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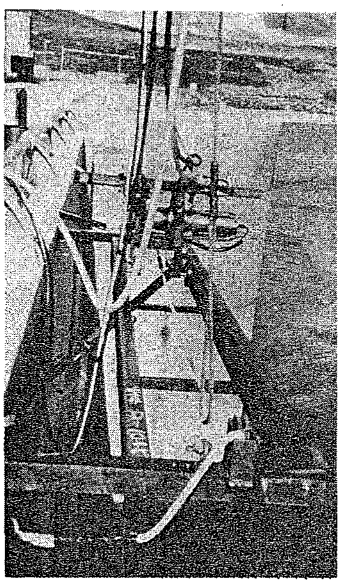

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The REMR Bulletin

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

VOL 1, NO. 3 — INFORMATION EXCHANGE BULLETIN — JUL 1984

Acrylic Latex Concrete Repair

by Rosemarie Braatz
US Army Engineer District, St. Paul

Acrylic latex concrete seems to have passed the "freeze-thaw" test of the northern climate, according to the Construction-Operations Division of the St. Paul District.*

At Lock and Dam No. 9 on the Mississippi River near Lynxville, Wis., Lockmaster Lee Stenerson has been using the "breathing" concrete mortar for regular and preventative maintenance for the past six years — since it was introduced to the market. He has kept detailed records of the method, age, durability, size, and cost of each patch, and concludes that acrylic latex concrete is definitely extending the life of the aging lock and dam structure, reducing the need for far more costly conventional concrete repair.

"It has high bonding properties, and its permeability prevents the buildup of water behind it that could freeze and thaw to force off the patch. It's easy to apply, more slip-resistant than other concrete, and safe to use," Stenerson points out. It can make surface repair as simple as troweling on a second coat, and when it's applied over areas extensively patched by the conventional method, it improves the appearance of the structure by providing uniformity of color, along with further protection.

Stenerson recommends one part portland cement, two parts silica sand, and enough liquid acrylic latex to produce a trowelable mortar.

"The adhesive quality of this mortar is higher than that of concrete, but is only as good as the surface of the concrete it is applied to," Stenerson stresses. "You've got to follow the basic procedures of good concrete work—the proper mixture and a good surface." All loose and powdery material must be removed. If concrete needs to be removed to more than 1/2 inch deep to reach solid concrete, then it's probably too late to use the acrylic latex procedure.

In that case, Stenerson says, it will be necessary to saw-cut and jackhammer to at least 3-1/2 to 4 inches deep, and apply a conventional air-entrained concrete pack, using expansion material at all monolith joints.

Supposing that the concrete surface condition is still sound enough to use the acrylic latex concrete, only cleaning is necessary (to remove all dirt, oil, grease, powdery cement, and paint). To do this, the concrete should be thoroughly washed down, with water and brush, or with pressure hose equipment.

When the acrylic latex concrete mixture is used on new concrete, to protect it from weathering, Stenerson emphasizes that the new concrete must be thoroughly washed to remove any powdery residue. This residue can decrease the adhesiveness of the latex mixture and cause it to spall off.

The best results in applying the acrylic latex mortar were obtained on cool, cloudy days, Stenerson says. Hot, dry, windy days caused too rapid an evaporation of the water. He also advises dampening the wall surface before troweling on the mortar, "but it should not be *wet*!"

* Readers should note that official Corps of Engineers guidance on use of latex concrete has not yet been established.

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The mortar should be of a consistency to allow easy application with a steel-finish trowel. Then, brush or broom while still wet to get the desired appearance, Stenerson notes.

"We know that we are still doing some things wrong, because occasionally a patch will spall, or crack, but basically, this latex mixture offers more 'forgiveness' that other types of concrete repair methods," Stenerson says. Keeping in mind that the laborers who do the repair work on the locks and dams are not professional masons, this is an important factor, he remarks. "When we've tried to do repairs that required precise methods and measures we've had a much higher failure rate."

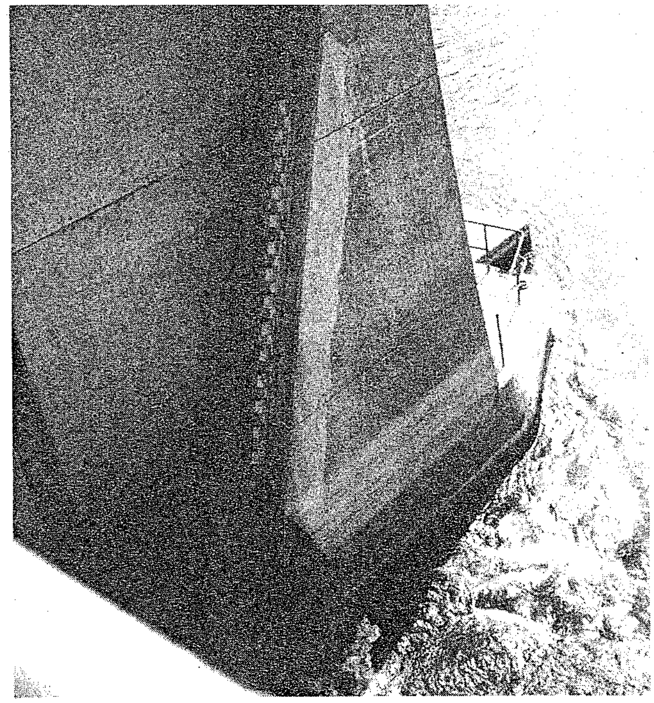
"One of our problems with the acrylic latex concrete mixture is that there are so many variables involved — the depth and breath of application, temperature, humidity, all make a difference in how the patch will hold. Sometimes we use more sand for a more solid consistency," Stenerson points out. About 15 percent latex solids is considered most advisable; a mixture too rich in latex has been found to reduce permeability.

As to costs for the acrylic latex procedure, Stenerson breaks a total of $13.66 per 100 square foot to:

1/3 bag cement at $5.09/bag	$1.69
75 lb silica sand at $3.00/100 lb	2.25
2 gal latex liquid at $4.86/gal	9.72

Mixing and applying in 1 man-hour at $7.00 brings the cost to $20.66 applied (not including overhead or benefits).

Lockmaster Lee Stenerson points to an area where latex mortar was used in 1980 in a test repair of voids over 3/4 inch deep in the lock wall, Lock and Dam No. 9, Mississippi River, near Lynxville, Wis.



Roller gate rack and track area sealed in 1980 with brushed on latex mortar

By comparison, the cost of having to do the more extensive concrete application, removing 3-1/4 to 4 inches of concrete and placing new, comes to an average of $374 per 100 square feet.

The concept of preventing deterioration of aging concrete by use of acrylic latex concrete is especially pertinent in St. Paul District where the headwaters reservoir dams are as old as 80 or 90 years, and most of the dams on the Mississippi River are over 50 years old. "When the locks and dams in this District were built, we didn't have air-entrained concrete, so the freeze-thaw effect in this climate is severe," Senerson points out.

Many techniques and materials have been tried, but considering factors such as cost, durability, and safety, the "breathable acrylic latex concrete—used before deterioration advances—is proving to be most effective."

Rose Braatz has worked as a writer-editor and in public affairs for the St. Paul District since 1973, and is currently employed in the Construction-Operations Division. A journalism graduate of the University of Wisconsin, she had for 15 years previously edited a weekly newspaper at nearby St. Croix Falls, Wis.

Seattle District Testing Novel Approach to Reducing Spillway Leakage at Chief Joseph Dam

by Paul F. Johnson
US Army Engineer District, Seattle

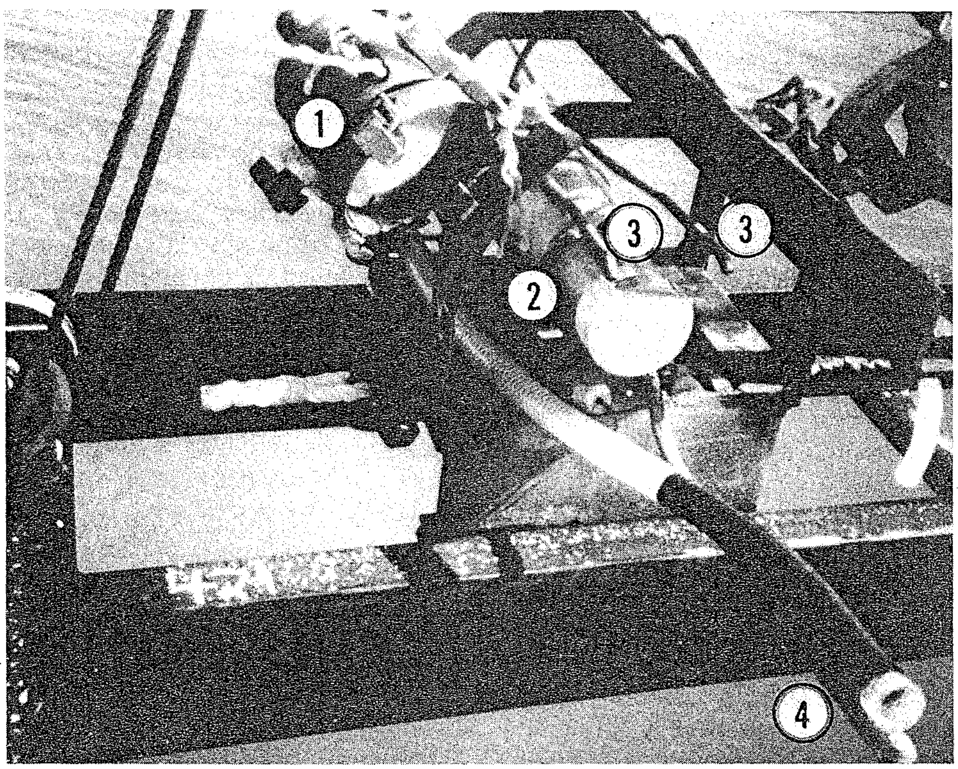
Seattle District is testing a remote evaluation and repair system as part of a maintenance program to locate and seal cracks in the upstream face of Chief Joseph Dam.

Chief Joseph is located 1.5 miles upstream of Bridgeport, Wash., on the Columbia River. The spillway has both face and joint drains running parallel to the upstream face of the dam that were designed to intercept any water leakage past the dam face. Inflow through these drains exits into the drainage and grouting gallery where it is pumped out of the gallery by four sump pumps.

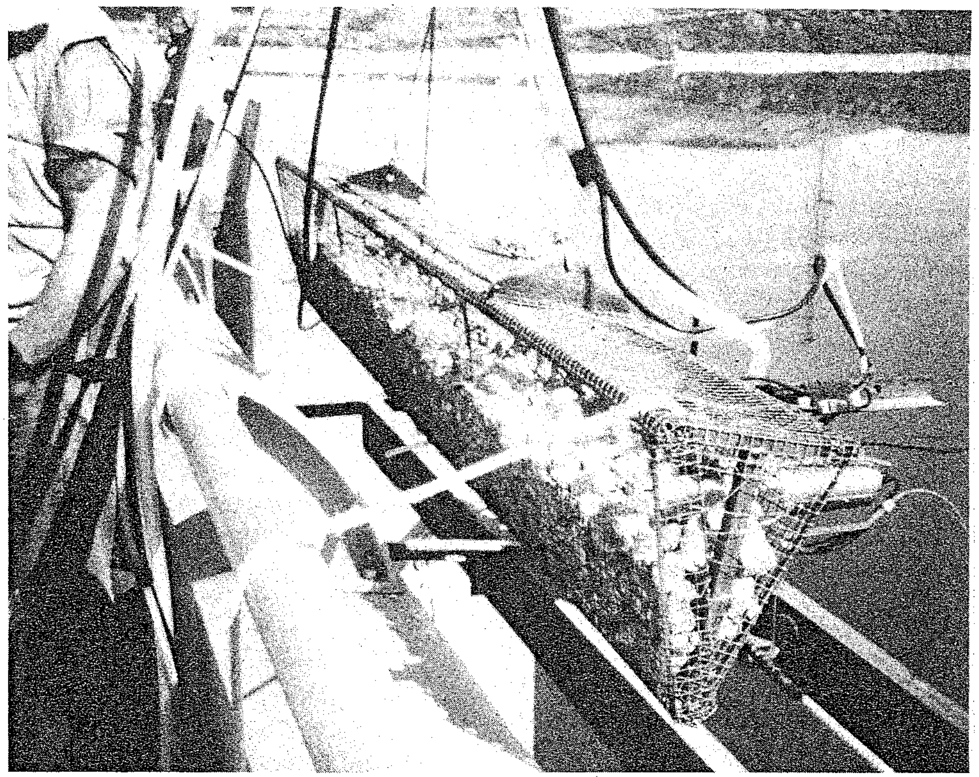
Prior to construction to raise the dam height in 1977, the spillway leakage varied from 25 gpm in the summer to 950 gpm in the winter. After construction and before the 10-foot pool raise, the peak inflow increased to 2800 gpm. After the pool was raised 10 feet, the flow increased to a maximum of 4000 gpm.

The annual variation in leakage rates is caused by the movement of concrete expanding and contracting with the seasonal concrete temperature change. Leakage increases through the winter months, peaking in February, and gradually decreases during the spring and summer months. Data from recent years indicate that there has been a continuous rate of increase in leakage at the same concrete temperatures each successive year.

In February 1983, a two-phase test program was initiated to locate areas of leakage in the upstream face and seal the cracks with various materials. An underwater color video camera mounted on an 8-foot steel frame was rigged to be moved sideways along the frame by a system of ropes and pulleys. Positioned under the camera and visible in the video picture were two tubes connected to containers on the surface: one tube for delivering a green fluorescent dye, and the other for transporting crack-sealing materials. A crane was used to lower the camera and frame to the desired depth, and the camera and tubes were moved back and



Camera and tubing rig: light assist (1) for underwater video camera (2), shown with its cap in place; ends of water jets (3) for injecting clear water into the immediate vicinity of the camera; and end of tube (4) for transporting crack-sealing materials from containers on the surface



Wire cage for lowering compressed wood fiber pellets to the elevation of a leaking joint where they slowly disintegrate, allowing the wood fibers to be sucked into the joint

forth along the face as the survey progressed. The entire survey was directed by an "operator" monitoring the work via the video image and was recorded on a video recording system.

The first phase of the test program involved surveying every square foot of one monolith and the lift joints of a second monolith. As the survey progressed, dye was injected near the horizontal lift joints and the vertical monolith construction joints. Through the video monitor, dye could be seen as it exited the tube and entered open joints. The dye was also observed by personnel in the drainage gallery as it entered the drains.

On the two monoliths surveyed, leakage was observed along one horizontal lift joint in each monolith and in various areas along the vertical monolith construction joint. No random cracks were found in the areas between lift joints.

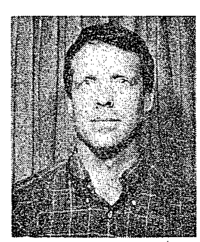
The second phase of the test program involved sealing areas of leakage. Materials tested for this purpose were bentonite, wood fibers, water-activated urethane foam, and granular materials (crushed walnut hulls, natural cinders, and mica).

The bentonite and granular materials were applied by compressed air down the tube which was positioned next to the joint. Wood fibers compressed into 1-1/4-inch-diameter cylindrical pellets were placed inside a wire cage and lowered to the desired elevation. The pellets slowly disintegrated and individual fibers began to swell as they were sucked into the joints. The water-activated foam was delivered to the joints by pressure injecting the material down the tube.

The granular and foam materials were not measurably effective. The foam did flow into the joints but apparently did not set fast enough to reduce the leakage. The granular materials were too heavy or too large to effectively seal the open joints. Both wood fibers and bentonite decreased the leakage by approximately 50 percent.

Further investigations are planned to refine methods for sealing other monoliths.

Paul Johnson is a materials engineer in the Site and Inspection Branch, Construction Division, Seattle District. At the time he wrote this article, he worked in the Foundation and Materials Branch of the Engineering Division. He received his B.S. in civil engineering from the University of Washington.



Underwater Inspection and Repair Workshop Planned for November

The Waterways Experiment Station will host a workshop devoted to an assessment of the current state of knowledge in the area of underwater inspection and repair of concrete in hydraulic structures.

The workshop is tentatively planned for 27-28 November 1984 in Vicksburg, Miss.; dates and the location will be confirmed in September.

Participants will include experts in the areas of visual and tactile examination, underwater television and video, remote controlled equipment, sampling and nondestructive testing techniques, material selection, mixture proportioning, concrete placement, and tremie concrete.

Attendance is *not* restricted to the Corps of Engineers, but an effort will be made to limit the number of participants to maximize interaction among them. Recommendations on potential participants will be considered.

For additional information, write: Commander and Director, US Army Engineer Waterways Experiment Station, WESSC-R, PO Box 631, Vicksburg, MS 39180-0631; or call: Jim McDonald, 601-634-3230 or FTS 542-3230.

Symposium Scheduled on Liquefiable Soils

A symposium on remedial treatment of liquefiable soils beneath existing foundations will be held September 6 and 7, 1984, at the Waterways Experiment Station (WES), Vicksburg, Miss.

The purpose of the symposium is twofold: to stimulate exchange of ideas and information among leading practitioners, and to provide an authoritative review of the state of the art for potential users, primarily those within the federal government.

Speakers will include: J. K. Mitchell, University of California, Berkeley; W. D. Liam Finn, University of British Columbia; W. H. Baker, Hayward Baker Co.; E. D. Graf, Pressure Grout Co.; R. R. Davidson, Woodward-Clyde Consultants; R. G. Lucas, Soil Testing Services, Inc.; R. D. Barksdale, Georgia Institute of Technology; T. Dobson, GKN Keller, Inc.; and R. H. Ledbetter, WES.

For further information, write: Commander and Director, US Army Engineer Waterways Experiment Station, WESGH-R, PO Box 631, Vicksburg, MS 39180-0631; or call: Richard Ledbetter, 601-634-3380 or FTS 542-3380.

Request for Articles

The next issue of *The REMR Bulletin* will focus largely on field experiences with the geotechnical features of Corps civil works projects. If you have experience in this area, we would appreciate your drafting an article describing your work or contacting us for assistance in doing so. If so desired, we can provide editorial assistance in preparation of your article. Along with the article, please furnish accompanying illustrations (original glossy photographs, slides, or line drawings).

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, PO Box 631, Vicksburg, MS 39180-0631. Or call: Tim Ables at 601-634-2587 (FTS 542-2587), Britt Mitchell at 601-634-2640 (FTS 542-2640), or Jerry Huie at 601-634-2613 (FTS 542-2613).

Dan Kumlin, an employee at Lock and Dam No. 9 on the Mississippi River in St. Paul District, defines a "working crack" in concrete as one that "no matter how hard you work, you can't fix it."

COVER PHOTOS

Lee Stenerson, Lockmaster at Lock and Dam No. 9 on the Mississippi River near Lynxville, Wis., inspecting an area of lock wall where deteriorated concrete was removed and replaced with 4 inches of new concrete.

Steel frame, underwater video camera, and tubing forming an evaluation and repair system being tested by Seattle District for locating and sealing cracks in the upstream face of Chief Joseph Dam on the Columbia River near Bridgeport, Wash.

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), PO Box 631, Vicksburg, MS 39180-0631, or calling 601-634-2587 (FTS 542-2587).

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Colonel, Corps of Engineers
Commander and Director
Waterways Experiment Station

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