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**Case Study**

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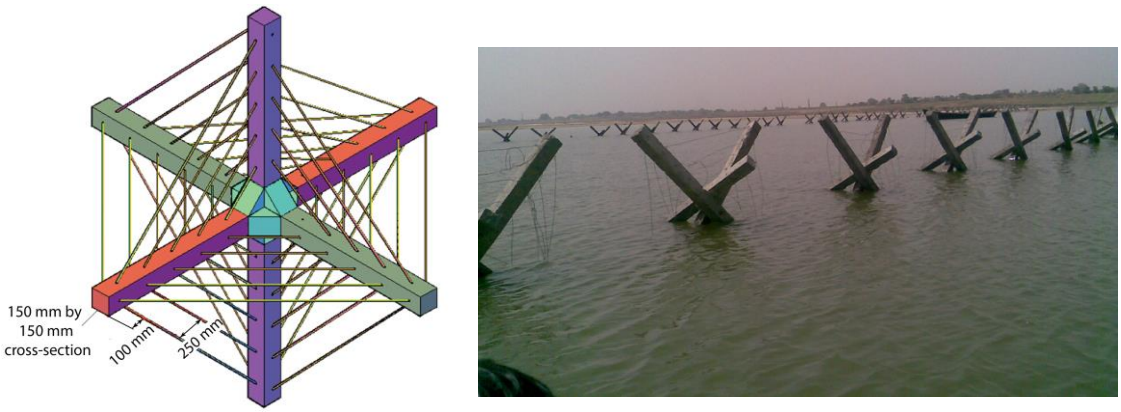
# DEVELOPMENT AND FIELD APPLICATION OF THE RCC JACK JETTY FOR RIVER TRAINING

Nayak, Anupama[1], Sharma, Nayan[2] and Mazurek, Kerry[3,4]
[1] Water Resources Department, Government of Odisha, Bhubaneswar, Odisha, India
[2] Professor, Department of Civil Engineering, IIT Roorkee, Roorkee, India
[3] Associate Professor, Civil Engineering, University of Saskatchewan, Saskatoon, Saskatchewan
[4] Kerry.Mazurek@usask.ca

## 1 INTRODUCTION

Jack Jetties were river training structures used for bank protection and creating sediment deposition in the United States in the 1920's. A Jack was a structure that looked like the jacks that children had played with earlier in that century. The Jacks were made of steel and were strung together to form lines much like the groynes that are used today. A Jetty is a line of Jacks and Jetty Field was a series of Jetties. The structures were seen to be reasonably effective at producing sedimentation but design procedures were ad hoc. Ultimately, their use in North America did not continue because of their potential for disrupting navigation. In India, however, problems with river engineering are significant; rivers can be large. As such, any river engineering measure developed should be inexpensive due to the scale of the work that can be required. Jack Jetties are of interest for renewed investigation for application in Indian rivers as an inexpensive river engineering structures. Because of the costs of steel, it was thought instead the jacks could be made of cheaper reinforced concrete (RCC). Figure 1 gives a sketch of a Jack and photo of a RCC Jack Jetty field.




(a) (b)

Figure 1: (a) RCC Jack Jetty of 3 m length and 0.15 m by 0.15 m cross-section (adapted from Nayak *et al*. 2017) and (b) RCC Jack Jetty field in the River Ganga at Nakhwa

A study of the efficacy of the Jack Jetties was therefore conducted to determine their potential to create sediment deposition in large rivers in India. First, measurements were conducted in the laboratory to examine the flow field behind single and multiple Jacks set parallel with, then perpendicular to, the flow. A further laboratory study was conducted to study the optimum configuration of Jacks for sediment deposition to develop guidelines for how much sediment deposition might be expected for different flow, sediment concentrations, and submergence conditions of the Jacks. Finally, a field test was conducted in the River Ganga at Nakhwa to test the effectiveness at producing sedimentation in a Jack Jetty field configuration expected to produce a significant sedimentation from the laboratory experiments.

## 2 LABORATORY EXPERIMENTS AND FIELD TRIAL

The laboratory experiments to examine the flow field behind a Jack or multiple Jacks either inline or as Jetty were conducted in two parts. The first set of experiments was conducted at the Indian Institute of Technology (IIT) Roorkee, in Roorkee, India, within a 22.5 m long, 1.2 m wide, 0.6 m high flume with a sand bed of mean grain size of 0.25 mm. Jacks of 0.08 m or 0.1 m height were placed individually, with 2-4 placed in a single or double row parallel to the flow, or 2-4 placed in a single to quadruple row across the flume, with a depth of flow of 100 or 200 mm. The flow rate was 0.013 to 0.039 $m^3/s$ and the Froude number was kept constant at 0.11. A second set of experiments were conducted within a 25 m long, 1.25 m wide, 0.6 m deep flume in the Hydraulics Laboratory at the University of Saskatchewan in Saskatoon. A fine sand of 200 mm depth served as the flume bed with an average grain size of 0.59 mm. Single or multiple Jacks of 0.2 m or 0.3 m height were placed in the flume in a line of 1 to 3 Jacks parallel to the flow. The flow rate range from 0.071 to 0.107 $m^3/s$, with a flow depth of 300 or 400 mm, and a constant Froude number of 0.1. Velocity measurements in both sets of experiments were carried out in clear water and taken just upstream and behind the Jacks using an Sontek 16 MHz MicroADV. The objective was to observe how much the velocities behind the structures were reduced by installation of the Jacks. Results indicated up to a 60 % velocity decrease with the Jack in the flow and this occurred immediately behind the obstacle.

Further experiments were conducted in the Hydraulics Laboratory at IIT Roorkee to examine how much sediment would deposit for different configurations of Jack Jetty fields for varied sediment concentration in the flow (250 to 1000 ppm). The Jacks were 0.1 m high and were set in a 0.5 m wide flume on a sand bed of 0.15 m thickness. Two sands of average grain size of 0.248 mm and 0.59 mm were used, the flow rate ranged from 0.013 to 0.0225 L/s, and the Froude number ranged from 0.11-0.15. Tests were first run for 30 minutes with clear water, after which the bed profile was measured. Then, flow in the flume was reinitiated and sediment was injected for 4 hours, after which the flow was again stopped and the bed profile measured to judge the amount of sediment deposition on the bed. From the work, guidelines were developed for the design of a Jack Jetty field configuration to provide different (qualitative) amounts of sediment deposition (Nayak *et al.* 2017) for varied suspended sediment concentrations in the flow. This is done in terms of a bed deposit factor, the ratio of the bed deposition to the total depth of water, and the Jetty Field Density Index, which is the ratio of the length of a Jack Jetty to the Jetty centre-to-centre spacing.

Next, a field trial was conducted to test the efficacy of a RCC Jack Jetty field in the River Ganga at Nakhwa, where the channel is split into two. The left channel was to be reduced to force more flow through the right channel to improve navigability. After installation of a Jack Jetty field at the site, due to deposition, there was a reduction in width from 246 m to 50 m over two years in the left channel of the river.

## 3 CONCLUSION

The Jack Jetty appear to be an effective, inexpensive means of forcing sediment deposition river and reducing the width of the river to provide sufficient draught for navigation.

## REFERENCES

Nayak, A., Sharma, N., Mazurek, K.A., and Kumar, A. 2017. Design Development and Field Application of RCC Jack Jetty and Trail Dykes for River Training, in *River System Analysis and Management*, N. Sharma, ed., Springer, Singapore.