

# Evaluation of the Impact of Side Scouring of the Cipeles River on the Reliability of the Cipeles Bridge on the Cisumdawu Toll Road STA 9 + 050 - STA 9 + 350 West Java

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## ABSTRACT

The Cileunyi-Sumedang-Dawuan Toll Road (Cisumdawu) is located in West Java, that connecting Bandung, Sumedang, and Majalengka. There are many bridges in the Cisumdawu Toll Road construction project, including the Cipeles Bridge, which is crossed by the river below. The river under the Cipeles Bridge can affect the lower construction of the bridge. In this study, researchers conducted field surveys to determine the location and conditions of the bridge. After knowing the location of the bridge, the researcher collected data related to the research. In this study, there are two types of data: there is geotechnical data and hydrological data. Geotechnical data contains the soil characteristics around the research location, while hydrological data includes the river characteristics of the research location. Data analysis was performed on Geotechnical data using empirical methods, while hydrological analysis used empirical methods with a return period of 100 years. After obtaining the two analysis results, the research was continued by making mathematical modeling using the HEC-RAS software. This mathematical modeling aims to get the pattern and depth of scouring that occurs in the Cipeles River. After doing mathematical modeling using HEC-RAS, the results show that the scour pattern close to the Cipeles Bridge Pillar this phenomenon can endanger the bridge's construction. Therefore, handling is needed by making protective buildings around the river.

**Keywords:** *Bridge\_Security, Cisumdawu, HEC-RAS, Scour.*

## 1. INTRODUCTION

Increased public demand for transportation is not aligned with the availability of road facilities built by the government. As a result, there is a buildup of vehicles due to the lack of available road land or what is called a jam. To unravel the congestion, the government has built alternative roads that are commonly called toll roads to overcome congestion [1]. Benefits with the construction of toll roads will, among other things, affect regional development and economic improvement and increase the mobility and accessibility of goods and people [2] [3]. There are several toll road supporting infrastructure parts, namely Bridges, Overpasses, Underpasses, and others. This research took place at the Cipeles Bridge, the Cileunyi-Sumedang-Dawuan Toll Road Development Project (Cisumdawu). When a bridge is constructed in a river, the flow pattern around the bridge changes because a unique flow field develops locally around the bridge pier and abutment. This unique flow field with the higher velocity can seriously damage bridge foundations. Thus, if the depth of the foundation is not deep enough, the chance of bridge failure becomes higher [4]. Similar

research was carried out by Fuad (2014) [5], who argued that water flowing in the river would result in the ground scouring process, and the scouring process occurred due to the influence of river morphology in the form of bends or narrowing of the river channel. Given the complexity and urgency of the problem, treatment is needed that can reduce the depth of the scour hole in the form of scouring control buildings around the pillars and abutments [6].



**Figure 1.** Research location map  
(source: Google Earth 2020)

**2. MATERIALS**

**2.1. Soil Investigation**

Soil is a component part of the earth's crust, which is composed of minerals and organic matter. Basically, the soil has different characteristics. However, the land can change according to the surrounding conditions. There are several factors that can affect soil properties, including sunlight and rainwater. For example, the example of rainwater on the scouring behavior that occurs in the Bridge case. Rainwater will continuously soak excessively into the soil surface, causing an increase in soil weight. This results in material shifting and scouring that is formed from the process of flow instability, which is getting bigger over time [7]. Also, the effect of different soil types can affect the scour depths, and as the soil becomes finer, there is a higher chance of scouring [8].

**2.2. Hydrological Analysis**

The hydrological analysis was carried out to obtain hydrological conditions in the area. The hydrological parameters are rainfall, rain intensity, rain discharge, and flow coefficient in the watershed area analyzed on the one-hundred-year return period. The results of the hydrological analysis will be used for mathematical modeling using the HEC-RAS software to obtain the scour size. The HEC-RAS software has been used to predict hydrological phenomena such as floods [9] [10]. A well-planned hydrological data collection program leads to an orderly and effective analysis [11].

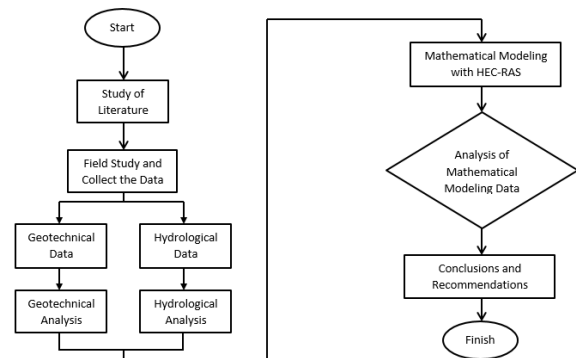
**2.3. Scouring**

Scour is the magnification of a flow accompanied by the transfer of material through the action of fluid motion. The scouring process will occur naturally, either due to the influence of river morphology or changes in inflow conditions. Sediment transport increases with increasing sediment shear stress [7]. Scour may occur in two conditions; namely, clear-water scours and live-bed scour. "Clearwater scour" occurs when there is no nearby

sediment transport flow down the scour hole. In other conditions, "Live-bed scours" happen when the scour hole is continuously fed with sediment by the approaching flow [12]. There are several parameters used to get the amount of scouring that occurs. These parameters are the Topographic Map, Geological Map, Catchment Area, Rainfall Data, and Watershed Area. Some of these parameters will be processed through the HEC-RAS software to determine the pattern and depth of scouring that occurs at the Cipeles Bridge. This mathematical modeling is done by modeling the river along the 300 m upstream and 300 meters downstream.

**3. METHODOLOGY**

The research flow chart can be seen in Figure 2.



**Figure 2.** Research flow chart

The Research Methodology step will be described as follows: The Researcher search the literature study for theoretical references that are relevant with the topic being researched by the researcher. The references of literature study can be research from journals, books, research report article, theses, and websites on the internet. The purpose of literature study is to identify problem as well as become a theoretical basis for conduct research.

After conducting a literature study, the researchers conducted data collection and field surveys. In this research, there are two types of data that must be collected, namely Geotechnical Data and Hydrological Data. Geotechnical Data contains soil type, analysis of soil grains, and soil moisture content. Hydrological data contains Rainfall Data, River Cross-Section Data, RBI Map. RBI Map in Indonesian called "Peta Rupa Bumi Indonesia", that the map displays the appearance of the Indonesian part of the earth from a satellite.

After collecting data, both data were analyzed. The geotechnical analysis is carried out to classify the characteristics of soil types at the research location, such as the soil properties index and the soil properties for construction. Some of the parameters that are in the geotechnical analysis will later be used for hydrological or hydraulic analysis because, in a water channel, there are several sediments that are transported at the time of its flow.

Hydrological or Hydraulic analysis aims to determine the cross-sectional capacity of the river and how much scour it occurs. For this hydraulic analysis, HEC-RAS (Hydrologic Engineering Center's-River Analysis System) is used, which is a software to make it easier to find out the phenomenon of the hydraulic behavior of waterways.

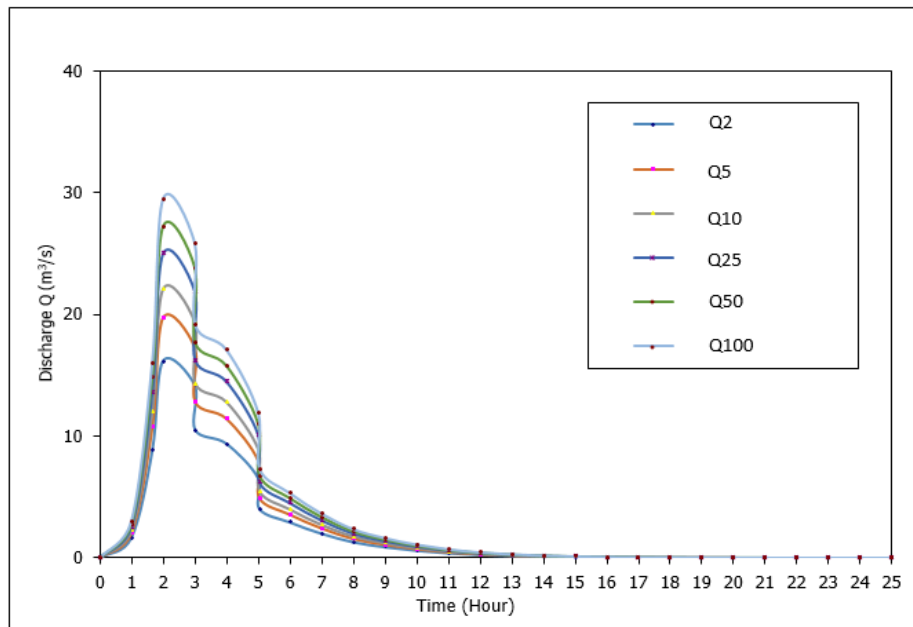
After running the HEC-RAS program, the cross-sectional area of the river and the amount of scouring occurred. From the data, the data is analyzed again, and conclusions are drawn.

The conclusions obtained from this study are how much the river carrying capacity and how much scouring occurs in the Cipeles River. From the scour that occurs, we can conclude that the scouring can affect the surrounding construction or not. The solution that researchers can convey is the installation of gabions on the side of the river.

#### 4. RESULTS AND DISCUSSION

From the soil investigations that have been carried out, the results of soil characteristics are obtained. Soil types in the Cipeles area are silt soil. The characteristic of silt soil itself is soil that is between sand and clay in size. If the soil is held by a hand, the soil can immediately crumble like grains of sand. Based on the results of the grain size analysis test, grain size d50 shows the number 0.085. The results obtained from the grain size analysis, that result will be used in calculating the amount of scouring that occurs.

From the hydrological analysis that has been carried out, which consists of rainfall, watersheds, and etc., using the Nakayasu method, the hydrograph diagram of rain can be obtained, as shown in Figure 3.



**Figure 3.** Nakayasu HSS method of flood discharge chart for each period

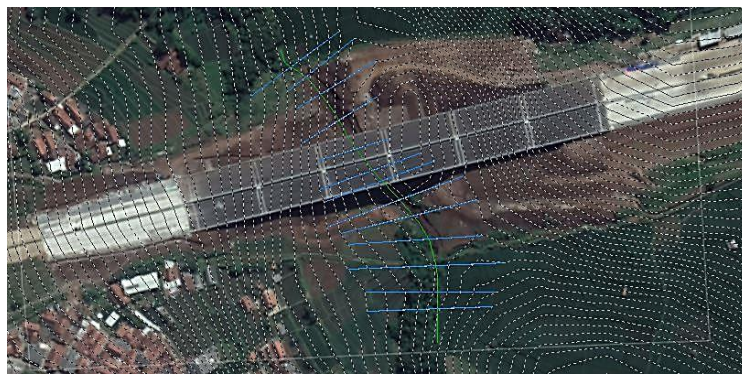
Figure 3 above shows the rain intensity data between 1 to 3. where this has an impact on the discharge that will flow in the Cipeles River. In the first few hours, the diagram shows an increase in discharge increasing until it reaches a peak at 2 hours; after reaching the peak, the rainfall begins to decrease.

After Hydrological and Geotechnical Analysis, Mathematical modeling was carried out using HEC-RAS. However, before running the HEC-RAS program, first look for the coordinates and location of the research site, which will be used as input into the HEC-RAS software.

In this research, to determine the location and place of research, researchers used Google Earth software. From Google Earth, we get the coordinates and areas of the research location. After obtaining the coordinates, the data is imported into Civil 3D software, which will produce a contour map of the location along with a cross-section of the river. An overview of the location map, along with a cross-section of the river, can be seen in Figures 4 and 5.



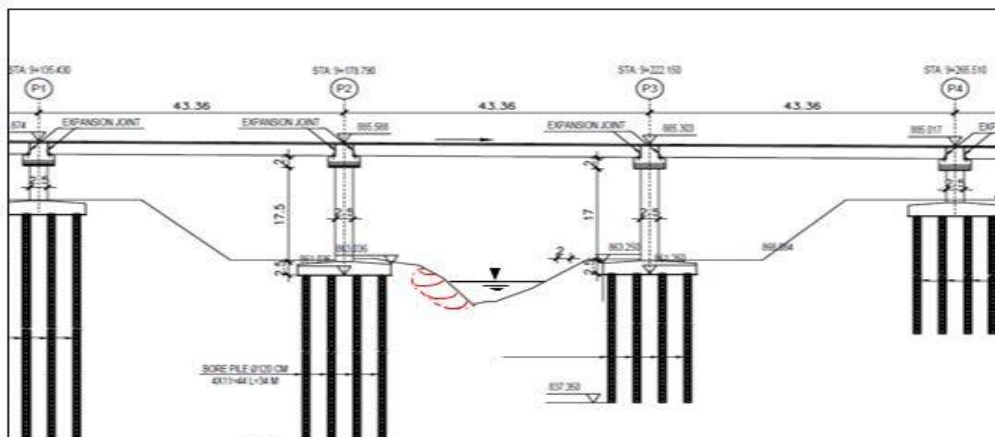
**Figure 4.** Research location map with google earth



**Figure 5.** Research location contour and cross section river with Civil 3D

From the figure 4, we can see the shape of the research location taken from Google Earth. From Google Earth, the coordinates of the location of the research. The coordinates that have been obtained from Google Earth are then imported into the global mapper software to get the contours of the research location. Furthermore, the map obtained from google earth and the location contours obtained from the global mapper software are integrated into Civil 3D software. The results of this merger can be seen in Figure 5.

From the results of mapping carried out using Civil 3D software, a river flow was obtained, which would later be used as input to the HEC-RAS software. After the data has been collected, a river simulation is performed using the HEC-RAS software, which will produce a scouring pattern that occurs in the Cipeles River. The following picture is an illustration of the scour that occurs in the Cipeles River.



**Figure 6.** A side plan of the scour that occurred

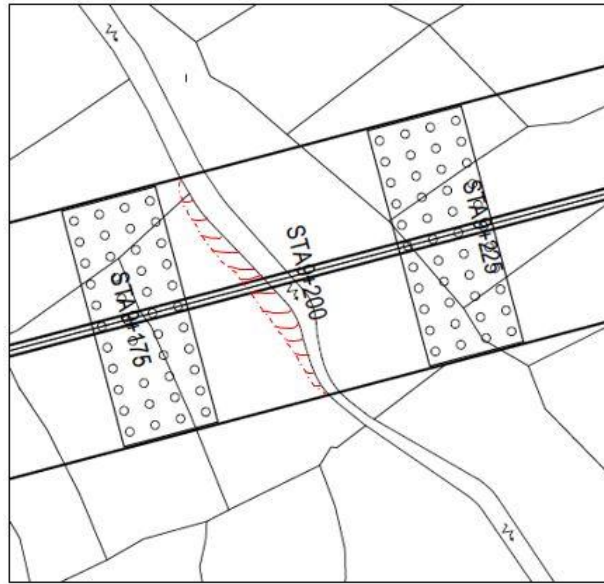


Figure 7. Floor plan view of the scour that occurred

From figures 6 and 7, we can see that the scouring that occurs in the Cipeles River occurs due to the behavior of river morphology. At the time of the simulation using HEC-RAS software, scouring occurs around the lower structure of the bridge; this can cause a decrease in the bearing capacity of the underlying bridge structures.

The scour that occurs in the Cipeles River is categorized as side scour. the magnitude of the side scour that occurs in the Cipeles River is approximately 1-2 meters. the scouring that occurs can endanger the lower structure of pillar number 2. Therefore, it is necessary to strengthen the river walls of the Cipeles River.

## 5. CONCLUSION

Based on the research that has been done, it is found that the scour that occurs in the Cipeles River is very dangerous because it has a scale of 1-2 meters to pillar No.2 and can affect the construction of the lower part of the Cipeles Bridge. Because this scour can endanger the subordinate construction of the Cipeles Bridge, effective treatment is needed to overcome these problems.

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