LOW COST TECHNIQUES TO RECOVER AGRICULTURAL LAND THROUGH RIVER BANK EROSION PROTECTION

TECHNIQUES A BON MARCHE POUR RECUPERER LA TERRE AGRICOLE PAR PROTECTION DES BERGES CONTRE L'EROSION

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ABSTRACT

Bangladesh is a land of rivers. There are about 310 small rivers in Bangaladesh including the main three rivers: the Padma, the Meghna and the Jaumuna. Most of the river basins comprise alluvial deposits. During the monsoon the river banks are eroded and engulfed by the river itself. The river width is increasing and depth is decreasing. Every year these same situations arise. As a result, the agricultural lands have been decreasing all over the country through river bank erosion, which is a national disaster in Bangladesh. In this paper the performance of the low cost techniques (bamboo bandalling structure) is applied which is constructed for the river bank erosion protection. This structure is constructed near the river bank erosion prone area of the Jamuna River for its erosion protection. The sediment available in the flowing water in the river deposits downstream & between the constructed bamboo bandalling structures due to the comparatively lesser flow velocity behind and in between the bandals.

Key words: *bandalling, structure, construction, sedimentation.*

RESUME

Le Bangladesh est un pays des fleuves. Il y a environ 310 fleuves, y compris les trois rivières principales : Padma, Meghna et Jaumuna. La plupart des bassins fluviaux comprennent les matériaux alluviaux. Au cours de la mousson, les berges sont érodées et submergées par la rivière. Donc, la largeur de la rivière augmente et la profondeur diminue. Chaque année ces mêmes situations surgissent. En conséquence, la superficie agricole a diminué dans le

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pays par l'érosion des berges, ce qui est un désastre national. Cette étude vise à examiner la performance des techniques à bon marché (bamboo bandalling structure – structure constituée par une ossature en bambou) qui sont utilisées pour la protection des berges contre l'érosion. Cette structure est construite sur la rivière Jamuna près des berges susceptibles à l'érosion. Le sédiment disponible dans l'eau écoulée de la rivière est déposé en aval et dans la structure de bambou car la vitesse de l'écoulement est basse derrière et au milieu de bandals.

Mots clés: *bandalling, structure, construction, sédimentation.*

1. INTRODUCTION

River bank erosion is the single most common problem in the rivers, which flow through the low-lying alluvial plains. The erosion causes a lot of damage such as river meandering, loss of land, or property and endanger people who live near the river. The standard bank erosion control structures are expensive, massive (made using cement concrete blocks) and incompatible with environment and aesthetic. They have bad influence on the vegetation growth and habitat of species that are living around water and hence are not eco-friendly. Because those are costly, they are mostly used to protect important place or populous and settled urban areas. While, in rural areas where the value of land or property is low, they cannot be protect by above structures, because that is not viable if compared with the cost.

Fig. 1. River System of Bangladesh

The River Jamuna in Bangladesh is a braided river whose braiding index varies spatially as well as with time. In general, the braiding index and the overall width are large at the upstream than in the downstream, probably due to the effects of higher slope and grain sizes. The overall width of the river exhibits an increasing trend and there is tendency of shifting westwards, especially at the upstream part of the river within Bangladesh. The widening can be attributed to an advancing alluvial fan or to the not yet completed adaptation process after the shift to its new course according to FAP 24 (1994). The shifting rate of the first-order channel of the Jamuna River is 75 to 150 m per year. The second-order channels change continuously, large channels being abandoned and new ones developing in a few years only (Klassen,G.J.and Masselink,G.,1992). A bank erosion rate of the second-order channels of 250 m to 300 m/ year is common and in extreme cases, it can be more than 800 m/year (Klassen,G.J. et al, 1993). There are some attempts made to address the river bank erosion protection issues (Rahman, M.L.et al, 2009). The river systems of Bangladesh are shown in Figure 2 in which so many agricultural land engulfed by the river systems.

The Bamboo Bandalling Structure is one of the low cost structures, as shown in Table 1 in which the comparative statements of implementation costs for the different river erosion protection structures are given (Rahman, M.L. et al, 2009).

Table1. Comparison among implementation cost of different river bank protection structures

Type of structure	Name of the River	Agency	Cost US$/m	Effective-ness
Guide Bank	Jamuna Bridge	Foreign	33,000	Effective
Hard point	Sirajganj (Jamuna)	Foreign	21,000	Effective
Solid spur	Kalitola (Jamuna)	Foreign	12,500	Effective
Revetment (Geobags)	Jamuna	Foreign	2000-3000	On going
Revetment	Jamuna	BWDB	3800-4000	70-80 %
RCC spur	Jamuna/ Ganges	BWDB	950	60-70 %
RCC spur	Teesta	BWDB	350	100 %
Bandalling structures	Jamuna	RRI	70	On going

The land is mostly owned by impecunious farmer and is the only resort for his life. Disturbance to this land brings misery to them. The River Research Institute, Faridpur, Ministry of Water Resources, Bangladesh has developed bamboo bandalling structure, which entails much low expenditure in river bank protection works. They are easy to construct using natural and local materials that are harmonious with the environment. To protect river bank erosion and channel shifting of the untrained alluvial rivers of Bangladesh a number of earthen embankments were constructed along the major rivers for the protection of rural people and agricultural lands from flooding during the nineteen sixties. Since then the embankments have been damaged 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 for bank protection. Very recently the concept of hard points (strong revetment type structure) at the most vulnerable locations along the Jamuna river are considered; while in between hard points, spurs or permeable groynes are recommended (Klaassen, 2002). By

constructing spurs or groyne type conventional structures, the river bank erosion at the short term basis can be contained, but the long term stable channel or regime channel cannot be developed. Alternative solutions that can be locally adaptive and environment-friendly need to be developed, though as a short term solution of the problem. Locally adaptive and eco-friendly solutions need also to be developed for the long-term stabilization of river channels. The possibility of using bandals for long-term channel stabilization is examined using field data and laboratory investigation (Rahman et al., 2003). The responses of large alluvial rivers against sudden changes created by conventional structures are not suitable for the overall stabilization of river courses. Therefore, it is important to have alternative long-term solution for river stabilization that will create minimum disturbance to river courses.

2. METHODOLOGY

During the dry season huge sediment is deposited over the river bed reducing the river conveyance capacity and accelerating river bank erosion during the monsoon in every year. A series of bandals were constructed in the left bank of the Jamuna River near the downstream of the Bangabandhu Bridge. It was found that water flow diverted towards the main river due to bandal structures had low velocity near the river bank. Thus, the effect of the bandal was to promote sedimentation near them and hence, near the river banks.

There was huge river bank sedimentation due to the construction of bamboo bandalling structures at the upstream of the Bangabandhu Bridge East Guide Bund near Shaheed Salahuddin Cantonment of the Bhuapur upazila under Tangail District, Bangaladesh. The selected problem area is about the 1.5 km river bank reach in which there are 138 cross-sections considered for the bathymetry data analysis as in the index map shown in Figure1. For its pictorial evidences, three reaches such as the 0.50 km downstream reach, 0.70 km middle and 0.3 km upstream reach within the 1.5 km stretch are considered for the analysis of effectiveness of bamboo bandalling structures. The bed level and water level data are collected in this problem area with reference to a Temporary Bench Mark (TBM) near the Bangabandhu Bridge East Guide Bund.

The working principles of bamboo bandals is to control the water and sediment flow such that sediments are transported as bed load and suspended load. Within the lower half of the flow depth, major portion of the sediment flow is concentrated, whereas, within the upper half the sediment concentration is low. 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 upstream and downstream side of bandal. The flow near the bed is directed perpendicular to the bandal resulting 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.

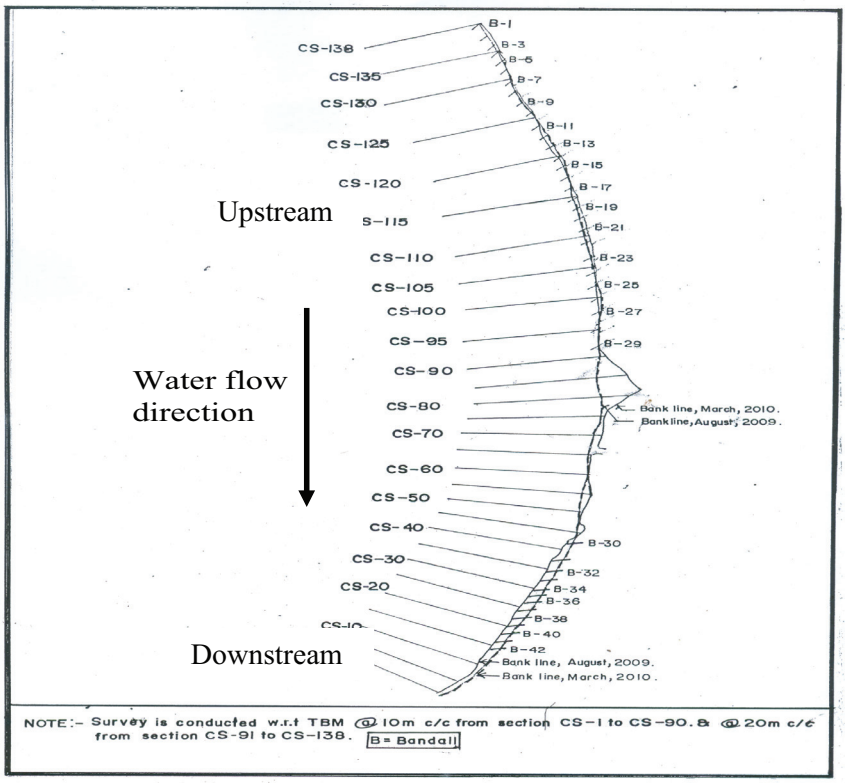

Fig. 2. Location of river cross-sections in the left river bank towards main river

Fig. 3. Bamboo Bandalling in progress in the Jamuna River of Bangladesh

Fig. 4. Crop Plantation within the recovered agricultural land

Fig. 5. Recovery of agricultural land through river bank erosion protection

Fig. 6. Paddy cropping in the agricultural land by river bank erosion protection

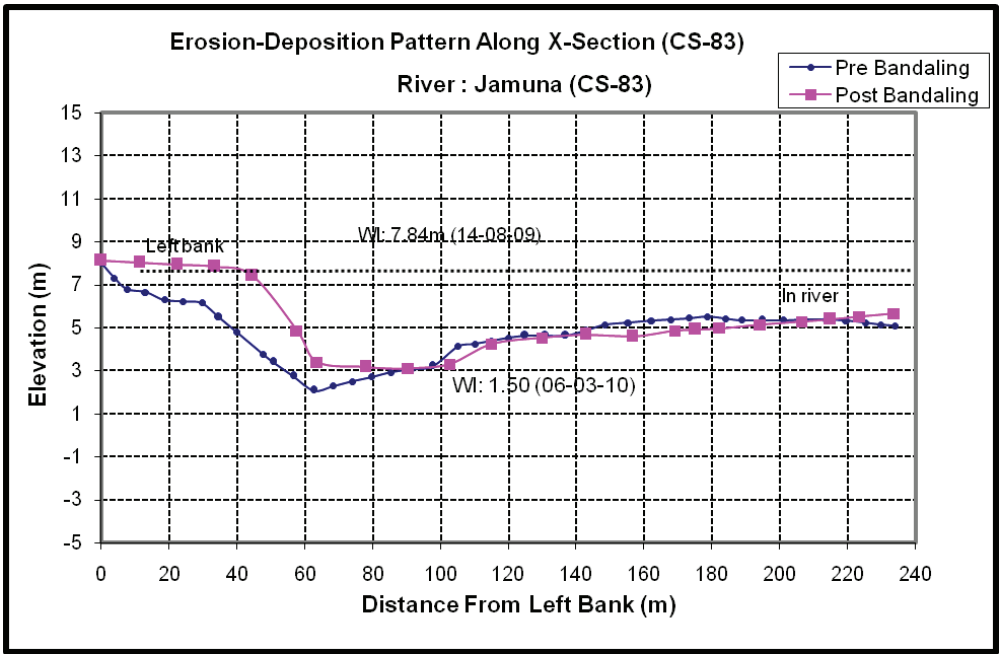

Fig. 7. Agricultural land recovery by river bank erosion protection with bandalling

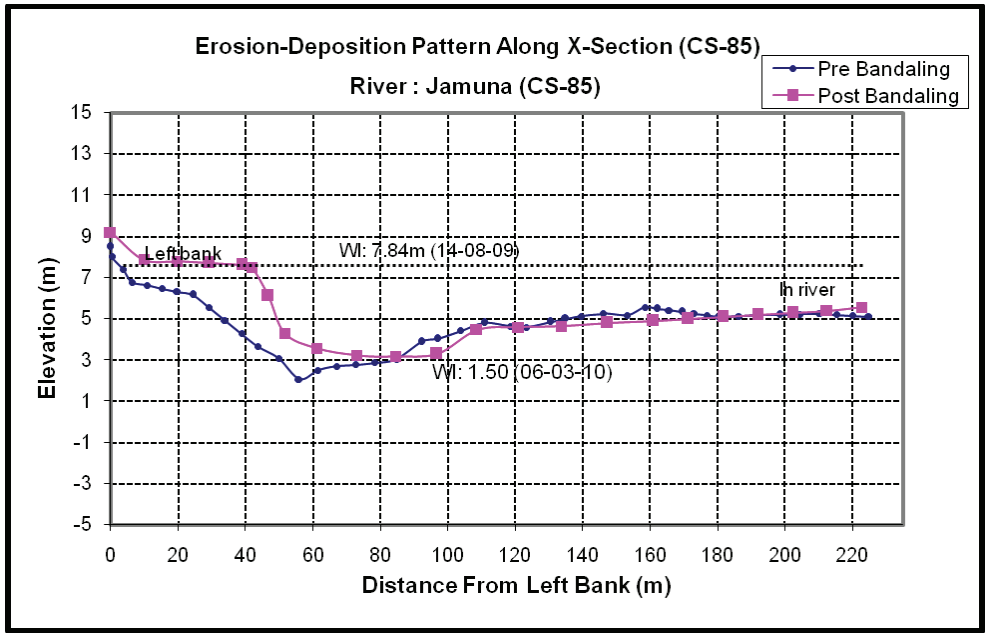

Fig. 8. Agricultural land recovery by river bank erosion protection with bandalling

3. RESULTS AND DISCUSSIONS

It is seen from the Figure 3 so that the construction of bamboo bandalling is going on. It is found in Figure 4 that the top of the surface water for the constructed bamboo bandalling is blocked by the bamboo fencing for which the velocity near the river bank is low than that of less velocity away from the river channel. It is seen from Figure 5 & Figure 6 that huge amount of sedimentation occurred in which the agricultural land is recovered during flood period due to effect of bamboo bandalling structures. In this recovered agricultural land, the crops are panted whose yield is higher than the normal agricultural land. Figure 7 & Figure 8 has also given the erosion and siltation pattern at two different sections along the river and indicate the good performance of bamboo bandalling structures to protect river bank erosion as well as recover agricultural land.

4. CONCLUSIONS

It is concluded that, due to construction of bamboo bandals, there is a siltation near the river bank where as there is deep pool away from the river bank. So it is obvious that the bamboo bandals are working as a river bank erosion protection & recovery of agricultural land with the aid of sedimentation near the river bank. So the bamboo bandalling structures 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 and depths are higher at the main channel that ensure the navigational channel development. If the bandal structure functions well, the river can get sufficient time for its adjustment and new main channel and bank line development.

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