

# Redesign of Monmouth County Bridge MA-14

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## Abstract

The MA-14 Bridge is on County route 6 (West Front Street and Amboy Avenue) in Monmouth County. The bridge connects the borough of Keyport with the township of Aberdeen and spans over Matawan Creek. By the National Bridge Inventory, the original bridge was considered functionally obsolete and structurally deficient. Therefore, a redesign and replacement of Bridge MA-14 is authorized. This project focuses on structural and geotechnical design for the replacement of Bridge MA-14. The goal for the project is to have the bridge redesign support both vehicular and pedestrian traffic, and have a 100-year lifespan with minimal maintenance required in between.

To maintain structural integrity a deck thickness of 8 inches was selected, and 5 girders evenly spaced 8 3/4 feet apart were chosen to support this deck. When the girder design was finalized, live load factors were calculated to account for the distribution of load due to different potential locations of vehicles on the bridge. Once the main structural components were chosen, stiffeners, panels, and shear connectors were selected to end the structural design process.

The geotechnical design scope included a soil improvement design, deep foundation design, pier design and abutment design. A soil improvement design was determined after analyzing both the East and West approach embankments. A column supported embankment design was recommended. Deep foundation design included designing the quantity and arrangement of piles to support the bridge. The piers and the East and West abutments were designed and analyzed.

## Design/Methods

### Structural

- Design of concrete deck and girders to withstand structural loads and traffic
- Calculation of Live Load distribution factors to determine effects of traffic on girders
- Shear and Moment effects from loads checked on deck and compared to maximum values
- Abutment loads due to the combination of loads was given to the geotechnical team for abutment design
- Raised roadway to allow an average height boat to pass through

### Geotechnical

- Soil boring logs and laboratory test results were given to determine the soil profile and soil properties of the project site.
- An embankment settlement analysis and slope stability analysis were performed using the computer software programs EMBANK and WINSTABL.
- Soil improvement design was determined from the embankment analysis. Column supported embankment design was selected, which included controlled modulus columns (CMC) with a load transfer platform (LTP).
- Designed the water piers using the programs APile and GROUP to get the capacity and deflection of the piles
- Designed the Abutment and checked the Factor of Safety for overturning and Sliding

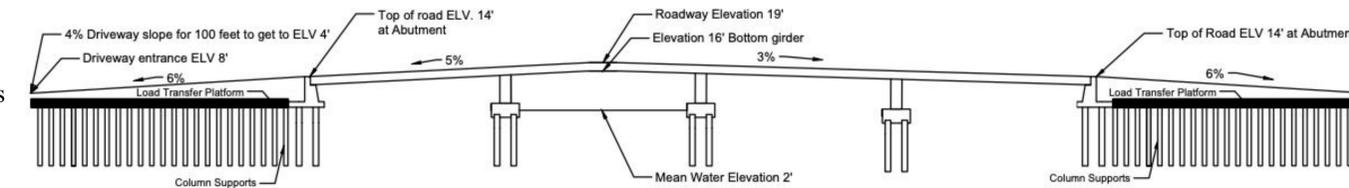


Figure 1: Proposed Bridge Elevation View

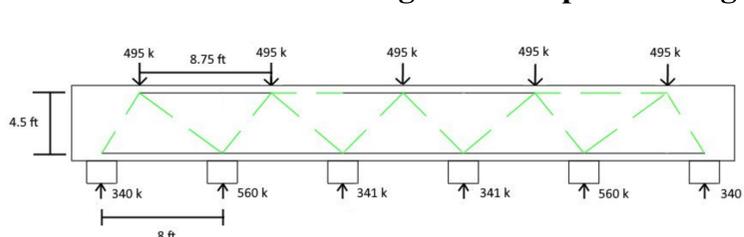


Figure 2: Pier Cap Strut and Tie Design

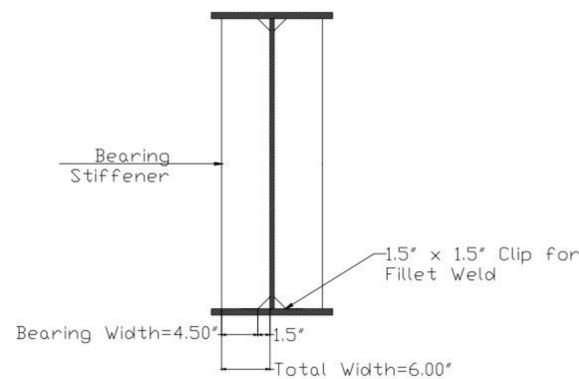


Figure 3: Stiffener and Girder Cross Section

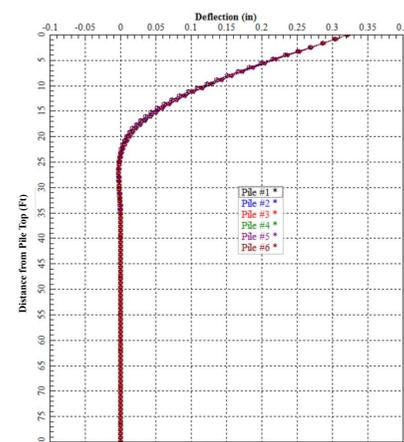


Figure 5: Pier Lateral Deflection

## Acknowledgements

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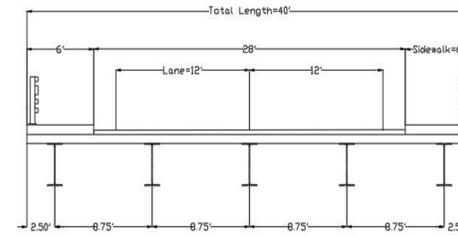


Figure 4: Deck and Girder Cross Section

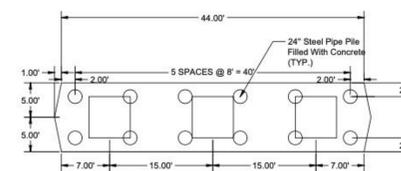


Figure 6: Pier Pile Layout and Cross Section

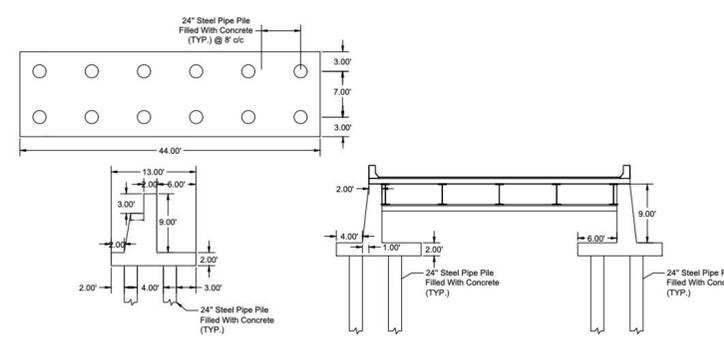


Figure 7: Abutment Pile Layout and Cross Section

## Conclusion

As per AASHTO LRFD bridge design specifications, structural adequacy was maintained by following STRENGTH I considerations. The geotechnical design of the bridge foundations were confirmed to be acceptable. The approach embankments required a column supported embankment design for additional soil improvement. Pedestrian usage was also assured with the bridge height being adequate for boating clearances, and integration of sidewalks.

## Results

Structural- Super Structure Design		
Element	Material	Design
Deck	Pre-stressed concrete	8" depth, 40' wide, 280' long
Deck Overhang Reinforcement	#3 rebar	12" spacing c/c at 1.2" depth
Simply supported Deck Reinforcement	#4 rebar	8" spacing c/c at 6.75" depth
Girder	Grade 50 Steel	5 girders at 8.75' spacing, 2.5ft deck overhang
Web	Grade 50 Steel	3/4" x 36"
Top Flange	Grade 50 Steel	1" x 16"
Bottom Flange	Grade 50 Steel	1" x 16"
End Panel	Grade 50 Steel	1" x 50"
Interior Panel	Grade 50 Steel	1" x 108"
Shear Connector	Grade 50 Steel	3/4" x 6"
Stiffener	Grade 50 Steel	6" wide, .5" thickness, 1/4" weld

Geotechnical- Pile Design	
Pier Layout	2x6, 24" Cylindrical Steel Pipe Piles filled w/ Conc.
Pier Pile Minimum Tip Elevation	-92.0 FT
Pier Lateral Deflection	0.32 IN
Pier Pile Length	99.0 FT
Pier Geotechnical Capacity	2457.36 KIPS
Large Abutment Layout	2x6, 24" Cylindrical Steel Pipe Piles filled w/ Conc.
Small Abutment Layout	2x6, 24" Cylindrical Steel Pipe Piles filled w/ Conc.
Abutment Pile Minimum Tip Elevation	-86.0 FT
Abutment Lateral Deflection	0.55 IN
Abutment Pile Length	99.0 FT
Abutment Geotechnical Capacity	6652.32 KIPS
Pile Structural Capacity	554.36 KIPS

## References

1. AASHTO LRFD Bridge Design Specifications (2012)
2. NJDOT Design Manual for Bridges and Structures (2015)
3. AISC Steel Bridge Design Handbook (2015)