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The Ability of Different Grass Root's Soil at the Entrance of Pagoh Hub

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Abstract: This case studied the performance of grass roots in stability of slope at Pagoh Hub entrance between 3 main soil conditions at Pagoh Hub, namely; Vertiver grass' soil, Cow grass' soil with 3 samples each and 1 unrooted soil taken to check the soil performance in slope stability. The objective of the project is to analyse the effect of different types of grass roots on the stability of soil slope at the entrance of Pagoh Edu Hub and profiles of slopes were obtained from previous study. Basic measurements and calculation have been made on the samples to obtain basic geotechnical parameters such as atterberg limits, specific gravity, natural moisture content, dry sieve analysis and direct shear, run in laboratory in order to obtain data's. In addition, cohesion, internal friction angle, and unit weight of the soil are calculated in order to run GeoSlope software in obtaining slope safety factor. From all 7 sites, we can conclude that Vertiver grass has the best performance as it reaches the highest value in every measurement; followed by Cow grass and unrooted soil. 51.1% moisture content at 20mm penetration, 2.84 highest value for specific gravity, highest cohesion value with 184.73Kn/m2 and 88.21 friction angle, and highest value for slope safety of factor 89.284, shows that Vertiver's grass have the best performance in slope stability than vetiver and unrooted soils.

Keywords: Vertiver Grass, Cow Grass, Geoslope, Soil Performance

1. Introduction

Slope is an earth landscape that lies at an angle to the horizontal with different high. Slope stabilization is to count in shear stress, loading, tensile strength, and lateral forces. Slope stabilization is an important element that has been taken care to avoid unwanted events such as slope failure and soil erosion. There are few engineering techniques to stabilize slope such as soil nailing, rock bolting, retaining wall, and planting.

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Pagoh Edu Hub entrance slopes have been observed as the focal point in this study. The 7 slope profiles are chosen as data collection points such as; moisture content, plastic limit and liquid limit, soil particles distribution, density of soil, stain and shear stress, specific gravity. All slope profiles were taken from a previous study, 'Estimate the stability of the slope at the entrance of Edu Hub Pagoh using Geoslope version student'.

Presently, the stability of the slope can be analysed using several geotechnical-software. . It includes stability modelling (SLOPE/W), has been designed and developed to be the standard for the stability analysis of earth structures. SLOPE/W has five sub routines geometry, soil strength, pore water pressure, reinforcement or soil, and imposed loading (live load). Regions define the slope geometry and stratigraphy, and may be drawn or imported from a DXF or DWG file. The material properties describe the soil's shear strength and are generally defined by unit weight, cohesion, and friction angle.

Vertiver grass is a straightforward, practical, inexpensive, low maintenance and very effective means of soil and water conservation, sediment control, land stabilisation and rehabilitation, and phytoremediation. Being vegetative it is also environmentally friendly. When planted in rows Vetiver plants will form a hedge which is very effective in slowing and spreading runoff water, reducing soil erosion, conserving soil moisture and trapping sediment and farm chemicals on site.

Cow grass is very resilient, often used in average places, playing fields, road shoulders. It is resistant to all attack by oil, disease, weather and weeds. But the need for trim is often better every 2 weeks. The cultivation method is adequate by sport turf because cow grass is very easy to breed in a short period of time.

1.1 Research Statement

Grass roots normally gives better stabilizer in which is to prevent it from sliding and it cost lower than concrete barrier and is more eco-friendly even though it is not the only method used to hold slopes. Grass planting and barrier construction is a common method in preventing slope sliding in Malaysia. Common grass type used to slope stabilization is Vertiver grass and Cow grass.

Landslide and soil erosion have been a concern to slope and would affect road users as they worried while going to/comeback from work or anywhere. Unstable slopes can slide without warning and are unnoticeable especially during raining and floods as nothing can hold it.

Research focuses on the performance of Vertiver and Cow grass roots in the stability of slope near Pagoh Hub entrance as new technology to maintain slope stability and decrease the cases of landslides and soil erosion. Some laboratory tests were conducted on both disturbed and undisturbed samples from the site.

Vertiver grass and Cow grass are the most common types of grass used for slope stabilization. It is because Vertiver grass has the longest root length than other grass which give it a lot better garb on the soil, while cow grass has roots that creep fast and are easy to handle. To show the difference, a sample from unrooted slopes will be tested also.

2. Materials and Methods

Materials and methods in this studies focus on sieve analysis, atterberg limit, specific gravity, and direct shear as performance of soil's samples.

2.1 Materials/Apparatus

2.1.1 Soil sampling

For this test, some samples have been taken from Vertiver's site, Cow's site and unrooted site. Few materials have been used to run this test such as mould/cylinder that make it easier to bring the samples and keep the original condition of the samples to the laboratory to run a few other tests and hoe/core cutter- hoe used to take out the samples from site to laboratory, while core cutter was a common equipment used to take samples for dry density test. This test takes a day to run.

Soil samples were taken from sites to run moisture content, specific gravity, atterberg limit, and sieve analysis.

2.1.2 Sieve analysis

A Sieve analysis test was run to determine particles consisting in the slopes from the size distribution curve of soil samples larger than 75µm. It also known to determine grain size distribution curve of samples by passing through stack of sieves with decrement size and measured weight of retained soils. Soil from each sites were taken to be analysed.

Apparatus used in this test were, dry sieve set from 7.5cm to 75µm and pan at the bottom to collect soil passing through each sieve. Mechanical sieve shaker make it easier to vibrate sieve set and more convenient and soft wire brush to dust off previous samples on sieve mesh before test and after test to keep the mesh clean. This test took a day to complete all the assessment.

2.1.3 Atterberg limit

i. Plastic limit (PL) test used to determine lowest moisture content in samples which represent the soil plasticity behaviour. This behaviour helped a plastic material to be moulded into shape and maintain the shape. However, samples consider as solid or non-plastic if moisture content below plastic limit. Plasticity index (PI) gave the different between plastic and liquid limit while also indicated water range of water content which remained the plasticity state.

   For plastic limit test, these apparatus were used in this experiment: evaporating dish to place the specimen in the dish, a clean glass plate used as the surface can affect the result, palette knives/spatula easy to mix samples with water and to put the samples on a dish, and other apparatus such as container, balance and oven.

ii. Liquid limit (LL) test apparatus were as followed; penetrometer apparatus complying requirements of BS 1377: Part 2:1990, cone for penetration purposes consist of stainless steel cone, smooth and polished surface, 35mm length and 30˚angle, sharp point, and cone mass and sliding shaft 80g, flat glass plate with dimension 500mm square and 10mm thick, metal cup to put specimens in the cup for penetration, and other apparatus were the same as a plastic limit test.

   Liquid limit was tested to determined liquid limit behaviour of soil by using ‘Cone Penetration Method’ where water added with minimum water content at which samples still remained liquid state with a little shear strength against flow. Theoretically, clayey soil changes behaviour plastic to liquid gradually on water content. Both plastic limit and liquid limit took approximate 2 day to complete.

2.1.4 Specific gravity

Specific gravity (G_s) test was run to define the relation between soil unit masses and water, also can be used to determined relationship between weight and volume of soils. Specific gravity one of dimensionless parameter where density of soil divided with density of water.

A pre-dried soil kept in standard density bottle. The de-aired, distilled water added and vacuumed samples to remove air prior to topping up.

Apparatus used in this experiment were volumetric flasks (250ml) with stoppers, numbered, calibrated and inserted mixed samples in flasks, vacuum pump to decrease oxygen from effecting the specimen behaviour, balance to take weight data, distilled desired water was a material used to mix with specimens and free from foreign material that can affect results, thermometer to monitor temperature, and evaporating dish to put in samples. Total 2 days was taken to finish this test.

2.1.5 Direct shear

Direct shear tests are run using a direct shear machine provided in the laboratory. Samples that have been cut in square will be brought to the lab and the samples will be put on the machine and run the test. Results obtained directly from the machine reading.

2.2 Methods

2.2.1 Specific gravity

The determination of specific gravity of soil conducted by using the pycnometer that help in calculation of void ratio, degree of saturation and other different soil properties. The specific gravity of soil particles came within the range 2.65 and 3.00. If the soil consists of porous and organic materials, a specific gravity value greater than 3 shown by soils that have heavy substance. The specific gravity of a soil defined as the ratio between the unit masses of soil particles and water.

2.2.2 Plastic limit test

The plastic limit is defined as the moisture content at which soil begins to behave as plastic material. A plastic material can be moulded into a shape and the material will retain that shape. If the moisture content is below the plastic limit, it is considered to behave as a solid, or a non-plastic material. The objective of this experiment is to determine the lowest moisture content at which the soil behaves plastically.

2.2.3 Liquid limit test

Liquid limit can be defined as minimum water content at which the soil is still in the liquid state, but has a small shearing strength against flow. The liquid limit (LL) is conceptually defined as the water content at which the behaviour of a clayey soil changes from plastic to liquid. However, the transition from plastic to liquid behaviour is gradual over a range of water contents, and the shear strength of the soil is not actually zero at the liquid limit. The precise definition of the liquid limit is based on standard test procedures.

2.2.4 Sieve analysis

The objectives of this experiment are to determine the grain size distribution curve of soil samples by passing them through a stack of sieves of decreasing mesh opening sizes and by measuring the weight retained on each sieve. The sieve analysis is generally applied to the soil fraction larger than 75µm.

2.3 Equations

Shear, $\tau = c + \sigma_n * \tan(\varphi)$ Eq.1

Water content, $w = \frac{Mw}{Md} = \frac{M_2 - M_3}{M_3 - M_1} x100$ Eq. 2

Bulk density, $\rho_b = \frac{M_2 - M_1}{V}$ Eq.3

Dry density of soil, $\rho_d = \frac{\rho}{1+w}$ Eq.4

Plastic limit, PI = LL – PL Eq.5

Specific gravity, $G_s = \frac{mass\ of\ soil\ particles}{mass\ of\ an\ equal\ volume\ of\ water}$ Eq.6

3. Results and Discussion

3.1. Results and discussion

Show highest results and discussion on every parameters.

3.1.1 Atterberg Limit

Table 1: Moisture content vs penetration for S6

Moisture Content	Penetration
47	11.1
53.4	20.3
55.5	26.2
60.6	34
64.7	37.3

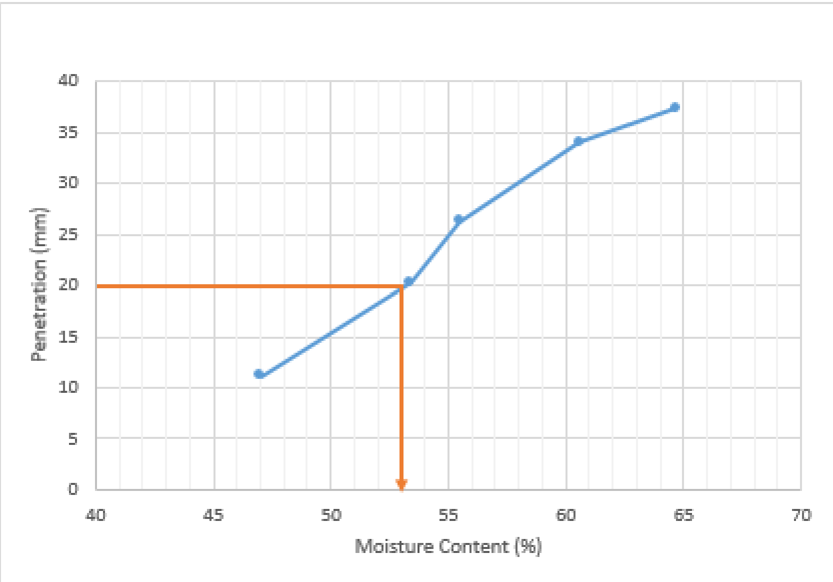

Figure 4.2.4 Liquid Limit test for Cow grass (S1)

For plastic limit, liquid limit, and plasticity index, can conclude that Vertiver grass has more plastic limit and liquid limit, but less plasticity index than Cow grass. As for the result, the moisture content for 20mm penetration was 53.0% for Vertiver grass (S6), while 52.0% moisture content for 20mm penetration in Cow grass (S1). Vertiver grasses have the mostly the highest value as this grass give more strength to the soil and hold it. A constant penetration value at 20mm was used to determine the different between samples in atterberg limit.

3.1.2 Specific gravity

Table 2: Soil's specific gravity, Gs

Site	Specific Gravity
S1	2.72

S2	2.77
S3	2.68
S4	2.72
S5	2.63
S6	2.84
S0	2.37

From the calculation that have been done, specific gravity for Vertiver grass was 2.25 and Cow grass is 2.29 in range 2.00-2.30. From the calculation, value of specific gravity higher at Vertiver grass' sites with each soil values 2.77, 2.72 and 2.84, follow by Cow grass's sites with each specific gravity values are 2.72, 2.68 and 2.63, lastly is unrooted soil with 2.18 as the lowest value. This shows that Vertiver grass soils are stronger than Cow grass and bold soil.

3.1.3 Sieve analysis

Table 3: The particle distribution percentage for sites

site	Gravel	Sand	Silt
S1	17	75	8
S3	13	85	2
S5	14	80	6
S2	20	77	3
S4	16	83	1
S6	19	80	1
S0	18	79	3

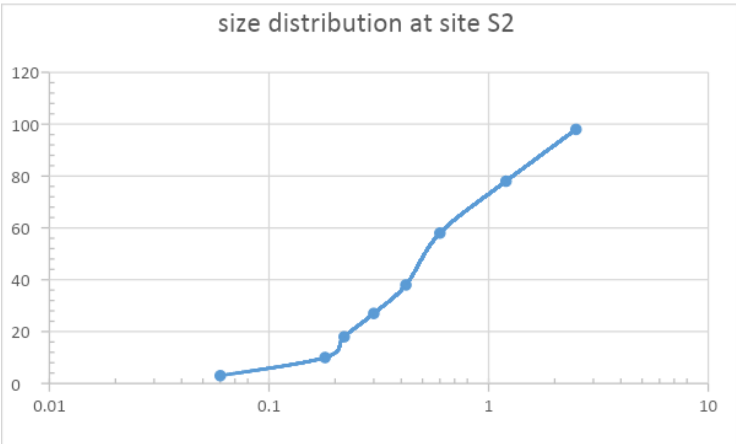

Figure 3.2 Site distribution at site S2

As for discussion, can conclude that the soil generally found in the study area at the entrance of Edu Hub Pagoh at each sites mostly is well graded. Sieve analysis test determines the grain size distribution curve of soil samples by passing them through a stack of sieves of decreasing mesh opening sizes and measuring the weight retained on each sieve. From the seven sites, all of the graphs of grain size distribution are directly proportional. As the sieve size increases, the percentage passing increases too.

3.1.4 Direct shear

Table 4: Cohesion and Friction Angle Value for Rooted and Unrooted Site Samples

	Site	Cohesion Value (kN/m^2)	Friction Angle (Ø)
Cow Grass Slope	S1	148.26	88.64
	S3	138.59	88.65
	S5	155.68	88.31
Vetiver Grass Slope	S2	176.06	88.28
	S4	172.95	87.99
	S6	184.73	88.21
Unrooted Slope	S0	112.67	88.08

From slope at site 1, the cohesion (c) value is 148.26 kPa while the friction angle (Ø) is 88.64, as shown in Figure 4.13.

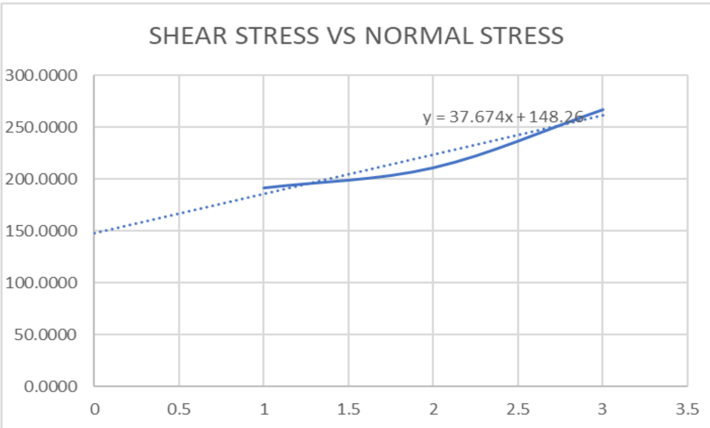

Figure 3.3: Shear Stress Vs Normal Stress for S1 (COW GRASS)

Direct shear stress used undisturbed soil samples. In direct shear test experiments, the cohesion of samples for all sites are vastly different based on the type of roots the soil sample is taken from. The most significant difference is when the cohesion for the unrooted slope is compared to the rooted slope, it shows that the roots increase the strength of the soil. But when the rooted slopes are compared, which is slope 1, 3, 5 for Cow Grass and slope 2, 4, 6 for Vetiver Grass, it is observed that vetiver grass slopes on average yields a higher cohesion and friction angle values. All soil samples still have the same shear strength due to having the same type of soil. Angle of friction was obtained from shear stress vs normal stress graph after the direct shear test. Value of cohesion, angle of friction and gamma for each site was tabulated to run for Geoslope to get the safety factor.

3.1.5 Slope/W analysis

Table 5: Factor of Safety Rooted and Unrooted Sites

	Site	Factor Of Safety
Cow Grass Slope	S1	67.21
	S3	77.12
	S5	72.27
Vetiver Grass Slope	S2	74.85
	S4	75.21
	S6	89.284
Unrooted Slope	S0	66.70

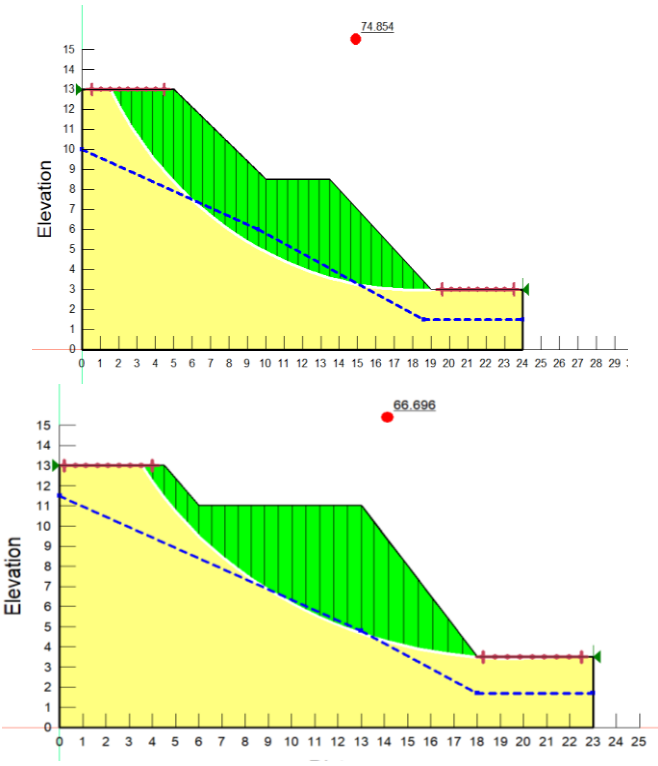

Figure 3.4: GEO SLOPE Analysis for S1 and S0

All the sites are suitable for construction because the FS of the slope is high and the slopes are difficult to collapse. For the analysis of Geo Slope, the result shows the safety factor of the slope. The hill shape and dimension were drawn with the water in soil included. The value of cohesion, angle of friction, and gamma that has been calculated from each site were entered into Geo slope. The slope is stable because the safety factor of all slopes is more than 1. The safety factor obtained is considered too high due to the type of soil and the addition of roots that increases the strength of soil by a significant figure. The unrooted slope obtained the lowest safety factor value due to the lack of additional strengthening properties or grass roots.

4. Conclusion

Based on the results obtained for 13 weeks long, a conclusion can be made that different types of grass do have a different performance in increasing the stability of slopes. These differences in performance can be determined by doing several experiments towards the samples that have been collected from a slope location near the entrance of EDU Hub Pagoh, UTHM. As for conclusion, from all the test and results, it can be concluded that Vertiver grass was the most suitable one that was been used to maintain soil stability with the highest data value. It was found that the cohesion values and friction angle of slopes profiles were in stable condition. The results obtained become more convincing and precise by the help of Geo- Slope software, which determines the external and internal structure of the slopes in a more detailed way. All parameters and properties have been analysed and compared between three (3) condition of soil in create stable slope. All objective in this experiment were obtained.

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