Potential collapse due to geological structures influence in Seropan Cave, Gunung Kidul, Yogyakarta, Indonesia

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Abstract. This study aims to estimate the potential collapse in the Seropan cave, based on the existing geological structure conditions in the cave. This is very necessary because in the Seropan cave will be built Microhydro installation for power plants. The electricity will be used to raise the underground river water in the cave to a barren soil surface, which can be used for surface irrigation. The method used is analysis the quality of rock mass along the cave. Analysis of rock mass quality using Geomechanical Classification or Rock Mass Rating (RMR), to determine the magnitude of the effect of geological structure on rock mass stability. The research path is divided into several sections and quality analysis is performed on each section. The results show that the influence of geological structure is very large and along the cave where the research there are several places that have the potential to collapse, so need to get serious attention in handling it. Nevertheless, the construction of this Microhydro installation can still be carried out by making a reinforcement on potentially collapsing parts

Keywords: cave, collapse, geological structure, geomechanics classification, microhydro installation

1. Introduction
Karst area is an area consist of limestone that is soluble Carbonate as the main constituent of the limestone is dissolved by the surface water entering through the crack or joint of rock formed by the geological structures that work in the area. As a result of the dissolution, the landscape of the karst area has many surface holes and cavities beneath the earth's surface. The landscape on the surface of many holes is called Eksokarst, while the cavities in subsurface surface are referred to as Endokarst [1]. The landscape is as shown in Figure 1.

In karst areas, the landscape of dry season and rainy season is very different. In the dry season, the conditions are very dry, not many plants are alive, the water is very difficult, so make the soil become barren. While in rainy season, water on the surface so much that many plants that live with fertile. Although in the dry season the surface water is very difficult and the soil is barren, but in subsurface there are many water and become underground river [2]. Seropan underground river is located at a depth of about 60 - 75 m. To utilize this river water, then the river water will be pumped by using microhydro installation in cave [3], [4]. In the framework of making these installations, there should be research on rock stability and the potential collapse due to the influence of geological structures in the area.
Seropan Cave is one of the big cave in karst area in Gunung Kidul, Yogyakarta (Figure 2). Inside in this cave is an underground river (Figure 3) with a fairly large debit, about 800 liters/sec, so it can be used to move the turbine that produces electricity. Therefore, in the underground river will be built microhydro installation to pump subsurface water. Although in surface are barren conditions, but in subsurface water is quite a lot and even a river, such underground river Seropan. However, due to the geological structure in the form of cracks or faults or stocky it will cause rock conditions around the cave to become unstable [5], [6]. This is potentially the occurrence of ruins on the walls and roof of the cave [2]. For that it is necessary to research to determine the potential for such collapse, for the safety and security of microhydro installation.

To know the potential of collapse, conducted research on the techniques quality of limestone in Seropan cave. The method used is to make the Rock Mass Classification with Rock Mass Rating system or known as Geomechanics classification [6]. With the classification of this Geomechanics will be known the techniques quality of limestone in the cave Seropan and how big the influence of geological structures on the rock mass stability in the cave [7]. Based on the description, the main objective of this research is to know how big the potential collapse of rock mass in this Seropan cave.

2. Research Method

The method used in this study is the analysis based on observation and calculation of existing data. Research area have divided into 7 (seven) segments, and the analysis was performed on each segment along the research path using Geomechanics Classification. To create a Geomechanical Classification,
six parameters are required: Uniaxial Compressive Strength (UCS), Rock Quality Designation (RQD), Spacing of Discontinuous, Discontinuous plane conditions, groundwater and Orientation from the discontinuous field (Figure 4). Based on the analysis of these parameters will be obtained class and rock mass quality. The influence of geological structure can be identified from the quality and class of rock mass [8]. From the magnitude of the influence of these geological structures will be able to know the stability of the rock and its potential collapse, and at the same time how to overcome them.

Figure 3. Main entrance to Seropan cave and Seropan subsurface river

Figure 4. Measure discontinue plane and other datas to make geomechanic classification, in Seropan subsurface river.

3. Results and Discussion
After obtaining the data, both data for Geomechanical classification parameter and other required data, the next step is to analyze the existing geological structure, condition analysis and location of discontinuous fields then analyze the potential of collapse in each segment. The geological structure was analyzed by Geomechanical classification and the making of Roset Diagram, while Potential collapse was analyzed from the position, condition and orientation of the discontinuous plane to the cave position.
**Figure 5.** Correlation of geological structure condition and potential collapse in each segment along Seropan cave research.
The results obtained shown in Figure 5, as follows:

1. In segment-1, there are some discontinuous planes whose existence is very unfavorable orientation, such as the N78°E, N100°E, N152°E, and N151°E directed intersections will intersect above the right cave, where this condition has the potential to collapse if there is movement along the discontinuous plane.

2. In segment-2, there are several discontinuous planes whose existence is very unfavorable orientation, such as N78°E, N100°E, N152°E, and N151°E directed intersections over the right cave, where this condition has the potential to collapse if there is movement along the discontinuous plane.

3. In segment-3, there are some discontinuous planes whose existence of orientation is very unfavorable, such as N179°E, N194°E, N183°E, N165°E, N331°E and N334°E will intersect each other which produces three (3) crash-prone locations when there is movement along the discontinuous plane.

4. In segment-4, there are some discontinuous fields whose orientation direction is very unfavorable, but when it is reconstructed all the fields, there are no pieces of discontinuous plane that can collapse.

5. In segment-5, there is a discontinuous plane whose existence of orientation is very unfavorable, such as N146°E oriented braces, where this field may intersect with other discontinuous fields which produce two (2) crash-prone locations where there is movement along the discontinuous plane.

6. In segment-6, there are some discontinuous planes whose existence is very unfavorable orientation, such as N7°E, N103°E braced, and N114°E will intersect above the cave, where this piece has the potential to collapse if there is movement along the discontinuous plane.

7. In segment-7, there is no discontinuous field in which the orientation direction is very unfavorable, and when reconstructed all the fields, there is no discontinuous pieces of fallible pieces, but with rocky conditions that are quite fragile on the roof, then in sub section 7 This remains to be warranted because with rock conditions that are quite fragile this can be a potential collapse in this area.

4. Conclusion

Based on the results of the analysis on each segment, it can be concluded that in each segment there is potential for collapse, especially on the roof of the cave. Although each segment has the potential to collapse, but the potential for each segment varies. Discontinuous plane conditions such as strike direction, slope direction and magnitude of slope, discontinuous plane orientation as well as the presence or absence of discontinuity at the top or roof of the cave have great effect on the potential for collapse. Potential collapse of the roof of the cave can be overcome or reduced the level of risk by using some reinforcement techniques, for example with rock bolt, supporting system, shotcrete, or a combination of several methods. Although there is a possibility of collapse, but with some methods such reinforcement techniques, Microhydro Installation can still be built.

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