REMR TECHNICAL NOTE CS-MR-1.11

CONCRETE REMOVAL TECHNIQUE: DIAMOND WIRE CUTTING

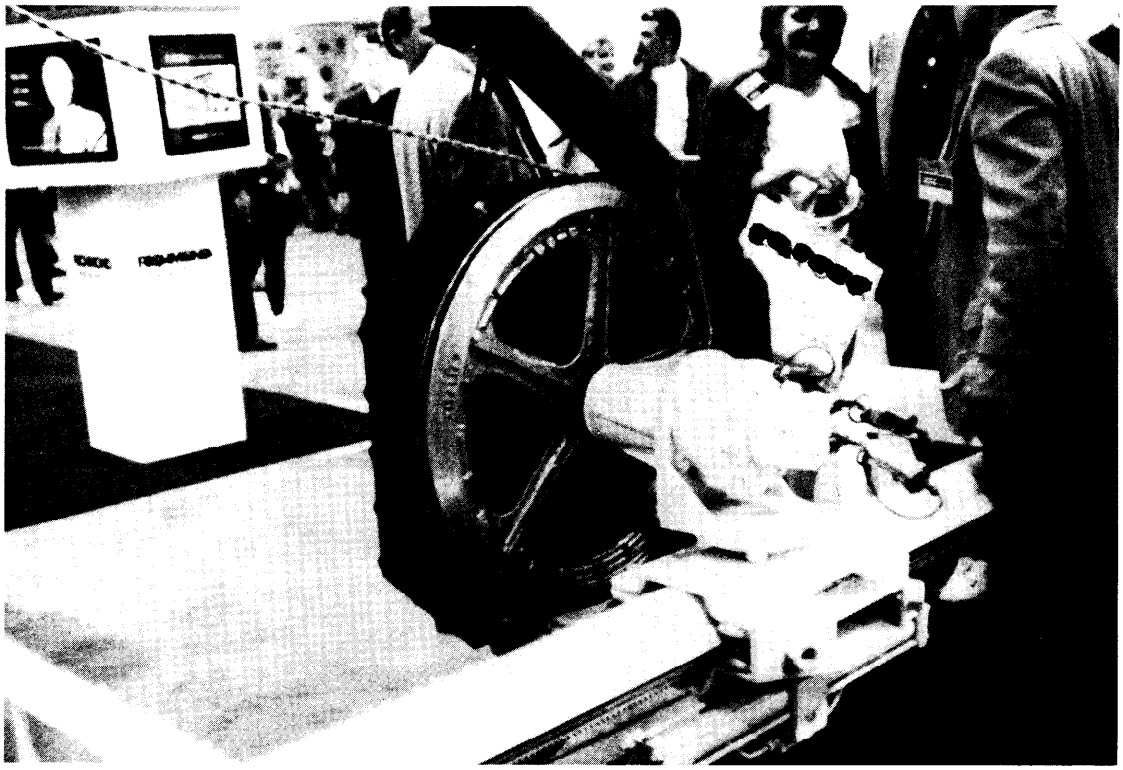

Figure 1. Diamond wire saw

PURPOSE: To describe use of diamond wire cutting as a technique for concrete removal.

APPLICATION: Diamond wire cutting technique is used to cut out concrete sections for removal from areas where depths are greater than those that can be economically cut with a diamond blade saw, such as mass concrete floors, walls, and piers.

ADVANTAGES: The diamond wire cutting technique can be employed in areas difficult to access, and it is not limited by depth of cut. It can be used to make cutouts through concrete without damaging the concrete that remains and without overcutting the corners. Sections are removed as a unit, resulting in a more efficient operation and better containment of the removed concrete (an important feature for concrete contaminated with hazardous or radioactive materials). No vibration and little noise are produced by the cutting operation. In situations in which both wire cutting and stitch drilling are applicable, the wire cutting technique is less costly and more expedient.

LIMITATIONS: Time and cost of cutting concrete with diamond tools increase as the percentage of steel in the cut area and the hardness of the aggregate

increase. When a deep opening is to be cut out, the cutting planes must be tapered so that the cutout (plug) does bind during removal. As the wire diameter and cut opening are reduced with time due to wear, a new wire cannot be used to continue a cut made by a worn wire unless a smaller diameter wire is used. Some projects, especially those involving the removal of concrete containing hazardous materials, require containment of cooling water.

PERSONNEL REQUIREMENTS: Well trained and experienced personnel are required for planning, cutting, and maintaining equipment.

EQUIPMENT: Typically, the equipment consists of a power unit, saw, idler wheels, and a wire loop. The saw (Figure 1) is comprised of a flywheel, its motor, and a wire-tensioning system. The flywheel motor can be electric or hydraulic. Hydraulic motors are preferred because they provide infinitely variable speeds and are reversible (ref a). The tensioning system typically uses either a slide assembly with a hydraulic stroke cylinder or a motor-driven rack and pinion system to vary the position of the flywheel to provide the desired tension in the wire loop. Idler wheels are used to guide the wire and direct the cut. The steel wire rope comes in 1/4-in. to 3/4-in. diam and is encased in a series of alternating beads and spacers. The beads are steel with embedded diamonds (electroplated or impregnated), and the spacers are spring-injected steel or plastic sleeves. Beads with impregnated diamonds are more durable; however, they are more expensive and slower cutting. In the field, the wire is cut to the required length and made into a loop with a steel coupling. Cutting life for diamond wires is estimated to be 1 to 10 sq ft per linear ft of wire (ref a).

BACKGROUND: Diamond wire cutting is a stone quarrying technique that has been adapted to concrete removal. It has been used primarily for the extraction of marble, but it has also been used for sandstone, limestone, and limited amounts of granite (ref a). In 1987, diamond wire cutting was successfully employed at Marseilles Dam on the Illinois River to cut out the top downstream corner of six piers as a part of the renovation of the dam's gate system. The approximately 54-year-old concrete in the piers had a compressive strength in excess of 8,000 psi. Aggregate contained in the concrete had a maximum size of 2-1/2 in. and a well-rounded dolomite as the dominant portion of the coarse aggregate.

The work initially included nine piers. A boom-mounted breaker with 250-ft-lb limit and hand-held breakers were being used to do the removal. However, the removal was taking approximately 10 working days and cost $7,000 per pier, which was more than the contractor had estimated. After work was completed on three piers, the contractor changed to the diamond wire cutting technique for the remaining piers. The wire cutting resulted in a pier completion every three days at a cost of $6,500 per pier. The average cutting rate, including set-up and take-down times, was approximately 4.3 sq ft/hr.

Both the horizontal and vertical cuts were started from the same borehole to avoid overcutting at the corner of cutouts. The boreholes were drilled 2-1/2-in. in diam, even though, only 1-in. holes were needed. Each pier contained four 4-in.-diam trunnion anchors and numerous 2-1/2-in.-diam anchor bolts that had to be cut. The resulting cutouts were 6 ft by 8 ft by 9 ft and weighed approximately 30 tons.

The general procedure for making cutouts was to drill borehole across the pier at the bottom upstream corner of cutout, set up the saw and idler wheels, insert the diamond wire through borehole, splice the ends of wire with a steel couple to complete the loop, make the horizontal cut while placing steel shims in cut to maintain opening as cutting proceeded, relocate idler wheels, shorten and resplice wire, and make the vertical cut starting again at the borehole. A crane was used to remove the cutout section.

ENVIRONMENTAL CONSIDERATIONS: Large amounts of concrete removed from Corps projects might be placed in open water to serve as a fish attractor reef. Several references are available (Ref b, c, d, and e) that contain suggestions for locating, sizing, and marking fish attractors. If toxic material is present, proper handling and disposal under Resource Conservation and Recovery Act regulations may be required (see Technical note EI-M-1.2, "Handling and Disposal of Construction Debris"). For removal in which no hazardous debris is produced and the debris (cuttings transported by wire's cooling water) is to enter a waterway, a determination of the change in water quality and its impact will be required.

COST: The cost of cutting will depend on the percent of steel to be cut, type of aggregate, and size of the job. At Marseilles Dam the cost was approximately $63/sq ft of cut.

REFERENCES:

a. Hulick, R. M. and Beekman, T. R. 1989 (Mar). "Diamond Wire Cutting of Concrete," Concrete International, pp 29-32.

b. Nelson, R. W., Horak, G. C., and Nelson, J. E. 1978. "Western Reservoir and Stream Habitat Improvements Handbook," US Department of the Interior, Fish and Wildlife Service, Fort Collins, CO.

c. Ryder, L. L. 1981. "Concrete Rubble and Miscellaneous Materials as Artificial Reef Materials," Artificial Reefs, D. Y. Aska, ed., Report 41, University of Florida, Gainesville, Florida Sea Grant College, pp 89-91.

d. Shnick, R. A., et al. 1982. "Mitigation and Enhancement Techniques for the Upper Mississippi River System and Other Large River Systems," Resource Publication 149, US Department of the Interior, Fish and Wildlife Service, Washington, DC.

e. Seeborn, M. E. 1985. "Fish Habitat Improvement Handbook," Technical Publication R8-TP-7, US Department of Agriculture, Forest Service, Southern Region, Atlanta, GA.