Study of Effect Side Wall Angle on The Control of Scour Around of Spur Dike In River Bend

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ABSTRACT

Occurrence of scour around spur dikes in arched pathways, is one of the main reasons for their destruction. In the present study to investigate the effect of wall angle on scouring around the spur dike, four kind of spur dike with a slope of body 65, 75, 85 and 90 degree at position 70 degree bend of 180 degrees in the bed of the flume installed and tested. Experiment with four different flow rate and the deep of steady stream of clear water conditions were conducted. Results of this study showed that the presence of a dip in the wall of spur dike reduces scour whole dimensions around it. Also was created minimum amount of scouring around the spur dike at a wall angle of 65 degree and its maximum around the spur dike at a wall angle of 90 degree.

INTRODUCTION

Spur dike are structures that are used with the aim of deviation of the flow of river bank erodible, creating a path for guiding the flow of, flood control, establish the necessary depth for navigation purposes, the outer wall of the arc protection and improvement of the river pathway.

One of the main problems in the bend of rivers is creating a secondary flow and erosion of the outer wall of arc that construction of spur dike diverting the flow from margins and avoid from dealing with the wall coastal. Water velocity when dealing with spur dike decreases and flow after rotating deal to the next spur dike and thereby dissipating the force of water erosion. On the other hand due to low water velocity, may be deposited the sediment carried by the river between each pair from epithelium.

The spur dike structures, although are created with the goals of sedimentation and to prevent erosion margin and positioning of the rivers, yet own is influence the erosion induced from focusing the flow, especially on the cape. On the Cape, localized increase in flow rate caused by constriction of cross sections and the occurrence of downwards the spin flow resulting in the formation of the horseshoe-shaped cavity and its progress, threaten the stability of the structure. If the spur dike is located on the outer arc is much more critical than the direct mode and may even after some time lead to the loss of spur dike or lack of productivity from it. Therefore spur dike shall be designed to have the lowest scouring.

Kuhnle et al. [2] were study the pattern of scouring around a spur dike with 45, 90 and 135 degree. In evaluation conducted with three angles of spur dike, was diagnosed the best design for epithelium with an angle of 135 degree. Because potential from the erosion of the seabed in near the beach is minimal, while showing the highest rate of scouring.

Fazli et al. [3] studied the scour and flow field at a spur dike in a 90 degree channel. It is obvious that there is lack of knowledge regarding the scour and flow pattern around the spur dike in a curved channel.

Ghosdian et al. [4] studied scour and flow field in a scour hole around a T-shape spur dike in a 90 degree bend. The effects of the length of the spur dike, the wing length of the spur dike and Froude number on the scour and flow field around a T-shape spur dike in a 90 degree bend were investigated in this study. The main results of this experimental study are: At the upstream of the spur dike, a main vortex with anti-clock wise direction is formed in the zone of the spur dike. At section 77.5 degree of the bend a vortex having a clock wise
direction is formed between the spur dike wing and the channel wall. The maximum value of the longitudinal velocity component at section 65 degree of the bend is close to the outer wall of the channel and near the water surface. By increasing Froude number the maximum scour depth and the volume of scour whole increases. The dimensions of the scour hole increase as a result of increase in the length of the spur dike. The amount of scour at the upstream of spur dike is much more as compare to that at the downstream of spur dike.

Masjedi et al. [5] studied on the time development of local scour at a spur dike in a 180 degree flume bend. Tests were conducted using one spur dike with 110 mm length in position of 60 degree under four flow conditions. In this study, the time development of the local scour around the spur dike plates was studied. The effects of various flow intensities (u*/u*c) on the temporal development of scour depth at the spur dike were also studied. The time development of the scour hole around the model spur dike installed was compared with similar studies on spur dikes. The results of the model study indicated that the maximum depth of scour is highly dependent on the experimental duration. It was observed that, as flow intensities (u*/u*c) increases, the scour increases. Measuring time and depth of scouring based on experimental observation, an empirical relation is developed with high regression coefficient 97%.

The purpose of this study was to introduce body optimum angle a minimum depth of scouring spur dike bend, to reduce cost and to identify the critical aspects of the spur dike is to stabilize the structure and prevent potential losses.

MATERIAL AND METHODS

Given the constant flow and constant fluid properties, the following relation between the parameters affecting the scouring around spur dike in the balance:

\[ f(L, b, S_0, Rc, \rho_s, \Phi, \mu, \alpha, Q, h, v, d_s, \rho_w, g, B, X, \theta) = \cdot \]  

In which (1), L is length of spur dike, b is width spur dike, \( \theta \) is body side slope, h is depth of flow, \( S_0 \) is bed slope, V is flow velocity, g is gravitational acceleration, d_s is parameter represents the depth of scour, Rc is central radius of bend, \( \rho_s \) is sediment density, \( \Phi \) is angle of internal friction bed particles, \( \mu \) is the fluid viscosity, \( \rho_w \) is the density of water, B is flume width, Q and X is the longitudinal coordinate. By refraining from constant parameters in equation (1), the following equation is obtained:

\[ f(h, v, d_s, \rho_w, g, B, X, \theta) = \cdot \]  

Using dimensional analysis, Eq. (2) can be written as:

\[ f\left(\frac{X}{B}, Fr, \frac{d_s}{h}, \theta\right) = \cdot \]  

This experiment was conducted in a laboratory flume at hydraulic laboratory of Islamic Azad University of Ahvaz. The study was conducted using in a 180 degree laboratory flume bend with a relative radius of Rc/B=4.7. Relative curvature of bend was Rc/B=4.7 which defines it as a mild bend. Straight entrance flume with the length of 9.1 m was connected to the 180 degree bend flume. This bended flume is connected to another straight flume with the length of 5.5m. The working section of the flume is made up of an aluminum bottom and Plexiglas sidewalls along one side for most of its length to facilitate visual observations. At the end of this flume a controlling gate was designed to adjust the water surface height at the desired levels (Figure 1).
Based on the recommendations Raudkivi and Attema [6] to prevent the formation of ripple, average particle diameter of substrate must be 0.7 mm larger. Also for eliminate the effect size of sediment on scouring depth, particles standard deviations must be less than 1.3. So for bed material was used flume of natural sand with uniform grain size $D_{50} = 2$mm and uniformity coefficient of 1.3 and about 20 cm from the bottom of the channel was filled of materials.

Donat [1] the maximum length of the spur dike should be considered between 10 to 20 percent of the width of the channel, in this study, experiments on four types of spur dike with upper width 1cm and a length of 12cm were doing and the angle of the walls 90, 85, 75 and 65 degrees Plexiglas and affected by four type of flow with Froude number 0.283, 0.330, 0.383 and 0.450 (Figure 2).

**Fig. 2:** Schematic illustration of a shape spur dike with wall angle.

In all experiments, was selected the landing number and the flow, as did not exist the general scour the channel. At the beginning of each experiment using mobile chariot leveling, channel the substrate equipped with a constant slope, then sediments with a thickness of 20 cm was placed around the spur dike.

The following procedure was used for each experimental run. Before the experiment with the spur dike model in place, the sediment bed surface was leveled with a scraper blade mounted on a carriage that rode on the steel rods. After the bed was completely wetted and drained. The flume was then filled with water to obtain the desired depth. Before the pump was started an initial set of transects of the anticipated scour region was collected. At the completion of each test, the pump was shut down to allow the flume to slowly drain without disturbing the scour topography. The flume bed was then allowed to dry, during which time photos of the scour topography around the pier were taken, and the final maximum scour depth was recorded using the point gauge having an accuracy of ±0.01 mm (Figure 3).

**Fig. 3:** Scour pattern at the end of a test

*Discussion And Conclusions:*

In all experiments, after adjusting the flow rate and depth, immediately formed around the spur dike inclined vortices and began scouring high speed. With the formation of scouring hole sediments derived from downstream were transported, shortly after the start of the experiment, sediment scouring the area are derived that decline the impact on the spur dike steep and the effect was negligible vortices behind the spur dike. The condition scouring sediments were transferred affected of the secondary flow downstream and were formed two or more small grooves around the breakwater.
**Effect of Angle of wall on the Scour Hole:**

Figure 4 shows the longitudinal profile of scouring around the spur dike at four Froude number 0.283, 0.330, 0.383 and 0.450 and the angle of spur dike walls 65, 75, 85 and 90 degree are provided. The results show figures, reduce the spur dike wall angle of 90 to 65 degree cause to reduce the depth and dimensions of scouring holes around the spur dike. Also maximum scouring wall at an angle of 90 degree and viewing angle is at least 65 degree. With increased angle of spur dike wall (90 degree), wall spur dike with more flowing lines and as a result of eddy currents around the breakwater more that makes more displacement sediment downstream and increased scouring hole dimensions and is stretch downstream sedimentation. In other words whatever structure becomes bevel (the angle is 65 degree) than course direct approach and therefore less scouring. To compare the spur dike angle of the wall on the scouring depth slope. The results show that scouring hole dimensions as well as maximum scour depth by reducing the angle of the wall, reduced and the slope of the wall reduces scouring depth around the spur dike.

**Fr = 0.283**

**Fr = 0.330**

**Fr = 0.383**
Fig. 4: Longitudinal profile scouring the headland spur dike in front of the body at different angles

Conclusion:
1. The maximum scouring depth in all spur dikes can be seen in upstream and near the prow spur dike.
2. The minimum and maximum scouring occurs in angle of 65 degree and 90 degree.
3. With increasing angle of the spur dike wall, the sedimentation elongation and progressive increases downstream, so that occurs least it at 65 degree angle wall and most at 90 degree.
4. Most of percentage reduction in scouring depth of spur dike wall was at an angle of 65 degree and it was 60%.

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