Ownership/Public Use/Management

Replacement of the Third Avenue Bridge Over the Harlem River

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Abstract

The design for the replacement of the 105-year old Third Avenue Swing Bridge is complete. The new 5-lane crossing will consist of 17 approach spans and a 350-ft long swing span for an overall bridge length of 1500 feet. Including on-grade approaches, the overall project length is 3500 feet. The scheme selected is an on-line replacement, requiring complex staged construction that includes a temporary bridge and float-in of the fully-assembled swing span, which has been barged roughly 1800 miles to New York City from Alabama.

Introduction

The existing Third Avenue Bridge has served as a vital part of New York City's infrastructure since its construction in 1897. Spanning the Harlem River, the bridge is an essential component in the critical system of crossings that link the boroughs of Manhattan and the Bronx over this navigable waterway and is one of seven Harlem River drawbridges owned and operated by the New York City Department of Transportation (NYCDOT). Having been originally designed to carry trolleys and horse-drawn carriages, the burden of carrying New York City traffic for over 100 years has taken its toll on the existing structure, which can no longer accommodate modern demands.

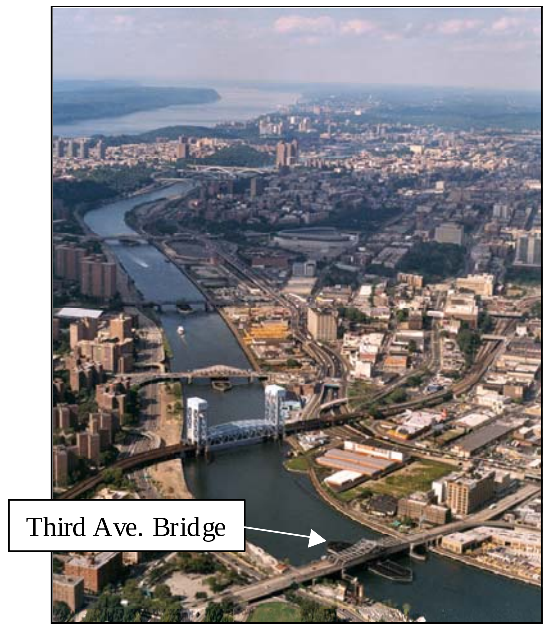

PHOTO 1: View of Harlem River Looking North

To address the problems plaguing the structure - traffic congestion; substandard geometry that has led to high accident counts; deteriorating components; inadequate live load capacity; inadequate seismic capacity; and obsolete, deficient mechanical and electrical systems - the NYCDOT Division of Bridges moved ahead with plans to replace the aging bridge in 2001. The $118.8 million Reconstruction of the Third Avenue Swing Bridge, scheduled for completion in 2005, involves six stages of work, and includes complete substructure and superstructure replacement of the ramps, approach spans, and swing span, including the mechanical and electrical systems and control house. In total, the reconstruction project encompasses 3500 feet of structure.

This paper presents a brief history of the Third Avenue Bridge, followed by discussion of the problems that led to its replacement, challenges faced by the designers of the new bridge, and solutions developed to meet these challenges. Also presented are descriptions of some of the design features of the new structure.

Bridge History

The existing 105-yr old Third Avenue Bridge over the Harlem River is actually the third crossing to be located at this site. The first bridge at this site was known as the Coles Bridge and was opened to traffic in 1797, serving as a link in an important route between New York and New England. This toll structure, owned and operated by the Harlem Bridge Company, primarily carried horse-drawn carriages, but also served as a river crossing for pedestrians and livestock.

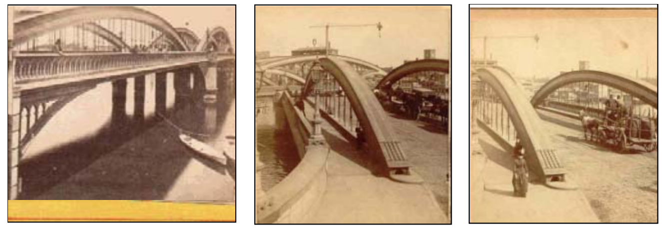

PHOTO 2: New Harlem Bridge (Predecessor to the Existing Third Avenue Bridge)

In 1868, in an effort to provide increased capacity to meet population growth on both sides of the crossing, New York State completed construction of the second bridge at this site, which became known as the New Harlem Bridge. This highly ornamental replacement structure was significantly larger than the first bridge, and, to accommodate increased river traffic, included a steam-powered swing span that created two 80-ft wide navigable channels with the span in the open position and provided a 13-ft vertical channel clearance with the span closed. The span itself was a heavy three-arched iron structure, supported on iron cylinder piers. The bridge was the first Harlem River crossing to carry rail traffic, which consisted of horse-pulled railroad cars until 1891, when an overhead trolley system was installed, and was the Harlem River's first movable bridge.

As the turn of the century approached, the continuing growth of industry and the accompanying influx of immigrants resulted in rapid increases in New York City's population and the demand for further development of the city infrastructure. The bridge felt this demand, as increased road and river traffic led to increased maintenance costs. Subject to these traffic demands and, to some extent, unable to accommodate its own massive weight, the bridge deteriorated rapidly soon after its construction. To address this problem, satisfy demands for reduced span opening time and increased navigation clearances along the Harlem River, and accommodate the development of elevated rail lines extending out of Manhattan, New York State began construction of a more functional replacement structure in 1893, just 25 years after the $2 million second bridge was opened to traffic.

At a cost of $4 million, the current Third Avenue Bridge - the third crossing to be constructed at this site - was opened to traffic in 1898. Its main span is a 300-ft long, 80-ft wide through truss swing span that provides two 100-ft wide navigation channels with 25ft of vertical channel clearance in the span-closed position. In addition to providing significantly greater bridge traffic capacity and navigation clearances, the bridge has utilized electric power since 1913 to drastically reduce span opening times over its steam-powered predecessor. Reduced opening time was crucial as river traffic grew at the turn of the century. For the first 30 years or so of its existence, the span opened roughly 3000 times a year, with up to 9000 vessels passing through the drawn span annually. During this same period, another 50,000 to 75,000 boats passed beneath the closed span each year.

FIGURE 1: Sketch of the Current Third Ave. Bridge after Original Construction

Originally, the swing span consisted of 4 parallel through trusses, with trolley service in the center lane and the outside lanes used primarily for carriages. Pedestrians traveled on the sidewalks at each side of the structure. In 1953, trolley service on the bridge ceased and the center lane was converted for motor vehicle use. As part of an extensive rehabilitation of the bridge in the late 1950's, the entire center portion of the swing span, including the 2 inboard trusses, was removed and sold as a complete bridge. In its place, a single truss was constructed along the centerline of the bridge and tied into the existing structure, which resulted in the span's present 3-truss arrangement. The traffic flow on the bridge was changed from 2-way to 1-way traffic inbound to Manhattan around this time. Having undergone this major reconstruction, only the modified swing span, river piers, and the substructure below the Third Avenue ramp on the Bronx approach remain from the a 1898 structure.

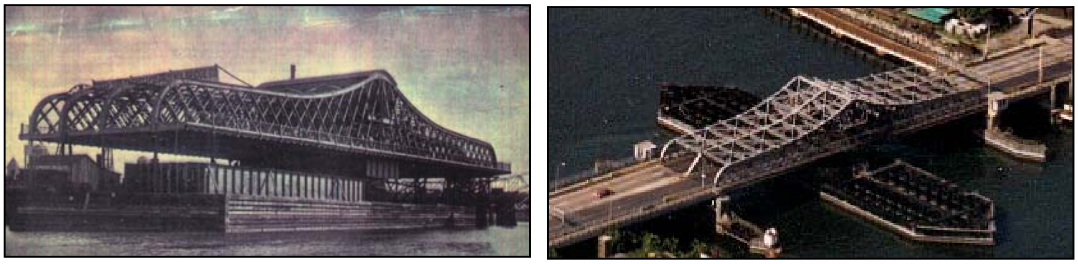

PHOTO 3: Top – Four parallel truss arrangement prior to 1950's rehab. Bottom – Three parallel truss arrangement after 1950's rehabilitation.

Third Avenue Bridge Today

At its opening at the turn of the century, the Third Avenue Bridge carried horse-drawn carriages, trolleys, and pedestrians. Today, the bridge functions as a major urban arterial that carries four lanes of one-way traffic into Manhattan from the Bronx, and serves as a couplet to the adjacent Willis Avenue Bridge, which carries four lanes of traffic from Manhattan into the Bronx. Current traffic totals amount to roughly 80,000 vehicles daily, including high truck counts. Ongoing vehicles enter from one of two ramps on the Bronx side of the bridge – the Third Avenue or the Bruckner Boulevard ramp - and exit onto one of three ramps on the Manhattan side – the 128th Street, 129th Street, or Harlem River Drive ramp.

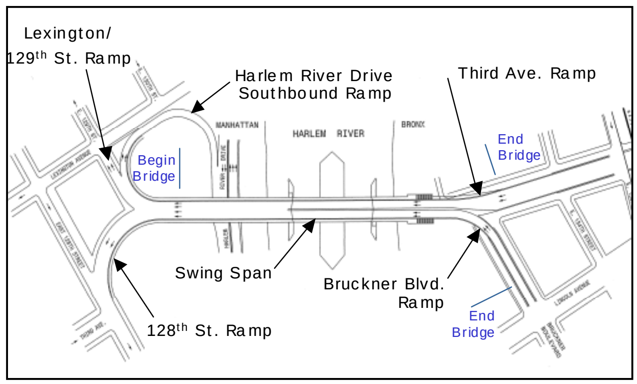

FIGURE 2: General Plan of the Existing Bridge

In all, the existing Third Avenue Bridge is comprised of 41 approach and ramp spans, and the overall bridge length is roughly 1400ft. Including on-grade approaches, the overall structure length is over 3400ft. In addition to spanning over the Harlem River and the Harlem River Drive, it crosses over the Oak Point Link Railroad (CSX) that travels along the east side of the Harlem River in the Bronx. There are service roads with commercial properties along both of the Bronx ramps, and, on the Manhattan side, the Harlem River Park is located at the abutment and between the three off ramps.

In contrast to the high volume of vessels that traveled beneath the bridge and through its draw span for several decades after its construction, current boat traffic on the Harlem River is relatively light. Currently, less than 10,000 vessels pass beneath the closed span annually. The span swings open only less than 30 times a year, mostly for routine maintenance.

Existing Bridge Deficiencies

The 1995 Bridge Reconstruction Project Report (BRPR) included an in-depth inspection and complete structural load rating and evaluation. It also presented comprehensive rehabilitation/replacement schemes and documented several significant deficiencies. The report concluded that the bridge is approaching the end of its service life.

Generally, the bridge is in poor physical condition, with substantial and unacceptable levels of deterioration throughout. In addition, the bridge possesses inadequate live load capacity. Overall, hundreds of members, including superstructure and substructure components, possess insufficient live load ratings. The BRPR study also revealed the necessity of complete substructure replacement and significant superstructure rehabilitation in order to meet current seismic code requirements.

PHOTO 4: Unsafe Weaving Condition (Note Center Truss of Swing Span)

Traffic-related problems plague the existing structure. Daily traffic congestion and substandard bridge geometry have created dangerous travel conditions and resulted in an excessive number of traffic accidents. This traffic problem is inherent to the general configuration of the bridge, which keeps the two lanes of traffic entering on the Third Avenue ramp in the north lanes of the bridge and the two lanes of traffic entering on the Bruckner Boulevard ramp in the south lanes of the bridge until after the swing span is crossed. Weaving of all four lanes of traffic to exit the bridge, at either the Harlem River Drive and Lexington Avenue ramps on the north side of the bridge or at the 128th Street ramp on the south side of the bridge, must occur within roughly 550ft. Approximately 150ft short of the state's minimum requirement, this substandard weave distance results in high accident counts and congestion. Because the center truss of the swing span is located at the center of the roadway, separating the two north lanes from the two south lanes, the only alterative to the weaving problem is replacement of the swing span.

A feasibility study of rehabilitation and replacement options was performed as part of the BRPR. In consideration of the major deficiencies and substandard features described above and the substantial work necessary to properly address them, H&H recommended and NYCDOT concurred that a complete replacement of the bridge was warranted.

Proposing A Solution

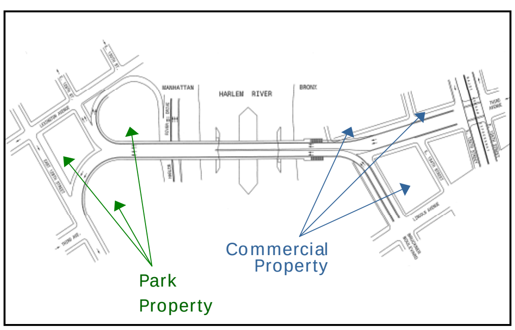

FIGURE 3: Property ownership on each side of the bridge

Evaluating the existing structure and concluding that a new structure was necessary proved far less challenging than developing a concept for the replacement bridge that would not only address the noted problems, but also allow for construction that minimizes bridge traffic disruption and channel closures, while maintaining a high level of service for both throughout construction. In addition, the new bridge had to meet or exceed existing bridge channel clearances, have minimal impact on the heavily developed property surrounding the approaches, and satisfy New York City Arts Commission requirements.

Several bridge configurations were considered as potential replacement structures, including a swing bridge, a vertical lift bridge, and a high level fixed bridge, with online (within the same footprint as the existing structure) and offline (located to the north of the existing bridge) replacements considered for each scheme. Because of the property ownership and development of the land on either side of the bridge, any scheme that requires much change to the bridge's surrounding landscape is not feasible. This essentially eliminated fixed bridge and offline schemes from consideration, leaving online replacement with either a swing bridge or a lift bridge as viable options. Giving consideration to Arts Commission desires to maintain the general aesthetics of the existing bridge while keeping within the general architecture of the surrounding Harlem River crossings, the City selected the online swing bridge replacement scheme with a through truss main span. Thus, the selected replacement configuration maintains the general architecture of the existing bridge and provides the means to satisfy channel clearance requirements.

Although the construction staging necessary for the online scheme adds complexity to the design details and construction procedures, staging the work allows for achieving the City's goals of minimizing disruption to bridge and navigation traffic during replacement of the structure. The City decided to move forward with a staged construction design for this reason.

In 1997, the NYCDOT directed H&H to begin final design of the replacement of the Third Avenue Swing Bridge. The remainder of this paper describes concepts and details of the design of the new bridge, including discussion of the complex staging of the online construction that significantly affected the design.

Construction Staging

Early design efforts focused heavily on the development of construction staging concepts and details that would allow for minimal disruption to both vehicular and marine traffic. Originally, the design included closure of the bridge for 6 months to allow for construction of the swing span. But the NYCDOT Office of Construction Management and Coordination (OCMC) required that two lanes of traffic and one sidewalk be maintained during the entire construction period. In addition, the Coast Guard required, at a minimum, that one navigation channel be maintained throughout construction. The goal of the staging design was to limit necessary exceptions to these requirements. The decision to float the existing swing span out and float the new, fully-assembled swing span into position was paramount in developing a scheme that could achieve these goals.

Overall, the design scheme involves three stages of construction (six including sub-stages), and will require approximately four years to complete. By utilizing a float-out/float-in scheme in conjunction with a temporary bridge, complete bridge traffic closures are limited to two weekends, and navigation channel height restriction for vessels that necessitate the opening of the span is limited to a single 5-month period. To accomplish this, the timeliness of construction necessary to tie traffic into the temporary bridge and to receive the floated-in swing span is critical and conceptually controlled the staging design.

In order to maintain vehicular and marine traffic throughout construction, the existing swing span must remain in-place and operational until the temporary bridge is functional. Because the temporary bridge will not be a movable structure, the clock on the 5-month channel restriction starts once the temporary spans over the navigation channel are erected. Thus, all work that can not be completed prior to removal of the existing swing span and that is necessary to achieve an installed and operational new swing span—including demolition of the existing rest piers and pivot (center) pier, construction of the new rest piers and pivot pier, float-in of the new swing span, and mechanical and electrical work—must all be completed within this restrictive 5-month stage. The development of a scheme that allows performing as much of this work as possible in advance was critical to the project.

Looking for ways to complete some of this work ahead of time, the designers focused on the existing and new substructures By locating the new rest piers sufficiently beyond the existing rest piers and selecting a pivot pier design that effectively spans over the existing pivot pier and is founded on large drilled shafts, much of the new rest and pivot piers could be constructed prior to removal of the existing span. The decision to replace the existing rim-bearing span with a center-pivot swing bridge also reduced the amount of work to be performed during the float-in stage by simplifying installation procedures and allowing for utilization of a more favorable drilled shaft arrangement.

Preparation for the float-in will begin in the first construction stage, during which the south halves of the rest piers are constructed. Installation of the drilled shafts located on the south side the pivot pier and clear of the existing bridge will also occur during the first stage. To accomplish this work, the Bruckner Boulevard ramp will be closed, with two lanes of traffic maintained on the north side of the bridge.

During the second stage, the Third Avenue ramp will be closed and two lanes of traffic will travel on the south side of the bridge. This enables demolition of the north side of the existing bridge and construction of the north side of the new bridge, with the exception of the swing span. Work performed during this stage will include completion of the north halves of the rest piers and installation of the drilled shafts located on the north side of the pivot pier and clear of the existing bridge. At the end of this stage, the temporary bridge will be constructed just to the north of the existing swing span. The two channel spans of the temporary bridge, each roughly 150ft long, will consist of modular truss panels.

After installation of the temporary bridge, traffic will return to the north side of the bridge, diverted around the swing span for the third and final construction stage. This configuration provides for the maintenance of two lanes of traffic while the south side of the existing bridge is demolished and the south side of the new bridge is constructed. It is during this stage that the existing swing span is floated out, existing pivot pier demolition and new pivot pier construction are completed, the pivot pier machinery is installed, and the new swing span is floated into place. When floated in, the new 350-ft long, 6 million pound swing span will be completely assembled. Only during float-out and float-in procedures will the bridge be closed to traffic, with weekend closures required for each procedure. At the end of this stage, the bridge replacement project will be complete.

New Bridge Design

General Configuration

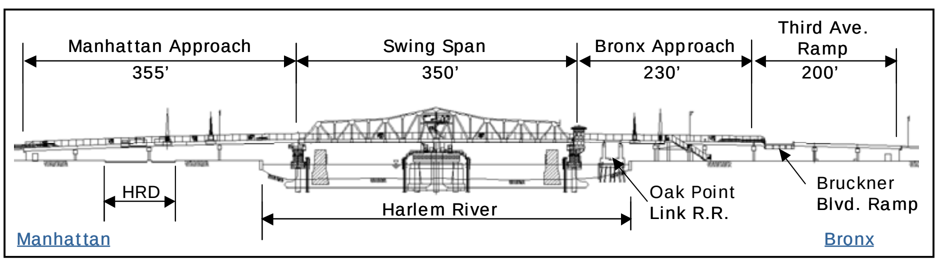

FIGURE 4: General Elevation of New Bridge Design

The design of the new Third Avenue Bridge represents a significant improvement over the existing structure. In addition to addressing all the substandard and deficient conditions described above, the traffic capacity of the new bridge increases from 4 to 5 lanes in comparison to the existing structure, and the horizontal clearance of each of the navigation channels increases from 100ft to 116ft. To achieve vertical clearance requirements throughout, the profile of the replacement structure has been raised roughly 5ft above the existing bridge. Additionally, the design increases the width of the sidewalks located on each side of the new bridge to 8ft. In total, the new structure will measure 1500ft between abutments, and will consist of 18 spans, representing a significant reduction from the current 41 spans for roughly the same bridge length. Adding the nearly 2000ft of on-grade approaches, the overall project length is roughly 3500ft.

Swing Span

The main feature of the new bridge is the movable span. The design calls for a 350-ft long, 88-ft wide through truss swing span, operable from a control house located above the roadway at the center of the span. When drawn, the span will provide unlimited vertical clearance for the two equal 116-ft wide channels. In the closed span position, the design provides a minimum vertical clearance of 26′-6″, an 8” improvement over the existing bridge. Unlike its rim-bearing predecessor, the new span will be a center bearing swing, supported on a single center bearing on which the span will rotate when opening and closing. To best utilize the current channel configuration, the design locates this center pivot coincident to the center of the existing span.

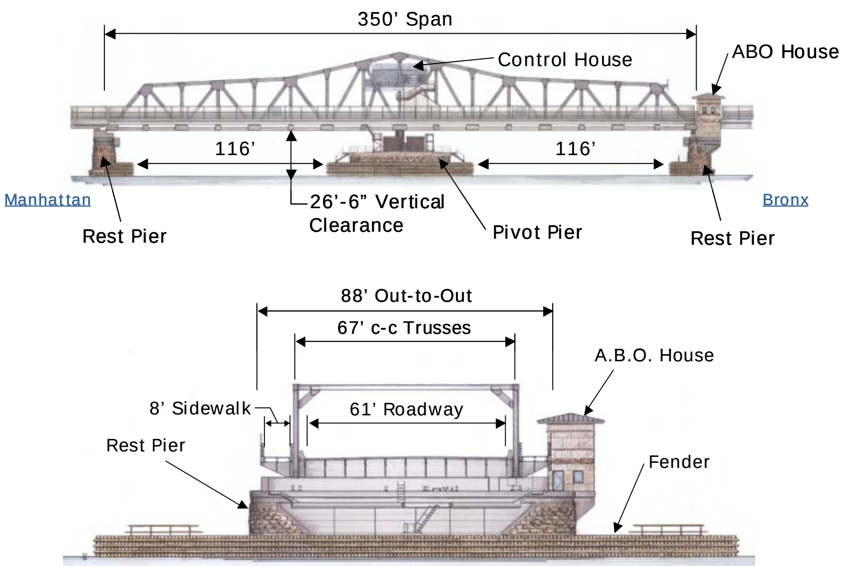

FIGURE 5: Rendering of the New Swing Span. Top – Elevation View. Bottom – Section Thru Span at Rest Pier

Swing Span Substructure

The substructure of the new swing span will consist of the same components as the existing bridge – a pivot pier at the center of the span, and a rest pier at each end of the span. The new pivot pier resembles a tabletop, with a 100’x 60’ reinforced concrete cap that is 11ft thick and supported by ten 6-ft diameter drilled shafts. The drilled shafts consist of ¾” thick steel casings, filled with reinforced concrete and socketed into rock beneath the river bottom. It is anticipated that the length of these shafts will be at least 100ft. By locating the shafts at the perimeter and center of the pivot pier, the concrete cap will span over the existing center pier. This allows the existing pivot pier, which consists of a 100-year-old granite-faced concrete ring founded on a massive timber caisson, to remain in-place. Not only does this arrangement eliminate the need for costly demolition of the existing pier, but takes advantage of its hollow center by locating the

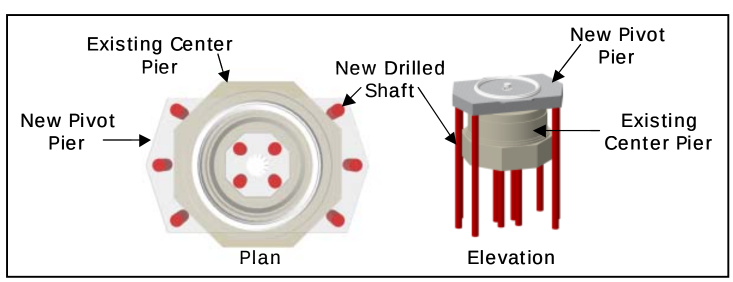

FIGURE 6: New Pivot Pier

drilled shafts clear of the sure-to-be impenetrable existing caisson. This arrangement also allows for ideal positioning of the center four shafts to carry the 6 million pound dead load of the new swing span concentrated at this location beneath the span's center bearing. By installing the six drilled shafts that are located beyond the existing pier and beyond the limits of the existing bridge prior to span float-out, significant construction time will be saved during the channel closure stage.

The rest pier design consists of reinforced concrete shafts that are founded on drilled shafts similar to those utilized at the pivot pier. In addition to supporting the ends of the swing span under live load, the rest piers support the approach spans that flank the swing span, the end lift machinery, and the sockets for the swing span centering lock machinery. As described in the staging discussion, the rest piers will be constructed in two stages – the south halves during the first stage and the north halves during the second stage. To account for this, details have been provided to accommodate the full-height vertical construction joints located just off the middle of the piers.

Swing Span Superstructure and Machinery

Two parallel Warren trusses represent the main load-carrying members of the swing span superstructure design. Unlike for the three-truss arrangement of the existing span, traffic traveling across the new span can weave unimpeded. The new trusses each consist of 16 equally spaced panels and are braced together at the top by a system of sway frames and portals and at the bottom by the floorsystem. The individual truss members are welded steel boxes, ranging in dimension from 20"x 20" to 20"x 24". To reduce future maintenance efforts, the truss members have been designed as sealed boxes, with handholes for bolting provided only at connection locations. Internal, solid diaphragms beyond connection limits seal the truss members against water intrusion, thus eliminating the need to paint the box internals in the future. To maintain category B fatigue details throughout the trusses, all connections between and within members are bolted.

The steel floorsytem consists of parallel stringers spaced at just over 6 feet with floorbeams that span between the trusses. The floorbeam spacing matches the 22-foot truss panel spacing. The floorsystem directly supports the steel grating bridge deck, which will be filled with concrete for half its depth to create a smooth and durable riding surface. The key element of the floorsystem is the pivot girder, which not only serves as the floorbeam at the truss center panel point, but more importantly carries the full dead load of the span from the truss directly to the center bearing. The pivot girder is a 5-ft wide, 15-ft deep box girder that carries a cantilevered load of roughly 3 million pounds at each of its ends. In order to accomplish this, the connection of the pivot girder to the truss utilizes over 400 one-inch diameter high strength bolts at each end of the girder. The steel comprising the pivot girder weighs over 100 tons.

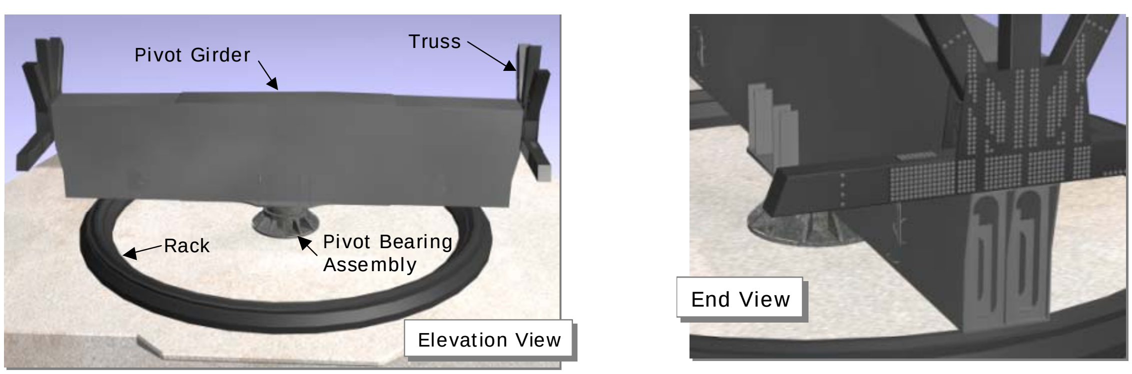

FIGURE 7: Views of the Pivot Girder

The swing span relies on mechanical components to transfer dead and live loads to the supporting substructure. In the open position, the span model comprises two balanced cantilevers supported solely at the center pivot assembly. It is the pivot assembly that carries the entire dead load of the span directly to the pivot pier. This assembly houses a spherical roller thrust bearing, which, in addition to having capacity to safely support the 6 million pound swing span plus impact forces associated with operation, can resist horizontal forces due to a seismic event predicted to be as high as 1 million pounds. As to be expected, the detailed assembly is very large, with an overall height of nearly 5ft and a base diameter of nearly 10ft.

A spherical roller thrust bearing was selected because it provides several significant advantages. Its low coefficient of friction decreases the power required to open/close the swing span, which results in smaller, less expensive drive train components. In addition, the physical composition of the bearing allows for main electrical cables to pass through its center, which results in a consolidated, unexposed arrangement of wiring that is not forced to drag across the center pier during operations. The load-carrying capabilities of the bearing allows for high thrust loads and moderate radial loads, which simplify design details allowing the compact assembly to take periodic horizontal seismic loads that would otherwise need to be resisted by special seismic restraining fixtures. The spherical roller thrust bearing designed for this project is believed to be the largest, in terms of load carrying capacity, ever used for a center bearing swing span.

When in the closed position, the span will behave as a two-span continuous structure under live load, supported at its ends and at the center. In this configuration, center wedge and end lift machinery will transfer live loads to the pivot and rest piers, respectively. Mounted to the underside of the swing span, the center wedge machinery will drive wedges between the bottom of the center truss post and a stiff column supported directly on the pivot pier after each span operation. When driven, these center wedges create, in effect, live load bearings at the center of the span. The end lift machinery will be mounted directly to the top of the rest piers and will lift each corner of the span approximately 1” after span operation to ensure positive contact. When engaged, the end lifts function as bearing mechanisms, transferring span live loads to the rest piers through its supports.

In addition to machinery that transfers loads to the substructure, the design employs other mechanical systems to open and close the drawspan. The turning machinery is located both above and below the roadway at the center of the span. Along with the control desk and electrical equipment, the turning machinery’s 150 horsepower main motor and differential reducer is located inside the control house, along the centerline of the bridge over the roadway. Horizontal shafting extends the drive train from the differential reducer output shafts through the control house walls to engage bevel gear boxes that are positioned in-line with each of the trusses. Vertical shafting extends down from the bottom of the bevel

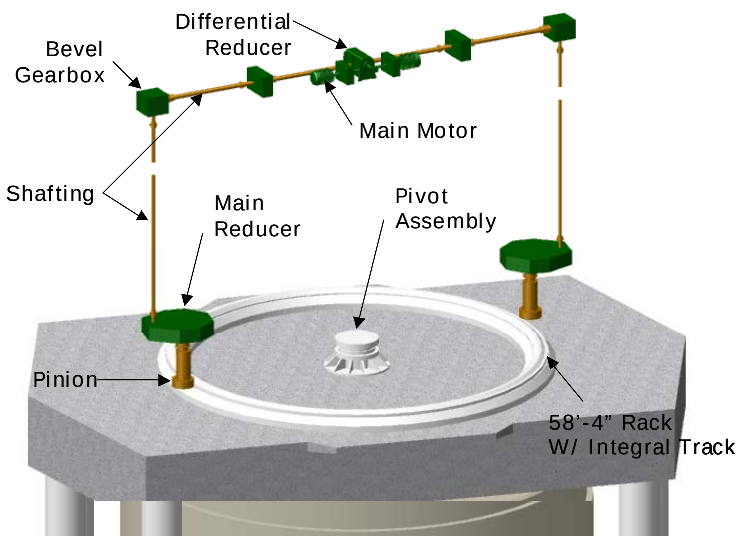

FIGURE 8: Turning Machinery

gear boxes, through the plane of each truss, and engages the main reducers mounted to the underside of the span floorsystem. Finally, output shafting from the main reducers couple with pinion shafts that ultimately turn the two main pinions. During span operations, the main pinions will engage the 58'- 4" diameter rack to be anchored to the pivot pier, thus turning the span. As required by the owner, the new span will have the ability to open 90 degrees in either the clockwise or counterclockwise direction and, as an added precaution, be capable of continuing rotation to nearly 180 degrees if required due to an emergency condition. In total, 5 speed reductions will be performed within the reducers to move the span at the desired speed, resulting in a total time to fully open and close the span of 4 minutes.

To account for the inherent instability of the swing span as it rotates about its pivot, the design provides balance wheels, positioned concentric with the pivot along a diameter of just over 54'- 8" to stabilize the span in the event that wind or other unbalanced loads tip the span during operation. With the span closed and the end lifts engaged, a 1/8" vertical gap will exist between the balance wheels and the circular track to be mounted integrally with the rack on the pivot pier. However, in the event that the span tips during operation, the balance wheels will come into contact with and travel along the track until the span rights itself.

PHOTO 5: Machining of Rack and Track in Shop

Swing Span Electrical Control System

A programmable logic controller, commonly referred to as a PLC, will perform the logic and functions necessary to operate the machinery. Under normal conditions, the PLC will operate the span automatically once the operator pushes a single button. Overall, the electrical control and power systems have been designed with redundancy to ensure operation in the event of component failure. The PLC will be equipped with redundant central processing units, and the span drive is to be equipped with two full size motors, each capable of moving the span individually. To safeguard against power failure, two separate electrical services are to be supplied to the bridge – one from the Bronx and one from Manhattan. The traffic control devices, including the traffic signals, warning gates, and barrier gates, will normally be controlled from the operator's desk located in the operator's house. However, if needed in the event of emergency, auxiliary traffic gate and signal controls will be located in an auxiliary bridge operator house located on the Bronx rest pier.

Bronx And Manhattan Approaches

The design of the replacement bridge includes seventeen spans that comprise the Bronx and Manhattan approaches. The Third Avenue and Bruckner Boulevard ramps will carry traffic entering the bridge from the Bronx, merging to form the Bronx approach some 250ft away from the east end of the swing span. The design of the Third Avenue ramp consists of three simple spans that range in length from 52 to 77ft, totaling roughly 200ft. With span lengths ranging from 44 to 79ft, the 5-span Bruckner Boulevard ramp design totals 370ft. The Bruckner Boulevard ramp arrangement includes three simple spans, two of which are curved, and two continuous spans. The remaining five spans on the Bronx side of the bridge comprise the Bronx approach, which carries traffic from the ramps to the swing span, and which spans a total distance of 230ft. Included within the Bronx approach is a shallow 20-ft span above the Oak Point Link Railroad.

The geometry of the Manhattan approach is simpler than the Bronx side, consisting of four straight spans that carry vehicles from the swing span to the on-grade Manhattan ramps. This approach structure includes two 2-span continuous units, varying in span length from 66 to 98ft, totaling over 350ft.

Approach Span Substructure

With the exception of the Bruckner Boulevard ramp and the span over the railroad, the Bronx and Manhattan approach spans will be supported on pile bent substructures, consisting of reinforced concrete pile caps founded on 2-foot diameter, cast-in-place concrete piles. The Bruckner Boulevard ramp will be supported on cast-in-place reinforced concrete piers, comprised of solid walls and footings that transfer loads to the steel H-pile foundations. The existing piers that support the span above the railroad will remain in-place, representing the only portion of the existing structure that will be utilized for the new bridge. Reconstruction of the upper portion of these concrete piers is the only work necessary to accommodate the new superstructure. Details for the Manhattan and Bronx approach substructure include construction joints located near the centerline of the bridge and reinforcement couplers to accommodate the staged construction previously described.

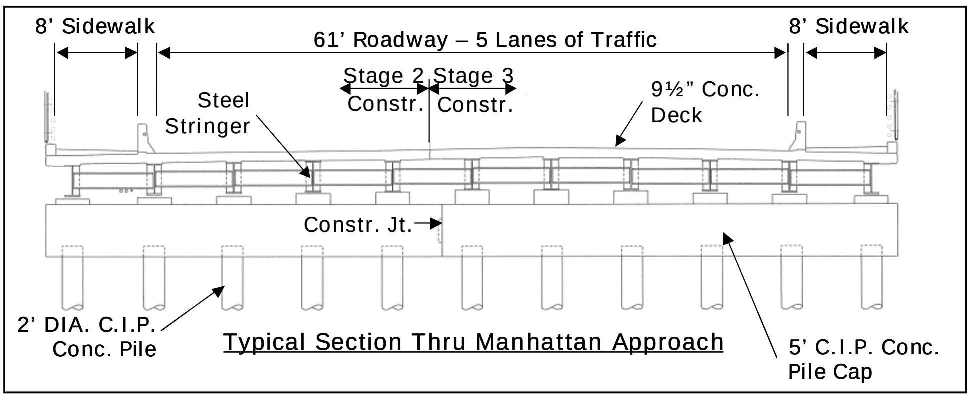

FIGURE 9: Typical Section Thru Approach Spans

Approach Span Superstructure

The superstructure design of the Bronx and Manhattan approach spans consists of a 9½" cast-in-place concrete deck with isotropic reinforcement, supported on and composite with longitudinal steel stringers. The span over the railroad will be unique. In order to keep the superstructure shallow enough to provide adequate clearance above the rail tracks, the design utilizes an arrangement consisting of a 6-inch concrete deck supported on a mat of 1-ft deep by 3-ft wide prestressed concrete solid slabs. Also unique to the new structure will be the two spans of the Bruckner Boulevard ramp that will consist of parallel curved girders, designed with diaphragm details capable of distributing significant lateral live load forces. Where necessary to address staging requirements throughout the Bronx and Manhattan approaches, deck details include construction joints and rebar couplers, and stringers have been located to accommodate the construction joint locations.

Construction

Currently under construction by New York-based KiSKA Construction Corporation, the project recently entered its final stage, with completion scheduled for Summer, 2005. KiSKA hired G&G Steel Inc., a machine and steel shop in Alabama, not only to fabricate the swing span steel and mechanical components, but also to fully erect the swing span in Mobile, where transfer of the fully assembled span onto an ocean-going barge took place in early July.

PHOTO 6: Assembled Swing Span Leaving Alabama

PHOTO 7: Swing Span Passing Downtown New York City

Transfer of the span onto the barge concluded a 3-year fabrication and erection process. G&G utilized two shops to fabricate the 1900 tons of swing span steel and shop assemble each of the main trusses in their entirety to verify geometry and connections. The trusses and floorsystem were shipped in sub-assemblies to a port on the Gulf of Mexico in Mobile, Alabama for erection of the entire span. Using a system of motorized transporters, the assembled span was lifted off its land supports, driven onto an ocean-going barge in an adjacent berth, and supported and braced carefully for the 1800-mile ocean journey. With the exception of the bride deck and finishing components of the control house, the assembled span, weighing about four million pounds, embarked on a successful ten-day voyage from Mobile to the Harlem River in New York City. The trickiest stage of the journey occurred only about 1000 feet south of the Third Avenue Bridge site, where, with careful navigating, the 104-foot wide barge passed through the 109-foot clear channel of the Willis Avenue Bridge's drawn span. The Willis Avenue Bridge was one of three Harlem River drawbridges that opened to allow the barge to pass.

To prepare for the float-in of the new span, the 2000-ton existing swing span was cut in half with torches and saws and removed from the site in three major pieces. Next, the new swing span was transferred from a single barge to two barges, so positioned to allow clearance with the fender and pivot pier during float-in. Over the next several months, the span will remain atop on these two barges, moored along the Manhattan bulkhead of the Harlem River, about 200 yards south of the bridge, where installation of the bridge deck, barriers, and railings, completion of the control house, and installation of the electrical systems will take place. During this same time period, just upstream, the pivot pier will be constructed, pier mounted machinery will be installed, and the remaining work on the approach spans will conclude.

With the bridge ready to receive its main span, the swing span will be floated into position and permanently lowered onto its pivot assembly. After this time, only four weeks or so will be necessary to complete the project, including placing concrete in the grid deck, aligning machinery, completing electrical hook-ups, and testing the mechanical and electrical systems. This final work will bring to completion a complex, important, and historic bridge replacement project.

References

1. Reier, Sharon, “The Bridges of New York”, 1977.