Effectiveness of a groundsill structure in reducing scouring problem at Cimadur River, Banten Province

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Abstract. Groundsill is a transverse threshold structure that can be built on water body as one alternative in reducing the upstream water velocity and therefore could maintain the upstream sedimentation rates. Due to scouring problems faced in the Cimadur River, Banten Province, a groundsill structure has been constructed at one location in Cimadur River which is near to the Bantar Karang bridge structure. The scouring problem is worried to damage the abutment of the bridge structure. This study aims to investigate the effectiveness of the groundsill structure in reducing the scouring problem in Cimadur River, Banten Province. The effectiveness is determined by comparing the riverbed elevation around the Bantar Karang bridge structure, before and after 5 months construction of the groundsill structure. The results showed that the presence of the groundsill structure has increased the riverbed elevation especially around the abutment of the Bantar Karang bridge (approximately 25 cm in average after 5 months installation of the groundsill structure). It is therefore can slowly reduce the local scouring problem around Bantar Karang bridge. Besides, the results also showed that there is small reduction of riverbed elevation at the downstream area of the groundsill structure approximately about 10 cm in average. It can be concluded that the groundsill structure is quite effective in reducing the local scouring problem in Cimadur River, especially upstream area of their structure around Bantar Karang bridge.

Keywords: Cimadur River, Groundsill Structure, Scouring, Sedimentation

Track Name: Land, Water, Forests and Food Security
1. Introduction

River is one type of surface waters that continuously flow from upstream to downstream area [1-5], while bridge is a structure connecting areas separating by the river [6]. In water resources management, erosion or scouring problem in the water body is the most serious problem that need to be solved [7-13]. Scouring is an enlargement of a flow accompanied by transfer of material through the action of fluid motion. Scouring problem faced in the river can damage river structures and cause bad impact to the river environments.

Since the past decades, the scouring problem in the river especially near to the bridge foundation has become the major discussion by researchers [14-17]. One approach that can be applied in order to reduce the scouring problem in the river is by constructing a structure in the river that can be implemented in reducing the water flow velocities, such as a groundsill structure [18]. Groundsill structure is one alternative structure that can be built in the water body in order to reduce the water flow velocity and maintain sedimentation rates at the upstream area of its structure [18]. There were some researchers that have applied a groundsill structure as an effort to reduce scouring problem and protect the important structures in the river [18-21]. Generally, the groundsill structures were built up at downstream area of the threatened structure of being damage in the river. Recently, there is still lack studies discussed about the effectiveness of a groundsill structure in reducing scouring problem in the river. Therefore, this study aims to investigate the effectiveness of a groundsill structure that has been built in the Cimadur River, Banten Province especially near to Bantar Karang bridge. The study can provide the important information for the water resources managers regarding scouring problem and existence of groundsill structure in the river.

2. Materials and Methods

2.1 Study Area

This study is carried out at the middle part of Cimadur River located at Lebak District, Banten Province. Geographically, Lebak district is positioned at 6° S to 7° S (latitude) and 105° 25” E to 106° 30” E (longitude) as shown in the Figure 1 below. There are scouring problems being faced in Cimadur River since the last decade. One location of the scouring problems in Cimadur River is near to Bantar Karang bridge (Figure 1). Continuous scouring problem is worried to breakdown the abutment structure of the Bantar Karang bridge, therefore, an effort in reduction of the scouring problem is urgent importance.

Topographic condition in the middle part of Cimadur River is characterized with steep slope where the riverbed elevations are approximately between 80 m and 400 m above means sea level (MSL). Steep slope of the riverbed in this area causes the high-speed velocities in the water flow and give high potential for the local scouring problem in the river. Based on field measurement using current meter, water velocities in the middle part of Cimadur River are approximately 2.64 m/s in average.
2.2 Construction record of the Groundsill Structure

In 2019, a groundsill structure has been constructed at one cross section in the middle part of Cimadur River especially near to Bantar Karang bridge. The position of the groundsill structure is about 90 m at downstream of the Bantar Karang bridge. The local scouring problem faced in Cimadur River around Bantar Karang bridge has encouraged an idea to construct the groundsill structure. Figure 2 show the detail description for the groundsill structure near to Bantar Karang bridge structure.

Figure 1. Location of the study area at Lebak district, Banten Province.
Figure 2. Detail description of the groundsill structure.
The groundsill structure has been designed based on 50 years return period of the flood discharges in Cimadur River. Dimensions of the groundsill structure are 35 m of the width and 7 m of the maximum height from the ground level. The maximum crest level of the groundsill structure is 281.5 m above mean sea level (MSL). The distance of the groundsill structure from the Bantar karang bridge is about 90 m positioned at downstream area of the bridge.

2.3 Data Collection
Riverbed elevations at a cross section (cross-section 1) in Cimadur River, Lebak district which is exactly located at 70 m upstream from the groundsill structure or 20 m downstream from the Bantar Karang bridge were monitored before and after 5 months construction of the groundsill structure. Besides, riverbed elevations at another cross section (cross-section 2) in Cimadur River, Lebak district located at 5 m downstream from the groundsill structure was also monitored (before and after 5 months construction of the groundsill structure). The riverbed elevations at cross-section 1 and cross-section 2 were monitored using theodolite equipment during normal water level condition at dry season.

2.4 Analyses of the Effectiveness of the Groundsill Structure in Reducing Scouring Problem
The effectiveness of the groundsill structure in reducing scouring problem around the Bantar Karang bridge, in Cimadur River is determined by comparing the riverbed elevations at both cross sections (cross-section 1 and cross section 2) in Cimadur River as mentioned in sub-section 2.3. Increment of riverbed elevations in the cross-section area means that there is an increase of sediment accumulations around the cross-section area and therefore could reducing the local scouring problem near to the cross-section area. In contrast, reduction of the riverbed elevations in the cross-section area means that there is reduction of sediment accumulations around to cross-section area and therefore can cause increasing the local scouring problem at surrounding of the cross-section area.

3. Results and Discussion
Figure 3 and Figure 4 show the comparisons of the riverbed elevations at both cross-sections (cross-section 1 and cross-section 2) before and after 5 months construction of the groundsill structure in the Cimadur River. Cross section in Figure 3 is located approximately at 70 m upstream from the groundsill structure or 20 m downstream from abutment of Batan Karang bridge, while cross section in Figure 4 is located approximately at 5 m downstream from groundsill structure.

![Figure 3](image-url)

**Figure 3.** Riverbed elevations at cross-section 1 (upstream area of the groundsill structure).
Based on Figure 3, the result showed that the presence of groundsill structure in Cimadur River especially at the downstream of the Bantar Karang bridge has slowly help in reducing the local scouring problem around abutment of Bantar Karang bridge. In Figure 3, it has been recorded that there is increasing the riverbed elevations approximately about 25 cm in average at cross section 1 located approximately at 20 m downstream from Bantar Karang bridge structure or 70 m upstream from groundsill structure. The results are found to be in line with the research done by previous studies such as Sucipto and Tugino [21], Budi et al. [22], Permata [23] and Tungga et al. [24]. In examples, Sucipto and Tugino have recorded a returning riverbed elevations (to be normal elevations as before degradation) around abutment of one bridge in Java Province after construction of a groundsill structure at downstream area of the bridge.

Besides, based on Figure 4, there is small reduction of the riverbed elevations approximately about 10 cm in average at cross section 2 which is located approximately at 5 m downstream from the groundsill structure. It means that local scouring could be happened at downstream area of the groundsill structure and therefore more studies need to be carried in order to avoid the possibility scouring problem caused by groundsill construction itself.

4. Conclusion

The problem of local scouring in the river body was becoming the major issue in the world since the past few decades. Groundsill structure has been constructed recently in the river as one alternative to reduce the local scouring problem in Indonesia. It is because the groundsill structure can reduce the water flow velocities and maintain the sedimentation rates in the river especially at the downstream area of the structures. Based on this study, the groundsill structure was found to be effective in slowly reducing local scouring problem in the river especially at upstream area of the groundsill structure. Unfortunately, there is a negative impact found due to the presence of groundsill structure in the river where there was a scouring recorded in the area downstream of the groundsill structure.

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