Effect of particle shape against pumice particle strength

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1. Introduction

Single particle strength is one of the micro parameters of a grain of material. Several researchers, such as Basoka et al., (2023), Shen et al., (2016), and Yoshimoto et al., (2012), conducted tests on the single particle strength of materials such as sand. Shen et al., (2016) describe the particle shape, surface texture, and behavior of manufactured sand (MS). In contrast to river sand (RS), the results show that MS has more excellent roundness, a longer width-to-length ratio, and broader distribution ranges for those parameters. Yoshimoto et al., (2012) studied about crushing characteristics of each individual grain, and single particle crushing tests were conducted on different types of granulated coal ash. Investigations also looked into the features of the individual particles, such as shape. The results of Shen et al., (2016) and Yoshimoto et al., (2012) show a relationship between the shape and strength of the material. Based on that, this study analyzed the effect of particle shape on pumice particles.

2. Material and Methodology

The analysis was carried out using initial test data conducted by Basoka et al., (2023)

Table 1. Data sample (Basoka et al., 2023)

Sieve Opening (mm)	Mass Retained (gr)	Mass Passing (gr)	% Finer by Mass
4.750	0.00	201.38	100.00
2.000	7.71	193.67	96.17
0.850	133.84	59.83	29.71
0.425	39.56	20.27	10.07
0.250	4.74	15.53	7.71
0.106	1.90	13.63	6.77
0.075	0.58	13.05	6.48
Pan	13.05	-	-

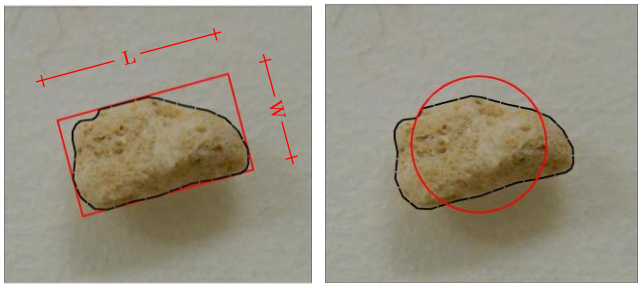
The data that has been collected is then measured. Based on the Shen et al., (2016) the shape parameter that can be analyzed is the aspect ratio as in Equation 1:

$$\text{Aspect Ratio} = \frac{L}{W} \quad (1)$$

Where L is the length of the sample and W is the width of the sample. For roundness coefficient can be described as Equation 2:

$$\text{Roundness} = \frac{P^2}{4\times\pi\times A} \quad (2)$$

Where P is the perimeter of sample, A is the area of sample.



(a) (b)

Figure 1. (a) aspect ratio (b) roundness

Based on Figure 1 (a) describes how to measure the aspect ratio component, L is the longest part of the sample, and W is the shorter part of the sample. Figure 1 (b) describes the roundness coefficient. The red circle reflects approximately the shape of the particle from the original shape to the circle shape. The black dash line is a particle shape that should calculate the perimeter and area of the dashed line. This measurement is done using photo measurement to get better results.

3. Results and Discussions

Based on the analysis carried out, it can be obtained that the Weibull distribution is illustrated in Figure 2, is the probability of the Weibull distribution with scale parameters is 2.343 and shape parameter is 2.410.

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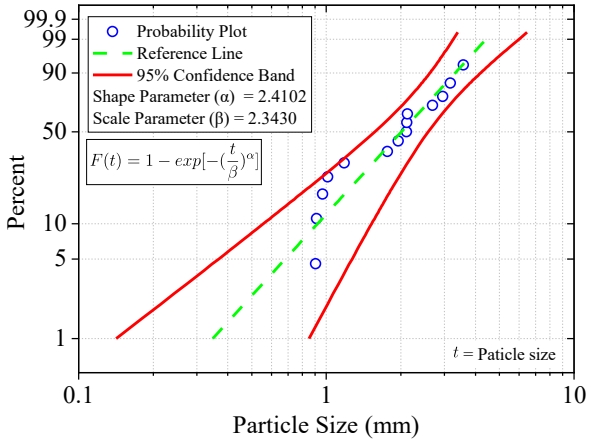

Figure 2. Weibull probability plot.

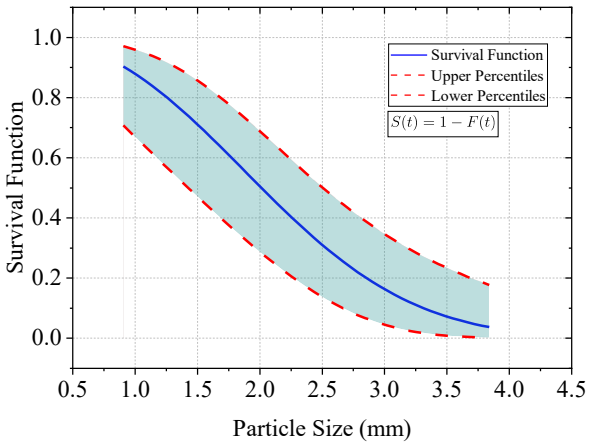

Figure 3. Survival function.

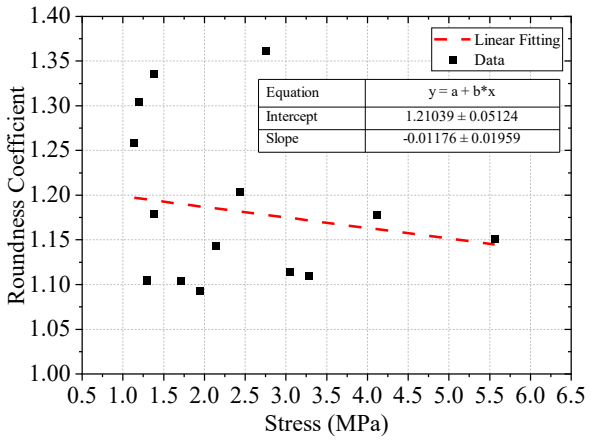

Figure 4. Roundness coefficient vs stress.

Figure 3 is a function of survival obtained based on the probability of Weibull, where we can see that the larger the particle size, the smaller the chance of survival, it is inversely proportional to the probability of failure in Figure 2. In Figure 4 the relationship between the roundness coefficient and stress can be seen that there is an increase in stress when the roundness coefficient value decreases.

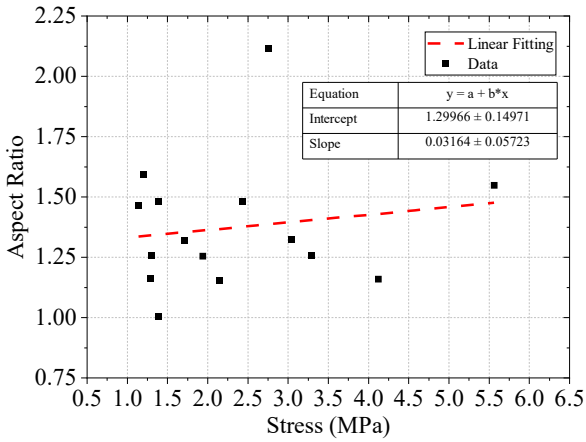

Figure 5. Aspect ratio vs stress.

Figure 5 shows that the higher the aspect ratio, the higher the stress on the pumice sand.

4. Conclusions

Based on the studies conducted, the shape of the particles also influences changes in the strength of pumice sand material, which can be seen from the relationship between the roundness coefficient, aspect ratio, and stress. Moreover, the limited number of tests is a limitation to generalizing the properties (especially the strength) of pumice sand, so it is necessary to pay attention to the number of particles tested.

References

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