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The Use of Different Type of Sand in Calibration of Sand Replacement Test

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Abstract : Sand is a granular material that contains organic matter and is made up of finely split rock and mineral particles. Three type of sand was selected to check the sand availability as replacement for the standard sand that used in sand replacement test in laboratory. The aim of this study is to identify different type of sand that can replace standard sand used in the sand replacement test. Various sampling sand was taken in Selangor and Melaka states. The sea sand, river sand and quarry sand along with standard sand was tested in soil classification to determine the soil within a group with similar properties. Soil classification test such as sieve analysis, moisture content, particle density, relative density, direct shear, and in-situ field density using sand replacement test method to find type of soil that have similar attributes. The result of study showed that dry density value from sand replacement test shows that sea sand displayed the most similar with the standard sand. The classification test of various sand was expected to have same properties with the standard sand.

Keywords: standard sand, replacement test, moisture content, soil classification

1. Introduction

Sand is a granular material that contains organic matter and is made up of finely split rock and mineral particles [1]. There are many different forms of sand, including coral sand, glass sand, silica sand, pit sand, river sand, and much more. Sand should also be classified using the According to Sand to Size (ASTM) approach, which divides the material into three categories: Fine Sand, Moderately Coarse Sand, and Coarse Sand [1]. Different type of sand is tested to display its availability to act as replacement for the standard sand in sand replacement test if shortage of standard sand happening.

The aim of this study is searching the closest criteria between the various sand samplings and the standard sand. It is to make sure the sand replacement test can still be operating if there is a shortage of standard sand supply. There are many types of sand such silica sand, pit sand, coral sand, and much more. River sand, seasand and quarry were selected based on its availability in Malaysia [2]. In advance the complete understanding on various sand aspect can be an advantage to society [3].

2. Materials and Methods

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Several tests will be conducted such as particle size analysis, moisture content determination andsand cone replacement test. So, there are a lot of materials used.

2.1 Materials

Standard Sand, Duyong River Sand, Klebang Sea Sand, Shah Alam Quarry Sand

2.2 Equipment

Dry sieve analysis test, the equipment that be used are sieve shaker – BS410 Standard sieves, 0.1g accuracy balance – weigh the sieves and specimen, oven – let the specimen in dry form, cleaning brush – clean the sieve after used, receiving pan – to collect all passing specimen and clock – timing for sieving. Water content test, the equipment that be used are large size oven – dry the specimen, weight scales – weigh specimen after dry and specimen plate – small plate to put specimen in it. Particle density test, the equipment that be used are picnometer flask – measure density, glass stopper – seal the specimen and weight scale – weigh specimen.

Relative density test, the equipment that be used are bore gauge – measure interior diameter of mould, flat plate – put the mould on, desicator – protect mould from other chemical reaction and thermometer – measure temperature. Direct shear test, the equipment that be used are two metallic plates – in the direct shear machines, two screws – hold specimen and direct shear machines – measure direct shear. Sand cone replacement test, the equipment that be used are pouring cylinder – sand replacement device, calibrating container – sand replacement device, excavation tools – dig a hole, tray – collect the excavated soil, measuring tape – measure the hole and oven – dry the excavated soil.

2.3 Methods

Dry sieve analysis test, dry every sample of sand in the oven at least in 24 hours. After that, let it cool and measure its weight. Use a stack of sieves appropriate for the testing of the sand. For this test, astack of seven or six sieves is usually appropriate. The sand top sieves should be marginally larger than the largest particles and free. Arrange the stack of sieves such that the bottom is the smallest mesh opening and the top is the largest. Fix a pan to the bottom of the stack of sieves.Dump the sample on the top sieve. Apply the cover plate to prevent dust and particle loss when shaking. In the mechanical shaker, position the stack of sieves and shake for around 10 minutes or until further shaking does not make appreciable improvements in the quantities of material contained in each sieve. After sieving, take out the stack of sieve. Weigh each sieve and jot down the data.

Water content test, the mass of a clean and dry specimen container (Mc) obtained using the scales. Record every single container that used and the mass of specimen on a data sheet. Place the wet soil (sand) within the container. Weigh the mass of the container and wet sand (Mwc) usingscales. Place the container and wet sand in an oven and then dry the sand overnight at a temperature of 110°c. After that, take them out from the oven. Let it cool for a minute and weigh it using the balance to receive the container mass and the dry soil (Mdc). Particle density test, weigh and record the mass of a picnometer flask with a glass stopper. Fill the flask halfway with air-dried dirt. Weigh the flask, the stopper, and the soil separately. Make a note of the total mass. Slowly pour water into the soil, vigorously shaking the flask to fully mix the soil and water. Allow the air bubbles to float to the top of the water. Using a few more drops of water, float the froth out of the flask. Place the stopper in place, wipe the exterior dry, weigh, and keep track. Fill a garbage pail halfway with the contents and rinse the flask. Then fill

the flask with only water, close it, wipe the exterior dry, weigh it, and keep track of it. After that, do the calculations.

Relative density test, using a bore gauge, measure the interior diameter of the mould at various depths and average the results. Place the mould on a flat surface or a flat plate to keep it in place. Take theaverage of the height measurements taken in various positions (accuracy = 0.025 mm). Determine the volume. Fill the mould halfway with distilled water until it overflows. Slide a thick glass plate over the mould top surface. Weigh the water in the mould as it fills. Take noteof the water's temperature. Using physical tables, calculate the density of water at the above temperature. Calculate the volume of the mould, which is equal to the weight of the water filling the mould divided by the density of the water.

Direct shear test, put the soil sample in the direct shear device. Then, apply a predefined normal stress and provide the conditions for the specimen to be wetted and/or drained. Then, under normal stress, solidify the specimen. Remove the pins that hold the test specimen in place in the shear box halves. Shear the specimen by displacing one shear box half laterally with respect to the other at a constant rate of shearing deformation while measuring the shearing force, normal displacement and relative lateral displacement [4]. The shearing rate must be modest enough to allow for nearly full pore pressure dissipation.

Sand cone replacement test, fill the sand cone contraption with sand and weigh it. Place the density plate on a clean, levelled test surface. Dig a 4" to 6" deep holes in the dirt that is the same diameter asthe density plate hole. With a brush and a spoon, remove all loose soil from the test hole. Gather and weigh all the excavated soil. To tilt the hole with sand, invert the sand cone apparatus over the density plate and open the valve. Close the valve and remove the device from the test hole once the sand has stopped flowing. With the remaining sand, weigh the sandcone contraption. Collect as much sand as you can from the hole. Place a sample of excavated soil in the weighed moisture container and put it into the oven. Let it overnight. After that, weigh it once more to determine the water content [5].

3. Results and Discussion

This study used a variety of experiments to determine the link between Standard Sand, Duyong River Sand, Shah Alam Quarry Sand, and Klebang Sea Sand. After sieving each sample of sand, grain size analyses were performed. The sand cone replacement method was used to compare the suitability of each variety of sand for replacing conventional sand in calculating the subsoil field density. All of the tests carried out in these studies followed standard protocols such as those suggested by the British Standard (BS-1377) and the American Standard Test Method (ASTM) and the results showed in table and figure.

From the results of the tests, Klebang Sea Sand was had the most potential as replacement for the standard sand because almost all tests performed showed Klebang Sea Sand give the results near to Standard Sand. The various sand is expected to have same comparison in aspect with the standard sand used in sand replacement test.

Table 1: Result of particles size analysis test

Type of soil	Standard Sand	Klebang Sea Sand	Shah Alam Quarry Sand	Duyong River Sand
Gravel	2.00%	0.80%	7.00%	2.70%
Sand	97.93%	99.13%	92.93%	97.19%
Silt	0.07%	0.07%	0.07%	0.11%

Refer **Table 1**, found that standard sand consists of 2% gravel (> 2 mm), 97.93% sand (0.063– 2 mm) and 0.07% silt (0.063 – 0.002mm). However, for river sand consist of 2.7% gravel (> 2mm),

97.19% sand (0.063 – 2 mm) and 0.11% silt (0.063 – 0.002mm). For sea sand consist of 0.8% gravel (> 2 mm), 99.13% sand (0.063 – 2 mm) and 0.07% silt (0.063 – 0.002mm). For quarry sand consist of 7% gravel (> 2 mm), 92.93% sand (0.063 – 2 mm) and 0.07% silt (0.063 –0.002mm).

Table 2: Results of moisture content test

Type of soil	Standard Sand	Klebang Sea Sand	Shah Alam Quarry Sand	Duyong River Sand
1	0.00%	0.58%	1.12%	1.91%
2	0.95%	1.37%	0.79%	1.35%
3	1.00%	0.81%	1.47%	1.20%
Average	0.65%	0.92%	1.13%	1.49%

Refer **Table 2**, the moisture content of standard sand is only 0.65%. This indicates that the standard sand is practically totally dry. Compared to other forms of sand, sea sand has a moisture content of 0.92%, which suggests that the state of sea sand is virtually as dry as standard sand. While the moisture content in quarry sand is 1.13% and 1.49% in river sand, the moisture content in these two types of sand is higher than standard sand as our research guideline because the saltines feature of this sand may absorb the humidity in the environment.

Table 3: Results of Particles Density Test

Type of soil	Standard Sand	Klebang Sea Sand	Shah Alam Quarry Sand	Duyong River Sand
1	76.00%	86.20%	100.00%	76.00%
2	71.40%	80.80%	100.00%	73.70%
3	85.70%	72.20%	100.00%	77.70%
Average	77.70%	79.70%	100.00%	75.80%

Refer to **Table 3**, the relative density value for standard sand, sea sand and river sand equals to 77.70%, 79.70% and 75.80%. The value can be categorized in relative density of dense condition because for this condition the Dr value must in range of 65% to 85%. While for quarry sand the Dr value is higher than other sand that is 100%.

The geotechnical laboratory software was used to conduct the test to determine the directshearof the samples. **Figures 1** and **2** shows the connection between shear stress and normalstress. Standard sand has a cohesion coefficient of 0 kPa and sea sand has a cohesion coefficientof 0 kPa with is same with standard sand [6].

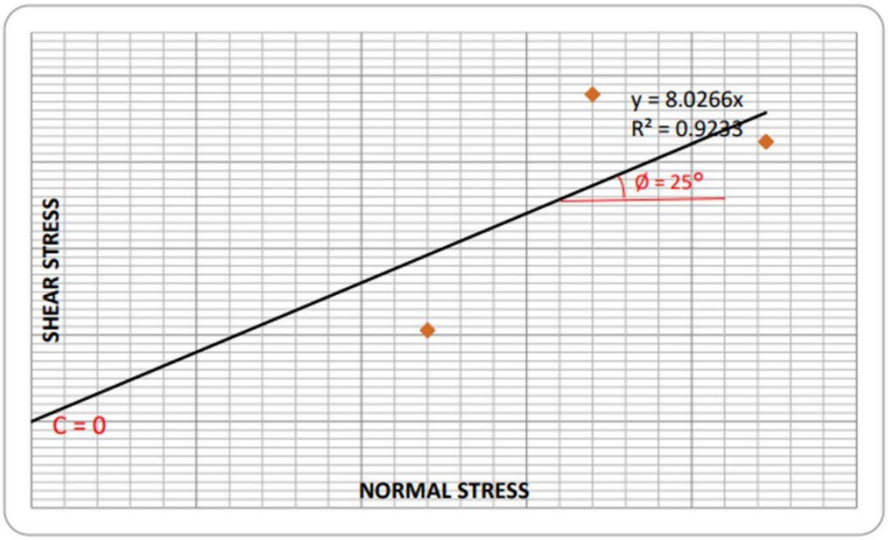

Figure 1: Shear stress versus normal stress (Standard Sand)

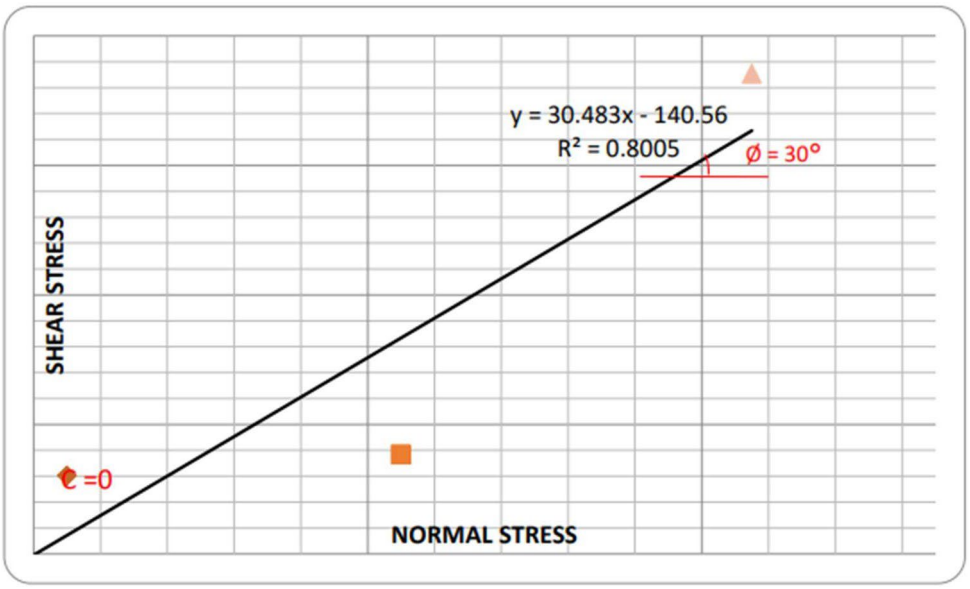

Figure 2: Shear stress versus normal stress (Klebang Sea Sand)

Referring to **Figure 3**, graph between Klebang Sea Sand and Standard Sand show almost 45º based on results dry density from sand replacement test with is results of Standard Sand from three samples are 1.06 g/cm^3, 0.99 g/cm^3, 0.94 g/cm^3 while results of Klebang Sea Sand are 1.02 g/cm^3, 0.98 g/cm^3, 0.96 g/cm^3. So, that is why Klebang Sea Sand has potential as to replace Standard Sandbased on graph that shown.

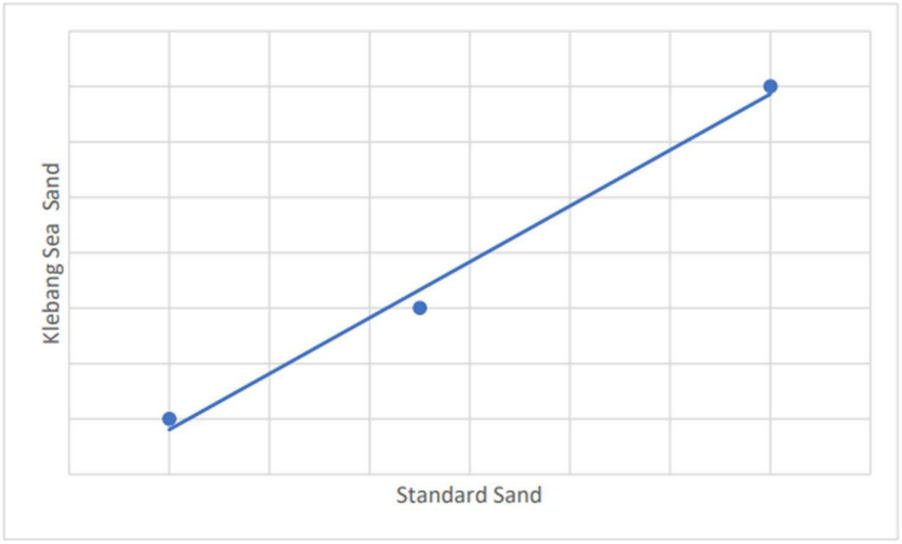

Figure 3: Relationship between Standard Sand and Klebang Sea Sand

4. Conclusion

From the study that have been made, it can be concluded that sea sand is the most same comparison with standard sand compare with river sand and quarry sand. Sea sand result align with standard sand in sand cone replacement in term of the moisture content test. As suggestion, sea sand maybe can be used as replacement to the standard sand in sand cone replacement if this research is studied more deeply.

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