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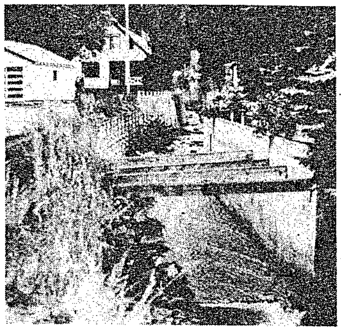
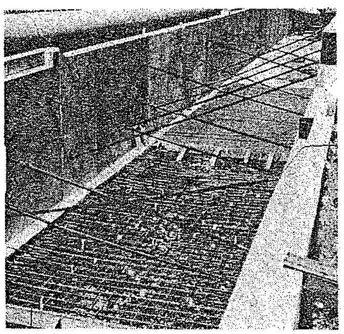
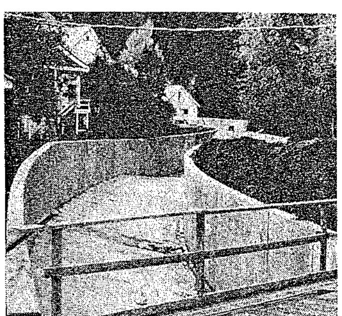


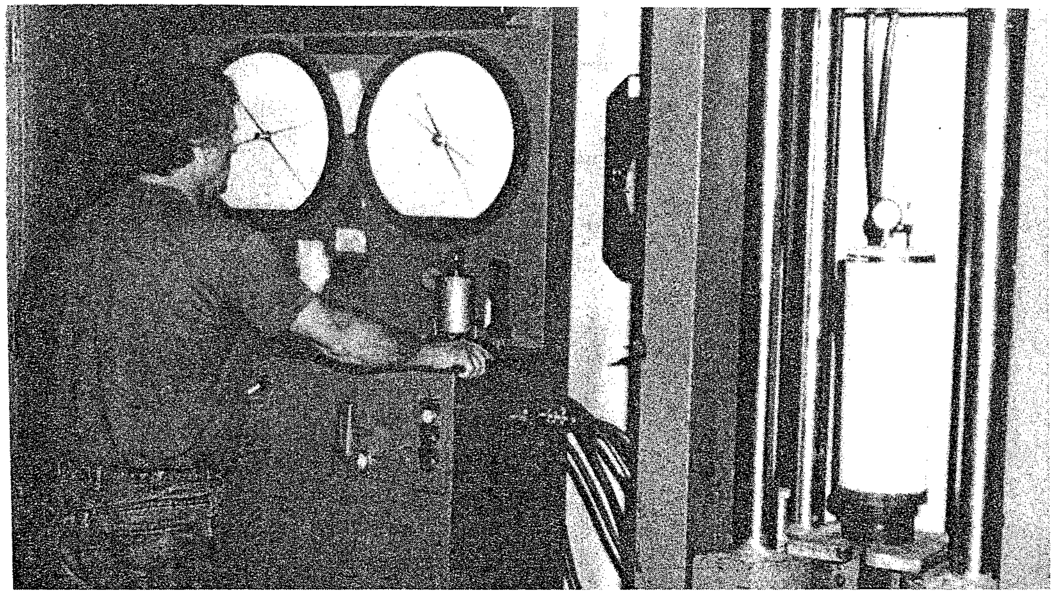




The REMR *Bulletin*

News from the Repair, Evaluation, Maintenance, and Rehabilitation Research Program

VOL 3, NO. 3 INFORMATION EXCHANGE BULLETIN DEC 1986



Results From TVA Testing of Grouting Systems for Concrete Anchors

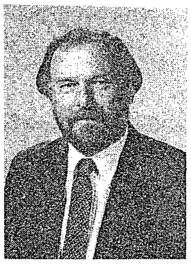
by
James E. McDonald, US Army Engineer Waterways Experiment Station
J. Floyd Best, Tennessee Valley Authority

Rehabilitation of navigation locks usually requires removal and replacement of deteriorated concrete on lock walls. Steel dowels are normally used to anchor the new concrete facing to the existing concrete walls and to position vertical and horizontal reinforcing steel in the concrete facing. In most cases, these dowels are embedded in drill holes using prepackaged polyester-resin grout.

Field pullout tests of concrete anchors installed in this manner under *dry* conditions indicate this to be a satisfactory procedure. However, over the past decade, a number of failures of anchors embedded in polyester-resin grout under *wet* conditions have been reported.

FIELD EXPERIENCE

Prepackaged polyester-resin grout was used in 1976 to embed Dywidag bars underwater in repairing the stilling basin at the Corps of Engineers' Old River Control Structure on the Mississippi River. These bars were used to anchor prefabricated modules of half-inch steel plate to concrete in the stilling basin floor between the downstream row of baffles and the end sill. A diver inspection eight months



Jim McDonald is a research civil engineer in the Concrete Technology Division, Structures Laboratory, WES. He received his B.S. and M.S. degrees in civil engineering from Mississippi State University. He is Problem Area Leader for the Concrete and Steel Structures portion of REMR and is also principal investigator for five REMR work units, including 32303, "Application of New Technology to Maintenance and Minor Repair."

Floyd Best is supervisor of the Concrete and Soils Unit of the Tennessee Valley Authority's Singleton Materials Engineering Laboratory in Knoxville, Tennessee. He received his B.S. degree in civil engineering from the University of Tennessee where he has also taken advanced postgraduate courses. He is currently conducting two research studies under a Support Agreement with the Corps as part of REMR Work Unit 32303.

following completion of repairs revealed a number of anchors broken flush with the steel plate, broken flush with the grout, or pulled completely out of the concrete. Additional failures were reported in subsequent inspections at Old River.*

Cement-grouted anchors were specified for lock wall stabilization during 1978-80 rehabilitation efforts at the Corps' Locks and Dam 3, Monongahela River. As an option, the contract allowed use of resin-grouted anchors. The contractor proposed a hybrid system in which polyester-resin grout would be used for the anchorage length in rock while cementitious grout would be used within the concrete lock wall.**

The polyester resin manufacturer recommended a 2-1/4-inch-diameter drill hole for the anchorage length in rock to allow proper mixing of the 45-mm-diameter grout cartridge with a 1-1/4-inch-diameter bar. A 4-1/2-inch-diameter drill hole was used within the lock wall. The anchors were installed and grouted under wet conditions. Following this procedure, the contractor was unable to stress 35 anchors in the middle and river walls to the design load.

In the search for a possible explanation of the failures, a failed anchor was removed from the middle wall and closely examined. The general appearance of the bar in the anchorage zone indicated that the polyester-resin grout had not bonded to the bar. The lower 5 feet had a light gray material lodged between the deformations of the bar that appeared to be polyester resin. However, the material was soft and pliable and could easily be removed from the bar. Along other sections of the bar, the grout was not soft and was harder to remove from the bar.

The contractor claimed that improper mixing occurred because the hole had become enlarged due to caving of the weak rock. To determine if the 2-1/4-inch-diameter hole was being enlarged during drilling, the hole from which the failed anchor had been removed was filled with a reddish grout and a larger diameter core boring was taken. The core showed that the original drill hole was consistently 2-1/4 inches in diameter.

In the interest of better consistency and progress in the anchor installation on the project, the Corps directed that a portland-cement grout system be used to anchor the bars. The contractor then started drilling 4-1/2-inch-diameter holes for the full embedment length and using cementitious grout. The anchors were tensioned after nine days and the stressing length grouted. This method produced more consistent results and far fewer failures, and it was used to install approximately one-fourth of the anchors on the middle wall and three-fourths of the anchors on the river wall.

LABORATORY INVESTIGATION

Due to the extensive lock rehabilitation work under way and planned by the Corps, a study was initiated in April 1985 to evaluate the effectiveness of selected grout systems for embedment of anchors in concrete. This work is being conducted by the Tennessee Valley Authority's Singleton Materials Engineering Laboratory under the direction of the Waterways Experiment Station. The work is part of a study in the Concrete and Steel Structures Problem Area of the REMR Research Program.

The grout systems are being tested under both wet and dry conditions, and test results have been obtained through 16 months of testing. Additional tests are scheduled at 36 months. Upon completion of this long-term testing, a technical report will be written, and final guidance on selection of grout

* "Maintenance and Preservation of Concrete Structures; Repair of Erosion-Damaged Structures." J. E. McDonald. US Army Engineer Waterways Experiment Station, Vicksburg, MS, Apr 1980. Technical Report C-78-4, Report 2. (NTIS No. AD A089 764).

** "Experience and Problems in the Pittsburgh District Installing Rock Anchors at Lock 3, Monongahela River." Anton Krysa, In: *Concrete Structures Repair and Rehabilitation.* US Army Engineer Waterways Experiment Station, Vicksburg, MS, Sep 1982. Volume C-82-1.

systems for concrete anchors will be provided as deemed necessary.

Three different types of grout are being tested:

- a portland cement-water grout with an expansive grout additive and accelerator.
- a two-component epoxy system mixed with silica sand.
- a polyester-resin grout which is preproportioned by the manufacturer and sold in mylar-encased cartridges.

The cementitious and epoxy grouts can be pumped into the drill hole with the bar in place, or under dry conditions poured into the hole prior to inserting the bar. The polyester-resin grout cartridges are first dropped into a drill hole, after which the rebar is inserted with enough force to break the mylar capsule, and the rebar is then rotated in the hole at 100 rpm for 30 seconds to mix the grout.

The manufacturer of the polyester-resin cartridges stated that the grout could be placed and cured either underwater or in the dry. The epoxy manufacturer did not recommend underwater placement; rather, they suggested removal of excess water from the drill hole prior to grouting, then resubmerging the test specimens after grouting. The recommendations of each manufacturer were followed in preparation of test specimens using their respective materials.

The evaluation is being accomplished in five phases: (1) physical characteristics of the grouts, 2) effects of temperature and moisture on the placement and early age service performance, (3) long-term pullout strength under varying curing conditions, (4) creep under sustained loading, both wet and dry, and (5) effects of hole roughness and cleanliness on grout performance. Except in phase 1, test specimens generally consist of 6- by 18-inch concrete cylinders into which 3/4-inch-diameter reinforcing bars have been grouted to a depth of 12 inches in nominal 1-1/8-inch-diameter holes.

TEST RESULTS

Slant shear tests (CRD-C 596-78*)

Slant shear bond strengths were determined on specimens fabricated and cured under both wet and dry conditions. A significant correlation existed between dry bond strength and testing age for both the cementitious and polyester-resin grout. Bond strengths for the polyester-resin grout were considerably higher than those for the cementitious grout but lower than the epoxy grout at all testing ages for dry conditions (Figure 1). No significant correlation existed between the dry bond strength and age of the epoxy grout although there was a trend toward a slight reduction with age.

* "Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete." In: *Handbook for Concrete and Cement.* US Army Engineer Waterways Experiment Station, Vicksburg, MS, 1949, with quarterly supplements. (ASTM C 882-78)

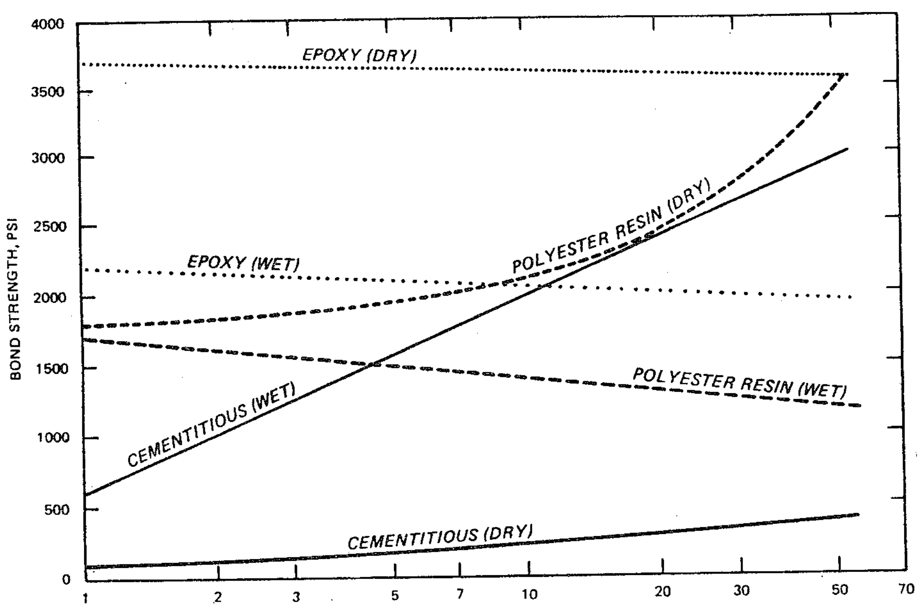


Figure 1. Results of slant shear bond strength tests on specimens cast and cured under wet and dry conditions

A significant correlation existed between wet bond strength and testing age for both the cementitious and polyester-resin grout. The bond strength of polyester-resin specimens, fabricated by applying the resin to wet concrete surfaces then immediately submerging in water, decreased from 1660 psi at 1 day to 1270 psi at 28 days age. The wet bond strength of polyester-resin specimens at 28 days was approximately 50 percent less than the dry bond strength. The cementitious grout specimens were fabricated by applying the cementitious grout to wet concrete surfaces, then allowing the grout to reach initial set prior to submerging. Bond strengths increased from 610 psi at 1 day to 2440 psi at 28 days age.

The epoxy grout specimens were fabricated by applying the epoxy to wet concrete surfaces, allowing air curing for 7 days, then submerging until tested. There was no significant correlation between the wet bond strength of epoxy grout and testing age, although a trend towards a slight reduction with time was indicated. Wet bond strengths of the epoxy ranged from 1640 psi to 2580 psi with an overall average of 2100 psi, approximately 40 percent less than the average dry bond strength.

Pullout strength tests

Pullout strength tests are being conducted under both wet and dry conditions at eight different ages ranging from 1 day to 3 years. With the exception of the cementitious grout tested at 1 day, all grouts developed early age pullout strengths approximately equal to the ultimate strength of the rebar when the test specimens were fabricated under dry conditions, regardless of curing conditions. The pullout strengths of all grouts were generally lower for wet casting and curing conditions in comparison with dry conditions. This trend was particularly evident for the pullout strength of the polyester-resin grout which was approximately 30 percent lower under submerged conditions. In comparison, the pullout strength for the epoxy was approximately 7 percent lower under wet conditions. While the pullout strength of the cementitious grout was lower under submerged conditions at both 3 and 7 days age, the overall average was essentially the same for both submerged and dry conditions. Grout placement and curing at 40°F appeared to have little effect on the pullout strength of any of the grouts tested after 1 day age. Only the cementitious grout exhibited significantly lower pullout strengths at 1 day compared to results at later ages.

Results to date of pullout strength tests to determine long-term performance of embedment grouts at 70°F show that the cementitious, epoxy, and polyester-resin grout systems all perform well when cast and cured under dry conditions. The pullout strengths for all tests were essentially equal to the ultimate strength of the rebar.

The results obtained from specimens grouted and cured under wet conditions are shown in Figure 2. With the exception of the polyester-resin grout cast and cured under submerged conditions, pullout strengths were essentially equal to the ultimate strength of the rebar. The overall average pullout strength of polyester-resin specimens cast and cured under submerged conditions was approximately one third less than the strength of polyester-resin specimens cast and cured under dry conditions. The largest reductions in pullout strength, approximately 50 percent, occurred at 6 and 16 months. Similar strength reductions were obtained for the polyester-resin grout cast under

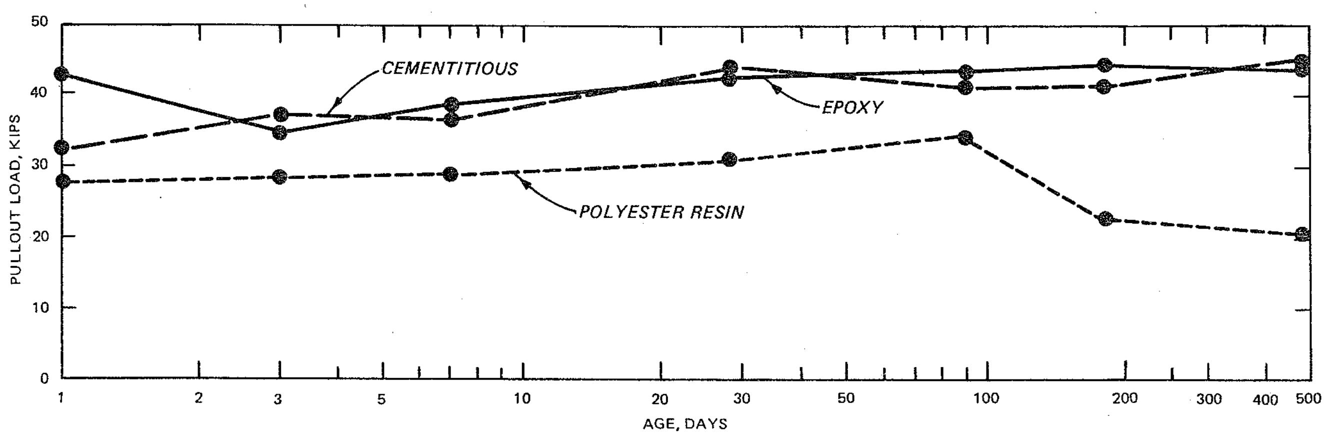


Figure 2. Results of pullout tests, casting and curing at 70°F under wet conditions

submerged conditions and cured under alternating wet and dry conditions. Alternating 7-day cycles of wet and dry curing of polyester-resin specimens cast under submerged conditions resulted in approximately 10 percent higher pullout strengths compared to submerged curing.

None of the grout systems exhibited a significant reduction in long-term pullout strength when they were cast in a dry environment and then cured under submerged conditions or alternating cycles of wet and dry curing.

Creep tests

Creep tests were conducted by subjecting pullout specimens to a sustained load of 60 percent of the rebar yield strength. Deflections of the rebar at the end of the specimen opposite the loaded end were measured periodically during the loading period.

After 6 months under load, the cementitious and epoxy grout specimens cast and tested under dry conditions exhibited very low rebar slippage, averaging 0.0013 and 0.0008 in., respectively (Figure 3). Under similar conditions, the polyester-resin grout specimens exhibited an average rebar slippage of 0.0305 in., approximately 30 times higher than the cementitious and epoxy grout.

Results of creep tests on specimens fabricated and tested under wet conditions follow a similar trend. After 6 months under load, the average rebar slippage for the cementitious and epoxy grout was 0.0028 and 0.0033 in., respectively, or 2 to 4 times higher than results under dry conditions. Polyester-resin grout specimens, fabricated and cured under submerged conditions, exhibited significant rebar slippage; in fact, in one case the rebar pulled completely out of the concrete after 14 days under load. After 6 months under load, the two remaining specimens exhibited an average rebar slippage of 0.0822 in., approximately 30 times higher than the cementitious grout.

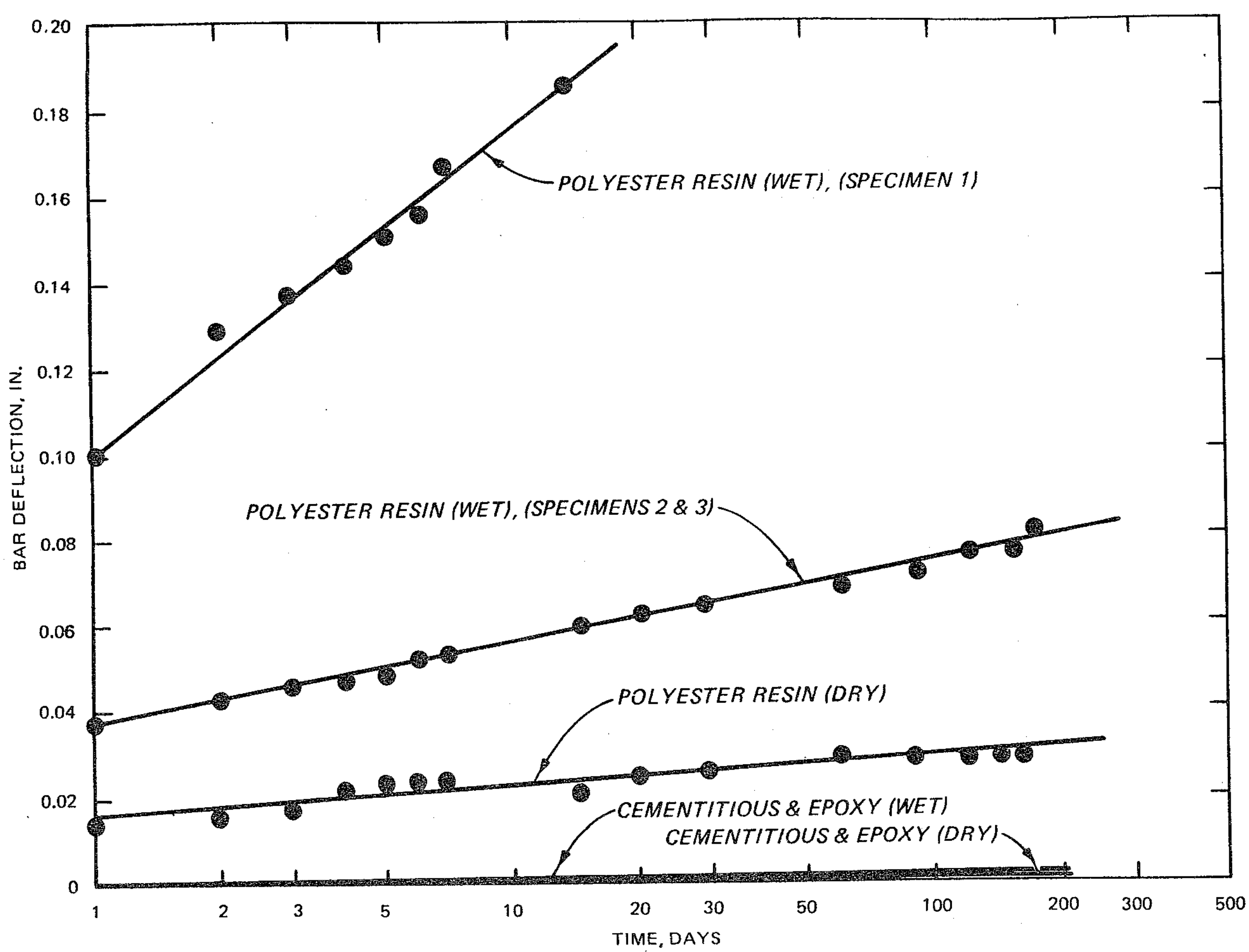


Figure 3. Results of creep tests, casting and curing under wet and dry conditions

CONCLUSIONS

For the concrete anchor grout systems tested, all grouts developed pullout strengths beyond 1 day age approximately equal to the ultimate strength of the rebar when the test specimens were cast under dry conditions. However, significantly higher creep was exhibited by the polyester-resin grouted concrete anchors than that exhibited by the cementitious and epoxy grouted anchors. Creep data should be considered in the selection of an anchorage grout for use in concrete where the frictional resistance and bond between the surfaces of the two masses to be anchored together are important.

Polyester-resin grout for concrete anchors installed under submerged conditions and cured under submerged or alternating wet and dry conditions exhibited a significant loss in pullout strength. A submerged environment is a hostile test for concrete anchor systems. Care is recommended in the selection of the grout to be used and the design of the grouting system (hole diameter and length, mixing time, installation procedure, long-term performance, etc.) for the installation of concrete anchors under submerged conditions.

For more information on this testing program, contact Jim McDonald at FTS 542-3230 or 601-634-3230.

(Readers should also note that a study of the use of polyester-resin grout with rock anchors is being initiated in FY 87 under the REMR Research Program.)

Workshop on Repair and Maintenance of Shallow-Draft Training Structures

A REMR workshop on repair and maintenance of shallow-draft training structures is scheduled for February 24 and 25, 1987. The workshop will be held at the Waterways Experiment Station, Vicksburg, Mississippi, and will focus on materials, methods, and equipment for repair, evaluation, maintenance, and rehabilitation of various dikes found in shallow-draft navigable rivers of the United States.

Persons who are interested in participating in the workshop or who have questions concerning it should call Dave Derrick at FTS 542-3603 (601-634-3603) or Bob Athow at FTS 542-2135 (601-634-2135).

Planning Under Way for Workshop On Control of Nuisance Birds

A REMR workshop is being considered on control of nuisance birds at Corps civil works projects. As envisioned, Corps personnel would meet with bird damage control experts from the US Department of Agriculture to learn about the latest methods and devices for controlling and managing nuisance birds. Participants would also obtain information on how to get assistance with such problems from other federal, state, and local agencies who have experience in controlling birds.

If you are interested in participating in or in sending personnel to such a workshop, contact Dr. Tony Krzysik at FTS 958-7737 or 217-352-6511, ext. 737.

REMR Research Program

KEY PERSONNEL

	Office	Office Symbol	Commercial No.	FTS No.
DRD Coordinator, HQUSACE				
Jesse A. Pfeiffer, Jr.	Civil Works Programs	DAEN-RDC	202-272-0257	272-0257
Overview Committee, HQUSACE				
James E. Crews (Chairman)	Operations Branch	DAEN-CWO-M	202-272-0242	272-0242
Tony C. Liu	Structures Branch	DAEN-ECE-D	202-272-8672	272-8672
Bruce L. McCartney	Hydraulic Design Branch	DAEN-CWH-D	202-272-8502	272-8502
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G. Britt Mitchell (Geotechnical—Soils)	Geotechnical Laboratory, WES	WESGE-E	601-634-2640	542-2640
Jerry S. Huie (Geotechnical—Rock)	Geotechnical Laboratory, WES	WESGR-M	601-634-2613	542-2613
Glenn A. Pickering (Hydraulics)	Hydraulics Laboratory, WES	WESHS-L	601-634-3344	542-3344
D. D. Davidson (Coastal)	Coastal Engineering Research Center, WES	WESCW-R	601-634-2722	542-2722
Ashok Kumar (Electrical and Mechanical)	Construction Engineering Research Laboratory	CERL-EM	217-373-7235	958-7235
Jerome L. Mahloch (Environmental Impacts)	Environmental Laboratory, WES	WESEP-W	601-634-3635	542-3635
Anthony M. Kao (Operations Management)	Construction Engineering Research Laboratory	CERL-EM	217-373-7238	958-7238
Field Review Group				
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James C. Wong	New England Division	NEDOD-P	617-647-8411	839-7411
Stanley R. Jacek	North Central Division	NCECO-O	313-226-6797	226-6797
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Carl F. Kress	South Pacific Division	SPDCO-O	415-556-8549	556-8549
Neal H. Godwin, Jr.	Southwest Division	SWDCO-O	214-767-2429	729-2429
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Eugene Brickman	North Atlantic Division	NADEN-MG	212-264-7141	264-7141
John G. Oliver	North Pacific Division	NPDEN-T	503-221-3859	423-3859
Karl V. Keller	Pacific Ocean Division	PODEN-T	808-438-1635	
James W. Erwin	South Atlantic Division	SADEN-F	404-221-4256	242-4256

12/86

Precast Panels Speed Rehabilitation of Placer Creek Channel

by
Kathy Hacker
US Army Engineer District, Seattle

Placer Creek, which flows through the town of Wallace, Idaho, drains a large area of steep, forested land. Since 1910, when the St. Joe fire leveled much of the forest land surrounding the creek, Wallace has periodically sustained flood damage from overbank flooding and sediment movement. During the past 80 years, a flood control channel through the city was built, rebuilt, and patched to combat flood problems. However, through the years, the channel linings became badly deteriorated. Also, large volumes of debris entering the channel further reduced its capacity and damaged the walls and adjacent property.

In 1965, channel improvement was selected as the best method to alleviate the flooding problem, and the rehabilitation project was authorized by Congress in December 1970. Project design was verified by hydraulic model tests conducted by North Pacific Division's Hydraulic Laboratory, and construction began in July 1981.

PRECAST ADVANTAGES

The contractor elected to use a cast-in-place concrete channel bottom and precast concrete channel walls. Use of the precast option for the channel walls had a number of advantages:

- congestion was reduced at the project site
- excavation requirements were reduced, thereby avoiding unnecessary encroachment of property along the channel as well as the hazards of excavation
- costs associated with the forming system were decreased
- rehabilitation time was reduced
- only two-thirds of the work force required for cast-in-place construction was needed for the precast option.

All concrete construction was completed by December 1982, and the rehabilitated channel was dedicated 15 July 1983.

Placer Creek has a 15.6-square-mile, steep-sided drainage basin emptying into the South Fork of the Coeur d' Alene River. When flooding occurred, flows would spread over the alluvial fan upon which Wallace is located.

The average annual discharge at the Wallace gage station is 44 cfs; it has ranged from 1 to 1300 cfs. The channel improvements provided a capacity of 4600 cfs corresponding to a 200-year flood with a minimum freeboard of 2.5 feet.

Placer Creek valley contains recent coarse stream alluvium with very little cover over bedrock. Groundwater encountered in borings is at essentially the same level as the creek. The soil is a highly pervious, free-draining material.

During construction, heavy equipment had to travel roads which run parallel to the channel. To handle these loads, channel walls and bridge crossings were designed with a surcharge load equivalent to an AASHTO (American Association of State Highway and Transportation Officials) HS 20-44 truck loading. In addition to the surcharge, horizontal and vertical bridge reactions were included in the design.

DEBRIS BASIN

To prevent debris from flowing into the channel, a 600-foot basin with a debris barrier was constructed upstream. The basin, formed by enlarging an existing, natural basin, was designed with a flat bottom and was sized to hold 17,000 cubic yards of debris. Upon completion, the basin proved effective in February 1982 when a flood of approximately 10-year frequency occurred. The structure trapped nearly 3000 cubic yards of debris and prevented damage to the channel and surrounding area. Periodic removal of debris is required to maintain adequate capacity.

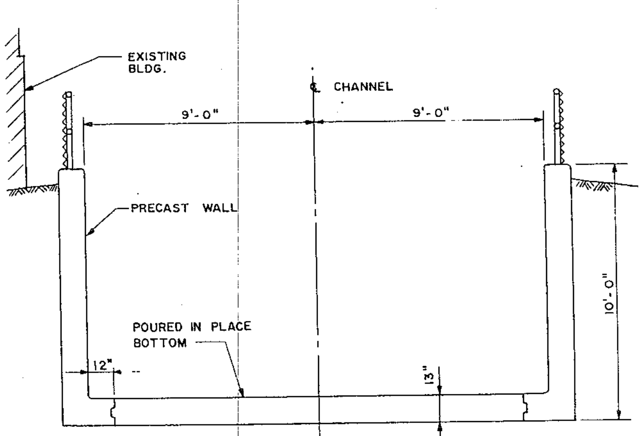
Diversion of Placer Creek was made through a bypass pipe on the streambank. A 48-inch corrugated metal pipe, designed for a flow of about 40 cfs, was used for the first increment; a 24-inch pipe, designed for about 25 cfs, for the second. With this plan, the upstream portion of the project was able to accommodate flows through the end of autumn.

Gas, water, sewer line, and power line crossings required minimal relocation. Utility relocations were handled by the utility owners; the contractor dug out and replaced unmapped utility line crossings and water and gas mains. During the rehabilitation work, private driveways crossing the channel were put out of service. Residents used temporary walkways built over the diversion pipe for pedestrian travel. One bridge was kept open for vehicular traffic.

Channel geometry consists of 17- to 18-foot-wide (bottom width) rectangular sections and 17- to 20-foot-wide (top width) V-bottom sections with vertical walls. The total channel length is 3700 feet. Transition zones account for a total of 70 feet, and the total length of the project is 4300 feet with an elevation drop of 102 feet.

One class of concrete was required. Specified compressive strength was 3000 psi at 28 days age. Air entrainment of 5.5 ± 1 percent was required. Maximum aggregate size was limited to 1-1/2 inches. Maximum allowable water-cement ratio was 0.45. Approximately 7000 cubic yards of portland-cement concrete was required for construction. A local ready-mix plant, using aggregates approved by the government, supplied the concrete.

The concrete floor of the channel was cast in place with keyed construction joints. Floor reinforcing steel was spliced to reinforcing extended from the precast wall panels. A 12-inch stub at the bottom of the panel provided continuity of the reinforcing through the corner joint. The extra 12 inches allowed for soil bearing pressures of approximately 1000 psf and the use of free-draining material as a foundation to establish the grade of each wall.



Typical channel section

Kathy Hacker is a structural engineer in the Design Branch, Engineering Division, Seattle District, and has worked on various projects within the Branch since 1983. She received her B.S. degree in civil engineering from Washington State University and has taken advanced classes at the University of Washington.

The channel walls were formed with over 600 precast panels, which were produced in a local casting yard. Each panel was approximately 15 feet long, 12 feet high, and weighs between 10 and 20 tons.

In some places, existing walls were used for shoring. Where they could not be used, an open cut was made and the existing walls were removed. Foundation material behind the walls was excavated to a 0.5H-on-1V cut, allowing for drainage at all times.

PLACEMENT PROCEDURE

Panels were set in place and secured by adjustable bracing within the channel. The procedure was developed so that alignment was controlled and vertical spacing between joints was kept uniform. A preformed neoprene compression seal was chosen as the most effective material for joint sealing. Polyurethane lubricant adhesive was used for installation of the compression seal.

Bracing was not removed until the concrete had reached a minimum compressive strength of 1500 psi. After the panels were set, random backfill was placed behind the walls in horizontal layers and compacted.

The construction cost estimate for the project was $3,870,000 in Federal costs and $350,000 in non-Federal cost sharing by the City of Wallace and Shosone County. The construction contract was awarded for $3,770,465, and non-Federal costs were $300,000. Contract modifications amounted to $323,000. Approximate savings attributable to use of precast panels was $185,557.

The new channel is more aesthetic in appearance than the old one. Timber foot bridges, vehicle bridges, and street bridges provide crossings to streets and homes. The debris basin and drop structure upstream use grouted riprap for lining and bank stability to create the appearance of a talus slope, thus blending with the surrounding valley. The clear water flowing over the drop structure resembles a waterfall, complementing the mountainous terrain surrounding Placer Creek. Floating debris that accumulates at the debris barrier is the same material that would be found in the natural watercourse upstream. Thus, the channel and surrounding terrain remain compatible throughout the length of the project. Swimmers, sunbathers, and picnickers take advantage of the debris basin waters and surrounding structures for recreational purposes.

For more information on the rehabilitation of Placer Creek Channel, contact the author, Kathy Hacker, or George England of the Structural Section, Seattle District, at FTS 399-3791 or 206-764-3791.

Kumar Named Problem Area Leader

Dr. Ashok Kumar, Engineering and Materials Division, Construction Engineering Research Laboratory, Champaign, Illinois, has been named Problem Area Leader for the Electrical and Mechanical portion of the REMR Research Program. Dr. Kumar replaces Dr. Paul A. Howdyshell who has been reassigned at CERL.

A revised list of key personnel for the REMR Research Program is included as an insert to this issue of *The REMR Bulletin.* Save it for a handy reference.

Request for Articles

If you have experience in any of the areas being addressed by the REMR Research Program which might be of interest to our readers, we would appreciate your drafting an article describing your work or contacting us for assistance in doing so. Articles by persons outside the Corps are welcome and will be considered for publication as long as they are relevant to REMR activities of the Corps.

Write to: Commander and Director, US Army Engineer Waterways Experiment Station, ATTN: WESSC-A, PO Box 631, Vicksburg, MS 39180-0631. Or call Tim Ables at 601-634-2587 (FTS 542-2587).

COVER PHOTOS

Section of unimproved channel of Placer Creek, Wallace, Idaho, prior to rehabilitation.

Typical view of channel rehabilitation, showing placed and braced wall panels, bottom reinforcing in place, freshly placed bottom, and completed channel section. Ledge in top of wall in foreground is bridge seat; corrugated pipe at top is for stream diversion.

View of rehabilitated channel showing superelevated wall and bottom which confine large, high-velocity flows in the channel at curves by preventing turbulent flow wave action.

The REMR *Bulletin*

The REMR Bulletin is published in accordance with AR 310-2 as one of the information exchange functions of the Corps of Engineers. It is primarily intended to be a forum whereby information on repair, evaluation, maintenance, and rehabilitation work done or managed by Corps field offices can be rapidly and widely disseminated to other Corps offices, other US Government agencies, and the engineering community in general. Contributions of articles, news, reviews, notices, and other pertinent types of information are solicited from all sources and will be considered for publication so long as they are relevant to REMR activities. Special consideration will be given to reports of Corps field experience in repair and maintenance of civil works projects. In considering the application of technology described herein, the reader should note that the purpose of *The REMR Bulletin* is information exchange and not the promulgation of Corps policy; thus, guidance on recommended practice in any given area should be sought through appropriate channels or in other documents. The contents of this bulletin are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products. *The REMR Bulletin* will be issued on an irregular basis as dictated by the quantity and importance of information available for dissemination. Communications are welcomed and should be made by writing the Commander and Director, US Army Engineer Waterways Experiment Station, ATTN: T. D. Ables (WESSC-A), PO Box 631, Vicksburg, MS 39180-0631, or calling 601-634-2587 (FTS 542-2587).

DWAYNE G. LEE
Colonel, Corps of Engineers
Commander and Director

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