Engineering and Technology Journal e-ISSN: 2456-3358

Volume 09 Issue 08 August-2024, Page No.- 4657-4660

DOI: 10.47191/etj/v9i08.06, I.F. – 8.227

The Impact of Flow Patterns Due to the Cold Lahar Flooding of Mount Semeru on the Collapse of the Bridge Connecting Malang District and Lumajang District

Djoni Irianto[1], Nur Andajani[2], Nurmi Frida[3], Andang Wijaya[4], Heri Suryaman[5], Desy Ratna Arthaningtyas[6], Arvieka Sabilla Putri Setiadi[7], Muhammad Evanni[8], Naufal Dhiya U[9]

[1,2,3,4,5,6,7,8,9] Department of Civil Engineering, Faculty of Engineering, Surabaya State University, Ketintang, Surabaya, 60231, Indonesia.

ABSTRACT: The flow patterns that occur in rivers as a result of falling cold lava often cause damage here and there. This incident cannot be separated from the large volume of water mixed with material that crosses the open channel which is caused by input water supply or water supply from river reservoirs crossed by cold lava. by water researchers for water mixed with volcanic eruption material suspended above. The event of water flowing through a river is influenced by the presence of the surface profile of the river bed and the various widths of the river that occur. If a volume with a certain viscosity is given, a thick flow will be formed that can be seen on the surface of the river, while that which is not visible to the naked eye above the water surface is called thick viscosity.

If the runoff of cold lava material that occurs in the channel is not measured, it will result in wild jumps. The wild and viscous jumping structure that has been arranged can be observed as to how the flow pattern occurs. To avoid not detecting the flow pattern, water measuring structures are needed, one of which is a threshold with openings below or what is known as flow above the threshold along with existing bridge buildings around it. This sluice gate is easy to operate manually. The need for water operations with excess water availability is not an easy thing to calculate, because of the influence of depth and jumps that occur around the bridge, hydraulic jump patterns often ignore this measurability, this will be an obstacle if there is a large supply of cold lava. mixed with rainwater during peak conditions in the drainage process. Observations of this completion need to be proven by carrying out model tests using a tool known as the Threshold which produces a water jump along with the material. This requires further investigation for research in the model channel.

For modeling thresholds and bridges connecting between plains, this tool provides instruments and many threshold treatments as well as regulating pressurized water with a pump at a certain flow rate in a measurable manner. To analyze the height of building damage, determine the flow pattern, speed by observation, test results with valve openings on certain pumps, researchers tested and measured the position of cold lava deposits one by one, the position of the slope of the river in certain sections, starting with an opening of 0.5; 0.75, read the instrument, move the threshold position from a bridge distance of 20 cm, 40 cm, to the furthest distance of 240 cm. Make graphs of test results for the threshold of the bridge opening transfer tool by testing the tool and opening 3 times for each pump opening, recording, mapping the depth values, jump length and travel time of the instrument on the test tool. Recommend the results of the analysis of the Threshold and Bridge tests to provide information to bridge construction planners that the test results with various threshold positions in certain conditions have the value of the Glidik II bridge collapse, the jump with the travel time of the speed of passing cold lava. Next, the bridge is determined and the next threshold can be used to determine how severe the damage is to the river. This research is laboratory research with threshold and bridge models. The target of this output is a journal article resulting from a simulation of determining the flow pattern that occurs in the channel by shifting the position of the threshold relative to the location of the bridge from the channel model with various diameter sizes of the model material, the results of which are in the form of a table and graphed on the part modeled in the water laboratory, especially flow with sediment and cold lava material. The results of this section were observed up to the collapse of the bridge at a depth of 4.5 cm with an opening of ½ second to 37 (on the model scale) observed or a depth of 45 meters (on the empirical scale). to then be written in the form of an article to be included in an international journal.

KEYWORDS: bridge position, flow pattern, threshold, thick viscosity.

1. INTRODUCTION

The flood disaster accompanied by material on Mount Semeru, Lumajang Regency, East Java on Friday 7 July 2023 caused the collapse of a bridge in Sidomulyo Village, Pronojiwo District. The flooding of Mount Semeru material has resulted in national road access in the southern region of East Java being cut off, because this is the only bridge that connects Malang Regency with Lumajang Regency. The Ministry of Public Works and Public Housing (PUPR) through the East Java-Bali National Road Implementation Center (BBPJN), the Directorate General (Ditjen) of Highways will build the Kali Gldik II Bridge to permanently handle Mount Semeru flooding.

According to the Head of BBPJN East Java-Bali, Rakhman Taufik, the survey results show that technically, the temporary treatment option of installing a Bailey Bridge is not feasible. Apart from that, one of the two pillars of the Kali Glidik II Bridge was lost in the flood. Under these conditions, the planned temporary treatment alternative with the installation of a Bailey Bridge is less feasible to be implemented at the existing location of the Kali Glidik II Bridge. This is because the existing pillars are not safe to support the Bailey Bridge.

Minister of Public Works and Public Housing (PUPR) Basuki Hadimuljono provided information on the cause of the Kali Glidik Bridge being swept away by the lava flood from Mount Semeru. The foundation of the Kali Glidik II Bridge apparently did not penetrate the rocks at the bottom of the river because there were lava deposits so that when it was hit by a lava flood with a large water discharge and carrying volcanic material, the bridge was destroyed.

The Kali Glidik II Bridge was built in 1970 or is 53 years old. This bridge is 37 meters long with a width of 6.8 meters. The upper building of the bridge is a permanent steel girder and consists of 3 spans. As a result of the collapse of the Kali Glidik II bridge, it also caused a landslide on the cliff of the national road in Sumberwuluh Village, Candipuro Lumajang District, precisely at KM Turen 58+700. The plan to install the Bailey Bridge as a replacement for the Kali Glidik II Bridge is being implemented in 2 stages, namely stage 1 with a span of 30 meters and stage 2 with a span of 18 meters. In the future, it will be necessary to limit the maximum vehicle load to 25 tons.

Events that occur in the river, if not measurable, will result in damage to the land around the channel and can even damage the channel structure. In order to avoid damage to the model area, a water measuring building is needed, one of which is a sluice gate with an opening under the door or what is known as the Ambang. It is easy to move either manually. The need for operational water with excess water availability is not an easy thing to calculate, because the influence of depth, differences in height upstream and downstream, differences in hydraulic jumps often ignore this measurability, this will be an obstacle if there is an increase in the amount of water supply at the time. peak conditions in the flow process. This determination needs to be proven by carrying out model tests using a tool known as a wide threshold that produces a hydraulic jump. In-depth research is needed in the laboratory.

Furthermore, recommending the results of the analysis of the threshold location test to provide information to water building construction planners that the test results with various door openings in certain conditions have different values of depth, pitch.with travel time. This will then be applied to sluice gates and other water structures which can then be used to determine the distance between the threshold and the bridge after the flow of cold lava material (cm).

The reading of the observation results is in manual form so that it makes it easier for researchers to read the data. On the outside of the tool there is a sign reading the distance between the threshold and the bridge which indicates it will collapse. The instrument after crossing the Threshold and Bridge is measuring cm. The urgency of this research is expected to make recommendations on the flow that occurs in the Glidik II River, to make it easier for field implementers to determine the type of viscosity of the flow pattern that is dangerous to residents around the river.

2. LITERATURE REVIEW

2.1. Cold lava flood

Anita Megawati produced a work entitled Study of the Effect of Cold Lava on the Utilization of Raw Water Sources in Areas Prone to Mountain Disasters (Case Study: Mount Semeru). The spread of cold lava flows to raw water sources in the Mount Semeru disaster-prone area, the influence of cold lava on the provision of raw water for residents in the Mount Semeru disaster-prone area is also explained.

The activity of Mount Semeru since it erupted in 1818 shows that this mountain has the potential for an eruption that could cause a bigger disaster. Semeru is the most active mountain on the island of Java. Mount Semeru eruptions occur every 10 to 30 minutes, emitting ash, sand, rock and lava towards the southeastern slopes. There are three river channels on the southeastern slopes, namely the Mujur river, Rejali river and Glidik river. In these rivers, volcanic mud flows often cause damage to plantations and yards. (Nur Ahmi, 2020)

2.2 Threshold Length

In open channel hydraulics, many flow phenomena cannot be analyzed correctly with this mathematical formulation because the approach ignores the basic properties of liquids and flows, such as:

a. The viscosity of the liquid is ignored.

b. The mass density of water is always constant so that changes are ignored.

Referring to the statement of an expert (Ir. Bambang Triatmodjo) who said that it was possible to find the threshold jump length (Lj). There is no definite theoretical formula that can be used to calculate it and the length of the water jump can only be found through laboratory research, so to bridge this gap, it is necessary to seek correction figures for theoretical calculations obtained through tests on several hydraulic models.

2.3. Threshold.

A threshold is a tool for changing the flow pattern in a channel by utilizing the energy of the path to become a water jump, which means that the faster the openings produced by the threshold, the higher the resulting jump so that water can be distributed to other places higher, faster and more measurably (Hannif Chaudri, 2000)

A threshold is a tool that aims to convert movement energy into a jump. Thresholds are used to dam, raise the water surface with kinetic energy and hydrodynamic energy from sub-critical fluid flow to become super-critical jumps (Subramanya, 2016).

The operation of this tool is to make a height difference between the inlet and the outlet. In words, it functions to change energy mechanical energy from a source (driver) becomes kinetic energy (Froude number) where this energy overcomes the jumps along the channel.

The threshold occurs due to changes in flow from super critical flow becomes critical flow. Generally, this threshold jump occurs when the threshold path is below the critical depth of a flow, or when water comes out of a spillway. At the Threshold, a very large wave can be seen, which is accompanied by a very large reduction in energy, so that after the jump the water flow becomes calm because the speed decreases suddenly and the depth of the flow increases rapidly. Applications of water jumps include, among others, as an energy reducer in a water structure so that erosion of the downstream structure can be prevented, increasing the pressure on the protective layer so as to reduce the lifting pressure on the threshold structure by increasing the runoff distance on the protective layer, to remove air pockets from the mud supply network. , thereby preventing viscous fluid pressure locking.

2.4.Model Iteration.

Iteration of river flood waves after the disaster in Korea using modeling in the 1D routing method laboratory resulted in unsteady velocity propagation in open channels (Ven Tee Chow 2015).

Flood wave propagation for dam break cases and calibration using 1D experiments in the laboratory at the University of Mississippi, America, for head loss using weighting of various valve openings were able to be simulated and data obtained (Xinya Ying, 2013).

Modeling by conducting physical flow experiments with finite element method breaking wave propagation compared with laboratory experiments, it turns out that the compressible flow method is able to simulate head loss propagation (A. Kaceniauskas, 2016).

3. RESEARCH METHODS

3.1. The research method is described as follows:

1. Survey to a location close to the upstream source of the cold lava.
2. Survey approaching the river and Glidik II Bridge.
3. Setting and Research Characteristics.

Modeling was carried out in the Unesa water laboratory

4. Research Procedures

Running the Research Simulation is to carry out irrigation on the Filting Flume tool with liquid contents mixing cold lava samples with water. The research was conducted during June-November 2024.

5. Target points of research tools and steps

a). Tools used:

Water gate models, pumps, tilting flume

Flow watch

Tank for holding test water.

Height measuring ruler.

Writing equipment for recording data.

b).Work Steps:

Prepare the tools above

Prepare a model of the material used for observation during research.

Measure the width and height of the duct to calculate the volume.

Treat the location using existing model bridges.

Flow valve opening treatment ½, ¾

4. RESULTS AND DISCUSSION

Table of test results with sediment

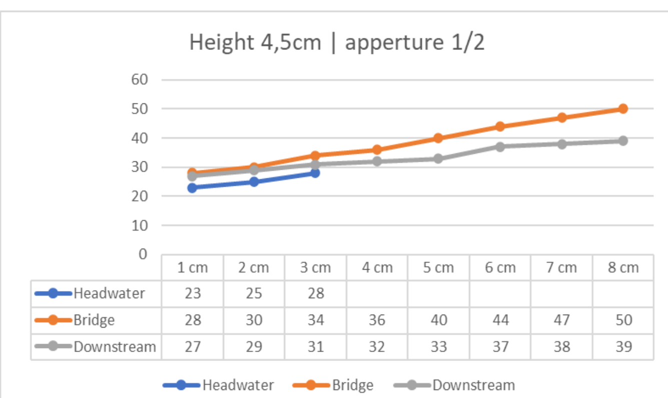
Height 14cm | apperture 1/2				
	Headwaters (dt)	Bridge (dt)	Downstream (dt)	Inform
1 cm	23	28	27	
2 cm	25	30	29	
3 cm	28	34	31	
4 cm		36	32	
5 cm		40	33	
6 cm		44	37	
7 cm		47	38	
8 cm		50	39	

Height 14cm | apperture 3/4				
	Headwaters (dt)	Bridge (dt)	Downstream (dt)	Inform
1 cm	20	32	23	
2 cm	21	33	25	
3 cm	24	34	28	
4 cm	33	35	29	
5 cm		37	30	
6 cm		39	32	
7 cm		41	34	
8 cm		43	35	

Height 14cm | apperture 1				
	Headwaters (dt)	Bridge (dt)	Downstream (dt)	Inform
1 cm	20	25	23	
2 cm	21	27	25	
3 cm	24	33	26	
4 cm	33	37	28	
5 cm		39	29	
6 cm		40	31	
7 cm		42	33	
8 cm		44	35	

Height 4,5cm | apperture 1/2				
	Headwaters (dt	Bridge (dt)	Downstream (dt)	Inform
1 cm	22	25	26	
2 cm	24	29	28	
3 cm	26	37	29	bridge collapsed
4 cm				
5 cm				
6 cm				
7 cm				
8 cm				

Graph of when the bridge collapsed



CONCLUSION

1. Material at the location before and after the Glidik II bridge can be taken with a diameter of 3 cm to 200 cm.
2. The flow pattern that occurs is based on information from BPBD Lumajang officers, BBWS Pasirian Lumajang, documentation photos, modeling results in the UNESA water laboratory, namely Turbulance Flow with a channel bottom slope before the bridge of more than 45º
3. The Old Bridge with a height of 45 meters, and 90 meters from the river bed below the bridge experienced a collapse both from the information above and from the modeling results
4. The collapse of the Glidik II Bridge from the modeling results occurred at a height of 4.5 cm with an opening of ½ at the 37th second, or 45 meters on an empirical scale

SUGGESTION

1. It is recommended that the bridge at Glidik II Besuk Koboan be placed at a height of 18 cm (for modeling) / 180 meters above the river bed
2. At a height of 150 meters above the river bed, there is still the potential for bridge collapse, so you need to be careful if there is heavy rainfall and more than 2 hours on the slopes of Mount Semeru, there will be a threat of bridge collapse.

REFERENCES

Journal

1. Pagular Andri. 1988. Mississippi River Flood Simulation. Journal.
2. Kris Darmadi. 2014. Steady Flow. Journal.
3. Kaceniauskas. 2005. Simulation of Physical Flow Experiments. Journal.
4. Ying Xinya. 2004. Flood Prediction Simulation. Journal.

Book

1. Mawardi, Imam. 2012. Permanent Dam. Jakarta
2. Irianto. 2012. Hydraulics 2. Unipress Unesa.
3. Irianto. 2012. Water Buildings. JTS Unesa
4. Irianto. 2013. River Engineering. JTS Unesa
5. Irianto. 2018. Hydraulic Modeling. JTS Unesa.
6. Kustini Indiah. 2013. Irrigation and Water Buildings. JTS Unesa. 7. Soedradjat. 1983. Fluid Mechanics and Hydraulics. Nova. Bandung. 8. Subramanya. 2015. Open Channel Flow. McGraw Hill.
7. Ven Te Chow. 2005. Open Channels. McGraw Hill.