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Research Article

Effective factors in investigation of scour depth of bridge lateral foundations

Hamed Nayebi[1], Mohammad Shirvani[2*] and Mahdi Kamfiroozi[3]

[1]Department of water engineering, Faculty of Technology and Engineering,
Bandar Abbas Branch, Islamic Azad University, Bandar Abbas, Iran.
[2]Sama technical and vocational training college, Islamic Azad University,
Bandar Abbas Branch, Bandar Abbas, Iran. * **Corresponding Author**
[3]Sama technical and vocational training college, Islamic Azad University,
Bandar Abbas Branch, Bandar Abbas, Iran.

ABSTRACT

Due to the extensive studies that have been carried out in estimation of scour depth, many relationships have been introduced in order to estimate of scour depth by researchers, that this relationship in general, divided into three categories: Relationships that attributingerosion depth to increase the flow rate (flow), experimental methods, which are usedin themfrom dimensional analysis of effective parameters to scour or quasi-experimental and analytical methods.Thus, for each types of general and localscour and of course, with regard the scour mechanism action should be used relationship to it. Of course, there is not a general formula that could be used to determine the erosion depth in each of the scenarios. Given that estimate the scour depth is dependent on factors such as flow hydraulic conditions, sediment characteristics, and geometrical conditions; a method that is commonly used is the creation of a relationship in the lab and using hydraulic models.

Keywords: Scour, Bridge Foundation, Scour Relations, Scour Depth, Gradation Effect

1. INTRODUCTION

Many studies have been done about the scour depth of bridge lateral foundations by researchers, and presented relationships in this field by them. This relationship can be divided into 3 categories: (1) Relationships that attributing erosion depth to increase the flow rate (flow), (2) experimental methods, which are used in them from dimensional analysis of effective parameters to scour, and (3) or quasi-experimental and analytical methods.(Barbhuiya & Dey, 2004).In the field of scour depth of bridge lateral foundations provided many empirical relationships by researchers, which can be noted such studies of (Liu et al, 1961), (Laursenm, 1963), (Froehlich, 1989), (Dey & Barbhuiya, 2004), and (Al Saadi et al, 2013), (Mohammadpour et al, 2013).Most of these relationships have been built and fitted using thedimensionless parameters. Liu(1961), to examine the scour depth of bridge lateral foundations isaction to build an experimental model. Hisattributions scour depth to the foundationlengthparameters of flow depth and Froude number.

Laursen(1963), the scour depth have been attributed to the foundation length and flow depth. In this regard, it is not considered the effect of flow rate. Froehlich(1989) also provided a relationship such as Liu(1961) and scour depth have been attributed the foundation length of the flow depth and Froude number. Also, the two parameter offoundation shape coefficient and the foundation angle coefficient included in this relation to flow.

Dey & Barbhuiya(2004),the scour depth have been attributed to flow depthparameters, foundation length, sediments diameter and critical Froude number. Also, for three different shapesfoundation of vertical, semi-circular and winged, areexpressed three separate relationships. This relationship, by a gradationcoefficient, can also consider the effect of sediment gradation.

Also in recent years, carried out extensive studies as such can be noted to study of Al Saadi et al, (2013), which pay the reviews of around bridge foundationsscour and in his study, the upstreameffect, foundation size, sediment mid-diameter, as well as the distance foundation from together and from the candles, knowing of the effective factors on the maximum depth of scour.Them in their experimental model have use of subcritical flow and clean water conditions and were used from the non-sticky non-uniform substrate materials and used three different sizes to foundation in his experiments.They are by their experimental data and statistical analysis could provide a new formula for scour. Their relationship obtained by the Froude number, size foundation, size of the bottom sediments, flow depth, flow rate and distance between foundations.

Mohammadpour et al., (2013) carried out to investigate the size and local scour temporal changes in the clean water conditions and laboratory methods. They have used multiple linear regression and genetic programming and artificial neural networks. Their results show that the neural network method is more accurate, and also important parameters in their study was includes time coefficient, coefficient of length to depth, and speed to critical speed.

2. Scour types

Generally, the scour can be divided into two categories: general and local scour.

- General scour

A) In the place which the river has not yet reached to equilibrium state and the potential for sediment transport in ranging from rivers, is more than the amount of input sediment to this period.

B) In the place which the flow rate is increased for some reason, such as the reducing the level of the river at the bridge, which in narrow section is occurs public scour.

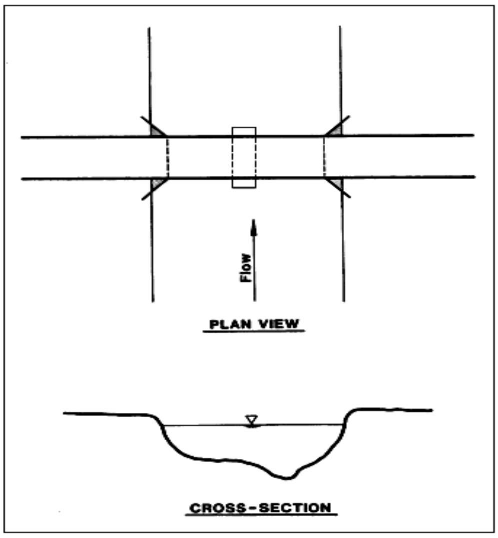

Fig1. Scour due to flow narrowing section (FHWA, 2001)

To calculate the amount of scour in effect of narrowing are also provided relationships, such that it can be noted the relationship (Laursen & Toch, 1956), which is expressed in the following way:

$$(1)\quad \frac{y_{m.e+h0}}{h0} = \frac{1}{(1-m)^{\beta}}$$

In this relation:

B_2: Narrow section width (m)

B_1: River width (m)

h_0: Flow depth in narrow section upstream (m)

$m = \frac{B_2}{B_1}$: Narrowing ratio

$y_{m.e}$: Scour depth in narrow section (m)

β : It is coefficient is varying between 0.67 and 0.80.

In that case, the flow isoverflowing of the river side's the equation (1) is as follows:

$$\frac{y_{m.e+h0}}{h0} = \frac{1}{(1-m)^{\beta}} \frac{Q}{Q-Q}$$ (2)

In this relation:

Q: Total flow

Qb: overflowing Flow

- Local scour

Local scour occurs anywhere that the intensity of turbulent flows increases locally.Local scour of hydraulic structures downstream is such as spillway, shots, gates and bridge foundations, which arise due to the local speed over the critical speed (speed threshold motion of particles). It causes can be expressed as follows:

1) Change the flow gradient and increase the speed around structures.

2) Conversionthe speed head to pressure head in flow dealeffect to structure, and as a result, direct the flow to downward. (Figure 2.2)

3) The creation of torsional flows in downstream of the foundation.

The scour depth for each of the structures depends on the flow hydraulic conditions and sediment characteristics and geometrical conditions.Estimate the scour depth; hence it is important that this phenomenon may result in damage to the structure.

There is not a general formula that could be used to determine the erosion depth in each of the scenarios.The method commonly used is the creation of relationship in the laboratory and by using hydraulic models. To obtain a hydraulic relations at the start of particle motion proposed several methods.Figure (2-2) shows foundation downstream scour. The amount of scour depth D_s, for each of the structures depends on the flow hydraulic conditions and sediment characteristics and geometrical conditions.

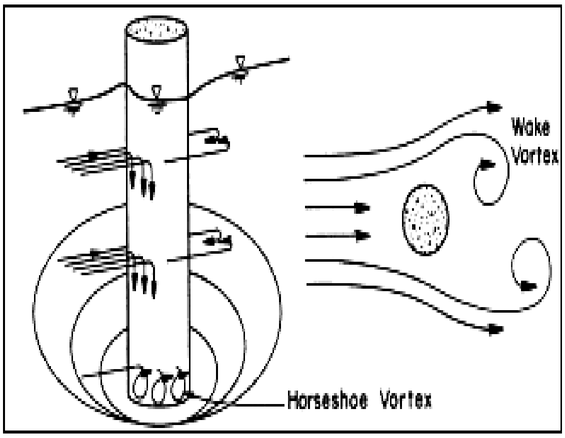

Fig2. The mechanisms of candlesfoundation local scour (Richardson, 2001)

3. Mechanisms of bridge foundation scour

Scour occurs when the foundation obstructs front of the flow. As a result the interaction of water flow and foundations is forming a horizontal vortex in the upstream, and the end of the foundation, which moves along the foundation platform, and caused creates a ring vortex in downstream of foundation. (Richardson, 2001)Flow field is complex around vertical foundations, which are in bed with loose sediment. This complexity increases with the development of the scour hole and caused creates a three-dimensional vortex at the foot of the foundation. (Barbhuiya & Dey, 2004).Horseshoe vortex in the vicinity of candles, as specified in (Figure 2-2) with flows downward, is a major cause of scour at the foundations.On the up side is developed on foundation of vertical pressure gradient, which is due to stop the flow. This pressure gradient is directed flow to downward and after hitting the floor, turn of this process caused creates the primary vortex.The magnitude of this vortex depends on the development of the scour hole. Also, is identifying a secondary vortex in the direction in opposite to the primary vortex that happens after the initial vortex.In downstream of the foundation, will arise ring vortex due to separation the flow from the corner of the foundation. These vortices compared to the primary vortex are very weak and acted like a tornado and are made up of bottom sediments. (Richardson, 2001)

4. DISCUSSION AND CONCLUSION

At construction location of bridge, breakwater or coastal wall, usually are reducing the width of the river.This action causes that increased flow rate in this range, and thus added to the sediment transport capacity, and will cause to the erosion the river bed in this place.Erosion action so continues to decline the sediment transport capacity and is equal to the capacity of sediment transport in the upstream section.In this case, erosion is stopped at this place. However, this erosion causes the reduced impact of rejection water in upstream, but because of this problem, should not be allowed to be erosion, because scour will cause serious risks, such as the loss of the bridge. Estimate the scour depth; hence it is important that this phenomenon may result in damage to the structure. There is not a general formula that could be used to determine the erosion depth in each of the scenarios.Given that estimate the scour depth depends on the flow hydraulic conditions, sediment characteristics and geometrical conditions, a method that is commonly used is the creation of a relationship in the lab and using hydraulic models.

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