</tr>
<tr>
<td>a4</td>
<td>48</td>
<td>( 5/8'' ) Dia., 146'' [3708] Long Longitudinal Bar</td>
<td>ASTM A615 Grade 60</td>
<td>SWC09</td>
</tr>
<tr>
<td>a5</td>
<td>96</td>
<td>( 3/4'' ) Dia., 36'' [914] Long Anchor Loop Bar</td>
<td>ASTM A615 Grade 60</td>
<td>SWC09</td>
</tr>
<tr>
<td>a6</td>
<td>32</td>
<td>( 3/4'' ) Dia., 101'' [2565] Long Connection Loop Bar</td>
<td>ASTM A709 Grade 70 or A706 Grade 60</td>
<td>SWC09</td>
</tr>
<tr>
<td>a7</td>
<td>32</td>
<td>( 3/4'' ) Dia., 91'' [2311] Long Connection Loop Bar</td>
<td>ASTM A709 Grade 70 or A706 Grade 60</td>
<td>SWC09</td>
</tr>
<tr>
<td>a8</td>
<td>32</td>
<td>( 3/4'' ) Dia., 102'' [2591] Long Connection Loop Bar</td>
<td>ASTM A709 Grade 70 or A706 Grade 60</td>
<td>SWC09</td>
</tr>
<tr>
<td>b1</td>
<td>22</td>
<td>( 5'' \times 3'' \times 3/16'' ) [127x76x5], 12'-9 3/16'' [3891] Long Splice Main Tube</td>
<td>ASTM A500 Grade B Galvanized after Welding</td>
<td>FVWO2</td>
</tr>
<tr>
<td>b2</td>
<td>20</td>
<td>( 4 1/2'' \times 4 1/2'' \times 1/4'' ) [114x114x6], 22'' [559] Long Splice Insert</td>
<td>ASTM 572 Grade 50 Galvanized</td>
<td>-</td>
</tr>
<tr>
<td>b3</td>
<td>11</td>
<td>42''x33'' [1067x838] 10 Gauge Mounting Bracket Plate</td>
<td>ASTM A1011 Grade 50 Galvanized after Welding</td>
<td>-</td>
</tr>
<tr>
<td>b4</td>
<td>88</td>
<td>( 1'' ) [25] Dia. Washer</td>
<td>ASTM FB44 Galvanized</td>
<td>-</td>
</tr>
<tr>
<td>b5</td>
<td>44</td>
<td>( 1'' ) [25] Dia. UNC, 12 3/4'' [324] Long Heavy Hex Bolt and Nut</td>
<td>Bolt ASTM A325/A449 Type 1 Galvanized, Nut ASTM A563 Galvanized</td>
<td>-</td>
</tr>
<tr>
<td>b6</td>
<td>248</td>
<td>( 3/4'' ) [19] Dia. Washer</td>
<td>ASTM FB44 Galvanized</td>
<td>-</td>
</tr>
<tr>
<td>b7</td>
<td>80</td>
<td>( 3/4'' ) [19] Dia. UNC, 6 1/2'' [165] Long, 2'' [51] Threaded Hex Bolt and Nut</td>
<td>Bolt ASTM A325/A449/SAE Grade 5 Galvanized, Nut ASTM A563Dh Grade 5 Galvanized</td>
<td>-</td>
</tr>
<tr>
<td>b8</td>
<td>44</td>
<td>( 4'' \times 3'' \times 3/8'' ) [102x76x10], 12'' [305] Long L-Bracket</td>
<td>ASTM A529 Grade 50 Galvanized</td>
<td>-</td>
</tr>
</tbody>
</table>
RETOFIT, LOW-DEFLECTION, PORTABLE CONCRETE BARRIER

SWC20a-b

MwRSF

SHEET NO. DATE:
1 of 10 3/19/2015
INTENDED USE
Retrofit, Low-Deflection, Portable Concrete Barrier is a non-proprietary system and is to be used in situations where limited system deflection is required. The Retrofit, Low-Deflection, Portable Concrete Barrier should be used in locations where a maximum dynamic deflection of 43.0" [1,092] or less is acceptable and where a working width of 55.1" [1,400] is provided. The Retrofit, Low-Deflection, Portable Concrete Barrier with L-Brackets should be used in locations where a maximum dynamic deflection of 40.7" [1,034] or less is acceptable and where a working width of 51.9" [1,318] is provided. The system should be placed with a minimum distance of 24" [610] between the back face of the concrete barrier and the edge of the bridge deck or drop off. Retrofit, Low-Deflection, Portable Concrete Barrier may be used on a concrete or asphalt surface. The Retrofit, Low-Deflection, Portable Concrete Barrier system is intended for use with the Portable F-shape Concrete Barrier Element (SWC09) and the Portable Concrete Barrier Connector Pins with or without the retainer bolt (FMW02 or FMW03). The Portable F-shape Concrete Barrier Elements (SWC09) are to be placed in a straight line or a large radius curve where the existing design tolerances can accommodate the small angles between adjacent Portable F-shape Concrete Barrier Elements (SWC09). The Retrofit, Low-Deflection, Portable Concrete Barrier has been crash tested under Test Level 3 (TL-3) conditions of the Manual for Assessing Safety Hardware (MASH) and deemed acceptable according to the MASH safety performance criteria.

COMPONENTS
Unit Length = 307 3/8" [7807]

<table>
<thead>
<tr>
<th>DESIGNATOR</th>
<th>COMPONENT</th>
<th>NUMBER</th>
<th>SYSTEM</th>
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</thead>
<tbody>
<tr>
<td>FBX20a</td>
<td>6 1/2&quot; [165] Hex Bolt and Nut</td>
<td>16</td>
<td>a-b</td>
</tr>
<tr>
<td>FBX20b</td>
<td>13&quot; [330] Hex Bolt and Nut</td>
<td>8</td>
<td>b</td>
</tr>
<tr>
<td>or FMW02</td>
<td>14 1/4&quot; [362] Threaded Straight Anchor Stud and Nuts</td>
<td>8</td>
<td>b</td>
</tr>
<tr>
<td>FMX24b</td>
<td>12 3/4&quot; [324] Hex Bolt and Nut</td>
<td>8</td>
<td>a-b</td>
</tr>
<tr>
<td>or FMW03</td>
<td>14&quot; [356] Threaded Straight Anchor Stud and Nuts</td>
<td>8</td>
<td>a-b</td>
</tr>
<tr>
<td>SWC09</td>
<td>Connector Pin</td>
<td>2</td>
<td>a-b</td>
</tr>
<tr>
<td>or FMW03</td>
<td>Connector Pin with Retaining Bolt</td>
<td>2</td>
<td>a-b</td>
</tr>
<tr>
<td>FWC20a</td>
<td>Plain Round Washer</td>
<td>48</td>
<td>a-b</td>
</tr>
<tr>
<td>FWC24a</td>
<td>Plain Round Washer</td>
<td>16</td>
<td>a-b</td>
</tr>
<tr>
<td>SWC09</td>
<td>Portable Concrete Barrier with Bolt Holes</td>
<td>2</td>
<td>a-b</td>
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<tr>
<td></td>
<td>10-Gauge Mounting Bracket</td>
<td>2</td>
<td>a-b</td>
</tr>
<tr>
<td></td>
<td>Main Tube</td>
<td>2</td>
<td>a-b</td>
</tr>
<tr>
<td></td>
<td>Splice Tube Insert</td>
<td>2</td>
<td>a-b</td>
</tr>
<tr>
<td></td>
<td>L-Bracket</td>
<td>8</td>
<td>b</td>
</tr>
</tbody>
</table>

ELIGIBILITY
FHWA eligibility will be pursued.

REFERENCES

CONTACT INFORMATION
Midwest Roadside Safety Facility
Nebraska Transportation Center
University of Nebraska-Lincoln
130 Whittier Research Center
2200 Vine Street

RETROFIT, LOW-DEFLECTION, PORTABLE CONCRETE BARRIER

SWC20a-b

SHEET NO. 2 DATE: 3/19/2015
RETOFIT, LOW-DEFLECTION, PORTABLE CONCRETE BARRIER

SWC20a-b
ISOMETRIC VIEW

PLAN VIEW

ELEVATION VIEW

RETROFIT, LOW-DEFLECTION, PORTABLE CONCRETE BARRIER
SPECIFICATIONS

The Main Tube shall be manufactured using ASTM A500 Grade B steel. The Splice Tube Insert shall be manufactured using ASTM A572 Grade 50 steel or equivalent, and the 10-Gauge Mounting Bracket shall be manufactured using ASTM A1011 Grade 50 steel.

The L-Bracket should be a pre-manufactured piece made from ASTM A529 Grade 50 steel and meeting the dimension specifications herein.

The Main Tube, Mounting Bracket, L-Bracket assembly, and the Splice Tube Insert should be zinc-coated according to AASHTO M111 (ASTM A123) except when corrosion resistant steel is requested.

Dimension tolerances not shown or implied are intended to be those consistent with the proper functioning of the part, including its appearance and accepted manufacturing practices.
10-Gauge Mounting Bracket

Profile View

Main Tube

L-Bracket for b

3/16" [5] (TYP)

3/16" [5] (TYP)

L-Bracket for b

1/8" [3] (TYP)

Main Tube

PROF VIEW

SWC09 Bolt Hole Placement
Elevation View

RETROFIT, LOW-DEFLECTION, PORTABLE CONCRETE BARRIER

SWC20a-b

MwRSF

SHEET NO. DATE:
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RETROFIT, LOW-DEFLECTION, PORTABLE CONCRETE BARRIER

SWC20a-b

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<tbody>
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</tr>
</tbody>
</table>
PLAN VIEW

ELEVATION VIEW

ISOMETRIC VIEW

PROFILE VIEW

FLAT PATTERN

10-GAUGE MOUNTING BRACKET PLATE

RETROFIT, LOW-DEFLECTION, PORTABLE CONCRETE BARRIER

SWC20a-b

MWRSF

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ISOMETRIC VIEW

PLAN VIEW

ELEVATION VIEW

PROFILE VIEW

FLAT PATTERN

SPICE TUBE INSERT

RETROFIT, LOW-DEFLECTION, PORTABLE CONCRETE BARRIER

SWC20a-b

MwRSF

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