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EXTENDED ABSTRACT

Investigating the Effect of Coastal Triangular Boundaries on the Topography of the 180-Degree of the Jangiye Bend of the Karoon River using a Physical Model

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Introduction

Meandering river bend migration is a common phenomenon which destroys agricultural lands and civil infrastructures around the river. The main cause of such migration is due to developing a secondary flow within the bend in which a helicoidally circulation is developed and as a results the scour hole at the outer bank toe is created which causes collapse of the outer bank and its migration. Over the last decade many countermeasures against such scour have been developed. These measures modify the flow within the bend redistribute the local bed shear stress for the purpose of reducing the toe bank scour. Triangular vanes are one of such structures that help stabilize the outer bank by modifying the flow pattern in the river bend to prevent the scouring of the outer bank. Triangular vanes have been studied successfully by Bhuiyan et al. (2010) in a sinuosity river path and in a 90 degree flume bend by Bahrami-Yarahmadi and Shafai Bejestan (2016). Based on these studies this measure, if designed properly, not only can shift the scour from the outer bank toe to the middle of the river, it transport sediment to the downstream of the vane and deposited in between the vanes which create a new bank. The structure has been defined environment friendly since it create an environment suitable for aquatic animals. The aim of the present study is to investigate the application of triangular vanes in a 180 degrees of Jangiyeh bend in Karoon River south of Ahvaz and to determine the bets distance for installing the vanes.

Material and Methods

The experimental work was carried out in the Hydraulic Laboratory of Shahid Chamran University of Ahvaz. First, a distorted physical model of a 180-degree convergent bend of Jangiye which is located at the downstream of Ahvaz along the Karoon River was constructed with a horizontal scale of 300 and a vertical scale of 50. Figs. (1) and (2). Then the model was hydraulically calibrated by adding artificial roughness to have the Froude number ratio equal to one. The average size of bed sediment particles was 1.85 mm in the model. This size of sand was determined by initial tests to maintain the clear water condition in the model, and for the range of flow conditions, the erosion and sedimentation around the vane provide the required accuracy in the measurements. At the beginning of each test, the bed was carefully leveled. The experiments were carried out at 16, 18, and 19.5 l /s (scaled to less than, equal to and larger than with a two-year return period flood discharge of the Karoon River) with constant flow depth of 12 cm. The height of the vane was selected according to previous studies. Triangular vanes were made of plexiglas and installed with angle of 30 degrees to the upstream bank. The effective length of the vanes was taken equal to the river width at its location (Bahrami Yarahmadi and Shafai Bejestan., (2016). Vanes were installed in series in the downstream segment of the bend which bank failure due to toe scour is very active (Fig. 3).

Fig. 1- Jangiye Bend (prototype)

Fig. 2- Jangiye Bend (distorted model)

Fig. 3- a view of installed triangular vanes installed

In the present study two series of tests were conducted with and without installed vanes. Each test carried out under three different flow conditions and at the end of each test the bed topography was measured using laser meter. Test with vanes were conducted with installed vanes with different vanes distance of 4, 5, 6 and 8 times of the effective vane length.

Results

The bed topography of each test were plotted using SURFER software. Fig.4 show as an example for test with installed vanes with distance of 5 times the effective vane length and Froude number 0.29. The scour dimensions were extracted from these figures and compared. Fig (5) shows that as the Froude number increase, the scour dimensions increase too.

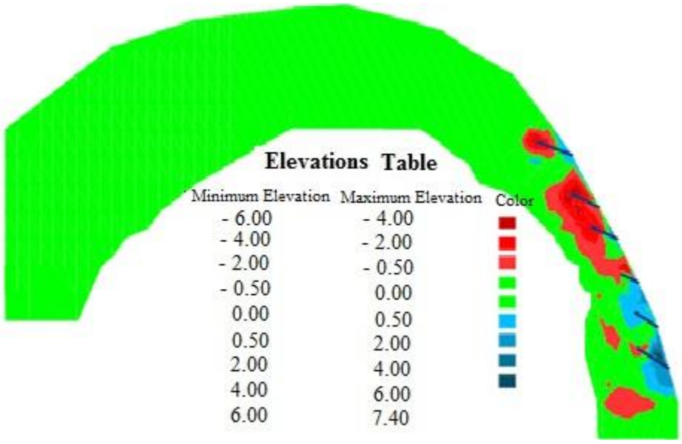

Fig. 4- Bed topography for Fr=0.29

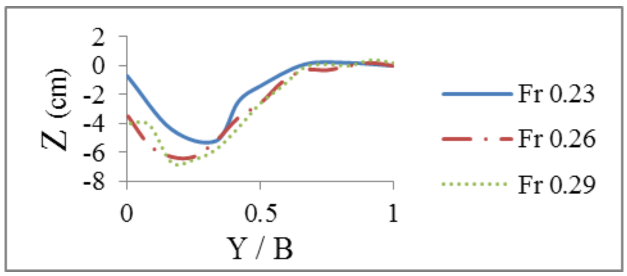

Fig. 5- Scour profile for different flow conditions

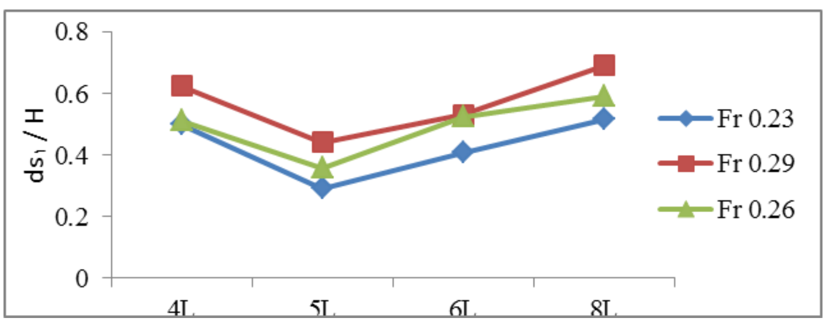

Fig 6- dimensionless scour depth versus vane distance for different flow conditions

Fig.(6) shows variation of dimensionless scour depth versus distance between vanes. As it shows the scour depth increases as the effective length increase from 4L to 5L and then increase for vane distances of 5L, 6L and 8L.

The maximum scouring depth occurs at vane distance of 8L. This is due to the large spacing between the vanes, which has the effect of reducing the vane on each other, and each structure acts individually, thus scouring is increased. In all flow conditions, the minimum scouring ratio was measured when the vane were installed at 5 times the effective length, indicating the appropriate distance between the vanes for this bend. The observations showed that when the scouring is started, the sediments move along the axis of the structure towards the outer bank. If the spacing of the structures is relatively large, the sediments along the length of the channel and in the direction of the outer bank are deposited before reaching the next structure, by reducing the distance between the structures (e.g. 4L in this study), the sediments due to the formation of a strong clockwise horizontal vortex in between the vanes, are shifted toward to the flume center and transported to the downstream and therefore the scour depth at the vane's toe increases.

Conclusion

The results of this study indicated that triangular vanes, if installed at proper distance prevent the erosion of the outer bank to a large extent. Sediment deposition in between the vanes can create a new outer bank. The scour at the toe of the vane can cause the instability of the vane and it was found that when the vane are installed with distance of 5L, minimum scour depth occur, and the sedimentation between the vanes is maximum. Therefore, the use of these triangular vanes is recommended in order to protect the outer bank in the meandering rivers.

References

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