Study of Bamboo Bandalling Structures in the Tidal River for River Bank Erosion

Md. Lutfor Rahman

Abstract In this case, the V-shape bamboo bandalling structures are constructed with 45° angle with the flow direction. The experimental setup is facilitated with both the flood and ebb tide from upstream to downstream and vice versa. There is an arrangement at the upstream for flow entry and flow out and also the same arrangement in the downstream to ensure the flood and ebb tide. For this reason, riverbank as well as riverbank sedimentation which is demonstrated in the real Rupsha River near the city of the Khulna, Bangladesh.

Keywords Tidal river · Bamboo bandalling structures · Velocity · Sedimentation

1 Introduction

Bangladesh is a riverine country. One-third of the rivers are tidal in nature. There is a lot of erosion in the tidal rivers. Both the ways water flow is to be guided by the V-shape bamboo bandals. Bandal is used to prevent riverbank from erosion. V-shaped bandal is effective against both spring tide and neap tide.

Bank protection and river training works are 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. Untrained alluvial rivers of Bangladesh are big problems to the socioeconomic and environmental sector of the country. 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 riverbank erosion and bank protection are often required during the monsoon and post-monsoon season. Groins and revetments are applied as a method of bank protection as a conventional method.

Md. L. Rahman (✉)
Hydraulic Research Directorate, River Research Institute, Faridpur, Bangladesh
e-mail: lutforntf@gmail.com

K. Murali et al. (eds.), *Proceedings of the Fourth International Conference in Ocean Engineering (ICOE2018)*, Lecture Notes in Civil Engineering 23,
https://doi.org/10.1007/978-981-13-3134-3_5

The bank protection structures and the recurrent measures have been monitored for several years. FAP 21 produced some progress in process-based modeling of two mechanisms by which the mere presence of bank protection structures increases the loads: (i) the deeper bend scour due to stopping of bank migration [1]; and (ii) the attraction of channels and associated flow attack toward 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 the 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 planform changes in the Brahmaputra–Jamuna.

2 Methodology

To meet the above objectives of the study, a laboratory experimental setup was used as shown in Fig. 1. The data is collected for water depth and velocity from the laboratory experimental setup. Length of left bank is 14.15 m and right bank is 15.43 m and that of channel width is 1.0 m. Area of two fixed beds is 4.9 m^2 and area of mobile bed is 29.4 m^2 and both of the two banks were constructed by bricks. Volume of sand in the mobile bed is 6.76 m^3. The d50 and specific gravity of the sand are 0.225 mm and 2.65, respectively. Twelve number of V-type bandals were installed in the flume bed. The distance from one bandal to another is 1.35 m. Length of each bandal is 0.70 m. Four bandals were installed along the left bank. First of these bandals is 1.0 m apart from the upstream fixed bed. Another set of four bandals was installed along the left bank in the downstream. In the middle portion of the longitudinal section, another set of four bandals was installed.

With the aid of this experimental setup, there are the working principles of bandals as shown in Fig. 2. In this working principle, it is seen that bed load and suspended load is transported [7]. In details, it is noted that the surface current is diverted toward the main channel. The sediment in water is pushed down through the bandals and deposited behind the bandals with the low velocity of water.

3 Objectives of the Study

The main objectives of this study to investigate the 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.

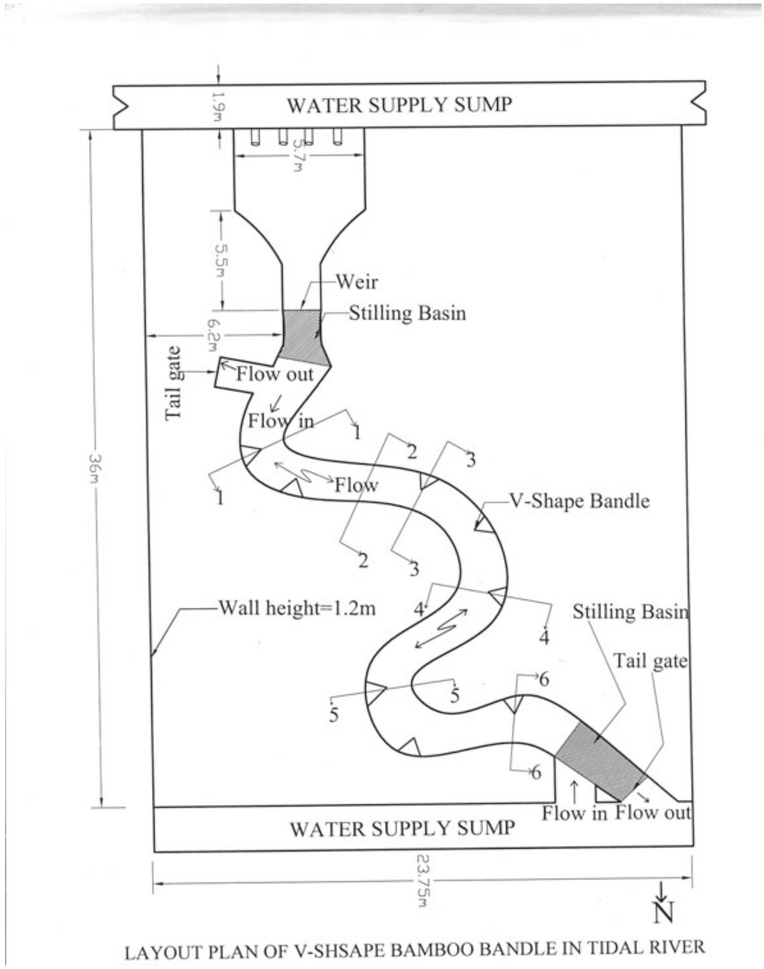

Fig. 1 Experimental setup

(2) to understand the application of bamboo bandalling structures when placed both in laboratory and field.
(3) to get an idea about the performance of the bamboo bandalling structures.

4 Data Collected for Analysis

Data collected from the experimental setup of Fig. 1 is presented in Table 1. Data collected was the distance from the left bank of the channel, water depth and measured

Table 1 Collected velocity at a different location of the experimental setup

Section no.	Distance from LB (cm)	Depth, d (cm)	Velocity (m/s)		
			0.2d	0.6d	0.8d
1	30	24	0.110	0.150	0.150
	60	24	0.264	0.305	0.243
	90	27	0.397	0.418	0.408
	120	32	*0.511*	0.490	0.459
	150	30	0.418	0.418	0.408
	180	26	0.233	0.253	0.356
2	30	23.5	0.031	0.031	0.041
	60	25	0.161	0.212	0.192
	90	27.5	0.253	0.325	0.336
	120	33	0.439	0.480	0.500
	150	29	0.500	*0.521*	0.480
	180	22.5	0.449	0.511	0.511
3	30	24	0.031	0.031	0.031
	60	25	0.031	0.130	0.031
	90	25.5	0.264	0.264	0.233
	120	27	0.428	0.439	0.387
	150	28	0.480	*0.531*	0.511
	180	28	0.521	0.449	0.459
4	30	25	0.061	0.031	0.161
	60	27	0.295	0.336	0.284
	90	26	0.346	0.397	0.367
	120	28	*0.439*	0.408	0.356
	150	29	0.367	0.367	0.305
	180	29	0.356	0.346	0.336
5	30	31	0.031	0.031	0.031
	60	35	0.150	0.181	0.150
	90	29	0.356	*0.387*	0.336
	120	30	*0.387*	0.377	0.315
	150	28.5	0.367	0.336	0.315
	180	27	0.377	0.346	0.284
6	30	25	0.031	0.031	0.181
	60	26	0.212	0.212	0.264
	90	30	0.367	0.346	0.325
	120	31.5	0.356	0.356	0.336
	150	34	0.356	0.356	0.346
	180	30.5	*0.377*	0.356	0.325

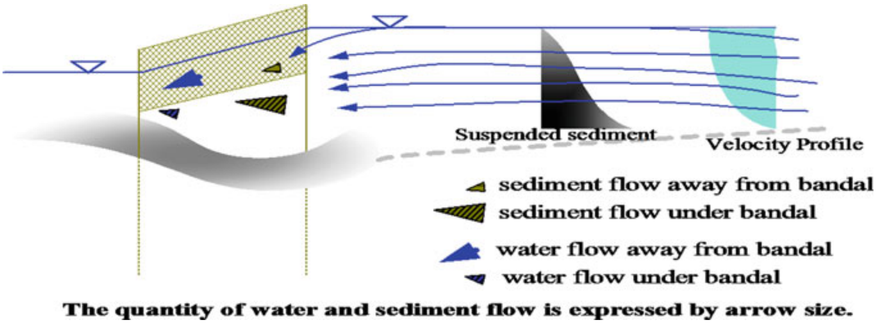

Fig. 2 Working principle of the bamboo bandalling structures

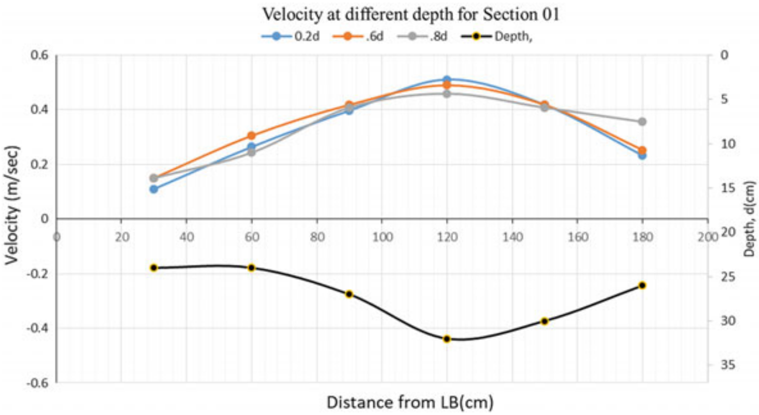

Fig. 3 Velocity plot from left bank (LB) toward right bank versus water depth

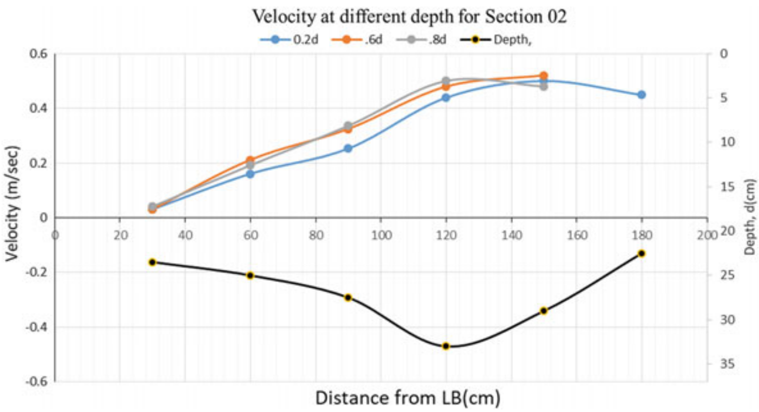

Fig. 4 Velocity plot from left bank (LB) toward right bank versus water depth

velocity in 0.2, 0.6, and 0.8 times the water depth. This three-point velocity is plotted in Figs. 3, 4, 5, 6, 7, and 8.

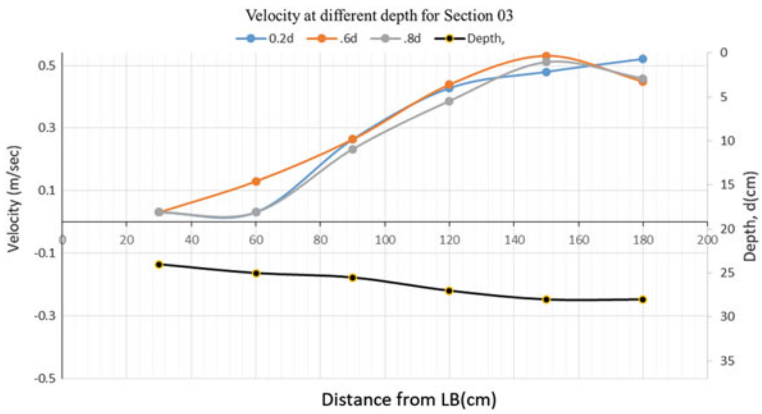

Fig. 5 Velocity plot from left bank (LB) toward right bank versus water depth

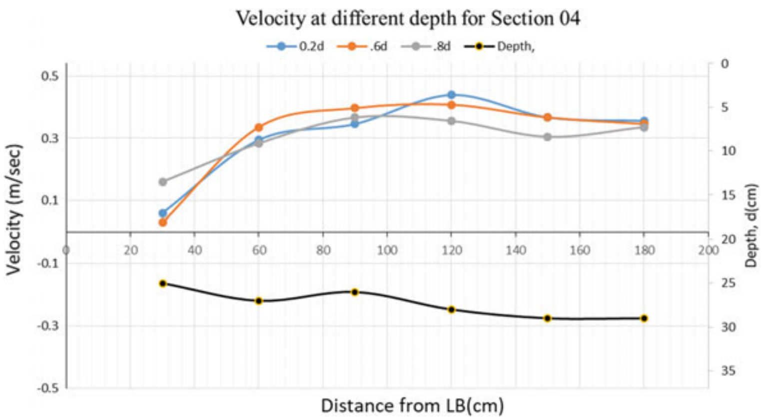

Fig. 6 Velocity plot from left bank (LB) toward right bank versus water depth

Some photographs have been taken to observe the sedimentation phenomena near the riverbank, which is demonstrated in the real Rupsha River near the city of the Khulna, Bangladesh as shown in Fig. 9.

5 Result and Discussion

It is referred to all the figures and Table 1 to observe the performance of the bamboo bandalling structures applied in the tidal river in Bangladesh. It is evident from the plot of the section-1 through section-6 that there is maximum velocity at the center of the channel, where the flow is concentrated due to the effect of the bamboo bandals. Velocity is less near the bamboo bandals area both in the laboratory experiment as

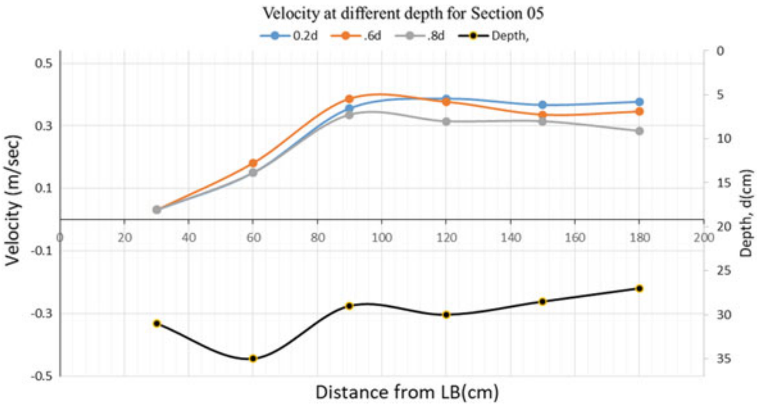

Fig. 7 Velocity plot from left bank (LB) toward right bank versus water depth

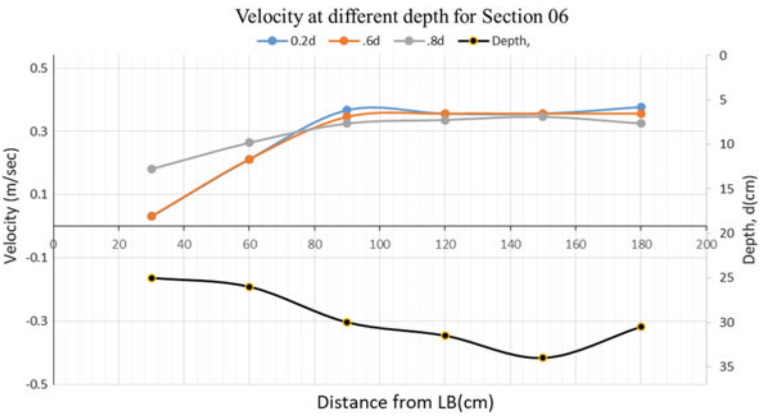

Fig. 8 Velocity plot from left bank (LB) toward right bank versus water depth

Fig. 9 The river bank of Rupsha River is protected by using bamboo bandalling structures at Khulna, Bangladesh

well as in the real river of the Rupsha. In the area within the bamboo bandals, the velocity is reduced where siltation is encouraging.

6 Conclusion and Recommendation

In conclusion, it can be stated that the performance of the bandals is acceptable in the tidal river. There is sediment deposition as in Fig. 10 and that of as in Fig. 11 of the bamboo bandals used for the river bank erosion protection. Due to the effect of the bamboo bandalling, deposition occurred near the bandals. The bamboo bandals will be the sustainable solution. Further study will be required to make the test result more fruitful.

Fig. 10 Photographs shows the sediment deposited near the eroded bank within the bamboo bandals field

Fig. 11 River before the construction of bamboo bandals in the left and that of after the flood in the right of the photographs

References

1. Mosselman E, Shishikura T, Klaassen GJ (2000) Effect of bank stablization on bend scour in anabranches of braided rivers. Phys Chem Earth Part B 26(7–8):699–704
2. Mosselman E, Sloff CJ (2002) Effect of local scour holes on macroscale river morphology. In: Bousmar D, Zech Y (eds) River flow 2002: proceeding of the international conference on fluvial hydraulics, vol 2, Louvain la Neuve, Belgium, 4–6 September 2002, pp 767–772, Balkema, Lisse
3. Klaassen GJ, Mosselman E, Brühl H (1993) On the prediction of planform changes in braided sand bed rivers. In: Wang SSY (ed) Advances in hydro science and engineering. University of Mississippi, University, Mississippi, pp 134–146
4. Klassen GJ, Masselink G (1992) Planform changes of a braided river with fine sand as bed and bed and bank material. In: Proceedings of the fifth international symposium on river, sedimentation, 6–10 April 1992, Karlsruhe, pp 459–471
5. Jagers HRA (2001) A comparison of prediction methods for medium-term planform changes in braided rivers. In: Proceeding IAHR symposium on River Coastal and Estuarine Morph dynamics, Genova, 10–14 September 2001, Obihiro, Japan, pp 713–722
6. Jagers HRA (2003) Modelling planform changes of braided rivers. PhD theses, University of Twente. ISBN 90-9016879-6
7. Rahman MM, Nakagawa H, Ishigaki T, Khaleduzzaman ATM (2003) Channel stabilization using bandalling. Annuals of Disaster Prevention Research Institute, Kyoto University, no 46 B, pp 613–618