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VELOCITY DISTRIBUTION AROUND BANDALLING FOR NAVIGATION CHANNEL DEVELOPMENT

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ABSTRACT

An experimental investigation was conducted in the mobile bed river at the laboratory of River Research Institute, Faridpur, Bangladesh. A series of test runs were completed for the different scenarios using Bandalling for the river bank erosion protection. The low cost Bandalling structures are placed at the laboratory river bank at different angles with water flow direction for the spacing 2 times the Bandals length. It was observed that water flow diverted towards the main river due to Bandals resulting maximum velocity accumulated at the centre of the river whereas comparatively less velocity appeared near the river bank where Bandals are placed resulting sediment deposition. The sedimentation near the river bank as well as river bed erosion at the main channel of the river gives an indication that the Bandalling structures can be used successfully for the river bank erosion protection.

Keywords: Bandalling ,Erosion, Deposition, Sediment, River Bank

1. INTRODUCTION

Bandals are one of the local low cost structures and there is an opening below bandal while obstruct flow near the water surface and allow it to pass near the riverbed. Bandals are positioned at an angle with the direction of flowing water. Naturally available materials such as bamboo and timber are used for bandals. The surface current is being forced from upstream side of the bandals and pushed it down near the bed towards bank at the down streamside. More sediment flow than water flowing towards the bank from the river side so that excess sediment deposited near the riverbank. There is a considerable pressure difference between the upstream and downstream side of the bandal.

Much sediment is supplied towards the countryside and relatively much water is transported to the riverside. Bank protection and river training works are therefore, one of the prime necessities for poverty alleviation and national growth. The issue is the safety of lives, land and sustainability of the infrastructure against the forces acting in the rivers. Bank erosion and channel shifting of the untrained alluvial rivers of Bangladesh are big problems to the socio-economic and environmental sector of the country. During 1960's, a number of earthen embankments were constructed along the major rivers for the protection of rural people and agricultural lands from flooding. Since then the embankments were retired several times due to river bank erosion and bank protection are often required during the monsoon and post-monsoon season. Conventionally, groynes and revetments are applied as a method of bank protection.

Alluvial rivers are characterized by the fact that the alluvia on which the rivers flow, are built by rivers themselves. The main characteristics of these river reaches is the zigzag fashion in which they flow, called meandering. They meander freely from one bank to other and carry sediment which is similar to bed material. Material gets eroded constantly from the concave bank (outer edge) of the bend and gets deposited either on the convex side (inner edge).

One would assume a large river flowing in alluvium would maintain a relatively uniform morphology because its dimension should follow the rules of hydraulic geometry, and its gradient and pattern should reflect the type of sediment load and valley characteristics. The significant stream power exerted by these formidable fluvial systems should ensure that long reaches of alluvial channels maintain a characteristic and relatively uniform morphology. But, in fact, the substantial energy of these mega river systems in many cases is inadequate to overcome accidents of geologic history and geologic controls. Large alluvial rivers appear to be sensitive to influences that can be relatively small. They frequently respond to factors that are not included in hydraulic models and sediment transport equations.

The performances of the bank protection structures and the recurrent measures, as well as the response of the river, have been monitored for several years, developing and applying new techniques of measuring

& modeling. FAP 21 produced some progress in process based modeling of two mechanisms by which the mere presence of bank protection structures increases the loads on these structures : (i) the deeper bend scour due to stopping of bank migration [1]; and (ii) the attraction of channels and associated flow attack towards scour holes [2]. The stopping of bank erosion is assumed to produce deeper bend scour through: (i) prevention of bank sediment supply, (ii) channel narrowing due to retarded point bar growth, (iii) bend deformation due to local prevention of channel migration and (iv) vortices generated by flow impingement. A method was developed by Klaassen et al. [3], based on empirical laws derived from a large set of satellite images [4].

Jagers implemented the prediction method in a computer model and tested it against observations [5],[6]. He also constructed and tested an artificial neural network for the prediction of low-water plan form changes in the Brahmaputra-Jamuna

2. OBJECTIVES OF THE STUDY

The main objectives of this study to investigate the sediment deposition and flow field around the bamboo bandalling structures. The specific research objectives are as follows:

(1) to know the navigational channel development due to the effect of bamboo bandalling structures constructed near both the laboratory flume.

(2) to understand the characteristics of the flow field around the bamboo bandalling structures when placed in the different scenarios.

(3) to get idea about the bamboo bandalling structures for the navigational channel development.

3. METHODOLOGY

To meet the above objectives of the study, a laboratory experimental set-up was used as in below as in figure-1 to collect the different types hydraulic and morphological data. The data that is collected water depth, water velocity etc from the laboratory experimental set up.

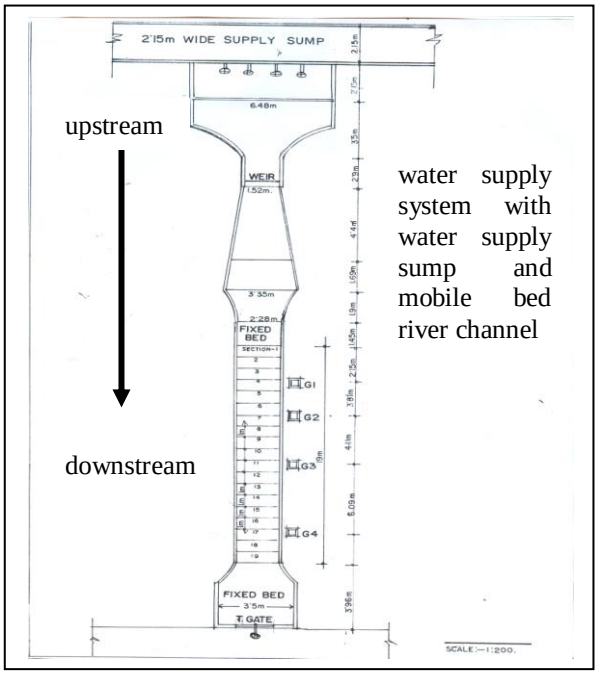

Fig 1. Experimental set-up used for data collection in the laboratory

With the aid of this experimental set-up, the working principles of bandals for the control of water and sediment flow are shown schematically in Figure-2, where sediments are transported as bed load and suspended load [7]. In details, it is notted that within the lower half of the flow depth, major portion of the sediment flow is concentrated, whereas, within the upper half water discharges are more. Bandals are commonly applied to improve or maintain the flow depths for navigation during low water periods in alluvial rivers of Indian sub-continent. The essential characteristics of bandals are that they are positioned at an angle with main current and there is an opening below it while the upper portion is blocked. As an empirical rule the blockage of the flow section should be about 50% in order to maintain the flow acceleration

The surface current is being forced to the upstream face creating significant pressure difference between the upstr eam and downstream side of bandal. The flow near the bed is directed perpendicular to the bandal resulting near bed sediment transport along the same direction. Therefore, much sediment is supplied to the one side of channel and relatively much water is transported to the other side. The reduced flow passing through the opening of bandals is not sufficient to transport all the sediment coming towards this direction, resulting sedimentation over there. On the other side, more water flows with little sediment, resulting bed erosion of the channel on that side.

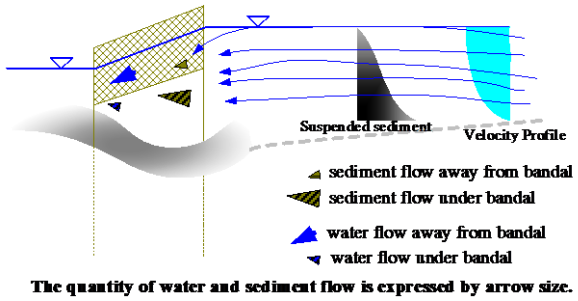

Fig 2. Working principles of bandals

4. DATA COLLECTION & ANALYSIS

The data collected from the laboratory river channel of River Research Institute, Faridpur is used for this research paper. The dimensions of the river in the laboratory in length, width & depth are 22 m, 2.2 m and 1.50 m respectively. The low cost bamboo bandalling structures are placed on both sides in the laboratory river channel from up stream to downstream at 30 degree angles with the water flow direction. The collected data for the bed topography is plotted as in figur-4 and that of plotted as in figure-5 for the navigational channel development with the channel flowing water in the as in figure-3.

Fig 3. Bandals constructed in the laboratory rivers for navigation channel development

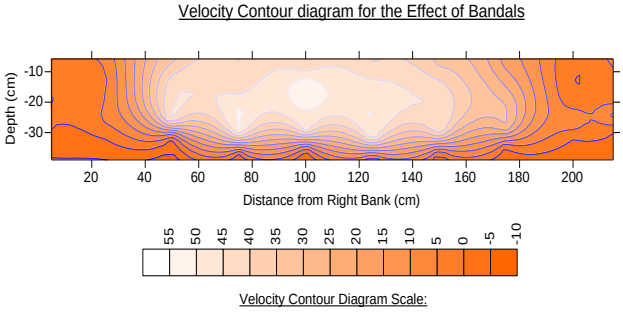

Fig 4. Velocity contour diagram due to effect of bandal structures in both the two sides of the Channel

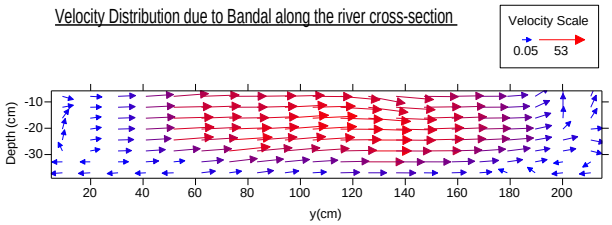

Fig 5. Velocity vector diagram due to effect of bandal structures in both the two sides of the Channel

5. RESULT AND DISCUSSIONS

The flow velocity data was collected during laboratory test run. During the experiment, the water depth was 25 cm of which 10 cm blocked from the upper surface of the flowing river by bamboo fencing. Flow passing through the river channels consists of primary current and secondary current. The primary current plays an important role for the determining the sediment load capacity. The secondary current transfers momentum to the outer bank in the upper part and to the inner bank in the lower part of the bandals in flow. On the bottom of the river, the secondary current directly transports bed load from the river bed to near the bank.

It is seen from the above figures so that there is siltation in the river channel near the bank. It is also seen from the figures that the velocity near the river bank is low than that of away from the river channel. So it can be concluded that the bandals are working as a river bank erosion protection structures resulting navigational channel development.

6. CONCLUSION

Bandals are capable for protecting river banks by flow diversion towards the main channel leading to deep navigational channel formation in the main river. On the other hand, flow velocities are reduced near the bank lines that ensure bank protection by the deposition of sediment. If the bandal structure functions optimistically, the river can get sufficient time for its adjustment and new main channel and bank line development.

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