Replacement of the East 78th Street Bridge Over FDR Drive in New York City

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ABSTRACT: This paper describes the complexities encountered during the design for the replacement of a 70-year-old, 9-span, 105.67 meter long pedestrian bridge over the six-lane FDR Drive and entrance ramp. The bridge, owned by NYC Department of Parks and Recreation, is maintained by NYCDOT which was also responsible for bidding and awarding the construction contract. The design addressed major issues and constraints, such as limited working space; load restrictions on FDR Drive; strict enforcement of working hours, lane closures, noise and dust control, demolition and erection restrictions, night-time detours, placing traffic agents along the detour route, community relations, and approval from the NYC Art Commission. The most critical requirements of the design are the demolition of the main span over the FDR Drive weighing 1250 kN (140 tons) by saw-cutting and lifting it by a barge-mounted crane in the East River on one Sunday, between the hours of 2:00AM and 7:00AM under full closure of the FDR Drive, and installing the new span at a later date with the same restrictions. The project is under construction and expected to be completed in August 2011.

1 INTRODUCTION

Two days after the August 1, 2007 collapse of a truss bridge on I-35 West in Minneapolis, the New York Times published a list of the three worst bridges in New York City. The East 78th Bridge in Manhattan was one of the bridges. When the design for the replacement of the bridge began, it was owned and maintained by the New York City Department of Transportation (NYCDOT). However, during the design stage, the ownership of the bridge was transferred to the New York City Department of Parks and Recreation (NYCDPR), but the responsibility for its maintenance remained with the NYCDOT as before.

The nine-span, L-shaped bridge with ramps at both ends was built around 1941 (Figure 1). The ramp structures are also included in these nine spans. The bridge provides access from East 78th Street to the esplanade along the East River by going over the entrance ramp to the southbound FDR Drive and six lanes of the heavily travelled FDR Drive which runs north-south on the east side of Manhattan.

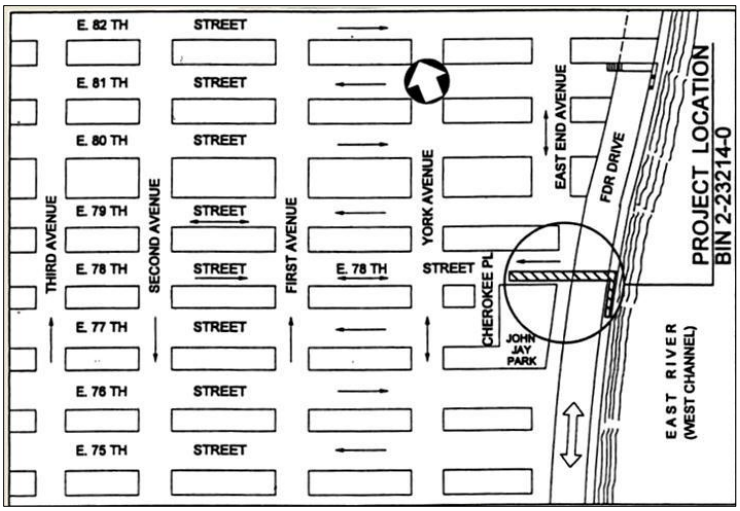

Figure 1. The East 78th Street Bridge location plan in Manhattan.

2 EXISTING BRIDGE

Figure 2 shows the elevation of the bridge looking north. At the east end of the bridge, stairs and a ramp come down from the bridge to the esplanade level. The esplanade near the ramp is about 6.2 m (20’4”) wide, and the stairs and ramp use up most of that width (Figure 3). There is no space left between the East River bulkhead and the east ramp wall (Figure 4). The pedestrian walkway is 1.83 m (6’0”) wide (Figure 5).

Figure 2. The bridge elevation looking north. Note the stairs and the ramp along the East River esplanade.

Figure 3. A close-up of the stairs and ramp looking north in the esplanade area between the two railings.

Figure 4. The East River bulkhead line looking south. The Queensboro Bridge is in the background and the wall supports the ramp.

Figure 5. The pedestrian bridge looking west.

The west ramp leading down from the bridge to East 78th Street is shown in Figure 6. It abuts the north wall of the John Jay Park. The ramp and the John Jay Park wall have matching stone facing. To discourage access from the park to the ramp or vice versa, the park wall has a cast iron bear-claw fence. At the bottom of the ramp there is a door to a storage room of the park (Figure 7). In the new bridge design, this ramp length must be increased to comply with the Americans with Disabilities Act (ADA) and care must be taken to provide access to the storage room.

To prevent accidents caused by spalling of concrete from the underside of the bridge and hitting vehicles, a shield was provided under the bridge and over the FDR Drive. The existing bridge contains asbestos and lead paint, and the slope of the ramps are not in compliance with ADA requirements. The bridge has outlived its useful life and needs to be replaced. It was decided to demolish the existing bridge and replace it with a new bridge at the same location, eliminating the substandard features.

Figure 6. West ramp along 78th Street.

Figure 7. The door and windows of the storage room at John Jay Park.

3 SCOPE OF WORK

The scope of work included the following tasks:

1. Demolition and removal of the existing bridge superstructure and substructure
2. Construction of a new 13-span bridge structure on new substructures and foundations
3. New lighting inside the John Jay Park adjacent to the proposed west ramp
4. Repointing the existing stone masonry retaining wall on East 78th Street
5. New bridge lighting on and under the bridge
6. A new bridge drainage system
7. Site and landscaping restoration work

4 PROPOSED BRIDGE

Design of the proposed bridge was achieved using the references listed at the end of this paper. The schematic cross-section of the bridge over FDR Drive is shown in Figure 8. The rendering of the bridge deck, railing, and safety fence is shown in Figure 9. The north elevation of the box girder with a safety fence over FDR Drive is illustrated in Figure 10.

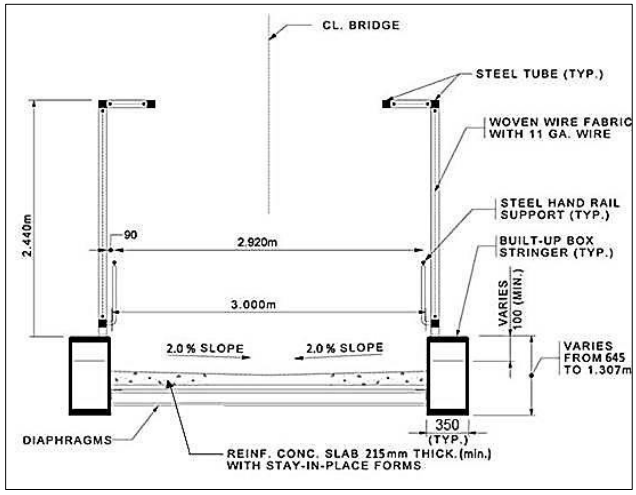

Figure 8. Schematics of bridge elevation over FDR Drive.

Figure 9. Rendering of the bridge looking east.

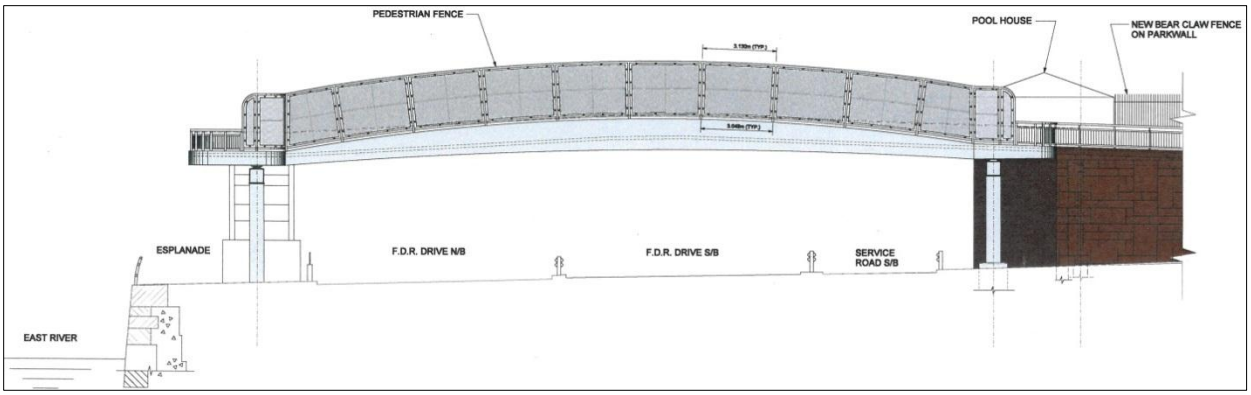

Figure 10. The north elevation of the bridge with a safety fence and beginning of the west ramp.

The new bridge will replicate the stone facing of the East 78th Street bridge ramp and the north wall of the John Jay Park (Figure 11). The rendering of the ramp on the east side along the esplanade is shown in Figure 12.

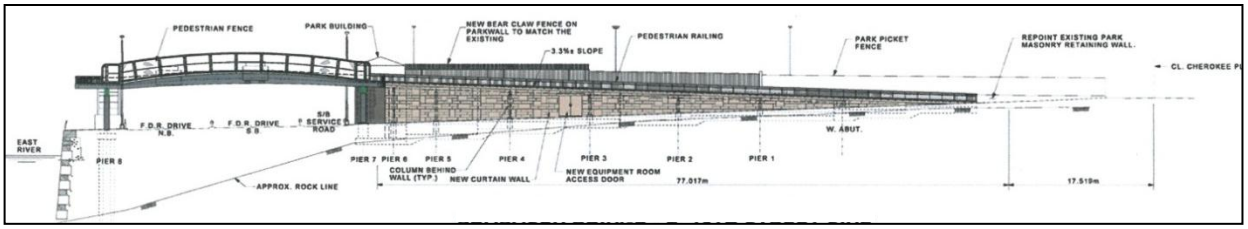

Figure 11. Rendering of the East 78th Street ramp and John Jay Park wall.

Figure 12. The east ramp with a safety fence along FDR Drive and the regular railing along the esplanade.

The new bridge eliminated the substandard features of the existing bridge. The comparison between the old and new bridge is given below:

Substandard features	Existing Bridge	Proposed Bridge
Slope of the east ramp	10.5%	7.365%
Length of the east ramp	42.83 m (140.52 feet)	75.23 m (246.81feet)
Slope of the west ramp	10.0%	3.35%
Length of the west ramp	28.45 m (93.3 feet)	74.77 m (245.31 feet)
Minimum vertical clearance	3.96 m (13.0 feet)	4.88 m (16.0 feet)
Width of walkway	1.83 m (6.0 feet)	2.44 m (8.0 feet)

5 TRAFFIC STIPULATIONS FOR LANE CLOSURES AND CONSTRUCTION ACTIVITIES

Any work on local streets or arterial highways in New York City requires a permit and traffic stipulations from the NYCDOT's Office of Construction Mitigation and Coordination (OCMC). These traffic stipulations spell out in detail when a contractor is permitted to close one or more lanes and between what hours. Because of limited space, and high levels of pedestrian and vehicular traffic conflicts, a bridge replacement project such as East 78th Street Bridge involves multiple stages of construction and detours.

The traffic stipulations for the East 78th Street Bridge defined 3 separate entities involving an arterial highway, local streets, and a riverfront esplanade as follows:

FDR Drive Level: Includes a section of roadway between East 42nd Street and East 96th Street

Street Level Includes:

1. East 96th Street and East 42nd Street, both between FDR Drive and 2nd Avenue
2. 2nd Avenue between East 96th Street and East 42nd Street
3. 1st Avenue between East 96th Street and East 61st Street
4. East 78th Street between a southbound service road and Cherokee Place
5. Southbound service road between East 80th Street and FDR southbound

Esplanade Level: includes the section of esplanade between East 78th Street and East 76th Street

Figures 13 and 14 show staging areas for the northbound and southbound FDR Drive lane closures, and East 78th Street, respectively.

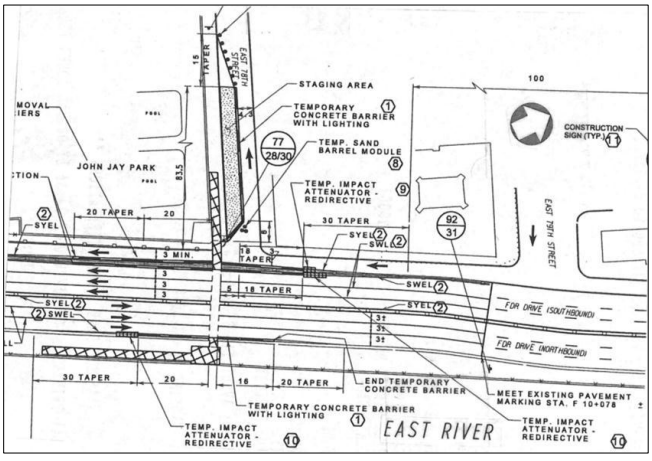

Figure 13. Staging areas (shaded) for northbound and southbound FDR lane closures.

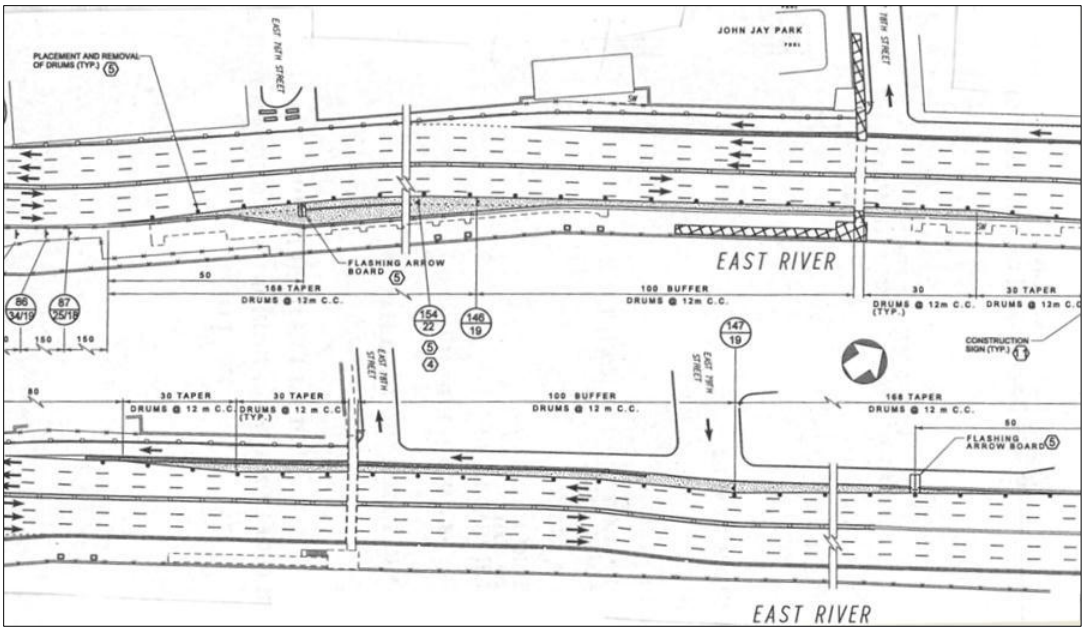

Figure 14. Staging areas (shaded) for East 78th Street.

The most drastic and severe case is the closing of the entire FDR Drive between East 42nd Street and East 116th Street. This happens twice during the construction of the bridge. The first time is when the Contractor is demolishing the existing span over the FDR Drive weighing 1250 kN (140 tons) by a barge-mounted crane in the East River, and the second time when he is installing a new steel arch box girder bridge using the same crane at a later date. The detour plan is shown in Figure 15. This plan applies to those vehicles which are already on the FDR Drive on either the southside of East 42nd Street or the northside of East 116th Street. However, for those motorists who are not aware of the total closure of FDR Drive and who are trying to enter FDR Drive from the East 78th Street, 92nd Street, 102nd Street, and 116th Street ramps, the detour plan is shown in Figure 16.

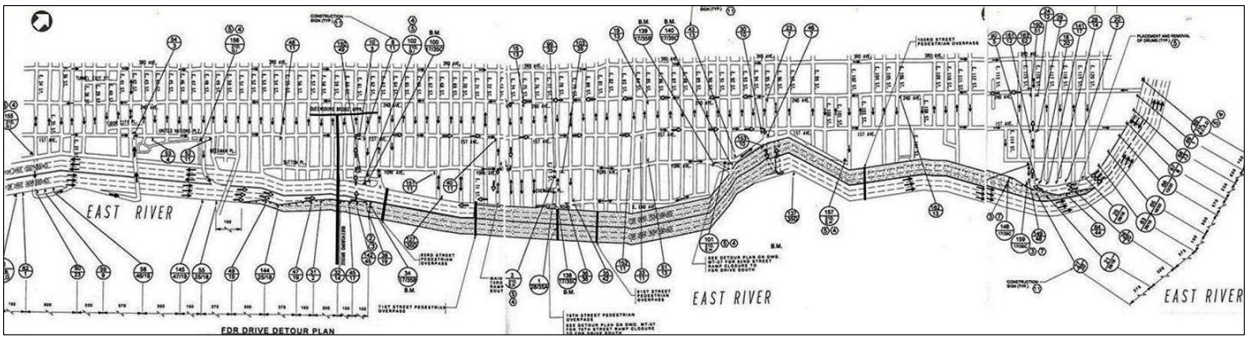

Figure 15. Detour plan during the closure of FDR Drive between East 42nd and East 116th Street.

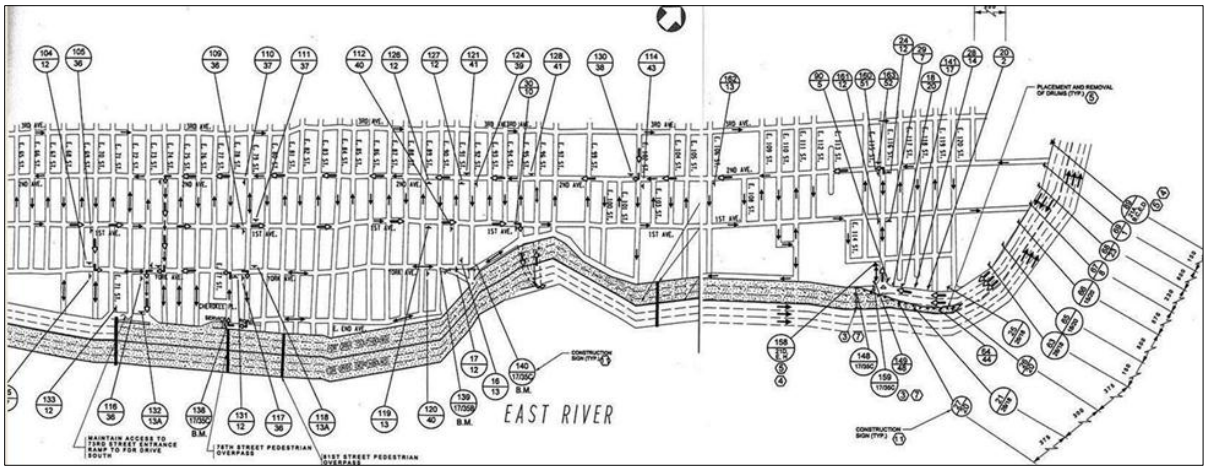

Figure 16. The detour plan during the closure of entrance ramps to FDR Drive from East 78th, 92nd, and 102nd Streets.

The Contractor is required to post traffic agents at each of the following locations from 1:00AM until 8:00AM when FDR Drive would be fully closed:

96th Street at 2nd Avenue	1 Agent
96th Street at 1st Avenue	2 Agents
96th Street at FDR Drive	2 Agents
2nd Avenue at 74th Street	1 Agent
1st Avenue at 74th Street	1 Agent
1st Avenue at 61st Street	1 Agent
York Avenue at 61st Street	1 Agent
York Avenue at 73rd Street	1 Agent
York Avenue at 74th Street	1 Agent
73rd Street at FDR Drive	1 Agent
116th Street at Pleasant Avenue	1 Agent
116th Street at 2nd Avenue	1 Agent

6 CONSTRUCTION SCHEDULE

The construction activities were broken down into seven stages, and each stage clearly identified which activities could be performed at the FDR Drive level, the street level, and the esplanade level.

Stages 1 through 5 of construction involved demolition of the superstructure and substructure of the existing bridge in two months. Stages 6 and 7 projected construction of the foundation and substructure in 4 months, and superstructure in 3 months, respectively. The 13-month schedule is summarized below:

Task	Stages	Number of Months
Preparation and approval of shop drawings and fabrication of steel		4 months
Demolition of existing bridge	1-5	2 months
Construction of foundation and substructure	6	4 months
Construction of superstructure, completion of punch-list items, and project close-out	7	3 months
		13 months

The bridge will be open to pedestrians for the first four months when the Contractor is planning and preparing for the demolition of the bridge. It will be closed for 9 months during which time pedestrians will use a pedestrian bridge in the north on East 81st Street or south at East 71st Street.

7 COORDINATION WITH CONSTRUCTION OF EAST 81st STREET PEDESTRIAN BRIDGE

Plans are under way for the replacement of the East 81st Street Pedestrian Bridge about 230 m (750 feet) north of the East 78th Street Bridge. It is not very likely that the two adjacent bridges would be under construction at the same time. If this does happen, for whatever reason, one of the two bridges would remain open for pedestrian use. The coordination between the two construction projects would be managed by the OCMC.

8 NOISE AND DUST CONTROL

The contract required the Contractor to limit his noise intensive operations in residential areas, such as pile driving, to daytime operations as follows:

Weekdays:	8:00 AM to 6:00 PM
Weekends and holidays:	9:00 AM to 5:00 PM

The contract also required the Contractor to perform maintenance cleaning of pavements and shoulder areas within the contract limits, and removal of all debris that would impede the flow of traffic or storm water or clog the catch basins.

9 WEIGHT AND HEIGHT RESTRICTIONS ON FDR DRIVE

Commercial vehicles, including heavy construction equipment, are not permitted on the section of the FDR Drive between East 34th and East 96th Streets. There is a weight limit of 4 tons (3.64 metric tons). This is due to a section of the FDR Drive supported on timber piles constituting what is known as a "relieving platform". As the waters in the New York Harbor are becoming cleaner due to environmental laws, the activities of marine borers are increasing, causing concern for the weight-carrying capacities of pile-supported platforms.

Similarly, the existing pedestrian bridges were built over FDR Drive at different times with varying minimum vertical clearances. Now all replacement pedestrian bridges, such as the East 78th Street Bridge, are required to have a minimum vertical clearance of 4.878 m (16'0"). The existing clearance of the East 78th Street Bridge is 3.963 m (13'0").

10 COMMUNITY LIAISON

Any major construction project in New York City requires close consultation and coordination with the community where the project is located. This project was located in Community Board 2 in Manhattan. Gandhi Engineering made several presentations to the Community Board, explaining not only the design of the bridge, but also the phasing of construction work, loss of available parking spaces during construction, the length of time during which the bridge would be closed to pedestrians, the staging area for the contractor, dust and noise control, and the hours of work during the day, night, and weekends. Progress meetings were held with the Transportation Committee of Community Board 2. The two final presentations were held in a large auditorium to accommodate all interested residents and organizations. The details of the bridge and planned construction were approved by Community Board 2.

11 APPROVAL FROM NEW YORK CITY ART COMMISSION

Established in 1898, the Art Commission is empowered to review and approve the design of all structures including bridges on New York City property. It also has the authority, in principle, to review and approve the design of privately owned bridges over property owned by the City.

Several presentations were made to the Art Commission (now known as the Public Design Commission) for the elevation of the main curved box girders over the six lanes of the FDR Drive, the hand railing, the fabric, and the mesh size and shape of the safety fence. Special renderings were prepared at the junction between the bridge and the ramps, and around the corners to clarify the design intent. The curved box girder design was approved by the Art Commission.

There is another pedestrian bridge at East 81st Street (about 245 meters or 800 feet) north of the existing bridge, and the Art Commission wanted to know how the ramps of these two pedestrian bridges would appear to the passengers on the Circle Line Ferry which provides boat rides around the island of Manhattan. Gandhi Engineering prepared a composite rendering of the two pedestrian bridges with their proposed ramps for review by the Art Commission.

12 DEMOLITION OF MAIN SPAN OVER THE FDR DRIVE

The most critical operation of the entire construction is the demolition of the main span over FDR Drive by saw-cutting it and lifting it by a barge-mounted crane with sufficient reach and lifting capacity. The Contractor is given permission to close the entire FDR Drive for one Sunday between the hours of 2:00AM and 7:00AM. As explained, due to load limitations on FDR Drive, the suggested scheme is shown in Figure 17.

The Contractor has also been given permission for the total closure of the FDR Drive when he would install the new bridge at a later for one Sunday between the hours of 2:00AM and 7:00AM using, again, a barge-mounted crane as shown in Figure 17.

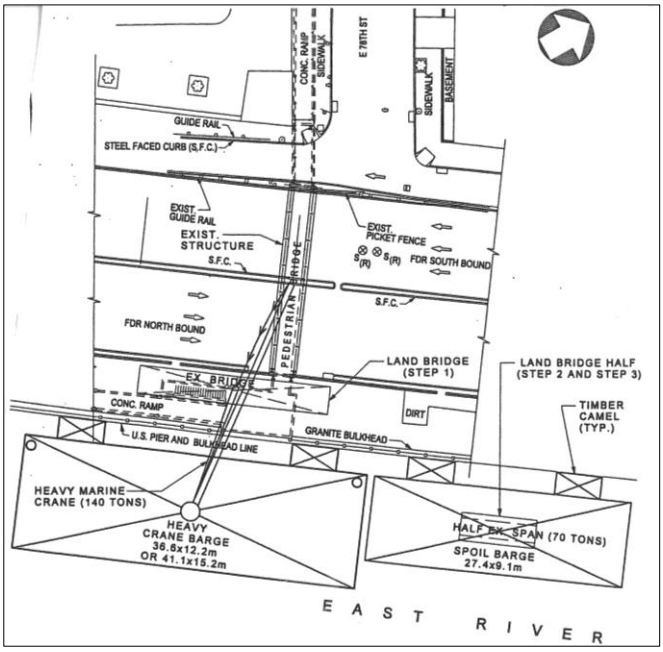

Figure 17. Suggested scheme for lifting the main span over the FDR Drive

13 CONCLUSION

The construction contract has been awarded for $11.93 million, and the replacement bridge is expected to be completed in 2011. The new bridge will provide a trouble-free service to pedestrians for the next 75 years or more with proper maintenance. It will also no longer be considered one of the three worst bridges in New York City.

14 ACKNOWLEDGMENTS

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