Local scour around bridge piers Foundation

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Abstract - Scour at expressway intersections is made out of long term aggradation and debasement, compression and nearby scour. As a rule these parts are added substance. Furthermore sidelong moving of the stream or waterway can likewise bring about extension solidness issues. Investigation of scour, particularly withdrawal and neighborhood scour is entangled by states of stream and geometry. Local scour at bridge pier bringing about the advancement and suggestion of functional choice criteria for extension dock scour counter measures, Guidelines and details for plan and development of those counter measures, and rules for their examination, support, and execution assessment.

Key words: design scour, pier scour, scouring process.

1. Introduction

At the point when connect pier are determined to erodible beds the locally high speed of stream brought on by the liquid structure collaboration and the related withdrawal regularly made scour happen in the region of the pier. Surge stream in regular waterways scours the stream quaint little inn expansive gaps around bridge pier that steadily reach out underneath them, in the end devastating them. Imperative Investigation on the time variety of scour has beforehand been completed by Chabert and Engeldinger (1956), Ettema (1980), Kothyari (1990) and Yanmaz (1991) et al.

In this way, the nonappearance of exhaustive scientific strategies for foreseeing scour depth for pier configuration is a huge reason that makes certain extensions fall, bringing about antagonistic money related effect, expanded travel time because of the

interruption of travel courses, and once in a while in death toll. Many lab pier scour tests have been directed; however field examinations are expected to build our insight into the subject. The point of the present review is to display a general perspective of the scouring procedure at bridge pier on the ground.

2. Types of Bridge Scour

2.1 General Scour

General scour is the scour which happens regardless of the nearness of the extension because of the morphological conduct of a waterway, the procedures of aggradation and debasement of stream bed, wandering, twisting, cut-off development, conversion of streams upstream of bridge destinations, and so on. Long haul conduct of a waterway in the region of a bridge must be completely investigated to locate the possible change in stream bed rise at the proposed connect site. While debasement of stream bed may bring about establishment disappointment, general aggradation will bring about ascent in HFL, decreasing free board and debilitating the wellbeing of the superstructure.

2.2 Constriction Scour

Constriction scour happens in an extension where the street or railroad approach dike confines the typical conduit. It happens additionally at such area where the bridge is sited at a characteristic constriction of a waterway typically chosen as extension site for lessening the cost of superstructure. Bringing down of the bed happens locally inside the contracted reach because of stream quickening and expanded speed of stream. Unnecessary withdrawal of ordinary conduit expands development cost of substructure because of exorbitant scour. It additionally causes a few unsafe impacts, e.g. inordinate afflux, longer backwater reach requiring surge security, sedimentation with in the backwater reach because of diminishment in silt transporting limit of the stream, winding, stream unsteadiness, and etc.

2.3 Local Scour

Local scour in bridge piers occur due to obstruction by pier and pier foundation and the consequent changes in the flow field around the piers. Because of variation in velocity from top to bottom of a pier, the stagnation pressure head is the highest at top and lowest at the bottom of pier, thereby inducing a pressure gradient, since the potential head is highest at the top and lowest at the bottom of the pier. This causes a downward

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vertical flow impinging the bed. At the pier base, two horse-shoe vortices develop due to flow separation. It is primarily due to the vortex formation and the downward flow impinging on the bed that causes scour at the base of the pier.

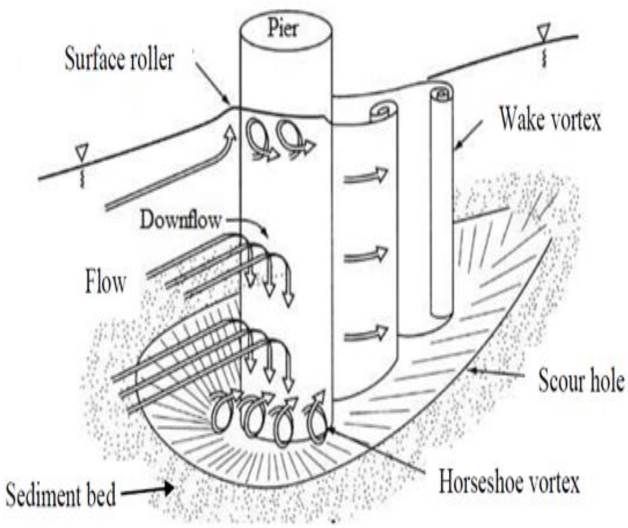

Fig.1 Scour Patterns around Circular Pier

2.3.1 Clear-water and Live Bed Scour

Clear-water scour happens when there is no development of the bed material of the stream upstream of the intersection however the increasing speed of the stream and vortices made by the pier or projections makes the material at their base move. Live-bed scour happens when the bed material upstream of the intersection is likewise moving.

Connects over coarse bed material streams frequently have clear-water scour at lower streams, live-bed scour at the higher releases and afterward clear-water scour for the falling stages. Clear-water scour achieves its most extreme over a more drawn out timeframe than live-bed scour. This is on account of clear-water scour happens for the most part on coarse bed material streams. Truth is told clear-water scour may not achieve its greatest until after a few surges have been experienced. Additionally, most extreme clear-water scour is around 10 percent more than the greatest live-bed scour.

Live-bed scour in sand bed streams with a rise bed arrangement changes around a harmony scour depth. This is brought on by the fluctuating way of the silt transport of the bed material in the moving toward stream when the bed setup of the stream is hills. For this situation (hill bed arrangement in the channel upstream of the extension) most extreme depth of scour is around 30 percent bigger than equilibrium depth of scour.

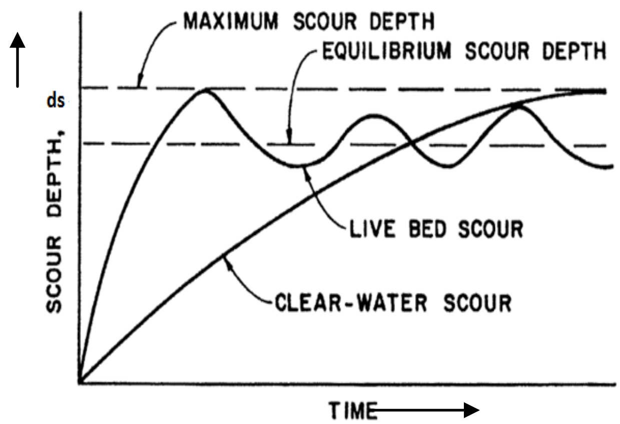

Fig.2 Scour Depth as a function of Time.

3. DIFFERENT METHODS USED FOR SCOUR ESTIMATION

3.1 Melville and Coleman Method

Melville and Coleman (2000) registered aggregate scour profundity by including the general scour, the contraction scour and local scour. Techniques for evaluating general and choking scour which is practically the same in every one of the models that have been as of now talked about. Local scour around pier (ds) underneath waterway bed has been communicated by Melville and Coleman.

$$d_s = K_{yb} . K_1 . K_d . K_s . K_{a1} . K_g . K_t \quad (1)$$

$$K_1 \begin{cases} \frac{V-(V_a-V_c)}{V_c} & \frac{V-(V_a-V_c)}{V_c} \\ 1.0 & \frac{V-(V_a-V_c)}{V_c} \end{cases} \quad (2)$$

$$K_d \begin{cases} 0.57\log\left(2.24\frac{B}{d_{50}}\right) & \frac{B}{d_{50}} \leq 2.5 \\ 1.0 & \frac{B}{d_{50}} > 2.5 \end{cases} \quad (3)$$

$$Kg = \begin{cases} \left(\frac{l}{B}\sin\theta + \cos\theta\right)^{0.65} & \text{non-circular piers} \\ 1 & \text{circlar piers} \end{cases} \quad (4)$$

$$Kg = \begin{bmatrix} \sqrt{1-\left(\frac{L^*}{L}\right)\left[1-\left(\frac{y^*}{y}\right)^{\frac{5}{3}}\left(\frac{n}{n_*}\right)\right]} \\ 1.0 \end{bmatrix} \quad (5)$$

All other parameters except K_{yb} are non-dimensional and K_{yb} is having the same dimension as that of ds scour depth in meter. K_{yb} is depth-size or shallowness factor and is given by the relation K_{yb} = 2.4 b when b/y < 0.7, K_{yb} = 4.5y when b/y > 5 and K_{yb} = 2 $\sqrt{yb}$ when 0.7 < y/b<5, K_1 is flow intensity factor including sediment gradation, K_d is sediment size factor, K_s is pier shape factor is value Ks=1.0(circular, round nosed and skewed piers), K_{a1} is pier alignment factor, K_g is channel geometry factor, K_t=1.0 (time factor),where B≡ b for piers and B=L for abutments, L and L^* total length of the abutments and length of abutments spanning to flood channel, y and y^* flow depth in main and flood channels, n and n^*manning roughness coefficient of main and flood channel,$v_a$is armour velocity, l is piers length.

3.2 HEC-18 Method (Richardson and Davis)

HEC-18 (By Richardson and Davis, 1995) prescribes that the total scour should be separated as general scour, contraction scour and local scour. Computation of general and contraction scour depth are already discussed. For local scour estimation, Richardson and Davis (1995) recommend use of the following equation for both clear water and live bed scour depth, ds (measured below bed) , in terms of approach flow depth, y_1 as

$$\frac{d_s}{y_1} = 2K_1.K_2.K_3.K_4.(\frac{b}{y_1})^{0.65}.F_{r1}^{0.43} \qquad 6$$

where; K_1 is correction factor for pier nose shape i.e. K_s in Mellville equation, K_2 is correction factor for flow obliquity i.e. K_{a1} in Melville equation, K_3 is correction factor for bed condition i.e. plain bed, ripple and dune bed etc., K_4 is the correction factor due to armoring of bed in non-uniform sediments, F_{r1} is the approach flow Froude number directly upstream of pier given by the relation

$$F_{r1} = \frac{V_1}{\sqrt{gy_1}} \qquad 7$$

where; V_1 is the mean velocity of flow and y_1 is the average flow depth directly upstream of piers.

3.3 IRC Method (Lacey/ Inglis)

IRC:5, IRC:SP:13 & IRC: 78, published by Indian Roads Congress (IRC), recommend use of Lacey's (1930) equations for estimating scour depth in a pier. Unlike the other mathematical models, IRC method does not distinguish between local scour, constriction scour and general scour. The total scour depth (measured below HFL) is assumed to be 2 times Lacey's R, as per the prototype scour observations made by Inglis (1949) at bridge sites.

$$R = 0.473\left(\frac{Q}{f}\right)^{\frac{1}{3}}, \qquad 8$$

$$R = 1.34\left(\frac{q^2}{f}\right)^{\frac{1}{3}}, \qquad 9$$

Here, Q is the design discharge in cumec, R is the regime depth, q is the discharge intensity i.e. m^3/s/m i.e. Q/L and f is Lacey's silt factor, L is the clear waterway under the bridge and W is the mean width of waterway in the approach channel corresponding to design discharge Q.

4. PREDICTION OF SCOUR DEPTH

The scour depth potential for the sand-bed reach is relatively small, and the Blench (1969) formula, which was developed for canals/rivers in regime. In contrast, the gravel-bed river reaches in intermittent rivers apparently are under non-equilibrium sediment transport conditions, and the applicability of the formula is relatively low. Maximum total scour depth (below HFL) i.e. the sum total of general scoured flow depth (below HFL), constriction scour depth and local scour depth .Since Lacey's method, (as adopted in IRC: SP-13, IRC-5 and IRC-78) do not distinguish between local and general scour, only total scour depth below HFL. In the general scoured flow depth is taken as the average of regime depths found by Lacey's and Blench formula. The general scoured flow depth is taken as the mean flow depth measured above the mean bed level (i.e. HFL-Mean Bed Level) as obtained from the bed profile during low flow period, assuming that the bed profile of the stream remains the same during low and high flow periods.

5. CONCLUSIONS

Estimation of scour around bridge pier is a normal work for establishment plan. The present technique for scour estimation as recommended in IRC, RDSO and IS Codes (utilized as a part of India) depends on Lacey's administration hypothesis created in 1930. Lacey's technique has a few restrictions as it overlooks numerous critical parameters like size shape and of wharf and its establishment land and dregs degree and so on. A few scour, constriction scour and local scour. General approach for anticipating scour depth at an extension site is exhibited, this approach having been aggregated from subjective and quantitative techniques for the forecast of individual parts of scour. Notwithstanding the scour segments dissected for the present contextual investigations, the impacts (Melville and Coleman 2000) of projection scour, silt wave extents, aggradation, thalweg depth and development, twist development, wander movement, and channel augmenting additionally should be incorporated into scour examinations where these wonders impact scour at an extension site. What's more, as to ascertaining all out scour, until further research lights up how isolate scour forms consolidate to act together at an bridge establishment, straight superposition of the impacts of these marvels remains the best means by and by accessible for deciding the aggregate scour happening at an establishment.

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