BUILDING BETTER BRIDGES

Context-Sensitive Bridge Design Balances Community Values and Aesthetics with Budget Considerations

Pennsylvania is replacing a lot of bridge these days, and engineers are looking at more than just their function when designing the structures. Community values, aesthetic and historic considerations, and environmental concerns are all coming into play as engineers try to create structures that fit into their surroundings and reflect the visions of the communities in which they are located.

BY **BRENDA WILT** / ASSOCIATE EDITOR

It is no secret that Pennsylvania has a lot of structurally deficient bridges — about 8,000 statewide. As the state, counties, and local governments seek to repair or replace these aging and deteriorating spans, they are considering the bridges' appearance, as well as function. Context-sensitive bridge design, which has become prevalent in the last decade or so, takes into account the impact a project will have on the surrounding community and strives to make sure it conforms with the community's values.

"It's going beyond the nuts and bolts of the structural capacity, cost, and lifespan of the bridge," says Quentin Rissler, chief bridge engineer for the Lancaster-based engineering firm RETTEW. "It's putting the right bridge in the right place."

Enhancing the community

The Federal Highway Administration defines context-sensitive design as an approach that places the preservation of history, scenery, the environment, and other community values on an equal footing with mobility, safety, and economics.

"It centers on making a bridge fit in with its surroundings and community," says Brian Hare, chief of the Design Services Division in the state Department of Transportation. "Our intent is to enhance the community with our projects."

Hare lists five major components of context-sensitive design:

1) community character, including the community's vision for its future;

2) environmental issues, usually addressed through regulation;

3) land use issues, including existing and future development;

4) transportation needs; and

5) financial considerations, including building the best bridge possible within budget.

Context-sensitive design goes hand-in-hand with PennDOT's smart transportation initiative, Hare says, which

PHOTOS COURTESY OF RETTEW

Lancaster-based engineering firm RETTEW applied context-sensitive design principles when replacing a historic concrete through-arch bridge in Lancaster County *(above)*. The bridge deck was cast on-site, while the through arches were cast in Bedford County and then lowered into place *(top right)*. The new bridge *(right)* looks very similar to the historic structure it replaced.

integrates land use planning with transportation projects. *(For more about smart transportation, see Page 8.)*

In the current economic climate, however, financial considerations have taken center stage when designing transportation projects, he says. "If you design a project you can't afford to build, you haven't gotten any closer to solving the problem," he says. Getting the best bang for the transportation buck means weighing the project cost against the community's vision for its future.

Meeting needs responsibly

This tension between vision and cost is an important aspect of context-sensitive design, says John Zarsky, P.E., an associate vice president with Pennoni Associates Inc. "We have to not only be environmentally sensitive but also fiscally responsible," he says.

In the current economic downturn, especially, more emphasis is being placed on designing a bridge so that it meets transportation goals without being larger than it needs to be, he says.

"We have to be aware that one-size-fits-all design doesn't work in every case," Zarsky says. "From a design perspective, we have to ask what we are trying to accomplish. Can we shrink the size and still meet the transportation needs?"

This may also mean rehabilitating bridges, rather than replacing them. "You can save money if you can get another 20 to 30 years out of an existing bridge," he says. Also, reducing the size of projects or repairing existing bridges may mean more bridges can be repaired or replaced.

Whether aesthetic or financial concerns take precedence in a bridge's design really depends on a community's values and what the residents want to see when they travel through their township, Zarsky says.

"We're trying to make bridges that last longer and longer," Rissler of RETTEW says. "If a bridge is going to be around for 75 to 100 years, that's a long time to look at an ugly bridge."

> "If a bridge is going to be around for **75 to 100 years,** that's a long time to look at an **ugly bridge.**"

Maintaining historic bridges

In some cases, a community decides that having a bridge fit in with its surroundings and historical context is worth the extra cost. When Lancaster County was faced with replacing a historic concrete through-arch bridge — one of only four such structures remaining in Pennsylvania — it decided to replicate the original, which had

"These **stone bridges** have been there a long time and if **properly maintained, last longer** than concrete pipes or precast bridges."

been erected in 1922 and was eligible for listing on the National Register of Historic Places. The bridge carries Auction Road over Big Chiques Creek in Penn and Rapho townships.

"The county was concerned about maintaining its historic bridges," Rissler says. "It asked if we could create a bridge that looked similar to the original." The 1922 bridge, a single-lane span, no longer met the area's transportation needs and, in fact, had a weight limit of three tons, or roughly the weight of a standard sport utility vehicle. RETTEW designed a replacement to replicate the look and function of the original, while extending the length and expanding it to two lanes.

Each side of a through-arch bridge consists of a top arch supported by vertical and diagonal members that rest on a horizontal member. As a vehicle drives across the bridge deck, the arches compress to counteract the downward force, Rissler explains. While the concrete bridge deck was cast in place, the two side arch pieces were cast in Roaring Spring, Blair County, because factory controls allowed a higher-strength concrete to be used.

The new bridge looks very similar to the original, Rissler says, which has pleased the county and its residents. "The public has reacted very favorably," he says. "I've heard nothing but positive comments."

RETTEW also used context-sensitive design when replacing another historic Lancaster County-owned bridge, this time in Ephrata Township, Rissler says. Slated for replacement under the county's bridge program, the timetable was moved up when the bridge started to sag.

To fit the new concrete bridge into its surroundings, RETTEW incorporated arch-shaped walls along the road to replicate the original, Rissler says. When the concrete was cast, textured form liners were used inside the molds to give the concrete the appearance of stacked stones.

"The form liners were requested by the owners of the adjacent historic property, the township, and the county," Rissler says. Once in place, the "stone" was stained to match the color of the stone on the adjacent house. As with the Auction Road bridge, RETTEW widened the structure to carry two lanes of traffic, rather than one.

The two Lancaster County bridges are prime examples of context-sensitive design, Rissler says. "Aesthetics are being considered, rather than being ignored," he says. "It's an important element."

Finding treasure

Although PennDOT's Brian Hare says context-sensitive design need not be more expensive if it's considered early in the budgeting process, things like form liners and staining can add to a project's cost.

Many townships facing bridge replacements don't have the funds to include such "extras," but now and then, things fall into place to allow a local government to do something special.

Take Upper Tulpehocken Township in Berks County, for example. The township had two stone-arch bridges that were falling apart but did not have the funds to replace them.

"The problem with the first bridge, over Swatara Creek, was discovered last summer because of flooding," township secretary Shirley Adam says. "You can't

PHOTOS COURTESY OF RETTEW

When replacing another historic concrete bridge in Lancaster County, RETTEW replicated the arched sides of the original and used stamped concrete to create the appearance of stone *(see inset).*

PHOTOS COURTESY OF
UPPER TULPEHOCKEN TOWNSHIP, BERKS COUNTY

Upper Tulpehocken Township in Berks County turned to a stone mason on its road crew to repair a double-barrel stone-arch bridge that the township didn't even know it had. Before its facelift *(the finished bridge is above),* the bridge was in much the same state of deterioration as another stone-arch bridge the township planned to repair this spring *(left).*

"If we can **design a bridge** that is **similar** to the existing one or reflects some of its **distinguishing characteristics,** it softens the blow somewhat of **having to replace it.**"

really see the bridge walls from the road, but when the road crew checked it out from within the creek, they realized it was a double-barrel stone-arch bridge."

Adam says stones were falling off the bridge and a tree had grown into the wall. Restoring the stone bridge would likely cost as much or more than replacing it, township officials thought. That is, until they discovered a hidden treasure in their midst: namely, a road crew member named Dwain Schlappich.

Schlappich, a stone mason who joined the road crew a few years ago, felt he could redo the stonework on the bridge without much trouble. The township purchased stone through the state contract, and Schlappich did the work at his regular hourly wage. The township was so pleased with the result that they tapped the mason to repair another stone bridge this spring.

The second bridge, over Birch Creek, is a single-barrel stone arch that, like the other restored span, can only be seen well from the creek. It just looks like a culvert from the road, Adam says. At some point, a metal pipe was inserted perpendicular to the bridge and paved over to expand it to two lanes. Flooding in 2006 damaged the pipe and weakened the roadbed, forcing a lane closure.

Once again, the road crew examined the damage and discovered another stone-arch bridge. "The engineer wanted to replace it with a precast concrete bridge," Adam says. Another option was to replace it with a concrete pipe. Instead, the township opted to widen the arch to accommodate the second lane and have Schlappich do the stonework. At press time, the prep work had been done and he had chosen the stone.

"If we didn't have this guy on the road crew, we would have replaced the bridges with concrete ones," Adam says. "These stone bridges have been there a long time and if properly maintained, last longer than concrete pipes or precast bridges."

Although the Swatara Creek bridge can't be seen easily from the road, now that people know about it, they drive out of their way to catch a glimpse of it, Adam says. "We're very proud of the job the crew did on the first bridge and know that the other will be just as good," she says.

While some would argue that context-sensitive design is not worth the effort if the bridge can't be seen, Adam disagrees. "We wanted to preserve the history, even though in both cases you can't appreciate it fully unless you're standing in the creek," she says.

Softening the blow

Given the number of bridges that need to be replaced in Pennsylvania, context-sensitive design is sure to remain in the forefront of the planning process, Rissler says.

"We're replacing a lot of historic bridges now," he says. "If we can design a bridge that is similar to the existing one or reflects some of its distinguishing characteristics, it softens the blow somewhat of having to replace it."

Bridge designers depend more and more on public input when replacing structures in community settings, PennDOT's Brian Hare says. Therefore, it would behoove townships to communicate their community's goals and values when the state or county schedules a bridge to be replaced within their borders. They might just be pleasantly surprised at the results. ✦