



## Experimental Study of the Effect of Netted Collar position on Scour Depth Around Oblong-Shape Bridge Pier

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**ABSTRACT:** Scouring is a natural phenomenon that arises from the erosive action of flow field in the alluvial streams. Local scour around bridge piers is a special type of scour. This type of scour is one of the reasons of bridge failures. One of the methods of scour reduction around bridge piers is to install collar on the piers. Netted the collar may affect the flow pattern and also makes the collar lighter. Furthermore the position of collar plays an important role in reduce of scour bridge pier. Therefore, in this study the effects of position of netted collar around oblong bridge pier is investigated. The experiments performed on a flume with the length of 6 m, wide of 73 cm and a depth of 60 cm with slope near zero. In this study, simple collar and three netted collars (with opening parts equal to 30, 50 and 70 percent) in four levels including, on the bed, 0.1 B under the bed (B is pier width), 0.5 B and B above the bed. The results showed that levels under the bed and on the bed were the best position to install the collars. On the bed, the simple collar 100% controlled the erosion and the 70% netted collar had 92% efficiency in reducing the scour. In level under the bed simple collar and netted collars had the same performance and scour depth decreased by 88%.

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### 1-Introduction

Bridge is one of the most important structure that scour around them should be taken into consideration because their stability plays an important role in the safety of passersby including pedestrians and cars. For this reason, many studies have been conducted to find ways to reduce scour around bridges.

Collar is a horizontal plate that is placed on the pier and changes the pattern of the flow around the pier and consequently reduce the amount of scour. From the study of Singh et al. (2001) it was concluded that the efficacy of a collar in preventing scour is a function of its width and its elevation relative to the bed surface. They found that collar of width of 1.5D, 2D and 2.5D placed on the bed reduced the scour depth by 50%, 68% and 100%, respectively; collar of 2D wide placed at -0.1D resulted a maximum reduction in scour depth [1]. Alem et al. using a 33% netted collar on laboratory bridge abutment at the 2 cm and 4 cm above the bed reduced scouring compared to the simple collar about 10.4 and 9.4 percentage, respectively [2]. Jalili and Ghomeshi used netted collars in their studies to reduce the cubic bridge scour. They tested three netted collars (with opening parts equal to 15, 30 and 40 percent). According to their results, the 30% netted collar had the best efficiency [3].

Due to the lack of investigation on the effect of netted collar, in this study the effect of netted collar position on scour depth around of oblong-shape bridge pier are investigated.

### 2-Methodology

Experiments were carried out in a flume with length of 6 m, width of 73 cm and a slope of the bed near zero at the Hydraulic Lab of Shahid Chamran University of Ahvaz. According to Chiew

and Melville's advice (1987), in order to eliminate the effect of channel walls on scour depth, the diameter of the pile should not be greater than 10% of the channel width. Therefore, from the oblong pier with width of 2 cm were used [4]. Also According to Chiew and Melville (1987), in order to prevent the effect of the particle size on the scour depth, the ratio of the diameter of the pier to the average diameter of the sediment particles should be more than 50 and to eliminate the non-uniformity of the sediments on the reduction of scour, the standard deviation of the particles should also be less than 1.3 [4]. Therefore, the average diameter of the selected particles was 0.5 mm and the standard deviation of the particles was 1.18. Collars were made of Plexiglas plates with triple the bridge width and tested in four cases, simple and netted with openings of 30, 50 and 70% at the levels of B, 0.5B, 0.12B under the bed and on the bed surface around oblong bridge pier. To determine the time of experiments, a test with a maximum flow rate of 20 L/s was performed without the presence of collars in long time, and over a period of 4 hours, more than 90% of scour depth occurred. So, the time of experiments was considered to be 4 hours. Table 1 shows the hydraulic conditions of the experiments.

Table 1. hydraulic conditions of the experiments

| Re    | Y(m) | Fr   | Vc (m/s) | V (m/s) | Q (L/s) |
|-------|------|------|----------|---------|---------|
| 27300 | 0.13 | 0.19 | 0.91     | 0.23    | 0.21    |
|       |      |      |          |         | 20      |

### 3-Results and Discussion

- Collar placed in level of 0.12B under the bed:  
By placing collars under the bed, only the sediments on the

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collars were washed because these sediments are considered to be part of the scour. In level under the bed simple collar and netted collars had the same performance and scour depth decreased by 88% and maximum scour depth in this case was equal to the height of the collar under the bed.

• Collar placed on the bed surface:

Simple collar on the bed level showed 100% efficiency, it showed the best performance in reducing scour depth. In this level the 70% netted collar had 92% efficiency in reducing the scour. 30% and 50% netted collars showed respectively 85% and 65% efficiency in reducing the scour. In this level opening on the collar surface increased the depth of the scour.

• Collar placed in level equal to B:

In this level the simple collar and netted collars showed less efficiency in compare with the collar installed on the bed, due to the high elevation of the bed surface and the operation of the vortices under the collar. The simple collar and 50% netted collar reduced the maximum scour depth of the front pier about 23%. Also 30% and 70% netted collars reduced the maximum scour depth of the front pier about 15%.

• Collar placed in level equal to 0.5B:

In this level the simple collar and netted collars also showed less efficiency in compare with the collar installed on the bed, due to the high elevation of the bed surface and the operation of the vortices under the collar. The simple collar and 30% netted collar reduced the maximum scour depth of the front pier about 31% and 19% respectively. Also 50% and 70% netted collar reduced the maximum scour depth of the front pier about 27%. In Figure 1, scour dimensionless depth changes relative to dimensionless elevation of sedimentary bed surface is showed. Table 2 shows the scour decreasing percentage of oblong pier for collars at different levels.

**4-Conclusions**

As the netted collar position decreases relative to the bed, the performance of the netted collar increases. Among experiments, simple collar on a bed with 100% efficiency and a 70% netted collar in level of on bed with 92% efficiency had the greatest effect on scour depth reduction. In level under the bed, the simple collar and netted collars had the same performance and scour depth decreased by 88%.

Figure 1. scour dimensionless depth changes relative to dimensionless elevation of sedimentary bed surface

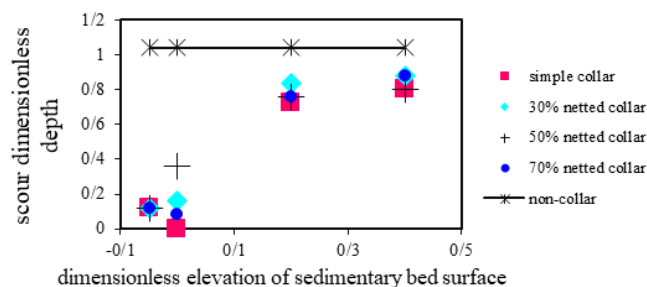


Table 2. scouring depth decreasing percentage

| Scouring decrease percentage relative to the non-collar mode |                   |                   |               |                 |
|--|-------------------|-------------------|---------------|-----------------|
| 70% netted collar  | 50% netted collar | 30% netted collar | Simple collar | Collar level    |
| 88   | 88                | 88                | 88            | 0.12B under bed |
| 92   | 65                | 85                | 100           | On bed          |
| 27   | 27                | 19                | 31            | 0.5B above bed  |
| 15   | 23                | 15                | 23            | B above bed     |

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