CONCRETE PAVED BANK REVETMENT*

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I MPROVEMENT of the Missouri River by the United States government, by means of works designed for the contraction of channel widths and bank protection, began as early as 1876.

The successful protection of caving banks is the foundation of the improvement of the river, and has been the great study to those engaged on the work. This study, combined with trials and experiments with many types of work, resulted in the évolution of what is known as "Standard Revetment" . . . This consists of a continuous woven willow brush mattress ballasted to cover the bank below the water line and, on the river bed, for protection of the subaqueous bank, the upper sloped bank being covered with a rough pavement of one-man riprap stone. It has generally been found that, from the use of this type fair results have been obtained, due, perhaps, to the fact that it readily adjusts itself to any disturbance of its foundation which may reduce the extent of the disturbance, and because it lends itself to repair which can



Plate 1-General Plan, Standard Revetment

readily and economically be made in its incipiency. The estimated cost of the standard type is \$10 per linear foot for completed work. For general plan, see Plate 1.

Concrete Paved Bank

There seems to be no record of any claim for the first experiment in protecting the slope of a river bank by paving it with concrete, although it was used as early as 1897 in protecting the toe of the slope for the Holland dikes, and in 1900 by the Corps of Engineers, U.S. Army, for the upper bank paving in river improvements.

This type is somewhat like a monolithic structure and tends to lose the advantage of automatic adjustment to slight changes in the foundation, so that there is a con-

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stant uncertainty as to its condition and a possibility of a serious collapse in after years.

This revetment is a departure from the standard type used on the Missouri River in that the upper bank is paved with a 4-inch layer of reinforced concrete slabs instead of broken stone, and the subaqueous willow mattress pro-



Plate 2—General Plan, Combination Concrete and Willow Mattress Revetment

tected for about 10 feet width from the shore edge, with reinforced concrete blocks connected to the solid upper pavement, and so laced and tied together with wire strand within themselves as to form a flexible covering instead of the compact layer of stone for the same width. For the general plan, see Plate 2.

The concrete paved bank revetment, selected for description, is known as the Bates Island Bend revetment, located on the right bank of the river at mile 98, above the mouth.

It was the first piece, of any magnitude, constructed on the river in which machinery and a system of organization for progress was used, and comprises 14,188 feet of finished work at \$7.58 per linear foot. It was begun in March, 1912, and completed September 8th, 1913, by hired labor and government plant.

Plant

The plant used on the work consisted of the following: One double-decked quarterboat with a capacity of housing from 60 to 70 laborers and necessary foremen, I hydraulic grader, I mattress barge, I barge for concrete mixer plant, 6 material barges, and I tow boat. The working plant was supplemented by an 8-inch suction pump, installed on a material barge, for procuring gravel. The value of this plant is estimated at \$60,000, no charges having been made for depreciation.

Material

The principal material used, which was procured locally and delivered by barge, consisted of willow brush at \$1.60 per cord; stone at \$0.68 per cubic yard, and sand and gravel at \$0.08 per cubic yard; manufactured material delivered by freight consisted of 3%-inch galvanized strand at \$0.71 per linear foot; 50-inch galvanized woven-