HEAVY MOVABLE STRUCTURES, INC.
TWENTIETH BIENNIAL SYMPOSIUM

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FDOT Sheridan Street over ICWW Bascule Bridge Rehabilitation Project

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SHERATON HOTEL
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Background/Introduction

Purpose of Project

In 2018, the Florida Department of Transportation (FDOT) advertised a professional services contract to design the rehabilitation of the bascule bridge carrying east and westbound SR-822/Sheridan Street over the Intracoastal Waterway in Hollywood, Florida. TranSystems (Consultant) was selected to perform the in-depth inspection, rehabilitation design, and post-design services for the double leaf bascule bridge. The in-depth inspection, testing, and evaluation for rehabilitation, including strain gage span balance testing, counterweight pockets survey, and detailed trunnion bearing/journal inspection began in early 2019.

In May 2021, PCL Construction (Contractor) was awarded the bridge rehabilitation/construction services through the traditional hard bid solicitation process. Pinnacle Consulting Enterprises, Inc. was selected by FDOT to perform project administration and independent construction engineering and inspection services.

The objectives for the rehabilitation included enhancing pedestrian/bicyclist and driver safety, improving bridge operational reliability and resiliency, and extending the useful life of the 60-year-old movable structure. The bridge is 354'-3" long and includes a 109'-0" double leaf bascule span. The bridge had been previously rehabilitated in 1993 and 2003. The mechanical drive machinery was replaced during the 1993 rehabilitation with a hydraulic cylinder drive system.

Major Scopes of Work

The project consisted of improvements to bridge operation and locking machinery, electrical and control systems, hydraulic fluid power systems, and structural elements. Specifically, the major scopes of work included upgrades to:

1. <u>Electrical Service and Main Feeder</u>: Replacement of three-phase electrical service, service meter, main disconnect (main feeder), and grounding electrodes.
2. <u>Standby Backup Generators</u>: Installation of 200 kW main standby generator with 100 kW load bank and 300A manual transfer switch, 60 kW house standby generator with 30 kW load bank and automatic transfer switch, and all associated conduit and wiring.
3. <u>Motor Control Center and Power Distribution Panel</u>: Replacement of motor control equipment, lighting transformer, lighting panel, and installation of uninterruptible power supply.
4. <u>Span Drive Motor (Hydraulic Pump Prime Movers)</u>: Replacement of existing motors with variable speed induction motors with flux vector drives for the new hydraulic power unit speed control.

FIGURE 1: Motor Control Center

5. Surge Suppression and Lightning Protection: Installation of surge suppression and lightning protection components to achieve NFPA 780 for the entire bridge system.
6. Bridge Control System: Installation of relay control system with PLC monitoring, including new control panel and control console.
7. Submarine Conduit: Installation of submarine HDPE conduit system via horizontal directional drilling methods, stainless steel submarine cable junction boxes, and all non-armored submarine cables with suitable number of spare conductors.
8. Vehicular and Pedestrian Traffic Control: Replacement of existing traffic signal and signal heads, and installation of new swing arm style sidewalk pedestrian gates.
9. CCTV, Communications, and Alarms: Installation of closed-circuit television (CCTV) camera system, public address and speaker communications system, and fire alarm system.
10. Lighting and Receptacles: Installation of LED lighting in all levels of the control house, maintenance and access safety lighting at all structure entrances/exits, battery operated emergency lighting in the control house, GFCI duplex receptacles, exterior light pole luminaires, fender system/pier lighting, clearance gauge lighting, and bascule span tip navigational lighting.
11. Span Position Indication: Installation of near and far rotary cam limit switch and ethernet/IP absolute rotary shaft encoders.
12. Span Drive Machinery: Replacement of both of the existing hydraulic power units (HPUs) with dual pump/motor HPUs, each which includes a 300-gallon reservoir and breather, main valve manifold, bladder accumulator, fill port assembly, temperature and oil level switches, immersion heater and fan, counterbalance valve manifold, hydraulic hoses, stainless steel tubing assemblies, debris shield, and associated valves, pressure gauges, meters, filters, couplings, and fittings.
13. Span Drive Hydraulic Cylinders: Disconnection of cylinder rod end clevis from bascule steel to clean upper clevis bearing and cylinder rod, and replacement of urethane cylinder rod seals and wipers, nitrile rubber barrel O-rings, bronze upper and wear rings bushings, and felt seal washers for all eight hydraulic cylinders.
14. Span Lock Machinery: Replacement of existing under sidewalk span locks with new traffic barrier-mounted hydraulically actuated span lock system, including installation of new HPU with stainless drip tray, hydraulic cylinder and associated hydraulic plumbing, cylinder support weldment, lock bar, front guides, rear guides, receivers, limit switches, steel housing, and lubrication system.
15. Live Load Shoes: Replacement of existing steel live load support assemblies with stainless steel strike plate and live load shoes secured to the pier wall with new epoxy grout pad and stainless-steel anchors.
16. Trunnion Bearing Lubrication: Removal of existing trunnion cap to support a third-party inspection of the trunnion shaft, cleaning of trunnion grease grooves, and installation of new grease fittings, stainless steel braided lubrication hoses, and purge port manifold.

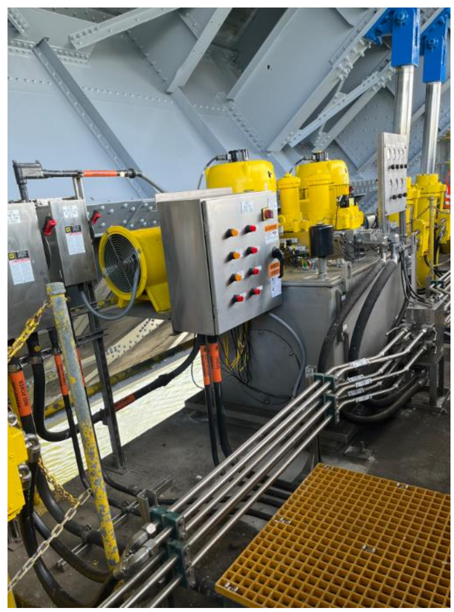

FIGURE 2: Span Drive HPU

17. Concrete Generator Pad: Construction of onshore concrete pad and retaining wall for standby generators, electrical service, and main feeders.
18. Bascule Span Structural Steel: Replacement of cantilever sidewalk brackets and flooring system to accommodate new traffic barriers and span lock housings, non-slip aluminum walking surface, median traffic barrier, pedestrian traffic barrier, various steel stringers and other deteriorated steel members, and installation of bicycle friendly riding surface on the existing steel grid deck.

FIGURE 3: Bascule Span Sidewalk Floor System

19. Approach Span Pedestrian Safety & Bridge Maintenance Access: Installation of new cantilever maintenance access platforms at roadway level with stairways for access to bascule pier machinery rooms, strengthening of bascule pier sidewalk stringers, replacement of existing concrete curb traffic separator with 32” tall concrete traffic barrier, replacement of existing concrete barrier with 42” decorative aluminum pedestrian/bicycle railing, and reconstruction/widening of the approach slab sidewalks.
20. Bridge Tender/Control House Renovation: Strengthening existing concrete cantilever brackets with new reinforced concrete infill, construction of new roadway level balcony access, replacement of existing windows with reinforced concrete, construction of new reinforced concrete second story/operator level, installation of steel ship ladder and access railing, replacement of existing asbestos flooring with new tile flooring, construction of new operator level balcony with decorative aluminum railing, replacement of concrete roofing with prefinished standing seam aluminum roof and soffit system, and installation of new impact-resistant windows, bullet-proof doors at roadway and operator levels, new restroom including toilet and vanity with sink, sanitary sewer and potable water plumbing, kitchenette/desk, insulation, drywall, and multi-level heating, venting, and air conditioning (HVAC) system.

FIGURE 4: Control House Renovation

21. Roadway and Bridge Deck: Improvements included milling and resurfacing asphalt pavement within project limits, replacement of concrete bridge deck epoxy overlay, replacement of bridge

tender parking area, construction of shoulder concrete barrier wall, installation of guardrail and crash cushion attenuator, replacement of permanent signing, and application of new thermoplastic, painted, and permanent tape pavement markings.

22. Superstructure Steel and Bascule Pier Coating: Blast cleaning and application of four coat paint system on bascule span and flanking span structural steel, pressure washing and application of Class IV coating on bascule piers, cleaning and coating median barrier armored joints, and application of Class IV coating on control house concrete.

FIGURE 5: Bascule Span Cleaning & Coating

Project Challenges

Backup Standby Generator Lead Time

Due to the supply chain issues from the COVID-19 pandemic, the lead time for the 60 kW and 200 kW standby generators was identified as a schedule impact as soon as the project was awarded to the Contractor. The issue was that the generators would be arriving after the scheduled 90-day bridge closure, which would delay final testing and acceptance of the project. The project team discussed several mitigation strategies, including:

- Sourcing alternate suppliers/manufacturers
- Alternate size/configuration/components for the standby generators
- Using a rental generator as a temporary backup
- Relocation and reuse of the existing 60 kW generator as a temporary house backup generator

FIGURE 6: Standby Backup Generators

The Consultant performed generator load calculations to confirm the existing bridge generator could support the new control house loads. A decision was made to relocate the existing generator from the control house to the new concrete generator pad, provide a temporary 200 kW main generator (furnished by an equipment rental company), and integrate both temporary generator sets into the new control system as back-up power until the new generators arrive.
This collaborative solution allowed the 60-day functional acceptance testing period to commence after completion of the structural, mechanical, and control system upgrades. After receipt of the permanent generators to the project, the Contractor removed the temporary generators, installed the permanent generators, and performed testing to confirm the new generators were functional with the new control system.

Directional Bore Profile

The original design for the submarine conduit path was developed using the shortest path achievable based on the minimum bend radius for the HDPE conduit, which could be achieved by digging directional bore termination pits within the Intracoastal waterway. This resulted in a submarine conduit run of roughly 400 feet, which is approximately the width of the waterway from seawall to seawall. Due to the potential damage to the seawall that could have been introduced by these construction methods and the additional permit efforts to get these excavation methods approved by permitting agencies, the team was tasked with coming up with an alternate approach that would avoid extending the overall project duration.

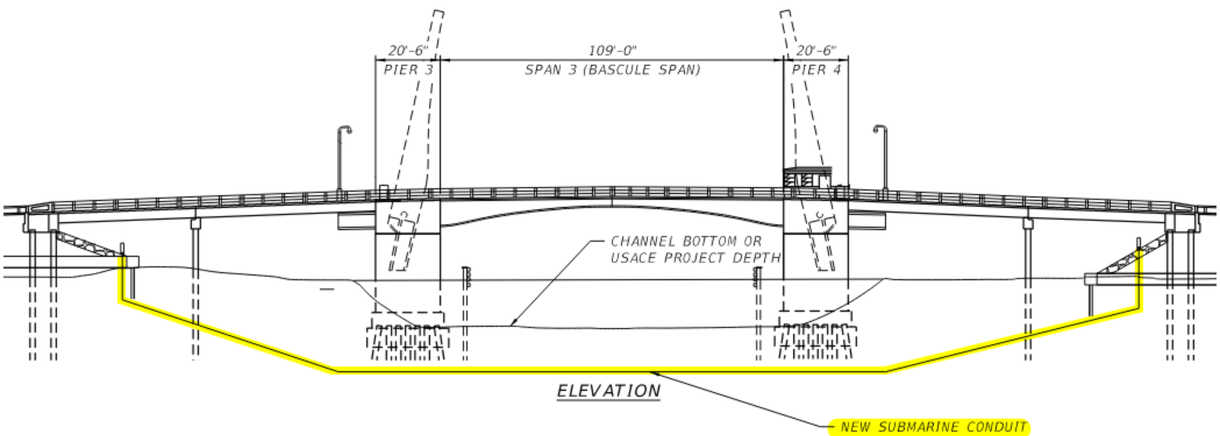

FIGURE 7: Originally Designed Directional Bore Profile

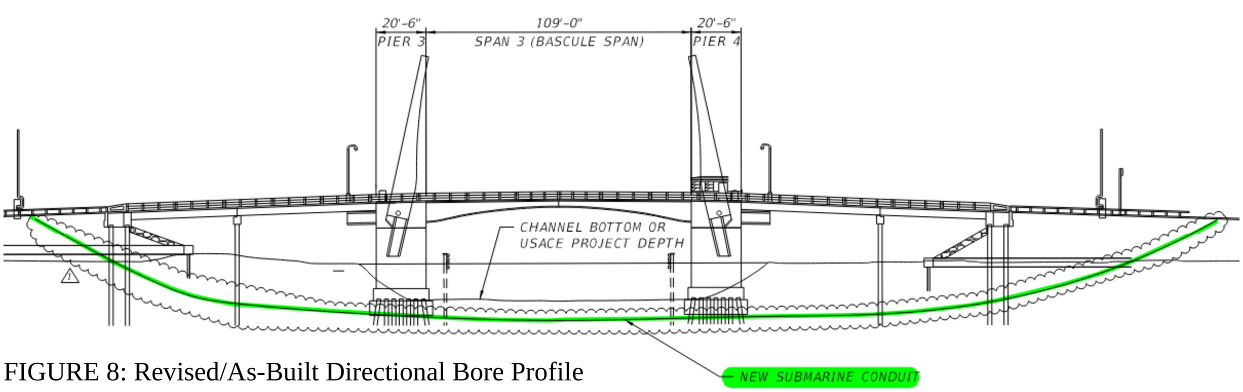

FIGURE 8: Revised/As-Built Directional Bore Profile

The Contractor challenged its directional bore subcontractor to come up with the possible bore profiles that would mitigate cost impacts to the Department. Based on survey of the existing conditions and the capabilities of the directional bore machine drill rods, the directional bore contractor proposed a 577-ft long bore that achieved the minimum-required depth below mudline using the allowable permitted construction methods. The 577-foot option also offset the directional bore exit and entry pit locations to minimize interference with the seawall, fender piling, and new concrete generator pad.

In anticipation of the increased length of the submarine conduit, and roughly 400-foot overall increase to the circuit, voltage drop calculations were rechecked for the original conductor sizes. It was determined that the additional length for the main power feed resulted in a need to upsize both the conductor ampacity and the size of the conduit, as well as the addition of sinewave output filters for the far side variable frequency drives. Due to the issue being identified prior to construction, the electrical contractor was able to accurately re-arrange the layout of the electrical cabinets, devices, and raceways, and order the appropriate materials without affecting the critical path of the project.

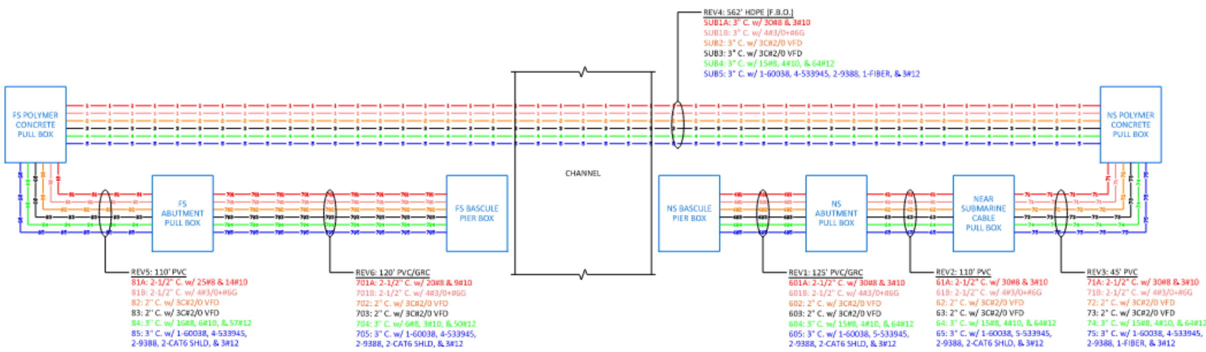

FIGURE 9: Revised Submarine Conductors and Conduits

Bascule Leaf "Twist"

After the live load shoes were replaced and the load was equalized, the Contractor discovered an undocumented as-built condition in the existing bascule span structural steel. The bascule span leaves were found to be "twisted" in opposite directions with respect to each other, and deflect significantly under live load, producing vibration at the tip of each leaf. The vibration was perceived by the Department to be excessive and was exacerbated by the impact loading received at the tip of each leaf due to the difference in elevation. The twist was such that the east leaf was higher than the west leaf at the south curb line and the west leaf was higher than the east leaf at the north curb line. This twist meant that vehicles traveling in both eastbound and westbound directions impacted the leaf tips as they crossed the centerline floor break. In order to reduce the impact of wheel loads at the leaf tips and reduce the perceived vibration, the Owner and Consultant team determined the twisting could be reduced and the elevation differences between east and west leaves could be minimized. In coordination with all contracted parties, the following procedures were completed:

FIGURE 10: Abandoned Span Lock Shafting

- Measurements were taken at the tips of the leaves under a zero live load condition
- Abandoned span lock shafts and access platform was removed from the east leaf to reduce dead load deflection and overall weight
- Counterweight plates were added near the west leaf tip, inside of the north span lock enclosure to induce deflection at the corners (opposite to the existing twisting).
- East leaf live load shoes were shimmed to be tight and achieve live load sharing.
- The west leaf live load shoes were shimmed to raise the tip of the west leaf while achieving load sharing and minimizing the difference in tip elevations between the east and west leaves. Final tip differences between east and west leaves of less than +/-5/16” were achieved and deemed acceptable. This iterative process can be found in Appendix A.
- The leaf twisting and final shimming resulted in elevation differences between sidewalk plates in both north and south sidewalks. Custom aluminum ramps with non-slip surfaces were added to equalize the elevations.

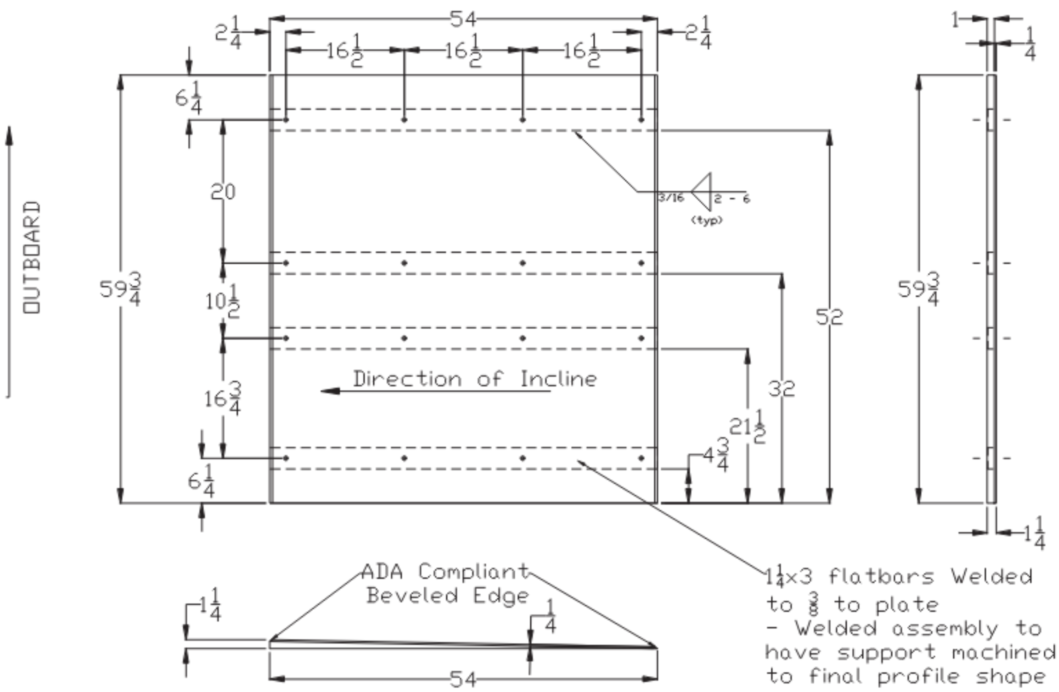

FIGURE 11: Custom Aluminum Sidewalk Ramp

Due to the bridge leaf twist issues, the span locks could not be aligned to meet all the requirements of the project specifications for allowable clearances and taper in all directions. In order to open the bridge to traffic on the scheduled date to accommodate peak vehicular tourist traffic in the area, the span lock clearances were permitted to be left “out of tolerance” and then remediated at a later date. In addition to the modified live load shimming procedure, the Owner and Consultant team determined it would be acceptable to install full-length tapered shims, which were machined from unused shims originally furnished for the project.

Description				Acceptable Values			Measurements				Taper		
				Minimum (in)	Maximum (in)	Total Range (in)	East (in)	West (in)	Allowable (in)	Difference in clearance along the lock bar through the shoe (i.e. = East - West) (in)	Allowable (in)	East - Difference in clearance along one side of the lock bar (i.e. = 1 - 2, 3 - 4) (in)	West - Difference in clearance along one side of the lock bar (i.e. = 1 - 2, 3 - 4) (in)
North Span Lock Assembly	Front Guide	Top/ Bottom	1	-	-	0.015" - 0.025" total (max top+ max bottom)	0.016	0.019	0.003	0.003	0.002	0.001	0.001
			2				0.017	0.020	0.003	0.006			
			3				0.002	0.000	0.003	0.002	0.002	0.000	0.000
			4				0.002	0.000	0.003	0.002			
		Sides	5	0.005	0.015	-	0.008	0.012	0.003	0.004	-	-	-
			6				0.009	0.007	0.003	0.002			
			7				0.010	0.008	0.003	0.002	-	-	-
			8				0.012	0.016	0.003	0.004			
	Rear Guide	Top/ Bottom	1	-	-	0.015" - 0.025" total (max top+ max bottom)	0.021	0.024	0.003	0.003	0.002	0.000	0.000
			2				0.021	0.024	0.003	0.003			
			3				0.003	0.000	0.003	0.003	0.002	0.000	0.000
			4				0.003	0.000	0.003	0.003			
		Sides	5	0.005	0.015	-	0.006	0.010	0.003	0.004	-	-	-
			6				0.006	0.011	0.003	0.005			
			7				0.013	0.009	0.003	0.004	-	-	-
			8				0.014	0.010	0.003	0.004			
	Receiver	Top/ Bottom	1	0.005	-	0.015" - 0.025" total (max top+ max bottom)	0.011	0.011	0.003	0.000	0.002	0.001	0.003
			2				0.012	0.014	0.003	0.002			
			3				0.010	0.008	0.003	0.002	0.002	0.000	0.002
			4				0.010	0.010	0.003	0.000			
		Sides	5	1.625	1.875	-	1.750	1.750	0.003	0.000	-	-	-
			6				1.750	1.750	0.003	0.000			
			7				1.750	1.750	0.003	0.000	-	-	-
			8				1.750	1.750	0.003	0.000			

FIGURE 12: Span Lock Clearance Measurements

The end goal was to not use the span lock bars to adjust the elevation of the tips, but create clearances that would be acceptable for the longevity and reliability of the span lock system. The Contractor was able to achieve this shimming operation during nightly bridge closures performed during the off-season.

Final Balance

The bridge twist issue also resulted in impacts to the bridge balance. The contract documents called to replace the existing concrete blocks in the counterweight pockets with a maximum of 1400 cast iron balance blocks. After all cast iron blocks were installed to offset the effects of the added weight on the spans, including the final toe counterweight to offset the bridge twist, the Contractor was unable to return the bridge to its initial balance state of a roughly 2000-pound toe reaction.

Installed Y/N	NO. OF PSC. or GROUPS	DESCRIPTION	Location and Moment x (ft)	Wx (kip-ft)	y (ft)	Wy (Kip-ft)	Single Piece Wt from Shops (lbs)	Single Piece Wt Calculated (lbs)	Total W (lbs)	Wx (kip-ft)	Wy (kip-ft)	Running Totals WL (kip-ft)	Alpha (deg)	Tip Reac Seated (kips)
		Pocket 4 (Furthest South)								984.3	8.0			
Y	-27	Remove Concrete Balance Blocks	-16.000	32.400	-2.000	4.050	75.00	75.000	-2025.000	1016.7	12.0	1016.7	0.7	15.404
Y	45	Install Steel Balance Blocks 8/2/22	-16.000	-55.440	-2.000	-6.930	77.00	77.000	3465.000	961.2	5.1	961.2	0.3	14.564
Y	31	Blocks Installed During Containment Installation	-16.000	-38.192	-2.000	-4.774	77.00	77.000	2387.000	923.0	0.3	923.0	0.0	13.985
Y	40	Install Steel Balance Blocks on 9/17/22 - For Median	-16.000	-49.280	-2.000	-6.160	77.00	77.000	3080.000	873.8	-5.8	873.8	-0.4	13.239
Y	60	Install Steel Balance Blocks on 10/5/22 - For Sidewalk	-16.000	-73.920	-2.000	-9.240	77.00	77.000	4620.000	799.8	-15.1	800.0	-1.1	12.119
Y	17	Install Steel Balance Blocks on 10/6/22 - **POCKET IS FULL**	-16.000	-20.944	-2.000	-2.618	77.00	77.000	1309.000	778.9	-17.7	779.1	-1.3	11.801
	193	**Total Steel Blocks in Pocket 4**						0.000	0.000	778.9	-17.7			
										778.9	-17.7			
		Pocket 3								778.9	-17.7			
Y	-57	Remove Concrete Balance Blocks	-16.000	68.400	-2.000	8.550	75.00	75.000	-4275.000	847.3	-9.2	847.3	-0.6	12.838
Y	57	Install Steel Balance Blocks 8/2/22	-16.000	-70.224	-2.000	-8.778	77.00	77.000	4389.000	777.1	-17.9	777.3	-1.3	11.774
Y	31	Blocks Installed During Containment Installation	-16.000	-38.192	-1.000	-2.387	77.00	77.000	2387.000	738.9	-20.3	739.2	-1.6	11.195
Y	24	Install Steel Balance Blocks 9/2/22	-16.000	-29.568	-2.000	-3.696	77.00	77.000	1848.000	709.3	-24.0	709.7	-1.9	10.747
Y	25	Install Steel Balance Blocks on 9/17/22 - For Bicy PL	-16.000	-30.800	-2.000	-3.850	77.00	77.000	1925.000	678.5	-27.9	679.1	-2.4	10.280
Y	50	Install Steel Balance Blocks on 9/27/22	-16.000	-61.600	-2.000	-7.700	77.00	77.000	3850.000	616.9	-35.6	617.9	-3.3	9.347
Y	44	Install Steel Balance Blocks on 10/6/22 - Housing #1 without doors	-16.000	-54.208	-2.000	-6.776	77.00	77.000	3388.000	562.7	-42.3	564.3	-4.3	8.526
N	24	Install UNPAINTED STEEL Balance Blocks on 10/7/22 - **POCKET IS FULL**	-16.000	-29.568	-2.000	-3.696	77.00	77.000	1848.000	562.7	-42.3			
N	-23	Remove Unpainted Steel Blocks	-16.000	28.336	-2.000	3.542	77.00	77.000	-1771.000	562.7	-42.3			
	232	**Total Steel Blocks in Pocket 3**						0.000	0.000	562.7	-42.3			
										562.7	-42.3			
		Pocket 2								562.7	-42.3			
Y	-57	Remove Concrete Balance Blocks	-16.000	68.400	-2.000	8.550	75.00	75.000	-4275.000	631.1	-33.8	632.0	-3.1	9.562
Y	57	Install Steel Balance Blocks 8/2/22	-16.000	-70.224	-2.000	-8.778	77.00	77.000	4389.000	560.9	-42.6	562.5	-4.3	8.498
Y	31	Blocks Installed During Containment Installation	-16.000	-38.192	-2.000	-4.774	77.00	77.000	2387.000	522.7	-47.3	524.8	-5.2	7.919
Y	24	Install Steel Balance Blocks 8/30/22	-16.000	-29.568	-2.000	-3.696	77.00	77.000	1848.000	493.1	-51.0	495.8	-5.9	7.471
Y	25	Install Steel Balance Blocks on 9/17/22 - For Bicy PL	-16.000	-30.800	-2.000	-3.850	77.00	77.000	1925.000	462.3	-54.9	465.6	-6.8	7.005
Y	50	Install Steel Balance Blocks on 9/27/22	-16.000	-61.600	-2.000	-7.700	77.00	77.000	3850.000	400.7	-62.6	405.6	-8.9	6.071
Y	39	Install Steel Balance Blocks on 10/6/22 - Housing #2 without doors	-16.000	-48.048	-2.000	-6.006	77.00	77.000	3003.000	352.7	-68.6	359.3	-11.0	5.343
Y	24	Install UNPAINTED STEEL Balance Blocks on 10/7/22 - to get to acceptable balance	-16.000	-29.568	-2.000	-3.696	77.00	77.000	1848.000	323.1	-72.3	331.1	-12.6	4.895
Y	-25	Remove Unpainted Steel Blocks on 1/23/23	-16.000	30.800	-2.000	3.850	77.00	77.000	-1925.000	353.9	-68.4	360.5	-11.0	5.362
	225	**Total Steel Blocks in Pocket 2**						0.000	0.000	353.9	-68.4			
										353.9	-68.4			
		Pocket 1 (Furthest North)								353.9	-68.4			
Y	-51	Remove Concrete Balance Blocks	-16.000	61.200	-2.000	7.650	75.00	75.000	-3825.000	415.1	-60.8	419.5	-8.3	6.289
Y	51	Install Steel Balance Blocks 8/2/22	-16.000	-62.832	-2.000	-7.854	77.00	77.000	3927.000	352.3	-68.6	358.9	-11.0	5.337
Y	32	Blocks Installed During Containment Installation	-16.000	-39.424	-2.000	-4.928	77.00	77.000	2464.000	312.8	-73.6	321.4	-13.2	4.740
Y	40	Install Steel Balance Blocks on 9/17/22 - For Median	-16.000	-49.280	-2.000	-6.160	77.00	77.000	3080.000	263.6	-79.7	275.4	-16.8	3.993
Y	60	Install Steel Balance Blocks on 10/5/22 - For Sidewalk	-16.000	-73.920	-2.000	-9.240	77.00	77.000	4620.000	189.6	-89.0	209.5	-25.1	2.873
Y	12	Install Steel Balance Blocks on 10/6/22	-16.000	-14.784	-2.000	-1.848	77.00	77.000	924.000	174.9	-90.8	197.0	-27.5	2.649
	195	**Total Steel Blocks in Pocket 1**												
Y		**FDOT 2018 BALANCE CONDITION**										208.6	-50.9	**1.994**
Y		**PCL / FLANDERS INITIAL BALANCE CONDITION**										178.0	-41.0	**2.036**

FIGURE 14: Balance Calculations

Since the lead time to procure more cast iron balance blocks would have resulted in a delay to the overall project, the Contractor worked with the local bridge maintenance company to procure additional balance blocks. The Contractor installed these blocks during regularly scheduled bridge openings to avoid impacts to traffic. Using the balance spreadsheet, the Contractor installed additional blocks until it calculated a seated reaction that was nearest to the original condition. After concurrence with the calculations, the project's balance engineering consultant performed final pressure transducer balance measurements. Minor modifications to the number of balance blocks in the pockets were made, and with concurrence by the Consultant the team was able to achieve a final balance condition for each leaf of roughly 3000 pounds (toe reaction) and acceptable angle of imbalance.

FIGURE 13: Painted Cast Iron Balance Blocks

Hydraulic Cylinder Field Reconditioning

Prior to the bridge closure, the Contractor's hydraulic subcontractor was able to unpin the clevis from the bridge and unthread it from one of the hydraulic cylinder pistons. This allowed the existing bushings and seals to be removed from the top. The hydraulic subcontractor was then able to take precise measurements to create the shop drawings and ultimately fabricate the replacement components (rod seal, rod wiper, barrel O-rings, bronze bushings, and felt seal washer). Based upon the parts removed from the first cylinder, the team found little to no wear or deterioration of the rod gland bushings or the seals and there was no evidence that there was any side loading on the rod or rod bushing. This existing cylinder was left out of service while the leaf operated on the remaining three cylinders. During the bridge closure, after the replacement cylinder components were fabricated, the hydraulic subcontractor attempted to remove the clevis for the remaining seven cylinders as it had done previously, but now was unable to break the friction at the upper clevis threaded interface. Various methods were attempted, including heating the clevis, injecting anti-seize lubricants, and drilling and tapping a hole into the side of the clevis to assist the wrench. None of these methods proved successful.

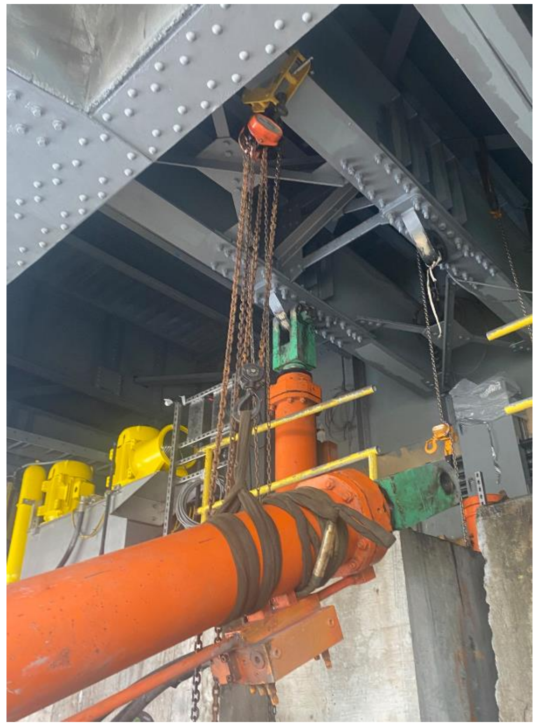

FIGURE 15: Removal of Hydraulic Cylinders

Through coordination and approval by the Department, the Contractor was directed to remove each cylinder one at a time from the bridge and deliver to a local hydraulic repair shop to perform the following:

- Remove Hydraulic Oil from Cylinder
- Remove Piston from the cylinder bore
- Install Contractor-supplied Rod End seals and bearings,
- Furnish and Install New Piston Seals
- Polish Cylinder Rod
- Clean Cylinder
- Bench Test Cylinder

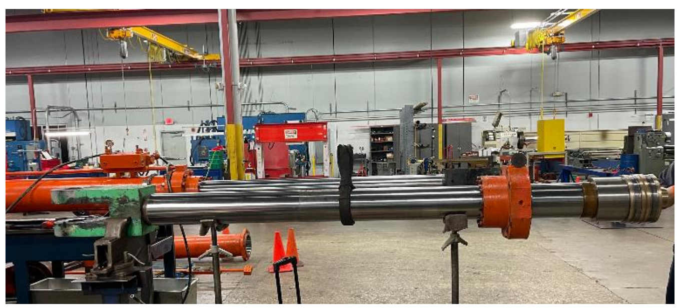

FIGURE 16: Shop Repair of Hydraulic Cylinders

The lesson learned for the project team was seeing firsthand the difficulty of getting components apart that have not been moved in nearly 20 years. Additionally, it was determined that even though upper and lower clevis pin connections were being greased on a monthly basis, the exposure of the cylinder to ambient conditions and humidity warrants a more though maintenance routine. Many of the threaded connections showed signs of rust, which proved that oxidation had penetrated into the threaded connection for the piston rod and rod end clevis. This issue should provide a good example of the benefits of incorporating the removal of rod eye clevises into yearly equipment maintenance schedules.

Conclusions and Lessons Learned

The overall construction cost was approximately $14 million, and the project was completed in June 2023. As with most movable bridge rehabilitation project, numerous challenges were encountered as soon as construction started. It was vitally important for all parties (Owner, Inspection, Engineer, Contractor, Subcontractor, and Suppliers) to work as partners to deliver the best project possible in order to avoid delays in construction and hostility on the project. All teaming partners must be available and willing to honestly discuss the issues and how to best resolve them to the benefit of the project. We'd like to thank:

Owner, Inspection, & Engineering Consultants
Florida Department of Transportation District 4
Pinnacle Consulting Enterprises, Inc. – Project Administration and Quality Assurance Inspection
Civil Works, Inc. – Roadway and TTCP design, utility coordination
Currie Sowards Aguila Architects, Inc. – Architectural Design
KTA-Tator, Inc. – Coatings Assessment
Keith and Associates, Inc. – Survey and Mapping
Tierra South Florida, Inc. – Geotechnical Engineering
Modjeski & Masters, Inc. – Contractor's Mechanical Systems Engineer
Flanders Engineering Group, Inc. – Contractor's Bridge Balance Engineering
Seismic Surveys, Incorporated – Contractor's Bridge Settlement Monitoring Engineer
Subcontractors
Faith Technologies Incorporated – Bridge Electrical and Controls Integration
MFP Automation Engineering – Bridge Main Drive and Span Lock Hydraulic Systems
Florida Drawbridges, Inc. – Bridge Operations
Rampro Construction and HDD, LLC – Horizontal Directional Drilling (HDD)
Qualis Concrete LLC – Flatwork and Slip-form Barrier Wall
General Caulking & Coatings Co., Inc. – Epoxy Overlay
Signal Technology Inc. – Roadway Signing and Signalization
Bob's Barricades, Inc. – Work Zone Traffic Control
Vesta Industrial Contractors, Inc. – Control House Access Scaffolding
RHI Contruction Inc. – Control House Roofing
Sasser Commercial Glass, Inc. – Control House Window & Door
HVAC Sales & Service, Inc. – Control House HVAC
Atlas Plumbing of Hollywood – Control House Plumbing
KHS&S Contractors – Control House Framing, Drywall, and Insulation
Speedy Concrete Cutting, Inc – Core Drilling and Sawcutting
Blue Iron Foundations & Shoring, LLC – Generator Pad Sheet Pile Wall
Southeast Highway Guardrail & Attenuator – Guardrail and Crash Cushion
Atlantic Southern Paving & Sealcoating – Asphalt Paving
Suppliers
Steward Machine Co., Inc. – Span Lock, Live Load Shoe, and Machinery Lubrication Systems
Precision Build Solutions, LLC – Structural Steel & Access Platform
SLIPNOT – Non-slip Bicycle and Sidewalk Flooring
US Foundry & MFG Corporation – Cast Iron Balance Blocks
Titan Florida LLC – Ready-Mix Concrete
CMC Rebar – Reinforcing Steel

Appendix A – Modified Live Load Shimming Procedure

TRANSYSTEMS **Memorandum**

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TO:	Tyler Furrey, PE, Construction Project Manager	**DATE:**	April 27, 2023
FROM:	Alan Klevens, PE Consultant Project Manager		
PROJECT:	FPID 441462-1-52-01 SR-822 Sheridan St. over ICWW Bridge 860043	**SUBJECT:**	LLS Shimming Post Design
COPY TO:	Eric Reid, PE Consultant Deputy Project Manager	**CIRCULATE TO:**	File P310180007

Background

The bascule span leaves at the Sheridan Street Bridge are twisted with respect to each other and deflect significantly, producing vibration. The vibration is perceived to be excessive and is exacerbated by the impact loading received at the tip of each leaf due to the twisting of the leaves. The twist appears to be an undocumented as-built condition. The twist is such that the east leaf is higher than the west leaf at the south curbline and the west leaf is higher than the east leaf at the north curbline. This twist means that vehicles traveling in both eastbound and westbound directions impact the leaf tips as they cross the centerline floorbreak. A reasonable effort was made to correct the twist of the west leaf when the twist was discovered during the rehabilitation construction. Counterweight steel plates were installed at the north tip of the west leaf. Additional counterweight was added in the counterweight pockets behind the trunnions to balance the leaf. No tip-weighting was attempted at the east leaf as this leaf was already near its weight capacity.

On March 27, 2023, TranSystems measured the differences in elevation between the east and west leaves at the north and south curblines. This was done around midday and the ambient temperature was approximately 90 degrees Fahrenheit. Under those conditions, it was found that the east leaf was approximately ½" higher than the west leaf at the south curbline and ¼" higher at the north curbline. It was also discovered that there was slight vertical movement at the north live load shoe of the west leaf. All other liveload shoes were tight and did not move under live load.

The issue was discussed in a conference call with FDOT, TranSystems (EOR), Pinnacle Engineering (CEI), and PCL (contractor). It was decided to shim the west leaf at the live load shoes to minimize the difference in tip elevations between the east and west leaves, as well as eliminate the movement at the northwest live load shoe.

Procedure for Shimming West Leaf LLS

- Note that the span locks must be reshimmed after this procedure to ensure they are within the specified tolerances.
- Allow only the minimum number of people and equipment on the leaves as needed to take the measurements.
- In recording measures of deck elevation differences, east leaf higher than west are positive, east leaf lower than west are negative.

1. With the bridge closed to traffic, the leaves lowered, and the span lock bars ENGAGED, measure the differences in elevation between the east and west leaves at the curblines. Measure and record the elevation differences at the rear floor break between the movable span and the fixed flanking span for both east and west leaves. Measure and record the gaps if any at the live load shoes. Record the measurements in Table 1.

   All measures in the following steps are to be taken with lock bars withdrawn and the bridge closed to traffic.

2. Lower the leaves, measure the differences in elevation between the east and west leaves at the curblines. Measure and record the elevation differences at the rear floor break between the movable span and the fixed flanking span. Measure and record the gaps if any at the live load shoes. Record the measurements in Table 1.

   If the measurements at the rear floor break of the east leaf indicate the leaf is high (movable deck lower than flanking span deck) then this this procedure should be modified to remove shims at the east leaf live load shoes rather than adding shims at the west leaf. Notify the Engineer.

3. Add a shim at the southwest LL shoe of thickness equal to ([XS + XN] x 0.1500)/2 plus a temporary shim of ¼" nominal thickness [see Table 1 below and attached sketch for "X"].

   Lower the leaves using outboard cylinder adjacent to the north girder. Measure the gap at the northwest LL shoe and record in Table 1. Repeat using the outboard cylinder adjacent to the south girder. Record the measurement in Table 1. Average the two measurements to obtain G2.

4. Remove the temporary ¼" shim from the SW live load shoe and install at the NW live load shoe. Lower the leaves using outboard cylinder adjacent to the north girder. Measure the gap at the southwest LL shoe and record in Table 1. Repeat using the outboard cylinder adjacent to the south girder. Record the measurement in Table 1. Average the two measurements to obtain G3.

5. If the gaps G2 and G3 measured under the two live load shoes with the temporary shim in place are equal, no additional shim adjustment is required at this time.

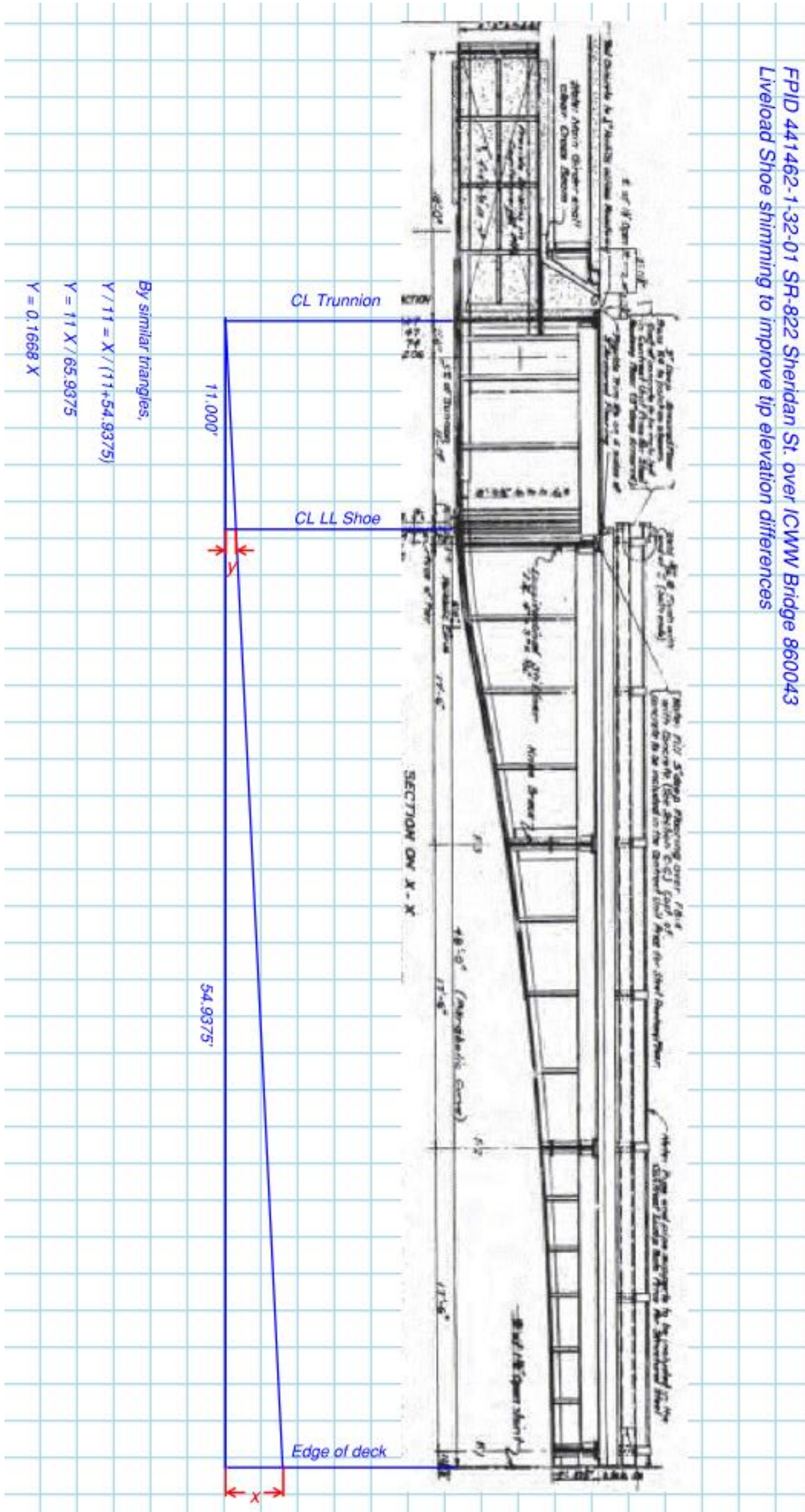
6. If G2 is greater than G3, additional shims must be installed under the SW live load shoe with a thickness of T= (G2-G3)/2. If G3 is greater than G2, additional shims must be installed under NW shoe with a thickness of T= (G3-G2)/2.

7. Repeat measurements at the curblines and live load shoe gaps shown in Table 1. Record measurements in Table 1. If there is a gap at any live load shoe, repeat steps 3 thru 6 above. If any curbline difference between east and west leaves exceeds +/- 5/16", notify the engineer. If not, proceed to span lock alignment.

8. Align span locks per original TSP and Plans.

TABLE 1										
DATE:			TIME:				TEMPERATURE:			
CONDITION DESCRIPTION	DIFFERENCE IN TIP ELEVATIONS				DIFFERENCE IN DECK ELEVATIONS AT REAR FLOOR BREAK				GAP AT WEST LEAF LIVELOAD SHOES	
	South curb line	**South edge of median**	**North Edge of Median**	**North curb line**	**South curb line**	**South edge of median**	**North Edge of Median**	**North curb line**	**North LL Shoe**	**South LL Shoe**
Leaves fully lowered span locks ENGAGED										
West leaf - Leaves fully lowered; locks DISENGAGED	XS = _____			XN = _____						
0.1500 x ([XS + XN]/2 shim added at SW LL shoe										
(G1 +1/4 in) shim at the NW LL shoe using north cylinder										G2 = ____
(G1 +1/4 in) shim at the NW LL shoe using south cylinder										G2 = ____
1/4 in shim at the SW LL shoe using north cylinder									G3 = ____	
1/4 in shim at the SW LL shoe using south cylinder									G3 = ____	
Add'l shim T added										
West leaf - Leaves fully lowered; locks DISENGAGED	XS = _____			XN = _____						

All measurements are to be taken with the bridge closed to traffic, the leaves lowered, and the span lock bars withdrawn, except as noted.


FPID 441462-1-32-01 SR-822 Sheridan St. over ICWW Bridge 860043
Liveload Shoe shimming to improve tip elevation differences
CL Trunnion
CL LL Shoe
Edge of deck
SECTION ON X-X
11.000'
54.9375'
y
x
By similar triangles,
Y / 11 = X / (11+54.9375)
Y = 11 X / 65.9375
Y = 0.1668 X