Paper No. 2

Ownership/Public Use/Management

Sheridan Street Bascule Bridge Repair

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TENTH BIENNIAL SYMPOSIUM

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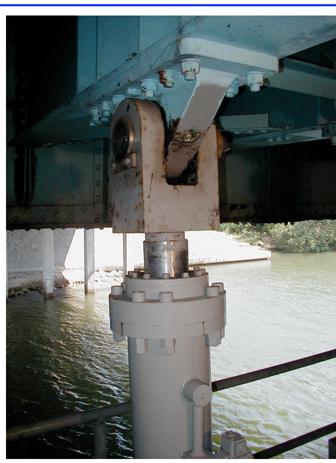
Introduction

Background

The Sheridan St. Bridge is a Hopkins trunnion type double leaf bascule bridge over the Intracoastal Waterway in Hollywood, Florida. The bascule piers are an open counterweight design. Opening the bascule span for navigational traffic requires the operating machinery to rotate each leaf about two collinear trunnion shafts. The outboard end of the trunnion rotates within a sleeve bearing supported on concrete pedestals mounted on the bascule pier, and the inboard end is fixed to a longitudinal trunnion girder, which rotates with the leaf.

Cylinder “Gimbal” assembly



Upper cylinder clevis mount

Operating machinery for each leaf consisted of a retrofitted hydraulic cylinder design (Installed in 1994) replacing the original electro-mechanical gear train design. Each leaf was operated by four hydraulic ram assemblies (2 pairs per leaf) powered by a hydraulic power unit mounted to the concrete machinery platform located inside the bascule pier in front of the counterweight. Each hydraulic actuated piston rod was attached to a longitudinal lifting girder with mating clevis connections. A fitted pin and spherical plain bearing secured the female cylinder rod clevis to the male clevis. The male clevis is bolted to the lifting girder. The lifting girders (1 for each cylinder) framed in between the counterweight girder and a floor beam (FB1). The cylinder housings were supported by a steel ring assembly consisting of an inner and outer steel collar. The inner collar was welded to the cylinder housing with an upper and lower fillet weld. The inner collar was mounted, longitudinally, (in reference to the bridge roadway centerline) to both sides of the outer collar with a cylinder pin and bushing arrangement. Each outer collar was mounted on both sides, transversely, with a trunnion shaft machined from the outer collar, which was mounted in spherical plain bearings inside the trunnion housings. Because of the relative rotation between the perpendicular axes of the inner and outer collars, the cylinder ring assembly and trunnions together are referred to as a gimbal assembly. Adhesive anchor bolts secured the trunnion housing supports to the bascule pier machinery platform. The bottom of the cylinder housing was free and floated in an opening in the concrete platform.

During operation, two 50-gpm pumps are fed hydrostatically by a 300 gallon hydraulic fluid reservoir. Each pump is driven by a 1750-rpm motor. The outlet of each pump continues through a main control manifold. Fluid flow parameters such as direction, pressure and flow rate are controlled and monitored by switches and valves located at the main control manifold. There are two outlets of the main control manifold each connected to two (2) hydraulic cylinders. During operation of the bridge there is a return flow of hydraulic fluid to the reservoir.

The Florida Department of Transportation had experienced cracks exhibited at the lower fillet weld connections of the cylinder wall to the inner collar of the trunnion mounted cylinder ring assembly. In one case, a crack was visible for approximately 200 degrees of the cylinder circumference, prompting corrective action. Six of the eight cylinders exhibited circumferential cracking of the weld. An initial attempt was made to repair the welds in February 1997. The cylinders were removed from the bridge and brought back to the original fabricator of the cylinders for re-welding. The cracks in the welds reappeared shortly after reinstallation of the cylinders (March 1997).

The recurring cracks prompted the FDOT to explore the possibility of retrofitting the Sheridan Street Bridge to accept the hydraulic cylinders originally fabricated for the Las Olas Blvd. Bridge but not installed during the latest rehabilitation. Due to the similarity in size of the two bascule spans and identical hydraulic power units fabricated for each bridge, a feasibility study was commissioned by the FDOT and confirmed the retrofit was possible.

Corroded Counterweight girder

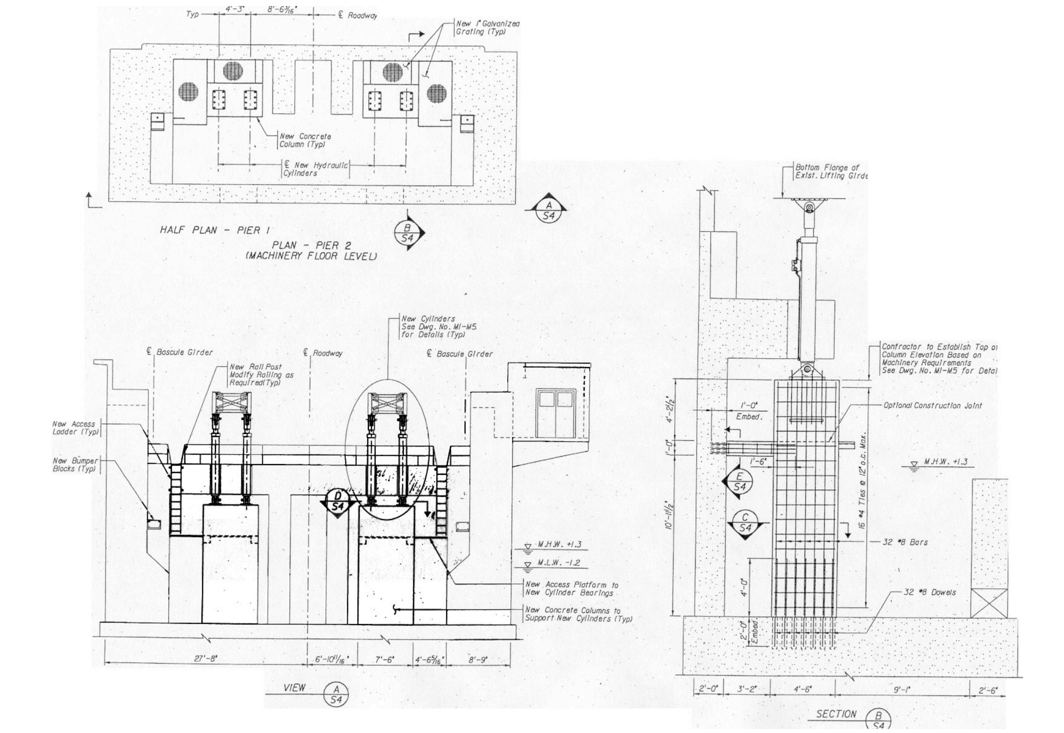
The Department solicited proposals from Design/Build teams to retrofit the existing gimbal mounted hydraulic cylinders with clevis mounted cylinders, perform minor structural repairs to the bascule span and counterweight areas, and paint the entire structure. The Department required a corrosion preventative system be designed and installed to arrest the recurring rapid corrosion rate of the bascule leaf counterweight steel as part of the new coating system and be warranted for seven years, a major caveat considering the existing counterweight dipped into the surrounding seawater at high tide.

Design Options

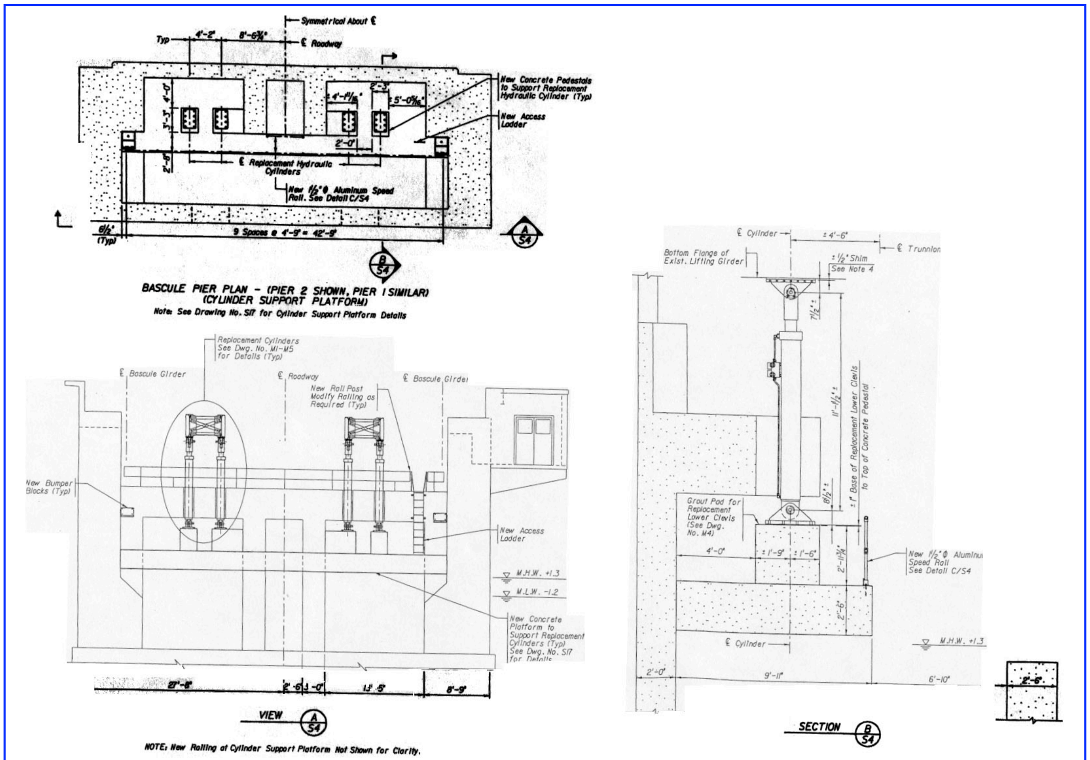
Two hydraulic cylinder-mounting configurations and two corrosion-arresting options were considered for this proposal. The first mounting option involved constructing two concrete pedestals in each counterweight pit and the second involved constructing a concrete platform between the two pier walls perpendicular to the channel centerline. In addition to the cylinder mount configuration, the two corrosion-suppressing options were complete enclosure of the existing counterweight area and a modified coating system combined with a counterweight modification.

Cylinder Support

The first mounting alternative considered and initially proposed to the Department involved the construction of two concrete pedestals in each counterweight pit. The pedestals would originate at the floor of the pit and terminate in a level surface for the lower clevis mounts to bear. This configuration was similar to what was originally proposed at the Las Olas Boulevard Bridge but was eventually ruled out after the contract was awarded due to the possible complications involved with draining and cleaning the counterweight pits as well as the preference of the Department for a work platform that provided better access to the lower cylinder clevises for maintenance activities. The final design incorporated a 2’-6” thick, 3-way concrete slab located just above the mean high water line and spanning between the side walls as well as the splash wall of the bascule pier counterweight pit.

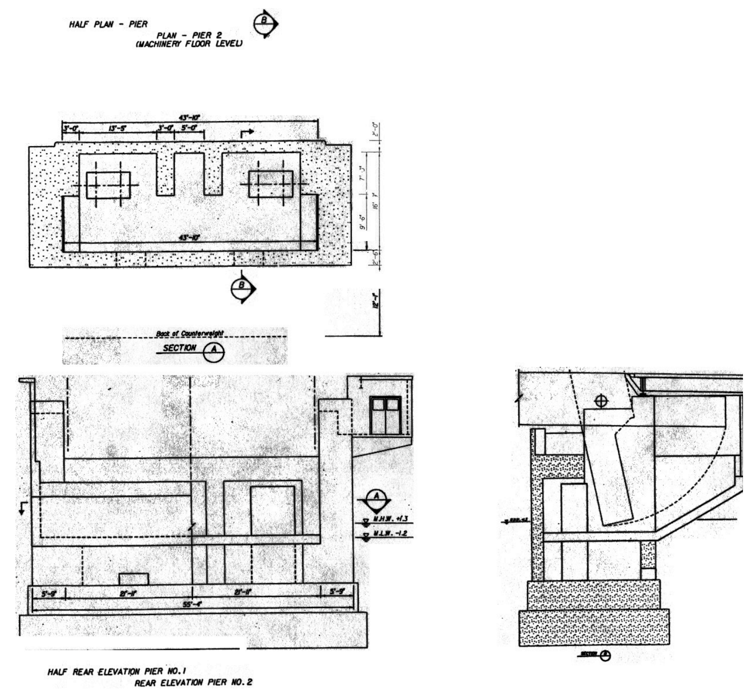


Initial Cylinder Support Option: Pedestals from Counterweight Pit



Final Cylinder Support Configuration

Corrosion Suppression



Cantilevered Counterweight Enclosure

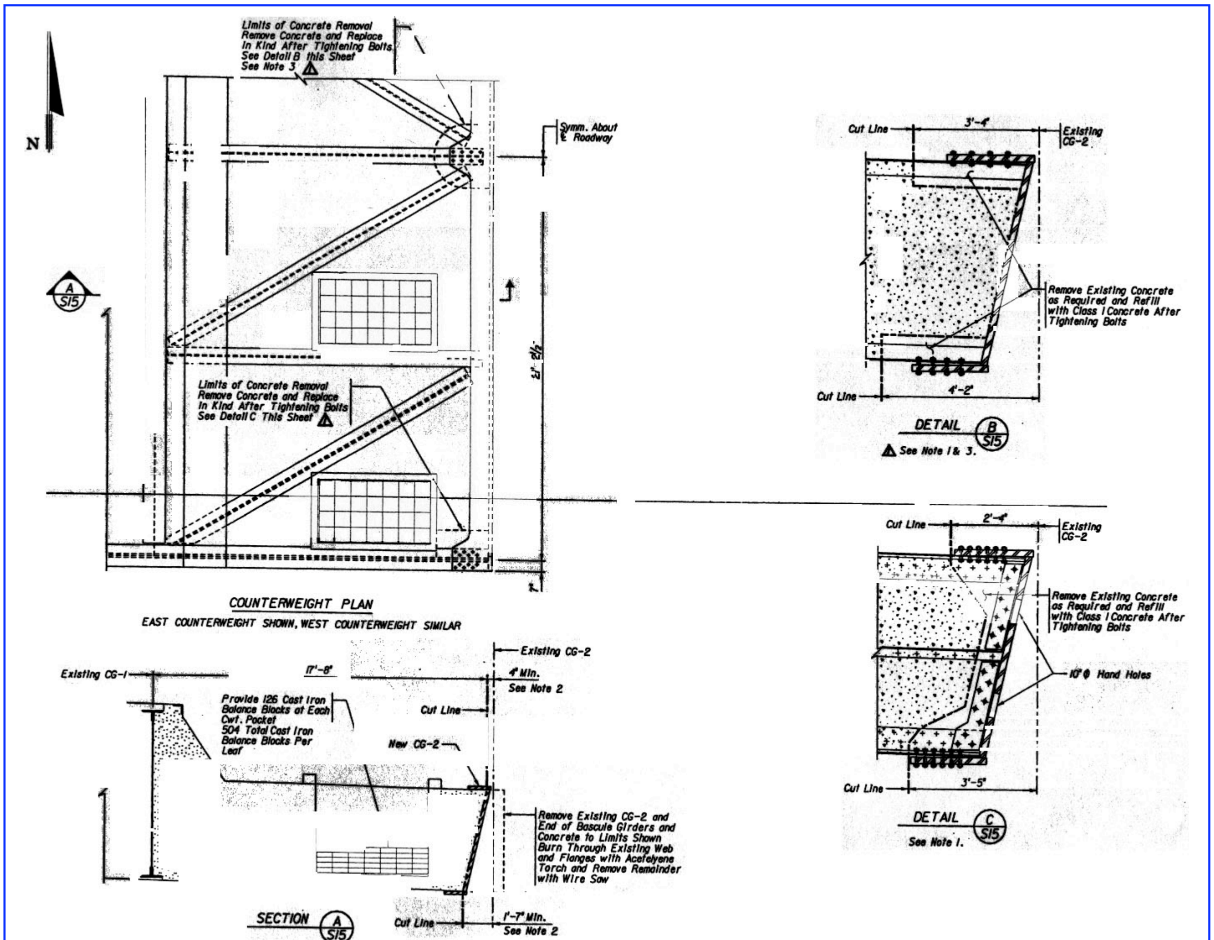
Looking at ways to suppress the corrosion occurring at the counterweight girder proved to be more challenging. The team initially considered enclosing each of the counterweight pits utilizing a cantilevered enclosure that extended below the mean high water line. Issues surrounding construction of the cofferdam under the existing flanking spans as well as doweling of the reinforcing steel into the existing bascule piers eventually led the team to look at other alternatives

The team felt that a traditional field coating system typically used on an FDOT structure consisting of aluminum epoxy mastic primer over coated with aliphatic polyurethane would not provide the required seven year warranty protection against corrosion because of the continual cyclic submersion in salt water. The cyclic submersion as well as surface preparation of the substrate were major contributing factors influencing this decision, so the team explored avenues to improve preparation, the actual coating system and an additional means to protect the coating system from submersion.

Improvements to the painting process for the structural steel encompassed an increase in the pressure used for cleaning from 5,000 to 10,000 psi, and all surfaces were to be blast clean to a “Near White Blast” condition as defined by SSPC-SP-10. In addition, Interzinc 52 organic zinc epoxy primer was to be applied followed by 670HS aluminum epoxy mastic intermediate coat and a finish coat of 990HS aliphatic polyurethane. The intent of the changes was to provide the FDOT with a practical, high performance system that has an extremely high probability of successfully protecting the structure for a duration extending well beyond the warranty period.

Since the final elevation of the structure could not be changed and enclosing the counterweight was not a feasible option, the last possibility to prevent the counterweight from submersing in the surrounding salt water was to shorten the length of the counterweight. This solution was a viable alternative considering steel repairs needed to be performed on the counterweight and it would be virtually impossible to remove all the existing corrosion during surface preparation for the coating system. By shortening the counterweight length by approximately 20”, then fabricating and installing a new counterweight girder, submergence of the counterweight into the seawater could be virtually eliminated.

A sloped counterweight girder was designed to minimize the amount of mass that needed to be removed from the structure. The girder is comprised of a 2” plate web, with welded 2” plate top and bottom flanges. The span balance was analyzed utilizing the new structural configuration and it was determined the imbalance induced by removing the existing counterweight girder associated concrete could be compensated for through the use of steel counterweight blocks in lieu of the existing concrete ones.



Modified Counterweight Girder Design

CONSTRUCTION

Overview

The sequence of construction consisted of the following: construct the 3-way slab in the east pier counterweight pit area while the existing hydraulic cylinders continued to operate the leaf. Once the slab was completed, remove two of the old hydraulic cylinders and install two new cylinders. Once the cylinder pair was operational, the remaining two old cylinders were to be removed and the remaining new cylinders installed. While the east counterweight was shortened and the new counterweight girder installed, the west bascule pier 3-way slab was to be constructed and the new hydraulic cylinders installed. Upon completion of the east counterweight girder installation and west leaf cylinder replacement, the west counterweight would be modified. All painting activities were to be concurrent with the aforementioned construction.

Cylinder Supports

A temporary work platform was constructed just below the bottom elevation of the 3-way slab using removable aluminum beams and panels. Plywood was placed on top of the panels to serve as the bottom concrete form for the 3-way slab. The top and bottom mats of rebar were doweled into the bascule pier walls and the cylinder support pedestal reinforcement was placed. Cast-in-place anchor bolts for the lower cylinder clevis were positioned and the concrete was placed. Once the slab obtained initial cure, the first new pair of hydraulic cylinders was installed.

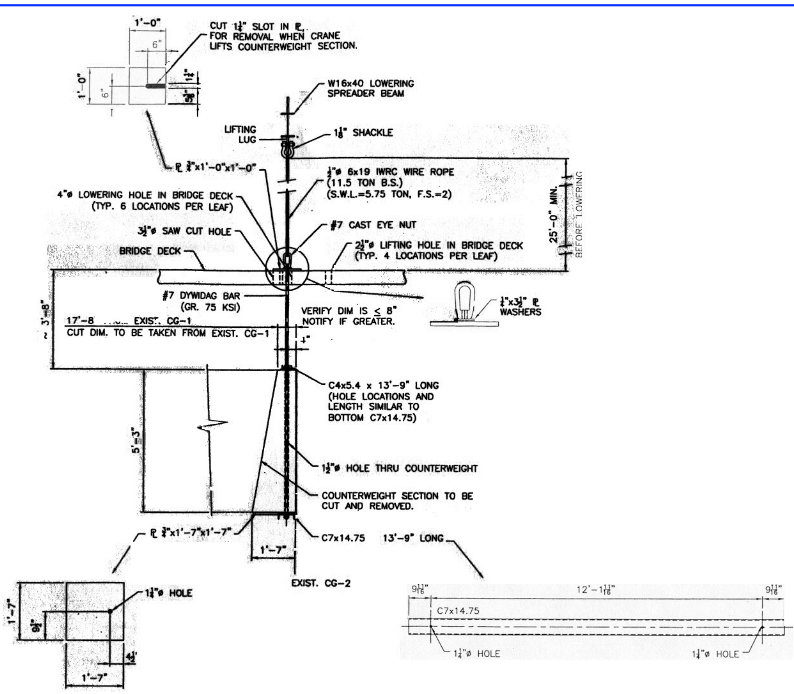

Construction of 3-way slab


3-way slab and support pedestal reinforcement


3-way slab completed and first pair of cylinders installed. Second pair is awaiting installation.

Counterweight Modifications

A series of holes were cored vertically through the counterweight to allow the contractor to install #7 Dywidag bars with top and bottom support channels, cast eyes nuts and grooved plates necessary to support the weight being removed. The holes in the counterweight lined up with corresponding holes cored through the flanking span deck directly above. In addition, two vertical grooves were cut into



Proposed means to lower portion of counterweight


#7 Dywidag bars and channel installed to support counterweight section to be removed.


Dywidag bars extending up through flanking

the existing counterweight girder and one groove was cut into of the each main girders to act as guides when the counterweight was cut. The Contractor chose to cut the counterweight to be removed into thirds and was accomplished by coring two additional holes through the counterweight concrete at the proper locations and using a wire saw to transversely cut through the outer third of the structure on both sides, leaving the entire section to be removed supported by the middle third and the Dywidag bars. Two longitudinal cuts were then made into the counterweight separating it into three separate portions for removal. Each third was then lowered onto a barge positioned under the flanking span and removed from the work area.


Wire saw pulley system on flanking span. Note support plates and cast eye nut in foreground.


Pulley system beneath flanking span to change wire saw direction


Wire saw making transverse cut through counterweight.


Workers attaching spreader bar and cable rigging to cast eye nuts in preparation to lower counterweight section.


Counterweight section being lowered onto barge.


Counterweight section resting on barge.

Prior to installation of the new counterweight girder, additional concrete had to be chipped away from the remaining structure for access to the bolted connections. Once concrete "clearancing" was complete, installation of the new counterweight girder was the reverse of the removal, but a larger spreader bar was used.


Counterweight concrete condition after saw cut


New counterweight girder on-site


New girder being hoisted into position


New girder being hoisted into position

Completed counterweight, machinery area and painting.

Sheridan Street Bridge

SUMMARY

The Sheridan Street Bridge project was intended to repair recurring problems with the collar fillet weld s supporting the hydraulic cylinders, correct minor structural issues and extend the life of the structure by performing maintenance painting.

Construction Value:	$2,500,000
Advertised Contract Time:	365 Days
Proposed Contract Time	270 Days