PROJECT CASE STUDY – CONRAC AUTOMATED PEOPLE MOVER

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ABSTRACT

The City of Atlanta is in the midst of a massive expansion at Hartsfield-Jackson Atlanta International Airport, including an Automated People Mover (APM) operating on a 1.5 mile long overhead guideway. The City elected to procure the APM through the design-build-operate-maintain (DBOM) procurement method. The structural design was developed by Archer-Western and Heath & Lineback (H&L) to produce the most efficient solution to the various constraints and to maximize the strengths and expertise of the construction company and led to a unique solution including a variety of structural arrangements. The basic superstructure type is a simple span, single cell precast prestressed concrete box beam. The deck is cast with the box and the deck edges follow the curved alignment of the guideway. The webs and bottom flange of the box are chorded to fit from pier to pier. Several spans had to reach in excess of 120' and in these locations the box beams were "stretched" increasing the amount of prestressing strand. The lifting and shipping weight had to be limited to 250,000 lbs however, so lightweight concrete (120 pcf) was prescribed for spans in excess of 120' to a maximum of 140'. The maximum span length of 165' was outside the reach of precast beams due to weight restrictions and too high and difficult for a cast-in-place solution. For these longest spans, steel tub girders were used. A four-span continuous unit was used over I-85 and a two-span continuous unit over Airport Blvd. Several of the spans were in tight horizontal curvature (radius < 520'). At these radii it was not feasible to maintain the concept of chording the spans. Two or three span continuous units of cast-in-place post-tensioned box girders were detailed for these locations. The typical substructure element is cast-in-place with a single column pier and a hammerhead cap aligning with the box beam soffit.

Keywords: Bridge, Prestressed, Transit, Box, Beam, Span, Lightweight

INTRODUCTION

The City of Atlanta is in the midst of a massive expansion at Hartsfield-Jackson Atlanta International Airport. The work completed to date includes the new 5th Runway and improvements to the arrivals and departures driveway. Work continues on the site preparation for the proposed International Terminal. One critical component of the expansion is that of moving all Rental Car facilities to a remote site that is accessed by an Automated People Mover (APM) vehicle operating on an overhead guideway.

The City will build two parking garages for approximately 8700 vehicles at the new site of the Consolidated Rental Car Facility (CONRAC) which is located approximately 1 ½ miles from the main terminal. All rental car facilities including parking, maintenance and ticketing will be located at the facility. Passengers arriving at the airport will travel on the APM system to CONRAC, complete the rental paperwork and leave via new access roadways to I-85 to be built as part of the CONRAC site contract.

GENERAL LAYOUT

Beginning at the airport, an elevated station is proposed immediately adjacent to the existing MARTA (transit) station and the arrivals/departures main terminal. This Central Passenger Terminal Complex (CPTC) Station will receive passengers at ground level, with the platforms elevated above (Figure 1).

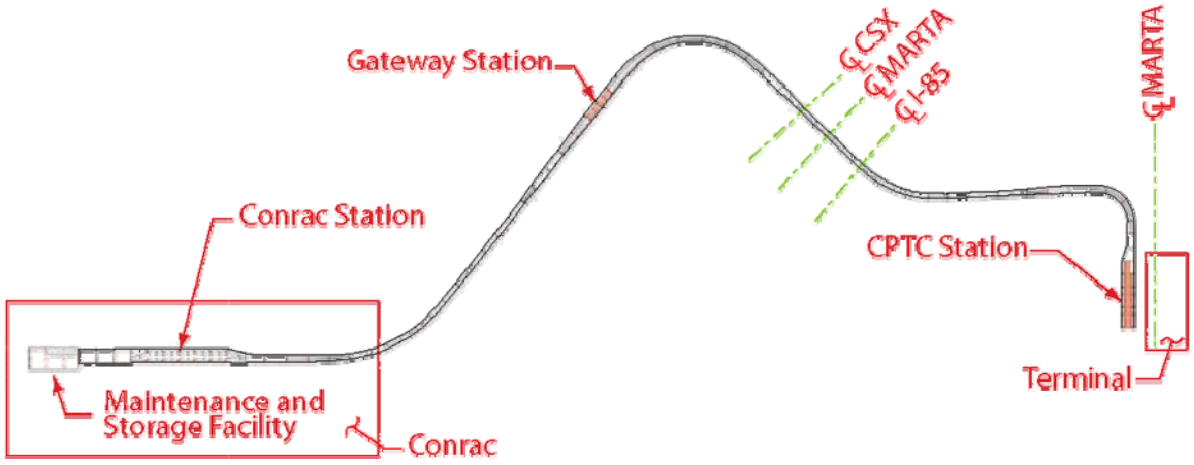

Figure 1 – General Layout

From CPTC, the system guideway will run as a pinched loop system along an all elevated curvilinear alignment that is generally north and west crossing the N. Terminal Parkway, parking lots, Airport Boulevard, I-85, MARTA, CSX Railroad, West Point Avenue, US 29/Roosevelt Highway and Convention Center Concourse on a 1 ½ mile alignment to an

elevated station at CONRAC. At approximately mid length of the alignment, an intermediate elevated platform at Gateway Station will provide access to the existing Georgia International Convention Center and proposed hotel complex. Beyond the CONRAC Station, the alignment terminates at an elevated Maintenance & Storage facility. The entire guideway is comprised of a total of 73 spans for a total bridge length of 8,112'. There are 58 precast girder spans for 5,970', 9 cast-in-place girder spans for 1,189' and 6 steel tub girder spans for 953'.

The CONRAC site comprises two main parking decks wrapping to either side of the APM guideway, together with the various access roadways and the rental car operational facilities.

PROCUREMENT

The City elected to procure the APM through the design-build-operate-maintain (DBOM) procurement method. The procurement included all aspects of the structure, vehicle guidance and operational systems as well as the vehicle itself and included the Maintenance & Storage facility as well as structural work (platforms) at the Gateway and CPTC structures. A five year operations and maintenance period was included.

Upon receipt of all responses to the RFQ the City prequalified three teams and after receiving priced proposals in response to the RFP the Archer Western/Mitsubishi team was selected and negotiation proceeded to achieve agreement in the best and final offer. The complete design/build team was then:

Archer Western, Ltd/Capitol Contractors	Civil/Structural Construction
Mitsubishi/Sumitomo	Vehicle/Systems & Operations
Heath & Lineback Engineers, Inc.	Civil/Structural Design
PB Americas	Systems Design
The Architecture Group	Architectural Design
Accura/United Consulting Group	Geotechnical/QA Inspection
Street Smarts	Civil/Survey

CONSTRAINTS

The design of the system was constrained by the performance and aesthetic specification set by the Owner, and clearance requirements for the major facilities crossed. Mitsubishi offered their "Crystal Mover" vehicle for the project. The Crystal Mover is a rubber tired electric driven vehicle that can operate in a two-car or four-car configuration. Initial configuration and fleet size was based on operating two-car systems, but all components had to be designed for eventual expansion to a four-car arrangement. Mitsubishi provided the vehicle operational envelope, systems and loadings for the structural team. The allowable live load deflection was set at span length divided by 800 with L/1000 being desirable.

DESIGN DEVELOPMENT

The structural design was developed by Archer-Western and Heath & Lineback (H&L) to produce the most efficient solution to the various constraints and to maximize the strengths and expertise of the construction company and led to a unique solution including a variety of structural arrangements.

PRECAST BOX BEAMS

The basic superstructure type is a simple span, single cell precast prestressed concrete box beam. The section of the cell was sized so that the webs are centered under the running plinths for the vehicle. The design was optimized for tangent section of single track guideway at a span length of 120'. In this arrangement the box depth of 5'0" gave optimum efficiency for casting, delivery and erection. Concrete strengths of 7000 psi at 28 days and 5000 psi at release were required. A minimum of 20 and maximum of 102 – 0.60 in. diameter straight strands were used with no more than 40% debonded.

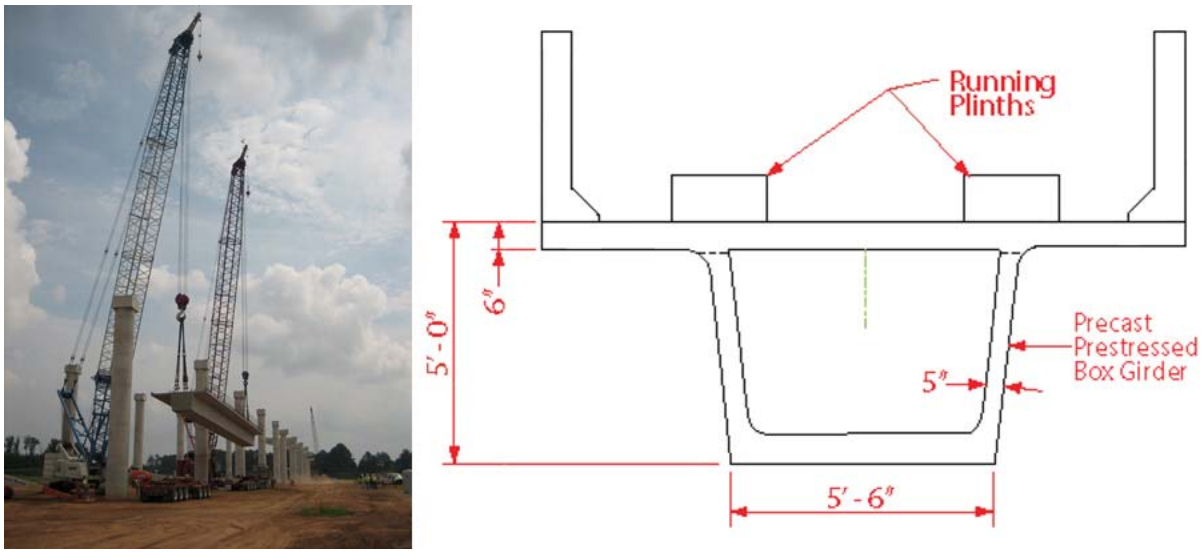

Figure 2 – Precast Box Beams

The basic box design was modified for length of track with gentle horizontal curvature (radius > 785'). At these radii the box was built with straight (parallel) webs but the deck slab was curved. The structure as erected is therefore a chorded structure but the deck and guidance system follow the true curved alignment.

For significant lengths of the alignment the two parallel guideways run close together (14' centers). In this configuration the two parallel box beams were made continuous across the width of deck slab, by means of a cast-in-place closure pour (Figure 3).

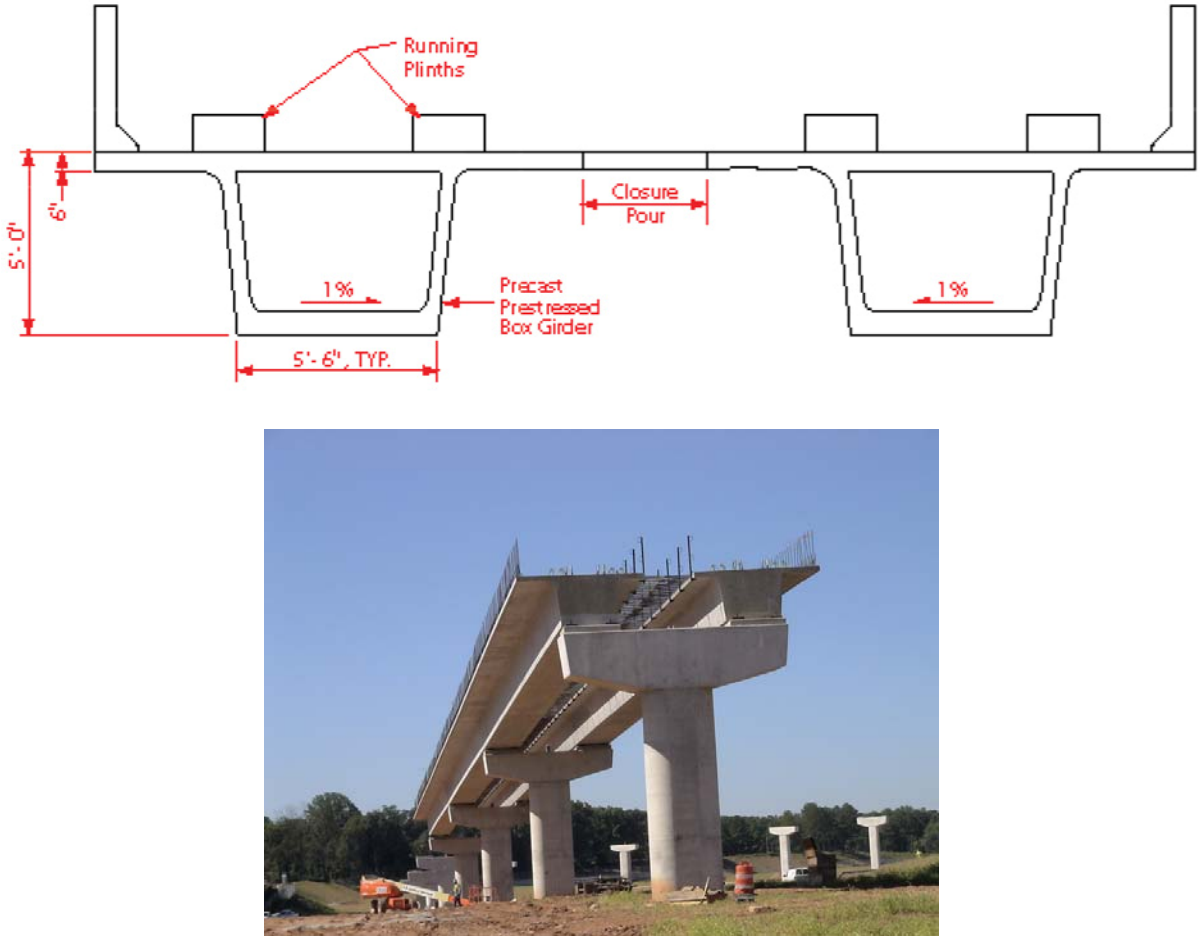

Figure 3 – Parallel Guideways

Several spans had to reach in excess of 120’ to clear road and rail facilities. In these locations the box beams were “stretched” increasing the amount of prestressing strands. The lifting and shipping weight had to be limited to 250,000 lbs however and so lightweight concrete was prescribed for spans in excess of 120’ to a maximum of 140’. A unit weight of 120 pcf was used for the lightweight concrete girders. The box depth could not be varied for aesthetic reasons.

CAST-IN-PLACE BOX GIRDERS

Several of the spans were in tight horizontal curvature (radius < 520’). At these radii it was not feasible to maintain the concept of chording the spans. Two or three span continuous units of cast-in-place post-tensioned box girders were detailed for these locations. The box girder was designed as separate single cell structures with full width diaphragms at each pier (Figure 4).

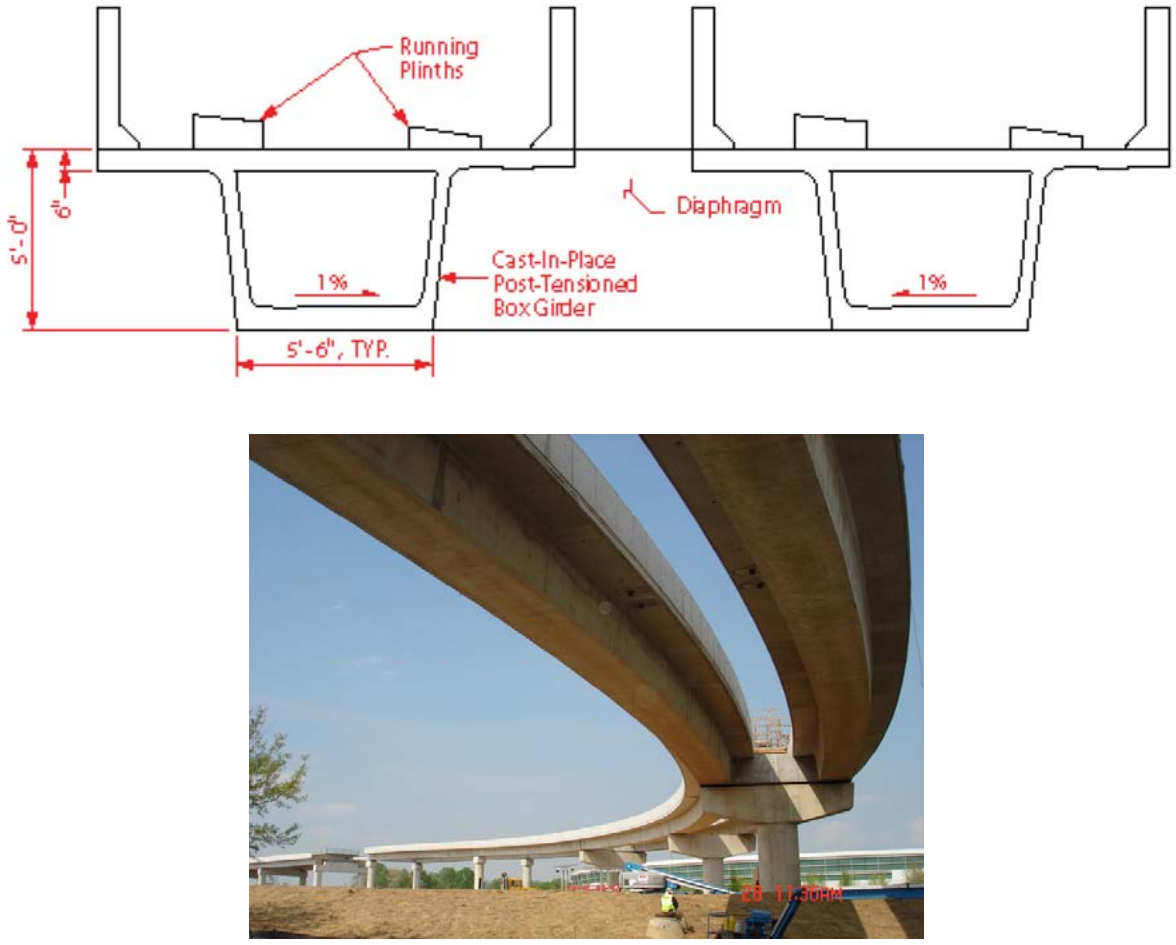

Figure 4 – Cast-in-place Girders

STEEL "TUB" Girders

The spans over the I-85/CSX/MARTA Transportation corridor and over Airport Boulevard are in excess of 140 ft (with a maximum of 165 ft) and out of the range of the precast solutions because of weight restrictions, were too high and too difficult to build on falsework for cast-in-place solutions, and there was not enough structure to justify a segmental solution. For these spans steel welded plate box girders "tubs" with cast-in-place deck were detailed (Figure 5). A four-span continuous unit in horizontal curve was used over the transportation corridor with a two-span continuous unit in tangent over Airport Boulevard.

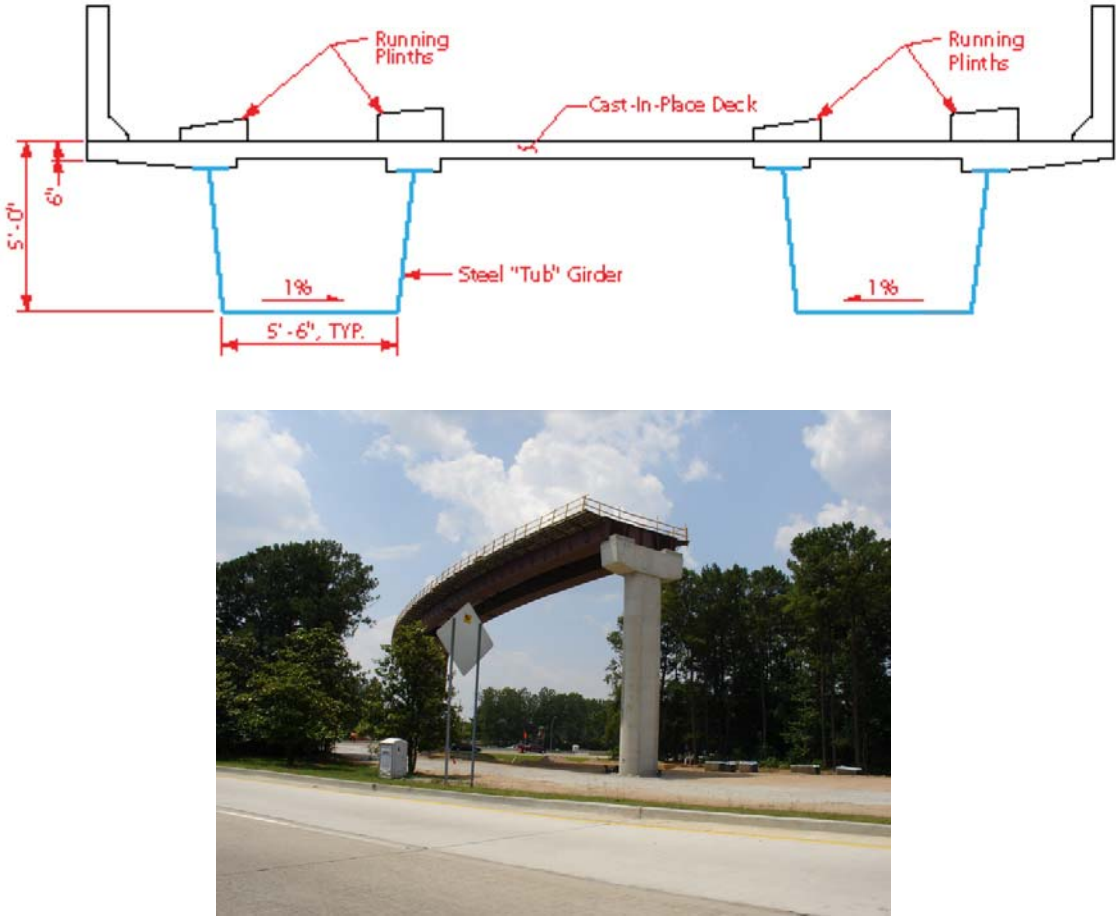

Figure 5 – Steel “Tub” Girders

BRIDGE ARTICULATION

The majority of the superstructure is supported on laminated neoprene pads with a single 1 in. diameter steel dowel engaged in either a slotted or round hole in the bottom flange of the box girder. The steel dowel is designed to keep the box girder aligned in the proper location while allowing for thermal movements when used in conjunction with a slotted hole in the bottom beam flange.

SUBSTRUCTURE

The typical substructure element is cast-in-place with a single column pier and hammerhead cap aligning with the box beam soffit. Double boxes use a single pier shaft with full hammerhead. All piers are bull nosed for aesthetic purposes and were founded on heavy steel H piling (typically HP driven to 280 tons).

CONCLUSION

Design for APM Systems provides the structural engineer with some unique challenges. Most challenging is to meet the exacting geometrical and deflection criteria that are needed to provide a high quality smooth ride. The high visibility of the elevated system requires attention to aesthetics to ensure that the facility provides an exciting and vibrant portal. Precast concrete tub girders make this project economical while maintaining and enhancing the required aesthetics and contributing to the overall success of this rewarding project.

The completion of the Hartsfield APM, anticipated for 2008, will offer a major improvement to the Atlanta Airport facility.