A Study of Methods for Preservation of River Banks in order to Reduce Sediments

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Abstract—Reducing river sediments through path correction and preservation of river walls leads to considerable reduction of sedimentation at the pumping stations. Path correction and preservation of walls is not limited to one particular method but, depending on various conditions, a combination of several methods can be employed. In this article, we try to review and evaluate methods for preservation of river banks in order to reduce sediments.

I. INTRODUCTION

VARIOUS methods for preservation of river banks have been mentioned [1]-[4] each of which has its own advantages and disadvantages depending on the condition of the river. Therefore, in the structural method, using constructional material, all types of resistant structures including covering type, structures related to organizing the river, and riverbed stabilization structures are designed and constructed. A great deal of material and technical and workshop facilities are required for these methods and they are usually costly. But where physical and hydraulic destructive factors of the walls are involved, they are more efficient. Also, in the natural method, using natural materials such as vegetation (grass, bushes, shrubs, and trees) or using wood and interwoven sticks, a sort of natural preservation and stabilization is created over the surface of the walls or the riverside area. Preservation mechanism is achieved through strengthening of walls and banks. Although these methods involve complex natural and agricultural problems, yet, in many cases, they are economically and ecologically preferable and are quite efficient where the current speed is low and physical condition of walls are suitable. However, their useful life is short and they are in need of constant protection and maintenance. And in the natural-structural method, all the conditions for structural preservation and biological stabilization are provided. For instance, in the covering structure, the riverside is structurally protected up to the current level of the dry season and above that level, it is preserved by vegetation. Such combined methods are adaptable to various conditions and, today, are considered economical and efficient methods.

Numerous studies have been performed on the classification of the structures for stabilization of the riverbed [5]-[7] and these structures can be divided into three groups based on the type of the materials and their physical and mechanical characteristics:

A) These structures are either flexible or solid.
B) These structures are either penetrable or impenetrable.
C) These structures are either temporary or permanent.

II. EROSION DUE TO WATER CURRENT

Erosion of river banks and washout of its bed due to water current occurs when the particles composing these parts are exposed to a force strong enough to move them. Besides, speed distribution throughout the channel is affected by the walls. As a result, a three dimensional current system is established in the river. Secondary currents and the shape of cross sections cause complex changes in borderline cross section tensions. Figure 1 shows an example of speed and cross section distribution observed in a trapezoid channel.
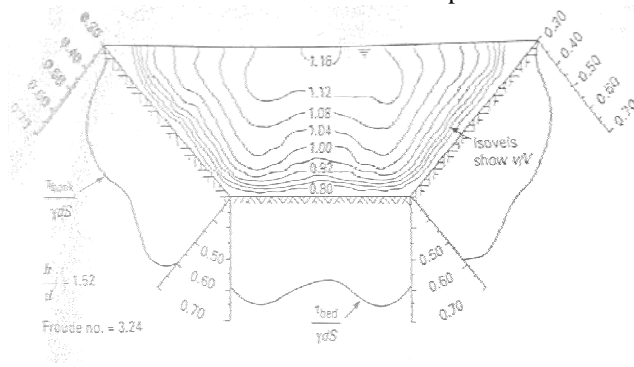

Fig. 1 distribution of speed and borderline cross section tension in a trapezoid channel [7]

Maximum amounts of cross section tension on the border between water and walls are developed in areas where three dimensional current is created near the river banks. In these areas speed gradient is topically high. The amount of tangential tension which is exactly enough for moving riverbed particles with given characteristics is known as critical tangential tension. If riverbed particles are not made of

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adhesive materials, a relationship can be defined between the critical tangential tension, average diameter, and relative density of the riverbed particles.

III. VARIOUS METHODS FOR PRESERVATION OF RIVER BANKS

On initial consideration, these methods can be divided into two categories: direct and indirect preservation.

Direct preservation is the operation that is directly performed on the river banks. For example, preserving bulwark slope and the upper part of the river bank and it bottom claw against erosion and correction of roof surface or installation of drainage rows to ensure stability against leakage and soil saturation. Since this operation is continuously conducted along a specific length of the river bank, it is also called continuous preservation.

Indirect preservation is an operation which is not directly conducted on the river banks, but in front of them and with the objective of reducing the erosive force of the current. This aim is achieved by two methods; trying to move away from the river banks and sedimentation of the current in front of the river banks. This is usually done by constructing Epi's at specific distance from each other and, therefore, this method is also called discontinuous preservation.

In both methods of direct and indirect preservation, based on the continuity of these activities, some differences can be identified:

1. Temporary preservation which is conducted in order to control erosion during the emergencies.

2. Semi-permanent preservation using bushes, bamboos, cluster particles or wire networks which are less continuous than other methods.

3. Permanent preservation which includes methods using stronger materials such as stone, concrete, and lumber or bush covering (in case they are constantly kept beneath water surface).

IV. METHODS FOR DIRECT PRESERVATION OF THE RIVER BANKS

Methods for direct preservation of the river banks are those methods which by separating the walls from the water current protect the river banks from erosion along its course. For instance, a covering prevents the current from, directly, reaching the channel walls.

On the other hand, there are methods which preserve the river banks by altering the hydraulic condition of the current. For example, by diverting the water current from the river banks towards the inner parts of the river, a breakwater reduces the erosion of the banks. These are called indirect methods for preservation of the river banks which will be explained in the next section.

Natural methods for preservation of the river banks, using guard weight walls, buttressing and installing metal plates, prefabricated concrete units, reinforced soil, worn automobile tires, stonework coverings, stone/net coverings, prefabricated concrete blocks, using asphalt materials, sack coverings.

V. INDIRECT METHODS FOR PRESERVATION OF THE RIVER BANKS

Indirect preservation includes operations which are conducted in the river and their objective is to reduce the erosive force of the current. This objective is achieved by distancing the current from the banks and making the sedimentation occur in front of the banks. Because of the shape of the structures, this preservation method is also known as the discontinuous preservation method. Indirect or discontinuous preservation of the river banks is generally less expensive than the direct or continuous preservation but it is not always efficient. These methods are divided into two groups of slowing and deviating the current.

Discontinuous temporary preservation is performed by using braided trees, sunken trees, floating lumbers, or bush packages hung from buttress structures. These methods are mostly used for topical preservation when river bulwark or any other structure is exposed to the risk of washout.

a) Using nets
b) Metal jack method
c) Buttress water breaks

VI. RESULT

Generally, flexible structures have a better function than the solid ones because if the wall undergoes an inhomogeneous sinking due to leakage force, or the riverbed goes down due to washout, a solid structure is cracked and even some parts of it and, eventually, the whole structure may be destroyed. Whereas flexible structures can adjust themselves to possible changes and can be altered, strengthened, repaired, or reconstructed.

Besides, penetrable structures are hydraulically superior to impenetrable ones especially in course correction plans. Penetrable units on the river banks cause topical turbulence and whirling current and besides reducing the current speed and controlling the initial flow of the river (along the course) they expand and develop the secondary current. In this way, without exerting a considerable force, part of the current which contains sediment loads crosses the structure and starts sedimentation in the area behind it which leads to the gradual expansion and natural stability of the wall. Impenetrable structures (especially of the water break type) prevent water from crossing the structure but due to deviation of the water course from the river banks towards the midline of the river, they cause vortex movements in the area between successive structures and by subduing the current, sediment loads are gradually deposited. In case of linear impenetrable walls, the flood current can only deposit its sediments behind these structures by spillage. Accumulation of the sediments between the river border and natural walls using natural or artificial vegetation stabilizes the river. Therefore, these structures are considered combined structures.

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VII. CONCLUSION

Measuring the distribution of the cross section tension in the curves of winding rivers has shown that the ratio of maximum tension to its average amount at these curves is a function of the ratio between the channel width and the radius of the river curve, coarseness of the walls, and the existence of other curves in the upper parts of the river. The maximum amount of this case can be as much as three times the amount of the maximum cross section tension in straight channels.

Many studies have been performed on the classification of structures stabilizing the riverbed and, in general, flexible structures have a better function than solid structures. And also penetrable structures are hydraulically superior to impenetrable structures especially in path correction plans.

Methods for preservation of the river banks in order to reduce the sediments differ depending on the place, time, climatic conditions, time and place facilities and the financial power of the executors of the plan and decision must be made with regard to these conditions.

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