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

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

June 26, 2013

In Reply Refer To:
HSST/ B-97C

Mr. Barry Stephens
Trinity Highway Products
3617 Cincinnati Ave.
Rocklin, CA 95765

Dear Mr. Stephens:

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: Yodock TL-2 & TL-3 Barrier Rail Kit
Type of system: Portable Barrier
Test Level: National Cooperative Highway Research Program (NCHRP) Report 350 Test Level 3
Testing conducted by: n/a
Task Force 13 Designator: SWM19
Date of request: April 2, 2013
Date of completed package: May 6, 2013

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

- Yodock TL-2/TL-3 Barrier Rail Kit

Based on a review of original crash test results and computational analysis submitted by the manufacturer certifying the device described herein meets the crash test and evaluation 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
To be found eligible for Federal-aid funding, roadside safety devices should meet the crash test and evaluation criteria contained in the National Cooperative Highway Research Program (NCHRP) Report 350 or the American Association of State Highway and Transportation Officials' Manual for Assessing Safety Hardware (MASH).

Description
The 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.

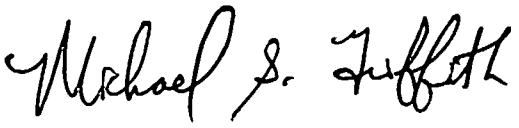
Please note the following standard provisions that apply to FHWA eligibility letters:

- 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 NCHRP Report 350 criteria 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 crash test and evaluation criteria of the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of eligibility is designated as number B-97C 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.
- The Yodock TL-2 & TL-3 Barrier Rail is a patented product and considered 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.
- Because some water ballasted barriers and channelizers are similar in appearance, the FHWA recommends labeling each unit or module to indicate limitations on use. When

used as a barrier all hardware, both internal and external that was used in the crash testing, shall be installed per the manufacturer's instructions. Recommended guidance for such labels may be found on the web site of the AASHTO/AGC/ARTBA Task Force 13 at http://www.aashtotf13.org.

- Because it is a steel product, the Yodock TL-2 & TL-3 Barrier Rail is subject to Section 635.410 (Buy America) of Title 23, U.S. Code of Federal Regulations, and cannot be permanently incorporated into any federally funded project unless it is made in the U.S. from U.S. steel.

Sincerely yours,



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

Enclosures

Request for Federal Aid Reimbursement Eligibility Of Highway Safety Hardware

Submitter			
	Date of Request:	April 02, 2013	◉ New ○ Resubmission
	Name:	Bret Eckert, P.E.	Signature: Bret Eckert
	Company:	Trinity Highway Products	
	Address:	3617 Cincinnati Ave., Rocklin, CA 95765	
	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.

Help

System Type	Submission Type	Device Name / Variant	Testing Criterion	Test Level
'B': Barriers (Roadside, Median, Bridge Railings)	◉ Physical Crash Testing ○ FEA & V&V Analysis	Yodock TL-2/TL-3 Barrier Rail Kit	NCHRP Report 350	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 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:	Bret Eckert, P.E.	Same as Submitter ☒
Company Name:	Trinity Highway Products	Same as Submitter ☒
Address:	3617 Cincinnati Ave., Rocklin, CA 95765	Same as Submitter ☒
Country:	USA	Same as Submitter ☒

PRODUCT DESCRIPTION

○ New Hardware	◉ Modification to Existing Hardware	Non-Significant - Effect is positive or inconsequential

This modification is for an improved Yodock TL-2/TL-3 Barrier Rail kit. The modification consists of improved brackets that connect the two load bearing longitudinal rails on each side of the Yodock Barrier. The current longitudinal rails, end connector channels and end connector hardware will be unchanged and continue to be made from 3 1/2" x 3 1/2" x 1/4" A500 structural tubing, 3/8" A36 plate, and 3/4" Grade 8 fasteners, respectively. The current brackets are made from a combination of 3/8" thick A36 steel plates and 3/8" thick x 4" x 3" A36 steel angle that are welded to each longitudinal rail, and the two rail assemblies joined using two (2) 1/2" diameter Grade 5 fasteners. The proposed brackets are made from 1/2" thick A36 formed steel angles also welded to each longitudinal rail, and the two rail assemblies are also joined using two (2) 1/2" diameter Grade 5 fasteners. The longitudinal rails are maintained at the exact elevation as tested in the original NCHRP 350 TL-2/ TL-3 qualification testing. The overall weight of the current version is 192 lbs. and the weight of the proposed version is 218 lbs. See the attached drawings for exploded isometric drawings of each Yodock TL-2/TL-3 Barrier Rail kit example. We certify that the improved Yodock TL-2/TL-3 Barrier Rail kit is a non-significant and positive modification and request FHWA provide certification for continued Federal-aid reimbursement eligibility.

Request for Federal Aid Reimbursement Eligibility Of Highway Safety Hardware

Submitter	Date of Request:	April 09, 2013	◉ New ○ Resubmission
	Name:	Bret Eckert, P.E.	Signature:
	Company:	Trinity Highway Products	
	Address:	3617 Cincinnati Ave., Rocklin, CA 95765	
	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.

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CRASH TESTING

A brief description of each crash test and its result:

Required Test Number	Narrative Description	Evaluation Results
3-10 (820C)	Test 3-10 was originally conducted as Test No. 400001-YWC8 on 1/28/02 and reported in TTI Crash Test Report No 40001-YWC8 per NCHRP 350 Test 3-10, TL-3 test level requirements. Test 3-10 is requested to be waived for this modification in lieu of the positive results as provided on the attached engineering analysis.	WAIVER REQUESTED
S3-10 (700C)	Test S3-10 is an optional test and was waived in the original FHWA acceptance letter HSA-10/B97. Test S3-10 is requested to be also waived for this modification in lieu of the positive results as provided on the attached engineering analysis.	WAIVER REQUESTED
3-11 (2000P)	Test 3-11 was originally conducted as Test No. 400001-YWC6 on 9/14/01 and reported in TTI Crash Test Report No 400001-YWC6 per NCHRP 350 Test 3-11, TL-3 test level requirements. Test 3-11 is requested to be waived for this modification in lieu of the positive results as provided on the attached engineering analysis.	WAIVER REQUESTED
3-20 (820C)	Not Applicable	
S3-20 (700C)	Not Applicable	
3-21 (2000P)	Not Applicable	

Full Scale Crash Testing was done in compliance with NCHRP 350 eff 6/11/13 ~~MASH~~ by the following accredited crash test laboratory (cite the laboratory's accreditation status as noted in the crash test reports.):

Laboratory Name:	Texas Transportation Institute	
Laboratory Contact:	Eugene Buth	Same as Submitter ☐
Address:	The Texas A&M University System College Station, TX 77843-3135	Same as Submitter ☐
Country:	USA	Same as Submitter ☐
Accreditation Certificate Number and Date:	2821.01, 4/30/2015	

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:

Eligibility Letter		AASHTO TF13	
Number	Date	Designator	Key Words
B97C	May 17, 2013	SWM19	Work Zone Barrier; portable energy disbursement cell; blow molded high-density polyethylene; Barrier Wall Kit; water ballasted

TRINITY
HIGHWAY PRODUCTS
ENERGY ABSORPTION SYSTEMS
3617 Cincinnati Ave, Rocklin, CA 95765
(916) 645-8181 Fax No (916) 645-3495

Engineering Analysis Of Improved TL-3 Rail Kit For Yodock Longitudinal Barrier

Energy Absorption Systems Inc.
3617 Cincinnati Ave.
Rocklin, CA, 95765

March 28, 2013

Keith Wilson
Applications Engineer

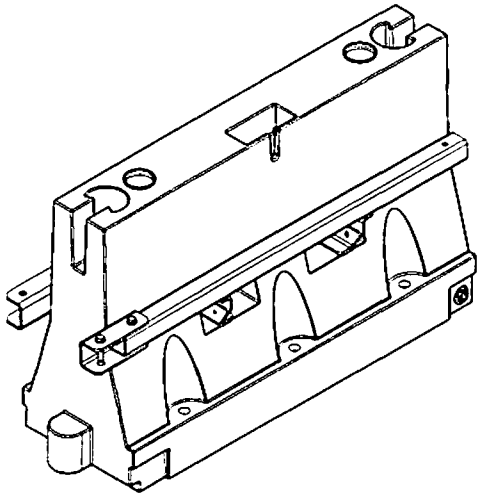

Figure 7. Model 2001 Yodock Barrier equipped with new Rail Kit

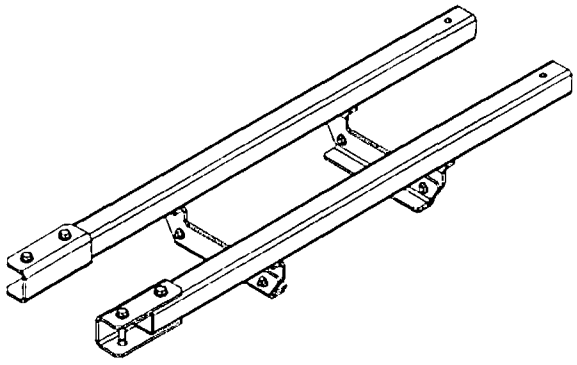

Figure 8. New Rail Kit – uninstalled

COMPONENT ANALYSIS – MOUNTING BRACKET:

The simplification of the mounting bracket design, located within the forklift pocket, is the basic change to the rail kit. There are 2 areas to analyze with the new bracket design:

- Strength of Bracket Assembly
- Snag Potential

Each area will be discussed in detail below:

Strength of Bracket Assembly

When considering the strength of the new bracket assembly we compare the weakest element of each assembly. Version 1's weakest element is the (2) 3/4" diameter bolts which extend through the rail, through the wood spacers and finally through the c-channel below; see Figure 9 for reference. With version 3 we evaluate the three following modes of failure to determine the weakest element compared to version 1:

a) Mounting bracket failure
b) Bolted mounting bracket connection
c) Strength of weld at mounting bracket to rail tube

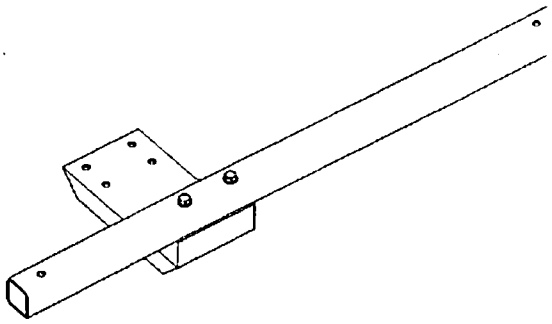

Figure 9. Evaluating (2) 3/4" bolts At version 1.

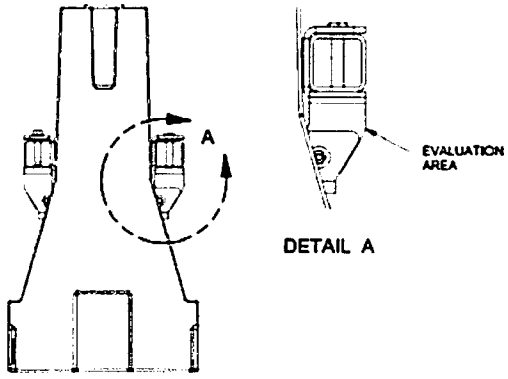

Figure 10. Evaluating smallest cross-sectional area of version 3

First we evaluate the shear strength of the (2) 3/4" bolts at version 1:

$$\tau = .577\sigma = \frac{F}{2A}$$

Where:

Area = .344 in^2 (Tensile stress area of a 3/4-10 bolt)

σ = 120,000 psi

We solve to the find the maximum force allowable from version 1:

$$\therefore F = .577(120{,}000) * 2(.344)$$

$$\therefore F = 46{,}252\ lbs$$

---

a) Mounting bracket failure

Refer to Figure 10 above. Evaluating the shear strength of the base material of the version 3 bracket we have:

$$\tau = .577\sigma = \frac{F}{A}$$

Where:

Area = smallest cross-sectional area of bracket = 3.50in x .5in thick = 1.75in^2

σ = ultimate stress of A36 steel = 58,000 psi

$$\therefore F = .577(58{,}000)(1.75)$$

$$\therefore F = 58{,}570\ lbs$$

---

b) Bolted mounting bracket connection

As mentioned previously, the version 3 rail kit will use (2) 3/4" diameter grade 5, hex head bolts to assemble the two rail kits together at each barrier. Therefore identical to the evaluation above we have:

$$\tau = .577\sigma = \frac{F}{2A}$$

Where:

Area = .344 in^2

σ = 120,000 psi

We solve to the find the maximum force allowable from version 1:

$$\therefore F = .577(120{,}000) * 2(.344)$$

$$\therefore F = 46{,}252\ lbs$$

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c) Strength of weld at mounting bracket to rail tube

As mentioned previously the version 3 rail kit mounting bracket is now welded to the underside of the rail tube. Evaluating the strength of weld for maximum force we have:

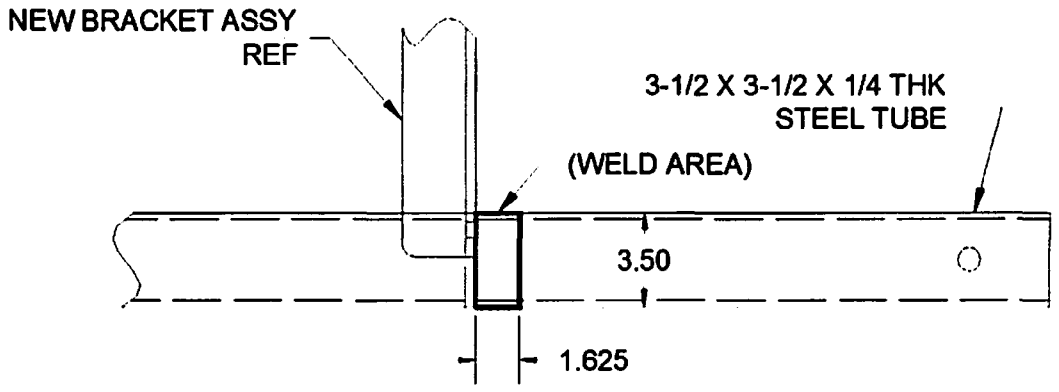


Figure 11. Strength of weld evaluation at underside of rail kit to mounting bracket

$$Average\ Shear\ Stress \quad \tau = \frac{F}{0.707hl}$$

Where: τ = 36,000 psi A36 Steel Shear Strength

h = .250in Height of Weld

l = 10.25in Total Length of Weld

$$Evaluating\ for\ \max force \therefore\ F = 36{,}000(0.707)(.25)(10.25)$$

$$\therefore\ F = 65{,}220\ lbs$$

Upon analyzing the three modes of failure we see the weakest element of the version 3 bracket assembly, failure mode "b", is equally as strong as the weakest element of version 1. Failure mode "a" and "c" are greater in strength compared to version 1.

Snag Potential

When evaluating the snag potential of the new design with the tested and approved design of version 1, it can be seen from the figures below that the snag potential area is less than it was with the version 1 kit, therefore qualifying the version 3 kit. See Figure 12 below:

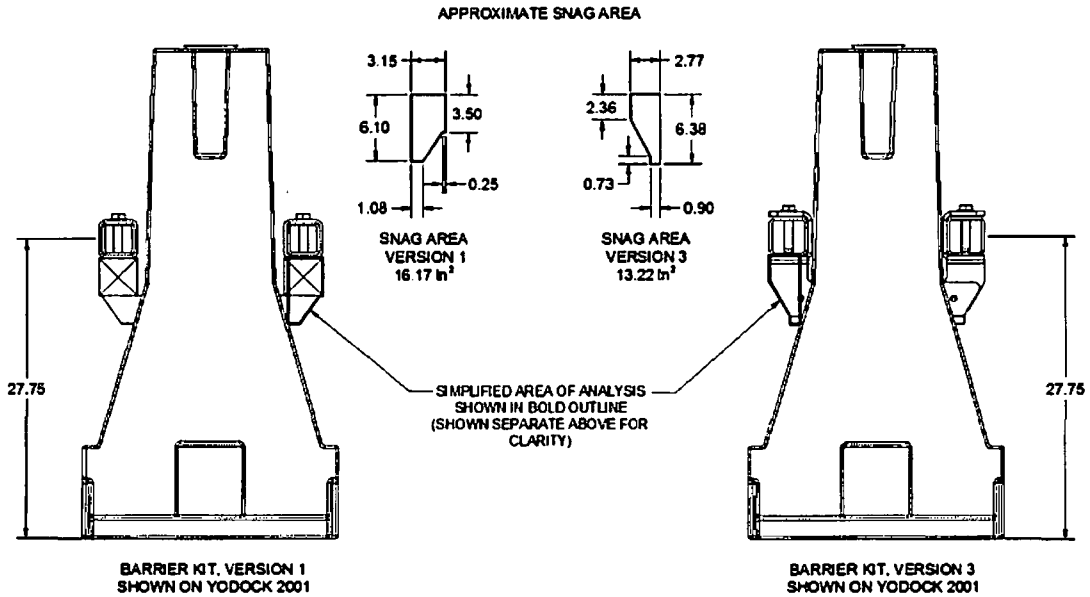


Figure 12. Evaluating Snag Area Potential, version 1 vs. version 3

COMPONENT ANALYSIS – ADDITIONAL AREAS OF IMPORTANCE:

Beyond the analysis of the mounting bracket and areas affected by *its* change, we can now look at other key elements and areas of importance when comparing all three versions.

- Rail Height
- Strength of hardware and other components
- Overall Weight

Rail Height

The centerline height of the rail above grade is dependent upon which barrier the rail kit is mounted to. However, as shown above in Figure 12, the relative height between version 1 and version 3 is identical at 27.75" above grade.

Strength of Hardware and other components

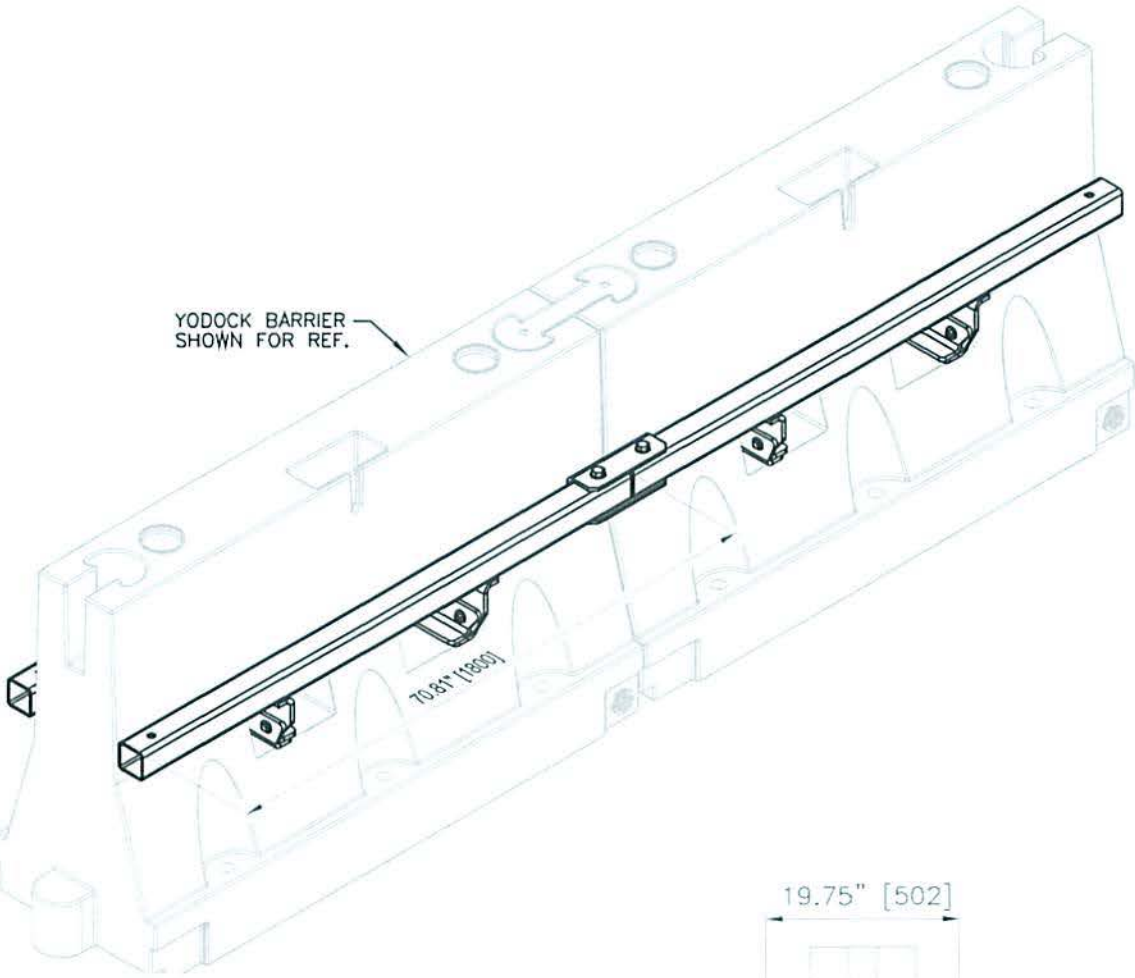
All hardware used at the splice location of the version 3 barrier kit is grade 8 steel and will be identical in strength and size to the hardware used on version 2. The tube rails and splice bracket itself will also be identical to the approved version 2 rail kit, see Figure 4 above for reference.

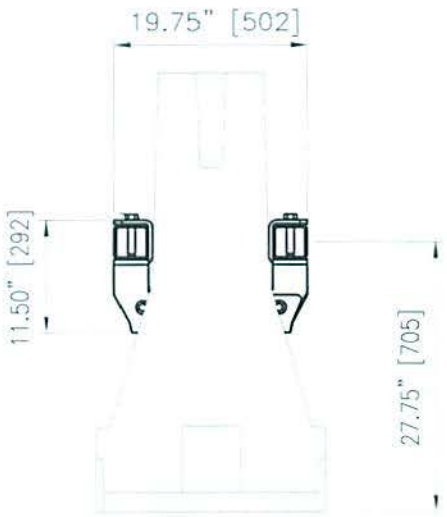
Weight

Due to all materials being either very similar or identical in size, type and shape the overall weight of the barrier kit is virtually unchanged. Total unit weight of version 3 is to be comparable to version 2, which is approximately 200 lbs.

CONCLUSION:

Given the fact that the core design of the barrier kit (i.e. impact rails, splice connector, hardware material, size and grade) is identical to one or both of the previously approved rail kit versions, and given the analysis shown herein qualifying the revised brackets, it would be expected that the integrity of the design is maintained and the barrier kit will still perform as designed, tested and approved by FHWA for TL-2 & TL-3 applications as for which they were originally intended.





END VIEW

YODOCK LONGITUDNAL BARRIER STEEL REINFORCEMENT KIT

YODOCK®
A TRINITY INDUSTRIES, INC. COMPANY

SWM19

SHEET NO.	DATE:
1 of 2	04/01/2013

INTENDED USE

The Yodock Longitudinal Barrier Steel Reinforcement Kit is a connection system for use with the Yodock Barrier. Yodock Barriers are typically a channeling device, however if assembled with the Longitudinal Barrier Steel Reinforcement Kit, the system will meet NCHRP 350 criteria for TL2 and TL3 applications as indicated below:

TL-2

- Model 2001M - Yodock Barrier w/Reinforcement Kit
- Model 2001MB - Yodock Barrier w/Reinforcement Kit

TL-3

- Model 2001 - Yodock Barrier w/Reinforcement Kit

The Reinforcement Kit runs parallel along the sides of each Yodock Barrier and consists of a set longitudinal steel tube members with a c-channel splice connector which connects each adjacent barrier/reinforcement kit to one another over the length of the system.

APPROVALS

FHWA Acceptance Letter HAS-10/B97, March 27th 2002.
FHWA Acceptance Letter HAS-10/B97A, January 27, 2010

REFERENCES

H.E. Ross, Jr., D.L. Sicking, R.A. Zimmer, and J.D. Michie, *Recommended Procedure for the Safety Performance Evaluation of Highway Features*, National Cooperative Highway Research Program (NCHRP) Report Number 350, Transportation Research Board, Washington, D.C. 1993

CONTACT INFORMATION

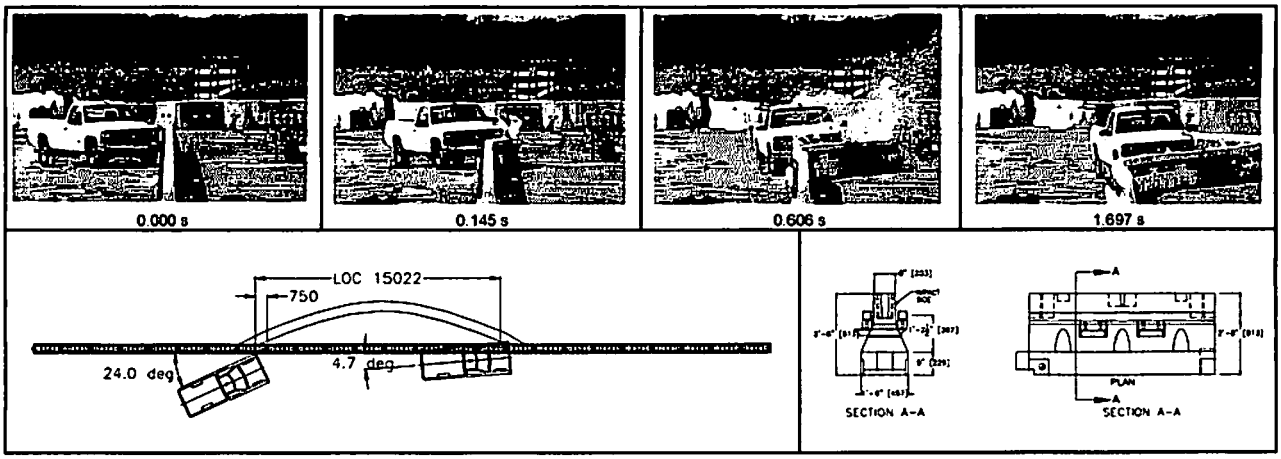
Corporate Offices:
2525 North Stemmons Freeway
Dallas, TX 75207
Telephone: (888) 323-6374
Fax: (800)770-6755
http://www.yodock.com

YODOCK LONGITUDNAL BARRIER STEEL REINFORCEMENT KIT

SWM19

SHEET NO.	DATE
2 of 2	04/01/2013

YODOCK®
A TRINITY INDUSTRIES, INC. COMPANY

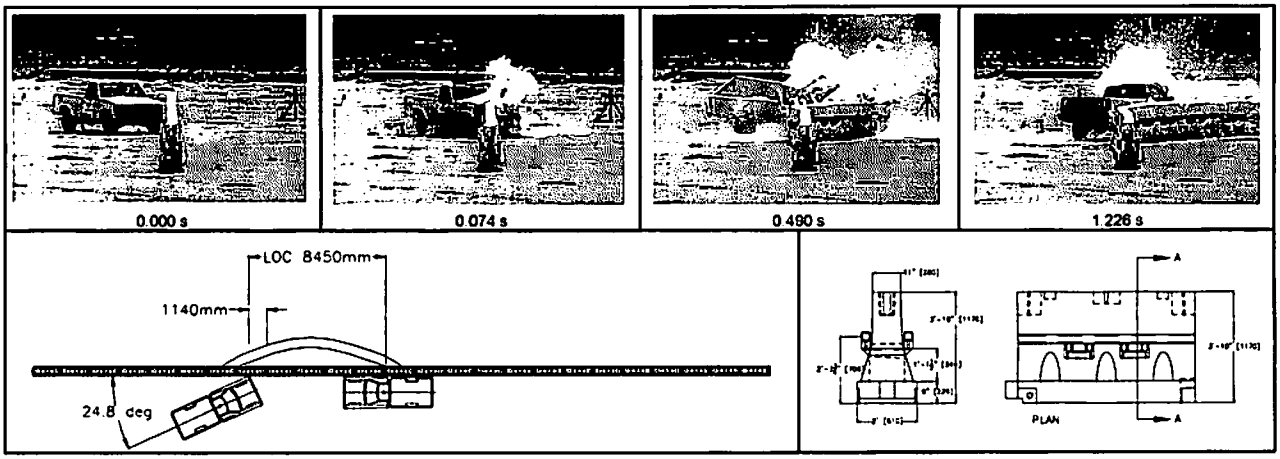


General Information	
Test Agency	Texas Transportation Institute
Test No.	400001-YWC5
Date	09/13/01
Test Article	
Type	Median Barrier
Name	Energy Dispersement Cell
Installation Length (m)	45.75
Material or Key Elements	813 mm tall Yodock Energy Dispersement Cells
Soil Type and Condition	Concrete Pavement, Dry
Test Vehicle	
Type	Production
Designation	2000P
Model	1996 Chevrolet 2500 Pickup Truck
Mass (kg)	
Curb	2136
Test Inertial	2042
Dummy	No Dummy
Gross Static	2042

Impact Conditions	
Speed (km/h)	68.5
Angle (deg)	24.0
Exit Conditions	
Speed (km/h)	30.0
Angle (deg)	4.7
Occupant Risk Values	
Impact Velocity (m/s)	
x-direction	3.7
y-direction	3.2
THIV (km/h)	15.4
Ridedown Accelerations (g's)	
x-direction	-5.4
y-direction	8.2
PHD (g's)	8.2
ASI	0.37
Max. 0.050-s Average (g's)	
x-direction	-3.4
y-direction	2.9
z-direction	1.7

Test Article Deflections (m)	
Dynamic	3.68
Permanent	3.68
Working Width	4.11
Vehicle Damage	
Exterior	
VDS	11LFQ2
CDC	11LFEW2
Maximum Exterior	
Vehicle Crush (mm)	300
Interior	
OCDI	LF0000000
Max. Occ. Compart. Deformation (mm)	0
Post-Impact Behavior	
(during 1.0 s after impact)	
Max. Yaw Angle (deg)	18
Max. Pitch Angle (deg)	-1
Max. Roll Angle (deg)	3

Summary of results for test 400001-YWC5, *NCHRP Report 350* test 2-11.

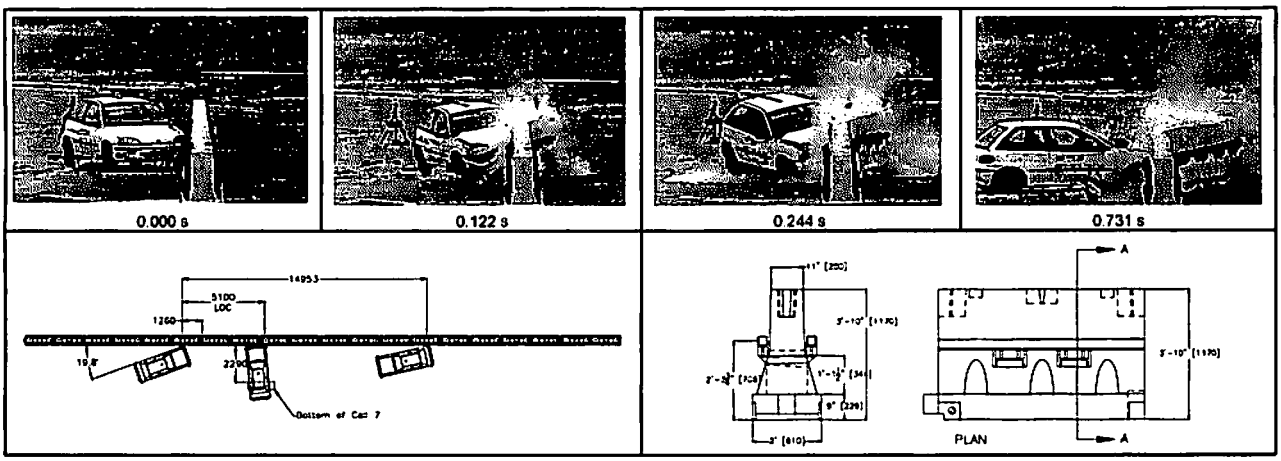


General Information	
Test Agency	Texas Transportation Institute
Test No.	400001-YWC6
Date	09/14/01
Test Article	
Type	Median Barrier
Name	Energy Dispersement Cell
Installation Length (m)	45.75
Material or Key Elements	1160 mm tall Energy Dispersement Cells with Tubular Steel Rail Elements
Soil Type and Condition	Concrete Pavement, Dry
Test Vehicle	
Type	Production
Designation	2000P
Model	1996 Chevrolet 2500 Pickup Truck
Mass (kg)	
Curb	2137
Test Inertial	2041
Dummy	No Dummy
Gross Static	2041

Impact Conditions	
Speed (km/h)	98.4
Angle (deg)	24.8
Exit Conditions	
Speed (km/h)	11.6
Exit Trajectory Angle (deg)	27.5
Vehicle Heading Angle (deg)	60.5
Occupant Risk Values	
Impact Velocity (m/s)	
x-direction	11.6
y-direction	2.3
THIV (km/h)	42.6
Ridedown Accelerations (g's)	
x-direction	-10.0
y-direction	-6.1
PHD (g's)	10.5
ASI	1.11
Max. 0.050-s Average (g's)	
x-direction	-13.3
y-direction	4.2
z-direction	-4.7

Test Article Deflections (m)	
Dynamic	4.28
Permanent	4.02
Working Width	4.62
Vehicle Damage	
Exterior	
VDS	11LFQ5
CDC	11FLEK3 & 11LYEW4
Maximum Exterior Vehicle Crush (mm)	840
Interior	
OCDI	LF0010000
Max. Occ. Compart. Deformation (mm)	72
Post-Impact Behavior (during 1.6 s after impact)	
Max. Yaw Angle (deg)	-147
Max. Pitch Angle (deg)	-4
Max. Roll Angle (deg)	21

Summary of results for test 400001-YWC6, *NCHRP Report 350* test 3-11.



General Information
- Test Agency ..... Texas Transportation Institute
- Test No. 400001-YWC8
- Date 01/28/02

Test Article
- Type ..... Median Barrier
- Name ..... Yodock Model 2001 Energy Dispersement Cell
- Installation Length (m) 36.58
- Material or Key Elements .. 1170 mm Tall Energy Dispersement Cells With Tubular Steel Rail Elements
- Soil Type and Condition .... Concrete Pavement, Dry

Test Vehicle
- Type ..... Production
- Designation 820C
- Model ..... 1996 Geo Metro
- Mass (kg)
  - Curb 820
  - Test Inertial 820
  - Dummy 76
  - Gross Static 896

Impact Conditions
- Speed (km/h) 97.7
- Angle (deg) 19.8

Exit Conditions
- Speed (km/h) 26.2
- Angle (deg) 95.9

Occupant Risk Values
- Impact Velocity (m/s)
  - x-direction 11.0
  - y-direction 3.7
- THIV (km/h) 41.4
- Ridedown Accelerations (g's)
  - x-direction ..... -10.4
  - y-direction 2.7
- PHD (g's) 10.7
- ASI 1.03
- Max. 0.050-s Average (g's)
  - x-direction ..... -11.0
  - y-direction 5.3
  - z-direction ..... -2.1

Test Article Deflections (m)
- Dynamic 1.230
- Permanent 1.195
- Working Width 1.845

Vehicle Damage
- Exterior
  - VDS 11FL3
  - CDC 11FLEW3
- Maximum Exterior
  - Vehicle Crush (mm) 390
- Interior
  - OCDI LF0011000
- Max. Occ. Compart. Deformation (mm) 46

Post-Impact Behavior (during 1.0 s after impact)
- Max. Yaw Angle (deg) ..... -174
- Max. Pitch Angle (deg) .... -4
- Max. Roll Angle (deg) ..... -14

Summary of results for test 400001-YWC8, *NCHRP Report 350* test 3-10.