fence wire, for the paving, at \$0.06 per linear foot; 22inch fence wire, for blocks, at \$0.03 per linear foot; lumber, for forms, at \$22 per M. b.m., and Portland cement at \$0.75 per bbl. (f.o.b. factory). The gravel for the concrete paving and blocks was procured from the Gasconade River about 2 miles above the mouth, and delivered on barges by an 8-inch suction pump. It is a natural mixture of clean sand and gravel, the latter rang-



Fig. 1-Typical Concave Bank

ing in size from a <sup>1</sup>/<sub>4</sub>-inch to 3-inch pebble; it was impracticable to keep an itemized cost of procuring this gravel as it was in conjunction with other items of construction.

The cement used was of the American Portland brand. The finished aggregate is of a 1:2:4 mixture.

The 3%-inch diameter galvanized strand is composed of seven No. 11 wires, having a tensile strength of about 5,000 pounds.

The reinforcing for the paving consists of galvanized woven-wire fabric, diamond mesh 50 inches wide, formed of thirteen No. 10-gauge line wires uniformly spaced, with No. 12½-gauge stay wires at 4-inch intervals; elastic limit 75,000 pounds to the square inch. In addition to the woven-wire fabric, and the mattress 3%-inch anchor strands, similar strands for block fastenings are spaced 16% feet, which gives a 3%-inch strand reinforcing every 8½ feet, in the slab, anchored to a deadman on top bank.

The reinforcing for the concrete blocks consists of 22inch woven-wire fabric, similar to that used in the paving. In addition to the woven fabric, two 3%-inch strands are placed with an "eye loop" at each end for joining the blocks. These blocks, 2 ft. x 2 ft. x 4 ins., were made at a central yard at a cost of 28 cents each, and delivered by barge at site of the work.

In the construction of revetment the work is practically divided into three general classes: First, grading; second, mattressing; and third, paving. In the matter of cost accounting, the two latter classes are subdivided into the necessary heads for determining the expenditures of procuring, delivering, and placing the material. As these are usually variable quantities fixed by accessibility and the law of supply and demand, these detailed headings will be omitted. For a typical concave bank, see Fig. 1.

## Grading

The bank is graded by the hydraulic method to 1 on 3, which gives a length of slope from 42 to 54 feet according to height above standard low water, which also determines the length of a slab. (Fig. 2.)

## Mattress

After the bank is graded the continuous mattress, 86 feet wide, is woven of bar-growth willows, from 1/2 to 2 inches in diameter at the butt end and 10 to 25 feet long. The header, about 12 inches in diameter, is formed by lapped bundles of willows bound together to the desired width of mattress, by 3%-inch strand. The stitch is then started by inserting single willows into the bundle at an angle of about 45 degrees, from one end of the header to the other; then the willows are inserted at the same angle in the reverse direction, the last willow inserted being on top (Fig. 3). This makes the weaving a continuous over process, the stitch having an over and under appearance. The willows are placed in such numbers and closeness of weave as to make a mattress 12 inches thick. As the weaving progresses a selvage is made along each side of the mattress by turning in the tops of the outer willows, or an equally good selvage (known as the "sidewalk") is made by platting willows, longitudinally along the edges.

The mattress is strengthened by a longitudinal and cross system of 3/8-inch in diameter galvanized strand. The longitudinal system for an 86-foot mattress consists of 6 pairs of strands, spaced as required, each pair consisting of I strand underneath and I strand on top of the mattress. The cross systems are in pairs, one underneath and one on top, spaced 162/3 feet apart. At each intersection of the two strands underneath and the two strands on top, all four are drawn together tightly with a 7/16-inch U-shaped clip, after all the slack has been taken out of the strands by block and tackle. The head of the continuous mattress, or any section of mattress, is anchored by three pairs of strands fastened to the respective longitudinal strands, one pair 4 feet, one pair 16 feet, and the remaining pair 46 feet back from the outer corner and run ashore at a 45° angle with the upper edge of the mattress and fastened to deadmen 50 feet back from the edge of the bank. The continuous mattress is anchored to the bank



Fig. 2-Hydraulic Grading of Bank; Slope 1 on 3

by each pair of cross strands carried up the slope and fastened to a deadman placed 8 feet back, and 4 feet below the top of slope.

It was planned to string the concrete blocks, forming the ro-foot width inshore mattress flexible protection, on six longitudinal 3%-inch strands passed through the eye loops, but this method was found difficult and slow. A change was made for connection of the inside blocks by using short pieces of 3%-inch strand passed through the