

## Variations on a theme

### Projects demonstrate design and application options for retaining walls.

By Bob Drake

Adjacent to highways, streams, runways, and other structures and land developments, segmental and mechanically stabilized earth retaining wall systems are solving many grade-separation, slope stability, and erosion control problems. Retaining wall manufacturers provided the following project summaries demonstrating a variety of successful applications.

#### U.S. Highway 285, Conifer, Colo.

U.S. Highway 285 is a main route for Denver and mountain-area commuters. Every day, more than 17,000 vehicles passed through one of its signal-free intersections known as Shaffer's Crossing, located southwest of Conifer, Colo. The Colorado Department of Transportation (CDOT) completely redesigned the intersection to create a new interchange incorporating an embankment supported by a concrete segmental retaining wall (SRW) that elevates the highway to enhance traffic flow and improve safety. The SRW used is the Anchor Diamond Pro system.

Sean Chiang, P.E., the principal engineer with Ground Engineering Consultants in Denver, designed the 65,000-square-foot SRW and embankment that support the roadway. Design considerations required the installation to occur at the bottom of a slope and above a creek. Wall heights reach 53 feet. Chiang also incorporated features that were predesigned by CDOT engineers to accommodate environmental and site conditions, including two large culverts to handle spring flooding and a wildlife passage integrated into the wall for the area's elk and deer.

CDOT specifies SRW systems for road construction projects because of cost efficiency and aesthetics. The Anchor Diamond Pro Stone Cut system has been used by CDOT in other projects, including a 28,000-square-foot project on U.S. Highway 40 in Golden, Colo. For the Shaffer's Crossing project, the block system had to meet freeze-thaw testing criteria. Additionally, CDOT includes strict aesthetic specifications to ensure completed projects complement the surrounding mountains and wildlife areas. The Diamond Pro Stone Cut wall system offers 8-inch-tall blocks in lengths of 7, 11, and 18 inches that complement the area's rock outcroppings. Local manufacturer Pavestone Co. in Henderson, Colo., manufactured two color blends — antique pewter and tan brown — with block sizes and colors installed randomly to further blend in with the surroundings.

*Information provided by Anchor Wall Systems Inc.*

#### Shopping center, Strongsville, Ohio

Visconsi Companies, a shopping center developer in Ohio, challenged Boulderscape to create a fractured rock granite finish to a series of seven retaining walls within a major shopping center in Strongsville, Ohio. The more than 22,000-square-foot project included creating seven sculpted, fractured rock light pole bases and staining an existing gravity wall.

Visconsi hired contractor Great Lakes Construction Co. in the spring of 2008. "They asked us to call in Boulderscape for this project because they wanted something unique and natural looking," said Adam Dougher, a superintendent at Great Lakes. "The original plan called for standard modular brick walls with the use of a manufactured stone veneer finish, but Visconsi knew what they wanted and Boulderscape's bid was less than other comparable wall facings."

By working with color and emulating what is seen in nature, Boulderscape was able to create computerized renditions of the wall for the client's approval.

Great Lakes built the cast-in-place walls and then Boulderscape drilled dowels, added mesh, and sprayed two layers of shotcrete before sculpting the walls. Its team came in 12 to 48 hours later to apply the color stain, giving the walls a fractured rock finish based on natural geology in the area.

"Visconsi saved 30 percent off the cost of the project by switching from a veneer stone to Boulderscape," said Steve Jimenez, vice president of commercial sales at Boulderscape. "What would have taken at least 40 days to complete using the modular brick and stone veneer wall idea took less time with Boulderscape, and the results were much more dramatic."

*Information provided by Boulderscape*

#### Rocky Mountain Metropolitan Airport, Broomfield, Colo.

When drivers pass Rocky Mountain Metropolitan Airport (RMMA) along Colorado State Highway 128, they see a soaring retaining wall adorned with the airport's logo in earth tones that coordinate with the surrounding landscape. Located in suburban Broomfield, Colo., between Denver and Boulder, RMMA is owned and operated by Jefferson County. When recent FAA-funded airport improvements included the extension of a taxiway to accommodate bigger aircraft, the project required an expansive retaining wall.

Original plans specified a concrete panel wall system, but with the help of Keystone Retaining Wall Systems' engineering department, Craig Lyons of Boral Best Block, Littleton, Colo., demonstrated that a SRW using the Keystone KeyGrid

System would be a more economical and appealing option. The resulting project not only saved the county money, but also met the airport's tight construction timeline. Keystone was able to integrate the airport's logo into the wall with custom colors.

More than 32,000 square feet of Keystone Compac II units were used in the project. The wall includes a 675-foot-long lower tier with a maximum height of 55 feet, and a 735-foot-long upper tier with a maximum height of about 15 feet. A new access road runs between the two tiers.

Cost savings were achieved with the type and amount of soil reinforcement used. "Our goal was to use geogrid, a less expensive option than steel, and use an economical amount of it," said Artur Sakaev, staff engineer for Keystone. With a combination of Compac II units and Mirafi geogrid, Sakaev created a highly efficient design that met strict American Association of State Highway and Transportation Officials (AASHTO) and CDOT standards.

Engineers created mock-up walls using different colored blocks to enable airport officials to choose the correct color. Because of the high profile of the wall, the color and look was extremely important. "We wanted to keep the wall color close to the colors in the surrounding area," said Ken Maenpa, airport manager. "We're extremely pleased with how the project turned out. We know we got the best value instead of just a wall."

*Information provided by Keystone Retaining Wall Systems*

### Stream bank, Florence, Ky.

When a sharp turn in a stream began eroding homeowners' yards during storm events, the city of Florence, Ky., needed a solution — and fast. Erosion to the 10-foot-high stream bank was becoming a major issue. The city worked with engineers from Viox & Viox and H. C. Nutting/Terracon, held public meetings, and met with property owners as they worked toward a solution.

The city's goals for the project included stabilizing the stream banks and creating an aesthetically pleasing green area along the creek. Minimizing excavation and disturbance to residential yards was also a priority.

After photo documentation of the site, H. C. Nutting/Terracon performed global and internal stability calculations for the channel walls and designed erosion control features. The designs called for a reinforced footer to act as the base of the wall. On top of the footer, two courses of 60-inch-deep Redi-Rock bottom blocks were installed, with 41-inch-deep Redi-Rock blocks for the rest of the wall.

"The flow from one of the creeks was overriding the top of the wall, so we designed a controlled density fill to reinforce the back of the wall. We made the wall impermeable to water to prevent erosion or scour from behind the wall," said Jeff Barrow, P.E., H.C. Nutting/Terracon.

Because of environmental permitting, the entire channel had



Anchor Wall Systems Inc.

The Shaffer's Crossing interchange included segmental retaining walls that reached heights of 53 feet. To meet the high aesthetic standards of the project, two colors of the Diamond Pro Stone Cut wall system were installed randomly.



Boulderscape

A shopping center developer in Ohio challenged Boulderscape to apply a fractured rock granite finish that matches the area geology to a series of seven retaining walls.



Keystone Retaining Wall Systems

The Rocky Mountain Metropolitan Airport's retaining wall features the airport's logo built out of Compac II segmental units in a contrasting color.

## ENGINEERED SOLUTIONS

to be constructed from the top of the stream banks. Contractor Dudley Construction Co. cut benches along the creek banks and selected Redi-Rock of Kentuckiana to assemble the wall.

In total, the 4,800-square-foot combination of walls took less than two weeks to install. At the highest point, the walls stand 13-1/2 feet tall. Once the walls were completed, Dudley Construction Co. installed a decorative metal fence along the top edge of the channel.

“The ability to construct the wall without geogrid reinforcement was critically important to this project,” said Justin M. Verst, P.E., with Viox & Viox. “The construction space was tight.”

Peter Glenn, project manager for the city of Florence, said: “We originally considered using gabion baskets or plain con-

crete walls, but we wanted an aesthetic finish to the channel. We chose Redi-Rock because we had more finish options, including the new LedgeStone face.”

One-ton Redi-Rock blocks harness the power of gravity to build tall walls that often don't require reinforcement. For this project, the ability to build the 13-1/2-foot-high channel walls without reinforcement minimized excavation and disturbance to adjacent properties and yards.

Redi-Rock's new LedgeStone face “matches the Cincinnati and northern Kentucky limestone bedrock we have in our area, so it's very visually appealing,” Barrow said.

*Information provided by Redi-Rock International*

### I-15 North Corridor, Las Vegas

In May 2007, the Nevada Department of Transportation (NDOT) received proposals for widening Interstate 15, north of downtown Las Vegas. This portion of I-15, built in the 1960s with no major improvements since its opening, has witnessed traffic grow to more than 170,000 vehicles per day.

The design-build project was awarded to North Corridor Constructors (NCC), a joint venture between CH2M HILL and Las Vegas Paving Corp. In March 2008, NCC issued The Reinforced Earth Company (RECo) a contract for the design and supply of 29 walls totaling 189,100 square feet — 123,000 square feet of mechanically stabilized earth (MSE) walls directly support a roadway and 65,100 square feet of MSE walls were designed under bridge abutments. The walls were designed to support an additional lateral load of 40,000 pounds per pile imposed by bridge movement during a potential seismic event.

As NCC progressed in the design, it quickly realized the potential savings in using MSE walls under bridge abutments as opposed to traditional cast-in-place retaining walls. However, design of these walls was a challenge because the severe skew between I-15 and the surface streets resulted in acute corners with angles as small as 50 degrees. RECo's reinforcing strip system consists of discrete soil reinforcements bolted to a precast panel. The bolted connection allows skewing of the reinforcing strip and facilitates its installation around obstructions such as abutment piles. In addition, the reinforcing strips may be used in acute corner situations to tie across each face of the corner.

RECo designed the acute corners with bin walls using a combination of precast panel walls and galvanized wire-faced walls. Tied-across reinforcing strips and long skewed reinforcing strips were utilized to stabilize the acute corner bin walls against the imposed earth pressure loads. Permanent wire walls also were used in phase two to eliminate any side earth pressure on the bin walls.

In December 2009, NCC celebrated the early completion of the project after a total project duration of 28 months, which enabled NDOT to shave a year off the project timeline.

*Information provided by The Reinforced Earth Company* ■



Redi-Rock International

One-ton Redi-Rock blocks create inside and outside curves for this stream bank application. These walls were engineered to withstand high water flows and include design features that allow water to flow up over the wall in one section without causing damage.



The Reinforced Earth Company

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