Structural Design for an Automated People Mover

Hartsfield Jackson International Airport

By John Heath, P.E. and Gary B. Lineback, P.E.

The City of Atlanta is in the midst of a massive expansion at Maynard Jackson Hartsfield 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 1½ miles from the main terminal. All rental car facilities including parking, maintenance and ticketing will be located at the central facility. Passengers arriving at the airport will travel on the APM system to CONRAC, complete the rental paperwork at the airport 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 two platform station is proposed immediately adjacent to the existing MARTA (transit) station and the arrivals/departures main terminal. This Central Passage Terminal Complex (CPTC) Station will receive passengers at ground level, with the platforms elevated above. (*Figure 1*)

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 1½ 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.

Guideway at Future Gateway Station.

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. It also included the Maintenance + Storage facility, as well as structural work (platforms) at the Gateway + CPTC structures. A five year operations and maintenance period was included.

Upon receipt of all responses to the RFQ, the City prequalified three teams. After receiving priced proposals in response to the RFP, the Archer Western/Mitsubishi team was selected.

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 consys. 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.

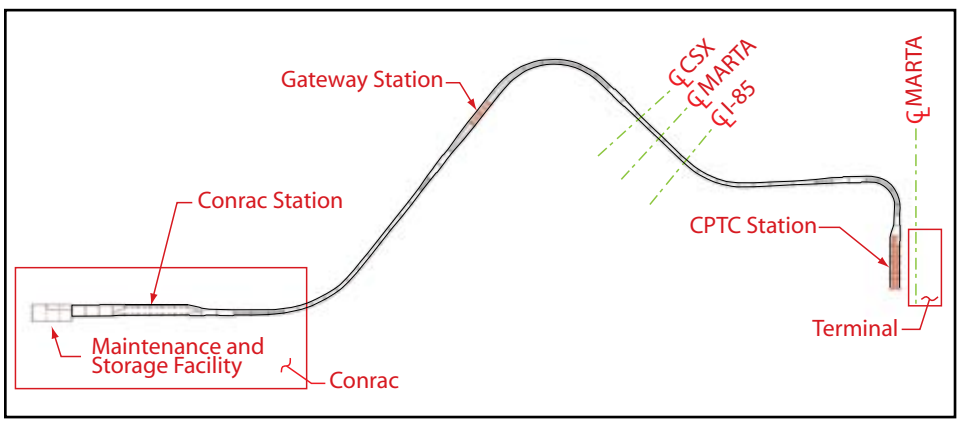

Figure 1

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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. The process led to a unique solution including a variety of structural arrangements.

Design/Build Team

Civil/Structural Construction
Archer Western, Ltd/Capitol Contractors

Vehicle/Systems & Operations
Mitsubishi/Sumitomo

Civil/Structural Design
Heath & Lineback Engineers, Inc.

Systems Design
PBQD

Architectural Design
The Architecture Group

Geotechnical/QA Inspection
Accura/United Consulting Group

Civil/Survey
Street Smarts

Precast Box Beams

The basic superstructure type is a simple span, single cell precast prestressed concrete box beam (*Figure 2*). The section of the cell was sized so that the webs are centered under the running plinths for the vehicle. The design was idealized for tangent section of single track guideway at a span length of 120 feet. In this arrangement the box depth of 5 feet gave optimum efficiency for casting, delivery and erection. Concrete strengths of 7000 psi at 28 days and 5000 psi at release were required.

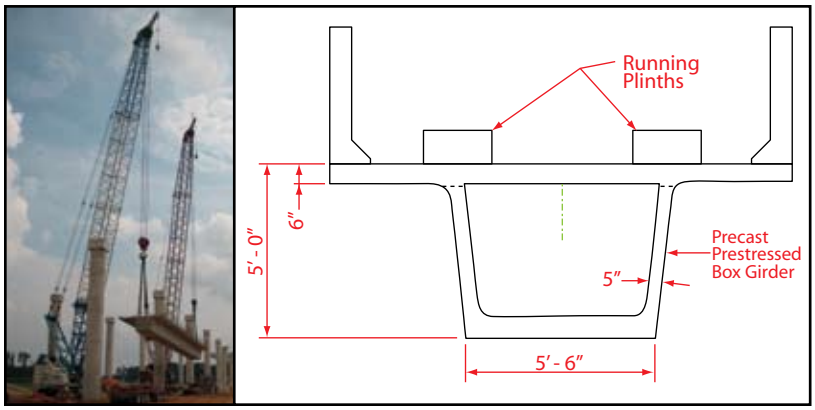

Figure 2: Precast Box Beams.

The basic box design was modified for length of track with gentle horizontal curvature. 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-foot 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*).

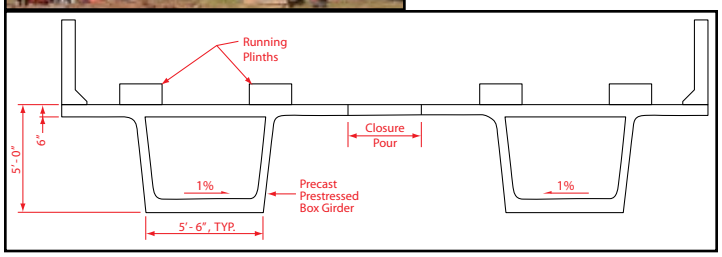

Figure 3: Parallel Guideways.

Several spans had to reach in excess of 120 feet to clear road and rail facilities. In these locations the box beams were "stretched", increasing the amount of the prestressing strand. The lifting and shipping weight had to be limited to 250,000 pounds however. Lightweight concrete was prescribed for spans in excess of 120 feet to a maximum of 140 feet. The box depth could not be varied for aesthetic reasons.

CIP Box Girders

Several of the spans were in tight horizontal curvature (radius < 520 feet). 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*). The box girder depth and external section was identical to the precast spans for aesthetic reasons.

Steel Tubs

The spans over the I-85/CSX/MARTA Transportation corridor and over Airport Boulevard are in excess of 140 feet (165 max) and out of the range of the precast solutions because of weight restrictions. The spans 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 over Airport Bouelvard. The external dimensions of the tubs matched that of the concrete boxes.

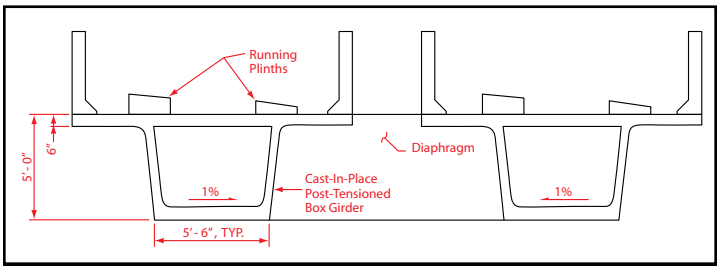

Figure 4: Cast-in-Place Girders.

Bridge Articulation

The majority of the superstructure is supported on steel reinforced neoprene pads with a single pintel.

Substructure

The typical substructure element is a single column pier with a truncated hammerhead to match the width of 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.)

Summary

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.

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

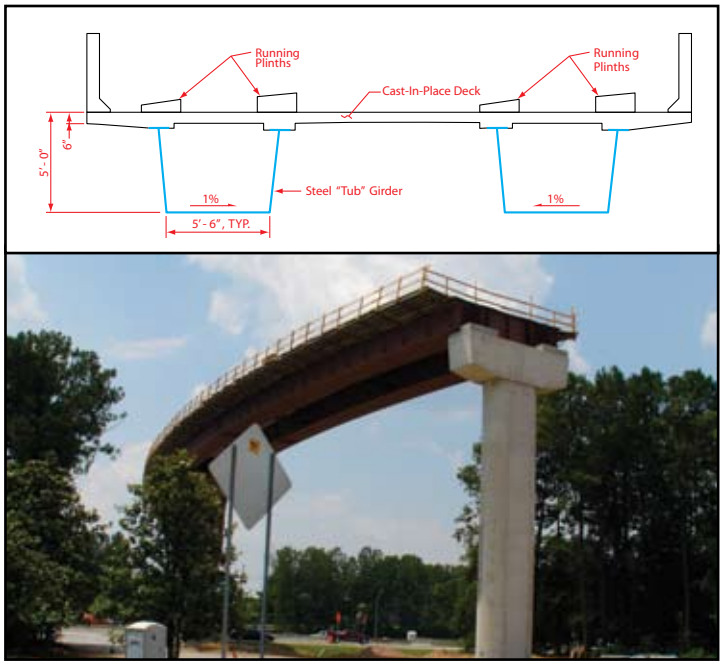

Figure 5: Steel "Tub" Girders.

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