EXPERIMENTAL STUDY OF BRIDGE PIERS OF DIFFERENT SHAPE SURROUNDED BY MESH WIRE TO MINIMIZE THE LOCAL SCOUR

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Abstract -It is the local scour that is causing the most serious damage to the bridge. One of the most important considerations in pier design is how to minimize scouring. The experimental decrease of scouring around various kinds of bridge piers using mesh wire is investigated in this paper. There are many kinds of mesh wires that are put above the streambed level around the piers of bridges to decrease scouring. Using mesh wire to around the circular pier gave us the finest results. Compared to conventional bridge piers, scouring on the circular pier with mesh wire was reduced by up to 52% after 48 hours of testing. In comparison to square and rectangular bridge piers with mesh wire, the scouring on circular and square bridge piers was reduced by 52% each. This means that the most effective mesh wire bridge pier is a circular bridge pier.

Keywords: Scouring; mesh wire; Rectangular Bridge Pier; Scour Reduction, Piers

Introduction

Small scour holes around bridge piers are inevitable in alluvial channel beds exposed to the erosive action of approaching river flows. Bridges that span alluvial channels need to be designed and built with a knowledge of the maximum scour depth that may occur near the piers over the expected lifetime of the bridge [1]. Scour depth at piers is still in its infancy because of the intricacy of the scour challenges. Floods, with their unpredictable and even counter-flowing flows, are ideal conditions for major scouring. The local flow structure, which has a high degree of volatility and vorticity, causes bed material erosion, resulting in scour, which is caused by a three-dimensional boundary-layer separation at the pier. Researchers have been studying scouring at bridge piers for some years now. Alluvial channel scour has been studied extensively, and researchers have developed a set of prediction equations to estimate the maximum scour depth at bridge piers under diverse approach flow, sediment size and gradation, and pier type and size situations. [2]. It takes time for the hydrodynamic forces in the scour hole to no longer remove particles from the pier scour hole, which is why it persists for a long period. When the scour hole achieves this equilibrium, the scour depth does not fluctuate much until the flow conditions or bed material changes. The purpose of this paper to minimize the scouring around the different shapes of bridge piers by placing the mesh wire at the bottom of piers on the bed of the ground [3]. however, the aim of this research is to investigate the scouring around the different shapes of piers using the mesh wire and compare their results in reduction of the scouring.

Experimental Procedures

All the experiment was 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 was supplied 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}=.51mm) bed material and pier base was 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 [4]. The diameter of the pier was not more than 10% of the channel width to prevent the effect of walls on scouring [5]. therefore double square pier modelled by 0.06m dimension of wood material. 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 slopes of the TBCW was 1V:2H, which is more stable and seepage control [6] The dimension of *TBCW* was within the limits [7]. The mesh wire of size 0.5" X 0.5" is used in addition to the foundation which is placed at ground level of the bed to encounter the scouring.

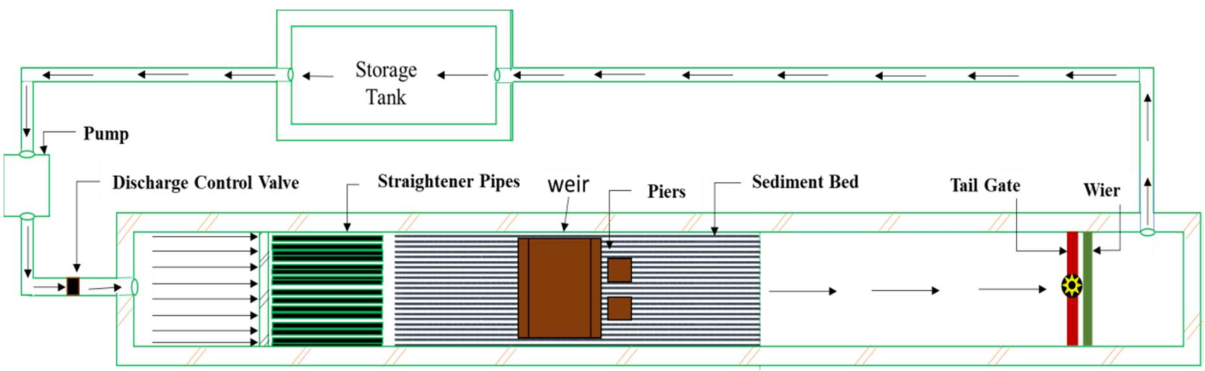

Fig 1: Plan View of Channel

Research Methodology

- The experimental setup took place in the hydraulic lab's open channel.
- Wooden bridge piers of all shapes and sizes are used.
- Square mild steel wire mesh of size: 0.5" X 0.5" & Diameter 1.2mm is used at the bottom of bed of different shapes of bridge piers of size 6"x6" after scaling down.
- A flume is used to test the effectiveness of scouring on various pier configurations.
- Each inclined bridge pier's scour depth is recorded.
- used to determine distance and/or surface roughness

1.1 Equation

Clear water conditions were used for all the trials. The following equation should be used to calculate the discharge value.

$$Q = \frac{2}{3} C_{rd2}\sqrt{2g}\, b_2 h_2^{3/2} + \frac{2}{3} C_{rd1}\sqrt{2g}\,(2b_1) h_1^{3/2} + \frac{8}{15} C_{td}\sqrt{2g}\tan\left(\theta/2\right) h_{1e}^{5/2}$$

Alternately, we may say that b is the width of the weir and the angle of the notch. Discharge coefficient for rectangular sharp-crested weirs and triangular sharp-crested weirs, respectively. Weir crest water head (h), effective head (he), and gravitational acceleration (g) are all measured in feet.

Results

Table 1: Experimental Condition and Result

Case	Pier Shape	Q (m^3/s)	T (hr)	h (m)	ys_f (cm)	ys_ f/D
1	Circular Pier with mesh wire	0.020	2	0.15	6.3	0.75
2		0.029	2	0.15	6.8	0.78
3		0.038	2	0.15	7.4	0.81
4	Square Piers with mesh wire	0.020	2	0.15	4.3	0.88
5		0.029	2	0.15	5.0	0.9
6		0.038	2	0.15	5.7	0.933333
7	Rectangular piers with mesh wire	0.020	2	0.15	5.1	1.03
8		0.029	2	0.15	5.6	1.09
9		0.038	2	0.15	6.2	1.12

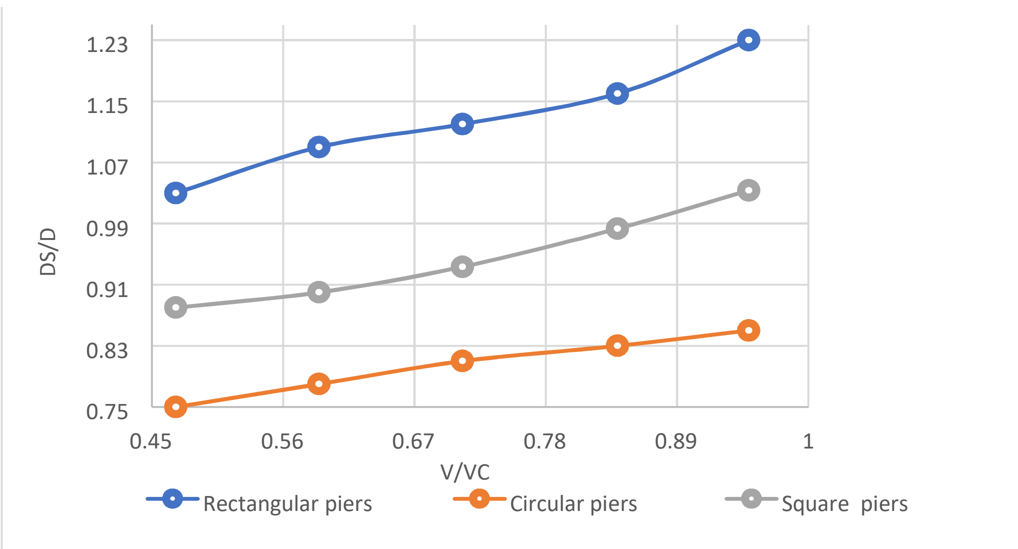

Figure 1: Relationship b/w Effective depth and effective velocity of different piers with mesh wire

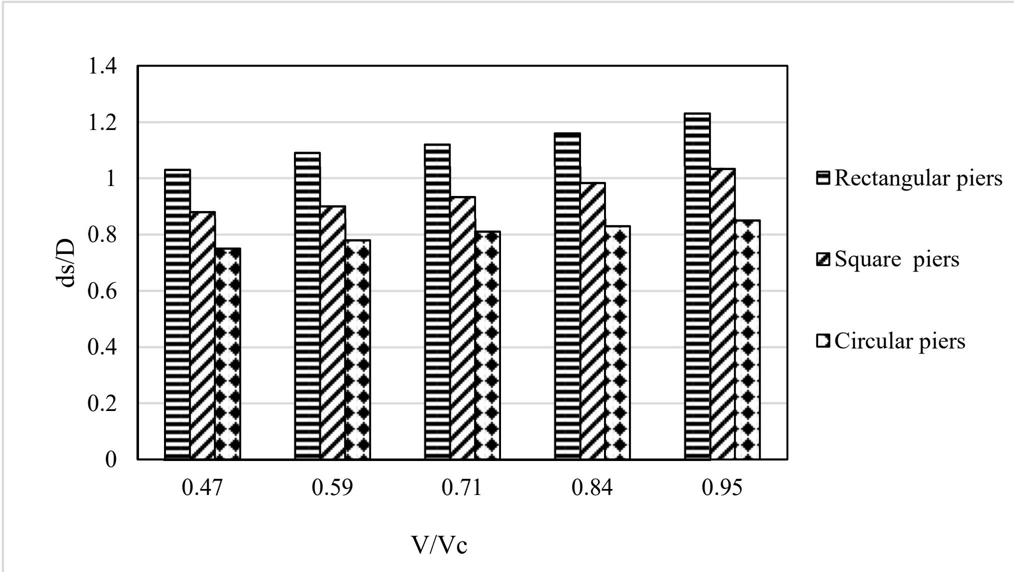

Fig 2: Scouring depth near the different shapes of Piers with mesh wire

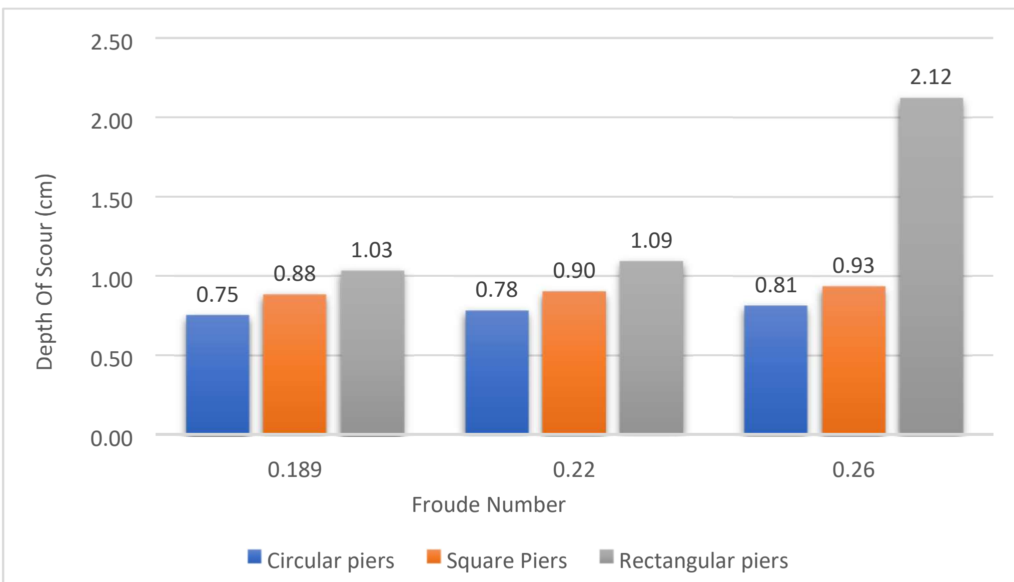

Fig 3: Relationship B/W souring depth with Froud number using different shapes of bridge piers with mesh wire

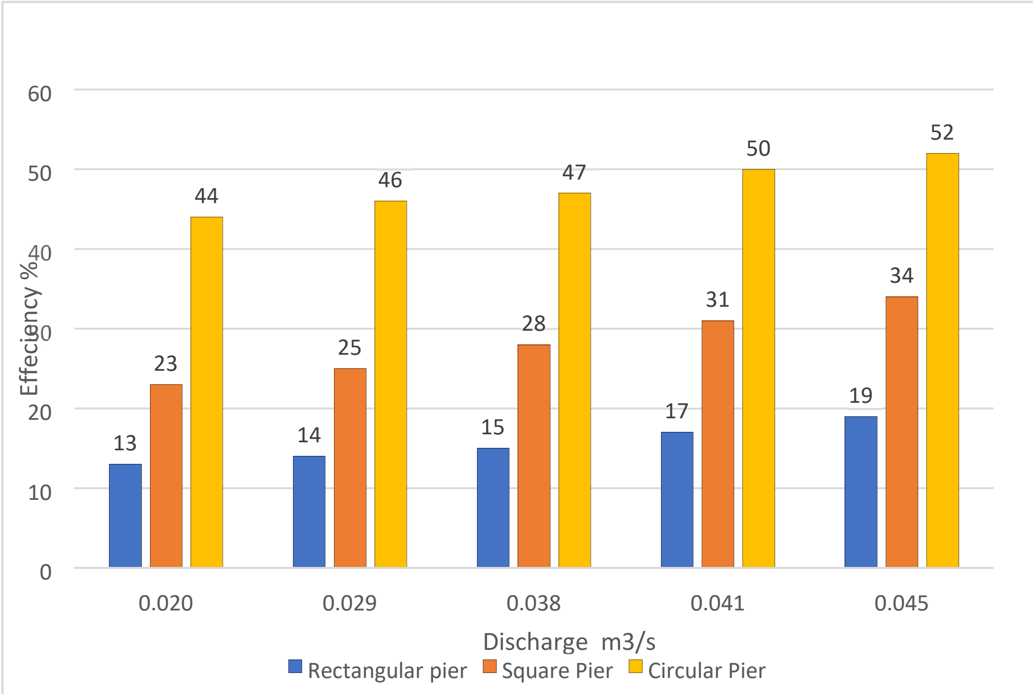

Fig4: Relation b/w efficiency % and Discharge with mesh wire

Table 1: shows the Experimental Condition and carried out in lab with different shapes of piers (Rectangular, Square, Circular) with mesh wire at the three different discharges *Fig* 1 and Fig 2 shows the scouring around the different shapes of piers it shows that the effective velocity increases the scouring depth around the piers increased. The scouring depth is maximum for the rectangular shapes bridge piers i.e., 1.12 and minimum for the circular shapes piers i.e.,0.75
Fig 3 Shows the relationship between the Froud number and depth of scouring of different shapes of bridge piers with mesh wire shows that as the Froud number increased the scouring depth around the bridge piers increased mean Froud number has the directly relation with Scouring depth. From this Fig 3 we noted that the Scouring depth is minimum i.e., 0.81 for circular shape pier for each Froud number and Scouring depth is maximum i.e., 2.12 for rectangular shaped pier for each Froud number. Fig 4 Shows that the percentage reduction in scouring is maximum for the circular pier with mesh wire i.e., 52% and for the square pier with mesh wire is 34% and for the rectangular pier with mesh wire is 25%. Hence the most efficient pier with mesh wire is circular pier. Scouring can be minimized by using mesh wire for circular pier.

It's far expected that the research carried out in this research will contribute to the development of opportunity substances in successfully reducing bridge pier scour. There's big ability for this subject matter to end up value effective and sustainable even as also being completely operational. It's far predicted that the varying parameters used inside the checking out will immediately make contributions to the reduction or enhancement of a scour hollow across the bridge pier. Wire mesh technique can be employed in bridge piers like the gabion wall used for protection.

Conclusion

An open channel experiment was used to test the effectiveness of various bridge pier forms utilizing mesh wires in this study.

1. Based on the results of this experiment, the following conclusions were drawn:
2. A reduction in the scouring depth is achieved by using mesh wire around the different shaped piers.
3. Increasing the channel discharge minimized scouring using mesh wire around different-shaped bridge piers.
4. Rectangular Bridge pier with mesh wire at the bed level outperformed all other types of bridge piers, with a 52 percent efficiency rating. With the round bridge pier, the scouring is decreased by up to 52% compared to the traditional bridge-piers.

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