Paper No. 17

Performance/Construction/Maintenance

Design And Construction Challenges Of The Alteration Of The Florida Avenue Bascule Bridge In New Orleans, Louisiana, With A Vertical Lift Bridge Under The Truman Hobb's Act

Jacob Patnaik
U.S. Coast Guard Headquarters

William Conway
Modjeski & Masters, Inc.

HEAVY MOVABLE STRUCTURES, INC.

TENTH BIENNIAL SYMPOSIUM

OCTOBER 25 - 28, 2004
The Omni Orlando Resort at ChampionsGate

DESIGN AND CONSTRUCTION CHALLENGES OF THE ALTERATION OF THE FLORIDA AVENUE BASCULE BRIDGE IN NEW ORLEANS, LOUISIANA, WITH A VERTICAL LIFT BRIDGE UNDER THE TRUMAN HOBB'S ACT.

By

Jacob Patnaik, Chief, Engineering Division, U.S. Coast Guard Headquarters
and
William Conway, Chairman, Modjeski & Masters, Inc.

ABSTRACT

This paper describes various design and construction challenges and techniques used to over come: complex site limitations and restrictions; highway, railroad, and marine traffic maintenance issues; environmental impacts and their mitigation measures; complex flood control measures, removal of the existing Strauss Heel Trunnion Bascule Bridge without interruption to marine traffic; removal of siphon canal 40 ft below the canal; construction of a redundant pumping station to handle the flood waters out of the city, complex foundation construction; erection of 240 foot tall towers; assembly, float-in, and erection of a 340 ft, about 4 million pound steel lift span, 9.2 million pounds total steel for span and towers, and quick erection of p/s concrete beam tower spans; impact of the new lift bridge on the COE's industrial canal lock replacement project. Lessons learned, and techniques used in both design and construction of this $50 million complex structure will be beneficial to project managers and practicing engineers engaged in the design and construction of heavy movable bridges.

Project Background:

The Inner Harbor Navigation Canal (IHNC), which provides access for marine vessels from the Mississippi to Lake-Ponchartrain and Mississippi River Gulf Outlet (MRGO) in New Orleans, Louisiana, is a vital link in the nations inland waterway navigation system. The three bridges across the IHNC which provide access to and from the central business district are: (1) a four lane, low level, single leaf highway bascule bridge at St. Claude Avenue; (2) a four lane mid-level vertical lift bridge at Claiborne Avenue; and (3) a combination rail and two lane low level bascule bridge at Florida Avenue. The existing Florida Avenue Bridge is located about 1.8 miles north of the IHNC's intersection of the Mississippi River and about 4000 feet south of the intersection of IHNC with MRGO. The Florida Avenue Bridge is the only rail crossing across the IHNC. Improvement of the canal is critically linked with the Florida Avenue Bridge, a bottleneck in the system. The Florida Avenue Bridge is a combination highway and railroad structure across the IHNC at New Orleans, Louisiana owned and operated by the Port of New Orleans (PONO). The current navigation channel is 100 feet wide at the bridge, 175 feet on the south (river) side, and 150 feet on the north (lake) side with tentative plans for widening the channel to 300 feet.

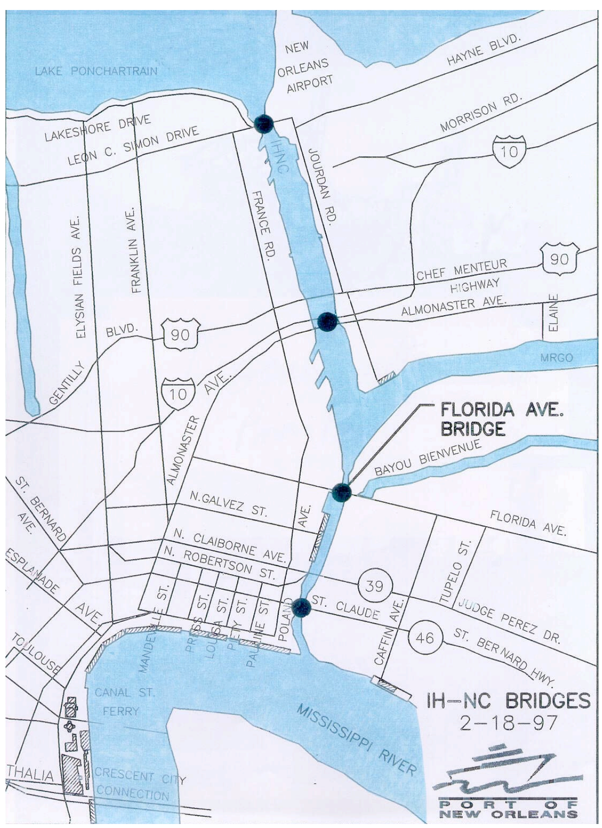


Fig-1
Location Plan

The 97.67 feet limited horizontal navigation opening causes unreasonable vessel delays and numerous allisions. 43 major allisions have occurred over a thirty year period causing more than $1 million damage to vessels and the bridge. Vessels delays are caused by pilots dropping their speed to about one-half of their normal speed in order to transit the bridge safely. Ocean going vessels with a beam of 86 feet or less can use the canal. Only three or four ship owners in the world market supply the ship types with gear to go through the Florida Avenue Bridge. Presently large vessels pass through the existing bridge with tremendous difficulty with no room for maneuverability and having not much leeway for anticipated winds and currents. The average annual transits have dramatically increased from 1024 vessels in 1989 to the present nearly 50,000 vessels of varying sizes and shapes, types, and uses. In addition to adverse impacts on navigation and on vehicular traffic resulting from an out of service bridge, rail track damage caused by bridge/ship allisions cause railroad stoppage, inevitable delays, unnecessary repairs and unrecoverable expenses.

Existing Bridge:

The existing Strauss Heel Trunnion Bascule Bridge, built in 1919 at a cost of $224,000, carries a double railroad track at the center of the bridge with one lane highway (12' wide) on each side of the tracks. The bridge services 4 to 5 rail crossings per day (1,600 rail cars per month), three to five pedestrians/bicycle users per hour, and 10,800 vehicles per day of which 21.5% is truck traffic. Sight distance is limited since the approaches to the bridge are located on sharp curves. The bridge is a contentious structure. It is often broken, its span is too short (97.67 feet horizontal clearance between fenders). It provides 1 foot of vertical clearance in the closed position and unlimited vertical clearance in the open position. When the bascule bridge is in the closed position, it affords no vertical clearance and serves as a virtual barrier to marine traffic. The bridge features reinforced concrete substructure. The trunion and counterweight piers rest on a 66'X50' footing and the rest pier is supported by 20'X56' footing. The counterweight weighs 800 ton of reinforced concrete. The superstructure weighs 1,600,000 pounds. The moving leaf is 117 feet long.

Fig-2 Existing Bridge

Investigations:

The Coast Guard completed a preliminary investigation in November 1991, and scheduled a public hearing in March 1992 to receive comments on the unreasonable obstructive character of the bridge and the required navigation opening to handle the present and future navigation. Based on the final investigation report, the Coast Guard determined that a total navigation befit of $3.5 million can be realized by means of $3.3 million in Transit Time Savings, $180, 000 in Waterway Accident Reduction, and $93,000 in Certain Other Savings; and the annualized construction cost for a new vertical lift bridge is $2 million. This provided a Benefit to Cost ratio of 1.76 to 1. As a result, the Coast Guard determined the Florida Avenue Bridge to be an unreasonable obstruction to navigation and issued an Order to Alter on 30 July 1992 on the PONO.

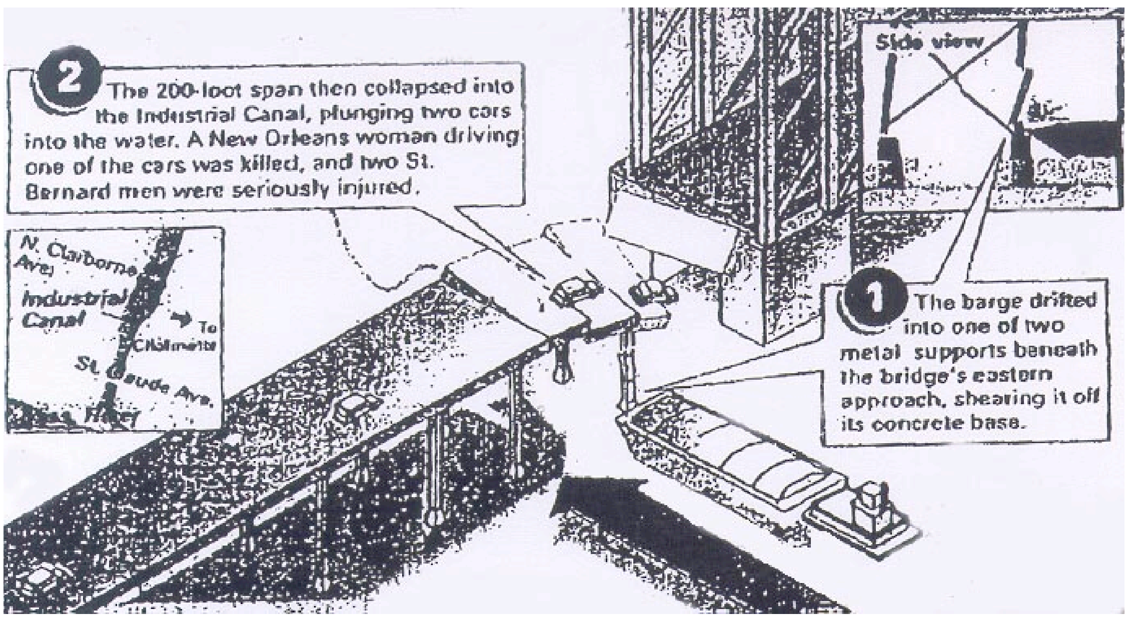


Fig-3 Bridge Allision

Environmental Assessment:

The Coast Guard Environmental Assessment was prepared in accordance with Commandant Manual Instructions M16475.1C and in compliance with the National Environmental Policy Act of 1969 (P.L.91-190) and the Council of Environmental Quality Regulations dated 29-Nov-1978 (40 CFR 1500-1508). This environmental assessment concisely describes the proposed action, the need for the proposal, the alternatives, the environmental impacts of the proposal and alternatives, comparative analysis of the action and alternatives, a statement of environmental significance, and lists of the agencies and persons consulted during its preparation.

Historic Significance of the Bridge:

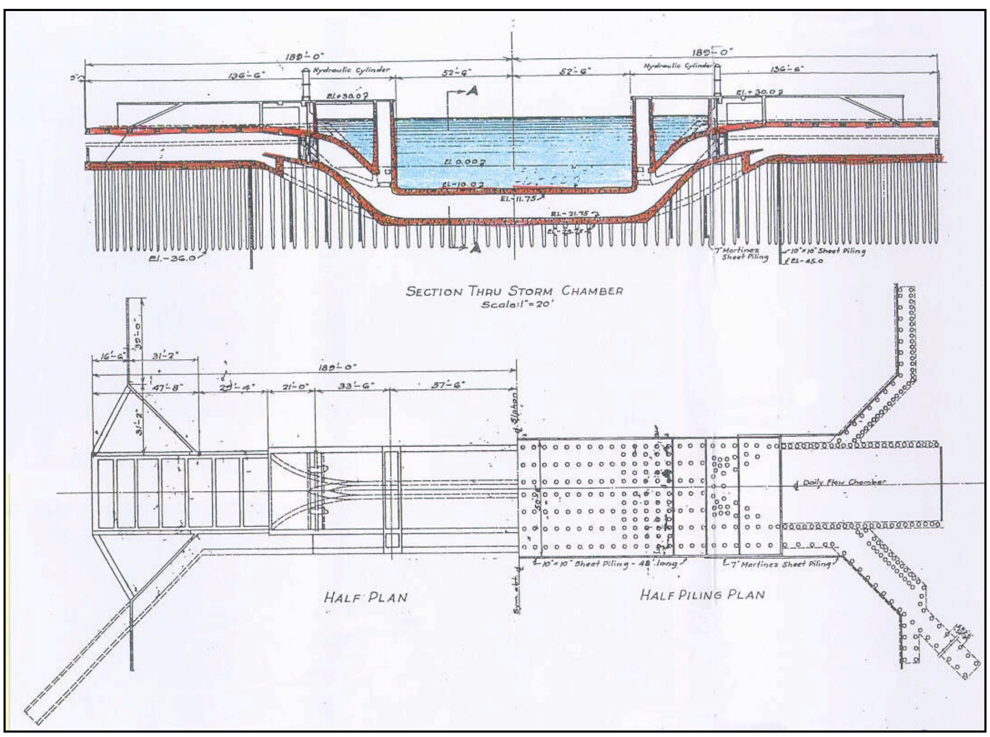
The Louisiana State Historic Preservation Office determined that the structure was eligible for inclusion in the National Register of Historic Places. The Florida Avenue is an example of a bridge type referred to as a Strauss Heel Trunnion Bascule Bridge. It is one of the only five such bridges remaining of its type in Louisiana. Four bridges of this type were built in the New Orleans Area. This bridge was designed by the Strauss Bascule Bridge Company of Chicago, Illinois between 1916 and 1918, and the design was patented by Joseph B. Strauss. It was constructed by the Bethlehem Steel Bridge Corporation and the New Orleans Dock Board in 1918-1919. It was originally designed to carry both rail and vehicular traffic.
There is no feasible and prudent alternative that avoids replacing the existing Florida Avenue Bridge . Since the only feasible and prudent alternative is to construct the proposed vertical lift span , the Coast Guard will ensure that the existing bridge will be documented in accordance with the provisions of the Memorandum of Agreement between the Coast Guard, Louisiana SHPO, and the Port for inclusion in the Historic American Engineering Record (HAER) Level II documentation. This detailed record will mitigate the physical loss of the bridge and will enable persons having the intense interest in the bridge to study the history and rigorously inspect its design. Although the structure will not actually exist, this detailed record will provide an accurate conceptualization of those wanting to study the bridge's design, operation, and history. Additionally, the Port will make the bascule bridge available to a state, local or a private entity that will agree, in writing to install and maintain the bridge and the features that make it significant at a different location, and assume legal and financial responsibility of the bridge.

Impact on the Historic 4(f) Property:

The proposed project will be built on a parallel alignment to the existing structure. The project requires the total demolition of the existing bridge after the new bridge is completed if a state, local, or private entity do not wish to take the ownership. The Coast Guard applied the Criteria of Effects in accordance with 36 CFR 800.3(b), regulations implementing Section 106 of the National Preservation Act, and has determined that the proposed action will adversely affect the qualities which make the Florida Avenue Bridge eligible for inclusion in the National Register for Historic Preservation (NRHP). The Coast Guard requested the FHWA to become a cooperating agency in the preparation of the Section 4(f) documentation based upon their status as an expert agency. FHWA agreed to become a cooperating agency and they then determined that every effort was made to find a feasible and prudent alternative to altering this historic bridge, and that all possible planning to minimize harm before authorization to alter this bridge is given. Thus, FHWA issued a Programmatic 4(f) determination on July 29, 1999.

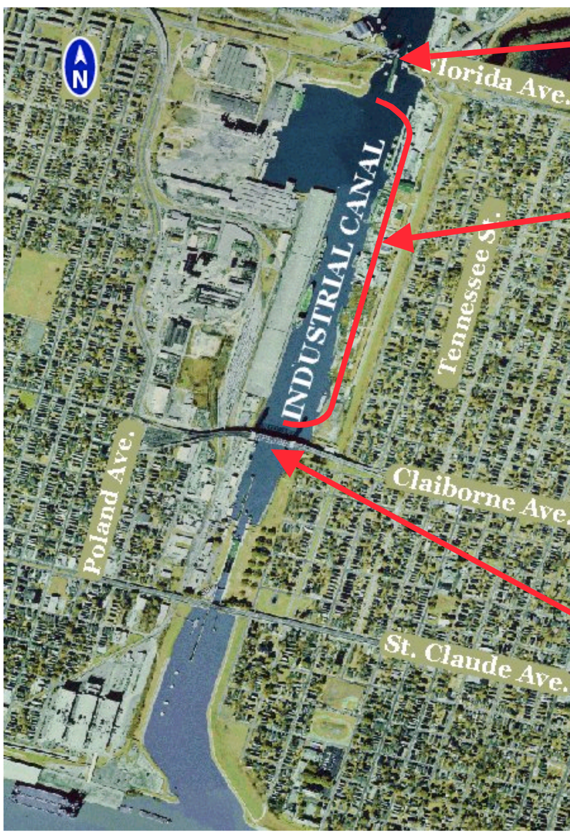
Existing Siphon:

Four canals carry the entire drainage water out of the City, three discharge into Lake Ponchartrain and the fourth into Bayou Bienvenue. In 1914 the Louisiana State legislators authorized the Dock Board to build the Florida Avenue Siphon, an underground culvert like structure designed to pass surface water of the Florida Avenue Drainage Canal 40 feet under the IHNC to drainage pumping station #5 and into the Bayou Bienvenu. The siphon was divided into four compartments: one 4'X10' normal weather chamber, two storm chambers each 10'X13', and one public utility duct. The concrete floor of the siphon is 2' thick and was laid 46 feet below the ground surface. Eight sluice gates were installed to open and close chambers. The siphon was 378 feet long, was engineered to withstand a pressure of 2000 psf, and the capacity to handle 2000 cubic foot of water per second and was the largest siphon of its kind in USA. The siphon was completed in 1921 at a cost of $856,483. This cost is four times the cost of the Florida Avenue Bridge ($223,491). Removal of concrete siphon became part of the Florida Avenue Bridge Alteration project by Congressional Action/language inserted in the Coast Guard Authorization Act of 1996. Several siphon removal options were explored: (1) discard and remove the siphon to clear 300 feet Bridge opening at an estimated cost of $1M; (2) extend siphon to widen the channel opening to the required 300 feet at an estimated cost of $12.5M; (3) build a new siphon with top of siphon at elevation -19.00 at an estimated cost of $15M.. Removal option appeared to be the most cost effective alternative. However, with this option the City would lose the redundancy of draining storm water via the siphon. In order to compensate this redundancy, first an independent power source was created by installing two 60Hz generators and two auxiliary generators and then constructing a pumping station # 19 to pump the storm water out which would have been handled by the siphon. Interestingly, the Port and the Coast Guard worked closely with the Corps of Engineers to successfully put in place a cost reimbursement agreement for an amount of $6.8M between the Sewerage & Water Board and the COE thus, keeping this expenditure off of the Truman Hobbs alteration cost.



Industrial Canal Lock Replacement Project:

The present lock which is 75 feet wide, 640 feet long and 31.5 feet deep, connecting Mississippi to the ICWW system, is one of the most congested locks. Average wait time to pass is 10 hours and often reaches 24 to 36 hours. In order to alleviate the present congestion, a 110 feet wide, 1200 feet long and 36 feet deep new lock is planned to be built. Construction of this new lock is planned by offsite fabrication (east of the existing bridge) in four modules, and then floating the modules by barge through the new Florida Avenue Bridge to the lock site at the mouth of Mississippi. The existing bridge would not provide required clearances. COE estimates the annual navigation benefits to cost ratio for the lock project to be $110M to $50M i.e. 2.2 to 1.



Florida Avenue Bridge

Lock Site
Off-site fabrication 110’ x 1200’
Float-in modules
Estimated start date Oct. 2004
Construction Period 63 months

Claiborne Avenue Bridge

Replacement Bridge Alternatives:

A high level fixed bridge was considered as opposed to a movable bridge. Since the bridge carries a railroad and the railroad must be maintained the approach grades cannot be more than 1.25%. In order to create a vertical clearance of 156 feet, the structural approaches of the fixed bridge would extend about 13,000 feet on each side. At

$4,000/ft, the cost of the structure would exceed $100M. Additional cost of relocating tracks, residences, industry, build access roads, mitigate significant environmental impacts all would increase the total project cost significantly. Based on the above , obviously, the low level movable bridge became the logical choice.

Existing and Off-Line Alignments:

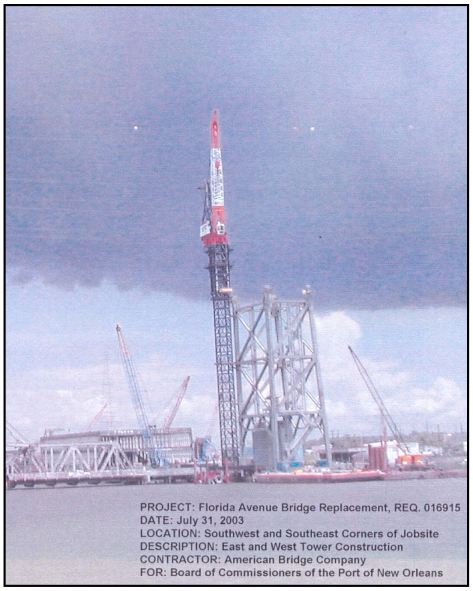
Although, building the replacement bridge on the existing alignment required least adjustment to approach railroad track and approach roadways, construction of main piers under and around existing tracks and roadways will be difficult and costly. It will also require complex and strict sequencing of construction activities to maintain the railroad, roadway, and waterway in service during construction. There will be as high as 20% construction cost premium due to difficult and highly sequenced construction process.

The off-line alignment has to be at least 75 feet away from the existing bridge for constructability reasons. Off-Line alignment on the north side of the existing bridge became unsuitable and too expensive because of the presence of New Orleans Power System (NOPSI) transmission tower and the Sewerage and Water Board pump station #19 on the north, and because it will require complete relocation of the eastbound Florida Avenue. Off-line alignment about 100 feet away on the south side required removal of the siphon, relocation of the drainage canal, conflicts with flood walls, approach roadway work, and railroad realignment conflicts. The Coast Guard pushed hard through M&M and replaced the two tracks, one for NS and another for Public Belt, with one track. The single track bridge reduced the loads by 40%, reduced overall construction cost of the new bridge, increased existing roadway width from 13'-6" to 15 feet with a median and provided two (6'and 4') walkways for pedestrians.

Scope of the Project and Bid Opening:

The alteration work consisted of building a new 340- foot vertical lift bridge carrying a two lane roadway and a single railroad track with two 240-foot towers; removal of an existing inverted siphon adjacent to the bridge; construction of new fender system with four large protection cells; and 175 feet of channel dredging on each upstream and downstream side of the bridge to create the transition from 150 feet channel width to a full 300 feet channel at the bridge. The scope also included construction of an operator house; several sections of the flood wall; new signal, electrical, and mechanical systems with bridge opening and closing time set at 2.8 minutes each; removal of the existing bascule bridge with bascule and rest piers to 4 feet below the required channel bottom, and parts outside the channel to be removed one foot below ground level.

Bids were opened by the Port of New Orleans on 2 November 2000. The low bid by American Bridge of Coraopolis, Pennsylvania, was $42,189,146.00. This low bid was about $6 million higher than the engineer's estimate. The primary reasons for this increase in bid cost was due to the higher unit bid price of steel, the estimated $1.34/pound of steel vice the actual bid at $1.78/pound for the required 9.2 million pounds of steel; and higher than anticipated railroad signalization cost. Interestingly, the low firm bid is $10M below the rest of the four bids. Mitsubishi International Corporation was the supplier of the fabricated Korean steel for the towers and the lift span via Hanjin Heavy Industries & Construction Company Ltd, Seoul, South Korea.



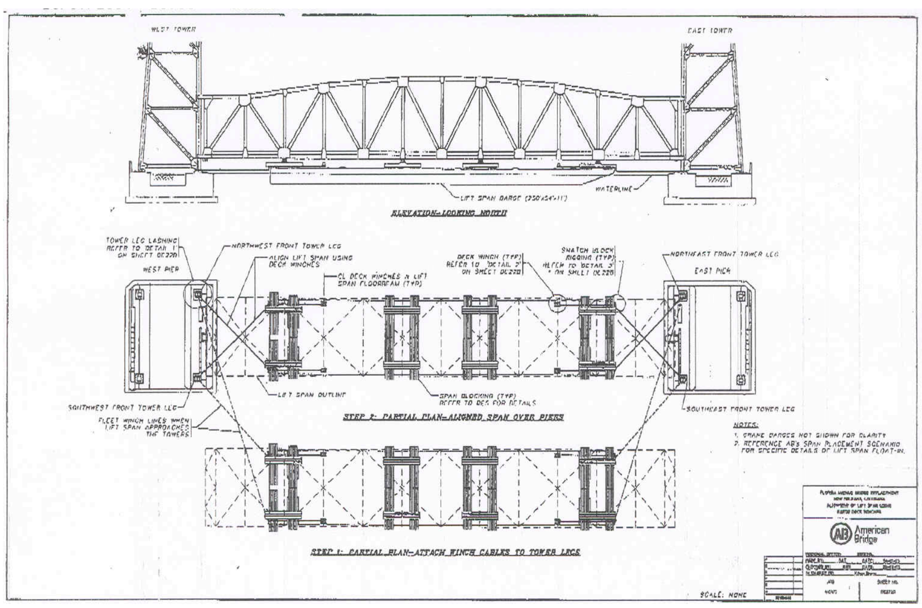
Removal of Siphon and Pier Construction:

Portions of the siphon below the river bed and the sluice gates were removed by use of explosives, steel punch, and clam buckets. This work was accomplished within the allotted waterway closure time. Simultaneous to removal of the siphon, cofferdams were constructed in preparation for driving piles and building pier footings. The contractor used the pier foundation and cofferdam construction methods which ran into difficulty and may not have been quite compatible with the site conditions. Contractor maintained dewatered cofferdams in an attempt to keep the areas in dry condition within the cofferdam after driving the piles but prior to sealing the bottoms of the excavation with tremie concrete. It was very hard for the contractor to maintain dewatered cofferdams against a hydrostatic head of 21 to 27 feet. Consequently, the west cofferdam partially collapsed before it was fully constructed. Contractor claimed that additional work was done in removing existing timber piles which he called unexpected debris, and voids/holes under siphon below the west and east cofferdams.   This should have been anticipated as the scope included demolition and removal of an existing under water siphon, over 80 years old that is pile supported in very soft soils, in a shipping canal.

Lift Span Float-In:

Contractor's preparation for lift span float-in was carried out meticulously prior to the 72 hour marine closure. All obstructions to float-in operation such as channel dredging, and existing fender and dolphins were completed. The aerial cables were erected. A brief safety meeting was performed prior to the start and at each shift change. Interestingly, four temporary lift span support pedestals at piers 2 and 3 were installed, aligned, and made ready to support the new lift span at a height much above the bearing elevation. The purpose of this temporary pedestals were to receive the floated-in lift span at a higher level than the bridge seat level without ballasting the lift span barge completely and sinking. It should be noted that the bridge seats are very low almost at the water level to maintain the railroad and the roadway grades. The lift span was erected on one lift span barge (54'x 250' x 11') on scaffoldings in the turning basin with mechanical components, electrical and control systems, railroad track work, and railroad signal system. Since the lift span barge was smaller than the length of the span, the ends of the assembled lift span were over hanging and thus has to be assembled on scaffolding. The lift span was leveled both longitudinally and transversely by ballasting the lift span barge. Guide brackets, track miter joints, a portion of sidewalk were not connected but kept separately to be attached at the final location. The lift span weight was measured, recorded and submitted to the engineer. Similarly the counterweight weights were measured and recorded along with 100 counterweight balance blocks per counterweight to ensure span heavy float-in. On Piers 2 & 3 expansion bearing, fixed bearing, and the centering devices were installed. The lift span finger dams at panel point 0 were installed with bolts fully tightened. Span lock bars with lock bar retracted, span guide brackets, span guide rollers, were all erected.

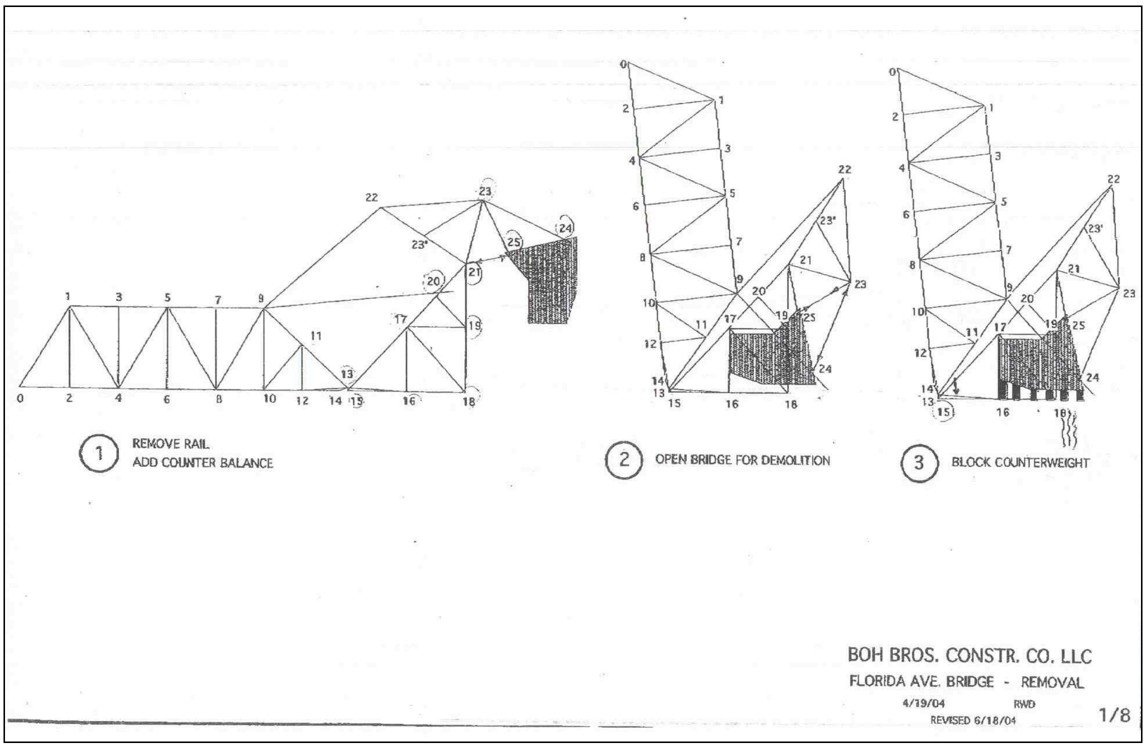
Two crane barges were attached to the south face of the lift span barge. The lift span was transported by two tug boats pushing the crane barges. Spuds were pulled by cranes on each barge and the lift span was released. As the lift span passed the operator house, the southwest bottom chord span guide bracket was connected to the lift span otherwise it would have interfered. The bracket was then tied with lashing and was rotated into position using the west barge crane. As the lift span approached the piers, the lift span barge deck winches were prepared and the spuds were lowered to temporarily hold the span stationary temporarily. Slowly the winches were tensioned until they became taut. Next, counterweight rope sockets were connected to lifting girders. Lift span positioning on the pedestals continued with use of deck winches. The lift span was lowered by flooding the lift span barge. As the lift span was lowered, the counterweight ropes became tensioned. Initial balancing was then performed by measuring the weight differential between the counterweights and the lift span by jacking the lift span at each pier pedestal. Each jack and guage shall be calibrated and have a corresponding pressure load chart. Record all four reactions and compare with target tolerance of 4,750 to 5,250 pounds per pedestal. While monitoring the balanced conditions of the lift span at the pier pedestals, the remaining counterweight balance blocks were added to achieve an initial balanced condition. Using emergency drive motors, the span was raised 5 to 10 feet for clearance to remove the pedestals. The span and roller guides were aligned to maintain a gap of about 1/8 inch between the span guide bracket rollers and the tower guides. After removing all tools, equipment, and personnel final span balancing was performed.

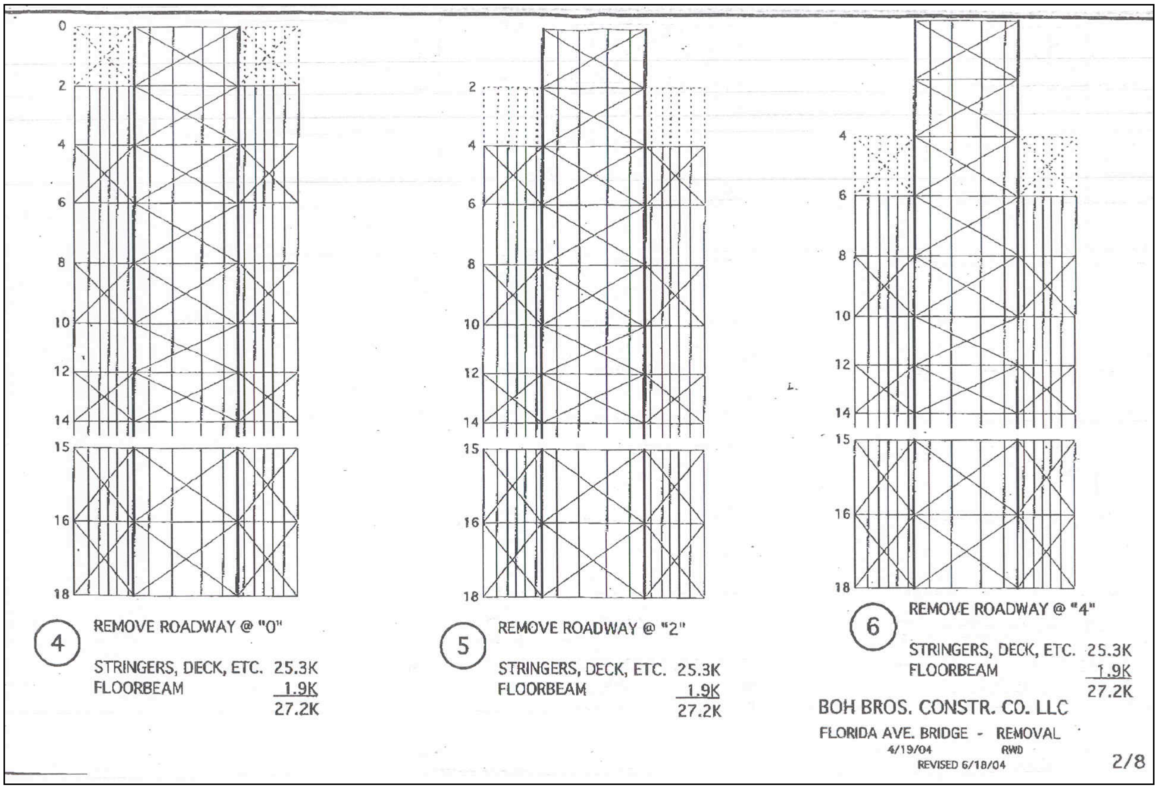


Demolition of Existing Bascule Bridge:

A suggested sequence of procedure for removal of the bascule bridge was to first place the span in the down position. Next, the counterweight was planned to be removed in one piece, and then the existing operating strut, tension links and counterweight trusses, and bascule towers were planned to be removed. Finally, barges were to be set beneath the existing bascule span to float out the entire bascule bridge at one shot. Subsequently, the trunnion and rest piers were planned to be removed by blasting and counterweight demolished. The above operations for removing the bascule span and the counterweight were planned to be accomplished within 38 hours of continuous closure of waterway; and removal of the trunnion and rest piers were planned to be accomplished within 48 hours of discontinuous closure of waterway.

However, in reality American Bridge is planning to remove the bascule bridge in open position in November of 2004. First the rail and highway traffic would be closed and the span would be kept operable for marine traffic only. As part of the pre removal work, the required structural steel cut areas of the bascule span would be marked and paint would be removed from these areas. Conley joints would be unspiked, removed and stockpiled. Rails and guardrails would be unspiked, removed, unbolted, and stockpiled. W24x104 beams would be attached to the toe end to compensate for the weight of the removed rails and guardrails. Counterweight would be pre drilled in preparation for demolition. Crane mats would be placed on tower span and west approach railway spans to block the counterweight. After removing the span locks, the bridge would be raised and lashed in the up position and counterweight would be blocked as shown. Material barges and crane would be positioned to begin demolition and removal of roadway concrete deck, stringers, and floor beams from the bascule end of the bridge gradually proceeding towards the trunnion end. Next, the truss members would be removed from the bascule end proceeding gradually towards the trunnion end as shown. After removing the operating strut or rack all machinery would be removed from the machine house. A temporary strut would be attached to the counterweight truss as shown to maintain stability and facilitate removal of the counterweight link. After removing the counterweight truss, American Bridge would drill and load counterweight with non electric caps which are not subject to unplanned detonation due to electric currents resulting from radios, weather, and power lines. The blast area would be covered with crane mats, cloth and wire netting as necessary to control flying rocks. A marine safety zone extending 500 yards north and south of Florida Avenue would be set up and all traffic would be stopped. As intended, the concrete counterweight hopefully would be broken into pieces and removed by conventional excavation equipment. The remaining concrete from the counterweight would be removed with a backhoe mounted hoe ram, scooping it out as it comes loose. The blast would be monitored using blast monitors and the registered readings would be checked for acceptable/safe levels of vibration and noise levels. American Bridge has negotiated a contract extension of 47 days to accomplish the removal of the bascule span, and the counterweight.

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STRINGERS, DECK, ETC. 25.3K
FLOORBEAM 1.9K
27.2K
5
REMOVE ROADWAY @ "2"
STRINGERS, DECK, ETC. 25.3K
FLOORBEAM 1.9K
27.2K
6
REMOVE ROADWAY @ "4"
STRINGERS, DECK, ETC. 25.3K
FLOORBEAM 1.9K
27.2K
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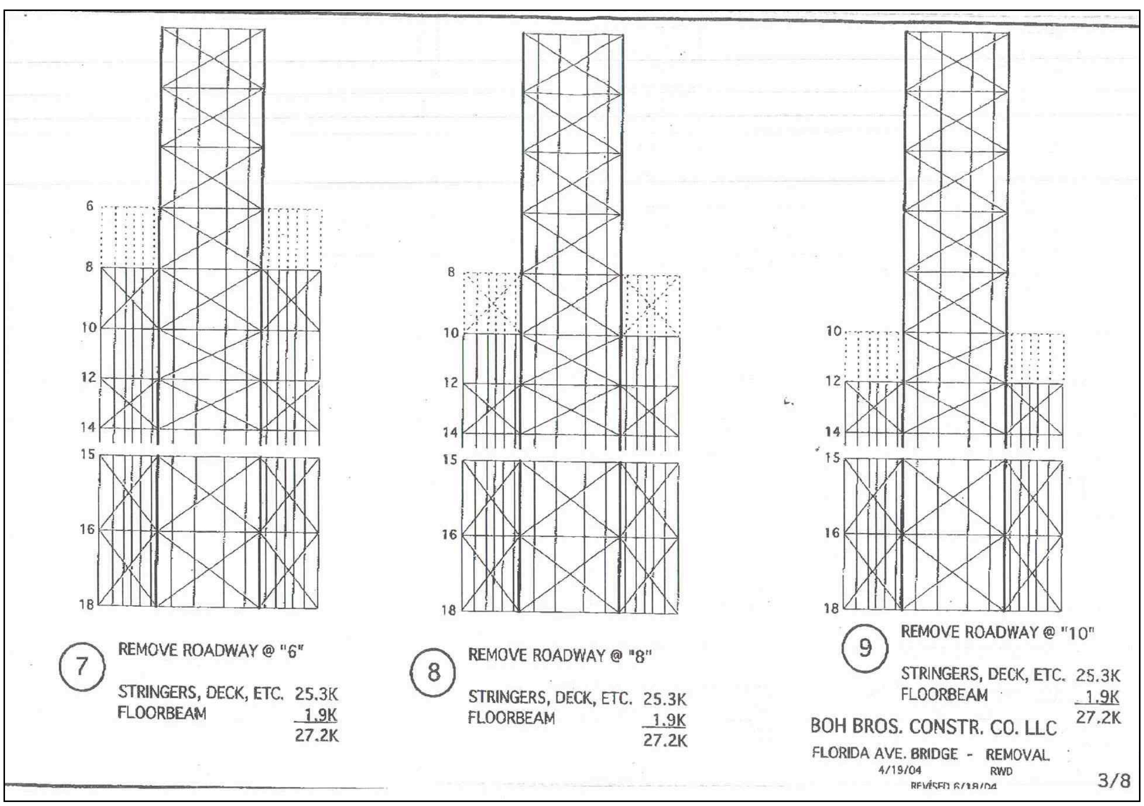
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FLOORBEAM 1.9K
27.2K
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FLORIDA AVE. BRIDGE - REMOVAL
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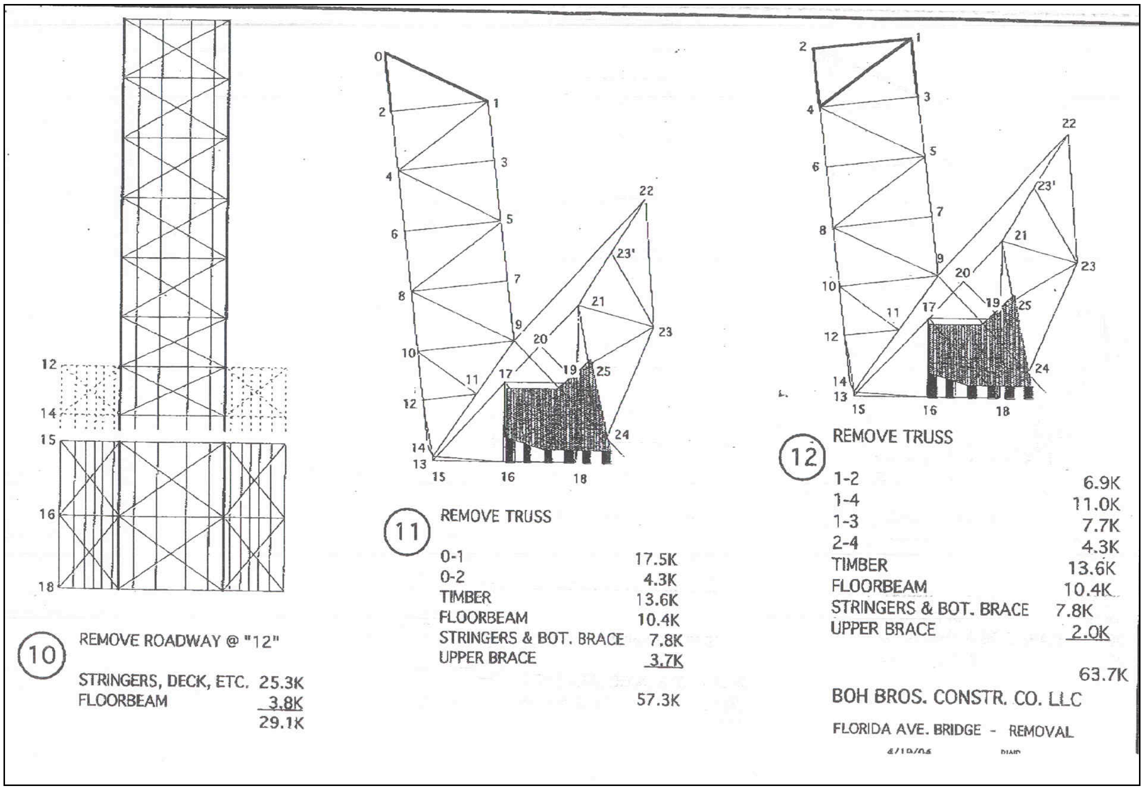
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UPPER BRACE 3.7K
57.3K
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1-4 11.0K
1-3 7.7K
2-4 4.3K
TIMBER 13.6K
FLOORBEAM 10.4K
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UPPER BRACE 2.0K
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BOH BROS. CONSTR. CO. LLC
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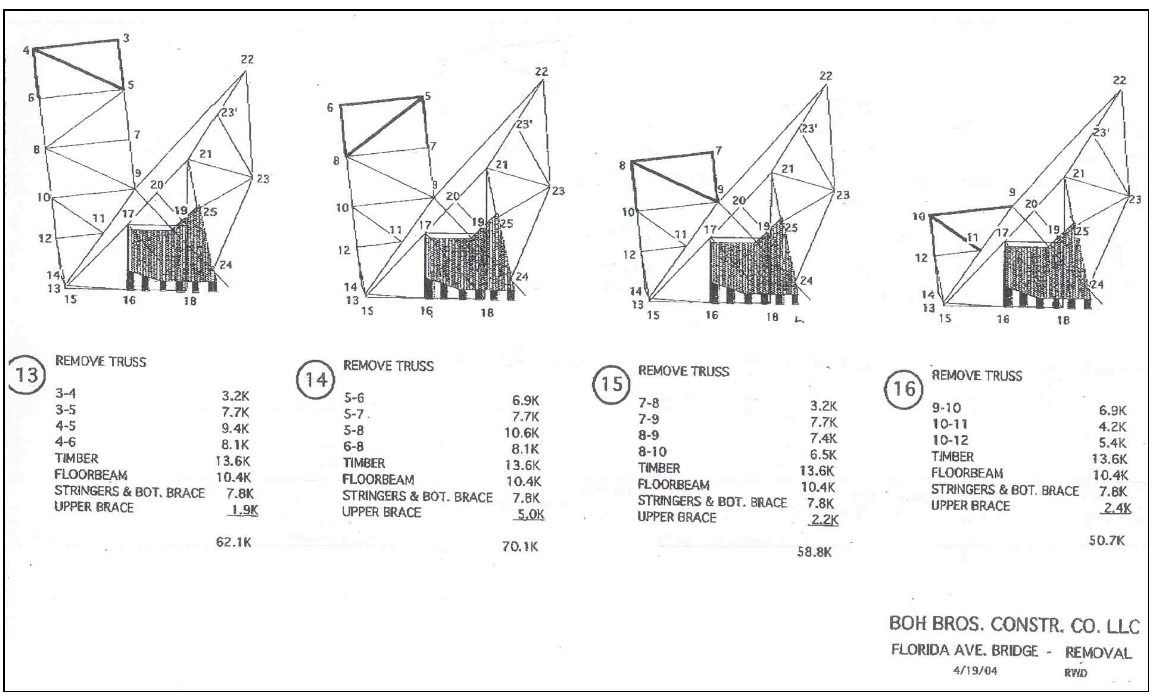
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TIMBER 13.6K
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STRINGERS & BOT. BRACE 7.8K
UPPER BRACE 1.9K
62.1K
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FLOORBEAM 10.4K
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BOH BROS. CONSTR. CO. LLC
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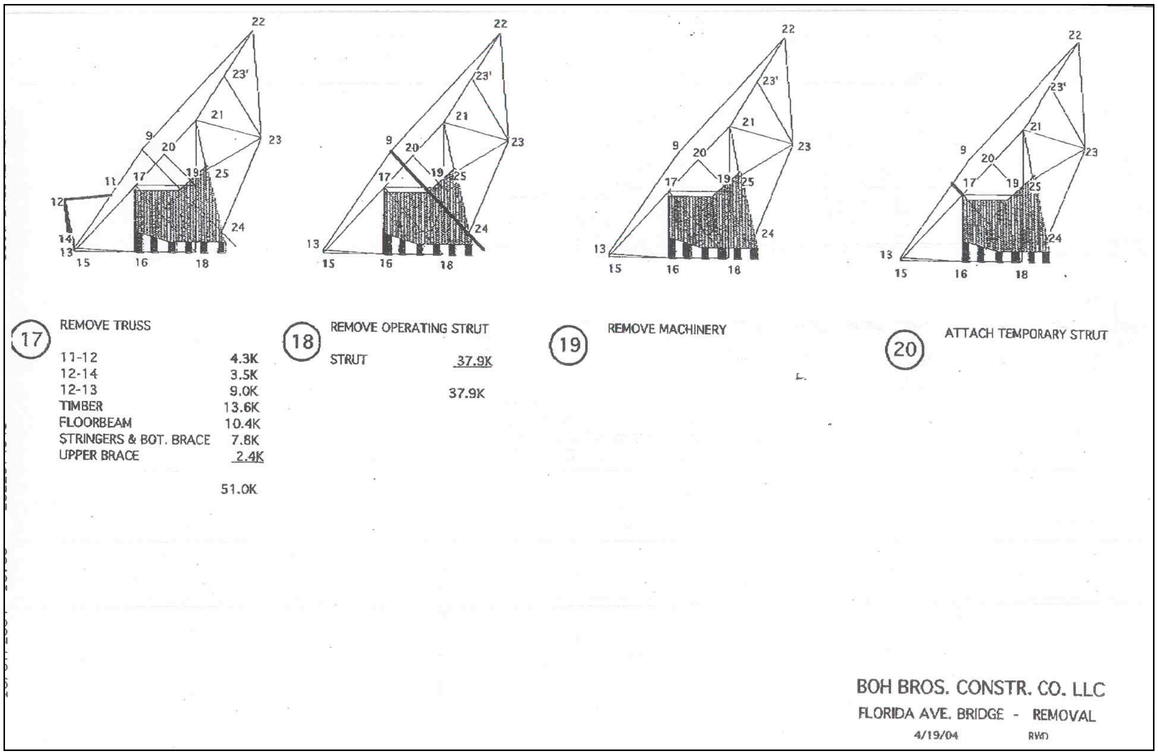
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FLOORBEAM 10.4K
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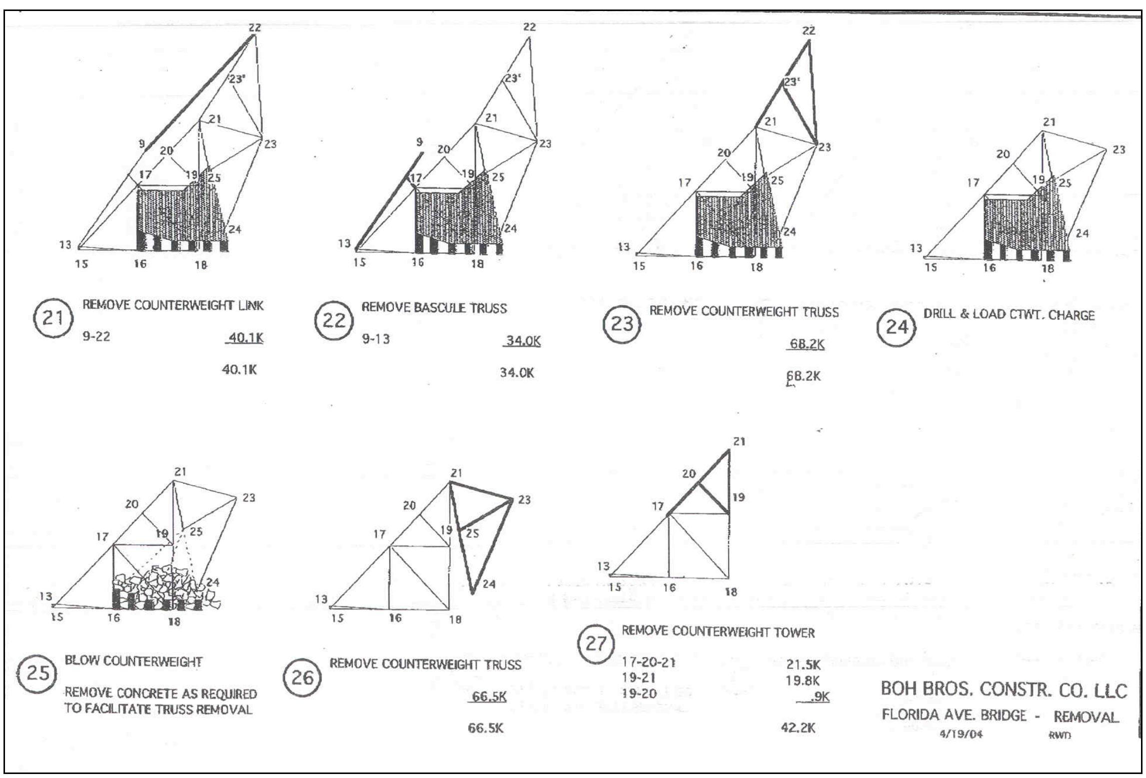
UPPER BRACE 2.4K
51.0K
18
REMOVE OPERATING STRUT
STRUT 37.9K
37.9K
19
REMOVE MACHINERY
20
ATTACH TEMPORARY STRUT
BOH BROS. CONSTR. CO. LLC
FLORIDA AVE. BRIDGE - REMOVAL
4/19/04
RWD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68.2K
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DRILL & LOAD CTWT. CHARGE
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BLOW COUNTERWEIGHT
REMOVE CONCRETE AS REQUIRED
TO FACILITATE TRUSS REMOVAL
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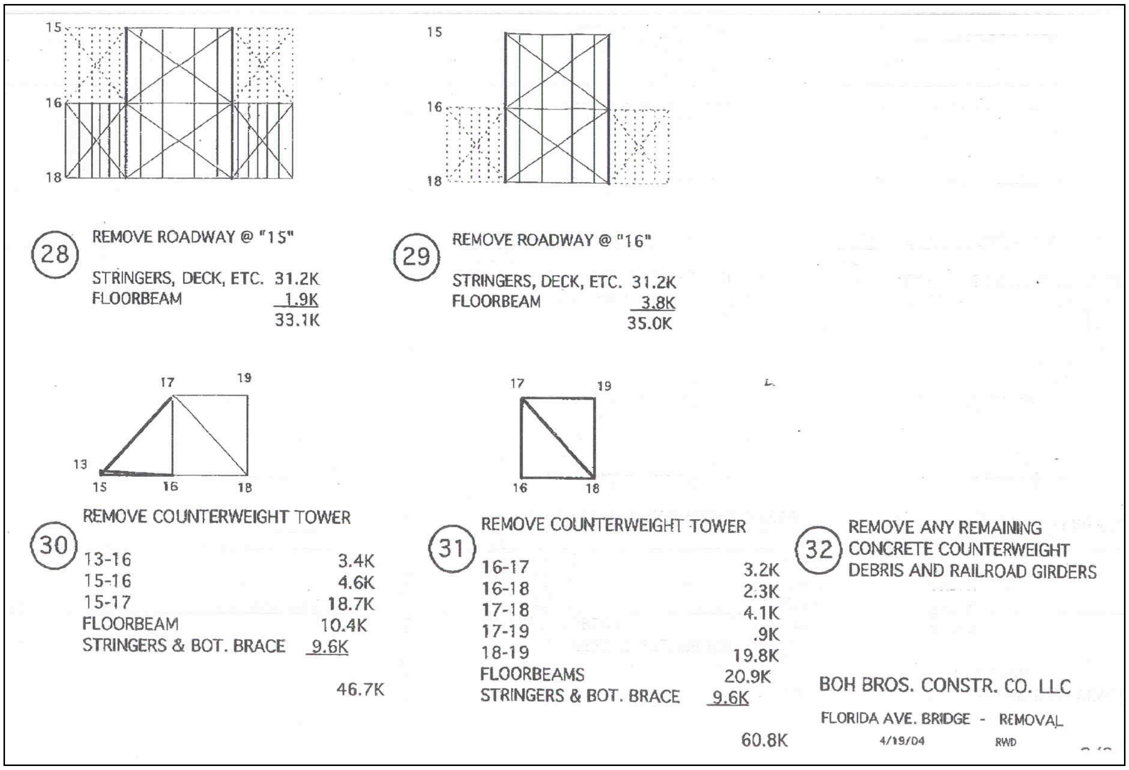
REMOVE COUNTERWEIGHT TRUSS
66.5K
66.5K
27
REMOVE COUNTERWEIGHT TOWER
17-20-21 21.5K
19-21 19.8K
19-20 .9K
42.2K
BOH BROS. CONSTR. CO. LLC
FLORIDA AVE. BRIDGE - REMOVAL
4/19/04
RWD



Unexpected Settlement and Soil Movements:

As the construction proceeded, roadway approaches, particularly the west end of the eastbound roadway showed significant (about 8 inches) settlement. Although, the cause of this excessive settlement still remains under investigation and the situation is being monitored with three inclinometers, it is felt that the initial prediction of embankment settlement of 30 inches in 30 years did not take into account a layer of soft clay with high water content and low shear capacity. This situation was possibly further deteriorated and aggravated by cofferdam construction blow-ins which disturbed cohesion of underlying soil. Additionally, dredging of channel side slopes in front of the main pier and operator's house reduced the passive pressure and may have contributed to further settlement. The roadway and railway embankments consisted of granular materials extending from 0.0 to +10.5 at the bridge. Portions of the embankments were also placed at the bottom of the siphon canal at or near -20.0. Thus, some portions of the embankment were about 30 feet high.

The main pier foundation design was primarily concentrated on transferring large vertical dead and live loads by piles to suitable bearing stratum. 187 steel H-piles were provided for each pier with pile tip elevation set at -152 to limit permanent settlement of 1/2 inch or less. Horizontal loads were carried by battered piles and bending of vertical piles. Measurements taken on 8 April 2004 subsequent to float-in indicate an increase in translation of west tower bearing from 1-5/16 inches at pre-float-in by +1/8 to 1/4 inch, and the east tower bearing from 3/4 inch at pre-float-in by +1/8 to 1/4 inch. New computations of the capacity of the main pile group to resist lateral load indicates a maximum deformation of 1.7 inches. This is what the pier is actually experiencing now.

In case the settlement and translations are not stabilized/stopped after the trains run on the bridge, the situation can be remedied by construction of soil/cement columns placed throughout the construction area. Such columns are constructed by a process of "jet grouting" in which a highly energy jet of fluid erodes soil in place and mixes it with a cementitous slurry to form soil/cement column of up to 12-foot diameter. Such columns would extend from just under the existing soil surface to the top of the dense sands and stiff clays located at elevation -46 and below. The columns would act to transfer the load of the embankment fills to the deeper layers, by passing the soft clay layers. Although this is an acceptable and practical way of dealing with very soft soils, it is very expensive.

Thus, several other remedial methods conventional to New Orleans area are currently being evaluated to correct the situation such as constructing roadways as pile supported slabs. In such a procedure, piles are driven on a grid of 10' centers in both directions, a layer of compacted material is placed and graded to form the bottom of the slab, and a concrete roadway slab is poured with sufficient rebar to span as structural slab between piles, Such an installation has the virtue of reducing the roadway settlement to a very low amount. However it has the defect of not eliminating the weight of the roadway embankment on the underlying soft soils and thus not eliminating the movement of those soils.

The approach roadway bridge could have been completely eliminated by constructing approach roadway as concrete slab span bridge structure with 20 feet spans on pile bents. However, pile supported track or roadway was discouraged during the design stage due to the added cost.

Fairly large pavement settlements occur in the New Orleans area roadway and this is periodically remediated by bringing the roadway grade back up to an acceptable grade with an asphaltic concrete overlay.

Finally, the active pressure of the driving wedge is creating horizontal forces greater than of the passive pressure of the resisting wedge. Thus, addition of a layer of rip-rap to the resisting wedge at 3/1 slope along the front of the pier and operator house will not only guard against scour of soil from underneath the tremie seal and footing but also help stabilize the soil movement.

Currently, the Port of New Orleans is monitoring and measuring soil movements and settlements at the bridge with all dead and live loads in place prior to making a decision and taking any remedial actions. Trains just started to use the bridge starting on 26 September, 2004. No impacts on settlement of soil/pavement or movements of pier bearings, and inclinometer readings have been noticed so far. Trains are currently running at 5 mph while Norfolk Southern is inspecting and adjusting track alignment and grades on the bridge approaches.