Maura Healey, Governor
Kimberley Driscoll, Lieutenant Governor
Monica Tibbits-Nutt, Secretary & CEO
Jonathan L. Gulliver, Highway Administrator

massDOT
Massachusetts Department of Transportation
Highway Division

January 15, 2025

610869-128933

ADDENDUM NO. 1

To Prospective Bidders and Others on:

NATICK
Pedestrian/Bike Bridge Superstructure Replacement, N-03-007, Spring Street over the MBTA

THIS PROPOSAL TO BE OPENED AND READ: WEDNESDAY, JANUARY 22, 2025 at 2:00 P.M.
Transmitting revisions to the Contract Documents as follows:

QUESTIONS AND RESPONSES: One page.

DOCUMENT 00010: Revised page 2.

DOCUMENT A00803: Inserted new document (34 pages).

DOCUMENT A00804: Inserted new document (96 pages).

Take note of the above, substitute the revised page for the original, insert new documents in proper order, and acknowledge Addendum No. 1 in your Expedite Proposal file before submitting your bid.

Very truly yours,

Eric M. Cardone Digitally signed by Eric M. Cardone
Date: 2025.01.15 10:14:03 -05'00'

Eric M. Cardone, P.E.
Construction Contracts Engineer

SP
cc: W Brown, Project Manager

Ten Park Plaza, Suite 4160, Boston, MA 02116
Tel: 857-368-4636, TTY: 857-368-0655
mass.gov/massdot

NATICK
PEDESTRIAN/BIKE BRIDGE SUPERSTRUCTURE REPLACEMENT, N-03-007, SPRING STREET OVER THE MBTA

(610869-128933)

Questions and Responses Addendum No. 1, January 15, 2025

Kinetic Demolition & Engineering, LLC, email dated, January 13, 2025

Question 1) Are there any existing plans, inspection reports, and/or rating reports available for the existing structure?

Response 1) There are no existing bridge plans on file. See new Documents A00803 and A00804.

Contech Engineered Solutions LLC, email dated, January 14, 2025

Question 2) Considering the shallow depth requirement for the bridge from top of deck to lowest steel member, we are trying to understand our constraints as much as possible. It appears that the concrete deck thickness as measured at the centerline is 6.5” from top of deck to vertical centerline of the SIP form, please confirm. Is there are a certain SIP form corrugation pattern that this is based upon? Also it does not appear that the SIP forms are resting on the floor beams as there is additional space shown between, please confirm that this is a detailing error and it is understood that SIP’s will rest on the floor beams.

Response 2) This will be answered in a future addendum.

Question 3) What is the weight per linear foot of the 8” steel gas main (including pipe supports)?

Response 3) This will be answered in a future addendum.

① Addendum No. 1, January 15, 2025

TABLE OF CONTENTS (Continued)

*** END OF DOCUMENT ***

DOCUMENT A00803

STRUCTURES INSPECTION FIELD REPORT

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MASSACHUSETTS DEPARTMENT OF TRANSPORTATION PAGE 1 OF 6

STRUCTURES INSPECTION FIELD REPORT

CLOSED/REHABILITATION INSPECTION

2-DIST	B.I.N.	BR. DEPT. NO.
03	29N	N-03-007

CITY/TOWN	8.-STRUCTURE NO.	11-Kilo. POINT	90-ROUTINE INSP. DATE	93*- INSPECTION DATE
NATICK	N03007-29N-DOT-CLP	000.241	JUN 1, 2020	JUN 1, 2020

07-FACILITY CARRIED	MEMORIAL NAME/LOCAL NAME	27-YR BUILT	106-YR REBUILT	YR REHAB'D (NON 106)
HWY SPRING ST	DEFLUMERI DIGERONIMO	1896	0000	0000

06-FEATURES INTERSECTED: RR MBTA/CSX

26-FUNCTIONAL CLASS: Urban Local

DIST. BRIDGE INSPECTION ENGINEER **M. Azizi**

43-STRUCTURE TYPE: 303 : Steel Girder & Floorbeam

22-OWNER: State Highway Agency

21-MAINTAINER: State Highway Agency

TEAM LEADER **D. Smith**

107-DECK TYPE: 8 : Timber

WEATHER: Clear

TEMP. (air): 14°C

TEAM MEMBERS: Michael McGinty

ITEM 58	*DECK*	3
ITEM 59	*SUPERSTRUCTURE*	2
ITEM 60	*SUBSTRUCTURE*	7
ITEM 60	- (From U/W Report)	N
ITEM 61	*CHANNEL*	N
ITEM 61	- (From U/W Report)	N
ITEM 62	*CULVERT*	N
ITEM 62	- (From U/W Report)	N

ITEM 41 *STRUCTURE OPEN, POSTED OR CLOSED*

K:CLOSED Date : 07/09/1998

ITEM 36 *TRAFFIC SAFETY*

	36	COND	DEF
A. Bridge Railing	0	0	-
B. Transitions	0	0	-
C. Approach Guardrail	0	0	-
D. Approach Guardrail	0	0	-

TOTAL HOURS 8

PLANS (Y/N) N

(V.C.R.) (Y/N) N

TAPE#:

Pedestrian Access (If YES please explain) (Y/N) Y

Roadway Abandoned (Y/N) N

Barricades In Place (Y/N) Y

TYPE: JERSEY BARRIERS

SIGNS *Not Applicable* ☐

Legend: BRIDGE CLOSED

	At bridge N	At bridge S	Advance N	Advance S
Signs In Place (Y=Yes ,N=No, NR=Not Required)	Y	NR	Y	Y
Legibility/ Visibility	7 / 7		7 / 7	7 / 7

To be filled out by District Bridge Inspection Engineer

1) This bridge is scheduled for:

Replacement ( ) *Rehabilitation* ( ) *Repair* ( ) *Removal* ( ) *Unknown* (X)

2) If under construction please answer the following:

Contract Number:

Amount:

Completion Date:

Contractor:

Resident Engineer:

Scope of Work:

Remarks:

ACCESSIBILITY (Y/N)

	Needed	Used
Lift Bucket	N	N
Ladder	Y	N
Boat	N	N
Wader	N	N
Inspector 50	N	N
Rigging	N	N
Staging	N	N
Traffic Control	N	N
RR Flagger	Y	N
Police	N	N
Other:	N	N

X=UNKNOWN N=NOT APPLICABLE H=HIDDEN/INACCESSIBLE R=REMOVED

CLO. REHAB(1)7-96

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	**29N**	**N-03-007**	**N03007-29N-DOT-CLP**	**JUN 1, 2020**

REMARKS

BRIDGE ORIENTATION

According to the rating report, the approaches are North and South and the elevations are East and West. This is a single span riveted plate through girder bridge with a timber deck. There are 2 girders numbered West to East with 5 floorbeams numbered South to North. There are 13 roadway stringers in each bay numbered West to East and 6 bays numbered South to North.

GENERAL REMARKS

Posting

The South "Bridge Closed" sign located at the corner of Spring St. and Middlesex Ave. is within 150 ft. from the bridge and is sufficient to act as both the *At bridge* and *Advance* signs. **See Photo 1.** There is a "Bridge Closed" sign at both the North *At bridge* and *Advance*. **See Photo 2.**

Pedestrian Access

There are two concrete Jersey barriers across both bridge approaches spaced apart to allow pedestrian access to the bridge. **See Photo 3.**
The bituminous concrete wearing surface has heavy transverse and map cracking with several bituminous patches throughout.
Pedestrian access to both timber sidewalks is blocked by a 5 ft. high chain link fence and "Danger Pedestrian Traffic Prohibited" signs at all four sidewalk ends. The Southeast sign is covered with vegetation. **See Photo 4.**
Several sidewalk planks are missing and many planks and stringers throughout both sidewalks are heavily rotted and loose. The West sidewalk has an 11 ft. long x full width section that is missing. **See Photo 5.**

Collision Damage

There is old minor collision damage to girder #1 at the floorbeam #4 connection. The gusset plate in this area is bent down and there is a minor scrape to the underside of the bottom flange/cover plate of the girder. There are minor collision scrapes to the underside of the bottom flange of girder #2. All of the above mentioned collision damage is over the North railroad track.

Floor Stringers

The stringers throughout all bays show heavy surface rusting and areas of minor to heavy rust flaking. **See Photo 6.**
The seats to stringers #1, #2, #4 and #13 on floorbeam #2, #12 and #13 at floorbeam #3, and #8, #9, #12 and #13 on floorbeam #4 have areas of 100% section loss.
In bays #3 and #4 there are many stringers that have intermittent areas of 100% section loss throughout to the top and bottom flanges and isolated web locations. Stringer #2 in bay #3 has areas of 100% section loss to the web. **See Photos 7 and 8.**
Note, the stringers in addition to resting on the seats are riveted to the floorbeams.

See Fracture Critical Inspection dated 6/01/20 for additional comments on girders and floorbeams.

Photo Log

Photo 1 :	South intersection with Middlesex Ave.
Photo 2 :	North approach.
Photo 3 :	South approach.
Photo 4 :	North approach.
Photo 5 :	West sidewalk.
Photo 6 :	Underside looking North.
Photo 7 :	Floorbeam bay #3.
Photo 8 :	Floorbeam bay #4.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	29N	N-03-007	N03007-29N-DOT-CLP	JUN 1, 2020

PHOTOS

Photo 1: **South intersection with Middlesex Ave.**

Photo 2: **North approach.**

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	**29N**	**N-03-007**	**N03007-29N-DOT-CLP**	**JUN 1, 2020**

PHOTOS

Photo 3: **South approach.**

Photo 4: **North approach.**

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	**29N**	**N-03-007**	**N03007-29N-DOT-CLP**	**JUN 1, 2020**

PHOTOS

Photo 5: **West sidewalk.**

Photo 6: **Underside looking North.**

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	**29N**	**N-03-007**	**N03007-29N-DOT-CLP**	**JUN 1, 2020**

PHOTOS

Photo 7: Floorbeam bay #3.

Photo 8: Floorbeam bay #4.

Report Date: July 14, 2021 DEFLUMERI DIGERONIMO

State Information

BDEPT#= N03007 Agency Br.No.
Town= Natick L.O. MHD
B.I.N= 29N AASHTO= 032.0
RANK= 0 H.I.= 0 FHWA Select List= N (6/21/2017)

Identification

(8) Structure Number N0300729NDOTCLP
(5) Inventory Route 151000000
(2) State Highway Department District 03
(3) County Code 017 (4) Place code 43895
(6) Features Intersected **RR MBTA/CSX**
(7) Facility Carried **HWY SPRING ST**
(9) Location .3 MI. W. OF ST-27
(11) Kilometerpoint 0000.241
(12) Base Highway Network N
(13) LRS Inventory Route & Subroute 000000000000
(16) Latitude 42 DEG 17 MIN 07.22 SEC
(17) Longitude 71 DEG 21 MIN 00.90 SEC
(98) Border Bridge State Code Share %
(99) Border Bridge Structure No. #

Structure Type and Material

(43) Structure Type Main: Steel Code 303
Girder & Floorbeam Jointless bridge type: Not applicable
(44) Structure Type Appr:
Other Code 000
(45) Number of spans in main unit 001
(46) Number of approach spans 0000
(107) Deck Structure Type - Timber Code 8
(108) Wearing Surface / Protective System:
A) Type of wearing surface - Bituminous Code 6
B) Type of membrane - None Code 0
C) Type of deck protection - None Code 0

Age and Service

(27) Year Built 1896
(106) Year Reconstructed 0000
(42) Type of Service: On - Highway-Ped
Under - Railroad Code 52
(28) Lanes: On Structure 02 Under structure 00
(29) Average Daily Traffic 000000
(30) Year of ADT 2019 (109) Truck ADT 00 %
(19) Bypass, detour length 002 KM

Geometric Data

(48) Length of maximum span 0019.5 M
(49) Structure Length 00021.0 M
(50) Curb or sidewalk: Left 01.5 M Right 01.8 M
(51) Bridge Roadway Width Curb to Curb 006.7 M
(52) Deck Width Out to Out 010.8 M
(32) Approach Roadway Width (w/shoulders) 005.5 M
(33) Bridge Median - No median Code 0
(34) Skew 00 DEG (35) Structure Flared N
(10) Inventory Route MIN Vert Clear 99.99 M
(47) Inventory Route Total Horiz Clear 06.7 M
(53) Min Vert Clear Over Bridge Rdwy 99.99 M
(54) Min Vert Underclear ref R 05.38 M
(55) Min Lat Underclear RT ref R 06.1 M
(56) Min Lat Underclear LT 00.0 M

Navigation Data

(38) Navigation Control - Not applicable, no waterway Code N
(111) Pier Protection Code
(39) Navigation Vertical Clearance 000.0 M
(116) Vert-lift Bridge Nav Min Vert Clear M
(40) Navigation Horizontal Clearance 0000.0 M

Classification Code

(112) NBIS Bridge Length Y
(104) Highway System N
(26) Functional Class - Urban Local 19
(100) Defense Highway 0
(101) Parallel Structure N
(102) Direction of Traffic - 2-way traffic 2
(103) Temporary Structure N
(105) Federal Lands Highways 0
(110) Designated National Network N
(20) Toll - On free road 3
(21) Maintain - State Highway Agency 01
(22) Owner - State Highway Agency 01
(37) Historical Significance not eligible N

Condition Code

(58) Deck 3
(59) Superstructure 2
(60) Substructure 7
(61) Channel & Channel Protection N
(62) Culverts N

Load Rating and Posting Code

(31) Design Load - H 10=M 9 1
(63) Operating Rating Method - Allowable Stress (AS) 2
(64) Operating Rating 00.0
(65) Inventory Rating Method - Allowable Stress (AS) 2
(66) Inventory Rating 00.0
(70) Bridge Posting 0
(41) Structure - Closed K

Appraisal Code

(67) Structural Evaluation 0
(68) Deck Geometry 5
(69) Underclearances, vert. and horiz. 0
(71) Waterway adequacy N
(72) Approach Roadway Alignment 7
(36) Traffic Safety Features 0 0 0 0
(113) Scour Critical Bridges N

Inspections

(90) Inspection Date 06/01/20 (91) Frequency 24 MO
(92) Critical Feature Inspection: (93) CFI DATE

(A) Fracture Critical Detail	Y	24	MO A)	06/01/20
(B) Underwater Inspection	N	00	MO B)	00/00/00
(C) Other Special Inspection	N	00	MO C)	00/00/00
(*) Other Inspection ()	N	00	MO *)	00/00/00
(*) Closed Bridge	Y	12	MO *)	06/09/21
(*) UW Special Inspection	N	00	MO *)	00/00/00
(*) Damage Inspection			MO *)	00/00/00

Rating Loads

Report Date 00/00/00	H20	Type 3	Type 3S2	Type HS
Operating	0.0	0.0	0.0	0.0
Inventory	0.0	0.0	0.0	0.0

Field Posting

Status CLOSED Posting Date 07/09/98

	2 Axle	3 Axle	5 Axle	Single
Actual				
Recommended				

Missing Signs N

Misc.

Bridge Name DEFLUMERI DIGERONIMO
N Anti-missile fence N Acrow Panel N Jointless Bridge
Freeze/Thaw N : Not Applicable

Accessibility (Needed/Used)

N / N Liftbucket
Y / N Ladder
N / N Boat
N / N Wader
N / N Inspector 50

N / N Rigging
N / N Staging
N / N Traffic Control
Y / N RR Flagperson
N / N Police

N / N Other

Inspection Hours: 008

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MASSACHUSETTS DEPARTMENT OF TRANSPORTATION PAGE 1 OF 6

2-DIST	B.I.N.	BR. DEPT. NO.
03	29N	N-03-007

STRUCTURES INSPECTION FIELD REPORT

FRACTURE CRITICAL INSPECTION

CITY/TOWN	8.-STRUCTURE NO.	11-Kilo. POINT	90-ROUTINE INSP. DATE	93a - F.C. INSP. DATE
NATICK	N03007-29N-DOT-CLP	000.241	Jun 1, 2020	Jun 1, 2020

07-FACILITY CARRIED	MEMORIAL NAME/LOCAL NAME	27-YR BUILT	106-YR REBUILT	*YR REHAB'D (NON 106)
HWY SPRING ST	DEFLUMERI DIGERONIMO	1896	0000	0000

06-FEATURES INTERSECTED	26-FUNCTIONAL CLASS	DIST. BRIDGE INSPECTION ENGINEER
RR MBTA/CSX	Urban Local	M. Azizi

43-STRUCTURE TYPE	22-OWNER	21-MAINTAINER	TEAM LEADER
303 : Steel Girder & Floorbeam	State Highway Agency	State Highway Agency	D. Smith

107-DECK TYPE	WEATHER	TEMP. (air)	TEAM MEMBERS
8 : Timber	Sunny	14°C	M. MCGINTY

WEIGHT POSTING *Not Applicable* ☒

	H	3	3S2	Single
Actual Posting	N	N	N	N
Recommended Posting	N	N	N	N

Waived Date: 00/00/0000 EJDMT Date: 00/00/0000

	At bridge N	At bridge S	Advance N	Advance S
Signs In Place (Y=Yes,N=No, NR=Not Required)				
Legibility/ Visibility				

PLANS (Y/N): N

(V.C.R.) (Y/N): N

TAPE#:

RATING

Rating Report (Y/N): N Date: ----

Recommend for Rating or Rerating (Y/N): N

If YES please give priority: HIGH ( ) MEDIUM ( ) LOW ( )

REASON:

Inspection data at time of existing rating

I 58: 6 I 59: 7 I 60: 6 I 62: Date : 11/16/1977

FRACTURE CRITICAL MEMBER(S):

	MEMBER	CRACK (Y/N):	WELD'S CONDITION (0-9)	LOCATION OF CORROSION, SECTION LOSS (%), CRACKS, COLLISION DAMAGE, STRESS CONCENTRATION, ETC.	CONDITION PREVIOUS (0-9)	CONDITION PRESENT (0-9)	INV. RATING OF MEMBER FROM RATING ANALYSIS H-20	3	3S2	Deficiencies
A	Item 59.2 - Floorbeams	N	N	See remarks in comments section.	2	2	7	10	15	S-A
B	Item 59.4 - Girders or Beams	N	N	See remarks in comments section.	4	4	32	40	53	S-A
C										
D										
E										

List of field tests performed:

None

	I-59	I-60
(Overall Previous Condition)	2	7
(Overall Current Condition)	2	7

DEFICIENCY: A defect in a structure that requires corrective action.

CATEGORIES OF DEFICIENCIES:

M= Minor Deficiency - Deficiencies which are minor in nature, generally do not impact the structural integrity of the bridge and could easily be repaired. Examples include but are not limited to: Spalled concrete, Minor pot holes, Minor corrosion of steel, Minor scouring, Clogged drainage, etc.

S= Severe/Major Deficiency - Deficiencies which are more extensive in nature and need more planning and effort to repair. Examples include but are not limited to: Moderate to major deterioration in concrete, Exposed and corroded rebars, Considerable settlement, Considerable scouring or undermining, Moderate to extensive corrosion to structural steel with measurable loss of section, etc.

C-S= Critical Structural Deficiency - A deficiency in a structural element of a bridge that poses an extreme unsafe condition due to the failure or imminent failure of the element which will affect the structural integrity of the bridge.

C-H= Critical Hazard Deficiency - A deficiency in a component or element of a bridge that poses an extreme hazard or unsafe condition to the public, but does not impair the structural integrity of the bridge. Examples include but are not limited to: Loose concrete hanging down over traffic or pedestrians, A hole in a sidewalk that may cause injuries to pedestrians, Missing section of bridge railing, etc.

URGENCY OF REPAIR:

I = Immediate- [Inspector(s) immediately contact District Bridge Inspection Engineer (DBIE) to report the Deficiency and to receive further instruction from him/her].

A = ASAP- [Action/Repair should be initiated by District Maintenance Engineer or the Responsible Party (if not a State owned bridge) upon receipt of the Inspection Report].

P = Prioritize- [Shall be prioritized by District Maintenance Engineer or the Responsible Party (if not a State owned bridge) and repairs made when funds and/or manpower is available].

X=UNKNOWN N=NOT APPLICABLE H=HIDDEN/INACCESSIBLE R=REMOVED

F.C.(1)7-96

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	**29N**	**N-03-007**	**N03007-29N-DOT-CLP**	**JUN 1, 2020**

REMARKS

BRIDGE ORIENTATION

According to the rating report, the approaches are North and South and the elevations are East and West. This is a single span riveted plate through girder bridge with a timber deck. There are 2 girders numbered West to East with 5 floorbeams numbered South to North. There are 13 roadway stringers in each bay numbered West to East and 6 bays numbered South to North.

GENERAL REMARKS

This WAS NOT a hands on inspection. This was a visual inspection performed from the ground only due to the continued inability to get flagging services provided by CSX Railroad.

ITEM 59 - SUPERSTRUCTURE

Item 59.2 - Floorbeams

There is severe section loss throughout the floorbeams, up to 100%, mostly at the ends beyond the cover plates. The location of the heaviest section loss is adjacent to the built up areas. The condition of the floorbeams with the section loss is as follows:

Floorbeam #2 at the West end: The South side of the built up bottom flange has 100% section loss adjacent to the cover plate, 34 in. long x up to 3 in. wide. The angle is back to original thickness at 36 in. from the cover plate.
The bottom angle on the North side has areas of up to 100% section loss adjacent to the cover plate, 24 in. long x 4 in. wide. There is heavy pitting on top of the bottom angle from the cover plate to the end of the floorbeam. **See Photo 1.**

Floorbeam #2 at the East end: The South side of the bottom angle has 100% section loss adjacent to the cover plate, 21 in. long x up to 1-1/2 in. wide. The angle is back to original thickness at 25 in. from the cover plate.
The bottom angle on the North side has areas of up to 100% section loss adjacent to the cover plate, 28 in. long x 3 in. wide. The angle is back to original thickness at 30 in. from the cover plate. **See Photo 2.**

Floorbeam #3 at the West end: The South side bottom angle has 100% section loss adjacent to the cover plate, 17 in. long x 2 in. wide. The angle is back to original thickness at 20 in. from the cover plate.
The North side bottom angle has areas of up to 100% section loss throughout, starting at the cover plate with some areas 3/4 in. wide. **See Photo 3.**

Floorbeam #3 at East end: The bottom angle on the South side has 100% section loss adjacent to the cover plate, 24 in. long x 2 in. wide. The angle is back to original thickness at 20 in. from the cover plate. **See Photo 4.**
The bottom angle on the North side has areas of up to 100% section loss adjacent to the cover plate, 12 in. long x up to 3/4 in. wide. The angle is back to original thickness at 14 in. from the cover plate.

Floorbeam #4 at West end: The bottom angle on the South side has 100% section loss adjacent to the cover plate, 10 in. long x 3/4 in. wide. The angle is back to original thickness at 15 in. from the cover plate.
The bottom angle on the North side has an area of 100% section loss starting at 8 in. out from the cover plate to 18 in. x 2-1/2 in. wide. **See Photo 5.**

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	**29N**	**N-03-007**	**N03007-29N-DOT-CLP**	**JUN 1, 2020**

REMARKS

Item 59.4 - Girders or Beams

Both girders have up to 50% section loss to the bottom flanges at the interior South ends at the bearings.
Both girders have up to 15% section loss to the bottom flanges and the interior North ends.
The bottom flange of girder #1 has a 12 in. long x 1 in. wide area of 100% section loss at floorbeam #5.

There is an approximately 12 in. long x 2 in. wide area of 100% section loss to the bottom flange of girder #1 at floorbeam #1. **See Photo 6.**
Both girders have moderate to heavy paint peeling and surface rusting with intermittent areas of rust pack between bottom flanges and interior web faces.
There is old minor collision damage to girder #1 at floorbeam #4. The gusset plate in this area is bent down and there is a minor scrape to the underside of the bottom flange. There are minor collision scrapes to the underside of the bottom flange of girder #2 above the North railroad tracks.

Photo Log

Photo 1 :	West end of floorbeam #2.
Photo 2 :	East end of floorbeam #2.
Photo 3 :	West end of floorbeam #3.
Photo 4 :	East end of floorbeam #3.
Photo 5 :	West end of floorbeam #4.
Photo 6 :	Girder #1 at floorbeam #1.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	29N	N-03-007	N03007-29N-DOT-CLP	JUN 1, 2020

PHOTOS

Photo 1: West end of floorbeam #2.

Photo 2: East end of floorbeam #2.

REM.(2)7-96

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	29N	N-03-007	N03007-29N-DOT-CLP	JUN 1, 2020

PHOTOS

Photo 3: West end of floorbeam #3.

Photo 4: East end of floorbeam #3.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	**29N**	**N-03-007**	**N03007-29N-DOT-CLP**	**JUN 1, 2020**

PHOTOS

Photo 5: **West end of floorbeam #4.**

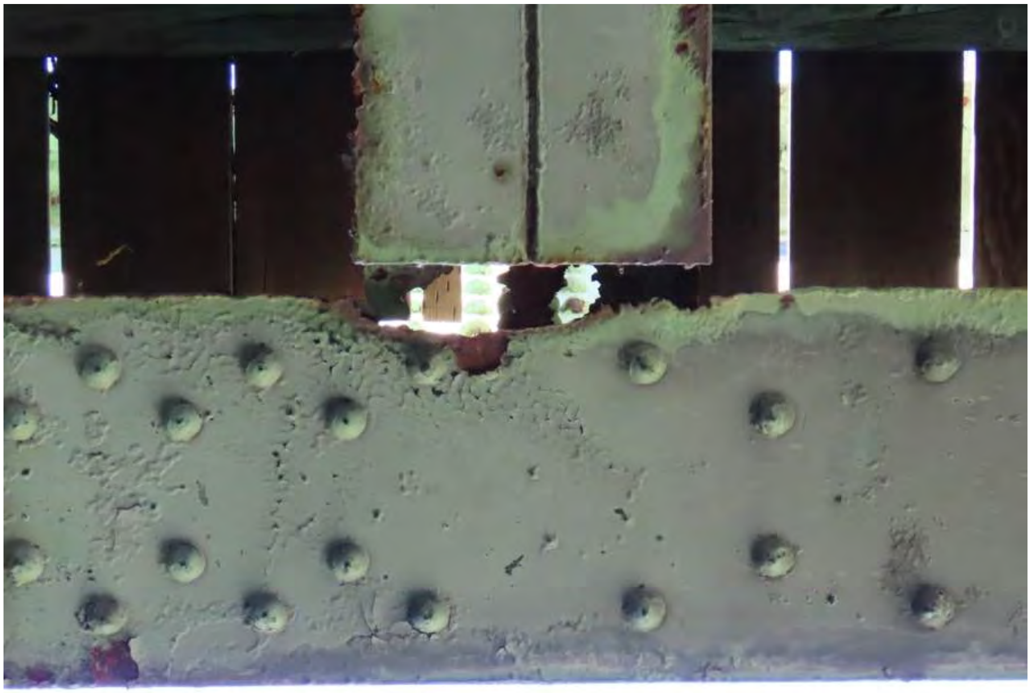

Photo 6: **Girder #1 at floorbeam #1.**

Report Date: July 14, 2021

DEFLUMERI DIGERONIMO

State Information

BDEPT#= N03007 Agency Br.No.

Town= Natick L.O. MHD

B.I.N= 29N AASHTO= 032.0

RANK= 0 H.I.= 0 FHWA Select List= N (6/21/2017)

Identification

(8) Structure Number	N0300729NDOTCLP
(5) Inventory Route	151000000
(2) State Highway Department District	03
(3) County Code 017 (4) Place code	43895
(6) Features Intersected	**RR MBTA/CSX**
(7) Facility Carried	**HWY SPRING ST**
(9) Location	.3 MI. W. OF ST-27
(11) Kilometerpoint	0000.241
(12) Base Highway Network	N
(13) LRS Inventory Route & Subroute	000000000000
(16) Latitude	42 DEG 17 MIN 07.22 SEC
(17) Longitude	71 DEG 21 MIN 00.90 SEC
(98) Border Bridge State Code	Share %
(99) Border Bridge Structure No. #	

Structure Type and Material

(43) Structure Type Main: Steel Code 303

Girder & Floorbeam Jointless bridge type: Not applicable

(44) Structure Type Appr:

Other Code 000

(45) Number of spans in main unit 001

(46) Number of approach spans 0000

(107) Deck Structure Type - Timber Code 8

(108) Wearing Surface / Protective System:

A) Type of wearing surface - Bituminous Code 6

B) Type of membrane - None Code 0

C) Type of deck protection - None Code 0

Age and Service

(27) Year Built 1896

(106) Year Reconstructed 0000

(42) Type of Service: On - Highway-Ped

Under - Railroad Code 52

(28) Lanes: On Structure 02 Under structure 00

(29) Average Daily Traffic 000000

(30) Year of ADT 2019 (109) Truck ADT 00 %

(19) Bypass, detour length 002 KM

Geometric Data

(48) Length of maximum span 0019.5 M

(49) Structure Length 00021.0 M

(50) Curb or sidewalk: Left 01.5 M Right 01.8 M

(51) Bridge Roadway Width Curb to Curb 006.7 M

(52) Deck Width Out to Out 010.8 M

(32) Approach Roadway Width (w/shoulders) 005.5 M

(33) Bridge Median - No median Code 0

(34) Skew 00 DEG (35) Structure Flared N

(10) Inventory Route MIN Vert Clear 99.99 M

(47) Inventory Route Total Horiz Clear 06.7 M

(53) Min Vert Clear Over Bridge Rdwy 99.99 M

(54) Min Vert Underclear ref R 05.38 M

(55) Min Lat Underclear RT ref R 06.1 M

(56) Min Lat Underclear LT 00.0 M

Navigation Data

(38) Navigation Control - Not applicable, no waterway Code N

(111) Pier Protection Code

(39) Navigation Vertical Clearance 000.0 M

(116) Vert-lift Bridge Nav Min Vert Clear M

(40) Navigation Horizontal Clearance 0000.0 M

Classification

		Code
(112) NBIS Bridge Length		Y
(104) Highway System		N
(26) Functional Class -	Urban Local	19
(100) Defense Highway		0
(101) Parallel Structure		N
(102) Direction of Traffic -	2-way traffic	2
(103) Temporary Structure		N
(105) Federal Lands Highways		0
(110) Designated National Network		N
(20) Toll -	On free road	3
(21) Maintain -	State Highway Agency	01
(22) Owner -	State Highway Agency	01
(37) Historical Significance	not eligible	N

Condition

	Code
(58) Deck	3
(59) Superstructure	2
(60) Substructure	7
(61) Channel & Channel Protection	N
(62) Culverts	N

Load Rating and Posting

		Code
(31) Design Load -	H 10=M 9	1
(63) Operating Rating Method -	Allowable Stress (AS)	2
(64) Operating Rating		00.0
(65) Inventory Rating Method -	Allowable Stress (AS)	2
(66) Inventory Rating		00.0
(70) Bridge Posting		0
(41) Structure -	Closed	K

Appraisal

	Code
(67) Structural Evaluation	0
(68) Deck Geometry	5
(69) Underclearances, vert. and horiz.	0
(71) Waterway adequacy	N
(72) Approach Roadway Alignment	7
(36) Traffic Safety Features	0 0 0 0
(113) Scour Critical Bridges	N

Inspections

(90) Inspection Date 06/01/20 (91) Frequency 24 MO

(92) Critical Feature Inspection: (93) CFI DATE

(A) Fracture Critical Detail	Y	24	MO A)	06/01/20
(B) Underwater Inspection	N	00	MO B)	00/00/00
(C) Other Special Inspection	N	00	MO C)	00/00/00
(*) Other Inspection ()	N	00	MO *)	00/00/00
(*) Closed Bridge	Y	12	MO *)	06/09/21
(*) UW Special Inspection	N	00	MO *)	00/00/00
(*) Damage Inspection			MO *)	00/00/00

Rating Loads

Report Date 00/00/00	H20	Type 3	Type 3S2	Type HS
Operating	0.0	0.0	0.0	0.0
Inventory	0.0	0.0	0.0	0.0

Field Posting

Status CLOSED Posting Date 07/09/98

	2 Axle	3 Axle	5 Axle	Single
Actual				
Recommended				

Missing Signs N

Misc.

Bridge Name DEFLUMERI DIGERONIMO

N Anti-missile fence N Acrow Panel N Jointless Bridge

Freeze/Thaw N : Not Applicable

Accessibility (Needed/Used)

N / N	Liftbucket	N / N	Rigging	N / N	Other
Y / N	Ladder	N / N	Staging		
N / N	Boat	N / N	Traffic Control		
N / N	Wader	Y / N	RR Flagperson	Inspection Hours:	008
N / N	Inspector 50	N / N	Police		

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MASSACHUSETTS DEPARTMENT OF TRANSPORTATION PAGE 1 OF 6

STRUCTURES INSPECTION FIELD REPORT
CLOSED/REHABILITATION INSPECTION

2-DIST	B.I.N.	BR. DEPT. NO.
03	29N	N-03-007

CITY/TOWN	8.-STRUCTURE NO.	11-Kilo. POINT	90-ROUTINE INSP. DATE	93*- INSPECTION DATE
NATICK	N03007-29N-DOT-CLP	000.241	JUL 9, 1998	JUN 8, 2022

07-FACILITY CARRIED	MEMORIAL NAME/LOCAL NAME	27-YR BUILT	106-YR REBUILT	YR REHAB'D (NON 106)
HWY SPRING ST	DEFLUMERI DIGERONIMO	1896	0000	0000

06-FEATURES INTERSECTED	26-FUNCTIONAL CLASS	DIST. BRIDGE INSPECTION ENGINEER
RR MBTA/CSX	Urban Local	M. Azizi

43-STRUCTURE TYPE	22-OWNER	21-MAINTAINER	TEAM LEADER
303 : Steel Girder & Floorbeam	State Highway Agency	State Highway Agency	L. Fijol

107-DECK TYPE	WEATHER	TEMP. (air)	TEAM MEMBERS
8 : Timber	Clear	14°C	Kristen Houatchanthara

ITEM 58	*DECK*	3
ITEM 59	*SUPERSTRUCTURE*	2
ITEM 60	*SUBSTRUCTURE*	7
ITEM 60	- (From U/W Report)	N
ITEM 61	*CHANNEL*	N
ITEM 61	- (From U/W Report)	N
ITEM 62	*CULVERT*	N
ITEM 62	- (From U/W Report)	N

ITEM 41 *STRUCTURE OPEN, POSTED OR CLOSED*

K:CLOSED Date : 07/09/1998

ITEM 36 *TRAFFIC SAFETY*

	36	COND	DEF
A. Bridge Railing	0	0	-
B. Transitions	0	0	-
C. Approach Guardrail	0	0	-
D. Approach Guardrail Ends	0	0	-

TOTAL HOURS 8

PLANS (Y/N) N

(V.C.R.) (Y/N) N

TAPE#:

Pedestrian Access (Y/N) Y
(If YES please explain)

Roadway Abandoned (Y/N) N

Barricades In Place (Y/N) Y

TYPE: JERSEY BARRIERS

SIGNS *Not Applicable* ☐

Legend: BRIDGE CLOSED

	At bridge N	At bridge S	Advance N	Advance S
Signs In Place (Y=Yes ,N=No, NR=Not Required)	Y	NR	Y	Y
Legibility/ Visibility	7 / 7		7 / 7	7 / 7

To be filled out by District Bridge Inspection Engineer

1) This bridge is scheduled for:

Replacement ( ) *Rehabilitation* ( ) *Repair* ( ) *Removal* ( ) *Unknown* (X)

2) If under construction please answer the following:

Contract Number:

Amount:

Completion Date:

Contractor:

Resident Engineer:

Scope of Work:

Remarks:

ACCESSIBILITY (Y/N)

	Needed	Used
Lift Bucket	N	N
Ladder	Y	N
Boat	N	N
Wader	N	N
Inspector 50	N	N
Rigging	N	N
Staging	N	N
Traffic Control	N	N
RR Flagger	Y	N
Police	N	N
Other:	N	N

X=UNKNOWN N=NOT APPLICABLE H=HIDDEN/INACCESSIBLE R=REMOVED

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	**29N**	**N-03-007**	**N03007-29N-DOT-CLP**	**JUN 8, 2022**

REMARKS

BRIDGE ORIENTATION

According to the rating report, the approaches are north and south and the elevations are east and west. This is a single span riveted plate through girder bridge with a timber deck. There are two girders numbered west to east with five floorbeams numbered south to north. There are thirteen roadway stringers in each bay numbered west to east and six bays numbered south to north.

GENERAL REMARKS

Posting

The south "Bridge Closed" sign located at the corner of Spring Street and Middlesex Avenue is within 150' from the bridge and is sufficient to act as both the *At bridge* and *Advance* signs. **See photo 1**.
There is a "Bridge Closed" sign at both the North *At bridge* and *Advance*. **See photo 2**.

Pedestrian Access

There are two concrete Jersey barriers across both bridge approaches spaced apart to allow pedestrian access to the bridge. **See photo 3**.
The bituminous concrete wearing surface has heavy transverse and map cracking with several bituminous patches throughout.
Pedestrian access to both timber sidewalks is blocked by a 5' high chain link fence and "Danger Pedestrian Traffic Prohibited" signs at all four sidewalk ends. The southeast sign is covered with vegetation. **See photo 3**.
Several sidewalk planks are missing and many planks and stringers throughout both sidewalks are heavily rotted and loose. **See photo 4**.
The west sidewalk has an 11' long x full width section that is missing. **See photo 5.**

Collision Damage

There is old minor collision damage to girder 1 at the floorbeam 4 connection. The gusset plate in this area is bent down and there is a minor scrape to the underside of the bottom flange/cover plate of the girder. There are minor collision scrapes to the underside of the bottom flange of girder 2. All of the above mentioned collision damage is over the north railroad track.

Floor Stringers

The stringers throughout all bays show heavy surface rusting and areas of minor to heavy rust flaking. **See photo 6**.
The seats to stringers 1, 2, 4, and 13 on floorbeam 2, 12, and 13 at floorbeam 3, and 8, 9, 12, and 13 on floorbeam 4 have areas of 100% section loss.
In bays 3 and 4 there are many stringers that have intermittent areas of 100% section loss throughout to the top and bottom flanges and isolated web locations. Stringer 2 in bay 3 has areas of 100% section loss to the web. **See photo 7.**.
Note, the stringers in addition to resting on the seats are riveted to the floorbeams.

See Fracture Critical Inspection dated 6/08/22 for additional comments on girders and floorbeams.

Photo Log

Photo 1 :	South intersection with Middlesex Ave.
Photo 2 :	North approach.
Photo 3 :	South end.
Photo 4 :	West sidewalk.
Photo 5 :	West sidewalk, missing section.
Photo 6 :	Underside, looking north.
Photo 7 :	Floorbeam, bay #3.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	29N	N-03-007	N03007-29N-DOT-CLP	JUN 8, 2022

PHOTOS

Photo 1: South intersection with Middlesex Ave.

Photo 2: North approach.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	29N	N-03-007	N03007-29N-DOT-CLP	JUN 8, 2022

PHOTOS

Photo 3: **South end.**

Photo 4: **West sidewalk.**

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	29N	N-03-007	N03007-29N-DOT-CLP	JUN 8, 2022

PHOTOS

Photo 5: **West sidewalk, missing section.**

Photo 6: **Underside, looking north.**

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	**29N**	**N-03-007**	**N03007-29N-DOT-CLP**	**JUN 8, 2022**

PHOTOS

Photo 7: **Floorbeam, bay #3.**

Report Date: May 26, 2023 DEFLUMERI DIGERONIMO

State Information

BDEPT#=	**N03007**	Agency Br.No.	
Town=	**Natick**	L.O.	MHD
B.I.N.=	**29N**	AASHTO=	032.0
RANK= 0	H.I.= 0	FHWA Select List=	N (6/21/2017)

Identification

(8) Structure Number	N0300729NDOTCLP
(5) Inventory Route	151000000
(2) State Highway Department District	03
(3) County Code 017 (4) Place code	43895
(6) Features Intersected	**RR MBTA/CSX**
(7) Facility Carried	**HWY SPRING ST**
(9) Location	.3 MI. W. OF ST-27
(11) Kilometerpoint	0000.241
(12) Base Highway Network	N
(13) LRS Inventory Route & Subroute	000000000000
(16) Latitude	42 DEG 17 MIN 07.22 SEC
(17) Longitude	71 DEG 21 MIN 00.90 SEC
(98) Border Bridge State Code	Share %
(99) Border Bridge Structure No. #	

Structure Type and Material

(43) Structure Type Main:	Steel	Code	303
Girder & Floorbeam	Jointless bridge type: Not applicable		
(44) Structure Type Appr:			
Other		Code	000
(45) Number of spans in main unit			001
(46) Number of approach spans			0000
(107) Deck Structure Type -	Timber	Code	8
(108) Wearing Surface / Protective System:			
A) Type of wearing surface -	Bituminous	Code	6
B) Type of membrane -	None	Code	0
C) Type of deck protection -	None	Code	0

Age and Service

(27) Year Built			1896
(106) Year Reconstructed			0000
(42) Type of Service: On -	Highway-Ped		
Under -	Railroad	Code	52
(28) Lanes: On Structure	02	Under structure	00
(29) Average Daily Traffic			000000
(30) Year of ADT	2019	(109) Truck ADT	00 %
(19) Bypass, detour length			002 KM

Geometric Data

(48) Length of maximum span	0019.5 M
(49) Structure Length	00021.0 M
(50) Curb or sidewalk: Left 01.5 M Right	01.8 M
(51) Bridge Roadway Width Curb to Curb	006.7 M
(52) Deck Width Out to Out	010.8 M
(32) Approach Roadway Width (w/shoulders)	005.5 M
(33) Bridge Median - No median Code	0
(34) Skew 00 DEG (35) Structure Flared	N
(10) Inventory Route MIN Vert Clear	99.99 M
(47) Inventory Route Total Horiz Clear	06.7 M
(53) Min Vert Clear Over Bridge Rdwy	99.99 M
(54) Min Vert Underclear ref R	05.38 M
(55) Min Lat Underclear RT ref R	06.1 M
(56) Min Lat Underclear LT	00.0 M

Navigation Data

(38) Navigation Control - Not applicable, no waterway	Code N
(111) Pier Protection	Code
(39) Navigation Vertical Clearance	000.0 M
(116) Vert-lift Bridge Nav Min Vert Clear	M
(40) Navigation Horizontal Clearance	0000.0 M

Classification

		Code
(112) NBIS Bridge Length		Y
(104) Highway System		N
(26) Functional Class -	Urban Local	19
(100) Defense Highway		0
(101) Parallel Structure		N
(102) Direction of Traffic -	2-way traffic	2
(103) Temporary Structure		N
(105) Federal Lands Highways		0
(110) Designated National Network		N
(20) Toll -	On free road	3
(21) Maintain -	State Highway Agency	01
(22) Owner -	State Highway Agency	01
(37) Historical Significance	not eligible	N

Condition

	Code
(58) Deck	3
(59) Superstructure	2
(60) Substructure	7
(61) Channel & Channel Protection	N
(62) Culverts	N

Load Rating and Posting

		Code
(31) Design Load -	H 10=M 9	1
(63) Operating Rating Method -	Allowable Stress (AS)	2
(64) Operating Rating		00.0
(65) Inventory Rating Method -	Allowable Stress (AS)	2
(66) Inventory Rating		00.0
(70) Bridge Posting		0
(41) Structure -	Closed	K

Appraisal

	Code
(67) Structural Evaluation	0
(68) Deck Geometry	5
(69) Underclearances, vert. and horiz.	0
(71) Waterway adequacy	N
(72) Approach Roadway Alignment	7
(36) Traffic Safety Features	0 0 0 0
(113) Scour Critical Bridges	N

Inspections

(90) Inspection Date 07/09/98 (91) Frequency 24 MO

(92) Critical Feature Inspection:				(93) CFI DATE
(A) Fracture Critical Detail	Y	24	MO A)	06/08/22
(B) Underwater Inspection	N	00	MO B)	00/00/00
(C) Other Special Inspection	N	00	MO C)	00/00/00
(*) Other Inspection ()	N	00	MO *)	00/00/00
(*) Closed Bridge	Y	12	MO *)	06/08/22
(*) UW Special Inspection	N	00	MO *)	00/00/00
(*) Damage Inspection			MO *)	00/00/00

Rating Loads

Report Date 00/00/00	H20	Type 3	Type 3S2	Type HS
Operating	0.0	0.0	0.0	0.0
Inventory	0.0	0.0	0.0	0.0

Field Posting

Status CLOSED Posting Date 07/09/98

	2 Axle	3 Axle	5 Axle	Single
Actual				
Recommended				

Missing Signs N

Misc.

Bridge Name DEFLUMERI DIGERONIMO

N Anti-missile fence N Acrow Panel N Jointless Bridge

Freeze/Thaw N : Not Applicable

Stairs On/Adjacent 0 Stair Owner(s)

Accessibility (Needed/Used)

N / N	Liftbucket	N / N	Rigging	N / N	Other
Y / N	Ladder	N / N	Staging		
N / N	Boat	N / N	Traffic Control		
N / N	Wader	Y / N	RR Flagperson	Inspection Hours:	008
N / N	Inspector 50	N / N	Police		

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MASSACHUSETTS DEPARTMENT OF TRANSPORTATION PAGE 1 OF 6

2-DIST	B.I.N.		BR. DEPT. NO.
03	29N		N-03-007

STRUCTURES INSPECTION FIELD REPORT

FRACTURE CRITICAL INSPECTION

CITY/TOWN	8.-STRUCTURE NO.	11-Kilo. POINT	90-ROUTINE INSP. DATE	93a - F.C. INSP. DATE
NATICK	**N03007-29N-DOT-CLP**	**000.241**	**Jul 9, 1998**	**Jun 8, 2022**

07-FACILITY CARRIED	MEMORIAL NAME/LOCAL NAME	27-YR BUILT	106-YR REBUILT	*YR REHAB'D (NON 106)
HWY SPRING ST	**DEFLUMERI DIGERONIMO**	**1896**	**0000**	**0000**

06-FEATURES INTERSECTED	26-FUNCTIONAL CLASS		DIST. BRIDGE INSPECTION ENGINEER
RR MBTA/CSX	**Urban Local**		**M. Azizi**
43-STRUCTURE TYPE	**22-OWNER**	**21-MAINTAINER**	**TEAM LEADER**
303 : Steel Girder & Floorbeam	**State Highway Agency**	**State Highway Agency**	**L. Fijol**
107-DECK TYPE	**WEATHER**	**TEMP. (air)**	**TEAM MEMBERS**
8 : Timber	**Clear**	**14°C**	**K. HOUATCHANTHARA**

WEIGHT POSTING *Not Applicable* X

Actual Posting	N	N	N	N
Recommended Posting	N	N	N	N

Waived Date: 00/00/0000 **EJDMT Date:** 00/00/0000

Signs In Place (Y=Yes,N=No, NR=Not Required)
Legibility/ Visibility

At bridge N	At bridge S	Advance N	Advance S

PLANS (Y/N): N

(V.C.R.) (Y/N): N

TAPE#:

RATING

Rating Report (Y/N): N Date: ----

Recommend for Rating or Rerating (Y/N): N

If YES please give priority: HIGH ( ) MEDIUM ( ) LOW ( )

REASON:

Inspection data at time of existing rating

I 58: 6 I 59: 7 I 60: 6 I 62: Date : 11/16/1977

FRACTURE CRITICAL MEMBER(S):

	MEMBER	CRACK (Y/N):	WELD'S CONDITION (0-9)	LOCATION OF CORROSION, SECTION LOSS (%), CRACKS, COLLISION DAMAGE, STRESS CONCENTRATION, ETC.	CONDITION PREVIOUS (0-9)	CONDITION PRESENT (0-9)	INV. RATING OF MEMBER FROM RATING ANALYSIS			Deficiencies
A	**Item 59.2 - Floorbeams**	N	N	**See remarks in comments section.**	2	2	7	10	15	S-A
B	**Item 59.4 - Girders or Beams**	N	N	**See remarks in comments section.**	4	4	32	40	53	S-A
C										
D										
E										

List of field tests performed:
None

	I-59	I-60
(Overall Previous Condition)	2	7
(Overall Current Condition)	2	7

DEFICIENCY: A defect in a structure that requires corrective action.

CATEGORIES OF DEFICIENCIES:

M= Minor Deficiency Deficiencies which are minor in nature, generally do not impact the structural integrity of the bridge and could easily be repaired. Examples include but are not limited to: Spalled concrete, Minor pot holes, Minor corrosion of steel, Minor scouring, Clogged drainage, etc.

S= Severe/Major Deficiency Deficiencies which are more extensive in nature and need more planning and effort to repair. Examples include but are not limited to: Moderate to major deterioration in concrete, Exposed and corroded rebars, Considerable settlement, Considerable scouring or undermining, Moderate to extensive corrosion to structural steel with measurable loss of section, etc.

C-S= Critical Structural Deficiency A deficiency in a structural element of a bridge that poses an extreme unsafe condition due to the failure or imminent failure of the element which will affect the structural integrity of the bridge.

C-H= Critical Hazard Deficiency A deficiency in a component or element of a bridge that poses an extreme hazard or unsafe condition to the public, but does not impair the structural integrity of the bridge. Examples include but are not limited to: Loose concrete hanging down over traffic or pedestrians, A hole in a sidewalk that may cause injuries to pedestrians, Missing section of bridge railing, etc.

URGENCY OF REPAIR:

I = Immediate-	[Inspector(s) immediately contact District Bridge Inspection Engineer (DBIE) to report the Deficiency and to receive further instruction from him/her].
A = ASAP-	[Action/Repair should be initiated by District Maintenance Engineer or the Responsible Party (if not a State owned bridge) upon receipt of the Inspection Report].
P = Prioritize-	[Shall be prioritized by District Maintenance Engineer or the Responsible Party (if not a State owned bridge) and repairs made when funds and/or manpower is available].

X=UNKNOWN N=NOT APPLICABLE H=HIDDEN/INACCESSIBLE R=REMOVED

F.C.(1)7-96

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	**29N**	**N-03-007**	**N03007-29N-DOT-CLP**	**JUN 8, 2022**

REMARKS

BRIDGE ORIENTATION

According to the rating report, the approaches are north and south and the elevations are east and west. This is a single span riveted plate through girder bridge with a timber deck. There are 2 girders numbered west to east with 5 floorbeams numbered south to north. There are 13 roadway stringers in each bay numbered west to east and 6 bays numbered south to north.

GENERAL REMARKS

This WAS NOT a hands on inspection. This was a visual inspection performed from the ground only due to the continued inability to get flagging services provided by CSX Railroad.

ITEM 59 - SUPERSTRUCTURE

Item 59.2 - Floorbeams

There is severe section loss throughout the floorbeams, up to 100%, mostly at the ends beyond the cover plates. The location of the heaviest section loss is adjacent to the built up areas. The condition of the floorbeams with the section loss is as follows:

Floorbeam #2:

West end:
The south side of the built up bottom flange has 100% section loss adjacent to the cover plate, 34" long x up to 3" wide. The angle is back to original thickness at 36" from the cover plate.
The bottom angle on the north side has areas of up to 100% section loss adjacent to the cover plate, 24" long x 4" wide. There is heavy pitting on top of the bottom angle from the cover plate to the end of the floorbeam. **See photo 1.**

East end:
The south side of the bottom angle has 100% section loss adjacent to the cover plate, 21" long x up to 1-1/2" wide. The angle is back to original thickness at 25" from the cover plate.
The bottom angle on the north side has areas of up to 100% section loss adjacent to the cover plate, 28" long x 3" wide. The angle is back to original thickness at 30" from the cover plate. **See photo 2.**

Floorbeam #3:

West end:
The south side bottom angle has 100% section loss adjacent to the cover plate, 17" long x 2" wide. The angle is back to original thickness at 20" from the cover plate.
The north side bottom angle has areas of up to 100% section loss throughout, starting at the cover plate with some areas 3/4" wide. **See photo 3.**

East end:
The bottom angle on the south side has 100% section loss adjacent to the cover plate, 24" long x 2" wide. The angle is back to original thickness at 20" from the cover plate. **See photo 4.**
The bottom angle on the north side has areas of up to 100% section loss adjacent to the cover plate, 12" long x up to 3/4" wide. The angle is back to original thickness at 14" from the cover plate.

Floorbeam #4:

West end:
The bottom angle on the south side has 100% section loss adjacent to the cover plate, 10" long x 3/4" wide. The angle is back to original thickness at 15" from the cover plate.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	**29N**	**N-03-007**	**N03007-29N-DOT-CLP**	**JUN 8, 2022**

REMARKS

The bottom angle on the north side has an area of 100% section loss starting at 8" out from the cover plate to 18 " x 2-1/2" wide. **See photo 5.**

Item 59.4 - Girders or Beams

Both girders have up to 50% section loss to the bottom flanges at the interior south ends at the bearings.
Both girders have up to 15% section loss to the bottom flanges and the interior north ends.
The bottom flange of girder #1 has a 12" long x 1" wide area of 100% section loss at floorbeam #5.

There is an approximately 12" long x 2" wide area of 100% section loss to the bottom flange of girder #1 at floorbeam #1. **See photo 6.**

Both girders have moderate to heavy paint peeling and surface rusting with intermittent areas of rust pack between bottom flanges and interior web faces.
There is old minor collision damage to girder #1 at floorbeam #4. The gusset plate in this area is bent down and there is a minor scrape to the underside of the bottom flange. There are minor collision scrapes to the underside of the bottom flange of girder #2 above the north railroad tracks.

Photo Log

Photo 1 :	West end of floor beam #2.
Photo 2 :	East end of floorbeam #2.
Photo 3 :	West end of floorbeam #3.
Photo 4 :	East end of floorbeam #3.
Photo 5 :	West end of floorbeam #4.
Photo 6 :	Girder #1 at floorbeam #1.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	29N	N-03-007	N03007-29N-DOT-CLP	JUN 8, 2022

PHOTOS

Photo 1: **West end of floor beam #2.**

Photo 2: **East end of floorbeam #2.**

REM.(2)7-96

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	29N	N-03-007	N03007-29N-DOT-CLP	JUN 8, 2022

PHOTOS

Photo 3: **West end of floorbeam #3.**

Photo 4: **East end of floorbeam #3.**

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	29N	N-03-007	N03007-29N-DOT-CLP	JUN 8, 2022

PHOTOS

Photo 5: **West end of floorbeam #4.**

Photo 6: **Girder #1 at floorbeam #1.**

Report Date: May 26, 2023

DEFLUMERI DIGERONIMO

State Information

BDEPT#= N03007 Agency Br.No.

Town= Natick L.O. MHD

B.I.N= 29N AASHTO= 032.0

RANK= 0 H.I.= 0 FHWA Select List= N (6/21/2017)

Identification

(8) Structure Number	N0300729NDOTCLP
(5) Inventory Route	151000000
(2) State Highway Department District	03
(3) County Code 017 (4) Place code	43895
(6) Features Intersected	**RR MBTA/CSX**
(7) Facility Carried	**HWY SPRING ST**
(9) Location	.3 MI. W. OF ST-27
(11) Kilometerpoint	0000.241
(12) Base Highway Network	N
(13) LRS Inventory Route & Subroute	000000000000
(16) Latitude	42 DEG 17 MIN 07.22 SEC
(17) Longitude	71 DEG 21 MIN 00.90 SEC
(98) Border Bridge State Code	Share %
(99) Border Bridge Structure No. #	

Structure Type and Material

(43) Structure Type Main: Steel Code 303

Girder & Floorbeam Jointless bridge type: Not applicable

(44) Structure Type Appr:

Other Code 000

(45) Number of spans in main unit 001

(46) Number of approach spans 0000

(107) Deck Structure Type - Timber Code 8

(108) Wearing Surface / Protective System:

A) Type of wearing surface - Bituminous Code 6

B) Type of membrane - None Code 0

C) Type of deck protection - None Code 0

Age and Service

(27) Year Built 1896

(106) Year Reconstructed 0000

(42) Type of Service: On - Highway-Ped

Under - Railroad Code 52

(28) Lanes: On Structure 02 Under structure 00

(29) Average Daily Traffic 000000

(30) Year of ADT 2019 (109) Truck ADT 00 %

(19) Bypass, detour length 002 KM

Geometric Data

(48) Length of maximum span 0019.5 M

(49) Structure Length 00021.0 M

(50) Curb or sidewalk: Left 01.5 M Right 01.8 M

(51) Bridge Roadway Width Curb to Curb 006.7 M

(52) Deck Width Out to Out 010.8 M

(32) Approach Roadway Width (w/shoulders) 005.5 M

(33) Bridge Median - No median Code 0

(34) Skew 00 DEG (35) Structure Flared N

(10) Inventory Route MIN Vert Clear 99.99 M

(47) Inventory Route Total Horiz Clear 06.7 M

(53) Min Vert Clear Over Bridge Rdwy 99.99 M

(54) Min Vert Underclear ref R 05.38 M

(55) Min Lat Underclear RT ref R 06.1 M

(56) Min Lat Underclear LT 00.0 M

Navigation Data

(38) Navigation Control - Not applicable, no waterway Code N

(111) Pier Protection Code

(39) Navigation Vertical Clearance 000.0 M

(116) Vert-lift Bridge Nav Min Vert Clear M

(40) Navigation Horizontal Clearance 0000.0 M

Classification

		Code
(112) NBIS Bridge Length		Y
(104) Highway System		N
(26) Functional Class -	Urban Local	19
(100) Defense Highway		0
(101) Parallel Structure		N
(102) Direction of Traffic -	2-way traffic	2
(103) Temporary Structure		N
(105) Federal Lands Highways		0
(110) Designated National Network		N
(20) Toll -	On free road	3
(21) Maintain -	State Highway Agency	01
(22) Owner -	State Highway Agency	01
(37) Historical Significance	not eligible	N

Condition

	Code
(58) Deck	3
(59) Superstructure	2
(60) Substructure	7
(61) Channel & Channel Protection	N
(62) Culverts	N

Load Rating and Posting

		Code
(31) Design Load -	H 10=M 9	1
(63) Operating Rating Method -	Allowable Stress (AS)	2
(64) Operating Rating		00.0
(65) Inventory Rating Method -	Allowable Stress (AS)	2
(66) Inventory Rating		00.0
(70) Bridge Posting		0
(41) Structure -	Closed	K

Appraisal

	Code
(67) Structural Evaluation	0
(68) Deck Geometry	5
(69) Underclearances, vert. and horiz.	0
(71) Waterway adequacy	N
(72) Approach Roadway Alignment	7
(36) Traffic Safety Features	0 0 0 0
(113) Scour Critical Bridges	N

Inspections

(90) Inspection Date 07/09/98 (91) Frequency 24 MO

(92) Critical Feature Inspection: (93) CFI DATE

(A) Fracture Critical Detail	Y	24	MO A)	06/08/22
(B) Underwater Inspection	N	00	MO B)	00/00/00
(C) Other Special Inspection	N	00	MO C)	00/00/00
(*) Other Inspection ()	N	00	MO *)	00/00/00
(*) Closed Bridge	Y	12	MO *)	06/08/22
(*) UW Special Inspection	N	00	MO *)	00/00/00
(*) Damage Inspection			MO *)	00/00/00

Rating Loads

Report Date 00/00/00	H20	Type 3	Type 3S2	Type HS
Operating	0.0	0.0	0.0	0.0
Inventory	0.0	0.0	0.0	0.0

Field Posting

Status CLOSED Posting Date 07/09/98

	2 Axle	3 Axle	5 Axle	Single
Actual				
Recommended				

Missing Signs N

Misc.

Bridge Name DEFLUMERI DIGERONIMO

N Anti-missile fence N Acrow Panel N Jointless Bridge

Freeze/Thaw N : Not Applicable

Stairs On/Adjacent 0 Stair Owner(s)

Accessibility (Needed/Used)

N / N	Liftbucket	N / N	Rigging	N / N	Other
Y / N	Ladder	N / N	Staging		
N / N	Boat	N / N	Traffic Control		
N / N	Wader	Y / N	RR Flagperson	Inspection Hours:	008
N / N	Inspector 50	N / N	Police		

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DOCUMENT A00804

PRELIMINARY STRUCTURE REPORT
April 18, 2023

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April 18, 2023

PRELIMINARY STRUCTURE REPORT

Town of Natick
Spring Street
over MBTA/CSX
Bridge No. N-03-007 (29N)

Submitted to:

Moving Massachusetts Forward. massDOT Highway

Submitted by:

wsp

WSP USA, Inc.
100 North Parkway, Suite 110
Worcester, MA 01605
Tel: 508.248.1970
Web Site: www.wsp.com

Natick: Spring Street over MBTA/CSX: Preliminary Structure Report
Br. No. N-03-007 (29N) (MassDOT Project File No. 610869)

TABLE OF CONTENTS

Natick: Spring Street over MBTA/CSX: Preliminary Structure Report
Br. No. N-03-007 (29N) (MassDOT Project File No. 610869)

EXECUTIVE SUMMARY:

WSP evaluated the subject bridge to develop recommendations for the extent of rehabilitation or replacement required for the existing structurally deficient structure. The evaluation included reviewing the current 2022 inspection reports, an additional field evaluation performed by WSP in November 2022, reviewing the 2002 Geotechnical Report and performing preliminary stability analysis of the abutments.

The recommended approach for the proposed structure, which will carry pedestrian and bicycle traffic only, is to remove and replace the existing single-span superstructure and rehabilitate and reuse the existing abutments.

Given the condition of the existing timber deck and girder-floorbeam-stringer superstructure, which has been closed to vehicular traffic since 1998, repair or rehabilitation is not deemed practical or cost effective to provide a structure with a 75-year service life. Therefore, it is recommended that the superstructure be entirely replaced. The focus of this report is evaluating whether the existing abutments are suitable for reuse in support of a new pedestrian/bicycle bridge.

EXISTING BRIDGE DESCRIPTION

The existing bridge is a single span and carries Spring Street over two (2) MBTA/CSX railroad tracks in the Town of Natick. The superstructure is a through girder bridge consisting of two (2) built-up steel through girders, five (5) built-up steel floorbeams, nineteen (19) rolled steel stringers (including sidewalk stringers) and a timber deck with asphalt overlay. The bridge was constructed in 1896 and has been closed to vehicular traffic since 1998. There are concrete barricades with an opening at either end of the bridge and the timber sidewalks are blocked by a combination of barrier and chain link fencing. During the field visit, it was observed that pedestrians are still regularly crossing the bridge.

The North and South abutments are composed of granite stone masonry blocks, which are believed to rest directly on bedrock. The South abutment wingwalls are parallel with the abutment stem and the North abutment wingwalls are splayed.

The Spring Street alignment is skewed from the intersection with Middlesex Avenue South of the bridge and runs along a tangent over the bridge through the North approach. At the North approach, the alignment curves in the Northwesterly direction and extends in a tangent line to the intersection of Cochituate Street. The profile over the bridge is approximately a crest vertical curve with a gradual slope on the North approach and a steep grade of approximately 8.0% on the South approach. There is no discernable bridge skew.

The span length is 64’-7” and the overall out-to-out width of the structure is 35’-6”±. The curb-to-curb width of the structure is 21’-10”±. Along each side of the roadway, there is a 5’-6”± wide timber sidewalk.

There is a 10” diameter water main along the inside of the East through girder on top of the sidewalk and an 8” diameter gas main along the top of the West through girder (see Photos #7 and #8, respectively of the General Photos in Appendix B). There are overhead electric and telecommunication lines over the West side of the bridge that continue along both approaches. There is a low-voltage power line parallel to the tracks under the bridge near the North abutment. Along the front of the South abutment, there is a partially buried and deteriorated pipe, with large rust holes. This pipe will be investigated for future submissions.

CURRENT CONDITION ASSESSMENT

The most recent inspections of the bridge are a closed/rehabilitation inspection and a fracture critical inspection, both conducted by MassDOT in June 2022. These inspections were visual inspections only, performed from the ground, due to access issues with CSX. In November 2022, WSP personnel completed a visual and hands-on inspection of the existing abutments being evaluated for reuse. In November 2001, a subsurface exploration program was performed by Zoino-Hebert, Inc. at each of the abutments under the guidance of WSP personnel to assist in determining the geometry of the existing abutments in addition to the subsurface soil conditions.

Sketches of the existing abutment sections are included in the figures and the 2022 inspection reports are included in the appendices of this report. Select photos from the WSP field visit are included within this condition assessment narrative and additional photos are provided in Appendix B.

Deck ITEM 58 (NBIS Condition Rating – 3 (Serious))

Deck Condition:

From the most recent closed/rehabilitation inspection report, the deck condition is classified as serious. The top of the timber deck between the sidewalks is obscured by pavement, which has significant cracking throughout. The undersides of the planks typically show significant rotting. The sidewalks have numerous loose or missing planks and access to both sidewalks is prevented by chain link fencing.

Natick: Spring Street over MBTA/CSX: Preliminary Structure Report Br. No. N-03-007 (29N) (MassDOT Project File No. 610869)

Superstructure ITEM 59 (NBIS Condition Rating – 2 (Critical))

View of the underside of the bridge.

East elevation of the bridge.

Steel Through Girders:

The steel through girders are in poor condition. There is typically moderate to heavy paint peeling and surface rusting with intermittent areas of pact rust between the bottom flange angles and interior web faces. Both girders have up to 50% section loss to the interior half of the bottom flange near the South bearing and up to 15% section loss to the interior half of the bottom flange near the North bearing.

The bottom flange of Girder 1 has a 12” long x 2” wide area of 100% section loss at Floorbeam 1. At Floorbeam 4, there is minor collision damage and the gusset plate is bent down and there is a minor scrape to the bottom flange. The underside of the bottom flange of Girder #2 has minor collision scrapes above the North railroad track.

Steel Floorbeams:

The steel floorbeams are in critical condition with areas of severe section loss throughout, but particularly beyond the ends of the bottom flange cover plates.

There are five floorbeams and the 2022 fracture critical inspection report lists section losses for floorbeams 2, 3 and 4 as follows:

Floorbeam 2: The bottom flange near the West end of the cover plate has areas of 100% section loss measuring 34” long x up to 3” wide at the South leg and 24” long x 4” wide at the North leg. At the East end of the cover plate, the bottom flange has areas of up to 100% section loss measuring 21” long x up to 1.5” wide at the South leg and 28” long x 3” wide at the North leg.

Floorbeam 3: The bottom flange beyond the West end of the cover plate has areas of up to 100% section loss x up to 0.75” wide at the North leg and the South leg has an area of 100% section loss measuring 17” long x 2” wide. The bottom flange near the East end of the cover plate has areas of 100% section loss measuring 24” long x 2” wide at the South leg and 12” long x 0.75” wide at the North leg.

Floorbeam 4: The bottom flange near the West end of the cover plate has areas of 100% section loss measuring 10” long x 3/4” wide at the South leg and 18” long x 2-1/2” wide at the North leg.

Natick: Spring Street over MBTA/CSX: Preliminary Structure Report
Br. No. N-03-007 (29N) (MassDOT Project File No. 610869)

Steel Stringers:

The steel stringers are in critical condition and typically show heavy surface rusting and areas of minor to heavy rust flaking. In Bays 3 and 4, there are numerous full depth holes to the top and bottom flanges and to the web in isolated locations. The stringer seat connections at floor beams 2, 3 and 4 have scattered areas of full depth loss.

Typical condition of the stringers, showing significant section loss to the bottom flanges.

Natick: Spring Street over MBTA/CSX: Preliminary Structure Report Br. No. N-03-007 (29N) (MassDOT Project File No. 610869)

Substructure ITEM 60 (NBIS Condition Rating – 7 (Good))

Abutments:

The condition of both abutments is listed as good per the most recent 2022 inspections. There are no deficiencies noted for the abutments in the current inspection report. From the recent field visit, the stone masonry shows no significant signs of deterioration. There are scattered areas of missing or deteriorated mortar, some with moss growth. No cracked stones were observed and there are no visible signs of settlement or misalignment. There is a short granite block retaining wall in front of the North Abutment. At the time of the WSP field visit, there was water trapped between the abutment and the wall that was roughly 1' deep (see Photo #3 of the Condition Photos in Appendix B). Along the front of the South Abutment, there is a partially buried and deteriorated pipe, with large rust holes (see Photo #4 of the Condition Photos in Appendix B). This pipe will be investigated for future submissions.

South Abutment, showing general condition of the abutment and wingwalls.

North Abutment, showing general condition of the abutment.

Typical condition of the North Abutment Wingwalls.

Typical example of area of deteriorated or missing mortar (South Abutment, near bridge seat, shown).

STRUCTURAL ANALYSIS/EVALUATION

Seismic Criteria:

Based upon the boring information and the provisions outlined in the MassDOT LRFD Bridge Manual and the AASHTO Guide Specifications for LRFD Seismic Bridge Design, the bridge is classified as SDC A (see Appendix D for the 2002 Geotechnical Report and the abutment sketches under the Figures, which compile information on the soil properties and bedrock depth from the Geotechnical Report). Per the MassDOT manual, for single-span conventional bridges classified as SDC A, the abutments themselves do not need to be designed for seismic forces, nor does the inertial mass of the abutment itself or the seismic soil force need to be considered in design. However, connections between the superstructure and substructure do need to be designed in accordance with Article 4.6 of the AASHTO Guide Specifications for LRFD Seismic Bridge Design. In addition, minimum support lengths (i.e. bridge seat widths) need to be checked to ensure compliance with Article 4.12. In addition, the connection of the proposed cap to the existing masonry abutments will be designed to handle the seismic load. The following Seismic Design Parameters were determined in support of the design requirements stated above.

- Design Return Period = 1000 years (conventional structure, non-essential)
- Site Class = B
    - Site Class B was determined due to the abutments being founded on bedrock. Additionally, the soils located above the footings are not anticipated to have significant influence on the dynamic response of the structure.
- Seismic Design Category = SDC A
- As = 0.070
- Horizontal Design Connection Force = 25% x Tributary Dead Load (As > 0.05)
- Minimum Support Lengths = 12”± for both abutments

Capacity of Existing Steel Superstructure:

The existing superstructure was designed for unknown loading. As stated previously, the bridge was closed in 1998 due to advanced deterioration. MassDOT recommended that the superstructure be removed per the Scope of Work provided to WSP. Given the age and level of deterioration of the superstructure, rehabilitation of the superstructure is not believed to be practical.

Capacity of Existing Abutments:

Subsurface Exploration:

No plans were located which give dimensions of the substructure. The geometries of the existing stone masonry abutments were determined based on field measurements of the exposed portions of the abutments and a subsurface investigation program performed in November 2001. The 2002 Geotechnical Report is included in Appendix D and the abutment sketches under the Figures, compile information on the assumed abutment geometry, soil properties and bedrock depth. The subsurface investigation included a line of eight (8) probes running perpendicular to the back of each abutment to establish the approximate abutment geometry. One (1) boring was performed at each abutment to confirm the bedrock elevation. At both abutments, the first probe (approximately 2’ from the back of the backwall) hit what is believed to be the top of abutment and the second probe (2’ from probe 1) hit an obstruction at a much lower elevation (either the back of the abutment or bedrock). The remaining probes consistently hit obstructions around mid-height of the abutment walls. The borings at both abutments also took 10’ cores starting near the same elevation. The abutments appear to have a very slender shape and it is assumed that they rest directly on bedrock. Based on the first two probes, the 2002 Geotechnical Report estimated that the abutment width is at least 1.9 meters = 6’-2 ¾”, and this width was assumed in the stability calculations in the Geotechnical Report as well as in the current report.

Stability Analysis:

The 2002 Geotechnical Report analyzed the existing abutments for a superstructure replacement project that was ultimately cancelled. The proposed plan was to re-use the existing abutments for a single-span composite steel beam bridge designed to support two lanes of vehicular traffic. The North abutment was determined to control, by inspection, since it was assumed to be slightly taller. It appears that the analysis was per the AASHTO Standard Specifications for Highway Bridges. The report determined the following factors of safety for stability:

2002 Geotechnical Report abutment analysis results (for a vehicular bridge project that was ultimately canceled):

	Factor of Safety	Required Factor of Safety
Overturning	2.35	2.00
Sliding	3.76	1.50
Bearing	3.84	

For this report, stability was investigated per the AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges. The abutments were evaluated for 90 psf pedestrian load and an H10 vehicle. It was agreed upon with MassDOT that the bridge will have a clear path width of 10 feet. Per AASHTO, path widths up to and including 10 feet require a design load of at least H5. Since pedestrian load still controls, the abutments were checked for H10 load. The abutment width, backfill friction angle, approximate abutment height and bedrock bearing resistance were taken per the 2002 Geotech Report. Per MassDOT’s LRFD Bridge Manual, Part I, Section 3, all cantilever and gravity abutments founded on rock shall assume at-rest soil pressure. However, in agreement with the 2002 Geotech Report, active earth pressure was assumed for this abutment analysis (which results in a lower, less conservative, overturning soil pressure compared to at-rest). Given the very slender assumed abutment geometry and the likely more flexible nature of stacked granite blocks compared to reinforced concrete, it is assumed that the abutments rotate and deflect sufficiently to cause active earth pressure. Also, it is likely that there is a leveling pad between the abutment blocks and bedrock that would further allow for abutment rotation. Conservatively, no passive restraint was assumed for the fill in front of the abutments.

The abutments have been in place for over 120 years, and there are no signs of structural distress or movement. From a more analytical perspective, both abutments were determined to meet AASHTO LRFD requirements for stability, including bearing, sliding and eccentricity/overturning (See Appendix E). Given the unusually slender abutment geometry, an approach slab was required at both abutments, to remove live load surcharge, to satisfy stability requirements. The stability analysis results are as follows:

Current Analysis, Based on Proposed Design (not including Construction Case):

	R_r/R_u	
Overturning	1.27	Eccentricity Limit/Eccentricity
Sliding	3.16	Factored Resistance/Factored Load
Bearing	1.62	Factored Resistance/Factored Load

CONCLUSIONS and RECOMMENDATIONS:

WSP’s recommendations for the Final Design Scope of Work for this bridge are as follows:

1. There is significant deterioration to the timber deck and the steel stringers, floor beams and through-girders. It is recommended to replace the entire single span superstructure with a single span prefabricated steel truss.
2. An added benefit of superstructure replacement is that the current vertical clearance can potentially be increased.
3. The existing abutments are generally in good condition. They meet AASHTO stability requirements when evaluated for the proposed design loads. It is recommended to retain the existing abutments and rehabilitate them as necessary to accommodate the proposed prefabricated bridge superstructure. Given the proximity of the existing abutments to the railroad tracks, reusing the abutments is highly advantageous given it minimizes track interference. Replacing any larger portions of the existing substructure would drastically change the scope of the project. Considering the limited bridge footprint, the constraints of the MBTA tracks and that the proposed bridge will be open exclusively to pedestrians, complete replacement of the substructure should be avoided to the extent practical.

ESTIMATED CONSTRUCTION COST:

The table below provides preliminary construction cost estimates for the proposed steel superstructure replacement alternative and includes a 35% contingency. A cost is provided for a superstructure replacement as well as a full replacement of both the superstructure and substructure. The estimated costs also include the highway work associated with reconstructing the bridge approaches. See Appendix C for a detailed breakdown of the estimated bridge construction costs.

As stated previously, the recommended scope of work is to replace the existing bridge superstructure and retain/rehabilitate the existing substructure to the greatest extent possible.

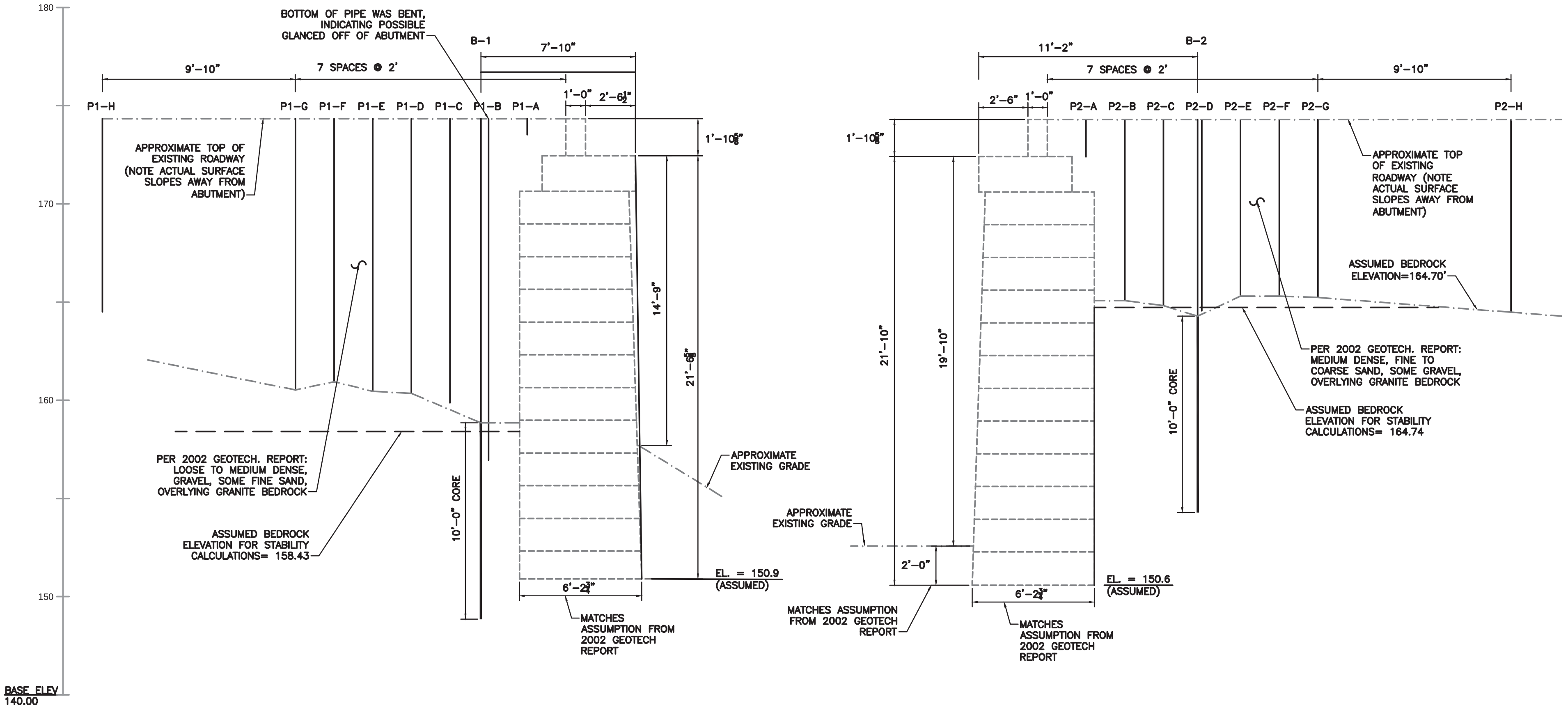
	Superstructure Replacement, Substructure Rehabilitation, & Highway Work	Full Replacement of Superstructure and Substructure, & Highway Work
Prefabricated Steel Pedestrian Truss	$1,930,544	$3,002,000

Table 1: Cost Estimates

Natick: Spring Street over MBTA/CSX: Preliminary Structure Report
Br. No. N-03-007 (29N) (MassDOT Project File No. 610869)

Figures

North and South Abutment Cross-Sections



SOUTH ABUTMENT SECTION

NORTH ABUTMENT SECTION

NOTES:
- **ALL DIMENSIONS ARE APPROXIMATE.**
- PROBES AND BORINGS TAKEN BETWEEB NOVEMBER 6 AND 8, 2001 BY ZOINO-HEBERT, INC. AND RESULTS ARE SUMMARIZED IN THE 2002 GEOTECHNICAL REPORT AS WELL AS ABOVE.
- EXPOSED PORTIONS OF THE ABUTMENTS WERE MEASURED DIRECTLY DURING THE NOVEMBER 2022 FIELD VISIT BY WSP.
- ALL OTHER DIMENSIONS WERE APPROXIMATED BASED ON THE PROBE AND BORING DATA.

WSP USA Inc.
100 NORTH PARKWAY
SUITE 110
WORCESTER, MA 01605
TEL: +1 508.248.1970

NATICK

SPRING STREET OVER MBTA/CSX
BRIDGE NO. N-03-007 (29N)
ABUTMENT CROSS SECTIONS

Appendix A

Inspection Reports

PAGE 1 OF 6

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION

STRUCTURES INSPECTION FIELD REPORT

CLOSED/REHABILITATION INSPECTION

2-DIST	B.I.N.	BR. DEPT. NO.
03	29N	N-03-007

CITY/TOWN **NATICK**	8.-STRUCTURE NO. **N03007-29N-DOT-CLP**	11-Kilo. POINT **000.241**	90-ROUTINE INSP. DATE **JUL 9, 1998**	93*- INSPECTION DATE **JUN 8, 2022**
07-FACILITY CARRIED **HWY SPRING ST**	MEMORIAL NAME/LOCAL NAME **DEFLUMERI DIGERONIMO**	27-YR BUILT **1896**	106-YR REBUILT **0000**	YR REHAB'D (NON 106) **0000**
06-FEATURES INTERSECTED **RR MBTA/CSX**	26-FUNCTIONAL CLASS **Urban Local**	DIST. BRIDGE INSPECTION ENGINEER **M. Azizi**		
43-STRUCTURE TYPE **303 : Steel Girder & Floorbeam**	22-OWNER **State Highway Agency**	21-MAINTAINER **State Highway Agency**	TEAM LEADER **L. Fijol**	
107-DECK TYPE **8 : Timber**	WEATHER **Clear**	TEMP. (air) **14°C**	TEAM MEMBERS **Kristen Houatchanthara**	

ITEM 58	*DECK*	3
ITEM 59	*SUPERSTRUCTURE*	2
ITEM 60	*SUBSTRUCTURE*	7
ITEM 60	- (From U/W Report)	N
ITEM 61	*CHANNEL*	N
ITEM 61	- (From U/W Report)	N
ITEM 62	*CULVERT*	N
ITEM 62	- (From U/W Report)	N

ITEM 41 *STRUCTURE OPEN, POSTED OR CLOSED*

K:CLOSED Date : 07/09/1998

ITEM 36 *TRAFFIC SAFETY*

	36	COND	DEF
A. Bridge Railing	0	0	-
B. Transitions	0	0	-
C. Approach Guardrail	0	0	-
D. Approach Guardrail Ends	0	0	-

TOTAL HOURS 8

PLANS (Y/N) N

(V.C.R.) (Y/N) N

TAPE#:

Pedestrian Access (If YES please explain) (Y/N) Y

Roadway Abandoned (Y/N) N

Barricades In Place (Y/N) Y

TYPE: JERSEY BARRIERS

SIGNS *Not Applicable* ☐

Legend: BRIDGE CLOSED

	At bridge N	At bridge S	Advance N	Advance S
Signs In Place (Y=Yes ,N=No, NR=Not Required)	Y	NR	Y	Y
Legibility/ Visibility	7 / 7		7 / 7	7 / 7

To be filled out by District Bridge Inspection Engineer

1) This bridge is scheduled for:

Replacement ( ) *Rehabilitation* ( ) *Repair* ( ) *Removal* ( ) *Unknown* (X)

2) If under construction please answer the following:

Contract Number:

Amount:

Completion Date:

Contractor:

Resident Engineer:

Scope of Work:

Remarks:

ACCESSIBILITY (Y/N)

	Needed	Used
Lift Bucket	N	N
Ladder	Y	N
Boat	N	N
Wader	N	N
Inspector 50	N	N
Rigging	N	N
Staging	N	N
Traffic Control	N	N
RR Flagger	Y	N
Police	N	N
Other:	N	N

X=UNKNOWN N=NOT APPLICABLE H=HIDDEN/INACCESSIBLE R=REMOVED

CLO. REHAB(1)7-96

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	**29N**	**N-03-007**	**N03007-29N-DOT-CLP**	**JUN 8, 2022**

REMARKS

BRIDGE ORIENTATION

According to the rating report, the approaches are north and south and the elevations are east and west. This is a single span riveted plate through girder bridge with a timber deck. There are two girders numbered west to east with five floorbeams numbered south to north. There are thirteen roadway stringers in each bay numbered west to east and six bays numbered south to north.

GENERAL REMARKS

Posting

The south "Bridge Closed" sign located at the corner of Spring Street and Middlesex Avenue is within 150' from the bridge and is sufficient to act as both the *At bridge* and *Advance* signs. **See photo 1**.
There is a "Bridge Closed" sign at both the North *At bridge* and *Advance*. **See photo 2**.

Pedestrian Access

There are two concrete Jersey barriers across both bridge approaches spaced apart to allow pedestrian access to the bridge. **See photo 3**.
The bituminous concrete wearing surface has heavy transverse and map cracking with several bituminous patches throughout.
Pedestrian access to both timber sidewalks is blocked by a 5' high chain link fence and "Danger Pedestrian Traffic Prohibited" signs at all four sidewalk ends. The southeast sign is covered with vegetation. **See photo 3**.
Several sidewalk planks are missing and many planks and stringers throughout both sidewalks are heavily rotted and loose. **See photo 4**.
The west sidewalk has an 11' long x full width section that is missing. **See photo 5.**

Collision Damage

There is old minor collision damage to girder 1 at the floorbeam 4 connection. The gusset plate in this area is bent down and there is a minor scrape to the underside of the bottom flange/cover plate of the girder. There are minor collision scrapes to the underside of the bottom flange of girder 2. All of the above mentioned collision damage is over the north railroad track.

Floor Stringers

The stringers throughout all bays show heavy surface rusting and areas of minor to heavy rust flaking. **See photo 6**.
The seats to stringers 1, 2, 4, and 13 on floorbeam 2, 12, and 13 at floorbeam 3, and 8, 9, 12, and 13 on floorbeam 4 have areas of 100% section loss.
In bays 3 and 4 there are many stringers that have intermittent areas of 100% section loss throughout to the top and bottom flanges and isolated web locations. Stringer 2 in bay 3 has areas of 100% section loss to the web. **See photo 7.**.
Note, the stringers in addition to resting on the seats are riveted to the floorbeams.

See Fracture Critical Inspection dated 6/08/22 for additional comments on girders and floorbeams.

Photo Log

Photo 1 : South intersection with Middlesex Ave.
Photo 2 : North approach.
Photo 3 : South end.
Photo 4 : West sidewalk.
Photo 5 : West sidewalk, missing section.
Photo 6 : Underside, looking north.
Photo 7 : Floorbeam, bay #3.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	29N	N-03-007	N03007-29N-DOT-CLP	JUN 8, 2022

PHOTOS

Photo 1: South intersection with Middlesex Ave.

Photo 2: North approach.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	**29N**	**N-03-007**	**N03007-29N-DOT-CLP**	**JUN 8, 2022**

PHOTOS

Photo 3: **South end.**

Photo 4: **West sidewalk.**

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	29N	N-03-007	N03007-29N-DOT-CLP	JUN 8, 2022

PHOTOS

Photo 5: **West sidewalk, missing section.**

Photo 6: **Underside, looking north.**

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	29N	N-03-007	N03007-29N-DOT-CLP	JUN 8, 2022

PHOTOS

Photo 7: **Floorbeam, bay #3.**

Report Date: November 21, 2022

DEFLUMERI DIGERONIMO

State Information

BDEPT#=	**N03007**	Agency Br.No.	
Town=	**Natick**	L.O.	MHD
B.I.N=	**29N**	AASHTO=	032.0
RANK= 0	H.I.= 0	FHWA Select List=	N (6/21/2017)

Identification

(8) Structure Number	N0300729NDOTCLP
(5) Inventory Route	151000000
(2) State Highway Department District	03
(3) County Code 017 (4) Place code	43895
(6) Features Intersected	**RR MBTA/CSX**
(7) Facility Carried	**HWY SPRING ST**
(9) Location	.3 MI. W. OF ST-27
(11) Kilometerpoint	0000.241
(12) Base Highway Network	N
(13) LRS Inventory Route & Subroute	000000000000
(16) Latitude	42 DEG 17 MIN 07.22 SEC
(17) Longitude	71 DEG 21 MIN 00.90 SEC
(98) Border Bridge State Code	Share %
(99) Border Bridge Structure No. #	

Structure Type and Material

(43) Structure Type Main:	Steel	Code 303
Girder & Floorbeam	Jointless bridge type: Not applicable	
(44) Structure Type Appr:		
Other		Code 000
(45) Number of spans in main unit		001
(46) Number of approach spans		0000
(107) Deck Structure Type -	Timber	Code 8
(108) Wearing Surface / Protective System:		
A) Type of wearing surface -	Bituminous	Code 6
B) Type of membrane -	None	Code 0
C) Type of deck protection -	None	Code 0

Age and Service

(27) Year Built		1896
(106) Year Reconstructed		0000
(42) Type of Service: On -	Highway-Ped	
Under -	Railroad	Code 52
(28) Lanes: On Structure	02	Under structure 00
(29) Average Daily Traffic		000000
(30) Year of ADT	2019	(109) Truck ADT 00 %
(19) Bypass, detour length		002 KM

Geometric Data

(48) Length of maximum span		0019.5 M
(49) Structure Length		00021.0 M
(50) Curb or sidewalk:	Left 01.5 M	Right 01.8 M
(51) Bridge Roadway Width Curb to Curb		006.7 M
(52) Deck Width Out to Out		010.8 M
(32) Approach Roadway Width (w/shoulders)		005.5 M
(33) Bridge Median -	No median	Code 0
(34) Skew 00 DEG	(35) Structure Flared	N
(10) Inventory Route MIN Vert Clear		99.99 M
(47) Inventory Route Total Horiz Clear		06.7 M
(53) Min Vert Clear Over Bridge Rdwy		99.99 M
(54) Min Vert Underclear ref	R	05.38 M
(55) Min Lat Underclear RT ref	R	06.1 M
(56) Min Lat Underclear LT		00.0 M

Navigation Data

(38) Navigation Control -	Not applicable, no waterway	Code N
(111) Pier Protection		Code
(39) Navigation Vertical Clearance		000.0 M
(116) Vert-lift Bridge Nav Min Vert Clear		M
(40) Navigation Horizontal Clearance		0000.0 M

Classification

		Code
(112) NBIS Bridge Length		Y
(104) Highway System		N
(26) Functional Class -	Urban Local	19
(100) Defense Highway		0
(101) Parallel Structure		N
(102) Direction of Traffic -	2-way traffic	2
(103) Temporary Structure		N
(105) Federal Lands Highways		0
(110) Designated National Network		N
(20) Toll -	On free road	3
(21) Maintain -	State Highway Agency	01
(22) Owner -	State Highway Agency	01
(37) Historical Significance	not eligible	N

Condition

	Code
(58) Deck	3
(59) Superstructure	2
(60) Substructure	7
(61) Channel & Channel Protection	N
(62) Culverts	N

Load Rating and Posting

		Code
(31) Design Load -	H 10=M 9	1
(63) Operating Rating Method -	Allowable Stress (AS)	2
(64) Operating Rating		00.0
(65) Inventory Rating Method -	Allowable Stress (AS)	2
(66) Inventory Rating		00.0
(70) Bridge Posting		0
(41) Structure -	Closed	K

Appraisal

	Code
(67) Structural Evaluation	0
(68) Deck Geometry	5
(69) Underclearances, vert. and horiz.	0
(71) Waterway adequacy	N
(72) Approach Roadway Alignment	7
(36) Traffic Safety Features	0 0 0 0
(113) Scour Critical Bridges	N

Inspections

(90) Inspection Date 07/09/98 (91) Frequency 24 MO

(92) Critical Feature Inspection:				(93) CFI DATE
(A) Fracture Critical Detail	Y	24	MO A)	06/08/22
(B) Underwater Inspection	N	00	MO B)	00/00/00
(C) Other Special Inspection	N	00	MO C)	00/00/00
(*) Other Inspection ()	N	00	MO *)	00/00/00
(*) Closed Bridge	Y	12	MO *)	06/08/22
(*) UW Special Inspection	N	00	MO *)	00/00/00
(*) Damage Inspection			MO *)	00/00/00

Rating Loads

Report Date 00/00/00	H20	Type 3	Type 3S2	Type HS
Operating	0.0	0.0	0.0	0.0
Inventory	0.0	0.0	0.0	0.0

Field Posting

Status CLOSED Posting Date 07/09/98

	2 Axle	3 Axle	5 Axle	Single
Actual				
Recommended				

Missing Signs N

Misc.

Bridge Name DEFLUMERI DIGERONIMO

N Anti-missile fence N Acrow Panel N Jointless Bridge

Freeze/Thaw N : Not Applicable

Stairs On/Adjacent 0 Stair Owner(s)

Accessibility (Needed/Used)

N / N	Liftbucket	N / N	Rigging	N / N	Other
Y / N	Ladder	N / N	Staging		
N / N	Boat	N / N	Traffic Control		
N / N	Wader	Y / N	RR Flagperson	Inspection Hours:	008
N / N	Inspector 50	N / N	Police		

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION PAGE 1 OF 6

STRUCTURES INSPECTION FIELD REPORT

FRACTURE CRITICAL INSPECTION

2-DIST	B.I.N.	BR. DEPT. NO.
03	29N	N-03-007

CITY/TOWN	8.-STRUCTURE NO.	11-Kilo. POINT	90-ROUTINE INSP. DATE	93a - F.C. INSP. DATE
NATICK	N03007-29N-DOT-CLP	000.241	Jul 9, 1998	Jun 8, 2022

07-FACILITY CARRIED	MEMORIAL NAME/LOCAL NAME	27-YR BUILT	106-YR REBUILT	*YR REHAB'D (NON 106)
HWY SPRING ST	DEFLUMERI DIGERONIMO	1896	0000	0000

06-FEATURES INTERSECTED	26-FUNCTIONAL CLASS	DIST. BRIDGE INSPECTION ENGINEER
RR MBTA/CSX	Urban Local	M. Azizi

43-STRUCTURE TYPE	22-OWNER	21-MAINTAINER	TEAM LEADER
303 : Steel Girder & Floorbeam	State Highway Agency	State Highway Agency	L. Fijol

107-DECK TYPE	WEATHER	TEMP. (air)	TEAM MEMBERS
8 : Timber	Clear	14°C	K. HOUATCHANTHARA

WEIGHT POSTING *Not Applicable* X

Actual Posting	N	N	N	N
Recommended Posting	N	N	N	N

Waived Date: 00/00/0000 **EJDMT Date:** 00/00/0000

	At bridge N	At bridge S	Advance N	Advance S
Signs In Place (Y=Yes,N=No, NR=Not Required)				
Legibility/ Visibility				

PLANS (Y/N): N

(V.C.R.) (Y/N): N

TAPE#:

RATING

Rating Report (Y/N): N Date: ----

Recommend for Rating or Rerating (Y/N): N

If YES please give priority: HIGH ( ) MEDIUM ( ) LOW ( )

REASON:

Inspection data at time of existing rating

I 58: 6 I 59: 7 I 60: 6 I 62: Date : 11/16/1977

FRACTURE CRITICAL MEMBER(S):

	MEMBER	CRACK (Y/N):	WELD'S CONDITION (0-9)	LOCATION OF CORROSION, SECTION LOSS (%), CRACKS, COLLISION DAMAGE, STRESS CONCENTRATION, ETC.	CONDITION PREVIOUS (0-9)	CONDITION PRESENT (0-9)	INV. RATING OF MEMBER FROM RATING ANALYSIS			Deficiencies
A	Item 59.2 - Floorbeams	N	N	See remarks in comments section.	2	2	7	10	15	S-A
B	Item 59.4 - Girders or Beams	N	N	See remarks in comments section.	4	4	32	40	53	S-A
C										
D										
E										

List of field tests performed:

None

	I-59	I-60
(Overall Previous Condition)	2	7
(Overall Current Condition)	2	7

DEFICIENCY: A defect in a structure that requires corrective action.

CATEGORIES OF DEFICIENCIES:

M= Minor Deficiency Deficiencies which are minor in nature, generally do not impact the structural integrity of the bridge and could easily be repaired. Examples include but are not limited to: Spalled concrete, Minor pot holes, Minor corrosion of steel, Minor scouring, Clogged drainage, etc.

S= Severe/Major Deficiency Deficiencies which are more extensive in nature and need more planning and effort to repair. Examples include but are not limited to: Moderate to major deterioration in concrete, Exposed and corroded rebars, Considerable settlement, Considerable scouring or undermining, Moderate to extensive corrosion to structural steel with measurable loss of section, etc.

C-S= Critical Structural Deficiency - A deficiency in a structural element of a bridge that poses an extreme unsafe condition due to the failure or imminent failure of the element which will affect the structural integrity of the bridge.

C-H= Critical Hazard Deficiency A deficiency in a component or element of a bridge that poses an extreme hazard or unsafe condition to the public, but does not impair the structural integrity of the bridge. Examples include but are not limited to: Loose concrete hanging down over traffic or pedestrians, A hole in a sidewalk that may cause injuries to pedestrians, Missing section of bridge railing, etc.

URGENCY OF REPAIR:

I = Immediate-	[Inspector(s) immediately contact District Bridge Inspection Engineer (DBIE) to report the Deficiency and to receive further instruction from him/her].
A = ASAP-	[Action/Repair should be initiated by District Maintenance Engineer or the Responsible Party (if not a State owned bridge) upon receipt of the Inspection Report].
P = Prioritize-	[Shall be prioritized by District Maintenance Engineer or the Responsible Party (if not a State owned bridge) and repairs made when funds and/or manpower is available].

X=UNKNOWN **N=NOT APPLICABLE** **H=HIDDEN/INACCESSIBLE** **R=REMOVED**

F.C.(1)7-96

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	**29N**	**N-03-007**	**N03007-29N-DOT-CLP**	**JUN 8, 2022**

REMARKS

BRIDGE ORIENTATION

According to the rating report, the approaches are north and south and the elevations are east and west. This is a single span riveted plate through girder bridge with a timber deck. There are 2 girders numbered west to east with 5 floorbeams numbered south to north. There are 13 roadway stringers in each bay numbered west to east and 6 bays numbered south to north.

GENERAL REMARKS

This WAS NOT a hands on inspection. This was a visual inspection performed from the ground only due to the continued inability to get flagging services provided by CSX Railroad.

ITEM 59 - SUPERSTRUCTURE

Item 59.2 - Floorbeams

There is severe section loss throughout the floorbeams, up to 100%, mostly at the ends beyond the cover plates. The location of the heaviest section loss is adjacent to the built up areas. The condition of the floorbeams with the section loss is as follows:

Floorbeam #2:

West end:

The south side of the built up bottom flange has 100% section loss adjacent to the cover plate, 34" long x up to 3" wide. The angle is back to original thickness at 36" from the cover plate.
The bottom angle on the north side has areas of up to 100% section loss adjacent to the cover plate, 24" long x 4" wide. There is heavy pitting on top of the bottom angle from the cover plate to the end of the floorbeam. **See photo 1.**

East end:

The south side of the bottom angle has 100% section loss adjacent to the cover plate, 21" long x up to 1-1/2" wide. The angle is back to original thickness at 25" from the cover plate.
The bottom angle on the north side has areas of up to 100% section loss adjacent to the cover plate, 28" long x 3" wide. The angle is back to original thickness at 30" from the cover plate. **See photo 2.**

Floorbeam #3:

West end:

The south side bottom angle has 100% section loss adjacent to the cover plate, 17" long x 2" wide. The angle is back to original thickness at 20" from the cover plate.
The north side bottom angle has areas of up to 100% section loss throughout, starting at the cover plate with some areas 3/4" wide. **See photo 3.**

East end:

The bottom angle on the south side has 100% section loss adjacent to the cover plate, 24" long x 2" wide. The angle is back to original thickness at 20" from the cover plate. **See photo 4.**
The bottom angle on the north side has areas of up to 100% section loss adjacent to the cover plate, 12" long x up to 3/4" wide. The angle is back to original thickness at 14" from the cover plate.

Floorbeam #4:

West end:

The bottom angle on the south side has 100% section loss adjacent to the cover plate, 10" long x 3/4" wide. The angle is back to original thickness at 15" from the cover plate.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	**29N**	**N-03-007**	**N03007-29N-DOT-CLP**	**JUN 8, 2022**

REMARKS

The bottom angle on the north side has an area of 100% section loss starting at 8" out from the cover plate to 18 " x 2-1/2" wide. **See photo 5.**

Item 59.4 - Girders or Beams

Both girders have up to 50% section loss to the bottom flanges at the interior south ends at the bearings.
Both girders have up to 15% section loss to the bottom flanges and the interior north ends.
The bottom flange of girder #1 has a 12" long x 1" wide area of 100% section loss at floorbeam #5.

There is an approximately 12" long x 2" wide area of 100% section loss to the bottom flange of girder #1 at floorbeam #1. **See photo 6.**

Both girders have moderate to heavy paint peeling and surface rusting with intermittent areas of rust pack between bottom flanges and interior web faces.
There is old minor collision damage to girder #1 at floorbeam #4. The gusset plate in this area is bent down and there is a minor scrape to the underside of the bottom flange. There are minor collision scrapes to the underside of the bottom flange of girder #2 above the north railroad tracks.

Photo Log

Photo 1 : West end of floor beam #2.
Photo 2 : East end of floorbeam #2.
Photo 3 : West end of floorbeam #3.
Photo 4 : East end of floorbeam #3.
Photo 5 : West end of floorbeam #4.
Photo 6 : Girder #1 at floorbeam #1.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	29N	N-03-007	N03007-29N-DOT-CLP	JUN 8, 2022

PHOTOS

Photo 1: **West end of floor beam #2.**

Photo 2: **East end of floorbeam #2.**

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	29N	N-03-007	N03007-29N-DOT-CLP	JUN 8, 2022

PHOTOS

Photo 3: **West end of floorbeam #3.**

Photo 4: **East end of floorbeam #3.**

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
NATICK	29N	N-03-007	N03007-29N-DOT-CLP	JUN 8, 2022

PHOTOS

Photo 5: West end of floorbeam #4.

Photo 6: Girder #1 at floorbeam #1.

Report Date: November 21, 2022

DEFLUMERI DIGERONIMO

State Information

BDEPT#=	**N03007**	Agency Br.No.	
Town=	**Natick**	L.O.	MHD
B.I.N=	**29N**	AASHTO=	032.0
RANK= 0	H.I.= 0	FHWA Select List= N (6/21/2017)	

Identification

(8) Structure Number	N0300729NDOTCLP
(5) Inventory Route	151000000
(2) State Highway Department District	03
(3) County Code 017 (4) Place code	43895
(6) Features Intersected	**RR MBTA/CSX**
(7) Facility Carried	**HWY SPRING ST**
(9) Location	.3 MI. W. OF ST-27
(11) Kilometerpoint	0000.241
(12) Base Highway Network	N
(13) LRS Inventory Route & Subroute	000000000000
(16) Latitude	42 DEG 17 MIN 07.22 SEC
(17) Longitude	71 DEG 21 MIN 00.90 SEC
(98) Border Bridge State Code	Share %
(99) Border Bridge Structure No. #	

Structure Type and Material

(43) Structure Type Main:	Steel	Code	303
Girder & Floorbeam	Jointless bridge type: Not applicable		
(44) Structure Type Appr:			
Other		Code	000
(45) Number of spans in main unit			001
(46) Number of approach spans			0000
(107) Deck Structure Type -	Timber	Code	8
(108) Wearing Surface / Protective System:			
A) Type of wearing surface -	Bituminous	Code	6
B) Type of membrane -	None	Code	0
C) Type of deck protection -	None	Code	0

Age and Service

(27) Year Built			1896
(106) Year Reconstructed			0000
(42) Type of Service: On -	Highway-Ped		
Under -	Railroad	Code	52
(28) Lanes: On Structure	02	Under structure	00
(29) Average Daily Traffic			000000
(30) Year of ADT	2019	(109) Truck ADT	00 %
(19) Bypass, detour length			002 KM

Geometric Data

(48) Length of maximum span			0019.5 M
(49) Structure Length			00021.0 M
(50) Curb or sidewalk:	Left 01.5 M	Right	01.8 M
(51) Bridge Roadway Width Curb to Curb			006.7 M
(52) Deck Width Out to Out			010.8 M
(32) Approach Roadway Width (w/shoulders)			005.5 M
(33) Bridge Median -	No median	Code	0
(34) Skew 00 DEG	(35) Structure Flared		N
(10) Inventory Route MIN Vert Clear			99.99 M
(47) Inventory Route Total Horiz Clear			06.7 M
(53) Min Vert Clear Over Bridge Rdwy			99.99 M
(54) Min Vert Underclear ref	R		05.38 M
(55) Min Lat Underclear RT ref	R		06.1 M
(56) Min Lat Underclear LT			00.0 M

Navigation Data

(38) Navigation Control -	Not applicable, no waterway	Code	N
(111) Pier Protection		Code	
(39) Navigation Vertical Clearance			000.0 M
(116) Vert-lift Bridge Nav Min Vert Clear			M
(40) Navigation Horizontal Clearance			0000.0 M

Classification

		Code
(112) NBIS Bridge Length		Y
(104) Highway System		N
(26) Functional Class -	Urban Local	19
(100) Defense Highway		0
(101) Parallel Structure		N
(102) Direction of Traffic -	2-way traffic	2
(103) Temporary Structure		N
(105) Federal Lands Highways		0
(110) Designated National Network		N
(20) Toll -	On free road	3
(21) Maintain -	State Highway Agency	01
(22) Owner -	State Highway Agency	01
(37) Historical Significance	not eligible	N

Condition

	Code
(58) Deck	3
(59) Superstructure	2
(60) Substructure	7
(61) Channel & Channel Protection	N
(62) Culverts	N

Load Rating and Posting

		Code
(31) Design Load -	H 10=M 9	1
(63) Operating Rating Method -	Allowable Stress (AS)	2
(64) Operating Rating		00.0
(65) Inventory Rating Method -	Allowable Stress (AS)	2
(66) Inventory Rating		00.0
(70) Bridge Posting		0
(41) Structure -	Closed	K

Appraisal

	Code
(67) Structural Evaluation	0
(68) Deck Geometry	5
(69) Underclearances, vert. and horiz.	0
(71) Waterway adequacy	N
(72) Approach Roadway Alignment	7
(36) Traffic Safety Features	0 0 0 0
(113) Scour Critical Bridges	N

Inspections

(90) Inspection Date 07/09/98 (91) Frequency 24 MO

(92) Critical Feature Inspection:				(93) CFI DATE
(A) Fracture Critical Detail	Y	24	MO A)	06/08/22
(B) Underwater Inspection	N	00	MO B)	00/00/00
(C) Other Special Inspection	N	00	MO C)	00/00/00
(*) Other Inspection ()	N	00	MO *)	00/00/00
(*) Closed Bridge	Y	12	MO *)	06/08/22
(*) UW Special Inspection	N	00	MO *)	00/00/00
(*) Damage Inspection			MO *)	00/00/00

Rating Loads

Report Date 00/00/00	H20	Type 3	Type 3S2	Type HS
Operating	0.0	0.0	0.0	0.0
Inventory	0.0	0.0	0.0	0.0

Field Posting

Status CLOSED Posting Date 07/09/98

	2 Axle	3 Axle	5 Axle	Single
Actual				
Recommended				

Missing Signs N

Misc.

Bridge Name DEFLUMERI DIGERONIMO

N Anti-missile fence N Acrow Panel N Jointless Bridge

Freeze/Thaw N : Not Applicable

Stairs On/Adjacent 0 Stair Owner(s)

Accessibility (Needed/Used)

N / N	Liftbucket	N / N	Rigging	N / N	Other
Y / N	Ladder	N / N	Staging		
N / N	Boat	N / N	Traffic Control		
N / N	Wader	Y / N	RR Flagperson	Inspection Hours:	008
N / N	Inspector 50	N / N	Police		

Appendix B

General Photos and Existing Abutment Condition Photos

Photo 1: East elevation of the bridge, looking West.

Photo 2: South approach roadway leading up to the bridge, looking North.

Photo 3: North approach roadway leading up to the bridge, looking South.

Photo 4: Roadway over the bridge, looking North.

Photo 5: Typical condition of the underside of the bridge, looking North

Photo 6: Typical condition of the abutments (South Abutment shown), looking South.

Photo 7: Water utility attached to the top of the East sidewalk (photo from 2001), looking Northeast.

Photo 8: Gas utility attached to the top of the West through girder, looking Southwest.

Spring Street Bridge
Photo #: 1

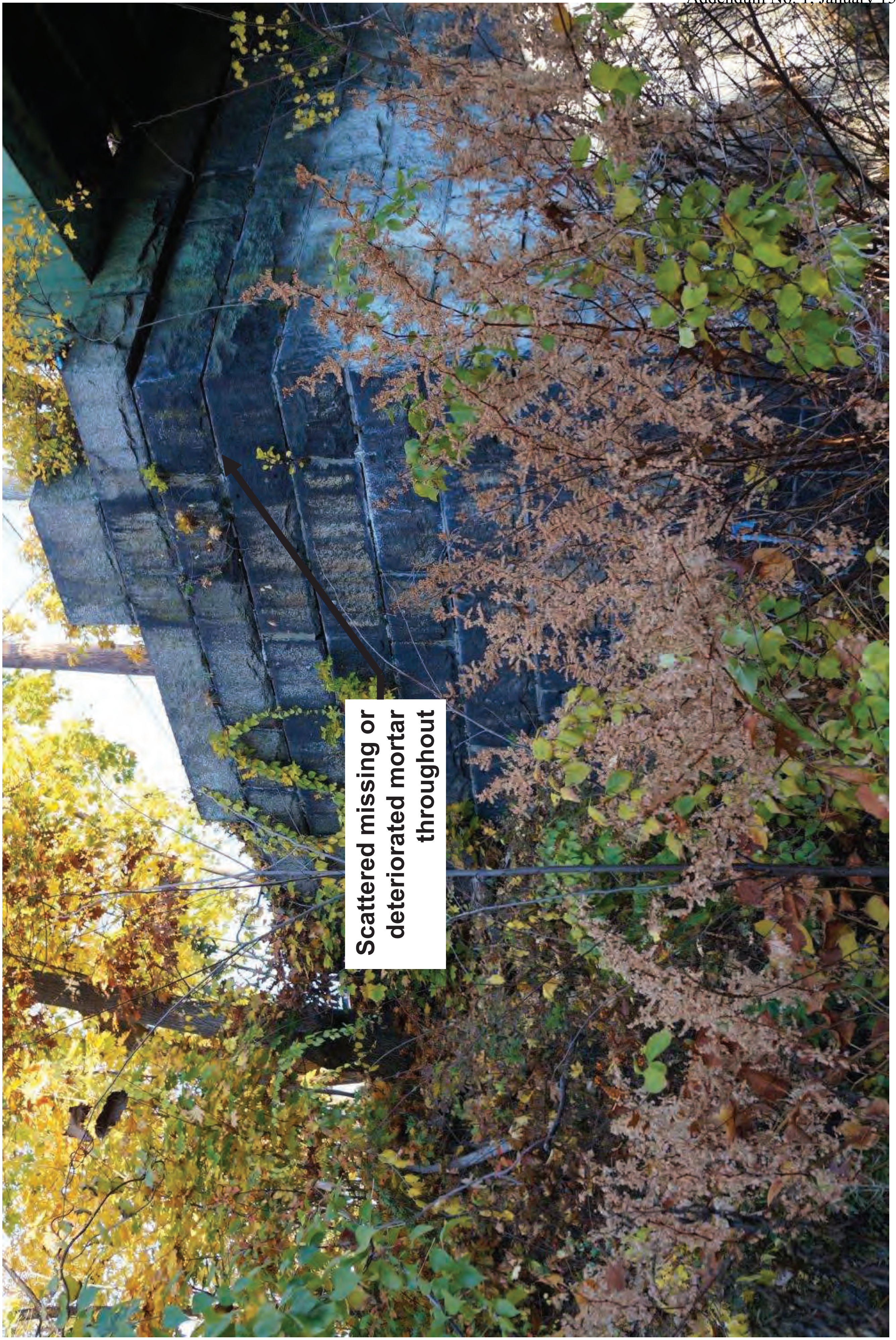
11/3/2022

Scattered missing or deteriorated mortar throughout

View of the North Abutment, looking North.

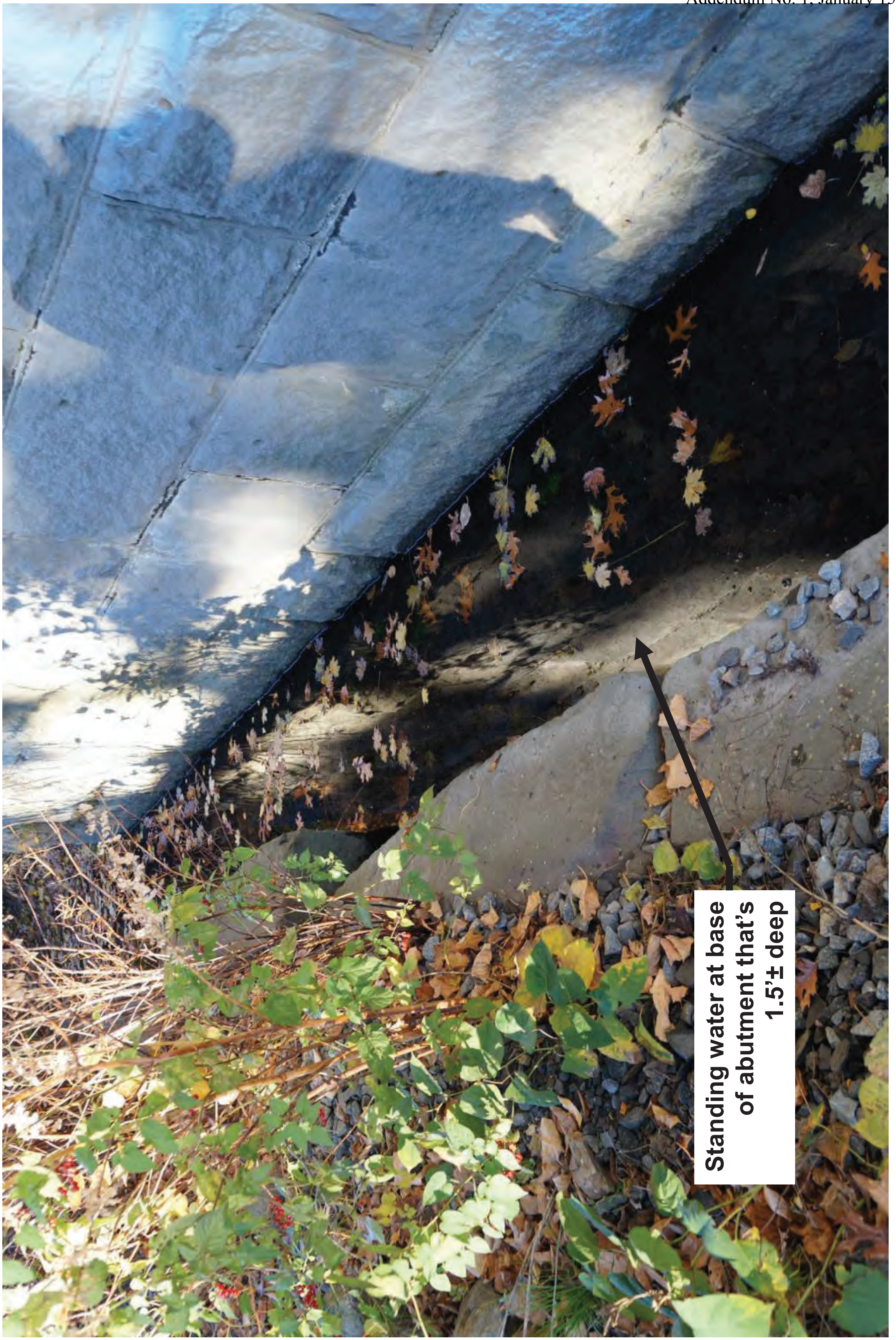
Spring Street Bridge
Photo #: 2

11/3/2022



Scattered missing or deteriorated mortar throughout

West end of the North Abutment, looking Northeast.



Spring Street Bridge
Photo #: 3

11/3/2022

Standing water at base of abutment that's 1.5'± deep

Base of the North Abutment, looking Northwest.

Spring Street Bridge
Photo #: 4

11/3/2022

Scattered missing or deteriorated mortar throughout

Deteriorated pipe

View of the South Abutment, looking South.

Spring Street Bridge
Photo #: 5

11/3/2022

Scattered missing or deteriorated mortar, some with moss growth, throughout

West end of the South Abutment, looking Southeast.

Spring Street Bridge
Photo #: 6

11/3/2022

East end of the South Abutment, looking South.

Scattered missing or deteriorated mortar, some with moss growth, throughout

Spring Street Bridge
Photo #: 7

11/3/2022

Granite wall and standing water at the base of the North Abutment, looking West.

Appendix C

Preliminary Construction Cost Summaries

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION
PROJECT MANAGEMENT DIVISION
BRIDGE SECTION

BRIDGE NO.
N-03-007
12/7/2022

TOWN Natick
FA#
CLASS H-5
STATION TBD (Middlesex Ave. to Cochituate St.)
ROAD Spring Street
OVER MBTA/CSX
TYPE Prefab. Ped. Bridge
ROADWAY 10'-0" (Shared Use Path)
WALKS -
SPAN (1) 65'-8"+/-
LENGTH 65'-8"+/-
CL. UNDER BR. 18'-0"

PRELIMINARY STRUCTURES REPORT ESTIMATE OF QUANTITIES AND COST OF BRIDGE

Spec?	ITEM NO.	QTY	UNITS	ITEM	UNIT PRICE	AMOUNT
*	114.1	1	LS	Demolition of Superstructure of Bridge No. N-03-007 (29N)	$267,600	$267,600
*	127.	17	CY	Concrete Excavation	$1,000.00	$17,000
	140.	55	CY	Bridge Excavation	$40.00	$2,200
*	144.	11	CY	Class B Rock Excavation	$150.00	$1,650
	151.2	15	CY	Gravel Borrow for Backfilling Structures and Pipes	$50.00	$750
*	184.1	15	TON	Disposal of Treated Wood Products	$260.00	$3,900
*	908.40	240	SY	Repointing	$200.00	$48,000
*	912.4	150	EA	Drilled and Grouted #4 Dowels	$50.00	$7,500
*	964.3	898.0	SF	Elastomeric Protective Coating	$5.00	$4,490
*	994.01	1	LS	Temporary Protective Shielding Bridge No. N-03-027	$22,000	$22,000
*	995.	1	LS	Bridge Structure, Bridge No. N-03-027	$558,359	$558,359

Years until mid way through Const. = 1.5 **yrs**

Bridge Subtotal =	$933,449
Highway Subtotal ($30 / SF * 16,671 SF) =	$450,120
Inflation (3% Per Year) =	$62,725
Contingency (35%) =	$484,249
Bridge Item Total =	**$1,930,544**

ESTIMATED BY: NC

CHECKED BY: GNM

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION - HIGHWAY DIVISION
PROJECT MANAGEMENT DIVISION
BRIDGE SECTION

BRIDGE NO.
N-03-007
12/7/2022

TOWN	Natick	**FA#**		**CLASS**	H-5
STATION	TBD (Middlesex Ave. to Cochituate St.)	**ROAD**	Spring Street	**OVER**	MBTA/CSX
TYPE	Prefab. Ped. Bridge	**ROADWAY**	10'-0" (Shared Use Path)	**WALKS**	-
SPAN	(1) 65'-8"+/-	**LENGTH**	65'-8"+/-	**CL. UNDER BR.**	18'-0"

PRELIMINARY STRUCTURES REPORT ESTIMATE OF QUANTITIES AND COST OF BRIDGE

Spec?

ITEM NO.	QTY	UNITS	ITEM	UNIT PRICE	AMOUNT
114.1			BREAKDOWN OF ITEM 114.1 DEMOLITION OF SUPERSTRUCTURE OF BRIDGE NO. N-03-007 (29N)		
Sub-Item No.					
117.1	1	LS	General Engineering Costs	$6,000.00	$6,000
117.2	112500	LB	Structural Steel Removal	$0.80	$90,000
117.3	29000	LB	Timber Deck Removal	$0.30	$8,700
117.4	45800	LB	Bituminous Wearing Surface Removal	$3.00	$137,400
117.5	40	FT	Remove Existing Concrete Barriers	$50.00	$2,000
117.6	1	LS	Relocate Existing Utilities	$20,000.00	$20,000
665.	140	FT	Chain Link Fence Removed and Stacked	$25.00	$3,500
				TOTAL =	$267,600
				SAY =	$267,600

ITEM NO.	QTY	UNITS	ITEM	UNIT PRICE	AMOUNT
995.			BREAKDOWN OF ITEM 995. BRIDGE STRUCTURE BRIDGE NO. N-03-007 (29N)		
Sub-Item No.					
901.	22	CY	4000 PSI, 1.5 Inch, 565 Cement Concrete	$1,250.00	$27,500
904.	12	CY	4000 PSI, 3/4 Inch, 610 Cement Concrete	$2,300.00	$27,600
904.4	20	CY	4000 PSI, 3/4 Inch, 585 HP Cement Concrete	$2,470.00	$49,400
910.1	11000	LB	Steel Reinforcement for Structures - Epoxy Coated	$2.75	$30,250
955.1	267	FT	Timber Rub Railing	$20.00	$5,340
960.01	1	LS	Prefabricated Tubular Steel Truss Superstructure	$404,768.24	$404,768
970.	500	SF	Damp-Proofing	$3.00	$1,500
972.1	20	FT	Cover Plate System	$600.00	$12,000
				TOTAL =	$558,358
				SAY =	$558,359

ESTIMATED BY: NC

CHECKED BY: GNM

CONSTRUCTION COST ESTIMATE - December 7, 2022
Natick
Spring Street over MBTA/CSX
Br. No. N-03-007 (29N)

BRIDGE FULL REPLACEMENT ALTERNATIVE

(Includes Full Abutment and Wingwall Replacement)
Project File No. 610869

Bridge Dimensions

	feet	allowance feet	sidewalk feet	offset feet	feet	square feet
Length =	67.0	0.0			67.0	
Width =	20.0				20.0	
Area =						1340.0
						Urban Local

Bridge Replacement:	1340.0	s.f.	@			$1,000.00	/s.f.	=		$1,340,000.00
Bridge Rehabilitation:										
		s.f.			of		/s.f.	=	$	-
Subtotal 1 (Bridge Construction Cost)									$	1,340,000.00
Additional Costs:										
Temporary Traffic Signals:								=		
Temporary Earth Support (for RR Track Protection)								=	$	100,000.00
Removal/Deconstruction of Existing Structure:								=	$	350,000.00
Temporary Utility Bridge:	350.0	s.f.	@			$500.00	/s.f.	=	$	175,000.00
Reconstruct roadway approaches:										
	--	mi	@	100%	of	$2,000,000.00	/mi	=	$	495,137.00
Subtotal 2 (Bridge and Highway Cost)									$	2,460,137.00

Highway		(Of Subtotal 1)		=	$	-
			Subtotal 3		$	2,460,137.00
TMP	3%	(Of Subtotal 2)		=	$	73,804.11
			Subtotal 4		$	2,533,941.11
Contingencies	35%	(Of Subtotal 1)		=	$	469,000.00
			TOTAL		$	3,002,941.11
			SAY =		**$**	**3,002,000.00**

Notes:
* Assume no detour required, add small amount for TMP for contingency
* This cost estimate assumes a full bridge replacement.
* Contingency includes inflation

Appendix D

2002 Geotechnical Report

(Note, the abutment stability calculations included at the end of this 2002 report are based on a different proposed superstructure from a design project that was cancelled)

Design Consultant copy

OCT 11 2002

THE COMMONWEALTH OF MASSACHUSETTS

MASSACHUSETTS HIGHWAY DEPARTMENT

INTEROFFICE MEMORANDUM

TO: Alex Bardow, Bridge Engineer

THROUGH: John Blundo, Deputy Chief Engineer of Highway Engineering

FROM: Nabil Hourani, Geotechnical Engineer

DATE: October 9, 2002

SUBJECT: NATICK - Bridge No. N-3-7
Spring Street over CSX Railroad
Project File No.: 126201

The Geotechnical Section has completed a soil and foundation investigation for the bridge, which is in the Pre-Engineered/Pre-Fabricated Program. Enclosed, please find a copy of the Geotechnical Report prepared by Mr. John Pettis of this section. A copy of this report should be forwarded to the design consultant, Chas. Sells, Inc.

We will be prepared to perform any additional analysis necessary during the final design stage. If you have any questions please contact me at x-8832, or John Pettis at x-8831.

JP/jp
Copy: Engineering Expediting – Michael Bloukos (w/o attachment)
Design Consultant – Chas. Sells, Inc.
attach.

GEOTECHNICAL REPORT

BRIDGE NO. N-3-7
SPRING STREET OVER CSX RAILROAD
NATICK, MASSACHUSETTS

SUBMITTED BY: JOHN PETTIS, P.E.

October 2002

MASS HIGHWAY

Massachusetts Highway Department
Geotechnical Section
10 Park Plaza, Boston, MA 02116

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Existing Conditions

This report presents the results of a soil and foundation investigation for bridge no. N-3-7, located in Natick. Figure 1 of this report shows the location map for this project.

The existing one span bridge carries Spring Street over the CSX Railroad. The bridge was built in 1896 and has a structural length of 21.0 meters. Stone masonry abutments and wingwalls support the existing superstructure. The stones used to build the substructure are of consistent height and the abutments and wingwalls appear to be in very good condition. Old plans dated 1928 were found but do not contain any details of the substructures. The bridge is currently closed, and will remain so during construction.

1.2 Proposed Construction

It is the understanding of the Geotechnical Section that the preferred scheme consists of cutting-down and reusing the existing abutments. New concrete bridge seats are to be constructed on top of the cut-down abutments. The new superstructure shall be a precast, precompressed, composite concrete-steel panelized system. Figure 2 shows the alignment of the bridge.

2. SUBSURFACE INVESTIGATION

The field investigation for this project consisted of two borings and two lines of probes. Zoino-Hebert, Inc. conducted the borings and probes between November 6 and 8, 2001. Justin Downing of Chas. Sells, Inc. inspected the borings and probes. The boring locations are shown on figure 2 of this report. The logs for the borings are contained in Appendix A.

The standard sampling technique (split-spoon sampler advanced during Standard Penetration Testing) was used at the borings. Each boring was terminated after coring 3 meters into bedrock, which began at depths of 4.72 and 3.05 meters, respectively. Based on the depth to bedrock at the borings it appears that the abutments bear directly on bedrock. Ground water was not encountered at either boring.

Based on the borings, a review of the samples, and the Standard Penetration Test (SPT) N-values, the subsurface conditions at the project location consists of the following:

South abutment:	4.7 meters loose to medium dense, gravel, some fine sand, overlying granite bedrock.
North abutment:	3.05 meters medium dense, fine to coarse sand, some gravel, overlying granite bedrock.

The Bedrock Geology Map for the Natick Quadrangle identifies bedrock in the project area as Dedham Granodiorite, describing it as rock ranging from granite to quartz diorite. The rock mass was classified as "fair rock" using the Rock Mass Rating (RMR) System. This RMR value

value is based partly on point load testing on selected samples of the recovered bedrock core. Refer to Appendix A for photos of the entire recovered core runs and close-ups of the top of each run.

The two lines of probes were laid out to aid in determining the configuration of the abutments. The consistency of the refusal depth in the probes also appears to give a good indication of the location of the top of rock behind the abutments.

The following table summarizes the distance from the probes to the respective face of abutment backwall.

South Abutment	Dist. From backwall, m	Depth of Refusal, m	North Abutment	Dist. From backwall, m	Depth of Refusal, m
P1-A	0.6	0.25	P2-A	0.6	0.58
P1-B	1.2	5.3*	P2-B	1.2	2.81
P1-C	1.8	4.41	P2-C	1.8	2.89
P1-D	2.4	4.26	P2-D	2.4	2.97
P1-E	3.0	4.23	P2-E	3.0	2.74
P1-F	3.6	4.08	P2-F	3.6	2.74
P1-G	4.2	4.21	P2-G	4.2	2.76
P1-H	7.2	3.0	P2-H	7.2	2.99

*It was noted in the field that when the pipe was retrieved at probe P1-B that the bottom section of pipe was bent, indicating that the pipe may have glanced off the abutment. Therefore, the depth to refusal at this location may be lower than indicated.

Refer to figure 3 for a review of the above conditions.

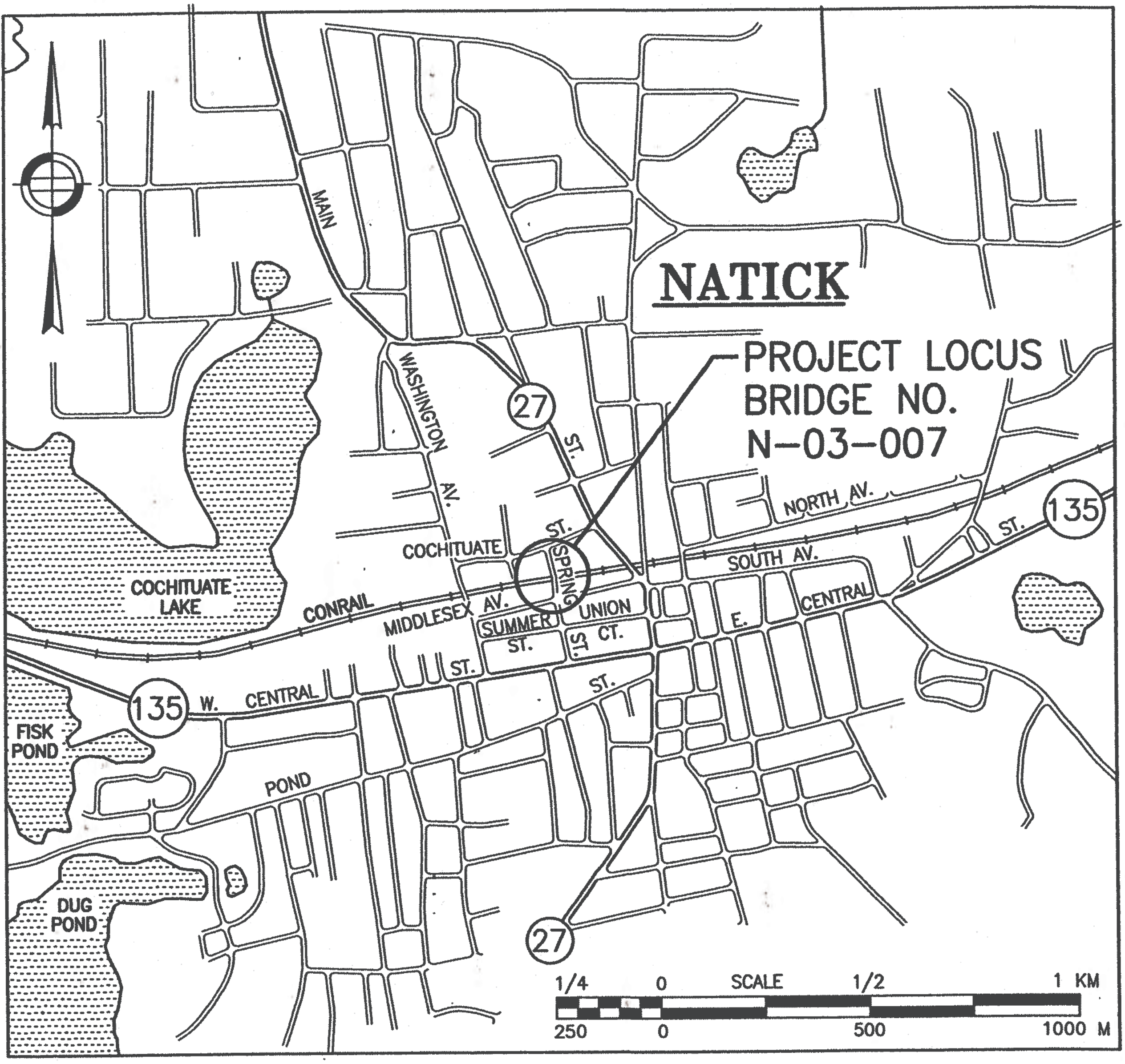
3. FOUNDATION RECOMMENDATIONS

3.1 Reused Abutments

Based on the subsurface investigation it appears that both abutments rest directly on bedrock. The factored bearing capacity was calculated to be 1500 KN/m^2, based on a performance factor of 0.6. Settlement is expected to be negligible. The factor of safety against overturning and sliding were calculated to be 2.35 and 3.76, respectively. The unfactored maximum toe pressure was determined to be 657 KN/m^2.

3.2 Seismic Considerations

Based on the MHD Bridge Section's interpretation of the AASHTO recommended seismic design map, the design horizontal acceleration is 0.17g. The project has Soil Profile Type I, and Site Coefficient (S) = 1.0. The soil at the project location is judged to be not susceptible to liquefaction.



LOCUS PLAN

FIGURE 1

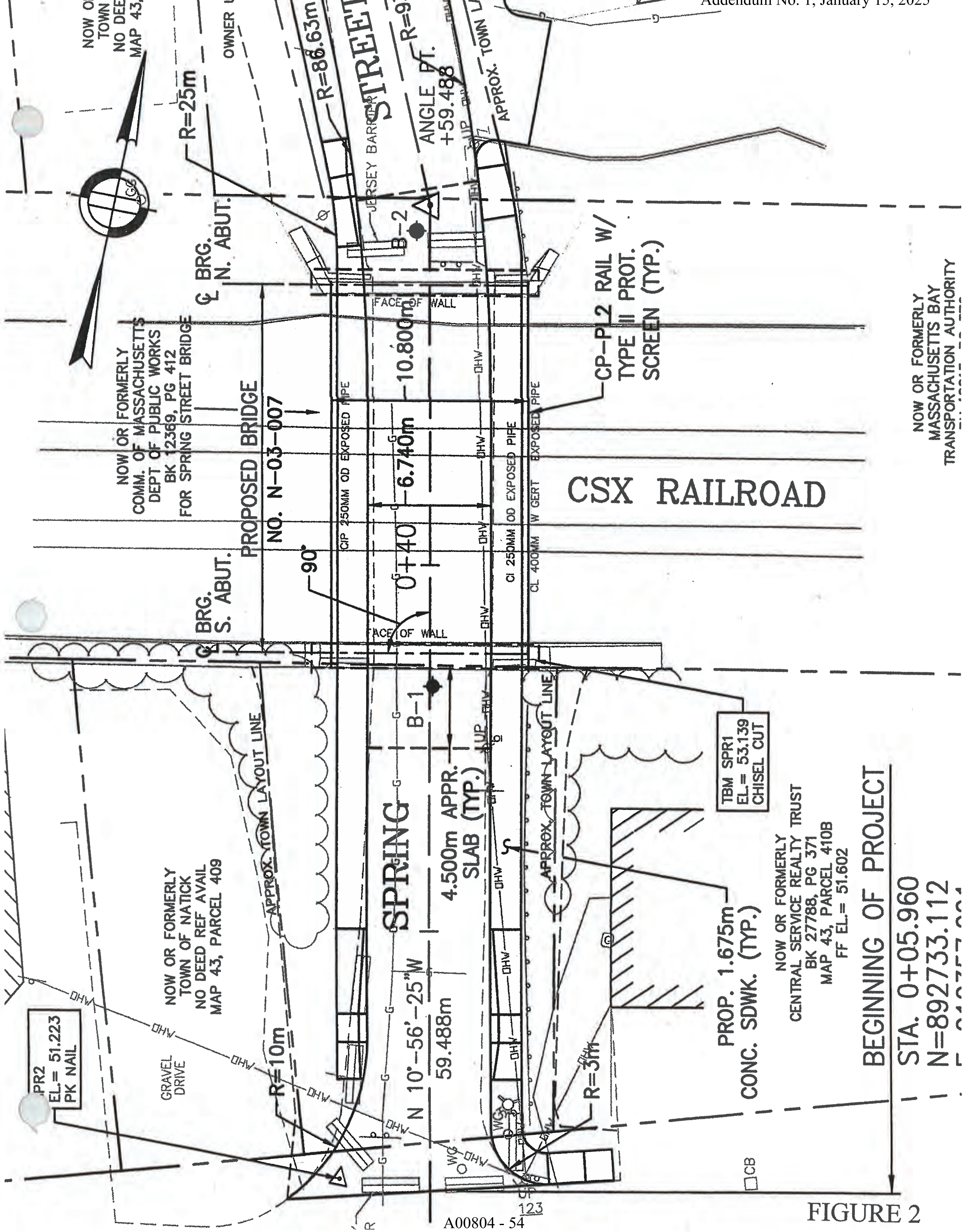
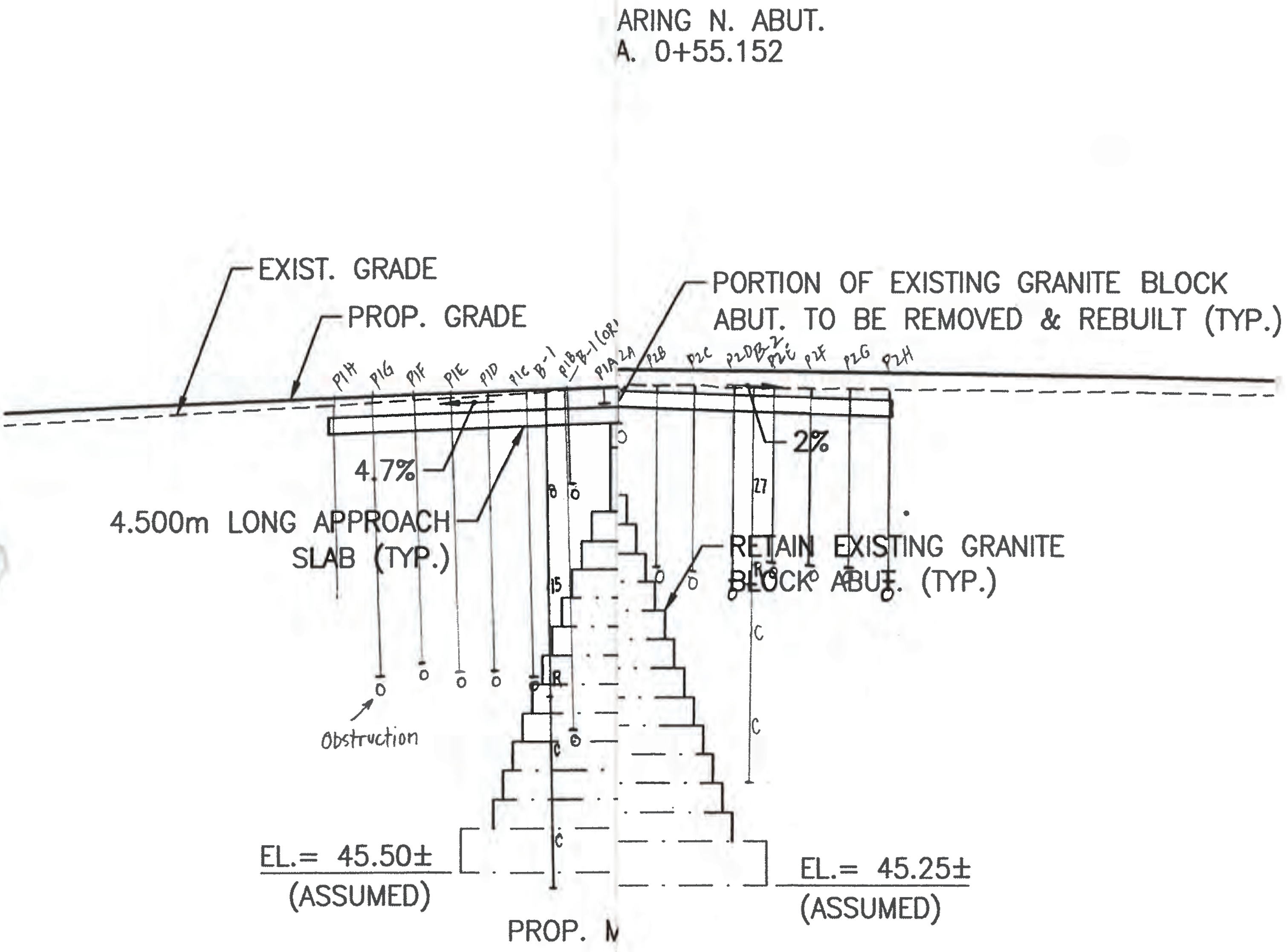

NOW OR FORMERLY
COMM. OF MASSACHUSETTS
DEPT OF PUBLIC WORKS
BK 12369, PG 412
FOR SPRING STREET BRIDGE
PROPOSED BRIDGE
NO. N-03-007
℄ BRG.
N. ABUT.
℄ BRG.
S. ABUT.
R=25m
R=86.63m
R=9.
STREET
SPRING
ANGLE PT.
+59.488
JERSEY BARRIER
APPROX. TOWN LAYOUT LINE
B-2
B-1
FACE OF WALL
10.800m
6.740m
0+40
90°
CIP 250MM OD EXPOSED PIPE
CI 250MM OD EXPOSED PIPE
CL 400MM W GERT EXPOSED PIPE
CP-PL2 RAIL W/
TYPE II PROT.
SCREEN (TYP.)
CSX RAILROAD
NOW OR FORMERLY
MASSACHUSETTS BAY
TRANSPORTATION AUTHORITY
TBM SPR1
EL.= 53.139
CHISEL CUT
4.500m APPR.
SLAB (TYP.)
PROP. 1.675m
CONC. SDWK. (TYP.)
NOW OR FORMERLY
CENTRAL SERVICE REALTY TRUST
BK 27788, PG 371
MAP 43, PARCEL 410B
FF EL.= 51.602
NOW OR FORMERLY
TOWN OF NATICK
NO DEED REF AVAIL
MAP 43, PARCEL 409
N 10°-56'-25"W
59.488m
R=10m
R=3m
SPR2
EL.= 51.223
PK NAIL
GRAVEL
DRIVE
BEGINNING OF PROJECT
STA. 0+05.960
N=892733.112
NOW OR
TOWN
NO DEE
MAP 43,
OWNER
CB
123

FIGURE 2



*note:

when retrieved pipe @ P1B, bottom sec

pipe may have glanced off abutme

For B-1 and B-2:

#'s indicate SPT "N" value

R = Refusal (N ≥ 120)

C = Cored Bedrock

FIGURE 3

APPENDIX A

BORING LOGS AND BEDROCK CORE PHOTOS AND DESCRIPTION SHEET

ZOINO-HEBERT, INC.
GEOTECHNICAL & ENVIRONMENTAL DRILLING SERVICES
3034 POST ROAD
WARWICK, RI 02886

Natick
Spring St Bridge over CSX Railroad
Bridge # N-3-7

BORING NUMBER: B-1
SURFACE ELEVATION:
STA: OFF:
START: 11-8-01 AT: 08:30
FINISH: 11-8-01 AT: 15:00
TOTAL HOURS: 6.5
CONTRACT NO.
OUR FILE NO.

ENGINEER/ARCHITECT: Mass Highway
DRILLING FOREMAN: B. Hasse
MUD INSPECTOR: J Downing

	CASING	SAMPLER	CORE BAR.
TYPE:	HW	SS	HX
SIZE, I.D.:	102 mm	51 mm	
HAMMER WT.	136 kg	63.5 kg	
HAMMER FALL	610 mm	760 mm	

GROUNDWATER OBSERVATIONS

DATE	TIME	DEPTH	STABILIZATION TIME
			None Encountered

No.	DEPTH RANGE IN METERS	SAMPLE BLOWS PER .15M	CASING BLOWS CORING TIMES PER .3M	FIELD CLASSIFICATION	DEPTH IN METERS
	0-0.05			Asphalt	0.05
S1	1.22-1.82	4-4-4-5		Moist, loose, brown, COARSE GRAVEL, some fine Sand, trace inorganinc Silt	
S2	2.7-3.3	9-5-10-32		Moist, medium dense, brown, COARSE GRAVEL, trace fine sand, trace inorganic silt	
S3	4.26-4.5	67-120/.075		Moist, very dense, grey, MEDIUM TO COARSE GRAVEL, some inorganic, trace fine sand	4.72
C1	4.72-5.63		8-8-13	Highly Fractured GRANITE Percent Recovery = 100%	
C2	5.63-6.4		7-8-7	Highly Fractured GRANITE Percent Recovery 100%	
C3	6.40-7.78		6-7-6-9	Highly Fractured GRANITE Percent Recovery = 100%	
				Bottom of Boring at 7.78m	7.78

0 2 4 6 8 10 12 14 16 18 20

Remarks: Engineer instructed 1st sample at 1.2 m

SCALE: 1:100

ZOINO-HEBERT, INC.
GEOTECHNICAL & ENVIRONMENTAL DRILLING SERVICES
3034 POST ROAD
WARWICK, RI 02886

Natick
Spring St Bridge over CSX Railroad
Bridge # N-3-7

BORING NUMBER: B-2
SURFACE ELEVATION:
STA: OFF:
START: 11-7-01 AT: 09:30
FINISH: 11-7-01 AT: 16:00
TOTAL HOURS: 6.5
CONTRACT NO.
OUR FILE NO.

ENGINEER/ARCHITECT: Mass Highway
DRILLING FOREMAN: B. Hasse
MUD INSPECTOR: J Downing

	CASING	SAMPLER	CORE BAR.
TYPE:	HW	SS	NX
SIZE, I.D.:	102 mm	51 mm	
HAMMER WT.	136 kg	63.5 kg	
HAMMER FALL	610 mm	760 mm	

GROUNDWATER OBSERVATIONS

DATE	TIME	DEPTH	STABILIZATION TIME
			None Encountered

No.	DEPTH RANGE IN METERS	SAMPLE BLOWS PER .15M	CASING BLOWS CORING TIMES PER .3M	FIELD CLASSIFICATION	DEPTH IN METERS
	0-0.05			Asphalt	.05 0
S1	1.22-1.82	17-15-12-17		Moist, medium dense, brown, FINE to COARSE SAND, some fine gravel, trace inorganic silt	
					2
S2	2.7-2.93	35-120/.075		Dry, very dense, brown, COARSE SAND, some coarse gravel, trace inorganic silt	3.05
C1	3.05-4.57		15-7-9-8-10	**Top of Bedrock** **Coarse Grain GRANITE** **100% Recovery**	4
C2	4.57-6.1		5-7-9-10-10	**Coarse grain GRANITE** **100% Recovery**	
				Bottom of Boring @ 6.10m	6.1 6
					8
					10
					12
					14
					16
					18
					20

Remarks: Engineer instructed 1st sample at 1.2 m

SCALE: 1:100


NATICK N-3-7 B-1, runs 1,2
NATICK N-3-7 B-1, run 3 B-2, runs 1,2
B-1 Natick
B-2 Natick


NATICK


NATICK

MHD STANDARD ROCK CORE DESCRIPTION AND CLASSIFICATION

City/Town: NATICK Bridge or Hwy No.: N-3-7	Boring No.: B-1 B-2 Core length drilled/recov.: 3m/3m 3m/3m	Core diameter: 63.5m 51 mm Average Core rate: 13min/0.5m 15min/0.5m	Completed by / date JP / 5-02

Rock type	*Igneous* - [✓ granite], syenite, diorite, gabbro, pegmatite, rhyolite, diabase, basalt, tuff
	Sedimentary - shale, siltstone, graywacke, sandstone, conglomerate, limestone, dolomite, gypsum
	Metamorphic - slate, phyllite, schist, gneiss, quartzite, apphibolite, marble, hornfels

Grain Size	amorphous	fine grained	[✓ medium]	[✓ coarse]	very coarse		
	<0.075 mm	0.075-0.5 mm	[✓ 0.5-2 mm]	[✓ 2-5 mm]	>5 mm		
Secondary items	infilling, voids, [✓ veins], fossils, bedding planes, foliation, [✓ intermittant weathered zones]						

Weathering - *fresh*-rock rings under hammer blow, may show some staining, crystals are bright; [✓ *slightly*] -weathering limited to joints, rings under hammer blow, some discoloring of crystals; [✓ *moderate*] - weathering extends throughout the rock, has dull sound when struck by hammer, most minerals are dull and discolored severe - rock "fabric" is evedent and rock is partly friable, some fragment of strong rock left; *complete* - reduced to soil, rock "fabric" is not discernable

1. Strength of intact rock material							
Point-load strength index (MPa) avg=1.4	10	4-10	2-4	[✓ 1-2]	use uniaxial test here		
Uniaxial compressive strength (MPa)	250	100-250	50-100	25-50	5-25	1-5	<1
General hardness*	very hard	hard	moderate	low	friable	soft	
Rating	15	12	7	[✓ 4]	2	1	0
2. Drill Core Quality (RQD = pieces>0.1 m / run length; neglect vertial joints, do not count drill breaks, measure from core centers)							
RQD (%) 40, 63; 81, 82	90-100	[✓ 75-90]	[✓ 50-75]	25-50	[✓ <25]		
Rating	20	17	13 Call =10	8	3		
3. Spacing of discontinuities	>2 m	0.6 - 2 m	[✓ 200 - 600 mm]	[✓ 60 - 200 mm]	[✓ < 60 mm]		
Rating	20	15	10	[✓ 8]	5		
4. Condition of dicontinuities	very rough surfaces not continuous no seperation	[✓ slightly rough surfaces seperation < 1 mm slightly weathered walls]	[✓ slightly rough surfaces seperation < 1 mm highly weathered wall]	[✓ slickenside surfaces gouge < 5 mm thick seperation 1-5 mm]	soft gouge>5 mmthick seperation > 5 mm		
Rating	30	25	[✓ 20]	10	0		
5. Groundwater General Conditions	completely dry	damp	[✓ wet]	dripping	flowing		
Rating	15	10	[✓ 7]	4	0		
B. Rating adjustment for discontinuity orientations							
Strike/dip orient. of discontinuities	very favorable	favorable	[✓ fair]	unfavorable	very unfavorable		
Foundations	0	-2	[✓ -7]	-15	-25		
Slopes	0	-5	-25	-50	-60		
C. Total Rock Mass Rating 4+10+8+20+7-7 = 42							
Rating	81 - 100	61 - 80	[✓ 41 - 60]	21 - 41	<20		
Description	very good rock	good rock	[✓ fair rock]	poor rock	very poor rock		

* very hard - cannot scratch with knife, knife leaves steel on surface, breaking of specimen requires several hard hammer blows; hard - difficult to scratch, scratch is faintly visible, hard hammer blow needed to break, rebounds when impacted by ballpeen hammer; moderate - readily scratched by knife, moderate blow will fracture specimen, splits when impacted by ballpeen hammer low - can gouge to 3 mm deep by knife, dents when impacted by 1/2 kg ballpeen hammer, similar to strength of concrete; friable - can be crumpled in hand, thin pieces can be broken by finger pressure, craters when impacted by ballpeen hammer; soft - can be carved by knife, easily scratched by fingernail, easily crumpled by hand

APPENDIX B

CALCULATIONS

MASS HIGHWAY

Massachusetts Highway Department, Geotechnical Section
Ten Park Plaza, Boston, MA 02116

Project NATICK N-3-7
Engineer J. PETTIS Date
Reviewer Date
Sheet No. 1 of 5

from Consultant {

DL	1565.06 kN/Abut
DL_{slab}	229.68
LL	550
$LL_{sidewalk}$	96.25
	2441 $= Q_V$

$Q_H \simeq 0.1\,Q_V$
$= 244.1\,kN$

for backfill, $\phi_f \simeq 33°$ $\gamma \simeq 19\,kN/m^3$ $\delta \simeq \frac{2}{3}\phi_f = 22°$

$K_a = 0.265$ (Conservatively assuming all backfill is soil, likely partly rock)

$$P_a = \frac{1}{2}(0.265)(19\,kN/m^3)(7.3')^2 = 134.2\,kN/m$$

$$P_{ah} = P_a \cos 22° = 124.4\,kN/m$$

$$P_{av} = P_a \sin 22° = 50.26\,kN/m$$

Assumed Abutment Configuration: from S. Abutment borings/probes:

from B-1 (original) and P1B - see Figure 3

appears that abutment at least 1.9m in width.

Use 1.9 m as width of abutment and assume 0.6m depth below ground to bottom of abutment. Determine stability for N. Abutment (tallest)

MASS HIGHWAY

Massachusetts Highway Department, Geotechnical Section
Ten Park Plaza, Boston, MA 02116

Project NATICK, N-3-7
Engineer J. PETTIS Date
Reviewer Date
Sheet No. 2 of 5

VSC Abut length, L = 10.8 m	Force per m, kN	Moment Arm, m	Moment per m, kN·m
Q_H	244.1 / 10.8	6.7	151.43
P_{ah}	-124.4	7.3/3	-302.71
	$\Sigma F_H = -103.65$		
Q_v	2441/10.8	0.55	124.31
P_{av}	50.26	1.9	95.49
Abut	(7.3m)(1.9m)(1m)(25.9 kN/m³)	1.9/2	341.24
	$\Sigma F_v = 635.48$		$\Sigma M_{TOE} = 409.76$

$$\bar{X} = \frac{409.76}{635.48} = 0.645 \quad (\text{w/in middle third})$$

$$FS_o = \frac{409.76 + 302.71}{302.71} = 2.35 > 2.0 \quad ✓$$

$$FS_s = \frac{635.48 \tan 35° + 22.60}{124.4} = 3.76 > 1.5 \quad ✓$$

MASS HIGHWAY

Massachusetts Highway Department, Geotechnical Section
Ten Park Plaza, Boston, MA 02116

Project NATICK N-3-7
Engineer J.PETTIS Date
Reviewer Date
Sheet No. 3 of 5

using $B = 1.9\,m$ $\quad e_B = \frac{1.9}{2} - 0.645 = 0.305$

$$e_B < B/6 = 1.9/6 = 0.317$$

since $e_B < B/6$

$$q_{max} = \frac{(635.48\,kN/m \times 10.8\,m)\left[1 + \frac{6(0.305)}{1.9}\right]}{10.8\,m\,(1.9\,m)} = 656.6\,kN/m^2$$

Bearing Capacity:

from Point Load testing, $I_{s\,avg} = 1.4\,MPa$

$$C_o \simeq 24\,(1.4\,MPa) = 33.6\,MPa$$

$$q_{ult} = N_{ms}\,C_o = (.075)(33.6\,MPa) = 2.52\,MN/m^2$$

$$FS_{BC} = \frac{2520\,kN/m^2}{656.6\,kN/m^2} = 3.84$$ ✓

for plans

$$\text{factored capacity} = 2520\,kN/m^2 \times (\overset{\text{bearing in rock}}{\phi = 0.6}) = 1510 \simeq 1500\,kN/m^2$$

4/5

Point Load Strength Index

date

Location: NATICK N-3-7

Borehole ref: B-1 & B-2

Description GRANITE

Depth from to

No.	Type	W-mm	D-mm	P-kN	De²-mm²	De-mm	I_s (MN/m²)	F	$I_{s(50)}$
B-1 a	d	70	76	5.5	5776	76	0.95		
b	a	76	83	14	8032	90	1.74		
c	d	127	76	13	5776	76	2.25		
d	d	95	76	4	5776	76	0.69		
B-2 a	d	64	51	20	2601	51	7.69		
b	d	64	51	8	2601	51	3.08		
c	d	114	51	12	2601	51	4.61		
d	d	89	51	13	2601	51	5.00		

Type data
d - diametral
a - axial
b - block
i - irregular lump
relationship to weakest plane
- perpendicular
// - parallel

Result summary
mean $I_s(50)$ 1.4 MN/m² @B-1
mean $I_s(50)//$ 5.1 MN/m² @ B-2

Signed John Pettis

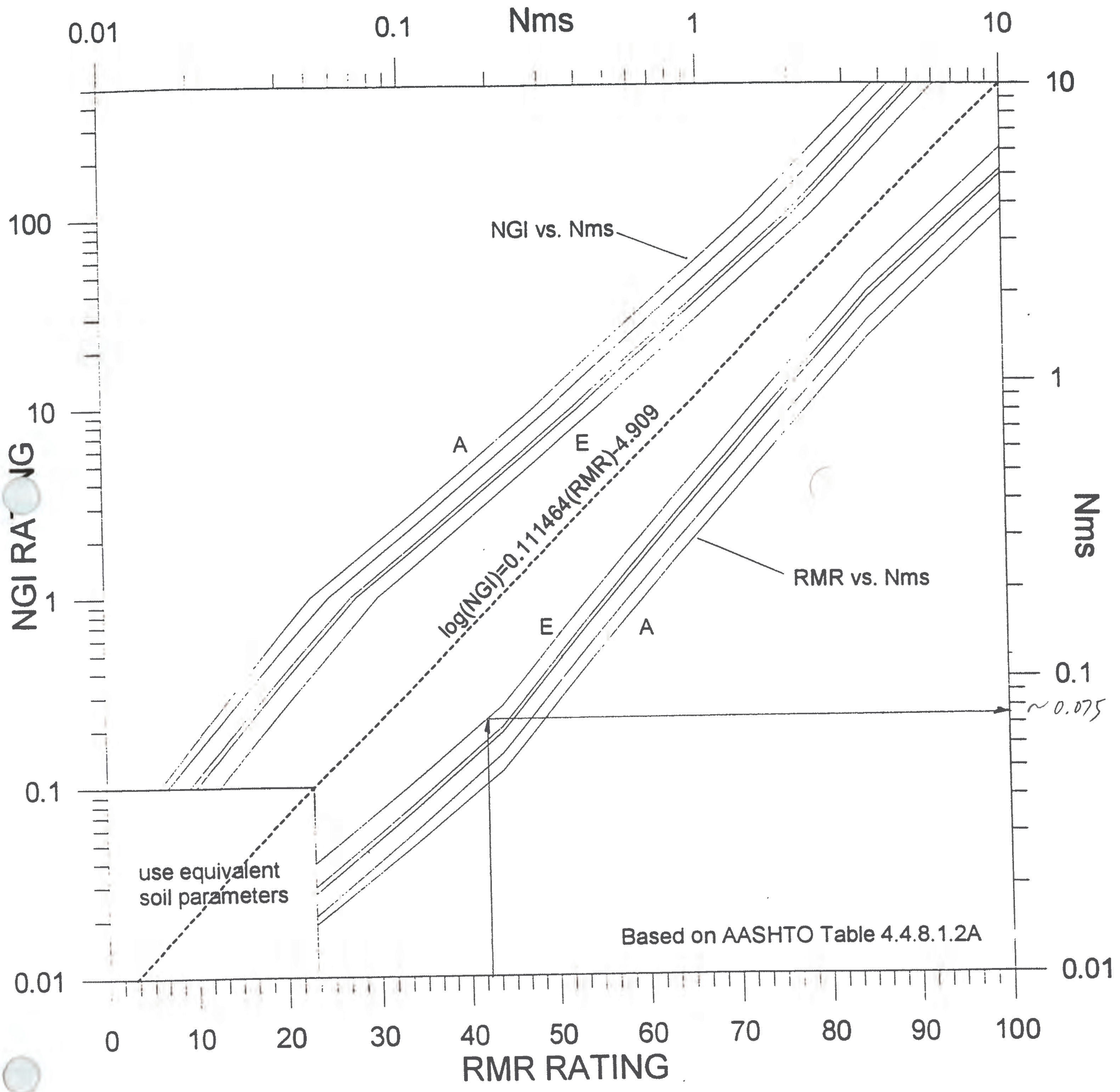
Date 5/02

Figure 11

MASS HIGHWAY

Massachusetts Highway Department, Geotechnical Section
Ten Park Plaza, Boston, MA 02116

Project NATICK N-3-7
Engineer J. PETITS Date
Reviewer Date
Sheet No. 5 of 5



Appendix E

Abutment Analysis

References

NORTH ABUTMENT

STABILITY CHECK & DESIGN

Design Properties:

- For determining k_a, per C3.11.5.3, the friction angle between fill and concrete wall can be taken as $\delta = 0.67 * \phi_f$ or directly from Table C3.11.5.3-1.

- For sliding, per C3.11.5.3, $\tan(\delta) = 0.8 * \tan(\phi_f)$ for p/c on soil OR

$\tan(\delta) = 1.0 * \tan(\phi_f)$ for concrete cast on soil

Concrete Unit Weight, γ_c = **0.150** kip/ft^3

Soil Unit Weight, γ_s = **0.120** kip/ft^3

Bituminous Unit Weight, γ_b = **0.140** kip/ft^3

Granite Unit Weight, γ_g = **0.165** kip/ft^3

Internal Friction Angle: Soil Below Footing, ϕ_f = **35.0** ° *- See Geotech Report*

Backfill Soil, ϕ_f = **33.0** ° *(typical backfill)* 0.5760 rad

Slope Angle of Soil, β = **0.00** ° 0.0000 rad

Angle of Backface of Wall, θ = **90.0** ° 1.5708 rad

Friction Angle Between Fill and Wall, δ = **22.0** ° *- See Geotech Report* 0.3840 rad

Top of Backwall Elevation = 174.50 ft

Bridge Seat Elevation = 171.75 ft

Bottom of Footing Elevation = 150.59 ft

Proposed Truss Length, L = **65.50** ft

Bridge Skew = **0.000** ° (from vertical)

Abutment Length, L_a = **35.80** ft

Abutment Height, H_a = 23.91 ft *(Bottom of Abutment to Top of Backwall)*

Abutment Width, W = 6.23 ft

Live Load Surcharge Height, h_s = **0.00** ft AASHTO LRFD

Construction Surcharge Height, h_{cs} = **3.000** ft *(estimated)* Tbl. 3.11.6.4-1

Height of Water Table, h_w = **0.00** ft

Nominal Bearing Resistance, p_n = **2520.00** kN/m^2 *- See 2002 Geotech Report*

= 52.64 kips/ft^2

Resistance Factor, Φ_b = **0.45** AASHTO LRFD

Factored Bearing Resistance, $p = p_n * \Phi_b$ = 23.69 kips/ft^2 Tbl. 10.5.5.2.2-1

	Wall Height ft	Surcharge ft	
Surcharge Height for Abutments Perpendicular to Traffic:	**5**	**4**	
	10	**3**	
	20	**2**	
Height =	7.760	3.448	ft, based on H20, from Bridge Code
		1.724	ft, based on H10

References

NORTH ABUTMENT

STABILITY CHECK & DESIGN

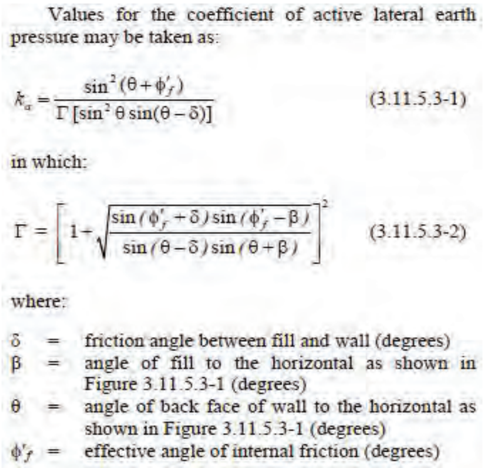
Assumptions:

1. Analysis is done according to the methods outlined in AASHTO LRFD Manual.
2. Analysis performed checking per foot of footing length.
3. Per MassDOT, all cantilever and gravity walls founded on rock shall assume at-rest soil pressure. However, active earth pressure is assumed for this abutment analysis. Given the very slender assumed abutment shape and the likely more flexible nature of stacked granite blocks compared to a reinforced concrete abutment with the same dimensions, it is assumed that the abutment rotates/deflects enough to cause active earth pressure. Also it is likely that there is a leveling pad between the abutment and bedrock that could further allow for rotation.

MassDOT LRFD
Br. Manual
Pt. I - 3.1.5

Earth Pressure Coefficient:

Active Earth Pressure Coefficient:



Values for the coefficient of active lateral earth pressure may be taken as:

$$k_a = \frac{\sin^2(\theta+\phi'_f)}{\Gamma\,[\sin^2\theta\,\sin(\theta-\delta)]} \qquad (3.11.5.3\text{-}1)$$

in which:

$$\Gamma = \left[1+\sqrt{\frac{\sin(\phi'_f+\delta)\sin(\phi'_f-\beta)}{\sin(\theta-\delta)\sin(\theta+\beta)}}\right]^2 \qquad (3.11.5.3\text{-}2)$$

where:

δ = friction angle between fill and wall (degrees)

β = angle of fill to the horizontal as shown in Figure 3.11.5.3-1 (degrees)

θ = angle of back face of wall to the horizontal as shown in Figure 3.11.5.3-1 (degrees)

ϕ'_f = effective angle of internal friction (degrees)

$\sin^2(\theta + \phi)$ =	0.703
$\sin^2\theta$ =	1.000
$\sin(\theta - \delta)$ =	0.927
$\sin(\phi + \delta)$ =	0.819
$\sin(\phi - \beta)$ =	0.545
$\sin(\theta + \beta)$ =	1.000

K_a = **0.264**

At-rest Earth Pressure Coefficient:

K_o = 1 - $\sin\phi$
= **0.455**

AASHTO LRFD
3.11.5.2

Design Earth Pressure Coefficient:

MassDOT LRFD
Br. Manual
3.1.6

K_d =	0.5 * (K_o + K_a)	=	0.360	Walls <5ft and founded on soil
		K_a =	0.264	Walls >5ft and founded on soil
		K_o =	0.455	Use when founded on rock

Use K_o = 0.264

References

NORTH ABUTMENT

STABILITY CHECK & DESIGN

Calculate Loads on Abutment:

Superstructure Dead Loads:

- Approach Slab Load Calculation:

- Live load, by inspection, is controlled by pedestrian load instead of the H10 truck.

Length of Approach Slab, L = **15.000** ft
Width of Approach Slab, W = **10.000** ft
Thickness of Approach Slab, t_{slab} = **10.000** in
Thickness of Pavement Structure Above Slab, t_{pave} = **14.000** in
Weight of Approach Slab, w_{slab} = $(L * W * t * \gamma_c) / 2 + (L * W * t * \gamma_b) / 2$
= 21.625 kips

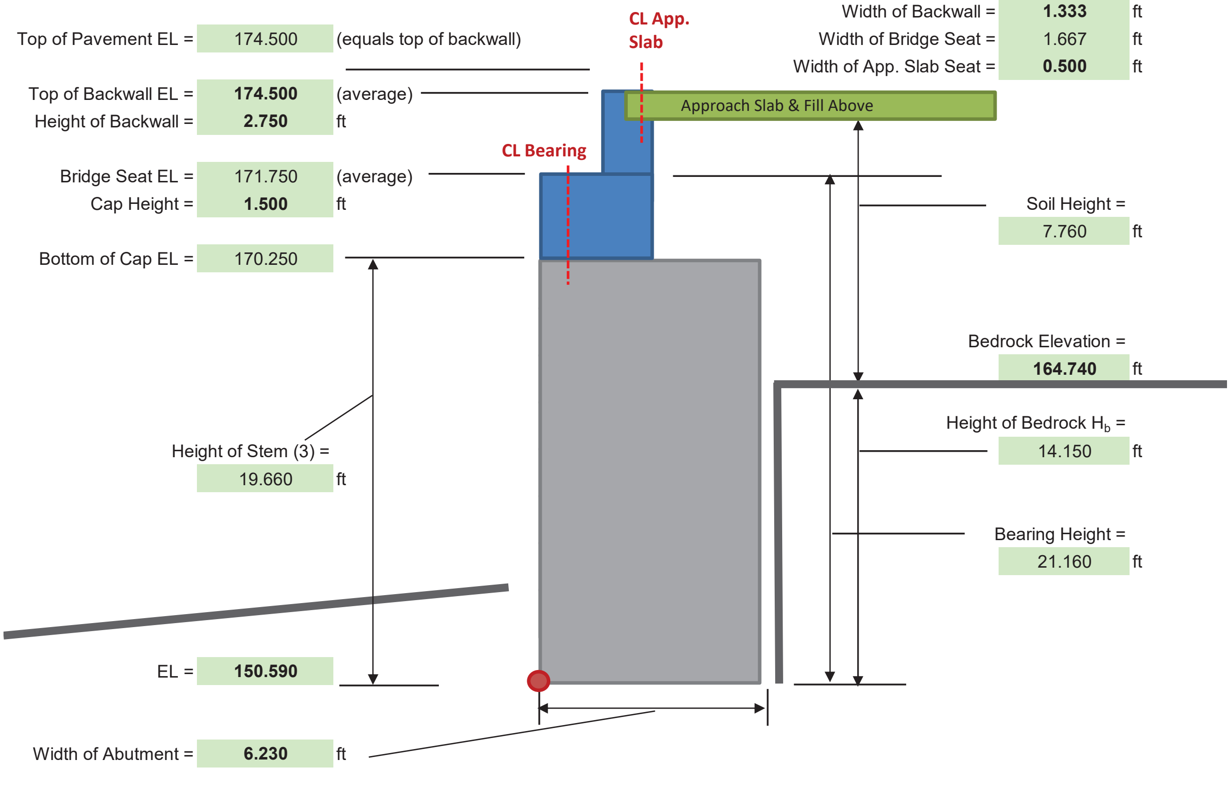
- Moment is taken about the toe of the footing

Centerline of Bearing from Toe of Abutment = **1.000** ft (1 foot from face of cap)
Centerline of Approach Slab from Toe of Abutment = **2.750** ft

	Total R [kip]	Per Foot $V = R/L_a$ [kip]	Moment Arm a [ft]	Moment $V \cdot a$ [kip*ft]	
DC Reaction, R_{DC} =	**62.031**	1.73	1.00	1.73	
DW Reaction, R_{DW} =	**8.200**	0.23	1.00	0.23	
LL Reaction, R_{LL} =	**29.475**	0.82	1.00	0.82	*(Pedestrian Controls)*
Approach Slab Reaction, R_{App} =	21.625	0.60	2.75	1.66	

From Contech

Abutment Dead Load, DC:



Width of Abutment Cap = **3.000** ft
Width of Backwall = **1.333** ft
Width of Bridge Seat = 1.667 ft
Width of App. Slab Seat = **0.500** ft

Top of Pavement EL = 174.500 (equals top of backwall)

Top of Backwall EL = **174.500** (average)
Height of Backwall = **2.750** ft

Bridge Seat EL = 171.750 (average)
Cap Height = **1.500** ft

Bottom of Cap EL = 170.250

Soil Height = 7.760 ft

Bedrock Elevation = **164.740** ft

Height of Bedrock H_b = 14.150 ft

Height of Stem (3) = 19.660 ft

Bearing Height = 21.160 ft

EL = **150.590**

Width of Abutment = **6.230** ft

References

NORTH ABUTMENT

STABILITY CHECK & DESIGN

- Moment is taken about the toe of the abutment

Section	Base (ft)	Height (ft)	Shape Factor	Material Density	Weight, V (kip)	Mom. Arm (ft)	Moment (kip-ft)
1-Backwall	1.33	0.75	**1.00**	**0.150**	0.15	2.33	0.35
2-Backwall	0.83	2.00	**1.00**	**0.150**	0.25	2.08	0.52
2-Cap	3.00	1.50	**1.00**	**0.150**	0.68	1.50	1.01
3A-Stem	6.23	19.66	**1.00**	**0.165**	20.21	3.12	62.95
3B-Stem	**0.00**	**0.00**	**1.00**	**0.150**	0.00	**0.00**	0.00
3C-Stem	**0.00**	**0.00**	**1.00**	**0.150**	0.00	**0.00**	0.00
4-Footing	**0.00**	**0.00**	**1.00**	**0.150**	0.00	**0.00**	0.00
				V_{DC} =	21.28	M_{DC} =	64.84

Vertical Earth Pressure, EV:

- Moment is taken about the toe of the footing

Section	Base (ft)	Height (ft)	Shape Factor	Material Density	Weight, V (kip)	Mom. Arm (ft)	Moment (kip-ft)
5A-Heel Soil	**3.23**	**2.25**	**1.00**	**0.120**	0.87	**4.62**	4.02
5B-Heel Soil	**0.00**	**0.00**	**1.00**	**0.120**	0.00	**0.00**	0.00
5C-Heel Soil	**0.00**	**0.00**	**1.00**	**0.120**	0.00	**0.00**	0.00
				V_{EV} =	0.87	M_{EV} =	4.02

- Consider soil over Toe of Footing for Bearing Resistance Check Only

Section	Base (ft)	Height (ft)	Shape Factor	Material Density	Weight, V (kip)	Mom. Arm (ft)	Moment (kip-ft)
6A-Toe Soil	**0.00**	**0.00**	**1.00**	**0.120**	0.00	**0.00**	0.00
6B-Toe Soil	**0.00**	**0.00**	**1.00**	**0.120**	0.00	**0.00**	0.00
				V_{EV2} =	0.00	M_{EV2} =	0.00

References

NORTH ABUTMENT

STABILITY CHECK & DESIGN

Horizontal Earth Pressure, EH:

Earth Pressure Force:

$F_{EH} = 0.5 * \gamma_s * K_d * (H - h_w)^2$

$=$ 0.96 kip

Components:

$F_{EH\text{-}h} = F_{EH} * \cos(90 - \theta + \delta)$

$=$ 0.89 kip

$F_{EH\text{-}v} = F_{EH} * \sin(90 - \theta + \delta)$

$=$ 0.36 kip

Overturning Moment:

Moment Arm for Backfill, $a_b = (H - h_w)/3 + H_b$ *(triangular pressure on back of abutment, therefore H/3)*

$=$ 16.74 ft

$M_{EH\text{-}O} = F_{EH\text{-}h} * a_b$

$=$ 14.83 kip-ft

Resisting Moment:

Resisting Moment Arm, $a_r =$ 6.23 ft (abutment width)

$M_{EH\text{-}R} = F_{EH\text{-}v} * a_r$

$=$ 2.23 kip-ft

NORTH ABUTMENT

STABILITY CHECK & DESIGN

References

Live Load Surcharge, LS:

Live Load Surcharge can be ignored since approach slabs are provided.

AASHTO LRFD 3.11.6.4

Surcharge Force:

$F_{LS} = K_d \cdot \gamma_s \cdot h_s \cdot H$ *(Height is conservatively to top of backwall)*

$= 0.00$ kip

Components:

$F_{LS\text{-}h} = F_{LS} \cdot \cos(90 - \theta + \delta)$

$= 0.00$ kip

$F_{LS\text{-}v} = F_{LS} \cdot \sin(90 - \theta + \delta)$

$= 0.00$ kip

Overturning Moment:

Moment Arm for Surcharge, $a_s = H / 2 + H_b$ *(constant pressure on back of abutment, therefore H/2)*

$= 18.03$ ft

$M_{LS\text{-}O} = F_{LS\text{-}h} \cdot a_s$

$= 0.00$ kip-ft

Resisting Moment:

- for sliding and eccentricity:

Resisting Moment Arm, $a_b = 6.23$ ft (applied at back face of stem)

$M_{LS\text{-}R1} = F_{LS\text{-}v} \cdot a_b$

$= 0.00$ kip-ft

- for bearing:

Resisting Moment Arm, $a_b = 6.23$ ft (applied at back face of stem)

$M_{LS\text{-}R2} = F_{LS\text{-}v} \cdot a_b$

$= 0.00$ kip-ft

Construction Surcharge, CS:

Surcharge Force:

$F_{CS} = K_d \cdot \gamma_s \cdot h_{cs} \cdot H$

$= 0.74$ kip

Components:

$F_{CS\text{-}h} = F_{CS} \cdot \cos(90 - \theta + \delta)$

$= 0.68$ kip

$F_{CS\text{-}v} = F_{CS} \cdot \sin(90 - \theta + \delta)$

$= 0.28$ kip

Overturning Moment:

Moment Arm for Surcharge, $a_s = H / 2 + H_b$ *(constant pressure on back of abutment, therefore H/2)*

$= 18.03$ ft

$M_{CS\text{-}O} = F_{CS\text{-}h} \cdot a_s$

$= 12.35$ kip-ft

Resisting Moment:

- for sliding and eccentricity:

Resisting Moment Arm, $a_b = 6.23$ ft (applied at back face of stem)

$M_{CS\text{-}R1} = F_{CS\text{-}v} \cdot a_b$

$= 1.72$ kip-ft

- for bearing:

Resisting Moment Arm, $a_b = 6.23$ ft (applied at back face of stem)

$M_{CS\text{-}R2} = F_{CS\text{-}v} \cdot a_b$

$= 1.72$ kip-ft

NORTH ABUTMENT

STABILITY CHECK & DESIGN

References

Thermal Uniform Load, TU:

** Assume elastomeric bearings and assume point of zero movement is at midspan.*

** Load is transferred to the abutments via bearing deflection*

$P_{TF(abut.)}$ = **6.00** kip (Per Abutment) From Contech

= 0.17 kip (Per foot of Abutment)

Moment Arm = **21.16** ft (Applied at bridge seat)

Overturning Moment, M_{TF} = 3.5 ft-k

$P_{TF,long} = P_{TF}$*cos(skew) = 0.17 kips

$P_{TF,trans} = P_{TF}$*sin(skew) = 0.00 kips

$M_{TF,long} = M_{TF}$*cos(skew) = 3.55 kips/ft

$M_{TF,trans} = M_{TF}$*sin(skew) = 0.00 kips/ft

Moment Transferred by Bearings, BRG:

AASHTO LRFD 14.6.3.2

- Neglect, assume negligible

M_u = 1.60*(0.5 * E_c * I) * ϑ_s / h_{rt}

where:

ϑ_s = All Rotations

= **0.0000** radians

I = ¼ * π * $(D/2)^4$ * N_p

where:

Length of Pad (along abutment), b= **5.00** in

Width of Pad (perpendicular to abutment), h = **3.00** in

N_p = **1** pad at each truss corner

= 11.3 in^4

h_{rt} = **1.00** in - from Contech Details

E_c = 4.8 * G * S^2

where:

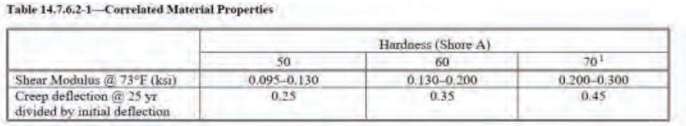


Table 14.7.6.2-1—Correlated Material Properties

	Hardness (Shore A)		
	50	60	70^1
Shear Modulus @ 73°F (ksi)	0.095–0.130	0.130–0.200	0.200–0.300
Creep deflection @ 25 yr divided by initial deflection	0.25	0.35	0.45

G_{max} = **0.500** ksi

S = (L * W) / [2 * h_{rt} * (L + W)]

$h_{prov.}$ = 1.000 in

S = 0.938

= 2.1 ksi

= 0.000 ft-k (per beam)

where:

N_{brg} = **2**

$M_{u(abut.)}$ = M_u * (N_{brg} / L_a)

= 0.000 ft-k (per ft of abutment)

$M_{u,abut\ long} = M_{u,abut}$*cos(skew) = 0.000 kips/ft

$M_{u,abut\ trans} = M_{u,abut}$*sin(skew) = 0.000 kips/ft

NORTH ABUTMENT

STABILITY CHECK & DESIGN

References

Braking Force, BR:

- Braking Force is ignored since bridge is intended for pedestrian use.

- Breaking Force shall be the maximum of: 3.6.4

1 - 25% $\cdot$ W_{truck}
Weight of Truck, W_{truck} = **0.0** kip
= 0.0 kip

3 - 5% $\cdot$ [W_{truck} + (w_{lane} $\cdot$ L)]
Lane Load, w_{lane} = **0.000** kip/ft
= 0.0 kip

2 - 25% $\cdot$ W_{tandem}
Weight of Tandem, W_{tandem} = **0.0** kip
= 0.0 kip

4 - 5% $\cdot$ [W_{tandem} + (w_{lane} $\cdot$ L)]
= 0.0 kip

Controlling, F_{max} = 0.0 kip
Max No. Lanes in same Direction, N_L = **1** *(assume only (1) truck breaking in same direction)*
Multiple Presence Factor, m = 1.20

Breaking Force, F_{BR} = (N_L $\cdot$ m $\cdot$ F_{max})/L_a
= 0.00 kip (per abutment) Tbl. 3.6.1.1.2-1
= 0.00 kip (per foot abutment)
Moment Arm, a_{BR} = 21.16 ft - Breaking Force acts at Bridge Seat Elevation

Breaking Force Moment, M_{BR} = F_{BR} $\cdot$ a_{BR}
= 0.00 kip-ft

$F_{BR,long}$ = F_{BR}*cos(skew) = 0.00 kips
$F_{BR,trans}$ = F_{BR}*sin(skew) = 0.00 kips
$M_{BR,long}$ = M_{BR}*cos(skew) = 0.00 kips/ft
$M_{BR,trans}$ = M_{BR}*sin(skew) = 0.00 kips/ft

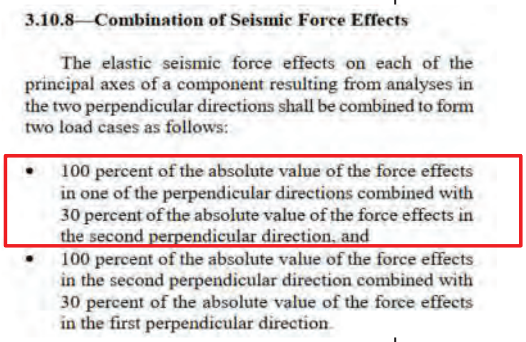
NORTH ABUTMENT

STABILITY CHECK & DESIGN

References

Earthquake/Seismic Loads, EQ:

- Per MassDOT Part I 3.4.4.3, conventional bridges, both single and multi-span, classified as SDC A, the abutments do not have to be designed for seismic forces.



3.10.8—Combination of Seismic Force Effects

The elastic seismic force effects on each of the principal axes of a component resulting from analyses in the two perpendicular directions shall be combined to form two load cases as follows:

- 100 percent of the absolute value of the force effects in one of the perpendicular directions combined with 30 percent of the absolute value of the force effects in the second perpendicular direction, and
- 100 percent of the absolute value of the force effects in the second perpendicular direction combined with 30 percent of the absolute value of the force effects in the first perpendicular direction.

Total Superstructure Dead Load at North Abutment = ∑ =	**0.000**	kips
Total Superstructure Dead Load at South Abutment = ∑ =	**0.000**	kips
Total =	0.000	kips

- Weak Direction Force (Normal to Abutment):

- Longitudinal Force used to check abutment stability.

- Longitudinal Moment used to check abutment stability.

P_{EQ} = Total Structure Weight * 25%
= 0.000 kips

Weak Direction Force = 100% x P_{EQ} =	0.000	kips	(total on abutment)
=	0.000	kips	(Per foot of Abutment)
Moment Arm =	21.160	ft	(Applied at bridge seat)
Weak Direction Moment =	0.000	kip-ft	
$P_{EQ,long} = P_{EQ}$*cos(skew) =	0.000	kips	
$P_{EQ,trans} = P_{EQ}$*sin(skew) =	0.000	kips	
$M_{EQ,long} = M_{EQ}$*cos(skew) =	0.000	kips/ft	
$M_{EQ,trans} = M_{EQ}$*sin(skew) =	0.000	kips/ft	

- Strong Direction Force (Parallel to Abutment):

- Longitudinal Force used to check abutment stability.

- Longitudinal Moment used to check abutment stability.

P_{EQ} = Total Structure Weight * 25%
= 0.000 kips

Strong Direction Force = 30% x P_{EQ} =	0.000	kips	(total on abutment)
=	0.000	kips	(Per foot of Abutment)
Moment Arm =	21.160	ft	(Applied at bridge seat)
Strong Direction Moment =	0.000	kip-ft	
$P_{EQ,long} = P_{EQ}$*sin(skew) =	0.000	kips	
$P_{EQ,trans} = P_{EQ}$*cos(skew) =	0.000	kips	
$M_{EQ,long} = M_{EQ}$*sin(skew) =	0.000	kips/ft	
$M_{EQ,trans} = M_{EQ}$*cos(skew) =	0.000	kips/ft	

Wind Load on Structure: WS

	Strength III	Service I	Strength V			
Wind Load Normal to Abutment Face =	**10.87**	**10.87**	**10.87**	kips	*- conservatively uses Contechs value for all limit states*	From Contech
=	0.30	0.30	0.30	kips/ft	*- per Foot of Abutment Length*	
Moment Arm =	21.16	21.16	21.16	ft	*- applied at bridge seat*	
Overturning Moment, M_{Wind} =	6.43	6.43	6.43	kip-ft		

References

NORTH ABUTMENT

STABILITY CHECK & DESIGN

Load Combinations for Retaining Wall Design:

NOTE: * Resisting Forces = **ALL** Vertical Loads. Used to determine sliding capacity.

* Overturning Forces = **ALL** Horizontal Loads. Used for Sliding Load.

* Net Moment / Resisting Forces = Eccentricity from "Toe".

* Overturning check satisfied if eccentricity of bearing pressure is within middle 2/3rds of footing for footings on soil and middle 9/10ths for footings on rock AND bearing capacity check satisfied.

* For footings on **soil**, the vertical stress shall be calculated assuming a **uniformly** distributed pressure over an effective base area, which equals the total bearing area minus an area to account for the effects of the eccentric load and for **rock** a **linearly** distributed pressure.

* Loads and factors shall be combined to produce the maximum effect for bearing, sliding and eccentricity.

* For the bearing check the max load factors are applied to vertical loads and for the sliding/eccentricity check the min load factors are applied to the vertical loads (less vertical load = lower sliding capacity and greater eccentricity). See Figures C11.5.6-1 and C11.5.6-2

AASHTO LRFD C11.5.5

Service I = DC + DW + EH + EV + LL + LS + BR + TU

Strength I = $(\gamma_{DC} \cdot DC) + (\gamma_{DW} \cdot DW) + (\gamma_{EH} \cdot EH) + (\gamma_{EV} \cdot EV)$ + 1.75(LL + LS + BR) + 0.50(TU) + 1.0(BRG)

Strength III = $(\gamma_{DC} \cdot DC) + (\gamma_{DW} \cdot DW) + (\gamma_{EH} \cdot EH) + (\gamma_{EV} \cdot EV)$ + 0.50(TU) + 1.0(BRG) + 1.0 (WS)

AASHTO LRFD Tbl. 3.4.1-1

Extreme Event I = $(\gamma_{DC} \cdot DC) + (\gamma_{DW} \cdot DW)$ + 1.0(BRG) + $(\gamma_{EV} \cdot EV) + \gamma_{EQ}$(LL + BR) + 1.0(EQ) + $(\gamma_{EH} * EH)$

Construction = $(\gamma_{DC} \cdot$ DC(Abutment)) + $(\gamma_{DW} \cdot DW) + (\gamma_{EH} \cdot EH) + (\gamma_{EV} \cdot EV)$ + 1.0(BRG) + 1.5(CS)

AASHTO LRFD C11.5.6

Load Modifier, η_i = **1.00** *NOT Critical / Essential*

* Construction Load Case checks abutment stability under a scenario where the bridge superstructure is not yet installed and the abutment is completely backfilled. An additional surcharge load is applied to simulate construction equipment sitting behind the abutment.

Bearing:

	Unfactored (Service)		Strength I			Extreme Event I		
	F (kip)	M (kip-ft)	Factor	F (kip)	M (kip-ft)	Factor	F (kip)	M (kip-ft)
RESISTING (Vertical Loads)								
DC	23.02	66.57	**1.25**	28.77	83.21	**1.00**	23.02	66.57
DW	0.23	0.23	**1.50**	0.34	0.34	**1.00**	0.23	0.23
LL	0.82	0.82	**1.75**	1.44	1.44	**0.00**	0.00	0.00
App. Slab	0.60	1.66	**1.25**	0.76	2.08	**1.00**	0.60	1.66
EV1 (Heel)	0.87	4.02	**1.35**	1.18	5.43	**1.00**	0.87	4.02
EV2 (Toe)	0.00	0.00	**1.35**	0.00	0.00	**1.00**	0.00	0.00
EH-v	0.36	2.23	**1.35**	0.48	3.01	**1.00**	0.36	2.23
LS-v	0.00	0.00	**1.75**	0.00	0.00	**0.00**	0.00	0.00
CS-v	0.28	1.72	**0.00**	0.00	0.00	**0.00**	0.00	0.00
	25.90	**75.54**		**32.97**	**95.52**		**25.08**	**74.71**
OVERTURNING (Horizontal Loads)								
EH-h	0.89	14.83	**1.35**	1.20	20.02	**1.00**	0.89	14.83
LS-h	0.00	0.00	**1.75**	0.00	0.00	**0.00**	0.00	0.00
TU	0.17	3.55	**0.50**	0.08	1.77	**0.00**	0.00	0.00
BRG	**0.00**	0.00	**1.00**	0.00	0.00	**1.00**	0.00	0.00
BR	0.00	0.00	**1.75**	0.00	0.00	**0.00**	0.00	0.00
EQ	0.00	0.00	**0.00**	0.00	0.00	**1.00**	0.00	0.00
CS-h	0.68	12.35	**0.00**	0.00	0.00	**0.00**	0.00	0.00
WS	0.30	6.43	**0.00**	0.00	0.00	**0.00**	0.00	0.00
	1.36	**24.80**		**1.28**	**21.79**		**0.89**	**14.83**
	(no EQ, CS)							

References

NORTH ABUTMENT

STABILITY CHECK & DESIGN

	Unfactored (Service)		Construction			Strength III		
	F (kip)	M (kip-ft)	Factor	F (kip)	M (kip-ft)	Factor	F (kip)	M (kip-ft)
RESISTING (Vertical Loads)								
DC	23.02	66.57	**1.25**	26.61	81.04	**1.25**	28.77	83.21
DW	0.23	0.23	**0.00**	0.00	0.00	**1.50**	0.34	0.34
LL	0.82	0.82	**0.00**	0.00	0.00	**0.00**	0.00	0.00
App. Slab	0.60	1.66	**0.00**	0.00	0.00	**1.25**	0.76	2.08
EV1 (Heel)	0.87	4.02	**1.35**	1.18	5.43	**1.35**	1.18	5.43
EV2 (Toe)	0.00	0.00	**1.35**	0.00	0.00	**1.35**	0.00	0.00
EH-v	0.36	2.23	**1.35**	0.48	3.01	**1.35**	0.48	3.01
LS-v	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00
CS-v	0.28	1.72	**1.50**	0.42	2.59	**0.00**	0.00	0.00
	25.90	**75.54**		**28.68**	**92.08**		**31.53**	**94.07**
OVERTURNING (Horizontal Loads)								
EH-h	0.89	14.83	**1.35**	1.20	20.02	**1.35**	1.20	20.02
LS-h	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00
TU	0.17	3.55	**0.00**	0.00	0.00	**0.50**	0.08	1.77
BRG	**0.00**	0.00	**0.00**	0.00	0.00	**1.00**	0.00	0.00
BR	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00
EQ	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00
CS-h	0.68	12.35	**1.50**	1.03	18.53	**0.00**	0.00	0.00
WS	0.30	6.43	**0.00**	0.00	0.00	**1.00**	0.30	6.43
	1.36	**24.80**		**2.22**	**38.54**		**1.58**	**28.22**
	(no EQ, CS)							

Comp By: **NPB 7/21** Project: **NATICK: Shared Use Path over MBTA**
Chkd By: **GNM 12/22** Subject: **Design Calculations: Bridge No. N-03-007 (29N)** Job No.: **52680A41**

References

NORTH ABUTMENT

STABILITY CHECK & DESIGN

Sliding & Eccentricity:

	Unfactored (Service)		Strength I			Extreme Event I		
	F (kip)	M (kip-ft)	Factor	F (kip)	M (kip-ft)	Factor	F (kip)	M (kip-ft)
RESISTING (Vertical Loads)								
DC	23.02	66.57	**0.90**	20.72	59.91	**1.00**	23.02	66.57
DW	0.23	0.23	**0.65**	0.15	0.15	**1.00**	0.23	0.23
LL	0.82	0.82	**0.00**	0.00	0.00	**0.00**	0.00	0.00
App. Slab	0.60	1.66	**0.90**	0.54	1.50	**1.00**	0.60	1.66
EV1 (Heel)	0.87	4.02	**1.00**	0.87	4.02	**1.00**	0.87	4.02
EV2 (Toe)	**0.00**	**0.00**	**0.00**	0.00	0.00	**0.00**	0.00	0.00
EH-v	0.36	2.23	**1.35**	0.48	3.01	**0.90**	0.32	2.01
LS-v ***(Sliding)***	0.00	0.00	**1.75**	0.00	0.00	**0.00**	0.00	0.00
CS-v	0.28	1.72	**0.00**	0.00	0.00	**0.00**	0.00	0.00
	25.90	**75.54**		**22.76**	**68.59**		**25.04**	**74.49**
OVERTURNING (Horizontal Loads)								
EH-h	0.89	14.83	**1.35**	1.20	20.02	**1.00**	0.89	14.83
LS-h	0.00	0.00	**1.75**	0.00	0.00	**0.00**	0.00	0.00
TU	0.17	3.55	**0.50**	0.08	1.77	**0.00**	0.00	0.00
BRG	**0.00**	0.00	**1.00**	0.00	0.00	**1.00**	0.00	0.00
BR	0.00	0.00	**1.75**	0.00	0.00	**0.00**	0.00	0.00
EQ	0.00	0.00	**0.00**	0.00	0.00	**1.00**	0.00	0.00
CS-h	0.68	12.35	**0.00**	0.00	0.00	**0.00**	0.00	0.00
WS	0.30	6.43	**0.00**	0.00	0.00	**0.00**	0.00	0.00
	1.36	**24.80**		**1.28**	**21.79**		**0.89**	**14.83**
	(no EQ, CS)							

- (soil over toe only applicable for bearing)

	Unfactored (Service)		Construction			Strength III		
	F (kip)	M (kip-ft)	Factor	F (kip)	M (kip-ft)	Factor	F (kip)	M (kip-ft)
RESISTING (Vertical Loads)								
DC	23.02	66.57	**0.90**	19.16	58.35	**0.90**	20.72	59.91
DW	0.23	0.23	**0.90**	0.21	0.21	**0.65**	0.15	0.15
LL	0.82	0.82	**0.00**	0.00	0.00	**0.00**	0.00	0.00
App. Slab	0.60	1.66	**0.90**	0.54	1.50	**0.90**	0.54	1.50
EV1 (Heel)	0.87	4.02	**1.00**	0.87	4.02	**1.00**	0.87	4.02
EV2 (Toe)	**0.00**	**0.00**	**0.00**	0.00	0.00	**0.00**	0.00	0.00
EH-v	0.36	2.23	**1.35**	0.48	3.01	**1.35**	0.48	3.01
LS-v ***(Sliding)***	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00
CS-v	0.28	1.72	**1.50**	0.42	2.59	**0.00**	0.00	0.00
	25.90	**75.54**		**21.68**	**69.67**		**22.76**	**68.59**
OVERTURNING (Horizontal Loads)								
EH-h	0.89	14.83	**1.35**	1.20	20.02	**1.35**	1.20	20.02
LS-h	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00
TU	0.17	3.55	**0.00**	0.00	0.00	**0.50**	0.08	1.77
BRG	**0.00**	0.00	**0.00**	0.00	0.00	**1.00**	0.00	0.00
BR	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00
EQ	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00
CS-h	0.68	12.35	**1.50**	1.03	18.53	**0.00**	0.00	0.00
WS	0.30	6.43	**0.00**	0.00	0.00	**1.00**	0.30	6.43
	1.36	**24.80**		**2.22**	**38.54**		**1.58**	**28.22**
	(no EQ, CS)							

References

NORTH ABUTMENT

STABILITY CHECK & DESIGN

Abutment Stability Check

Resistance Factors:

Bearing Resistance, ϕ_b = **0.45** - Footings on Rock

Sliding Resistance, ϕ_τ = **0.80** - Cast-in-pace concrete on Sand

Overall Stability for Service I Limit State, ϕ_{os} = **0.65** - limited geotechnical info.

AASHTO LRFD Tbl. 10.5.5.2.2-1 & 11.6.3.6

Service I Limit State Check:

AASHTO LRFD 11.6.3.6

Overall Stability $\geq$ 1

= (ϕ_{os} * Resisting Moments)/(Overturning Moments)

= 1.98 **OK**

Strength and Extreme Event I Limit State Check:

AASHTO LRFD 11.6.3.2

Bearing Resistance (for footings on rock):	**Strength I**	**Extreme Event I**	**Construction**	**Strength III**	**Service I**		
Net Moment (Resist. - Overturn), M =	73.73	59.89	53.53	65.86	50.74	k-ft	
Vertical Forces for Bearing, V_b =	32.97	25.08	28.68	31.53	25.90	kips (= sum of all vertical loads)	
Resultant, R = M/V_b=	2.24	2.39	1.87	2.09	1.96	ft (from "toe")	AASHTO LRFD
Eccentricity, e = (W/2) - R =	0.88	0.73	1.25	1.03	1.16	ft (from cent. of base)	Fig. 11.6.3.2.1
For Resultant within middle one-third:	**YES**	**YES**	**N/A**	**YES**	**N/A**		
Max Bear. Stress, $\sigma_{vmax} = V_b / W * [1 + 6 * (e / W)]$ =	9.77	6.85	N/A	10.06	N/A	kip/ft^2	
Min Bearing Stress, $\sigma_{vmin} = V_b / W * [1 - 6 * (e / W)]$ =	0.81	1.21	N/A	0.06	N/A	kip/ft^2	
For Resultant outside middle one-third:	**N/A**	**N/A**	**YES**	**N/A**	**YES**		
Max Bear. Stress, $\sigma_{vmax} = (2 * V_b) / 3 * [(W / 2) - e)]$ =	N/A	N/A	10.24	N/A	8.82	kip/ft^2	
Min Bearing Stress, σ_{vmin} = 0 =	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	kip/ft^2	
Factored Bearing Capacity/ Prop. Pressure =	2.42	3.46	2.31	2.35	2.69		11.6.3.2
	OK	**OK**	**OK**	**OK**	**OK**		

Overturning:

AASHTO LRFD 11.6.3.3

Net Moment (Resist. - Overturn), M =	46.80	59.66	31.13	40.37	k-ft
Vertical Forces for Bearing, V_e =	22.76	25.04	21.68	22.76	kips (= sum of all vertical loads)
Resultant, R = M/V_e=	2.06	2.38	1.44	1.77	ft (from "toe")
Eccentricity, e = (W/2) - R =	1.06	0.73	1.68	1.34	ft (from center of base)
Acceptable Eccentricity (middle 2/3 of base) for Soil =	2.08	2.08	2.08	2.08	ft (from center of base)
Acceptable Eccentricity (middle 9/10 of base) for Rock =	2.80	2.80	2.80	2.80	ft (from center of base)
Is Resultant within limits?	**OK**	**OK**	**OK**	**OK**	(Foundation founded on rock)

Sliding:

AASHTO LRFD 10.6.3.4

Vertical Forces for Sliding, V =	22.76	25.04	21.68	22.76	kips
Internal Friction Angle, ϕ_f =	35.0	35.0	35.0	35.0	
tanϕ_f =	0.70	0.70	0.70	0.70	
C =	**1.00**	**1.00**	**1.00**	**1.00**	*Concrete cast against soil*
R_t = C * V * tanϕ_f =	15.94	17.54	15.18	15.94	
$\phi_\tau * R_\tau$=	12.75	14.03	12.14	12.75	
Capacity/Load =	9.96	15.84	5.46	8.05	
	OK	**OK**	**OK**	**OK**	

SOUTH ABUTMENT

STABILITY CHECK & DESIGN

References

Design Properties:

- *For determining k_a, per C3.11.5.3, the friction angle between fill and concrete wall can be taken as $\delta = 0.67 * \phi_f$ or directly from Table C3.11.5.3-1.*
- *For sliding, per C3.11.5.3, $\tan(\delta) = 0.8 * \tan(\phi_f)$ for p/c on soil OR*

$\tan(\delta) = 1.0 * \tan(\phi_f)$ for concrete cast on soil

Concrete Unit Weight, γ_c = **0.150** kip/ft^3

Soil Unit Weight, γ_s = **0.120** kip/ft^3

Bituminous Unit Weight, γ_b = **0.140** kip/ft^3

Granite Unit Weight, γ_g = **0.165** kip/ft^3

Internal Friction Angle: Soil Below Footing, ϕ_f = **35.0** ° - *See Geotech Report*

Backfill Soil, ϕ_f = **33.0** ° *(typical backfill)* 0.5760 rad

Slope Angle of Soil, β = **0.00** ° 0.0000 rad

Angle of Backface of Wall, θ = **90.0** ° 1.5708 rad

Friction Angle Between Fill and Wall, δ = **22.0** ° - *See Geotech Report* 0.3840 rad

Top of Backwall Elevation = 174.28 ft

Bridge Seat Elevation = 171.53 ft

Bottom of Footing Elevation = 150.92 ft

Proposed Truss Length, L = **65.50** ft

Bridge Skew = **0.000** ° (from vertical)

Abutment Length, L_a = **44.00** ft

Abutment Height, H_a = 23.37 ft *(Bottom of Abutment to Top of Backwall)*

Abutment Width, W = 6.23 ft

Live Load Surcharge Height, h_s = **0.00** ft — AASHTO LRFD Tbl. 3.11.6.4-1

Construction Surcharge Height, h_{cs} = **3.000** ft *(estimated)*

Height of Water Table, h_w = **0.00** ft

Nominal Bearing Resistance, p_n = **2520.00** kN/m^2 - *See 2002 Geotech Report*

52.64 kips/ft^2

Resistance Factor, Φ_b = **0.45** — AASHTO LRFD Tbl. 10.5.5.2.2-1

Factored Bearing Resistance, $p = p_n * \Phi_b$ = 23.69 kips/ft^2

Surcharge Height for Abutments Perpendicular to Traffic:

Wall Height ft	Surcharge ft	
5	**4**	
10	**3**	
20	**2**	
Height = 13.854	2.615	ft, based on H20, from Bridge Code
	1.307	ft, based on H10

SOUTH ABUTMENT

STABILITY CHECK & DESIGN

References

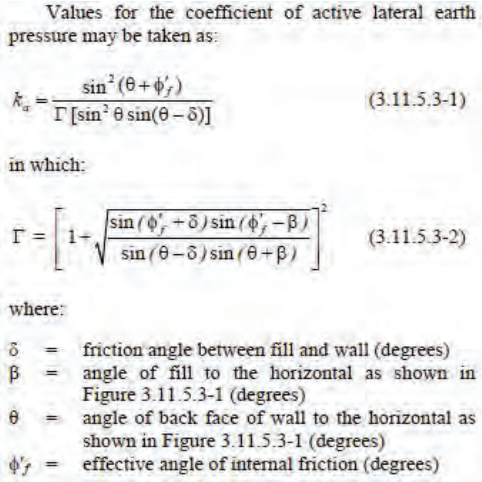
Assumptions:

1. Analysis is done according to the methods outlined in AASHTO LRFD Manual.
2. Analysis performed checking per foot of footing length.
3. Per MassDOT, all cantilever and gravity walls founded on rock shall assume at-rest soil pressure. However, active earth pressure is assumed for this abutment analysis. Given the very slender assumed abutment shape and the likely more flexible nature of stacked granite blocks compared to a reinforced concrete abutment with the same dimensions, it is assumed that the abutment rotates/deflects enough to cause active earth pressure. Also it is likely that there is a leveling pad between the abutment and bedrock that could further allow for rotation.

MassDOT LRFD
Br. Manual
Pt. I - 3.1.5

Earth Pressure Coefficient:

Active Earth Pressure Coefficient:



Values for the coefficient of active lateral earth pressure may be taken as:

$$k_a = \frac{\sin^2(\theta+\phi'_f)}{\Gamma\,[\sin^2\theta\,\sin(\theta-\delta)]} \qquad (3.11.5.3\text{-}1)$$

in which:

$$\Gamma = \left[1+\sqrt{\frac{\sin(\phi'_f+\delta)\sin(\phi'_f-\beta)}{\sin(\theta-\delta)\sin(\theta+\beta)}}\right]^2 \qquad (3.11.5.3\text{-}2)$$

where:

δ = friction angle between fill and wall (degrees)

β = angle of fill to the horizontal as shown in Figure 3.11.5.3-1 (degrees)

θ = angle of back face of wall to the horizontal as shown in Figure 3.11.5.3-1 (degrees)

ϕ'_f = effective angle of internal friction (degrees)

$\sin^2(\theta + \phi)$ = 0.703

$\sin^2\theta$ = 1.000

$\sin(\theta - \delta)$ = 0.927

$\sin(\phi + \delta)$ = 0.819

$\sin(\phi - \beta)$ = 0.545

$\sin(\theta + \beta)$ = 1.000

K_a = **0.264**

At-rest Earth Pressure Coefficient:

K_o = 1 - $\sin\phi$

= **0.455**

AASHTO LRFD
3.11.5.2

Design Earth Pressure Coefficient:

MassDOT LRFD
Br. Manual
3.1.6

K_d =	0.5 * (K_o + K_a)	=	0.360	Walls <5ft and founded on soil
		K_a =	0.264	Walls >5ft and founded on soil
		K_o =	0.455	Use when founded on rock

Use K_a = 0.264

References

SOUTH ABUTMENT

STABILITY CHECK & DESIGN

Calculate Loads on Abutment:

Superstructure Dead Loads:

- Approach Slab Load Calculation:

- Live load, by inspection, is controlled by pedestrian load instead of the H10 truck.

Length of Approach Slab, L = **15.000** ft
Width of Approach Slab, W = **10.000** ft (along skew)
Thickness of Approach Slab, t_{slab} = **10.000** in
Thickness of Pavement Structure Above Slab, t_{pave} = **14.000** in
Weight of Approach Slab, w_{slab} = $(L * W * t * \gamma_c) / 2 + (L * W * t * \gamma_b) / 2$
= 21.625 kips

- Moment is taken about the toe of the footing

Centerline of Bearing from Toe of Abutment = **1.000** ft (1 foot from face of cap)
Centerline of Approach Slab from Toe of Abutment = **2.750** ft

Pedestrian Load, w_{ped} = **0.090** ksf
Roadway Width, W = **10.000** ft
Pedestrian Total Reaction, $w_{ped\text{-}tot}$ = $L * w_{ped} * W / 2$
= 29.475 kips

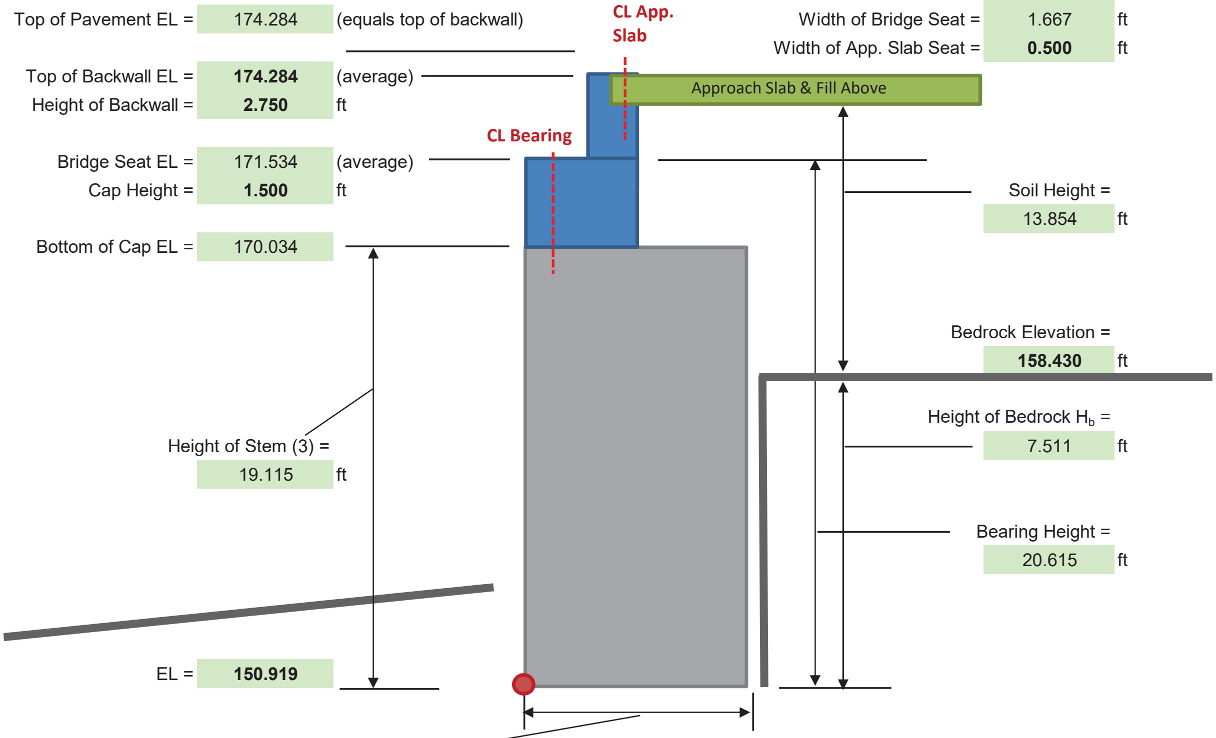
	Total R [kip]	Per Foot $V = R/L_a$ [kip]	Moment Arm a [ft]	Moment $V \cdot a$ [kip*ft]	
DC Reaction, R_{DC} =	**62.031**	1.41	1.00	1.41	
DW Reaction, R_{DW} =	**8.200**	0.19	1.00	0.19	
LL Reaction, R_{LL} =	**29.475**	0.67	1.00	0.67	*(Pedestrian Controls)*
Approach Slab Reaction, R_{App} =	21.625	0.49	2.75	1.35	

From Contech

Abutment Dead Load, DC:

Width of Abutment Cap = 3.000 ft
Width of Backwall = **1.333** ft
Width of Bridge Seat = 1.667 ft
Width of App. Slab Seat = **0.500** ft

Top of Pavement EL = 174.284 (equals top of backwall)
Top of Backwall EL = **174.284** (average)
Height of Backwall = **2.750** ft
Bridge Seat EL = 171.534 (average)
Cap Height = **1.500** ft
Bottom of Cap EL = 170.034



Soil Height = 13.854 ft
Bedrock Elevation = **158.430** ft
Height of Bedrock H_b = 7.511 ft
Bearing Height = 20.615 ft
Height of Stem (3) = 19.115 ft
EL = **150.919**
Width of Abutment = **6.230** ft

References

SOUTH ABUTMENT

STABILITY CHECK & DESIGN

- Moment is taken about the toe of the abutment

Section	Base (ft)	Height (ft)	Shape Factor	Material Density	Weight, V (kip)	Mom. Arm (ft)	Moment (kip-ft)
1-Backwall	1.33	2.75	**1.00**	**0.150**	0.55	2.33	1.28
2-Backwall	0.83	2.00	**1.00**	**0.150**	0.25	2.08	0.52
2-Cap	3.00	1.50	**1.00**	**0.150**	0.68	1.50	1.01
3A-Stem	6.23	19.12	**1.00**	**0.165**	19.65	3.12	61.21
3B-Stem	**0.00**	**0.00**	**1.00**	**0.150**	0.00	**0.00**	0.00
3C-Stem	**0.00**	**0.00**	**1.00**	**0.150**	0.00	**0.00**	0.00
4-Footing	**0.00**	**0.00**	**1.00**	**0.150**	0.00	**0.00**	0.00
				V_{DC} =	21.12	M_{DC} =	64.02

Vertical Earth Pressure, EV:

- Moment is taken about the toe of the footing

Section	Base (ft)	Height (ft)	Shape Factor	Material Density	Weight, V (kip)	Mom. Arm (ft)	Moment (kip-ft)
5A-Heel Soil	**3.23**	**2.25**	**1.00**	**0.120**	0.87	**4.62**	4.02
5B-Heel Soil	**0.00**	**0.00**	**1.00**	**0.120**	0.00	**0.00**	0.00
5C-Heel Soil	**0.00**	**0.00**	**1.00**	**0.120**	0.00	**0.00**	0.00
				V_{EV} =	0.87	M_{EV} =	4.02

- Consider soil over Toe of Footing for Bearing Resistance Check Only

Section	Base (ft)	Height (ft)	Shape Factor	Material Density	Weight, V (kip)	Mom. Arm (ft)	Moment (kip-ft)
6A-Toe Soil	**0.00**	**0.00**	**1.00**	**0.120**	0.00	**0.00**	0.00
6B-Toe Soil	**0.00**	**0.00**	**1.00**	**0.120**	0.00	**0.00**	0.00
				V_{EV2} =	0.00	M_{EV2} =	0.00

References

SOUTH ABUTMENT

STABILITY CHECK & DESIGN

Horizontal Earth Pressure, EH:

Earth Pressure Force:

$F_{EH} = 0.5 * \gamma_s * K_d * (H - h_w)^2$

$= 3.05$ kip

Components:

$F_{EH\text{-}h} = F_{EH} * \cos(90 - \theta + \delta)$

$= 2.82$ kip

$F_{EH\text{-}v} = F_{EH} * \sin(90 - \theta + \delta)$

$= 1.14$ kip

Overturning Moment:

Moment Arm for Backfill, $a_b = (H - h_w)/3 + H_b$ *(triangular pressure on back of abutment, therefore H/3)*

$= 12.13$ ft

$M_{EH\text{-}O} = F_{EH\text{-}h} * a_b$

$= 34.25$ kip-ft

Resisting Moment:

Resisting Moment Arm, $a_r = 6.23$ ft (abutment width)

$M_{EH\text{-}R} = F_{EH\text{-}v} * a_r$

$= 7.11$ kip-ft

References

SOUTH ABUTMENT

STABILITY CHECK & DESIGN

Live Load Surcharge, LS:

Live Load Surcharge can be ignored since approach slabs are provided. AASHTO LRFD

Surcharge Force: 3.11.6.4

$F_{LS} = K_d * \gamma_s * h_s * H$ *(Height is conservatively to top of backwall)*

= 0.00 kip

Components:

$F_{LS\text{-}h} = F_{LS} * \cos(90 - \theta + \delta)$

= 0.00 kip

$F_{LS\text{-}v} = F_{LS} * \sin(90 - \theta + \delta)$

= 0.00 kip

Overturning Moment:

Moment Arm for Surcharge, $a_s = H / 2 + H_b$ *(constant pressure on back of abutment, therefore H/2)*

= 14.44 ft

$M_{LS\text{-}O} = F_{LS\text{-}h} * a_s$

= 0.00 kip-ft

Resisting Moment:

- for sliding and eccentricity:

Resisting Moment Arm, a_b = 6.23 ft (applied at back face of stem)

$M_{LS\text{-}R1} = F_{LS\text{-}v} * a_b$

= 0.00 kip-ft

- for bearing:

Resisting Moment Arm, a_b = 6.23 ft (applied at back face of stem)

$M_{LS\text{-}R2} = F_{LS\text{-}v} * a_b$

= 0.00 kip-ft

Construction Surcharge, CS:

Surcharge Force:

$F_{CS} = K_d * \gamma_s * h_{cs} * H$

= 1.32 kip

Components:

$F_{CS\text{-}h} = F_{CS} * \cos(90 - \theta + \delta)$

= 1.22 kip

$F_{CS\text{-}v} = F_{CS} * \sin(90 - \theta + \delta)$

= 0.49 kip

Overturning Moment:

Moment Arm for Surcharge, $a_s = H / 2 + H_b$ *(constant pressure on back of abutment, therefore H/2)*

= 14.44 ft

$M_{CS\text{-}O} = F_{CS\text{-}h} * a_s$

= 17.66 kip-ft

Resisting Moment:

- for sliding and eccentricity:

Resisting Moment Arm, a_b = 6.23 ft (applied at back face of stem)

$M_{CS\text{-}R1} = F_{CS\text{-}v} * a_b$

= 3.08 kip-ft

- for bearing:

Resisting Moment Arm, a_b = 6.23 ft (applied at back face of stem)

$M_{CS\text{-}R2} = F_{CS\text{-}v} * a_b$

= 3.08 kip-ft

SOUTH ABUTMENT

STABILITY CHECK & DESIGN

References

Thermal Uniform Load, TU:

** Assume elastomeric bearings and assume point of zero movement is at midspan.*

** Load is transferred to the abutments via bearing deflection*

$P_{TF(abut.)}$ = **6.00** kip (Per Abutment) From Contech

= 0.14 kip (Per foot of Abutment)

Moment Arm = 20.62 ft (Applied at bridge seat)

Overturning Moment, M_{TF} = 2.8 ft-k

$P_{TF,long}$ = P_{TF}*cos(skew) = 0.14 kips

$P_{TF,trans}$ = P_{TF}*sin(skew) = 0.00 kips

$M_{TF,long}$ = M_{TF}*cos(skew) = 2.81 kips/ft

$M_{TF,trans}$ = M_{TF}*sin(skew) = 0.00 kips/ft

Moment Transferred by Bearings, BRG: AASHTO LRFD 14.6.3.2

- Neglect, assume negligible

M_u = 1.60*(0.5 * E_c * I) * ϑ_s / h_{rt}

where:

ϑ_s = All Rotations

= 0.0000 radians

I = ¼ * π * $(D/2)^4$ * N_p

where:

Length of Pad (along abutment), b= **5.00** in

Width of Pad (perpendicular to abutment), h = **3.00** in

N_p = **1** pad at each truss corner

= 11.3 in^4

h_{rt} = **1.00** in - from Contech Details

E_c = 4.8 * G * S²

where:

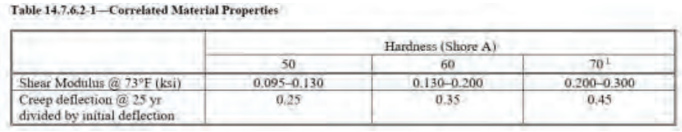


Table 14.7.6.2-1—Correlated Material Properties

	Hardness (Shore A)		
	50	60	70 [1]
Shear Modulus @ 73°F (ksi)	0.095–0.130	0.130–0.200	0.200–0.300
Creep deflection @ 25 yr divided by initial deflection	0.25	0.35	0.45

G_{max} = **0.500** ksi

S = (L * W) / [2 * h_{rt} * (L + W)]

$h_{prov.}$ = 1.000 in

S = 0.938

= 2.1 ksi

= 0.000 ft-k (per beam)

where:

N_{brg} = **2**

$M_{u(abut.)}$ = M_u * (N_{brg} / L_a)

= 0.000 ft-k (per ft of abutment)

$M_{u,abut\ long}$ = $M_{u,abut}$*cos(skew) = 0.000 kips/ft

$M_{u,abut\ trans}$ = $M_{u,abut}$*sin(skew) = 0.000 kips/ft

SOUTH ABUTMENT

STABILITY CHECK & DESIGN

References

Braking Force, BR:

- Braking Force is ignored since bridge is intended for pedestrian use.

- Breaking Force shall be the maximum of: 3.6.4

1 - 25% $\cdot$ W_{truck}

Weight of Truck, W_{truck} = **0.0** kip

= 0.0 kip

2 - 25% $\cdot$ W_{tandem}

Weight of Tandem, W_{tandem} = **0.0** kip

= 0.0 kip

3 - 5% $\cdot$ $[W_{truck} + (w_{lane} \cdot L)]$

Lane Load, w_{lane} = **0.000** kip/ft

= 0.0 kip

4 - 5% $\cdot$ $[W_{tandem} + (w_{lane} \cdot L)]$

= 0.0 kip

Controlling, F_{max} = 0.0 kip

Max No. Lanes in same Direction, N_L = **1** *(assume only (1) truck breaking in same direction)*

Multiple Presence Factor, m = 1.20

Breaking Force, F_{BR} = $(N_L \cdot m \cdot F_{max})/L_a$

= 0.00 kip (per abutment) Tbl. 3.6.1.1.2-1

= 0.00 kip (per foot abutment)

Moment Arm, a_{BR} = 20.62 ft - Breaking Force acts at Bridge Seat Elevation

Breaking Force Moment, M_{BR} = $F_{BR} \cdot a_{BR}$

= 0.00 kip-ft

$F_{BR,long}$ = F_{BR}*cos(skew) = 0.00 kips

$F_{BR,trans}$ = F_{BR}*sin(skew) = 0.00 kips

$M_{BR,long}$ = M_{BR}*cos(skew) = 0.00 kips/ft

$M_{BR,trans}$ = M_{BR}*sin(skew) = 0.00 kips/ft

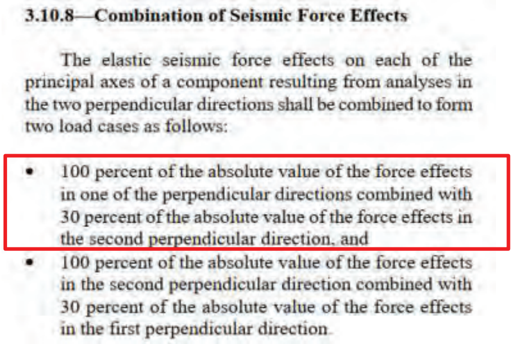
SOUTH ABUTMENT
STABILITY CHECK & DESIGN

References

Earthquake/Seismic Loads, EQ:

- Per MassDOT Part I 3.4.4.3, conventional bridges, both single and multi-span, classified as SDC A, the abutments do not have to be designed for seismic forces.

Total Superstructure Dead Load at North Abutment = ∑ = **0.000** kips
Total Superstructure Dead Load at South Abutment = ∑ = **0.000** kips
Total = 0.000 kips



3.10.8—Combination of Seismic Force Effects

The elastic seismic force effects on each of the principal axes of a component resulting from analyses in the two perpendicular directions shall be combined to form two load cases as follows:

- 100 percent of the absolute value of the force effects in one of the perpendicular directions combined with 30 percent of the absolute value of the force effects in the second perpendicular direction, and
- 100 percent of the absolute value of the force effects in the second perpendicular direction combined with 30 percent of the absolute value of the force effects in the first perpendicular direction.

- Weak Direction Force (Normal to Abutment):

- Longitudinal Force used to check abutment stability.

- Longitudinal Moment used to check abutment stability.

P_{EQ} = Total Structure Weight * 25%
= 0.000 kips

Weak Direction Force = 100% x P_{EQ} = 0.000 kips (total on abutment)
= 0.000 kips (Per foot of Abutment)
Moment Arm = 20.615 ft (Applied at bridge seat)
Weak Direction Moment = 0.000 kip-ft
$P_{EQ,long}$ = P_{EQ}*cos(skew) = 0.000 kips
$P_{EQ,trans}$ = P_{EQ}*sin(skew) = 0.000 kips
$M_{EQ,long}$ = M_{EQ}*cos(skew) = 0.000 kips/ft
$M_{EQ,trans}$ = M_{EQ}*sin(skew) = 0.000 kips/ft

- Strong Direction Force (Parallel to Abutment):

- Longitudinal Force used to check abutment stability.

- Longitudinal Moment used to check abutment stability.

P_{EQ} = Total Structure Weight * 25%
= 0.000 kips

Strong Direction Force = 30% x P_{EQ} = 0.000 kips (total on abutment)
= 0.000 kips (Per foot of Abutment)
Moment Arm = 20.615 ft (Applied at bridge seat)
Strong Direction Moment = 0.000 kip-ft
$P_{EQ,long}$ = P_{EQ}*sin(skew) = 0.000 kips
$P_{EQ,trans}$ = P_{EQ}*cos(skew) = 0.000 kips
$M_{EQ,long}$ = M_{EQ}*sin(skew) = 0.000 kips/ft
$M_{EQ,trans}$ = M_{EQ}*cos(skew) = 0.000 kips/ft

Wind Load on Structure: WS

	Strength III	Service I	Strength V			
Wind Load Normal to Abutment Face =	**10.87**	**10.87**	**10.87**	kips	*- conservatively uses Contechs value for all limit states*	From Contech
=	0.25	0.25	0.25	kips/ft	*- per Foot of Abutment Length*	
Moment Arm =	20.62	20.62	20.62	ft	*- applied at bridge seat*	
Overturning Moment, M_{Wind} =	5.09	5.09	5.09	kip-ft		

References

SOUTH ABUTMENT

STABILITY CHECK & DESIGN

Load Combinations for Retaining Wall Design:

NOTE: * Resisting Forces = **ALL** Vertical Loads. Used to determine sliding capacity.

* Overturning Forces = **ALL** Horizontal Loads. Used for Sliding Load.

* Net Moment / Resisting Forces = Eccentricity from "Toe".

* Overturning check satisfied if eccentricity of bearing pressure is within middle 2/3rds of footing (entire bearing area in compression) AND bearing capacity check satisfied.

* For footings on **soil**, the vertical stress shall be calculated assuming a **uniformly** distributed pressure over an effective base area, which equals the total bearing area minus an area to account for the effects of the eccentric load and for **rock** a **linearly** distributed pressure.

* Loads and factors shall be combined to produce the maximum effect for bearing, sliding and eccentricity.

* For the bearing check the max load factors are applied to vertical loads and for the sliding/eccentricity check the min load factors are applied to the vertical loads (less vertical load = lower sliding capacity and greater eccentricity). See Figures C11.5.6-1 and C11.5.6-2

AASHTO LRFD C11.5.5

Service I = DC + DW + EH + EV + LL + LS + BR + TU

Strength I = $(\gamma_{DC} \cdot DC) + (\gamma_{DW} \cdot DW) + (\gamma_{EH} \cdot EH) + (\gamma_{EV} \cdot EV) + 1.75(LL + LS + BR) + 0.50(TU) + 1.0(BRG)$

Strength III = $(\gamma_{DC} \cdot DC) + (\gamma_{DW} \cdot DW) + (\gamma_{EH} \cdot EH) + (\gamma_{EV} \cdot EV) + 0.50(TU) + 1.0(BRG) + 1.0\ (WS)$

AASHTO LRFD Tbl. 3.4.1-1

Extreme Event I = $(\gamma_{DC} \cdot DC) + (\gamma_{DW} \cdot DW) + 1.0(BRG) + (\gamma_{EV} \cdot EV) + \gamma_{EQ}(LL + BR) + 1.0(EQ) + (\gamma_{EH} * EH)$

Construction = $(\gamma_{DC} \cdot DC(Abutment)) + (\gamma_{DW} \cdot DW) + (\gamma_{EH} \cdot EH) + (\gamma_{EV} \cdot EV) + 1.0(BRG) + 1.5(CS)$

AASHTO LRFD C11.5.6

Load Modifier, η_i = **1.00** *NOT Critical / Essential*

* Construction Load Case checks abutment stability under a scenario where the bridge superstructure is not yet installed and the abutment is completely backfilled. An additional surcharge load is applied to simulate construction equipment sitting behind the abutment.

Bearing:

	Unfactored (Service)		Strength I			Extreme Event I		
	F (kip)	M (kip-ft)	Factor	F (kip)	M (kip-ft)	Factor	F (kip)	M (kip-ft)
RESISTING (Vertical Loads)								
DC	22.53	65.43	**1.25**	28.17	81.79	**1.00**	22.53	65.43
DW	0.19	0.19	**1.50**	0.28	0.28	**1.00**	0.19	0.19
LL	0.67	0.67	**1.75**	1.17	1.17	**0.00**	0.00	0.00
App. Slab	0.49	1.35	**1.25**	0.61	1.69	**1.00**	0.49	1.35
EV1 (Heel)	0.87	4.02	**1.35**	1.18	5.43	**1.00**	0.87	4.02
EV2 (Toe)	0.00	0.00	**1.35**	0.00	0.00	**1.00**	0.00	0.00
EH-v	1.14	7.11	**1.35**	1.54	9.60	**1.00**	1.14	7.11
LS-v	0.00	0.00	**1.75**	0.00	0.00	**0.00**	0.00	0.00
CS-v	0.49	3.08	**0.00**	0.00	0.00	**0.00**	0.00	0.00
	25.89	**78.77**		**32.95**	**99.96**		**25.22**	**78.10**
OVERTURNING (Horizontal Loads)								
EH-h	2.82	34.25	**1.35**	3.81	46.24	**1.00**	2.82	34.25
LS-h	0.00	0.00	**1.75**	0.00	0.00	**0.00**	0.00	0.00
TU	0.14	2.81	**0.50**	0.07	1.41	**0.00**	0.00	0.00
BRG	**0.00**	0.00	**1.00**	0.00	0.00	**1.00**	0.00	0.00
BR	0.00	0.00	**1.75**	0.00	0.00	**0.00**	0.00	0.00
EQ	0.00	0.00	**0.00**	0.00	0.00	**1.00**	0.00	0.00
CS-h	1.22	17.66	**0.00**	0.00	0.00	**0.00**	0.00	0.00
WS	0.25	5.09	**0.00**	0.00	0.00	**0.00**	0.00	0.00
	3.21	**42.15**		**3.88**	**47.64**		**2.82**	**34.25**
	(no EQ, CS)							

References

SOUTH ABUTMENT

STABILITY CHECK & DESIGN

	Unfactored (Service)		Construction			Strength III		
	F (kip)	M (kip-ft)	Factor	F (kip)	M (kip-ft)	Factor	F (kip)	M (kip-ft)
RESISTING (Vertical Loads)								
DC	22.53	65.43	**1.25**	26.41	80.03	**1.25**	28.17	81.79
DW	0.19	0.19	**0.00**	0.00	0.00	**1.50**	0.28	0.28
LL	0.67	0.67	**0.00**	0.00	0.00	**0.00**	0.00	0.00
App. Slab	0.49	1.35	**0.00**	0.00	0.00	**1.25**	0.61	1.69
EV1 (Heel)	0.87	4.02	**1.35**	1.18	5.43	**1.35**	1.18	5.43
EV2 (Toe)	0.00	0.00	**1.35**	0.00	0.00	**1.35**	0.00	0.00
EH-v	1.14	7.11	**1.35**	1.54	9.60	**1.35**	1.54	9.60
LS-v	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00
CS-v	0.49	3.08	**1.50**	0.74	4.62	**0.00**	0.00	0.00
	25.89	**78.77**		**29.86**	**99.68**		**31.78**	**98.79**
OVERTURNING (Horizontal Loads)								
EH-h	2.82	34.25	**1.35**	3.81	46.24	**1.35**	3.81	46.24
LS-h	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00
TU	0.14	2.81	**0.00**	0.00	0.00	**0.50**	0.07	1.41
BRG	**0.00**	0.00	**0.00**	0.00	0.00	**1.00**	0.00	0.00
BR	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00
EQ	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00
CS-h	1.22	17.66	**1.50**	1.83	26.49	**0.00**	0.00	0.00
WS	0.25	5.09	**0.00**	0.00	0.00	**1.00**	0.25	5.09
	3.21	**42.15**		**5.65**	**72.72**		**4.13**	**52.74**
	(no EQ, CS)							

SOUTH ABUTMENT

STABILITY CHECK & DESIGN

Sliding & Eccentricity:

	Unfactored (Service)		Strength I			Extreme Event I			References
	F (kip)	M (kip-ft)	Factor	F (kip)	M (kip-ft)	Factor	F (kip)	M (kip-ft)	
RESISTING (Vertical Loads)									
DC	22.53	65.43	**0.90**	20.28	58.89	**1.00**	22.53	65.43	
DW	0.19	0.19	**0.65**	0.12	0.12	**1.00**	0.19	0.19	
LL	0.67	0.67	**0.00**	0.00	0.00	**0.00**	0.00	0.00	
App. Slab	0.49	1.35	**0.90**	0.44	1.22	**1.00**	0.49	1.35	
EV1 (Heel)	0.87	4.02	**1.00**	0.87	4.02	**1.00**	0.87	4.02	
EV2 (Toe)	**0.00**	**0.00**	**0.00**	0.00	0.00	**0.00**	0.00	0.00	- (soil over toe only applicable for bearing)
EH-v	1.14	7.11	**1.35**	1.54	9.60	**0.90**	1.03	6.40	
LS-v ***(Sliding)***	0.00	0.00	**1.75**	0.00	0.00	**0.00**	0.00	0.00	
CS-v	0.49	3.08	**0.00**	0.00	0.00	**0.00**	0.00	0.00	
	25.89	**78.77**		**23.26**	**73.85**		**25.11**	**77.39**	
OVERTURNING (Horizontal Loads)									
EH-h	2.82	34.25	**1.35**	3.81	46.24	**1.00**	2.82	34.25	
LS-h	0.00	0.00	**1.75**	0.00	0.00	**0.00**	0.00	0.00	
TU	0.14	2.81	**0.50**	0.07	1.41	**0.00**	0.00	0.00	
BRG	**0.00**	0.00	**1.00**	0.00	0.00	**1.00**	0.00	0.00	
BR	0.00	0.00	**1.75**	0.00	0.00	**0.00**	0.00	0.00	
EQ	0.00	0.00	**0.00**	0.00	0.00	**1.00**	0.00	0.00	
CS-h	1.22	17.66	**0.00**	0.00	0.00	**0.00**	0.00	0.00	
WS	0.25	5.09	**0.00**	0.00	0.00	**0.00**	0.00	0.00	
	3.21	**42.15**		**3.88**	**47.64**		**2.82**	**34.25**	
	(no EQ, CS)								

	Unfactored (Service)		Construction			Strength III		
	F (kip)	M (kip-ft)	Factor	F (kip)	M (kip-ft)	Factor	F (kip)	M (kip-ft)
RESISTING (Vertical Loads)								
DC	22.53	65.43	**0.90**	19.01	57.62	**0.90**	20.28	58.89
DW	0.19	0.19	**0.90**	0.17	0.17	**0.65**	0.12	0.12
LL	0.67	0.67	**0.00**	0.00	0.00	**0.00**	0.00	0.00
App. Slab	0.49	1.35	**0.90**	0.44	1.22	**0.90**	0.44	1.22
EV1 (Heel)	0.87	4.02	**1.00**	0.87	4.02	**1.00**	0.87	4.02
EV2 (Toe)	**0.00**	**0.00**	**0.00**	0.00	0.00	**0.00**	0.00	0.00
EH-v	1.14	7.11	**1.35**	1.54	9.60	**1.35**	1.54	9.60
LS-v ***(Sliding)***	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00
CS-v	0.49	3.08	**1.50**	0.74	4.62	**0.00**	0.00	0.00
	25.89	**78.77**		**22.78**	**77.24**		**23.26**	**73.85**
OVERTURNING (Horizontal Loads)								
EH-h	2.82	34.25	**1.35**	3.81	46.24	**1.35**	3.81	46.24
LS-h	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00
TU	0.14	2.81	**0.00**	0.00	0.00	**0.50**	0.07	1.41
BRG	**0.00**	0.00	**0.00**	0.00	0.00	**1.00**	0.00	0.00
BR	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00
EQ	0.00	0.00	**0.00**	0.00	0.00	**0.00**	0.00	0.00
CS-h	1.22	17.66	**1.50**	1.83	26.49	**0.00**	0.00	0.00
WS	0.25	5.09	**0.00**	0.00	0.00	**1.00**	0.25	5.09
	3.21	**42.15**		**5.65**	**72.72**		**4.13**	**52.74**
	(no EQ, CS)							

Comp By: **NPB 7/21** Project: **NATICK: Shared Use Path over MBTA**
Chkd By: **GNM 12/22** Subject: **Design Calculations: Bridge No. N-03-007 (29N)** Job No.: **52680A41**

SOUTH ABUTMENT
STABILITY CHECK & DESIGN

References

Abutment Stability Check

Resistance Factors:

Bearing Resistance, ϕ_b =	**0.45**	- Footings on Rock	AASHTO LRFD
Sliding Resistance, ϕ_τ =	**0.80**	- Cast-in-pace concrete on Sand	Tbl. 10.5.5.2.2-1
Overall Stability for Service I Limit State, ϕ_{os} =	**0.65**	- limited geotechnical info.	& 11.6.3.6

Service I Limit State Check: AASHTO LRFD 11.6.3.6

Overall Stability $\geq$ 1
= (ϕ_{os} * Resisting Moments)/(Overturning Moments)
= 1.21 **OK**

Strength and Extreme Event I Limit State Check:

Bearing Resistance (for footings on rock):	**Strength I**	**Extreme Event I**	**Construction**	**Strength III**	**Service I**		AASHTO LRFD 11.6.3.2
Net Moment (Resist. - Overturn), M =	52.32	43.85	26.95	46.05	36.62	k-ft	
Vertical Forces for Bearing, V_b =	32.95	25.22	29.86	31.78	25.89	kips (= sum of all vertical loads)	
Resultant, R = M/V_b=	1.59	1.74	0.90	1.45	1.41	ft (from "toe")	AASHTO LRFD
Eccentricity, e = (W/2) - R =	1.53	1.38	2.21	1.67	1.70	ft (from cent. of base)	Fig. 11.6.3.2.1
For Resultant within middle one-third:	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**		
Max Bear. Stress, $\sigma_{vmax} = V_b / W * [1 + 6 * (e / W)]$ =	N/A	N/A	N/A	N/A	N/A	kip/ft^2	
Min Bearing Stress, $\sigma_{vmin} = V_b / W * [1 - 6 * (e / W)]$ =	N/A	N/A	N/A	N/A	N/A	kip/ft^2	
For Resultant outside middle one-third:	**YES**	**YES**	**YES**	**YES**	**YES**		
Max Bear. Stress, $\sigma_{vmax} = (2 * V_b) / 3 * [(W / 2) - e)]$ =	13.84	9.67	22.06	14.62	12.21	kip/ft^2	
Min Bearing Stress, σ_{vmin} = 0 =	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	kip/ft^2	
Factored Bearing Capacity/ Prop. Pressure =	1.71	2.45	1.07	1.62	1.94		11.6.3.2
	OK	**OK**	**OK**	**OK**	**OK**		

Overturning:						
Net Moment (Resist. - Overturn), M =	26.21	43.14	4.52	21.11	k-ft	AASHTO LRFD
Vertical Forces for Bearing, V_e =	23.26	25.11	22.78	23.26	kips (= sum of all vertical loads)	11.6.3.3
Resultant, R = M/V_e=	1.13	1.72	0.20	0.91	ft (from "toe")	
Eccentricity, e = (W/2) - R =	1.99	1.40	2.92	2.21	ft (from center of base)	
Acceptable Eccentricity (middle 2/3 of base) for Soil =	2.08	2.08	2.08	2.08	ft (from center of base)	
Acceptable Eccentricity (middle 9/10 of base) for Rock =	2.80	2.80	2.80	2.80	ft (from center of base)	
Is Resultant within limits?	**OK**	**OK**	**NG**	**OK**	(Foundation founded on rock)	

Sliding:						AASHTO LRFD 10.6.3.4
Vertical Forces for Sliding, V =	23.26	25.11	22.78	23.26	kips	
Internal Friction Angle, ϕ_f =	35.0	35.0	35.0	35.0		
tanϕ_f =	0.70	0.70	0.70	0.70		
C =	**1.00**	**1.00**	**1.00**	**1.00**	*Concrete cast against soil*	
R_t = C * V * tanϕ_f =	16.28	17.58	15.95	16.28		
$\phi_\tau * R_\tau$=	13.03	14.07	12.76	13.03		
Capacity/Load =	3.36	4.98	2.26	3.16		
	OK	**OK**	**OK**	**OK**		

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