Deep under cover

Lightweight fill solves storm-water culvert issues

By Laura Drotleff and Don Eberly
Contributing Authors

The final segment of work required to connect Corridor X, soon to be known as I-22, with I-65 in Birmingham, Ala., presented an unseen challenge. The Corridor X interchange begins northwest of I-65 and extends southeast of I-65 to U.S. 31.

The interchange is complex geometrically, with four levels and nearly 20 bridges, and traffic is busy on I-65, requiring extra lanes. Finally, the environmental factors are sensitive, and several utility lines run through the area, including an existing concrete drainage system that must shoulder the weight of the new traffic lanes.

The finished interchange construction project will complete Alabama's 96-mile portion of the Birmingham-to-Memphis I-22 and connect it to I-65.

"Construction of the interchange is the largest and most expensive project the Alabama Department of Transportation [ALDOT] has awarded in more than 40 years," said ALDOT spokesperson Tony Harris. Construction began in August 2010 with a contract completion date of Oct. 15, 2014.

As with all projects of this magnitude, there are challenges that arise along the path to completion—some of which lie below the surface. In the case of Corridor X, one such challenge was addressed with a resourceful approach.

Blasting ahead

Contracted to Atlanta-based Archer Western, much of the initial work required blasting, drilling and hauling away rock before construction could begin. According to Michael Chance, one of two Archer Western civil superintendents on the job, the crew performed a mass excavation

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>
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of dirt and rock required to extend the six-lane highway to eight lanes—four in each direction.

"The big trial for the crew was the amount of rock; this includes drilling and blasting 1.9 million yards of material that also have to be moved on-site," Chance said. "It was challenging to coordinate trucks and operations to keep production on track."

Still, he and his team forged ahead with a good measure of excavation ingenuity, unearthing and realigning the groundwork phase by phase.

Chance is in charge of all grading and underground utilities, including storm sewers, water lines, guardrails and proper signage. Archer Western also has two bridge superintendents and a senior superintendent overseeing the work. Upon completion, the four-level interchange will measure 85 ft tall and span 1.5 miles long, including 18 bridges and five ramps.

Under pressure

The project's groundward challenge and, ultimately, its engineering feat came into play with an existing concrete drainage system that runs north of the interchange, along 1-65 and I-31. The system drains storm-water runoff for hundreds of acres along the highway, so it is a crucial part of the infrastructure that must be protected.

Widening of the road required construction of two new traffic lanes, which would be built over portions of the drainage system, where half of the drainage system's box culvert would be under traffic and the other half would face the adjacent slope. ALDOT wanted to ensure the box culvert, some 25 ft underground, would be cushioned from the load—the material covering the culvert, the new roadway and the weight of eventual traffic.

In three 250-ft-long spans, the team had to excavate down to the box culvert, inspect it for damage and cracks, wash it off and cover it with a black membrane and adhesive to seal it. Then, fill material was necessary to bring the area back up to grade and accommodate the load. The problem was in that the weight of ordinary soil and fill material, plus the weight and wear-and-tear of traffic, could cause the box culvert to be overstressed and potentially crack.

Engineers determined the use of a lightweight aggregate as a fill material, at half the weight of ordinary fill, should

replace more widely used material like ordinary soil, sand or gravel.

"But getting the gradation down to the necessary weight was an issue for the local aggregate supplier in Birmingham," said Chance. A lighter weight specification was necessary, which he determined was possible with the use of Riverlite, a lightweight aggregate manufactured by Big River Industries.

"Our requirement was to get the weight of the lightweight aggregate down to 77 lb per cubic foot," Chance said. "The lightweight aggregate fill took all of the direct weight and pressure off the top of the culvert." In fact, the lightweight aggregate fill was well below the design density, with compacted densities of less than 60 lb per cubic foot.

Rotary kiln-produced expanded clay lightweight aggregate has been effectively used for almost 50 years to solve geotechnical engineering problems and to convert unstable soil into usable land. The aggregate used in this geotechnical application is manufactured at Big River's Livingston, Ala., plant.

"When we mine our clay, we bring it into a shed to control the moisture," explained Jeff Speck, Big River Industries' vice president of sales and marketing. "We process it by heating it to about 2,000°F in a rotary kiln. After it cools, it's no longer clay. It's a ceramic, hard, inert aggregate. It's structural and very tough. After the material cools, we crush, screen and grade it to customer specifications."

Protecting a concrete pipe or culvert from being damaged by weight is a relatively new application for the product.

"Corridor X is only the second project of this type for which we've supplied lightweight aggregate for fill over the top of a pipe that's buried deep beneath a highway. It's a strategic application of lightweight aggregate because it reduces the load on the pipe or box culvert by more than half, as compared to normal weight material," Speck said. The aggregate has very low density and an extremely high angle of internal friction; thus, the pressure is greatly reduced.

Up to grade

An average of 10 trucks a day delivered loads of lightweight aggregate from the Livingston facility, about two hours south of the jobsite. Because it is lightweight, coarse and noncompacting, a straight mix could be used to backfill the trench, directly on top of the membrane-covered culvert, without having to use any equipment to tamp

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After two weeks of placement, the culvert was again deep underground and the crew set to work paving the filled-in trench. For Chance and his crew, next steps involved backfilling the last section of the culvert, approximately 800 ft farther south, and putting this section of the project in the rearview mirror.

Eventually, tons of traffic will travel over the area, with drivers never aware what lies beneath the surface and the requirements that make new lanes like these a reality. **R&B**

Drotleff and Eberly are with Eberly & Collard Public Relations, a national firm specializing in research, writing and marketing within the design, architecture, building and engineering industries.

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