Mudflow utilization for construction materials of tertiary irrigation canal lining

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Mudflow Utilization for Construction Materials of Tertiary Irrigation Canal Lining

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Abstract. Mudflow in Siring Village, Sidoarjo Regency, Indonesia, has been in eruption since May 29, 2006. It still shows irregular large bursts which loaded in a sludge reservoir with capacity of 59 million m^3. From 2007 until 2015, there were more than 20 studies which concluded that the mudflow could be used as a mixture of building materials. However, the studies were not detailed and needed further research. This research aims to investigate the use of mudflow as tertiary irrigation canal lining material. This research comes with several laboratory tests to obtain a mixture that is solid and water-resistant. The methods that were used are descriptive methods as follows: 1). Sampling of mudflow, to be analyzed in Material Testing Laboratory. 2). Sampling of soil at research site, to be analyzed in Soil Mechanics Laboratory 3). Mixing of materials which are consist of mudflow and other materials and doing strength test in the laboratory. 4). Installation of tertiary irrigation canal lining using materials that have been tested. 5). Observation of lining's strength inactive soil pressure-bearing and its impermeability. It is expected that the results of this research will be applied extensively throughout the tertiary irrigation canals, so mudflow can be utilized as raw materials that are environmentally friendly, which are able to help preserving the environment, also to reduce the removal of sand / rock in the river, which has been used for lining materials, that benefits in preventing damage to the river ecosystem.

INTRODUCTION

Until now, the mudflow in Siring Village, Porong Sub-district, Sidoarjo Regency, East Java, Indonesia that occurred since 29 May 2006 is still continuing. The mudflow still has the potential to pose a serious threat.

The construction of the mud retaining embankment is carried out in a disaster situation to overcome the disasters of the Sidoarjo mudflow in order to secure the wider community and to prevent the occurrence of state losses in the larger community. The embankment line was built on the outer boundary line of the Impacted Area Map (PAT) on March 22, 2007. The mud levee strip has been defined and there is no other option, so in the construction of the embankment, it cannot apply the technical requirements for the creation of a dam that has a bedrock/geological formation, solid and free of geological deformation in the form of subsidence and horizontal movement.

The embankment is built around a mountain of volcanic mud. The mud flowing from the top of the mountain has a water content of about 60 ~ 70%, but on the way to the pond of reservoirs, the water is refit, the mud is left behind when the mudflow touches the water in the pond.

With the construction of embankments, mud reservoir and rainwater have been formed. Due to the embankment built around the foot of the mountain (mud) then the rainwater reservoir formed consists of several sections of the reservoir. The reservoir is formed at the foot of the furthest mud volcano adjacent to the embankment. Water reservoir must be managed by minimum 50 m from the edge of the embankment. The main guideline for the management of water-filled sludge reservoirs is that water should be as low as possible by being pumped or flowed to low ground. The volume of mud reservoir is approximately 59 million cubic meters.

If this condition is left unchecked and not handled seriously it will certainly have a tremendous direct impact on people's lives around the mudflow site and also indirectly impact the community outside the mudflow location because of the location of the mudflow near the road and infrastructure of railway connecting the city of Malang and the city

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of Surabaya, a city with a rapid economic activity. The location of the mudflow and puddles is also very close to the location of Porong River, so it is feared this mud flow will disrupt the sustainability of the river.

Attempts to remove the mudflow around the site are impossible. The best thing to do is to make the utilization of the mudflow into one of the mixed materials of construction material that does not need the heavy construction strength. One construction that is most likely to be implemented with a mixture of mudflow is the construction of a tertiary irrigation canal lining.

LITERATURE REVIEW

Global warming that causes climate change and the shift of the rainy season and dry season will certainly have an impact on the amount of surface water including irrigation water. Almost in all parts of Indonesia are affected by climate change.

In order to maintain the continuity of irrigation water supply, efforts should be made to provide a lining to the construction of irrigation channels so that the limited water can be effectively and efficiently utilized.

During this construction of irrigation channel lining using pairs of rocks consisting of species and rocks taken from the river. During this time the community's need for stone and sand materials to conduct rehabilitation of irrigation networks is very high.

Rocks and sand are non-renewable minerals and natural resources in the river. Efforts should be made to prevent sand and stone mining to conserve the river and its ecosystem. Otherwise, over a period of time, the degradation and erosion will occur at the bottom of the river due to the mining.

Stone, being a natural resource, cannot be renewed and over time will run out while the need for irrigation water increases along with the increasing of the population in Indonesia. An important thing to keep the continuity of irrigation water discharge is to keep the irrigation channel intact by developing waterproof construction on the wall and bed of the irrigation channel [1].

The assumption is that the experiences provide advice to the decision makers to find ways/methods to improve regional or country water resources system planning and analysis [2].

To minimize the irrigation water contamination as well as to preserve the environment due to the increase of Sidoarjo mudflow, it is best if the mudflow is used for the mixture of materials used as wall pairs of irrigation canals and bed of irrigation channels. Sidoarjo mudflow bursts can be utilized as renewable natural resource materials as Sidoarjo mudflow continues to grow.

The most important thing is to make a mixture of Sidoarjo mudflow and other materials into a strong, solid and water-resistant mixture.

The mudflow location map is presented in Fig. 1 while the change of the situation since 2006 are shown in Fig. 2 to Fig. 6.

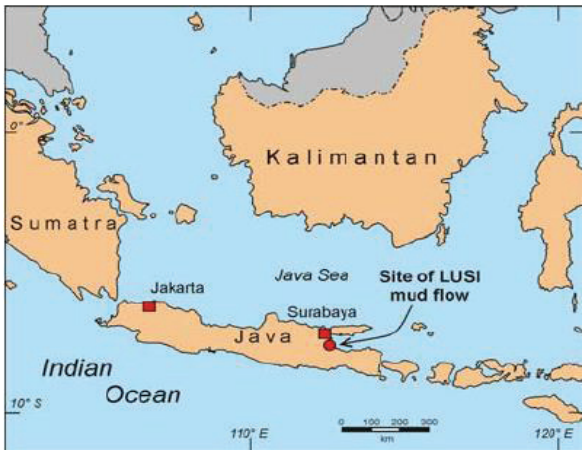

FIGURE 1. Location map of mudflow [7]

FIGURE 2. Photo before mudflow accident [7]

FIGURE 3. Photo shortly after the event of mudflow accident [7]

FIGURE 4. Photo in 2008 [7]

FIGURE 5. Photo of mudflow [7]

FIGURE 6. Photo of mudflow [7]

The water quality of Porong River which is located near the mudflow of Sidoarjo must also be maintained because the water is also used for the irrigation in Sidoarjo Regency. In fact, the irrigation water supply can also be taken from a reservoir of a dam. Dam construction is one of the best solutions to develop the potential of water resources given the current imbalance of water resources [3]. But the location of the district area Sidoarjo is landward and near the estuary of the river that is not enabled to build a dam. Under these conditions, it is necessary to make new innovations to utilize Sidoarjo mudflow as sand/rock substitute for mixed pairs of irrigation channel construction.

New innovations should be implemented in order to ensure the strength of construction materials as well as a fixed percentage of mortar materials to meet the standards on irrigation channels. If this research success, the national innovation will succeed also. Finally, the Sidoarjo mudflow as seen in Fig. 7 does not get worse.

FIGURE 7. Recent photo of mudflow [7]

If the new research or innovation is successful it will certainly be followed by the utilization of Sidoarjo mudflow as a mixture of construction materials for road drainage, urban drainage and so on. In addition to research on the utilization of Sidoarjo mudflow, it is also important to give priority to the handling of irrigation channels using construction materials from the mixture of Sidoarjo mudflow with other materials. Besides looking for innovation of construction materials, it is also important to do a hydraulic analysis of irrigation water. Hydraulics analysis aims to determine the ability of a drainage channel to accommodate the discharge plan [4].

The rapid development of science and technology has an impact on the emergence of efforts to promote the acceleration of infrastructure development including irrigation network. The strategy on the development of adequate, appropriate and sustainable irrigation infrastructures urgently required in order to improve the national economy and food durability in Indonesia [5].

The studies conducted since 2007 until 2015 regarding the utilization of mud, generally are not in-depth and detailed. One of the researchers produced is about the utilization of Sidoarjo mudflow for building accessory. In practice, it was a good raw industrial material for interior and exterior decoration in general and for making statues using the molding technique in particular [6]. Therefore, it is necessary to conduct a research that will conduct a detailed and in-depth study on the utilization of Sidoarjo mudflow equipped with several laboratory tests such as Physical Parameters Test and Sidoarjo mudflow Chemistry Test. In addition to these tests, Scanning Electronic Microscope and Microspore Structure Tests should also be conducted

The initial phase of this research will be conducted on the utilization of mud as a mixture of stone lining on the irrigation canal. Sidoarjo mudflow volumes will be gradually added to the research mixture and standardized strength tests in the laboratory, resulting in a strong, solid and water-resistant mixture. Gradually the volume of mud can be enlarged to reduce the volume of the stone river.

METHOD

The method used in this research is a descriptive method that is direct observation at the research location and record things that need to be done as well as to conduct laboratory test of Sidoarjo mudflow materials including strength test of Sidoarjo mudflow mixed with other material. The problem approach and the relevance of the methods used to achieve the goals and objectives are:

- Sidoarjo mudflow is laid in a flat place to remove its water content.
- While waiting for the mudflow to dry, the mudflow sampling is done and the ground in the irrigation channel location of the research plan to be tested in the soil mechanics laboratory.
- Mixing of construction materials consisting of cement, water and Sidoarjo mudflow with various percentage comparisons.
- From each percentage of strength, the test is conducted in a concrete laboratory that includes the test.
- After the results of the test according to Irrigation Standards is obtained, we proceed with the installation of a tertiary irrigation canal with construction materials in accordance with the test results at the research site in tertiary irrigation channel of the region of Sidoarjo Regency along the 100 meters on the left and right side.
- After completion of the irrigation lining operation, followed by observation of the strength of the lining in holding the active pressure load of the soil from the back of the channel and also its resistance to the possibility of water seepage.
- The possibility of seepage can be known from the irrigation water flow at the starting point and the irrigation water flow at the end point of research at each 100 meters of an irrigation canal.

RESULT AND DISCUSSION

Based on existing problems and as an effort to handle these problems and whether the research can be properly implemented, the benefits of the research are as follows:

- Qualitatively the results of this research are very useful, especially as one effort to preserve the environment and obtain materials that are environmentally friendly. Utilizing Sidoarjo mudflow is also an effort to reduce negative impact in Porong River and its estuary.
- If Sidoarjo mudflow can be utilized for irrigation lining then qualitatively this research will produce a very helpful outcome to the efforts of the Ministry of Public Works and Public Housing in improving Indonesia food security through the rehabilitation of irrigation networks and efforts of the Ministry of Environment and Forestry in preserving the environment.

- The volumes of Sidoarjo mudflow which are continuous and unpredictable, can be utilized to reduce the deposition of Sidoarjo mudflow in the reservoir.
- If the volume of Sidoarjo mudflow remains or decreases because some of it has been utilized, then it is no longer necessary to increase the height of the embankment, so it can reduce the government budget in handling the Sidoarjo mudflow.
- The other output is the decrease of sand/rock capture in the river, the region and around Sidoarjo Regency as well as the economic value of the Sidoarjo mud, which previously constituted a material that disturbs the environment into a material that has a selling value.
- In the medium term, it will be able to increase the income of the surrounding community by becoming a Sidoarjo mudflow picker.

CONCLUSION

The benefits of activities/research to be conducted are:

- Utilization Sidoarjo mudflow as an environmentally friendly building material.
- Reduce the negative environmental impacts in the area round of the Sidoarjo mudflow.
- Reducing the negative environmental impact of the Porong River.
- Reduce the negative impact of the Porong river estuary.
- Reduce the removal of sand/stone in the river of the region and around the area of Sidoarjo regency.
- Preserve the river environmental ecosystem.
- Improve value of the economic results from Sidoarjo mudflow, which previously is a material that disturbs the environment into materials that have value to sell.
- Increase the income of the surrounding community by becoming the Sidoarjo mud picker.
- There is no need to increase the height of the embankment so as to reduce the State budget.

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