



Rehabilitation Design of the Alexander Hamilton Bridge Complex

Martin KENDALL

Director of Struct. Eng.
Jacobs Edwards and Kelcey
New York, NY, USA
Martin.Kendall@jacobs.com

Martin Kendall received his civil engineering degree from the Univ. of Birmingham UK. He has worked on major bridge projects in many countries including the Tagus Bridge Phase II in Lisbon, Portugal, and the East River Bridges in NYC.

1 Introduction

The Alexander Hamilton Bridge (AHB) carries the Cross Bronx Expressway (CBE), a section of Interstate Route I-95, over the Harlem River in the middle of New York City, as well as serving as the intersection with Interstate Route I-87. The deck is in bad condition and requires total replacement. Significant deterioration of the structure, and structural vulnerability due to lack of redundancy, needed to be addressed. The major concern was how to rehabilitate the bridge and keep 188,000 vpd moving with the minimum of disruption. The solution included replacement of two bridges that span over the CBE, with piers located in the median, to permit the staged construction on the AHB.

2 Existing Structure

There are nine (9) bridge structures as a part of the overall AHB complex to be reconstructed in this project. These comprise three groups of structures. They are the Alexander Hamilton Bridge mainline structure; two bridges (Ramp TE and Undercliff Avenue) carrying roadways over I-95 (CBE), and the Highbridge Interchange.

2.1 Alexander Hamilton Bridge Mainline Structure

The Alexander Hamilton Bridge is a ten span bridge structure approximately 452.7m long between abutments. It includes a hingeless arch bridge over the Harlem River, with West and East Approach viaducts comprised of twin plate girder structures with non-composite reinforced concrete decks. Each set of eastbound and westbound lanes is supported at present on its own individual structure. The anchorages for the arch span consist of reinforced concrete pedestals on stepped spread footings founded on bedrock. The substructures for the Approach Spans are made up of large diameter circular reinforced concrete column pier shafts, one shaft supporting each girder. The column shafts are supported on pile caps with multiple reinforced concrete piles. The last pier on the East Approach is a concrete wall supported on large diameter cast-in-place shafts.

2.2 Ramp TE and Undercliff Avenue

Ramp TE is a one lane roadway supported by a ten span concrete box structure on a 64.2m radius. The piers are single large diameter steel pipes filled with reinforced concrete, supported on spread footings on rock. One of the piers is located in the center median of the CBE. Undercliff Avenue Bridge is a two span reinforced concrete rigid frame bridge, also spanning over the CBE, immediately to the east of the East Abutment of the AHB. Foundations are on spread footings.

2.3 Highbridge Interchange

The connecting ramps between the CBE (on the AHB) and I-87 are curved roadways supported on six bridge structures and on-grade roadways. Leading down from the eastbound CBE is a two lane



wide roadway ramp, designated Ramp D, which splits into two single lane roadways. Leading up to the westbound CBE is a ramp designated as Ramp A which commences in two locations from northbound and southbound roadways of I-87, which join and feed the westbound lanes of the AHB

3 Rehabilitation Requirement

The reinforced concrete deck of the Alexander Hamilton Bridge is not in good condition. The simply supported twin girder configuration of the approach spans was also deemed to be fracture critical. The thermal movement performance of the bridge was also giving cause for concern with rocker bearings exhibiting tilts of over 50mm at normal mean temperatures (20°C). However the bridge complex is an extremely important node on the US Interstate Highway system, particularly with respect to traffic entering and leaving New York City. Any scheme for the rehabilitation of the bridge complex had to allow for the maintenance of the full number of traffic lanes at all times. No permanent closure of lanes would be permitted. The rehabilitation scheme that was developed to meet these criteria also ultimately restores the roadway on the bridge to meet the Federal Highway Administration (FHWA) highway design standards with respect to safety shoulders

4 Proposed Structural Changes

4.1 Alexander Hamilton Bridge.

There are three major structural changes proposed for the Alexander Hamilton Bridge. These are: 1) widening the deck by 3.35m to each side; 2) eliminating half of the transverse deck joints and the whole of the longitudinal deck joint; and 3) the introduction of additional girders in the Approach Spans. The first change allows for maintaining the full traffic patterns in each direction on bridge during construction. The second change eliminates joints in deck and girders at Piers 2W, 2E, 4E, and 6E for the approach spans, (increasing the redundancy of the Approach Spans structures); and at the arch panel points 3 and 3'. The elimination of the longitudinal deck joint will combine the two independent structures into one. The third change will reconfigure the cross section of the Approach Spans, converting it to a homogeneous multiple girder cross section. Modifications to substructure include the conversion of the independent shaft piers to full reinforced concrete rigid frames, by the construction of reinforced concrete cap beams to the tops of the existing column shafts, and the replacement of all existing bearings with new pot bearings. Piers 2E and 4E need the addition of new pre-loaded piles between the existing pile caps to share the increased load and connection of the existing independent pile caps. Pier 5E requires the installation of shear collar reinforcement at the base of these column shafts to upgrade the seismic capacity. The seismic loading of the column structures is further reduced by the revised layout of the expansion bearings.

4.2 Ramp TE and Undercliff Avenue

In order to provide the necessary lateral clearances to permit the widening of the AHB, two of the piers of the Ramp TE bridge structure needed to be relocated, as they are presently positioned immediately adjacent to the edge of the roadway deck of Span 2W. A third pier supporting Ramp TE in the center median of the AHB in the middle of Span 2W, blocks any relocation of traffic lanes during staged construction. On the east side of the river, the center pier of the Undercliff Avenue Bridge also blocks staged construction. The two bridge structures are to be totally replaced. Ramp TE will be a five span twin steel tub girder structure with a composite concrete deck. Undercliff Avenue Bridge will be replaced with a one span multiple steel stringer bridge.

4.3 Highbridge Interchange

The Highbridge Interchange Ramps are being reconstructed by replacing the existing reinforced concrete decks with new composite cast-in-place reinforced concrete decks. Temporary bridges are to be constructed in order to maintain the full number of traffic lanes on the ramps at all times during construction.