EXECUTIVE SUMMARY

The purpose of this document is to present the findings of the foundation analysis performed to study the feasibility of the superstructure replacement alternative. The foundations were analyzed for existing loadings and future loadings representative of the new wider superstructure.

The in situ foundations for piers 6, 7, and 8 will require some strengthening to bring them up to the current AASHTO code recommended loadings. It is reasonably certain that strengthening and scour mitigation can be performed for under $28 Million dollars for these three piers. We are optimistic that this cost can be reduced through further study of additional strengthening techniques and their feasibility.

The superstructure replacement on existing piers continues to be a viable option. At this point, the estimated 2009 construction cost including ceiling pier strengthening and scour mitigation is as follows:

- 32 FT Curb to Curb $ 98 million (2009)
- 42 FT Curb to Curb $ 110 million (2009)

It is important to note that these costs do not include any existing bridge demolition costs, right of way, or approach improvements.

At this time we recommend that the superstructure replacement alternative be moved forward with further study on pier strengthening/costs, scour analysis, subsequent scour mitigation methodology/cost and demolition versus bridge closure estimates. Bridge closure was previously estimated at 12 months. Bridge demolition is interrelated with bridge closure and requires more in-depth study since it could range from $ 5 million to $ 15 million (see discussion in Section 2.5 below).

1. ASSUMED SUPERSTRUCTURE

Because the bridge type has not been selected for the Superstructure Replacement, a truss bridge similar in appearance to the existing bridge was assumed. For the purpose of the foundation analysis, the span arrangement (Figure 1) for the existing bridge was assumed.

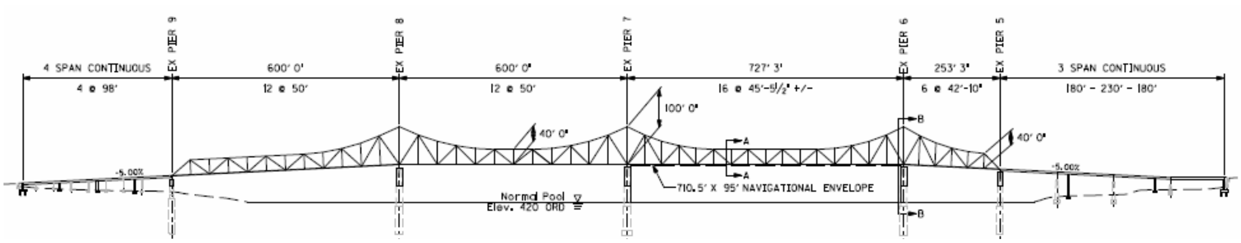


Figure 1 - Assumed Span Arrangement

Going forward it is recommended that the northern most truss span be lengthened to approximately 400 ft to eliminate the uplift that could develop at its supporting pier. This would eliminate the existing pier 5 and require a shorter Indiana approach as shown..

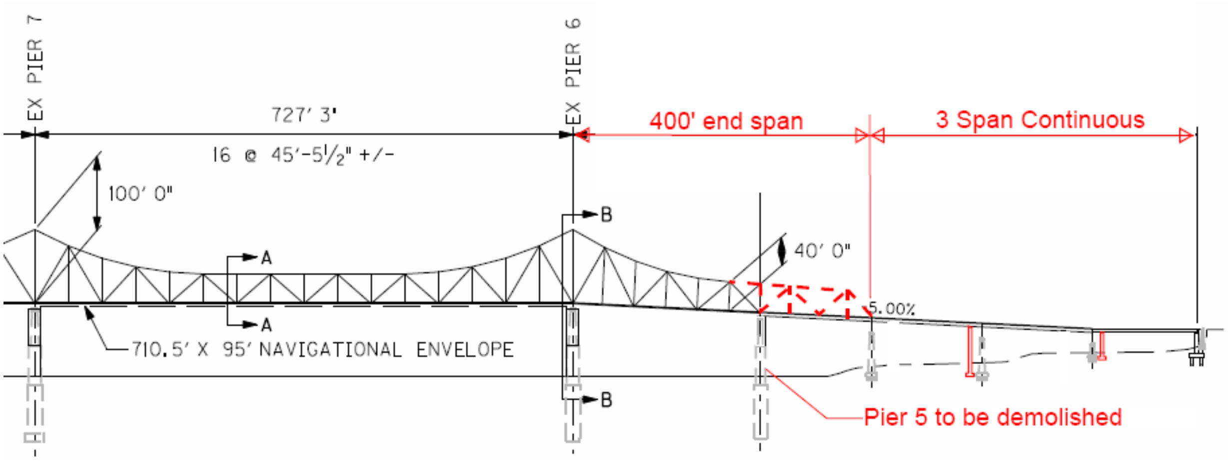
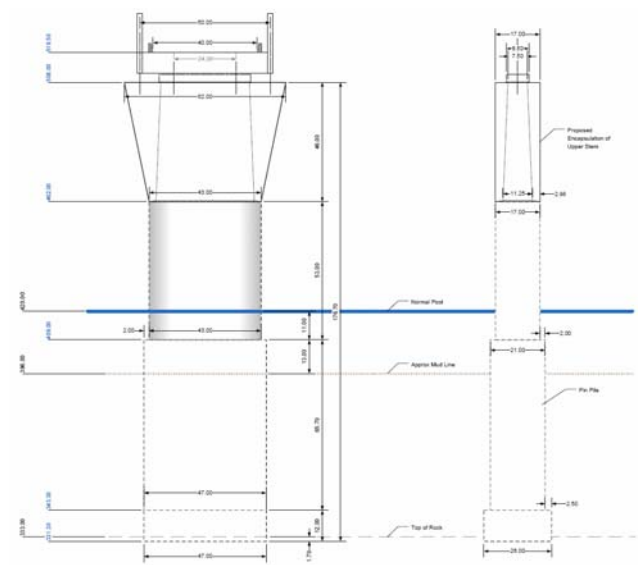


Figure 2 - Modification to span arrangement

Two options for bridge width considered in this study of the foundations consisted of the following.



- 2-12' lanes, 2-4'' shoulders for a total of 32' curb to curb
- 2-12' lanes, 2-8' shoulders for a total of 40' curb to curb.
- A 5' sidewalk was also cantilevered on the downstream side of the bridge.

The existing superstructure has a curb-to-curb width of 20ft-9in.

To support the wider superstructure some type of hammerhead pier will be required. In order to estimate pier weights, the flared pier depth was assumed to extend from the pier cap to the step in section half way between the water and the bridge deck. Full width of the solid shaft was assumed.

Preliminary checks of the pier shafts indicate that the section is under reinforced for some of the bending loads and may require additional reinforcement through the use of post tensioning.

2. FOUNDATION ANALYSIS

A four step foundation analysis was identified to study the foundation. Loadings and Foundation pressures would be developed for the four steps below:

- Step 1 – Original bridge design (Baseline)
- Step 2 – Existing bridge with exodermic bridge deck.
- Step 3 – Construction stage prior to removal of superstructure
- Step 4 – Final replacement superstructure.

Step 2 was omitted by inspection as not causing loads which would differ significantly from step 1. For additional studies of pier strengthening, we envision a check being done for the step 3 construction stage where the existing bridge will be taking traffic as the new pier caps are installed.

2.1. Analysis

Loads were calculated according to the AASHTO Standard Specifications, 17th ed. Structural analysis models were developed to determine loadings for the existing bridge and the replacement superstructure. Other loadings evaluated included Wind loading, Braking, Temperature Effects and Barge Impact. Seismic loadings were not included in the foundation analysis. Preliminary foundation pressures were calculated assuming that the existing foundations behaved as spread footings on rock, however, tension pressures were calculated rather than allowing the foundations to lift off the rock.

Allowable bearing pressures were provided by the KYTC Geotechnical Branch. An ultimate bearing capacity of 75ksf was provided along with a factor of safety of 2.5. The resulting allowable bearing capacity of 30ksf was used for foundation comparisons.

2.2. Scour

The existing foundations for piers 6-8 lie approximately 50ft beneath the river bed. It was theorized that the existing caisson foundations derive some of their resistance to lateral loads from the support of the adjacent soils. The lateral resistance of the soils was evaluated and found to be insufficient for the calculated lateral loads. The soil resistance was not included in the calculations do to the unknown potential for scour.

A conservative scour analysis will be performed as part of the ongoing study for the superstructure replacement alternative. The lateral resistance of the foundations can then be re-evaluated based on the scour depths or the presence of scour mitigation countermeasures.

We have identified some scour countermeasures such as a Rip Rap Mat or Articulated Block Mat. Assuming a conservative mitigation area formed by a 100 ft radius around the center of the pier and approximately 6 ft deep mat of rip rap protection, we estimate a cost of approximately $170,000 per pier. This estimated cost should be conservative if the scour analysis shows that scour will occur into the rock foundation.

2.3. Foundation Strengthening

The results of the foundation analysis show that the existing foundations are sufficient to carry the increased vertical loads. The lateral loads exceed what the caissons can carry either with or without support from the surrounding soils.

Alternatives were identified to develop a range of potential costs for strengthening the foundations. The options identified are described briefly below. These options initially appear to be feasible and should be studied in greater detail. The options presented below can be designed to resist the lateral loads without support of the surrounding soils.

a. Class C Concrete Pedestal - Sheet piling would be driven to bedrock and the soil overburden would be excavated using a clamshell. Excavation and the Class C concrete placement which follows would occur in the wet condition. Once sufficient class C foundation has been placed, a reinforced concrete footing would be cast to transfer the loads between the existing pier and the new foundation. The footing would extend 10-15 ft in all directions beyond the existing pier faces.
b. Drilled Shaft Foundations – Drilled shafts would be placed in a pattern around the existing caisson foundation. The drilled shafts would be tied in to a pier cap below the draft of the future navigation channel. The number and size of the drilled shafts would depend on the amount of scour estimated at the site.
c. Pin Piles / Rock Anchors – Pin piles would be installed through the existing caisson into the rock providing additional vertical resistance. Alternating post tensioning/rock anchors would be installed between the pin piles and anchored into rock. The P/T would then be stressed providing additional vertical load on the piers resisting the overturning moments by reducing the effective eccentricity.

2.4. Cost

Strengthening of the foundations will increase the cost of the superstructure replacement alternative chosen. The options shown above will likely increase the duration of the construction schedule but not necessarily the bridge closure time.

(2009$)	32' Curb to Curb[2]	40' Curb to Curb [2]
Superstructure Replacement [1]	70 M	82 M
Foundation Strengthening	28 M	28 M
Total	**98 M**	**110 M**

[1] Includes bridge cost from existing abutment to existing abutment (see Figure 1) along the current alignment. Does not include any costs associated with the closure (i.e. ferry / user impacts).
[2] Includes the cost of lengthening bridge and replacing pier 5 on shoreline.

The costs presented above do not include demolition of the existing bridge, nor do they include R.O.W., utilities, or roadway improvements. The costs include a 30% contingency as appropriate for a very early estimate such as this.

2.5. Demolition Costs and Bridge Closure

Bridge demolition and how it relates to the bridge closure schedule requires further study to be able to estimate a reasonable cost range. In discussing this with Baker Construction Management Professionals the cost could range from $ 5 million to $15 million depending on what type of demolition will be permitted, with the low cost involving explosive demolition and dropping the truss in the river.

The desire to minimize bridge closure requires pier modification and new pier bent construction to take place while traffic is still on the existing bridge. Explosive demolition has the potential to damage newly completed portions of the substructure. Further study of demolition methods and potential costs is recommended to assess the relationship between cost and construction schedule.

A preliminary construction schedule was derived that indicated a 12 month closure of the bridge during construction was reasonable. We recommend the construction schedule be re-visited to assess the impact on closure and schedule associated with foundation mitigation, as well as demolition.