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The Effectiveness Of Water-Filled Rubber Weir Management On Flood Mitigation Caused By Rain And "Rob" (Java Slang) In Demak District

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Abstract - In Indonesia, there are many sources of water. They can be ground water, rivers or seas which are certainly not easy to process these resources. Many problems have to be solved in processing these resources, such as flooding and "rob" problems in the Demak district. When dry season comes, how can we provide raw water and pure water for irrigation and other problems? One of the right solutions is to make a rubber weir that contains water. Normally, weir contains wind but this study tries to use different methods of filling weir by using water to make it easier and more practical in the treatment. Identifying problems such as alternative flood and rob handling is intended to unravel the problems in traffic congestion, submerged settlements and industrial estates, and analyzes the stability of the flow that occurs in the water-filled rubber weir model. The formulation of the problem with the model of water-filled rubber weir must be followed by the experimental system conducted in the Lab Faculty of Engineering UNISSULA Semarang. Therefore, the main problems studied in this research are the experiment of the water-filled rubber weir, the hydraulic effectiveness of the water-filled rubber weir, and stability analysis of numerical models of the water-filled rubber weir. The purposes of this study are analyzing the hydraulic effectiveness of water-filled rubber weir with SOBEK application, analyzing the characteristics of the water-filled rubber weir to obtain a good weir material based on appropriate technology, and conducting a stability analysis of the flow occurring in the water-filled rubber weir model, prototype simulation of water-filled rubber weir.

Keywords: *Management effectiveness, Water-filled rubber weir, Flood and rob prevention*

1. Preface

A. Background

There are many water resources in Indonesia, whether it is ground water, river, or sea. Of course, it is not easy to process these resources. Many problems must be solved in processing these resources, such as flood and rob problems in Demak District, drought during dry season, how we should provide raw water and water for irrigation when drought strikes, and other problems. One of the right solutions is to make a rubber weir that contains water. It usually contains wind but this study tries to use a rubber weir that contains water for easier and more efficient treatment.

B. Purposes and objectives

1. Analyzing the hydraulic effectiveness of water-filled rubber weir.
2. Analyzing the characteristics of the water-filled rubber weir to obtain a good weir material based on appropriate technology.
3. Conducting a stability analysis of the flow that occurs in the model of water-filled rubber weir.
4. Conducting a simulation of water-filled rubber weir prototype.

2. Literature Review

A. The Meaning of Weir

Weir is a Water Building Construction across a river that aims to raise the water level of the river in Upstream. The remaining objective is to increase the water level so that it can be used to irrigate the fields (irrigation).

Based on the characteristics of its construction, weir is divided into 2 (two) types:

1. Simple Weir (non-permanent).
2. Permanent Weir (Technical).

Kalijajar Weir in Demak District is one type of permanent weir. Here are the divisions of permanent weir types:

1. Fix Weir, is a type of weir that keeps its crest elevation fix, so that the water level elevation cannot be set.
2. Barrage Weir, is a weir with a non-fix crest elevation (moveable), or equipped with a regulator/door, so it can adjust the water level elevation.

Types of Barrage Weir based on the shape of the regulator:

a. Sluice Gate

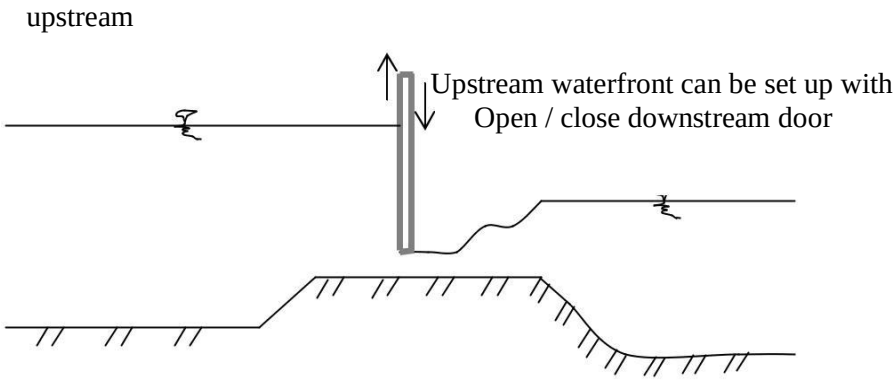

Figure 1. Bend slide gate

Radial Gate

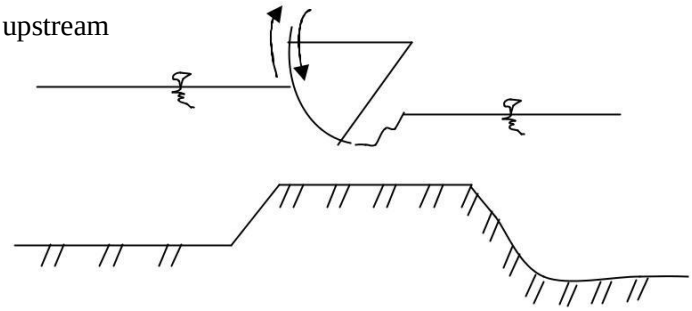

Figure 2. Bend Motion: Radial Gate

b. Rubber Weir

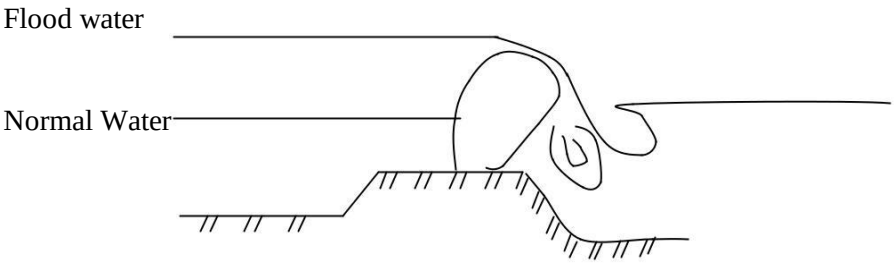

Figure 3. Bend Motion: DAM Rubber dam

The regulator of Rubber Weir can be pumped as needed, by adding or reducing its contents. A rubber weir can be filled with water or air.

B. Design Flood Discharge Analysis

The selection of design flood for aquatic building is a problem that relies heavily on statistical analysis of the sequence of flood events either in the form of river water or rainfall discharge.

C. Rainfall Data Analysis

By determining the rainfall data from the recorder, only rainfall at a certain point (point rainfall) can be obtained. To get the rate of areal rainfall can be calculated by several methods:

A. Algebra Average Method
B. Polygon Thiessen Method
C. Isohyet Method

3. Research Methods

A. How to Research

This research uses qualitative and quantitative research strategies supported by several tactics and research stages. Objectively, this research covers the importance of water-filled rubber weir in handling flood and robs water.

B. Place and Time of Research

The research is conducted in Demak District and applied the model in Civil Engineering Laboratory of Sultan Agung Islamic University (UNISSULA) SEMARANG in four months.

C. Population and Sample

Technique of data population used in Kalijajar River Demak District is the calculation of weir's stability and dimension. It is expected to give the right conclusion among samples taken.

D. Flow Chart of Research

Here is a flowchart of the research proposal that will be implemented:

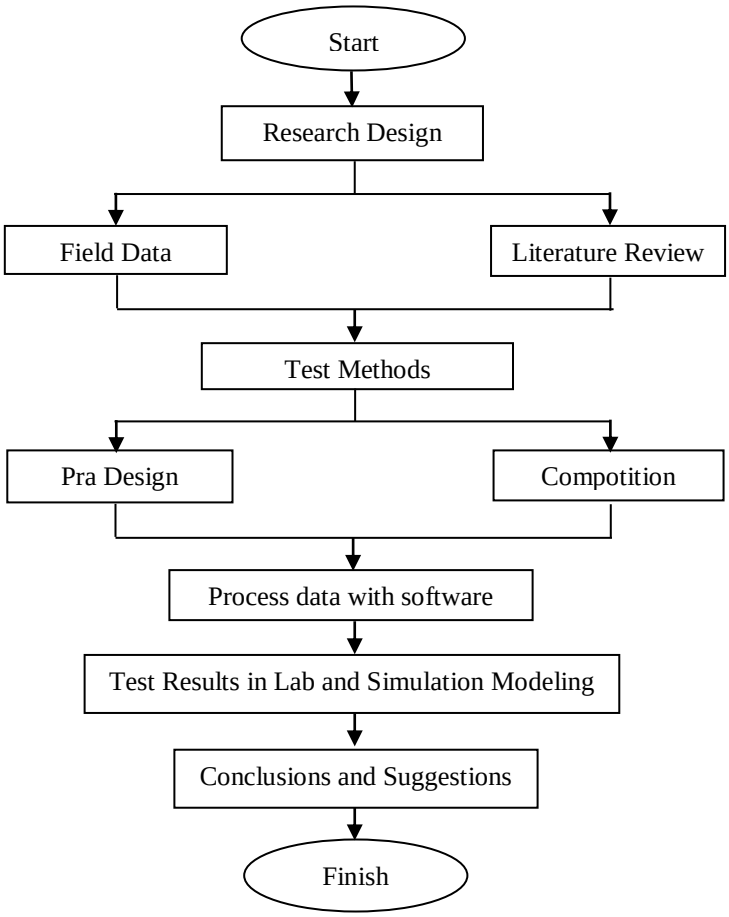

Figure 4. Flowchart Of Research

4. Results And Discussion

The width of the weir is the distance between the abutments and should be equal to the average width of the river on the stable part. In the bottom section of the river, the average width can be taken at bank full discharge, while at the top of the river it is difficult to determine the full discharge. The maximum width of the weir should be no more than 1.2 times the average width of the river on a stable groove.

Table 1. Prices of Pillar Contraction Coefficients (Kp)

No		Kp
1	For rectangular-shaped pillars with rounded corners on the fingers Almost equal to 0.1 of thick pillars	0,02
2	For rounded pillar	0,01
3	For a pointed pillar	0,00

Table 2. The Contraction Coefficient of Bendung (Ka)

No		Ka
1	For the base of the rectangular wall with the upstream wall at 900 to the flow direction	0,20
2	For the base of the round wall with the upstream wall at 900 in the flow direction with 0.5 Hl> r> 0.15 Hl	0,10
3	For the base of the round wall where r> 0.5 Hl and the upstream wall is not more than 450 to Flow direction	0,00

Type Of Weirs Crest

For the type of weirs crest in Indonesia, there are generally two types of crests, the Ogee and circular type. A weir with circular crest has a much higher coefficient of discharge than the broad crest weir's coefficient. The discharge coefficient becomes higher because there is a crest in streamline curvature is and the negative pressure.

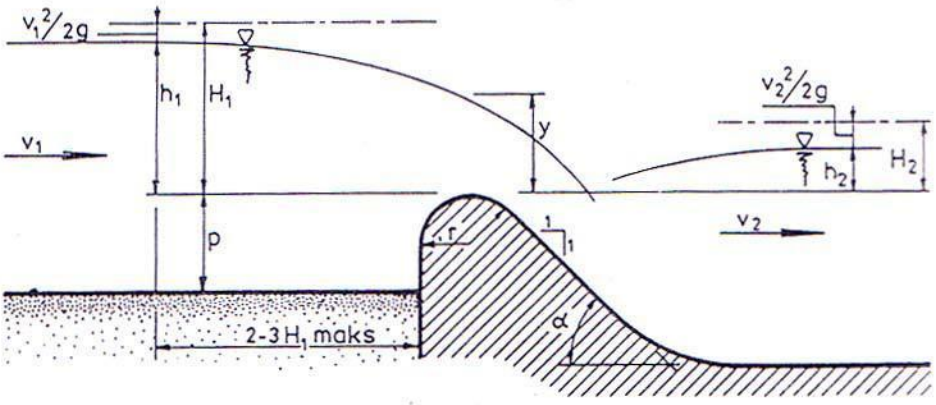

Figure 5. Bendung with Mercu Round

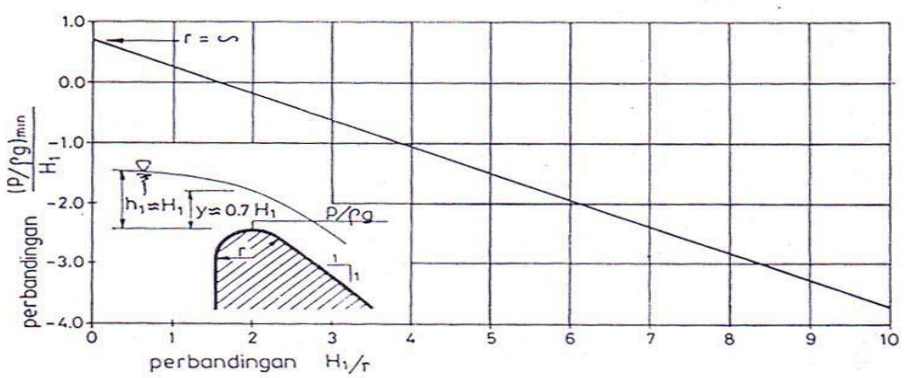

Figure 6. Pressure on Mercu Bendung Bulat as Comparison Function H1 / r

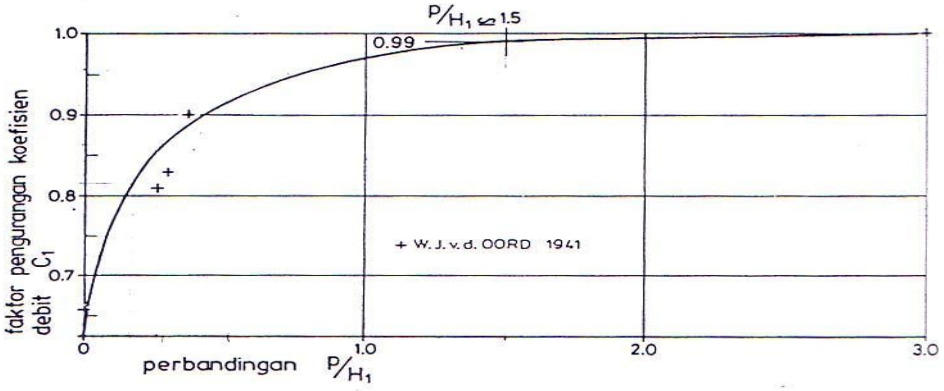

Figure 7. Coefficient C1 as Comparison Function p / H1

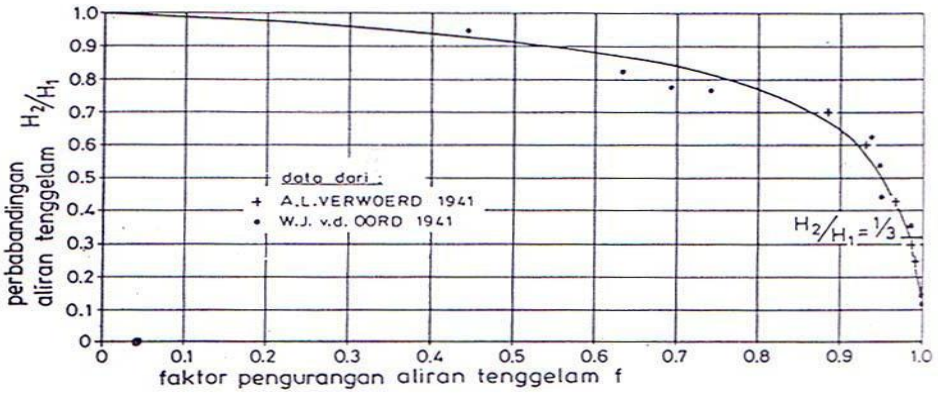

Figure 8. Sink Flow Reduction Factor with H2 / H1 Function

Downstream tilt	**K**	**n**
Vertical	2,000	1,850
3 : 1	1,936	1,836
3 : 2	1,939	1,810
1 : 1	1,873	1,776

The shape of the light can be seen in Figure 2.15 below:

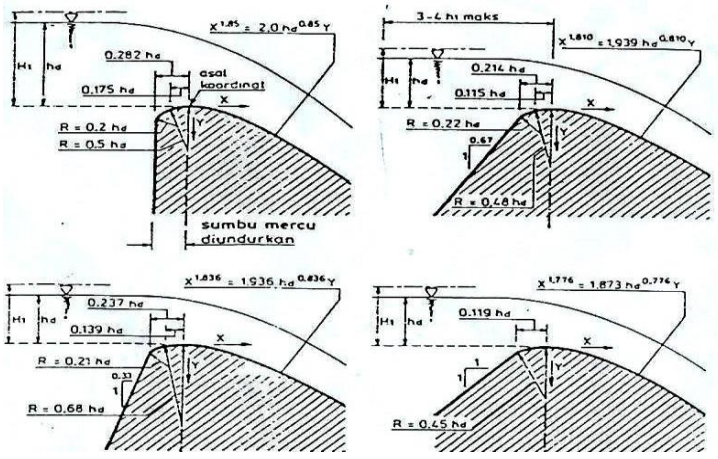

Figure 9. Type Mercu Ogee

Parts of Weir

A weir consists of several components, namely:

1) Body of Dams serves as a water barrier.
2) Foundation keeps the dam sturdy.
3) Gates is used to regulate, open and close the flow of water
4) Gate Leaf holds water pressure and can be moved to open, regulate, and close the flow of water.
5) Guide Frame keeps the movement of the door accordance as planned.
6) Anchorage holds the guide frame in order to move the load from the gate to the concrete construction.
7) Hoist is a tool to move the gate leaf to open and close easily.
8) Spill Way drains the flood water into the dam so it does not endanger the safety of the dam.

The definition of Rubber Weir

Rubber weir can function to elevate the water level by inflating the body of the weir and lower the water level by deflating it. The opening of the weir can be done automatically by deflecting the rubber tube, while inflation can only be done manually. The rubber weir was first built in 1957 in the United States by using textile materials to form the weir body. In 1978, the material was developed into nylon fibers wrapped in synthetic rubber. The development of rubber weir in Indonesia was begun in 1990. Its application found many problems and resulted in low performance of weir. The problem is caused by the lack of theory and experience supports. In addition, there were no guidelines that could be used as a reference for the rubber weir planning. Therefore, guidelines for rubber weir design are prepared. This guideline outlines the basics of consideration for building rubber weir, the location requirements, rubber weir structures, and technical planning.

Kinds of Rubber Weir

In its making, there are 2 kinds of rubber. They are:

1) Air-filled Rubber Weir, which uses air as a rubber tube filling medium. And,
2) Water-filled Rubber Weir, which uses water medium as a filler medium for rubber tube.

Considerations in Rubber Weir Selection

The selection of rubber weir should consider the following matters:

1) Application alternative of other types of weir which are cheaper without neglecting the effectiveness for the purpose of constructing a weir;
2) The rubber weir is only applied on a condition when the weir is used; it will increase the threat of flood that is difficult to overcome;
3) Rubber weir alternative is selected if the other types of moving weir cannot guarantee the certainty of the weir's opening when flood and rob come, considering the area that must be secured against the threat of flood is an important area.

Requirements for Construction of Rubber Weir

1) River Flow Condition;
2) Having subcritical flow;
3) No severe sedimentation that interferes the mechanism of the rubber tube;
4) Not transporting rough sediments;

5) The river flow does not transport large and hard waste;
6) River water does not contain chemical waste that can react with rubber;
7) Materials used for the weir itself;
8) Made weir's filler media
9) Rubber tubes are made of elastic, strong, airtight, non-easily penetrating, and durable material;
10) The planning of rubber material whether its type, strength or dimensions should be adjusted to the producer's ability to provide them;

Operation and Maintenance Requirements

In order for the rubber weir's operation can be carried out properly, the following matters are required:

1) Good weir's condition and not leaking.
2) Installation of inflation/deflection and pumps can function properly.
3) Detailed instructions and operating patterns are provided
4) The weir operation should be done following the predefined pattern.
5) Operation officers who master the instructions and patterns of rubber weir operation.
6) Maintenance of the rubber weir, especially the rubber, it should be done with high intensity, considering the trivial disruption to the rubber can result in weir's malfunction.

Weir's Body Planning

Rubber material

It should be rubber sheets made of elastic, strong, solid and durable rubber material. In general, rubber materials used have the following specifications:

Hardness

The abrasion test uses the H18 method with a 1 kg load on a 1000 times spin,not exceeding 0.8 m3/mile

1. **Tensile Strength**
   Tensile strength at normal temperature ≥ 150 kg / cm2
   Tensile strength at temperature 100o ≥ 120 kg / cm2
   The rubber material is reinforced with a nylon yarn fabric which gives the tensile strength as needed to withstand the force as described. Rubber base material commonly uses synthetic rubber, such as ethylene propylene diene monomer (EPDM), chloroprene rubber (CR), etc. To reduce scratches because of sharp/hard objects, the outer surface of the rubber can be coated with a ceramic material.
2. **trength**
   The strength of the rubber sheet must be able to withstand the force of water pressure combined with the air pressure force within the weir body.

Rubber Weir's Design

The design of the rubber weir is based on the following provisions.

1. Based on the hydraulic, Rubber weir must meet the following requirements:
   a. Being able to serve the planned water level.
   b. Opening automatically in case of floods that exceed a certain limit.
   c. On weirs that serve to withstand saltwater intrusions, the salt water trapped in the upstream weir should be pushed downstream.
   d. Safe against the scouring of river basins due to waterlogged energy.
   e. Safe against interference from water flow and transported solids.

f. The height of the rubber weir generally does not exceed 5,00 m, with the consideration that the construction of a rubber dam with a height> 5,00 m is not efficient anymore.

2. Based on the structure, Rubber weir must meet the following requirements:
   a. Strong and stable against soil's bearing capacity, overthrowing, and distorting as well as foundation base erosion;
   b. The weir layout is planned in such a way that it can provide facilities for the repair work of the weir body easily and cheaply.
   c. Layout of the weir
   d. The length of the weir is cultivated equal to the normal width of the river channel.

Installation Planning

1. Water Hole
   It is a hole for water to enter and exit in the rubber tube.
   Pumps and Air Channels
2. Air pump should be provided to inflate the rubber tube. Air pumping into a rubber tube must be equipped with an air pressure controller (manometer).

Good Weir's Criteria

Related to operations and maintenance, a good rubber weir has the following criteria.

1. It can be developed properly without leakage
2. It can deflate automatically and manually on the planned conditions
3. There is a foundation that can be dewatering and rubber patching easily.
4. The weir body is protected from sunstroke, for example by using pedestrian bridges.
5. The weir body is safe against public disturbance and river transportation.
6. The weir body is resistant to sediment abrasion, safe against water flow and sediment/garbage transport.

Automation System

The working principle of the automation system is that if the river water upstream has reached the planned deflated water level, there will be an inrush flow into the system, which is set to move the lever of the air channel from the rubber tube. The usual lever drive systems used are as follow:

1. The bucket system, the water flow is accommodated in a bucket tied to the automation box. As the weight of the bucket becomes heavier, the bucket position will descend to turn the air channel lever.
2. Flotation system, the water flow is accommodated in a tub in which a buoy is tied. It is tied with a rope connected to the automation box. If the water level rises, the buoy goes up and moves the lever.

Application

Maintenance work is divided into four kinds:

1. Periodic inspection to know the condition of the building.
2. Periodic maintenance of each component of the weir.
3. Repair which is done in case of the weir is damaged.
4. Continuous security to prevent weir damage

Positive Impacts of Rubber weir's construction

Benefits of Rubber weir include:

1. Provision of raw water in rural areas
2. Preventing sea water intrusion
3. Flood control, and
4. Provision of irrigation water

Negative Impacts of Rubber weir's Construction

The construction of weir which is across the river, evaluated from the river restoration, has negative impacts on biotic and a biotic life in rivers. Some of these impacts are as follows.

1. Changing the balance of sediment transport
2. Changing the groundwater level's elevation
3. Reducing water discharge on Main River

5. Conclusions And Suggestions

A. Conclusion

After analyzing the effectiveness of the water-filled rubber weir management for flood and "rob" prevention in Demak District, it can be drawn some conclusions:

1. The selection of materials/materials used in a water-filled rubber weir project depends on the pressure of the flow stability which is going through and the ease-of-material source of the material which is easily operable.
2. Characteristic of the water-filled rubber weir requires good material based on the appropriate technology. However, the material itself has not been easy to obtain in the free market.
3. In an effort to overcome the problems of irrigation in dry season, the manufacture of water-filled rubber weirs needs to be declared. This technology can save water supplies during the rainy season and community should help keep the weir made. However, it's good to pay attention to the negative impacts of its manufacture.

Suggestions

From all the stages of analysis that have been done, some suggestions can be given to obtain better results, including:

1. For the effectiveness of flood and rob management that occur, especially in the north coast area, it should be noted that there is a solution by using the water-filled rubber weir, pay attention to the calculation of flow stability, the weight of the weir itself and the carrying capacity factor of the soil.
2. Selection of weir point location should consider the study of supporting data factors that burden the river flow on the weir.
3. The manufacture of water-filled rubber weir must be done better to be appropriate, and it is better to make more research about this method in order to make a weir without damaging the ecosystem of the area around the river. Every option does have its risks, but we must try to minimize the risk so that the balance is maintained.

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