

MIAC  
THE STUDY OF EROSION CONTROL

MOHAMAD ASHRAF BIN ABD LATIF

B. ENG(HONS.) CIVIL ENGINEERING

UNIVERSITI MALAYSIA PAHANG



## **SUPERVISOR'S DECLARATION**

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Civil Engineering.

---

(Supervisor's Signature)

Full Name : PN WAFTY BT ABD RAHMAN

Position : LECTURER

Date : JUNE 2018



## **STUDENT'S DECLARATION**

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

---

(Student's Signature)

Full Name : MOHAMAD ASHRAF BIN ABD LATIF

ID Number : AA14116

Date : June 2018

MIAC  
THE STUDY OF EROSION CONTROL

MOHAMAD ASHRAF BIN ABD LATIF

Thesis submitted in fulfillment of the requirements  
for the award of the  
Bachelor Degree in Civil Engineering

Faculty of Civil Engineering and Earth Resources  
UNIVERSITI MALAYSIA PAHANG

JUNE 2018

## **ACKNOWLEDGEMENTS**

Grateful thoughts and million thanks go to Almighty Allah (S.W.T) for giving me guidance and good health to complete this Final Year Project as a requirement to graduate and acquire a bachelor degree in Civil Engineering from University Malaysia Pahang (UMP). In preparing this project report, it was never an individual report. In meticulous I wish to express my greatest sincere appreciation to my supervisor Pn Wafty Bt Abd Rahman. With all the guidance and advices given from the supervisor this final year project is able to complete on time. Her dedication and continuous assistance have led me to strive for better achievement in this final year project. I am also wish to express my gratitude to my family and friends for their support and assistance at various occasions and I want to thanks to the consultant company Wan Hussein Associated Sdn Bhd for giving me the drawing that help me in this study. I also like to take this opportunity to convey deepest gratitude to the Faculty of Civil Engineering and Earth Resources staffs who had contribute their valuable knowledge towards the success of this project. Last but not least, I also wish to all those who have contributed in any way in making this Final Year Project a possible one.

## **ABSTRAK**

Penukaran status tanah dari hutan kepada pembangunan telah menyebabkan penebangan hutan secara meluas, pengurangan bilangan hutan dan kemusnahan tempat tinggal hidupan liar. Kebanyakan tanah yang dikurangkan bertujuan kepada pembangunan dan antaranya tanah yang subur telah digunakan untuk kawasan perumahan, rekreasi dan perindustrian. Penebangan hutan menyebabkan tanah yang terlindung didedahkan kepada pelbagai bencana alam. Ini disebabkan ketidakupayaan hutan berfungsi sebagai kawasan tadahan hujan. Apabila hujan lebat melanda kawasan, air hujan yang turun ke permukaan dan kemudiannya menghakis tanah ke sungai atau mana-mana longkang yang sedia ada. Insiden ini kebanyakkan berlaku dalam kejadian tanah runtuh. Insiden ini berlaku kerana ketiadaan akar tumbuhan yang bertindak sebagai penyokong terutamanya di tebing atau dataran tinggi. Pada Julai 2017, banjir kilat telah berlaku di Lot 1210, Lapangan Terbang Sultan Abdul Aziz Shah, Subang Selangor Darul Ehsan Malaysia. Kajian ini adalah untuk mengkaji pengangkutan sedimen dan perbandingan saiz reka bentuk kolam takungan sedimen dengan yang sedia ada. Kegagalan reka bentuk boleh menyumbang ke arah banjir kilat.

## **ABSTRACT**

Conversion of land from forests to development has led to widespread deforestation, reducing the number of forests and the diversity of forests and wildlife. Despite the fact that most of the land reduced to development, most fertile land is use for other purposes such as housing, recreation and industrial areas. Deforestation cause protected land to be exposed to various natural disasters. This is due to inability of the forests to function as rain catchment areas. When heavy rains hit an area, the water descended on the surface and then eroded the soil into the river or any existing drain. This incident is mostly prefer in the case of landslides. This incident occurred due to the absence of plant roots that landed mainly on the cliffs or highlands. In July 2017, a flash flood had been observed in Lot 1210, Sultan Abdul Aziz Shah Airport Subang Selangor Darul Ehsan Malaysia. This research is to study the sediment transport and to compare the design size of sediment basin with the existing one. The failure of the design may affect the flash flood prediction.

## TABLE OF CONTENT

<b>DECLARATION</b>	
<b>TITLE PAGE</b>	
<b>ACKNOWLEDGEMENTS</b>	<b>ii</b>
<b>ABSTRAK</b>	<b>iii</b>
<b>ABSTRACT</b>	<b>iv</b>
<b>TABLE OF CONTENT</b>	<b>v</b>
<b>LIST OF TABLES</b>	<b>ix</b>
<b>LIST OF FIGURES</b>	<b>xi</b>
<b>LIST OF SYMBOLS</b>	<b>xiii</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xiv</b>
<b>CHAPTER 1 INTRODUCTION</b>	<b>1</b>
1.1 Background of Study	1
1.2 Statement of the problem	2
1.3 Objectives of study	4
1.4 Scope of study	4
1.5 The importance of the study	4
<b>CHAPTER 2 LITERATURE REVIEW</b>	<b>5</b>
2.1 Weather in Southeast Asia	5
2.1.1 Hydrological cycle	6
2.2 Rainfall intensity and pattern in Malaysia	7
2.2.1 Rainfall Intensity-Duration Frequency (IDF)	8



2.3	Soil Type	10
2.3.1	Type of soils and size	10
2.3.2	Determine of particle size	11
2.3.3	Top soils	13
2.4	Soil Erosion and Sediment Processes	14
2.4.1	Universal Soil Loss Equation (USLE)	14
2.4.2	Modified Universal Soil Loss Equation (MUSLE)	15
2.5	Catchment Area	20
2.5.1	Time of Concentration, $t_c$	21
2.5.2	Rational Method	22
2.6	Sediment Transport	23
2.6.1	Open Channel Flow	23
2.6.2	Sediment Load	26
2.6.3	Bed form and Flow resistance	29
2.6.4	Compute Transport capacity	33
2.6.5	Overland Flow	35
2.7	Sediment Basin	38
2.7.1	Urban Stormwater Management Manual For Malaysia (MSMA)	39
2.7.2	Design Criteria	40
<b>CHAPTER 3 METHODOLOGY</b>		<b>42</b>
3.1	Introduction	42
3.2	Flow chart of the study	43
3.3	Study area	44
3.4	Data and information collection	47
3.4.1	Primary data	47

3.4.2	Secondary data	48
3.5	The design of Sediment Basin	49
3.5.1	Sieve analysis	49
3.5.2	Method to calculate the time of concentration	51
3.6	The design of Sediment Transport	52
3.6.1	Method to calculate Modified Universal Soil Loss Equation (MUSLE)	52
3.6.2	Method to calculate the peak discharge, $Q_p$	52
3.6.3	Method to calculate the Runoff volume (in $m^3$ )	52
3.6.4	The value of Soil erodibility factor, K	53
3.6.5	Method to calculate the Topographic Factor, LS	53
<b>CHAPTER 4 RESULTS AND DISCUSSION</b>		<b>54</b>
4.1	Introduction	54
4.2	The determination of sediment basin size	56
4.2.1	The type of soil	56
4.2.2	The time of concentration, $t_c$	59
4.2.3	Summary of sediment basin	64
4.3	The study of sediment transport	67
4.3.1	Runoff Volume, V ( $m^3$ )	67
4.3.2	Peak Discharge, $Q_P$ ( $m^3/s$ )	73
4.3.3	Soil Erodibility Factor, K	75
4.3.4	Topographic Factor, LS	76
4.3.5	Cover factor, C	77
4.3.6	Management practice factor, P	78
4.3.7	Summary of sediment transport	79

<b>CHAPTER 5 CONCLUSION</b>	<b>84</b>
5.1 Introduction	84
5.2 Recommendations	85
<b>REFERENCES</b>	<b>86</b>
<b>APPENDIX A RAINFALL DATA</b>	<b>88</b>
<b>APPENDIX B Runoff coefficients</b>	<b>89</b>

## LIST OF TABLES

Table 2.1	The NN factor data (Stone, 2015)	18
Table 2.2	Bed form classification (Mays, 2010)	30
Table 2.3	Summary description of sediment transport (Mays, 2010)	31
Table 2.4	Sediment Basin Types and Design Considerations (Zakaria <i>et al.</i> , 2004)	40
Table 2.5	Dry Sediment Basin Sizing Guidelines (Zakaria <i>et al.</i> , 2004)	40
Table 2.6	Design criteria of sediment basin for sediment control (Zakaria <i>et al.</i> , 2004)	41
Table 4.1	The Results of the percentage silt, sand and clay	56
Table 4.2	The average percentage of silt, clay and sand	57
Table 4.3	Types of soil	59
Table 4.4	The length of overland flow for Site A	59
Table 4.5	The length of overland flow for Site B	59
Table 4.6	The length of overland flow for Site C	60
Table 4.7	The result of average of catchment slope for Site A	61
Table 4.8	The result of average of catchment slope for Site B	61
Table 4.9	The result of average of catchment slope for Site C	61
Table 4.10	Time of concentrations for Site A	62
Table 4.11	Time of concentrations for Site B	62
Table 4.12	Time of concentrations for Site C	63
Table 4.13	The total time of concentration	63
Table 4.14	Summary of data	64
Table 4.15	Sediment Basin Types and Design Considerations (Zakaria <i>et al.</i> , 2004)	64
Table 4.16	Dry Sediment Basin Sizing Guidelines (Zakaria <i>et al.</i> , 2004)	65
Table 4.17	The interpolation data for site A	65
Table 4.18	The interpolation data for site C	66
Table 4.19	Comparison size of design for sediment basin	67
Table 4.20	The result of direct runoff by weekly	69
Table 4.21	The result of the runoff volume for site A	70
Table 4.22	The result of the runoff volume for site B	71
Table 4.23	The result of the runoff volume for site C	72
Table 4.24	Summary data for rainfall intensity	74
Table 4.25	Summary data for peak discharge	75

Table 4.26	Summary data for topographic factor	76
Table 4.27	Parameters for MUSLE	79
Table 4.28	The value of MUSLE (in m <sup>3</sup> ) for site A	80
Table 4.29	The value of MUSLE (in m <sup>3</sup> ) for site B	81
Table 4.30	The value of MUSLE (in m <sup>3</sup> ) for site C	82
Table 4.31	The total value of MUSLE	83
Table 4.32	The number of excavation need to be done	83

## LIST OF FIGURES

Figure 1.1	Flash flood in Bangsar, Kuala Lumpur (BERNAMA, 2017)	3
Figure 2.1	Southeast Asia Region (Loo, Billa, & Singh, 2014)	5
Figure 2.2	The hydrologic cycle (USGS, 2015)	7
Figure 2.3	Example for IDF Curve (Zakaria <i>et al.</i> , 2004)	9
Figure 2.4	Size range of grains (Davidson, 2000)	11
Figure 2.5	Sieve Analysis Test (Davidson, 2000)	11
Figure 2.6	The particle size distribution grading curves (Davidson, 2000)	13
Figure 2.7	The value for K factor (Stone, 2015)	17
Figure 2.8	The value for C factor (Zakaria <i>et al.</i> , 2004)	19
Figure 2.9	The value for P factor (Zakaria <i>et al.</i> , 2004)	20
Figure 2.10	Example of catchment area (Department of Agriculture, 2007)	21
Figure 2.11	Geometric Properties for open channel flow (Jamal, 2017)	24
Figure 2.12	Bed load and Suspended load. (Mays, 2010)	26
Figure 2.13	The parameters $\psi$ and $\tau_c$ (Mays, 2010)	28
Figure 2.14	The process of Overland flow (Das, 2000)	35
Figure 2.15	The process of rain-splash (Das, 2000)	36
Figure 2.16	The example of Rill erosion (Queensland, 2013)	37
Figure 2.17	The example of Gully erosion (Queensland, 2013)	37
Figure 2.18	The example of wet sediment basin (Baramy, 2002)	38
Figure 2.19	The example of dry sediment basin (Baramy, 2002)	39
Figure 3.1	Flow chart of study	43
Figure 3.2	Location of the study area	44
Figure 3.3	Location of site A	45
Figure 3.4	Location of site B	45
Figure 3.5	Location of site C	46
Figure 3.6	The location of the sample that were taken	48
Figure 3.7	Laboratory dry oven	49
Figure 3.8	Mechanical sieve shaker	50
Figure 3.9	Weight machine (in mm)	50
Figure 3.10	The Canadian Soil Texture Triangle (Canada, 2013)	51
Figure 3.11	Rainfall-Runoff Chart (Rome, 1991)	53
Figure 4.1	The mud flood affects the temple near to the project area	55
Figure 4.2	The mud flood affects the house near to the project area	55

Figure 4.3	The result for the type of soil at site A	57
Figure 4.4	The result for the type of soil at site B	58
Figure 4.5	The result for the type of soil at site C	58
Figure 4.6	The general information on how to calculate a slope	60
Figure 4.7	The CN factor for agricultural and urbanized area (Zakaria et al., 2004)	68
Figure 4.8	The rain gauge location and constant value (Zakaria <i>et al.</i> , 2004)	73
Figure 4.9	K factor (Stone, 2015)	75
Figure 4.10	C factor for construction sites (Stone, 2015)	77
Figure 4.11	Management practice factor, P (Stone, 2015)	78

## LIST OF SYMBOLS

$\lambda, \kappa, \theta$ and $\eta$	Fitting constants dependent on the rain gauge location.
$\sigma_g$	geometric standard deviation
$\tau_o$	bottom shear stress
$\Upsilon$	specific weight of water
$\Psi$	a coefficient that depends on characteristics of the sediment
$\nu$	kinematic viscosity
%	Percentage



## LIST OF ABBREVIATIONS

RIt	The average rainfall intensity (mm/hr) for ARI and duration t
R	Average return interval (years)
t	Duration (minutes)
T	Average recurrence interval – ARI
i	Average rainfall intensity (mm/hr)
d	Storm duration (hours)
D <sub>84</sub>	84 percentage weight of the sample
D <sub>16</sub>	16 percentage weight of the sample
D <sub>g</sub>	Geometric mean diameter
R	Average return interval (years)
A	Annual soil loss, in tonnes ha <sup>-1</sup> year <sup>-1</sup>
K	Soil erodibility factor
LS	Topographic factor
C	Cover factor
P	Management practice factor
Q <sub>p</sub>	Peak discharge in m <sup>3</sup> /s
Y	Sediment yield per storm event (tonnes)
t <sub>c</sub>	Time of concentration
L	Length of overland flow (ft, m)
S	Average catchment slope (ft/ft, m/m)
n	Manning's Roughness Coefficient
S <sub>o</sub>	Energy slope of the channel flow
V	Average velocity (fps)
V <sub>cr</sub>	Average flow velocity (fps) at incipient motion
MSMA	Urban Stormwater Management Manual For Malaysia
ESCP	Erosion Sediment Control Plans
DID	Department of Irrigation and Drainage Malaysia

## CHAPTER 1

### INTRODUCTION

#### 1.1 Background of Study

Sediment is grains of minerals, organic matters, or prior rocks which can be moved by water. Sediment can be relates to the erosion and sedimentation process. Erosion is the demonstration in which earth is worn away, frequently by water, wind, or ice. A comparative procedure, weathering, separates or breaks up rocks, debilitating it or transforming it into little pieces. The procedure of erosion moves bits of soil starting with one place then onto the next. Most erosion is performed by water. Sedimentation is the way toward enabling particles in suspension in water to settle out of the suspension under the impact of gravity. The particles that settle out from the suspension progress toward becoming residue, and in water treatment is known as slop. At the point when a thick layer of silt keeps on settling, this is known as solidification. At the point when solidification of sediment, is helped by mechanical means then this is known as thickening (Department of Agriculture, 2007). In construction, there are several things need to be considered after deforestation which is erosion and sedimentation process. These two of processes are important to emphasize because uncontrolled sediment flow can cause a flash flood and landslides. Sediment transport and sediment basin are the method and study of sediment control Sediment control is the procedure whereby the potential for dissolved soil being transported as well as stored past the breaking points of the development site is limited.

Sediment transport can be defined as the movement of sediment by water. If the flow increases, the sediment that had been conveyed also increase. Therefore, the sediment travel should be controlled and stored in sediment basin. Sediment basin is a temporary storage that was installed in construction site after deforestation in order to

avoid flash flood happened. The volume of sediment basin was determined by according to the size of catchment area.

The location of study on sediment transport and sediment basin design is at Subang Airport, Selangor. Basically, the design of sediment basin and the effectiveness of sediment transport are included in Erosion Sediment Control Plans (ESCP). The failure of the design may affect the flash flood prediction. The design of the sediment basin and sediment transport may depend on the size of catchment area, longitudinal slope, and the rainfall intensity. The catchment area known as construction sites that developed by government which need ESCP to control the environmental impacts of erosion and sedimentation. An Erosion ESCP is a practice or a plan that are commonly used for new development project nowadays. The aims of ESCP are to prevent controllable erosion and to minimise the adverse effects of sediment transport from on-site to off-site areas. Minimum areas applying for the ESCP is approximately 5 hectares and the maximum areas is approximately not more than 50 hectares. In general, an ESCP for a development project serves to provide a clear interpretation of proposed erosion and sediment control measures. The main principle of ESCP preparation is to ensure the erosion and sediment control measures are fully integrated into the development sequence.

## **1.2 Statement of the problem**

Conversion of land from forests to development has led to widespread deforestation, reducing the number of forests and the diversity of forests and wildlife. Despite the fact that most of the land has been reduced to development, most fertile land is used for other purposes such as housing, recreation and industrial areas.

Deforestation cause protected land to be exposed to various natural disasters. This is due to the fact that forests can no longer function as rain catchment areas. When heavy rains hit an area, the water descended on the surface and then eroded the soil into the river. This incident can be seen in the case of landslides. This incident occurred due to the absence of plant roots that landed mainly on the cliffs or highlands. The river will become increasingly shallow as a result of precipitation of the mud base. This situation will cause flash floods more easily to hit.

Flash flood are the natural disaster that caused by heavy rain or low-lying areas where the rain water been flow and stored. In October 2017, a flash flood had been observed in Bangsar, Kuala Lumpur (Figure 1.0). According to the report, it caused by heavy rain, poor drainage efficiency and unavailable sediment basin or detention pond near to the construction site. (BERNAMA, 2017)



Figure 1.1 Flash flood in Bangsar, Kuala Lumpur (BERNAMA, 2017)

Improper design of Erosion Sediment Control Plans will cause some problem to the environment. Floods have some bad effects on all living things that can lead to death. Among the effects of floods are can drown the house, sweep things away, and damage other items such as electrical goods, cars and so on. This brings huge losses to the population. Flash floods may occur if the development areas ignore the ESCP. In Malaysia these guidelines are made available in the Urban Stormwater Management Manual for Malaysia (MSMA).

## REFERENCES

- (n.d.). Retrieved from <http://www.aboutcivil.org/open-channel-properties.html>
- Agriculture, D. o. (2007). Part 630 - Hydrology. In D. o. (2007), *National Engineering Handbook*.
- Baets, S. D., Poesen, J., Gyssels, G., & Knapen, A. (2005). Effects of grass roots on the erodibility of topsoils during.
- Baramy. (2002). Retrieved from <http://www.baramy.com.au/scr-wetsediment>
- BERNAMA. (2017). *DBKL probes development project for link to flash floods*. Kuala Lumpur: New Straits Times.
- Canada, G. o. (2013). *Glossary of Terms in Soil Science*. Retrieved from <http://sis.agr.gc.ca/cansis/glossary/t/>
- Cremers. (1996). LISEM: A single-event, physically based hydrological and soil erosion model for drainage basins. .
- Das, G. (2000). *Hydrology and Soil Conservation Engineering*. Retrieved from <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=2091>
- Davidson, D. L. (May, 2000). Retrieved from Soil description and classification: <http://environment.uwe.ac.uk/geocal/SoilMech/classification/default.htm>
- google maps*. (n.d.). Retrieved from <https://www.google.com.my/maps/place/Sultan+Abdul+Aziz+Shah+Airport/@3.1190338,101.5611376,16.5z/data=!4m5!3m4!1s0x31cc4e69fad84daf:0xf31205014d7bc894!8m2!3d3.1328029!4d101.5543995?hl=en>
- Hudson, N. W. (1993). Field measurement of soil erosion and runoff. Food and Agriculture Organization of the United Nations.
- J.Feyen, E. (1994). Effects of tillage and rainfall on soil surface roughness and properties.
- Jamal, H. (2017). Retrieved from <http://www.aboutcivil.org/open-channel-properties.html>

- Loo, Y. Y., Billa, L., & Singh, A. (2014). Effect of climate change on seasonal monsoon in Asia and its impact on the variability of monsoon rainfall in Southeast Asia. *Geoscience Frontiers*.
- Mays, L. W. (2010). In L. W. Mays, *Water Resources Engineering, 2nd Edition*.
- Queensland. (2013). *Queensland Government*. Retrieved from <https://www.qld.gov.au/environment/land/soil/erosion/types>
- Rome. (1991). *Water harvesting (AGL/MISC/17/91)*. Retrieved from <http://www.fao.org/docrep/u3160e/u3160e05.htm>
- Römken, M. J. (2001). Soil erosion under different rainfall intensities, surface roughness, and soil water regimes.
- Stark, D. T., Bartlett, D. F., & Arellano, D. (2016). *Industry Alliance*. Retrieved 28 April, 2018, from Industry Alliance: <http://www.civil.utah.edu/~bartlett/Geofoam/EPS%20Geofoam%20Applications%20&%20Technical%20Data.pdf>
- Stone, R. P. (2015). *Engineer, Soil Management/OMAFRA*. Retrieved from <http://www.omafra.gov.on.ca/english/engineer/facts/12-051.htm>
- Team, T. F. (2004). *FishXing*. Retrieved from [http://www.fsl.orst.edu/geowater/FX3/help/FX3\\_Help.html#1\\_TOC/Hydraulic\\_Reference\\_TOC.htm](http://www.fsl.orst.edu/geowater/FX3/help/FX3_Help.html#1_TOC/Hydraulic_Reference_TOC.htm)
- USGS. (2015). Retrieved from The USGS Water Science School: <http://water.usgs.gov/edu/earthgwlandsubside.html>.
- Zakaria, N. A. (2004). MSMA- A NEW URBAN STORMWATER MANAGEMENT MANUAL FOR MALAYSIA. In N. A. Zakaria, *MSMA- A NEW URBAN STORMWATER MANAGEMENT MANUAL FOR MALAYSIA* (pp. Engineering, VI, pp. 1–10.).