Highlights	Items
▪ French prototype leads to Skyway design ▪ County employs technology to avoid consequences of deferred maintenance	▪ Continuous girder supported by columns and stays ▪ FRP, Strain Transducers and joint-less, sprayed on membrane (restore capability, seal slabs on grade)

SPANS

Hillsborough County Florida
Bridge Team

The Quarterly Newsletter of Inspired Bridge Technologies — *April 2005, Volume 3*

Sunbeam in the Sky

The original Sunshine Skyway Bridge was brought down when the errant ore carrier Summit Venture collided with the second pier on the downhill side of the south bound structure in a blinding rainstorm on the morning of May 9, 1980. Twenty five years later we now reflect on this somber occasion and recall the replacement scenario.

The water crossing at the mouth of Tampa Bay was bridged in 1954 by the original Sunshine Skyway Bridge. This first, fixed crossing was a 4.1 mile long structure with an 846', main span, steel, cantilevered truss carrying one southbound and one northbound lane of vehicular traffic over the main shipping channel. The sister bridge to the original bridge was added in 1971 paralleling and just a short distance to the east. This second bridge added two more lanes providing two southbound and two northbound lanes with one-way traffic now on each structure.

Three thousand six hundred miles to the east at Brotonne, France there was in existence since 1977 a 1000' span bridge over the River Seine. This bridge was a proven design for a single plane of stays, radiating in a fan pattern from the tops of both pylons, supporting a continuous, segmental concrete box girder.

The decision by Governor Bob Graham, in January, 1981, to replace instead of rebuild saw the consulting firm of Figg & Muller selected for the design. Their Chief Design Engineer was the late Jean Muller whose experience on the

Figure 1: The 14'-8" deep, 4000' long girder spans Tampa Bay's main shipping channel.

Brotonne Bridge is quite evident in his magnificent solution for the new, 1200' main span Sunshine Skyway Bridge (Figure:1).

One feature on all bridges that design engineers must contend with is joints. These features are typically a necessary evil for while they do relieve points of stress concentration they are a costly maintenance problem. Here, the designer chose to eliminate all joints for the main girder. This beam has inelastic supports (columns) at 12 locations on either side of the 1200' main span which itself is supported at 84 anchor points by the stays which function as inelastic as inelastic supports (Figure: 2).

With one plane of stays down the middle of the highway (beam), there is very little torsional resistance offered to the roadway so it is necessary to provide the required rigidity by a cylindrical beam; however, the practicality of this situation dictates a box to ride on. Wings are provided as deck extensions to the box section for additional riding surface. Internally, the box is stiffened by two diagonal struts centered on the bottom of the top slab and reaching to the opposite bottom interior corners. This bracket is located in the center of the typically12'-0'' long segment and has a tie element

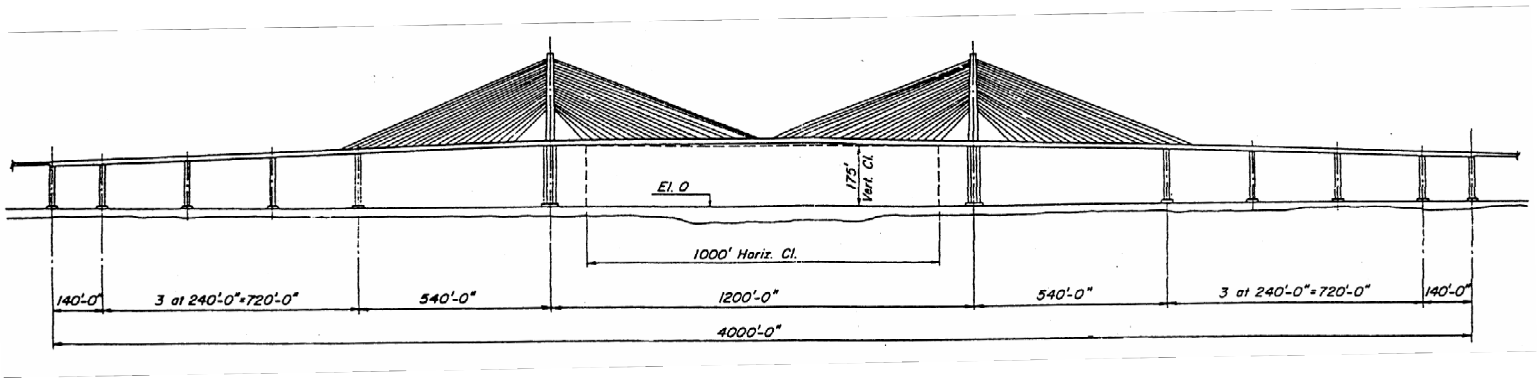

Figure 2: The beam, composed of 330 segments is supported by columns at 12 points and cables at 84 points (inelastic and elastic supports, respectively.)

across the top of the bottom slab that connects these two outward thrusting struts (Figure: 3).

With the piers in place and the towers topped out at 431’ above the water, the segments were barged to the construction site from the pre-casting yard which was in sight of the bridge, at Port Manatee. The eight approach spans, four at each side of the three cable stayed spans, were erected span by span, utilizing a launching truss. The work progressed from each extreme end, north and south, of the virtual 4000’ length of the continuous girder towards the channel span.

Correspondingly, the cable-stayed span segments progressed symmetrically, balanced about each tower reaching to connect to the bracketing approach spans to the north and south. Lastly, the two stayed, 600’ cantilevered halves of the main-span point to each other over this narrow, 13’ plus gap. Subsequently, the final pre-cast, closure segment would rigidly lock the wavering halves into a stable platform for the traveling public. Meanwhile, as an interim measure, a 4’ wide wood walkway with wood handrails was installed to span the gap for the convenience of the contractor.

The author recalls meeting with a local civic official in Tampa and inviting her to tour the bridge before closure. She was somewhat hesitant because she had her 10 year old son with her and he had a cold. I described to him how we would drive up onto the deck and park the car, climb down a ladder to enter the interior of the box girder at the base of the north tower and walk through this lighted tunnel to the open end at mid span. He wanted to go.

He was bundeled with a heavy jacket and not feeling well so I held his hand through-out the tour. As we walked the 600’ to the light at the end of the tunnel, I explained to him what the three inch long, three part, cone shaped steel wedges we found lying randomly on the floor were for. The anchor blocks for the cable stays are located at alternate segments and they project into the top of the box. The stays are attached to a segment on one side of the tower and reach up to the tower and are deviated back down through a nesting saddle in the tower to a symmetrical location on the opposite span, all in one continuous piece.

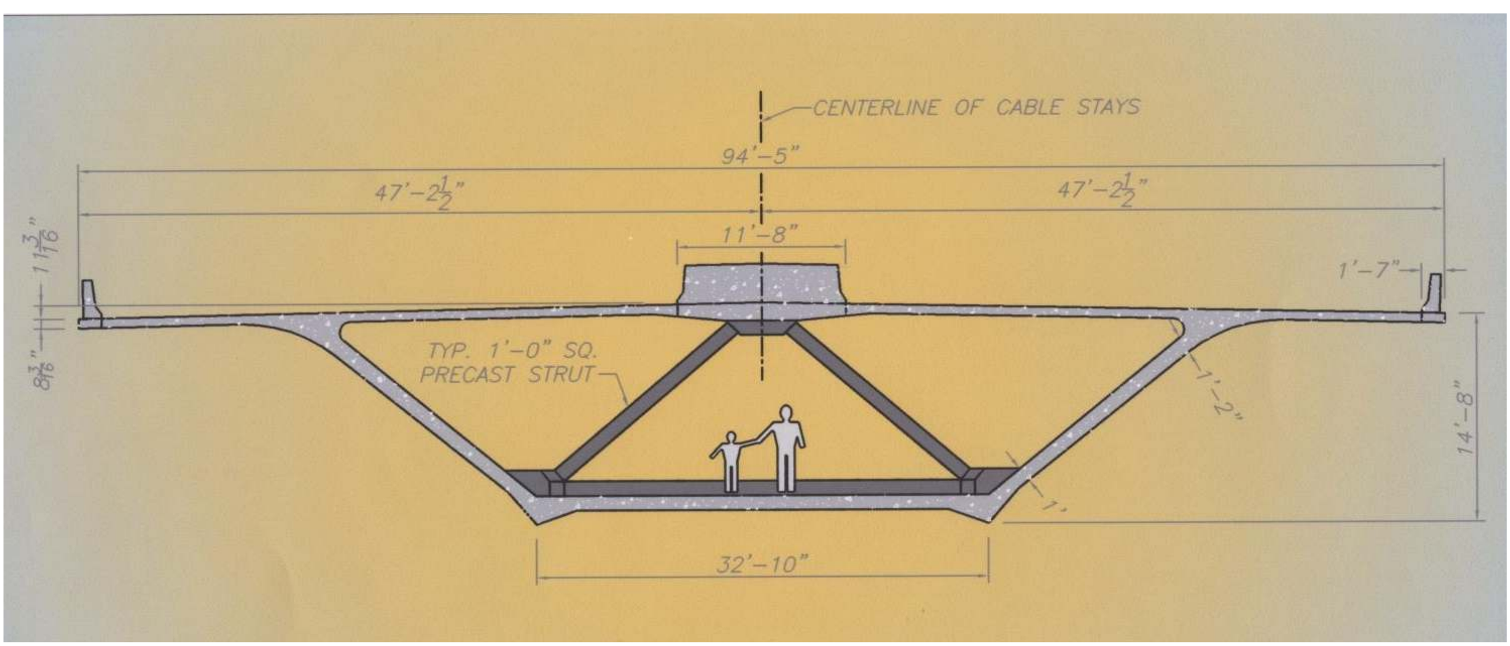

Figure 3: Deck section, near pylon, without cable-stays, carries two 12’ traffic lanes, with shoulders, each way (NB and SB)

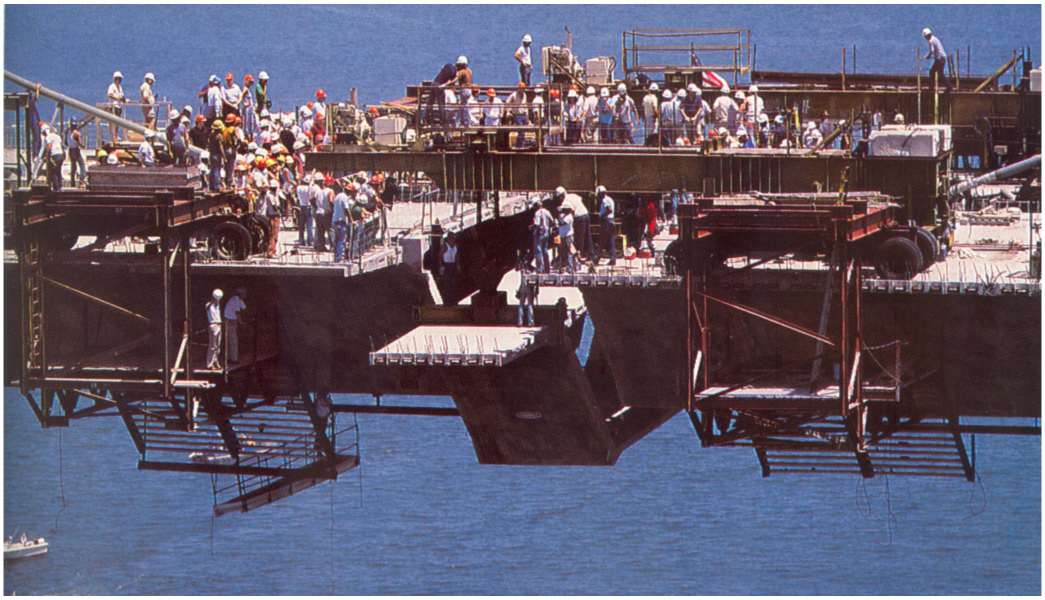

Figure 4: Pre-cast, closure segment with designed 12" gap enlarged to 16.2" with hydraulic jacks for pylon vertical alignment

The tensioning and anchoring of the stays takes place in the box and, apparently, some wedges were left behind. When I told our little friend that they hold up the beam we were walking in he began stopping and collecting them. Before reaching the end of the tunnel, I had to tell him that he could collect a few to take home and show his friends so, he obligingly emptied his jacket of a few pounds of steel billets.

At the mid-span gap we walked out onto the wood walk-way and stopped to gaze down the 180' to the water. Incredibly, as if on cue, we saw a giant tanker plowing through the water on its way to Tampa with tiny crew members waving up at us from the ship's bridge.

When we returned to our vehicles, up on the deck, I think without a prompt from his mom, he came over to me and said he had a good time. I do wonder if this experience has had any impact on his life.

The closure was subsequently completed with the erection of the final pre-cast segment (Figure: 4). By design, a one foot gap remained. The two, 2000' halves were aligned and clamped together with heavy steel brackets inside and out of the box-girder. Jacks were positioned between internal buttresses and the lower bracket and with a force of 4,400 tons expanded the gap by 4.2". Consequently, the pylons (monolithic with the girder) rotated with the beam away from the mid-span and into a final, more vertical position before the concreting of the 16.2" gap between the two halves effected the final, 4000' long, Sunbeam in the Sky.

Investing in Advanced Technologies to Head-Off Deferred Maintenance Consequences

The 2005 American Public Works Association (APWA), Florida Chapter, Annual Meeting and Trade Show was hosted by the West Coast Branch of the APWA in Tampa, Florida from April 18-21. For the Technical Sessions, papers were solicited from members and the Technical Sessions Steering Committee included the above titled paper, among others from Hillsborough County, for presentation.

The Bridge Team has been working for the past three years to adapt, implement and operate state-of-the-art computer software for their Bridge Management System (BMS). Moreover, in an effort to use new, advanced construction technologies to salvage the existing inventory by extending their useful life, we are using the following with success.

Fiber Reinforced Polymers, in an unprecedented initiative, were employed to strengthen bridge #104320, which was in structural distress. This effort was rewarded by having the DOT remove the restrictions on live loads for this bridge. Strain transducers for Live Load testing of our bridges were demonstrated and will be adopted, for they will apparently provide an electronic model of a bridge and virtual loads can verify the structural integrity of the tested bridge. Another promising solution appears to be an applied, flexible, seamless membrane coating that looks to be able to seal slab-on-grade slope protection against water intrusion and subsequent undermining of the bearing substrate.

The Bridge Section has endeavored to create and enhance the management and operational tools necessary to bring this program up to currency in order to provide a small staff with as much leverage as is reasonably possible using their very limited budget.

Guest Commentary

By Bill Krusen

Bridges are like women, they are all shapes and sizes. Holding this thought, as I shift my focus to bridges, I see the narrow, tunnel-like covered bridges of days gone by where they would carry horse drawn carriages and wagons, bicycles, pedestrians and beast of burden over streams and rivers which bisected the countryside. Then my thoughts leap to the grande dame Brooklyn Bridge, designed to carry the same traffic (but more of it) over tall ships navigating New York City's East River with the precedent setting 1600' main span in 1883. And then, we find the world acknowledged Miss Universe of Bridges in San Francisco, the Golden Gate Bridge.

I am not a bridge engineer, nevertheless, my career has been such that I have had the occasion to work closely with their development. Some years ago when I was the Chairman of the Hillsborough County Aviation Authority we had just added the second north-south runway, just west of the existing north-south strip. Unfortunately, the only access to the terminal was the roadway approaching the main terminal building from the south now bracketed by these dual, north-south runways.

As the case may be, an Eastern Airline passenger jet arrived for landing and the pilot lined-up the wrong runway and landed. After the realization sank in that Tampa now had two north-south runways, the plane had to take-off in order to re-land on the other side of the road and get his passengers to their proper gate. This occurrence made it clear that both strips had to be connected by a new taxiway. The only expeditious way this could be done was to bridge the roadway entrance - exit to the main terminal. The bridge had to support the 747 with upwards of 500,000 pounds on its 18 wheeled configuration.

We once owned pastures that are now the City of Tampa, where we built heavy timber bridges. I helped to build these homemade bridges without criteria or engineering designs. We would use these bridges to haul logs out of the swamp and to the sawmill. The trucks with the logs weighed 60,000 to 70,000 pounds. These bridges were there, they stayed there and they worked and that was the extent of my bridge building days.

The Eads bridge in St. Louis spans the Mississippi River and because of my early interest in aviation I recall the story about the flyer who delivered the mail by airplane and he once flew his plane under this bridge. This was quite a feat because the bridge spans were not too much wider than the wingspan of his plane. He did it and survived to later become the first man to fly the Atlantic alone, Charles Lindberg was his name.

That's about all I have to say about bridges and I appreciate being asked to do it.

Guest Commentary reflects the sole opinion of the commentator and is in no way intended to suggest an official County position

Coming Issues:

- The Gibraltar Bridge with computer monitored and actuated wind stabilizing airfoil
- Denmark's Storre Belt Suspension Span

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A Special Thanks to our Guest Commentator Mr. Krusen, long a prominent figure in the Tampa Bay Area; Aviator (23,000hrs), Author ("Flying the Andes"), Benefactor (Tony Janis Society), Businessman and Philantropist

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PASS-IT-ON, Please!