HEAVY MOVABLE STRUCTURES, INC.
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New Bascule Bridge for Historic New Bern, NC

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Project Background

Existing Bridge

The Alfred Cunningham Bridge, NCDOT Bridge 60 in Craven County, was designed in approximately 1953 and built in 1955. It was 1763 feet long and consisted of a 350 foot long New Bern approach, a 220 foot swing span, and a 1190 foot long James City approach. The approaches consisted of 35 foot long spans comprised of a reinforced concrete deck supported on rolled steel beams with a substructure composed of reinforced concrete pier cap bents on octagonal precast piles. The swing span was a center bearing through truss span with a concrete filled grating deck and reinforced concrete safety walks supported on a reinforced concrete circular pivot pier founded on octagonal precast piles (See Figure 1). The original control house was previously removed from the swing span and a new house was built behind the rest pier to the side of the James City approach. The bridge typical section consisted of a 28 foot clear roadway width (two 12 foot lanes with 2 foot shoulders) and two 3 foot wide sidewalks elevated 10 inches above the roadway surface (See Figure 2).

Figure 1. Elevation of Existing Swing Span of Bridge

Figure 2. View of roadway on Existing Swing Span of Bridge

The swing span provided two 78 foot navigational channels, between the fenders with unlimited vertical clearance when the span was in the open position. An approximate clearance of 14 feet was provided with the swing span in the closed position.

The bridge was in a deteriorated condition and had been classified by NCDOT as structurally deficient and functionally obsolete. The portals of the swing span did not provide sufficient clearance over the roadway which resulted in impact damage. Based upon the rating system of 1 (failed) to 9 (good), the rating of some of the critical members of the bridge were as follows:

Deck Expansion Joints: Grade 4 (poor)
Longitudinal Beams: Grade 4 (poor)
Precast Piles: Grade 4 (poor)
Paint: Grade 3 (poor)

Besides its deteriorated condition, the bridge also had inadequate sidewalk width, inadequate railing height and restricted vertical clearance.

The NCDOT gave the bridge a sufficiency rating of 8.0 out of 100 in its 2002 Inspection Report. (NCDOT, 2002) This is a scale based upon a weighted formula relating four unique factors: structural adequacy and safety (55%); serviceability and functional obsolescence (30%); essentiality for public use (15%); and special reductions (13% maximum). The Inspection Report indicated that the estimated remaining life of the structure without major maintenance or rehabilitation was 10 years. Two years earlier it had been estimated to be 8 years.

New Structure Design Constraints

NCDOT determined it was time to replace the existing structure and tasked HNTB Corporation to prepare the environmental studies, conduct stakeholder outreach, develop the alternatives for the bridge replacement and ultimately design the preferred alternative.

Bridge Type
During the National Environmental Policy Act (NEPA) process (NEPA 1970), 7 alternatives were investigated. These alternatives were 1) permanently remove the existing bridge; 2) rehabilitate existing bridge; 3) replace existing bridge with bascule type movable bridge; 4) replace existing bridge with a lift type movable bridge; 5) replace existing bridge with a tunnel; 6) replace existing bridge with a high level fixed bridge on existing alignment and 7) replace existing bridge with a high level fixed bridge on new alignment. A “No Build” alternative was also considered, but deemed unfeasible since the existing bridge only had 10 more years of useful life. Ultimately the bascule bridge on existing alignment was selected for implementation. This alternative was selected due to its ability to meet the purpose & need, strong agency and community support, minimal environmental impacts, competitive cost and unlimited vertical clearance at the navigational channel.

Project Commitments
In the development of the environmental documents, Categorical Exclusion, a series of project commitments were made to minimize the environmental impacts. (Categorical Exclusion, 2006)

These included:

- Replacement of the structure on the same alignment to minimize impact to the community. This required the bridge to be shutdown for the construction duration, approximately 3 years, but this was determined to be a temporary impact to businesses in the downtown, bicyclists and motorists.
- The use of a vibratory hammer during pile installation to reduce the noise. A vibration monitoring and enforcement program was to be implemented during construction to minimize the amount of vibration effects that the surroundings and buildings, some of which are historic, would be subjected.
- There will be no dredging in the Trent River.
- Existing 45 mph speed limit will be reduced to 35 mph.
- To allow stormwater from the new bridge to discharge directly into the Trent River, the impervious surface of the proposed bridge could not exceed the impervious surface of the existing bridge. To do this, the new cross section of the roadway consisted of two 11 foot lanes with a 4 foot shoulder along the northbound lane and a 2 foot gutter along the southbound lane. A raised sidewalk of 5 feet 6 inches in width on the bridge will be provided adjacent to the southbound lane. This made the out to out of the new bridge 36 feet- 1 inch while the existing bridge out to out dimension was 36 feet- 4 inch (See Figure 3).

- The bridge railing is to be a Texas Classic with arched cutouts. There will be no encroachment into Union Point Park in New Bern. The bridge retaining wall along E. Front Street will be covered with brick to match the New Bern Riverfront Convention Center. The color, material and design of the pedestrian railing on top of the retaining wall shall match the existing pedestrian railing used in Union Park. The areas around the retaining wall will also be landscaped.

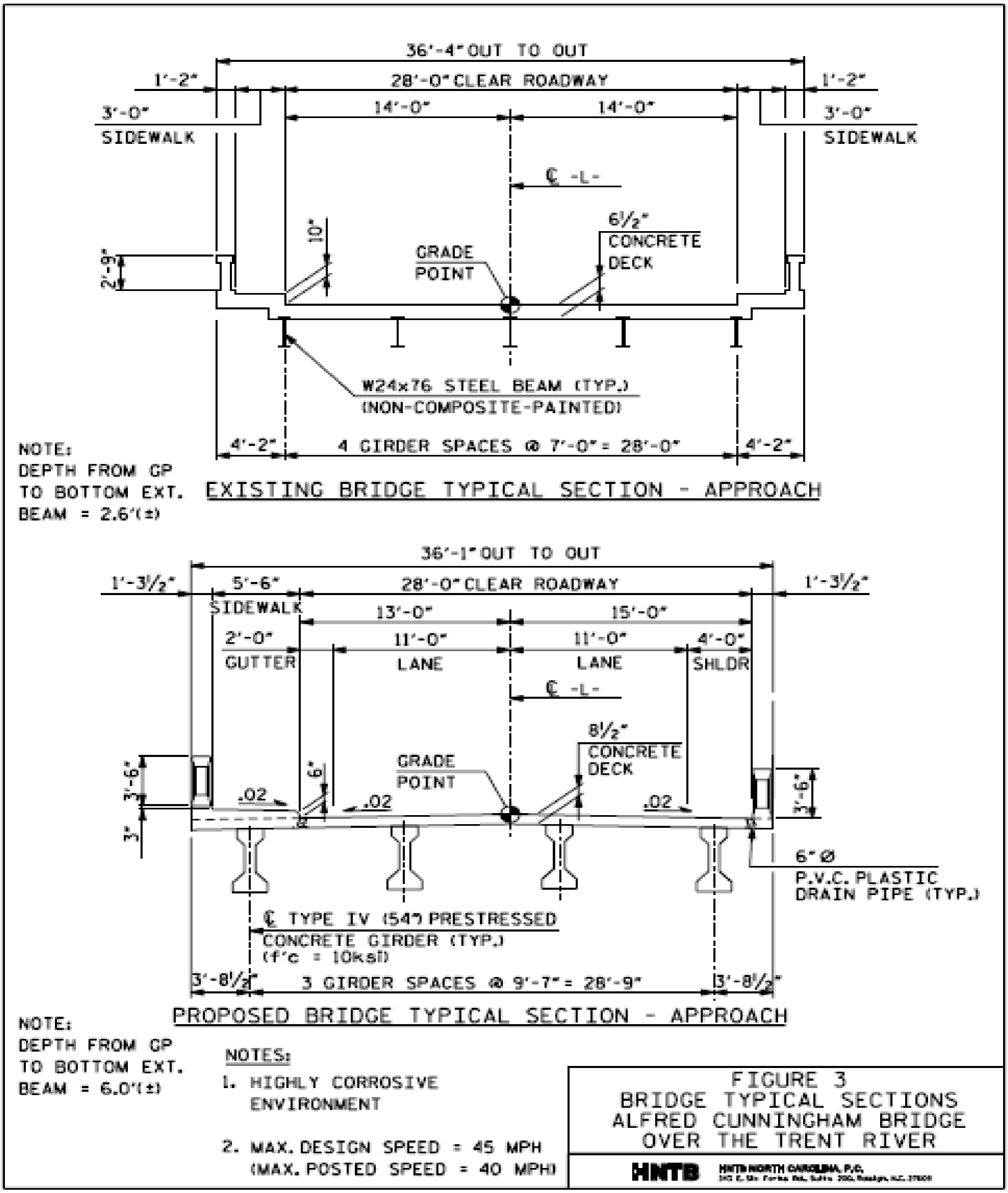

Figure 3. Existing and Proposed Bridge Cross Sections (Categorical Exclusion, 2006)

Project Location

The bridge was eligible for listing on the National Register of Historic Places. The northern end of the bridge is located in the City of New Bern and is adjacent to the New Bern Historic District, which features over 150 historic landmarks. Due to the bridge's eligibility for the National Register and its proximity to the New Bern Historic District, NCDOT consulted with the Advisory Council on Historic Preservation, NC-HPO and the New Bern Historic Preservation Commission (HPC) throughout the project to ensure documentation of the existing bridge as well as the appearance and details for the new bridge addressed their concerns. The main concern was the appearance of the new bridge. For this reason, two Bridge Aesthetics Forums (BAF) were held in New Bern to assist NCDOT with establishing the architectural treatment of the bridge. The BAF was composed of local planners, architects, landscape architects, artists, historians and others having special knowledge or skills related to New Bern's architecture and history. Particular attention was paid to bridge type, mass, scale, materials, colors as well as overall treatment of the bridge railing and pedestrian railing, the bridge operator's house, sidewalk design and detailing of the retaining wall at the north end of the bridge. The proposed architectural treatment of the new bridge was then presented in a joint public meeting to receive public comment.

New Structure

Structure Arrangement

As previously mentioned the new structure placed on the existing alignment was determined to be a bascule bridge with concrete approaches on either side. The movable portion of the bridge is a double leaf trunnion bascule. It is 147 feet from centerline trunnion to centerline trunnion and provides a 90 foot clear navigation channel that is on an 8 degree skew from perpendicular to the bridge. In the closed position the bridge provides 14 feet 11 inches of vertical clearance and when the bascule leaves are raised to their 71 degree normal open, the span provides unlimited vertical clearance in the channel (See Figure 4).

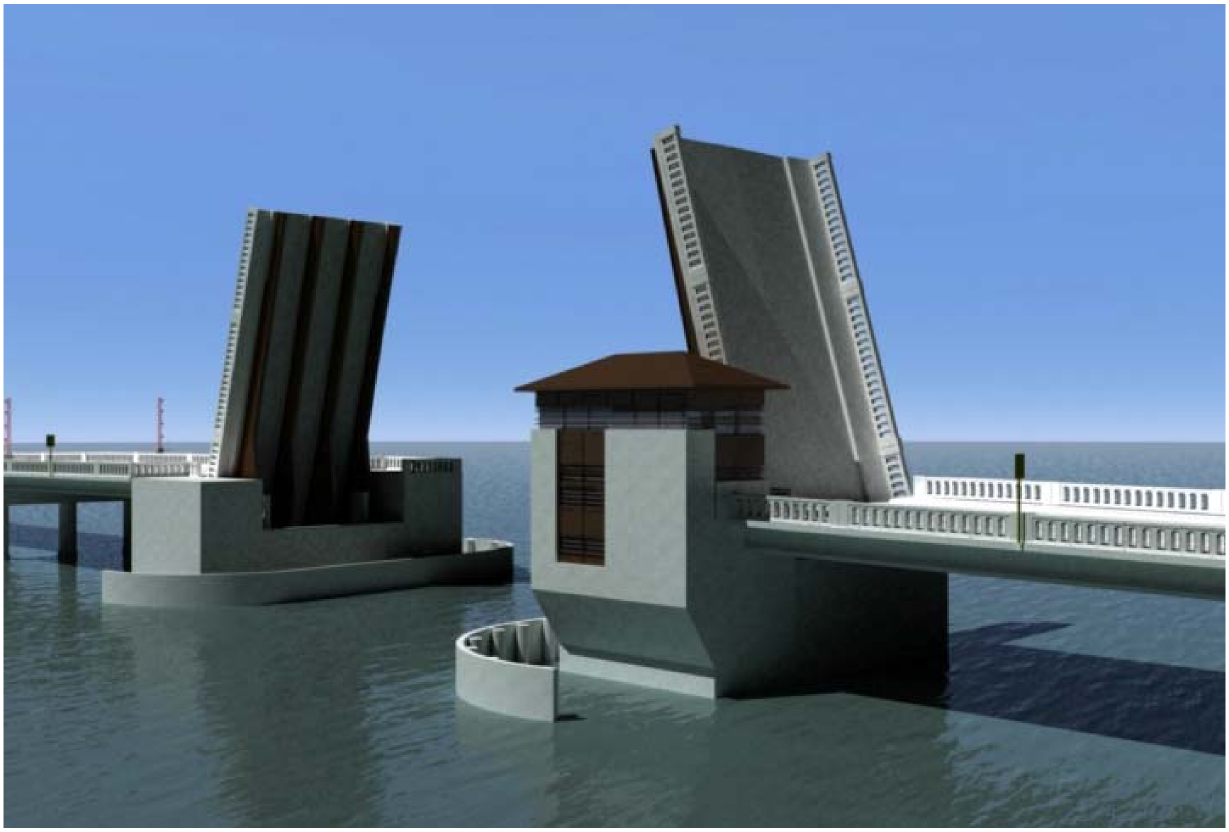

Figure 4. Rendering of Proposed New Structure

Context Sensitive Structure

Control House

The new bridge had to be designed to not only accent and highlight the features of the historic City of New Bern, but also to take some of the original characteristics from the older existing structure. During the development of concepts for the replacement structure certain specific areas were concentrated on to make the new bridge an important part of the surrounding community and still retain some details from the original bridge.

The most prominent feature of the new bridge, other than the bascule span is its control house and for this reason special emphasis was placed on the architectural treatment of the building. The control house is a three story structure that provides a critical function for the bridge. The top floor is the operator level. From here the traffic is stopped, communication with mariners is conducted and all operations of the bridge opening are performed. The roadway level is the entrance to the second level that houses the electrical equipment as wells as the bathroom facility for the operator. The third level below the roadway is where the generator, used as an alternate power source, is housed in case of power interruption.

When developing the details for the control house, HNTB's architects continued to look at the historic nature of downtown New Bern, but it was not the intent to make the control house appear historic or have construction details of the buildings from that period. Rather the appearance of the control house would utilize highlights from these building.

Many of the historic structures as well as the new convention center located adjacent to the Union Point Park are constructed of red brick (See Figure 5). This held an important link that the architects felt the control house should utilize. Since brick is not practical for construction on a bridge, the new control house, with its modern features, had the details and colors selected to highlight and match the red brick. The control house built mostly of concrete had the concrete made of the architectural white concrete and a terracota rainscreen wall system along with the building louvers made in red brick color. The combination of the red on white complimented each color. The adjacent convention center features a green patina roof and the architects utilized this by making the control house room constructed of a standing seam copper hip roof with deep overhangs for sun control. This roof will also turn patina green with time and weather. The modern features of the control house include glass all around to allow 360 degree viewing at the operator level (See Figures 6 & 7).

Figure 5. General View of New Bern

As previously mentioned, the control house along with other details of the structure including the bridge railing and the retaining wall supporting the downtown approach road were presented to the various stakeholders during two Bridge Aesthetics Forums to allow discussion explanation and receive input on the materials, appearance and details for the bridge.

Figure 6. Details of Proposed Bridge Control House (HNTB, 2007)

Figure 7. Completed Control House

Bridge Railing

To ensure some continuity of the original structure was incorporated into the new structure a concrete bridge railing reminiscent of the original one (See Figure 8) was included in the new bridge. The new railing had to meet minimum requirements for crash testing as well as have the features that were present on the original railing. The new railing (See Figure 9) is a Texas Classic arched railing (FHWA, 2005). To ensure continuity this railing had to exist not only on the approach roadways, but it also had to be utilized on the movable portion of the bridge.

Figure 8. Original Bridge Railing

Figure 9. New Bridge Railing

Unique Structure Characteristics

Bascule Deck

The deck of the bridge utilizes an 8 inch reinforced lightweight concrete deck. This was selected for its improved ride-ability, improved durability as well as its better composite action than other deck types. By using this type deck, the designers were also able to eliminate the lateral bracing of the movable span.

The roadway joint for the separation of the movable span to the fixed span is located at the rear of the bascule span. By doing this it reduces the complex details in the roadway that this joint generally produces as well as provides better protection of the machinery and trunnions below. By introducing the joint to the rear of the bascule span, it also eliminates the need for a flanking span or span specifically required to interface with the bascule counterweight. This further simplifies the details and cost associated with the structure. This also provides simpler details for the transition to the approach spans by having the approach span terminate onto the rear bascule pier wall. Since vehicular traffic rides on the counterweight, the use of tail locks was introduced to eliminate the potential of having vehicular traffic live load opening the bridge.

The unsymmetrical roadway cross section always causes concern for the engineer regarding design loads, but with a movable bridge it also makes for a difficult balancing condition and a more complex counterweight with different areas of unit weights for the concrete. In an effort to offset the magnitude of transverse imbalance, the designers used lightweight concrete for the railing and the sidewalk on the west side while using normal weight concrete on the east side railing.

Bascule Piers

The bascule piers are a four walled box configuration. This was done to allow the structure to be closed for protection from the elements as well as pigeons. It also allowed the counterweight to be able to dip lower than the water level when the span is open. As previously mentioned, the appearance of the structure along with its size and mass were important aesthetic considerations. Trying to minimize the size of these piers was important in keeping the proportioning of the substructure and its relation to the superstructure. The proportioning of the piers to the rest of the structure had to be considered so that they were not out of context. To maintain a clean appearance of the bascule piers, minimal treatment was done to the pier faces. This allowed the other aspects of the structure to be accented.

Figure 10. Aerial view showing outlook and two parking areas

The sidewalk is located on the west side of the bridge. Since the bridge is adjacent to a park and it was desired to integrate the bridge into the surrounding area, the opposite pier from the control house has an overlook. This overlook provides pedestrians a point to stop and observe the city, the Union Point Park, the water and nearby marinas. This added a feature to the bridge that makes it a destination to visit and observe the surrounding areas. This overlook also allowed the south pier to have similar proportioning to the north bascule pier. This overlook also served to provide access to the inside of the south pier.

An added convenience for maintenance personnel and the bridge operators are two parking areas, one behind each bascule pier where workers can safely park their vehicles close to the movable portion of the bridge and not reduce the lane width or close a lane. This had been provided on the previous bridge and was requested on this structure (See Figure 10).

Structure Proportions

The movable portion of this double leaf bascule bridge has a long and slender arrangement. To keep this proportioning as well as maximize the vertical clearance in the closed position, welded plate steel for the bascule girders was done. This allowed the designer the ability to detail the girder to the requirements of the design and optimize the geometry and material. As previously mentioned, the bascule piers were meant to be minimized for proportioning, but also for cost. The size of the back (or rear) portion of the bascule span determined not only the length of the pier longitudinally, but also its depth. This is due to the rotation of the span during an opening. Since the deck, sidewalk and railings on the bascule span were all made of concrete, wherever possible elsewhere, weight optimization was performed. The use of a practical, but heavy unit weight concrete for the counterweight was done to try and minimize the volume of concrete and the rear end of the bascule span. Coordination of the dimensions and details between the fixed and movable portion of the bridge to ensure sufficient clearances was required. This included the base of the bascule pier, the trunnion columns as wells as the platform that supports the operating machinery (See Figure 11).

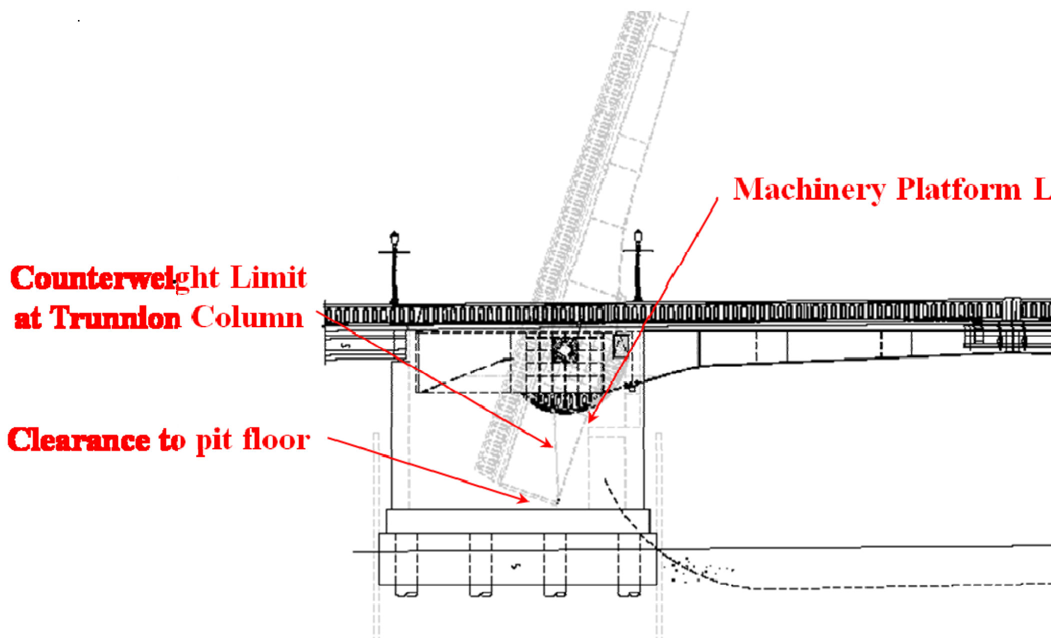

Figure 11. Tight Clearances in bascule pier

Figure 12. Finished Structure

Conclusion

Replacing an older bridge with a new structure in an historic district of a town can be a daunting task. It takes the right people who are, suitably prepared, ready to listen, understand, explain and be able to incorporate agency, historian and public concerns into the project. Being able to conceptualize, set proportions, select specific details, overcome unique challenges and explain the concept are critical for all parties to understand and reach consensus for the structure to be built successfully. Understanding the importance of each component and how it can affect the outcome is critical when designing any new movable structure. This paper only highlights a small portion of the effort, discussions, explanations, understanding, coordination and agreements necessary to produce a unique aesthetically pleasing, context sensitive structure situated in a historic city (See Figure 12).