STUDY & MEASUREMENT OF SCOUR AROUND BRIDGE PIERS USING SLOTS

Bhagyashri Mahakalkar[1], Kartik Billore[2], Bhagyashri Surkar[3]

(Civil department, K.D.K. College of Engineering, Nagpur)

ABSTRACT:-Erosion and transporting the separated bed materials by flow is called scouring. One of the main reasons for destruction of bridges, especially in flood events, is the local scouring around the bridge piers. Depth of local scouring around the bridge piers plays an important role to design the bridges against this destructive phenomenon. The present study examines, through laboratory experiments, the effectiveness of slots in the protection of bridge piers against local scour. The slots having different shape of different dimension and distance from the bed were experimentally studied. The experiments were conducted using different type of slots for same water flow condition.

Key word: Scour, Pier, Slot

1. INTRODUCTION

Many factors can lead to river bridges failure such as overtopping, structural failure, debris accumulation, embankment erosion and scoring. Statistics and information obtained in some countries show that scouring is the most important factor in the destruction of bridges. Pier scouring occurs when rapid water flows wash always big amount of soil materials adjacent to bridge piers and this can inn turn results in the destruction of the structure[1]. Scour is the depression left when sediment is washed away from bottom of river. Scouring is defined as erosion of stream bed around any obstruction in flow field. “Man who overlooks the water under bridge will find

the bridge underwater”. This anonymous citation highlights the detrimental effects that river flow can have on the stability of piers and abutments that support a bridge founded in river. The main cause of concern in stability of bridges founded in river-beds is the lowering of river –bed level caused by river flow around bridge elements such as piers, abutments and spur dikes and is termed ‘local scour’. An accurate estimation of scour depth below stream-bed during design is important since this determine the foundation levels of the bridge elements such as pier, abutment, guide bank, spur, etc. The depth of scour below the river-bed level around bridge elements in alluvial streams can be very large depending on flow, pier and sediment characteristics. The foundations of bridge piers should therefore have a great depth below the river-bed (up to 50m) in case of large rivers like the Ganga and the Brahmaputra. Considerable cost would be saved in the construction of bridge foundations if the maximum scour depth is realistically estimated during design.

2. PREVIOUS STUDY

The problem of scour around an isolated pier has been extensively studied and also documented by several investigators like Garde and Kothyari (1989), Shatirah Akib, Afshin Jahangirzadeh, Hossein Basser (2014) Talebbeydokti and M. Asadi Aghabolaghi (2006), A. M. Negm, Gmal M. Monstafa, Yasser M. Abdalla and Amira A. Fathy (2009), describe the phenomenon of scour around the bridge piers in and then enumerate the methods for its prediction. The scour data from prototype bridges are analysed to comments on the relative accuracy of four methods of scour prediction brief comments are made on scour around bridge piers in a clayey bed and gravel bed rivers.El-Razek, El-Motaleb and Bayoumy (2003) showed the openings reduce the maximum depth of scour. Talebbeydokht and Aghbolaghi (2005) show that for wide piers, computed scour depth is more than a measured one; the reason lies in the fact that many equations have been established based on small pier width in laboratory flumes.UmeshKotthyari (2007) describes the limitation of Lacey-Inglis method become apparent when compared with other method in the up to of principal of river hydraulics. Guney, Aksoy and Bombar (2011) reflect the sequence of experiments planned to investigate the evolution of local scours around bridge piers which affect life time and effective service of the bridges. Ackress and Kirby (2002), their objective of the project was to produce a guidance document for engineers engaged in the design, construction and maintenance of structures in the water environment that may be subject to the scour of erodible beds or banks.

This paper examines, through laboratory experiments, the effectiveness of slots in the protection of bridge piers against local scour.

3. EXPERIMENTAL SETUP

A laboratory setup was made to measure scour around the bridge piers. The experiment was conducted in circulating flume as shown in fig.1. The flume had a length of 234.84 cm, a width of 60 cm and depth 152.4 cm. Sand bed in the flume was of 188 cm long and 60 cm wide. The sump measured about 188cm long, 60cm wide, and 49cm depth. The water from the sump was pumped out and was circulated over the flume throughout the entire experiment. Sand of Kanhan River was used as the bed material. Sand was sieved using 4.75 micron sieve and was then laid on the bed of the flume. Bed layer of sand was laid for a depth of 12cm.Black stone having dimension 20mm were kept between two baffle walls to dissipate the energy and to reduce the turbulence in the flow of water and to make the flow steady and laminar. Flume and sump were made up of GI sheet of thickness 0.6 mm as per the design. The pump used was a 0.5 hp low head and high discharge pump running on a single phase and on220 v. A notch used for the measurement of discharge was of rectangular type. The material of the notch was brass and pre-configured and predetermined coefficient of discharge. The dimension of the notch was 5 cm x 12 cm. The discharge was measured over the notch.

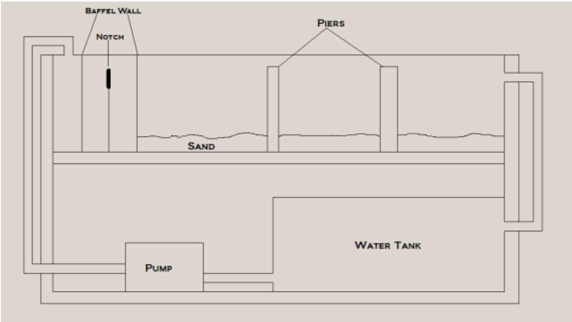


Fig. 1 Section of flume

4. DETERMINATION OF SCOUR DEPTH AROUND BRIDGE PIER

Bridge piers of sizes 7.5 cm and 11 cm were used for preliminary investigation regarding scour depth. Scour for 7.5 cm was more as compared to the bigger one. Hence detailed study need to be done by providing various slots in the pier.

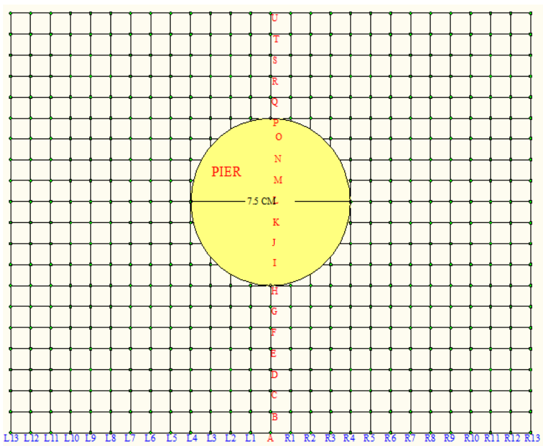


Fig. 2 Observation pattern and pattern for reading for depth of scour

A, B, C, D… J,K,L	Reference points on upstream side
M, N…. Q,R.	Reference points on downstream side
L1,L2,L3…….L11,L12,L13	Left hand side reading
R1,R2,R3…….R10,R11,R12	Right hand side reading

5. ANALYSIS

I. Sieve Analysis

Sieve analysis of 2000gm sand of Kanhan River is done in soil mechanics lab. Sieving had done using mechanical sieve shaker machine and different type of sieve size, time of mechanical sieving was 10minute. Following is analysis of sand. After the sieve analysis we used the sand for experiment for sand bed depth 12 cm for the cases.

Sieve Analysis of sand of Kanhan River

Sieve size	Retained weight (gm)	Cumulative weight (gm)	Percentage retained	Percentage passing
4.75mm	17.5	17.5	0.875	99.125
2.36mm	128.25	145.75	7.2875	92.713
1.18mm	185	330.75	16.54	83.46
600u	597	927.75	46.39	53.61
300u	930	1857.75	92.88	7.12
150u	125	1982.75	99.14	0.86
75u	11.25	1994	99.7	0.3
Pan	6	2000	100	0
Total	2000			

From this analysis it is found that sand used in this project is medium sand.

II. Determination of specific gravity of sand

1. We take empty weight of picnometer(w1) =533gm
2. Weight of sand +picnometer (w2)=1033gm
3. Weight of sand+picnometer+water(w3) =1810gm
4. Weight of picnometer +water(w4) =1495gm

$$G = (w_2-w_1) / (w_2-w_1)-(w_3-w_4)$$

G=2.68

III. Determination of the flow discharge

1. We take depth of fluid in container(h) =180mm
2. Time recorded for it(t) =3sec
3. Diameter of container =172mm
4. Area of container =0.0232m^2
5. Actual discharge Qact = V/ t

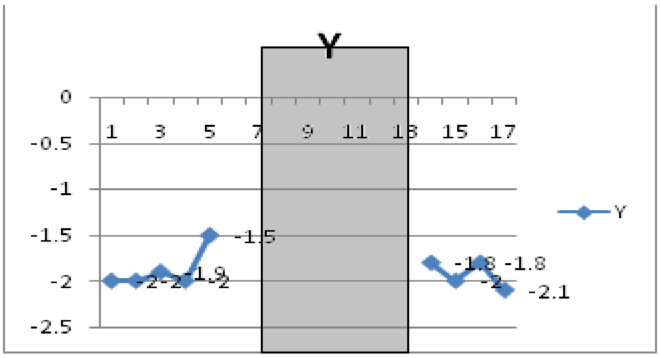
Volume (V) = Axh = 0.0232*0.180 = 0.00418m^3

Qact = 0.00418/3.2 = 1.3×10^{-3}

Actual discharge (Qact) = 0.0013 m^3/sec

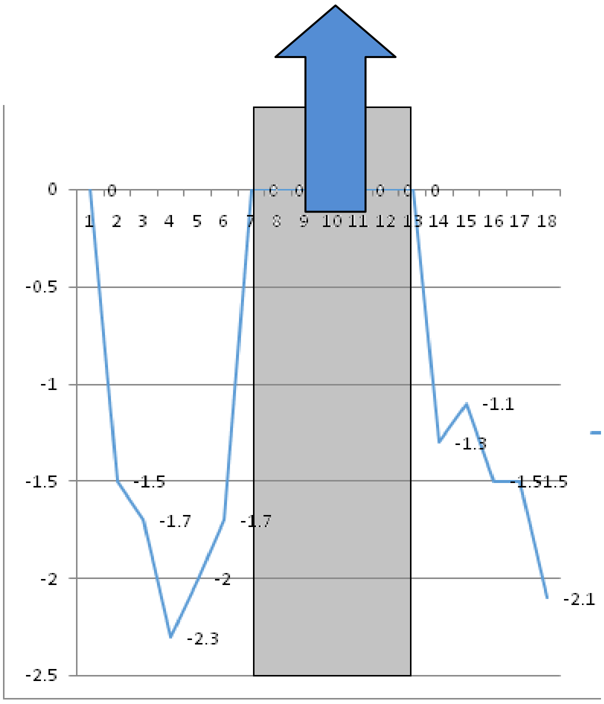
Condition 1: Circular pier without slots

For circular pier without opening plotted the section along Y-Y axis and along X-X axis shown in Fig. 9 and fig. 10. These graphs are plotted for the bed depth 15 cm and pier diameter of 7.5 cm. Maximum scour along the X-X axis was found 4.0 cm and along Y-Y axis it was 3.7 cm and minimum scour depth along the X-X axis was 0.2 cm and along Y-Y axis 0.4 cm.



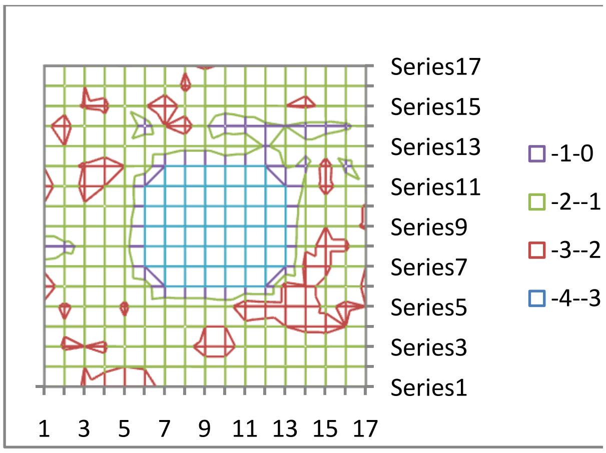
graph1. Grid point

Scour depth along YY axis



graph 2. Local scour

Scour depth along XX axis



Graph 3 Contour Graph

CONCLUSION:

Maximum scour in case of solid pier is found to be 4cm.further results of different cases are in process.

REFERENCES:

1. Kothyari U. C. 2003 Bridge pier scour in gravel – cobble and cohesive bed rivers, Report submitted to the IRC – sub-committee to review the aspects of scour around bridge foundations.

2. Kothyari U. C. June 2007, “Indian practice on estimation of scour around bridge piers – A comment Sadhana, Vol. 32, Part 3, pp. 187 – 197.

3. N. Talebbeydokhti and M. AsadiAghbolaghi“ Investigation of scour depth at bridge piers using bri-stars model”. April 30, 2005; final revised from November 5, 2005

4. Abd El- Razek M, Abd El-Motaleb M, and Bayoumy M, “Scour reduction around bridge piers using internal opening through piers”. Pp,241-248

5. R W P May, J C Ackers and A M Kirby, “Manual on scour at bridge and other hydraulics structure” criteria 551 2002

6. Dr. B. C. Punmia 2005, “Soil mechanics and foundation”, page no. 41-43.

7. EmanueleDefanti, Giancarlo Di Pasquale and DavidePoggi“ An experimental studies of scour at bridge piers: collars as a countermeasure” Dipartimento di Idraulica, TrasportiedInfrastruttureCivili, Politecnico di Torino, ITALY.

8. M.S. Guney, A.O. Aksoy and G. Bombar “Experimental study of local scour versus time around circular bridge pier” 6th International Advanced Technologies Symposium (IATS’11), 16-18 May 2011, Elazig, Turkey. pp 135 to 137

9. Thamer Ahmed Mohamed, MegatJohari M. M. Noor, Abdul Halim Ghazali and Bujang B. K. Huat, “Validation of Some

Bridge Pier Scour Formulae Using Field and Laboratory Data”. 2005