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Simulation of Cofferdam Calculations Using Geo-Studio Application in Peusangan Hydropower Dam Construction

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Abstract— The cofferdam construction is in the form of soil, stone, concrete or masonry with the aim of filling and storing water, preventing flooding and providing irrigation. The function of the cofferdam has many functions such as for agriculture, power generation, and tourist attractions. In addition, the construction of the cofferdam helps in flood control so that it does not overflow excessively which endangers the surrounding community. However, if the cofferdam collapses (fractures) it can cause flash floods. Therefore the cofferdam must be designed in a safe and technically feasible way, especially to function in the construction of a Hydropower Dam. Simulations in research use the GEO-SLOPE program. The conclusion from the analysis of slope seepage and seepage stability is that the Critical Safety Factor for cofferdam stability according to the results of the analysis after running SLOPE/W is 1.711 & 1.512 because it is higher than 1.5 (SNI 8460:2017 Geotechnical Design Requirements, this means that the stability of the cofferdam is safe. Results modeling shows that the seepage rate is 1.81x10-7 m3/s = 1.81x10-4 liters/second = 15.64 liters/day which is less than the maximum permissible discharge of 50 liters/day, so it can be concluded that seepage discharge is safe.

Keywords: Confferdam, Slope, software Geo Slope.

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1. Introduction

Cofferdam is a building that functions to divert the flow of the main river while the dam construction work is being carried out. Cofferdams are basically made by driving piles, usually steel or plate, in work from heavy wood, steel, or a combination of the two materials [1]–[3]. Various disasters that occur such as the sliding of a slope usually occur through one particular area which is called the Slip Surface field [4], [5]. Then the stability of the slope depends on the dodging force and the resisting force which is the force which resists so that a slide does not occur, while the driving force is the driving force which causes the failure to occur [4]–[7]. The ratio between the restraining forces and the soil-moving forces is called the slope safety factor [8]. Therefore, Cofferdam uses software designed to provide solutions for buildings in the form of landfill, stone, concrete or masonry to hold waste and collect water, prevent flooding, provide irrigation [9]–[11]. The building has many functions such as agriculture, power generation, and tourist attractions. Dams will also be very helpful in controlling floods which will control flood waters so that they will not overflow excessively which endanger the surrounding community [12]. Besides having great benefits, it also holds great potential as well. If the dam collapses (breaks) it will cause flash floods resulting in loss of life, property and severe environmental damage downstream. The sides of the cofferdam must be sturdy and well anchored to withstand the shock of the heavy water flow [13]. The cofferdam must also be able to withstand horizontal forces from the surrounding bodies of water. Seepage is reservoir water that seeks

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a way out through porous material or a fracture either in the body or the foundation of the cofferdam because water stored in a reservoir or river flow which is avoided will tend to find a way out to lower parts, especially to the lower part. downstream [14], [15]. One of the techniques to determine the stability of the cofferdam is by using the Geo Studio application for slopes and seepage of the cofferdam [16], [17]. In addition, this software is also able to determine the strength of slope stability and cofferdam seepage [18]. In order to obtain a hydropower dam construction simulation, the dam must be designed in a safe and technically feasible manner. Analysis of soil slope stability is generally carried out based on the limit tequilibrium approach, plastic limit theory, and numerical methods such as the finite element method in the boundary balance approach, usually only modeled as simple soil layers and cannot display stages. Soil strength arises from the contact area between soil particles which produces normal and shear forces. In general, the contact between soil particles mostly produces shear forces. Therefore the shear strength is directly affected by the effective stress.

2. Method

This research was conducted on a simulation of the construction of a hydroelectric power plant. The research approach used in this research is a quantitative approach, because the research results used are in the form of numbers which are the results of cofferdam analysis using the GEO-SLOPE 2012 program. effective and efficient. As for the preparatory stages of the research carried out, namely determining the necessary data to carry out observations. Make a literature study that is appropriate to the material related to the research being carried out. Interview with engineering construction, data collection related to activities and work, especially on tcofferdam. Preparation of tdata processing tby performing tcalculations either manually or using the tgeo tslope application. Comparative analysis of the aspects discussed. And also conclusions and suggestions based on the results of the discussion.

3. Result and Discussion

3.1. Analysis on Cofferdam Design Dimensions

Indonesia has many types of soil that can be used for embankment material, depending on the geological and geotechnical conditions in the project area. In the Indonesian Regulations or SNI (Indonesian National Standard), there is no recommendation for property values or embankment parameters that apply density values and soil shear strength parameters. In the General Specifications for Road and Bridge Construction Works, the requirements for property embankments are CBR values, namely 6% for ordinary embankments and 10% for selected embankments. The largest dimensional analysis design of the cofferdam with a height of 6 m. The slope is 1:1, the embankment elevation is 1231.00 and the water level for this calculation is the waer level 1230.50. The phreatic lines in the cofferdam follow the Seepage Analysis results shown by the blue lines. Seepage calculation issued by the Ministry of Public Works and Public Housing of the Republic of Indonesia. The critical safety factor for the reliability of the cofferdam according to the results of the analysis after running SLOPE/W is 1.711 and 1.512. Because it is higher than 1.5 (SNI 8460:2017 Geotechnical Requirements), based on this the cofferdam is safe. Then the value of the dam permit can be seen in table 1 below.

Table 1. Dam height permit values

Dam Height (m)	Seepage (litres/day)	
	O.K	Not O.K
< 5	<25	>50
5-10	<50	>100
10-20	<100	>200
20-40	<200	>400
>40	<400	>800

Based on table 1, the requirement above with a permit discharge of 6 m high dam is <50 liters/day while the modeling results show that the seepage discharge that occurs is 1.81x10-7 m3/s = 1.81x10-4 liters/s = 15.64 liters/day discharge less than the maximum permit of 50 liters/day. So it can be concluded that the seepage discharge park and the dam are safe.

3.2. Stability and Seepage Using Geostudio Software

Then the general specification also states that the type of soil that may not be used for embankment material is soil with high plasticity, expansive soil and soil containing organic matter. Cofferdam Stability And Seep Using Geostudio 2012 Slope/W And Seep/W Software. The first step for a SLOPE/W analysis is to enter soil property and geometry data. Soil properties according to tatast data (density, cohesion, and internal shear angle) and for geometry based on cofferdam and water table. Then the load given is heavier is the excavator. To see Input Geometry or Modeling with SLOPE/W, see Figure 1.

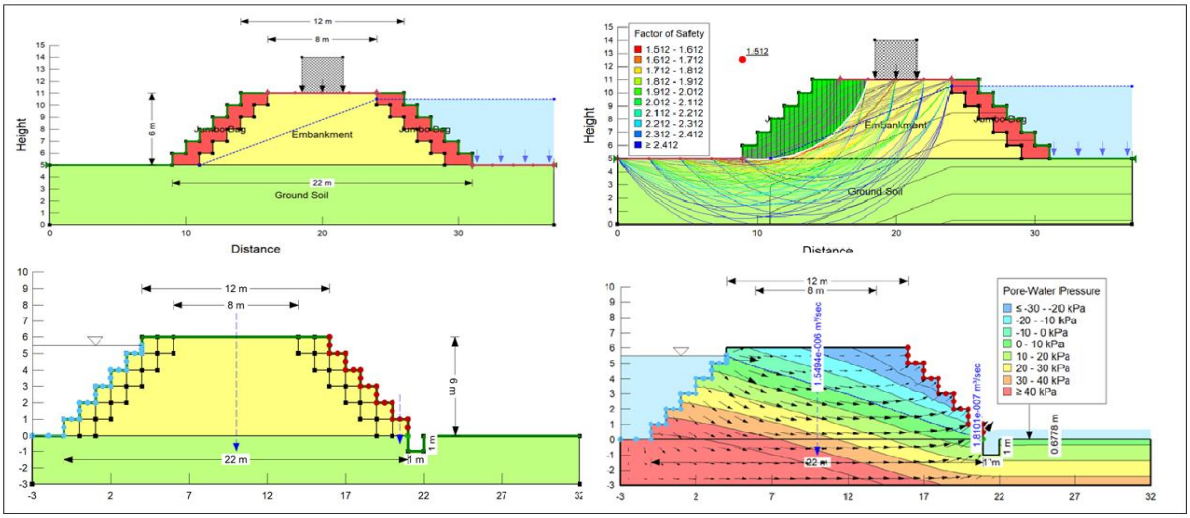


Figure 1. Input Geometry or Modeling with SLOPE/W and Analysis Results with SEEP/W

4. Conclusion

The following is the conclusion of the analysis of seepage slope and seepage stability where the critical factor of safety for cofferdam stability has decreased. The results of the analysis after running SLOPE/W are 1.711 & 1.512 because it is higher than 1.5 (SNI 8460:2017 Geotechnical Requirements), meaning that the cofferdam is safe for reliability. Whereas for manual calculations it is 1.24 for quick withdrawal of data that has been obtained. The modeling results show that the seepage rate of 1.81x10-7 m3/day = 1.81x10-4 liters/day = 15.64 lier/day is less than the maximum allowable discharge of 50 liters/day. So it can be concluded that the seepage is safe and the dam is safe.

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