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EXTENDED ABSTRACT

Investigation of the Effect of Six Legged Concrete (SLC) Elements Combined with Riprap on Scour Depth at Vertical Wall Bridge Abutments

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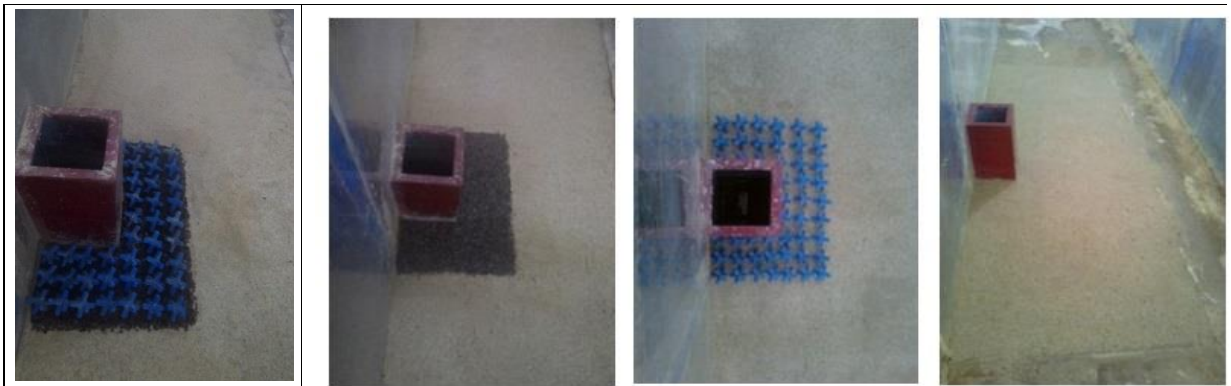
Introduction

Destruction of bridges caused by scour and other natural phenomenon brings about financial and life losses. Hence, researchers have been studied extensively the scour mechanism and methods of scour countermeasure. Usually scour at bridge occurs both around piers and abutments. Melville (1992)'s study showed that 70 percent of the failure of bridges in New Zealand was due to the abutment scour. Studies conducted on the failure of 383 bridges in the United States showed that in 25% of them the pier scour, and in 72% of them the damage was due to abutment scour (Kayatrak, 2005). The main cause of the abutment scour is due to complex flow vortices which developed around the abutment. Therefore, during the past decades many measures have been developed to protect the bed material against erosion. These techniques can be categorized in two types of covering methods and flow altering techniques. Design guidelines for some of these mitigation techniques can be found in Melville and Coleman (2000). For existing bridges the common practice is to use armoring materials around bridge abutment. Riprap, gabions, rectangular concrete blocks and tetrahedron frames concrete elements are the most effective material for covering and stabilizing the bed around the bridge abutments. In rivers with high flood discharge, the covering material are subject to high flow velocities and therefore large size of rocks have to be used. When the site construction is far away from mountain area or large sizes of the rocks are not available or too costly to transport, other material should be applied. In the present study, a new concrete element-six –legs concrete (SLC)- beside using of smaller size of rocks have been studied to find out the best combination for protecting bridge abutments against scour.

Material and Methods

The experimental tests were carried out in the Hydraulic Laboratory of Shahid Chamran University of Ahvaz in a water recycling flume with dimensions of 10m long, 1m wide and 0.6m height. A rectangular abutment model (0.15m × 0.15m which is categorized as medium size abutment) was installed at 4m downstream of the flume inlet which its bed is covered with fine uniform sand of 0.63mm in size. Four series of tests were conducted including a) no cover, b) using SLC, c) using riprap and d) combination of SLC and riprap (Fig.1). The SLC is a concrete element that is made up of two T-shaped concrete blocks which are attached to each other in the middle, which form the SLC shape. Small scale model (1/12 of the original size with 5 gr weight) were used in this study. small gravel size of 2.3mm was used for riprap material. Test were carried out applying four different flow conditions (Froude numbers of 0.179, 0.208, 0.225 and 0.250) under constant flow depth of 10 cm. To find out tests duration, a long duration test was conducted for series a (base line tests) and by plotting the scour depth versus time it was found that after 4 hours 90% of the maximum scour depth occurred therefore the rest of tests were run in four hours.



d) SLC and Riprap | **C) Riprap cover** | **b) SLC cover** | **a) No cover**

Fig.1 Four Series of bed cover

Results

Figs. (2) and (3) briefly present the ratio of maximum scour depth measured at the upstream tip of the abutment to the flow depth versus Froude number for different alternatives of bed coverage. In these figures B is for no cover, A is for SLC, R for riprap and B1, B2 and B3 stand for the tests in which SLC were placed above, half of the SLC size below the bed surface and entire SLC below the bed surface respectively. Test with RB3A stands for bed cover by riprap below the surface and SLC on top. As it shows generally the maximum scour depth increases as the Froude number increases for all types of coverage. However the maximum scour is usually greater in case of no cover (B). The maximum scour depth for combination of SLC and riprap is less than the SLC and it is less than riprap cover. For SLC coverage the best performance was obtain when it placed at the top of the bed. Among all coverage alternatives the scour depth is negligible once the SLC on bed surface and riprap placed below the bed surface (ARB2).

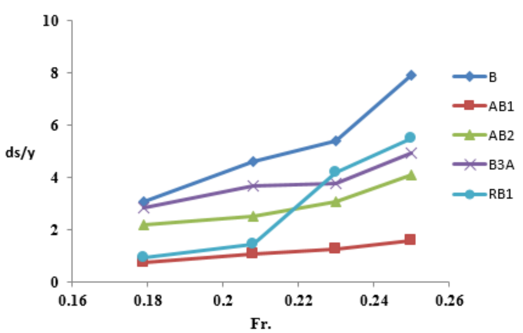


Fig.2 Dimensionless scour depth versus Fr for different alternatives of bed coverage

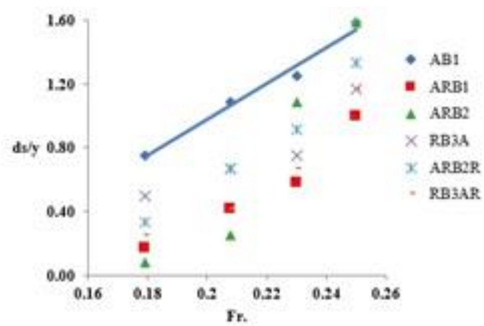


Fig.3 Dimensionless scour depth versus Fr for different alternatives of bed coverage

Conclusion

The results of this study indicate that the SLC if placed at top of the bed around the bridge abutment, the maximum scour depth at high Froude number is reduced by as much as 70% in

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comparison with when the riprap is used. It also found that for low flow conditions the best placement of the SLC elements is to be buried by half of their height with a combination of riprap (ARB2) which reduced the maximum scour depth by as much as 97%. For higher flow conditions it is best that the SLC is on top of the riprap and both on the bed surface (ARB1). In this cases of coverage the maximum scour depth is reduced by as much as 89%.

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