

Value Engineering Format Saves Time, Money



Bridge engineer finds many ways to save Ohio money, thanks to state's 1998 adoption of value engineering option—and precast concrete design

As states find a pressing need for more infrastructure repairs, and the cost of those repairs continues to rise quickly, transportation officials are seeking ways to reduce expenses and complete more work. Several states have found great success by incorporating provisions for value engineering (VE) into their contract documents, allowing contractors to submit design modifications after the project has been awarded. Ohio is the most recent state to do this, and consulting firm **Janssen & Spaans Engineering Inc. (JSE)** has thrived by taking advantage of that option—especially by incorporating precast concrete bulb-tee beams into the new designs.

“We’ve helped pioneer value engineering in several states,” explains David A. Tomley, an engineer with **JSE**. The company has offices in Columbus, Ohio, and Indianapolis, operating as an engineering consultant with a variety of bridge contractors and consultants in the region. It also does a substantial number of projects in Florida, where the designs tend to involve longer spans using segmental construction with post-tensioned precast spliced I-beams.

“Our work in different parts of the country gives us a chance to see a lot of projects being designed through the Departments of Transportation, and we can compare to see what works best,” Tomley explains. “In almost all of these projects, we find that precast bulb-tee beams will save money and/or time over the original design.”

The VE option can save dramatically in both time and money. The concept is incorporated into the state’s bid-proposal documents and explains that after winning the bid, a contractor may propose VE changes to the original design that lower project costs and/or reduce construction time. The changes

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must leave the original project’s goals intact and follow specific restrictions laid out in the VE guidelines. The contractor’s incentive to make those changes amounts to one-half of the total savings, which is split with the owner.

Ohio Codifies Options

Value engineering’s most recent proponent is the Ohio Department of Transportation (ODOT), which in January 1998 amended its Ohio Revised Code to encourage value engineering proposals. To have a Value Engineering Change Proposal (VECP) accepted, the guidelines state, the VECP must reduce the cost of a project or in some cases reduce construction time or do both. Changes that impact special architectural aesthetic treatments, noise barriers, or specific design elements won’t be accepted.

JSE has been creating such VECPs in Ohio for several years, even before the guidelines were enacted, because a precast alternative provided such strong advantages. “We found that precast bulb-tee beams almost always save cost and/or reduce construction time as well. Fabrication by local precasters is economical and precast bulb-tee beams have been emerging as a cost-saving method for long span bridges in the past few years,” Tomley explains.

Bulb-tee beams feature a thicker bottom flange. This flange holds more strands, making the top tee more efficient, especially at longer span lengths. The bulb-tees also feature a more-slender cross section overall, with a wider top flange that aids in stiffness for transportation and erection. The bulb-tee beams have been gaining popularity since the mid 1980s, as their ability to handle longer spans became more recognized.

Beams Cut Costs

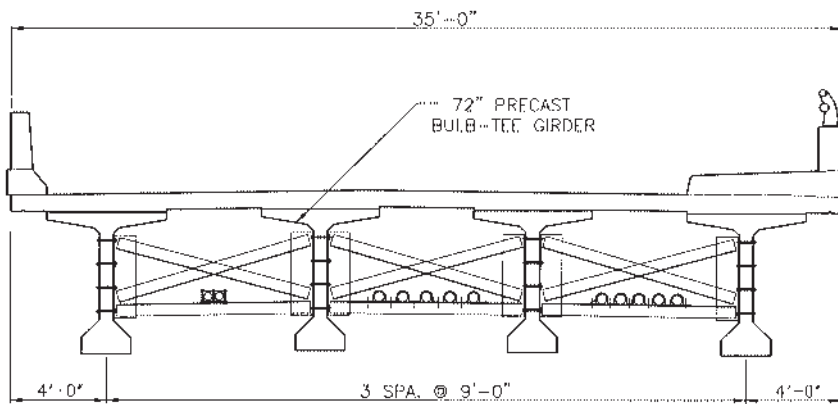
“Bulb-tees work well on projects with spans from 90 to 170 feet,” Tomley explains.

Bulb-tee beams promote longer spans, which help reduce the number of substructure units, which in turn reduces costs. Deck form work also is often reduced by the inherently wider top flanges. “Making just these changes keeps the structure very cost-competitive.”

The reduced construction time available with bulb-tee beams can be critical, especially on major widening projects with part-width construction



Now being completed, the Souder Avenue Bridge over the Scioto River in Columbus, Ohio, features three spans using continuous bulb-tee beams and hammerhead piers.



TRANSVERSE SECTION
 FRA-670-1.25, A-3, SOUDER AVENUE
 OVER SCIOTO RIVER

On the Souder Avenue Bridge, **Janssen & Spaans Engineering Inc.** completely redesigned the substructure and superstructure.

and traffic maintenance. “Bulb-tees work great on widening programs, because they meet scheduling demands and their speed of erection shortens traffic disruption.”

“Many contractors in the state indicate that delivery times for materials are crucial, and they like the speed of construction precast beams offer,” Tomley adds. “Precast I-beams are readily available and provide optimum schedules for the contractor.” With precast concrete components, the beams are ready for delivery as soon as the contractor is ready to erect them. Among contractors, this reliability factor is a major winning point on its own, even above the direct time savings that can be achieved.

Precast meets our delivery deadlines, and that reliability factor is a major winning point.

A recent example of cost savings can be seen in the Souder Avenue bridge over the Scioto River in Columbus, Ohio. Now being completed, this VECP project includes continuous precast bulb-tee beams with three spans in a configuration of 132-142-132 feet, with **JSE** providing a complete redesign of the superstructure and substructure.

“We were able to reduce the number of spans and eliminate a river pier by proposing a three-span solution, compared to the original four spans.” C.J. Mahan Construction Co. and Tecspan Concrete Structures Inc., both in Grove City, Ohio, were the bridge contractor and precaster respectively, while L. Thompson Consultants and Columbus Engineering Consultants served as the original engineers.

Competition Will Grow

The new Ohio VECP guidelines encourage competitive products, Tomley says. “With the documents now available on how to submit VECPs, I think we’ll definitely see enhanced competition resulting in fresh ideas throughout the state. This ultimately will benefit owners and the traveling public as a whole. It definitely opens the door wider for precast

The S.R. 315 ramp to I-670 over the Olentangy River in Columbus, Ohio, a 750-foot long bridge, contains the longest precast concrete bulb-tee beams in the state (165 feet).

concrete products.” Tomley also noted the encouragement supplied via timely reviews and other assistance by Lloyd Welker, an assistant engineer in the ODOT Office of Structural Engineering who has aided the company on many of its state projects.

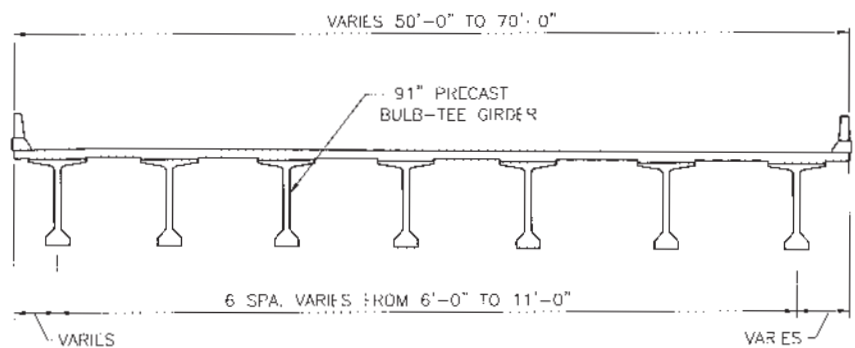
JSE works with a wide variety of precasters in the Midwest and Florida. In the South, these include Dura-Stress Inc. in Leesburg, Fla.; Standard Concrete Products Inc. in Tampa, Fla., and Atlanta and Savannah, Ga.; Sherman Prestressed Concrete in Pelham, Ala; Gate Concrete Products Co. in Jacksonville, Fla.; and Gulf Coast Pre-Stress Inc. in Pass Christian, Miss.

In the Midwest, the group includes Tecspan Concrete Structures Inc. in Grove City, Ohio, which has been the producer of all of the Ohio projects JSE has value-engineered, and Prestress Services Inc. with offices in Decatur, Ind.; Lexington, Ky.; and Melbourne, Ky. “We find the quality of delivered products is excellent, and there’s good competition among suppliers,” Tomley notes. “This combination gives us the scheduling and cost efficiency to compete with other products.”

The list of projects JSE has value engineered in Ohio using precast concrete designs and bulb-tee beams is long and varied. Here are some of the most recent ones, giving an idea of the range and scope:

S.R. 315 Ramp to I-670 over the Olentangy River, Columbus, Ohio: One of the more complicated projects undertaken by JSE, this 750-foot-long bridge contains the longest precast concrete bulb-tee beams in the state. “The structure shows the potential for long-span bulb-tee beams,” says Tomley. Completed in 1997, it features spans of 165 feet with variable-width roadways. It also has varying skews up to 50 degrees, super-elevation transitions and complex geometry for horizontal and vertical curves. The project provided a major link between I-670 and S.R. 315 surrounding major construction around the downtown Columbus area.

JSE provided design calculations and shop drawings on the project, which



TRANSVERSE SECTION
 FRA-315-0210
 ROAD "OE" AND RAMP "OF"
 OVER OLENTANGY RIVER

The State Route 315 ramp features varying skews up to 50 degrees, super-elevation transitions, and complex geometry for both horizontal and vertical curves.

was constructed by C.J. Mahan Construction, Co. John E. Foster & Associates served as the original engineer on the project. “We were able to produce a design that kept the girders straight and used the same span lengths per the original design,” Tomley says. “In addition to the bulb-tee beams, we changed the foundation and made a few adjustments to the design that reduced substructure costs as well.”

The company specified 7,000-psi design concrete strength for the precast bulb-tee beams with a semi-lightweight mix of 125 pcf. “That increased the cost per cubic yard slightly, but the benefits in creating more efficient components with added strength outweigh that expense and provided a greater payback,” Tomley says. “When we reach the 130- to 170-foot span range for bulb-tee beams, we tend to use the semi-lightweight concrete. Its

High-strength concrete combined with a semi-lightweight mix is common for 130- to 170-foot span ranges.

17 percent reduction in beam weight usually is needed when you get up into the longer span ranges. But it’s still beneficial, cost-wise.”

Another innovative design element included installing only one diaphragm at midspan. The single diaphragm with transverse post-tensioning helped reduce the weight and aid in the overall design. “We performed a live-load distribution analysis and concluded that one diaphragm would be sufficient,” he explains. The AASHTO Code allows refined structural analysis for diaphragms to prove adequate strength, which is the approach JSE took. “We showed that one diaphragm was enough when combined with transverse post-tensioning. That saved costs, too.”

Pedestrian Bridge over Winton Woods Harbor, Hamilton County, Cincinnati: Working with the architectural firm of Brandstetter/Carroll Inc. and Trend Construction Inc., JSE redesigned the superstructure plan for this pedestrian overpass from an original

Design-Build Offers Advantages

In addition to value engineering options, design-build formats produce cost and time savings on projects. A good example can be seen in the Milford Parkway project over the East Fork of the Little Miami River in Milford, Ohio. Janssen & Spaans Engineering Inc. served as consultant and bridge designer on the project, working with bridge contractor C. J. Mahan Construction Co. and precaster Tecspan Concrete Structures Inc.

The 323-foot bridge featured three spans each of 107 feet, using 60-inch precast bulb-tee beams. The design saved both time and money over the original estimate and planned design. “The project went great,” says David A. Tomley, JSE’s engineer on the project. JSE teamed with the contractor and produced construction plans, which were approved through the City of Milford and Ohio Department of Transportation’s Central Office. ODOT has completed about 10 projects in the design-build format, Tomley reports.

“It’s a format that puts all the responsibility on one entity and brings all parties together in an effort to minimize potential claims and lower construction costs and/or reduce construction time,” he explains. “It increases competition for the projects and brings out the most innovative bridge solutions. It also allows the contractor and engineer to use their best ideas.”

Design-build was used on the Milford project due to the need for quick turnaround. The first piles were driven in just 3 1/2 months after JSE received the authorization to proceed with the design. “Design-build can offer both a time savings and increased competition, and that’s bound to reduce overall project cost.”



The pedestrian bridge over Winton Woods Harbor in Cincinnati, was redesigned to use 90-foot precast bulb-tee beams, which reduced the number of original beams by 33 percent.

design created by engineering firm Graham, Obermeyer & Partners Ltd. The original design used 15 standard AASHTO type IV I-beams. JSE eliminated 33 percent of the original beams by using two bulb-tee beams per span for 10 beams total. This also reduced deck-forming costs. Overhangs of cast-in-place spandrel walls helped tie the concrete deck to the pier and created aesthetically pleasing cantilevered overlooks at spaced intervals along the pedestrian walkway.

The precast bulb-tee beams add an additional safety feature during construction due to their wider top flanges, which increase footprint area.

The bulb-tee beams add an additional safety feature for construction workers, Tomley adds. Their five-foot top flange offers better footing during construction. "Any time you have personnel working on beams, you want to give them as much working space as possible. This added measure of safety is very important."

State Route 741 over I-71, Cincinnati: To create a VECP of the original bridge overpass, JSE provided a redesign on both the superstructure and substructure, again working with bridge contractor C.J. Mahan Construction Co. and precaster Tecspan Concrete Structures Inc. The redesign, developed from an original design created by Woolpert Consultants, incorporated continuous bulb-tee beams with part-width construction so the bridge could remain open during replacement and widening. The project is one of the first in the state to feature precast bulb-tee beams on an interstate overpass.

In this case, the bulb-tees were used primarily to save money within a tight construction schedule, Tomley says. The bulb-tee design essentially used the original span layout of two 130-foot spans on cap and column piers and



The S.R. 741 overpass over I-71 in Cincinnati, was redesigned to feature continuous bulb-tee beams. The project is one of the first in the state to use precast bulb-tee beams on an interstate overpass.

Ohio Encourages Value Engineering

Guidelines for making value engineering change proposals to bridges in Ohio were released to contractors on January 7, 1998. The guidelines allow the Department of Transportation to accept Value Engineering Change Proposals (VECP) that save money and time, or in some cases offer a time savings alone, with the total savings split between the contractor and the state.

The change cannot affect "the essential functions and characteristics of a project," the guidelines state, defining those as the bridge's service life, reliability, economy of operation, ease of maintenance, safety, necessary standardization features, and any engineering commitments such as environmental-mitigation measures. It notes, however, the VECPs can alter these elements if they in some way combine, reduce or eliminate any element by making them nonessential or excessive.

VECPs also cannot affect changes to special architectural aesthetic treatments of the structure, the design and thickness of cast-in-place concrete decks, bridge designs with respect to roadway geometrics, overhead sign supports, breakaway sign supports, or the type of noise barriers used.

The guidelines stress the need for cost savings in the proposal, but it also will consider changes that reduce construction time, which ultimately lead to cost savings. "The purpose of this provision is to encourage the use of ingenuity and expertise of the contractors in arriving at alternate plans, specification, or other requirements of the contract," the guidelines state.

Durable precast concrete beams reduce life-cycle costs as well.

semi-integral abutments. The bulb-tee beams blended well with the Mechanically Stabilized Earth (MSE) Walls in front of the abutments.

In order to maximize the long-term durability of the precast bulb-tee

beams, 4 percent micro-silica was incorporated into the mix design with a specified water-cement ratio of 0.35 and conventional steam-curing. Precast concrete beams that are steam-cured with low water-cement ratios between 0.30 to 0.40 dramatically reduce chloride ion intrusion, Tomley points out. "Precast concrete adds a significant benefit to the owner because it can avoid the cost and traffic delays needed to paint steel structures regularly, especially over any interstate."

JSE's 22 Years of Bridge Expertise

Janssen & Spaans Engineering Inc. specializes in complex bridge designs, railroad structures, and other transportation facilities. The majority of its experience has been acquired by partnering with contractors and other consultants using both steel and concrete designs.

The staff includes founders Leo Spaans, who serves as president and offers 28 years of industry experience, and H. Hubert Janssen, the company's technical director, who adds 40 years of experience. The company has operated in its present form since 1985. JSE currently operates two offices with 20 employees (10 registered engineers, nine technicians and one office support person).

The firm's expertise in bridge design can be seen in the wide range of projects it has undertaken. Projects of note nationwide include the Nebraska City bridge, a 426-foot span cast-in-place bridge, the Seattle Access, connecting downtown Seattle to I-90, and the Shelby Creek Bridge, which featured a series of 208-foot post-tensioned precast spliced concrete beams. This latter project won the 1992 PCI Design Award for Bridges with Spans Greater than 135 feet. The company also has been involved in winning PCI Design Awards in three of the last four years.

Third Avenue Bridge over the Olentangy River, Franklin County, Columbus, Ohio: This project was designed by Jones-Stuckey Ltd. Inc. and constructed by C.J. Mahan, with Tecspan serving as precaster. It features a unique variable-depth precast bulb-tee beam spliced together via segmental construction, the first of its kind to be used in the state. The design incorporates two 135-foot spans comprising 28 variable-depth segments, each 67'4" long. The project was not a VE effort, but JSE provided a peer review for the superstructure design and prepared beam shop drawings.

"The innovative design used the standard 5-foot bulb-tee top flange and constant bottom bulb with the variable



The Third Avenue Bridge over the Olentangy River located in Franklin County, Columbus, Ohio, features a variable-depth post-tensioned spliced bulb-tee beam, the first of its kind to be used in the state.



The Third Avenue Bridge design incorporates two 135-foot spans comprising 28 variable-depth post-tensioned spliced bulb-tee beams, each 67'4" long.

depth taken up in the web," Tomley explains. Temporary falsework on existing foundations was used to support the precast beams until a cast-in-place diaphragm and longitudinal post-tensioning were installed. It also features a conventional cast-in-place concrete deck with transverse post-tensioning using 0.5-inch monostrand.

Bulb-tee beams have been emerging as a cost-saving method for long-span bridges since the mid 1980s.

Tees Add Versatility

This wide range of projects, all in one state, shows the versatility available through value-engineering designs and by examining all options—especially

the use of precast bulb-tee beams. Precast bulb-tee beams offer cost savings even after a project is awarded, Tomley stresses, and should be investigated at the preliminary design stage, for major widening projects and for rehabilitation projects. "Bulb-tee beams provide owners new options and flexible solutions for projects of all sorts," he says. "They have been successfully implemented on various VECP projects throughout the state, and in combination with current Ohio VECP guidelines should result in a growth in the number of projects." ■

— Craig A. Shutt