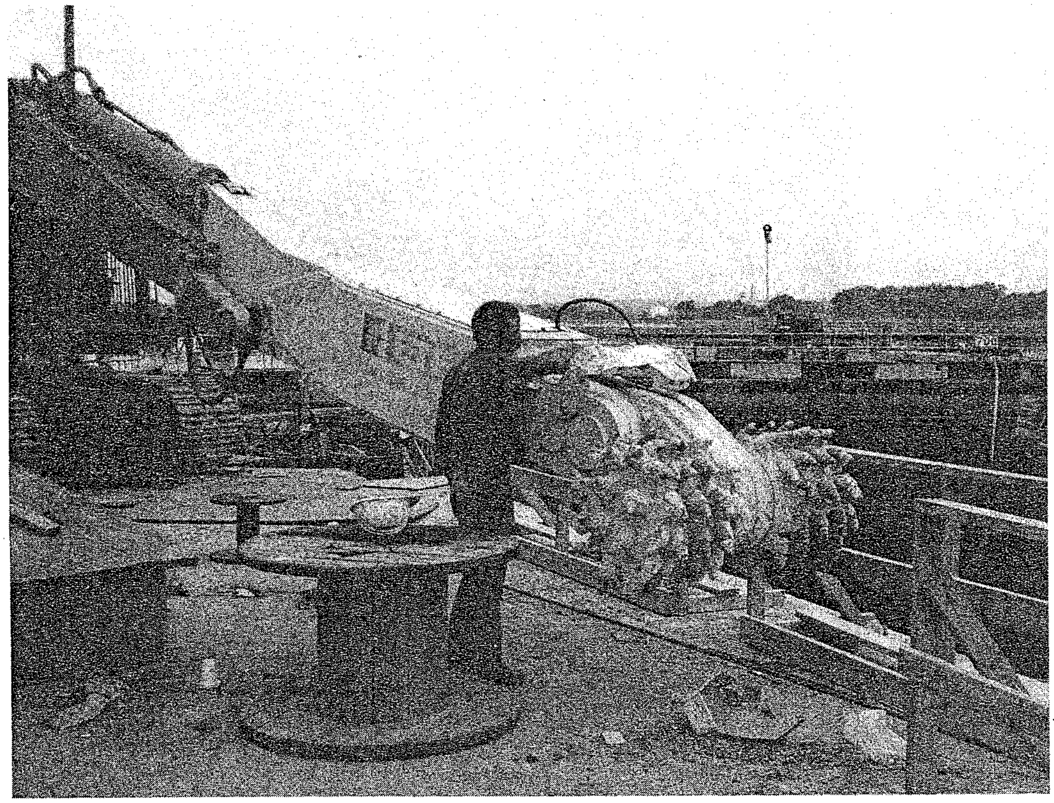
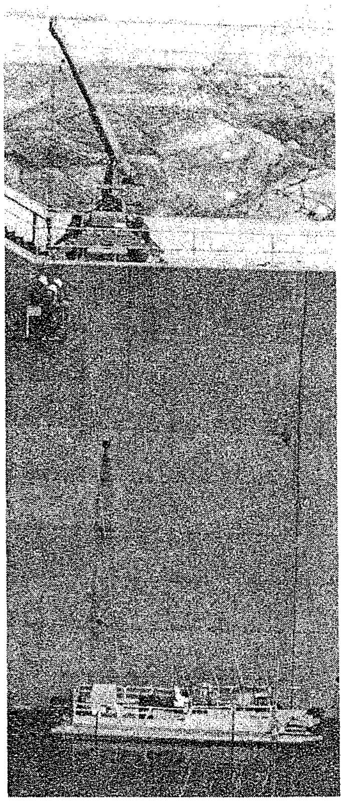
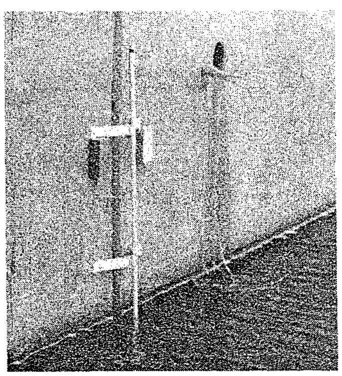
The REMR *Bulletin*

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

VOL 2, NO. 1 — INFORMATION EXCHANGE BULLETIN — MAR 1985





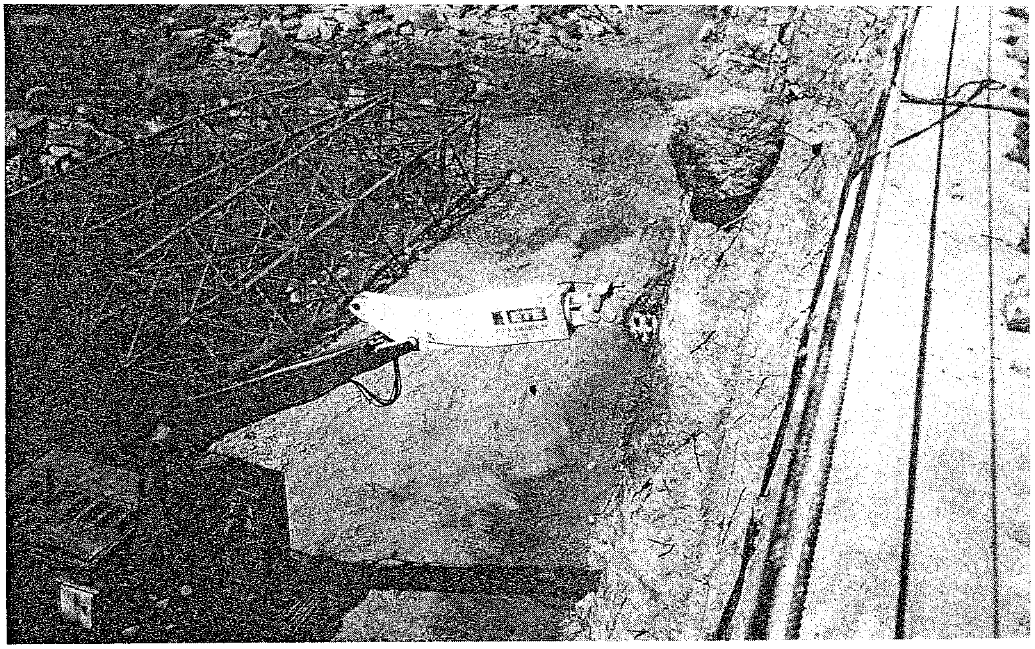


Mining Tool Adapted to Concrete Removal for Lock Wall Rehabilitation Project

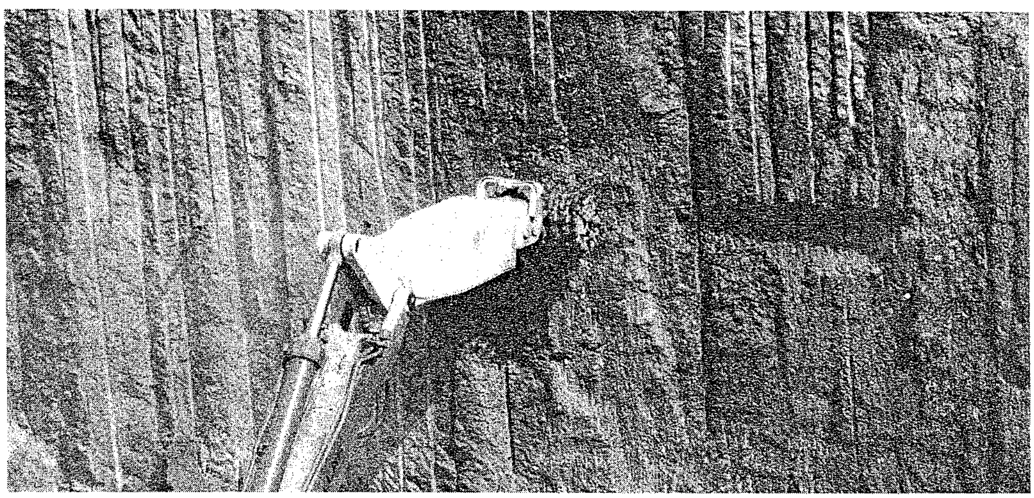
by Warren E. Parr
US Army Engineer District, Rock Island

Rehabilitation of lock walls at Brandon Road Lock on the Illinois Waterway near Joliet, Illinois, was the first known application in the Midwest of a highly effective concrete removal device — the Cutter Boom. Manufactured by Excavation and Tunneling Equipment (ETE) Corporation, State College, Pennsylvania, the Cutter Boom is a modified piece of mining equipment having a rotary head cutter with a series of carbide-tipped teeth that grind away at the concrete.

At Brandon Road, the contract called for removal of deteriorated concrete from the lock wall face over an area extending 40 feet down from the top level and along both walls between the service gate piers at opposite ends of the 600-foot-long chamber. The contractor, James McHugh Construction Co. of Chicago, used 100-grain Primacord inserted in holes drilled 40 feet into the structure on 80-inch centers to blast most of the concrete away. However, prior to any blasting, a horizontal sawcut 7 inches deep was made along the lower work line to prevent the blast from breaking out thin lenses of concrete beyond the work line. The resulting concrete removal line was approximately 21 inches from the original face



VIEW FROM TOP OF LOCK WALL



VIEW FROM TOP OF OPPOSITE WALL

Scaling of lock walls at Brandon Road Lock, Illinois Waterway, with Cutter Boom device

on one lock wall and 17 inches on the other.

The Cutter Boom device was mounted by McHugh on a Caterpillar Model 235 excavator, permitting the cutterhead to reach down a vertical surface approximately 17 feet below the machine platform elevation. By the same token, the machine, as rigged by McHugh, could reach up nearly 30 feet on a vertical wall without ramping the machine platform. In the Brandon Road application, the vertical lock walls were approximately 52 feet high, leaving a strip about 5 feet wide which the Cutter Boom could not reach without ramping. Since the cost of ramping was considered prohibitive, this strip was removed manually with chipping hammers.

The primary application for which McHugh developed the working unit was the scaling of the lock walls following the heavy removal work accomplished by blasting. On previous Corps of Engineers lock wall refacing jobs, this removal of loose concrete still clinging to the wall surfaces has generally been performed by manual processes, such as labor crews working from scissor lifts or scaffold platforms with jackhammers and chipping hammers. In addition to the scaling operation, McHugh operators used the Cutter Boom to effectively grind out soft pockets or honeycombed areas in the concrete structure which were detected by Corps and contractor quality control inspectors sounding the walls. In addition, deeper cuts were easily made by the Cutter Boom to accommodate steel appurtenances such as lock chamber exit ladders and line hook fixtures requiring deeper embedment in the new structure than was afforded by the standard removal line.

Other applications of the Cutter Boom at Brandon Road Lock included removal of concrete overburden dislodged by expansive grout in areas where explosives were prohibited and removal of approximately 2 feet of material along the top of the structure including the sidewalk. In areas near machinery recesses or gate anchorages, use of explosives had been prohibited. In these areas, the removal line was drilled much the same as for blasting, and expansive grout was placed in the holes to crack off, but not dislodge, the deteriorated concrete face. The Cutter Boom was then extremely effective in grinding off the overburden.

The concrete structure for Brandon Road Lock, having been completed in 1928, did not include reinforcing steel. However, in some areas, a considerable number of steel form ties protruded from the wall after blasting. The replaceable carbide cutting tips on the Cutter Boom clipped off most of these ties in the normal scaling operation. Also, the new sidewalk cap over the top of the structure included steel sidewalk mesh. In the initial phases of concrete removal, McHugh personnel were placing blasting mats on top of the structure and using small explosive charges to fracture the sidewalk and the 2-foot-deep concrete cap which had to be removed. After observing how effective the Cutter Boom was in clipping off steel form ties and grinding up the fractured sidewalk and structure cap, McHugh experimented with grinding away the structure cap and sidewalk without explosive fracturing and found the explosive application to be unnecessary.

While actual cost comparisons of manual removal of concrete versus removal by the Cutter Boom are not available to the author, the Cutter Boom was an obvious success at Brandon Road, where a compressed work schedule was in effect.

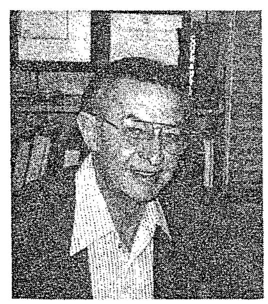
ETE Corporation manufactures Cutter Boom kits from 55 to 215 hp that can be custom fitted to most common backhoe excavators. The 165-hp version used at Brandon Road was powered by a 165-hp electric motor which runs on 440 volts AC and draws approximately 220 amps under load. A 165-hp rated transmission reduces the output speed to the cutter head assembly. A specially designed structural frame for mounting the electric motor and transmission was fastened to the Model 235 excavator using the existing stick pins. The 26-inch-diameter cutter head, which has 108 cutter bits, rotates at 82 rpm. The electric motor is water cooled with an open-loop cooling system that uses spray nozzles directed toward the cutter head for dust suppression. The main electrical enclosure was mounted on the swing frame, and the operator's control station was mounted in the cab area.

According to ETE, the performance characteristics of the 165-hp Cutter Boom working in concrete are as follows:

Concrete Strength psi	Net Cutting Rate cu yd/hr	Bit Costs ¢/cu yd	Maintenance Costs per Year (Single-Shift Operation)
5,000-6,000	10-15	50	$15,000

For more information about the rehabilitation work at Brandon Road Lock, contact the author, Warren Parr, at 309-676-4601. For more details concerning Cutter Boom kits, call Thomas A. Story, Vice-President for Engineering, ETE Corporation, at 814-234-1666.

Warren Parr is Assistant Project Engineer at the Illinois Waterways Project Office, Rock Island District. He received his B.S. degree in civil engineering from Bradley University. At the time of the rehabilitation work described in this article, he was temporarily assigned as Resident Engineer for Brandon Road Lock.



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 so 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).

Corps-BuRec Effort Results in High-Resolution Acoustic Mapping System

by Henry T. Thornton, Jr.
US Army Engineer Waterways Experiment Station

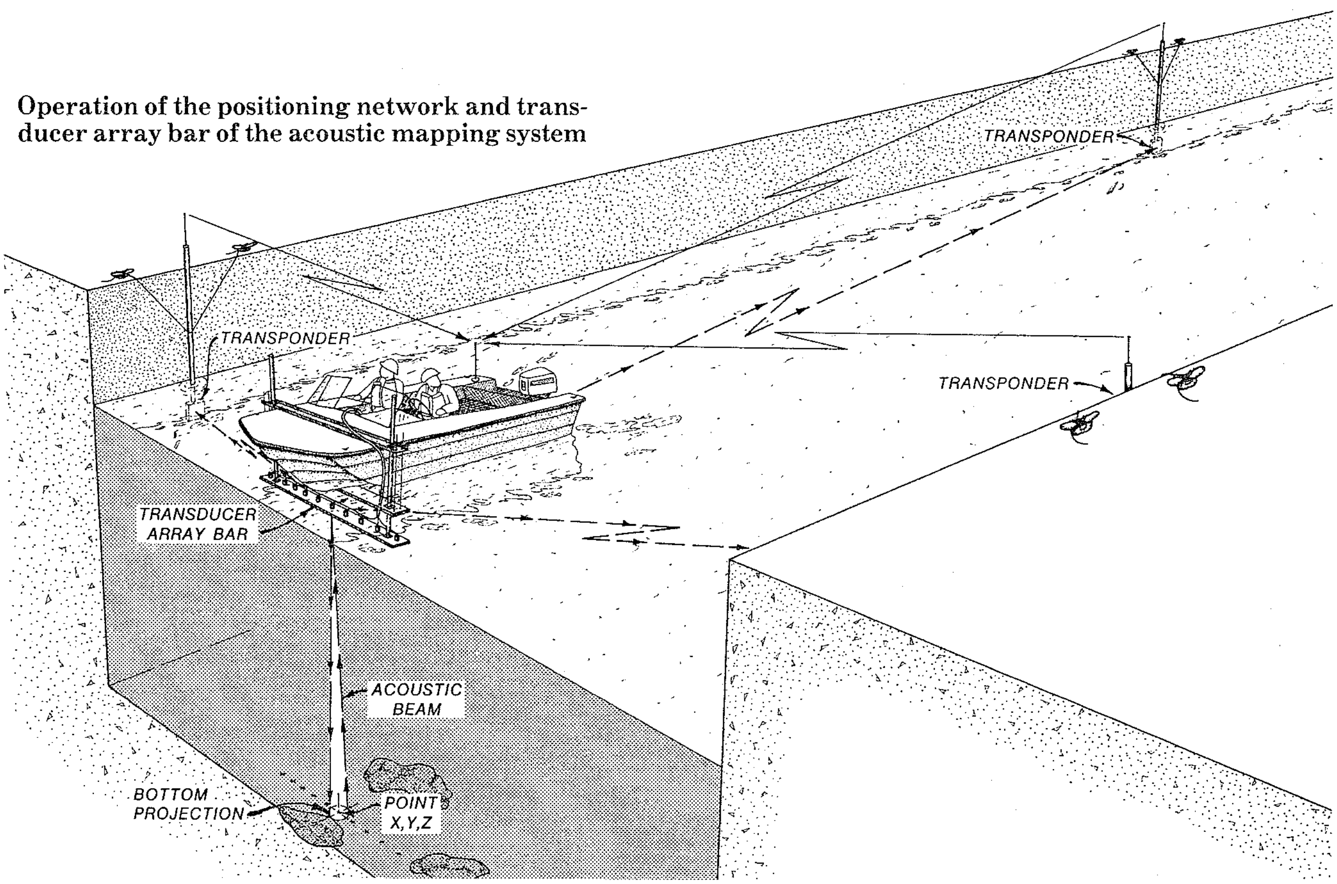
A high-resolution acoustic mapping system for performing rapid, accurate surveys of submerged horizontal surfaces has been developed as part of a joint research and development effort of the Corps of Engineers and the US Bureau of Reclamation. The system makes possible, without dewatering of the structure, comprehensive evaluation of top surface wear on such horizontal surfaces as aprons, sills, lock chamber floors, and stilling basins, where turbulent flows carrying rock and debris can cause abrasion-erosion damage.

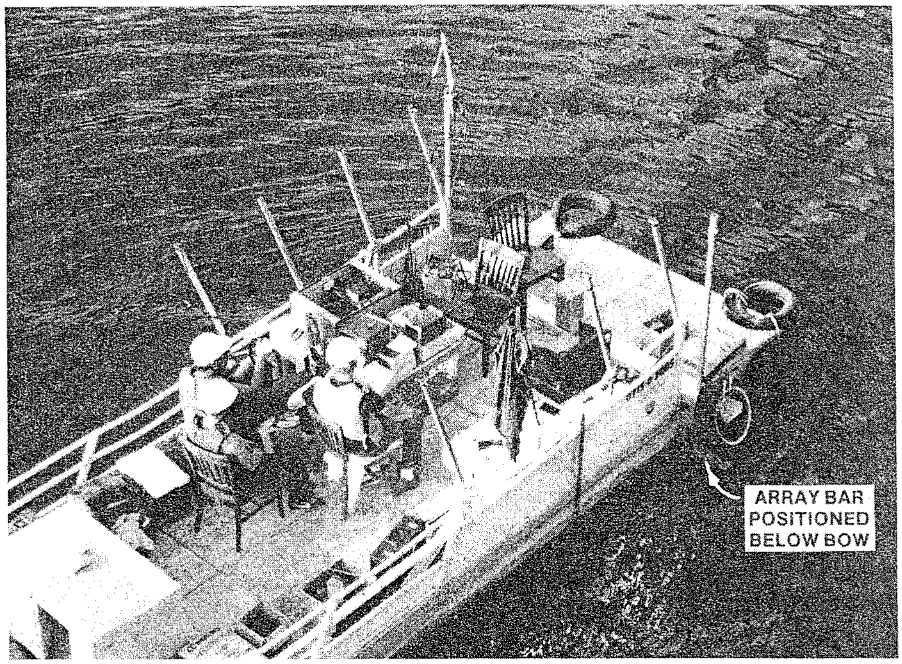
Developing capabilities such as this for nondestructively evaluating concrete in large structures is a shared interest of the Corps and BuRec. The recent heavy emphasis on evaluation of existing dams and the shift in policy from new construction to repair and rehabilitation of existing structures have underscored the need to develop and refine nondestructive testing (NDT) techniques for evaluating the condition of deteriorated concrete structures. In view of their mutual needs in this area, the Corps and BuRec entered into a cooperative R&D effort to increase NDT capabilities of both organizations, with each sharing in planning and financial support.

One problem of mutual interest was how to obtain rapid, accurate bottom-contouring data on submerged structures while avoiding the expense of dewatering and the dangers and inaccuracies inherent in diver-performed surveys. A survey of abrasion-erosion damage repairs indicated that dewatering accounts for over 40 percent of total repair costs. Nevertheless, dewatering is often necessary since the extent and location of damage must be known to determine what steps to take to correct the damage and to prepare valid cost estimates for repairs.

It was apparent that a system that would permit surveying without dewatering would be a major breakthrough for both the Corps and BuRec, and it was agreed that the most likely candidate would be

Operation of the positioning network and transducer array bar of the acoustic mapping system





Survey boat equipped with high-resolution acoustic mapping system under way on a data collection run at Folsom Dam, a BuRec project near Sacramento, California

a sonic system. However, erosion and downfaulting of submerged structures have always been difficult to accurately map using standard sonic surveys because of limitations of the various systems. Side-scan sonar, fathometers, and similar underwater mapping systems are designed primarily to see targets rising above the plane of the seafloor. Broad sonic beams provide broad coverage. A narrow beam is needed to see into depressions and close to vertical surfaces. This capability is provided by the high-resolution acoustic mapping system.

The system contains an acoustic subsystem, a positioning subsystem, and a compute-and-record subsystem. The acoustic subsystem includes a transducer array and a transceiver-signal processing module. The functions of the acoustic subsystem are to generate pulses to activate each of the transducers of the transducer array; to amplify, rectify, and detect the reflected acoustic signal received at the transducer array; to determine the time-of-flight for the acoustic signal from the transducer to the bottom surface and back; and to output the time-of-flight data to a computer.

The computer calculates the elevation of the bottom surface using the time-of-flight information and prerecorded water level data. This information is displayed on a video terminal on board the surveying boat, and the basic data are recorded on magnetic disks.

The primary interrogation transducers are designed to have a narrow cone transmission pattern. Their nominal operational frequency is 360 kHz, and the narrow pattern is achieved by using a piezoelectric ceramic element whose diameter equals several wavelengths. The resultant cone dispersion is 1 degree at 6 decibels. The transducers are classified as flat-piston radiators and transmit an essentially flat acoustic wave front. Their narrow beam design provides the capability for looking into a depression of 2 feet or larger in diameter and detecting the bottom elevation within ± 2 inches.

During a survey, as the boat-mounted array is moved forward, the multiple transducers are sequentially pulsed. The first signal returning to each transducer from the bottom is detected, and depth and location data are recorded.

The positioning subsystem keeps track of the position of the transducer array bar. Since the bar is mounted on a floating work platform, it is free to move in any direction and to rotate about any of three orthogonal axes; i.e., it has six degrees of freedom. The positioning subsystem is capable of controlling and determining the displacement of the bar in each of these six degrees of freedom. Because the system has excellent vertical resolution, the lateral position of the survey boat must be determined with greater accuracy than the 10- to

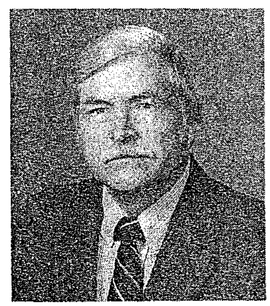
15-foot accuracy of standard ocean surveys to take full advantage of the system capabilities.

The lateral positioning network consists of a sonic transmitter on the boat and two or more transponders in the water at known or surveyed locations. Boat position can be calculated from two known distances. As each transponder receives the sonic pulse from the transmitter, it radios the time-of-detection back to the survey boat. Distance from the boat to the transponder is then calculated from the time-of-flight, and the position is calculated and displayed by an onboard computer. The network can be easily reestablished for subsequent surveys, and the survey boat and transducer array bar can be returned to any location within the network with the same accuracy.

The compute-and-record subsystem provides for computer-controlled operation of the system and for processing, display, and storage of data. Survey results are in the form of real-time strip charts showing absolute relief for each run, three-dimensional surface relief plots showing composite data from the survey runs in each area, contour maps of selected areas, and data printouts of the individual data point values.

The high-resolution acoustic mapping system is designed to operate in water depths of 5 to 40 feet and produce accuracies of ±2 inches vertically and ±1 foot laterally. The system has been successfully used to survey the stilling basin floor of Folsom Dam, a BuRec project near Sacramento, California, and the stilling basin of Ice Harbor Dam in the Corps' Walla Walla District near Richland, Washington. A detailed description and specifications of the system are available and can be furnished on request.

For more information about the acoustic mapping system and the surveys conducted at Folsom and Ice Harbor Dams, as well as for copies of the specifications and detailed description of the system, contact the author, Henry Thornton, at 601-634-3797 or FTS 542-3797.



Henry Thornton is Chief, Evaluation and Monitoring Unit, Concrete Technology Division, Structures Laboratory, WES. He received his B.S. in mathematics and physics from Mississippi College and his M.S. in management science from the University of Miami. He is principal investigator for REMR Work Units 32270, "Underwater Survey Techniques," and 32300, "Improved Nondestructive Testing Techniques for Concrete Structures."

News In Brief

CPT Wylie K. Bearup has been named Deputy Program Manager for the REMR Research Program. CPT Bearup is a graduate of the Engineer Officer Basic and Advanced Courses, and has served with the 78th and 326th Engineer Battalions and with Headquarters, 7th Engineer Brigade. He holds B.S. and M.S. degrees in civil engineering from the University of Arizona and is a registered professional engineer in Virginia.

★★★★★

Congratulations to **Jim McDonald**, REMR problem area leader for Concrete and Steel Structures, on being reappointed as chairman of American Concrete Institute Committee 546, Repair of Concrete, for an additional two-year term.

★★★★★

The American Concrete Institute has announced a 1985 seminar series to be presented in cities throughout the United States, and in Canada, covering Structural Concrete Repair. This program is to be presented by ACI, local ACI chapters, and various other organizations, in cooperation with ACI's Committee on Repair. At this advanced seminar, presenters will relate the actual "how-to's" of repairing structural concrete. The seminar will be offered in the following locations: Montreal, Quebec (April 9); Indianapolis (April 18); Detroit (April 25); Cleveland (May 9); Atlanta (May 23); Boston (October 17); and Baltimore (November 21). Registration fee is $145 for ACI members and $170 for nonmembers, and includes the seminar course manual. More information is available from the Education Department, American Concrete Institute, PO Box 19150, Detroit, MI 48219 or by calling 313-532-2600, ext. 77.

★★★★★

Carl F. Kress, Operations Division, South Pacific Division, has been named to the REMR Field Review Group replacing Donald E. Hambidge who has entered private business.

★★★★★

Robert E. Pletka, has been named Chief, Mechanical Facilities Section, Omaha District, and will no longer serve as Field Review Group member for Missouri River Division. His replacement will be announced at a later date.

★★★★★

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

Underwater Inspection and Repair Workshop Held

"Underwater Inspection and Repair of Hydraulic Structures" was the subject of a REMR workshop held in St. Louis, Missouri, on 27 and 28 November 1984. Seventeen presentations were given, and over 50 individuals representing 15 Corps of Engineers Districts and 9 other government agencies attended. The workshop was the fourth in a series being held as part of the REMR Research Program.

A set of eight videotapes of the workshop proceedings is available for loan. The entire set or individual tapes can be requested. Specific topics are listed below.

To request loan of workshop videotapes, call 601-634-2543 or 2355 (FTS 542-2543 or 2355), or write to: Commander and Director, US Army Engineer Waterways Experiment Station, ATTN: WESTL, PO Box 631, Vicksburg, MS 39180-0631.

Tape	Topic	Speaker	Time min
1	Introduction and REMR Overview	CPT Wylie Bearup	7
	Concrete and Steel Structures Problem Area	Jim McDonald	7
	Underwater Inspection of Coastal Structures	Gary Howell	47
2	Naval Facilities Specialized Inspection Program	Phil Scola	51
3	Underwater Survey Techniques of the Naval Explosive Ordnance Disposal Technology Center	John Pennella	17
	Inspection Techniques in Turbid Water	Dan McGeehan	18
	Inspection of Kinzua Dam	Anton Kryza	25
4	Underwater Survey and Repair (TVA)	Dave Hegseth	23
	Inspection of R. D. Bailey Dam	Lloyd Schell	20
5	Underwater Repair and New Survey Techniques	Steve Tatro	32
	Oahe and Fort Peck Flood Control Tunnel Inspection	John Monzingo	27
6	Wynoochee and Chief Joseph Dams Investigation and Repair	George England Paul Johnson	40
	Repair of Lock and Dam 26	Mel Stegall	16
7	Webber Falls Stilling Basin Repair	Reggie Kikugawa	30
	Underwater Repair of Hydraulic Structures (continued on Tape 8)	John Baehr	32
8	Underwater Repair of Hydraulic Structures (continued from Tape 7)	John Baehr	14
	FY 85 REMR Research Program Review	REMR Staff	43

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				
John R. Mikel (Chairman)	Operations Branch	DAEN-CWO-M	202-272-0242	272-0242
Tony C. Liu	Structures Branch	DAEN-ECE-D	202-272-0223	272-0223
Bruce L. McCartney	Hydraulic Design Branch	DAEN-CWH-D	202-272-0228	272-0228
Program Management				
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CPT Wylie K. Bearup (Deputy Program Manager)	Structures Laboratory, WES	WESSC-A	601-634-3815	542-3815
Timothy D. Ables (Technology Transfer Specialist)	Structures Laboratory, WES	WESSC-A	601-634-2587	542-2587
Problem Area Leaders				
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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
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Jerome L. Mahloch (Environmental Impacts)	Environmental Laboratory, WES	WESEP-W	601-634-3635	542-3635
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Eugene Brickman	North Atlantic Division	NADEN-TF	212-264-7556	264-7556
John G. Oliver	North Pacific Division	NPDEN-T	503-221-3859	423-3859
John D. Parsons	Ohio River Division	ORDED-T	513-684-3006	684-3006
Howard S. Kobayashi	Pacific Ocean Division	PODEN-T	808-438-2837	
James W. Erwin	South Atlantic Division	SADEN-F	404-221-4256	242-4256

Recent Publications

Engineering condition survey of concrete in service. R. L. Stowe, H. T. Thornton, Jr. US Army Engineer Waterways Experiment Station, Vicksburg, MS, September 1984. Technical Report REMR-CS-1.

This report summarizes pertinent inspection procedures and methods of evaluation used by the Corps of Engineers in evaluating concrete civil works structures. Methods of evaluation include experience gained at the Waterways Experiment Station. Techniques are presented which have a potential for ascertaining the extent and cause of inadequacies in concrete structures.

Mathematical analyses of landside seepage berms. R. A. Barron. US Army Engineer Waterways Experiment Station, Vicksburg, MS, September 1984. Technical Report REMR-GT-1.

This report describes a study that extends solutions for mathematical analyses of seepage berms presented in an earlier Waterways Experiment Station report. Because of the great difficulty in determining the permeability of foundations, top blankets, and seepage berms, it is recommended that the solutions presented in this report be used only as guidelines and that sound engineering judgment be applied to designs. Supplements have been added to the report to present solutions for seepage berms with constant slope of upper surface, riverside seepage berms, and general cases and short berms.

COVER PHOTOS

Crew members being lowered onto a survey boat equipped with a high-resolution acoustic mapping system for surveying the stilling basin floor of Folsom Dam, a US Bureau of Reclamation project near Sacramento, California.

One of three locator beacons mounted on the stilling basin wall for controlling and determining the position of the survey boat.

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 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).

ROBERT C. LEE
Colonel, Corps of Engineers
Commander and Director
Waterways Experiment Station

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