OBSER[illegible] .TTERN USING SEDIMENT RIVE[illegible] .RESENCE OF RAINFALL

NUR RAIHAN BINTI YAAKOB

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Faculty of Civil Engineering
UNIVERSITI MALAYSIA PAHANG

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ABSTRACT

Sediment can be categorized as loose sand, clay, silt and other soil particles that are settled down at the bottom of a water body. Sedimentation process is a process where sediment is being transported away from its original location and deposited to another place. Sedimentation process can cause harm if it does not being controlled properly. Excessive capacity of sediment can caused reduction in water storage capacity in a reservoir, collapsing a bridge, forming a sediment dam in a river and other disaster. However, the presence of rainfall can affect the sedimentation process by increasing the volume and velocity of the water in the river; meaning that it can doubled up the impact of sedimentation. This shows on how important it is to have a great understanding regarding to the sediment. In this study, the observation on the sediment pattern is done by using a 110x45x25 cm of river model with several physical features of river, presence of rainfall and sediment is being made. The purposes of the study are to understand better about both of sediment and its process. Three set of experiment is done by considering the location of the rainfall. The velocity of river flow and rainfall intensity; which are 0.35 m/s and 0.16 l/s respectively, is being fixed in order to distinguish the result. The sediment deposited along the river model and created a pattern. In order to recognize the pattern, the result is represented in a chart rate of sediment size distribution rate at five point of location along the river model. As the overview of the result, the pattern of sediment is differ due to the river features. Based on the analysis generated from the experimental result, it can be concluded that the presence of rainfall will increase the river discharged and hence, making the velocity and the flow rate of the river increased. The sediment pattern will be affected by the river changes. The presence of rainfall did affect the sedimentation in the matter of sediment quantity. This shows that rainfall can be another factor that promotes sedimentation.

ABSTRAK

Mendapan boleh dikategorikan sebagai pasir, tanah liat, kelodak dan elemen tanah lain yang terdapat di dasar sungai. Proses pemendapan adalah satu proses di mana sedimen dibawa dari lokasi asal ke tempat lain. Proses pemendapan boleh mengakibatkan kemusnahan jika tidak dikawal dengan rapi. Sedimen yang berlebihan boleh menyebabkan pengurangan kapasiti simpanan air dalam takungan, jambatan runtuh, membentuk empangan sedimen dalam sungai dan bencana lain. Walau bagaimanapun, kehadiran hujan boleh mempengaruhi proses pemendapan dengan meningkatkan kapasiti dan halaju air di dalam sungai; di mana ia boleh menggandakan kesan pemendapan. Ini menunjukkan bagaimana pentingnya untuk mempunyai pemahaman yang baik mengenai sedimen. Dalam kajian ini, pemerhatian ke atas corak sedimen dilakukan dengan menggunakan model sungai berukuran 110x45x25 cm dengan beberapa ciri-ciri fizikal sungai, kehadiran hujan dan sedimen. Tujuan kajian ini adalah untuk memahami sedimen dan prosesnya. Tiga set eksperimen dilakukan dengan mempertimbangkan lokasi hujan. Halaju aliran sungai dan intensiti hujan; masing-masing 0.35 m/s dan 0.16 l/s, ditetapkan untuk membezakan keputusan. Sedimen didepositkan bersama-sadi sepanjang model sungai dan mewujudkan corak sedimen. Untuk membezakan corak sedimen, hasil eksperiment adalah dalam bentuk carta kadar taburan saiz sedimen di lima lokasi di sepanjang model sungai. Sebagai gambaran keseluruhan, corak sedimen adalah berbeza disebabkan ciri-ciri sungai. Berdasarkan analisis yang dijana daripada hasil eksperimen, kesimpulan boleh dibuat di mana kehadiran hujan akan meningkatkan kadar pelepasan sungai dan dengan itu menjadikan halaju dan kadar aliran sungai meningkat. Corak sedimen akan terjejas oleh perubahan sungai. Kehadiran hujan memberi kesan pemendapan dalam kuantiti sedimen. Ini menunjukkan bahawa hujan boleh menjadi satu lagi faktor yang menggalakkan proses pemendapan.

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mm	Millimetre
cm	Centimetre
mic	Micron
l/s	Litre per second
m/s	Metre per second

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Solid material that is being moved and deposited from a location to another is called sediment. Rocks, minerals, as well as the remains of plants and animals can also be counted as elements of sediment. Sediment can be appeared as a range of size; from big rocks or gravel until small particle like clay and silt. The movement of sediment is named erosion; the removal and transportation of rock and soil. Generally, water, ice or wind can be the medium of transportation and removal of the sediment from a place to another.

In Malaysia, water is the main medium of transportation of sediment for a river. Sediment such as loose sand, clay, silt and other soil particles is transported altogether with the flowing water and settle at the bottom surface along the river. This process is known as sedimentation process. Sediment that is light enough to be carried by water without touching the stream bed is called suspended sediment, and is visible as cloudy or milky areas of water (Selander, 2009).

Malaysia is a nation of equatorial climates that also receives rainfall frequently. Rainfall has several pattern including uniform rainfall, drizzle rainfall, heavy rainfall any combination of two or more pattern. Rainfall is actually effecting erosion, transportation and deposition of sediment. Thus, it is very important to understand the mechanism of sedimentation process so that the understanding of the interaction between sediment particles, bank material, flow of water, and rainfall could be achieved.

1.2 PROBLEM STATEMENT

Sedimentation process in a river is the process of transportation of sediment inside the river where the sediment is being transported away from its original location and deposited to another place. The condition will produce a set of different pattern of sediments that are deposited along the river.

However, the process might be changed the structure of the river. For example, the excess of deposited sediment can change the dimension of the river and reduce the hydraulic capacity of stream channel, thus, make it shallower. This situation brings along a bunch of bad implication rather than the positive implication. A shallower river will increase the elevation of the water depth until it exceeding the maximum elevation. When it does, the river could not accommodate the excess water and finally will lead to overflow of water or flood.

The transportation of the sediment can be affected by several factor including the circumstances of the river itself, and external factor such as rain. Without any of the factor affecting the process, the pattern of the sediment should be differed than the one that are affected by a single or more factors.

1.3 OBJECTIVES

The objectives of the study are:

i. To observe and understand the sedimentation process and sediment pattern with the effect of river features and the presence of rainfall

ii. To determine the distribution of size of sediment at different point of the model river

1.4 SCOPE OF STUDY

The scopes of the study are:

i. The study is done based on the river model that will be built by concrete and plywood.

ii. The velocity of the flow of water used is 3.5 m/s.

iii. The intensity of the rainfall is 0.16 l/s. Three sets of experiment are done using different pattern of rainfall:
   1. Rainfall presence only at the upstream
   2. Rainfall presence only at the middle of the river model
   3. Rainfall presence only at the downstream

iv. The pattern is observed based on:
   1. Different angle of river slope; mild and steep river
   2. Shape of the river : straight, meandering and wide rivers
   3. Presence of rainfall

v. Sediment at selected point will be collected and sieved to determine the size distribution of the sediment.

1.5 SIGNIFICANCE OF STUDY

It is hard to find the existence of a river with all the river features, and even if it does, the distance of the river will be too long and will be harder to be studied. The river model that is built can help to observe the sedimentation process while considering some river features together with the presence of rainfall.

The river model can also be used as an educational instrument. Hopefully, the model can bring some idea on the process of sedimentation. It can be said that the designed river model can help the student to understand both theoretical facts from classes and practically understood from the demonstration of the sediment model.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Sedimentation that caused sediment is the loose soil particles that settled at the bottom of body water; where it always occurs in most of the river (Council, 2014). As rivers flow across the landscape they pick up and transport an incredible amount of sediment, ranging from large pebbles and boulders to very find sand and mud. As the rivers head down towards the sea, it brings along an enormous volume of sediment down to the sea.

Gathering the main factors or agent in sedimentation process will gain effect on the process. The factors are including water in river flow, gravity affection towards sediment particle, and other external or environmental factors that catalyze changes in sedimentation; such as rainfall.

2.2 SEDIMENT ELEMENT

The deposition of sediment into water bodies is called sedimentation or siltation. Increases in concentrations of suspended sediment can be detrimental to aquatic life. Fine sediment can reduce water transparency, clog fish gills, and can fill substrate pores, suffocating fish eggs and insect larvae. Chemicals such as nutrients, metals, hydrocarbons, and organic compounds can adsorb to sediment particles and enter the river through landscape erosion. Once in the river, these chemicals can be transported downstream, settle to the bottom with the sediments, or dissolve in the water (U.S Regional Aquatics Monitoring, 2008).

The sediment yield can be affected by many different hydrologic events. The sediment yield for each storm or flood will vary, depending on the meteorologic character of the storm event and the resulting hydrologic character of the floods. High-intensity storms may produce sediment yields well above the norm, whereas an equal amount of precipitation occurring over a longer period of time may yield relatively little sediment.

The sediment that occurs in the river, caused by sedimentation process was from three combinations of three modes; that is wash load, bed-load and suspended load.

2.2.1 Wash Load

Wash load is the finest-grained fraction of the total riverine sediment load and accounts of roughly 70 percent of sediment delivered to our world's oceans (Syvtski & Kettner, 2011).

Wash load is the part of the suspended load which is composed of particle sizes smaller than those found in appreciable quantities in the bed material. It is in near-permanent suspension and, therefore, mostly it is transported through the stream without deposition (Rjin & L.C.Van, 1986). The discharge of the wash load through a reach

depends only on the rate with which these particles become available in the catchment area and not on the transport capacity of the flow.

Wash load is very fine particles which are transported by water, but these particles do not exist on the bed. Therefore the knowledge of bed material composition does not permit any prediction of wash load transport (Leopold, Wolfman, & Miller, 1964).

Although wash load is part of the suspended-sediment load it is useful here to make adistinction. Unlike most suspended-sediment load, wash load does not rely on the force of mechanical turbulence generated by flowing water to keep it in suspension. Because these clays are always in suspension, wash load is that component of the particulate or clastic load that is washed through the river system (Hickin, 2001).

2.2.2 Bed Load

Bed load consists of the course sediment particle that is only seldom transported. Bed load is that portion of the total sediment in transport that is carried by intermittent contact with the streambed by rolling, sliding, and bouncing along its bed. The movement can be called saltation.

Saltation motion is the motion of sediment particles in a series of irregular jumps and bounces around the bed. These heavier particles are usually sands and gravels. Bed load is transported close to the bottom and moves at slower rate than the water flow. But, it can be suspended load under rapid flow. This is because bed load dominates for low flows or large grains.

Bed load is the part of the total load which has more or less continuous contact with the bed. Thus, the load must be determined in relation to the effective shear stress which acts directly on the grain surface (Liu, 2001).

2.2.3 Suspended load

Suspended sediment includes both wash load (mostly clay and silt that is more or less continually in suspension) and bed material load (which is suspended only during higher flow); bed material includes coarse silt and sand that may move as bed load during lower flow.

Suspended load does not have continuous contact with the bed. It moves through the fluid. Suspended load consists of generally finer, smaller particles than bed load. Turbulent flow suspends clay and silt in the stream. The finer-grained suspended load can be found far from the bottom and being transported at lower concentrations but at much higher rate.

Suspended load is the total load which is moving without continuous contact with the bed as a result of the agitation of the fluid turbulence. The appearance of ripples will increase the bed shear stress (flow resistance). On the other hand, more grains will be suspended due to the flow separation on the lee side (Liu, 2001).

2.3 CHARACTERISTIC OF THE RIVER

A stream or river is a body of water that carries rock particles and dissolved ions and flows down slope along a clearly defined path, called a channel. Thus, streams may vary in width from a few centimetres to several kilometres.

River carries most of the water that goes from the land to the sea, and thus are an important part of the water cycle. Streams carry billions of tons of sediment to lower elevations, and thus are one of the main transporting mediums in the sedimentation.

River is a major part of the erosional process, working in conjunction with weathering and mass wasting. Much of the surface landscape is controlled by erosion, where it can be evident to anyone looking out of an airplane window. Along the path of a

river, from source to mouth, the river shows many different features and is affected by several different processes.

2.3.1 Slope of The River

Channel slope or gradient is the difference in elevation between two points on a stream divided by the distance between them measured along the stream channel. The flow velocity, and thus power of the stream to do work is also directly related to the slope of the channel, the steeper the slope, the faster the velocity of flow.

The gradient for the river bed is the ratio for the horizontal and vertical fall over the river. The changes in gradient will affect the discharge. The discharge will decrease as the gradient increase, means that the river that has the steeper slope and higher diagram has the higher velocity.

For channels with steep slopes, there are the effect of gravity on the sediment transport exist. The effect of the gravity on the direction of bed load transport has been investigated by Englund (1974), Sekine and Parker (1992), and Wu (2004) (Lemann, 2010).

2.3.2 Shape of River

The river shape is formed from erosion mostly. There are 3 primary ways that streams erode into their channel; hydraulic action – flowing water pries rocks loose, solution – flowing water may gradually dissolve some rock types or cements,and abrasion - flowing water causes the stream channel bedrock to erode from impact with the sediment load (Gordon, 1957).

i. *Straight River*

Straight river channels can be of two types. The first forms on a low-gradient valley slope, has a low width-depth ratio channel, and is relatively stable. The second type is a steep gradient, high width-depth ratio, high energy river that has many bars, and at low flow is braided (Stephen & Nelson, 2003).

Straight rivers are generally regarded as one of the typical river patterns in conventional classifications in terms of their channel plain landforms. However, a few straight patterns were found to be distributed in wider spatial and temporal spans in the self-fluvial river (Ji & Rean, 2002).

ii. *Meander River*

Water flows in river affected by the gravity. Thus, the river flows cannot be always in straight direction.

Meander River is an extreme U-bend river in the course of a stream. Because of the velocity structure of a stream, and especially in streams flowing over low gradients with easily eroded banks, straight channels will eventually erode into meandering channels.

Erosion will take place on the outer parts of the meander bends where the velocity of the stream is highest. Sediment deposition will occur along the inner meander bends where the velocity is low. Such deposition of sediment results in exposed bars, called point bars. Because meandering streams are continually eroding on the outer meander bends and depositing sediment along the inner meander bends, meandering stream channels tend to migrate back and forth across their flood plain (Stephen & Nelson, 2003).

Meandering rivers have a low gradient and thus slower flow, and often have a high proportion of suspended sediment relative to the amount of bed load. A meandering river

channel has curves that meander back and forth on a slightly dipping plain (Selander, 2009).

2.4 RAINFALL

Malaysia is one of the tropical country which experienced temperatures that fluctuate between 25 and 35 degrees during the year (Ali & Yang, 2007). This caused by the common climate features of Malaysia which are uniform temperature, high humidity and copious rainfall.

Generally, rivers and others catchment are being altered from their natural states as time being passed. The weather condition; include rainfall, can barely be one of the reason why is this happen.

Rainfall can also cause erosion within the drainage basin, and elevated surface flows can carry eroded sediment to the river; which is a part of the sedimentation process. Rainfall will lead to increasing of the volume of water flow in the river. A high volume of water in the river makes a higher rate of sedimentation process that will take place (U.S. Geological Survey's, 2014).

Rainfall event is considered if precipitation in a particular area that drops to the ground is at least in the range of 0.5 mm to 3 mm (Chin, 2000). Annually, Malaysia received many trend of rainfall. The trend can be disguised by the intensity of the rainfall or its pattern in a specific period of time.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

The Chapter 3: Research Methodology will discuss about the method and the approach that has been used to achieve the objective. The study starts with the literature review on topics that are related to the title to gain more insight about the topic. Figure 3.1 showed that the flow chart methodologies that will be used as guidance during the study conducted.

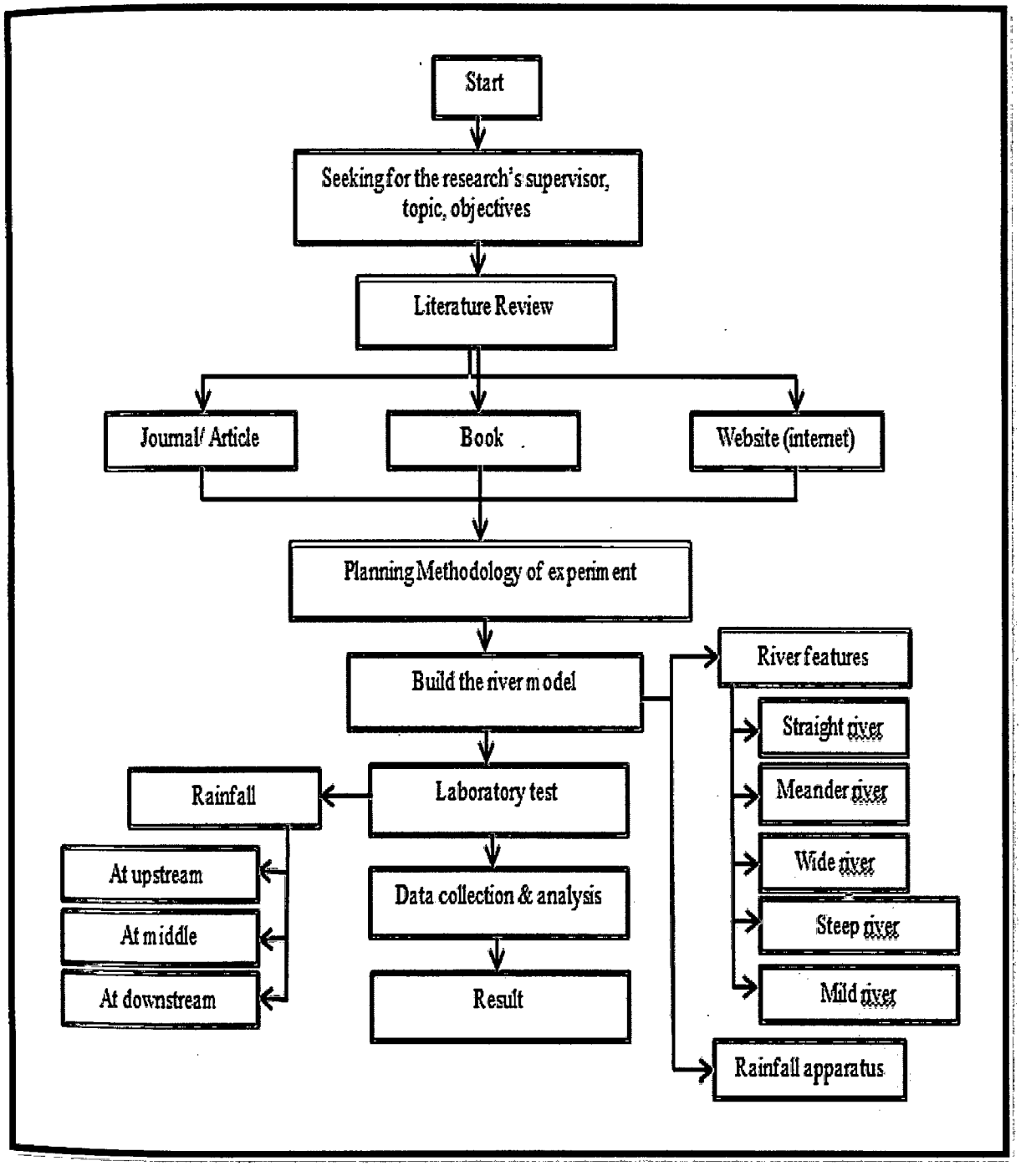

Figure 3.1: The flow chart of methodology

3.2 RIVER MODEL

The objectives of the study are planned to be achieved by using a river model as the main instrument. The river model will be constructed using a wooden box, filled by soil. The soil will be compacted well to form a stream channel. The physical features of the stream channel including its shape and size is formed randomly as it will fulfill the following criteria:

i. River gradient /slope angle
ii. The presence of obstruction
iii. Tributaries and confluence
iv. Shape of the river

The soil compacted will be overlaid by a layer of cement-water mixture. This is a step to avoid an excessive penetration by the water and hence to ensure that the shape of the river is being fixed. A sample of sand, representing the sediment will be placed on the surface of the stream channel. The sediment at a several location of the stream channel; before and after river flow and rain effect, will be undergoes sieve analysis. This analysis must help us to determine the effect of river flow and rain on the pattern of the sediment.

3.2.1 Experiment Procedure

The laboratory approach will be done by doing experiment towards the model of the river. At the end, the results may differ according to some factor and because of that, we need to standardized several factors so that we could compare the result. The factor include the physical state of the model river, the quantity and velocity of water of river, volume of rain and also the time taken for both rain and river flow.