CONCRETE PHILOSOPHY DRIVES Janssen & Spaans

by Craig A. Shutt

JSE worked under a design-build format to create the design for the Des Plaines River Valley Bridge on I-355 in Lemont, Ill. The bridge features a combination of 18 spans with simple pretensioned concrete beams and 17 spans with post-tensioned spliced girders over its 1.3-mile length. Photos: Illinois State Toll Highway Authority.

Whether bread-and-butter bridges or long, complex structures and projects, concrete designs offer the best alternative

In its nearly 30 years of operation, Janssen & Spaans Engineering Inc. (JSE) has created designs for a multitude of bridges, including some highly complex ones that have become its forte. Throughout that history, it has found one maxim to be true: Properly designed, a concrete bridge will outlast, outperform, and underbid any alternative.

"Every time we perform cost-alternate studies or work on design-build projects with contractors estimating construction costs, we find that concrete superstructures are consistently more economical than the corresponding steel superstructure alternates." says Leo Spaans, founder and co-owner of Indianapolis-based JSE. "In addition to the upfront construction cost savings of concrete over steel, we have witnessed continued cost savings throughout the life of these structures. These savings result from lower maintenance requirements of concrete structures and better long-term durability."

Over the years, this conclusion has been confirmed by a number of projects in which alternative designs were prepared. An example is the preparatory work completed for the Des Plaines River Valley Bridge on I-355 in Lemont, Ill. Created under a performance-based specification, the structure features 18 spans with simple precast, pretensioned concrete beams and 17 spans with post-tensioned spliced girders over its 1.3-mile length. The $125-million project, which includes 612 girders using three different depths, needed this combined approach to efficiently place piers in a complex terrain. (For more on this project, see the Spring 2008 issue of *ASPIRE*.™)

JSE created this option along with a steel-plate girder alternative, using two design teams that each presented their approach to the contractor, Walsh Construction Group in Chicago. "Walsh did the calculations and added up all the costs and chose the concrete design," Spaans says. "They made the choice based on the bottom line."

Close Relations with Contractors

JSE works closely with contractors, especially when they are using their preferred delivery method, design-build. "We love the design-build system," he says. "It helps create a level of freedom that permits us to be as efficient as possible. We like working closely with contractors. They're only interested in being efficient and in constructing the best design possible."

A recent example is the U.S. Route 460 Connector project in Buchanan County, Va., for which JSE provided design-build engineering services. The 1733-ft-long, six-span twin segmental box-girder bridge features two main spans of 489 ft with the box varying from 31 ft to 12 ft 6 in. in depth. The bridge is supported by H-shaped concrete columns with a maximum pier height of 220 ft, the tallest bridge piers in the state. The construction cost for JSE's design beat the next closest option by $3 million, on top of being the most responsive bid, based on the bids being weighted for technical proposal scores.

JSE designers relish the discussions that hone the final creation to make it as efficient as the talents of both sides will allow. "The contractors take our ideas, directly translate them into reality and give us feedback," he says. "It's a very interactive process with good give and take." Typically, weekly meetings are held as the project gets underway, to learn how smoothly the two groups will work and how close their visions of the final design are.

The effectiveness that this process provides when compared to the typical design-bid-build process can be striking, he adds. "When we are designing without having any idea who the contractor will be, we need to create engineering drawings that everyone can bid on. That lack of interaction keeps it from being as effective as possible and playing to the individual contractor's own skills." Value-engineering processes can follow, but those steps occur after the bidding and add time. "Design-build speeds up the process greatly."

Speed is Key Goal

The need for speed is a major ingredient in owners' goals today, he notes. Owners want projects completed faster to bring them online quicker and to have construction disrupt events for a shorter period, reducing user costs and increasing worker safety. The firm's work on the I-70 project in Indianapolis, Ind., shows the dramatic improvements that can be made in construction speed with a design-build process.

The $175-million project replaced all roadways and upgraded 23 bridges along a 6-mile stretch of highway. Two new bridges were constructed with precast, prestressed concrete I-beams—a design, he notes, that "is almost impossible to beat." The entire project took only 10 months, compared to an estimated 2-year process for a traditional design-bid-build project. JSE took 3 months to create the drawings and then dealt with construction issues for the remaining 7 months. "This approach saved a tremendous amount of time."

The success of this approach can be seen in the company's own projects in Indiana. JSE has a 70% success rate in winning projects that it proposes with a design-build delivery method, he says. "We've been extremely successful with it in Indiana, because it saves a tremendous amount of time."

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The $175-million "Super 70" bridge project in Indianapolis involves revamping 6 miles of I-70, comprising all roadway and 23 bridges. In addition, two new bridges were constructed with precast, prestressed concrete I-beams. The design-build project was completed in only 10 months. Photo: © 1800TOPSITE.com.

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New Partnerships Forming

The company also has been gaining success with public-private partnerships, which it sees growing as government agencies want to gain additional funding and private entities gain benefits from operating the roadway. One such project is currently underway in one of Canada's western provinces, where the roadway and 35 bridges (90% of them proposed to be constructed with prestressed concrete I-beams) are being improved. The $1-billion project is being funded by a private group, which will build and then maintain the highway.

"The owners are demanding anything possible to prolong life, because they are responsible for maintenance," he says. "These private entities understand that to keep the project profitable, the owner must look long term and account for all expenses throughout the structure's service life."

One way to lower maintenance and increase durability is using a concrete mix containing fly ash and a high-range, water-reducing admixture. These mixtures achieve high compressive strengths and have a low permeability. Additionally for deck protection, some owners are specifying an overlay of silica fume concrete, further increasing the long-term durability of the deck.

Durability a Requirement

Durability is a key concern as owners look to extend service life to 100 years or more. Concrete bridges can provide that attribute, Spaans says, by focusing more attention on bearings and expansion joints. "The use of integral abutments to eliminate or reduce the number of bearings, and the use of elastomeric bearings, can aid durability greatly," he says. Denser concrete, especially through adding fly ash and other admixtures, also offers potential for extending service life. "The more rigid the structure, the less vibration will be created and the better opportunities to avoid cracking."

But Spaans doesn't believe a 100-year service life will achieve the goals that bridge owners are hoping it will. "The bigger problem over that period is the functionality of the roadway and the bridges," he explains. As usage grows and codes change, bridges will need to be upgraded or replaced to handle traffic and satisfy new criteria rather than be replaced because they have worn out. "The bridges may still have life, but they will be functionally obsolete 100 years from now," he argues. "Current standards provide bridges with enough service life to last 75 years, and that durability will be enough."

High-performance concrete that focuses on improving concrete strengths, however, is offering new opportunities, especially for spliced-girder bridges. "Spliced bulb-tee girders are going to drive concrete strengths higher," he says. "Ten years ago, if we had said we wanted concrete of 7000 psi or higher, people wouldn't have known what to do with it. That has changed. The biggest trend in bridge design is the new properties we're able to achieve with concrete. We can gain higher strength and more durability, which aids design creativity and functionality."

Sand-Lightweight Concrete Grows

Sand-lightweight (SLW) concrete also is being used more often, he notes. "It can greatly reduce the weight for transporting and erecting larger beams for new projects." Unless there is significant widening involved, there is less need to use SLW concrete when replacing only superstructures in rehabilitation projects, he notes. "Foundations and substructures typically are robust enough that it does not create a problem to replace the superstructure with new materials."

An example of JSE's use of SLW concrete is the Kentucky Route 22 project currently underway in Gratz, Ky. Designed as a steel plate girder bridge, the precaster joined with JSE to propose a 900-ft-long, four-span (175, 200, 325, and 200 ft) spliced bulb-tee girder design. This design yielded a savings of more than $800,000 when compared to the as-bid steel design.

The main span features a 325-ft-long spliced bulb-tee girder, the longest in the country to feature this type of construction.

Janssen & Spaans' Long Prestressed Concrete History

Janssen & Spaans opened its doors in the early 1980s, but founders Hubert Janssen and Leo Spaans had many years of experience with concrete bridge designs before that. The two previously had worked together in the Netherlands for the engineering firm BVN. That company had a long history with prestressed concrete designs, as one of its own founders had been a student of Eugene Freyssinet of France, acknowledged as the inventor of prestressed concrete.

Spaans came to America in 1977 as part of a BVN team that worked with the Indiana-based engineering firm STS. Shortly after, the two companies merged to create BVN-STS, which later was purchased by HDR. Janssen and Spaans broke off on their own a few years later, focusing at first on segmental bridge designs. The company soon expanded its expertise beyond segmental bridges to all types and ultimately to pavement and roadwork projects as well.

Today, JSE's 65 employees work on more roadwork projects than bridges—but they also create more bridges than at any time in the past, an indication of the growth it has experienced.

The Kentucky Route 22 project in Gratz, Ky., was redesigned by JSE from a steel-plate girder bridge to a four-span, 909-ft-long spliced bulb-tee girder design that saved about $800,000 from the previous design. The 325-ft main span provides a record length for construction of this type. Photos: Janssen & Spaans Engineering.

SLW concrete was used to reduce its weight for handling purposes. The haunched pier segments are 16 ft deep, while the 9-ft-deep drop-in girders have a maximum length of 185 ft. The bridge will be completed in the summer for the Kentucky Transportation Cabinet.

Equipment Capabilities Expand

Aiding these projects are the improvements that precasters and erectors have made in their equipment, including special trucks for transporting large components, creativity in barging girders to the site, and larger and more adept cranes to pick and place pieces rapidly and efficiently. "There have been significant improvements in the past 10 years to aid transport and handling. Ten years ago, if we'd said we were going to create spliced bulb-tee girders for a span of 325 ft, they'd have said they couldn't get the pieces to the site. But today we can do it."

An example of the creativity that can be achieved with designs is the Fulton Road bridge replacement project in Cleveland, Ohio, for which JSE performed construction engineering services. The 1573-ft-long bridge features 35 spans of AASHTO Type III precast, prestressed concrete girders supported on five approach spans and six 210-ft-long precast, post-tensioned concrete arch spans with cast-in-place concrete piers, spandrel columns, and transverse cap beams. The bridge spans a park, the city zoo, a creek, and two active railroad lines.

The arch spans have a parabolic profile and a 41 ft 8 in. rise, consisting of three precast concrete sections, comprising two identical end segments and a crown segment. The owner's design specified cable stays for the erection of the arch pieces for two of the spans. JSE was able to develop an alternate erection scheme for the contractor that eliminated the cable stays by using conventional falsework, greatly speeding up the erection time while lowering erection costs. During erection, arch struts were installed between arch lines by bolting them to the face of the arches. The project was completed in the fall of 2009. (For more on this project, see the Spring 2009 issue of *ASPIRE*.)

Rehabilitation of existing bridges also is becoming a bigger part of JSE's business. The firm has an agreement with the state of Indiana to inspect and recommend action for bridges. One of the firm's groups is devoted exclusively to inspecting bridges, creating reports to recommend improvements, and following through with design plans if the state requires them. These recommendations can range from modest repairs through total replacement.

As the needs for repairs and replacement bridges grow in coming years, Spaans anticipates more improvements in concrete engineering and handling, making it even more the dominant material. "If you design properly, it's almost impossible to create a better bridge using steel," he says. That philosophy is helping the company produce economical designs and grow during the current recessionary times.

"Despite the economy, we are expanding and pursuing work in new areas of the country, as well as internationally." Those proposals include ones in Alberta, Canada, as well as the Middle East and Libya. In all of those projects, no doubt, Janssen & Spaans will build an efficient, attractive, and cost-effective structure—and it more than likely will be made with concrete.

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

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