Blue Ridge Parkway Viaduct around Grandfather Mountain, North Carolina

FIGG Envisions Concrete FUTURE

By Craig A. Shutt

FIGG has designed three of the five bridges to receive the Presidential Award for Design Excellence. One is the Sunshine Skyway Bridge across Tampa Bay, Florida.

Figg Engineering Group (FIGG) has become well known for its dramatic use of concrete to expand the material's capabilities and create distinctive structures. Its designs for a variety of concrete segmental bridges throughout America have shown that concrete's full capabilities are still being developed. The material's future, much like FIGG's own, is even brighter than its past has been, says the company's leader.

"The future of concrete segmental bridges is bright," says Linda Figg, President and CEO of the firm. "It provides the most cost-effective alternative for owners and offers great advantages in construction efficiency, durability, design innovation, and aesthetics." A majority of the company's bridge designs today feature concrete segmental components, she notes. "We are known as the leader in concrete segmental bridges and have designed more concrete cable-stayed bridges that have been built in the United States than any other firm."

The key to success since Gene Figg opened the firm's doors in 1978 has been to embrace concrete and fully use its capabilities. "The FIGG companies began with a vision and commitment to exclusively specialize in bridges," notes Figg. "Our vision continues, as we extend proven technology, especially in segmental and cable-supported bridges, to create better bridges for the future. We combine functionality with distinction and constructability with aesthetic appeal, to create bridges that celebrate the connections between people and provide an uplifting visual experience."

The firm has grown right along with advances in concrete, she notes, and has helped spur those improvements as well. "When we opened, we began introducing concrete segmental bridges to the United States, particularly for medium- and long-span bridges, which prior to then had been constructed mostly with steel." That growth was aided by the Federal Highway Administration requiring competition of materials, she notes. "By creating the availability of alternative design concepts, they opened the door to better and more cost-efficient designs. That competition, in turn, drove the steel industry to be more economical, too, benefiting everyone."

The demand has grown since then, she adds. "Over the last 15 years, interest in signature bridges has greatly increased. The pleasing aesthetics of our designs and the public-design charette process we developed have allowed us to help many communities achieve their vision for a world-class structure. Concrete is the preferred material for creating bridges that express themes with various shapes and aesthetic features."

Linda Figg has been a strong participant in the company's growth, joining

Bridge specialty firm creates dramatic concrete landmarks and expects 'revolutionary' nature of material to bring even more advances

The Natchez Trace Parkway Arches, Tennessee. All photos in this article courtesy of FIGG

her father's firm just four years after it opened, following her graduation from Auburn University with a civil engineering degree. Figg worked with her father for 20 years before being named President/CEO in March 2002. She was responsible for operating the company for the previous 10 years, helping their team of bridge specialists create many bridge firsts and industry records.

Timeless Works of Art

"FIGG's designs are a decisive demonstration of the constructability, efficiency, and economy of precast concrete segmental construction," she says. Our engineers pride themselves on the fact that they are "as focused on aesthetic achievement as they are on cost- and time-saving innovations." Throughout the years, she notes, "our vision has been to create bridges as timeless works of art that reflect the natural environment and the spirit of the community they serve."

Use of concrete continues to increase, she adds. "Owners are very focused on economy and long-term value today. They want structures that will last 150-plus years. Life-cycle costs are very important. As a result, concrete is a very attractive material for owners." Concrete segmental bridges in particular offer a number of benefits to owners in addition to initial economy and life-cycle costs, she stresses. "The majority of the bridges we design are concrete, because our customers recognize the many benefits of the material."

Among the key benefits is the ease and economy of long-term maintenance, particularly in coastal environments and restrictive sites. Concrete's durability and low-maintenance features make it an attractive choice for many owners. "Concrete segmental bridges have repeatedly proven their strength and endurance when tested by extreme natural forces," she says.

A number of the company's bridges built in sensitive locations around the Gulf Coast and East Coast have been the proof. They include the Dauphin Island Bridge near Mobile, Alabama, which won a Precast/Prestressed Concrete Institute (PCI) Design Award in 1983, and the Varina Enon Bridge over the James River in Richmond, Virginia, which was named one of the "12 Most Spectacular Bridges in America in 1995" by the American Council of Engineering Companies. Both have survived extreme weather events, as have all FIGG designed bridges along the southeastern U.S. and Gulf coasts during the recent severe hurricane seasons, Figg notes.

A History of Awards

With numerous "signature" bridges to its credit throughout America, FIGG focuses as much attention on aesthetic achievement as on cost- and time-saving innovations. "Our vision is to create bridges as timeless works of art that reflect the natural environment and the spirit of the communities they serve," says President/CEO Linda Figg.

In testament to that approach, FIGG's bridges have earned more than 250 awards, including three of the five bridges that have been honored with the Presidential Award for Design Excellence through the National Endowment for the Arts: The Sunshine Skyway Bridge across Tampa Bay, Florida; the Blue Ridge Parkway Viaduct around Grandfather Mountain, North Carolina; and the Natchez Trace Parkway Arches in Tennessee. All three are precast concrete segmental bridges.

In 2006, *Roads & Bridges* magazine named their top 25 bridges of all time, which included six designed by FIGG. Only 14 of the projects named were designed since 1978, when FIGG opened its doors.

Tex Hall, Chairman of the Mandan, Hidatsa and Arikara Nation, at the Four Bears Bridge dedication.

Two members of the Three Affiliated Tribes pose with a Four Bears Bridge sidewalk monument (Below Right).

'Over the last 15 years, interest in signature bridges has greatly increased.'

The Four Bears Bridge in North Dakota, a 15-span precast concrete segmental bridge in North Dakota, celebrates the culture of the local Three Affiliated Tribes. The project was the first in the state to use post-tensioned precast concrete segmental construction (Main Photo).

Four Bears Bridge symbol at pier (Inset Photo).

Four Bears Bridge

A recent example of a design that combines functionality with strong aesthetics is the Four Bears Bridge at Fort Berthold Indian Reservation in North Dakota. The 4500-ft-long bridge was designed to celebrate the culture and history of the Three Affiliated Tribes, while meeting highly functional needs as the primary crossing point of Lake Sakakawea. The bridge serves as a replacement structure for a historically significant bridge, and the new design had to reflect the local culture and be in context with the site.

The variable depth, precast concrete, segmental bridge features 15 spans, typically 316 ft long. The bridge was constructed using the balanced cantilever method. Cranes mounted on barges lifted the pier segments. Two beam and winch travelers lifted the other segments. The abutments connect to the superstructure via an expansion joint on each end, the only such joints in the bridge. The structure was aesthetically connected to the local area through symbols along the bridge's pedestrian walkways. Cultural symbols are showcased on the exterior sides of the spans above the piers, and these were highlighted with accent lighting to create nighttime aesthetics.

The bridge, the largest ever in North Dakota, was the first in the state to use post-tensioned, precast concrete segmental construction. It opened to traffic in September 2005, and in its first year of operation, received nine awards from state and national groups.

Span Lengths Increase

As materials and construction technologies have advanced, so have the lengths that precast concrete segmental main spans can achieve using the balanced cantilever method, Figg notes. The company continues to expand its use of this design through projects such as the Sagadahoc Bridge in Maine. Finished in 2000, it features a main span of 420 ft consisting of two-cell precast box girder segments. Its length surpassed the 400-ft U.S. record previously set by the Dauphin Island Bridge, and that record was broken again in 2004 with the Victory Bridge in New Jersey.

The Victory Bridge, a 3971-ft-long, $109-million structure, features a fully match-cast precast concrete main span of 440 ft with side spans of 330 ft each. The bridge carries traffic 110 ft above the Raritan River between Perth Amboy and Sayreville, replacing a 1927 steel-swing bridge. To expedite construction, the approach spans were erected using the span-by-span method simultaneously with the balanced cantilever main span. Precast piers up to 100 ft in height were erected in one day. The first of the twin structures was opened to traffic in only 15 months, with the second structure erected in just nine months. The project has received 13 awards for innovation, quality, and aesthetics.

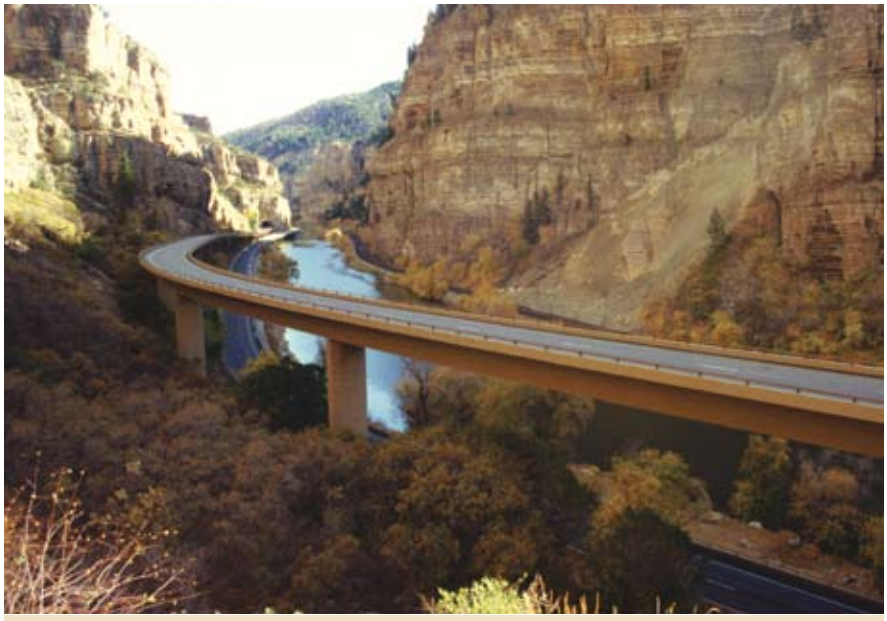
Concrete Offers Environmental Sensitivity

Environmentally sensitive areas are easily addressed by concrete segmental bridges, Figg says. This capability has become more prized in recent years, as communities focus on maintaining the beauty of their areas, as they realize how long it can take for the natural environment to bounce back if damaged during construction.

An example of this type of environmentally sensitive construction can be seen in the I-70 Hanging Lake Viaduct completed in Glenwood Canyon, Colorado. The viaduct carries the highway across the Colorado River through a narrow portion of the canyon. FIGG's design, developed for efficient construction to meet the challenging site conditions, resulted in the $34-million bridge being completed 5 months ahead of schedule.

Concrete segmental bridges have repeatedly proven their versatility during construction in environmentally sensitive areas.

The design focused on preserving the sensitive environment of the canyon, Figg explains. An overhead gantry was used to construct 8429 linear feet of precast concrete segmental bridges in balanced cantilever, with typical 200-ft-long spans that extended to 300 ft over the Colorado River. The firm's use of temporary straddle bents allowed work to continue over active traffic on U.S. Route 6, which flowed a few dozen feet beneath the construction. Once all traffic moved to the new elevated structure, permanent piers were centered under it, and the temporary bents were removed to create consistency of appearance for the bridges.



Design for the I-70 Hanging Lake Viaduct in Glenwood Canyon, Colorado, minimized its impact on the environment by using an overhead gantry to erect the precast concrete segments. Traffic continued beneath the construction until the project was completed.

More on FIGG

FIGG's design of the Pennsylvania Turnpike's bridge over the Susquehanna River is featured on page 34 of this issue of *ASPIRE*.™

The firm's design for the Penobscot Narrows Bridge & Observatory in Maine was featured in the Winter 2007 issue. FIGG also designed the concrete cable-stayed spans of the Leonard P. Zakim Bunker Hill Bridge, over the Charles River in Boston that was featured in the HNTB profile in the Winter 2007 issue. Both articles can be viewed at www.aspirebridge.org.

To learn more about other bridges FIGG has completed, visit www.figgbridge.com.

The design for the Lee Roy Selmon Crosstown Expressway in Tampa, Florida, shows the capabilities for concrete designs in tight urban spaces. Three reversible lanes were erected span by span in the highway's median using single piers only 6 ft wide at the base.
Photo: FIGG

Concrete bridges can be adapted to meet the community's vision.

Urban Designs Proliferate

The urban environment also can be handled easily with precast concrete segmental designs, Figg notes. "Precast concrete offers a significant and growing competitive advantage through its ability to be constructed in congested urban corridors, with erection next to and over traffic, while keeping traffic moving," she says.

One of the most dramatic examples of what can be achieved even with highly restrictive access is the recent work on the Lee Roy Selmon Crosstown Expressway in Tampa, Florida. Three reversible lanes were erected span-by-span within the median of the highway on single piers only 6 ft wide at the base. The 5.13-mile-long bridge, which opened this past July, more than doubled the tollway's capacity within the existing right of way, while maintaining essential traffic.

"Aesthetics on the new bridge were planned to provide drivers on the existing lanes with a pleasing visual experience," Figg notes. During the planning phases, the Tampa Hillsborough Expressway Authority stressed to the public that aesthetics would be a key criterion. "The project received overwhelming support, largely based on the commitment that the project would be attractive," she says.

The result was a bridge with curved superstructure box girders, curved tapering piers, and typical open spans of 142 ft that were erected in as little as 2½ days. A concrete sealer was used to add a uniform color in keeping with the site. "As a 'sculpture in the sky,' the colors reflect soft hues of the sky," Figg explains.

Transit Projects Expand

Transit projects of all types are proliferating, she notes. FIGG designed the first precast concrete segmental bridge for use in mass transit for MARTA in Atlanta, Georgia, in the early 1980s. One of the most recent prominent projects is Airtrain JFK, the shuttle train to and around JFK International Airport in Jamaica, New York. The 9-mile-long bridge included constructing 12,144 linear ft of bridge in the median of the Van Wyck Expressway in just 11 months. Construction took place while 160,000 vehicles passed by each day.

Span-by-span construction was used for

Precast concrete offers a significant advantage through its ability to be constructed in congested urban corridors.

90 percent of the project, with balanced cantilever construction used for tight horizontal curves or where span lengths were longer. The project comprised 5409 precast concrete segments, the most for any segmental bridge in the United States. Span lengths ranged from 51 to 150 ft, with a typical length of 125 ft. The entire 9-mile superstructure was erected in 20 months—and was completed two months ahead of schedule. The project later won the prestigious Dr. W. W. Hay Award for Excellence from the American Railway Engineering & Maintenance of Way Association, along with a dozen other honors and awards.

Cable-Stayed Designs

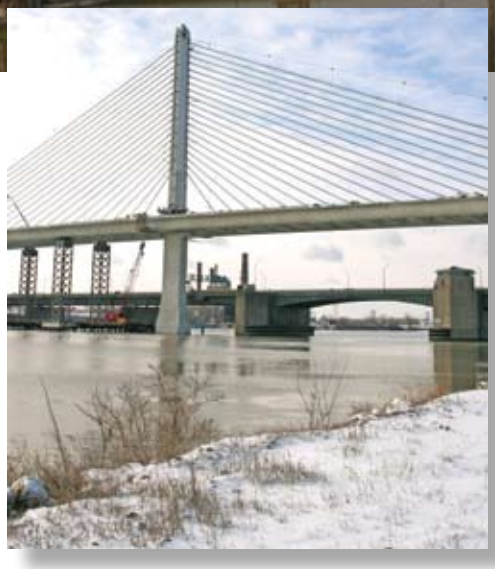
Concrete bridges continue to offer innovative applications that stretch the material in new directions, and that can be seen in the growth of cable-stayed bridges, Figg says. The I-280 Veterans' Glass City Skyway being constructed in Toledo, Ohio, she notes, "offers an outstanding illustration of innovation in precast concrete segmental bridges."

The unique cable-stayed structure carries I-280 over the Maumee River. The top 196 ft of the 404-ft-tall pylon features four sides of specially engineered glass with concrete, which will be illuminated by internal LED lights to produce a spectrum of vivid colors. The aesthetic feature was selected by community participants in design workshops as a tribute to the area's glass manufacturing history.

To create the slender concrete pylon shape and use a single plane of stays as desired by the community representatives, designers created and patented a cradle system that carries the stays through the pylon, eliminating the need for anchorages in the pylon. The cradle simplified construction while providing the opportunity for selective removal, inspection, and replacement of stays throughout the life of the bridge, even as the bridge carries traffic. The cradle also allows for stays to be larger than previously used on cable-stayed bridges. The largest stays on the project are an increase of 70 percent and use 156 strands—the largest in the world.

The bridge design also relies on precast delta frames, weighing up to 87.5 tons. They are placed in the box girders to transfer the weight of the superstructure to the single plane of stays. The bridge features a single pylon, with twin 612-ft-long, cable-stayed spans on either side.

A 9-mile-long bridge was erected in the median of an expressway for Airtrain JFK in just 20 months. The bridge features the most precast concrete segments (5409) of any segmental bridge in the United States.



The new Veterans' Glass City Skyway in Toledo, Ohio, is a cable-stayed structure that features an illuminated pylon and an innovative cradle system that carries the stays through the pylon, eliminating the need for anchorages in the pylon.

Community involvement, as seen in a number of these projects, has been enhanced by the creation of FIGG's Bridge Design Charette™ process, which engages owners and the public in selecting features. Between 20 and 100 community participants meet for a day to cover possible solutions, and then vote their preferences. Various key topics are presented by the designers, with multiple options offered. The participants score their preferences, and FIGG's designers use these for inspiration in capturing the local vision for the aesthetics.

Such local involvement is only one of the growing needs that owners have for ensuring they create functional, economical, and community-pleasing projects. "Bridge owners have always needed, and will continue to need, bridges that are economical and quickly constructed with minimal traffic disruption and sustainability for a 150-year-plus service life," says Figg. "Concrete bridges offer all those benefits, plus each bridge can be adapted to meet the community's vision."

Owner's needs have definitely expanded, she adds. "The biggest challenge today is the current construction market, which is characterized by a shortage of contractors that want to build large bridge projects, along with higher material prices." The ability of precast concrete to create repetitive shapes in an economic fashion meets the need for constructible details.

"When those designs are used, more local contractors with the knowledge of regional labor and materials markets can participate in major bridge projects," she says. "This increases competition and reduces construction costs." A recent example is the cable-stayed Penobscot Narrows Bridge & Observatory in Maine, which was highlighted in the Winter 2007 issue of *ASPIRE*.™ "Even though neither contractor in the joint venture previously had built a cable-stayed bridge, they successfully completed the concrete segmental bridge, with a 1161-ft-long main span on time."

Figg expects to see such an expansion of the market continue, with FIGG being an industry leader. "More than any other construction type, concrete segmental bridges provide an unequaled opportunity to marry engineering and art, the utilitarian and ethereal, and the intellect with the human spirit," she says. "The fruit of such unions are elegant, functional sculptures that inspire universal feelings of awe and pride."

For more information on these or other projects, visit www.aspirebridge.org.

30th pti ANNIVERSARY

PTI's Bridge Activities

Established in 1976, the Post-Tensioning Institute (PTI) is recognized as the worldwide authority on post-tensioning and is dedicated to expanding post-tensioning applications through marketing, education, research, teamwork, and code development while advancing the quality, safety, efficiency, profitability, and use of post-tensioning systems.

PTI's bridge activities include:

- *6th Edition of the Post-Tensioning Manual*—this major update includes two new chapters on bridges and stay cables.
- *Grouting Specification*—developed by PTI's Grouting Committee, this new specification represents a major advance in post-tensioned construction.
- *Recommendations for Stay Cable Design, Testing and Installation*—these recommendations serve as the standard for cable-stayed bridge construction around the world.
- *Certification – Bonded Tendon Installation*—this comprehensive training and certification program is intended for all field personnel involved in the installation of bonded post-tensioning, including installers, inspectors, and construction managers.

The *PT Journal* is published semiannually and often includes papers on durability and bridge design. PTI also sponsors an annual technical conference to showcase the latest in post-tensioning technology. The next conference will held in Miami, Florida, on May 6-8, 2007.

For more information on PTI, please visit www.post-tensioning.org.