



REMR TECHNICAL NOTE CS-MR-9.3

SPECIALIZED REPAIR TECHNIQUE:
CONCRETE UNDERWATER

PURPOSE: To provide information on available materials, equipment, and techniques necessary for successful placement of concrete underwater.

APPLICATION: Although the information provided in this technical note is applicable in any situation that requires concrete to be placed underwater, including new construction, it addresses primarily repair of an existing structure.

REPAIR PROCEDURES: In order for underwater concrete placement to be successful, the concrete must be protected from the water until it is in place so that the cement fines cannot wash away from the aggregates. This protection can be achieved through proper use of placing equipment, such as tremies and pumps. Also, the quality of the in-place concrete can be enhanced by the addition of an antiwashout admixture (AWA). An AWA increases the cohesiveness of concrete.

When a repair is to be made to an existing structure, following appropriate procedures increases the likelihood that the rehabilitation effort will be successful.

- a. The location and size of the area to be repaired should be well defined.
- b. The area should be thoroughly cleaned of all debris and fragmented concrete before new concrete is placed. Water jetting and air-lift techniques are effective cleaning methods. This cleaning is essential for any significant bond to occur between the newly placed and the existing concrete.
- c. In addition to cleaning, it is recommended that an appropriate number of anchors be grouted into the existing concrete to tie the new concrete to the existing concrete. The anchors are necessary to assure good bond because of the difficulty of keeping an existing surface clean until the new concrete is placed.
- d. All necessary equipment must be at the job site before any concrete placement is begun. There should be good coordination between all parties involved in the operation, from the concrete batch plant to the personnel actually placing the concrete.
- e. If the concrete is to be placed in thin lifts, in areas exposed to flowing water, or where it is to flow a considerable distance, the use of an AWA is essential. Under these conditions a relatively small amount of concrete is exposed to a large volume of water.

be washed from the aggregates. It is recommended that an AWA be used to increase the cohesiveness of all concrete placed underwater. While not essential in mass placements, an AWA will enhance the quality of the in-place concrete.

- f. When AWAs are used, it is not as critical to keep the discharge end of the tremie or the pump line embedded in the concrete as it is when they are not used. However, the concrete should not be unnecessarily exposed to water during placement. Once in place, concrete containing an AWA can flow up to 30 ft without harmful washout or segregation.
- g. The cohesiveness imparted by an AWA actually improves the pumpability of concrete for moderate distances. However, if the concrete has to be pumped a long distance, the pumping distance becomes an important parameter. If the pumping distance is 150 ft or less, there should be no problems. If the pumping distance exceeds 250 ft, pumping pressures will likely increase significantly. If the pumping pressures become excessive, the concrete mixture will have to be modified by adding water or reducing the amount of AWA, or the pump will have to be relocated to reduce the pumping distance. If the cohesiveness is reduced, the concrete is more susceptible to washout. Therefore, relocating the pump is the better solution.

PERSONNEL REQUIREMENTS- A qualified diving team is required when concrete is to be placed underwater. Safety cannot be overemphasized. Also, an expert should be consulted before a concrete mixture proportion is specified and accepted. If AWAs are to be used, personnel responsible for the concrete mixture proportions should be familiar with their use.

METHODS OF INSPECTION: There are a number of inspection techniques that can be used to evaluate the degree of success obtained in an underwater concrete placement. The selection of inspection techniques will be affected by type, size, location, and environmental conditions of a particular job, along with technical capabilities and limitations and monetary constraints.

Visual inspection is usually the first technique considered for underwater inspection. However there are environmental limitations, such as poor visibility and difficult working conditions in strong currents. When the inspection is to be done in turbid water, which is usually the case immediately after concrete placement, the diver can use tactile methods to characterize the repair. This type of inspection can also be used in zero visibility conditions.

More sophisticated techniques such as echo sounders, side-scan sonar, radar, laser mapping, and high-resolution acoustic mapping (HRAM) are also available. The HRAM system appears to be ideal for inspection of underwater repairs.

ENVIRONMENTAL CONSIDERATIONS: Although portland cement concretes have a long history of use in aquatic environments, reasonable caution should guide the preparation, repair, and cleanup phases of repair activities involving

potentially hazardous and toxic chemical substances. Manufacturer's directions and recommendations for the protection of occupational health and environmental quality must be followed. Material Safety Data Sheets must be obtained from the manufacturers of chemical materials.

Increased loading of suspended solids by washout of cement fines may be of some concern in sensitive environmental habitats if the exposure concentrations are high and the pH of the water is increased significantly. A neutralizing agent may reduce the toxicity to freshwater aquatic animals. If used properly, AWAs will reduce the amount of cement fines dispersed into the water.

REFERENCE: Neeley, B. D., Saucier, K. L., and Thornton, H. T. 1990 (Sep). "Laboratory Evaluation of Concrete Mixtures and Techniques for Underwater Repairs." Technical Report REMR-CS-34, US Army Engineer Waterways Experiment Station, Vicksburg, MS.