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Roughness Effect of Spur Dykes on Scour

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Abstract—*Spur dykes are typical man-made hydraulic structures and widely used in alluvial rivers to defend the effects for disaster reduction and river restoration. Spur dykes are generally built perpendicular or at an angle to the channel bank, to protect the channel bank against scouring. Spur dykes give impacts on the flow and bed load dynamics around itself and creates variation of flow pattern and bottom profile according to the relationship between the flow characteristics and bed configurations. In this paper we check the roughness of spur dykes on scour by varying parameters like contraction ratio, angles, velocity and D_{50}. This paper also include the comparison graph between velocity and scour depth.*

Keywords*: scour depth, spur dykes, contraction ratio, D_{50}*

INTRODUCTION:

Spur dykes are typical man-made hydraulic structures and widely used in alluvial rivers to defend the effects of disaster reduction and river restoration. Spur dykes are used to protect river banks from erosion and also keep the main channel navigable. It generally built perpendicular or at an angle to the channel bank or revetment, protruding into the watercourse. Spur dikes have been widely used to redirect the flow in channels and to protect eroding stream banks. They also used to enhance aquatic habitats by causing stable pools in unstable, distributed streams Klingeman, P.C. et al (1984). Spur dykes are classified in two types according to its structure, impermeable and permeable. An impermeable spur dyke blocks and defects the river flow, while a permeable one allows water to pass through it at a reduced velocity.

Spur dykes may be classified as attracting, deflecting or repelling spur dykes according to their inclination, shown in fig1.An attracting spur dyke points downstream and attracts the flow towards its head and thus to the bank. In contrast, a repelling spur dyke inclines in upstream direction and diverts the flow away from itself. The spur dyke normal to the flow is a deflecting one. It diverts the flow at its head and results in a wake zone behind it. Spur dykes are designed in many shapes mainly in terms of shape of head like mole-head, L-head, T-head or hockey-shaped shown in fig. 2.

Figure 1: Shows attracting, deflecting and repelling spur dykes respectively from left.

Figure 2: shows different shapes of spur dykes.

OBJECTIVES AND AIMS OF PRESENT STUDY:

This study investigate the effect of roughness on local scour depth and extant of the scour hole around spur dykes by using the parameters like contraction ratio, velocity, roughness and angle of inclination of the structure. We were also investigate and done comparison of followings:

- To study the scour around spur dykes and effect of constriction ratio.
- The effect of alignment of spur dykes on scour depth geometry and depth around spur dykes.
- To study the effect of roughness on local scour depth and extant of the scour hole around spur dykes.

Experimental Set-up

The experimental work was performed at hydraulics laboratory, National Institute of Technology Kurukshetra Harayana(India). A re-circulating flume of 15m long, 0.65m wide and .85m height was used. The bed material used were sand(having d_{50}= 0.26mm). The flume was provided with transparent glass on both side of the channel to view the flow conditions and flow mechanisms inside the channel. Scour depth measured the downstream of the channel. Scour depth measured with the help of Z-shaped pointer gauge. Nine impermeable spur dykes model were used with different dimensions shown in table below.

Table 1: Dimension of Spur Dykes

Angle θ	Contraction ratio(L/B)	Width of spur(m)	Thickness (m)	Obstruction width(m)	Height of spur(m)
90	10%	0.0650	0.015	0.0650	0.60
	20%	0.1300	0.015	0.1300	0.60
	30%	0.1950	0.015	0.1950	0.60
45	10%	0.0920	0.015	0.0650	0.60
	20%	0.1838	0.015	0.1300	0.60
	30%	0.2750	0.015	0.1950	0.60
135	10%	0.0920	0.015	0.0650	0.60
	20%	0.1838	0.015	0.1300	0.60
	30%	0.2750	0.015	0.1950	0.60

Three type of contraction ratio were used i.e, 10%, 20% and 30% respectively and three angles were used 45, 90 and 135 degree. Four different types of roughness used to compare the scour depth i.e, (0.26mm, 0.62mm, 2.6mm and 7.5mm).

Figure 3: Impermeable Spur Dykes models

Test Procedure

The following procedure was conducted:

The spur-dikes model was placed and fixed well to prevent any movement due to flow.

The bed material was leveled well so that all points of the bed had the same elevation.

A tail gate was kept temporarily closed until flume was filled up in a very low discharge to avoid any disturbance for the bed elevation.

The required discharge was allowed to flow gradually until it reaches a constant height in the channel.

The tail gate was lifted up gradually until it reaches the required water depth, then starts time of run is recorded.

As soon as the run time was over, the flow has been stopped then the water was drained slowly in order to prevent sediment movement. When the channel was dried, the measurement was recorded.

Flow Condition

The flow was uniform during the experiment. The waves generated at the inlet was removed by inducing the smooth curve at the entry of the flow. Further experiments were carried out at incipient velocity for clear water depth as well as live bed conditions by increasing the velocity of the flow.

Contraction Ratio: Experiments were performed at different contraction ratio (b/B), where b is the length of spur dykes and B is the width of the channel.

Experiment Duration: Each experiment was conducted for three hours assuming it an equilibrium scour depth by referring many research papers.

Experimental Result

By experimental study it was concluded that the scour depth varied with the flow condition as follows:

The results shows that the scour depth was decreases at 90 degree as compared to 45 and 135 degree.

The effect of roughness decreases the scour around the spur dykes at the same conditions (i.e, velocity, contraction ratio and angle).

It also shows that by increasing the velocity scour depth near the spur dykes increases.

Table 2: Scour depth at different velocity, C.R, and roughness

All the experimental results are shown in table 2, below:

Angle (θ)	Constriction ratio(b_s/b_c)	Velocity (m/s)	Scour hole(cm)				
			Roughness (0.00)mm	Roughness(0.26)mm	Roughness (0.62)mm	Roughness (2.6)mm	Roughness (7.5)mm
90	10%	0.155	3.60	3.56	3.53	3.48	3.40
90	20%	0.155	6.97	7.97	7.00	6.50	6.43
90	30%	0.155	7.95	7.89	7.77	7.71	7.50
90	10%	0.1458	2.55	2.61	2.37	2.32	2.54
90	20%	0.1458	6.23	5.44	5.84	5.52	4.23
90	30%	0.1458	7.11	7.05	6.86	6.78	6.62
90	10%	0.167	3.90	3.77	3.54	3.50	3.44
90	20%	0.167	7.43	6.96	6.26	6.18	6.06
90	30%	0.167	10.20	9.42	9.37	9.04	8.25

It was also observed that by increasing the contraction ratio of the channel scour depth also increased around spur dykes. In experiment three contraction ratio were used i.e, 10%, 20% and 30%.

At 10% contraction ratio scour it was observed that scour depth near spur dykes was minimum.

Experiment also shows that extent of scour depth was greater at downstream of spur dykes as compared to upstream of the section, shown in fig 4.

Figure 4: Extent of scour around spur dyke.

Conclusion

Scour experiment were conducted to investigate the characteristic of the scour depth around spur-dike installed in a straight flume, the result of these experimental test were analyzed and discussed, it shows that scour depth was minimum at 90 degree angle as compared to other angle. We also analyzed that by increasing the roughness of the spur dykes scour depth also increased.

References:

[1] Copeland, R. R.(1983) ‘‘Bank protection techniques using spur dikes.” ‘Miscellaneous Paper HL-831, U.S. Army Engineer Waterways Experiment Station, Vicksburgh, Miss.

[2] Klingeman, P. C., Kehe, S. M., and Owusu, Y. A. (1984) ‘‘Streambank erosion protection and channel scour manipulation using rockfill dikes and gabions.’’Rep. No. WRRI-98, Water Resources Research Institute, Oregon State Univ., Corvallis, Ore.

[3] Kuhnle, R. A., Alonso, C. V., and Shields, F. D. Jr. (2002). “Local scour associated with angled spur dikes.”J. Hydraul. Eng., 12812, 1087–1093

[4] Garde, R. J., Subramanya, K., and Nambudripad, K. D.(1961). ‘‘Study of scour around spur-dikes.’’ J. Hydraul. Div., Am. Soc. Civ. Eng., 87~HY6!, 23–37.

[5] Melville, B. W.(1997) ‘‘Pier and abutment scour: integrated approach.’’ J. Hydraul. Eng., 123~2!, 125–136.

[6] M.M.Ezzeldinet.all (2007) “Local Sour Around Spur Dikes” Eleventh International Water Technology Conference. IWTCH

[7] Fahmy Salah FahmyAbdelhaleem (2017): Roughened bridge piers as a scour countermeasure under clear water conditions, ISH Journal of Hydraulic Engineering, DOI: 10.1080/09715010.2017.1420498.