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Soil Stabilization Using Bionzyme: A Research Study

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Abstract: Soil stabilization is an essential aspect of geotechnical engineering, particularly for black cotton soil, which exhibits significant volumetric changes. This study investigates the effectiveness of Bionzyme, an eco-friendly soil stabilizer, in improving soil properties. Various laboratory tests, including Unconfined Compressive Strength (UCS), California Bearing Ratio (CBR), and Atterberg Limits, were conducted to evaluate the stabilization effects. The findings suggest that Bionzyme enhances soil strength, reduces swelling, and improves compaction characteristics, making it a sustainable alternative for soil stabilization.

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I.INTRODUCTION:

Black cotton soil presents challenges due to its high shrink-swell potential. Traditional stabilization methods involve the use of lime and cement, which can have environmental drawbacks. This study explores the potential of Bionzyme as a bio-stabilizer, emphasizing its effectiveness and sustainability in soil improvement.

II.LITERATURE REVIEW

Various studies have confirmed that bio-enzyme stabilization enhances compaction, strength, and durability of black cotton soil. Research highlights include:

- Improved UCS values.
- Reduction in swelling properties.
- Cost-effectiveness compared to conventional stabilizers.
- Environmental benefits due to reduced chemical usage.

III.PROBLEM STATEMENT

The rapid growth of urbanization and industrialization has led to an increasing demand for infrastructure development on soils that are often weak, expansive, or problematic. In India, large areas of black cotton soils—characterized by high clay content and poor engineering properties—pose significant challenges in construction, particularly for roads, embankments, and foundations. These soils exhibit substantial volumetric changes when exposed to moisture, resulting in poor compaction, low bearing capacity, and susceptibility to shrinkage and swelling, which can significantly compromise the stability and durability of structures built on them.

Traditional soil stabilization techniques, such as the use of lime, cement, and fly ash, are often not cost-effective, time-consuming, and environmentally damaging. Additionally, these methods may not always provide long-term stabilization or improve the soil to the desired levels.

Given the need for more sustainable, cost-effective, and environmentally friendly solutions, bio-enzyme-based soil stabilization presents a promising alternative. Bionzyme, a natural, biodegradable enzyme derived from vegetable extracts, has been identified as a potential solution. Despite its growing popularity in the field of soil stabilization, there is limited research on its full potential, optimal usage, and long-term effects.

IV.FUTURE SCOPE

Further research is recommended to:

- Optimize bioenzyme dosages for different soil types.
- Explore synergistic effects with other stabilizers.
- Evaluate long-term stability and environmental impacts.
- Investigate economic feasibility compared to traditional stabilization methods.

V. METHODOLOGY

Soil Sample Collection and Preparation

Black cotton soil samples were collected from multiple locations to ensure variability. The samples were analyzed for physical and chemical properties, including grain size distribution, Atterberg limits, and specific gravity.

Bioenzyme Treatment

A commercially available bioenzyme was selected for this study. The enzyme was diluted in water and applied at different dosages (200ml/3m³ to 200ml/1.5m³ of soil). The treated soil was compacted using the standard Proctor compaction test to determine Maximum Dry Density (MDD) and Optimum Moisture Content (OMC).

Testing Procedures

The following laboratory tests were conducted:

- Unconfined Compressive Strength (UCS): To assess shear strength improvement.
- California Bearing Ratio (CBR): To determine load-bearing capacity.
- Atterberg Limits: To evaluate plasticity index changes.
- Shrinkage and Swelling Tests: To measure volume change behavior.

METHODOLOGY AND EXPERIMENTAL SETUP

MIX PROPORTIONS

Combination of Black cotton soil+terrazyme

Sl no.	terrazyme	B c soil in %
1	0.0	100
2	200ml/3m3 of soil	100
3	200ml/2.5m3 of soil	100
4	200ml/2m3 of soil	100
5	200ml/1.5m3 of soil	100

Combination of Black cotton soil+terrazyme+lime

SL.NO	TERRAZYME	LIME In %	BC SOIL in %
1	0.00	10	100
2	200ml/3m3 of soil	10	100
3	200ml/2.5m3of soil	10	100
4	200ml/2m3 of soil	10	100
5	200ml/1.5m3 of soil	10	100

FOLLOWING TESTS WILL BE CONDUTED

1. Specific gravity test
2. Liquid limit test
3. Plastic limit test
4. Proctor compaction test
5. CBR test
6. Swelling index test

VI.RESULT AND DISCUSION

The various tests are explained in methodology is conducted and the results obtained for specific gravity, liquid limit, plastic limit, proctor compaction test ,and CBR test etc are discussed in this chapter.

MOISTURE CONTENT OF NATURAL SOIL USING OVEN DRY METHOD

- Weight of can = 4.96 gm
- Can no.= L10
- Weight of wet soil + can = W1= 15.1gm
- Weight of dry soil + can =W2=13.7455gm
- Weight of dry soil = W3=8.87575gm Water content = (W1-W2)*100/W3=15.42%

SPECIFIC GRAVITY OF BLACK COTTON SOIL USING PYCNOMETER

Observation:

1. Empty weight of pycnometer = W1 = 660 gms
2. weight of pycnometer + 1/3rd of B.C soil = W2 = 946gms
3. Weight of pycnometer + 1/3rd of B.C soil + Full of water= W3=1713gms
4. Weight of pycnometer + Full of water= W4=1549gms

Calculation:

Sp.Gr of B.C soil = (W2 – W1) / {(W4-W1)-(W3-W2)}

= (946-660)/{(1549-660)-(1713-946)}

= 2.

RESULTS OF OMC & MDD FOR VARYING DOSAGES

DOSAGE	OMC (%)	MDD g/cc
Conventional soil	21.15	1.41
200ml/3m3 of soil	20.6	1.49
200ml/2.5m3 of soil	15.77	1.63
200ml/2m3 of soil	11.97	1.67
200ml/1.5m3 of soil	14.72	1.64

From above table it is observed that OMC & MDD of conventional soil are 21.15% & 1.4 g/cc, as adding of dosages increases OMC & MDD values increases and it is observed that 200ml/2m3 of soil is optimum.

Free swell index

1. Initial volume of soil in distilled water =Vid =16 ml
2. Initial volume of soil in kerosene= Vik = 10ml
3. Final volume of soil in distilled water = Vfd = 16.5ml
4. Final volume of soil in kerosene = Vfk =10ml Free swell index % =(Vfd-Vfk)*100/Vfk = 65%

CBR TEST:

UNSOAKED CBR TEST FOR CONVENTIONAL SOIL

Constants;

1. proving ring constant;5.91kg
2. least count of strain dial gauge ;0.01mm

Sl No.	Dial Gauge reading(in divisions)	Proving ring reading(in divisions)
01	0	0
02	50	3
03	100	8
04	150	16
05	200	21
06	250	24
07	300	28
08	400	31
09	500	35
10	750	47
11	1000	-
12	1250	-

Calculation;

1. CBR at 2.5mm = (24x5.91)/(1370)x100
   = 10.35%
2. CBR at 5mm = (35x5.91)/(2055)x100
   = 10.01%

SOAKED CBR TEST FOR CONVENTIONAL SOIL

Sl No.	Dial Gauge reading(in divisions)	Proving ring reading(in divisions)
01	0	0
02	50	0
03	100	1
04	150	2
05	200	3
06	250	4
07	300	5
08	400	5
09	500	6
10	750	7
11	1000	-
12	1250	-

3. Calculation;)CBR at 2.5mm = (4x5.91)/(1370)x100
   = 1.72%
4. CBR at 5mm = (6x5.91)/(2055)x100
   = 1.72%

RESULTS OF CBR FOR VARYING DOSAGES

DOSAGE	UNSOAKED CBR VALUES (%)		SOAKED CBR VALUES (%)	
	2.5mm penetration	5mm penetration	2.5mm penetration	5mm penetration
Conventional soil	10.35	10.01	1.72	1.72
200ml/3m3 of soil	12.51	11.2	2.15	2.01
200ml/2.5m3 of soil	13.37	12.07	2.58	2.01
200ml/2m3 of soil	14.23	15.24	3.44	2.5
200ml/1.5m3 of soil	12.07	11.8	3.88	3.16

From above table it was observed that soaked cbr values of bc soil is 1.72 % & unsoaked is 12.07%. after adding terrazyme in different dosages as mentioned above ,the dosage 200ml/2m3 of soil is found to be maximum for unsoaked cbr values and for soaked cbr it is observed that it goes on increasing as dosage increases.

VII.CONCLUSION

The study confirms that Bionzyme significantly improves the properties of black cotton soil. Key findings include:

- Enhanced soil strength and stability.
- Reduced swelling and shrinkage.
- Sustainable and cost-effective application in road construction and foundation works.
- Potential for large-scale implementation with further optimization.

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