LOCAL SCOUR PROTECTION AT BRIDGE PIERS GROUPS USING COLLAR

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Local scouring is one of the most important causes of bridge failure. Countermeasures for local scour at bridge piers can be grouped in two categories: armoring devices and flow-altering devices. Armoring devices include riprap and alternatives to riprap, such as cable-tied blocks, dolos, etc. Flow-altering devices that have been used to protect piers against local scour include sacrificial piles placed upstream of the pier, Iowa vanes, slots and flow deflectors attached to the pier, such as collars. The basic principle of using a collar is to divert the down flow away from the bed or protect the riverbed from its direct impact.

Effectiveness of providing collars on the body of single circular and rectangular piers has been studied by a few investigators. No information however is available in the literature about the application of collars on pier groups. When the scour proceeds due to the presence of a group of piers, some mechanisms occur that make the phenomenon more complex.

The experimental work reported herein is part of a major experimental program in performance of the collar in bridge pier groups. The primary objective of the study was to determine the scour reduction efficacy of collars on groups of 2 and 3 piers with pier spacing of three and four times the pier diameter and two sizes of collars with a diameter of twice and three times the pier diameter aligned to the flow under clear-water conditions.

The experiments were conducted in the Hydraulics Laboratory of Isfahan University of Technology, Isfahan, Iran, in a 7-m-long, 0.32-m-wide, and 0.36-m-deep flume. A false floor was constructed along the length of the flume at 0.1 m above the bed. Scouring tests were carried out in a sediment recess section 3.5-m from the inlet. The recess was 1 m long, 0.32 m wide and 0.1 m deep. A uniformly graded sand of mean diameter d50 = 0.71 mm was used. The same type of sand was glued to the rest of the false floor. The flow conditions of the experiments are shown in table 1.

Table 1. Flow conditions for the experiments

d_{50} (mm)	b/d_{50}	U_{*c} (m/s)	Y_0 (m)	U_c (m/s)	Y_0/b	U_0/U_c	Fr
0.73	27.4	0.0188	0.13	0.293	6.5	0.9	0.234

In general, for all experiments existence of a collar reduces the rate of scouring to a great extent. Referring to the results obtained for the temporal variation of the normalized scour depth for a group of three piers protected by collar with a diameter equal to three times of the pier diameter and pier spacing of three times of pier diameter , during the initial stage which lasts 80 minutes for front pier, no scouring takes places upstream of the pier. The initial stage corresponds to the size of the collar, the spacing of the piers. According to the results, duration of the initial stage increased with increasing collar size and decreased with increasing pier spacing.

It can be seen from figure 1 that the smaller collar could reduce the scour depth 3% and 6% for the middle and rear piers, respectively, compared with the unprotected pier. Whereas, larger one with a diameter equal to three times the pier diameter could reduce the scour depth 17% and 43% for middle and rear piers, respectively.

From Figure 2 it is observed that decreasing the pier spacing from 4b to 3b causes the efficacy of collar increases from 5% to 42.5% for rear piers and only 15% to 16% for the middle pier. For front pier the decrease in pier spacing decreases the performance of the collar from 6% to zero.

To sum up, the efficacy of a collar for a single pier can not be applied for piers in a group pier. Also, the results indicated that installing of the collar on rear piers in a pier group is more effective than the front piers. Changing the pier spacing and the size of collar has significant influence of rear piers and minor effect on front piers.

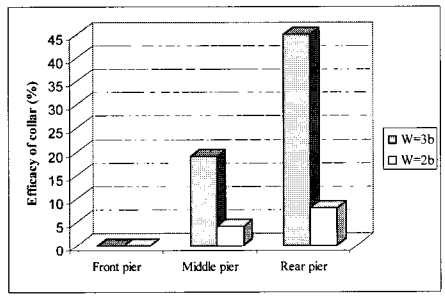

Fig. 1 Effects of collar size on equilibrium scour depth (3 pier groups; S=3b)

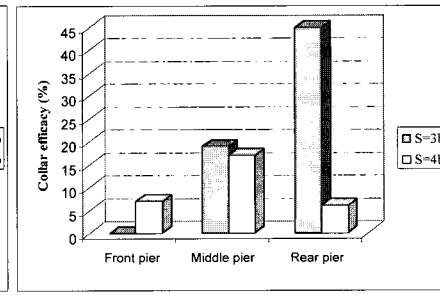

Fig. 2 Effects of pier spacing on equilibrium scour depth (3 pier groups; W=3b)