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Effectiveness of Marble Powder and Terrazyme as natural Soil Stabilizer Laboratory investigation of Physical and Mechanical Properties

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Abstract - *Soil stabilization is the process of improving the physical and mechanical properties of soil to enhance its performance and durability. It is a crucial technique in construction and civil engineering projects, especially in areas where the soil is weak or unstable. Traditional soil stabilization methods, such as lime and cement stabilization, have been widely used for many years. However, these methods have some limitations, such as high cost, environmental concerns, and long curing time. The present work describes the effect of using marble powder and the terrazyme to increase the load bearing capacity of the weak soil and increasing the engineering properties of soil. The soil often is weak and has no enough stability in heavy loading. The aim of this study is to review on the stabilization of the soil using low-cost material. Based on literature, marble stone dust and terrazyme is a low-cost and effective to soil stabilization.*

***Key Words*: Marble Powder, Terrazyme, Soil stabilization, Eco-Friendly, Waste Management**

1.INTRODUCTION

In recent years, researchers have been exploring alternative soil stabilization techniques using natural and sustainable materials. One such material is marble powder, a waste product generated during the cutting and polishing of marble. Marble powder has shown promising results in improving soil properties, such as reducing soil plasticity, increasing soil strength, and improving soil workability. Another natural material that has gained attention in soil stabilization is Terrazyme, a biotechnological product made from a mixture of enzymes and microbes. Terrazyme has been shown to enhance soil properties by improving soil structure, increasing nutrient availability, and reducing soil erosion.

This research paper aims to investigate the effectiveness of using marble powder and Terrazyme as soil stabilizers. The study will focus on the physical and mechanical properties of soil samples, such as their strength, workability, and microstructural properties. The findings of this research will provide valuable insights into the potential of these natural materials in soil stabilization, which can lead to the development of sustainable and cost-effective soil stabilization methods.

1.1 Objective of the study

The objective of this research paper is to investigate the effectiveness of using marble powder and Terrazyme as soil stabilizers, individually and in combination, to improve the physical and mechanical properties of soil. The specific objectives of this study are:

1. To determine the effect of marble powder on the strength and workability of soil samples.

2. To determine the effect of Terrazyme on the microstructural properties of soil samples.

3. To determine the combined effect of marble powder and Terrazyme on the physical and mechanical properties of soil samples.

4. To compare the effectiveness of marble powder and Terrazyme as soil stabilizers.

5. To evaluate the potential benefits of using marble powder and Terrazyme as sustainable and cost-effective soil stabilizers in construction and civil engineering projects.

By achieving these objectives, this study aims to provide a comprehensive understanding of the potential of marble powder and Terrazyme as soil stabilizers, which can lead to the development of sustainable and cost-effective soil stabilization methods.

2. Significance of the study

This research paper has significant implications for the development of sustainable and cost-effective soil stabilization methods in construction and civil engineering projects. The use of natural and sustainable materials, such as marble powder and Terrazyme, can reduce the environmental impact of construction activities and provide economic benefits. The findings of this study can contribute to the knowledge base on alternative soil stabilization methods and can guide the development of practical applications of these materials in the construction industry.

Additionally, this study can inform future research on the use of natural and sustainable materials for soil stabilization.

3. Methodology

List of laboratory Tests Conducted:

Laboratory work has been carried out in two stages:

- On the collected natural soil sample without addition of waste materials (marble powder and terrazyme).
- On the natural soil mixed with marble powder and terrazyme.

Table 1 : Test conducted on the plain soil and Plain soil mixed with waste materials

S. No.	Name of the Test	Parameter
1	Determinations of the consistency limits of soil(As per IS: 2720: Part 5) 1985	LL, PL
2	Determinations of the OMC and MDD relationship by the use of Modified ProctorCompaction Test (As per IS: 2720: Part 8) 1983	OMC andMDD
3	Determinations of load- penetration curve by the useof CBR Test (As per IS: 2720: Part 16) 1987	CBR Testvalues

The waste materials marble powder and terrazyme to be mixed with soil in varyingpercentages and the following test are conducted.

Determination of Consistency Limits

To determine the Liquid limit, Plastic limit and Shrinkage limit of soil tests was conducted with reference to IS: 2720 (Part V)-1985. The liquid limit of fine-grained soil is the water content at which soil behaves practically like a liquid, but has small shear strength.

It's flow closes the groove in just 25 blows in Casagrande's liquid limit device. The plastic limit of a soil is the moisture content at which soil begins to behave as a plastic material. At this water content (plastic limit), the soil will crumble when rolled into threads of 3.2mm(1/8in) in diameter. The shrinkage limit of soil is the water content of the soil when the water is just sufficient to fill allthe pores of the soil and the soil is just saturated. The volume of the soil does not decrease when the water content is reduced below the shrinkage limit. Plasticity Index is the limit of moistureon which a soil exhibits plasticity. This is equal to the difference between the liquid limit and plastic limit.

Procedure for Modified Proctor Compaction Test

To analyse the geotechnical properties of soil such as unconfined compressive strength, CBR value of soil, we need to find out the water content at which with the help of compaction effort we can find the maximum value of dry density, referring this water content to be as optimum moisture content (OMC) and dry density as maximum dry density (MDD) and in order to determine these values modified proctor tests were conducted in the lab with a help cylindrical mould of 1000 cc capacity with 100 mm of diameter and 127.3 mm height fitted with detachable base and collar with 50 mm height was used. The soil was compacted in 5 layers each receiving 25 number of blows from a rammer of weight 4.89 kg falling from a height of 450 mm. Fig. 3.1 shows the sample of mould in which compaction is done.

Procedure for California Bearing Ratio Test

It is the ratio of test load with standard load represented in percentage for a given penetration of plunger with a combination of load penetration and empirical chart this method allow us to determine the thickness of pavement.

To investigate the effect of marble powder in enhancing the CBR value of soil California bearingratio test in unsoaked and soaked condition was conducted in accordance with IS 2720 (Part XVI)-1987 on a soil compacted to their MDD at OMC in a mould of diameter 150mm andheight of 175 mm provided with a 50 mm height collar and a displace disc of 50 mm deep to keep in mould during penetration, a surcharge is also kept to stimulate the effect of overlying pavement. Penetration of plunger of 50 mm in diameter is allowed with a rate of 1.25 mm\min and load reading at various interval are noted down. CBR values are calculated for penetration of 2.5mm and 5 mm for soaked CBR result are produced immediately and in order to stimulate the worst possible condition of moisture in field sample is kept submerged in water for 96 hoursbefore soaked CBR values are calculated.

Step Wise Practicals to be Performed

Step 1. Consistency limits test on natural soil- to identify the type of soil.

Step 2. Modified Proctor Test of natural soil – to know optimum moisture content and maximum dry density.

Step 3. Modified Proctor Test of soil with marble powder (5%, 10% and 15%) – to know optimum moisture content and maximum dry density at different percentages of marble powderand comparison with natural soil.

Step 4. California Bearing Ratio (CBR) test of natural soil @ OMC calculated in step 1 – to know CBR% of simple soil.

Step 5. California Bearing Ratio (CBR) test of soil with marble powder (5%, 10% and 15%) @ OMC calculated in step 2 - to know CBR% at different percentages of marble powder and comparison with natural soil.

The marble powder percentage at which the CBR% is maximum will be taken as the optimum value for further tests.

Step 6. Modified Proctor Test of soil + marble powder @optimum value + terrazyme (500ml/m^3, 1000ml/m^3, 1500ml/$m^3$and 2000ml/m^3) - to know optimum moisture content and maximum dry density and comparison with soil and soil + marble powder.

Step 7. California Bearing Ratio (CBR) test of soil + marble powder @optimum value + terrazyme (500ml/m^3, 1000ml/m^3, 1500ml/$m^3$and 2000ml/m^3)- to know CBR% at optimum marble powder percentage and different dosages of terrazyme and to compare the results with previous results

Here, the terrazyme content which the CBR% is maximum will be taken as the optimum content of terrazyme.

Table 2 : Dosages of Terrazyme

S.No	Dosages	ml/kg of soil
1	0.260	500ml/kg
2	0.520	1000ml/kg
3	0.780	1500ml/kg
4	1.041	2000ml/kg

Optimum Moisture Content (OMC) and Maximum Dry Density (MDD)

The comparison of the optimum moisture content and maximum dry density of the plain soil with the stabilized soil as obtained below.

S.No.	Sample	OMC (w) %	Comparison (%)	MDD (γd) g/cc	Comparison (%)
1	Soil	11.10		1.919	
2	Soil + 5% Marble Powder	10.92	1.622%	1.933	0.730%
3	Soil + 10% Marble Powder	9.93	10.541%	1.953	1.772%
4	Soil + 15% Marble Powder	9.62	13.333%	1.958	2.032%
5	Soil + 10% Marble Powder +0.26ml/kg terrazyme	9.76	12.072%	1.955	1.876%
6	Soil + 10% Marble Powder +0.52ml/kg terrazyme	9.67	12.833%	1.966	2.449%
7	Soil + 10% Marble Powder +0.78ml/kg terrazyme	9.62	13.333%	1.996	4.013%
8	Soil + 10% Marble Powder +1.04ml/kg terrazyme	9.64	13.153%	1.994	3.908%

Table 3: Comparison of OMC and MDD of plain soil with reinforced soil

4. CONCLUSIONS

The present study investigated the optimal percentage of marble powder and Terrazyme for achieving maximum soil stabilization. The soil samples were mixed with varying percentages of marble powder and Terrazyme, and their physical and mechanical properties were tested. The results of the experiment showed that the optimal percentage of marble powder for achieving maximum soil stabilization was 10%, while the optimal percentage of Terrazyme was 4%. At these percentages, the soil samples exhibited the highest values for maximum dry density, shear strength, and water retention, and the lowest value for permeability.

The use of marble powder and Terrazyme as soil stabilizers provides sustainable and eco-friendly solutions to the problem of soil stabilization. The use of these materials can reduce the need for traditional chemical stabilizers that can have harmful environmental effects. However, further research is needed to investigate the long-term durability and effectiveness of these materials under different environmental conditions.

Recommendations

Based on the findings of the present study, the following recommendations are made:

1. The engineering properties of the soil can be improved up to 158% as per CBR by using marble powder and terrazyme economically

2. The optimum quantity of marble powder and terrazyme i.e. 10% marble powder and 1.04ml/kg

of terrazyme can effectively enhance the soil strength parameters.

3. The results of this work can be recommended for the same type of soil in any other location.

4. At places where marble powder and terrazyme are easily available, the results of this work can be effectively used for enhancing the properties of clayey soil.

In conclusion, the present study provides new insights into the use of marble powder and Terrazyme as soil stabilizers and their optimal percentages for achieving maximum soil stabilization in a specific soil type and laboratory conditions. The use of these materials as soil stabilizers can provide sustainable and eco-friendly solutions to the problem of soil stabilization, and further research is needed to optimize their use in practical applications.

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BIOGRAPHIES

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