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EXTENDED ABSTRACT

The Experimental Study of the Flow Pattern and Bed Topography Changes due to Variations in the Angle of the Gabion Spur Dike in the Open Channel with Erodible Bed

Z. Badpa[1*], M. Fazli [2] and S. Pazin [3]

1*- MSc of Water Engineering and Hydraulic Structures, Faculty of Engineering, Bu-Ali Sina University. (*Zainabbadpa2169@yahoo.com*).
2- Assistant Professor of civil Engineering, Faculty of Engineering, Bu-Ali Sina University.
3- MSc of Water Engineering and Hydraulic Structures, Faculty of Engineering, Bu-Ali Sina University.

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Introduction

The construction of structures such as spur dikes in open channels and rivers is done to control the coastal erosion or water guidance and diversion. Scouring due to changes in the pattern of flow around the structure may result in instability and structural insufficiency, and if designed improperly, it may lead to complete degradation. Thus, the flow pattern and scour depth around the spur dike should be carefully considered. In effect, the type of spur dike used in each project, depending on its usage in the flow path, the depth of scouring and economic considerations must be carefully selected. The open gabion spur dike is one of the most affordable ones and is of high quality in terms of efficiency and ease of construction.

A lot of research has been already conducted on impervious and angled spur dikes, including that of Ezzeldin et al.. In their research, they performed experiments on a blade spur dike at various angles (30,60 and 90 degree) and reported that the spur dike at 30 degrees was best in terms of depth of scouring and coastal protection. The maximum scour areas for the spur dike in their research were 90 and 60 degrees upstream of the spur dike, while the maximum scour area for the spur dike is 30 degrees along the length of the spur dike. Moreover, scour at 90 ° and 60 ° was equal, and in some cases higher scouring at a 60 ° angle and an increasing cost of constructing the spur dike in angular mode (Because of the real length of more in equal terms). The use of this type of spur dike was unrealistic at an angle of 60 degrees. In addition, Nagy (2005) showed a time test for the vertical and attracting spur dikes, as the scour rate for larger Froude number was higher, and the scour rate for the vertical state was greater than the attracting state. He further concluded that the angled spur dike had less scour depth and volume. Conducting experiments on the scouring around a trapezoidal spur dike at three angles to the downstream of the adjoining coast in two constricted ratios of 0.25 and 1.05, Kuhnle (2002) concluded that the 45 degree spur dike created the most scouring in the area adjacent to the coast, while less scouring was observed for the spur dikes of 90 and 135 degrees .

Methodology

In the present study, the velocity of three-dimensional flow and topography of the bed were measured using the ADV device. The experiments were carried out for three types of attracting (135 degree), repelling (45 degree), and vertical (90 degree) spur dike. The open gabion spur dike was made of rock materials with a specific gravity and the meshes were made in accordance with the porosity. The equilibrium time was determined by separate experiments, and was considered to be 540 minutes. In these experiments, the Froude number was fixed at 0.26 and the depth of flow in the set of experiments was 14.6 cm, which was extracted according to the discharge rate and the motion threshold formula (Yang, 1996). The experiments were carried out in such a way that the flow pattern measurement was started using the ADV device before the equilibrium of the bedding and scour harvest.

Table1. Geometric and Hydraulic Specifications of the Experiments

parameter	Range of changes
Q(lit/s)	28 lit/s
Froude number	0.26
Angle of spur dike	45, 90 , 135 degree
Type of spur dike	Spur dike with Porosity 30 & 50 percentage
Depth of flow in up stream	14.6
Length of spur dike	12 cm
Average of Sediment size	1.55 mm

Results and Discussion

According to the results, the vertical spur dike created the largest scour hole and sedimentary stacks. The sedimentary stack created in the presence of this spur dike was, indeed, large, as it was created in a large area of the canal, while the maximum amount of sediment in the repelling and vertical was almost of the same size. The scour hole in the presence of each spur dike was proportional to the angle of the spur dike, but the depth and breadth of the cavity were found to be higher for the vertical spur dike. In general, the vertical spur dike, due to its angle of inclination and effective length, created more turbulence in the path of the stream. The simultaneous effect of the angle and the effective length led to an increase in the velocity of the passage from the headland and the transverse flow. This, in turn, formed stronger vortexes and transferred more bed materials with greater power to the downstream. Hence, both the dimensions of the scour hole and the sedimentary stack were considerably larger.

In the angled spur dikes, the pattern of flow varied depending on the angle of the spur dike. For repelling spur dikes, the presence of the spur dike created a lot of turbulence in the flow path. The flow in the collision with the headland of the spur dike was, thus, directed substantially toward the opposite wall (relative to the vertical spur dike) and caused major changes in the structure of the flow. However, for attracting the spur dike that was downward, the spur dike diverted the flow to the center of the channel, and the turbulence of the stream was far less. Thus, the presence of this spur dike maintained the natural structure of the flow.

Conclusion

The results showed that the vertical deformations had a more destructive effect on the bed topography. Besides, the flow pattern changes of the repelling spur dike were found to have significant effects on the scour hole dimensions. In the vertical spur dike, most changes were related to increasing the longitudinal velocity of the flow at the headland of the spur dike resulting from more cross-section constrictions and effective length of the spur dike. Repelling the spur dike with the flow to the opposite wall and the high turbulence resulting from the opposite direction to the main flow after the vertical spur dike created large changes in the bed topography and larger scour holes than the attracting spur dike did.

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