DEVELOPMENT OF COST-EFEFFECTIVE DEMONSTRATION HYDRAULIC PHYSICAL MODEL OF DEBRIS FLOW

KARAM SHAMDEEN YASSER

SCHOOL OF CIVIL ENGINEERING
UNIVERSITI SAINS MALAYSIA
2022

DEVELOPMENT OF COST-EFEFFECTIVE DEMONSTRATION HYDRAULIC PHYSICAL MODEL OF DEBRIS FLOW

By

KARAM SHAMDEEN YASSER

This dissertation is submitted to

UNIVERSITI SAINS MALAYSIA

As partial fulfilment of requirement for degree of

BACHELOR OF ENGINEERING (HONS.)
(CIVIL ENGINEERING)

School of Civil Engineering
Universiti Sains Malaysia

August 2022

Appendix A8

UNIVERSITI SAINS MALAYSIA

SCHOOL OF CIVIL ENGINEERING
ACADEMIC SESSION 2021/2022

FINAL YEAR PROJECT EAA492/6
DISSERTATION ENDORSEMENT FORM

Title: DEVELOPMENT OF COST-EFFECTIVE DEMONSTRATION HYDRAULIC PHYSICAL MODEL OF DEBRIS FLOW

Name of Student: KARAM SHAMDEEN YASSER

I hereby declare that all corrections and comments made by the supervisor(s)and examiner have been taken into consideration and rectified accordingly.

Signature:

Date : 1\8\2022

Approved by:

ASSOC. PROF. DR. MOHD REMY ROZAINY MOHD ARIF ZAINOL
DEPUTY DIRECTOR
RIVER ENGINEERING & URBAN DRAINAGE RESEARCH CENTRE (REDAC)
ENGINEERING CAMPUS, UNIVERSITI SAINS MALAYSIA
14300 NIBONG TEBAL
PENANG

Name of Supervisor

Date : 1\8\2022

Approved by:

(Signature of Examiner)

Name of Examiner : DR NURUL HANA MOKHTAR KAMAL
PENSYARAH DS51
PUSAT PENGAJIAN KEJURUTERAAN AWAM
KAMPUS KEJURUTERAAN
UNIVERSITI SAINS MALAYSIA

Date : 8/8/2022

24

ACKNOWLEDGEMENT

To my supervisor Assoc. Prof. Dr. Mohd Remy Rozainy Mohd Arif Zainol I wish to express my sincere gratitude to you. Without you, this research would not have been achieved and shown in this form. Thank you for all your support, supervision, and motivation.

Moreover, in completing of the model, I had to take the help and guideline of some respected persons, who deserve our greatest gratitude; Mr. Kamil Nahrim for guiding and helping us in numerous consultations.

I would like to thank my beloved family which was my number one supporter since day one and I owe every achievement to them. Last but not least, I would like to thank my friends and colleagues who were there beside me throughout the whole process.

ABSTRAK

Penentuan kos bahan yang digunakan untuk membina model aliran puing yang kos-efektif, yang berpunca dari bndar-bandar dan kampung-kampung.Aliran puing adalah fenomena geologi dimana aliran air bercampur dengan tanah dan pecahan batu yang mengalir melalui cerun-cerun gunung, memasuki sungai dan membentuk lumpur yang tumpat dengan enapan dilantai lembah.Gentian kaca, simen-ferro dan papan lapis digunakan untuk membina model berkenaan.Keberkesanan model telah dikaji dengan menggunakan rumus Q=Av. Model itu mencapai harga yang baik dan berkesan. Kos model akhir dari segi harga bahan asas ialah RM 10,701. Kajian ini telah meninjau beberapa buah kedai, kilang dan syarikat bagi mendapatkan harga yang berpatutan untuk menentukan kos-faedah bahan-bahan yang digunakan untuk membina model aliran puing dan menguji kecekapan yang ditunjukkan oleh model aliran puing.Tujuan kajian ini adalah untuk mendapatkan kos bahan yang digunakan untuk membina model dan menilai prestasi model berkenaan.Ini akan memudahkan para pengkaji dan pelajar pada masa akan datang.

ABSTRACT

Identified cost benefit of materials used for debris flow model and construct and test efficiency of demonstration debris flow model. Debris flows are geological phenomena in which masses of water-filled soil and fragmented rock accelerate to the slopes of mountains, infiltrate the course of rivers, enter objects in their tracks, and form sediments Dense mud in the valley floors. Fiberglass, ferrocement and plywood were used to build our model. The study tested the effectiveness of the model by calculating Q=Av. The study did a survey of several stores, factories, and companies to acquire the right price to determine the cost benefit of materials used for debris flow model and to construct and test efficiency of the demonstration debris flow model. The model achieved a good and effective price. The final model cost in terms of basic material prices was Rm 10,701. The purpose of this research was to determine the cost of the materials used to construct the model and to evaluate its performance. This will make it easier for researchers and students to profit from the study in the future.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF EQUATION

CHAPTER 1

INTRODUCTION

1.1 Background of Study

A physical hydraulic model should be created to cost effective. The flow pattern of the dam and its effects on sedimentation, erosion, and vortex formation should be recognized to provide high efficiency and safe hydroelectric dams. Physical models can be thought of as scaled representations of hydraulic flow scenarios, including scaled flow fields and geometrical conditions (Chanson, 1999).

Debris flows are geological events that occur, when two or more water-laden, volumes of soil clash. and broken rock, fall down mountain slopes, funnelling into stream channels, entangling everything, in their path, and leaving a thick, muddy deposit on valley bottoms. Debris flows are made up of "loose" particles that move around freely inside the flow. Several factors can contribute to debris flows (Choi et al., 2017).

Debris flows most caused by a rapid rain when water begins to wash debris off a slope or when water removes material from recently burnt land. Rapid snowmelt can also contribute to this, since the newly melted snow water is channelled into a steep valley with enough loose material to pack. In either case, the water rushes down the slopes and into the canyons and valleys below, building up speed and debris as it makes its way down the canyon walls. Riverbank erosion is one more main cause of debris flows. The slide material or erosion at the base might eliminate the support and unleash the flow after being lubricated by the passage of water over the top of the old landslide (Choi et al., 2016).

The physical model is presented for analysis of debris flows based to identified cost benefit of materials used for debris flow model and to construct and test efficiency of demonstration debris flow model. The model's construction, including the materials used, the pipe system, the placement of the pump, and the price with the slope angle and to test efficiency of demonstration debris flow model.

1.2 Problem statement

The incident in the Gunung Jerai kedah that resulted in mudslides and floods was caused by the debris flow incident which is a common occurrence in mountainous areas. The debris flow is a more accurate description for the incident due to abnormally heavy rainfall in the area. a debris flow develops when soil and forest debris are combined with water and travel quickly downward through riverbeds until they reach the foothill. Four people lost their lives because of mudslides and landslides that occurred in the vicinity of Gunung Jerai because of an unexpected water flow (Rosli et al., 2021). An almost similar incident happened at Genting Sempah in 1995 that killed many people. 218 millimetres (mm) and 172 millimetres (mm) of rain were recorded at the rainfall stations at Gunung Jerai and Kampung Singkir Genting, respectively, during the occurrence. had caused the dam to break, bringing with it debris, rocks, wood debris, sediments, and silts (Figure 1.1) (Rosli et al., 2021).

Figure 1.1: Debris flow results in the Gunung Jerai Kedah (Rosli et al., 2021).

Several debris flows, tragedies have happened, in recent years, resulting in, hundreds of deaths missing or injured people and property damage (Choi et al., 2016).Floods are commonly said to have caused considerable property damage and fatalities because of these events. For example, morphological and morphological changes along riverbeds and mountain slopes. The debris flows at a tremendous rate Due to their large volume, rapid velocity, and high impact force sediment-water combination floods may be extremely damaging posing a significant risk to downstream people and infrastructure. When the detachable soil mass is combined with surface runoff mobile debris floods may occur. It might be exceedingly damaging and have far-reaching ramifications. Because of the debris flow an effective model must be established to mitigate the damages of the influx to society. Several models were built at different costs. So will build a model that is cost-effective, quality, and efficient.

1.3 Objectives

The objectives of this project are:

I. To identified cost benefit of materials used for debris flow model.

II. To construct and test efficiency of demonstration debris flow model.

1.4 Scope of work

In this dissertation, a case study in Malaysia is used. In this research, will be identified cost-benefit of materials used for debris flow model and construct and test efficiency of demonstration debris flow model. The goal of this research is to create a low-cost demonstration hydraulic physical model of debris movement. Will be the design of debris flow model to through slope angle, pump location, piping system, materials, cost. and then will consider of materials have use fiberglass, plywood, 3D printed objects.

This study also covers the construction of the model by the piping system, pump location, materials used. then will test the effectiveness of the model from leaking, water flow, the position of 3D objects. Through this form and tests, we will be able to know the cost-benefit of materials used and test the efficiency of the demonstration debris flow model. Humans will gain from this research because they will learn about the cost-benefit of the materials utilized and the effectiveness of the demonstration debris flow model. In this study, humans may learn about the effects of debris flows on the environment, as well as how to control debris flows, the cost of materials utilized, and model efficiency.

Future researchers will benefit from this study because they will be able to obtain information that they may require for their studies, and it is possible that this study will answer some of their questions.

1.5 Expected Outcome

the outcomes of this study are to identified cost benefit of materials used for debris flow model and choosing the materials used to build the model and determining the cost. describing generally the material and the cost. Besides, to construct and test efficiency of demonstration debris flow model. Necessary for cost estimation and testing for a safe life in the future. This because debris flows are still one of the most dangerous phenomena due to their velocity and quickly happening. So, the future goal will be to define clearly the cost of materials used and to construct and test efficiency of demonstration debris flow model to better understand the construction of debris flow fans and to predict, mitigate or control the hazard posed by these phenomena to communities situated into mountain areas.

1.6 Dissertation Outline

Chapter 1 presents the introduction chapter. In this chapter, a brief introduction about the research is discussed. A general background, problem statement, and objectives of this case of study will be introduced.

Chapter 2 presents the literature review which reviews some of the previous research studies that are related to Development of cost-effective demonstration hydraulic physical model of debris flow.

Chapter 3 presents the methodology that will be implemented with a clarifying flowchart, and a description of the methods briefly.

Chapter 4 shows the results of the analysis, discussion, and the comparative study that identified cost-benefit of materials used for debris flow model and constructed and test efficiency of demonstration debris flow model.

Chapter 5 suggests recommendations for the future researchers, to build upon in their studies. At last, this chapter will end with a conclusion that sums up the whole work.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

Topics relating to the research will be examined and addressed in this chapter. In this chapter, topics related to the study will be reviewed and discussed. The topics include type of Development of cost-effective demonstration hydraulic physical model of debris flow. The materials used, their effectiveness, and the impact of the water flow will all be studied.

2.2 Debris Flow

In debris flows volumetric silt levels reach 40 to 50 percent, with water accounting, for the remainder of the flow's volume. The term "debris" refers to silt, grains of all shapes and sizes, from little clay particles to enormous boulders. Debris flows continue to be one of the most dangerous natural hazards, resulting, in numerous yearly human deaths and property damage, across the world. The influence of a debris flow particularly its peak impact pressure, on a debris-resisting structure is crucially calculated throughout the design process Hard and flexible barriers, as well as other countermeasures, are being constructed(Choi et al., 2016).

The tremendous velocity of the water, as well as the significant impact forces, with a large run-out distance, as well as a lack of temporal predictability Debris flows are one of the world's most dangerous geological dangers today (Schmitt and Scheid, 2020).

Debris flows are one of the world's most dangerous geological dangers today (Choi et al., 2016). One of the key reasons for this is the great speed at which it can go, up to 160 km/h (100 mph). This is referred to as "debris flow," a natural danger that can occur everywhere on the planet. A single stream has the power to bury entire cities and settlements, cover highways, kill and injure people, ruin property, and halt all traffic.

A debris flow is a fast-moving landslide made from a liquid, unconsolidated, saturated material that looks like streaming concrete (Figure 2.1).

Figure 2.1: Disasters caused by debris flow (Choi et al., 2016)

Whether they happen in wealthy or poor nations, debris flows often happen fast and without notice, which can have serious repercussions. These include mudflows, mudslides, fast earth flows, hyper-concentrated flows, lahars, and debris torrents, among many other slope movement dangers. Some of the most damaging incidents linked to earthquakes, hurricanes, and volcanic eruptions include debris flows (Santi et al., 2011). Especially in hilly, volcanic, semi-arid, and sub-polar locations, debris flows are among the most common natural dangers. It's crucial to emphasize that most devastating debris flows worldwide are secondary risks brought on by other catastrophes. These additional occurrences include tropical cyclones and other powerful storms, floods, earthquakes, volcanic eruptions, sizable landslides, an offshoot of which are debris flows, swift snow or ice melt, and unexpected releases of water that have been pounded by vegetation, landslides, and glacial processes (Schuster et al., 2002).

In southern California, there is a high level of knowledge of debris flows, their risks, and hazards. Events happen frequently, there is a lot of journalistic attention, and there are many tangible reminders, such the various debris catchment basins that are there (Figure 2.2). The citizens of southern California are familiar with the wildfire-debris flow sequence, which occurs when dry-season wildfires are followed by wet-season debris flows (Bustillo, 2003).

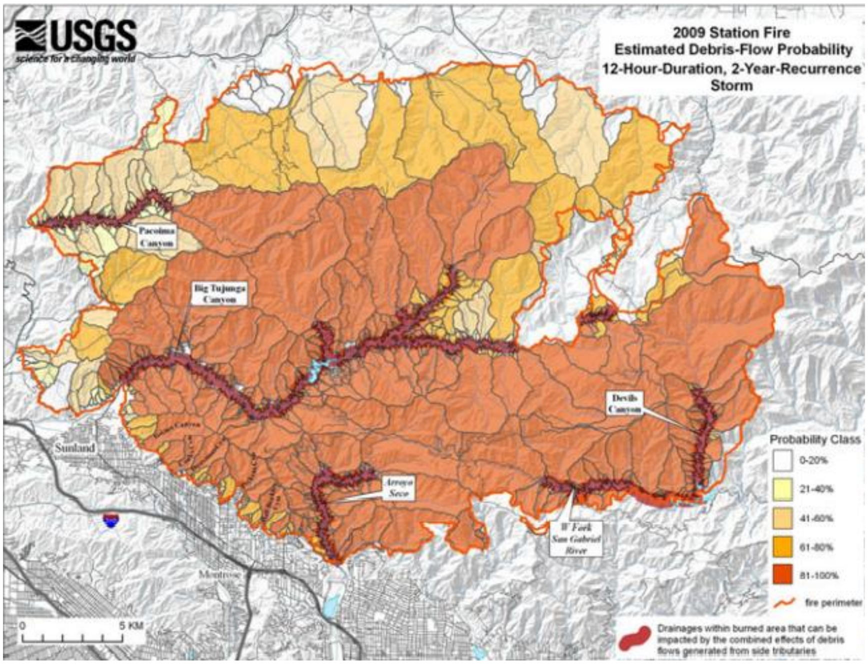

Figure 2.2: Example debris-flow hazard (probability of occurrence) map published following a wildfire in southern California (Cannon et al., 2011)

During wet or snowy seasons, debris flows are most common, and they frequently begin on slopes or mountains. Debris flows may reach speeds of up to 35 mph and transport big objects like rocks, trees, and automobiles. If debris flows reach a steep stream channel, they can move for kilometres, affecting regions that were previously ignorant of the danger. Debris flows are a kind of landslide also known as mudslides, mudflows, lahars, or debris avalanches (Bustillo, 2003).

A quick snowmelt, in which recently melted snow water is directed across a steep valley packed with loose enough material to be mobilized, can also be a cause. In either case, the fast-moving water cascades down the slopes and into the canyons and valleys below, picking up speed and debris as it goes. A feedback loop occurs as the system accelerates, in which the faster the water rushes, the more it can pick up. Although this wall eventually takes on the look of concrete, it is capable of tearing stones off canyon bottoms and hurling them along the route of the flow (Takayama et al., 2022).

In the foothills above San Bernardino, Rancho Cucamonga, and other minor neighbourhoods, the Grand Prix and Old Fire wildfires burnt more than 57,000 acres in October and November 2003(Figure 2.3). Less than two months after the wildfires, in December, a downpour caused 68 debris floods in the burnt regions, two of which claimed the lives of 16 people (Santi et al., 2011).

Figure 2.3: Example of severe debris-flow events in San Bernardino (Florey, 2004).

2.3 Classification of Debris Flow

The grain size distribution of the debris material and the depositional style of earlier debris flow episodes are linked to the principal flow processes: viscoelastic and frictional/collisional. Flow is defined by the Environmental Protection Agency (EPA) as a function of water quantity and velocity that can impact the dam bed and levees. Besides, flow pattern may alternatively be characterized as a streamlined flow in which fluid flows in layers that might be turbulent or laminar, according to the author. Due to the complexity of fluid behaviour in a system, the usage of a physical model is essential since most flow patterns are hard to quantitatively explain in many situations (Kamel, 2013).

The weight of the debris flow unit, the depositional/available volume of debris flow, and the deposition base slope (starting fan slope) all impact it. The depositional area and maximum length both expand at a somewhat faster pace than the depositional volume (Bezak et al., 2019).

Debris flow deposits are formed by the gravitational mass flowage of sediment-water combinations. The water column has a major role in changing debris flows in subaqueous settings, hence subaerial and subaqueous debris-flow deposits are distinguished. Diacetone with a fine-grained matrix (clay, silt, and sand) and varying clast concentrations make up bris flow deposits as Figure 2.4 (De Haas et al., 2020).

Figure 2.4 : Marginal Associations (Benjamin et al., 2019)

The utilization of debris-flow simulation models as a technique. Formation and routing are suggested for design and performance. a look back at the effort that has been done to limit debris flows. Cohesive and non-cohesive subaqueous debris flows are distinguished. These are subaqueous debris flows, which comprise a bigger group. debris flows that vary from non-cohesive to cohesive (hyper-concentrated density flows and concentrated density flows) as seen in Fig. 2.5, to turbulent flows (see section Turbidites) (Bernard et al., 2019).

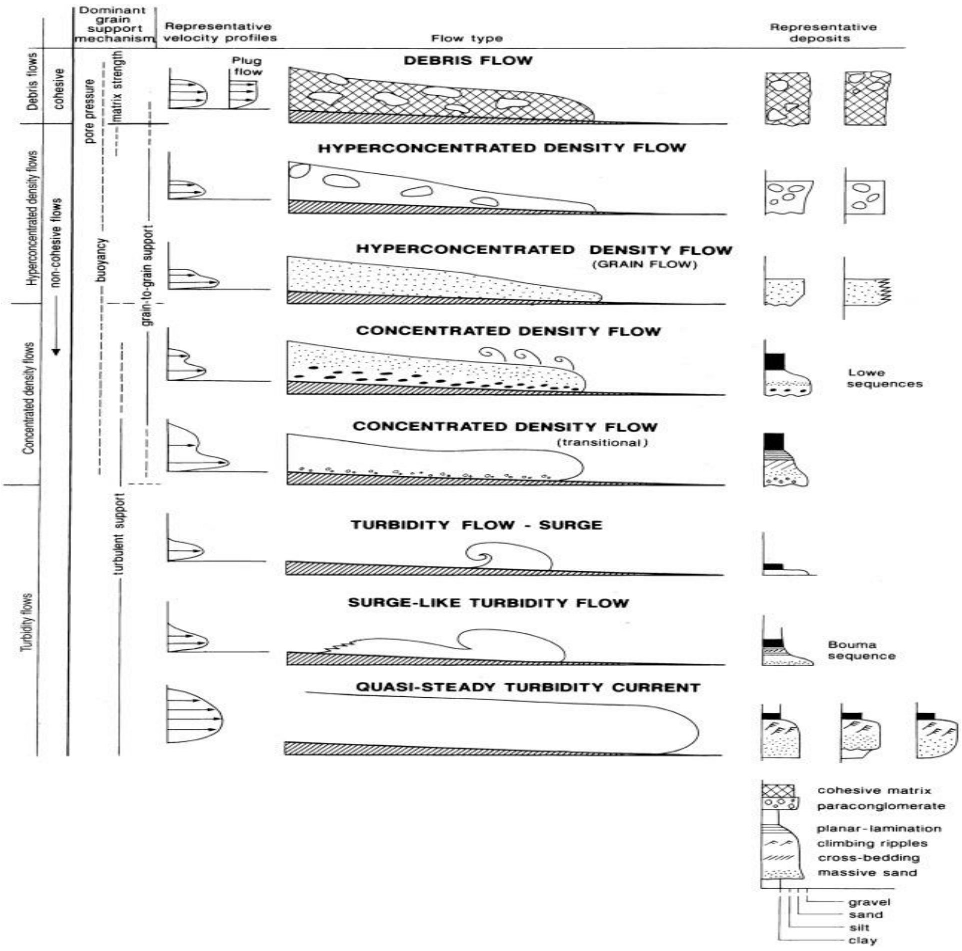

Figure 2.5: Cohesive and non-cohesive subaqueous debris flows are (Benjamin et al., 2019)

2.4 Hydraulic Physical Model

A physical model is a scaled depiction of a hydraulic flow condition that includes criteria like boundary conditions, upstream flow condition, and flow field. The flow conditions in both the physical model and the prototype are regarded equivalent if the model achieves geometric, kinematic, and dynamic similarities. A physical hydraulic model is often smaller than a prototype, and it is also possible to investigate a physical model in a laboratory under controlled circumstances (Chanson, 1999). Although the hydraulic physical model has many potentials, The hydraulic physical model has some advantages, but it also has certain disadvantages. Hydraulic Physical modelling, in compared to numerical modelling, demands a higher number of trials, a longer time, and is more expensive (Giorgi et al., 2020). Scale effects arise because of the difficulties in correctly scaling a free-surface hydrodynamic model utilizing water that obeys all the similitude rules. limitation of flow and reflection (Heller, 2011). As a result, significant knowledge and precise scaling are required to assure the hydraulic physical model's efficiency.

Figure 2.6: Example of a physical hydraulic model (Chiari et al., 2013)

The difference between a product's or service's actual cost and what it would cost if the quality were great should be reflected in total quality costs. It's also important to remember that quality is a system, not a single tool. It's risky to respond to a client problem with more internal actions like inspection or testing. as well as ignoring the negative consequences of poor quality (Wattanawarangkoon et al., 2022).

A physical model is one that, at the proper scale, replicates and portrays the flow of water. Both boundary conditions and behaviours are included on this measure. The variety of physical models between those with a fixed bottom (the model's bottom is constructed from a solid material like wood and hence does not occur and the exponential change in its topography is not measured) and those with a mobile bottom (in which the bottom of the model is made of a material that can be modified based on the flow passing over it, and then it is usually used in studies of erosion and sedimentation). The description of the latest physical models is based on the proportionality of the horizontal and vertical scale of the model with reality (García-Ruiz et al., 2013).

2.5 Flow Pattern

The grain size distribution of the debris material and the depositional style of earlier debris flow episodes are linked to the principal flow processes: viscoelastic and frictional/collisional. Flow is defined by the Environmental Protection Agency (EPA) as a function of water quantity and velocity that can impact the dam bed and levees. Besides, flow pattern may alternatively be characterized as a streamlined flow in which fluid flows in layers that might be turbulent or laminar, according to the author. Due to the complexity of fluid behaviour in a system, the usage of a physical model is essential since most flow patterns are hard to quantitatively explain in many situations (Kamel, 2013).

The system's flow rate, pressure, surface tension, density, geometry, and distance from the input all influence the flow pattern (Zhao et al., 2021). Upstream flow diversion and rainfall can also impact the flow pattern formed(Patil et al., 2022). For a clearer portrayal of the flow pattern based on experimental data, the flow pattern must be contoured (Kantoush and Sumi, 2010).

Flow pattern contouring (Figure 2.7) is essential to have better representation of the flow pattern based on the experimental data (velocity of flow). Flow pattern and its contour will assist in better understanding on the studied hydraulic structures such as upstream of dam, outlets and stilling basin (KANTOUSH and SUMI, 2010).

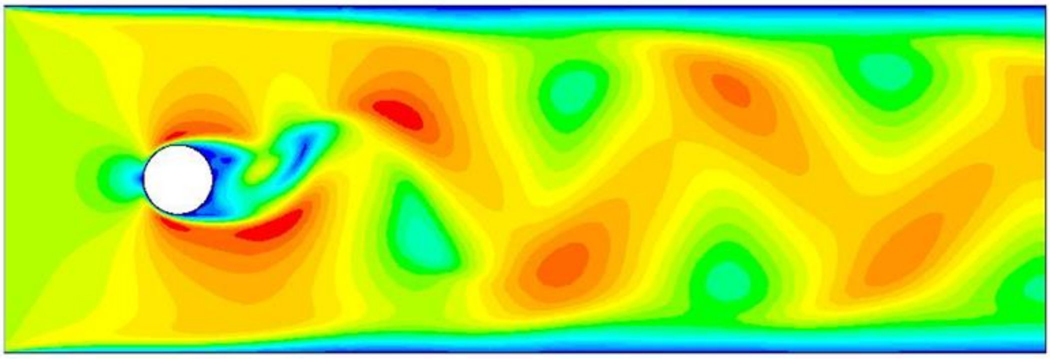

Figure 2.7: Flow pattern contour (Voelker et al., 2022)

Flow pattern can assist in designing better and more sustainable hydraulic physical structures such as dam, spillway and stilling basin. Many studies have been made to depict the use of flow pattern in the design of hydraulic structures (Kantoush and Sumi, 2010), flow pattern formed will assist in determining the sediment profile and deposition. Besides, the influence of geometry towards the flow stability and flushing process can be studied based on the flow pattern formed. Thus, optimal design of hydraulic structures can be proposed. Besides, flow pattern can also help in determining the areas with high and low 14 velocities. For dam purposes, areas with flow pattern which depicts low velocity are highly potential to undergo sedimentation and otherwise. The turbulency of the flow can also be observed for analysis purpose (Safarian and Afrous, 2014).

From the flow contour, circulation zones along the hydraulic structures, especially at the dam's outlet can be observed, resulting the formation of vortex (Azarpira et al., 2014). Thus, it shows how importance flow pattern in analysis for hydraulic physical models.

2.6 Sedimentation

Deposition of sediment occurs at dam due to the low flow velocity due to the increased of flow depth in which reduces the transport of sediment capacity and accelerates the sedimentation process (Schellenberg et al., 2017).

Watershed sediment production, transit speed, and deposition method all have an impact on the complicated process of sedimentation in reservoirs. Additionally, it is based on the geometry and functioning of the dam, the frequency of floods, and changes in land use throughout the course of the dam's lifetime. Due to the disruption produced by the construction of the dam, the silt from the dam upstream was dumped into the calm water of the dam (Kondolf, 1997).

Sedimentation may result from both natural and man-made processes. Geomorphology, hydrology, hydrogeology, geology, and soil characteristics are a few examples of natural forces. Anthropogenic influences include things like overgrazing, logging, and tillage techniques (Obialor et al., 2019).

When the flow velocity decreases and the bed turbulence is unable to sustain the denser particles, silt settles (Fondriest, 2014). The size and density of the particles affect the settling velocity of sediments. In comparison to less dense particles, larger and denser particles will settle more quickly (Palmer et al., 2010).

2.7 Natural Factor

Geomorphology refers to the topography of the land surface, including its location, size, and shape. The volume of stream let into the reservoir, the ratio of watershed area to reservoir area, and the amount of yearly rainfall may all have a significant impact on reservoir sedimentation. The sedimentation process will be impacted by the effect of groundwater contaminants on the sedimentation process in terms of hydrogeology.

Sedimentation will be caused by geology in the development of hydraulic infrastructure, as well as its environmental repercussions (Figure 2.8). The kind of soil present at the reservoir, as well as its susceptibility to be damaged by the water flow, can also cause sedimentation (Obialor et al., 2019).

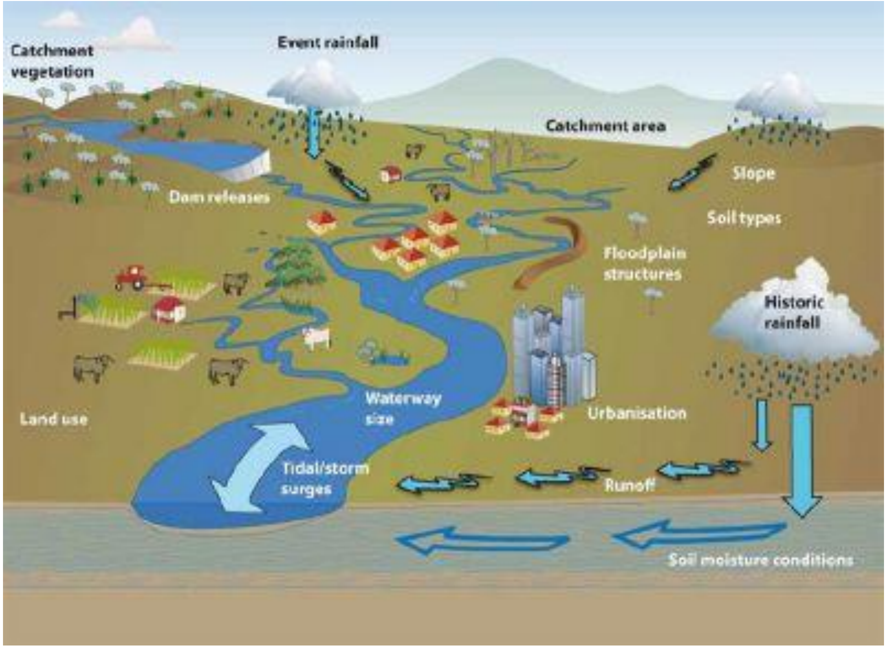

Figure 2.8: Example of Natural Factor (Obialor et al., 2019).

Tillage practices is an activity which carried out between the harvest and following sowing period. Livestock overgrazing may cause exposed soil to crumble and flow into upstream rivers, where it is deposited in dams. Human activities such as logging are one of the main causes of excessive dam sedimentation rates (Obialor et al., 15 2019). besides, Tillage is a process that occurs between harvest and the start of the next planting season. If tillage operations aren't done properly, loose soil may wash into surrounding bodies of water.

The earthquake is a natural occurrence that causes fast ground shaking. It is caused by ground movements and the breaking and shifting of rocks because of internal stress build-up brought on by geological factors that cause the movement of the earth's plates.

The earthquake may arise on account of the activities of volcanoes or because of the presence of slips in the layers of the earth, which is (9) degrees. If the degree of the earthquake is more than (5) degrees, it is destructive and earthquakes lead to cracks in the ground and the depletion of springs or the emergence of new springs or the occurrence of high waves if they occur Under the sea, as well as its disruptive effects on buildings, transportation and facilities, and often results from convective movements in the Asthenosphere, which move the continental plates, causing tremors, which are earthquakes (Kean and Staley, 2021).

2.8 Climatic factors

Hurricanes are ferocious spiral air storms that often form over tropical oceans. Because cold air (high pressure) circulates around a stationary core of warm air (low pressure), they are also referred to as tropical or tropical cyclones or cyclones. It moves at speeds that can exceed 300 kph in the direction of land but loses some of that speed due to friction with the earth's surface. A single vortex can have a diameter of 500 km and can endure anywhere from a few days to two weeks. The hurricane moves in straight or curved lines, causing immense destruction on land due to its lightning-fast speed. It is accompanied by the formation of stratigraphic and cumulus clouds to a height of 15 km, as well as phenomena of lightning and thunder. The hurricane may also produce high sailing waves that destroy villages caused the flow of debris (Pallàs et al., 2004).

2.9 Erosion

Erosion is a geological process that involves the removal and movement of surface material (earthen material) from one location to another using natural forces like water or wind (Balasubramanian, 2017).

Abrasion of the sediments they transport is also a part of erosion, which is the removal and movement of solid material caused by the action of water, wind, or ice. Water erosion frequently occurs in areas near dams. The term "water erosion" refers to soil material that is eroded by water, and it is greatly impacted by the soil's characteristics, the local environment, the weather, and the flow rate (Borrelli et al., 2020, Marzen et al., 2019).

Figure 2.9: Example of Erosion (Marzen et al., 2019)

2.10 Experiment of the previous studies

(Choi et al., 2017) Investigated the influence of slit-type barriers on the parameters of water-dominant debris flows using small-scale physical modelling. The trash is made up of a sand-water mixture and a sand-boulder-water mixture. Barrier configurations were duplicated and flowed against slit-type barriers in a variety of angles and shapes. The barrier designs' effectiveness was measured using the velocity decrease and trap ratio. The composition of the debris was determined by two sets of studies. One set of circumstances is when, the debris is made up of sand, and water, which is known as debris flow. The other is debris flow, with boulders, which happens, when there’s, a combination of sand, water, and boulders in the debris. A combination of sand, water, and rocks make up the debris. To generate, a debris flow, 3.5 kilograms of water, and 1 kilogram of dry, sand were mixed, in a soil-water mixture. Jumanji sand, a uniform-sized sand, with a mean grain size of 0.6 mm, was used as, solid soil debris, as shown in Figure 2.10.

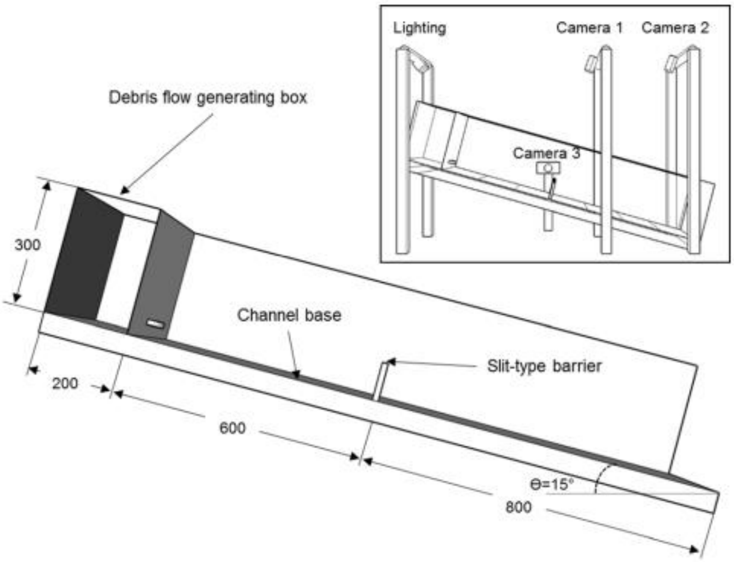

Figure 2.10: Model explantation (Choi et al., 2017)

When the angle of the barrier wall was reduced and the opening ratio was reduced, the amount of velocity reduction increased. Due to the smaller outflow, the backwater effect, was more noticeable in V-type configurations during the subsequent collision, than in Type designs, resulting in a higher bottleneck effect. As a result of the backwater effect, which occurred in front of the barrier, the debris was restricted. The barrier walls must 17 be less than 60 degrees to benefit from the debris trap systems. The velocity decline grew more dramatic when the debris included more stones. In both barrier types, an increase in boulder % resulted in an increase in trap ratio, like the velocity decrease. The angularity of the stones, on the other hand, had no discernible influence on the trap ratio in this investigation. The size of the overflow decreased as the angle of the walls and the effective opening ratio increased. According to the current study, a slit-type barrier may effectively reduce the hazard of debris flows by decreasing flow velocity and limiting debris mass.

2.11 Summary

This chapter covers debris flow, a physical hydraulic model, a flow pattern, and the causes of debris formation. Understanding the roles and types of debris flow models will aid in the development of materials for models such as hydropower models. Besides, the influence of flow pattern on, as well as the components, materials, and causes of formation, have all been identified. Apart from that, recognizing the causes, consequences, and needs for causes and materials to occur in the model has aided in realizing the relevance of a well-designed model in terms of its sustainability, efficiency, and cost.

CHAPTER 3

METHODOLOGY

3.1 Overview

This chapter explains the methodology involved Development of a cost-effective demonstration hydraulic physical model of debris flow.

This chapter also covers the equipment utilized, the materials approach, and cost effectiveness, as well as the survey. All these parts are required to meet the study's goals, which were outlined in Chapter 1.

The overall methodology for this study can be observed from the flow chart which has been depicted in Figure 3.1.

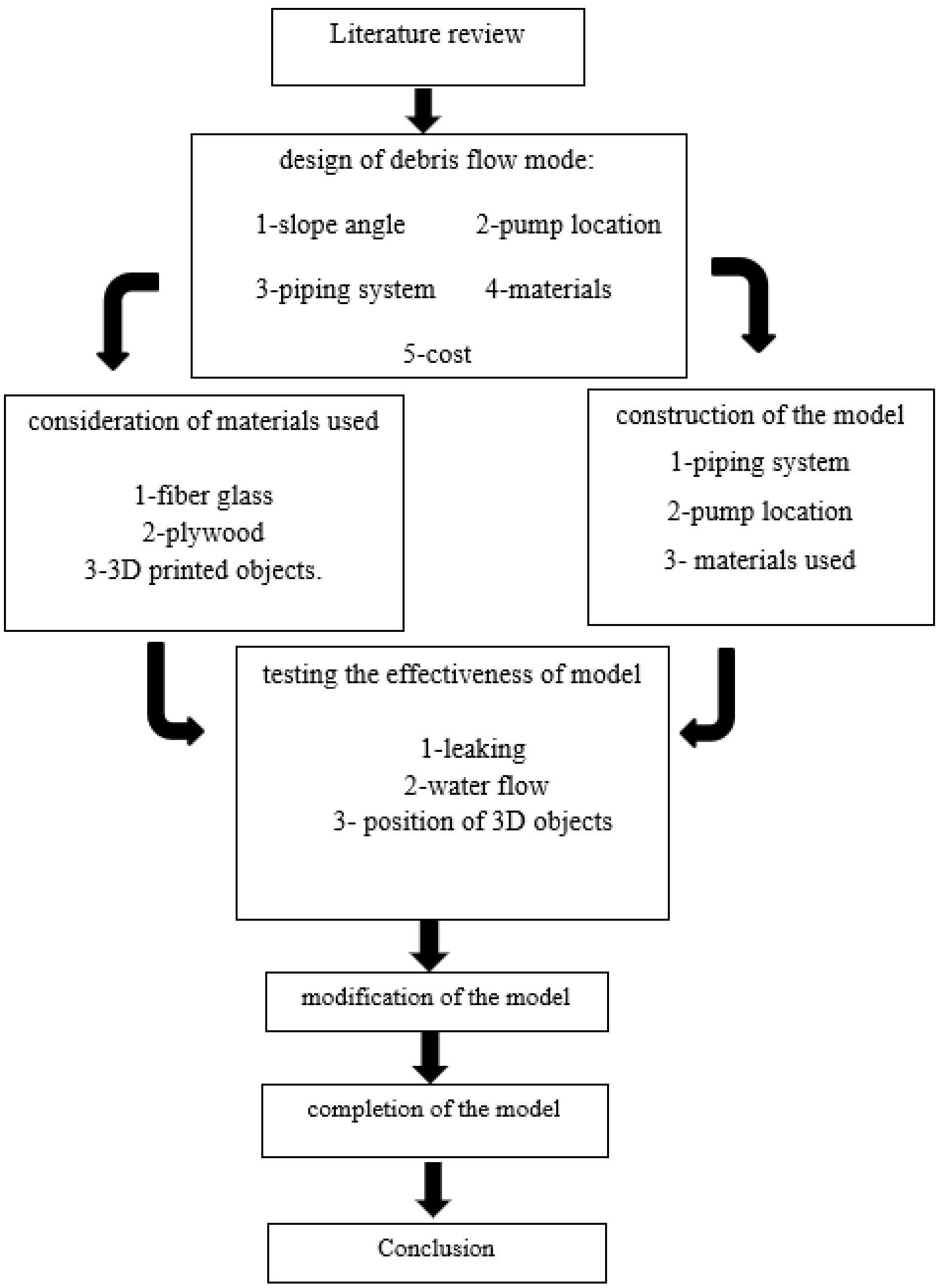

Figure 3.1: Overall flowchart of the study

3.2 Experimental Setup

Development of cost-effective demonstration hydraulic physical model of debris flow will be done using two different methods: to the identified cost-benefit of materials used for the debris flow model and to construct and test the efficiency of the demonstration debris flow model through design of debris flow model (slope angle, pump location, piping system, materials, cost), and consideration of materials used. (Fiberglass, plywood, 3D printed objects.), then construction of the model. (Piping system, pump location, materials used), then testing the effectiveness of the model (Leaking, water flow, position of 3D objects) last step is modification of the model. After the approach is completed, the cost-benefit of the materials employed in the debris flow model will be determined. In addition, the demonstration debris flow model's construct and test efficiency results.

The pipe system and pump position, as well as the materials utilized, will be used to make the model. A survey of the materials used, including quality, quantity, price, and the best among them, will be undertaken, and the materials will be compared to determine which is the best. The water's acceleration, the water tank, the technique of water flow from the tank, the amount of its influence on the surrounding environment, and how to identify which is best for the model will all be determined. Water flow and leaks will also be checked on the model. evaluating the model's efficacy from the perspective of a three-dimensional item (fiberglass, plywood and ferrocement). Therefore, based on the results, the form will be modified. the stores were visited to perform a pricing study of fiberglass, plywood, and ferrocement among the dealers. In terms of cost and preference for the model's manufacture and use. The three waves will also be utilized and tested, with the findings being released in terms of pricing and model choice. Ferrocement is known as is a building method that uses “forcemeat" of metal mesh, woven, expanded