International Journal of Research in Engineering, Science and Management
Volume-2, Issue-6, June-2019
www.ijresm.com | ISSN (Online): 2581-5792


# Simulation of Scour Around Bridge Pier

Akshay Bansode[1], Sarika Turkane[2], Rahul Udage[3], Vinayak Khadke[4]
[1,2,3,4]*B.E. Student, Dept. of Civil Engg., G. H. Raisoni Institute of Engineering and Technology, Pune, India*

***Abstract*: In this study, the effect of local scour at a bridge pier is presented for different flow parameters. The adoption of a countermeasure is based on the concept that its existence will sufficiently inhabit and/or deflect the local scour mechanisms so as to reduce the local scour immediately adjacent to the pier. The overall objective of the research is to study the temporal development of scour around a bridge pier in an alluvial channel. The selection of the pier width and shape can help in the reduction of the local scour depth in an appreciable manner. In this study Hydrological Engineering Centre River Analysis System (HEC-RAS) Software is used to evaluate local scour around bridge pier of various shapes.**

***Keywords*: Local scour, pier shape, scouring, scour depth, HEC-RAS**

## 1. Introduction

Scouring is the natural phenomenon of occurs due to the different parameters such as flood, erosive action of flowing water, high velocity etc. Bridge foundation is also responsible for local scour, pier and abutment. The few year ago bridge failure due to most of the unadequately design and faulty construction. In this study hydraulic modelling for conducting simulation experiments was perform using two dimensional U.S. Army crops of Engineers Hydrological Engineering Centre River Analysis System, HEC-RAS 5.0.6 evaluate the maximum scour depth around bridge piers.

### *A. Local scour mechanism*

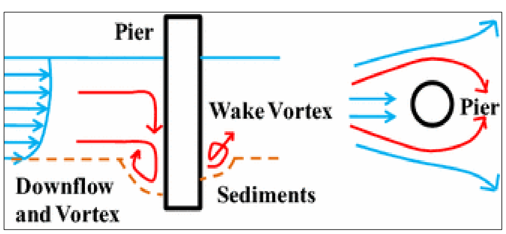



Fig. 1. Local scour mechanism

The flow decelerates as it approaches the pier coming to rest at the face of the pier. The approach flow velocity, therefore, at the stagnation point on the upstream side of the pier is reduced to zero, which result in a pressure increases at the pier face. The associated stagnation pressure are highest near the surface, where the deceleration is greatest, and decrease downwards. In other words, as the velocity is decreasing from the surface to the bed, the stagnation pressure on the face of the pier also decrease accordingly i.e. a downward pressure gradient. The pressure rising from the decrease pressure forces the flow down the face of the pier, resembling that of a vertical jet. The strength of the down flow reaches a maximum just below- the bed level.

### *B. Problem statement*

1. Scour is natural phenomenon caused by erosive action of flowing water on the bed and bank of alluvial
2. Debris can defect the water flow change in angle of attack, increasing local scour, debris can also have a substantial impact on bridge pier scour in several ways.
3. Many of the equation for scour were derived from laboratory studies, for which the range of applicability is difficult to ascertain.
4. The critical issue of the scouring decreasing life span of bridge.

### *C. Objective*

1. To identify pier shape that responses best in order to minimize scouring effect.
2. To estimate the bridge scour around the bridge pier by using HEC-RAS.

## 2. Methodology

To analysis the different shape of bridge pier in this project such as square, rounded, circular, sharp nose, group of cylinder etc. to calculate scour depth by using HEC-RAS software. The total scour at a highway crossing is comprised of three components: long-term aggradation and degradation, contraction scour and local scour at piers and abutments. Contraction scour occurs when the flow area of stream is reduced by natural contraction or a bridge constriction of the flow. The factors that affect the contraction scour are bridge Opening, road embankments, bridge abutments and bridge piers. It is based on Laursen's live bed scour equation (1960). Pier scours due to

The acceleration of flow around the pier and the formation of flow vortices are known as Horseshoe vortex (Figure 1). The factors that affect the depth of local scour at a pier are:

- Velocity of flow just upstream of the pier, depth of flow, width of pier, gradation of bed Material, shape of pier, length of pier, bed configuration and angle of attack of approach
- Flow. In the HEC-RAS model used in the present analysis, Colorado State University

- (CSU) equation for computation of pier scour under live bed condition is used.

By CSU equation (using formula):

$$ys = 2.0\ K_1\ K_2\ K_3\ K_4\ a^{0.65}\ y^{0.35}\ Fr^{0.43}$$

Where, $y_s$ = Scour depth

$K_1$ = correction factor for pier shape=1

$K_2$ = correction factor for angle of attack=1

$K_3$ & $K_4$ = correction factor for bed condition & bed material respectively= 1.1 & 0.4

a = pier width= 3m

y = flow depth = 4.33m

Fr = Frauds no. = 0.03

- By Froehlich Equation (using formula)

$$ys = 0.32\ \varphi\ (a')^{0.62}\ Y_1^{0.47}\ Fr_1^{0.22}\ D_{50}^{-0.09} + a$$

Where, $y_{s=}$ Scour depth

φ = correction factor = 0.7

a′ = projected pier width = 3

Y= flow depth = 4.33

Fr = Frouds no. = 0.004

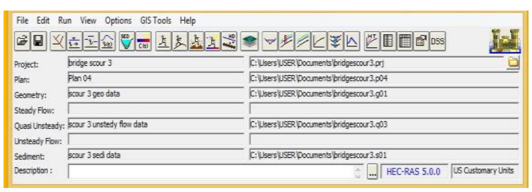
$D_{50}$ = particle size = 1.28 mm

Table 1
Pier shape and correction factor

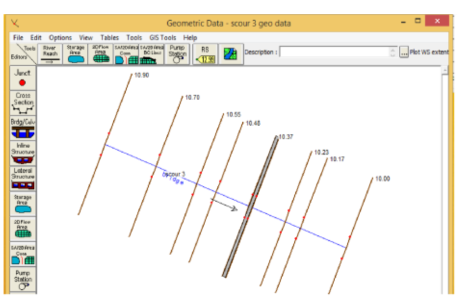
| S. No. | Pier Shape | Correction Factor for CSU Equation | Correction Factor For Froehlich Equation |
|---|---|---|---|
| 1 | Square nose | 1.1 | 1.3 |
| 2 | Circular Cylinder | 1 | 1 |
| 3 | Group of cylinder | 1 | 1 |
| 4 | Rounded nose | 1 | 1 |
| 5 | Sharp nose | 0.9 | 0.7 |

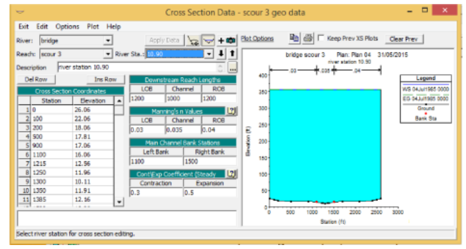
## 3. Figures

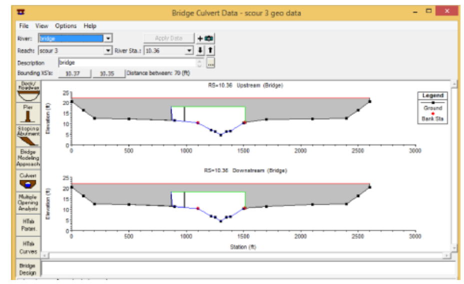
*Step 1:* Select a solver under HEC-RAS software as RAS 5.0.5.



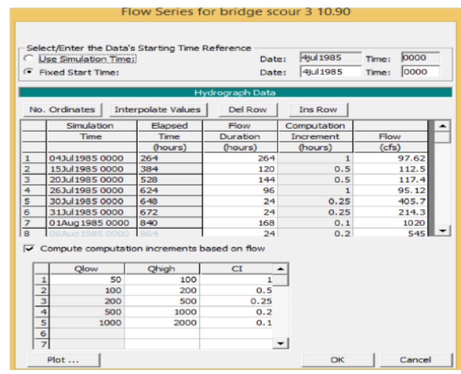
*Step 2:* Enter the geometric data which include river reach, cross sections and station elevations, bridge pier data. Save all the geometric data with name.

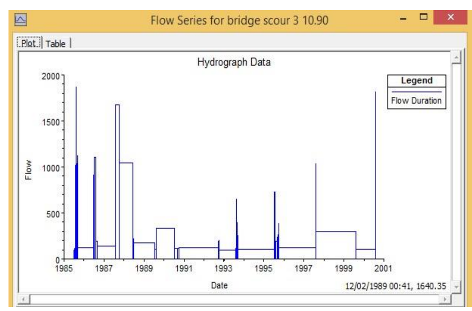


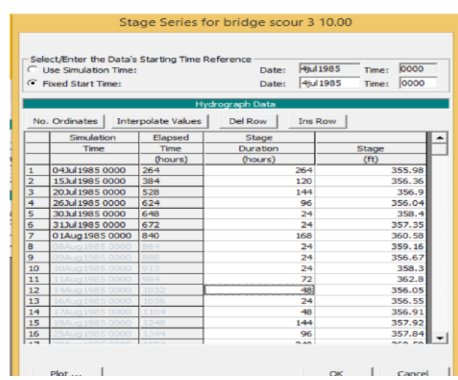


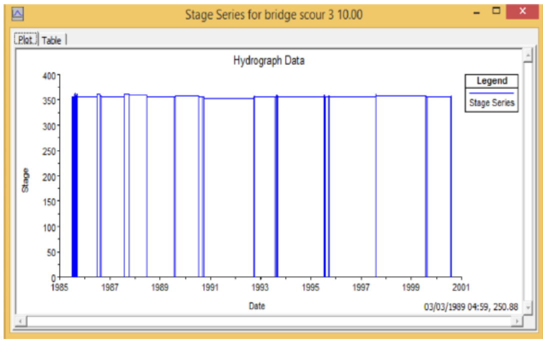


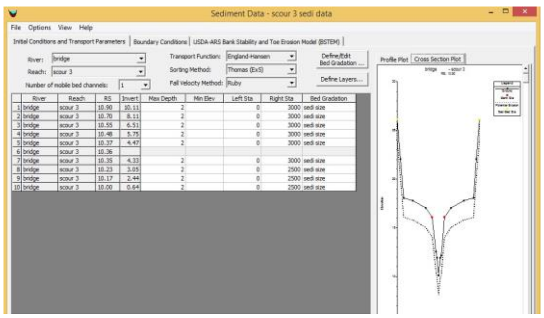
*Step 3:* Enter the flow data and save it.

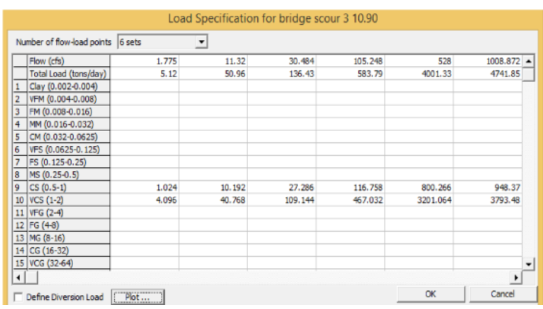






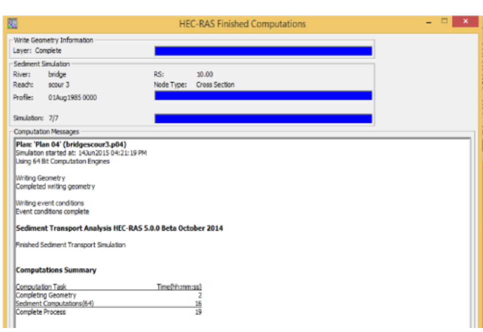


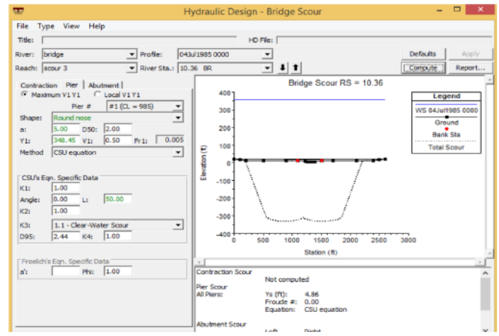



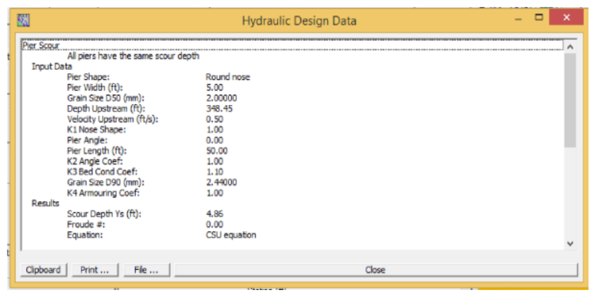


*Step 4:* Perform computations




*Step 5:* Perform hydraulic design computation




## 4. Result

Table 2
Result

| S. No. | Pier shape | Scour Depth | |
|---|---|---|---|
| | | CSU Equation | Froehlich's Equation |
| 1 | Square nose | 3.13 | 7.60 |
| 2 | Round nose | 2.84 | 6.54 |
| 3 | Circular | 2.84 | 6.54 |
| 4 | Group of Cylinder | 2.84 | 6.54 |
| 5 | Sharp nose | 2.56 | 5.48 |

## 5. Conclusion

This paper presented an overview on simulation of scour around bridge pier.

## References

[1] Kamini Bhagwat Funde, Dr. Milind Gidde, P.D. Patil, "Effect of Different Shapes of Bridge Piers to Minimize Local Scour", International Journal of Civil Engineering and Technology, Volume 9, Issue 1, January 2018, pp. 628-638.

[2] Chandan Roy "Effect of Bridge Pier Geometry on Local Scouring", International Journal of Earth Sciences and Engineering, Volume 10, Aril 2017, pp. 374-377.

[3] Mohammad Vagheei, Masoud Ghodsian and Saeid Salimi "The Effect of Circular Bridge Piers with Different Inclination Angles Toward Downstream On Scour" Indian Academy of Sciences, Volume 41, January 2016, pp. 75-86.

[4] T.I. Eldho, B.V.S. Viswanadham, B.A. Vijayasree, N. Siva Naga Venkat, Indian Institute of Technology, December 2011, Paper No. 266.

[5] Tran Dinh Nghein "current research on local scour at bridge pier in vietnam", December 2015, Volume 42.

[6] Ghulam Murtaza, Hashim Nisar Hashmi, Usman Ali Naeem, Daulat Khan and Naveed Ahmad, "Effect of Bridge Pier Shape on Scour Depth at Uniform Single Bridge Pier", Mehran University Research Journal of Engineering and Technology, Volume 37, Issue 3, July 2018, pp. 539-544.

[7] Md. Mosabbir Pasha, Aziz Hasan Mahmood, Shahriar Shams, "An Analysis of Scouring Effect On Various Shaped Bridge Piers", Brunei Darussalam Journal of Technology, vol. 7, no. 1, December 2013.
[8] P. D. Dahe, S.B. Kharode, "Evaluation of scour depth around bridge piers with various geometrical shapes", International journal of innovation research in advanced engineering, Volume 2, Issue 7, July 2015.
[9] Fatemeh Mousavi, Rasoul Daneshfaraz, "Evaluating various factor in calculation of scour depth around bridge piers using HEC-RAS software, CSU2001 and Froehlich equation", Journal of civil engineering, vol. 3, no. 6, 398-402, 2013.