EFFECT OF SLOPE GRADIENT ON THE APPLICATION OF VETIVER GRASS FOR SLOPE STABILIZATION

By :
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PRESENTATION OUTLINE

- **Introduction**
- **Problem statement**
- **Objectives**
- **Scope of work**
- **Literature review**
- **Research methodology**
- **Results & Analysis**
- **Conclusion**
- **References**

INTRODUCTION

Vegetation in the Malaysian environment has the **ability to give immediate mechanical shear strength for slope remediation and long- term advantages** (Bujang & Sina, 2010).

Public works department (JKR) routinely **provides vegetative cover on these cut slopes** to decrease erosion and to preserve susceptible slopes. (Aizat et al. 2020)

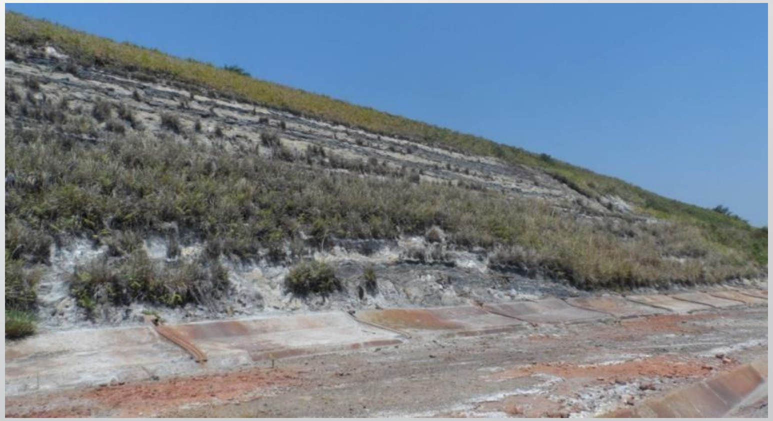
Bioengineering approach of plant cover was often used to mitigate slope collapse. The approach is **less expensive, grows quickly, and is simple to plant** (Noorasyikin & Zainab, 2016)

Vetiver Grass is considered a **special grass** and has **different characteristics** for various applications, deep/long roots for soil stabilization, thick and dense structures to spread water and retain sediment.

Vetiver System is very **practical, inexpensive, easy to maintain, and very effective in controlling slope failure and sedimentation and land stabilization and rehabilitation.**

PROBLEM STATEMENT

- Slope failure is **one of the world's most critical environmental challenges** (Rahman et al. 2009a).
- Serious slope failure might put **the environment, agricultural operations, and water supplies in jeopardy, diminishing reservoir storage capacity and threatening the environment's long-term viability** (Julio et al. 2017).
- Natural disasters are among the most harmful occurrences that may occur, **impacting everyday operations and causing damage to residential and commercial properties. These are also one of the most deadly** (Aizat et al. 2020).
- Due to the fact that Vetiver Grass has been used as a bioengineering technique on a slope in Malaysia, **failures still have occurred**.



The slope fail even apply with Vetiver grass at Lanchang area (KM 89.55 Westbound) Temerloh pahang (KM 151 Eastbound)

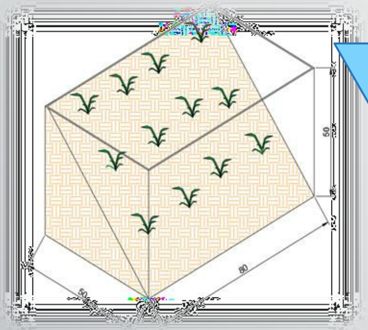
OBJECTIVES

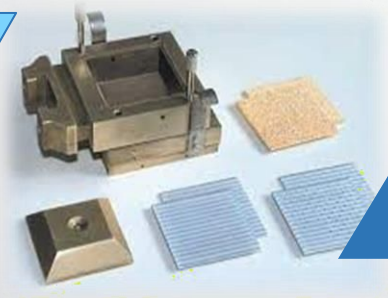
1. To identify the root morphology of Vetiver Grass

2. To measure the mechanical properties of root with soil with different slope gradient (45°, 50° and 60°).

SCOPE OF STUDY

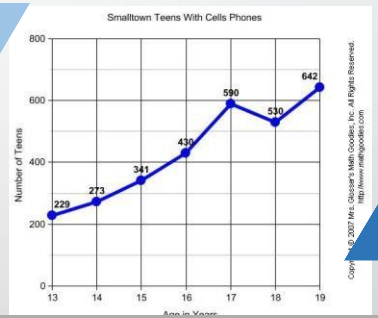
Modelling of soil





Laboratory Work

Data Analysis

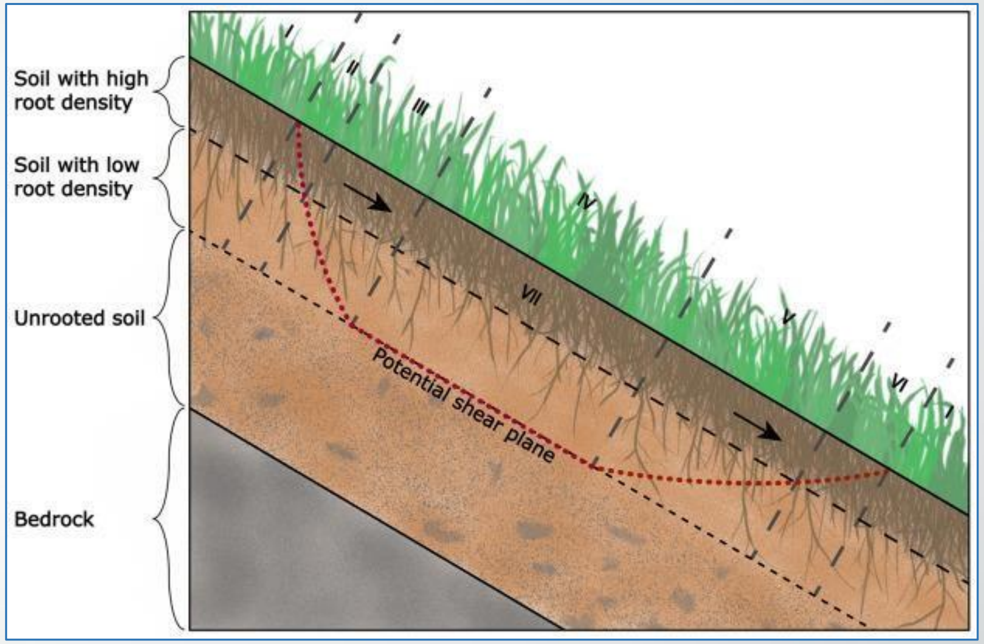


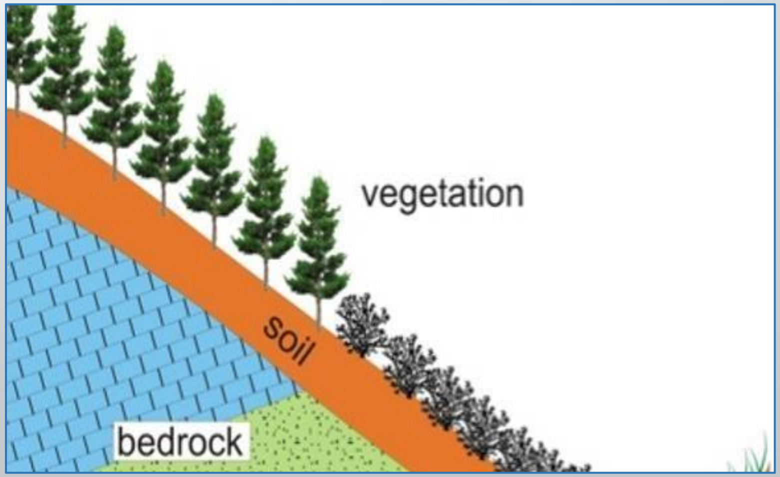
Result Comparison

LITERATURE REVIEW

Vegetation For Slope

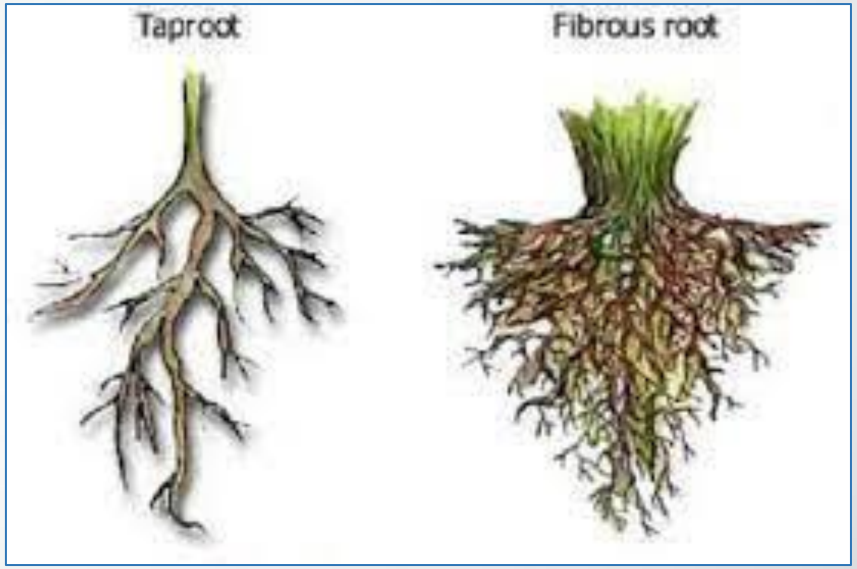
Findings	Author
• Planting vegetation on the slope's surface is a method to avoid slope erosion and landslides. • Effect of vegetation is to stabilise the slope by mechanically reinforcing soils through roots and to have a hydrological affect by reducing soil water content through transpiration and precipitation interception	• (Rahman et al. 2016) • (Ziemer 1981) • (Osman & Barakbah 2006)

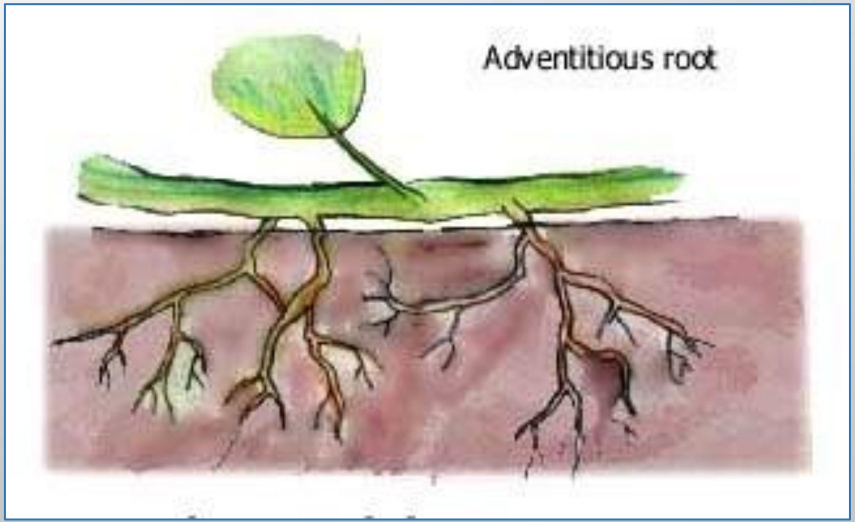




Root Morphology

Findings	Author
• Root morphology is the study of diverse plant organs in terms of form and function. • Root possess an influential role in enhancing the mechanical properties of soil by intensifying soil strength and its porosity. • Morphology of the root system varies according to species, soil type, and site conditions	• (Sabda 2021) • (Riham 2021) • (Stokes et al. 2008)





Root Strength

Findings	Author
• Assist stabilise slopes against landslides and anchor trees against wind loading • Shear strength of soil is the internal resistance per unit that the soil can provide to resist failure and sliding along any plane within it. • Root tensile strength testing is an important part of the evaluation process for root reinforcement.	• (Gerrit et al. 2019) • (O'Loughlin 1984) • (Islam et al., 2010) • (Böhm, 1979)

Type of slope Vegetation	Point Shear Strength (kPa)
Thick Bush (Diverse species; 1-3 in height)	**46.1±3.4**
Normal Bush (Diverse species; < 1 m in height)	**182.8±12.5**
Fern, Melastoma sp.	**132.5±9.6**
Melastoma sp., grasses	**110.7±11.5**
Grasses	**25.7±3.5**

Point Shear Strength for Different Types of Slope Vegetation (Normaniza & Barakbah, 2006)

Effect Of Slope Gradient To Slope Stability

Findings	Author
• Slope gradient has a significant impact on the amount of surface water runoff and soil sediment loss.	• (Wu et al. 2015) • (Kosma s 1999) • (Comin o 2010)

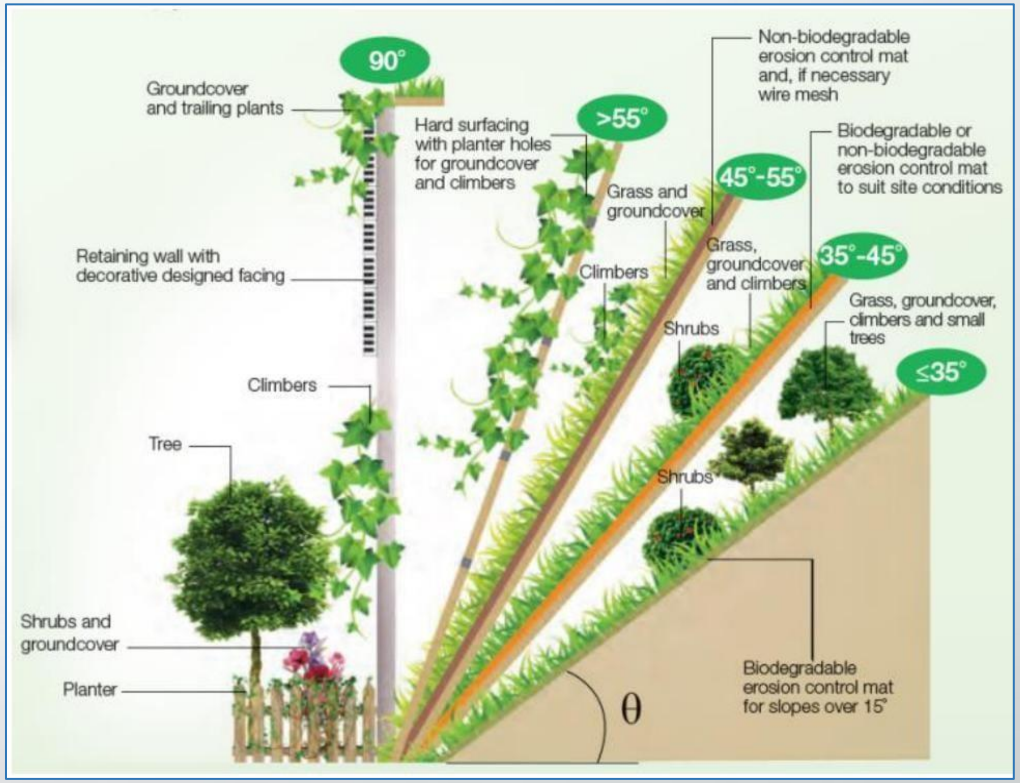
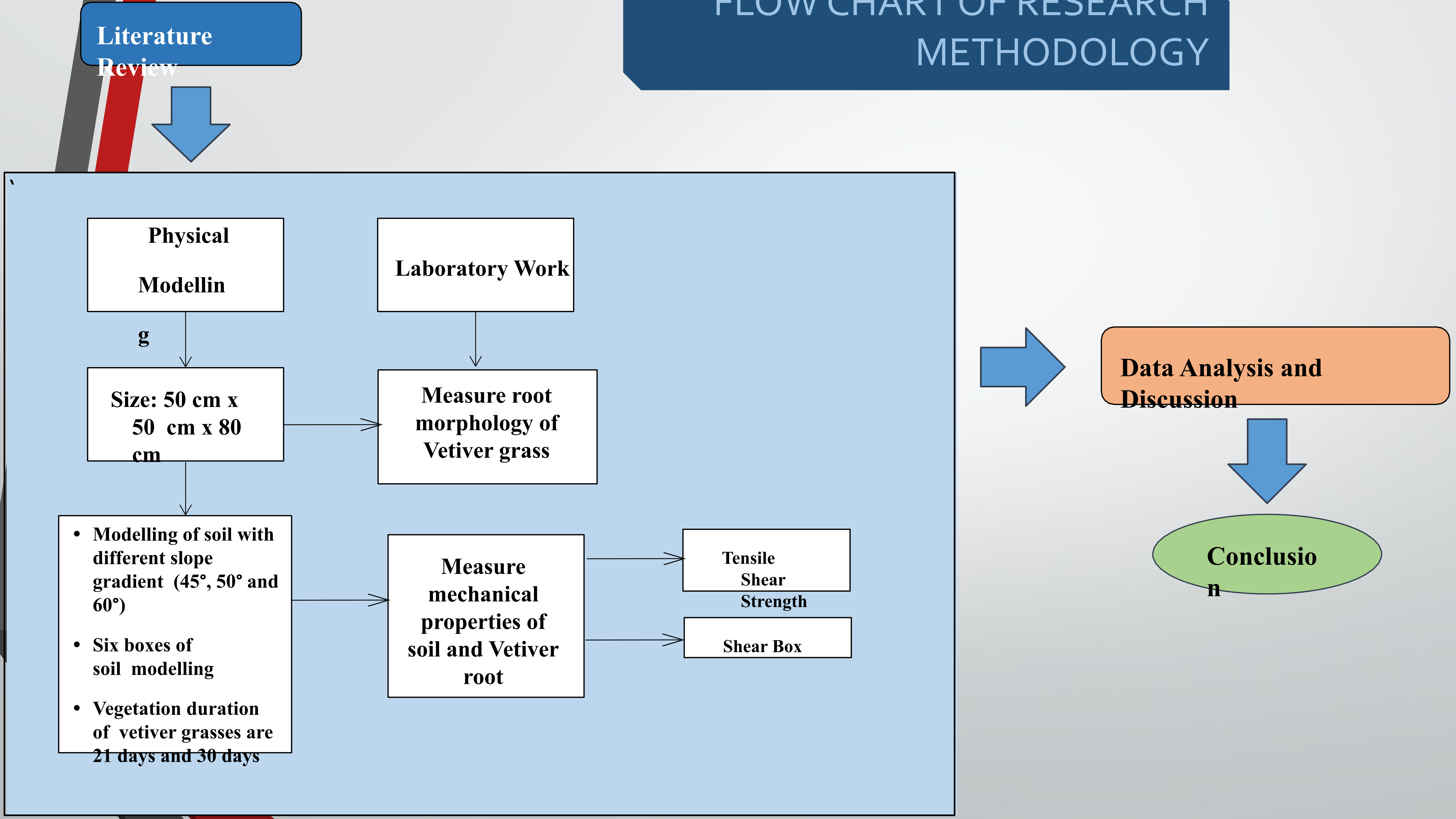
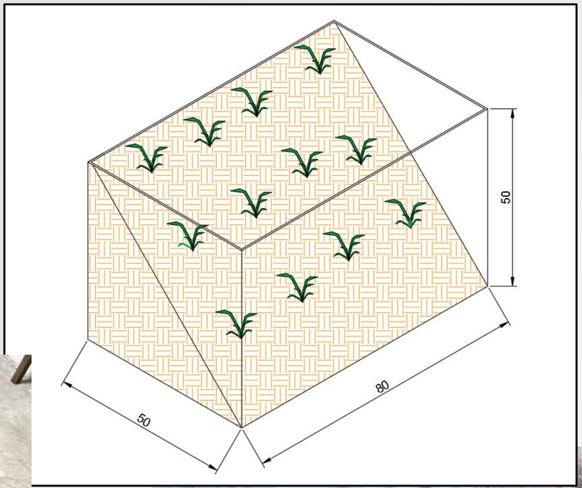


Illustration of slope gradient for vegetation to slope stability

FLOW CHART OF RESEARCH METHODOLOGY



Design & Material of Soil Modelling Box



The design of the modelling of soil.

The materials that use to make the structure of soil modelling

Plywood

1 x 2 inches wood

RESEARCH METHODOLOGY

Lab Test	Objectives	Equipment	Standard	Location
Direct Shear Box Test	• To determine the shear strength of soil	 	BS 1377-7:1990	UTHM
Root Tensile Strength Test	• To evaluate the tensile strength of the Vetiver Grass root by using Tensile Testing Machine. • To assess the tensile strength of the root system of plants and the bonding strength between the root system and the soil.		BS 1377-2:1990	UTHM

Soil Modelling Box With Different Slope Gradient – Planted duration 21 days & 30 days

The design of soil modelling with the slope gradient of 45°

The design of soil modelling with the slope gradient of 50°

The design of soil modelling with the slope gradient of 60°

RESULT AND ANALYSIS

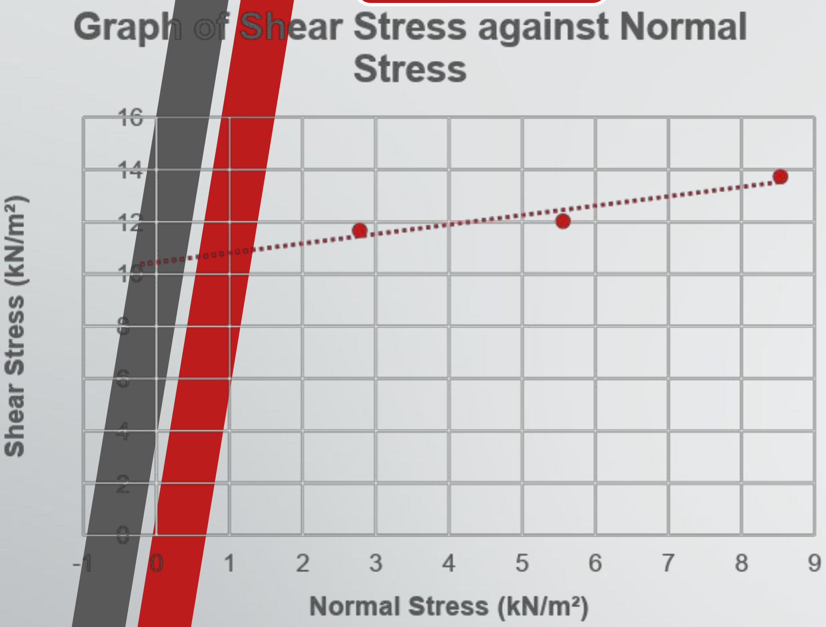
Root Morphology

From the observation, it is found that the root of Vetiver grass can be classified as fibrous root system

Direct Shear Strength Test

Shear Strength Test for slope gradient 45°.

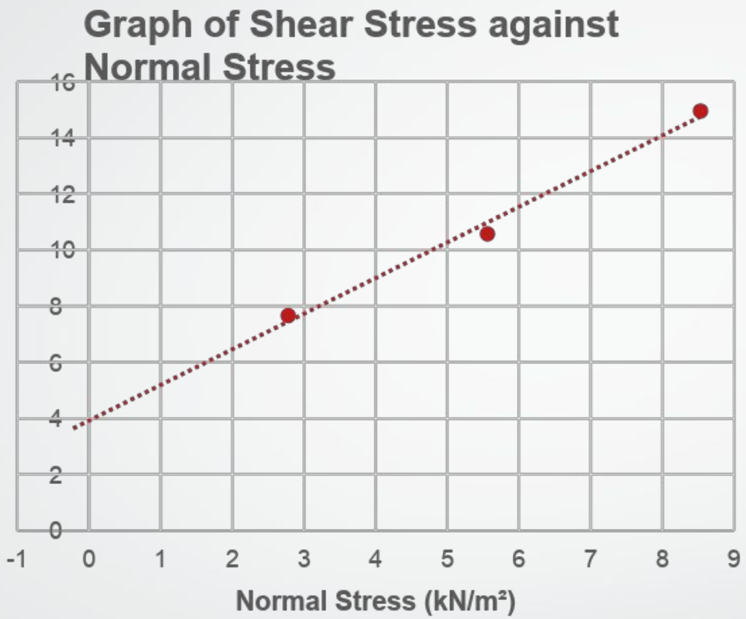
Without root



Cohesion,c	10.449
m	0.3605
phi (rad)	0.345998
Degree, °	19.82444

From the graph, the interception of the straight line does not pass through zero. Therefore, the cohesion. c = 10.45 kN/m². Besides, the angle of friction is obtained from the plot. From the calculation, the angle of friction of the soil sample is 19.82°.

21 days



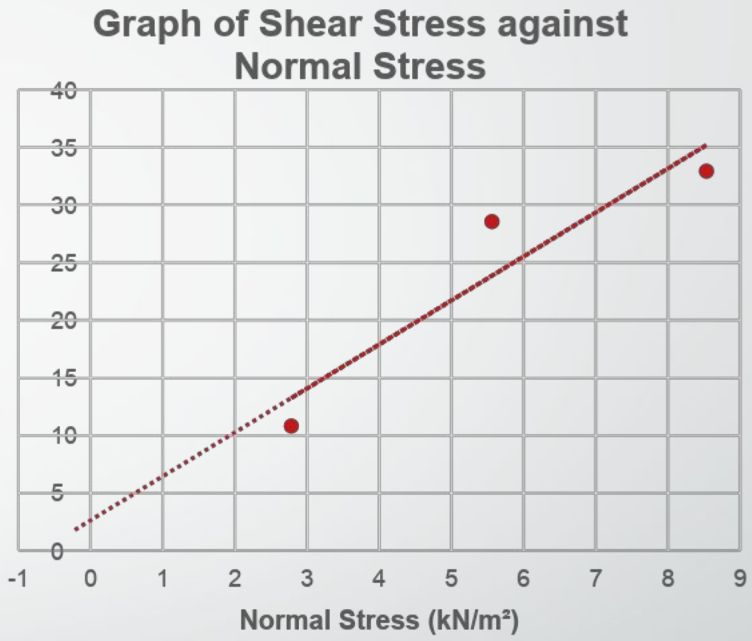
Cohesion, c	3.9196
m	1.2695
phi (rad)	0.903593
Degree	51.77

From the graph, the interception of the straight line does not pass through zero.

Therefore, the cohesion. c =3.92 kN/m².

the angle of friction of the soil sample is 51.77°.

30 days



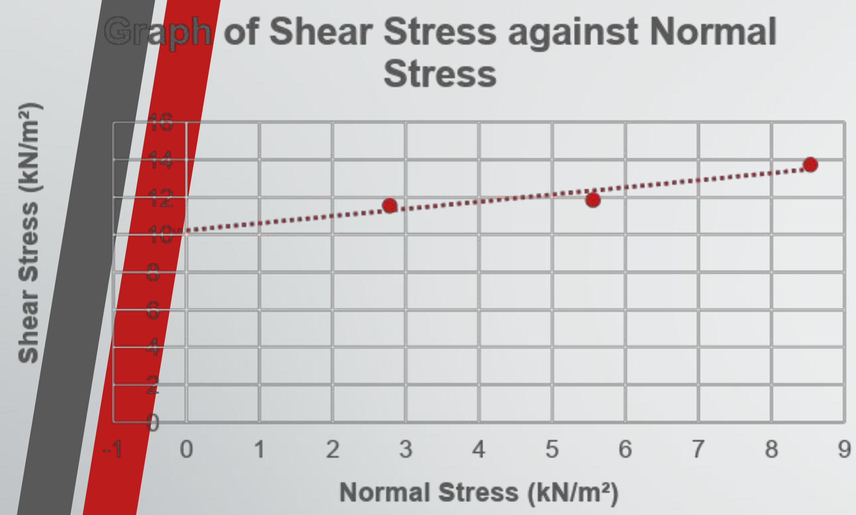
Cohesion,c	2.642
m	3.815
phi (rad)	1.314441
Degree, °	75.31268

From the graph, the interception of the straight line does not pass through zero. Therefore, the cohesion. c = 2.64 kN/m². Besides, the angle of friction is obtained from the plot. From the calculation, the angle of friction of the soil sample is 75.31°.

Direct Shear Strength Test

Shear Strength Test for slope gradient 50°.

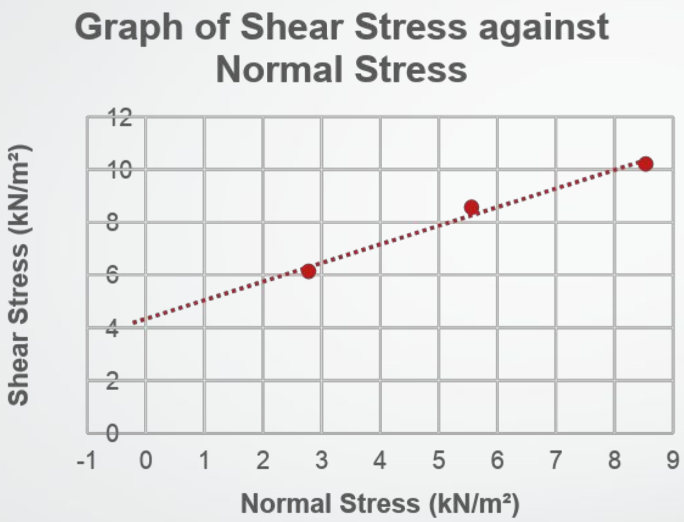
Without root



Cohesion,c	10.229
m	0.3819
phi (rad)	0.364806
Degree, °	20.90207

From the graph, the interception of the straight line does not pass through zero. Therefore, the cohesion. c = 10.23 kN/m². Besides, the angle of friction is obtained from the plot. From the calculation, the angle of friction of the soil sample is 20.90°.

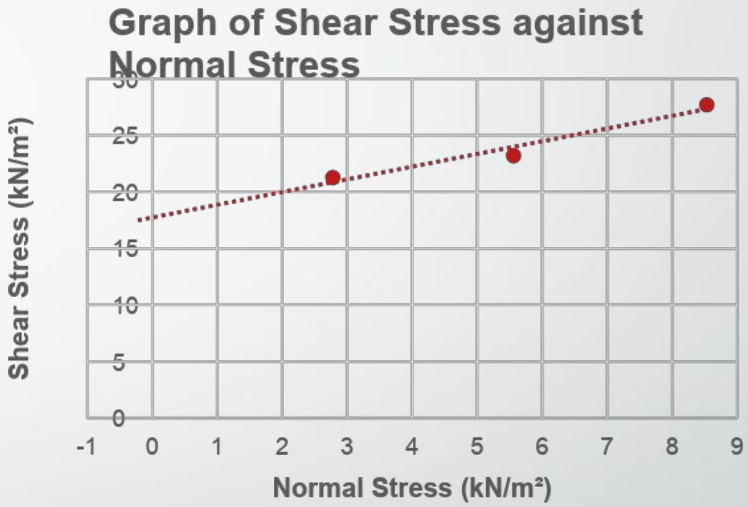
21 days



Cohesion,c	4.34
m	0.706
phi (rad)	0.614741
Degree, °	35.22246

From the graph, the interception of the straight line does not pass through zero. Therefore, the cohesion. c = 4.34 kN/m². Besides, the angle of friction is obtained from the plot. From the calculation, the angle of friction of the soil sample is 35.22°.

30 days



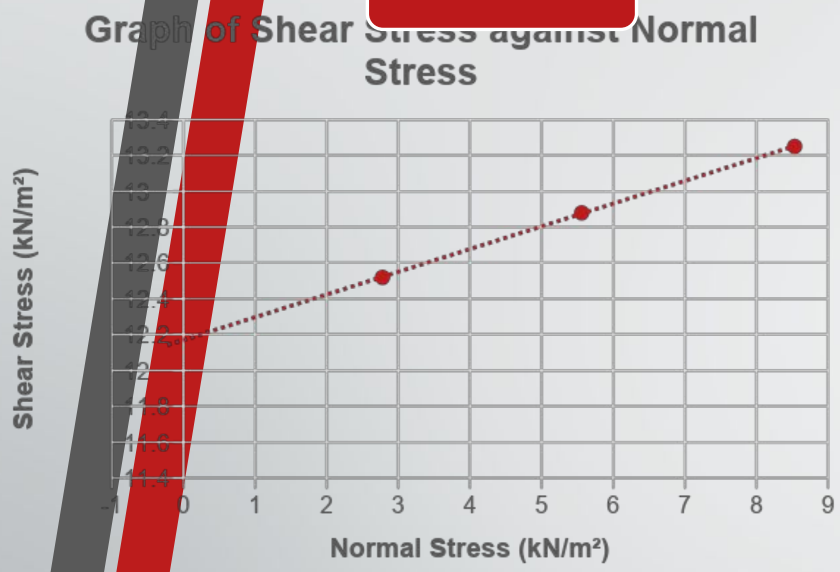
Cohesion,c	17.742
m	1.124
phi (rad)	0.843712
Degree, °	48.34166

From the graph, the interception of the straight line does not pass through zero. Therefore, the cohesion. c = 17.74 kN/m². Besides, the angle of friction is obtained from the plot. From the calculation, the angle of friction of the soil sample is 48.34°.

Direct Shear Strength Test

Shear Strength Test result for the soil for slope gradient 60°.

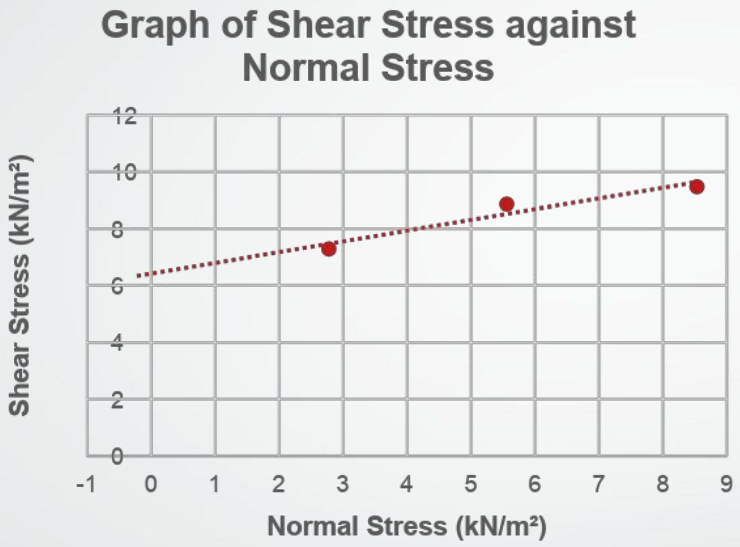
Without root



Cohesion,c	12.17
m	0.1269
phi (rad)	0.126225
Degree, °	7.232254

From the graph, the interception of the straight line does not pass through zero. Therefore, the cohesion. c = 12.17 kN/m². Besides, the angle of friction is obtained from the plot. From the calculation, the angle of friction of the soil sample is 7.23°.

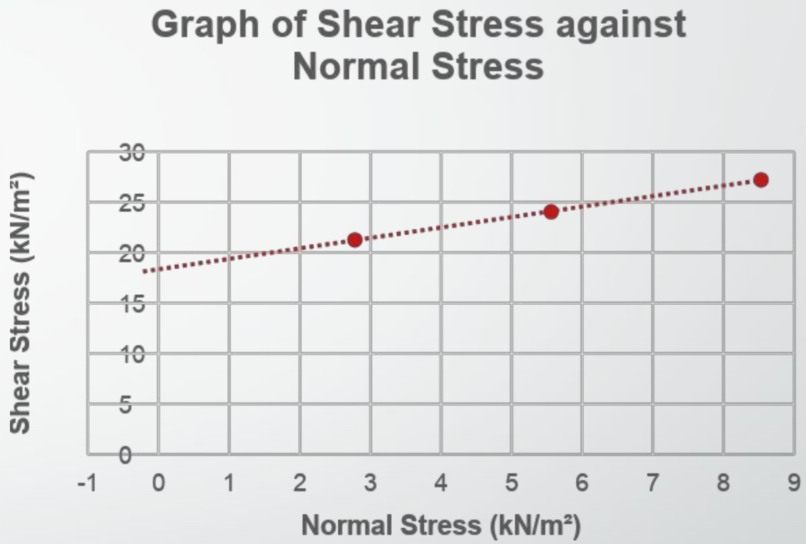
21 days



Cohesion,c	6.417
m	0.3786
phi (rad)	0.361923
Degree, °	20.73688

From the graph, the interception of the straight line does not pass through zero. Therefore, the cohesion. c = 6.42 kN/m². Besides, the angle of friction is obtained from the plot. From the calculation, the angle of friction of the soil sample is 20.74°.

30 days



Cohesion,c	18.365
m	1.0346
phi (rad)	0.802402
Degree, °	45.97474

From the graph, the interception of the straight line does not pass through zero. Therefore, the cohesion. c = 18.37 kN/m². Besides, the angle of friction is obtained from the plot. From the calculation, the angle of friction of the soil sample is 45.97°.

Direct Shear Strength Test

Based on the study, it can be summarized that the strength of soil without the presence of the root of Vetiver grass is weaker compared to that of soil with the support of the Vetiver grass root system.

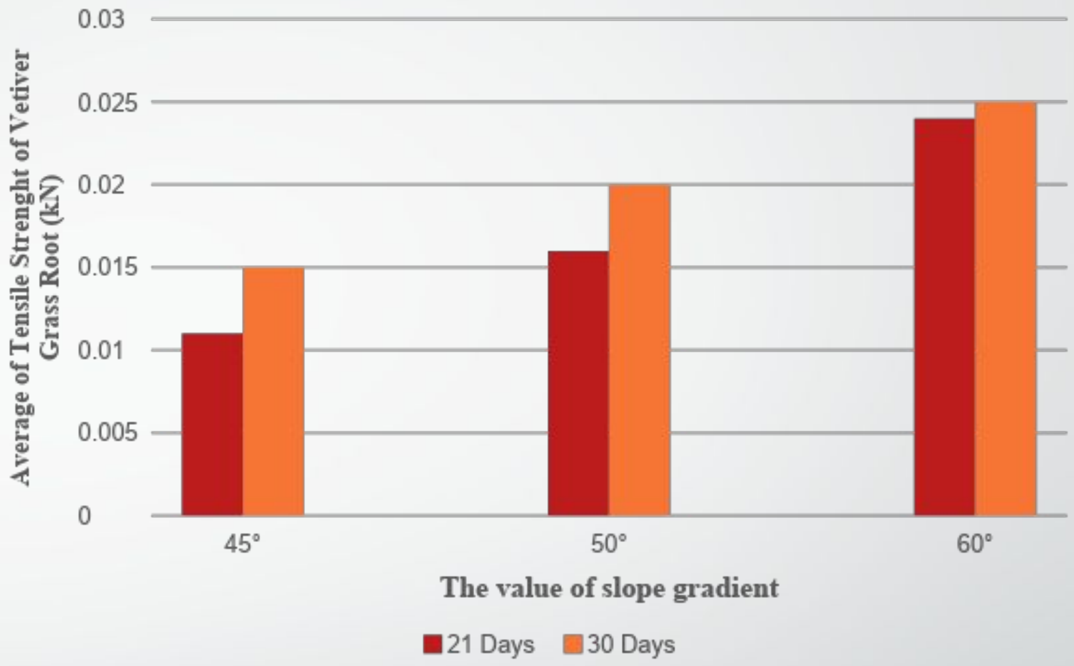
For 45° of slope gradient, the angle of friction of the soil sample 30 days is 75.31°.

For 50° of slope gradient, the angle of friction of sample 30 days is 48.34°.

For 60° of slope gradient, the angle of friction of sample 30 days is 45.97°.

Tensile Test

Sample No.	Tensile Strength (kN)					
	45°		50°		60°	
	21 Days	30 Days	21 Days	30 Days	21 Days	30 Days
1	0.010	0.006	0.011	0.014	0.024	0.024
2	0.011	0.016	0.016	0.018	0.015	0.016
3	0.011	0.021	0.021	0.013	0.028	0.051
4	0.025	0.010	0.019	0.019	0.023	0.011
5	0.005	0.016	0.026	0.015	0.027	0.016
6	0.015	0.023	0.009	0.016	0.024	0.021
7	0.004	0.009	0.015	0.028	0.031	0.012
8	0.024	0.017	0.013	0.013	0.033	0.020
9	0.005	0.016	0.015	0.033	0.018	0.058
10	0.004	0.018	0.013	0.027	0.014	0.023
Average	0.011	0.015	0.016	0.020	0.024	0.025



In this tensile test, 10 root samples are evaluated for each gradient of slope.

For a 45-degree slope gradient, the tensile strength for 30 days is 0.015 kN while for 21 days it is 0.011 kN.

For a slope gradient of 50 degrees, the tensile strength for 30 days is 0.020 kN and for 21 days, it is 0.016 kN.

For a 60-degree slope gradient, the tensile strength for 30 days is 0.025 kN and for 21 days it is 0.024 kN.

According to this study, the Vetiver root with a 60° slope gradient had the maximum tensile strength compared to slope gradients of 50° and 45.

CONCLUSION

- For 21 days, the greatest soil and root shear stress for 45°, 50°, and 60° slope gradients is 13.73 kN/m2 and 13.25 kN/m2, respectively. Therefore, the 45° and 50° slope gradients have the largest shear stress for 21 days. For 30 days, the greatest shear stress of soil with roots at 45°, 50°, and 60° slope gradients is 32.93 kN/m2, 27.71 kN/m2, and 27.22 kN/m2, respectively. Therefore, the 45° slope gradient has the largest shear stress for a period of 30 days. According to this research, among slope gradients of 50° and 45°, the Vetiver root for 60° slope gradient has the greatest value for tensile strength which are 0.025 kN for 30 days is while for a period of 21 days it is 0.024 kN.

CONCLUSION

- According to the findings of this study, the presence of Vetiver grass roots greatly affected the soil's strength. Due to the presence of highly erodible residual soils and severe wet weather conditions, Malaysia has made significant strides in the use of Vetiver grass for erosion control and slope stabilization.

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Tarikh : 27 Jun 2021

Dr. Noorasyikin binti Mohammad Noh
Melalui dan salinan :
Dekan Fakulti Kejuruteraan Awam dan Alam Bina
Universiti Tun Hussein Onn Malaysia

Puan,

TAWARAN GERAN PENYELIDIKAN TIER 1 2021

Dengan hormatnya perkara di atas adalah dirujuk.

2. Sukacita dimaklumkan bahawa Mesyuarat Jawatankuasa Teknikal Penyelidikan dan Pembangunan (JTPP) Bil. 1/ 2021 bertarikh 23 Jun 2021 dan Pusat Pengurusan Penyelidikan (RMC) telah bersetuju untuk membuat keputusan seperti berikut:

Status Permohonan	:	Lulus
Tajuk Projek	:	The Comparison of Vetiver Root Growth Performance with Coconut Coir and Phototropic Bacteria for Soil-Root Reinforcement Stability
Jumlah Diluluskan	:	RM 20,000.00
Agihan Pertama	:	RM 10,000.00 (01 Julai 2021 - 30 Jun 2022)
Agihan Kedua	:	RM 10,000.00 (01 Julai 2022 - 30 Jun 2023)
Tempoh Projek	:	01 Julai 2021 -30 Jun 2023 (24 Bulan)
KPI Geran	:	**Penyelidikan Bidang Sains & Teknologi (S&T):** Sekurang-kurangnya SATU (1) penerbitan dalam jurnal berindeks Scopus dan SATU (1) penerbitan prosiding berindeks Scopus/Jurnal UTHM

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