Concrete Landscape DESIGNS

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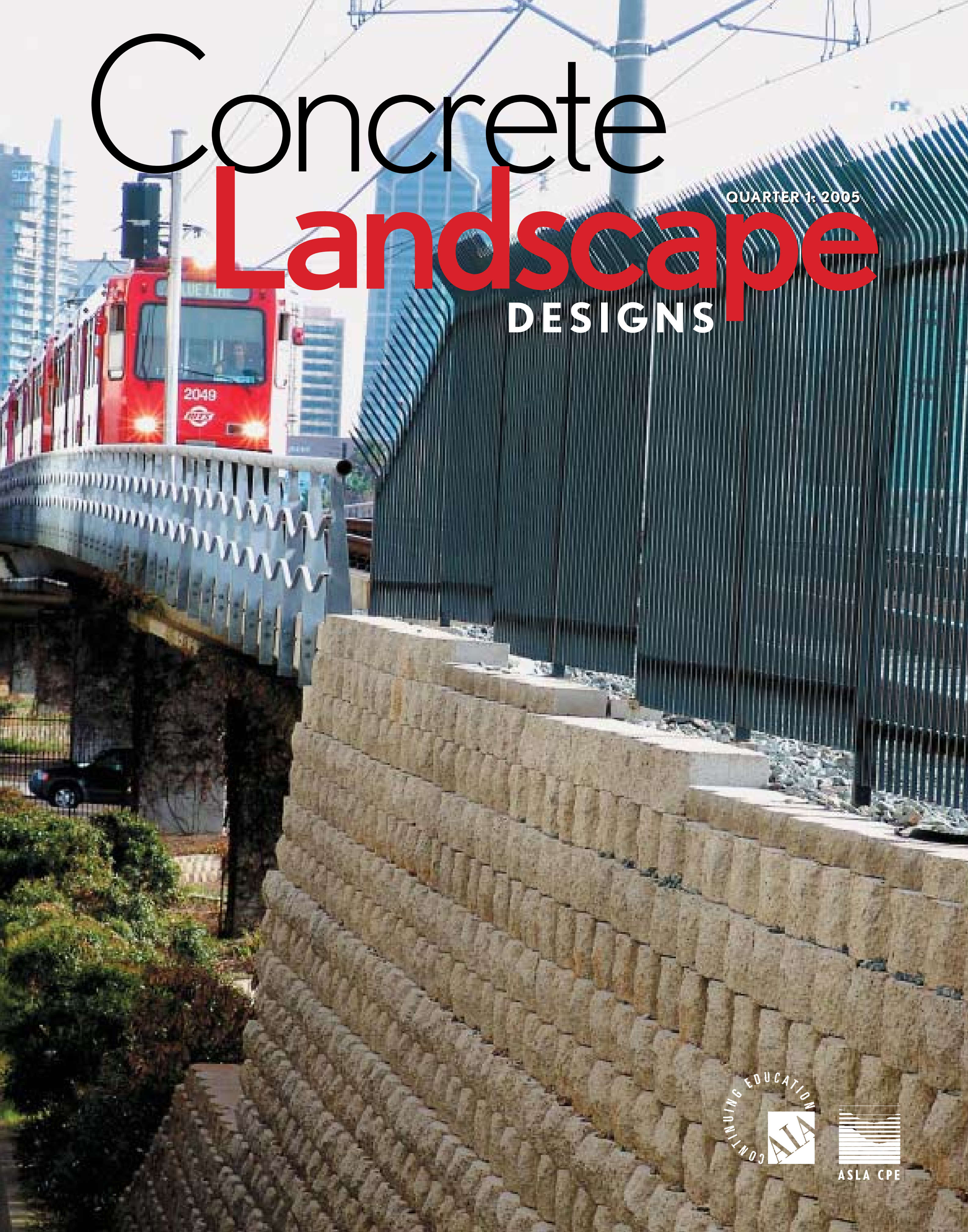

Re

taining Value

By Deborah Rider Allen

For the past ten years segmental retaining walls on the abutments and approaches to the San Diego trolley bridge over Laurel Street and Pacific Coast Highway in San Diego, California, have been a testimonial to the high performance of segmental retaining wall systems. Built at a time when stackable, mortarless concrete retaining walls were just breaking in to the market, it took the hard work of consultants, engineers and researchers to convince the Metropolitan Transit Development Board (MTDB) to build with it. They proved they could use a stackable interlocking concrete block, segmental retaining wall units, reinforced with a geosynthetic soil reinforcement anchorage system behind the facing that would save them time and money. And after ten years of superior performance, this segmental retaining wall stands as a symbol of enduring value.

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AIA/ASLA Learning Objective

After reading this article you should understand: The requirements of designing a segmental retaining wall system for transportation use

In 1994 Bob Basye, an earth retention consultant, was the designer on the project. “The original plans were for a different system that they had experience with but we changed their minds through value analysis,” said Basye explaining that his design called for concrete split-faced units for the vertical wall on the east side and plantable concrete units on the west side with reinforcement through layers of geogrid and compacting the soil. The entire project consists of 21,700 square feet (2,106 square meters) of segmental retaining wall that attaches to bridge abutments. The abutments are on caissons and the walls go up to and around the abutment and caissons to a maximum height of about 25 feet (8 meters).

Bayse specified standard split face units sized at 8 × 18 × 21 inches (203 × 457 × 533 mm) with an exposed face area of 1 square foot (.09 square meter) for the vertical wall on the east side. For the west side Bayse specified a combination of standard units and planter units 8 × 18 × 21 inches (203 × 457 × 533 mm) that have a one gallon (3.8 liter) planter cell, an indentation for drip irrigation lines and a hole in the base for root access. “The reason they wanted planters on the west side is that it is visible from the waterfront,” he said, adding that he used a computer design program to design the project.

Both products utilize a fiberglass pin system that provides a shear connector, geogrid proof positive holder and alignment device in one piece. The pins are 0.5 × 5.25 inch (12.7 × 133 mm) with 110,000 psi (758 megapascals) tensile strength, 0.5 × 5.25 inch (12.7 × 133 mm) flexural strength and 6,400 psi (44 megapascals) short beam shear strength. The pins ensure a positive mechanical connection between the structural wall unit and the geosynthetic soil reinforcement.

The site called for a near-vertical wall to fit into the space and segmental retaining walls were able to solve this building challenge.

Laurel Street and Pacific Coast Highway

Location: San Diego, California
Owner: Metropolitan Transit Development Board (MTDB)
Contractor: Herzog Contracting Corporation
Designer: Bob Basye
Geotechnical Engineer: Woodward Clyde
Structural Engineer: Daniel Engineering
Supplier: RCP Block and Brick
Year Built: 1994
Coverage: 21,700 ft^2 (2016 m^2)
Time to complete: 50 days
Cost: $500,000
Repair costs: $0

The walls are reinforced with geogrid that is manufactured with high molecular weight, high density, and high tenacity polyester yarn. Open apertures of the geogrid fit over the fiberglass pins in each block, perpendicular to the face of the wall at various points. The pins penetrate the soil from the back of the block at least 60 percent of the height of the wall section.

The entire segmental retaining wall system for the Laurel Street and Pacific Coast Highway section of the San Diego trolley was erected by excavating a shallow trench wide enough to fit the units and with enough space behind for a granular backfill drainage zone. The prepared base was leveled and compacted to 95 percent Standard Proctor or

greater with six inches (152 mm) of well-compacted granular fill. Because the bottom of the wall was sitting on poor soil matter, the whole base was reinforced with geogrid.

The base course of units were placed side by side (with sides touching) on the prepared base, with the unit's void facing down and the pinholes facing up. Two pins were placed into the paired holes in each unit using the front holes for the near vertical setbacks and the rear holes for the one-inch (25 mm) plantable setback. One-half inch to 0.75 inch (13 to 19 mm) crushed angular stone was used to fill in all voids. This was compacted and then it was backfilled with existing soil. Additional courses were added by placing the units over the fiberglass pins, fitting the pins into the kidney-shaped recesses and centering the unit over the two underlying units until it made full contact with both pins. Geogrid was added between courses as needed.

The walls were completed using segmental retaining wall caps, backfilling, compacting and grading the site. Landscape architects then put plants in the planter units. The project was completed in about 50 days and utilized lightweight equipment, like Bobcats, small front-end loaders and walk-behind compaction equipment.

Bayse value engineered the project for MTDB proving that there was a definite cost savings by using the segmental retaining wall units as opposed to the wall system that had been originally specified.

"I do know that it did save the project a considerable amount of money," said John Haggerty, design engineer for San Diego Association of Government who in 1994 was with MTDB as a design engineer for the project and was one of the persons responsible for researching the segmental retaining wall data. "We had seen the strap walls before but we did not have any experience with this type of system prior to that."


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Haggerty also said that besides costs savings, MTDB made the choice to use a segmental retaining wall system because it allowed them to use a more vertical pattern than the original system that had been specified. The site called for a near-vertical wall to fit into the space and segmental retaining walls were able to solve this building challenge.

Concrete masonry became the best choice for this project due to the tight clearance between the wall and the adjacent light rail tracks. The trolley track uses electricity through the rail system and segmental retaining walls were a good choice for this project because they provide a non-corrosive application area for the track.

"From our standpoint the approach and abutment has performed well and I am not aware of any settlement or track realignment that has occurred with regard to maintainability," said Haggerty. "We are happy with the abutments to the bridge and with the two approaches. We do not do the day-to-day maintenance but if something catastrophic happened we would be called in and we have not had to do anything to it since we turned it over to the San Diego Trolley."

Fred Byle, superintendent of wayside maintenance for San Diego Trolley, said that there has been a quarter to a half an inch (6.4 to 12.7 mm) of settlement of the track which is normal for this type of track configuration and common to bridge approaches. "But that has nothing to do with the walls," he said. "We have not had any problem with the wall. It is attractive and it holds up well."

In the case of the Laurel Street and Pacific Coast highway project segmental retaining walls were the right choice because they are not only attractive but they retain their retaining value. ■

Masonry Arches Carry the Load

While not used on the attached project, mortared masonry arches are a common method of spanning openings. From flat to jack, segmental, parabolic, circular and pointed gothic, fixed concrete masonry arches add beauty to any masonry project while also providing strength and support. These rigid spans curving upward between two points of support were originally developed for their firmness and stability to support the lofty spacious interiors of gothic cathedrals while minimizing the outward thrust. But as they also provided an ornamental effect, they quickly became a norm in adding attractiveness to masonry construction.

The most common concrete masonry arch is the minor arch. This arch is limited to about six feet (1.8 m) with a rise-to-span ratio that does not exceed 0.15 and can carry loads of up to 1500 pounds per foot (560 kg per meter) of span. Because this load can be subjected to shear, movement and thrust, the construction of masonry arches must be done with quality concrete masonry units, mortar and superior workmanship.

Concrete masonry units for arch construction should be one of three types: 100 percent solid, filled units or filled cell construction. The mortar or bond of these units is of paramount importance and though often difficult to do, all mortar joints in the arch must be completely filled in order to have sufficient shear resistance to withstand the imposing loads.

In order to construct the arch, most concrete masonry arches are built using a temporary support or form to hold it in place. The form is kept in place until the mortar has completely cured, leaving the arch strong enough to carry the loads to which it will be subjected. In the case of reinforced masonry arches, the forms are often kept in place at least a week after construction.

It is also important that the supporting walls that abut the arch be constructed so that the length of the span is consistent, the elevations of the arch ends are unchanged and the inclinations of the skewback remain fixed. Without these three conditions, sliding, settlement or rotation of the supporting abutments may occur. If done correctly, the masonry wall and the arch provides resistance to any progressive failure and even if a hole is put in the masonry wall, the arch over the opening will continue to carry the load and not fall down. Additional information on design and construction of arches can be found in NCMA TEK 14-14 "Concrete Masonry Arches" available on the web.