Paper No. 14

Performance/Construction/Maintenance

Reconstruction of the Third Avenue Bridge over the Harlem River in New York City

Jay A. Patel, P.E.
Rahul P. Shah, P.E.
NYCDOT, Division Of Bridges

Samuel R. Scozzari, P.E.
Parsons Brinckerhoff Construction Services

HEAVY MOVABLE STRUCTURES, INC.

TENTH BIENNIAL SYMPOSIUM

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

Introduction

The Third Avenue Bridge over the Harlem River is a swing span structure that connects the Boroughs of Manhattan and the Bronx in New York City. It carries approximately 68,500 (1999) vehicles per weekday on the four lanes of traffic from Third Avenue and Bruckner Boulevard in the Bronx to Lexington Avenue and South Bound FDR Drive in Manhattan. The functional classification of the Third Avenue Bridge is Principal Urban Arterial (connecting link).

Harlem River Bridges

The Harlem River is an off-shoot of the Hudson River at the northern tip of Manhattan. Harlem River divides the Boroughs of Manhattan and the Bronx. It merges into the East River at its southern tip. There are a series of movable bridges along the Harlem River. Figure 1 shows an aerial view of Harlem River Bridges. There are eleven movable bridges that span the Harlem River. Seven are swing bridges, and four are vertical lift bridges. Seven bridges carry vehicular and pedestrian traffic, three are railroad bridges, and one bridge carries both vehicular and railroad traffic. Eight bridges are owned, maintained and operated by the New York City Department of Transportation (NYCDOT).

Figure 1: Aerial View of Harlem River Bridges

All Harlem River movable bridges are operated by a six-person “Rolling” crew. This crew can be divided such that two bridges can be opened simultaneously. All Harlem River bridges require four-hour advance notice for marine opening. As per current US Coast Guard Regulations, these bridges can be opened between the hours of 10:00AM and 5:00PM on weekdays. Emergency openings can be performed any time. Figure 2 shows the location of Harlem River movable bridges.

Figure 2: Location of Harlem River Bridges

The Harlem River is used by private ferry services, cruise lines and small recreational boats. NY Waterways provides commuter and leisure ferry service in New York Harbor. Circle Line Cruises operates sightseeing tours in the Harlem River. Most of the vessels used by them do not require opening of the NYCDOT owned movable bridges on the Harlem River.

Harlem River Bridge	Type	Clear Height above MHW	Date Opened to Traffic
Broadway Bridge	Vertical Lift	24.35 ft (Closed); 135 ft (Open)	July 1, 1962
University Heights Bridge	Swing Bridge	25 ft (Closed)	January 8, 1908
Macombs Dam Bridge	Swing Bridge	29.2 ft (Closed)	May 1, 1895
145th Street Bridge	Swing Bridge	25.2 ft (Closed)	August 24, 1905
Madison Avenue Bridge	Swing Bridge	25 ft (Closed)	July 18, 1910
Third Avenue Bridge	**Swing Bridge**	**25.8 ft (Closed)**	**August 1, 1898**
Willis Avenue Bridge	Swing Bridge	25.1 ft (Closed)	August 22, 1901
Wards Island Pedestrian Bridge	Vertical Lift	55 ft (Closed); 135 ft (Open)	May 18, 1951

Figure 3: Harlem River Bridges - Facts

Most of the NYCDOT owned movable bridges were originally built in late 1800s or early 1900s. Figure 3 indicates the type and year these bridges were originally built. NYCDOT has embarked upon a very ambitious capital program to either reconstruct or replace all eight movable bridges that span the Harlem River.

Bridge Description & History

The Third Avenue Bridge was opened to traffic on August 1, 1898. The original construction cost in 1898 was $2.8M, which included $1.15M cost for acquisition. The original bridge consisted of four trusses, which carried two trolley tracks, two roadways and two sidewalks outside the outer trusses.

Figure 4: Aerial View of the Third Avenue Bridge

A major rehabilitation in 1954 – 1956, changed the four-truss system into a three-truss system. The Manhattan and the Bronx approaches were reconstructed to accommodate the Harlem River Drive in Manhattan and the Bruckner Boulevard approach in the Bronx. The reconstructed Third Avenue Bridge was opened to traffic on December 3, 1956.

Figure 5: Swing Span of the Third Avenue Bridge

The movable span over the Harlem River is a swing-type bridge and is located between the Madison Avenue Bridge to the north and the Willis Avenue Bridge to the south. The present bridge carries four lanes of traffic from the Bronx into Manhattan. It also carries two sidewalks. This structure spans over the Harlem River Drive, the Harlem River and the Oak Point Link railroad.

The Third Avenue Bridge and the adjacent Willis Avenue Bridge work as a couple to carry the traffic across the Harlem River. The Third Avenue Bridge carries traffic into Manhattan, while the Willis Avenue Bridge carries traffic into the Bronx. Combined Average Daily Traffic volume (1999) between these two bridges is 140,000.

Maritime requests for bridge openings are very few for the Third Avenue Bridge, but replacement of this bridge with a fixed bridge is not a cost effective option because of US Coast Guard requirement to maintain at least 55 feet of clearance over the navigable channel.

Existing Structure & Deficiencies

The existing Third Avenue Bridge connects the boroughs of Manhattan and the Bronx and crosses the Harlem River Drive, the Harlem River and the Oak Point Link Railroad. This structure consists of through-truss movable swing span, 29 multi-girder approach spans and 1 reinforced slab approach span. The total length of this structure is 1,269 ft with skew angles of various piers varying between 0 – 4 degrees. The curb to curb roadway width is 58 ft and there are two sidewalks, which are 7’-3” wide. There are four traffic lanes on the bridge with speed limit posted at 30 MPH. The bridge is also posted for vertical clearance of 13’-10” at the portals of the swing span through trusses.

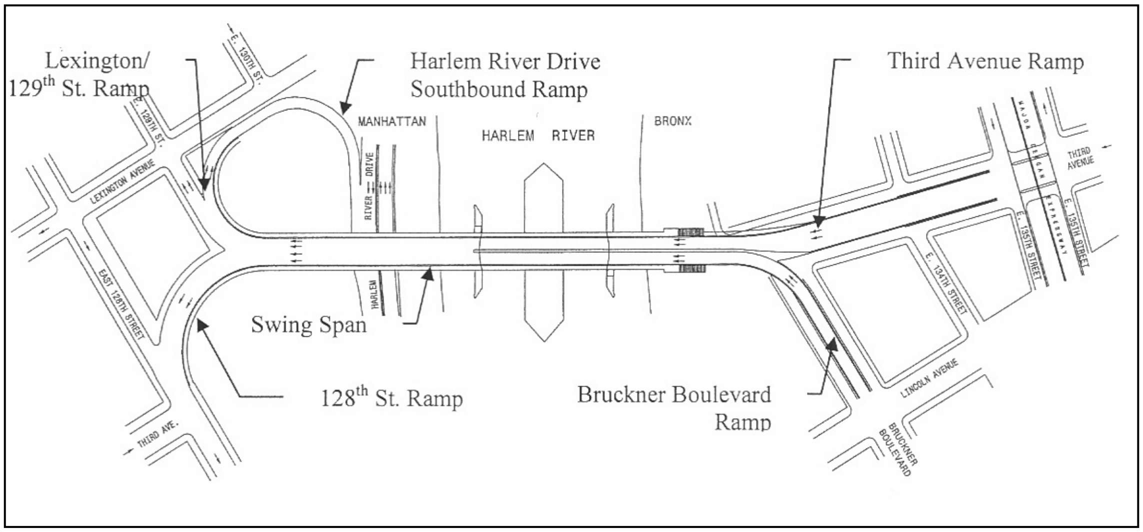

Figure 6: Plan View of Third Avenue Bridge

The following section discusses the deficiencies that were identified during the In-depth inspection, which was performed in September 1988. This inspection was performed by Hardesty & Hanover, LLP as part of their design agreement with NYCDOT.

Deck Condition

Results of deck cores from Manhattan approach spans revealed that the salt content in the top one-inch level is very high. The cores revealed good results in the freeze-thaw, compression and the air contents tests. Results of the deck cores from the Bronx approach spans revealed that the deck was generally in good condition. The results of deck cores on the Bruckner Boulevard Ramp in the Bronx revealed rusting of top reinforcements. It indicates unacceptable levels of salt content at top reinforcement level. Air content tests showed very low amount of entrained air. In general the deck was rated in fair condition.

Superstructure Evaluation

For the swing span, some of the diagonal members of the outer truss exhibited slightly buckled angles. The lower chord members, below the roadway deck, exhibited significant section loss and heavily deteriorated rivet heads. Floorbeams exhibited deterioration in the bottom six inch portion. Superstructure steel in both the Manhattan approach and the Bronx approach spans is in marginal condition. Superstructure steel of the Bruckner Boulevard Ramp, which was built in 1956, is in poor condition.

Figure 7: Temporary Shoring supporting the superstructure steel

Substructure Evaluation

The swing span center Pivot Piers and the Rest Piers exhibits erosion of the mortar between the granite blocks below the water line. No cracks were observed in these piers. The substructure piers for the Manhattan and the Bronx approaches are in fair condition. These steel columns and pier caps exhibits moderate to heavy section losses. The abutments for both approaches are in marginal condition with moderate spalling and cracking throughout. The Bruckner Boulevard Ramp is in fair to poor condition.

Foundation Evaluation

There was no evidence that suggests settlement or failure of the foundation below any portion of the bridge. However, extensive spalling on the column footing was evident, which could result in undermining of the column base plate. A scour pocket was identified at a river pier during the diving inspection, but no undermining was evident.

Mechanical Evaluation

The operating machinery needed improvement. Although components were still performing the functions in which they were intended, they were at the end of their useful life. The Brakes were in generally good condition with adequate oil levels in thrustors. None of the brakes produced noticeable heat. The reducers were also in generally good condition with housing securely fastened to its support. The oil levels were adequate. Scoring marks were evident on the gear teeth and the shaft bearing inside the reducer appeared to be in good condition. The open-type reduction gear sets were in marginal to poor condition. The spur gear sets exhibited abnormal wearing with gear tapered at the bottom, which indicates angular misalignment of the shafting. Both main pinions and rack were in poor condition. Five rack segments were observed to be loose due to missing fasteners. The teeth of both main pinions and the rack are abnormally worn. The rim bearing components were in fair condition. Only two out of eighty rollers have stopped rotating during bridge opening. The end lift machinery is generally in fair condition.

Electrical Evaluation

The swing span was electrically operated by two-30 HP wound-rotor motors, which were controlled by one master switch on the control desk. The end-lift machinery at the rest piers was driven by a 20 HP motor controlled by a reduced voltage starter. The control desk is located in the operator’s house, which houses all circuit breakers, fuses, contactors, relays, motor resistors and other apparatus for the control of electrical drives. Electrical power is brought to the center span from both Manhattan and the Bronx sides through submarine cables. All traffic signals, warning and barrier gates, and gongs are all interconnected at the control desk.

Overall condition of the electrical system is satisfactory but needs a functional upgrade to keep up with new emerging technologies. In addition, replacement parts are not readily available, because they are obsolete.

Harlem River Corridor Reconstruction Traffic Study

NYCDOT has embarked upon a very ambitious capital reconstruction program for the Harlem River Bridges. Because most of the movable spans on the Harlem River are swing trusses, it requires complete closure of the bridge crossing to traffic in order to replace/reconstruct the electrical and mechanical systems that operate the movable span. The Department undertook a study to review the construction staging plans of the Third Avenue Bridge, Willis Avenue Bridge and the 145th Street Bridge and evaluate the traffic flow consequences on all other Harlem River Bridges. As indicated earlier, the Third Avenue Bridge and the Willis Avenue Bridge are converted into a traffic couple, with Third Avenue carrying one-way traffic from the Bronx into Manhattan and the Willis Avenue carrying the one-way traffic in the reverse direction. Figure 8 indicates the capacity and ATR volumes at the 145th Street, Third Avenue and the Willis Avenue Bridges.

It is evident from Figure 8 that these crossings carry traffic to their practical capacity during peak hours, and complete closure of any of the crossing will have major impact on the adjoining crossings along the Harlem River. Fully closing the Third Avenue Bridge will render other Harlem River Bridges to be over their capacity in the Manhattan bound direction during AM peak hours.

Based on the study and analysis of traffic at all Harlem River crossings, it was determined that traffic impacts during construction of the Third Avenue Bridge can be mitigated by incorporating one reversing one lane on Willis Avenue Bridge during the morning peak hours. This reverse lane on the Willis Avenue Bridge was expected to handle up to 1,600 vehicles per hour of Manhattan bound traffic. This peak hours reverse lane will be in addition to two lanes of traffic that are maintained at all times through out the duration of the contract.

Harlem River Bridge	Traffic Direction	Practical Capacity	ATR Volumes			
			8-9AM	12-1PM	5-6PM	9-10PM
145th Street Bridge	Manhattan Bound	1000	925	580	771	433
	Bronx Bound	1000	783	664	956	619
Third Avenue Bridge	Manhattan Bound	4900	4621	3155	3815	2521
Willis Avenue Bridge	Bronx Bound	4700	3490	2803	4379	2561

Figure 8: Capacity and Traffic Volumes (1996 & 1997)

Project Objectives

The Department set the following objectives for the replacement of the Third Avenue Bridge.

- Ensure a minimum of 30-year service life (100 year desirable)
- Eliminate the substandard features
- Provide adequate structural capacity and fatigue life
- Meet applicable seismic criteria
- Maintain two lanes of traffic at all times and minimize traffic impacts during construction
- Meet Coast Guard requirements for channel clearances

Proposed Solution

With the above referenced objectives, the Department proceeded with the design of the replacement of the Third Avenue Bridge. The contract plans were advertised for bidding in November 2000 and the bids were opened in March 2001. The contract was awarded to Kiska Construction Corp – USA, with their bid of $118M. The solution that met the above referenced objectives is discussed in section below.

Construction Staging

The reconstruction of the Third Avenue Bridge was to be achieved by implementation of three construction stages. These construction stages were configured to maintain at least two lanes of traffic at this crossing at all times during construction. Figures 9, 10 and 11 indicate these construction stages. Incentive and disincentive amounts were tied into completion of some construction Milestones within these stages to ensure timely completion. Stages 1 and 3 maintains two lanes of traffic on the north half of the bridge whereas Stage 2 maintains two lanes of traffic on the south half of the bridge.

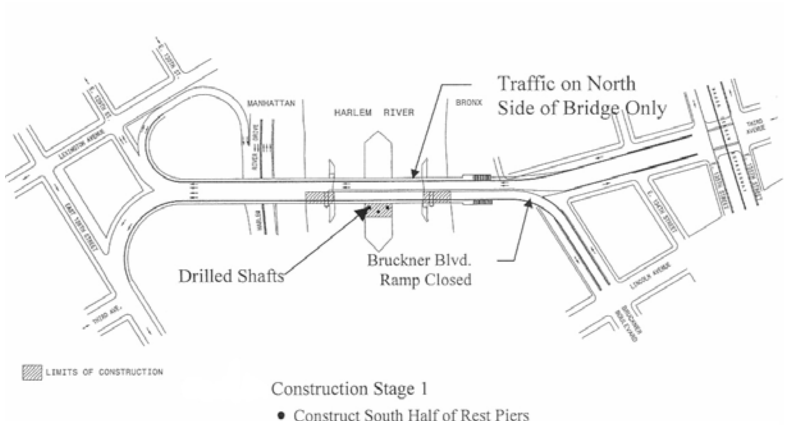

Figure 9: Construction Stage 1

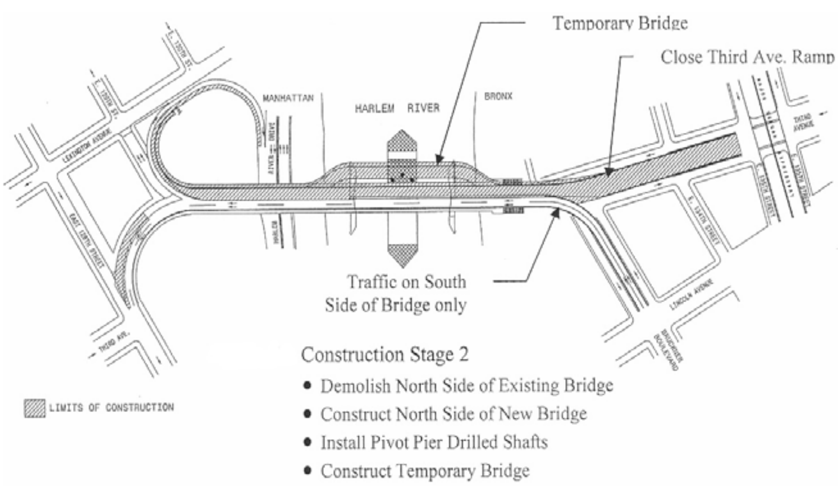

Figure 10: Construction Stage 2

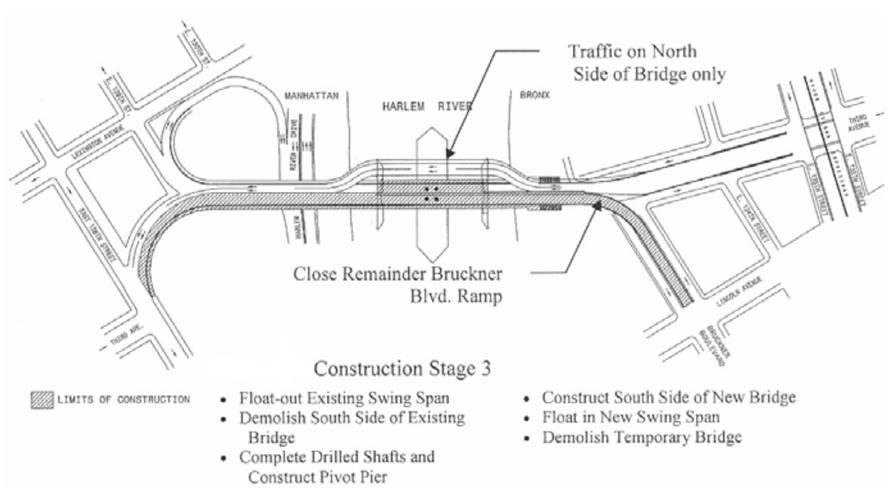

Figure 11: Construction Stage 3

Temporary Bridge

In order to maintain two lanes of traffic during the replacement of the swing span, it was necessary to construct a two lane wide temporary bridge (fixed span) to the north of the swing span. As a result, a permit was obtained from US Coast Guard to deviate from the regulation for bridge operation for taller vessels to pass underneath. The temporary bridge would be dismantled after the new swing span is constructed and commissioned to carry the traffic.

Figure 12: Temporary Bridge over the Harlem River

Willis Avenue Bridge Reversed Lane

As part of the Harlem River Corridor Reconstruction Traffic Study, it became evident that in addition to maintaining two lanes of traffic, it was necessary to mitigate the peak demands during morning rush hours. It was determined that that the adjacent Willis Avenue Bridge had unused capacity during the morning rush hours because of the reverse direction of traffic flow. As part of the Maintenance & Protection of Traffic scheme for the Third Avenue Bridge reconstruction contract, one lane of the north most Willis Avenue Bridge was reversed every week day throughout the construction duration between the hours of 6:00AM and 10:00 AM. Vehicles would be guided to the Willis Avenue Bridge by construction signage and positioning of traffic agents at key intersections in the Bronx.

Figure 13: Typical Pier Configuration for the Approach Spans

Substructure Foundations

The Third Avenue Bridge is an online replacement of the swing span and the approach spans. All substructure elements were replaced on the same alignment as that of the existing structure. Foundations for the piers in the Harlem River consisted of 6 ft diameter reinforced concrete Drilled Shafts. These shafts were approximately 100 ft long and are socketed into the bed rock. Foundations for approach spans consisted of 2 ft diameter Cast-In-Place Pipe Piles. The above ground portion of these piles would eventually act as the columns of these piers. These columns will be connected with a cast-in-place concrete cap beam. In addition to the 2 ft diameter Pipe Piles, the approach substructure also included H-Piles and Mini-Piles at some locations.

Figure 14: MSES Retaining Wall

Approach Ramps

All approach ramps were designed to be Mechanically Stabilized Earth System (MSES) retaining walls. This precast system was selected for rapid construction, minimum disruption to the local community, and minimum impact to the surrounding/infrastructure.

Approach Spans

All approach spans consists of multi-girder system with cast-in-place reinforced concrete deck slab. All spans are approximately 100 ft long on both Manhattan and the Bronx side. The girders are supported on steel reinforced elastomeric bearings, which are anchored to the bridge seat of the concrete pier caps.

Two-truss Swing Span system

The new swing span consists of two Warren trusses connected with top and bottom lateral bracing. The new swing span will carry five lanes of traffic between the trusses and one sidewalk on outer side of each truss. The flooring system consists of floorbeams spanning between the trusses and multi-girders, which are framed into the floorbeams. The final roadway consists of a concrete filled steel grid deck system with 2" overfill with light weight concrete. The truss members are welded box members with bolted connections.

Figure 15: New Two-truss Swing Span

Electrical & Mechanical Systems

The new movable span is a center pivot bearing Swing Bridge. The entire dead load plus impact forces associated with the operation of the swing span is transferred to the pivot pier through Spherical Roller Thrust Bearing. This bearing has a capacity to safely support nearly 6 million pounds of service loads and one million pound of horizontal forces during an seismic event. The span drive machinery is mounted in the control house at the center of the span. The end lift machinery is mounted directly on top of the rest piers and will lift each corner by 1" to ensure positive contact. The turning machinery's main motors are rated at 150 HP and are located in the control house. The 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. The vertical shafting extends down from bottom of bevel gear boxes through the plane of the truss and engages the main reducers mounted to the underside of span floor system.

A Programmable Logic Controller (PLC) will perform the logic and control functions that are necessary to operate the machinery. Ideally the PLC is designed to operate the bridge with a single push button. The traffic control devices will also be controlled from the operator's desk located in the operator's house, however they can also be operated from The Auxiliary Bridge Operator house located on the Bronx rest pier.

Construction

The construction phase of the Project required a full time Resident Engineer and Inspection staff (Parsons Brinckerhoff Construction Services, Inc.), which contracted directly with NYCDOT. Services included construction inspection in New York City, construction inspection at erection sites in Alabama, and QA inspection of Machinery and Electrical fabrication, schedule review, office engineering, on-site community liaison and outreach services, and specialty engineering services, such as Movable Bridge construction and naval architecture. In addition, the Designer of Record (Hardesty & Hanover, LLP) was retained to provide Construction Support Services for review of submittals and work drawings, response to RFIs, and coordination with NYCDOT-QA when reviewing the aforementioned. Both firms have worked together successfully in similar roles on other projects.

The following sections describe the basic elements of the Project's unique construction processes as well as an overview of incentives, disincentives, and the use of contract time.

Schedule and Contractor Incentives

The construction schedule and staging were planned in a manner that kept impacts to traffic and the public to an absolute minimum. The concept implemented through Contract is to maintain traffic volumes with reduced capacity for the shortest possible duration.

Reduced capacity is a result of staged construction of the bridge approaches in "halves" (two lanes closed and reconstructed while maintaining the remaining two lanes, and then vice versa). As stated above, while some reduced capacity could be withstood by the public during most day parts, morning peak traffic on business days would not withstand such a capacity reduction and a counter flow lane was incorporated into the contract document.

To maintain two lanes over the Harlem River, a temporary bridge was incorporated into the bid documents in a detoured alignment approximately 3 meters north of the existing swing and flanking spans. The Construction Contract called for a Contractor-designed temporary bridge to be constructed as a stand-alone payment item.

With the physical logistics of construction staging developed, it was necessary to minimize the traffic and neighborhood impacts as well as keep an effective schedule in relation to the rehabilitation of the other Harlem River bridges destined for Contract subsequent to Third Avenue Bridge. This was accomplished through an aggressive incentive/disincentive plan with monies appropriated in the Contract upon award (Fixed Lump Sum items that are the same for all bids).

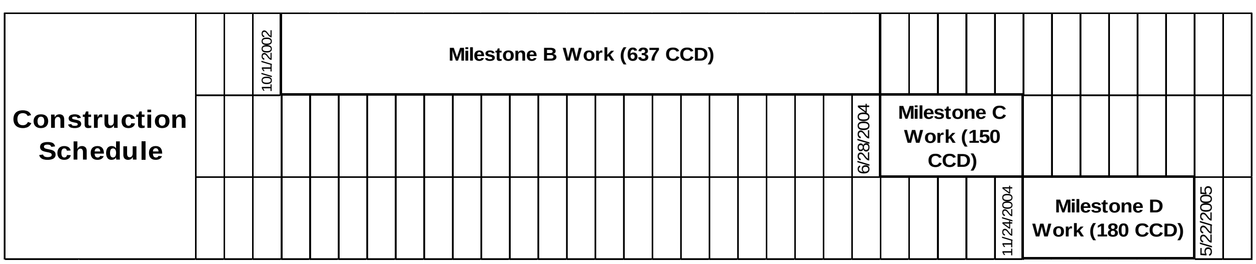

Figure 16: Construction Schedule

The contract provides an incentive to complete the work earlier than stated in the contract for various Milestones. The maximum amount of incentive the contractor can collect in this contract is $4.875M. At the same time, this contract includes a disincentive penalty if the contract work in not completed by Milestone dates. There is no cap on the disincentive penalty to the contractor.

Incentives/Disincentives: Advantages and Lessons Learned

Presently, it appears that the disincentives truly deter the schedule slippage, due to their commensurate amount. In addition, the disincentive/incentive ratio is not one to one, therefore slippage of one day could take 1.5 or more days to mitigate, thus a further incentive to avoid slippage of the milestones. Other day parts necessary to mitigate delays could cost the Contractor more money because those day parts command premium time wages of workers, such as time and a half for overtime and nights, and double-time for Sundays and holidays (for most NYC area unions).

The incentive amount of $4.875M maximum for this project likely added an element of competition to the bidding process that encouraged creativity in the field of movable bridges, which sometimes suffers with a lack of competition with respect to machinery and electrical systems. The prime contractor, Kiska, introduced a newcomer to the movable bridge field, G&G Steel (GGS), Russellville AL. Not only was GGS an integral contributor to the Project's machinery fabrication and machining, but they also were the structural steel fabricator for the new swing span, enabling them the potential to best coordinate the disciplines, shop drawings, and concurrent work. Not only relatively new to the movable bridge industry, but also new to the NYCDOT QA process, GGS was able to subcontract some system parts concurrently with machining of castings and other components of the mechanical systems.

Minimizing the Work Zone to Avoid Disruption to Local Streets and Neighborhoods: Mechanical Stabilized Earth Systems (MSES) Walls

The roadway embankment approaches were constructed with little encroachment of properties outside of the City's ROW. To work outside the ROW in the City of New York involves detailed multi-agency coordination that could have delayed the Project's commencement. One method of avoiding the need to encroach the ROWs was through the employment of Mechanically Stabilized Earth Systems (MSES) walls as retaining walls that encapsulate the fill for the inclined ramps in both Manhattan and the Bronx. These walls are a matrix of interlocking precast members held in place by the gravity of the earth behind them as it bears on metal straps that protrude into the earth perpendicular and attached to each precast wall panel. The wall strength is developed from the earth bearing on the straps and the interlocking character of the vertical panels. This eliminated the need for larger spread footings that would have caused damage and interruption to the use of New York City Parks Department property in Manhattan, and local streets in the Bronx. As an added feature, the walls are aesthetically pleasing and provide a finished product that is context sensitive.

Land Foundations

Land approaches employed h-piles, open ended pipe piles, and mini-piles, designed for seismic conditions. The foundation types varied from pier to pier, with h-piles being the most straightforward to drive. Open ended pipe piles, 2-feet in diameter, also doubled as above grade columns that aesthetically protrude from the ground to a cast-in-place pile cap that support the concrete deck spans. Care was necessary to avoid a "piping" condition when driving the open ended piles. Piles sometimes required immediate concrete placement upon excavating and placement of reinforcement, to avoid lost stability from quick conditions of soil below land piers that are close to the river edge.

Upon consultation with the Designer, it was determined that proper foundation criteria would be met, if adjustments were made to the situation that yielded quick conditions. Some of these adjustments included shortened overall pile and reinforcement length, and refraining from removing in situ material that is immediately above the quick condition. Other field conditions encountered included a slight variation in verticality or pile location for portions above grade when portions below grade were within tolerance, but not perfect. This condition exists because a pipe pile that may require 65 feet of embedment would need to protrude 30 feet above grade. Thus the tolerances below grade are inherent in the portions of the piles)acting as columns) that are above grade. Therefore, one can detect a slight variation of column location when peering at the seven or eight piles with the naked human eye.

The typical pipe pile operation was carried out on this project as follows:

- Drive open pipe piles to desired depth. Some depths were revised based on field conditions. Depths of elevations higher than those indicated in the Contact were only allowed upon consent of the designer of record.

- Splicing of piles as field conditions dictate.

- Excavate material. Sometimes, to avoid quick conditions in the bottom of the pile, a “plug” of in situ material was left in place to avoid a piping condition in the pile from head associated with the adjacent river.

- Install rebar to above grade elevation, near the pile cap.

- Place concrete below grade and erect forms for above-grade portion.

- Place concrete above grade and remove forms.

River Foundations

River foundations included 22, 6-foot diameter, drilled shafts that support the two rest piers and the center pier. The shaft casings, which serve to contain sediments during excavation and as a guide for the excavation of the shaft, are made from ¾”-thick rolled plate steel. Once located, the shaft casings were driven through mud to the bedrock surface. Material between the mudline and the bedrock was excavated and contained, and the casing, or “can”, was twisted or “socketed” approximately 14 feet into bedrock. The depth of mudline could be as deep as 30 – 40 feet below the mean water elevation and continued 40 - 60 more feet to rock. The reinforcement steel is a cage of concentric rebar hoops, held at even spacing with longitudinal bars that work in the vertical direction. High performance concrete is then placed by tremie method. Meanwhile, the contained material is characterized for the purposes of disposal.

These foundations were employed for the purpose of seismic design parameters. In addition, because the casings of the pipe piles remain as part of the permanent work, they act as confinement during excavation, thus no need to install cofferdams. Confined excavation is necessary in order to comply with clean water legislation that is regulated by the Environmental Protection Agency, Army Corps of Engineers, and New York State Department of Environmental Conservation. By utilizing casings in lieu of cofferdams, the barrier of overhead clearance restrictions for cofferdam installation below the existing bridge is eliminated, but the necessary containment of river bottom sediments that would be disturbed during excavation is achieved.

Center Pier Concrete – Mass Placement

Reconstruction of the center pier will involve 10 of the 22 drilled shafts, capped by a massive block of concrete that will support the rack and track and the entire weight of the swing span when the span is opened to mariners. The center pier's 11ft x 123ft x 85ft (approximate dimensions) pile cap commands over 2000 CY of high performance concrete in one placement. Because this is a mass placement, placement and curing procedures will be greatly scrutinized by NYCDOT's QA group. Some discussion is underway to divide the placement into sections. With one placement, it may be necessary to execute 24+ hours of concrete delivery to the site. With placement in multiple sections, the Contractor may have more control over curing and placement. The concrete delivery location may occur from either the temporary bridge or car-float barges, and will likely include redi-mix placed via concrete pump truck.

Temporary Bridge

The employment of a temporary bridge was necessary to maintain two lanes of Manhattan-bound traffic at all times for approximately 6 months, because the demolition and replacement of the swing span could not be performed with traffic on the span. The alignment of the temporary bridge is immediately north (3 meters fascia to fascia) of the alignment of the Third Avenue Bridge, with two reverse curves that connect the new approaches.

The temporary bridge was a series of temporary approach spans made from steel girders and steel deck that were connected to the two main river spans. The river spans are fixed spans by Mabey Bridge and were assembled off site in Brooklyn NY prior to delivery to the Harlem NY site. Upon the completion of their use on the Project, they will likely be recertified by Mabey and reemployed by another owner at some later date. The approach spans will be dismantled and materials will become the property of the Contractor after demolition. The spans are supported by pipe piles and a series of steel bents, and the wearing surface is 2 – 3 inches of bituminous concrete top course.

Demolition of the temporary bridge will occur after roadway traffic is diverted to the final alignment. Upon demolition, the new bridge will have the horizontal clearance necessary to make its first swing.

Removal of the Existing Swing Span

The existing swing span was weighed on February 29, 2004. The Contract discusses a "float-out" as a means of removing the swing span, but does not mandate it. Kiska opted to lift out the existing swing span with a water-mounted crane, in lieu of a "float-out" option, because they believed that the use of a crane would provide them with a better commercial outcome for this work.

A procedure was submitted and approved for the dismantling of the existing swing and flanking spans and lift them out of position with the crane, *Chesapeake 1000*, rated as a 1000 ton crane that is mounted to an ocean worthy barge. The sections to be removed included:

- Manhattan Flanking Span – First Section.
- Manhattan Flanking Span – Second Section.
- Bronx Flanking Span.

Figure 17: Demolition of Existing Swing Span

- Manhattan Draw Span (1/2 of the existing swing span).
- Bronx Draw Span (1/2 of the existing swing span).
- Center Pier Girder System.

Of the six sections, all but the Manhattan Flanking Span – second section were removed over a five day period betwixt June 28 and July 2, 2004. On July 28 – June 1, sections of least stability were removed, because NYCDOT allowed 15-minute traffic stoppages on the temporary bridge between the hours of 10am and 3pm, and it was mandated by the Resident Engineer that the picks be made with no traffic on the adjacent temporary bridge span, during the period of time when the load was transferred from it's at-rest position on the piers to the crane. The temporary span fascia is approximately 3 meters away from the fascia of the existing swing span. Kiska plans to remove the remaining portion of the Manhattan Flanking Span through conventional methods with one of their larger yard cranes.

The existing pieces are property of the Contractor, and were reported to be shipped to an approved disposal site in Bayonne NJ, via barge.

Fabrication, Assembly, and Erection of the New Swing Span

Because of the likeliness of limited staging area available in New York City, the Contract specified that the erection of the swing span would be at an off-site location. As stated above, the contractor for this project selected a fabrication company from Alabama, and also employed that firm to perform the final erection. The fabrication and some pre-assembly work were performed at shops in Russellville and Cordova, Alabama. The major portion of off-site erection work was performed at a site in Chickasaw, approximately 15 miles north of Mobile, Alabama.

Figure 18: New Swing Span leaving Alabama

The majority of the fabrication commenced in early 2003, with early stages of pre-assembly to follow in July 2003. The pre-assembly is considered a portion of final construction, so NYCDOT assigned Resident Engineering and Inspection (REI) staff to the Alabama sites. The preassembly was conducted concurrently with remaining fabrication, and was necessary to line up holes for match drilled connections in conjunction with the expected deflection of the structure in concert with the sequence of erection. Some sections remained assembled and were shipped to the Chickasaw site. The north and south trusses were divided into three sections, each, and shipped via barge over the Warrior and Tombigbee River Systems to the Port of Chickasaw. Final erection commenced in January 2004.

Figure 19: New Swing Span Arriving in New York

The erection commenced with the center pivot girder, followed by the center sections of the trusses, the completion of the south truss, completion of the west side of the north truss, and then erection of floor beams, top member, and the Control House. The east side of the north truss was completed last. In addition to structural steel erection, all turning machinery for the span was installed. A no-load spin test was performed on the machinery system installed prior to departure from Chickasaw.

Figure 20: Route from Alabama to NYC

The Contractor's specialty contractor, Mammoet, was employed to move the truss from its erection site on land, to the ocean transport barge in an adjacent berth. This involved the use of a their custom made "transporter", which is a multi-axle flatbed, controlled with a joy-stick type control pad, that lifted the entire truss and "walked" it on to the transport barge. This process took approximately 6 hours. The truss was then sea-fastened to the Marmac 400 barge (100 ft x 400 ft) and set sail for New York City on June 27, 2004. It arrived at Ambrose Light, approximately seven miles from Sandy Hook NY, on July 6, 2004, and arrived in Harlem on July 8, 2004.

From arrival in Harlem on July 8, until July 17, 2004, the work was focused on two operations associated with temporary mooring of the swing span for five months until float-in:

- Dismantling the sea-fastening from the ocean transport barge.
- Preparing two work barges with towers to support the span for the next five or six months.

Two work barges are required in order to place the span on the center pier, which would be between the two barges. Preparation of the work barges required towers that would support the span during the period between delivery and float-in. Once moored for the five month period, the following activities were performed:

- Completion of structural steel erection.
- Installation of remaining machinery and mechanical systems.
- Installation of the Control Desk, Control House, conduit, and conductor.
- Installation of steel grating for the bridge deck.
- Completion of coatings.

Upon completion of the work in the 5-month window before float-in and the next contractual milestone, the span will be ready for float-in from its temporary mooring location to final location. The two work barges shall be floated into position at high tide, and the span held in place with tug boats holding work barges until tide recedes and the span experiences “touch down” on its bearings. With this successful completion of the installation of the swing span, control desk will be energized, final conductor and conduit will be installed, the temporary will be bridge removed, and the bridge shall commence testing of the swing capabilities. Bridge testing will take place after removal of the temporary bridge and after traffic is switched to the final alignment. Thus, it will be necessary to perform test openings of the new span during overnight periods when roadway traffic is at its lowest volumes.

Acknowledgements

We would like to thank the following personnel for their assistance and guidance throughout this project.

Henry D. Perahia, P.E. – NYCDOT, Division of Bridges
Balram Chandiramani, P.E. – NYCDOT, Division of Bridges
Daniel Hom, P.E. – NYCDOT, Division of Bridges
Simona Finkelstein, P.E. – NYCDOT, Division of Bridges
Uday Shah – NYCDOT, Division of Bridges
Paul Connolly, P.E. – Hardesty & Hanover, LLP
John Gimblette, P.E. – Hardesty & Hanover, LLP
Raymond Moran, P.E. – Parsons Brinckerhoff Construction Services
Roni Werman, P.E. – Parsons Brinckerhoff Construction Services
Jaroslev Prokop, P.E. – Parsons Brinckerhoff Construction Services
Peter Thompson – Urbitran Associates