

Relationship between Rate of Water Content and State of Sand

Okayama Prefectural Kurashiki Amaki Junior and Senior High School

Introduction

The slope of a sand pile made of wet sand is larger than one made of dry sand. It shows that the pile made of wet sand is more stable than the other one made of dry sand. However, considering a much higher water content, the pile made of wet sand is very fragile though it is more stable. Therefore, some experiments were conducted to detect the factors and determine the state of the sand. In this study, the angle of repose was used to quantify the stability of sand, and water content (hereinafter referred as W) was measured to quantify the amount of water contained in the sand.

Experiment 1



Equipment

- sand (grain diameter: $75\mu\text{m}\sim 75\text{mm}$)
- tube (Bottom radius: 71mm)
- purified water
- surfactant (detergent)

Experimental method

- ① Place the tube on a Level desk and fill the tube with 500 mL sand
- ② Lift the tube straight up to form a sand pile
- ③ Measure the angle of repose of the sand pile

Experiment 2

—to detect the relationship between the constituent particles of sand and water

Equipment

- sand (the same type as Experiment 1)
- purified water
- petri dish
- red food coloring

Experimental method

- ① Prepare three types of sand with W of 0~3%, 3%~50%, 50%~.
- ② Observe each sand under a microscope

Result 1

The higher the rate of water content of the sand is, the larger its angle of repose is. (See Figure 1) The angle of repose of sand with surfactant is smaller than normal sand with the same W .

Sand with a water content greater than 3.0% was made into a cylindrical shape (hereinafter referred to as “cake shape”), which is shown in Figure 2.

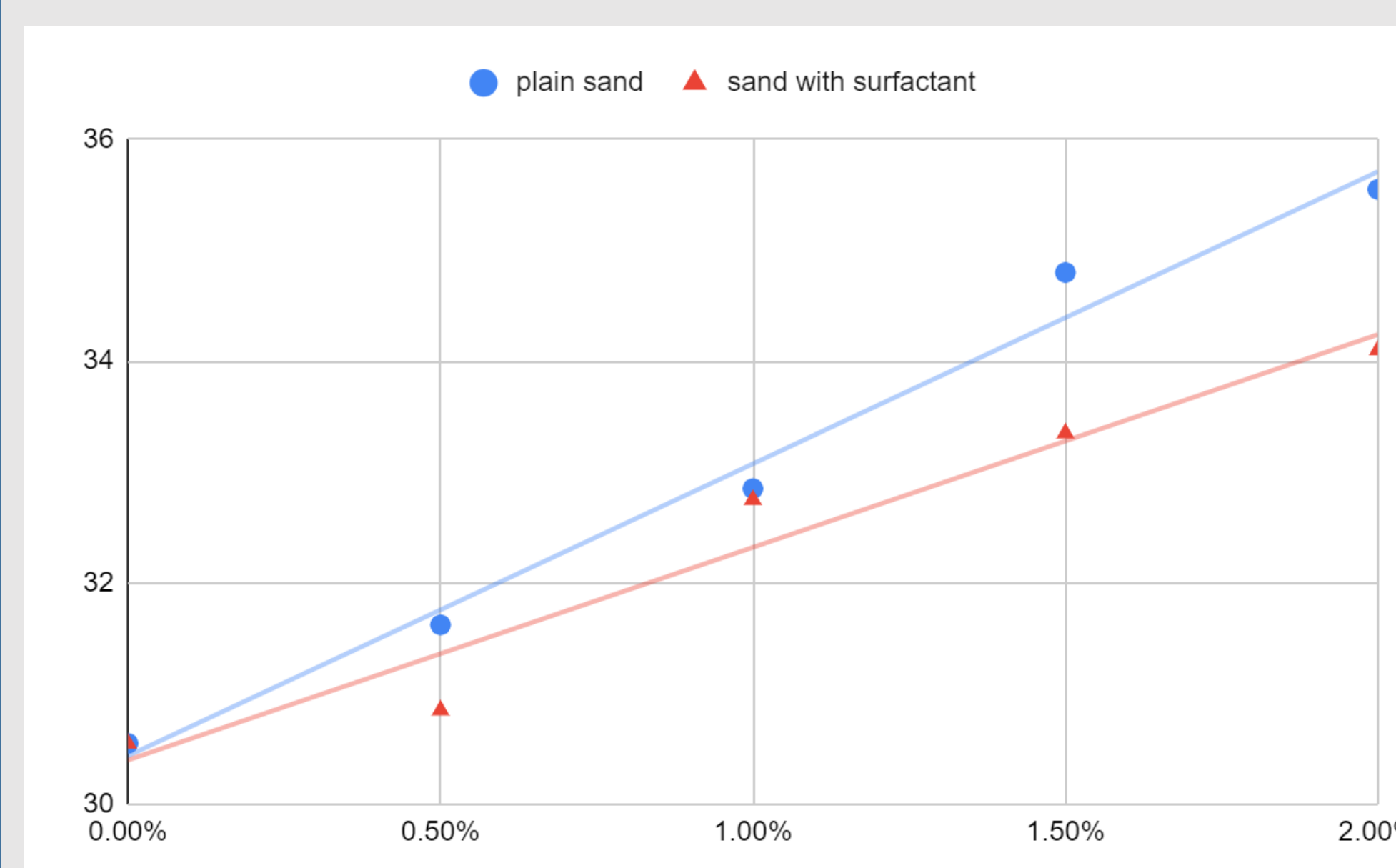


Figure 1

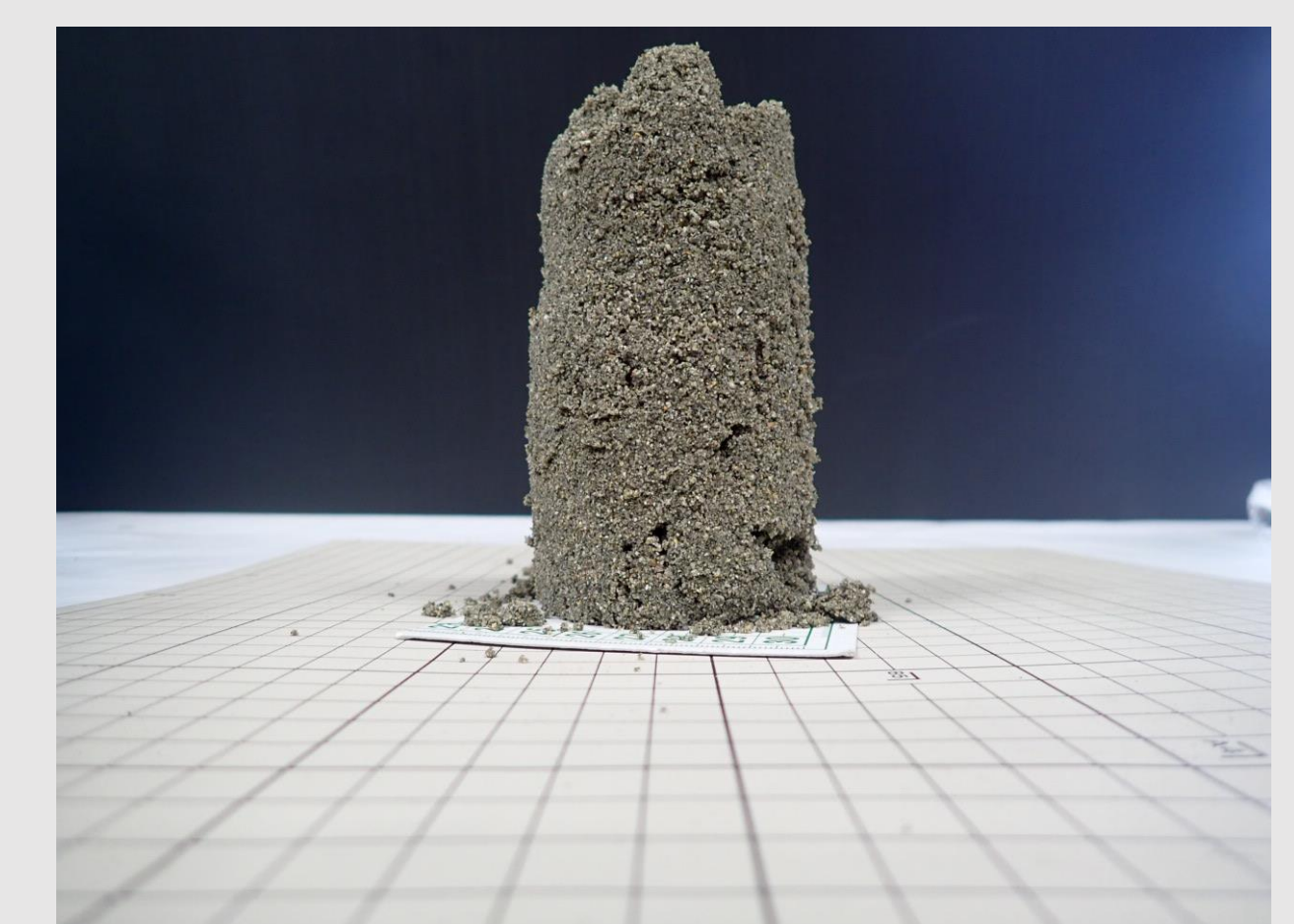


Figure 2

Result 2

In sand with W of 0~3%, water is connected point to point between particles. (See Figure 3)

In sand with W of 3~50%, water is continuously connected between particles and doesn't occupy the space. (See Figure 4)

In sand with W of 50%~, water occupies the space of particles. (See Figure 5)

Schematic diagram of each Figure is put.

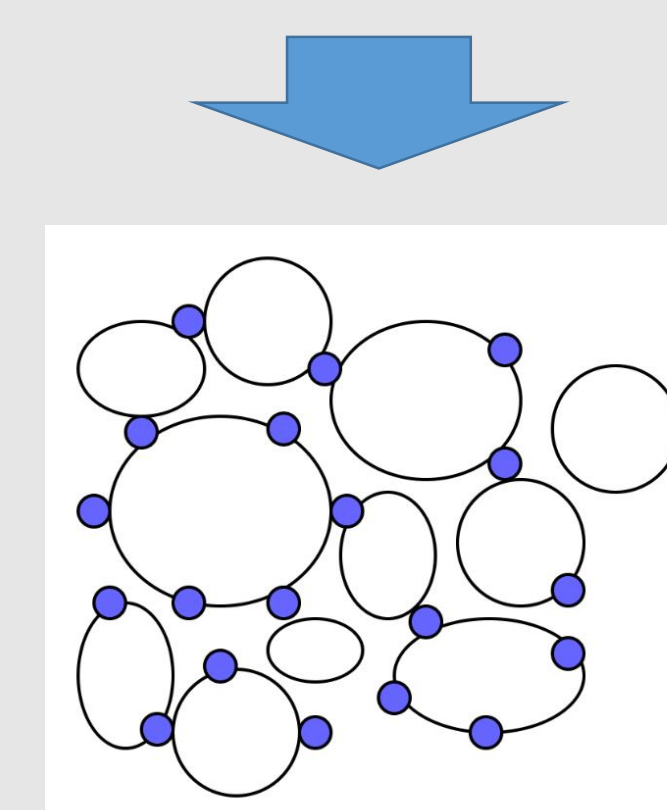
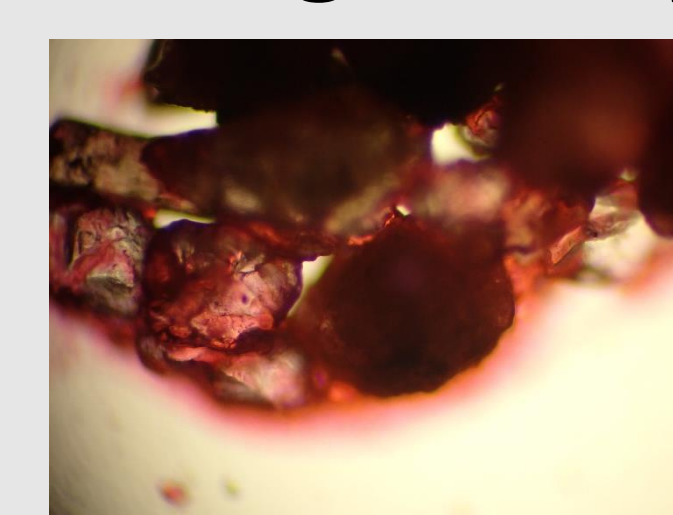
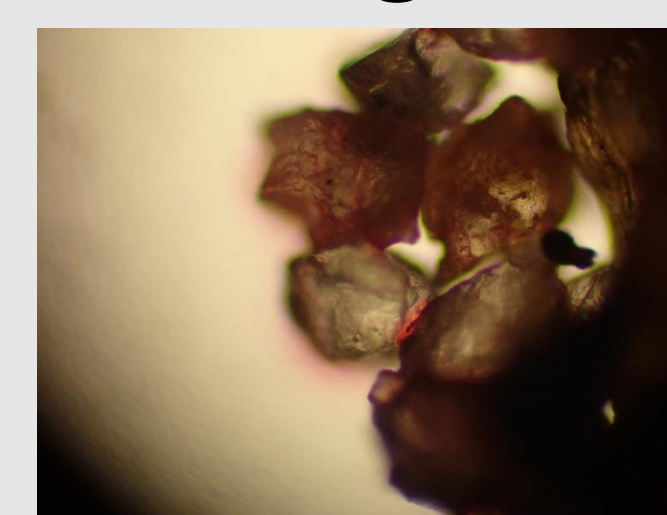


Figure 3

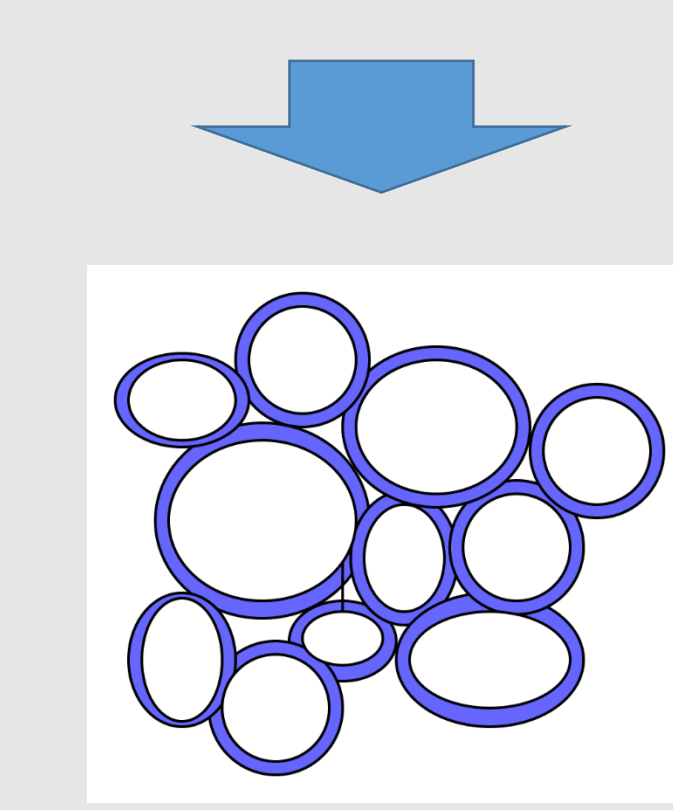


Figure 4

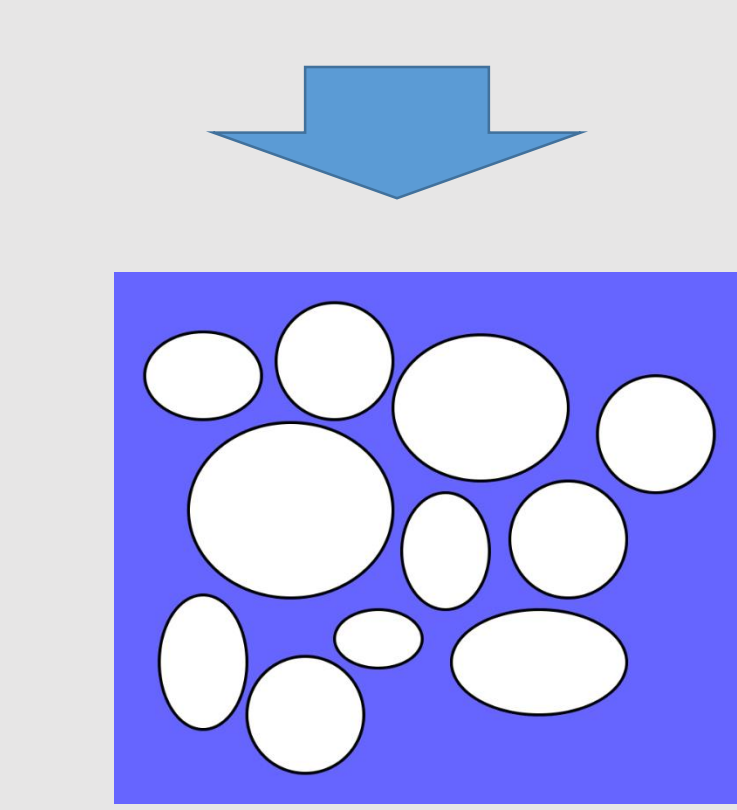


Figure 5

References

- ; 安川郁夫他: 絵とき土質力学(改訂3版). オーム社, (2022)
- ; 菊池統 他: 図解わかる土質力学(第2版), 学芸出版社(2023)
- ; 粒子の凹凸と内部安定角 (Reading date: 2023 11/29)
- <https://geolabo-chubu.com/wp-content/uploads/2019/08/1244789689.pdf>

Conclusion

It is concluded that water content contained in sand plays an important role in stabilizing the sand pile. Because the more water sand contains, the more stability sand gains, and the angle of repose of the sand with surfactant, which plays a role in lowering the surface tension of water plays a major role in stabilizing the sand pile. (According to Experiment 1)

Furthermore, degree of water contact between particles also plays a role in stabilizing the sand pile. (According to Experiment 2)