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# SPANS



Public Works Department

*The Quarterly Newsletter of Inspired Bridge Technologies*

*Volume 1, Issue 2; April 2003*

## ***Space Age Technology Applied to Hillsborough County Bridges***



**FIGURE 1: BLASTED CLEAN**



**FIGURE 2: FORMED**



**FIGURE 3: CONCRETE APPLICATION**



**FIGURE 4: CONCRETE REPLACED**



**FIGURE 5: FIBER APPLICATION**



**FIGURE 6: FIBER PAINTED**

What do the Corvette sports car, the USAF B-2 Stealth Bomber and Hillsborough County Public Works Department’s bridge No. 104320 have in common? Surprisingly, they all use fiber reinforced polymers (FRP), a technology born to the space age. The Corvette body is molded in FRP, the B-2’s shape and strength is only possible because of FRP and bridge No. 104320 has been resurrected due to the FRP reinforcement of its deck beams.

The County’s 241 bridges are composed of eight different structural

types and fully one-third of these are channel beams (Section A, page 2). Starting in the early 60’s and extending into the 80’s, this type of deck was routinely utilized by the County. The beams were sized by certain engineering tables and were shipped directly to the site for installation. Occasionally, during the casting of these structural beam elements when the concrete was cast into the forms, the pour was inadvertently interrupted. When the casting resumed, a surface was created between the old and new concrete.

This surface is commonly called a cold joint and is not a desired characteristic. Apparently, this happened to four of the twelve channel beams on this bridge. The “blasted clean” photo of Figure 1 above shows where the cold joint was, a probable factor in the bottom half of the outboard stem deteriorating over the intervening 37 years. In order to restore the bridge, it was decided to use the FRP technology described above.

A scope and fee were developed and a pre-qualified contractor was issued a work order to do the job. Figures 1 thru 6 vividly show the reconstruction process revealing a totally reconstituted beam in Figure 6. True, the painting of the two exterior beams gives the bridge a new appearance, however, the paint also functions as a UV filter against the penetrating Florida sun.

Before extending this methodology to the remaining 80 channel beam bridges, we had to determine how close the mathematically predicted capacity of the FRP enhanced bridge compared to a controlled, live load application to the same structure. We

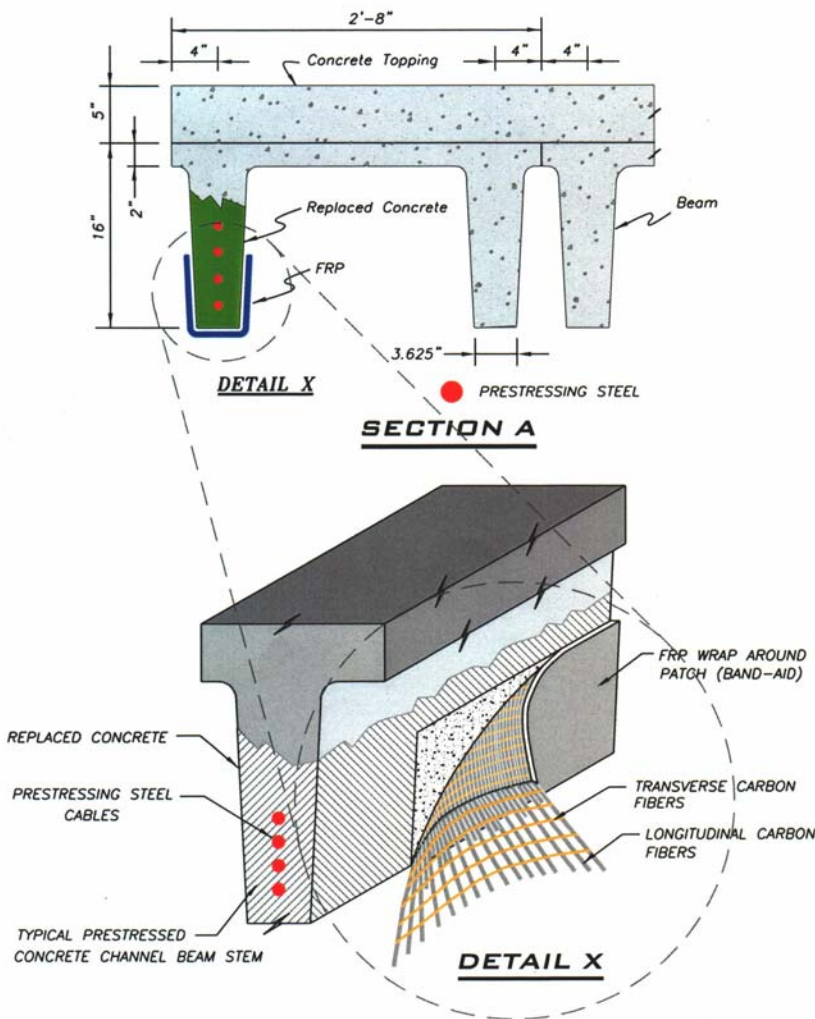
selected a consultant to do this loading and analysis. We required the consultant to closely coordinate his work with the Florida Department of Transportation (FDOT). The tests showed that the lost steel cross section was adequately replaced by the carbon fibers. The FDOT letter addressing these test results states that "all seven standard FDOT trucks can now cross the structure without restriction and no posting is required."

Detail X exaggerates the fiber being peeled off a repaired concrete stem, one of the two stems which compose the channel beam section. These fibers are positioned in a matrix

and held against the concrete with a polymerized paste. These carbon fiber tendons are the size of packaging cord but have a tensile strength of 600,000 pounds per square inch (psi). In comparison, the pre-stressing steel strand, which is replaced here, has a tensile strength of 250,000 psi and a rebar tensile strength of 60,000 psi.

Essentially, this is a structural fabric applied to the beam as a band-aid and as you do with a long sleeve shirt, bending the arm stretches the cloth across the elbow. Similarly, the channel beam flexes under load and the FRP patch takes tension. A critical factor with this procedure is that the contractor and the FRP material supplier must closely coordinate their activities in order to achieve a high quality end product. The concrete surface receiving the FRP cover has to be clean and free of deleterious materials before application and if this is assured, the composite action necessary will be achieved.

We may one day soon employ reinforcing bars made from glass or carbon fibers. Think of it, reinforcing bars stronger and lighter than steel and they do not rust. However, it is difficult to bend the glass or carbon bar, consequently, bends have to be molded and spliced to the straight bars. China has been building rail road bridges with glass and carbon bars for thirty years. Glass and carbon pre-stressing tendons have been under development for twenty years. The difficulty with these materials is the mechanisms of locking off the forces once the tendons have been stressed. Dr. Joseph Plecnek, Professor of Civil Engineering at California State University, Long Beach, has been meeting with success in his efforts to resolve the anchorage problems. So, a considerable story welcomes the County to the world of composite fiber construction.



## LETO HIGH SCHOOL COMPETES IN NATIONAL BRIDGE CONTEST

On February 27, 2003, extending the efforts of Hillsborough County's Outreach Program, the Bridge Team voluntarily responded to the interest expressed by LETO High School and provided a presentation to four drafting classes whose students are participating in the West Point Bridge Design Contest. A Bridge Team representative spoke to the classes about bridges and encouraged his listeners to interrupt with questions. The speaker was impressed by the number and intellectual quality of the questions asked. Subjects discussed varied from a civil engineer's typical salary to the instability of the Tacoma Narrows – Galloping Girdy. Also, the speaker explained to this group of avid listeners the complexities associated with building a bridge using a comparison of the Skyway Bridge's design and construction processes.

Mr. Steve Shettle, the Head of the Industrial Arts Department at LETO High School and teacher of four drafting and design classes, invited the Bridge Team to visit his classes in order to give his students an opportunity to learn more about bridges. In fact, for the first time, LETO High School students have entered the annual West Point Bridge Design Contest, sponsored primarily by the American Society of Civil Engineers (ASCE). The purpose of this competition is to introduce middle and high school students to

the field of engineering through a virtual experience. The winning team in the contest will be awarded a \$15,000 scholarship for each team member, \$5,000 for each second place winning team member, and each team member of the five finalist teams will be awarded a notebook computer.

The contest consists of three stages, the qualifying round (Jan. 11–April 10), the semi-final round (April 26) and the final round, which will take place at the United States Military Academy (USMA) on May 23, 2003.

Throughout the first round of the contest, the teams are encouraged to consult with their teachers and peers. Contestants will only be allowed to consult with each other during the three hour and two hour design time limit of the semi-final and final rounds.

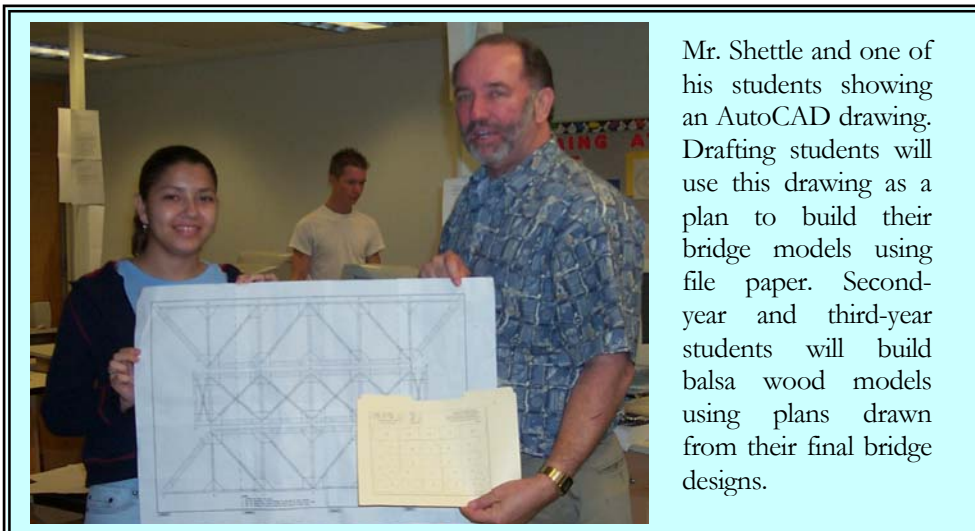
During the qualifying round, contest participants are allowed to submit their evolving virtual designs as they enhance them. Using the *West Point Bridge Designer 2003* software, students have to design their bridges from 58 different configurations. They have control over the type of bridge, the deck length, abutments, and whether they want to use piers as intermediate supports or not. The bridges will be judged based on strength (i.e. they will have to pass the WPBD Load Test) and bridge cost.

Freedom High School, Ben Hill Middle School, and Pierce Middle School students are also participating in the contest; however, LETO High School students represent 76% of Hillsborough County's contestants.

According to Mr. Shettle, this contest experience has had an impressive impact on his students. They seem to be eager to do their work, they are interested, challenged, and are having fun. The contest has encouraged them to work in teams, share ideas, and provided them with a hands-on introduction to the analytical side of technological and engineering design.

In addition to the virtual bridge design, LETO High School students will create a scaled, balsa wood rendition of their final bridge concept which will be displayed in the lobby of the Hillsborough County Center during National Public Works Week (May 19 thru 23).

Hillsborough County is pleased to host the bridge models of this ingenious group of youngsters. Congratulations to all LETO High School contestants and all those who continue efforts to introduce the younger generations to the engineering and technical professions.



Mr. Shettle and one of his students showing an AutoCAD drawing. Drafting students will use this drawing as a plan to build their bridge models using file paper. Second-year and third-year students will build balsa wood models using plans drawn from their final bridge designs.

Rank	Team Name	School
1	shockwave	Leto High School
2	no limit	Leto High School
3	GreenDay	Leto High School
4	BloodLust	Leto High School
5	TRunner	Leto High School
6	Team Leto	Leto High School
7	Truecolorz	Leto High School
8	zEx	Leto High School
9	curefortheitch	Leto High School
10	LarZDeeK	Leto High School

## Guest Commentary

### *Bridges*

*By Mariana Llanso*

*We have a fascination with bridges. This seems especially true of engineers. I remember during a visit from an engineer friend who lives abroad, having to cross the Sunshine Skyway five times in order to take pictures from e-v-e-r-y angle! The people at the toll plaza must have thought we were crazy. I also have a vivid memory from when I was ten years old, of driving across the bridge that spans the mouth of The Chesapeake Bay over water sometimes 100 ft deep, and my father (an engineer) marveling non-stop for the approximately one hour it took to cross, while my five siblings and I shared his enthusiasm for that wonderful creation of man.*

*In May, we will celebrate National Public Works Week, Stormwater Section will hold its Third Annual Art & Essay Contest for elementary school students. The theme for this year's contest, announced in February, is bridges. Kids from all county elementary schools are already submitting their art and essays, giving us interesting and creative perspectives on bridges. We look forward to selecting the winners with the experts of our Bridge Team.*

*This month, the Bridge Team honored me as Spans' guest commentator. I do not believe in coincidences, and therefore, decided it was the right time to meditate on bridges. Since I am not an engineer, you may immediately rest assured that a technical or structural dissertation does not follow.*

*So, what comes to mind when I think of bridges? The word itself is magnificent. It brings images of bonding, joining, togetherness, and brotherhood to mind. I think about how in this microcosm of society that is Hillsborough County government, we have been so completely blessed with opportunities to build bridges. We have an opportunity to build bridges among the diverse characters and cultures that make up our staff, and to build bridges between government and the citizens we serve. The basic building block for erecting these types of bridges is communication. Reaching out to those within our organization gives everyone an opportunity to become familiar with our work. Through communication, where we are informed of each others tasks and functions, and where we understand the processes that interact within government, we are provided with the necessary tools to address citizen concerns in an effective and efficient manner.*

*A bridge also symbolizes a transition or transformation. The Latin translation for bridges is *pontos*. It also means the path. I think about the DESS Bridge Team and the symbolic bridge they have built by working as a team to put this newsletter together. The span continues to extend as this team reaches out to their teammates throughout Hillsborough County government to join them in their labor of love. Building bridges of communication is truly the path to excellence in public service.*

### **Coming Issues:**

- Topical Issues
- Description of County's 241 Bridges
- A profile of the 1926 Platt Street Twin Bascule Bridge
- A Profile of the 1926 Columbus Drive Swing Span Bridge
- Streetcars and Bridges

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Our Special Thanks extend to Mr. Steve Shettle and LETO High School for letting us visit their drafting classes, take pictures and interview students.

