**POLITEKNIK MELAKA**

# SOIL STABILIZATION USING BIO-ENZYMES

**ZARIS NATASHA AYUNIE BINTI AZMIRSHAH**

**(11DKA23F1002)**

**CIVIL ENGINEERING DEPARTMENT**

**SESI I :2025/2026**

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This report submitted to the Civil Engineering Department in fulfillment of the requirement for a Diploma in Civil Engineering

## CIVIL ENGINEERING DEPARTMENT

## SESI I :2025/2026

# DECLARATION OF ORIGINALITY AND OWNERSHIP

## SOIL STABILIZATION USING BIO-ENZYMES

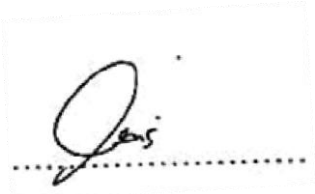
1. I, **ZARIS NATASHA AYUNIE BITNI AZMIRSHAH (M[redacted]-[redacted]** is a final year student of **Diploma in Civil Engineering, Politeknik Melaka** which is located at **No.2, Jalan PPM 10, Plaza Pandan Malim,75250 Melaka**.

2. I acknowledge that 'The Project above' and the intellectual property therein is the result of our original /creations without taking or impersonating any intellectual property from the other parties.

3. I agree to release the 'Project' intellectual property to 'The Polytechnics' to meet the requirements for awarding the**Diploma Kejuruteraan Awam** to me.

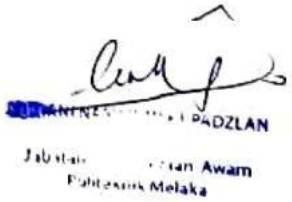
Made and in truth that is recognized by;

ZARIS NATASHA AYUNIE
BINTI AZMIRSHAH
(No. Kad Pengenalan : [redacted]



(ZARIS NATASHA AYUNIE
BINTI AZMIRSHAH)

In front of me,
PUAN SURIANI NASUTION BINTI PADZLAN
[redacted]
As a project supervisor, on the date: (20/3/2025)

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( PUAN SURIANI NASUTION
BINTI PADZLAN)

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I would also like to extend my gratitude to my project partner, Kaveesha a/p Ravi Shanker, for her commitment, teamwork, and cooperation in ensuring the smooth progress of this project. Working together, sharing ideas, and supporting each other have made this journey more manageable and productive. The teamwork shown throughout this project has contributed significantly to its successful completion.

The assistance, cooperation, and encouragement received from both my supervisor and my partner have played a crucial role in helping me complete this Final Year Project. I truly appreciate all the efforts and support that have been provided.

# ABSTRACT

This study was conducted to evaluate the effectiveness of a bio-enzyme as a more environmentally friendly soil stabilizing agent for improving the engineering performance of soft soil, particularly in paddy field areas. The main problem addressed in this research was the weak strength and high moisture sensitivity of soft clay, which can lead to instability in construction sites. To overcome this issue, laboratory testing such as Atterberg Limits and Standard Proctor Compaction were carried out on both untreated soil and soil treated with a bio-enzyme under different curing periods. The results revealed that the incorporation of the bio-enzyme increased the Maximum Dry Density (MDD) while reducing the Optimum Moisture Content (OMC), indicating improved compaction and stronger bonding between soil particles. These improvements confirmed that the bio-enzyme had a positive impact on reducing soil voids and enhancing overall soil stability. In conclusion, this study demonstrated that bio-enzymes have strong potential to be used as a sustainable and greener alternative in the construction industry. To further strengthen the findings, future research is recommended to include longer curing periods, additional strength tests and field applications to fully assess the real-life performance of bio-enzyme-treated soil.

# ABSTRAK

Kajian ini telah dijalankan untuk menilai keberkesanan bio-enzim sebagai bahan penstabil tanah yang lebih mesra alam dalam meningkatkan ciri kejuruteraan tanah lembut terutamanya di kawasan sawah padi. Masalah utama yang dikenal pasti ialah sifat tanah liat yang mempunyai kekuatan rendah, mudah berubah mengikut kandungan air dan boleh menyebabkan ketidakstabilan tapak pembinaan. Bagi mengatasi masalah ini, beberapa ujian makmal seperti Ujian Had Atterberg dan Ujian Pemadatan Standard Proctor telah dilaksanakan terhadap sampel tanah tanpa rawatan serta sampel tanah yang dirawat dengan bio-enzim pada tempoh pemeraman tertentu. Analisis keputusan makmal menunjukkan bahawa penggunaan bio-enzim telah meningkatkan nilai Ketumpatan Kering Maksimum (MDD) dan mengurangkan nilai Kandungan Lembapan Optimum (OMC), menunjukkan peningkatan dari segi daya pemadatan tanah. Ini mengesahkan bahawa terdapat interaksi yang baik antara bio-enzim dan zarah tanah dalam mengurangkan ruang liang. Secara keseluruhannya, kajian ini membuktikan bahawa bio-enzim berpotensi menjadi alternatif penstabil tanah yang lebih selamat dan mampan dalam industri pembinaan. Bagi memperkukuhkan lagi hasil penyelidikan, kajian lanjutan dicadangkan termasuk penambahan tempoh pemeraman, pelaksanaan ujian kekuatan tambahan serta ujian lapangan bagi menilai keberkesanan sebenar bio-enzim dalam keadaan pembinaan sebenar.

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# INTRODUCTION

## 1.1 INTRODUCTION

Soil found in paddy field areas is often weak, holds a lot of water, and compresses easily, making it difficult and unsuitable for construction unless it is properly treated. These conditions often lead to common problems such as soil settlement and low load-bearing capacity, which can eventually cause instability and even structural failure (Al-Shakarchi et al., 2020).

Building on this type of soil presents many challenges. One major issue is its tendency to retain water, which leads to poor drainage and makes the soil easily shrink or expand. Traditional stabilization methods, such as using cement or lime, are not only less sustainable but can also harm nearby agricultural areas.

In paddy fields, the constant presence of water makes the situation even more difficult. The high moisture content reduces the soil's strength and causes it to expand and contract more easily. While lime and cement have long been used to improve soil strength, they bring environmental concerns like carbon emissions and potential soil pollution. As a result, bio-enzymes have become a more sustainable alternative, offering an environmentally friendly and effective way to stabilize soil (Kumar et al., 2020).

## 1.2 BACKGROUND RESEARCH

Soil in paddy fields was a long-term and persistent problem, and it often led to costly repairs. The safety and well-being of residents were disrupted and severely affected. Therefore, the soil needed to be treated or improved before it was used for construction purposes.

In geotechnical engineering, soil stabilization was very important in strengthening or increasing the strength of weak soils, especially in construction projects. The presence of soft clay in paddy fields, such as in Pokok Mangga, Melaka, presented significant challenges due to its relatively high moisture content, low shear strength, and excessive settlement behavior. If the soil was not stabilized properly or promptly, the conditions could cause structural failure, increased maintenance costs, and negatively affected the safety of the surrounding population, making it unsuitable for occupation.

Therefore, one of the modern and environmentally friendly approaches was the use of bio-enzymes for soil stabilization, such as Terrzyme. These bio-enzymes functioned by altering the soil properties at the molecular level, which led to higher compaction, improved shear strength, and reduced permeability. Bio-enzymes also provided a sustainable and effective solution for soil improvement.

## 1.3 PROBLEM STATEMENT

Housing development in the vicinity of paddy fields faced significant challenges due to the presence of highly compressible and unstable soft clay soils. Interviews with relevant parties, including engineers and local residents, indicated that the unstable soil properties led to long-term and persistent structural problems such as foundation failure and building cracks. These issues resulted in costly repairs and financial burdens on homeowners. As a result, the safety and well-being of residents were significantly compromised when soil instability occurred. Concerns also arose about the long-term durability of structures in these areas.

Therefore, to ensure the progress of construction, the soil needed to be treated or improved properly before being used for development purposes. However, conventional techniques such as adding lime or cement were the most commonly used methods, but they had several disadvantages, including relatively high costs and environmental concerns. In addition, in rural and agricultural environments, these traditional stabilization techniques became a major challenge, thus limiting their practicality for large-scale applications.

As a result, in recent years, bio-enzymes received increased attention as a cost-effective and environmentally friendly soil stabilization alternative. These organic compounds were responsible for increasing soil particle bonding, enhancing load-bearing capacity, and reducing settlement without harming the environment. However, there was still a lack of research on the application of bio-enzymes specifically in paddy field conditions. Therefore, this study aimed to explore the effectiveness of bio-enzyme soil stabilization in such environments. Through this investigation, it intended to provide a sustainable solution by improving soil strength and ultimately contributed to safer, more durable, and cost-effective development in paddy field areas.

## 1.4 RESEARCH OBJECTIVES

The objectives of this study were:

i. To classify the soil in the Klebang paddy field using the Unified Soil Classification System (USCS).
ii. To analyze the changes in the geotechnical properties of the soil after Terazyme treatment.
iii. To compare the compaction characteristics improvement due to different bio-enzyme dosages.

## 1.5 SCOPE OF RESEARCH

i. This study focuses on stabilizing soft clay soil using bio-enzymes with Terazyme.
ii. Soft clay soil samples were collected from a paddy field at Pokok Mangga, Malim, Melaka.
iii. Classification of laboratory tests include Sieve Analysis and Atterberg limits.
iv. The soil properties tests were conducted for compaction for the treated soil.
v. The percentage of bio-enzymes used was 0.2 ml/kg (12%) under air-dry condition.
vi. The testing duration for assessing the soil properties was conducted at 7 and 14 days.

## 1.6 PROJECT SIGNIFICANCE

This study on Soil Stabilization Using Bio-Enzymes held significant importance in various aspects:

1) **Improving Soil Stability**

   - Bio-enzymes greatly helped to increase the strength, compaction, stability and permeability of the soil.
   - They made soft soil in rice fields suitable for construction.

2) **Sustainable & Eco-Friendly Approach**

   - It provided a more environmentally friendly alternative to conventional methods using cement and lime.
   -It reduced the negative impact on the environment and lowered carbon emissions.

3) **Cost-Effective Solutions**

   - It reduced the use of expensive building materials.
   - It saved construction costs without affecting soil stabilization.

4) **Better Infrastructure Durability**

   - It allowed the construction of more durable infrastructure with reduced maintenance time.
   - It helped to minimize the negative impact of structural failure risks, especially in clay soil areas that were often exposed to floods.

## 1.7 CHAPTER SUMMARY

This chapter outlined the background of soil stabilization using bio-enzymes, emphasizing the challenges associated with soft clay soil in paddy fields, particularly in Pokok Mangga, Malim, Melaka. The objectives of this study included classifying the soil using the Unified Soil Classification System (USCS) and analyzing the changes in geotechnical properties such as compaction after treatment with TerraZyme.