



**STUDY ABOUT THE SEDIMENT LOAD AND THE BED LOAD PATTERN AT
GALING RIVER**

CHAN CHEOW FAH

**Report submitted in partial fulfilment of the
requirements for the award of the degree of
B.Eng (Hons.) of Civil Engineering**

**Faculty of Civil Engineering and Earth Resources
UNIVERSITI MALAYSIA PAHANG**

JUNE 2014

ABSTRACT

Sediment is a naturally occurring particle that is broken down by the processes of weathering and erosion, which particles that with varying sizes that can be transported by fluid and flow along the fluid matter. The erosion or any other reason will cause the bed load increase at the river. It will make the river of the depth decrease. As the depth of the river decrease while the volume of the flow rate still same, it will cause the flooding when overflow. This study identified and analyzed about the bed load of this river and found out the sediment pattern from the sedimentation process. The purpose of the study was identified the size and types of sediment, analyzed the bed load discharge and identified the sediment pattern at Galing River. The study conducted at 3 stations, which are located at upstream, middle stream and downstream of the Galing River. The methods used to analyze sediment transport were Schoklitsch formula and Meyer-Peter Muller formula. In this research, the sizes and types of the sediment at Galing River are determined, and the parameter of the grain size diameter need to conduct the sediment transport analysis had been found out. Meyer-Peter Muller and Schoklitsch showed there were less sediment discharge due to the low velocity and several criteria of the Galing River. In addition, the patterns of the bed load are variable in depth within the period of the research; it shows there was movement of particle along the Galing River.

ABSTRAK

Mendapan merupakan zarah semula jadi yang dipecahkan oleh proses-proses luluhawa dan hakisan, zarah dengan pelbagai saiz boleh diangkut oleh cecair dan mengalir bersama-sama perkara cecair itu. Hakisan atau dengan beberapa sebab lain akan menaikkan beban dasar di sungai. Ia akan menjadikan kedalaman sungai berkurangan. Apabila kedalaman sungai berkurangan walaupun jumlah kadar aliran masih sama, ia akan menyebabkan banjir apabila limpahan berlaku. Kajian ini mengenal pasti dan menganalisis tentang beban dasar sungai dan mendapati corak sedimen dari proses pemendapan. Tujuan kajian ini mengenal pasti saiz dan jenis sedimen, menganalisis pelepasan beban dasar dan mengenal pasti corak sedimen di Sungai Galing. Kajian ini dijalankan di 3 stesen, yang terletak di hulu sungai, aliran pertengahan dan hiliran Sungai Galing. Kaedah yang digunakan untuk menganalisis pengangkutan sedimen adalah Schoklitsch formula dan Meyer-Peter Muller formula. Dalam kajian ini, saiz dan jenis sedimen di Sungai Galing dapat ditentukan, dan parameter untuk saiz diameter butiran yang diperlukan untuk menjalankan analisis pengangkutan sedimen telah diperolehi. Meyer-Peter Muller dan Schoklitsch menunjukkan pergerakan sedimen kurang disebabkan halaju yang rendah dan beberapa kriteria Sungai Galing. Di samping itu, berlaku perubahan kedalaman corak beban dasar dalam tempoh penyelidikan; ia menunjukkan wujudnya pergerakan zarah di sepanjang Sungai Galing.

TABLE OF CONTENT

DESCRIPTION	PAGE
SUPERVISOR'S DECLARATION	ii
STUDENT'S DECLARATION	iii
DEDICATION	iv
ACKNOWLEDGEMENT	v
ABSTRACT	vi
ABSTRAK	vii
TABLE OF CONTENTS	viii
LIST OF TABLES	xii
LIST OF FIGURES	xviii
LIST OF SYMBOLS	xxi

CHAPTER 1 INTRODUCTION

1.0	Introduction	1
1.1	Background of Study	1
1.2	Problem Statement	2
1.3	Objectives	3
1.4	Scope of Study	3
1.5	Significance of Study	3

CHAPTER 2 LITERATURE REVIEW

2.1	Size and Types of Sediment At Galing River	4
	2.1.1 Geometric Mean	5
2.2	Analysis Sediment Load	5
	2.2.1 Incipient Motion	5
	2.2.2 Meyer-Peter Muller	8
	2.2.3 Schoklitsch	9

	2.2.4	Dubois	10
	2.2.5	Einstein	11
2.3		Sediment Pattern	11
	2.3.1	Alluvial Channel	12
2.4		Cross Section of River	13
CHAPTER 3		STUDY AREA	
3.1		Galing River	14
3.2		Map Location	14
3.3		Site Location	15
3.4		Station Location	16
	3.4.1	Station 1	16
	3.4.2	Station 2	16
	3.4.3	Station 3	17
CHAPTER 4		METHODOLOGY	
4.0		Research Methodology	18
4.1		Sampling Data Coleection	18
	4.1.1	Measuring The Cross Section	19
	4.1.2	Measuring The Velocity	20
	4.1.3	Computing the Flow Rate	20
	4.1.4	Manning's n Roughness Coefficient	22
4.2		Grain Size Analysis	23
	4.2.1	Preparation of Sieve Analysis	24
		4.2.1.1 Sieve analysis	26
		4.2.1.2 Sieve analysis calculation	27
4.3		Particle Density Analysis	28
CHAPTER 5		RESULT AND DISCUSSION	
5.0		Introduction	31

5.1	Station 1	32
	5.1.1 Data Analysis of Station 1	32
	5.1.2 Grain Size of Station 1	35
	5.1.3 Mean Particle Size of Station 1	40
	5.1.4 Effective Diameter versus Mean Velocity	42
	5.1.5 Temperature versus Viscosity at Station 1	44
	5.1.6 Bed Load Pattern At Station 1	45
5.2	Station 2	47
	5.2.1 Data Analysis At Station 2	47
	5.2.2 Grain Size of Station 2	51
	5.2.3 Mean Particle Size of Station 2	53
	5.2.4 Effective Diameter versus Mean Velocity	55
	5.2.5 Temperature versus Viscosity at Station 2	56
	5.2.6 Bed Load Pattern At Station 2	58
5.3	Station 3	59
	5.3.1 Data Analysis At Station 3	59
	5.3.2 Grain Size of Station 3	64
	5.3.3 Mean Particle Size of Station 3	66
	5.3.4 Effective Diameter versus Mean Velocity	68
	5.3.5 Temperature versus Viscosity at Station 3	69
	5.3.6 Bed Load Pattern At Station 3	71
5.4	Sediment Transport at 3 Stations	72
	5.4.1 Particle Density	73
	5.4.2 Mean Velocity versus Mean Flow Rate	74
	5.4.3 Meyer-Peter Muller	75
	5.4.4 Schoklitsch Formula	77
	5.4.5 Incipient Motion versus Meyer-Peter Muller	79
5.5	Discussion	80

CHAPTER 6 CONCLUSION AND RECOMMENDATION

6.1	Conclusion	85
6.2	Recommendation	86

REFERENCE	88
------------------	-----------

APPENDICES	92	
A	Record of Trip 1	92
B	Record of Trip 2	94
C	Record of Trip 3	96
D	Record of Trip 4	98
E	Example of Total Flow Rate Calculation	100
F	Grain Size Distribution For Station 1	103
G	Grain Size Distribution For Station 2	108
H	Grain Size Distribution For Station 3	114
I	Calculate of The Mean Particle Size	120
J	Calculation of Effective Diameter	121
K	Table of Viscosity	122
L	Particle Density	123
M	Incipient Motion	125
N	Rainfall Data	128

LIST OF TABLES

Table No.	Title	Page
4.1	Data of Flow Rate	22
4.2	Grain Size Distribution	28
4.3	Particle Density Test	29
5.1	The sample coordination	31
5.2	Flow rate of Station 1 at Trip 1	32
5.3	Data of Station 1 at Trip 1	32
5.4	Flow rate of Station 1 at Trip 2	33
5.5	Data of Station 1 at Trip 2	33
5.6	Flow rate of Station 1 at Trip 3	33
5.7	Data of Station 1 at Trip 3 Flow rate of Station 1 at Trip 1	34
5.8	Flow rate of Station 1 at Trip 4	34
5.9	Data of Station 1 at Trip 4	34
5.10	Sieve Analysis of Station 1a	35
5.11	Sieve Analysis of Station 1b	36
5.12	Sieve Analysis of Station 1c	36
5.13	Mean Particle Size of Station 1	41
5.14	Effective Particle Diameter Size versus Mean Velocity of Station 1	42
5.15	Temperature versus Viscosity at Station 1	44
5.16	Bed Load Pattern at Station 1	45

LIST OF TABLES

Table No.	Title	Page
5.17	Flow rate of Station 2 at Trip 1	47
5.18	Data of Station 2 at Trip 1	48
5.19	Flow rate of Station 2 at Trip 2	48
5.20	Data of Station 2 at Trip 2	49
5.21	Flow rate of Station 2 at Trip 3	49
5.22	Data of Station 2 at Trip 3	50
5.23	Flow rate of Station 2 at Trip 4	50
5.24	Data of Station 2 at Trip 4	51
5.25	Mean Particle Size of Station 2	53
5.26	Effective Particle Diameter Size versus Mean Velocity of Station 2	55
5.27	Temperature versus Viscosity at Station 2	56
5.28	Bed load Pattern at Station 2	58
5.29	Flow rate of Station 3 at Trip 1	60
5.30	Data of Station 3 at Trip 1	60
5.31	Flow rate of Station 3 at Trip 2	61
5.32	Data of Station 3 at Trip 2	61
5.33	Flow rate of Station 3 at Trip 3	62
5.34	Data of Station 3 at Trip 3	62
5.35	Flow rate of Station 3 at Trip 4	63

LIST OF TABLES

Table No.	Title	Page
5.36	Data of Station 3 at Trip 4	63
5.37	Mean Particle Size of Station 3	66
5.38	Effective Particle Diameter Size versus Mean Velocity of Station 3	68
5.39	Temperature versus Viscosity of Station 3	69
5.40	Bed load pattern of Station 3	71
5.41	Particle Density of sand in 3 stations	73
5.42	Mean Velocity versus Mean Flow Rate in 3 stations	74
5.43	Meyer-Peter Muller in 3 stations	76
5.44	Schoklitsch Formula for 3 Stations	78
5.45	Incipient Motion versus Meyer-Peter Muller in 3 Stations	79
A1	Data collected at Station 1	92
A2	Data collected at Station 2	92
A3	Data collected at Station 3	93
B1	Data collected at Station 1	94
B2	Data collected at Station 2	94
B3	Data collected at Station 3	95
C1	Data collected at Station 1	96
C2	Data collected at Station 2	96
C3	Data collected at Station 3	97

LIST OF TABLES

Table No.	Title	Page
D1	Data collected at Station 1	98
D2	Data collected at Station 2	98
D3	Data collected at Station 3	99
F1	Analysis of Station 1a at Trip 2	103
F2	Analysis of Station 1b at Trip 2	103
F3	Analysis of Station 1c at Trip 2	104
F4	Analysis of Station 1a at Trip 3	104
F5	Analysis of Station 1b at Trip 3	105
F6	Analysis of Station 1c at Trip 3	105
F7	Analysis of Station 1a at Trip 4	106
F8	Analysis of Station 1b at Trip 4	106
F9	Analysis of Station 1c at Trip 4	107
G1	Analysis of Station 2a at Trip 1	108
G2	Analysis of Station 2b at Trip 1	108
G3	Analysis of Station 2c at Trip 1	109
G4	Analysis of Station 2a at Trip 2	109
G5	Analysis of Station 2b at Trip 2	110
G6	Analysis of Station 2c at Trip 2	110
G7	Analysis of Station 2a at Trip 3	111

LIST OF TABLES

Table No.	Title	Page
G8	Analysis of Station 2b at Trip 3	111
G9	Analysis of Station 2c at Trip 3	112
G10	Analysis of Station 2a at Trip 4	112
G11	Analysis of Station 2b at Trip 4	113
G12	Analysis of Station 2c at Trip 4	113
H1	Analysis of Station 3a at Trip 1	114
H2	Analysis of Station 3b at Trip 1	114
H3	Analysis of Station 3c at Trip 1	115
H4	Analysis of Station 3a at Trip 2	115
H5	Analysis of Station 3b at Trip 2	116
H6	Analysis of Station 3c at Trip 2	116
H7	Analysis of Station 3a at Trip 3	117
H8	Analysis of Station 3b at Trip 3	117
H9	Analysis of Station 3c at Trip 3	118
H10	Analysis of Station 3a at Trip 4	118
H11	Analysis of Station 3b at Trip 4	119
H12	Analysis of Station 3c at Trip 4	119
L1	Particle Density at Trip 1	123
L2	Particle Density at Trip 2	123
L3	Particle Density at Trip 3	124

LIST OF TABLES

Table No.	Title	Page
L4	Particle Density at Trip 4	124
M1	Incipient Motion Data during Trip 1	125
M2	Incipient Motion Data during Trip 2	126
M3	Incipient Motion Data during Trip 3	127
M4	Incipient Motion Data during Trip 4	127

LIST OF FIGURES

Figure No.	Title	Page
2.1	Shields diagram	7
2.2	Bed forms encountered in movable bed streams	12
3.1	Map of study area, along Galing River from Google Maps	15
3.2	Location of the stations from Google Earth	15
3.3	View of Station 1 at Semambu Baru	16
3.4	View of Station 2 at Pei Chai	17
3.5	View of Station 3 at Vistana	17
4.1	Setting out the station for measuring at station 2.	19
4.2	Measuring the depth and the velocity of the river	19
4.3	Open Face Measuring Tape	20
4.4	Manning's n for Channels	23
4.5	Soil Grain Sizes. (Refer from ARTHON)	24
4.6	Soil Sample at Station 1 before dry at oven.	24
4.7	Soil Sample at Station 2 before dry at oven.	25
4.8	Soil Sample at Station 3 before dry at oven	25
4.9	Soil samples after dried 24 hours	26
4.10	Sieve Analysis	27
4.11	Particle Density test's Bottles	29
4.12	Taking the reading of W4	30
5.1	Grain Size Distribution of Station 1 at Trip 1	37

LIST OF FIGURES

Figure No.	Title	Page
5.2	Grain Size Distribution of Station 1 at Trip 2	38
5.3	Grain Size Distribution of Station 1 at Trip 3	39
5.4	Grain Size Distribution of Station 1 at Trip 4	40
5.5	Mean Particle Size of Station 1	41
5.6	Effective Particle Diameter Size versus Mean Velocity of Station 1	43
5.7	Temperature versus Viscosity at Station 1	44
5.8	Bed Load Pattern at Station 1	46
5.9	Grain Size Distribution of Station 2 at Trip 1	51
5.10	Grain Size Distribution of Station 2 at Trip 2	52
5.11	Grain Size Distribution of Station 2 at Trip 3	52
5.12	Grain Size Distribution of Station 2 at Trip 4	53
5.13	Mean Particle Size of Station 2	54
5.14	Effective Particle Diameter Size versus Mean Velocity of Station 2	55
5.15	Temperature versus Viscosity at Station 2	57
5.16	Bed load Pattern at Station 2	59
5.17	Grain Size Distribution of Station 3 at Trip 1	64
5.18	Grain Size Distribution of Station 3 at Trip 2	65
5.19	Grain Size Distribution of Station 3 at Trip 3	65

LIST OF FIGURES

Figure No.	Title	Page
5.20	Grain Size Distribution of Station 3 at Trip 4	66
5.21	Mean Particle Size of Station 3	67
5.22	Effective Particle Diameter Size versus Mean Velocity of Station 3	68
5.23	Temperature versus Viscosity of Station 3	70
5.24	Bed load pattern of Station 3	72
5.25	Particle Density of sand in 3 stations	73
5.26	Mean Velocity in 3 stations	74
5.27	Meyer-Peter Muller in 3 stations	76
5.28	Incipient Motion versus Meyer-Peter Muller in 3 Stations	80
5.29	Kuantan, Malaysia Annual Yearly Climate Average	81
5.30	Precipitation amount of Kuantan, Malaysia	82
5.31	The obstacles found at Station 1	83
5.32	Hjulstrom Curve	84
K1	Table of Viscosity	122
N1	Rain fall data for the month of February	128
N2	Rain fall data for the month of March	128
N3	Rain fall data for the month of April	129

LIST OF SYMBOLS

Q	Flow Rate of water (m^3/s)
A	Cross Sectional Area (m^2)
V	Actual Velocity (m/s)
V_{mean}	Mean Velocity (m/s)
mm	Milimeter
R	Hydraulic radius
km	kilometer
m	meter
g	Gravitational Force (m/s^2)
n_s	Manning's roughness factor
τ_c	Critical Shear Stress
τ_o	Actual Shear Stress
D_s	Mean Diameter (mm)
ν	Viscosity (m^2/s)
γ	Specific Weight (N/m^3)
S	Slope
g_s	Bed Load Discharge ($\text{lb}/\text{sec}\text{-ft}$)
D_m	Effective Diameter (mm)
d	Mean Flow Depth (ft)
D_o	Mean Grain Diameter (inches)
ψ	coefficient depending on the mean size of bed sediment, $\text{ft}^3/\text{lb}/\text{sec}$

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

Sediment is a naturally occurring particle that is broken down by the processes of weathering and erosion, which particles that with varying sizes that can be transported by fluid and flow along the fluid matter. Some of the particles are deposited as a layer of solid particle on the water bed or at the bottom of a body of liquid.

The sediment's size, volume, density, and shape and the strength of the flow are the criterion that causes the sediment transported from one place to another place. The particle will be rise when the flow is strong enough to lift or drag it. Therefore, the sediment will be transported from one place to other places.

The sediment grain size that being moved as bed load is needed to identify first before doing the load calculations and stability analyses. The details of the size of the bed load indicate the size of the material being transported to downstream and the size of material that may be accumulated at upstream.

1.1 BACKGROUND OF STUDY

Kuantan river is the main river that flow in the middle of Kuantan town. Before the river flowing out to south china sea, Kuantan is from Lembing River run through Kuantan

city. Galing River is one of the major contributors to Kuantan River and covers the area from Semambu, Bukit Sekilau and flowing out to Kuantan River at the end of Kampung Tok Keratuat.

Galing river has been recorded by the Drainage and Irrigation of Department of Pahang as one of the high potential area to be effected by flood. This river was chosen by the state government for the "1 state 1 river" program. This river also being classified as class IV for its pollution level. This is due to the rapid development the basin area which is lead to many unfortunate events such as flooding, poor water quality, lack of clean water, resources and erosion (Omar, 2010).

The shape of rivers and streams shifts with the interrelationship between erosion, deposition, and transport of sediment. Rivers and streams maintain a dynamic equilibrium between discharge, sediment load, and sediment size (Lane, 1955). Long-term changes in equilibrium observed in the landscape can result from climate change, construction uplift and subsidence and hydrologic changes resulting from human activity such as irrigation diversion and dams.

1.2 PROBLEM STATEMENT

The erosion is one of the factors that cause the bed load increase at the river. It will make the river depth decrease and cause the flooding when overflow. In addition, the type and dimensions of a bed load pattern depend on the properties of the flow, fluid, and bed material. This study will identify and analyze about the bed load at Galing River and find out the sediment pattern from the sedimentation process.

1.3 OBJECTIVE

The research objectives of this study are:

- 1.3.1 To identify the size and types of sediment at Galing River.
- 1.3.2 To analyze the bed load discharge of Galing River using selected method.
- 1.3.3 To identify the sediment pattern/ bed load pattern due to sedimentation process.

1.4 SCOPE OF STUDY

The study will focus at 3 stations, which are located at upstream, middle stream and downstream of the Galing River. There are two methods will be used to calculate bed load. The methods are Schoklitsch formula and Meyer-Peter and Muller formula.

1.5 SIGNIFICANCE OF STUDY

This study can provide the data of bed load which can be used to make future research at Galing River. The patterns of bed load can be identified. The patterns of the bed load are changeable with time; hence this study can find out and determine the pattern of the bed load at Galing River. This research is able to become a reference for the future researcher to compare the data and help them for further research at Galing River.

CHAPTER 2

LITERATURE REVIEW

2.1 SIZE AND TYPES OF SEDIMENT AT GALING RIVER

The sediment's grain sizes provide an indication of the shear stress that must be applied by the medium to give the condition of the transport of the particle. The factors such as source material, topography and transport mechanisms will affect the grain size distribution. Hence, the grain size will be found out by using the difference sieving method. According to Abuodha (2003), the sieving method and settling tube techniques are used to determine the grain size. Sieving method is used to find out the spherical grain particle, while settling tube technique is used to measure the settling velocity of particles in a medium, and translate this size scale. According to Okeyode (2013), the only mechanical sieving method using a Ro-tap shaker was chosen for the dry sediment sample analysis. A small portion of the samples of sediment will be sort mechanically into a set of US mesh sieves using a Ro-tap shaker. A balance used to weighted the fraction retained on each sieve and the pan. Once the cumulative weight percentage was calculated, the grain size was then plotted on the ordinate and form a grain size distribution and a frequency curve for each sample. Both of the method will be able to calculate the statistical parameters of standard deviation, mean, median and used to derive the various grain size parameters.

2.1.1 Geometric Mean

Accordinging the principle of grain size distribution, it is able to find out the geometric mean of the sand from the cumulative curve.

Arithmetic method of moments

$$\text{Mean , } x = \frac{\Sigma fm}{100} \quad (2.1)$$

Logarithmic-(original) Folk and Ward (1957) graphical measures

$$\text{Geometric Mean, GM} = \frac{\phi_{16} + \phi_{50} + \phi_{84}}{3} \quad (2.2)$$

According to Simon (2001), sedimentologists are prefer to use the statistic which is expressed geometrically (in meteric units) compare with the logarithmic statistic (in phi units). It is due to the phi scale was seldom applied for others scientist.

2.2 ANALYSIS SEDIMENT LOAD

Normally, there are a lot of methods for analysis the sediment transport of the bed load. Now, three of the methods will be discuss and choose the most suitable method used to conduct the research.

2.2.1 Incipient Motion

Incipient motion of bed particles can be refer as the critical condition between transport and no transport of the particle.

The Shields diagram can be used to evaluate the critical shear stress (the shear stress at incipient motion). To use the Shields diagram, one must first compute the following:

$$\frac{D_s}{\nu} \sqrt{0.1 \left(\frac{\gamma_s}{\gamma} - 1 \right) g D_s} \quad (2.3)$$

Which can then be used to locate τ_* on the curve in the Shield diagram. With τ_* , the critical shear stress can be computed by:

$$\tau_c = \tau_* \left(\frac{\gamma_s}{\gamma} - 1 \right) \gamma D_s \quad (2.4)$$

The actual shear stress can be computed using

$$\tau_0 = \gamma R S \quad (2.5)$$

Then a comparison is made of τ_c and τ_0 . If τ_0 is larger than τ_c , transport is expected.

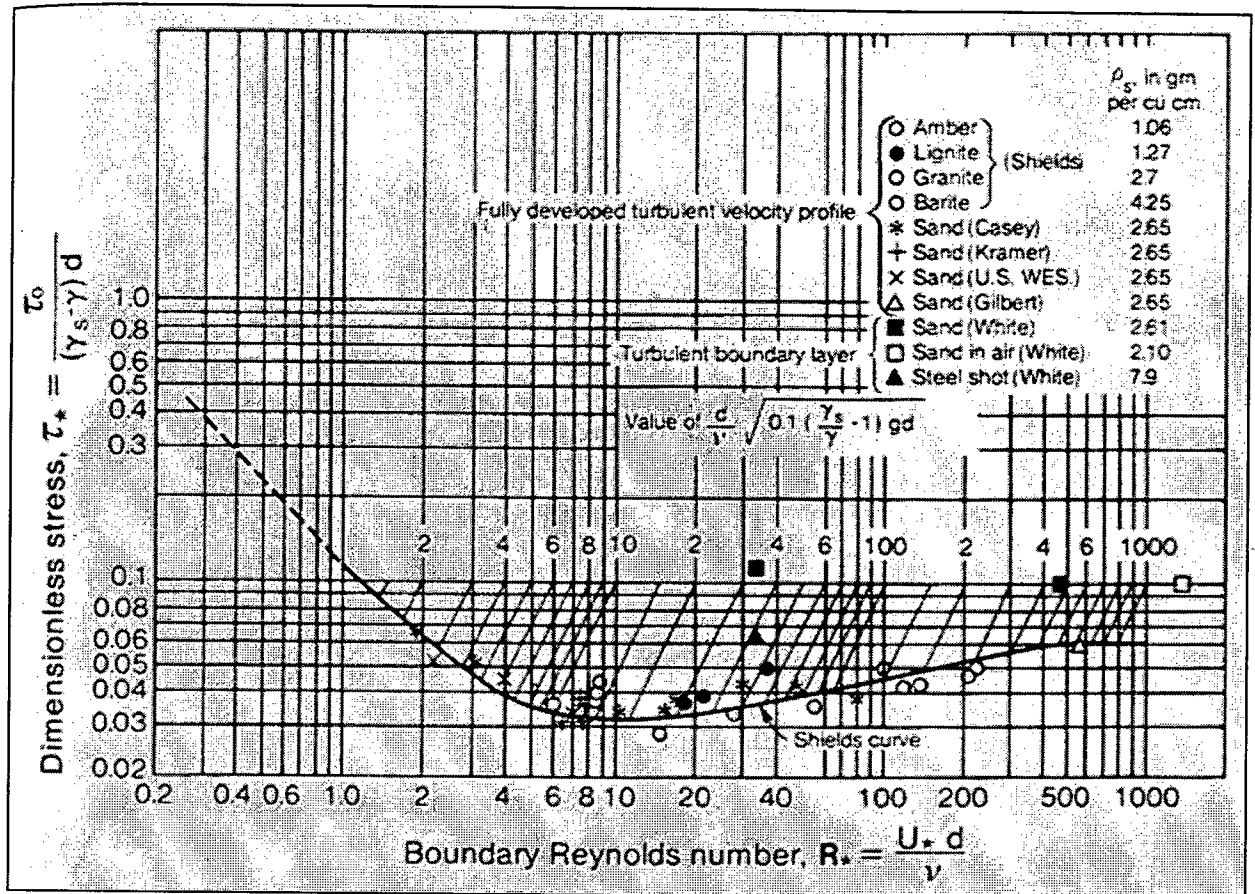


Figure 2.1: Shields diagram

Source:

<http://rpitt.eng.ua.edu/Class/StormWaterManagement/M3a%20Characteristics%20and%20Sources%20Internet%20material/M3a3%20sediment%20movement%20in%20sewers.htm>

In principle, incipient motion of particles on a stream bed can be predicted from a balance of the forces acting on the particles. Stefan et.al (2007) stated that on a natural river bed, the exposure of particles to the flow is variable; it is able to be analysis by using the critical Shields parameter of spherical particles. According to Buffington et.al (1997), Shields plot constructed from data that represent initial motion of the bed load material reveals systematic methodological biases of incipient motion definition. However, according to Cao et.al (2006), the implicit nature makes applications rather inconvenient,