

Pedricktown Bridge and Roadway Redesign

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Abstract

Pedricktown Bridge and Roadway warranted improvement due to flooding of the road and dangerous roadway geometry. After completing a hydraulic analysis looking at the 100 year rainfall data, it was established that the existing bridge does not overtop, but there is flooding along the roadway North of the bridge. This resulted in the most optimal solution to be maintaining the current bridge and carrying that elevation through the wetlands. In order to simplify design and construction while providing a long lasting solution, a reinforced concrete section consisting of a slab, tee beams and pile cap was designed to be cast monolithically and then dropped into place and connected to the pile using anchor bolts. The geotechnical design resulted in 18"x18" square concrete piles with steel reinforcement to be placed at 20' spacing. The water resources design found the maximum flood depth to be 2.32 feet. A minimum trail length of just under 1800 feet North of the bridge and trail height of around 2.5 feet above the ground bottom was established based on the flood levels. The transportation design accounted for the vehicular traffic prior to the Pedestrian Trail through a mini roundabout with a 65 foot circle diameter. The alteration of the road prior to the trail featured the addition of 110 foot circle diameter cul-de-sacs and 54'x90' parking lots on both ends of the trail.



Design/Methods

<u>Structura</u>

•Created geometry for new structure based on AASHTO specifications •Analyzed potential dead and live loads on the structure using the AASHTO specifications and ACI 318-14

•Designed reinforcement in slab, beams and pile cap by designing for worst-case scenarios, designed bolted connection to columns, and checked deflection and torsion

•Used AutoCAD Civil 3D Software to accommodate the reinforcement bars and stirrups

Water Resources

•Conducted a hydraulic analysis of watershed area and analyzed 100year rainfall data to find the peak water flow

•Created HEC-RAS model for existing bridge and roadway

•Established current bridge does not overtop and can be left intact

•Designed minimum heights and length for Pedestrian Trail along the entire area

•Modeled the Pedestrian trail design in HEC-RAS and found that the trail does not overtop at any location

Transportation

•Analyzed existing traffic conditions using Synchro Analysis with volumes as provided by the New Jersey Department of Transportation (NJDOT)

•Evaluated and adjusted roundabout and cul-de-sac central diameter and geometry, along with the parking lot geometry with the use of AutoCAD Civil 3D Software

•Established reconfiguration of roadway in accordance with the United States Department of Transportation Design (USDOT) Standards Geotechnical

•Subsurface exploration results were provided with borings which displayed 5 layers of soil beneath the ground surface.

•Utilized APile and LPile software with current site conditions to design and check the axial and lateral capacity of the concrete piles during design.

•Determined minimum tip elevation, lateral deflection, and the amount of embedment of the concrete piles.





Figure 5: Roundabout

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Figure 7: Pedricktown Rd. Cul-De-Sac

Results			
TABLE 1: STRUCTURAL DESIGN RESULTS			
Tee Beam Design		Slab Design	
Flexure	2 #8	Flexure	4 @ 9" c/c
Shear	#3 @ 6.5" c/c	Temp & Shrinkage	4 @ 13.5" c/c
LL Deflection	0.113"	Max LL Deflection	0.062"
Pile Cap Design		Bolt Anchor Connection Design	
Flexure	2 #7	0.75" Bolt As	0.44 in^2
Shear	#3 @ 6.5" c/c	Ld	9.5"
LL Deflection	0.048"	Section Check	
		Applied Torsion	15 kft
		Torsion Capacity	16.7 kft
T/4	BLE 2: GEOTECI	HNICAL DESIGN RESU	LTS
Pile Design			
Pile Layout:		1x1, 18"x18" Square Concrete Piles	
Pile Minimum Tip Elevation:		-43 ft	
Pile Lateral Deflection:		0.383"	
Pile Axial	Capacity:	800 Kips	
Reinforcement Design			
Reinforcement Layout:		10 # 8 Rebars	
Rebar Cover:		2.75"	
Ties Design:		#3 Ties @16" c/c	
TABLE 3: TRANSPORTATION DESIGN RESULTS			
Intersed		Ction Design	
Mini-Roundabout:		FHWA 2010: Mini Roundabout	
Max Recommended Speed:		00 IL 15 mph	
Max Grade:		2%	
Cul-De-Sac Designs			
FHWA 2010: Urban Single Lane			
Cul-De-Sac:		Roundabout	
Circle Diameter:		110 ft	
Max Recommended Speed:		15 mph	
Max Grade:		2%	
Parking Lot Designs (Equival		lent Designs at Both Cul-De-Sacs):	
Handicap Spots:		Standard Spots:	
2 total		17 total	
18' X 10' TABLE 4: WATER RESO		18' x 9' OURCES DESIGN RESULTS	
Hydraulic Anlaysis			
Watershed Area		39 square miles	
Longest Hydraulic Length		17.75 square miles	
Curve Number		77	
Average Watershed Slope		1.24%	
Lag time		709 minutes	
Peak flow		7310 cfs	
Flood Heights			
Maximum WSE		3.31 feet	
Maximum Depth		2.32 feet	

References

- 1. NJDOT Roadway Design Manual (2015)
- 2. WSDOT Design Manual M 22-01.19 (2020)
- 3. Chester County Multimodal Handbook (2016)
- 4. AASHTO LRFD Bridge Design Specifications (2012)
- 5. AASHTO LRFD Pedestrian Bridge Specifications (2009)
- 6. AASHTO Guide for the Design of Bicycle Facilities (2012)
- 7. ACI 318-14 (2014)