# Review on Counter Measures for Scouring Around the Bridge Pier

**Kuldeep Patel, Snehansu Nath**

***Abstract:*** ***Bridge pier as a crucial part of a bridge is used for various marine and transportation purposes. Local scouring around the bridge pier is a prominent cause which leads to the failure of the bridge system. scouring around the bridge pier is caused due to the effect of vortices created by water current. To prevent scouring we have to design the countermeasures and also maintain the sediments which are erodible. This review examines both type of countermeasure devices. Measures such as to divert the flow or to strengthen the river bed. Use of slot can reduce the scouring to 20% and with combination of collar and slot the reduction efficiency increases. Use of rip rap strengthens the river bed and reduces the scouring. Both the measures are different in their aspects and can be used to reduce scouring. Various countermeasures used together can reduce the scouring effectively.***

***Keywords: Bridge Pier, Collar, Countermeasures, Geo bags, Rip rap, Scouring, Slot.***

## I. INTRODUCTION

Bridge is widely used structure as a hydraulics structure in river[1][2]As the water passes in the river, the pier becomes an obstruction to the current. The current velocity will reach stagnation point at pier surface and the following water will push down the stagnant water fig-2[3][4]. As an effect of that horse shoe vortex will generate at the base of pier and scouring will occur fig-1[5]. Scouring around the bridge pier is considered to be the major cause of failure of the pier. Many researches have been done on estimating the scour depth, but very little research is done on countermeasures to be taken to reduce scouring. Countermeasures that we can take depends on the site condition. We can take countermeasures which either strengthens the bed surrounding the pier or which diverts the flow of current or both[1][6][7][8][9]. use of rip-rap, geo bags will strengthen the river bed. Use of guiding vane, collar, slot, different shape of pier will alter the course of current [1][6][4][10].

## II. USE OF RIVER BED STRENGTHENING MEASURES

### *A. ARTIFICIAL RIPRAP*

Artificial ripraps as shown in fig-3[1] can be placed around the bridge pier. Ripraps strengthens the river bed to a certain degree and also slows the water current velocity thus reducing the scouring around the pier. Different shapes can be used for ripraps and can be used.

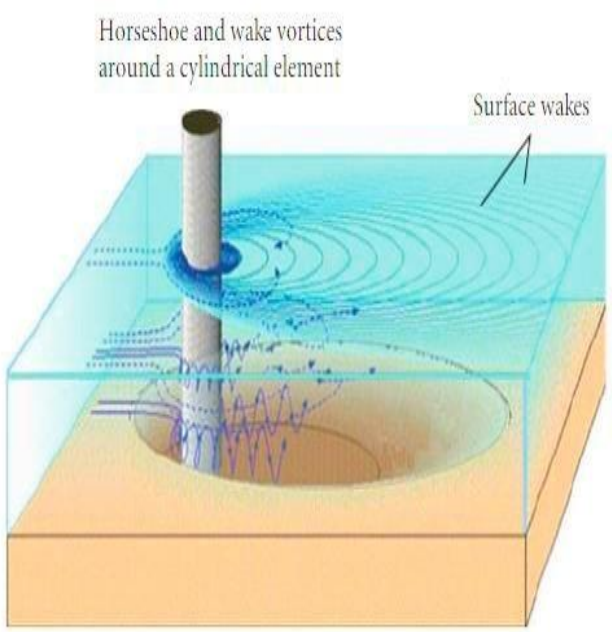


**Fig. 1. Local Scouring[5]**

Geo bags are also a countermeasure which strengthens the river bed and reduces the scouring around the pier.

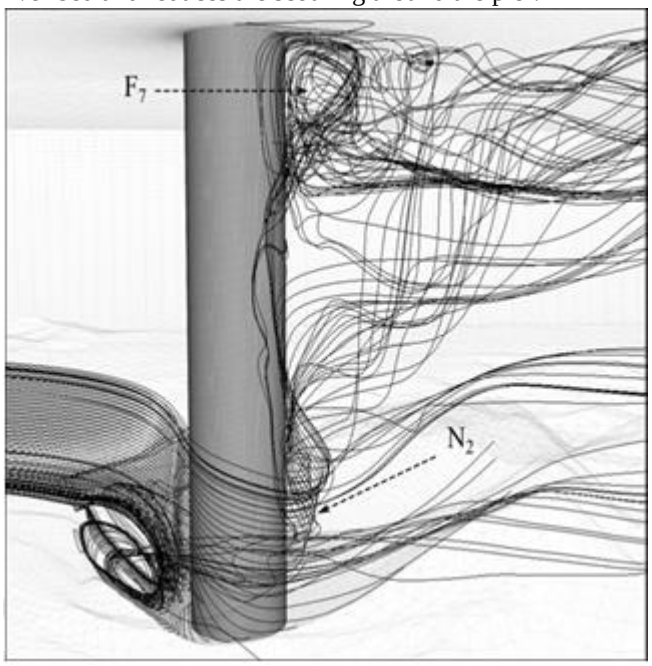


**Fig. 2. Representation Of. Horseshoe Vortex And Downflow[3]**

**Revised Manuscript Received on September 25, 2020.**
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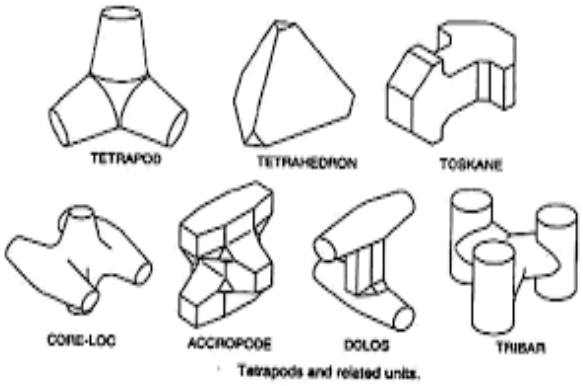


**Fig. 3. Artificial Riprap[1]**

## III. USE OF FLOW ALTERING MEASURES

### A. COLLAR

When the collar fig-4[1] is placed around bridge pier, the scour reduction is found to be efficient. Reduction of scouring varies according to the change in shape and position of collar[11][12]. Use of rectangular collar reduces the scouring up to 79% and weakens the horse shoe vortex and down flow as compare to the use of circular collar which reduces the scouring up to 71%[13].Rectangular collar having the same diameter as circular collar have more surface area than circular collar, so it covers moreareaandreducesscouringmoreeffectively[13][6][14].


**Fig. 4. Provision Of Collar In Bridge Pier [1]**

### B. SLOT

Slot(fig-5[15]) proves to be most effective when the shape of the slot is rectangular and makes no more than 20° angle with the current[10][16][17]. If the skew angle between a slot and the current increases over 35-40° the slot has no effect and the system behaves the same as of simple pier without a slot. as for the slot dimension, if we provide the slot width as one fourth of the diameter of pier near bed

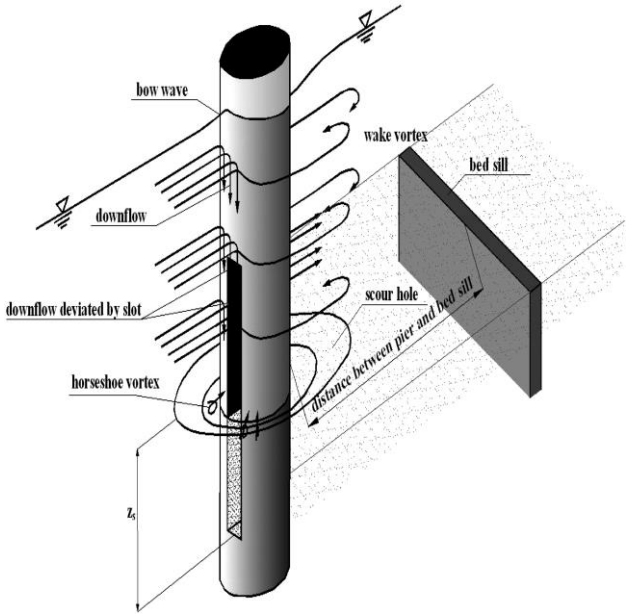


**Fig. 5. Provision of slot in bridge pier [15]**

level, the scouring reduces up to 20 percentage and if the width is one half of the diameter of pier, the scouring reduces up to 30%[18][19].As the shape of the slot changes the reduction of scouring changes. If we use Y and T shaped slot as a countermeasure to reduce the scouring, results are found to be as Y shaped slots were found more effective than T shaped slots.Maximum scour reductionefficiency was shown by two particular slots, one having decreased down flow angle of y shaped slot and one straight slot respectively 33% and 38 [20][21]. Increase in the exit angle of y shaped slot decreases the performance as it increases the energy loss and scouring. For volume of scour hole reduction, Y shaped slot with small angle between exit found to be more efficient as 59% reduction in volume and for straight slot reduction in volume of scouring is found to be 53%. scour reduction varies according to the change of position of the slot.

The scour reduction is found to be in the range 45-85% if the slot is provided from water surface and extending towards bed, and reduction of 60- 88% is found if the slot is provided starting from river bed and extending towards water surface [22].

### C. GUIDING VANES (SUBMERGED)

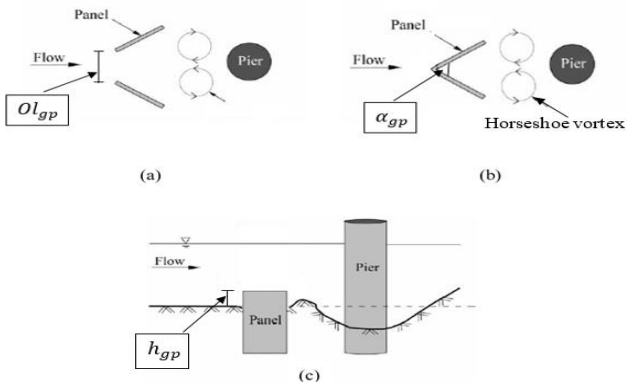


**Fig. 6. Provision Of Guiding Vanes(Submerged)**[23]

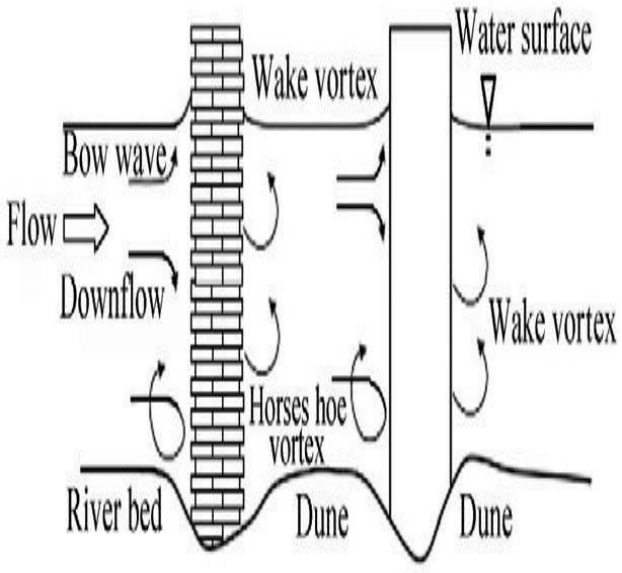


**Fig. 7. Provision Of Ring Column Before Bridge Pier**[24]

Submerged guiding vanes can be used to alter the flow direction and reduce the scouring[25]. As shown in Fig-6[23] the vanes placed before the bridge pier alters the flow direction, also it reduces the strength of the horseshoe vortex and creates resistance for the downflow[1][26]. Guiding vanes are proved more effective when submerged fully and it can reduce the scouring up to 60-70%[23]. Alternative methods are also being used to reduce the scouring around the bridge pier. Methods such as use of tetrahedron plates[4][1], use of skewed piers[19], and use of ring columns before the bridge pier. Ring column as shown in Fig-7[24] reduces the effect of horseshoe vortex and downflow and reduces the turbulence of the water current thus reduces the scouring around the bridge pier[24].

## IV. CONCLUSION

Reduction of scouring is possible by different approaches, using different countermeasures. Ripraps and geo bags reduce the scouring up to 40-50%. Collars reduces the scouring at great extent if it is placed at or below river bedlevel. Rectangular collar reduces the scouring to 79% Collar having dimension 1.5 to 2 times the pier dimension reduces the scouring in the range 55% to 96% Slot is most efficient if the angle between slot and the current is in the range 20°. If the slotwidthisonefourthofthepierdiameterthescourreduction is 20% and if the width is one half of the pier diameter, the scourreductionis30%.Iftheslotisplacedatriverbedlevel,it reduces the scouring to 60-88%. Scouring reduction of 100% ispossiblebyusingbothcollarandslotincombination.

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