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EVALUATION OF THE SHAPE AND SIZE OF THE BED MATERIALS USING SNEED AND FOLKS DIAGRAM

Nor Azidawati Haron & Ku Afiq Ku Haris
Infrastructure University Kuala Lumpur, MALAYSIA

ABSTRACT

Streams and rivers are critical components of the hydrological cycle. River flow can scour the beds, transport and deposit particles, and thus change the river sinuosity. They will become non-porous or impermeable if the grain is not preserved. Runoff water may immediately enter the river, increasing the water flow rate and causing a flood. The presence of grain particles in the river is critical because they can control the velocity of the water flow, especially during the wet season. This study aimed to examine the particle shapes and sizes of gravel bed materials in the upper, intermediate, and lower stream of the Lepoh River. For analysis, Sneed and Folk diagrams were used. This method has been advocated as the most appropriate method for presenting the shape of particles in an unbiased manner. Around 300-grain particles were collected from the river's upper, intermediate, and lower reaches. The frequency distribution of particles at a, b, and c of the axis was quantified to analyse the shape and size of the bed materials. The study concluded that bed material was classified as very coarse gravel with mostly bladed particles at a higher flow rate and the upper stream. The bed materials were classified as coarse gravel, and the particle shape was platy and bladed at the lower part of the river due to the lower elevation.

Keywords:
Clast Shape, Sneed and Folks, Grain Particles, Bladed, Platy

INTRODUCTION

Rivers flowing to the seas or lake are fed by tributaries and small gullies through which water trickles from rain, snow and ice or subsurface sources. The area of land draining into a river is called a catchment. Most commonly, the catchment is defined as the area that topographically appears to contribute all the water that passes through a given cross-section. River transports many chemical substances and biological species because of domestic, municipal and industrial wastewaters. Rivers flowing through the catchment transport water, sediment, other chemical substances, and biological species.

Deposition and transit of sedimentary materials indicate the transport and deposition methods. For example, if the materials slide down a hill, the resulting deposits are typically chaotic and exhibit a broad diversity of particle sizes. Sediment texture is determined by grain size and interaction between grains. It is possible to deduce transport and deposition modes by studying the microstructure of resultant deposits. When it comes to sorting, it's all about grain size consistency. Because of the energy of the carrying medium, particles are sorted according to cast density. Large clast particles can be carried by high-energy currents (Bui Bui & Rutschmann, 2019).

To sum up, criteria selection is crucial in defining the form and size of gravel bed material when utilising Sneed and Folks diagram as a guideline. It is a triangle (ternary) diagram that plots the ratios of the three orthogonal axes of the particles. Sneed and Folks initially proposed it, and Hickey (1970) and Ballantyne (1982) gave geometrically similar diagrams. This study embarks on the following objectives; (i) determine the factors that influence the shapes and sizes of the gravel-bed river; (ii) evaluate the shapes and size of the gravel-bed river using the Sneed and Folks diagram.

The Sneed and Folks diagram will be used to classify the gravel bed river's shape and size. While the forms and sizes of gravel-bed rivers are the manipulated factors in this study, Sneed and Folks diagram are the fixed variables used to categorise the shapes and sizes of gravel-bed rivers.

LITERATURE REVIEW

Introduction to Clast Classification

Chemical and clastic sedimentary rocks can be distinguished. A substance is carried as solid pieces (clasts), categorised as clastic, while a substance in solution is classified as chemical. Less than 1/16mm clasts are primarily clay minerals, whereas those bigger than 2mm are rock pieces that can be basalt or andesite, granite or gneiss, among other materials (Szilo & Bialik, 2018). As a result, the Udden-Wentworth grain-size scale has been used to study grain size categorisation. This article has six basic kinds of grain size: boulder, cobble, sand, silt and clay.

Clast Shape

There are a few sedimentary rocks that their clast form or roundness may differentiate. Round and angular shapes are associated with lengthy transportation distances and high-energy environments; rounded shapes are associated with long transportation distances and/or high-energy deposition environments such as beaches and rivers (Oakey et al., 2005). When it comes to depositional surroundings, the degree of sorting of clasts might be a significant indication. In water, bigger clasts are less likely to be carried long distances and settle more quickly. According to one theory of river sedimentation, as the energy in the river is lost by sedimentation, the bigger, heavier grains of coarse sand start to accumulate. In contrast, the finer, lighter mud grains are carried far away from shore by currents (Sharma, n.d.).

On the side of form and angularity, particles have angular edges rather than rounded, giving them their characteristic feature. Flow, drag, and lift forces impact the particle form, resulting in particle deposition, entrainment, and transport. Varied conditions with the same weight or b-axis size may react differently to water flow because of their different shapes. As a result, while studying particle shape, it is important to consider the longest, intermediate, and shortest axes, or all of them (Termini, 2021).

A grain's sphericity is determined by its shape, which is measured by its shape. Granules come in numerous forms. A few grains are elongated or flattened, while others are almost spherical (Krumbein, 1941). Diverse processes, weathering, erosion, deposition and transit, will cause the grains to emerge in different shapes. As a result of water or wind erosion, the rocks will seem rounded, whereas crushed rocks will appear angular (Cassel et al., 2021).

Clast Sizes

Particle sphericity refers to how well a particle of a given shape relates to the transport properties of a sphere. In contrast, the expression roundness refers to the degree to which the edges of a particle are rounded. Sphericity can be used as a measure of particle susceptibility and transportability, for instance, the particle's ability to remain in transit after being entrained in a stream. Since abrasion and susceptibility are two separate notions, it's necessary to utilise different spherical definitions in each situation (Afzalimehr et al.,2017).

Deposition and transit of sedimentary materials indicate the transport and deposition methods. For example, if the materials slide down a hill, the resulting deposits are typically chaotic and exhibit a broad diversity of particle sizes. Sediment texture is determined by grain size and interaction between grains. It is possible to deduce transport and deposition modes by studying the microstructure of resultant deposits. When it comes to sorting, it's all about grain size consistency. Because of the energy of the carrying medium, particles are sorted according to cast density. Large pieces can be carried by high-energy currents (Bui et al.,2019).

Larger and heavier particles are deposited as the energy diminishes, while smaller and lighter pieces continue to be carried. There is a sorting process owing to density in this case. As a result of abrasion, grains may be rounded during transit. Because of random abrasion, grains' sharp corners and edges will eventually be smoothed off. Grain rounding indicates how long sediment has been in transit. As a result of the correlation of the three particles' axes (a is the longest particle axis, b is the intermediate particle axis, and c is the shortest particle axis), particles may be grouped into four basic forms. Callipers, rulers, or a pebble box can be used to quantify particle length. In order to identify these forms, the form factor (F) may be used to measure their platy, bladed, and elongated characteristics.

Sneed and Folk Diagram

Particles can be classified as compact, platy, bladed, or elongated according to the Sneed and Folks diagram. Because it uses three orthogonal particle axes, it has been recommended as the best approach for impartially presenting primary particle shape data. Compared to other options, this graphic has some benefits (Graham & Midgley, 2000). Compared to other options, it is easy to grasp, and the plotted numbers are simple to calculate. It used a combination of compactness ratio c/a and form factor F, as shown in Table 1, which defines any point inside the triangle's boundaries. Particles with $F<0.33$ are platy, those with $0.33<F<0.67$ are long and thin-bladed particles and those with $F>0.67$ are elongated particles. The Sneed and Folks diagram shows in Figure 1, C stands for Compatibility, CP for Compact Plates, CB for Compact Blades, CE for Compact Elongated, P for Plates, B for Blades, E for Elongated, VP for Very Plates and VE for Very Elongated (John Wiley, 2000).

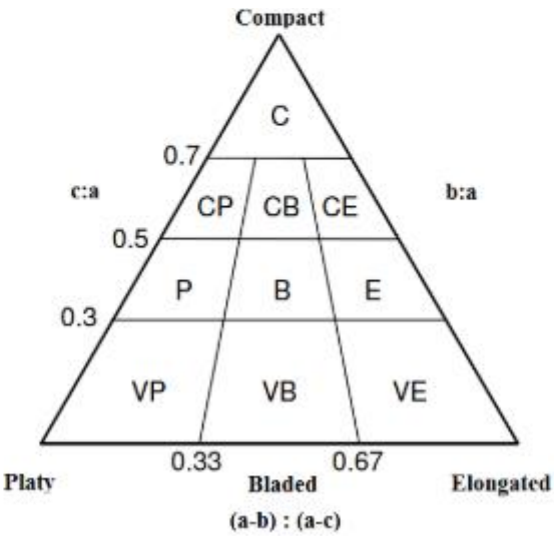
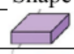


Figure 1: Form factor in Sneed and Folks diagram

Table 1: Form factor for Classification of Clast Shape

Form Factor	Classification	Shape
$F < 0.33$	Platy (P)	
$0.33 < F < 0.67$	Bladed (B)	
$F > 0.67$	Elongated (E)	

The degree of compactness, S, is also used to categorise the particle forms into orders, but differently. For example, when S is more than 0.7, a sphere-like arrangement is produced, and when S is between 0.5 and 0.70, the shape is somewhere between compact platy and bladed or elongated. The particles are extremely platy, bladed, or elongated if S is less than 0.3 or 0.5. If S is less than 0.3, they are classified as very platy

RESEARCH METHODOLOGY

The sample was collected at three locations, the upper, intermediate and lower stream of Lepoh River, with 300 samples. Then, the samples were measured for their dimensions and recorded into the spreadsheet for generating Sneed and Folks diagram. The result obtained was studied to classify the shapes and sizes of gravel-bed rivers using the Sneed and Folks diagram.

To determine the shapes and sizes of a gravel-bed river using a triangular diagram plotting spreadsheet known as Tri-Plot. The sample was collected from the Lepoh River. Therefore, setting up the experiment involved three parts: data entry area, plotting parameters area, isoline values area, Sneed and Folks classes' area and calculation area. First, enter the dimensions of each clast axes (a, b and c) into the data entry table after measuring the clast.

Next, identify the frequency and size of tick marks in plotting parameters, then proceed with isoline values. A minimum of ten data are required to enter the isoline tables for oblate-prolate isoline values and maximum projection sphericity isolines. Then, a specified amount and per cent are entered into the Sneed and Folks classes before Sneed and Folks diagram is fully generated. The data is for shapes of the gravel-bed river and to proceed with the same steps of finding the gravel size.

RESULTS AND DISCUSSION

Figure 2 shows the distribution of form factors in the Sneed and Folks diagram for three locations: the upper, intermediate and lower stream. The shapes and sizes of the particles vary significantly for each location caused by the erosion of water velocity. Hence, the collected data of a, b and c were calculated using Equation 1 to obtain the compactness ratio, elongated and form factor. The highest distribution of form factors at the upper stream is bladed classes (18%), at the intermediate stream is bladed classes (25%), while at the lower stream is compact bladed classes (25%). The deformation of grain shapes indicates the water velocity influence the shape of the grain.

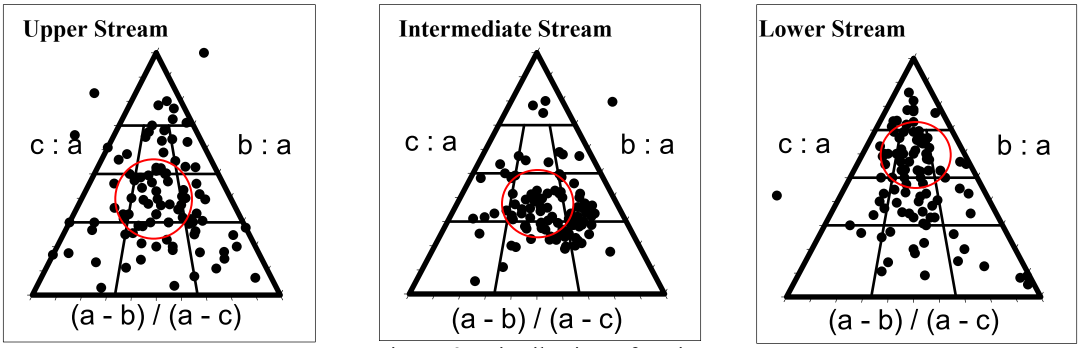


Figure 2: Distribution of grain classification

Next, Figure 3 shows the total amount of grain samples at different locations. The highest samples collected in the upper stream is a medium boulder (MB) with % and followed by the lowest with 0 grains for sand (S), very fine gravel (VFG), fine gravel (FG), medium gravel (MG), coarse gravel (CG) and very large boulder (VLB) and bedrock (B). Next, the highest samples collected for the intermediate stream are small cobble with 25 grains and 0 for sand, very fine gravel, fine gravel, medium gravel, coarse gravel and bedrock. However, it is vice versa for the lower stream, the highest number of samples collected is 20 for sand (S), and the smaller number of samples is 0 for large cobble (LC), small boulder (SB), medium boulder (MB), large boulder (LB), very large boulder (VLB) and bedrock (B).

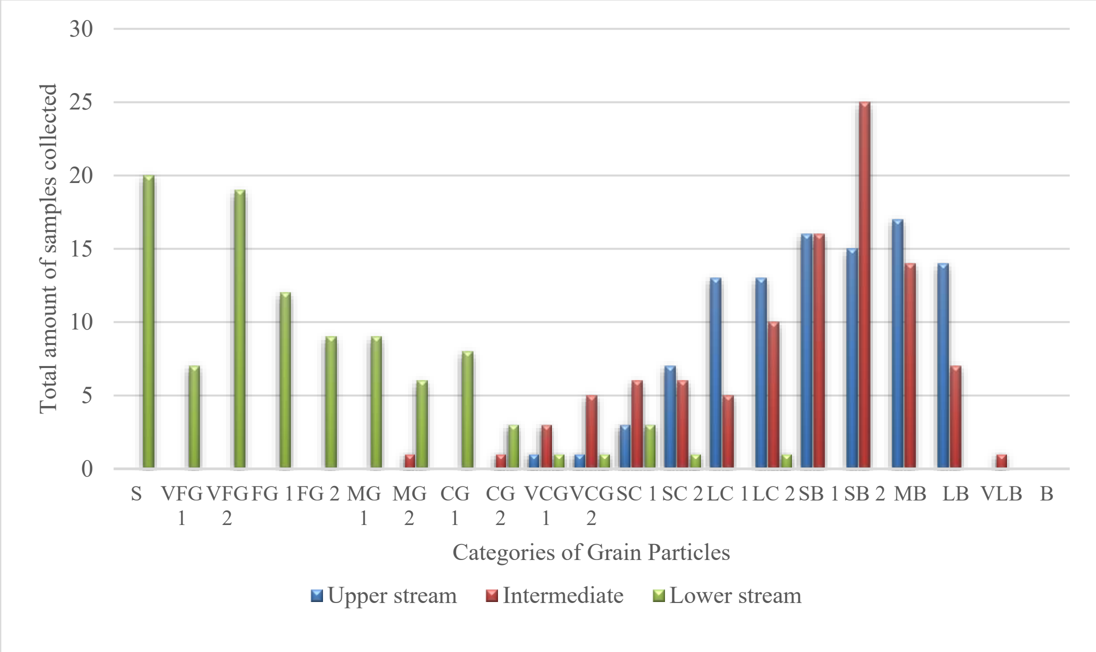


Figure 3: Distribution of grain particles associated with upper, intermediate and lower stream

Hence, the results show that the shape and size of grains vary depending on the location of the stream, which is influenced by the flow of water. The erosion becomes harder and more severe as the velocity of the water increases; however, water flow velocity decreases due to friction along the streambed, where it is slowest at the bottom and edges and fastest near the surface and in the middle. Furthermore, because the grains were transported over a short distance after being broken down from the crushed rock and did not roll very well, the grains became lighter as erosion occurred to the grains. Because of friction between the water and the air, the velocity below the surface is usually slightly higher than at the surface.

The samples collected show that the highest percentage of grains at the lower stream is the cobbles with 55%, followed by the intermediate stream with 50% for the boulders and lastly lower stream with 86% of gravel. It can be seen that the grain particles are significantly affected by the velocity of the stream. The results show that boulders and cobbles predominate upstream compared to downstream. The proportion of cobbles and boulders in the river decreases as it flows downstream, while the proportion of smaller-sized materials increases. Because of the dominance of bed materials and the high elevation, the discharge of upstream flow is greater than downstream. As the particles travel over time, they are worn down by the water or other particles, and their size decreases. The swift water will carry the smaller rocks and sand to the lower elevation. Therefore, the conclusion is in line with the previous research (Franzi, 2013; Haron, 2018; Yang, 2019), where the shapes of grains are larger and bladed at the upper stream while platy and bladed for grains at the lower stream.

Upper stream and intermediate stream obtained the highest percentage of bladed particles with 18% and 25%, respectively followed by very bladed particles with 17% and 23%. Generally, the increased numbers of grains collected were related to the water flow. Since the stream brings the grains, the shape is also affected due to the flow velocity from one place to another. However, it is different for the lower stream as it obtained the highest percentage of compact bladed with 25%, followed by bladed particles with 19%. After being broken down from the crushed rock, the particles were transported over a long distance. As a result of the abrasion, the particles become more compact.

CONCLUSION

From this study, it can be seen that the water flow influences the shapes of grains and the results show that in the upper stream, the grains are larger while the upper stream is smaller. It is concluded that each location has different shapes and sizes of grains affected by the water flow. The maximum percentage for shapes at the intermediate stream is 25% for bladed, followed by 25% at the lower stream for compact-bladed.

AUTHOR BIOGRAPHY

Nor Azidawati Haron, is an expert in Water Resource Engineering. Her research is focusing on Hydro-morphology, River Health Evaluation, Fluid, Hydraulics and Hydrology Design and Modelling Infrastructure Design. She is also interested in Green Technology.

Ku Afow Ku Haris is a final year student at Infrastructure University Kuala Lumpur. He is studying in Bachelor of Civil Engineering (Hons).

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