Flood and Environmental Protection

Mark Krebs, P.E.
President, Pacific Advanced Civil Engineering, Inc.
Huntington Beach, California

The Santa Clara River is one of the few remaining "natural" dry-rivers in Los Angeles County, and the community and environmental agencies are determined to keep it as "natural" as possible, while still providing appropriate flood protection for the area. Concerned about the lack of environmental sensitivity inherent to traditional methods of bank protection, the City of Santa Clarita and the project developer, Newhall Land and Farming Company, collaborated to investigate alternative methods of providing flood control for the residential and commercial Bridgeport development. Newhall turned to Pacific Advanced Civil Engineering, Inc. (PACE) and soil-cement technology for an innovative, environmentally sensitive, and cost-effective solution.

Soil-Cement Solution

PACE provided Newhall with bank stabilization design that provides adequate protection for the Bridgeport development and satisfies the environmental sensitivity necessary for construction within the Santa Clara River buffer. The lower level of bank protection design includes two levels of soil-cement connected by overbank grade control structures in a ladder-like framework, parallel to the river. The lower level offers scour and flood protection up to the 100-year storm event, while the upper level offers protection against the Los Angeles County Department of Public Works (LACDPW) Flood Control Division Capital Flood. The Capital Flood assesses the flows from the 1,640-square-mile (4,250-km^2) watershed including flow

View of completed bank stabilization. Soil-cement is buried beneath recreational trail and landscaping.

First lift of soil-cement being spread at elevation of maximum scour depth.

bulking as a result of a burnt watershed. The lower level of bank protection offers security from flows of approximately 35,000 cubic feet per second (1,000 m^3/sec), while the upper level provides protection from flows of 118,000 cfs (3,400 m^3/sec).

Both levels of bank protection are placed at a 1:1 slope and followed conventional soil-cement design and construction standards. Typical heights for the lower level range from 13 to 22 feet (4 to 6.7 m), while upper level heights are 7 to 19 feet (2.1 to 5.8 m). The project's soil-cement specifications called for a 7-day compressive strength of 750 psi (5.2 MPa). However, the actual 7-day average was in excess of 1,100 psi (7.6 MPa). Over 85,000 cubic yards (65,000 m^3) of soil-cement was placed to complete the bank protection along 10,500 linear feet (3,200 m) of the river. The cement content varied between 8% and 10%, based upon the variation in the base material. Construction costs for the soil-cement placement, including excavation, backfill, and finish grading, were between $300 and $400 per foot ($90 and $120 per m). Upon completion, most of the soil-cement bank protection was buried and the backfill stabilized by the revegetation of the disturbed overbank area.

The soil-cement bank stabilization along the Santa Clara River provides unique engineering and environmental benefits:

- Flood protection for the adjacent residential and commercial development
- Erosion protection within the river overbank area
- Elimination of costly, unsightly, and environmentally unfriendly bank protection systems that traditional design methods would require

Vibratory compactor shown compacting soil-cement lift.

Benefits for the Bridgeport Community

The bi-level soil-cement bank protection is a superior alternative to the concrete or rip-rap linings traditionally used along the Santa Clara River, providing unique benefits in terms of:

Safety The creation of a stabilized overbank area reduces flow depths and velocities at the river's edge, allowing improved public access into and out of the river in an emergency.

Flood conveyance The soil-cement bank stabilization system provides proven flood protection to convey the project design storm flows within the main river channel, while maintaining lower velocities in the overbank area, which will preserve vegetation.

Durability and maintenance Soil-cement is a highly durable and stable erosion protection system requiring minimal maintenance.

Environmental resource protection Soil-cement significantly reduces the amount of natural resources used in the construction process. With approximately 90% of soil-cement being on-site natural material, only 10% (cement) requires transport to the site. Reduced consumption of natural resources also reduces the amount of traffic, pollution, and overall "cost" to the environment associated with the soil-cement bank protection system. The bi-level bank design also results in less excavation and disturbance of the existing environmental resource area.

Recreational amenity The moderately sloped (approximately 6:1), stabilized river overbank area offers an enhanced area for revegetation and recreation, including an equestrian trail.

Aesthetics Soil-cement bank protection is 70% – 100% buried, which allows for minimal visual impact to the environment. Moreover, the natural embankment stabilization material (soil-cement) is 90% native

Continued on next page

Soil-Cement *Solutions*
Featuring In-depth Soil-Cement Projects

Soil-Cement Solutions is published by the Public Works department of the Portland Cement Association. Direct comments, address changes, and subscription requests to:

Randy Bass
Program Manager
Water Resources

The Portland Cement Association conducts extensive research, market development, and educational work on behalf of its members — cement companies in the U.S. and Canada.

For more information, visit the PCA Web site at **www.cement.org.**

Continued from previous page

and will blend into the surrounding environment wherever and whenever exposure occurs.

A Victory for Bridgeport and the Environment

Soil-cement has proven itself to be a highly reliable, durable, and safe means of flood control protection. Bridgeport's use of it in an innovative, bi-level design is a viable alternative to more traditional bank protection systems, providing benefits in terms of safety, cost-effectiveness, and environmental sensitivity that concrete and riprap linings cannot match. Several single-level (typical) soil-cement bank protection projects have been completed along the Santa Clara River watershed area, successfully providing environmentally sensitive bank protection. Single-level or bi-level soil-cement design produces a win for environmental resources, the public, flood control agencies, and developers. As the Bridgeport project has shown, with the right planning and engineering, development and the environment can coexist in harmony.

Continued from page 5 - **Thin Soil-Cement Protection**

Since the slopes were over 120 feet (37 m) long, placement of the soil-cement on the slopes exceeded the allowable time between mixing and compaction if placed in one section from bottom to top. Placement on about a third of the slope at a time worked best. This allowed placement of a wider area, which helped with the lateral stability of the soil-cement while meeting the time limit.

During placement, wrinkles caused by heating of the liner in the Texas sun worked their way up the slope and were pulled out in the anchor trench at the top of the slope. The ramp was fashioned last using some of the techniques employed for the haul road. The east reservoir was constructed in a similar manner.

The placement method required some trial and error, particularly on the slopes. After the material was pushed into place with the dozer, a smooth wheel vibratory roller was used for compaction. Four passes of the roller were required: The first was made without the vibration of the roller, and was followed by three passes with vibration when moving up the slope, and no vibration for compaction when moving down. The result was a well-compacted, smooth surface.

Conclusion

The HDPE liner with thin soil-cement proved to be an economical solution for rehabilitating the Cedar Creek Balancing Reservoir embankments, providing not only a durable surface, but an impermeable liner. The placement of the soil-cement on the liner required significant planning and flexibility to handle construction issues associated with the HDPE liner/soil-cement system. The project advanced soil-cement construction techniques with an innovative and economical solution that could be implemented in the field.

Portland Cement Association
5420 Old Orchard Road
Skokie, Illinois 60077-1083
847.966.6200 Fax 847.966.9781
www.cement.org

PL072.01