

Soil-Cement *Solutions*

SOIL-CEMENT FOR WATER RESOURCES APPLICATIONS



Soil-Cement Stands the Test of Near Record Breaking Rainfall in Southern California

Mark E. Krebs, P.E.

**President ,
Pacific Advanced Civil Engineering, Inc. (PACE)**

Buried soil-cement protects embankment following erosion of re-vegetated soil cover.

It has been less than two years since the Los Angeles County Department of Public Works (LADPW) officially approved soil-cement use for bank protection and less than six years since the first application was constructed in the County. In that time the soil cement has already been subject to a major durability test. The 2004-2005 winter rainy season was the second wettest on record for Los Angeles with slightly more than 38 inches (965 mm), which is less than one inch (25 mm) from breaking the record.

In the City of Santa Clarita's Newhall area, where most of the soil-cement bank protection has been applied in Los Angeles County, nearly 51 inches (1300 mm) have fallen this season. While many unstabilized areas, as well as areas protected by bank protection methods suffered damage, soil-cement in these areas has functioned faultlessly. With its natural appearance many nearby residents, unaware of its existence, have inquired if there are any flood control measures in place on the Santa Clara River.

Continued on next page

Continued from previous page

A major test of soil-cement bank protection came during the heavy rains for the 33-acre (13.4 hectare) site of the William S. Hart Baseball & Softball League fields in Santa Clarita. Historically, this area has been subject to major flooding during even minor rain events. In response, Newhall Land commissioned 3,500 linear feet (1,067 m) requiring 25,000 cubic yards (19,100 m³) of soil-cement bank protection to be placed along the Santa Clara River and South Fork confluence. The cement content ranged from 6.5% to 8%. Construction of the bank protection was complete in the fall of 2004, just in time for the rainy season. In January 2005, when a large portion of the major storm events took place, baseball tryouts went on as scheduled since no areas on the site were compromised by flooding.

Background on LADPW Approval Process for Soil-Cement Bank Protection

LADPW is one of the leading agencies in southern California in the establishment of flood control criteria and standards. For many years, concrete and rip-rap have been used per LADPW standards throughout the county for river and creek bank protection. Based upon improved environmental sensitivity, public safety and infrastructure cost, PACE, under the direction of its client, Newhall Land, sought to apply soil-cement as an alternative bank protection method along the Santa Clara River, a major regional watershed within LA County. The County's consideration for soil-cement began in early 2000 when Newhall Land sought to place 4,500 linear ft (1,360 m) or 32,000 cubic yards (24,500 m³) of soil-cement as bank protection along a portion of the San Francisquito Creek for the proposed Westcreek development project, which is located outside of the City of Santa Clarita and within LADPW jurisdiction. After reviewing existing soil-cement project applications and considering the potential far reaching benefits of soil-cement, LADPW identified Westcreek as a soil-cement



Exposed soil-cement embankment protection withstands flood waters.

pilot project and established a comprehensive plan to review soil-cement past performance, designs and construction Quality Assurance/Quality Control (QA/QC) specifications.

One of the first steps in the approval process included the engineer (PACE) preparing a soil-cement review program that identified performance history, and other agencies specifications and quality control standards. The work was closely coordinated with public agencies including the U.S. Fish and Wildlife, State Regional Water Quality Control Board (RWQCB), California Department of Fish and Game, and U.S. Army Corp of Engineers (USACE) to ensure the proposed soil-cement solution would address LADPW concerns regarding environmental and water quality issues related to bank protection. The review process began with the engineer providing several presentations regarding detailed aspects of soil-cement design, construction, and quality control to numerous departments within LADPW: Building and Safety, Land Development, Materials Engineering, Flood Maintenance, Soils and Geology, Stormwater, and Watershed Management. These presentations addressed the USACE, U.S. Bureau of Reclamation (USBR), Pima County and other flood control agencies' experience over the past 50 years. The discussions included design and testing standards that have been developed along the way.

The Portland Cement Association (PCA) was instrumental in providing current and historical design information and QA/QC data for LADPW review. Additionally, PCA coordinated with PACE to provide tours of in-place soil-cement applications in Orange County, CA; Pima

County, AZ; and Maricopa County, AZ for the Soils and Materials Testing Division of LADPW. These tours allowed LADPW engineers to view, first-hand, in place and ongoing soil-cement installations and discuss with other public agency personnel the past performance and maintenance requirements of the soil-cement bank protection.

LADPW began to realize the great potential for soil-cement as a bank protection method. As a result, they established a Soil-Cement Technical Review Committee (TRC). The TRC was formed to work with PACE to establish LADPW standards for soil-cement design, construction, and QA/QC procedures. With its desire to apply only the highest standard of engineering practice, LADPW had specific areas of concern that needed to be addressed in the consideration of soil-cement: (1) structural integrity, (2) flood protection durability, (3) in-field testing and quality control, and (4) long-term maintenance requirements.

Structural Integrity and Durability

A primary soil-cement consideration LADPW wished to address was structural integrity (durability and life expectancy). In response, the engineer researched and compiled data from a number of sources and presented a comparison analysis of soil-cement, rip-rap and reinforced concrete channels.

Findings concluded that soil-cement has very low maintenance requirements and outstanding long-term flood control/erosion resistance effectiveness compared to the alternatives. Pima County, AZ, was able to compare the durability of soil-cement in a before and after-installation comparison during 100-year storm events. Subsequently, Pima County will only allow the use of soil-cement for major bank protection projects, and over the past 30 years has placed more than 75 miles (120 km) of soil-cement.



Arial view of Hart Baseball Fields, Santa Clarita, CA during January 2005 storms.

In-field Testing and Quality Control

To address the LADPW TRC's concerns regarding in-field testing and quality control, the engineer developed numerous control systems and delivered presentations identifying design, construction testing and process overviews and standards including those applied by other agencies throughout the southwest. These presentations also stressed the importance of QA/QC through proper construction monitoring, review, and testing processes.

As part of the approval process, a QC training program was conducted for the LADPW Materials Testing and Construction personnel. PACE, along with other recognized experts in the field of soil-cement from the USACE and PCA, sponsored a two-day, hands-on training program in November, 2002, in conjunction with the construction of the Westcreek soil-cement project. The program was designed to train LADPW personnel in soil-cement field and laboratory testing standards, and construction QA/QC methods. The training included hands-on soil-cement testing in a laboratory and quality control field testing at the Westcreek project site.

Maintenance Requirements

The engineer has found that one of the best ways to determine the true maintenance requirements of soil-cement bank protection was to obtain accounts from flood control agency maintenance personnel in areas where

soil-cement has been in place for many years. The engineer and LADPW found through interviews with the USACE, Orange County, Pima County, and Maricopa County personnel that soil-cement has had minimal maintenance requirements and has proven to be exceptionally durable over long periods of time.

Design and Construction Guidelines Prepared

After some additional tours of soil-cement applications and numerous technical meetings with the TRC, LADPW was ready to finalize standards for soil-cement implementation. As part of this final phase, the engineer prepared design, construction and QA/QC guidelines that included specific guidelines for feasibility, design specifications, construction and QA/QC standards. In particular, specifications were provided for mixing and placement of soil cement based on a combination of existing specifications used by the USACE, Orange County, and Pima County. These guidelines provided a detailed plan for the developer, contractor, review agency, project engineer and geotechnical engineer for implementing a highly controlled and successful soil-cement project.

LADPW Approves Soil-Cement for Bank Protection Application

LADPW approved soil-cement as a standard approved bank protection method soon after the training workshop and completion of the Westcreek soil-cement project. Following LADPW's change in classification from "pilot" to "approved project," Westcreek became the first approved application of soil-cement bank protection in LADPW's history and the first new bank protection standard for LADPW in more than 50 years.

The Westcreek project includes over 4,500 linear feet (1,360 m) or 32,000 cubic yards (24,500 m³)



Standard Concrete Bank Protection

Standard Rip-Rap Bank Protection

Westcreek Soil Cement

Bank Protection Alternatives.

of soil-cement bank protection. It has both buried-revegetated and exposed conditions. The buried-revegetated areas appear undisturbed and the exposed soil-cement bank protection appears as native hardened soil providing a natural appearance along the creek edge. Since the approval of Westcreek, over 37,500 linear feet (11,400 m) or 290,000 cubic yards (221,700 m³) of soil-cement bank protection has been constructed in LA County, and there are plans for future construction of more than 75,000 linear feet (22,900 m).

Soil-cement is the first bank protection alternative to be approved within LADPW for nearly a half-century. It has made a significant improvement to the environmental and aesthetic aspects of bank protection, while maintaining a high level of flood protection for LADPW and the public. Through the efforts of PACE, Newhall Land, and LADPW, an innovative and improved bank protection method that is hydraulically sound, environmentally responsible and aesthetically superior can now be applied.