HEAVY MOVABLE STRUCTURES, INC.
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REHABILITATION OF THE HOLLYWOOD BOULEVARD (S.R. 820) BASCULE BRIDGE

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Introduction

The Hollywood Boulevard (S.R. 820) Bridge is located in the City of Hollywood, Florida and is owned and operated by the Florida Department of Transportation. The current structure consists of one main bridge, over the Intracoastal Waterway, carrying two lanes of eastbound traffic and two lanes of westbound traffic. The main bridge splits into three other structures; one flyover ramp carrying two lanes of traffic (S.R. 820 to northbound S.R. A1A and northbound S.R. A1A to S.R. 820), one off ramp carrying one lane of traffic from S.R. 820 to Southbound S.R. A1A and one on ramp that carries one lane of traffic from Southbound S.R. A1A to S.R. 820. The main span is a double leaf bascule type drawbridge spanning 129'-6" trunnion to trunnion. In the raised position, the bascule span gives unlimited vertical clearance for tall vessels to pass through a ninety foot navigable channel which leads to Port Everglades and the Atlantic Ocean to the North and to interior canals, inlets and Biscayne Bay to the South.

History

Envisioned by Joseph Young, the Hollywood Boulevard Bridge was first constructed in 1925 at the cost of $110,000. The bridge was first intended to be a small-scale crossing over the Atlantic Intracoastal Waterway from mainland Florida to the "crown jewel" of the east. That was how Young used to refer to his Hollywood Beach Hotel located in the eastern most section of Broward County at the end of the grand east-west corridor that was Hollywood Boulevard. The bridge was later replaced in 1976 with the current structure and was then rehabilitated in 1988. The rehabilitation included replacement of the Hopkins Frame mounted operating machinery gear train with hydraulic actuated rams to open the bascule span. Today, this heavily traveled thoroughfare provides access to major north-south routes including I-95, Florida's Turnpike, and US 441 heading west from the bridge and SR A1A (Ocean Avenue) heading east. The bridge also offers safe passage to the many pedestrians and bicyclists that use it everyday.

Project Description

Hardesty & Hanover performed an in-depth inspection in November 2000 in order to ascertain what improvements or modifications were necessary to easily maintain and ensure reliable performance of the structure. The report was submitted to FDOT in 2001 and plan production began shortly after for the rehabilitation of the structural, mechanical and electrical components with an estimated construction cost of approximately $4,000,000. During this time, the Hollywood Beach Community Redevelopment Agency (a division of the City of Hollywood) was conducting a major street planning and transportation study. The primary goal of the study was to identify key improvements that once implemented will reinforce the beach as a tourist destination and a great mixed-use urban village in which to live. One of the key improvements was to revitalize and return some of the historic significance to the beach gateway, the Hollywood Boulevard Bridge. At this time the Hollywood Beach CRA expressed their desire to FDOT of incorporating aesthetic improvements into the ongoing rehabilitation plans. The Hollywood Beach CRA offered to invest an additional $1,000,000 on the project with the condition that FDOT would increase their construction funds by an equal amount of $1,000,000. The extra $2,000,000 was supposed to cover the extra expenditures for the much desired aesthetic improvements. FDOT agreed to the city's proposal and in 2002, after the 60% submittal, plan production was stopped in order to make the necessary corrections and additions to meet the City of Hollywood's demands.

Early 2003, Hardesty & Hanover and FDOT, through a series of meetings, initiated discussions with the Hollywood Beach Community Redevelopment Agency and the City of Hollywood regarding the much anticipated aesthetic renovation of the Hollywood Boulevard Bridge. The proposed aesthetic improvements included replacement of the existing roadway lighting with decorative roadway lighting, construction of a new gate house on the northeast corner of the bascule span, renovation of the existing control house on the southwest corner of the bascule span, replacement of the existing fascia traffic barrier with decorative balustrade railing, and construction of new traffic barrier inboard

of the sidewalks. Also, at this time FDOT opted to replace the fender system. Final plans were submitted in January 2005 with an estimated construction cost of $10,000,000 ($4,000,000 more than expected). Construction began in April 2006 and ended in May 2007 with the project being completed two months ahead of schedule and a final cost of $11,000,000.

Major Items of Work

Renovation of Existing Control House

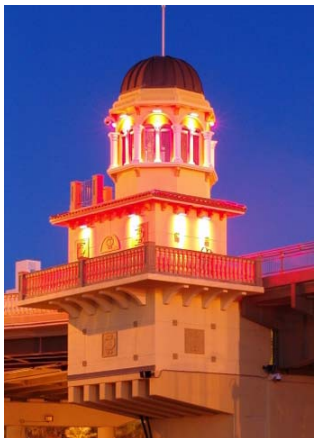
The existing control house is supported by six reinforced concrete cantilever brackets located on the south wall of the west bascule pier and consists of three levels altogether. The two lower levels hold the electrical equipment that powers and controls the machinery and the top level houses the control desk and the bridge operator. As part of the aesthetic improvements, the renovation of the control house included the demolition and reconstruction of the top two levels. The structure was redesigned not only to remain operational but also to resemble the influence of the Spanish architecture that was present at one time in Hollywood. The steel framing and glass windows that surrounded the top or control room level were replaced with reinforced concrete walls and bullet resistant windows for the bridge operator to have an adequate view of the roadway and the navigable canal. The steel frame flat roof was replaced with a single ridge roof composed of wood trusses and sheathing and Spanish clay tiles.

Existing Control House

Renovated Control House

Construction of New Gate House

In addition to the control house, a second house was built on the opposite corner of the bascule span. This structure although not necessary for the mechanical operation of the bascule leaves is a key addition to the bridge aesthetics. It depicts the moor influence that was once present in Hollywood. Unlike the west bascule pier, the original design of the east bascule pier did not anticipate the construction of a three story structure to be cantilevered off one of its side walls. Consequently, Hardesty & Hanover modeled the cantilever house along with the bascule pier in SAP (a computer structural analysis program) as a three dimensional space frame. The analysis concluded the pier wall was not adequate to support the new gate house and therefore had to be reinforced. For this, the side wall with a varying thickness of three to six feet and eighteen feet wide was removed down to the machinery platform level. Fifty seven #10 steel reinforcing bars (1.27 inches in diameter) were doweled eight feet deep into the concrete in order to



New Gate House

increase the wall's load carrying capacity. These massive vertical bars end in a hook and get spliced with #9 horizontal bars (1.13 inches in diameter) that make up the main reinforcing for the six cantilever brackets that support the three story gate house. After the steel work was done and the formwork was in place, the wall and bracket concrete was cast-in-place monolithically. Once the concrete achieved adequate compressive strength the forms were removed and construction of the gate house began. The cantilever brackets and the first two levels mimic those of the control house. The top level is an octagon shaped structure with arched windows all around topped by a copper dome. This top level is the feature that brings back the moor architecture once present in the city.

Pedestrian Safety Improvement

As mentioned before, the Hollywood Boulevard Bridge is heavily traveled by pedestrians and bicyclists. The existing cross section included 4'-8" wide raised sidewalks on both sides of the roadway. In order to provide a safer passage, the sidewalk width was increased to 6'-0" and crash tested traffic rails were installed inboard of the sidewalks providing an adequate barrier between vehicles and pedestrians.

Widened Sidewalk with Inboard Traffic Rail

Increasing Motorist Safety

The existing twelve foot lanes and the 40mph speed limit on the bridge west approach usually meant fast traveling motorists going east. These drivers had a difficult time negotiating the tight curves on the other side of the canal when they had to make a decision to either go right to Southbound S.R. A1A or left to Northbound S.R. A1A. Sometimes, an indecisive driver that would make a late right turn resulted in that driver rubbing or crashing against an attenuator, or crash cushion device, situated at the dividing point between the two ramps. In order to improve safety and minimize accidents, the twelve foot lanes were reduced from twelve to ten feet, the speed limit was reduced from 40mph to 25mph and the Southbound S.R. A1A Ramp was widened and the existing crash cushion which had become obsolete was replaced with a new more current model. Also, as a result of the widening, the new attenuator was pushed back away from traffic increasing the ramp's turning radius. In addition, the existing bascule span open grating was removed and replaced with a new hot dip galvanized grating with concrete filled wheel paths. The wheel paths provide better rideability for vehicles and at the same time reduce tire noise for the betterment of the many residents that live in the vicinity of the bridge.

New Attenuator

Construction of Balustrade with Columns

Construction of the interior traffic rail made possible the removal of the fascia concrete barrier which was replaced with a more architectural pleasing pedestrian balustrade. This is another key addition that truly enhances the bridge aesthetics. The 42" high balustrade consists of 32" high round balusters spaced 8" on center, 4"x9" cap rails and 6"x10" base rails. All three components are manufactured in the shop and shipped to the work site. The balustrade is then installed on a 12"x12" cast-in-place concrete curb achieving a total height of 54" which is the minimum required height for bicyclists. Balustrade segments connect to16"x16"x57"cast-in-place concrete columns typically located at both sides of the bridge deck expansion joints.

Balustrade with Columns

Field Machining of Trunnions

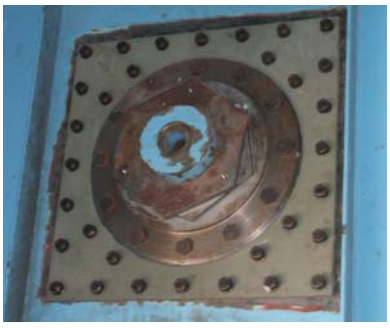
Opening the bascule span for navigational traffic requires the hydraulic operating machinery to rotate each bascule leaf about the trunnion journals. These are the two steel shafts about which the span rotates during operation and which transfers the entire leaf dead load to the supports inside the bascule piers. All four trunnions (two per leaf) exhibited moderate to heavy wear in the form of scoring, spalling and surface corrosion. This condition increases friction and stress on the trunnion which leads to accelerated wear and possibly cracking of the journal. Field machining of the journal using a portable lathe followed by a final polishing and bushing replacement was performed in order to provide a smooth journal surface and reduce stress concentrations.

Trunnion being machined

Field Alignment of Trunnions

The trunnion configuration is the Hopkins trunnion type. A collar assembly is mounted with a key around the center of each trunnion shaft and fixed to the main supporting girders. The inboard end of the trunnion shafts are fixed to trunnion girders by means of an eccentric collar. Collinear alignment adjustment capability between trunnion shafts of the same leaf is provided by the eccentric collar.

The eccentric collars were being replaced as part of the contract. Alignment of the trunnions along with replacement of the eccentric assemblies is typically done during the temporary closure of the bridge to vehicular traffic. This closure is limited in time and therefore any unforeseen problems have to be resolved quickly and effectively. During removal of the existing collars of the west bascule leaf, it was determined that the current misalignment was outside of the range of the eccentric collar's alignment capabilities (about 5/8"). Hardesty & Hanover was immediately called on site in order to assess the problem and aid the Contractor reach a solution. It should be noted that adjustment of the trunnion should be minimized since it distorts the bascule girder web. In this case, the amount of adjustment was too great (approximately 1") and after much deliberation it was decided to shift the eccentric collar axis to be in line with the trunnion rather than force the trunnion into the desired alignment.



New Web Plate with
Mounted Eccentric Assembly

Shifting the axis of the eccentric collar meant a new hole was needed in the trunnion girder web at the new location. In order to provide a new hole and still maintain the required LC1 fit between the hole and the new eccentric mounting collar, a web splice was necessary. New web plates were designed and ordered. They were fabricated and delivered in just three days to the job site. An oversized hole was cut on the existing web, the new plate was attached to the web with turned bolts and the eccentric collar was mounted on the new web plate and secured with turned bolts. After final adjustments the eccentric assembly components were tack welded together and to the trunnion girder webs to prevent any movement or misalignment.

Operating Machinery: Refurbishment versus Replacement

The operating machinery for each bascule leaf consists of two pairs of hydraulic cylinder assemblies, hydraulic power unit (HPU) and piping system. The hydraulic power unit of each movable leaf is mounted to the concrete machinery platform located inside the bascule pier in front of the counterweight. Each HPU consists of: two 20hp electric motors integral with two variable volume hydraulic pumps, one 130 gallon hydraulic oil reservoir with built-in heaters, level, temperature switches, breather, filters, and one main valve manifold

New Cylinder Assemblies

Initially the FDOT was seeking to refurbish the hydraulic cylinder assemblies as well as the hydraulic power unit. However, Hardesty & Hanover performed a cost analysis that included initial and maintenance cost of refurbished versus new cylinder assemblies. The study successfully showed that due to the high maintenance typically incurred by refurbished cylinders, providing new more durable cylinders was the more economical solution. Consequently, the hydraulic cylinder assemblies were replaced and the electric motors that along with the hydraulic pumps and reservoirs compose the HPU were refurbished.

Providing Unlimited Vertical Clearance within Navigation Channel

Bascule bridges typically provide unlimited vertical clearance within the navigation channel delineated by fender systems located between the bascule piers. Prior to the start of construction, it was determined that in the fully open position, the tips of the bascule leaves overhung the fenders. Thus a tall vessel navigating near one of the fender systems could potentially impact the bascule leaf tip. Field measurements showed the current angle of opening of the bridge being 67 degrees instead of the intended 75 degrees, 17 inches of clearance between the bottom of the counterweight and the top edge of the machinery platform and the bascule leaves tips encroaching the channel by approximately 5 feet. In order to increase the angle of opening, components such as the machinery platform, the hydraulic system inspection ladders and the machinery platform handrail required some type of modification or even removal. When the original Hopkins Frame mounted machinery gear train was replaced in 1988 with a hydraulic operating system there was not enough vertical clearance between the bottom of the new lift girders and the top of the existing machinery platform to accommodate the new cylinder assemblies. Consequently concrete supports were cast in place below the machinery platform to support the new cylinder assemblies, holes were cored into the machinery platform for the new cylinders to go through, inspection platforms were provided below the new cylinder supports and inspection ladders were mounted on the vertical face of the machinery platform to access the lower inspection platforms. Clearance diagrams revealed the greater angle of opening would reduce the 17 inch gap between the counterweight and the machinery platform to about 3 inches leaving no space left for the inspection ladders; thus, the ladders were removed. Next, the cored holes in the machinery platform were elongated about 6 inches towards the counterweight side to allow for the hydraulic cylinders

Elongated Cored Hole in Machinery Platform

Access Ladders and Inspection Platforms

to rotate further and achieve the required 75 degrees angle of opening. In addition, the machinery platform handrail that serves as fall protection was set back to maintain clearance between the bottom of the counterweight and the railing with the leaf in the fully open position.

Integration of New and Existing Electrical Systems

Prior to the bridge rehabilitation, the hydraulic cylinder system was controlled by a programmable logic controller (PLC). This is not an FDOT preference. Therefore, a new relay control panel was installed and the HPU control valving integrated with it. In addition, a new PLC was provided with the purpose of diagnosing instead of controlling overall bridge operations.

Social and Economic Considerations

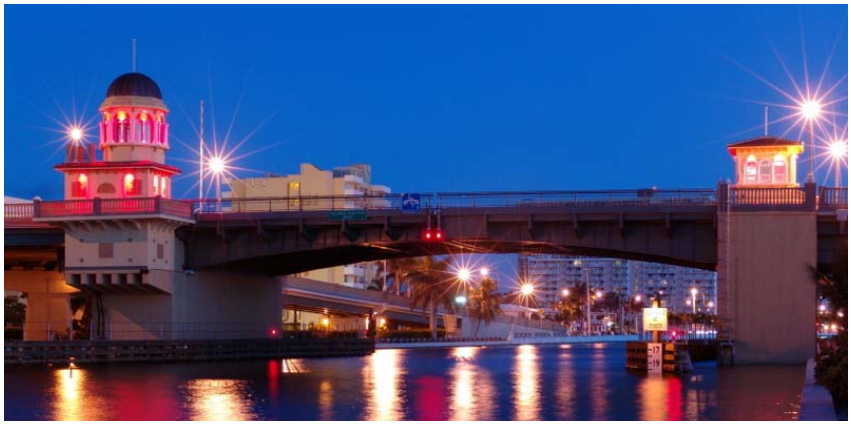
Rehabilitation of the Hollywood Boulevard Bridge is a key component of a master plan to revitalize the City of Hollywood. The previously mentioned aesthetic improvements not only have returned some of the lost historic significance but have successfully turned an ordinary structure into a signature bridge that serves as the gateway to Hollywood Beach. Completion of the project has reinforced the beach as a tourist destination and a great mixed-use urban village where to live which was the primary goal of the City of Hollywood when it joined the venture.

Awards

The project was awarded the Diamond Award for Engineering Excellence in March 2008 by the American Council of Engineering Companies of New York.

Conclusion

What initially started as a typical FDOT structural, mechanical and electrical rehabilitation estimated at $4,000,000 rapidly escalated into a major rehabilitation project with a final cost of $11,000,000 after aesthetic improvements were added to the scope of work. Hardesty & Hanover was able to satisfy the demanding needs from the owner to have a more reliable and easily maintainable bridge and still provide the City of Hollywood with a much desired signature bridge. Our extensive expertise in bascule bridge rehabilitation, along with excellent project planning by the Contractor, made the construction process go fast and with ease. As a result, completion of the project was achieved two months earlier.



North Elevation Looking South of Rehabilitated Structure