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Evaluation of Scour Around Bridge Pile in Flood with Hec-Ras Software

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ABSTRACT

The maximum depth of scour around bridge foundations are the most important topics in hydraulic engineering. The effects of changes in flow rate on bridge scour around the base of the fifth Dezful Hsec-Ras were investigated with numerical models. For the first data field using a hydraulic model of the River Range Paul is in the software was created. Then use discharge in range 250 to 1850 cubic meters and investigate scour around pile of bridge. The result shows that increase was that the rates were low to moderate (329 cubic meters per second) of scouring around the base of the middle most value, but the rates and conditions of torrential amount of scour at the base right side highest value to allocated, as well as 1,630 cubic meters of flood conditions safely scour rate was lowest in the left bearing because the riverbed morphological and conditions of the secondary flow in bend is created.

KEYWORD

Hec-Ras model, change discharge, bridge pile, flood, scour.

INTRODUCTION

In recent years because of computer development, therefore sciences will developed to thus computational fluid dynamic will develop to and these method were utilized a lot. In nowadays about scouring around bridge pier many studies had been done. But these experiments are based on empirically aspect and using these equations is too risky. In our country much research had been done. A first hydraulic description of Hydraulic Characteristic of main River Branches was provided by Studies of Huang and his associates(2002).They used a three dimensional model to record the features of flow in joint area. This model at first assessed by data of Schumate (1998) in upright joint of two opencast channels, and then it used for study of impact of the changes in joint angle on flow features. Finally, there was that this 3- dimensional developed model reproduced all important Hydro – dynamic features adapted to lab Observations. So, after that, we've had: Dimensions of separation area in face were more than floor and with reduction of discharge the main fork in creased. In same conditions for greater joint angles, depth of the flow in the up of main and side channels is more. Huang and associates suggested following and using models with higher degree for more attention. Also, they assessed the degree of depth in the up of joint while ratio of main fork to all was 25% and compared them with supposed of HSU (1998) and saw that conclusions of numeric simulations fore see more measures. Hasan zadeh . [4], et al determined scouring depth with using real data with using three different methods: csu, mevill and sounderl and Larson method and finally compare. This results with optimization methods. Kamanbedast et al. [5], tried to study water banned at downstream in Karkheh River. In this research depth of water estimated empirically and compares to result of hec-ras numerical model. Thamer et al. [10] said that because of complicated phenomenon of scouring, using software such as hec-ras is very useful. Zarezadeh,et al, . [11] Showed that the result of hec-ras model on reservoir dams at keeping on the Karoon River.

THEORY

Flow algorithm and scouring mechanism around bridge pier. Flow algorithm around bridge pier is very complicated. Phenomenon .Generally, around pier, complicated vortex will be appeared and because of its function, scouring will be created. According to recent studies, two important parameters are base of erosion=1 contact of flow, to pier, two; separation between flow stream lines near blocks. Flow compact is creation horse shoe scouring type. Some scientists believe that, horse shoe scouring is very common type of scouring phenomenon on the river. Some other people though that, when stream lines faces. Pier body, one very complicated system were created, therefore flow will split from pier and rising vortex will be seen.

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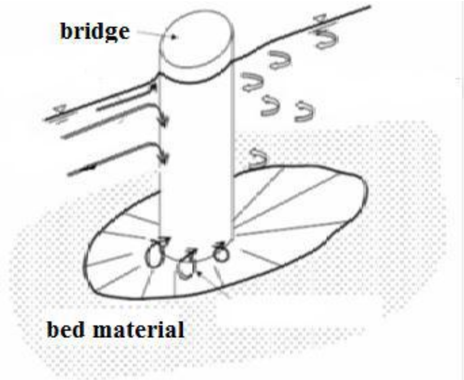

Fig.1. flow and scouring mechanism around

When stream lines faces pier noses on the pier, flow velocity increase gradually from river bed, therefore, more pressure is created on upper levels and pressure. Gradient on pier will move down ward. In the other hand a kind of down word flow regime is created normally. Down willing flow works is vertical jet and after contact one hole on the bed appeared. Some part of flow return up. Ward to surface and face to bridge repeatedly. This cycle, is known of vortex flow and will developed. Around pier and expand gradually. Shape of progress is like horse shoe and named horse shoe scouring mechanism. Vortex creation will accelerate flow. Velocity and shape of scouring expand more fluently. Around bridge, nears levels, flow are separated smoothly then special flow. Are appeared and will move upward, behavior cause. Some rise up vortex. Through stream lines flow, another vortex is named is core vortex or surface flow around pier nose are rune. Digging scouring flow will continue to all hales will be fluid and vortex energy dissipate, then. Equilibrium of scouring will be created and shown.

MATERIALS AND METHOD

Case study:

5th bridge of Dezful, is locate at upstream. Side of Dez diversion dam, (Fig. 2), this bridge has 9 pier and two noses. Height of bridge is 3 to 5.8 meter. Each pier has 45 meter distance. The dimension of bridge is 3m*0.6m and their shape is 1 rectangular.

Fig .2. view of bridge

MATERIALS AND METHODS

HYDRAULIC MODEL

In this research; hec-ras software is utilized. It is possible to inlet geometric data of Dez River to computer very easily. Then, other section of river such as; discharge and other parameters is intended to software. Cross section for study: for defining Bridge and culvert, 4 defined cross section, when are defining with energy head loss, are interfered model and used. Following pictures shows bridge cross sections.

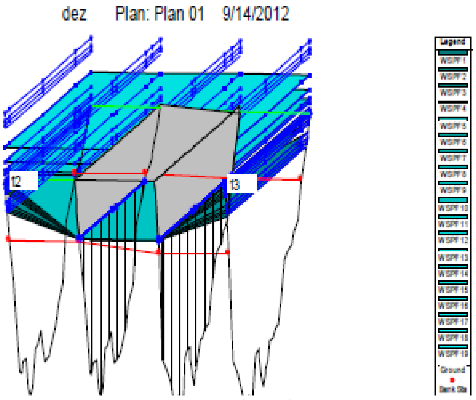

Fig.3. resisted cross section of Dezful Bridge

Useful equation in order calculating flow depth at hec-ras software in order to determine flow scouring depth all geometric data, data of real scouring, discharge with different frequencies (using csu method) are calculated very carefully. The equation when default of hec-ras is as below:

$Ys=2k_1.k_2.k_3.k_4.a.y_1.fr_1$

In which: Y_s=depth of scouring, y_1=upstream height of flow (meter), a= width of pier. Fr: upstream froude number. K_1=coefficient of pier nose shape: $0.9<k_1<1.1$ (Tab.1)

Tab.1. modifying shape of bridge pier at csu equation

(k1) modifying coefficient shape of pier nose	
Rectangular, square nose	1.1
Rectangular, curve nose	1.0
Cylinder	1.0
Sharp nose	0.9

K_2=contact angle. Coefficient: $k_2=(\cos\theta+L/a \sin\theta)^{0.65}$
L: length of flow path, θ: contact angle,
K_3= bed condition coefficient (tab .2.).
K_4= bed material reinforcement coefficient

Tab.2. modifying condition of bed at csu equation

bed condition	Dune height (m)	K_2
clean water	-	1.1
Smooth anti dune	-	1.1
Small dune	0.6<x<3	1.1-1.2
Medium dune	3<x<9	1.1-1.2
Huge dune	x≥9	1.3

More over another equation, in order calculating scoured. Depth is presented, but this equation is more useful for bank erosion phenomenon.

Ys=0.32 Ø. (a)

Ø: is pier nose shape modifying coefficient which are 0.7<Ø<1.3

a: is bank of bridge pier width.

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GEOMETRIC DATA

The basic geometric data consist of establishing the connectivity of the river system (River system schematic; cross section data; reach lengths; energy loss coefficients (friction losses, contraction and expansion losses); and stream junction information.

MANNING'S ROUGHNESS COEFFICIENT

Selection of an appropriate value for Manning's n is very significant to the accuracy of the computed water surface profiles. The value of Manning's n is highly variable and deepens on a number of factor including: surface roughness; vegetation; channel irregularities; channel alignment; scour and deposition; obstructions; size and shape of the channel; stage and discharge; seasonal changes; temperature; and suspended material and bed load [3, 6].Manning's n For Hofel and Nissan rivers 0.030 and Sableh is 0.027 are considered. And for another branches selected a suitable Manning's n.

DISCUSSION AND CONCLUCION

In this study 6flood discharge (from 450 to 1850 cms) are used. For each run software hec-ras is utilized, each effect on middle bridge. Pier, bank pier and their scouring data are studied carefully.

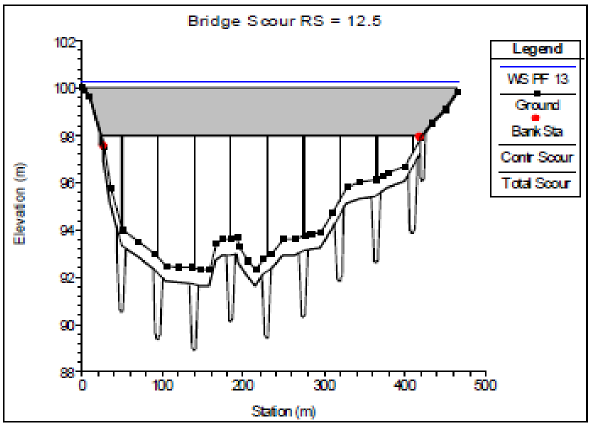

Fig.4. Scouring because of discharge, 450cms

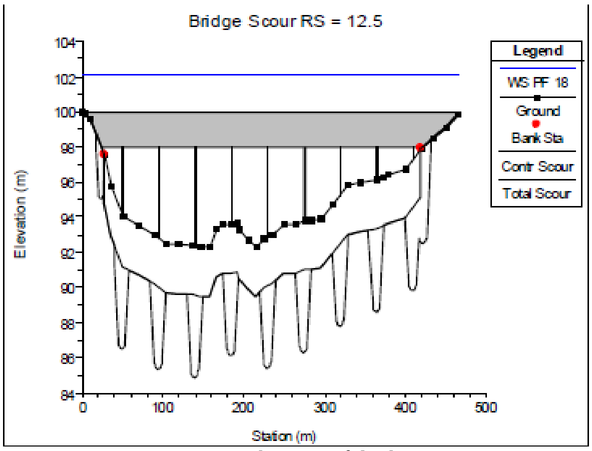

Fig.5. scouring because of discharge, 450cms

When flow is 450cms scoured depth for middle pier is 2.79m. For right over bank pier = 1.97 and for left pier depth of flushing is 0.46m. Contraction scoured depth is equal to 0.7m. When flow rate, changes to 600 (cms) , depth of middle scoured increase to 3.11m. For right over bank, this trend continues to 2.48m and also for left pier to 0.85m. In this situation, contraction scouring Changes to 1.78m. While flux rise to 900cms, this trend will be continued scouring depth rise to 3.62m for middle bridge pier and for left over bank. Effect of flow discharge on scouring phenomenon around bridge whit fresh water:

According to (Fig.6), when flow rises up, scouring at middle and over banks. Directly increase normally. Like as HOZLOLI. The results, show than when flow rate is low the maximum erosion depth is related to middle zone, (around middle bridge pier) but at some situation the erosion rate at two sides , suddenly move to increase . This situation is critical situation and sliding and construction movement are more possible. More over when discharge increase, gradually, right side. Scouring, directly increase, but at this condition at left side, some balance condition will be appeared and no scouring will be. This situation is because at left side bed river morphology, and creation scoured flow regime at outside of river. When discharge is equal at high rate, scouring depth will be quad for a while then condition change and scouring erosion increase suddenly at right hand. Although, around average of discharge at upstream is 55cms, it can be said that, at normal condition, bridge has very well. Resistance against scouring phenomenon but for more safety factor, it is better to use protective structure around piers.

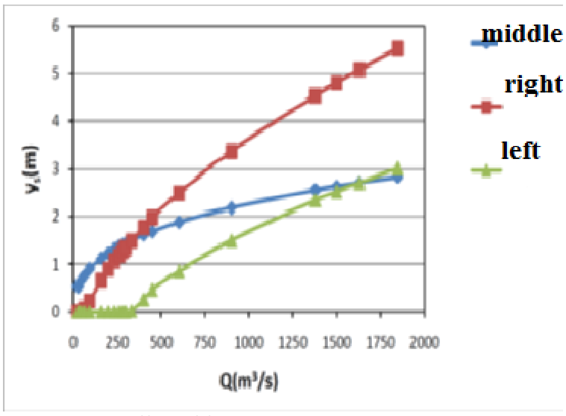

Fig.6. Effect of flow rate on scoring at middle pier

EFFECT OF FLOW RATE ON SCOURING AT CONTRACTION SECTIONS

According to (Fig.7), when flow rise to 329cms scouring is very low and could be neglected, but more than this range scouring suddenly rise is as high rocket, and erosion velocity is higher than local erosion around middle and right side of piers. Moreover, this fluctuation will continue to special discharge, (1378cms) and after that flow rate will move to constant situation. This behavior is result of change of flow passing area. Therefore capacity of sediment moving

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will decrease and will be equal to 8 capacity of sediment at upstream zone.

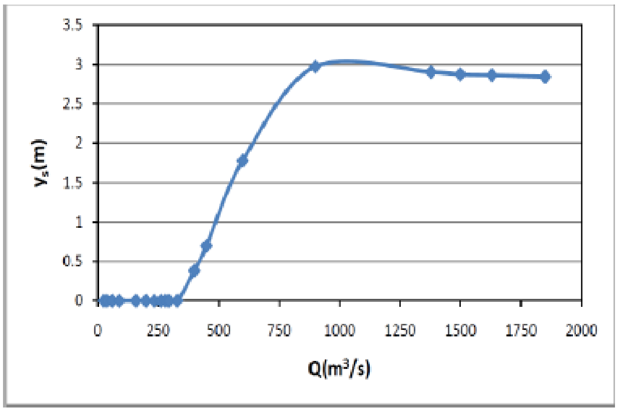

Fig.7. effect of discharge on scouring depth from contraction

Effect of discharge a scouring around middle and side pier at shallow water condition and existence of bed from: Effect of discharge at sides and clean water and bed form is similar, but around bridge pier is completely different (Fig.8) effect flow rate variation at clean water, dune is huge to medium, the scouring rate, around middle pier) is more than. Shallow water condition as a result, when pier going to be larger, scouring increase directly. Effect of flow variation on scouring from contraction at clean water and live bed form: (Fig.8) illustrates effect of flow rate on scouring because of contraction at clean water and live forms. At this situation scouring at live bed is very high than clean water situation but at flood period are almost uniform and the range.

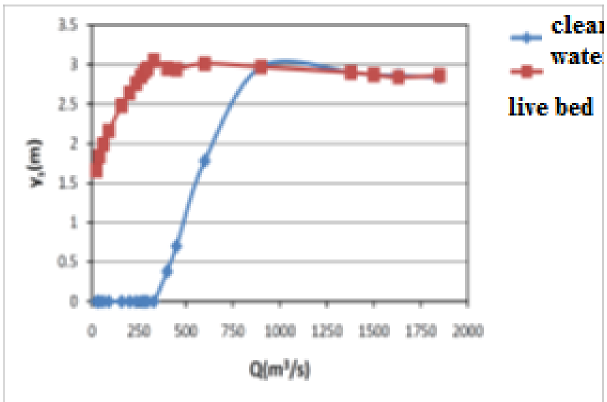

Fig. 8. Effect of flow on contraction at clear water and live bed

Conclusion

1-When discharge move upward, secondary flow condition will be appear And scouring hole develop around bridge pier.
2-At almost high flow rate scouring at left decreased and minimized. This event is because of river morphology and secondary flow effect.
3-At flood period; probability of bridge failure at right zone is more.
4-Erosion velocity at contraction zone is more than local situation.
5-Scouring rate at clean water and alive bed are completely different, but at flood zone, these ranges are about equal and are equal to scouring capacity at upstream.

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