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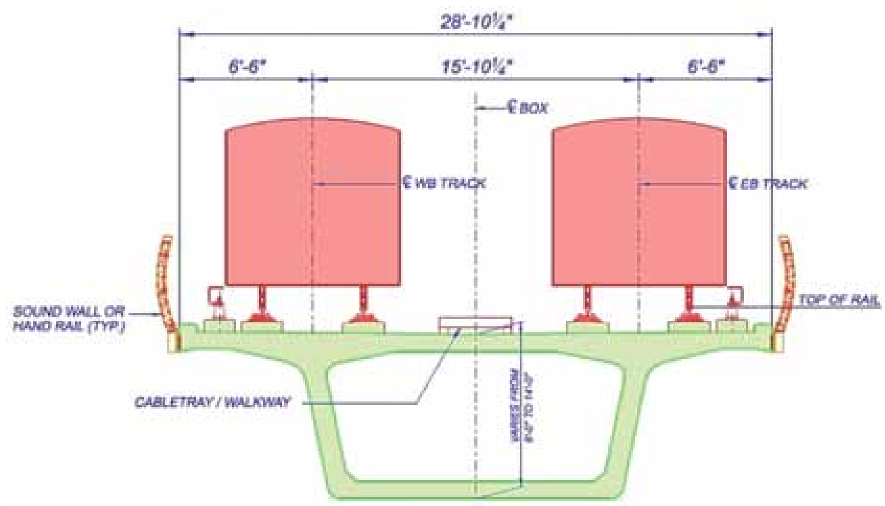
# The Miami Intermodal Center—Earlington Heights Connector

by Velvet Bridges, URS Corporation

## CONNECTING THE DOTS

The Miami Intermodal Center—Earlington Heights Connector (MIC-EHC) is located in the Greater Miami area east of the Miami International Airport (MIA). The MIC is a regional transportation hub of the Florida Department of Transportation (FDOT) that is now under construction. The facility will connect local and regional transportation networks to MIA, including Tri-Rail, Amtrak, Intercity bus, Metrobus, taxis, and tour buses to MIA. The MIC will also house the airport's rental car facilities. The MIC-EHC will provide a light rail connection to a new MIC Metrorail Station via a 2.4-mile-long elevated guideway from the existing Earlington Heights Metrorail Station located at State Road (SR) 112 and NW 22nd Avenue. The MIC Metrorail Station and MIA will be linked with an automated people mover owned by MIA. The MIC-EHC will become part of the Metrorail system Orange Line in Dade County and will be owned and maintained by Miami-Dade Transit (MDT).




Typical section through the dual-track segmental box girder. Drawing: URS Corporation.

### Project Requirements

The MIC-EHC has a variety of existing and future site conditions that require special span arrangements and structure types along its elevated 2.4-mile alignment. Structures in the vicinity of the MIC Metrorail Station had guideway span lengths limited to 130 ft to match the bus spacing at ground level. The South Florida Railroad Corridor (SFRC) required a three-span continuous structure with a minimum span length of 180 ft to span over the railroad tracks. At the Miami River, a three-span continuous structure with a minimum vertical clearance of 40 ft from mean high water was required, and with columns and footings of the guideway located clear of the river shoreline. A five-span continuous structure with a main span of 256 ft was required to span over the existing SR 112 eastbound and westbound roadways and the future Miami Dade Expressway (MDX) SR 112 project. To meet these varied requirements, the MIC-EHC designers utilized several superstructure configurations, including 72-in.-deep precast, prestressed concrete Florida U-beams; precast, post-tensioned segmental concrete box girders; and conventionally reinforced 30-in.-deep, cast-in-place concrete slabs.

### Structures Overview

Cast-in-place concrete slab bridges, 30-in.-deep, are used at the connection to the Earlington Heights Station. There are a total of 13 spans or 571 linear ft of guideway. Span lengths vary from 41

profile

**MIAMI INTERMODAL CENTER—EARLINGTON HEIGHTS CONNECTOR** / MIAMI, FLORIDA

**BRIDGE DESIGN ENGINEER:** URS Corporation, Tampa, Fla.

**PRIME CONTRACTOR:** Odebrecht Construction Inc.—Tower-OHL Group—Community Asphalt Corp.-OHL Group, Joint Venture, Miami, Fla.

**PRECASTER: U-BEAMS:** Standard Concrete Products, Tampa, Fla., a PCI-certified producer

**SEGMENT PRECASTER AND ERECTOR:** Rizzani de Eccher USA, Bay Harbor Islands, Fla.

**PIER SHELL REDESIGN:** McNary Bergeron & Associates, Broomfield, Colo.

**SEGMENTAL BRIDGES POST-TENSIONING SUPPLIER:** DYWIDAG Systems International-USA Inc., Bolingbrook, Ill.

**SEGMENTAL BRIDGES POST-TENSIONING CONTRACTOR:** Rizzani de Eccher USA, Bay Harbor Islands, Fla.

to 50.44 ft for a total of 10,932 ft$^2$ of structure.

The 72-in.-deep, precast, prestressed concrete Florida U-beams were used for 79 spans totaling 9589 linear ft of guideway. The typical span is 125 ft but spans vary from 82 to 133 ft. The total area of Florida U-beam guideway structure is 230,266 ft$^2$.

The segmental concrete box girder portion of the MIC-EHC features 13 units; with a total length of 1.1 miles of constant and variable depth, single-cell, precast concrete box girders totaling 145,538 ft$^2$ of structure. The single-track box girder has a constant depth of 7 ft 8 in., while the dual-track box girder has a variable depth ranging from 8 ft 0 in. at midspan to 14 ft 0 in. at intermediate piers. Typically, the box girder top flange widths match the top width of the Florida U-beam configurations for either single- or dual-track guideways.

The single-track box girder flange width is 15 ft 0 in., except for locations near the airport traction power substation where the width is 17 ft 0 in. in order to accommodate a jumper cable tray and a walkway. The dual-track box girder flange width is 28 ft 10¼ in. The number of spans per unit are either two or three for the single-track guideway, and from two to five for the dual-track guideway. The span lengths vary, with a maximum span of 256 ft at the SR 112 crossing.

The single- and dual-track box-girder segment lengths are 10 ft 9 in. and 10 ft 0 in. respectively. Longitudinally, the bridges are fully post-tensioned including face anchored top cantilever tendons, blister anchored bottom continuity tendons, pier segment anchored external continuity tendons, and blister anchored top continuity tendons. The expansion joint and pier segments are 7 ft 6 in. long, necessary to meet minimum FDOT bridge post-tensioning requirements.

The original design using cast-in-place concrete pier segments was redesigned by the contractor's construction engineer at the beginning of the work to allow the use of precast pier shells with cast-in-place diaphragms. A total of 23 shells were used throughout the project. There were five redesigned precast concrete pier shells, 10 ft 0 in. long for single piers and 18 shells, 27 ft 0 in. long for double piers. For the double piers, the pier shells are stressed together using post-tensioning bars prior to casting the diaphragm. The pier diaphragms are transversely post-tensioned once the cast-in-place concrete secondary placement has reached minimum strength. Pier and expansion joint segments are heavily reinforced to carry the guideway loads into the piers typically using disk bearings or an integral connection to the substructure (For additional information about precast concrete pier shells, see the Creative Concrete Construction article on page 30).

The substructure uses a combination of single and double piers, framed piers, straddle bents, and cantilever piers. The piers are supported by multiple auger-cast piles or drilled shaft footings. Single and double piers are typically used for both single- and dual-track segmental portions of the guideway. Framed piers are used for portions of the guideway at crossovers. Straddle bents and cantilever piers are used where existing or future underlying roadways preclude the use of conventional piers.

The lifting frame at the tip of the balanced cantilever construction over the Miami River required a three-span unit and minimum clearance of 40 ft. Photo: Rizzani de Eccher USA.

## 2.4-MILE-LONG ELEVATED GUIDEWAY OF SINGLE AND DOUBLE TRACK COMPRISING FLORIDA U-BEAMS, SOLID CONCRETE SLABS, AND PRECAST CONCRETE SINGLE-CELL SEGMENTAL BOX GIRDERS ON SINGLE AND DOUBLE CONCRETE PIERS / MIAMI-DADE TRANSIT, MIAMI, FLORIDA, OWNER

**READY MIXED CONCRETE:** Cemex USA and Tarmac America LLC, Fort Lauderdale, Fla.

**DISK BEARINGS:** RJ Watson Inc., Elmhurst, N.Y.

**LIFTING FRAME:** DEAL, Italy

**STRUCTURAL COMPONENTS:** 72-in.-deep Florida U-beams in the typical spans, segmental precast concrete box girders for the long-span units of the guideway structures, 30-in.-deep, cast-in-place concrete slabs at the connection to the Earlington Heights station, and precast concrete pier shells on cast-in-place concrete piers

**BRIDGE CONSTRUCTION COST:** $136.8 million

Balanced cantilever construction over SR 112 that required a main span of 256 ft. Photo: URS Corporation.

In this section of the Miami Intermodal Center—Earlington Heights Connector, 72-in.-deep Florida U-beams parallel to SR 112 were used. Photo: URS Corporation.

## Post-Tensioning Considerations

The FDOT five-part strategy for post-tensioning is intended to create a design, construction, and maintenance environment that will consistently ensure long-term durability of structures with post-tensioned tendons.

Some of the measures incorporated in this project are:

- Center-to-center internal longitudinal duct spacing of two times the duct outside diameter
- A 10-in.-minimum thickness of sections containing internal post-tensioning tendons
- Oversize ducts to accommodate couplers for post-tensioning bars
- A maximum of twelve, 0.6-in.-diameter strands per tendon
- Four, 0.6-in.-diameter strand tendons per web through mid-span and end-span closures
- Use of steel pipe ducts for tendons with anchorages embedded in diaphragms
- A 12-in.-minimum set back from the end of the segment for interior blisters
- A minimum of three bottom tendons per web
- Overlap of midspan continuity tendons by cantilever tendons
- External post-tensioning—in addition to the future strengthening—in the form of draped tendons extending from pier to pier passing through full-height intermediate deviator diaphragms providing an overlap of tendon anchors at the pier segments
- FDOT's standard grouting procedure, with high-performance grout and multiple levels of corrosion protection for the anchorages on interior and exterior surfaces

## Erection Scheme

All of the segmental units were designed to be erected using the balanced cantilever method. The cantilever stability was achieved by the use of frames around columns supported on permanent foundations and stability towers on one or both sides of piers on temporary foundation pads.

The guideway corridor is located along some of the most heavily traveled highways in south Florida. Construction had to be carried out with minimum disruption to the existing vehicular traffic and the residents of the neighboring areas. The installation of segments by crane was very difficult or impossible in some cases. Moreover, due to the proximity to MIA, the guideway was located under the airport glide path. A construction plan was developed that would not violate Federal Aviation Authority (FAA) airspace during the erection of bridge segments.

A segment lifting system was developed that consisted of the lifting frame, overhead traveling truss, lifting beam, and a secondary spreader beam. Each segment was lifted and transported to the end of the cantilever where it was moved into place. The segment was epoxied and attached to the previous segment with permanent post-tensioning bars.

## Project Schedule

Design was completed in October 2007. The project was let for construction in August 2008 with the elevated guideway extension scheduled for completion in June 2011. The first segment was cast at the end of December 2009. The estimated date for the MIC-EHC Orange line to begin revenue operation is April 30, 2012.

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*Velvet Bridges is senior structural engineer with URS Corporation in Tampa, Fla.*

**For additional photographs or information on this or other projects, visit www.aspirebridge.org and open Current Issue.**

A dual-track precast concrete pier shell segment. Photo: URS Corporation.