U.S. Department
of Transportation
Federal Highway Administration

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

March 14, 2014

In Reply Refer To:
HSST/B-50A

Mr. Chuck A. Plaxico, Ph.D.
RoadSafe LLC
12 Main Street
Canton, ME. 04221

Dear Mr. Plaxico:

This letter is in response to your request for the Federal Highway Administration (FHWA) to review a roadside safety system for eligibility for reimbursement under the Federal-aid highway program.

Name of system: Modified NETC 4-Bar Bridge Rail, Report 350
Type of system: Longitudinal Barrier
Test Level: NCHRP 350 TL4
Testing conducted by: Roadsafe, LLC
Task Force 13 Designator: SBB46d
Date of request: February 24, 2013
Date of completed package: February 26, 2014

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

- Modified NETC 4-Bar Bridge Rail, Report 350

Based on a review of FEA Analysis and Verification and Validation as per FHWA Memorandum "Roadside Safety Hardware-Federal-aid Reimbursement Eligibility Process", Dated May 21, 2012 of the modified device compared to original crash test results submitted by the manufacturer certifying the device described herein meets the crashworthiness criteria of the National Cooperative Highway Research Program (NCHRP) Report 350, the device is eligible for reimbursement under the Federal-aid highway program. Eligibility for reimbursement under the Federal-aid highway program does not establish approval or endorsement by the FHWA for any particular purpose or use. The FHWA, the Department of Transportation, and the United States Government do not endorse products or services and the issuance of a reimbursement eligibility letter is not an endorsement of any product or service.

Requirements
Roadside safety devices should meet the guidelines contained in NCHRP Report 350 (Report 350) if tested prior to January 1, 2011, or the American Association of State Highway and Transportation Officials' Manual for Assessing Safety Hardware (MASH) if tested after that date. The FHWA Memorandum "Identifying Acceptable Highway Safety Features", dated July 25, 1997, provides further guidance on crash testing requirements of longitudinal barriers.

Description
The modified device and supporting documentation are described in the attached form.

Summary and Standard Provisions
Therefore, the system described and detailed in the attached form is eligible for reimbursement and may be installed under the range of conditions tested.

Please note the following standard provisions that apply to FHWA eligibility letters:

- 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 existing Task Force 13 drawing for posting on the on-line 'Guide to Standardized Highway Barrier Hardware' currently referenced in AASHTO Roadside Design Guide.
- This finding of eligibility does not cover other structural features of the systems, nor conformity with the Manual on Uniform Traffic Control Devices.
- Any changes that may influence system conformance with MASH will require a new reimbursement eligibility letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals safety problems, or that the system is significantly different from the version that was crash tested, we reserve the right to modify or revoke this letter.
- You are expected to supply potential users with sufficient information on design and installation 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 NCHRP Report 350.
- To prevent misunderstanding by others, this letter of eligibility is designated as number B-50A and 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 at our office 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. The FHWA does not become involved in issues concerning patent law. Patent issues, if any, are to be resolved by the applicant.

Sincerely yours,

Michael S. Griffith

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

Enclosure

Request for Federal Aid Reimbursement Eligibility Of Highway Safety Hardware

Submitter	Date of Request:	February 27, 2014	◉ New ○ Resubmission
	Name:	Chuck A. Plaxico	Signature: Chuck Plaxico
	Company:	RoadSafe LLC	
	Address:	12 Main Street, Canton, ME 04221	
	Country:	U.S.	
	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.

System Type	Submission Type	Device Name / Variant	Testing Criterion	Test Level
'B': Barriers (Roadside, Median, Bridge Railings)	○ Physical Crash Testing ◉ FEA & V&V Analysis	Modified NETC 4-Bar Bridge Rail	NCHRP Report 350	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 NCHRP Report 350 (Report 350) and that the evaluation results meet the appropriate evaluation criteria in the Report 350.

Identification of the individual or organization responsible for the product:

Contact Name:	Chuck A. Plaxico	Same as Submitter ☒
Company Name:	RoadSafe LLC	Same as Submitter ☒
Address:	12 Main Street, Canton, ME 04221	Same as Submitter ☒
Country:	U.S.	Same as Submitter ☒

This request is for a determination of Federal-aid reimbursement eligibility using Finite Element Analysis and Verification and Validation Analysis [NCHRP Web-Only Document 179] (WD-179) for a structural change to previously eligible hardware where the effect on the crash test performance of the hardware is uncertain.

FEA PRODUCT DESCRIPTION	
Modification to Existing Hardware	◉ Non-Significant - Effect is Uncertain ○ Non-Significant - Effect is Positive or Inconsequential

Request for Federal Aid Reimbursement Eligibility Of Highway Safety Hardware

Submitter	Date of Request:	February 26, 2014	◉ New ○ Resubmission
	Name:	Chuck A. Plaxico	Signature:
	Company:	RoadSafe LLC	
	Address:	12 Main Street, Canton, ME 04221	
	Country:	U.S.A.	
	To:	Michael S. Griffith, Director FHWA, Office of Safety Technologies	

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System Type	Submission Type	Device Name / Variant	Testing Criterion	Test Level
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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 NCHRP Report 350 (Report 350) and that the evaluation results meet the appropriate evaluation criteria in the Report 350.

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Contact Name:	Chuck A. Plaxico	Same as Submitter ☒
Company Name:	RoadSafe LLC	Same as Submitter ☒
Address:	12 Main Street, Canton, ME 04221	Same as Submitter ☒
Country:	U.S.A.	Same as Submitter ☒

This request is for a determination of Federal-aid reimbursement eligibility using Finite Element Analysis and Verification and Validation Analysis [NCHRP Web-Only Document 179] (WD-179) for a structural change to previously eligible hardware where the effect on the crash test performance of the hardware is uncertain.

FEA PRODUCT DESCRIPTION	
Modification to Existing Hardware	◉ Non-Significant - Effect is Uncertain ○ Non-Significant - Effect is Positive or Inconsequential

FEA PRODUCT DESCRIPTION

The modified NETC 4-Bar bridge Railing described herein includes the use of proprietary ACROW deck panels which include a 6-inch (152 mm) tall integrated curb. The modified NETC 4-Bar bridge railing can also be used with other deck types (i.e., steel grating, timber, etc.) since the deck is not integral with the bridge railing. If deck types are used that do not have a curb, the lower railing can be positioned 7-inches (178 mm) from the top of the deck. This later arrangement is more similar to the original NETC 4-Bar bridge railing test so successful analysis of the higher rail with curb was judged to be the more critical analysis case.

The NETC 4-Bar bridge rail was originally tested under NCHRP Report 350 TL-4 as a sidewalk-mounted system with 8-ft post spacing (FHWA eligibility letter B-50). The NETC 4-Bar bridge rail design has been modified to allow for installation of the bridge rail alongside a pre-fab steel deck panel system installed on standard through-truss bridges. The modifications include: removal of the sidewalk, extending the post down to the bridge deck floor beams, increasing thickness of the post base plate and expanding post spacing to 10 feet. In accordance with the FHWA HSST memorandum May 21, 2012, finite element analysis (FEA) was used to simulate Report 350 test level 4 impact test conditions for the modified design to verify that the that crash performance is not negatively affected and meets FHWA crash testing standards.

Based on the findings of this study, we respectfully request that these modifications be formally accepted for FHWA Federal-Aid Reimbursement Eligibility under the original NCHRP Report 350 TL-4 classification. The modified design is non-proprietary; however, the specifics of this design were based on installation of the bridge rail on steel through- truss bridges that use Acrow deck panels, which are proprietary. We also request that the modified bridge rail design be eligible for Federal-Aid reimbursement when used on steel through-truss bridges with other deck types (e.g., wood or open steel grating) under the following restrictions:

- Maximum spacing of floor beams is 10 feet.
- The lower tubular rail element on the bridge rail system may be mounted onto the bridge rail posts at a minimum mounting height of 7 inches (i.e., original design) up to a maximum mounting height of 9 inches (i.e., design evaluated herein). When a drainage curb is not used on the deck, a mounting height of 7 inches shall be used according to the original design.
- The minimum thickness for the baseplate is 1.5 inches for all installations on steel through-truss bridge decks.
- The maximum post length shall be 44.6 inches, measured from top of post to top of base plate.
- All of the floor-beam stiffening alternatives presented herein are applicable for cases where the floor-beams are of size W27x146 or larger. In particular, the minimum thickness of the floor-beam flange is 0.975 inches, the minimum plastic modulus of the floor beam about its x-axis (i.e., Zx) is 461 in2 and the minimum plastic modulus of the floor beam about the y-axis (i.e., Zy) is 50.76 in2. If the floor beam is of smaller size, then a yield-line analysis or a FE analysis may be conducted to verify that excessive loads are not transferred into the bridge superstructure according to Section 13 of the LRFD Bridge Design Specifications.

FEA ANALYSIS OF CRASH TESTING

A brief description of each analysis and its result:

Required Test Number	Narrative Description	FEA Analysis Results According to Report 350?	V&V Analysis Results in accordance to WD-179?
4-10 (820C)	Based on the FEA analysis findings, it was further concluded that the analysis of the modified system under NCHRP Report 350 Test 4-10 is unnecessary. As shown in the crash test report for the original system (Test NETC-1 conducted by SwRI on 11/18/1997), the small car test resulted in (1) negligible damage to the barrier, (2) very stable redirection of the vehicles, and (3) reported occupant risk measures that were well below the limits of NCHRP Report 350. In particular, the small car test (i.e., Test NETC-1) resulted in OIV values of 4.6 ft/s and 21 ft/s in the longitudinal and lateral directions, respectively (compared to the limit of 39.4 ft/s); and maximum lateral ORA value of 6.4 g (compared to the limit of 20 g).	WAIVER REQUESTED	WAIVER REQUESTED
S4-10 (700C)	Not Required		
4-11 (2000P)	Based on the FEA analysis findings, it was further concluded that the analysis of the modified system under NCHRP Report 350 Test 4-11 is unnecessary. As shown in the crash test report for the original system (Test NETC-2 conducted by SwRI on 11/20/1997), the pickup truck tests resulted in (1) negligible damage to the barrier, (2) very stable redirection of the vehicles, and (3) reported occupant risk measures that were well below the limits of NCHRP Report 350. In particular, the pickup test (i.e., Test NETC-2) resulted in longitudinal OIV of 13.1 ft/s (compared to the limit of 39.4 ft/s) and maximum longitudinal ORA of 2.6 g (compared to the limit of 20 g).	WAIVER REQUESTED	WAIVER REQUESTED
4-12 (8000S)	8000S impacting at 80 km/hr and 15 deg.	PASS	YES
4-20 (820C)	Not Required		
S4-20 (700C)	Not Required		
4-21 (2000P)	Not Required		
4-22 (8000S)	Not Required		

The submitted Finite Element Analysis was conducted in compliance with FHWA Memorandum 'Roadside Safety Hardware -Federal-Aid Reimbursement Eligibility Process', dated May 21, 2012 including all updates to this memorandum by the following accredited laboratory (cite laboratory's accreditation status in the FEA Analysis final report):

FEA & V&V Laboratory Name:	Roadsafe LLC, Canton ME	
FEA & V&V Laboratory Contact:	Chuck A. Plaxico	Same as Submitter☒
Address:	12 Main Street, Canton, ME 04221	Same as Submitter☒
Country:	U.S.A.	Same as Submitter☒
Accreditation Certificate Number and Date:	N/A	

ATTACHMENTS

Attach to this form:

Finite Element Analysis using LS-Dyna that shows the modified hardware will perform in a similar manner to the NCHRP Report 350 crash testing that was first used to evaluate roadside hardware.

2) Validation and Verification (V&V) analysis and report conforming to Appendix E as per the NCHRP W 179 [NCHRP Web-Only Document 179] shall be submitted for both the original model compared to the baseline test and the model of the non-significant change compared to the baseline test.

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

FHWA Official Business Only:

Eligibility Letter		AASHTO TF13	
Number	Date	Designator	Key Words
B-50A	February 27, 2014	SBB46d	NETC 4-Bar bridge rail, NCHRP350, Through Truss Bridge Railing

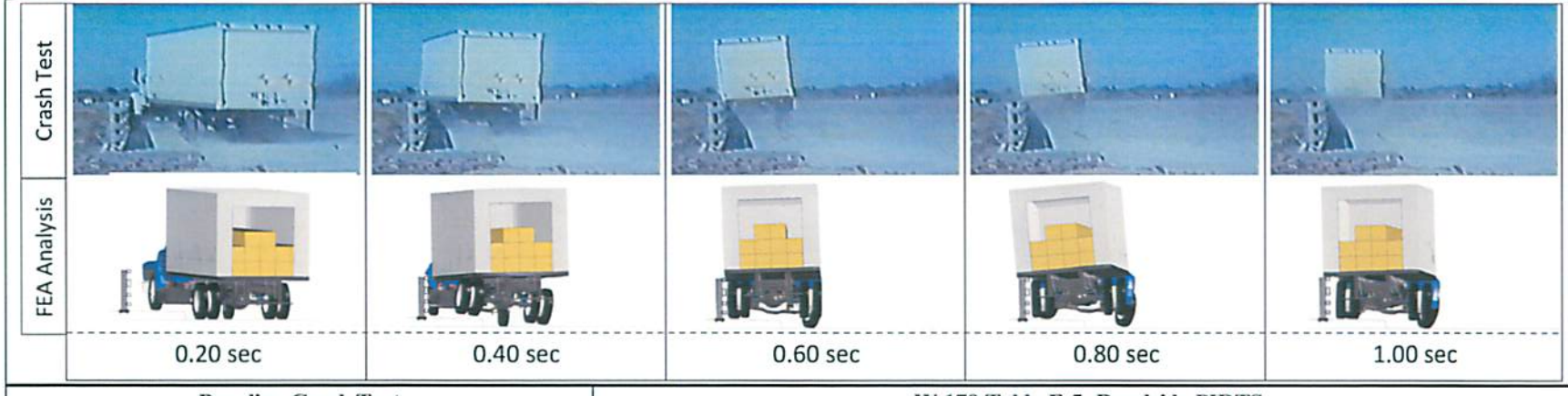
Date: 11/22/2013

Finite Element Analysis Determination of Elibibility for Reimbursement under the Federal-Aid Highway Program (FHWA Memorandum)

System Type:	Bridge Rail
Device Name:/Variant:	NETC 4-Bar w/ Side Walk
Testing Criterion:	NCHRP Report 350
Test Level:	TL 4
FHWA Letter:	B50

Comparison: Crash tested original design to FEA of original design

Submissions Type:	
	Non-Significant -- Effect is Uncertain
	Non-Significant -- Effect is Positive
	Non-Significant -- Effect is Inconsequential
X	**Baseline Validation of Crash Test to FEA Analysis.**



Baseline Crash Test	
Test Number:	SwRI NETC-3
Vehicle:	8000S
Vehicle Mass:	17,875 lb
Impact Speed:	49.8 mph / 15 deg
Impact Location:	27 in. upstream of Post 6
Tested Hardware:	Original Design
FEA Hardware:	Original Design

W-179 Table E-1: Verification Evaluation Summary		
Total Energy:	5.0%	Pass
Hourglass Energy:	0.0%	Pass
Mass Added:	<1%	Pass
Shooting Nodes:	No	Pass
Negative Volumes:	No	Pass

W-179 Table E-5: Roadside PIRTS					
Structural Adequacy	**Test**	**FEA**	**Occupant Risk (cont.)**	**Test**	**FEA**
A1 - Acceptable perf.?	Yes	Yes	L1 – Long. OIV	1.7 m/s	2.4 m/s
A2 – Permenant	0.51 in	0.66 in	L1 – Lat. OIV	2.9 m/s	5.5 m/s
A3 – Contact Length	40 ft	35 ft	L2 – Long. ORA	8.95 g	9.4 g
A5 – Comp. Failures?	No	No	L2 – Lat. ORA	14.3 g	14.6 g
A6 – Connection Failure?	No	No	**Vehicle Trajectory**		
A7 – Wheel Snagging?	No	No	M2 – Exit Yaw Angle	4.1 deg	0.5 deg
A8 – Vehicle Snagging?	No	No	M3 – Exit Velocity	35.8 mph	39.6 mph
Occupant Risk	**Test**	**FEA**	**W-179 Table E-3 (Multi-Channel Method)**		
D – Detached elements?	No	No	Sprague-Geer Magnitude < 40	19.7	Pass
F2 – Max. Vehicle Roll	Unk		Sprague-Geer Phase < 40	26.1	Pass
F3 – Max. Vehicle Pitch	Unk		ANOVA Mean	2	Pass
F4 – Max. Vehicle Yaw	Unk		ANOVA Standard Deviation	25.9	Pass

Figure 1. Summary of results from analysis compared with full-scale crash test for validation of the baseline model.

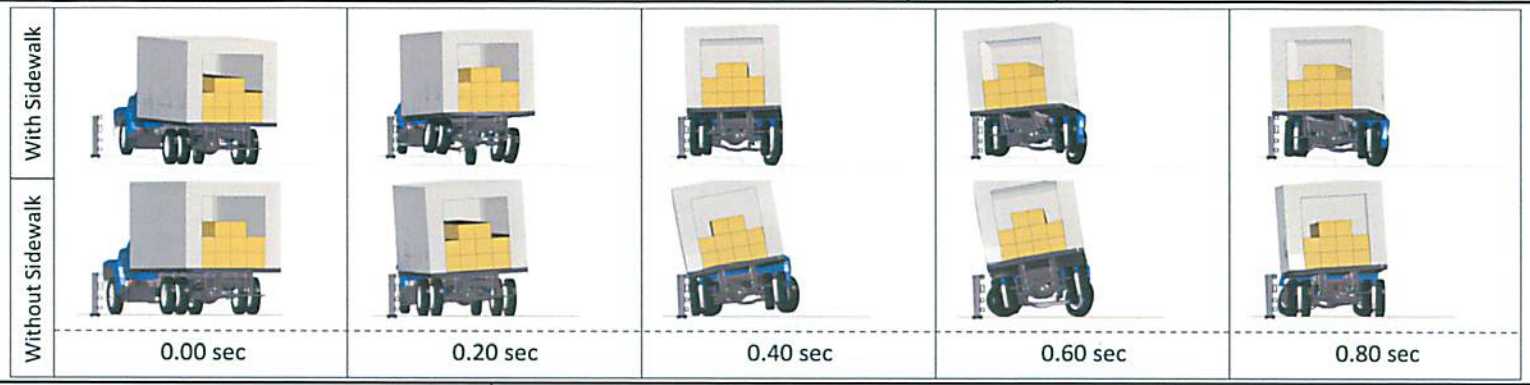
Date: 11/24/2013

Finite Element Analysis Determination of Elibibility for Reimbursement under the Federal-Aid Highway Program (FHWA Memorandum)

System Type:	Bridge Rail
Device Name/Variant:	Baseline NETC 4-Bar wo/ Sidewalk
Testing Criterion:	NCHRP Report 350
Test Level:	TL 4
FHWA Letter:	

Comparison: Crash tested original design to FEA of original design

Submissions Type:	
	Non-Significant -- Effect is Uncertain
	Non-Significant -- Effect is Positive
X	**Non-Significant – Effect is Inconsequential**
	Baseline Validation of Crash Test to FEA Analysis.



Baseline Crash Test		
Analysis Number:	NETC-3_R131114	
Vehicle:	50_F800-131025_FullBallast.k	
Vehicle Mass:	17,875 lb	
Impact Speed/Angle:	49.8 mph / 15 deg	
Impact Location:	24 inches upstream of Post 6	
Original Hardware	NETC with sidewalk 8-ft span	
Modified Hardware	NETC without sidewalk 8-ft span	
W-179 Table E-1: Verification Evaluation Summary		
Total Energy:	0.0%	Pass
Hourglass Energy:	0.0%	Pass
Mass Added:	<1%	Pass
Shooting Nodes:	No	Pass
Negative Volumes:	No	Pass

W-179 Table E-5: Roadside PIRTS					
Structural Adequacy	**w/ sidewalk**	**wo/ sidewalk**	**Occupant Risk (cont.)**	**w/ sidewalk**	**wo/ sidewalk**
A1 - Acceptable perf.?	Yes	Yes	L1 – Long. OIV	2.4 m/s	1.8 m/s
A2 – Permenant	0.66 in	2.0 in	L1 – Lat. OIV	5.5 m/s	3.9 m/s
A3 – Contact Length	35 ft	20 ft	L2 – Long. ORA	9.4 g	6.8 g
A5 – Comp. Failures?	No	No	L2 – Lat. ORA	14.6 g	15.0 g
A6 – Connection Failure?	No	No	**Vehicle Trajectory**		
A7 – Wheel Snagging?	No	No	M2 – Exit Yaw Angle	0.5 deg	0.6 deg
A8 – Vehicle Snagging?	No	No	M3 – Exit Velocity	39.6 mph	42.5 mph
Occupant Risk	**w/ sidewalk**	**wo/ sidewalk**	**W-179 Table E-3 (Multi-Channel Method)**		
D – Detached elements?	No	No	Sprague-Geer Magnitude < 40		N.A.
F2 – Max. Vehicle Roll	5.5 deg	10.4 deg	Sprague-Geer Phase < 40		N.A.
F3 – Max. Vehicle Pitch	3.3 deg	3.4 deg	ANOVA Mean		N.A.
F4 – Max. Vehicle Yaw	0.5 deg	4.1 deg	ANOVA Standard Deviation		N.A.

Figure 2. Summary of results for analysis of baseline design *without* sidewalk compared to analysis of crash tested design with sidewalk.

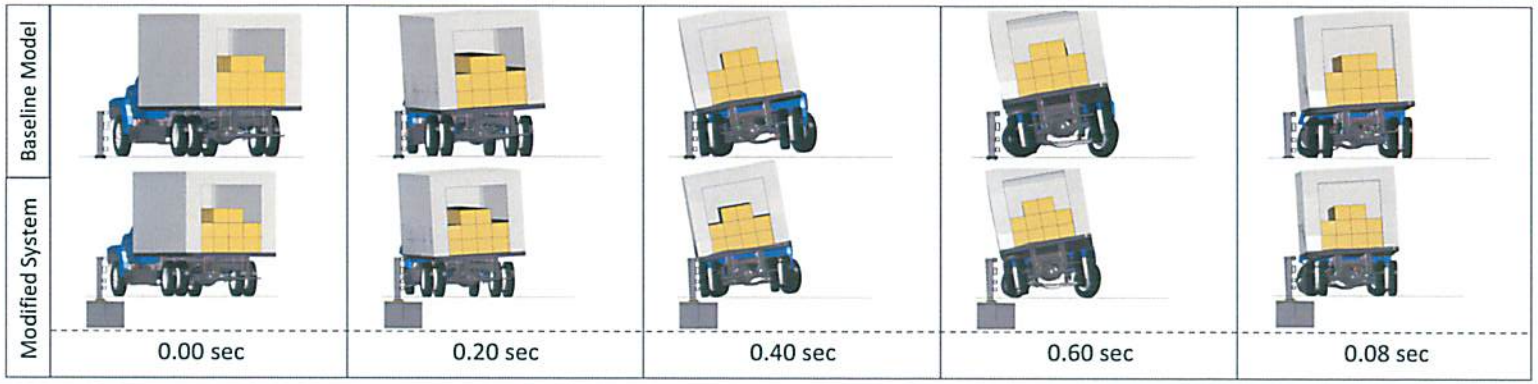
Date: 11/24/2013

Finite Element Analysis Determination of Elibibility for Reimbursement under the Federal-Aid Highway Program (FHWA Memorandum)

System Type:	Bridge Rail
Device Name:/Variant:	Modified NETC 4-Bar wo/ Sidewalk
Testing Criterion:	NCHRP Report 350
Test Level:	TL 4
FHWA Letter:	

Comparison: Crash tested original design to FEA of original design

Submissions Type:	
	Non-Significant -- Effect is Uncertain
	Non-Significant -- Effect is Positive
X	**Non-Significant – Effect is Inconsequential**
	Baseline Validation of Crash Test to FEA Analysis.



Baseline Crash Test	
Analysis Number:	NETC-NoCurb_131112
Vehicle:	50_F800-131025_FullBallast.k
Vehicle Mass:	17,875 lb
Impact Speed/Angle:	49.8 mph / 15 deg
Impact Location:	24 inches upstream of Post 6
Original Hardware	NETC wo/ sidewalk 8-ft span
Modified Hardware	NETC w/ Mount 11b and 10' span

W-179 Table E-1: Verification Evaluation Summary		
Total Energy:	0.0%	Pass
Hourglass Energy:	0.0%	Pass
Mass Added:	<1%	Pass
Shooting Nodes:	No	Pass
Negative Volumes:	No	Pass

W-179 Table E-5: Roadside PIRTS					
Structural Adequacy	**Baseline**	**Modified**	**Occupant Risk (cont.)**	**Baseline**	**Mod**
A1 - Acceptable perf.?	Yes	Yes	L1 – Long. OIV	1.8 m/s	1.4 m/s
A2 – Permenant	2.0 in	2.24 in	L1 – Lat. OIV	3.9 m/s	2.5 m/s
A3 – Contact Length	20 ft	24 ft	L2 – Long. ORA	6.8 g	7.8 g
A5 – Comp. Failures?	No	No	L2 – Lat. ORA	15.0 g	17.1 g
A6 – Connection Failure?	No	No	**Vehicle Trajectory**		
A7 – Wheel Snagging?	No	No	M2 – Exit Yaw Angle	0.6 deg	1.6 deg
A8 – Vehicle Snagging?	No	No	M3 – Exit Velocity	42.5 mph	42.4 mph
Occupant Risk	**Baseline**	**Modified**	**W-179 Table E-3 (Multi-Channel Method)**		
D – Detached elements?	No	No	Sprague-Geer Magnitude < 40	2.3	Pass
F2 – Max. Vehicle Roll	10.4	10.3	Sprague-Geer Phase < 40	16.54	Pass
F3 – Max. Vehicle Pitch	3.4	3	ANOVA Mean	0	Pass
F4 – Max. Vehicle Yaw	15.6	16.6	ANOVA Standard Deviation	11.4	Pass

Figure 3. Summary of results from the analysis of the modified design compared with the analysis of the baseline design without sidewalk.