Irrigation and Drainage Structures Engineering Research/Vol.21/No.78/ Spring 2020/P: 99-116

Laboratory Investigation of Effect of Collar on Scour at Bridge Piers Group and Abutment in the Presence of Debris

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Received: 3 June 2019, Accepted: 7 October 2019

Extended Abstract

Introduction

Local scour around piers and bridge abutments is one of the reasons for instability and destruction of the bridges. Local scour of a bridge foundation is almost inevitable as far as rivers are concerned. There are generally three types of scours that affect the performance and safety of bridges: local scour, contraction scour, and degradational scour. During the last decades, different arrangements were proposed to protect bridges against local scour. The arrangements for local scour at bridge piers can be grouped in two categories: armoring devices and flow-altering devices. Flow altering devices that have been used to protect piers against local scour include protecting piles placed upstream of the pier, Iowa vanes, and flow deflectors attached to the pier, such as collars. This study addresses the effectiveness of collars on scouring reduction around abutments and pier bridges.

Despite the availability of various studies about the effects of collar on scour at bridge pier and abutment (such as Laursen & Toch, 1956; Mashahir & Zarrati, 2002; Kayaturk, 2005 and Khozeymehnezhad *et al*., 2014), and due to importance of bridges structures, further laboratory investigations are needed to explain the different aspects of collars interactions with abutment and piers scouring phenomena. So the purpose of this study was to study the effects of different sizes of collars on a rectangular abutment and their location to the surface of the sedimentary abutment on bridge group piers scour reduction at the presence of debris.

Methodology

The experimental tests of this research were carried out at the Hydraulic and Water Structures laboratory of department of water engineering, Shahid Bahonar University of Kerman, on a laboratory flume with 8 m (length), 80 cm (width) and 60 cm (height), having glass walls and metal bottom. All experiments conducted in uniform flow with clear water, rectangular abutment and debris, rectangular collar and cylindrical piers, with non-cohesive particles of sediment with d_{50}=0.91 and Q=51 L/s. The piers model used in the experimental test were steel cylindrical tubes with an effective diameter of three cm and a rectangular abutment in the form of (12×6 cm) made from galvanized sheet; debris model was rectangular shape, 19×7 cm dimensions.

The arranangment of piers positions of were in the (2×2) piers group and debris was located on the front piers with a relative depth of 0.3. The dimensions of collars were considered to be 1.5-3

times the length of the abutment, and the experiments were designed in five different submergence ratios for each collar. Experiments on scour were in straight channel. Initially the bed surface was leveled, then inlet valve was opened slowly until discharge of water came to predetermined value so that no scour occurs at the mobile reaches of flume. The effects of four different size of collar in five different submerged ratios on protection of local scour around abutment and piers group with rectangular debris were investigated.

Results and Discussion

The results of the experiments were presented in two groups: without collars and in the presence of collars. To investigate the process of scour in presence protective measure, at fierst it needed a series of experiments without any collar on the front piers and bridge abutment. The results indicated that collars caused decrease in the scour hole in all ranges of the present experiment and different submerged ratios. With increasing in dimensions of collar, in all submerged ratios of collar location, corresponding protective capacity of the collars improved leading to reducing the scour depth.

Comparison of results indicated that the collar with dimension of 1.5 times the length of the abutment, had the lowest percentage reduction and the collar with dimension of 3 times the length of the abutment had the most percentage of scour reduction, 15% and 75% respectively. Also comparison of the effects of installation height of collars showed that collar reduced the local scour depth around the bridge piers and abutments. Results also indicated that collars installed under the riverbed had more influence on scour reduction than that installed upper riverbed, and collar exactly installed on riverbed had higher effect on scour reduction (nearly 75%).

Conclusions

In this research, scour around cylindrical piers and rectangular abutment and the effects of the collar dimension and different installation height on the scour protective effects were investigated by laboratory tests. Experimental investigations regarding local scour using collars on cylindrical piers and abutment in presence of debris were carried out. The protective efficiency of collars with different parameters, including collar installation height and collar dimension (size), were investigated and discussed

Keywords: Abutment, Clear Water, Erosion Control, Local Scour, Rectangular Collar