BETTER Bridges

by Tina Grady Barbaccia

Building blocks for bridges

Big chunks of polystyrene foam are helping rapid replacement bridge projects.

Constructing a bridge via Accelerated Bridge Construction (ABC) that uses lightweight fill material can involve what appears to be assembling giant building blocks. But these are made of polystyrene so contractors are working with huge plastic foam blocks.

"They are literally like assembling giant Lego blocks," explains Fred Doehring, deputy bridge engineer for the Utah Department of Transportation (UDOT). It's the use of innovative material such as this in construction that is enabling state agencies to speed up the repair of bridges.

UDOT believes that by using some of these innovative construction technologies, including Self-Propelled Modular Transporter (SPMTs) and Accelerated Bridge Construction (ABC), the agency was able to dramatically reduce the impact on roadway users of replacing Salt Lake City's I-215 bridge at 3300 South. The use of SPMTs – a series of hydraulic trailers – in conjunction with the lightweight expanded polystyrene Geofoam blocks rapidly sped up the replacement of the bridge, Doehring says.

Traditional bridge replacement requires lane closures and traffic impediments for many times a month a more, says Rick Chestnut, a principal at Terracon Engineering. However, with the I-215 at 3300 South bridge project, UDOT did a benefit-cost analysis of the project, known as the "delta" cost. It determined that using ABC technology would make a significant difference to the motoring public.

***Goefoam** blocks were stacked behind the abutment wall as backfill on the I-215 at 3300 South bridge project.*

Photo by Ralph L. Wadsworth Construction

The Utah I-215 at 3300 South bridge *moving onto Wasatch Boulevard by Self Propelled Modular Transports (SPMTs). The bridge weighed about 1.5 million pounds.*

Photo by Ralph L. Wadsworth Construction Company

Keeping open major arteries

When the UDOT put the structural repair of the bridge up for bid a requirement was to minimize delays. Utah's I-15 is the major corridor and I-215 wraps around it, making both highways major arteries. Shutting down the area or even rerouting traffic temporarily would be a major undertaking and severely interrupt traffic. That's why Ralph Wadsworth Construction, the contractor that UDOT ultimately awarded the job, proposed the project using ABC technology incorporating Geofoam (manufactured by ACH Foam) to minimize traffic impact. Just a year before, the I-215 bridge at 4500 South project also was completed through ABC by the same contractor.

"By using rapid replacement techniques, we only shut down I-215 for 19-1/2 hours," Bryan Jensen, field engineer with Draper, Utah-based Ralph Wadsworth Construction, points out. "After we reopened I-215, we finished the tie-ins and turned the bridge over to UDOT for use within eight days. According to UDOT, this was the fastest single-span bridge replacement. The rapid techniques allowed us to finish the bridge all within a short time frame instead of months of lane shifts and road restrictions."

Jensen notes that UDOT would only allow a window of 54 hours during with the bridge could be shutdown. "We accepted the challenge to do it," he says. Jensen is quick to point out, "With this project, it wasn't just about cost. UDOT was really good about considering the public's own time to make sure they aren't sitting in cars stuck behind orange barrels."

Although the substructure and superstructure took several months to complete, the impact on users was minimal until the bridge was ready to be removed and replaced. The success of this project and the other ABC projects completed by UDOT has led to a statewide adoption of this technology. In fact, UDOT is in the process of awarding a $1.2 billion ABC project – a single design-build contract – to reconstruct I-15 through Utah County.

UDOT has built/replaced 17 bridges using SPMTs, where sections of the bridge are built offsite and moved onsite by the special trailer transporters. The agency also has used several other methods of rapid replacement: It has completed five bridges where they were built adjacent to the existing bridge and then slid in place; two "drop in-place" bridges, where a superstructure is built and then cranes are used to put it into place and UDOT is currently working on its fourth and fifth bridge where all the components, including abutments, columns, bent caps, and decks, are pre-cast offsite and then hauled to the site.

"We've done a lot of tearing off of the old deck, where the existing girders are left in place and the deck is replaced using pre-cast deck panels," Doehring says.

Incorporating the use of a material such as the Geofoam in these rapid replacement projects is significantly more expensive than traditional fill material (dirt). "But the actual construction time and settlement time is significantly reduced," he says. As an owner, UDOT specifies lightweight fill material

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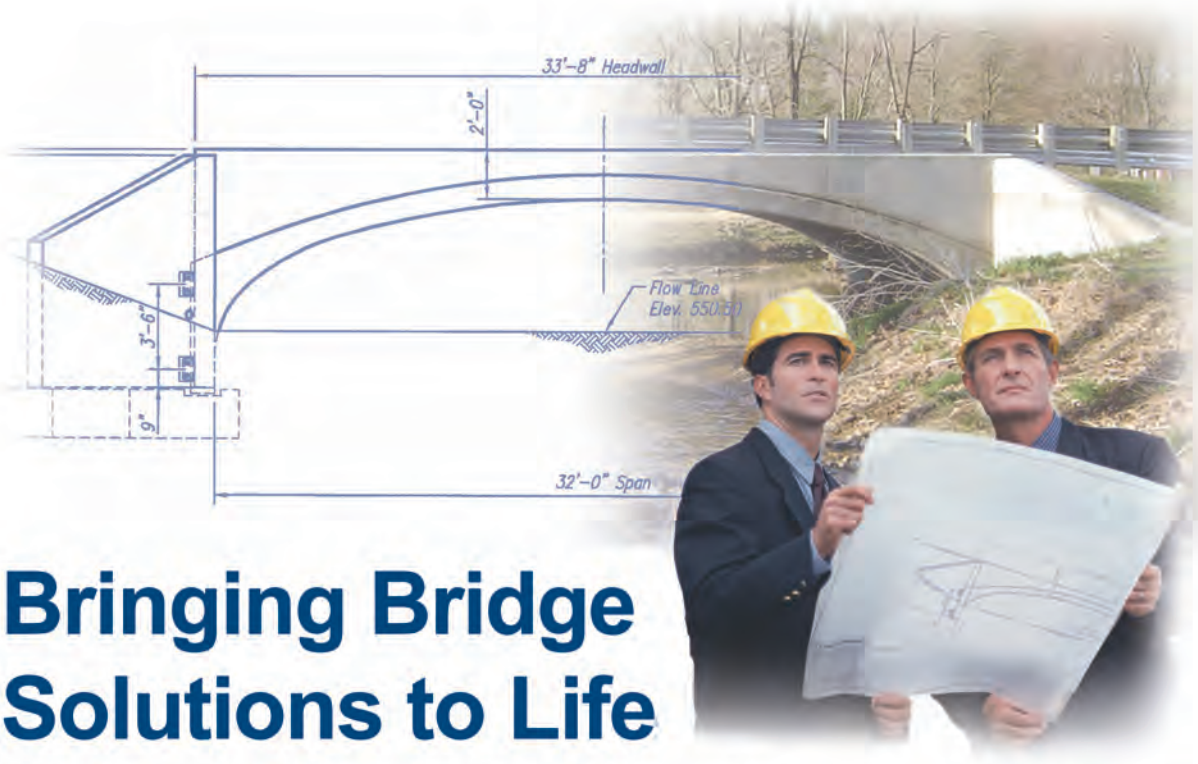

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> **When we build a new road or widen an existing road, we need time for the settlement to take place. This impacts the [construction] schedule.**
>
> — Fred Doehring,
> deputy bridge engineer for the Utah Department of Transportation

in areas where it believes settlement will be a concern. For example, if a sewer line is running under a fill slope, a low point can be created in the sewer if traditional fill is placed on top of it and settlement occurs. "We are liable for those damages to the sewer," Doehring says. "Oftentimes, we'll specify Geofoam over the critical utilities to avoid the relocation or replacement costs."

There are other lightweight fill materials available for use in ABC, including expanded shale material. It is lighter than traditional fill, costs less than Geofoam, and is another lightweight fill material in ABC. However, Doehring says that expanded shale is somewhat heavier than Geofoam, which is about 100 times lighter than soil and 20 to 30 times lighter compared to some other lightweight fill alternatives. "In some cases, it's just enough difference in weight where using the more expensive lightweight fill material will save you some headaches," Doehring says. And those headaches can ultimately put the brakes on a bridge reconstruction.

Making the decision: Traditional vs. ABC

Since replacing bridges quickly and with quality – but as economically as possible – is the goal, when does it make sense to use rapid reconstruction for bridges and when do you incorporate technology such as Geofoam? Doehring says the decision on the I-215 at 3300 South project to use ABC, and to incorporate the Geofoam, was made "so there weren't any settlement issues, which can sometimes take months".

"In this case, the bridge replacement [I-215 at 3300 South bridge project), the product was used to quickly fill the area behind the abutment," he continues. "In traditional construction, we would have had to get in there with dirt in 6- to 8-inch layers, compact it and then bring in the next layer."

UDOT used 24,200 cubic feet of EPS 22 Geofoam to reduce settlement on underlying soils and lateral pressure on the structural wall supporting at the bridge. Engineers used the Geofoam to reduce settlement of 20 feet of compressible clay in the soil beneath the I-215 bridge support sys-

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Just when you think . . .

Just 48 hours before the bridge was set to be moved 1.5 miles down city streets — and over utilities — by a 256-wheel Self-Propelled Modular Transporter (SPMT), one of the utility owners told the Utah Department of Transportation (UDOT) it wouldn't allow the superstructure to be moved across the area. "We had talked with the city, had talked to all of the utility people and had clearance from them to move this bridge," says Fred Doehring, deputy bridge engineer for the Utah Department of Transportation. "But then one of them said we couldn't drive over that area, even though we had the permit."

"Utility owners get very scared then a 2 million pound bridge coming down the road," Doehring continues. "But the way we move the bridges [on the SPMTs], the per-wheel-load is less than a garbage truck."

This was a learning experience for both UDOT and the contractor. "We talked to the people at the normal number we call when working on projects," Doehring says. "But it turns out that we were talking to the low-pressure gas line people when we needed to be talking to the high-pressure gas line people. We did everything we could and were supposed to do, but apparently, we needed to do more." Adds Bryan Jensen, field engineer with Ralph Wadsworth Construction, which was the contractor for the I-215 Bridge at 330 South: "Some of the biggest headaches are coordination efforts."

The lesson learned? "You have to make sure you are talking to the right people in the organization," Doehring says, adding that even if the person at a DOT who is coordinating a project is working with the person with whom he or she typically contacts, it's necessary to verify and re-verify that someone else does not need to be contacted. The problem with the utility company was solved "though a lot of heated negotiations and studies to show that we wouldn't damage their pipe," Doehring says. "We compromised and ended up putting steel plates over their pipe. We didn't feel it was necessary, but we did it to keep them happy. We definitely learned the need for constant good communication with utility owners and local governments."

tem. Using traditional fill material, such as soil, would have caused significant settlement problems and possible structural damage to the bridge.

With lightweight material, there aren't settlement issues. The Salt Lake Valley rests on a lakebed. With traditional fill, there can be several feet of settlement, Doehring says. "When we build a new road or widen an existing road, we need time for the settlement to take place. This impacts the [construction] schedule."

He also points out that the construction work areas were very confined. "It was only about 10-foot-wide between the old and the new abutments," Doehring says. "One of the big advantages of using a lightweight material is that two men could literally pick it up and put it in place. This probably saved at least a week for both abutments."

UDOT's "delta" cost analysis – i.e. the difference in cost of Accelerated Bridge Construction versus impacts to the general public with delays by using traditional construction methods – was on the order of nearly $4 million if a crossover was used in the re-routing of traffic with a reduction in speed limit from 65 mph to 55 mph Doehring notes. "A year to replace that bridge with the traditional method at about $20,000 per day adds up pretty quickly," he says. "It's very impactive to have to close the freeway for a weekend (which had to be done with the I-215 at 3300 South bridge project)." But Doehring quickly adds that, "You're looking at tens of thousands of dollars in user costs to do this with the rapid reconstruction versus millions of dollars to reroute traffic for a year." Closing the highway for a weekend came up to a ballpark figure of about $50,000 while the bridge was replaced, he says.

By using rapid replacement *the I-215 at 3300 South bridge was only shut down for 19-1/2 hours. After the bridge was re-opened, the bridge was turned over to the Utah Department of Transportation for use within eight days. According to UDOT, this was the fastest single-span bridge replacement.*

Photo courtesy of Utah Department of Transportation

The place where cast-in-place, the traditional method of bridge construction, may make sense is on a new road – a new alignment – a Greenfield project where the bridge is not on the critical path, Doehring says. "In many cases, it will take longer to build the roads between the bridges than to build the bridges themselves," he says. However, Doehring notes, every day that a facility is open earlier, it's a benefit to the traveling public. "Every day we delay opening a road, there is an opportunity cost to the public," he points out. "The road is being built for a reason…there is a demand. That's how we calculate benefit-to-cost ratio."

Does new technology mean new problems?

Doehring says UDOT has been using Geofoam extensively since the late 1990s and compromised safety hasn't been a problem. "We've been monitoring it closely and haven't had any issues with it," he says. The one concern that could potentially cause a problem was addressed prior to any installation of the material. "It is susceptible to damage from petroleum products, such as if a diesel tanker were to spill on the road and it seeped down," Doehring says. "It could melt away our fill slope." Pouring a concrete cap on top of the Geofoam and then sealing it with a membrane – a big rubber sheet on top of it, solved this prospective problem. "This keeps any petroleum products from making its way down to the foam," he says.

A material as lightweight as Geofoam has the appearance of not being very strong, thus, raising concerns about its ability to handle loads. However, the lightweight material has strength comparable to traditional soil as well as foamed concrete, waste tires, woodchips and wood fiber.

To address the issue of bridges with ABC technology needing added maintenance – a real concern for many agencies who already have a strapped budget and a skeleton crew of personnel – Doehring says, "We're designing these as much like traditional bridges as we can so we don't have to do anything special to them." However, he says, "We are still fairly new to these ABC methods. This is a new area and new techniques are being used. I don't think there will be any additional concerns, but it is important to keep an eye on it. We'll see in the next 10 to 15 years if we need to do anything differently." ❖