

## **ECONOMIC EXPANSION THROUGH DOUBLE DECKING IN THE MEDIAN**

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### **ABSTRACT**

*The Tampa-Hillsborough County Expressway Authority is expanding with an elevated concrete structure, designed to be financially and aesthetically attractive. With three elevated reversible lanes located in the median of the existing highway, capacity will be more than doubled without the purchase of additional right-of-way. Figg Bridge Engineers, Inc. in Tallahassee, Florida is designing the precast concrete segmental box girder bridges along this transportation facility. The features allow for construction to occur in a congested urban area without disrupting the existing traffic. Innovative contracting procedures are being implemented to accelerate the completion of the project.*

**Keywords:** Precast, Concrete, Segmental, Elevated, Superstructure, Expressway, Reversible

## INTRODUCTION

The capacity of the Lee Roy Selmon Crosstown Expressway in Tampa, Florida will be increased more than two-fold in each direction during commuter hours of high traffic volume by the addition of three reversible lanes. This will be achieved by constructing in the median of the Expressway, without the purchase of additional right-of-way, providing significant cost savings to the owner, and therefore, the customers who use the facility. It will also preserve the majority of the median to allow for future expansion of Expressway lanes and overpass bridges and for construction of the I-4 Connector. The Expressway (State Road 618) is a four-lane, divided, limited-access toll highway that is approximately 14 miles long and is owned by the Tampa-Hillsborough County Expressway Authority (THCEA).

The project, as shown in Fig. 1, is located in south Tampa and crosses the Palm River, CSX Railroad, I-75, and several streets on its traverse from Meridian Street in downtown Tampa to west of TownCenter Boulevard in the town of Brandon.

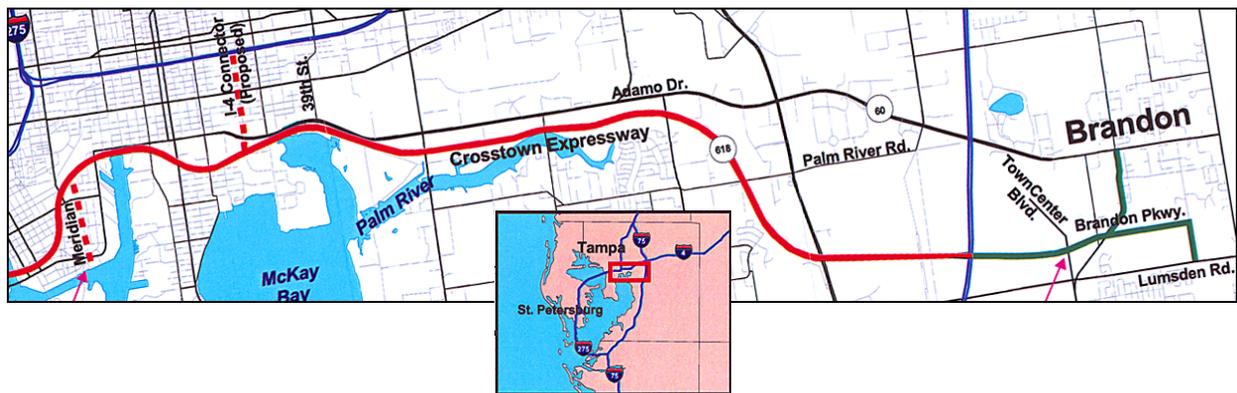


Fig. 1 Project Limits

## THE CHALLENGE

The existing Expressway begins at Gandy Boulevard and continues northeasterly into south Tampa and eastward to I-75 in Brandon. The Expressway is mostly used by toll-paying commuters in the morning and evening hours, causing traffic congestion during these times. To meet the growing needs of the community, the Expressway will require within 20 years twice its current capacity, or four lanes in each direction. With the I-4 Connector in place, five lanes in each direction would be needed for much of the Expressway. With this project, THCEA is expanding and extending into the town of Brandon with urgently-needed additional capacity.

The greatest challenge facing the owner is to avoid disrupting existing traffic. The expansion must at all times satisfy the customers who, after all, pay tolls to use the facility. THCEA evaluated several alternatives. The solution was to construct approximately nine miles of reversible express lanes in the median of the existing Expressway from downtown Tampa to I-75. The question then became “How do we do this with limited median space and without

purchasing expensive right-of-way?” One solution to increase the capacity was to construct at-grade, barrier-separated reversible lanes in the median. However, this would provide only two additional lanes in a given direction, would prevent future expansion within the median, and would require reconstruction of all of the Expressway’s 20 overpass bridges. Another solution was to widen the highway by only one lane in each direction. This, however, would not even provide half of the additional capacity needed. Another solution was to use conventional bridge construction. Because the bridge would overhang the inside express lanes by 6 ft, this would require closing the existing inside lanes during the placement of forms and placing of concrete for bridge decks.

The solution that would provide adequate additional capacity without disrupting traffic was to construct an elevated precast concrete segmental box girder bridge with three reversible lanes in the median, as illustrated in Fig. 2, between Downtown Tampa on the west and Palm River Road on the east. A portion of this length would be at-grade near the future I-4 Connector. The lanes would connect to an at-grade barrier-separated roadway with two reversible lanes in the median between Palm River Road on the west and I-75 on the east. An elevated precast concrete segmental box girder bridge with two reversible lanes would then span I-75 and continue eastward to the new “Brandon Parkway” at TownCenter Boulevard.

The selected alternative using segmental bridges was preferred because it would result in the least economic impact on both the owner and its customers. Because of the commitment of THCEA to its customers and the restrictions of the median width, the costs for design, contingency, mobilization, maintenance-of-traffic operations, construction engineering inspection and construction are lower for a segmental bridge than for a conventional bridge or at-grade roadway. This alternative would cause the least disruption of Expressway traffic during construction and would have the least impact on the environment. It would also preserve the most right-of-way for future capacity, including the ability to construct one future lane in each direction under the bridge. It best reflected the THCEA’s defining values and best fulfilled the THCEA’s public commitments.



Fig. 2 Elevated Segmental Bridge

## **SAVING SPACE**

Maximum the use of space is the key element of the project. Within the existing right-of-way, the number of lanes in each direction will be increased from two to five during peak hours from Downtown Tampa eastward to the west of Palm River Road. Two lanes will be added from Palm River Road eastward to TownCenter Boulevard.

The fact that the traffic is primarily by commuters becomes an advantage because the three additional elevated lanes will be reversible to provide additional capacity in the direction needed. Extreme efficiency arises from the fact that the reversible lanes will provide additional capacity only during times when needed, maximizing the use of at-grade and bridge lanes. 80% of the traffic in the morning peak is traveling westbound, and 75% of the traffic in the evening peak is eastbound. The elevated lanes will be open for cars and express buses only. The existing at-grade lanes will be used by trucks and local traffic.

State-of-the-art technologies such as dynamic message signing and remote systems to activate signals and gates will be used to ensure that drivers do not enter the express lanes traveling in the wrong direction. For further efficiency, an electronic toll collection system called SunPass will be used, allowing motorists to bypass conventional toll-collection booths.

The overall project consists of a combination of at-grade roadway and elevated structures, the segmental bridge lengths of which, going from west-to-east, are given below. Unique and innovative features of the elevated structures will be discussed in the next sections.

- 6837 ft of elevated segmental concrete box girder (3 lanes) from Meridian St. to east of 26<sup>th</sup> St.
- 16,995 ft of elevated segmental concrete box girder (3 lanes) from west of 39<sup>th</sup> St. to east of 78<sup>th</sup> St.
- 3248 ft of elevated segmental concrete box girder (2 lanes) from west of I-75 to west of TownCenter Blvd.

## **THE BRIDGES**

Figg Bridge Engineers, Inc. (FIGG) in Tallahassee, Florida designed the three segmental bridges and three of the overpass bridges along this transportation facility. The remainder of this paper will focus on the three segmental bridges, which have a combined length of 27,080 ft (5.13 miles). The bridges will be precast segmental, post-tensioned concrete box girders. As mentioned, the bridges will be built primarily in the median of the existing Expressway. The bridges contain 196 spans in 49 units and 13 straddle bents, with six abutments and 206 piers.

SUPERSTRUCTURE

The new 2-lane Brandon Parkway Gateway Bridge will span I-75 on the west and will go eastward to TownCenter Boulevard. The bridge will be 47 ft wide, carrying two-12 ft traffic lanes and two-10 ft shoulders. The shape of the box girder is shown in Fig. 3. The two 3-lane Downtown bridges will be 59 ft wide, carrying three-12 ft traffic lanes and two-10 ft shoulders. The box shape will be essentially the same for both the 47 ft wide and the 59 ft wide bridges, except for a 6 ft wing extension on either side, as shown in Fig. 4.

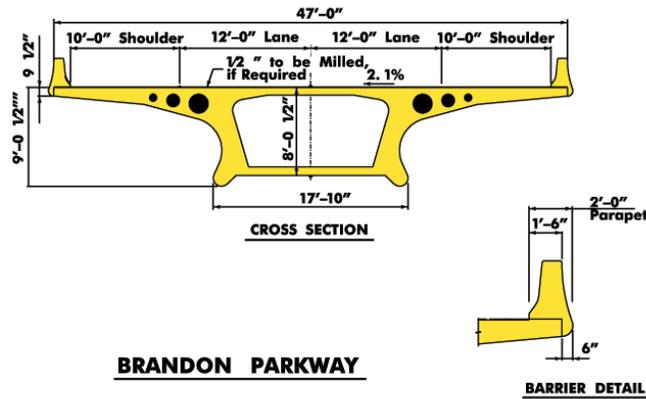


Fig. 3 47 ft. Wide Bridge Deck

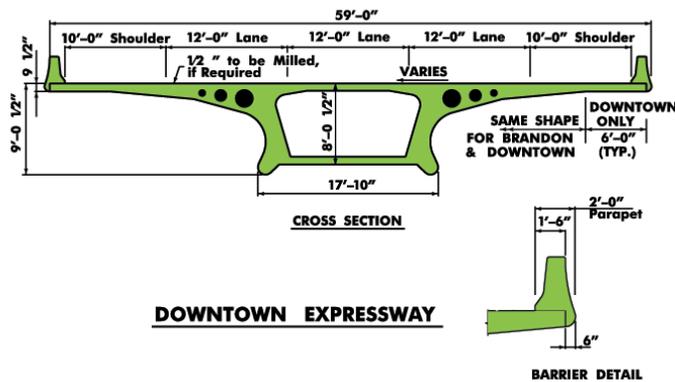


Fig. 4 59 ft. Wide Bridge Deck

The segments are typically 9 ft 4 in., with a few that are 9 ft 0 in. These lengths, along with varying closure joint widths, are combined to produce many different span lengths that are required to provide adequate clearance from roadways and utilities along the five miles of elevated structure. A typical span is shown in Fig. 5. These lengths were chosen, also, because they can be easily transported over roadways. Each 10 ft long pier segment, which is heavier per foot than a typical segment because of the weight of the diaphragm, will be

cast in two 5 ft halves so that the same equipment that is used for the typical segments can be used to lift and place the pier segments.

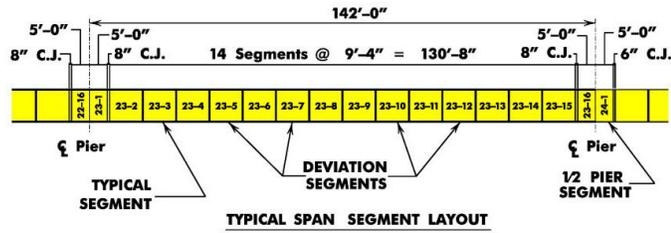


Fig. 5 Typical Span

Continuous units were selected to reduce the number of expansion joints and the quantity of post-tensioning required. Typically, there are four spans per unit. The spans, with a typical length of 142 ft, will use external longitudinal tendons, arranged as illustrated in Fig. 6. The typical (exterior) span has, in each web, four 27 x 0.6 in. strand tendons with a 16 x 0.6 in. strand tendon. Transverse post-tensioning in the top deck will provide for a long-lasting, durable riding surface. Approximately 6.5 million lb of post-tensioning tendons and bars will be used for the 3032 precast segments.

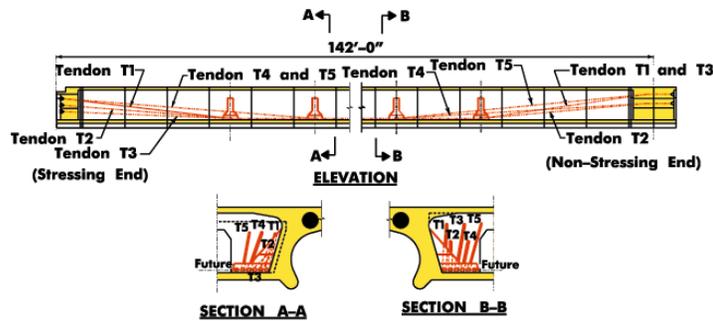


Fig. 6 – Post-Tensioning Layout

SUBSTRUCTURE

The 13 straddle bents, ranging from 75 ft to 111 ft long, will be in the three regions where the bridges cross over the existing Expressway at shallow angles. The straddle bent piers are placed to allow for future expansion of some of the at-grade Expressway lanes. The straddle bents will be post-tensioned and cast-in-place. To minimize their visual impact and the overall height of the structure, they will be 5 ft wide to match the width of the pier and will be the same depth as and integrally connected with the box girder, as illustrated in Fig. 7.

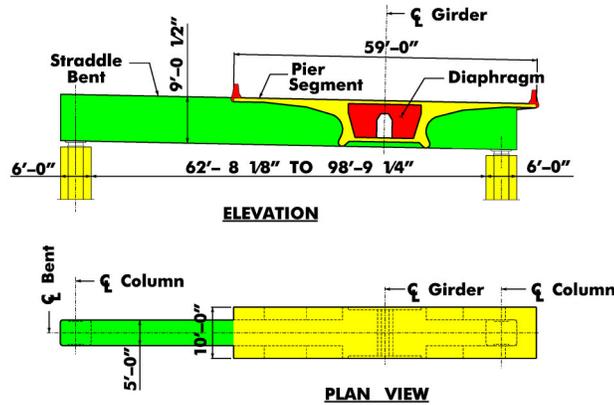


Fig. 7 – Straddle Bent Details

The abutments will each use 3 – 6 ft diameter drilled shafts. The piers will be cast-in-place with either a single 6 ft or 8 ft diameter drilled shaft. The piers, as shown in Fig. 8, have a footprint of 5 ft in the longitudinal direction by 6 ft in the transverse direction. They have a curved flare at the top, with a maximum width of 13ft-8in to approximately match the bottom slab of the box girder and to accommodate the bearings. The curved overhangs at the bottom of the superstructure overhang the top of the pier to hide the bearings and provide a smooth visual appearance between the box girder and the pier. Because of the differing shapes of the piers and drilled shafts, a collar will be built at their junction to provide easier transitioning of the reinforcing steel. The collars can also be used to support the trusses needed for superstructure erection (see Fig. 9).

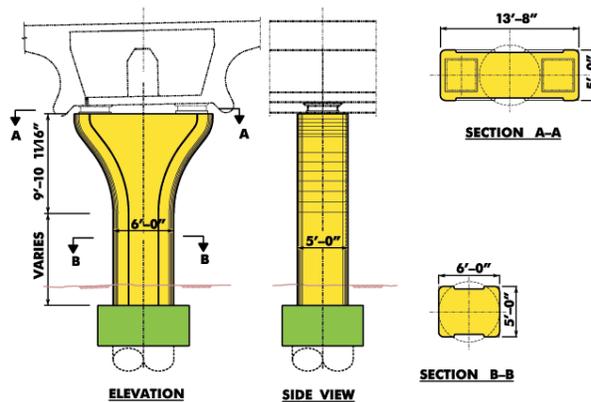


Fig. 8 Typical Pier Details

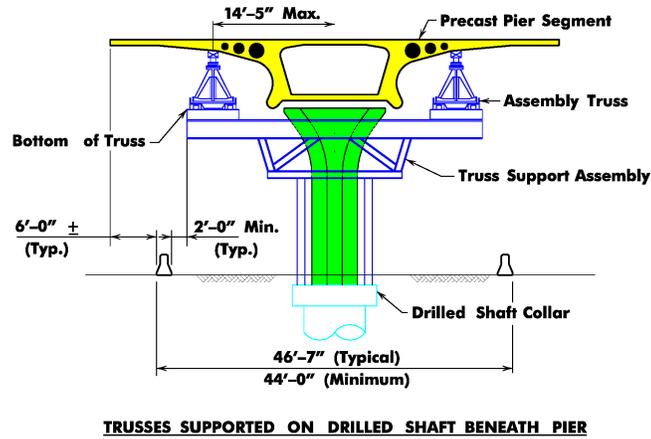


Fig. 9 Typical Superstructure Erection Details

## FOUNDATION

Single 6 ft or 8 ft diameter drilled shafts are used at each pier. This foundation alternative was selected because it results in a small “footprint” on the median. The collar, which is approximately 2 ft below the ground surface, at the top of the drilled shaft is only 8 ft by 9 ft. Constructibility is simplified because excavation, shoring, and dewatering systems that are associated with pile cap construction are eliminated.

Using drilled shafts requires less earthwork and fill material than other types of foundations or at-grade roadway. This will reduce the amount of hauling of materials and will have less impact on roadways. Furthermore, drilling shafts will cause less noise, vibration, and dust than pile foundations or at-grade roadway construction.

## DRAINAGE

The wings of the new bridges will overhang the existing lanes by 6 ft. To prevent drainage from spilling onto the lanes below the bridges, the bridges will have an internal drainage system, which will not be visible from outside. It will be comprised of inlets in the bridge deck, pipes through the wings, and pipes longitudinal to the bridge within the box. The drainage will be piped internally down the piers either to an underground piping system or to be discharged onto the ground.

## THE NEED FOR SPEED

Erection of 196 spans should be completed in approximately 18 months. This can be done using the span-by-span erection method, shown in Fig. 10. This erection method allows for rapid construction even in environments with limited accessibility. The design was developed based on an underslung truss system being used. With this system, the trusses are supported on the foundation or pier system under the wings of the box girder segments. The segments are delivered across the completed structure and placed onto the truss with a crane

mounted on the newly erected bridge deck. The segments on the trusses are supported under each wing of the segment. The underslung trusses will be designed to maintain the vertical clearance for active roadways.



Fig. 10 Span-by-Span Erection

The construction of the bridges over the existing roadways is facilitated through this erection method because the erection procedure can be done from the top with minimal disruption to the active traffic below. The erection equipment will not reduce the minimum vertical clearance over any overlying roadway; the vertical profile of the bridge was not raised to accommodate the erection equipment; and the erection equipment will not close or limit the existing Expressway travel lanes.

Because the new bridges will overhang the existing lanes by 6 ft, as shown in Fig. 9, the main priority of the THCEA is to limit lane closures. With the span-by-span erection method for segmental box girders, the only lane closures that will be necessary will be during placement of segments on the truss. These steps can all be done during the approximate six-hour off-peak period between morning and evening peaks. During peak hours, all lanes will be unobstructed and open to traffic.

#### AESTHETIC FEATURES

The aesthetics of the bridges are a high priority because of their visibility along the length of the project. The shapes of the box girder and piers were developed by FIGG and the THCEA.

The box girder, as shown in Figs. 3 & 4, has a sculpted shape with curves in the webs and on the bottom “corners” of the box. The sculpted shape is carried onto the back face of the traffic barrier where a rounded architectural detail has been added.

The piers, as shown in Fig. 8, are 5 ft in the longitudinal direction by 6 ft in the transverse direction and have rounded corners. They have a curved flare at the top, with a maximum width of 13 ft 8 in. A 3-inch recess along the height of the pier creates visual impact.

The superstructure and barriers will be sealed with a colored sealant, as will the piers and abutments. The recess in each pier will be slightly darker than the rest of the pier to add the appeal of contrast and depth. Feature lighting will be used to illuminate the piers from below the bridge. Light poles will be mounted to the barriers approximately every 200 ft to 240 ft to provide light on the bridge deck. These lights will be highly visible from a distance and will appear as a ribbon of lights to the onlooker.

## INNOVATION

Because of the magnitude and importance of the project, THCEA wanted the selected contractor to have previous experience in segmental construction. At the onset of the project, contractors were invited to submit a prequalification package, which was approved before the contractors were allowed to bid the project. The 11 contractors that prequalified demonstrated that they had experience in precast concrete segmental bridge construction and had completed at least one bridge of this type.

To speed construction, FIGG and THCEA decided to create “construction drawings” for the contractor. These drawings contain all the information that the contractor needs to fabricate the segments and construct the bridges, such as 3-D integrated color drawings of the complex pier segments, expansion joint segments, and deviation segments, as shown in Fig. 11. The plans also contain all bar bend diagrams and rebar dimensions; double-line rebar drawings; locations for drains, conduits, etc.; precasting camber geometry; dimensions for all 3032 segments; PT tendon stressing information; and pipe bend and exit information for approximately 17,000 tendon pipes. Furthermore, the contractor will be given the electronic files of all drawings to expedite shop drawing production.



Fig. 11 3-D Color Integrated Drawing

## THE FUTURE

The bridge segments will be cast with an extra ½ inch of concrete on the top slab so that, when erection is complete, the riding surface can be milled to meet rideability criteria and provide superior rideability. The riding surface is integral with the box so that an asphalt overlay will not be needed for many years to come. Furthermore, the bridge will be extremely durable because the bridge deck is bi-directionally post-tensioned.

The project will serve as a test bed for future advancements in transportation technology. The interior void, shown in Fig. 12, within the superstructure shape provides an ideal location for any testing materials and utility conduits, as well as secure access to these items. The spans will have empty conduits running transverse to the bridge for this purpose.



Fig. 12 Internal Section of Girder

The project allows for easier construction of and access to the I-4 Connector, which is being planned for the future to connect the Expressway to Interstate 4 approximately one mile to the north of the project. In this region, the reversible lanes are being built at-grade so that no elevated ramps or connection to the segmental bridges will be required.

As part of the Tampa-Ybor City revitalization, a track for an electric-powered rail streetcar, which will replicate service provided between downtown Tampa and Ybor City during the early 1900s, is being built alongside 13<sup>th</sup> Street. This is close to the west-end of the project near the segmental bridge abutment and is not affected by the new bridge.

## PROJECT STATUS

The design is complete. The bids have been received and are being evaluated. Estimated time for completion is 30 months.