Highlights

- PYLON CONCRETE VOLUME REDUCED TO 1700 CUBIC YARDS WITH 9000 psi CONCRETE
- 157.15' CANTILEVERED ARM REDUCES CABLE-STAYED SPAN REACTIONS ON MAIN PIER

SPANS

Hillsborough County Florida

Public Works Department
Bridge Team

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CONCRETE REPLACES STEEL SUPERSTRUCTURE (on Existing Foundation)

A 1971 rendering depicts E. Lionel Pavlo Engineering's steel, cable-stayed, Phase II for the proposed East Huntington, West Virginia, Ohio River span that connects with Proctorville, Ohio to the immediate north (Figure 1). This scene also includes what was called a Phase I, the interchange in East Huntington that would connect to the existing US Route 60. The West Virginia approaches to this two lane, iconic design are just east of and parallel to the Guyandotte River, which flows into the Ohio River at this point from the south.

A proposed toll booth on the north approach and on-off ramps to the west, over the Guyandotte, leading to and from a connection to US Route 60 are clearly delineated. The Southbound lane is carried down off the South approach, curving westward over the Guyandotte River and connecting to westbound movements on 4th Avenue to 31st Street. Correspondingly, the eastbound traffic on 5th Avenue, US60, swings in a wide loop to the south and curves up and across the Guyandotte and merges down and into the northbound lane of the main span, south approach.

Pavlo's proposal reveals a single pylon, asymmetric cable stayed bridge with the main pier in the middle of the river

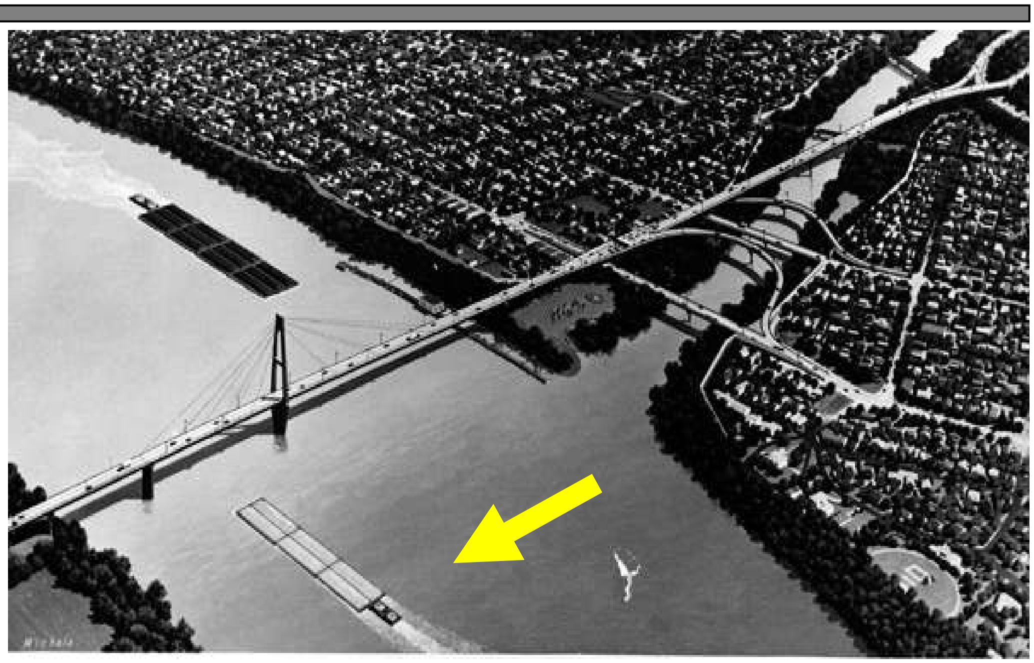

FIGURE 1: Southeast view of original, mid-stream, pylon location for the East Huntington, steel, cable-stayed bridge

providing a clear span to the south shore but, to the north, another intermediate pier was introduced creating smaller back spans. This Federal Highway Administration (FHWA) demonstration program aroused controversy early in 1972 with both the Huntington City Planners, as to the physical location for the bridge, and with the United States Coast Guard (USCG) questioning the horizontal navigational clearances. The ensuing consequences were that the bridge was not physically relocated; however, the main pier positioned in the middle of the river was moved closer to the north riverbank and a land pier, at the river's south bank, was moved 300 feet north into the river to the satisfaction of the USCG (Figure 5).

The concrete alternate, designed by Arvid Grant and Associates of Olympia Washington, and their consultant Dr.Fritz Leonhardt from Stuttgart Germany, was the winning design when bids were opened on May 5, 1981. The relocated, main pylon foundation had been built before the FHWA requirement for alternate material designs and was

FIGURE 2: Ohio shoreline view of the guyed, 278.83' tall concrete pylon atop the 87' high, existing , main river pier.

engineered for a lighter steel bridge. The heavier concrete alternate required special provisions for both the design and the construction phases in order to minimize the tendency to overload the main pier foundation. Despite this requirement, Melbourne Bros. Construction, of North Canton, Ohio and York Russell, Inc. of Toronto, Canada put together the winning concrete bid at, $23,508,051 which was about $10 million less than the low bid for the steel alternate.

The 1,966 feet of structure reaches north from the US 60 connecting ramps in the Phase I part of the project. Span one was the 150.42' of the south arm of the balanced cantilever, segmental box girder from pier 1. Span two was composed of the 150.42', north arm of the pier 1 girder and the 157.15' south arm of the pier 2 cantilever box girder. The 900' main span was a somewhat unusual structural hybrid composed of the 157.15' north arm of the pier 2 balanced cantilever superstructure and the 742.85' of the south, cable stayed, main span girder (Figure 5). The designer's efforts to minimize concrete loading on the main pier are apparent with several measures employed by the Engineers, including: the reduction of cable stayed deck girder slab thickness with closely spaced, transverse, composite steel deck beams (Figure 3). Additionally, the loads on the main pier, from the cable-stayed main span, were minimized by shortening the cable-stayed main span by 157.15' with an independently supported, balanced cantilever arm of a segmental concrete box girder (Figure 5). And, the 1700 cubic yards of concrete contained in the A-Frame, cable-stayed, compression pylon were the smallest volume and least weight attainable by using 9000 PSI, 28 day, high strength concrete.

Further accommodations to fit the concrete alternate onto the existing foundation of the steel alternate included the anticipated, construction scenario. The concrete erection sequence included the addition of the 278.83' pylon to the existing 87 foot tall main river pier. The 275 ton, cable-stayed, pre-cast, deck girder segments were erected alternatively about the main pylon, one side at a time (Figure 4). The unbalanced bending loads that would have been introduced into the main pier foundation by the back and forth deflections of the pylon were greater than for the steel alternate and to mitigate this tendency a temporary forestay and backstay were attached to the pylon-head to reduce this tendency (Figure 2).

Melbourne Bros. hired Contech Consultants Inc. of New York City to perform the construction engineering. The purpose of these services was to precede all major deck girder construction activities with a mathematical analysis that determined a stress and deformation condition for the structure at the completion of construction in conformance with the Contract Documents. These calculations were divided into three parts: Stage Analysis; Cycle Analysis; Camber Calculations and the related development of Casting Curves.

There were two construction stages considered; one was the casting of a single segment (using the long line method) and the other was the erection of each cable-stayed segment.

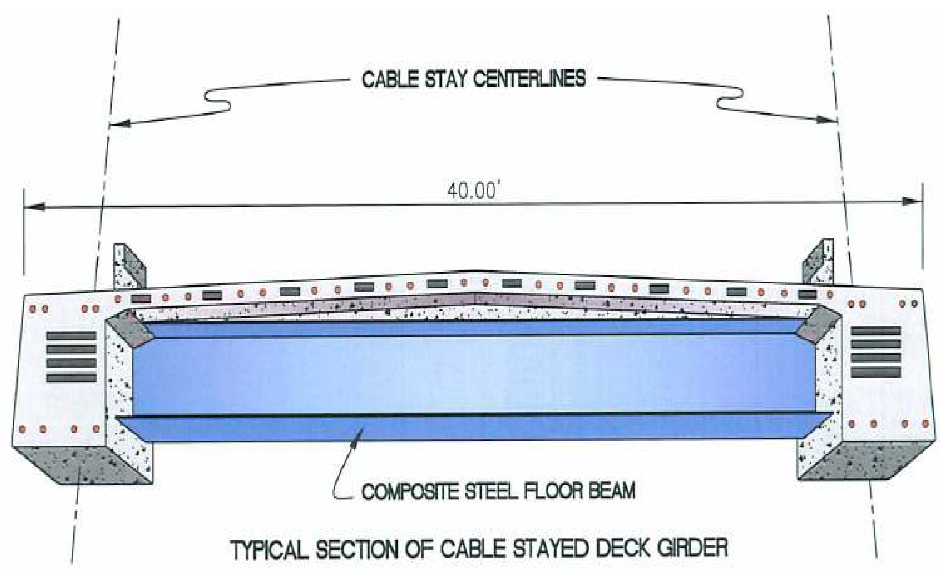

FIGURE 3: Diagram of the composite, steel, deck slab beam

Stage analysis determined the moment and forces at the end of each construction stage. This analysis determined the feasibility of construction and established requirements for cable force adjustments and other construction procedures.

A Construction Cycle consists of the advancement of the form traveler to the leading edge of the cable-stay supported segment. The so called form traveler is a two part, structural steel, clamping devise positioned on top of each edge girder that guides, aligns, and then temporarily holds the new segment 12" off the installed segment in order to allow epoxy application to the two interfacing surfaces before they are drawn together and connected by post tensioning bars. This tongue and groove mechanism has the groove firmly bolted to the fixed element and the tongue is likewise attached to the top of the new, crane supported segment.

This procedure was necessitated because the new segment was installed from a barge mounted crane, floating on a heavily traveled river, which held the new segment against the form traveler until the two stays are attached and stressed to support the front end of the segment. The form traveler supports the back end of the segment through the stay adjustment period and is removed after the segment is firmly post-tensioned to the preceding element.

The 372 tons of cable-stayed steel were installed with tower anchorages in-place first then the deck girder ends had a messenger cable tugging them into position for attachment and stressing at their predetermined locations along the edges of the progressing, cable-stayed deck girder. The 742.85' cable-stayed portion of the hybrid, main span girder is reaching for closure with the pier 2 supported, 157.15', cantilevered arm of the south approach, cast-in-place, segmental, concrete box girder superstructure.

The joining of a roadway structure supported by elastic supports to one with essentially, non-elastic supports is an unusual construction problem. After the last pre-cast segment has been installed, the last stay stressed and both the fore-stay and back-stay removed the connection process begins. Advance the form traveler, as in the typical cycle, for a partial closure pour. Lift the form traveler that is still locked to the stayed girder, shim the ensuing gap and lock the two girders together. Suspend formwork for the first stage of the closure pour from the form traveler and place the concrete. With a series of cable adjustments the formwork for the second phase of the closure is suspended between the stayed girder and the cantilevered girder for the final pour. Then, finally, the form traveler and erection cables are removed and all final cable adjustments made.

William D. Domico, P.E., the West Virginia Bridge Engineer, represented the owner's interests for this first cable stayed bridge built in his state and which was only preceded by two other similar type structures in the contiguous United States when the bridge was dedicated in August, 1985.

FIGURE 4: Barge mounted crane hoists 275 ton, pre-cast concrete, deck segment with alignment tongue in view

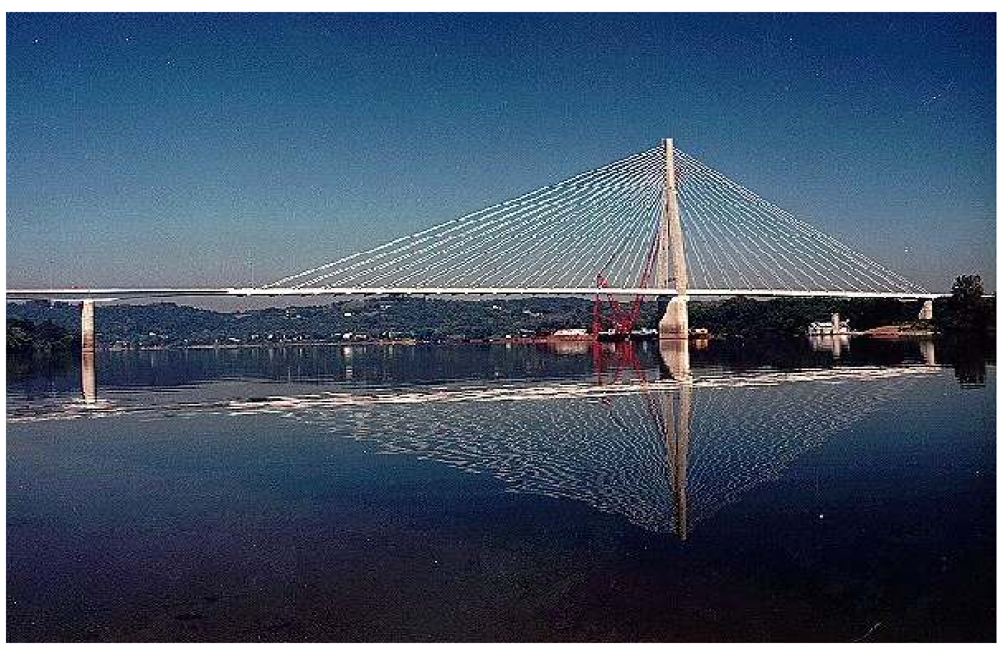

FIGURE 5: The Ohio River reflects east elevation of hybrid , main span girder; pier 2 cantilever (L), cable-stayed (R).

Guest Commentary

By: Charles l. Bosworth

The Skyway is Falling !

On May 9, 1980, the freighter SS Summit Venture collided with the southbound main pier of the Sunshine Skyway Bridge sending over 1200 feet of the bridge into Tampa Bay. Six automobiles and a Greyhound bus fell 150 feet down into the water, killing 35 people. One man survived when his pick-up truck landed on the deck of the Summit Venture before falling into the bay.

The construction of the new and current Skyway Bridge began in 1982 and was completed on February 7, 1987, at the cost of $244 million and was opened to traffic on April 20, 1987.

In 1990 the Florida Department of Transportation awarded the bid to demolish the rest of the bridge which included all steel and concrete sections from the incline up to the span to The Hardaway Company. In 1991 The Hardaway Company formed an Engineering and Management Team consisting of John Brown as the Project Manager and Jacob Apelbaum as the Project Engineer. The scope of the project was to remove all steel girders and all concrete roadway and pilling and place this material offshore and also along the remaining bridge approaches to become artificial reefs for the new planned state fishing park.

Disassembly and demolition began and with it came several difficult engineering challenges that had to be resolved: the order of disassembly, a safe method for detonating charges, and the safe removal of the remaining bridge's main span. A system was developed by the engineering team for a 4 x 1:16 ratio pulley system at all four corners of the main span and it was connected to 4 different 25-ton winches which lowered the steel span down to a waiting barge at a decent rate of up to 30 feet per minute. The whole process took 2 ½ hours to lower the 608 ton segment to the deck of the barge.

When it came time to begin the blasting, a company named C.D.I. (Controlled Demolition Int.) was called in to take on the challenge. Jack Loizeaux began C.D.I. in 1947 but the present owners are his two sons Doug, Mark, and his granddaughter Stacey. C.D.I. is a very well known company in the demolition business and they hold 4 world records for blowing up large structures. During the daily demolition activities, environmental agencies required steps to protect the multitude of marine mammals in the vicinity of the work. The engineering team developed bubble screens, underwater alarm systems, and confinement walls which were used throughout the duration of the job. The effectiveness of these systems was proved by the fact that none of the environmental agencies identified a single marine mammal casualty during the entire demolition process.

Surface crews worked on drilling hundreds of holes for the explosive charges, some holes were as deep as 40 feet. The charges were placed at strategic locations, shot guns were loaded with blanks and fired just before detonation to scare off the birds. The new bridge was shut down to traffic, a count down was given starting from 10 and a sequence of explosions could be heard from across Tampa Bay as blown up pieces of the bridge and piles fell into the water. A crane mounted on a barge then began the painstaking process of dredging up all the concrete and steel, cleaning the rebar off of the concrete and placing the rubble alongside the remaining sections of the old bridge which to this day has created a very popular breeding spot for a multitude of various species of fish. After the demolition was completed, the Hardaway Company then won the bid to construct the North fishing pier. At the end of the fishing piers you will find restrooms, bait and tackle shops and even a snack bar. Rest areas were also constructed at the North and South fishing piers making for an enjoyable day of fishing and relaxing .

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