Shaker Boulevard Bridge Replacement

Daniel Bartus, Luke Safford, Parker Swanson, Jacob Siegel, Stephen Nolin
Civil Engineering, University of New Hampshire, Durham, NH 03824

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Introduction

The current bridge spanning the Knox River on Shaker Boulevard in Enfield, NH, was put in place as a temporary bridge after the original bridge was destroyed in a flooding event caused by Hurricane Irene in 2011. This temporary bridge has been in place for approximately 13 years and is a one lane bridge. For these reasons, a new bridge must be deigned and constructed. This project will cover the design of the substructure, superstructure, and roadway using soil data, a hydraulic analysis, and the necessary load capacity. This project also includes a proposed detour to maintain traffic and permits required for completion of the project.

Existing Conditions

Existing Bridge

Image #1 Current State of bridge over Knox River

Locus Map

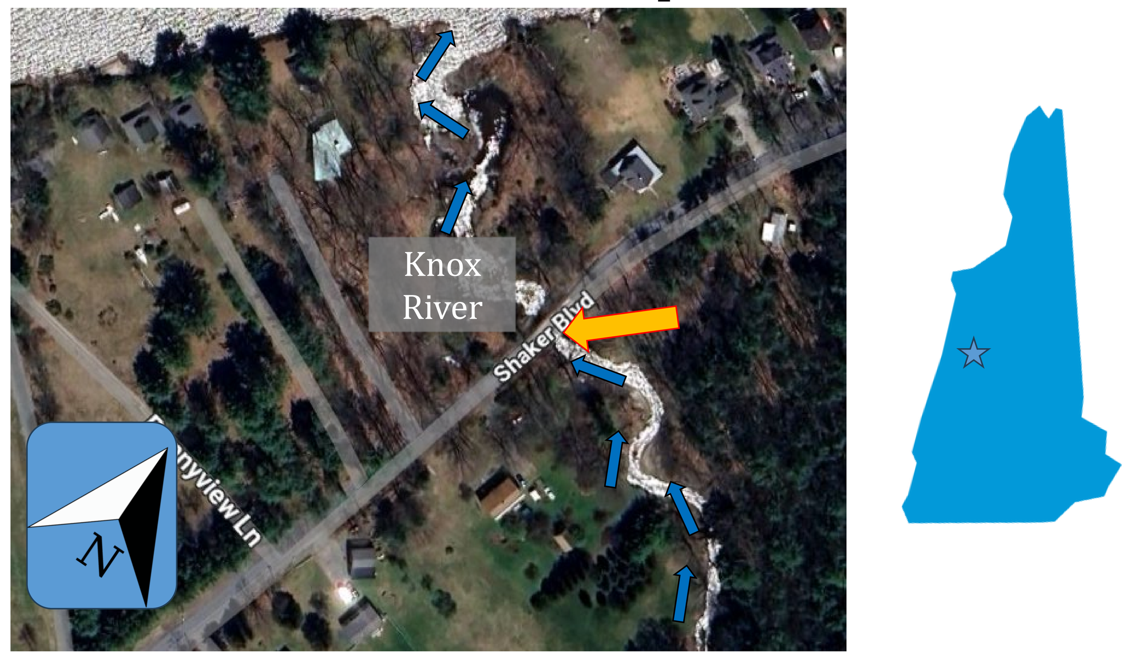


Image #2 Bridge Location

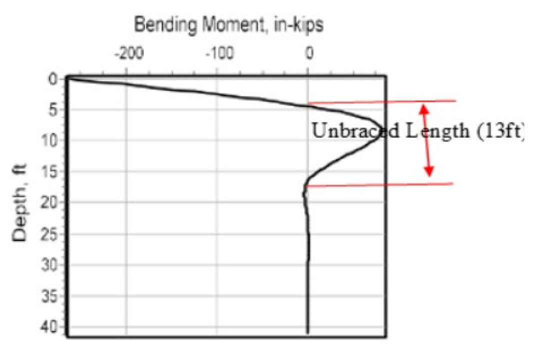
Permits

Standard Dredge and Fill Wetlands Permit (NHDES)

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Bridge Substructure Design

Bending Moment Diagram for East Abutment Piles



Cross Section of Integral Abutments

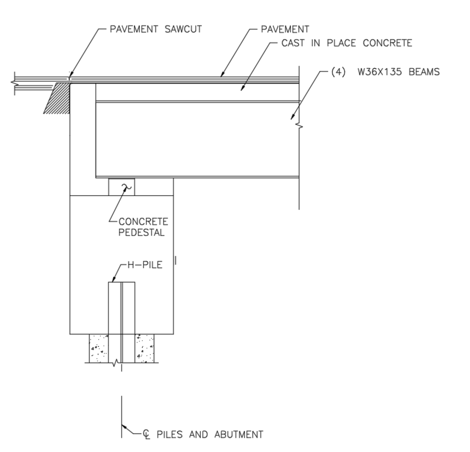


Chart #1: HP12x53 Piles would be sufficient for this application.

Bridge Superstructure Design

- Using CSI bridge, a required moment capacity of 1,781 kip-feet for an interior girder was determined based on HL-93 loading and the Strength I load combination
- It was determined that the four W36x135 steel girders used in the preliminary design were able to handle this loading
- Using SAP2000, the moment demand per longitudinal foot for the reinforced concrete slab was determined
- Longitudinal and Transverse reinforcing steel were designed accordingly

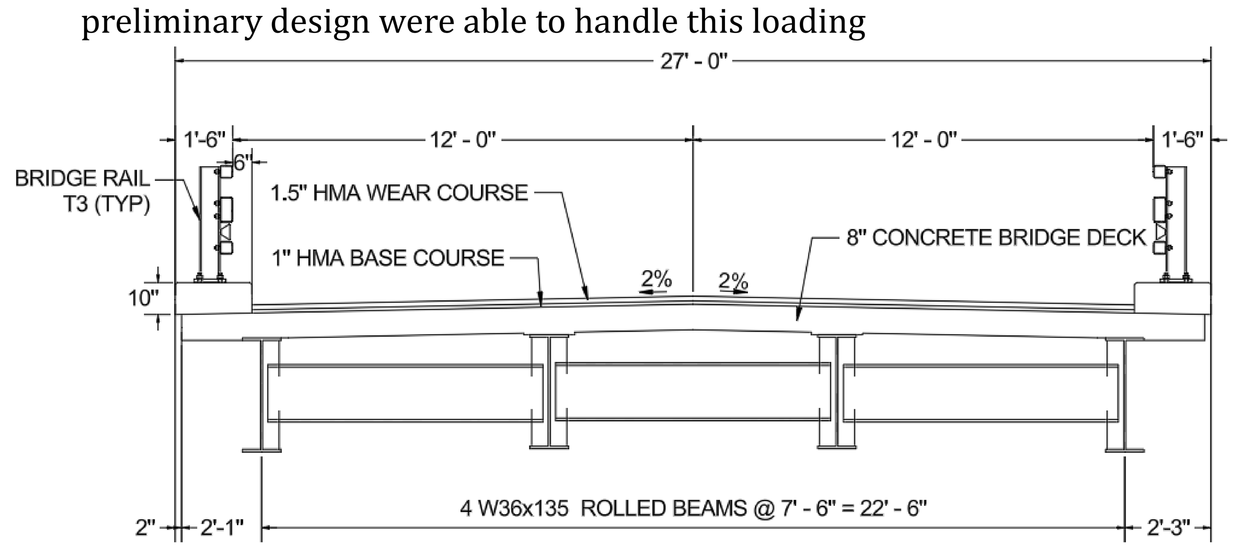


Image #3: Steel Cross Section Design

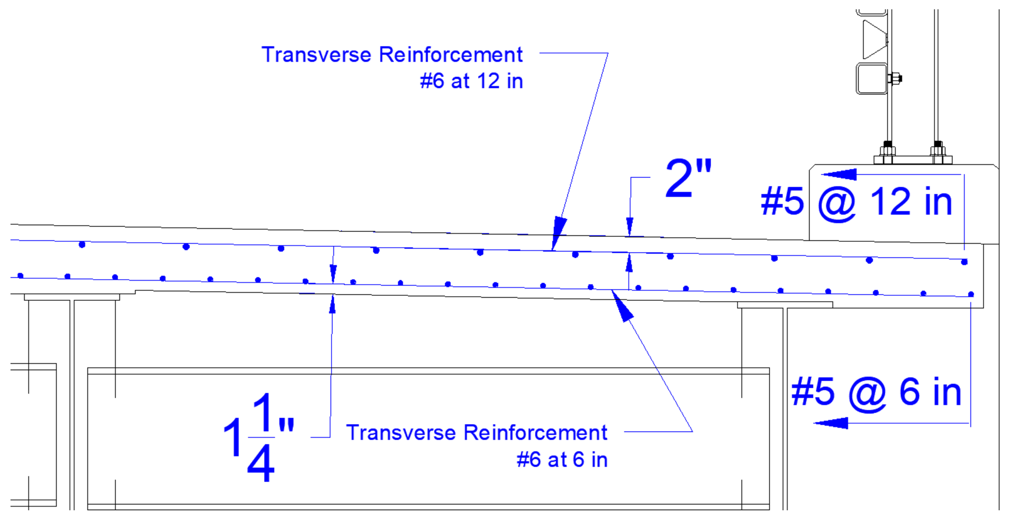


Image #4: Reinforcing Detail

Cost Analysis

ITEM	QUANTITY	UNIT		UNIT COST		COST
BRIDGE	1,560	SF	×	$420.00	=	$656,000
EXISTING BRIDGE REMOVAL	1	LS	×	$150,000.00	=	$150,000
DETOUR AND/OR TEMPORARY BRIDGE	1	LS	×	$75,000.00	=	$75,000
MISCELLANEOUS (TCP'S, FIELD OFFICE, ETC.)				25%	=	$221,000
MOBILIZATION				12%	=	$106,000
				STRUCTURE SUBTOTAL	=	$1,215,000
APPROACHES	500	LF	×	$608.00	=	$304,000
ENGINEERING, RIGHT OF WAY				20%	=	$243,000
MOBILIZATION				10%	=	$121,500
				SUBTOTAL	=	$1,883,500
CONTINGENCY				15%	=	$282,525
				TOTAL PROJECT COST	=	$2,166,025

Hydraulics

Hydraulic Analysis was conducted to find the bankfull width and the 50 and 100-year flood elevations needed to restrain minimum bridge span length

SECTION 5 - CROSS SECTIONAL CHANNEL GEOMETRY: MEASUREMENTS OF THE EXISTING STREAM WITHIN A REFERENCE REACH
*For **tier 2**, **tier 3** and **tier 4** crossings only.*

Describe the reference reach location:

Reference reach watershed size: acres

Parameter	Cross Section 1 Describe bed form BFW 55 (e.g. pool, riffle, glide)	Cross Section 2 Describe bed form BFW 27 (e.g. pool, riffle, glide)	Cross Section 3 Describe bed form BFW 39 (e.g. pool, riffle, glide)	Range
Bankfull Width	30.7 feet	36.8 feet	38.8 feet	8.1 feet
Bankfull Cross Sectional Area	52.19 SF	67.34 SF	77.6 SF	25.4 SF
Mean Bankfull Depth	2.83 feet	1.88 feet	2.54 feet	0.95 feet
Width to Depth Ratio	10.9	19.6	15.3	8.7
Max Bankfull Depth	3.4 feet	3.66 feet	4 feet	0.6 feet
Flood Prone Width	198 feet	40.1 feet	49.7 feet	157.9 feet
Entrenchment Ratio	6.45	1.09	1.28	5.36

*Use **Figure 1** below to determine the measurements of the Reference Reach Attributes*

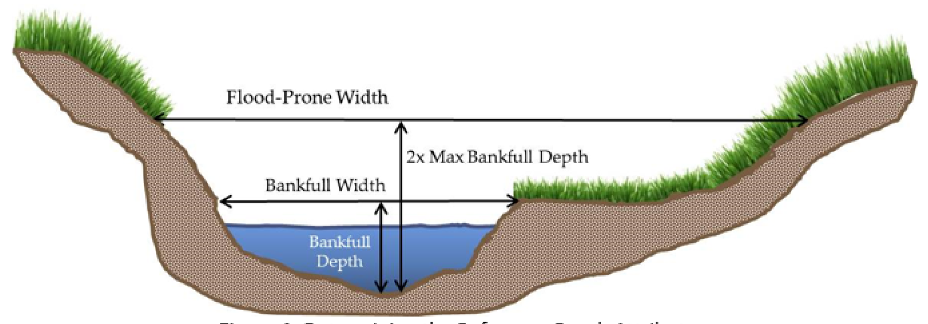
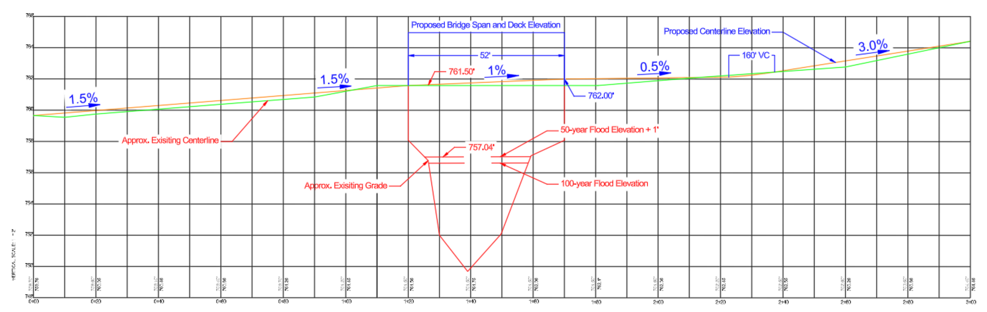


Figure 1: Determining the Reference Reach Attributes.

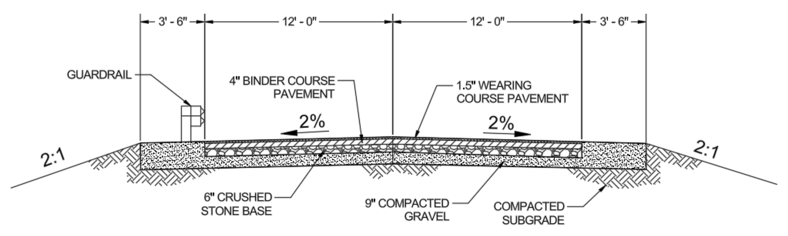
Roadway Design/Maintenance of Traffic

Vertical Roadway Profile

- Roadway width adjustment for a two-lane bridge
- Bridge deck sloped 1%
- Down station bridge side raised 0.5' to accommodate deck depth

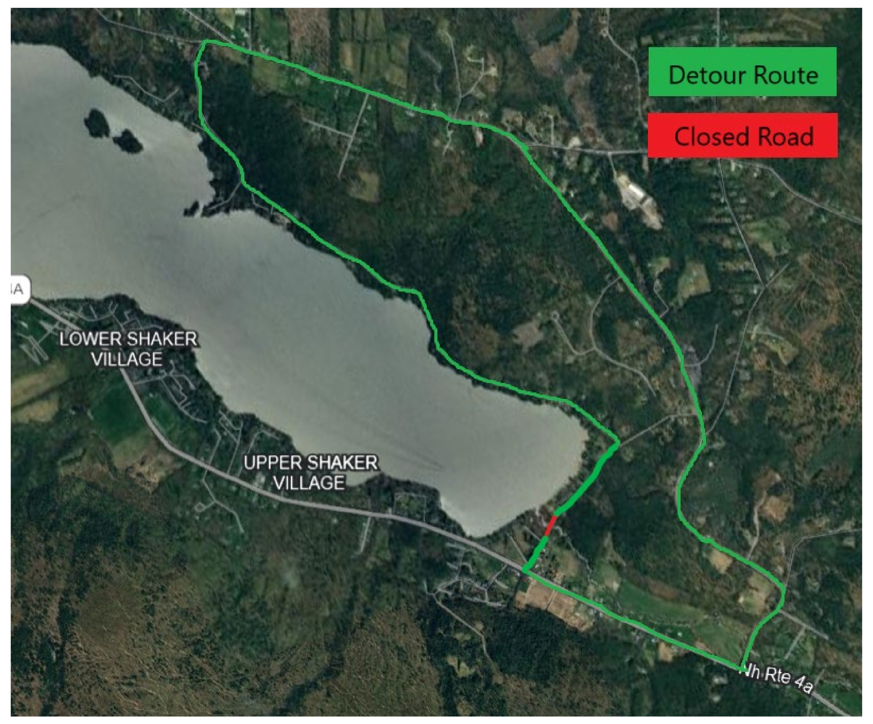


Typical Roadway Section



- Per NHDOT Pavement Design Manual
- 12' Lane Width
- 3.5' Shoulder

Maintenance of Traffic



During construction of the new bridge, the road will be closed for through traffic and traffic will utilize the mapped detour. The detour is 6 miles long and will result in a roughly 15-minute delay

Acknowledgements

Thank you to our project sponsor John Byatt, PE of BETA Group

Thank you to our project advisor Matthew Low, PE

Thank you to Dr. Bell for support during the design process

References

AASHTO LRFD Bridge Design Specifications. Washington, D.C. :American Association of State Highway and Transportation Officials, 2012.
AISC Steel Design Manual, 2022
ACI 318-19, 2019