CHAPTER 6

DEWATERING AND PRESSURE RELIEF

6-1. Purpose of Design. A cellular cofferdam is a temporary structure constructed in a river, lake, etc., to exclude water from an enclosed area (item 53). This allows the interior of the cofferdam to be dewatered and the permanent structure to be constructed in the dry. Usually cofferdams must withstand large differential heads of water; therefore, it is imperative that surface water and seepage be controlled, artesian pressure be relieved, and emergency facilities to prevent overtopping be made a part of the cofferdam to ensure a stable and competent structure.

6-2. Dewatering and Pressure Relief. Dewatering of a cofferdam can be accomplished in two phases. The first phase is initial dewatering (or pump down) to remove water from the interior of the cofferdam. The second phase is foundation dewatering to lower (or draw down) the ground water, to ensure a dry and stable construction area. The size and type of the dewatering system depends on the size of the cofferdammed area to be dewatered, total quantity of water to be pumped, geological conditions, and soil characteristics. According to TM 5-818-5 (item 1), a properly designed, installed, and operated dewatering and pressure relief system can greatly facilitate construction in the cofferdammed area by: intercepting seepage that would otherwise emerge from the slopes or bottom of the excavation; increasing the stability of the slopes and preventing the loss of material from the slopes or bottom of the excavation; reducing lateral loads on cofferdams; and improving the excavation and backfill characteristics of sandy soils.

a. Initial Dewatering. The maximum rate of dewatering is controlled by the stability of the inside land bank, by cell drainage, and by cell interlock stresses. Generally, the first 15 feet are dewatered without restrictions so that differential pressure can be developed quickly to close the interlocks tightly. Thereafter, the rate for dewatering is 5 feet per day, which is normal for large cofferdams (items 56 and 76). Drainage of the cells and connecting arcs must closely follow the dewatering of the cofferdammed area, and should cell drainage lag, the dewatering rate should be slowed down. For "clean" cell fill, weep holes should be burned in the inboard sheet pile of all cell and connecting arcs during dewatering. Current practice is to burn l-inch-diameter weep holes at about 5- to 6-1/2-foot centers vertically on every third to sixth sheet pile down to the top of the berm or to the inside ground surface if no berm is used (item 12). Throughout dewatering operations, the weep holes should be systematically rodded to maintain cell drainage. For marginal or "dirty" cell fill, weep holes by themselves may be insufficient to drain the cells; therefore, well points or deep wells should be installed in the cells to ensure adequate drainage and to increase cell rigidity (item 52). Occasionally, cell drainage is impeded by tremendous inflows through the interlocks on the outboard side of the cofferdam. Dropping clay, slag, cinders, or coal dust around the outside of the cofferdam to plug openings in the interlocks will rectify this condition (item 38). The need to keep the cells and connecting arcs free-draining cannot be overstated for the reason cited in paragraph 5-2a4. As the cofferdammed area is dewatered the sheet pile should be examined for damage. If split sheets or separated interlocks are revealed, dewatering must be stopped, according to Patterson (item 56). Should the damage extend for some distance, it may be necessary to reflood the cofferdam, excavate the fill from the questionable cell, and replace the damaged piling. If the damage is not extensive, straps should be welded across the split a short distance above the top of the split. Strapping should be carried closely along as the dewatering is continued. Dewatering of the cofferdammed area dictates that maximum pumping capacity be provided. Plenty of reserve pumping capacity should also be available in case of mechanical breakdowns. The pumps should be placed as near the water level as possible because the pumps will push water more efficiently than they will pull it, as explained in item 38.

b. Foundation Dewatering. After completion of the initial dewatering phase, the ground water in the foundation must be controlled throughout construction of the permanent structure. The ground water must be drawn down so that a dry and stable construction area is provided. The primary sources of ground water are seepage through and underneath the cells and surface water which percolates into the ground before it can be collected and pumped out. The quantity of seepage can be estimated using those methods discussed in paragraph 4-9a4e. The most commonly used dewatering method for soils that can be drained by gravity flow is the conventional wellpoint system. It is limited to about 15 feet of drawdown per stage; however, multiple stages may be used. This system is most practical for large excavations in the cofferdam basin where the depth of excavation does not exceed 30 to 40 feet. For large excavations deeper than 40 feet or where artesian pressure in a deep aquifer must be relieved (discussed in paragraph 6-2c) deep wells with turbine or submersible pumps should be used. Deep wells can be installed around the periphery of the excavation, thus leaving the construction area free of dewatering equipment. For more detailed information concerning dewatering methods and equipment refer to item 1.

c. Pressure Relief. Artesian pressures from underlying aquifers which endanger the stability of the cofferdam and berms or excavation in the interior of the cofferdam must be relieved. Depending on the piezometric level, pressure reduction in the aquifer may be required before dewatering of the cofferdam (item 72). Complete relief of artesian pressures to a level below the bottom of the excavation is not always required depending on the thickness, uniformity, and permeability of the materials. Artesian pressure can be relieved by deep wells or wellpoints as previously discussed in 6-2b. The penetration of the wells or wellpoints should be no more than that required to achieve the drawdown required to minimize artesian flows. The formulas for artesian flow presented in Appendix IV of TM 5-818-5 (item 1) should be used to design or evaluate the pressure relief system. Because of the critical nature of pressure relief and the rapid rate at which an aquifer would recover if pumping were interrupted, backup systems should be provided. The system should be designed for a capacity approximately 50 percent greater than that expected to be required. For more detailed information concerning design of relief wells, refer to EN 1110-2-1905.

6-3. Surface Water Control. A well-designed dewatering and pressure relief system must include provisions for collecting and pumping surface water so that dewatering pumps cannot be flooded. Surface water, which includes rainwater, inflow through the interlocks, drainage through the weep holes, and seepage which emerges from the surfaces of berm and excavation slopes, may be controlled with ditches, French drains, or sumps. The area enclosed by the cofferdam should be sloped to drain toward one or more centrally located sumps where the surface water is collected and pumped out. In addition, ditches or French drains should ring the perimeter of the cofferdammed area to divert inflow through the interlocks and drainage through the weep holes to the sumps. The number and size of the ditches, French drains, and sumps depend on the size of the cofferdammed area, characteristic of the soil, rainfall frequency and intensity, and the estimated inflow and drainage through the interlocks and weep holes, respectively. The estimated inflow through the interlock should be assumed to equal at least 0.025 gallons per minute per square foot of wall per foot of net head across the wall for installations in moderately to highly permeable soil (item 86).

6-4. Emergency Flooding. Large cellular cofferdams in areas where they may be overtopped should be constructed with sluiceways, floodgates, or both to control floodwaters (item 78). Flooding of the interior of the cofferdam by allowing uncontrolled floodwaters to overtop the cells may cause serious damage to the cofferdam by washing material from the cells or by eroding the berm, not to mention the damage to the permanent structure under construction. Frequently the cells are capped with 6 to 12 inches of lean concrete to prevent the washing out and saturation of cell fill. Enough floodgates should be provided so that, the cofferdammed area can be flooded at least two-thirds full within 4 to 6 hours, or before any cell is overtopped, if the cofferdam is in imminent danger of being overtopped (item 77). The size and number of floodgates depend on the size of the cofferdammed area to be flooded and the anticipated rate of rise of the river.

a. Construction of a floodgate is best done by using a connecting arc area between two circular cells at the downstream end of the cofferdam. The connecting arc sheet piles should be burned off near normal pool, and the area should be capped with 18 to 24 inches of reinforced concrete. A recess should be formed in the concrete cap to support the bottom of a timber or steel bulkhead. The area adjacent to the connecting arc should be sloped and protected with stone to prevent scouring as floodwaters enter the interior of the cofferdam.

b. Flood-stage predictions must be carefully monitored as a basis for determining when equipment should be evacuated from the cofferdammed area, and the floodgates should be opened to prevent overtopping, If serious inflows through the interlocks occur due to the flood stage, it may become necessary to flood the cofferdammed area to equalize pressures and prevent serious damage to the cofferdam, even though predictions do not anticipate that the cofferdam will be overtopped by floodwaters. Floodgates and sluiceways are also used for flooding the interior of the cofferdam upon completion of the construction and just prior to the removal of the cofferdam.