HEAVY MOVABLE STRUCTURES, INC.
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NW 17TH AVENUE BRIDGE REHABILITATION OVER THE MIAMI RIVER MIAMI-DADE COUNTY

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What can be done in 213 days!

CARIBE ROYALE HOTEL
ORLANDO, FL

Introduction

In light of the recent bridge failure of the I-35W Interstate Highway Bridge in Minneapolis and the shockwaves it caused, it was not surprising that when a South Florida local TV station ran an article on the NW 17th Avenue Bridge in downtown Miami, it caught the attention. The bridge was on the Florida's list of "structurally deficient" bridges and is one of the major crossings over the Miami River, while being near a major hospital and court houses. Excerpts of the article that was posted on the TV station's website stated:

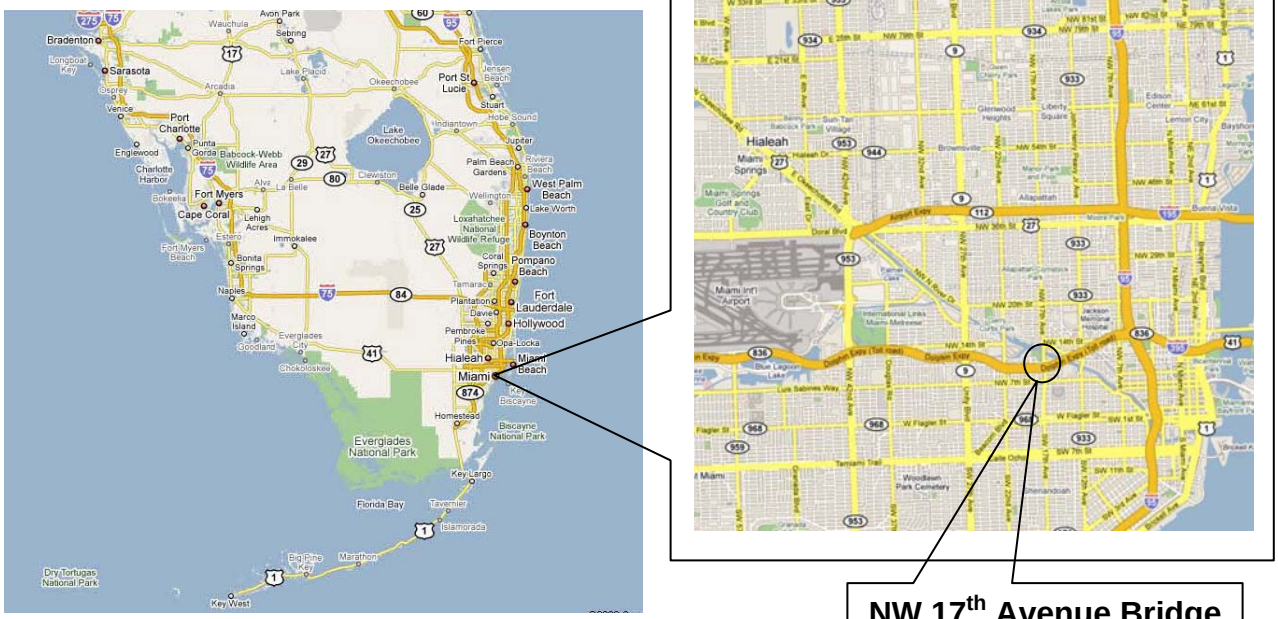
"NBC 6's Jeff Burnside looked at one of the 50 listed bridges Friday with an engineer from Florida International University. The bridge was visibly in poor shape – it shook when cars crossed over it. To be sure, Luis Prieto, a highly-credentialed FIU professor, inspected the bridge. "It's a potential danger, Prieto said. Trieto said, for 20 years, he's been bringing students to the NW 17th Avenue Bridge as an example of a dilapidated bridge. "I personally, if I were a director of public works, I would shut it down right now," Prieto said, "I think it is a serious situation.""

The week this ran, the Miami-Dade County had announced a weight restriction on the bridge for 5 Tons, which was initially being enforced by police officers. However, once they were removed, the load restriction was not obeyed which forced the County to completely close the bridge. This caused major delays especially when the adjacent NW 12th Avenue Bridge and the NW 5th Street Bridge were partially/completely closed for replacement. Further it was observed that many motorists would not stop on the bridge during red lights due to fears from the bridge vibrating and deflecting.

The bridge, a double leaf, simple trunnion type bascule span bridge constructed in 1928, was certainly showing its age.

Project Overview

Project Location

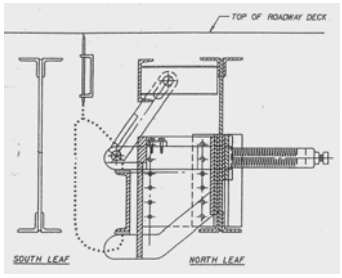


Bridge Description

The NW 17th Avenue Bridge, built in 1928, is a six span bridge with a double leaf bascule span carrying four lanes of traffic, two northbound and two southbound. The nearest bridges over the Miami River are the NW 12th Avenue Bridge to the east and NW 22nd Avenue Bridge to the west.

The existing bascule span was a three girder system with floorbeams that support a two level stringer system and an open deck roadway grating with filled concrete grating cantilevered sidewalks. The three girder system was a design developed by Harrington, Howard and Ash. John Lyle Harrington was the former partner of John Waddell – founder of Hardesty & Hanover, LLP. There are only about five known bridges of this type still in existence, four in Florida (one is being replaced currently, NW 5th Street Bridge) and one in New Jersey. The original floor system consisted of transverse floorbeams, longitudinal stringers and transverse timber ties supporting timber planking. The timber portions of the deck system were later replaced with transverse steel substringers (channels) and an open steel grating.

Mechanically, the existing machinery facilitated the rotation of each leaf and consisted of trunnion assemblies, rear live load anchors, and automatic mechanical latching span locks. The two separate cantilevered leaves of the moveable span are supported by trunnion shafts, through the bascule plate girders, seated in sleeve bearing assemblies. Moment on the leaf is reacted against by the live load anchors located between the bottom flange of the flanking span floor beam and the top of the bascule girders at the rear of the counterweight (there are no forward live load shoes). The tip of each north span girder at the channel side had an automatic mechanical latch. During movable span operation the north (near) leaf must be seated first and then the south (far) leaf bar engages with the north leaf latches (3 total). The latches transfer the shear force from traffic live loads crossing the span.



The existing operation was achieved by an electric motor energized to provide torque to the main drive rack pinion through 5 stages of an open gear train. The main drive pinion was fixed to the pier in the shaft sleeve bearings and the pinion engaged with the circular rack bolted to the center bascule girder. The leaf rotated as the drive pinion walked the rack.

Electrically, the existing electrical system provided speed and direction control of the main span motors and rudimentary safety interlocking with traffic signals and traffic gates. Drum switches in the control console on the observation level of the control house and resistors located at the floor below, limit the current to the motors thereby controlling their speeds.

Original Scope of Work

Contract Plans and Documents for the rehabilitation of the structural components and the replacement of the span lock mechanisms were completed about ten years ago by others but were not tendered. The County was in the process of finally tendering it at the time of the TV station's article.

The project was bid as a traditional design/bid/build project and the scope of work generally consisted of:

Bascule Span

- Structural
  - Repairs to bascule girders, floorbeams, trunnion girders, live load anchors and pedestrian railing
  - Replace deck and sidewalk grating, substringers and sidewalk stringers
  - Modifications to Thrie beam railing system
  - Lead abatement and painting of structural steel
- Mechanical
  - Replace the three span lock latches with two outboard span lock bars with Hydraulic Power Units (HPU) and one mechanical center span lock latch (similar to existing)
  - Balance spans
- Electrical
  - Limit switches, electrical power and control station for new span locks

Approach Spans

Repairs to deteriorated concrete on approach spans.

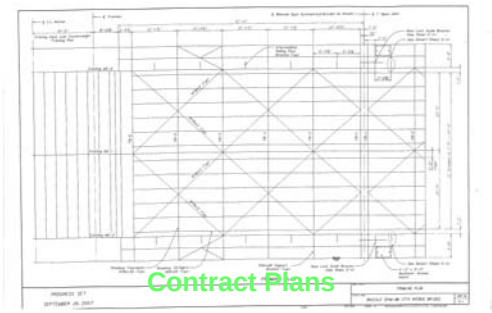
Project Challenges

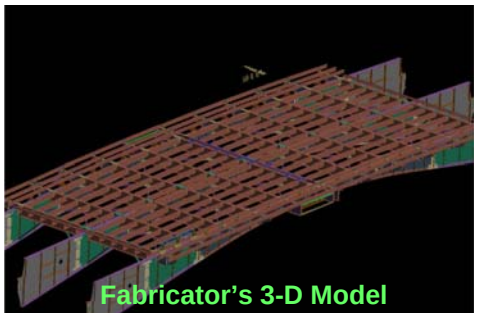
Due to the earlier that expected closure of the NW 17th Avenue Bridge, public awareness and the resulting traffic congestion, the project was turned into a fast tract project. PCL Civil Constructors Inc., the general contractor, was the successful contractor and at the start of construction soon realized that the Contract Plans for the project no longer were representative of the rapidly deteriorating bridge. Hardesty & Hanover was retained by PCL Constructors Inc., with consent from the County, to value engineer the rehabilitation project and provide the design for the additional extensive repairs that were not originally anticipated. What made this project schedule even more demanding was that the completion date of the project could not be changed despite the value engineering that had to be carried out and the resulting design that needed to be done as well as the additional design that was not in the original scope of work. It all had to be completed within the original contact duration of 260 days. Notice to Proceed was given to

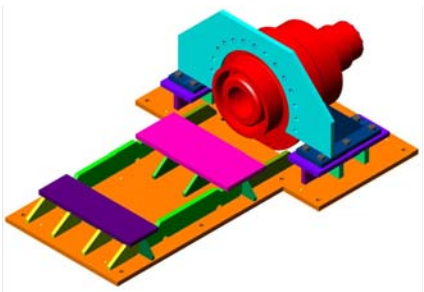
PCL Civil Constructors on September 4, 2007. The bridge had to be open to vehicular and pedestrian traffic on March 7, 2008 and marine traffic had to be maintained at all times during construction.

The value engineering indicated that it was more cost effective to completely replace the floor system including the sidewalk brackets in light of the fast track nature of the project and unchangeable completion date. To further complicate the already tight schedule, Hardesty & Hanover had completed earlier in 2007, a detailed inspection and evaluation of the mechanical and electrical systems on this bridge, and the County decided in early December 2007 to include the design and construction of the complete replacement of the mechanical and electrical systems in this contract. In addition, the Coast Guard required that the bridge opening provide a 75 feet vertical navigation clearance above mean high water level (MHW) and this had to be incorporated in the design.

This necessitated the need to work closely and concurrently with PCL Civil Constructors, steel fabricators, mechanical and electrical sub-contactors and suppliers, due to the extremely tight project schedule and budget restraints by the County. Hardesty & Hanover undertook the value engineering, detailed design and preparation of contract plans with enough details for the fabricators and sub-contractors to prepare shop drawings of the structural, mechanical and electrical work. Specifications were to be placed on the contract plans and shop drawings. In essence detail design, preparation of contract plans and shop drawings were basically occurring concurrently. The sub-contractors were in close contact with their suppliers to determine what materials and equipment were readily available so that it could be incorporated into the design and the major emphasis of the design was not only cost but speed of erection and installation. With the County's approval due to the urgent nature of the project and the unique circumstances, it was the final shop drawings that were to be signed and sealed by Hardesty & Hanover, the EOR for this work. The steel fabricator, Florida Structural Steel, Inc., for the first time, made a 3-D computer model of the entire structure, as part of their shop drawing preparation, which could be rotated in any direction, thus showing any fabrication or erection conflicts or problems. The mechanical sub-contractor, Electro Hydraulic Machinery Co., also produced 3-D renderings of the various mechanical components, all to minimize/eliminate fabrication and erection problems.


Contract Plans


Fabricator's 3-D Model



Once shop drawings were approved by Hardesty & Hanover, with short turnaround times ranging from 1 to 5 days, fabrication started immediately. Items with long lead times such as machinery equipment (span locks, main pinion assemblies and hydraulic system) were given priority.

Revised Scope of Work

The project originally bid as a traditional design/bid/build project, due to the revised scope of work was turned into a design-build project. The revised scope of work generally consisted of:

Bascule Span

- Structural
- - Repairs to bascule girders, floorbeams, trunnion girders and live load anchors
  - Replace the complete floor system with new floorbeams, stringers, lateral bracing, steel grating, sidewalk brackets, aluminum sidewalk grating and heel joint
  - Replace Thrie beam railing system and pedestrian railing with new Wyoming TL-4 railing system and aluminum pedestrian railing
  - Lead abatement and painting of structural steel
- Mechanical
  - Replace the complete mechanical open gear and electrical drive system with a hydraulic gear motor system
  - Replace pinions and shafts
  - Replace the three span lock latches with two outboard span lock bars with Hydraulic Power Units (HPU)
  - Increase span opening to provide 75 feet vertical navigation clearance above Mean High water level (MHW)
  - Balance spans
- Electrical
  - Replace the complete electrical system and new control system and power distribution systems

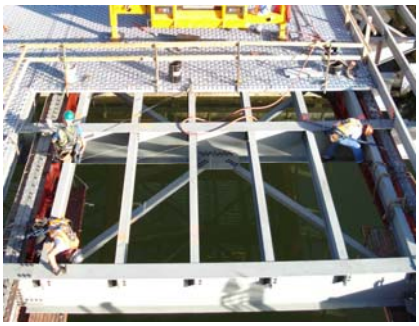
Approach Spans

Repairs to deteriorated concrete on approach spans
Replace deck slabs on spans over the counterweights (flanking spans).

What resulted was a $9.8 million design-build rehabilitation of the bridge including the replacement of the deck on the flanking spans and concrete repairs to the approach spans.

Improvements

Structural



The entire bascule deck and support system, stringers, floorbeams, grating and sidewalks were replaced in lieu of repairs (as per the original contract) due to the severity of the corrosion discovered, to reduce environmental impacts and to expedite construction. The two level stringer system was replaced with a conventional longitudinal single stringer system. The stringers were positioned to ensure that the grating did not have to be supported on the existing bascule girders as per the original design. This enabled the reinforcement of the bascule girder top flanges to be simplified with no interference from the grating. The concrete filled sidewalks were replaced with an aluminum closed grating which greatly reduced the weight on the bascule span leaves. Bascule span weight was one of the major issues that had to be considered in the design to ensure proper balancing of the bascule span leaves both during construction and at the end of construction. The two new span locks at the toe of the bascule span added a considerable weight to the north bascule leaf in terms of balancing, therefore considerable effort had to be made during design to reduce the weight on the bascule leaves.

Since marine traffic had to be maintained throughout construction, the bridge had to be in balance throughout construction. The existing TL-2

traffic railing was upgraded to a TL-4 traffic railing providing the proper protection to both vehicular and pedestrian traffic. Rather than repairing and repainting the aging existing pedestrian railing system, new aluminum pedestrian railings were used and thereby reducing the weight on the bascule span leaves. The remaining bascule and trunnion girders, as well as the new structural steel, were painted.

Repairs were also required to the main bascule girders due to deterioration to the girder webs behind existing connection angles for the floorbeams. The web plates had rusted through in many locations and reinforcing steel plates had to be provided to compensate for the section loss.

Mechanical

The open gear operating machinery was replaced with a hydraulic gear motor and planetary reducer directly driving the new main rack pinion. To minimize the field installation, the hydraulic motor, pinion/pinion shaft and bearings were all installed in the shop on a steel plate support assembly. This assembly was then positioned in the field on leveling screws and then grouted under the steel plate assembly and held in place with anchor bolts. The Hydraulic Power Units (HPU) were placed under the flanking spans for protection and to maximize space on the bascule piers. The HPU was placed about 10 feet above the hydraulic motor, however the head pressures did not negatively affect the operation of the bridge.

Hydraulic cylinders were considered as another alternative, which would push and pull on the bascule girders to raise and lower the bascule leaves. The advantage of installing cylinders is that the existing racks, and their an uncertain remaining service life, can be eliminated. Although the cylinders could be installed under the bottom flange of each bascule main girder with considerable modifications, it also would require considerable modifications to the bascule piers to accommodate the new hydraulic cylinders and this option was eliminated. It also would not fit the tight project schedule and would be more expensive.

Hardesty & Hanover redesigned the original contract two span lock and center latching mechanism with a two span lock system that is located under the sidewalks for easy accessibility.

Strain gauge balance analyses were carried out before and after construction as part of the bascule span leaf balancing services.

To satisfy Coast Guard requirements, the span opening had to be increased to provide a 75 feet vertical navigation clearance above mean high water level.

Electrical

Entire new electrical control and power distribution systems to operate the new hydraulic motors and span locks were also provided for this fast-track project, including a new control desk, limit/proximity switches, relays. The existing traffic gates and lights, warning gongs and navigation lights were integrated into the new control system.

Conclusions

On schedule, with the Contractor working around the clock in 3 shifts, the NW 17th Avenue Bridge was reopened to traffic on March 7, 2008, to the delight of the County and the travelling public. There were some skeptics that did not think that the work could be completed within the 7 months, but with team work starting with a good design and contractor and with corporation from the client down to the suppliers, these almost unbelievable goals can be successfully achieved with a grateful and appreciative client and public. One lawyer from the near by Richard E. Gerstein Justice Building was so elated about the bridge opening that he posted in the justice building blog "But now free at last, free at last, we can drive our fuel inefficient SUV's to work while on the phone and drinking Starbucks while screaming at a client, at last!" He had earlier mentioned that their commute time to work had doubled due to the NW 17th Avenue Bridge closure.

The project was completed in 213 day instead of the project 260 days despite the value engineering, redesign, additional mechanical and electrical work and repairs.