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Repairing Fish Pond Levees

Jim A. Steeby[1], Nathan Stone[2], H. Steven Killian[2] and Dennis K. Carman[3]

Many fish farms have older ponds that need repair. Because soils in the major catfish-producing areas of Mississippi, Arkansas and Louisiana are weak and erode easily, fish farmers should expect to repair pond levees every 7 to 10 years.

Pond renovation is expensive, with costs ranging from $300 to 1,000 per acre, equal to one-third or more of the initial earth-moving cost of pond construction. Potential income from fish sales is also lost when ponds are out of production.

Ponds are rebuilt for two major reasons:

- To repair levees that have become so thin that maintenance and feeding equipment cannot pass; and
- To dry pond bottoms to make harvesting more efficient. Soft, flocculant (fluffy) sediments accumulate at the bottom of older ponds and impair seining. The sediments are mostly silt and clay eroded from pond levees.

[1]Mississippi State University
[2]University of Arkansas at Pine Bluff
[3]USDA Natural Resources Conservation Service

Soil type, wind speed, and pond size and orientation influence the rate of erosion. Farmers have little control over these factors once ponds are built. To extend the useful life of a pond, farmers must rebuild the levees properly and take measures to reduce erosion. Establishing vegetation as quickly as possible after construction is especially important.

Building strong levees

The goal in rebuilding (or building) levees is to make them as strong and as erosion-resistant as possible, given the engineering properties of the existing soils. For a given soil, the useful life of a pond depends on levee design and construction practices.

Three design features are most important in increasing pond life:

- flattening the inside slope of the pond levee (Fig. 1);
- widening the top of the pond levee (Fig. 1); and
- strengthening the levee by compaction.

A gentle slope is critical to dissipating wave energy before it reaches the bank. Waves damage levees by undercutting the bank and leaving a vertical face on the levee. When all the wave energy is directed onto the levee, the soil

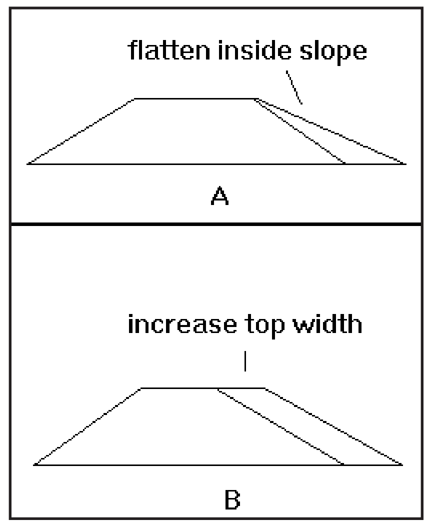

Figure 1. To extend pond life, lengthen the inside slope of the levee and widen the top.

erodes rapidly as bank sections slough off into the pond.

Increasing the slope of pond levees from 4:1 (a slope equal to 4 horizontal feet for every vertical foot) to 5:1 or 6:1 slows pond erosion on most clay soils. However, for a 6:1 slope, weigh the increased costs against the reduction in levee erosion. For a 10-acre pond with a 6-foot-high (on average) levee, building the pond with 6:1 inside slope costs about $3,000 more than one with a 4:1 inside slope. There is more shallow water in ponds with flatter levee slopes, which increases the habitat for marginal aquatic weeds. You may need additional grass carp to control submerged aquatic vegetation along extended shallows in ponds with slopes greater than 4:1.

The wider top lengthens the useful life of a pond by providing more levee to erode before it becomes too narrow to permit traffic. For a 10-acre pond with a 6-foot-high (on average) levee, building the pond with a levee top 6 feet wider costs about $3,000 more than a pond without the extra 6 feet.

Strengthening the soil

Two primary factors determine a soil's strength in a given levee:

- Force and degree of compaction; and
- Soil moisture at the time of compaction.

Soil strength greatly affects how much a completed levee can resist erosion. Draglines or trackhoes that simply dump pond sediments in piles and tamp the top of the piles with the back of the bucket do not compact the soil much. The compactive force is too small, and the soil is usually too moist for good compaction.

In highway, dam and building construction, engineers test the soil before and during construction. The American Society for Testing and Materials (ASTM) sets standards and procedures for testing. The most common laboratory test of compaction, the Proctor test (ASTM D698), involves compacting a soil sample under standard conditions (a set number of blows from a given weight hammer dropped from a specific height). Water is added repeatedly and the soil retested to determine the optimum moisture content for compaction (that which produces the densest soil).

For example, a typical clayey soil in the Delta (Alligator series) that is highly plastic (high shrink-swell soil) has an optimum moisture content ranging from 23 to 28 percent. Tests of compacted soils from a job site are compared to these results. Specifications often call for on-site compaction to meet or exceed a certain percent, often 95 percent, of the optimum compaction (soil density) obtained in the laboratory. Thus, pond levee soil compaction is typically discussed in terms of 95 percent Proctor or 95 percent ASTM standard (ASTM D698).

In practice, experienced contractors can determine if the soil is acceptably moist by its behavior during construction. Soil should be moist enough that equipment does not stir up clouds of dust. On the other hand, it should not be so wet that tires leave ruts deeper than an inch or two in the compacted fill.

A sheepsfoot roller is often used to compact soils. It consists of a cylinder with protruding blunt spikes, designed so that when it has made enough passes to compact the soil adequately, the cylinder no longer touches the ground, but is supported on the protruding feet. This is referred to as the feet "walking" the roller out of the fill. A sheepsfoot roller should "walk out" of the fill in four to five passes.

Soil that is too dry can be watered with a tank truck to increase soil moisture. For proper compaction, distribute the water uniformly throughout the soil by deep disking repeatedly before compacting the soil. Clayey soils need time for the water to soak into the soil before compaction. This can be done by watering the borrow area rather than wetting the fill. Work overly moist soils with a harrow or disk to dry them faster.

Where soils tend to seep, reduce permeability by compacting soils that are wetter than optimum. Tractors have been used to pull large rollers in ponds with 1 foot of water to help seal newly constructed, leaking ponds. For some clay soils, a few percent change in soil moisture content can alter the permeability by one or two orders of magnitude.

Strengthen the soil by increasing the force of compaction, by increasing either equipment weight or compaction frequency. Repeatedly passing equipment over the soil increases density, although each pass has less and less of an effect. Dirt pans compact more than dozers, as the wide tracks on dozers are designed to float on top of the soil. If you build a levee with a dozer, also use a sheepsfoot roller to compact the soil. For proper compaction, route equipment uniformly over the fill area during construction.

Rain can interfere with levee repair. Compared to a sheepsfoot roller, rubber-tired equipment leaves a smoother surface that allows rainwater to run off. Compact levees on a slight sideways slope to help them shed water during construction.

To make the levee as strong and uniformly compacted as possible, it is critical to place the soil in 6-inch-thick layers ("lifts") and compact each layer before adding the next layer. Running equipment over thicker layers compacts only the surface layer, leaving uncompacted soil underneath that is weak and easily eroded.

Reducing erosion

Repairing pond levees is expensive and time-consuming. The two most cost-effective measures are reducing erosion through proper pond design and soil compaction during levee construction.

Mechanical or structural treatments

Several mechanical or structural treatments also protect pond levees effectively, including rock riprap, geotextile fabric and soil-cement. Unfortunately, such methods are prohibitively expensive for most farms, except perhaps for spot treatments. A 3-foot-high band ($1^1/_2$ feet above and below the waterline) of 4- to 5-inch diameter rock riprap alone costs about $8.75 per foot of levee protected. Adding a geotextile base where the rock riprap is placed slows erosion significantly, but raises the total cost to about $11.50 per foot of levee protected.

Geotextile material used alone has been successful on the face of levees. The fabric should extend 1 1/2 feet above and below the pond waterline. Properly installed geotextile fabric should extend the life of a levee by about 5 years. This method costs about $3.80 per foot of levee protected (about $12,500 for a 10-acre pond, which would have about 2,600 linear feet of levee).

Soil-cement is a mixture of site soil and cement to resist erosion. The cement is usually mixed at about 10 to 13 percent by dry weight with slightly plastic clays or silts. The soil-cement mixture is placed in a 6-inch layer and extends 1 1/2 feet above and below the normal water line. Correctly installed soil-cement barriers control erosion for a long time. Soil-cement-treated levees cost about $9 per foot of levee treated.

Vegetation

Vegetation can stabilize stream, river and lake shores. Farmers should mulch reworked pond levees (about 100 pounds of straw per 1,000 square feet) and plant them with rye grass, centipedegrass or bermudagrass as soon as possible to reestablish vegetative cover and reduce erosion. Contact the county Cooperative Extension Service office for information on cover grasses best suited to your location.

Levee-stabilizing vegetation must not interfere with harvesting. Most commercial ponds are harvested several times a year; any vegetation that reduces or impedes seining efficiency is unacceptable.

Several types of plants are being examined as possible candidates to stabilize the side slopes of pond levees around the waterline. Plant species such as Halifax maidencane (*Panicum hemitomon*) and knot-grass (*Paspalum distichum*) are reducing erosion with some success on pond levees in Arkansas. These plants form a margin around the pond and help dissipate wave action before it damages the levee. They do not appear to interfere with current pond management practices, and therefore make good candidates for further research. Properly planted and managed levees can lengthen the time between levee reconstruction on commercial ponds.

Rebuilding ponds

To keep ponds in production, some farmers use a dragline or trackhoe to rebuild levees. They lower the pond water level to half-full and draw up the sediments near the worn levee with a trackhoe or dragline. Perching on top of the eroded levee, the machine scoops up pond bottom materials, starting as far as possible from the levee, and drawing in material toward the bank.

Levees rebuilt this way are compacted little and erode rapidly. This method also produces a trench around the base of the levee, which can interfere with harvest.

The dragline reaches farther into the pond than the trackhoe and results in less severe trenching at the levee base. The dragline method, which costs about $300 an acre, may give relief from the worn levee for 2 to 4 years. The dragline or trackhoe method may be the most useful technique to repair a worn levee temporarily if fish prices are high or for leased ponds that the owner refuses to repair.

The best time to rebuild by trackhoe or dragline is during drier periods, which allow the sediment to dry and grass to become established before rains wash soil back into the pond. Late spring or early summer is best. For ponds older than 10 years, draining and drying may be more suitable.

A traditional way to rebuild levees is to drain the pond and wait for the pond bottom to dry enough to support the weight of a tractor and dirt pan. Typically, pond bottom soils crust over, forming a firm surface layer with moist soils below. Disking the surface exposes deeper soils and speeds drying. A bulldozer can break up and mound the bottom soils so that they dry faster.

When weather permits, use dirt pans to rebuild levees, such as in the initial construction. The principal advantage is that by this time soils have dried enough to compact well during rebuilding. The process takes so long that an entire year’s crop may be lost because of the wait for sediments to dry enough for dirt pans to operate efficiently. Breaking the sediment crust the first time through the pond is essential for good drying.

Alternatively, after the pond bottom dries enough to support a wide-track dozer, use the dozer to push moist pond bottom soil to the levees. The dozer rolls up on the levee to pack the material back in place. Then use tractor-drawn dirt pans (Fig. 2) to finish the pond to grade, leaving a smooth surface that slopes to the drain. Bulldozers and dirt pans can be used to rebuild ponds as small as 1/4 acre. Laser sights on the equipment help the operator maintain the appropriate pond bottom slope.

Figure 2. A small dirt pan (dirt bucket) is used for finishing work in rebuilding levees.

Using a bulldozer to rebuild levees compacts the soil less than using tractor pans. This method is suitable for ponds built from very plastic soils with high clay content, where compaction affects soil strength less than with many other soils. For best results, compact the soils in shallow layers using a sheepsfoot roller or wheeled equipment.

A new technique of some Mississippi Delta farmers uses a dragline and bulldozer only. This method is usually reserved for ponds with deep sediments (more than 2 feet deep) in ponds not drained in 10 to 15 years. The Mississippi method involves draining the pond as usual for a complete reconstruction. After all the water is gone, the dragline digs a 3- to 4-foot-deep drainout ditch along the levee base around the entire pond, which allows water to weep from the pond sediments and leave at the drain (Fig. 3).

Figure 3. The first step in the Mississippi method of rebuilding ponds uses a dragline to dig a drainage ditch around the levee.

Slope the drainout ditch to the drain to carry out unwanted water. When the sediments have set up to a soft consistency (usually a week if no rain falls), fill back in a section of the ditch at the shallow end of the pond to form a ramp to allow a size 65D bulldozer to cross into the soft sediments. The bulldozer makes passes down the pond length, rowing up the soft sediment on either side of the blade on each pass (Fig. 4).

Figure 4. After pond bottom sediments become firm enough to flow, use a dozer to row up the material.

The sediment should be soft enough to still flow slightly. If allowed to dry too much, the mud pushes down the pond rather than flowing to the sides. The goal is to row up the mud (pile the bottom sediments in rows) down the pond length for good drainage and quick drying. You may need to make more than one pass, several days apart, to complete this stage of the process. The rows will be 4 to 5 feet high and of equal width, with the parent soil showing slightly between the rows (Fig. 5). Rains will drain off the rows and flow down the channels left by the bulldozer.

Figure 5. Rows of pond bottom sediments are usually 4 to 5 feet high.

Allow the rows to dry for 2 to 3 weeks, depending on rainfall, or until the rows are a heavy plastic consistency. Then, bulldoze across the rows starting at the pond center, moving toward the nearer levee. The push should pack the entire distance to the levee (Fig. 6). When all the sediment has been packed back into the levee slopes, top a small amount of the original clay from the pond bottom back over the packed sediment material. This minimizes erosion during the early period when the pond is refilled.

Figure 6. After material in the rows has dried to a heavy plastic consistency, pack the soil back against the levees.

Expect the levee to settle some as the packed material compacts in the next few months. With this method, a pond drained in late spring or early summer can be back in use by midsummer in most years. Again, compaction is less than optimum using this method.

Rainfall determines the time needed to finish any process, but the initial trenching and rowing process of this method allows rainfall to exit the pond rather than soak into the sediments. Ponds rebuilt this way should last 10 years.

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