CH2M HILL'S HOLISTIC APPROACH

by Craig A. Shutt

Combining design and construction services helps firm meet owners' growing needs for speed and constructibility

CH2M Hill's engineering, construction, and operations capabilities have served a large variety of clients throughout the world since the firm's founding in 1946. Those skills are being integrated closer than ever today, especially as the company meets a wider array of needs from owners of bridges and other transportation structures throughout the United States.

"We are a full-service provider," explains Joe Showers, Chief Bridge Engineer. "We have the depth and breadth of capabilities under one roof to provide flexibility to the client as we participate in a project. These range from the environmental document and planning stages through the final design stage and include being a designer-constructor. We span the length of the project from concept to completion.

"Design-build is a delivery method that we use frequently, and we consciously developed consulting and construction methods to allow it to happen. More owners are growing comfortable with the design-build format, because they recognize that the benefits can help achieve their goals. Design-build has been used with buildings for some time, and it's moving into the transportation field today, because owners are being driven by pressure on schedules in particular."

The design-build format can condense the time needed for the project, as construction can commence before all the design is completed. That not only saves time but can save money, shorten labor schedules, and reduce user costs incurred through detours and congestion delays. "A cost savings often is produced, but design-build definitely creates a savings in the schedule, which is the critical component in most cases."

The Kathleen Road Bridge over I-4 in Florida was created under a design-build approach and consists of a cast-in-place concrete deck, pretensioned concrete beams, cast-in-place concrete piers, prestressed concrete piles, and concrete panels for the mechanically stabilized embankment walls. The structure replaced a smaller 1958 design.

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Designs Are More Complicated

Owners are looking for new ideas to aid designs in every way possible, because bridge construction has become more complicated in the past 20 years, he adds. "Owners are very cost-conscious today, due to increases in costs for materials and labor." With cost escalations as high as 10 percent per year, it can be difficult to create budget estimates for bridges that will be constructed well after the design and material choices are finalized.

"Design-build formats in particular bring design engineers and constructors together on the same team, working toward a common goal, as opposed to being adversaries," he says. "More often today, the engineer and contractor work closely together rather than separately."

The functions used to be fairly split apart, but now owners understand the value of marrying the two closer to aid communication and input.

"We have to look at the total project for savings and constructibility, and the emphasis has become the total project cost, not just savings in design or construction. Our designs definitely focus on creating the most cost-effective bridge to be constructed, not just designed."

Traffic Control Key Ingredient

Owners also are putting an emphasis on traffic control, a result of projects becoming more congested as infrastructure expands outward from cities and becomes more complex. "There are few green-field sites today," Showers says. "Many of our projects involve rehabilitation and widening of corridors under traffic, and we have to deal with those challenges. They definitely are affecting how we plan projects."

An example of the attention paid to this factor is the Marquette Interchange upgrade in Milwaukee. The $1-billion project encompasses 12 miles of urban freeways, including the design of 50 ramps and construction of more than 180 bridge structures. It also features five levels of roadways and 300,000 vehicles per day. The project, a joint venture of CH2M Hill and HNTB, features 72-in.-deep precast, prestressed concrete I-girders for the bridges.

The four-year reconstruction was the largest and most complex transportation project ever undertaken in Wisconsin, Showers says. As a result, "Public perception of impacts and alternative routes around the construction were

Some of the 72-in.-deep precast, prestressed concrete I-girders are delivered and set for the I-794 bridges at the east end of the Marquette Interchange project in Milwaukee. The project was designed for the Wisconsin Department of Transportation by Milwaukee Transportation Partners, a joint venture of CH2M Hill and HNTB.
All photos: CH2M Hill.

identified as extremely important to the overall project's success." The Wisconsin Department of Transportation committed to keeping two lanes open in each direction during construction.

To achieve that, CH2M Hill developed a detailed schedule to clarify ramp and lane closure times and locations. In addition to creating disincentives for missing the schedule, the team also introduced a "lane rental" program, which gave contractors an allotment of hours in which to close freeway and ramp lanes without disincentives. "The lane-rental program was an effective tool to reduce unneeded lane closures and minimize disruptions to the public." The team also found paths for temporary roadways to pass under existing structures through the core of the interchange.

Aggressive communication with businesses about detours also has become commonplace on projects, Showers says. That was a key element in the success of the $150-million Colorado Springs Metro Interstate Expansion (COSMIX) project, which reconstructed 16 concrete bridges and widened another four. CH2M Hill created a joint venture with SEMA Construction to provide design-build services.

Those services included weekly meetings with local business owners, as well as maps and signage placed along the routes to ensure changes were well known. More than 20 informal and formal town-hall meetings were held during the project's course, which used more than 300,000 cu yd of concrete to rebuild I-25 through the metro area.

Durability Is Stressed

Durability also has come to the fore, as owners look to decrease costs and create added safety. "Owners are focusing more on life-cycle costs today and understand that it's worth spending more upfront, because it's a good investment if you don't have to

Owners are more willing to spend another dollar today to save $10 down the road.

As the largest highway-construction project in the Colorado Springs' history, the $150-million COSMIX project involved reconstruction of 16 bridges and widening four more. Rockrimmon Constructors, a CH2M Hill-led joint venture with SEMA Construction, also provided design-build services to expand 12 miles of highway capacity and reconfigure two major interchanges.

Working with the Idaho Transportation Department, CH2M Hill strengthened and restored the concrete-arched Rainbow Bridge between Boise and Cascade in Idaho. Key elements included replacing ornate concrete bridge rails, repairing corrosion-damaged stringers, and repairing and replacing corrosion-damaged columns.

spend money on maintenance later on. They realize the key is total costs, not necessarily just initial costs, and they're more willing to spend another dollar today to save $10 down the road."

Current specifications for a 75-year life contain "the rules of the road," he notes, "but some bridge owners are asking us to design for service lives of 100 to 150 years." European engineers already are evaluating ways to create such service lives routinely and are developing models for it. "We'll see some of that here in the coming years."

Likewise, sustainability is gaining ground, although Showers notes that it hasn't become as major a concern in America for bridges as it is in Europe already. "It's growing in interest here, certainly. Energy costs are becoming a key aspect of designing bridges, and the project's 'carbon footprint' is being discussed more."

Emphasizing Context Sensitivity

Along with sustainability is the need for context-sensitive solutions (CSS), which CH2M Hill emphasizes in its designs. The company literally wrote the book on this concept, as its staff served as primary authors on National Cooperative Highway Research Program Report 480: *A Guide to Best Practices for Achieving Context Sensitive Solutions.* "CSS is an emerging trend and requirement in the planning and design of highways, and CH2M Hill has been at the forefront," says Showers. The goal is to bring clients, stakeholders, agencies, and the public together in the earliest phases of projects to achieve sustainable solutions sensitive to the project context. This approach addresses safety, mobility, aesthetics, and other community values prior to design being finalized rather than reacting to issues later in the process. "This need has been driven by the public," he notes. "People are becoming more sensitive to the infrastructure and the public involvement in designing highway and railroad bridges in their communities." He likens it to the early 1900s "City Beautiful" movement, when emphasis was put on a city's physical state and how it could be improved. That urban-architecture movement found its way into bridge designs, and a similar movement seems to be underway today.

"Recreating bridges that have become local landmarks poses challenges," Showers adds. "To make an exact replica of a 100-year-old bridge is tough today, because we don't build like that anymore. If we can create a design that harmonizes with that style, new technologies and advances in concrete materials give us far more capabilities for achieving a high-quality, functional, and still complementary design."

An example can be seen in the Rainbow Bridge project, in which a 1933 concrete

CH2M Hill has been at the forefront of using context-sensitive solutions to meet challenges.

Sharing the Wealth

CH2M Hill opened its doors in Corvallis, Oregon, in January 1946 as a partnership among three Oregon State College engineering graduates and one of their professors: Holly Cornell, T. Burke Hayes, James Howland, and Fred Merryfield. Some 25 years later, the company merged with Clair H. Hill & Associates to create CH2M Hill.

The founders' concepts were simple but unusual: Grow the company by solving clients' problems, hire creative people to find new approaches to those challenges, and share the benefits of the company's success with them. The employees own the company through a stock-sharing program.

The company has won a number of awards for being employee-friendly. For instance, it was named one of *Fortune* magazine's "100 Best Companies to Work For" in 2006, one of "Denver's Best Places to Work" by the *Denver Business Journal*, and one of the "Top 50 Companies to Work For" by *Woman Engineer* magazine.

By the end of the 1960s, the company had achieved revenues of $6.2 million, generated by 310 employees. The firm gained momentum with the 1971 Hill addition and publicity from their partnership on a ground-breaking wastewater treatment facility. One decade later, the company had revenues of $95 million and 1800 employees.

Ralph Peterson was elected president in 1991, ushering in a period of rapid growth and diversification. By the mid 1990s, CH2M Hill's 6000 employees produced revenues close to $1 billion. In 2006, the company reported revenues of $5 billion achieved with 23,000 employees from activities in 31 countries.

'Designers are starting to treat concrete as a highly engineered material.'

CH2M Hill supplied design-build services for the new I-5/41st Street Interchange (at center) and a new flyover bridge (far left) that replaced an outdated left lane exit in Everett, Washington. The project included the widening of about 10 miles of highway and rebuilding bridges and interchanges.

spandrel-arch bridge over the Payette River between Boise and Cascade, Idaho, was rehabilitated. CH2M Hill provided both design and construction services for the $2.9-million project, which involved reconstruction of corrosion-damaged deck-stringer ends and repair of columns, piers, and arches. Existing decorative bridge rails also were replaced with an identical railing. Throughout the design, the original historic fabric of the bridge was retained whenever possible.

Concrete Helps Meet Challenges

Concrete materials can help meet a number of the challenges presented by these trends—and that, too, has been a trend for some time, he states. "The industry has been headed toward more concrete designs for the past 30 or 40 years." Earlier, virtually every interstate overpass, especially spans of more than 100 ft, was constructed with steel girders.

"Everything is changed now. We're seeing precast, prestressed concrete used much more often, with box girder spans as short as 80 ft. At the same time, some prestressed spliced girders are extending to 350-ft-long spans. Spliced-girders and segmental technology have expanded the use of concrete in bridges, and post-tensioning is more widespread than ever."

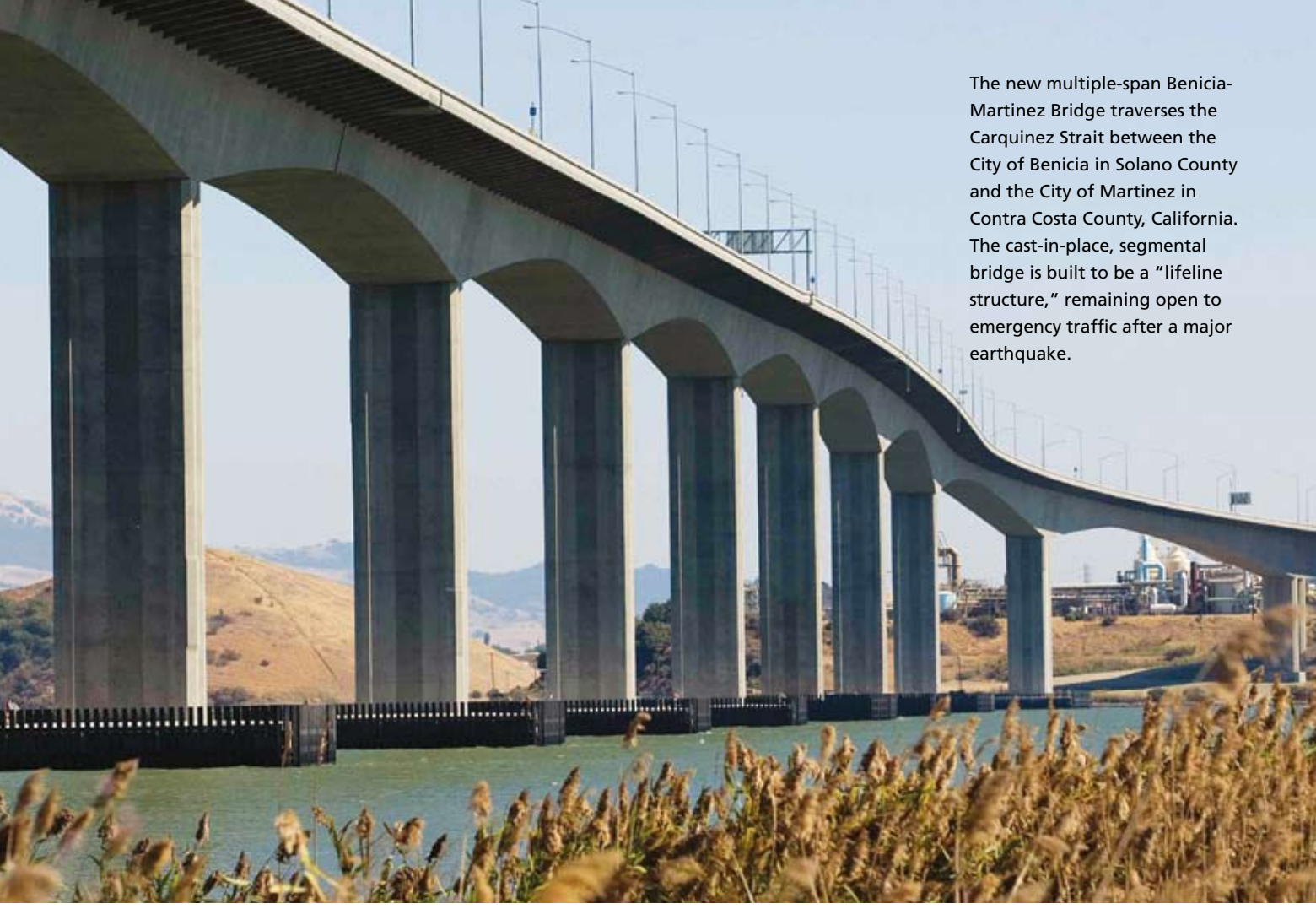
The concrete industry has changed dramatically in recent years, he adds, increasing its capabilities significantly. In the 1980s and 1990s, many of the advances in bridge engineering could be attributed to computer software that allowed designs to be modeled and better forecasts and calculations to be created. "But in the last 5 to 10 years, the changes we've seen have been due to changes in materials and better performance, and that includes concrete."

High performance concrete is a key example. "Designers are starting to

treat concrete as a highly engineered material, and that's an evolving change. These advances affect what can be accomplished with bridge engineering, and that's really exciting." The changes have been particularly notable in the precast concrete field, with techniques achieved with formliners, coloring, and other aesthetic options. "There really are a lot of new options being created."

It's up to designers to stay up to date and incorporate new ideas when applicable, he stresses. "Designers are gaining awareness, and they're asking questions about what can be accomplished." For that reason, CH2M Hill works closely with concrete suppliers early in the design process. "We don't want to overspecify materials, so we work closely with concrete producers, and they're very constructive with help at the concept level. And since we also are contractors, we can integrate the ideas throughout the process."

The new concepts are expanding concrete applications in new directions,



The new multiple-span Benicia-Martinez Bridge traverses the Carquinez Strait between the City of Benicia in Solano County and the City of Martinez in Contra Costa County, California. The cast-in-place, segmental bridge is built to be a "lifeline structure," remaining open to emergency traffic after a major earthquake.

he adds. For instance, the firm has worked with the Colorado Department of Transportation on one of seven bridges the department has developed using a curved, spliced-girder system. "They've pioneered this design and led the way, which is really an interesting approach. Owners are definitely sold on concrete concepts and are leading its use."

Lightweight Concrete Evolving

Concrete mixtures that have led to more lightweight concrete also are changing design concepts, he says. "Lightweight concrete is fast becoming a standard, and it has a tremendous influence on design."

An example can be seen in the company's work in a joint venture with T.Y. Lin International on the Benicia-Martinez Bridge in California. The project used "sand-lightweight" prestressed concrete box girders constructed primarily by the segmental, balanced cantilever, cast-in-place construction method. The sand-lightweight concrete uses normal weight sand and lightweight coarse aggregate to produce concrete that is lower in density than normal weight concrete. (For more on this project, see the Summer 2007 issue of *ASPIRE*.™)

"We needed to use concrete that was lightweight but that also offered other properties related to modulus of elasticity and creep," he explains. "We stretched the capabilities in that design, and that is happening more often all the time."

The design for the new 3175-ft-long concrete crossing of the Fraser River near Vancouver, British Columbia, Canada, features a much lower profile due to the concrete material and a new foundation design, which uses large-diameter bored piles to provide cost-effective construction in the deep layers of soft silt. The project also features an emphasis on aesthetics, using decorative eagles as a recurring theme on bridge towers and other locations.

Self-consolidating concrete also is being used more often, most usually to aid contractors in speeding construction rather than for design purposes. Showers notes. He also has great hopes for a variety of new reinforcement materials, such as fiber reinforced plastics or carbon fibers.

"A number of states have created demonstration projects with these materials, and there is some work being done in Europe," he says. "I haven't seen a massive breakthrough yet, but there could be one in the next few years. It would be ideal if the material could be put into slabs and wouldn't corrode. An indefinite service life would be the Holy Grail."

As concrete producers work with CH2M Hill toward that goal, the firm will continue to improve on its own design and construction processes, as well as their integration, to help cut costs and create designs that meet the more diverse, specialized, and challenging needs of all types of bridge clients.

CH2MHILL

Taking concrete innovations to new heights

CH2M HILL's recent preservation of the historic Rainbow Bridge in Idaho was recognized as the International Concrete Repair Institute's 2007 Project of the Year.

High above the Carquinez Straight, the new Benicia-Martinez Bridge now carries five lanes of northbound traffic, significantly reducing daily traffic congestion for the 100,000 vehicles using I-680. CH2M HILL, in a joint venture with TY Lin International, used lightweight concrete and a cast-in-place method in constructing the 1.6-mile-long bridge.

CH2M HILL applies innovative technology to complete complex projects. We're a leading design-build firm with more than 60 years of design, construction, and program management expertise. CH2M HILL can help you take your next concrete infrastructure project to new heights.

Solutions Without Boundaries

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