Paper 173 - RCC Jack Jetty and Bamboo Submerged Vanes Application for Navigation Fairway in Ganga River of India

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ABSTRACT: The conventional techniques of erosion control and river channelization for navigation are focused mainly on using bank revetment, spurs and groynes. These have proved to be highly capital intensive as well as fraught with instances of devastating sudden failure as in the case of stone spurs of Koshi river in Nepal / India during August 2008 causing the river to radically change its course by 120km. In the above context, there is an imperative need to develop cost effective and reliable techniques. Development of scientific design approach for RCC Jack Jetty system along with bamboo submerged vanes based on comprehensive lab investigations in IIT Roorkee and supported by pilot field application results near Nakhwa village on the Ganga river in India, is to be considered for developing countries as a semi-permanent cost effective approach of river management to develop inland navigation fairway in highly complex and unstable large river systems like the Ganga and the Brahmaputra in South Asia.

1 INTRODUCTION

In recent decades, the conventional river training techniques deployed for management of stream bank erosion and fairway development for Inland navigation have become increasingly expensive and less cost effective in large Indian rivers like the Ganga and the Brahmaputra due to various causes. One of the causes relate to rising costs of labour and the construction material such as, boulders, wire nets etc. used in conventional structures. Thus, the conventional river training techniques like, spur and groyne, bank revetment, bandalling, dredging etc. have become highly expensive - both in terms of capital cost as well as with regard to high yearly maintenance cost, without providing reasonably durable solution. In simple economic terms, the above situation has made the conventional river training techniques for inland navigation practically unaffordable for Indian and South Asia Rivers where thousands of kilometres of erosion affected stream bank-line await protection measures to sustain their navigability.

In the above backdrop, an imperative need is felt to develop and deploy modified cost effective river training measures to tackle the burning problem of stream bank erosion for channel stability so as to facilitate navigation in Indian rivers. Some attempts to use cost effective measures like, porcupine, bandalling etc. have been made by Inland Navigation Authority of India (IWAI) for stream bank protection and inland navigation channel maintenance. Attempts made so far in several major Indian rivers like the Brahmaputra, the Ganga, the Kosi etc. are based purely on a trial and error approach with a predominant element of conjecture. The Steel Framed Kellner Jack Jetty structure can be suitably modified to Jack Jetty made of RCC

construction based on scientific design supported by lab & prototype experimentation results to significantly cut down cost and improve its stability and also make it pilferage-proof in Indian context.

2 PILOT FIELD STUDY ON THE GANGA RIVER IN INDIA FOR FAIRWAY DEVELOPMENT

A pilot field study had been conducted near the Nakhwa site of the Ganga River which is about 12 KM downstream of Varanasi city. This particular site had been chosen to study the performance evaluation of the RCC Jack Jetty structure along with bamboo submerged vanes. Prime objectives of the pilot field study at this site were to close the secondary left channel which would thereby result in diverting the stream flow of the Ganga concentrating along the right channel (as shown in Figure 1: (A)&(B)) along with erosion control for increasing the navigation depth in the river.

The Nakhwa Site on the Ganga River was proposed to be provided with the following river training structures in two locations as (A) and (B) as shown in Figure1: (A) & (B). The location (A) is provided with two arrays of bamboo submerged vane, with each array containing 15 nos. of vanes. The approximate incident angle of the vanes with approach flow direction will be about 15^0. The objective of these vanes in location (A) is to divert the incoming lower layer sediment volume towards the existing secondary channel along the left bank for gradually causing it to choke; and thereby the right bank channel is expected to deepen due to flow diversion from secondary left channel.

The left channel on location (B) is provided with three arrays of bamboo submerged vanes, with each array containing 15 nos. of vanes [Figures 1 (B) and 2(A)]. The approximate incident angle of the vanes with approach flow direction will be about 15^0. The objective of these vanes in location (B) is to divert the incoming lower layer suspended and bed sediment load towards the existing middle channel in the middle of the river for gradually causing it to choke; and thereby the right bank channel is expected to develop by deepening due to flow diversion into it. Furthermore, to enhance the effect of submerged vane, three rows of RCC Jack Jetty screens were installed in the downstream of the submerged vane as shown in the Figure 1 (B) and Figure 2(B)&(C). These three rows of 300 m long RCC Jack Jetty screens were positioned about 100m downstream of the vanes. The right channel on location (B) was provided with two rows of diversion lines and 6 retards to protect 300m length stretch of the river from erosion to help stabilize and sustain the navigation waterway.

The channel configuration of the Ganga River at Nakhwa site was monitored with the help of satellite imageries of 2005 and March 2012. The morphological changes in the river verified by comparing the pre Jack Jetty installation PAN image of 2005 (as bench mark) and post Jack Jetty installation March 2012 image with GIS based measurements. The GIS measurements have been tabulated in Table No.1 which shows the width of the secondary left channel to be significantly reduced from 246m to 50m and the width of the intended navigable right channel to have widened from 180m to 341m.

Topographical river bed level survey of the study area at Nakhwa site was conducted for pre and post flood season to monitor the stream bed changes post Jack Jetty installation. The stability of stream bank is visibly improved with appearance of vegetation in post Jack Jetty installation as can be seen in Figure 2 (E).

After thorough investigation of the site by the satellite images, new river training structures comprising mainly RCC Jack jetty system with submerged vanes made of bamboos had been installed on a pilot study basis during 2009 and 2010, and results have come out to be very encouraging as borne out by the hard evidence discernible from the satellite imageries vide Figures 3 & 4. The particular site of the river had been monitored for one

flood season and streambed topographical survey had been carried out for pre and post flood period.

The analysis of the results has come out as per the desired objectives. The implementation of the river training measures of RCC Jack Jetty and bamboo submerged vanes have resulted in the desired successful closure of the secondary left channel of the Ganga River by inducing heavy sedimentation along with arresting erosion completely along the right bank which is a concave bank and was earlier undergoing erosion. This lab as well as field application study has demonstrated in prototype Ganga River that the RCC Jack Jetty along with bamboo submerged vanes may be reckoned as cost effective river training measure for the first time in the large Indian River of Ganga. One of the major contributions of this study is the efficacious performance of the relatively cheap and more affordable river training measure of RCC Jack Jetty and Bamboo Submerged Vanes as screen and as diversion / retard lines, which can be installed in the field avoiding any special care and with absolutely no maintenance cost. Keeping in view the sharp hike in prices of stone or steel in the developing countries of Asia and other parts of the world, this experience gained from actual field application albeit as pilot study, can potentially turn out to be a significant cost saving technology for sustaining Inland Navigation waterway in large rivers.

3 SUMMARY AND FINDINGS OF THE STUDY

1. The right bank of the channel of the Ganga river near Varanasi is a concave bank and was more susceptible to bank erosion during floods thereby constantly reducing inland navigation depth.
2. During dry weather low flow from December to June, the navigation depth was invariably insufficient.
3. The lab and pilot field study deploying modified RCC Jack Jetty supported by bamboo submerged vanes have achieved the following – the secondary left channel was nearly choked diverting the flow to the navigation channel along right bank, and also the ongoing bank erosion along the right bank could be arrested.
4. Evidently the above transformed channel processes resulted in developing and sustaining the desired Inland navigation waterway along the right bank as evidenced from satellite imagery as well as topographical survey.
5. The encouraging outcome of the pilot field study on the large Ganga river warrants replication of the modified cost effective technology in similar other river systems of the world with required fine tuning for specific site condition.

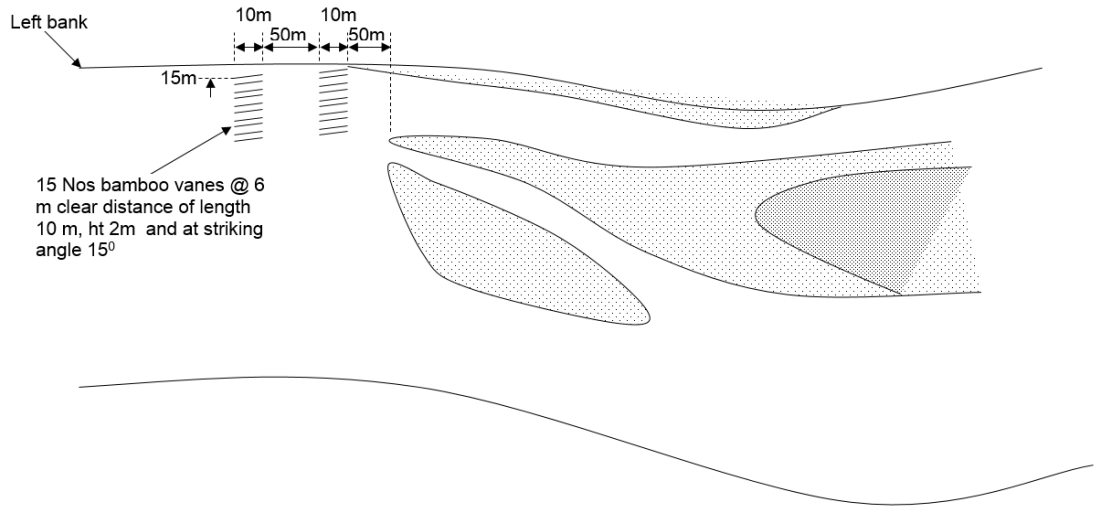

Figure 1-(A): Detail Arrangement of Location (A) At Nakhwa Site (Ch 1299)

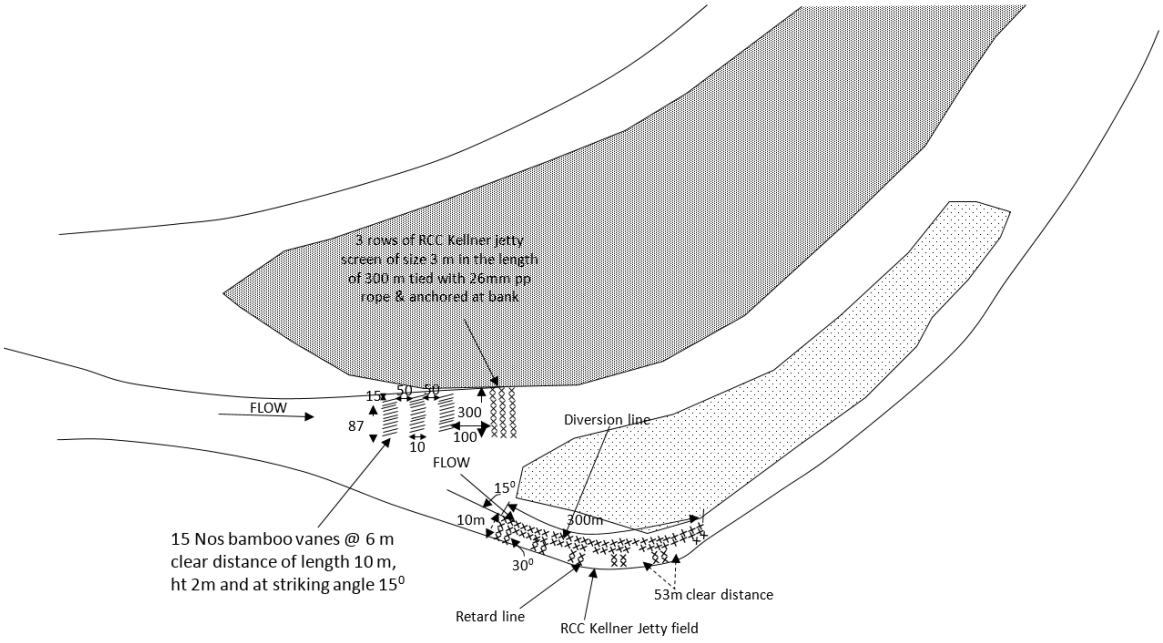

Figure 1-(B): Detail Arrangement of Location (B) At Nakhwa Site (Ch 1299)

Figure 2(A): Bamboo Submerged Vane on Ganga for secondary channel closure

Fig.2(B): RCC Jack Jetty Screen on Ganga for secondary channel closure

Figure 2(C): RCC Jack Jetty Screen on Ganga for secondary channel closure

Figure 2(D): RCC Jack Jetty diversion line on Ganga for erosion control

Figure 2 (E): Silting And Erosion Control with the RCC Jack Jetties on Ganga river

Figure 3: Satellite Image 2005 of Ganga River for Pre Jack Jetty Installation near Nakhwa Village (12KM D/S of Varanashi)

Figure 4: Satellite Image March 2012 of Ganga River for Post Jack Jetty Installation near Nakhwa Village (12KM D/S of Varanashi)

Table 1: GIS Measurements (With reference to Fig. 3 & 4)

Channel Location	2005 Image	March 2012 Image
Left channel width	246 m	50m
Right Channel width	180m	341m

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