EXPERIMENTAL STUDY OF T-SHAPED SPUR DIKE WITH DIFFERENT INCLINATION TO MINIMIZE THE LOCAL SCOUR

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Abstract- River bank erosion is controlled through spur dikes. The River banks scouring around spur dikes is complex, especially when they are engaged in the straight position. This is due to the interaction of the spur dike's flow pattern with the vortex helical currents. Experiment findings are presented in this research that flow around a T-shaped spur dike minimize through inclination. The impact of the inclination of the spur dike with unique geometry. Experiments are carried out in a rectangular channel with a recirculating flow. The findings indicate that the minimum scour depth, as well as the volume and dimensions of the scour hole, decreases as the inclination of the T-shaped spur dike rises. The height of the ridge downstream of the spur dike grows as the length of the spur dike is increased. The highest scour depths are found at a 0^0 inclination of T-Shaped dyke. After 36 hours of experiment, showing a maximum of 58% reduction in scouring for 15^0 inclination compared spur dyke without inclination. So, the more efficient T-shaped spur dyke with inclination.

***Keywords*: Scouring, Inclination, Spur dykes, Depth, Flume, T- shape

1 Introduction

A spur dike is a river training construction that extends away out from bank into to the channel. It diverts the flow stream away from the bank, protecting the bank against erosion. Another side after construction of spur dike velocity of flow become maximum around spur dike due to this channel bed scouring occurs. The main channel's depth is increased due to the flow limitation produced by the spur dike[1]. Over the years, this purpose of spur dikes, that can provide greater defense against bed scouring, has been chosen as the primary aim of spur dike development[2]. Spur dikes are constructed at an angle to the main flow. Depends upon construction material spur dikes are made of stone, gravel, rock, earth, concrete and wood[3]. Spur dikes are constructed to maintain a bottomless, straight channel for improved navigation, and they are also helpful in preventing ice jamming. Spur dikes are of various types that can be distinguished according to their appearance, construction and action on stream flow. Depends upon design, geometry of spur dikes the most important consideration[4]. A unified theory for determining scour depth at spurs dike is still very much in early stages due to the intricacy of the scour challenges. Major scouring occurs often during floods, which feature unstable flows and, in certain cases, flow directions that are opposite to those of typical flows. Scour is caused by three-dimensional boundary-layer separation near the dyke's end, which causes bed material erosion due to the high volatility and vorticity of the local flow structure[5]. Numerous experimental studies of local dike's shear failure in alluvial streams were conducted, and researchers developed a series of prediction methods to estimate the scour depth at various spur dikes to inclination under various flow dynamics, sediment size and differentiation. Experiments were carried out to study the scouring arrangement from around spur dike at various angles relative to the flow axis. The bed failure caused by aggressiveness of flow due to which it is always have a difficult and dangerous problem for hydraulic engineers. It has been known from the previous research that the scouring has a considerable effect by the shape and inclination of spurs and the location of maximum scour depth is highly dependent on the spur dike inclination angle.

2 Experimental Procedures.

All the experiment is performed in the Water resources & Hydraulics Engineering Laboratory of Department of Civil Engineering, University of Engineering and Technology, Taxila. The channel had specifications of 20 m length, 1 m wide and 0.75 m deep glass-sided flume with an adjustable tailgate at the channel-end to regulate the flow depth used for the experimental depth. Through the centrifugal pump, discharge is supplying to the tank then inter to the main channel by aligned honeycomb diffuser in the direction of flow for smooth and uniformly distribution of flow crosswise. At the tail of channel water enter in the sediment tank after filling and trapping the flowed sediments, the flow discharges in the main channel. Plan view of the Laboratory channel and experimental setup shown in (Figure 1): Plan View of Channel A 9m long, 0.20m deep and .96m wide false bottom of uniform, medium size (d_{50}=.60mm) bed material and T-shaped spurs dyke is introduce, sand size considered in this study stood in compliance to the condition of *D/d50 > 50* in order to dominate the sediment size effect on the scour evolution process guaranteeing non ripple-forming sand (Raudkivi & Ettema, 1983) (Ettema, Melville, & Barkdoll, 1998). The thickness of the spur dykes was 10 mm which is not more than 10% of the channel width to prevent the effect of walls on scouring (Chiew and Melville, 1987). The trapezoidal broad crested weir *(TBCW)* modelled by wood material, weir width equal to the full width of channel, crest length was 50cm, the weir was 5cm above the flat bed, the sides slope of the TBCW was 1V:2H, which is more stable and seepage control. (Fritzi & Hager, 1998). The dimension of *TBCW* was within the limits (Sturm, 2001) (Henderson 1966) (Chanson, 2004).

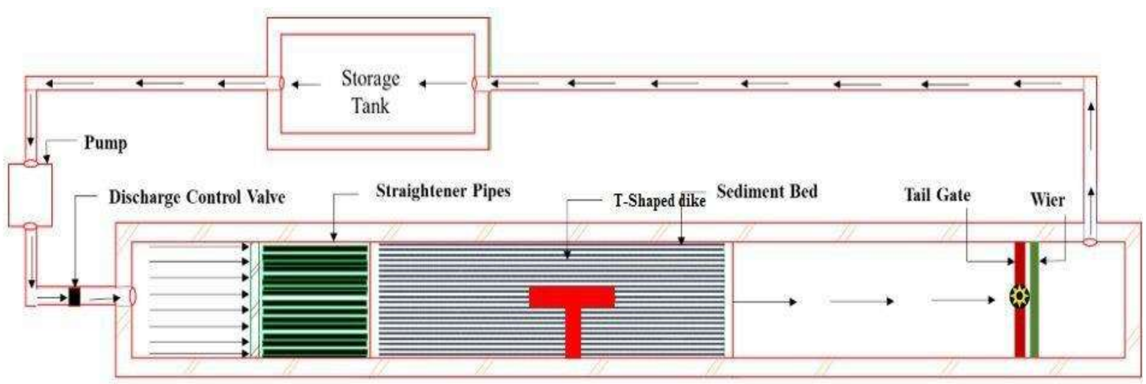

Figure 1: Plan View of Channel

3 Research Methodology

- Open channel in hydraulic lab will be used for experimental setup.
- The shape of spur dikes made of wooden will be used.
- To the evaluation of scouring around the different inclination of 0, 9, 15, spur dike will be placed in flume.
- The slope of the channel bed will be uniform and having sediments of the average diameter 0.71mm
- Scour depth will be measured around T-shaped spur dike with scour gauge or laser distance meter.

Equation:

Experimental work all were carried out in Hydraulics lab of civil engineering department, theoretical discharge equation used for measuring Discharge value.

$$Qt = 2/3Crd2\sqrt{2g}\,(b2h23/2) + 2/3Crd1\,\sqrt{2g}\,(2b1)\,h13/2 + 8/15Ctd\,\sqrt{2g}\,(\tan(\theta/2))\,h1\,e5/2$$

Where;

θ = Notch angle, b = Width of weir, Crd= Coefficient of discharge of the rectangular sharp-crested weir, Ctd= Coefficient of discharge for triangular sharp-crested weir, g = gravitational acceleration, h = Water head on the weir crest, he = Effective head

4 Results:

Table 1: Experimental Condition and Result

Dyke inclination	Q (m^3/s)	T (hr)	h (m)	ys_f (cm)	ys_ f/D
0^0	0.023	3	0.20	6.3	0.81
	0.031	3	0.20	6.8	0.83
	0.042	3	0.20	7.4	0.81
9^o	0.023	3	0.20	4.3	0.89
	0.031	3	0.20	5.0	0.95
	0.042	3	0.20	5.7	0.90
15^o	0.023	3	0.20	5.1	0.76
	0.031	3	0.20	5.6	0.75
	0.041	3	0.20	6.2	0.65

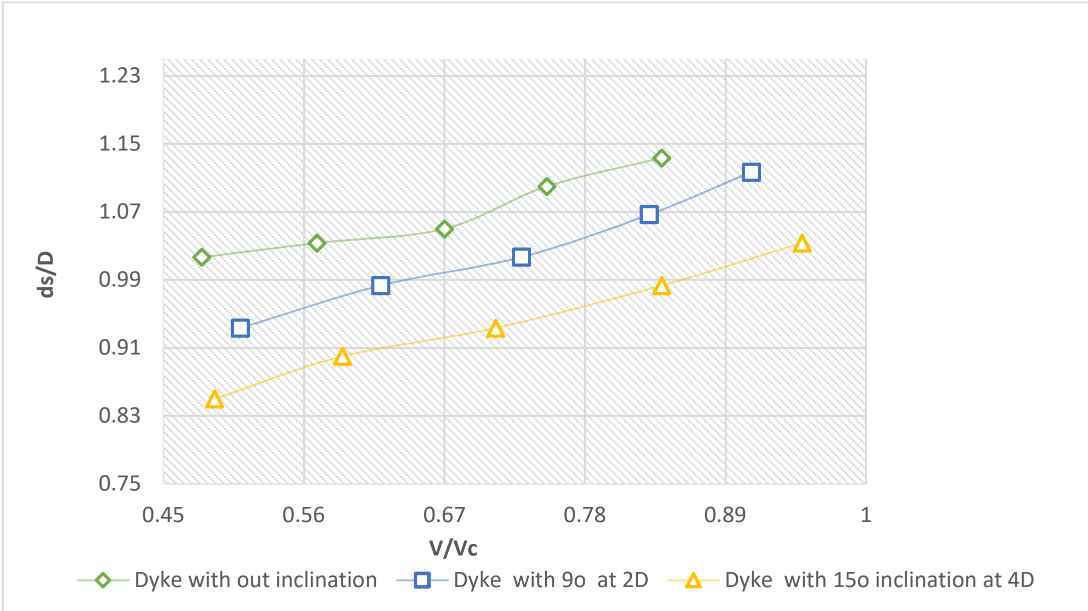

Figure 2: Relationship b/w Effective depth and effective velocity of different dyke inclination

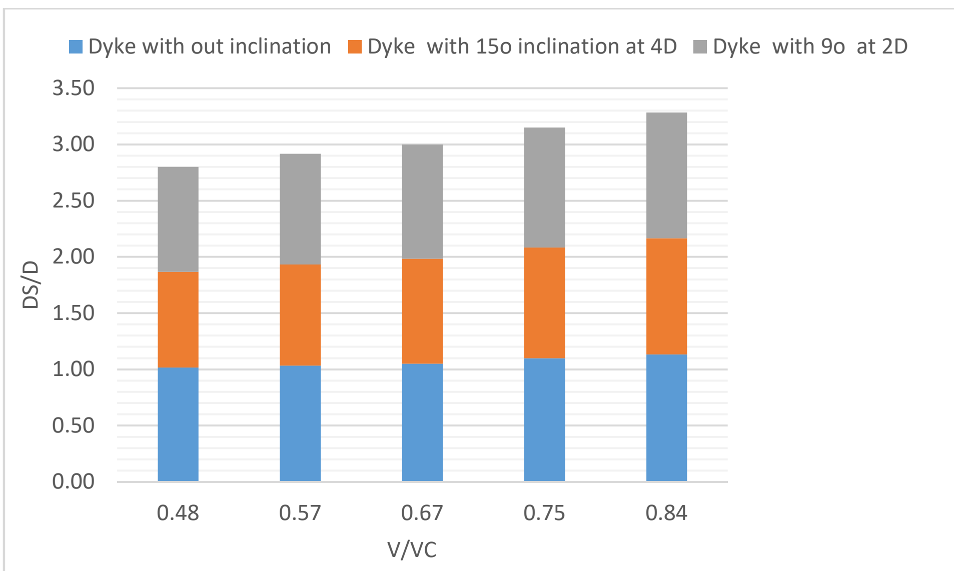

Figure 3:Scouring depth at different inclination

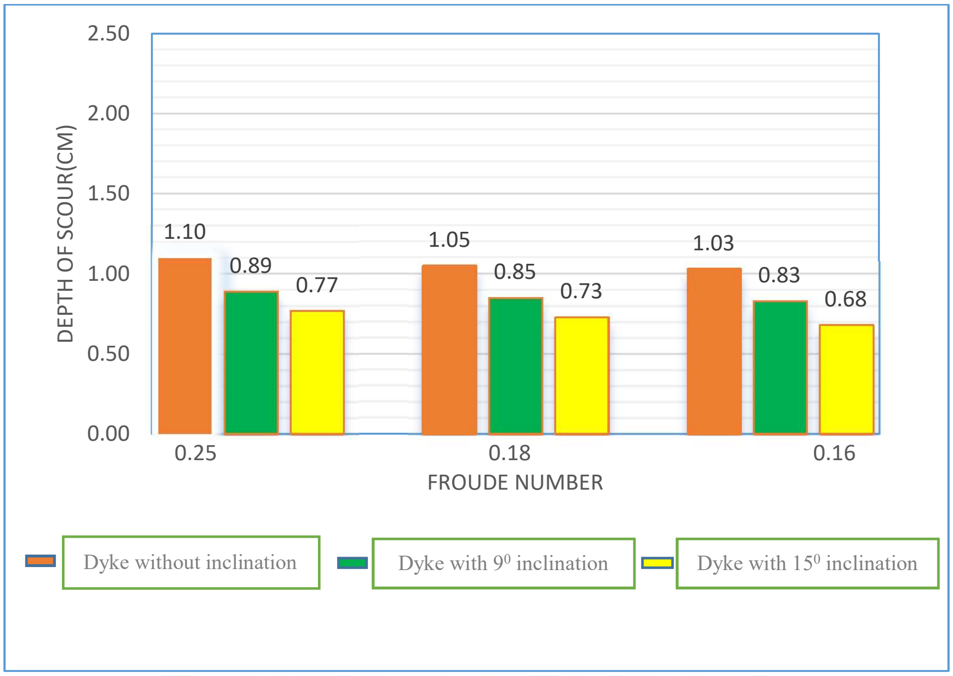

Figure 4: Relationship B/W souring depth with Froude number

Geometry and inclination of spur dike effects the local scouring of bed channel. Like (Figure 2) explain that scouring depth is maximum where spur dikes are without inclination and values of local scouring depth is minimum due to different spur dike inclination. Similarly, in (Figure 3) the relationship between the Froude number and depth of scouring with different inclination of spur dikes. Experimental work shows that spur dike local scouring is inverse relation with flow condition. The Scouring depth is minimum for spur dikes with maximum inclination for each Froude number and similarly Scouring depth is maximum for spur dikes without inclination as shown in (Figure 4). The purpose of this research is to control the channel bed scouring after construction of T-shaped spur dike with different inclination.

5 Conclusion

In this work, the efficiency of T-shaped spur dykes studied with different inclination by experimentally dykes placed in an open channel.

The following conclusions were drawn from this experimental work

1. Scouring depth decreases with the use of T-shaped spur dykes with inclination
2. The scouring around the T-shaped spur dykes with inclination decreased with increasing the discharge in channel.
3. The T-shaped spur dykes with 15^0 inclinations is most efficient that's reduced scouring up to 58% as compared to without inclination spur dyke.

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