Sketch Plan Submission
Supplemental Abutment Calculations

Superstructure Replacement
Bruce Freeman Rail Trail
Over Assabet River
Concord, MA

Bridge Number
C-19-031 (XXX)

GPI

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Wilmington, Massachusetts 01887
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SUBMITTED TO:

massDOT
Massachusetts Department of Transportation
Highway Division

Ten Park Plaza
Boston, MA 02116-3973

April 30, 2015

GPI

Massachusetts Department of Transportation
Bridge No. C-19-031 (XXX)
April 30, 2015

BRUCE FREEMAN RAIL TRAIL OVER ASSABET RIVER
BRIDGE C-19-031 – ABUTMENT REUSE JUSTIFICATION

REF: MAX-2010031.00

DATE: April 30, 2015

INTRODUCTION

Greenman-Pedersen, Inc. (GPI) has evaluated the existing abutments to determine if they are suitable for reuse to support the proposed prefabricated steel truss. Our evaluation is based on site observations of the existing abutment conditions, historic photographs of the bridge in service, as well as a load comparison.

Site Evaluation:
The existing abutments are constructed of ashlar stone masonry and do not show visible signs of settlements or rotations. The stone coursing is level and there are not indications of cracks within the stone blocks. There is minor vegetation intrusion into the stone joints, but the intrusion has not caused the blocks to shift or crack. The vegetation will be removed as part of the construction project. The wingwalls are also constructed with ashlar stone masonry are in the same acceptable condition as the abutments. Representative pictures of the abutments are shown below:

South Abutment Elevation – showing minor vegetation

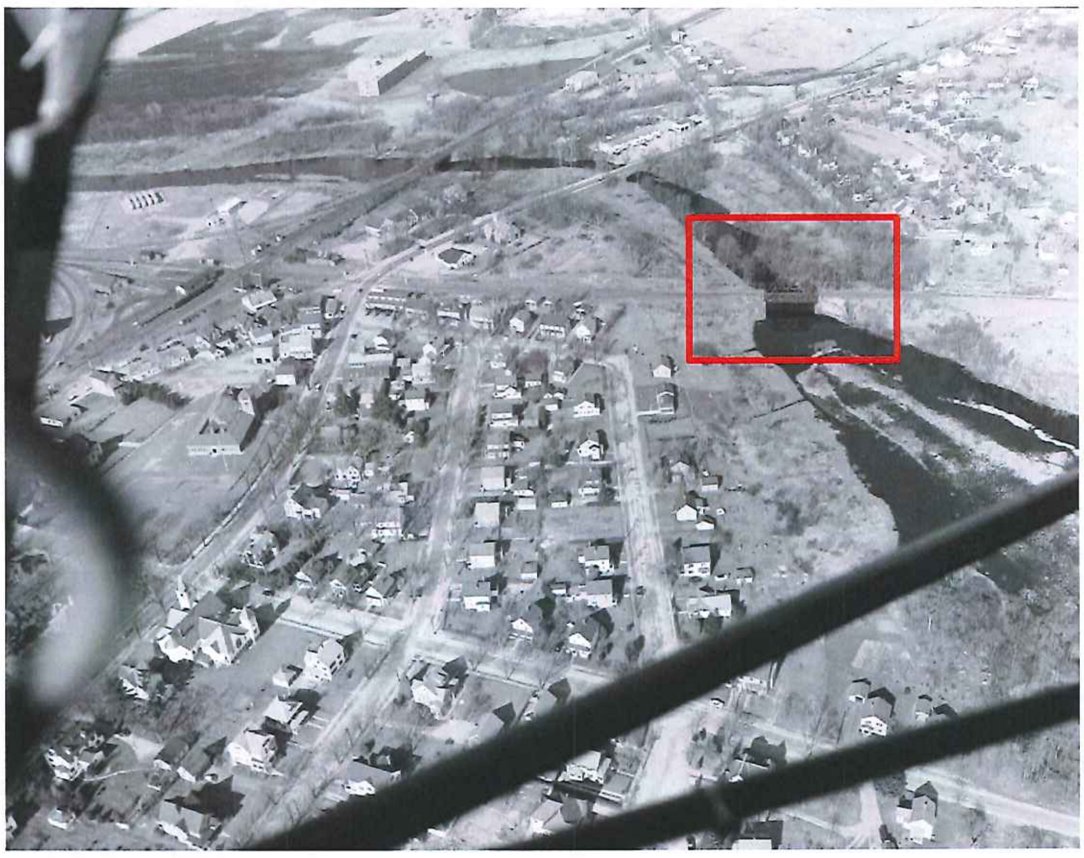
North Abutment Face – showing condition of ashlar masonry and alignment of stones

Typical Back of Wingwall Condition

Historic Bridge use and Photographs:

The Town of Concord provided documentation of the rail use across this bridge, as well as historic photographs that we used to consider if the abutments experienced larger past loading than the proposed condition. Our understanding is that freight service on this Lowell Secondary line was suspended in April 1982. The actual bridge was removed in the 1990's after a fatal suicide.

The photographs below are an undated aerial view showing the truss over the river, and a photograph from 1972 showing a train crossing the bridge. The exact loading for this engine is unknown, but it does represent historic past loading at this location for comparison to the proposed bridge.



Aerial Photograph – undated

Close up of Bridge Location

Train Going over the Old Bridge – circa 1972

Abutment Load Comparison:
The proposed superstructure abutment loads are significantly lower than the assumed past loading, as demonstrated by the enclosed calculations. Plans for the removed truss are not available, therefore our comparison did not include the dead load of the old bridge. Neglecting the dead load of the old bridge is a conservative approach to justify the proposed loads will be less than historical loading. The engine loading shown in the 1972 photograph is also unknown, so we assumed a Cooper E-40 loading for comparison.

The location of the old bridge's centerline of bearing is not precisely known, however it is assumed to be at the existing bridge seat location. Since the proposed truss will be located at the same general location, no change in superstructure eccentricity was included in our analysis.

The analysis used a proposed truss dead load provided to us by Contech. The proposed live load we evaluated was a pedestrian load of 90 psf as well as an H-15 vehicle load. The final bridge is anticipated to be designed for an H-10 vehicle load, but we used the H-15 for a conservative approach. Ultimately the 90 psf pedestrian loading is the controlling abutment live load.

When comparing the proposed dead and live load of the new prefabricated truss to the only the Cooper E-40 load, it is evident that the bridge abutments have experienced much greater loads in the past from direct superstructure loading. It is also evident that the live load surcharge from approaching train loading is much larger than any pedestrian or construction live load surcharges. Given that the ground levels near the bridge will remain essentially the same in the final construction, the historic lateral loading is also much greater than the proposed.

Conclusion:
The existing abutments are suitable for reuse to support the proposed prefabricated pedestrian truss bridge without modification.

The existing abutments and wingwalls are in very good condition with no signs of movements, settlements, or cracking. Based on historic photographs and our load comparison, the existing abutments have experienced greater load than is proposed.

CALCULATIONS

GPI Greenman-Pedersen, Inc.
Engineering and Construction Services
181 Ballardvale Street | Suite 202 | Wilmington, MA 01887

PROJECT:	Bruce Freeman Rail Trail	SHEET:	1
JOB NO.:	MAX-2010031.00	OF:	1
DESCRIPTION:	Bridge No. C-19-031	CALC. BY:	MS
		DATE:	4/15/15
		CHECK BY:	AMD
		DATE:	4/15/15

PRELIMINARY LOADS TO ABUTMENT

Reuse of Substructure - Load Analysis

Span Length: 87.00 ft.

Path Width: 14.00 ft.

Pedestrian Load: 90 psf

Proposed Loads[2]

Load	Load Case	Magnitude	
Superstructure Dead	DC	64.90 k	See attached CONTECH reference
H-15 Truck	LL+I	38.61 k	Use maximum of Truck and Ped. Loads
Pedestrian	PL	54.81 k	(see attached sheets)
	Total Load =	119.71 k	

Original Design Loads[3]

(conservatively ignore Dead Load and Impact)

Cooper E 40	LL	266.83 k	(Ref. AREMA 1.3.4, see attached sheets)

Conclusion:

The proposed loading to the abutment from the pedestrian bridge will be less than the original design loads, therefore the abutment is safe to reuse to support the proposed pedestrian bridge.

Notes:

1. Live loads were calculated using AASHTOWare Bridge Rating Software and checked independently. See attached sheets.
2. The proposed bridge will be designed for a 90 PSF pedestrian load and AASHTO H-10 loading without impact. The controlling case will be used to check substructure reuse. For this analysis an AASHTO H-15 truck with impact has been used, but the pedestrian loading still controls.
3. Assume Cooper E-40 train as the original design load.

- For four tracks, full live load on two tracks, one-half on one track, and one-quarter on the remaining one.
- For more than four tracks, as specified by the Engineer.
- The selection of the tracks for these loads shall be such as will produce the greatest live load stress in the member.

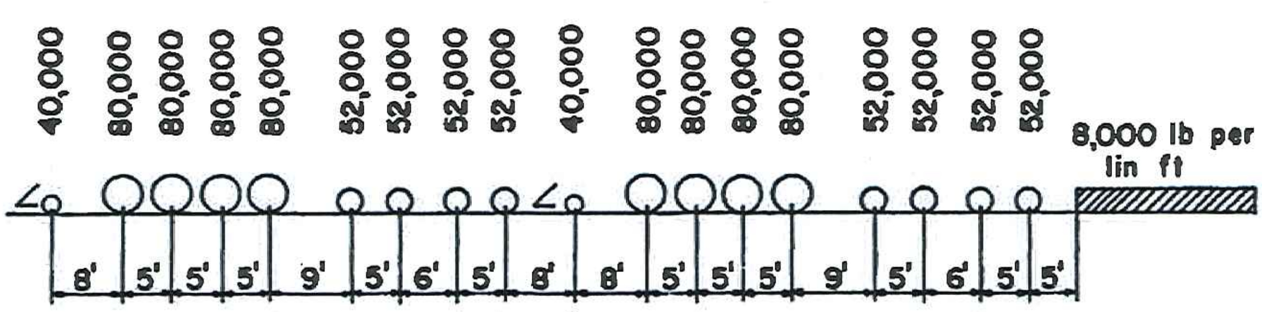


Figure 15-1-2. Cooper E 80 Load

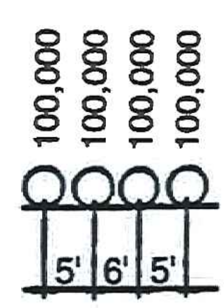


Figure 15-1-3. Alternate Live Load on 4 Axles

1.3.4 DISTRIBUTION OF LIVE LOAD (1993)[1] R(2008)

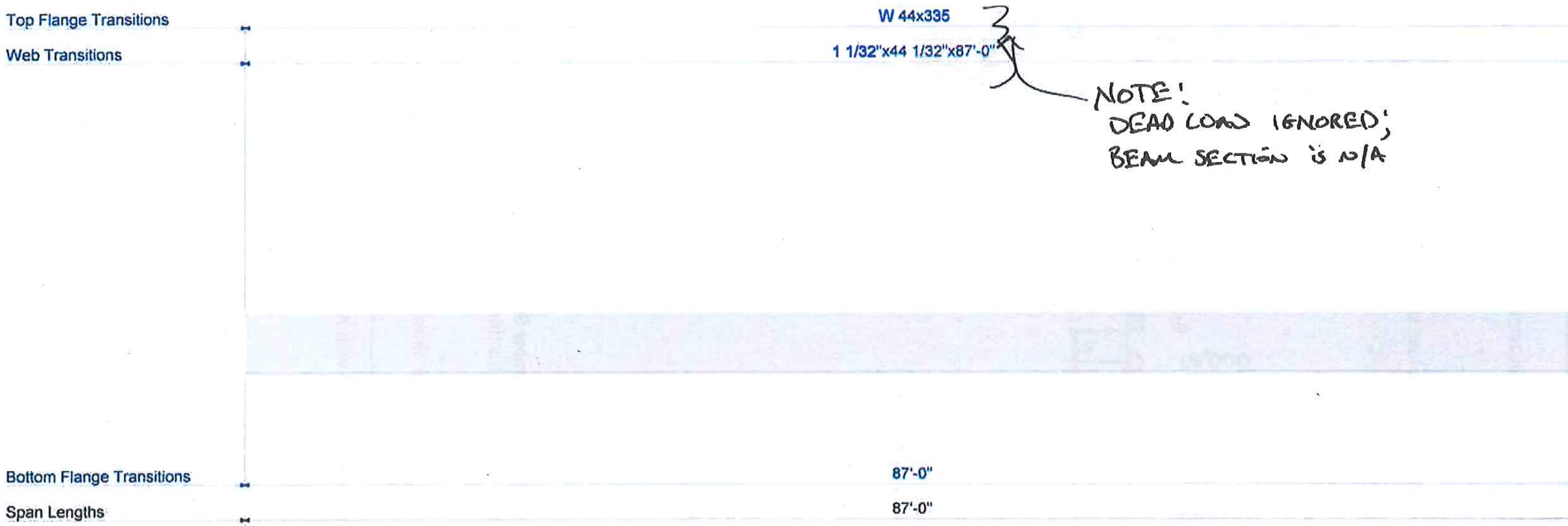
1.3.4.1 Open Deck Structures

a. Timber bridge ties shall be designed in accordance with the requirements of Chapter 7, Timber Structures, based on the assumption that the maximum wheel load on each rail is distributed equally to all ties or fractions thereof within a length of 4 feet, but not to exceed 3 ties, and is applied without impact.

b. For the design of beams or girders, the live load shall be considered as a series of loads as shown in Figure 15-1-2 or Figure 15-1-3. No longitudinal distribution of such loads shall be assumed.

c. Where two or more longitudinal beams per rail are properly diaphragmed, in accordance with Article 1.11.4, and symmetrically spaced under the rail, they shall be considered as equally loaded.

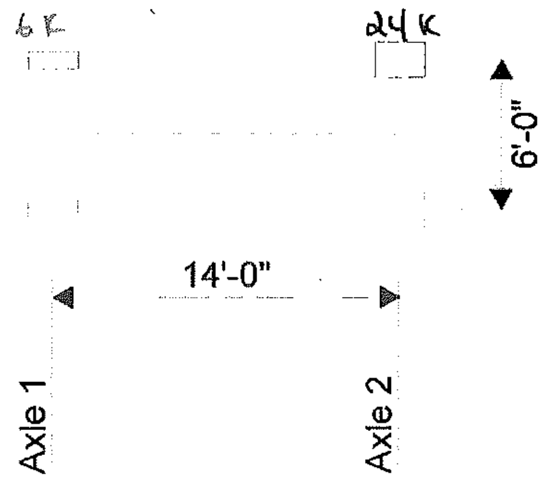
[1] See Part 9 Commentary



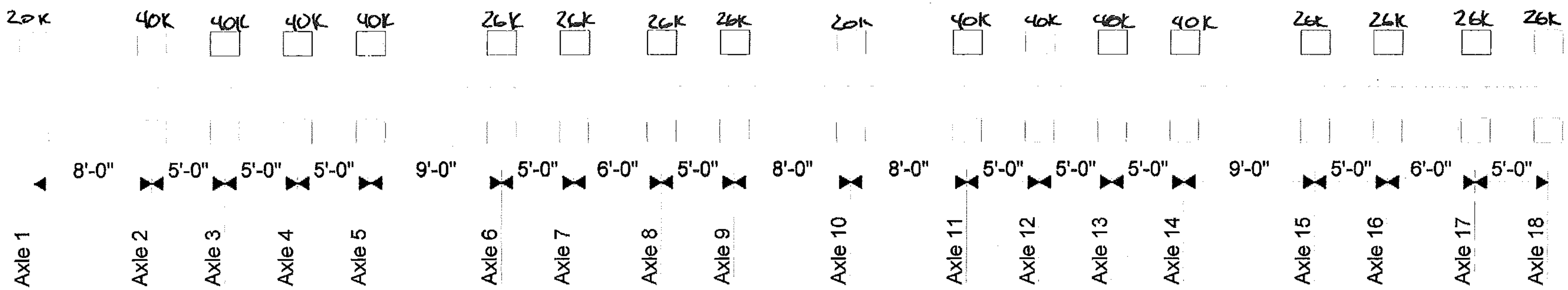
NOTE! DEAD LOAD IGNORED; BEAM SECTION IS N/A

Notes:
* All flange length dimensions are horiz. (length along flange may differ).
* Transverse stiffener pairs shown in red.
* Single transverse stiffener shown in blue.
* Bearing stiffeners shown in green.
* Dimensioning starts and ends at CL bearings.
* X denotes cross frame locations.

H 15-44
Vehicle Plan
01/01/05



Cooper E 40
Vehicle Plan
02/27/15



Live Load Actions Report

Name: C-19-031
Struct-Def: girder

Bridge ID: C-19-031
Member: G1

NBI:
Member Alt: G1

Stage: Composite (short term) ... Live Load: Cooper E 40 Live Load Type: Axle Load

	Span	Location (ft)	% Span	Posit	Negati	Posit	Negati	Posit	Negat	Positive Reaction (kip)	Negative React	Posit	Negat	Posit	Negat	% Im	% Im
	1	0.00	0.0	0	0	3	0	0	0	266.83	00	0	0	0	0	0	0

Live Load Actions Report

Name: C-19-031
Struct-Def: girder

Bridge ID: C-19-031
Member: G1

NBI:
Member Alt: G1

Stage: Composite (short term) ... ***Live Load: H 15*** ***Live Load Type: Axle Load***

	Span	Location (ft)	% Span	Positi	Negativ	Positi	Negativ	Positi	Negati	Positive Reaction (kip)	Negative Reaction	Positi	Negati	Positi	Negati	% Impa	% Impa
	1	0.00	0.0	0	0	3	0	0	0	29.03	00	0	0	0	0	0	0

AASHTO ASR Engine Version 6.4.0.3001
Analysis Preference Setting: None
Analysis Time: 02/27/2015 10:03:28
Print Time: 02/27/2015 10:04:20

Analyzed By: BridgeWare

Live Load Actions Report

Name: C-19-031
Struct-Def: girder

Bridge ID: C-19-031
Member: G1

NBI:
Member Alt: G1

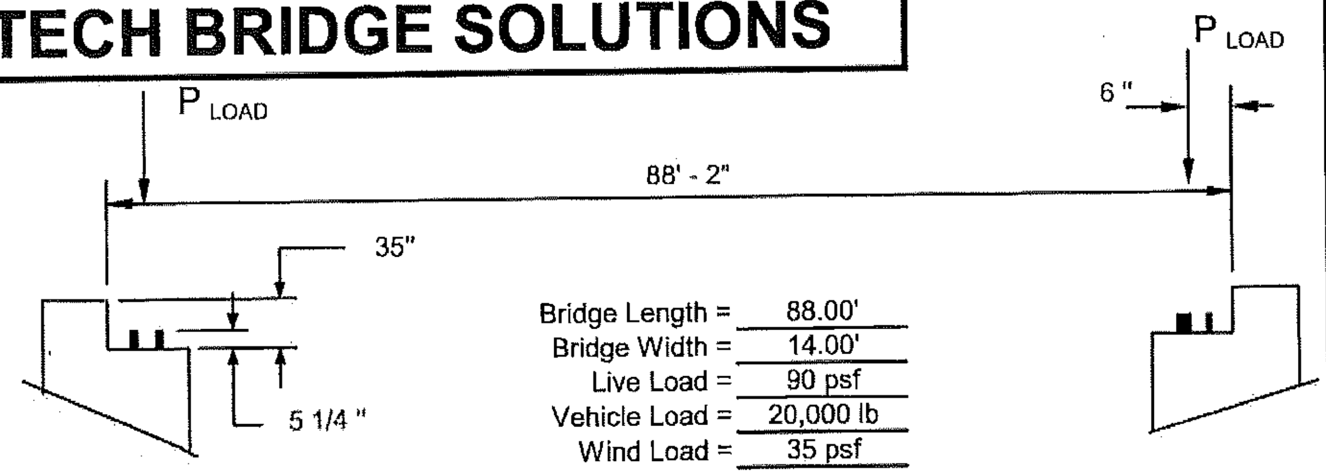
Stage: Composite (short term) ... ***Live Load: H 15*** ***Live Load Type: Axle Load***

	Span	Location (ft)	% Span	Positi	Negativ	Positi	Negativ	Positi	Negati	Positive Reaction (kip)	Negative Reaction	Positi	Negati	Positi	Negati	% Impa	% Impa
	1	0.00	0.0	0	0	3	0	0	0	29.03	00	0	0	0	0	0	0

CONTECH BRIDGE SOLUTIONS

PRELIMINARY ONLY NOT FOR CONSTRUCTION OR FINAL DESIGN

These details and values are being provided for reference use only. All dimensions and values are subject to change after final design.



Bridge Length = 88.00'
Bridge Width = 14.00'
Live Load = 90 psf
Vehicle Load = 20,000 lb
Wind Load = 35 psf
Design Code = LRFD
Anchor Bolt Diameter = 0.75 in

ANCHOR BOLT ELEVATION

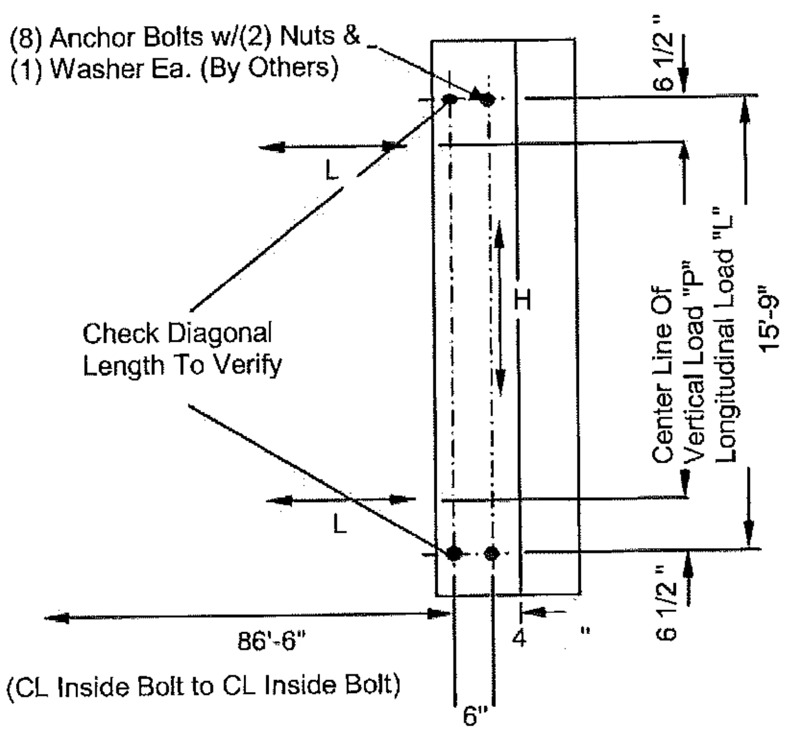
CONCRETE DECK

COMBINE REACTIONS AS PER LOCAL OR GOVERNING BUILDING CODES AS REQUIRED

BRIDGE REACTIONS - Upward Load

	P (LBS)	H (LBS)	L (LBS)
Dead Load	32,450		
Uniform Live Load	27,720		
Vehicle Load	10,000		
Wind Uplift 20 PSF	-10120		
Wind	+ -3360	11,345	
Thermal			4,870

"P" - Vertical Load at Each Base Plate (4 per Bridge)
"H" - Horizontal Load at Each Footing (2 per Bridge)
"L" - Longitudinal Load at Each Bearing (4 per Bridge)



PLAN

*Note: dead load reaction includes weight of concrete deck

**Note: If bridge is in Siesmic region, please contact CONTECH Rep with Design Code requirment for additional loading

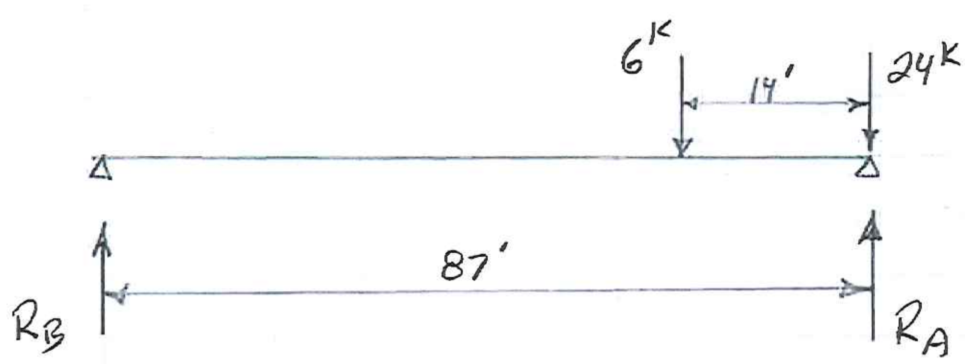
NOTE: All Dimensions And Values Are Subject To Change After Final Design.

Bridge Weight w/ Concrete Deck: **129,800 LBS**
Bridge Lifting Weight: **43,600 LBS** (not including weight of concrete deck)

BRUCE FREEMAN RAIL TRAIL – PHASE 2C

- H-15 LOADING ON BRIDGE C-19-031 FOR LOAD COMPARISON TO HISTORIC RAIL LOADING.

- USE A SINGLE H-15 TRUCK TO REPRESENT EMERGENCY VEHICLE LOAD AND IGNORE CONCURRENT LANE LOAD :



$$R_A = 24^k + 6^k\left(\frac{73^{FT}}{87^{FT}}\right) = 29.03^k$$ ← MATCHES VIRTIS OUTPUT

✓ OK JFW

COOPER E40 LOAD

* Use Ratio of Cooper E80 & Span length/train length

COOPER E80:

LOAD(k) 40 80 80 80 80 52 52 52 52 40 80 80 80 80 52 52 52 52
AXLE o oooo oooo o oooo oooo

109'

91'

Total Load = 952 K

SPAN L = 87'

FOR COOPER E40 = 952 K x $\frac{40}{80}$ = 476 K

PER ABUT = 476 K ÷ 2 = 238 K

LL = 238 K/ABUT

→ 266 K - OK