U.S. Department of Transportation
Federal Highway Administration

March 26, 2024

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

In Reply Refer To:
HSST-1/B-377

Benjamin F. Powell
Northern Infrastructure Products
21 Fortecon Drive
Stouffville, ON. L4A 2GB
Canada

Dear Mr. Powell:

We received your correspondence of July 29, 2022 requesting issuance of a reimbursement eligibility letter under the Federal-aid highway program for the roadside safety system, device, design, product, or hardware (collectively "device") described below. This letter is assigned Federal Highway Administration (FHWA) control number B-377.

ELIGIBILITY LETTERS

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

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

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

FEDERAL-AID REIMBURSEMENT

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

Name of system: Long Span Structure Connection
Type of system: Longitudinal Barrier
Test Level: Test Level 3
Testing conducted by: Applus Idiada Karco Engineering
Date of request: July 29, 2022

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

Eligibility letter B-377 is inapplicable to devices, optional equipment, alternate materials, or other features that were not crash tested in accordance with AASHTO's MASH.

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

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

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

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

INTELLECTUAL PROPERTY

Issuance of this eligibility letter does not convey property rights of any sort nor any exclusive privilege. This letter is not authorization or consent by the government for the use, manufacture, or sale of any patented or proprietary system, device, design, product, or hardware for which the requester is not the patent owner. Eligibility letters are not an expression of any view, position, or determination by the government as to the validity, scope, or ownership of any intellectual property rights to a specific device. These letters do not grant, impute, suggest, or otherwise establish any ownership, distribution, or licensing rights to the requester. The government expresses no opinion about the intellectual property rights relating to any device for which this or any other eligibility letter is issued.

PUBLIC DISCLOSURE

To prevent any misunderstanding, and as discussed above, this eligibility letter is assigned FHWA control number B-377. It should only be reproduced in full with its attachment(s). This letter and the material offered by the requester supporting its issuance is public information. All eligibility letters and supporting material are subject to public disclosure under the Freedom of

Information Act (FOIA). Eligibility letters are available to the public at https://safety.fhwa.dot.gov/roadway_dept/countermeasures/reduce_crash_severity/.

If you have any questions please contact Aimee Zhang at Aimee.Zhang@dot.gov.

Sincerely,

Amy S. Fox
Acting Director
Office of Safety Technologies
Office of Safety

Enclosures

Request for Federal Aid Reimbursement Eligibility of Highway Safety Hardware

Submitter	Date of Request:	July 29, 2022	◉ New ○ Resubmission
	Name:	Benjamin F. Powell	
	Company:	Northern Infrastructure Products	
	Address:	21 Fortecon Drive, Stouffville, ON. L4A 2G8	
	Country:	Canada	
	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.

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

! - ! - !

System Type	Submission Type	Device Name / Variant	Testing Criterion	Test Level
'B': Rigid/Semi-Rigid Barriers (Roadside, Median, Bridge Railings)	◉ Physical Crash Testing ○ Engineering Analysis	Long Span Structure Connection	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.

Individual or Organization responsible for the product:

Contact Name:	Benjamin F. Powell	Same as Submitter ☒
Company Name:	Northern Infrastructure Products	Same as Submitter ☒
Address:	21 Fortecon Drive, Stouffville, ON. L4A 2G8	Same as Submitter ☒
Country:	Canada	Same as Submitter ☒

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

Applus Idiada Karco Engineering [AIK] was contacted by Northern Infrastructure Products [NIP] to perform compliance full scale crash testing of the Long Span Structure Connection as per MASH 2016, September 2021 ERRATA [MASH16]. There are no shared financial interests in the as-tested device by AIK, or between NIP and AIK, other than costs involved in the actual crash tests of the as-tested device to existing MASH16 protocols and reports for this submission to the Federal Highway Administration [FHWA].

PRODUCT DESCRIPTION

(●) New Hardware or Significant Modification ( ) Modification to Existing Hardware

The test article described in this correspondence is transition from Thrie-Beam to a bridge, or roadside concrete parapet. The as-tested system consists of 25.0 ft. (7.6 m) of 12-gauge W beam (RTM01a-02b), guard rail system end treatment, Asymmetric W-Thrie Beam Transition (RWT02), 18.8 ft. (5.7 m) of Thrie Beam, and the Proprietary 2-Tube Transition. The total as-tested system length was 62.8 ft. (19.1 m).

The as-tested end treatment consisted of two (2) breakaway wooden posts, two (2) post anchor tubes, one (1) 10.4 ft. (3.2 m) long 12-gauge steel guard rail, one (1) rounded terminal, and one (1) cable assembly. At the end of the guard rail end treatment, 12-gauge W-beam is attached continued downstream. The 12-gauge W-beam consisted of five (5) 6.0 ft. (1.8 m) long W6 x 8.5 2 hole steel posts, and two (2) 13.5 ft. (4.1 m) long 12 Ga W-beam. Posts 3 through 7 utilize 14.25" x 8" x 6" plastic offset blocks. Numbered from up to downstream, the first 6 posts were spaced at 75 in. (1905 mm) and the spacing between post 6 and 7 was 37.5 in. (952 mm).

After the W-beam, the Asymmetric W-Thrie Beam Transition to the Proprietary 2-Tube Transition proprietary component begins. It consists of one (1) 87.5 in. (2223 mm) long 10 Ga Asymmetric W-Thrie Beam Transition, one (1) 87.5in. (2223 mm) long 12 Ga Thrie Beam Rail, one (1) double nested 162.5 in (4128 mm), 12 Ga Thrie Beam Rail, one (1) Proprietary 2-Tube Transition, one (1) 80.5 in. (2045 mm) 12 Ga Thrie Beam. Rail, and one (1) 30 in. (762 mm) Thrie Beam Terminal Connector. In the transition, there is a total of 6 posts: one (1) 6.0 ft. (1.8 m) long W6 x 8.5 2-hole steel post, two (2) 6.0 ft. (1.8 m) long W6 x 8.5 4-hole steel posts, and three (3) 7 ft. (2.1 m) long W6 x 15 4-hole steel posts.

There are two types of offset blocks used on these posts. Post 8 utilizes a 19" x 8" x 6" plastic offset block and Post 9 through 13 utilize a 6" x 8" x ¼" steel HSS offset block. Posts 7 through 10 were spaced at 37.5 in. (952 mm) and posts 10-13 were spaced 18.8 in. (451 mm).

The end anchorage plate on the Proprietary 2-Tube Transition proprietary component is mounted to reinforced concrete barrier. The barrier also simulated bridge barrier concrete vertical wall. The compression strength of the concrete was 3708 psi.

The Proprietary 2-Tube Transition consist of an approach post anchorage plate, 2-tube chords, and end anchorage plate. The end anchorage plate is installed to the vertical wall using epoxied anchors at a height from ground of 10.8 in. (273 mm), and 45.3 in (1149 mm) measured from end of vertical wall . The Proprietary 2-Tube Transition is clasped by a double nested Thrie Beam rail on the traffic side and a Thrie Beam rail on the field side. The post anchorage plate is mounted the offset block on Post 13.

The two (2) end treatment system posts were installed by auguring 2 ft. (0.6 m) diameter by 5.9 ft. (1.8 m) deep holes, inserting the posts, and backfilling and compacting the holes with AASHTO soil. Posts 3 through 5 we installed by auguring 2 ft. (0.6 m) diameter by 3.5 ft (1.1 m) deep holes. Posts 6 through 13 were installed by excavating a 2.0 ft. (0.6 m) wide by 17.2 ft. (5.2 m) long. 4.5 ft. (1.4 m) deep ditch, inserting the posts, and backfilling and compacting the ditch with material meeting AASHTO M-147-B soil. The soil was compacted in 6.0 in. (152 mm) lifts using a pneumatic tamper.

CRASH TESTING

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

Engineer Name:	Brandon Ubina	
Engineer Signature:	Brandon Ubina — Digitally signed by Brandon Ubina DN: cn=Brandon Ubina, o, ou, email=Brandon.ubina@idiada.com, c=US Date: 2023.09.06 10:42:23 -07'00'	
Address:	9270 Holly Road, Adelanto, CA 92301	Same as Submitter ☐
Country:	United States of America	Same as Submitter ☐

A brief description of each crash test and its result:

Required Test Number	Narrative Description	Evaluation Results
3-10 (1100C)	Device is not Length-of-Need Barrier Section	Non-Relevant Test, not conducted
3-11 (2270P)	Device is not Length-of-Need Barrier Section	Non-Relevant Test, not conducted

Required Test Number	Narrative Description	Evaluation Results
3-20 (1100C)	Test 3-20 specifies 1100C Test Vehicle impacting Long Span Structure Connection (Transition) test article at target impact velocity of 62 mph (100 km/h) and angle of 25.0deg. Target critical impact point (CIP) for 1100C Test Vehicle CIP 60 in (1524 mm) from end of concrete vertical wall. Results of MASH 1100C test 3-20 conducted on March 22, 2022 are found in the Applus IDIADA Karco Test Report TR-P42019-01-D, dated 09/06/23 . 1100C test vehicle traveling at speed 63.14 mph (101.61 km/h) contacted Transition at Actual CIP of 58.6 in. (1488 mm) at 24.3 deg. Upon impact Transition began to deflect at approx. 0.020 s. Front test vehicle proceeds downstream on Transition until impacting concrete vertical wall at 0.040 s. At approx. 0.095s the ATD's head broke side window and partially protruded out of vehicle. The test vehicle yawed clockwise until rear-end impacted Transition at approx. 0.195 s. The vehicle exited test article, separated at 0.350 s at velocity of 46.98 mph (75.61 km/h) at angle of 14.0° with respect to the barrier, or 56% of test impact angle (25deg) measured at time of vehicle loss of contact with test device [September 2021 ERRATA]. Test vehicle came to rest 114.0 ft. (34.7 m) down stream, 19.1 ft. (5.8 m) to right from its first point of contact with test article. Transition successfully contained/redirected 1100C test vehicle and did not penetrate, under ride or override the test article. Max. dynamic deflection transition during test 4.1 in (105 mm), working width 17.6 in. (448 mm), static deflection 1.5 in. (39 mm). No detached elements, fragments, other debris present to penetrate, show potential for penetrating occupant compartment. The 1100C test vehicle remained upright during and after event. Max roll and pitch angles were -12.6 and -5.1 respectively. Longitudinal OIV 7.1 m/s (23.3 ft/s) and Lateral OIV -10.7 m/s (-35.1 ft/s). Max longitudinal occupant ride down acceleration -17.1 g, and max. lateral occupant ride down acceleration 6.5 g. Occupant risk factors within MASH limits. Max. occupant compartment deformation, side front panel (forward of A-Pillar) 5.9 in. (149 mm), wheel/foot well and toe pan 1.9 in. (47 mm). No damage to the test vehicle's fuel tank or oil pan due to the crash test. The Transition performed acceptably for MASH Test 3-20.	PASS

3-21 (2270P)	Test 3-21 specifies 2270P Test Vehicle impacting Long Span Structure Connection (Transition) test article at target impact velocity of 62 mph (100 km/h) and angle of 25.0deg. Target critical impact point (CIP) for 2270P Test Vehicle CIP 108 in (2743 mm) from end of concrete vertical wall. Results of MASH 2270P test 3-21 conducted on April 19, 2022 are found in the Applus IDIADA Karco Test Report TR-P42019-01-D, dated 09/06/23 . 2270P test vehicle traveling at speed 62.43 mph (100.47 km/h) contacted Transition at Actual CIP of 110.7 in. (2811.8 mm) at 25.6 deg. Upon impact the front bumper of the vehicle began to deform, and post 13 began to deflect at approximately 0.016 s. Front test vehicle proceeds downstream on Transition until impacting concrete vertical wall at 0.110 s. As the vehicle continued downstream, the vehicle yawed clockwise until its rear end impacted the barrier at approximately 0.188 s. The vehicle then exited the system and separated from it at 0.350 s. The vehicle exited the barrier at a velocity of 45.66 mph (73.48 km/h) and an angle of 9.1° with respect to the barrier. The vehicle came to rest 146.0 ft. (44.5 m) downstream and 14.0 ft. (4.3 m) to the right from its first point of contact with the test article after the brakes were applied remotely. Transition successfully contained redirected 2270P test vehicle and did not penetrate, under ride or override the test article. Max. dynamic deflection transition during test 10.1 in (257 mm), working width 25 in. (635 mm), static deflection 8.3 in. (211 mm). No detached elements, fragments, other debris present to penetrate, show potential for penetrating occupant compartment. The 2270P test vehicle remained upright during and after event. Max roll and pitch angles were -54.6 and -15.8 respectively. Longitudinal OIV 7.1 m/s (23.3 ft/s) and Lateral OIV -8.1 m/s (-26.6 ft/s). Max longitudinal occupant ride down acceleration -10.3 g, and max. lateral occupant ride down acceleration 9.2 g. Occupant risk factors within MASH limits. Max. occupant compartment deformation, side front panel (forward of A-Pillar) 3 in. (76 mm), wheel/foot well and toe pan 1.8 in. (46 mm). No damage to the test vehicle's fuel tank or oil pan due to the crash test. The Transition performed acceptably for MASH Test 3-21.	PASS

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:	Applus IDIADA Karco Engineering, Inc.	
Laboratory Signature:	Brandon Ubina — Digitally signed by Brandon Ubina DN: cn=Brandon Ubina, o, ou, email=Brandon.ubina@idiada.com, c=US Date: 2023.09.06 10:41:40 -07'00'	
Address:	9270 Holly Road, Adelanto, CA 92301	Same as Submitter ☐
Country:	United States of America	Same as Submitter ☐
Accreditation Certificate Number and Dates of current Accreditation period :	TL 371: April 27, 2022 - April 27, 2024	

Submitter Signature*: Benjamin Powell — Digitally signed by Benjamin Powell Date: 2023.09.14 12:03:32 -04'00'

Submit Form

ATTACHMENTS

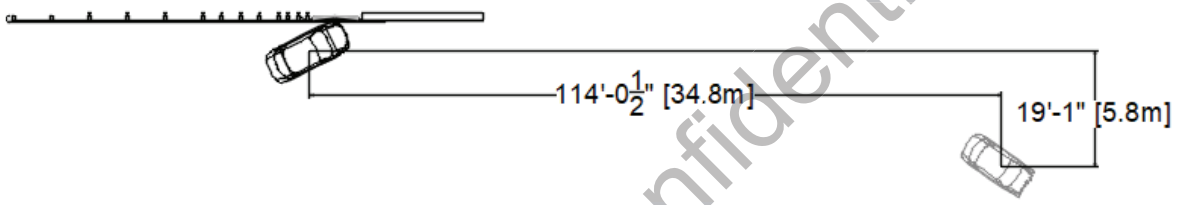
Attach to this form:

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

FHWA Official Business Only:

Eligibility Letter		
Number	Date	Key Words

MASH 2016 Test 3-20 Summary



GENERAL INFORMATION

Test Agency	Applus IDIADA KARCO
Test Number	P42019-01-C
Test Designation	3-20
Test Date	3/22/22

TEST ARTICLE

Name / Model	Long Span Structure Connection
Type	Transition
Installation Length	62.8 ft. (19.1 m)
Road Surface	Smooth, concrete and soil

TEST VEHICLE

Type / Designation	1100C
Year, Make, and Model	2016 Kia Rio
Curb Mass	2,575.0 lbs (1,168.0 kg)
Test Inertial Mass	2,427.2 lbs (1,101.0 kg)
Gross Static Mass	2,599.2 lbs (1,179.0 kg)

Impact Conditions

Impact Velocity	63.14 mph (101.61 km/h)
Impact Angle	24.3°
Location / Orientation	Plan Citical Impact Point 60.0 in. [Actual 58.6 in.] from Concrete Vertical Wall
Impact Severity	119.8 kip-ft (162.4 Kilojoules)
Minimum Impact Severity Required	51 kip-ft (69 Kilojoules)

Exit Conditions

Exit Velocity	46.98 mph (75.61 km/h)
Exit Angle	14.0°
Exit Box Criteria Met	Yes
Final Vehicle Position	114.0 ft. (34.7 m) Downstream 19.1 ft. (5.8 m) Right
Vehicle Snagging	Satisfactory
Vehicle Pocketing	Satisfactory
Vehicle Stability	Satisfactory
Maximum Roll Angle	-12.6°
Maximum Pitch Angle	-5.1°
Maximum Yaw Angle	52.9°

Occupant Risk

Longitudinal OIV	7.1 m/s (23.3 ft/s)
Lateral OIV	-10.7 m/s (-35.1 ft/s)
Longitudinal RA	-17.1 g
Lateral RA	6.5 g
THIV	12.6 m/s (41.3 ft/s)
PHD	17.5
ASI	2.59

Test Article Deflections

Static	1.5 in. (39 mm)
Dynamic	4.1 in. (105 mm)
Working Width	17.6 in. (448 mm)

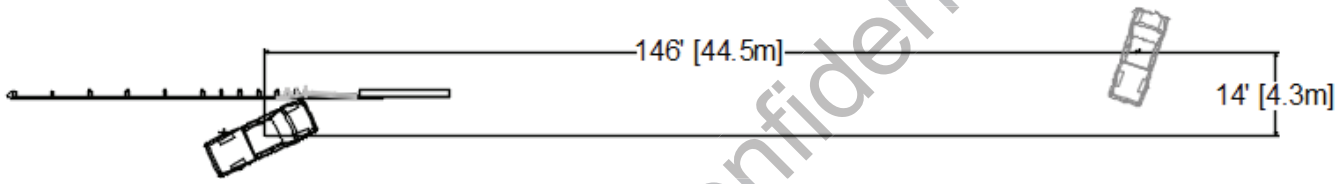
Vehicle Damage

Vehicle Damage Scale	11-LFQ-4
CDC	11FYAK3 and 11LDAS2
Maximum Deformation	5.9 in. (150 mm) Side Front Panel (Forward A-Pillar)

Figure 3 Summary of Test 3-20

MASH 2016 Test 3-21 Summary

0.000 seconds | 0.150 seconds | 0.300 seconds | 0.450 seconds | 0.600 seconds | 0.750 seconds

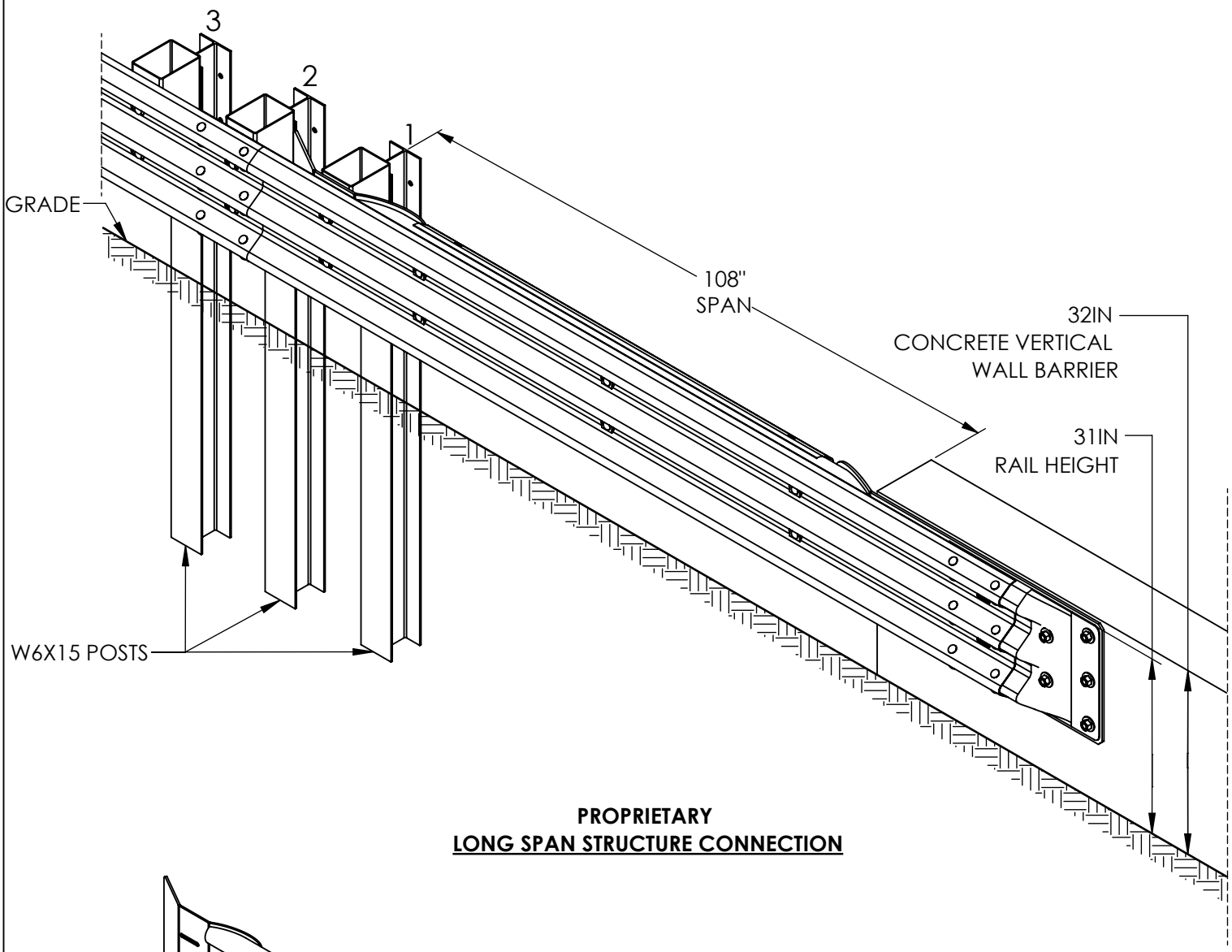


GENERAL INFORMATION	
Test Agency	Applus IDIADA KARCO
Test Number	P42019-01-C
Test Designation	3-21
Test Date	4/19/22
TEST ARTICLE	
Name / Model	Long Span Structure Connection
Type	Transition
Installation Length	62.8 ft. (19.1 m)
Road Surface	Smooth, concrete and soil
TEST VEHICLE	
Type / Designation	2270P
Year, Make, and Model	2016 Ram 1500
Curb Mass	5,250.2 lbs (2,381.5 kg)
Test Inertial Mass	5,019.8 lbs (2,277.0 kg)
Gross Static Mass	5,019.8 lbs (2,277.0 kg)

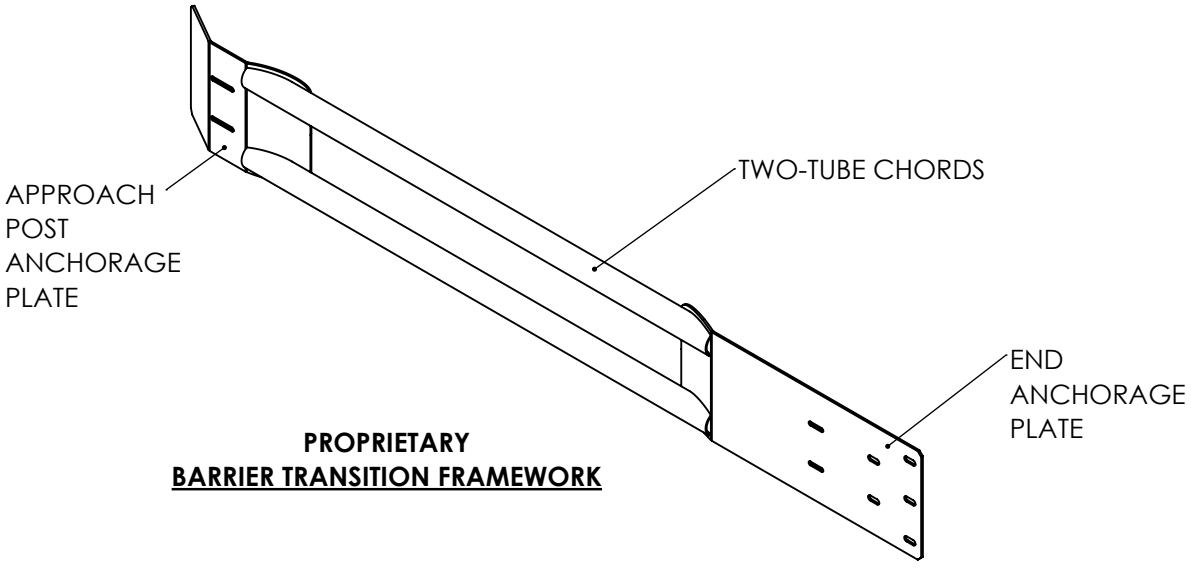
Impact Conditions	
Impact Velocity	62.43 mph (100.47 km/h)
Impact Angle	25.6°
Location / Orientation	Plan Critical Impact Point 108.0 in. [Actual 110.7 in.] from Concrete Vertical Wall
Impact Severity	122.1 kip-ft (165.6 Kilojoules)
Minimum Impact Severity Required	106 kip-ft (144 Kilojoules)
Exit Conditions	
Exit Velocity	45.66 mph (73.48 km/h)
Exit Angle	-9.1°
Exit Box Criteria Met	Yes
Final Vehicle Position	146.0 ft. (44.5 m) Downstream 14.0 ft. (4.3 m) Left
Vehicle Snagging	Satisfactory
Vehicle Pocketing	Satisfactory
Vehicle Stability	Satisfactory
Maximum Roll Angle	-54.6
Maximum Pitch Angle	-15.8
Maximum Yaw Angle	46.9

Occupant Risk	
Longitudinal OIV	7.1 m/s (23.3 ft/s)
Lateral OIV	-8.1 m/s (-26.6 ft/s)
Longitudinal RA	-10.3 g
Lateral RA	9.2 g
THIV	10.5 m/s (34.4 ft/s)
PHD	12.9
ASI	1.57
Test Article Deflections	
Static	8.3 in. (211 mm)
Dynamic	10.1 in. (257 mm)
Working Width	25.0 in. (635 mm)
Vehicle Damage	
Vehicle Damage Scale	11-LFQ-5
CDC	11FYAK3 and 11LDAS2
Maximum Deformation	3.0 in. (76 mm) Side Front Panel (Forward A-Pillar)

Figure 4 Summary of Test 3-21



PROPRIETARY
LONG SPAN STRUCTURE CONNECTION



PROPRIETARY
BARRIER TRANSITION FRAMEWORK

LONG SPAN STRUCTURE CONNECTION – MASH TEST LEVEL 3

NORTHERN
INFRASTRUCTURE PRODUCTS

Northern Infrastructure Products

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SHEET NO.	DATE:
1 of 2	09/15/22