JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue

JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Stabilization Of Soil Using Terrazyme & Coconut Coir Fibre

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Abstract : Soil stabilization is the technique of improving the shear strength parameters and bearing capacity of soil .When the soil available for construction is not suitable to carry the structural loads the alteration of soils is done by enhancing the engineering (physical) properties of soil.The present work describes the effect of Terrazyme and Coconut Coir Fibre on the engineering properties of the low plastic clay (CL). The main objective of this study is to evaluate the effects of Terrazyme and Coconut Coir Fibre on Optimum Moisture Content (OMC),Maximum Dry Density (MDD) and California Bearing Ratio (CBR) tests on soil sample.

Index Terms **- Terrazyme, Coconut Coir Fibre, Optimum Moisture Content, Maximum Dry Density, California Bearing Ratio Test.**

I. INTRODUCTION

Soil stabilization is a technique of changing the naturally available soil by any physical, chemical, mechanical, biological, or combined method to meet an engineering purpose.The properties comprises of mechanical strength, permeability, compressibility, durability and plasticity of soil. It is achieved by enhancing the shear strength and the overall bearing capacity of a soil. The main intent of stabilization is cost diminution and to effectively use the locally accessible material.

SOIL STABILIZATION USING BIO-ENZYMES : The alteration of soils to improve their physical properties is known as soil stabilization.Recent trends of innovative and creative techniques have evolved for consuming locally available agricultural throw away material for the modification of deficient soil. The improvisation of soil with bio-enzyme is a wide range technique which is in demand globally. The bio-enzymes available for stabilization of soil are Renolith, Perma-Zyme, Terrazyme, Fujibeton etc. When these bio-enzymes are mixed with soil they change engineering properties of it. Their efficiency depends upon the amount of dose, type of soil available and field conditions.

SOIL STABILIZATION USING COCONUT COIR FIBRE : To reinforce soil with any natural fibre has been done since past.. Any natural fibre reinforced soils have recently gained much attention in soil engineering. One such naturally available fibre is Coconut husk , its outer covering is a fibrous material which is the reject of coconut fruit. These fibre are normally 50–350 mm long. The husk from the coconut palm comprises 30% weight of fibre and 70% weight of pith material.

II .MATERIAL COLLECTION :

Collection of soil : The soil sample analyzed for study was taken from Baltana in Zirakpur (Punjab).The gravel part of soil was removed by sieving the sample through 4.75mm IS sieve .The soil was left for air drying for 24 hours prior to laboratory testing for the engineering strength properties of soil.

Terrazyme : The 200ml enzyme was received from (Avijeet Agencies , Chennai, India.)as in Fig 1.

Coconut Coir fibre : Coconut Coir fibre was collected from Amazon Online shopping platform in the 3 packets of 100 gm each as in fig 2.

FIg 1. TERRAZYME

Fig 2 .COCONUT COIR FIBRE

III. METHODOLOGY :

The laboratory tests has been carried out in two phases;

i. Testing of Virgin soil with out adding Terrazyme and Coconut coir fibre.

ii. Testing of Soil mixed with Terrazyme in dosages of 0.04ml, 0.05ml, and 0.06ml per kg of soil with Coconut coir fibre in percentages of 0.25%, 0.50%, 0.75%. & 1% by weight.

IV. EXPERIMENTAL RESULTS:

INDEX PROPERTIES : The index properties of the soil are illustrated in the below Table 1 and Fig 3:-

CONSISTENCY LIMITS : The consistency limit test was performed as per IS: 2720 (Part V) 1985 shown in the fig. 3,the LL of soil as 30 % and the PL of soil as 22.80 %

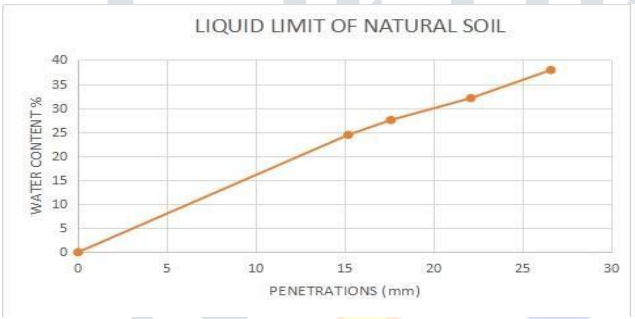

Fig. 3 WATER CONTENT vs PENETRATIONS

PLASTICITY INDEX (I_P): Plasticity index of collected soil sample is the range of water content present within which the sample behaves plastic. It depends mainly on the amount of clay mineral and to a lesser extent on the type of clay mineral. Larger is the plasticity index , greater is the plasticity of soil.i.e , $Ip = W_L - W_P$

$I_P = 30 - 22.80$ => **$I_P = 7.2$**

TABLE 1 . PROPERTIES OF COLLECTED SOIL SAMPLE

S. No.	CHARACTERISTICS	RESULTS
1.	Liquid limit (LL%)	30 %
2.	Plastic limit (PL%)	22.80 %
3.	Plasticity index (PI%)	7.2 %
4.	Indian Soil Classification	CL

Therefore , the virgin soil is classified as low plastic soil based on its plasticity index equal to **7.2**

MODIFIED PROCTOR COMPACTION TEST ON PARENT SOIL SAMPLE : Modified proctor compaction test was performed on virgin soil for determination of the OMC & MDD , as shown in the Table 2 and Fig 4.

TABLE 2. OMC & MDD OF VIRGIN SOIL

S.No	WATER CONTENT (%)	DRY DENSITY (g/cc)
1.	7.94	1.96
2.	9.73	2.05
3.	11.0	2.00
4.	9.57	1.85

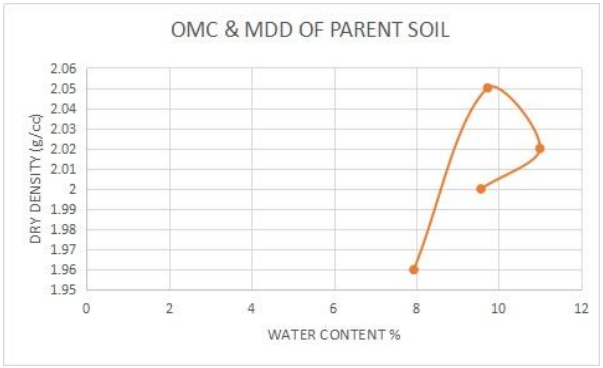

Fig. 4 OMC &MDD OF PARENT SOIL

Therefore, the OMC & MDD of the virgin soil was recorded as **9.73%** and **2.05 g/cc** respectively.

MODIFIED PROCTOR COMPACTION TEST ON SOIL ADMIXED WITH THREE DOSAGES OF TERRAZYME (0.04ml,0.05ml&0.06ml/Kg) & FOUR PERCENTAGES BY WEIGHT OF COCONUT COIR FIBRE (0.25%, 0.50%,0.75% & 1%) : The OMC & MDD values of all soil samples is illustrated in Table 3 and Fig 5.

Table 3. VALUES OF OMC AND MDD OF ALL SOIL SAMPLES WITH TERRAZYME & COCONUT COIR FIBRE.

S. NO.	PERCENTAGE OF TERRAZYME + COCONUT COIR fibre	OMC %	MDD (g/cc)
1.	0.04ml/kg + 0.25 %	8.67	2.03
2.	0.04ml/kg + 0.50 %	9.79	2.04
3.	**0.04 ml/kg + 0.75%**	**11.06**	**2.05**
4.	0.04ml/kg + 1%	8.75	2.01
5.	0.05ml/kg + 0.25 %	8.90	2.05
6.	0.05ml/kg + 0.50 %	9.70	2.07
7.	**0.05 ml/kg + 0.75%**	**11.33**	**2.09**
8.	0.05ml/kg + 1%	10.33	2.01
9.	0.06ml/kg + 0.25 %	7.90	1.94
10.	0.06ml/kg + 0.50 %	10.14	2.02
11.	**0.06ml/kg + 0.75 %**	**12.64**	**2.07**
12.	0.06 ml/kg + 1%	9.25	2.02

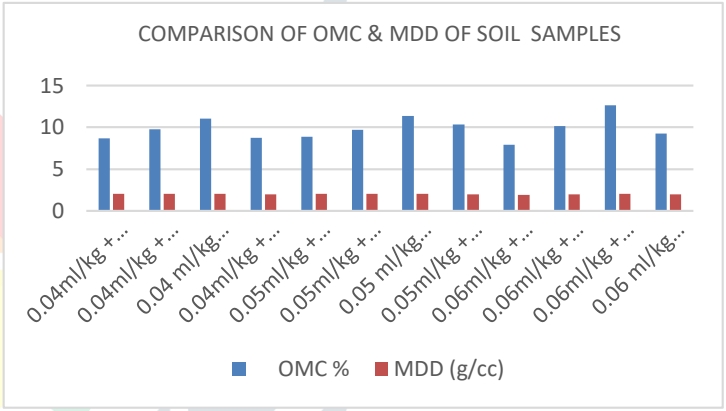

Fig 5. VALUES OF OMC AND MDD OF ALL SOIL SAMPLES WITH TERRAZYME & COCONUT COIR FIBRE.

OMC AND MDD FOR SOIL WITH TERRAZYME & OPTIMIZED 0.75% COCONUT COIR FIBRE.: The values OMC and MDD for soil samples mixed with 0.04ml, 0.05ml and 0.06ml with optimized percentage of coconut coir fibre as 0.75% is illustrated in Table 4 and Fig . 6

TABLE 4. VALUES OF OMC AND MDD FOR SOIL WITH TERRAZYME & OPTIMIZED 0.75% COCONUT COIR FIBRE.		
PERCENTAGE OF TERRAZYME + OPTIMISED COCONUT COIR fibre	**OMC (%)**	**MDD (g/cc)**
0.04ml/kg + 0.75%	11.06	2.05
0.05 ml/kg + 0.75%	11.33	2.09
0.06 ml/kg + 0.75%	12.64	2.07

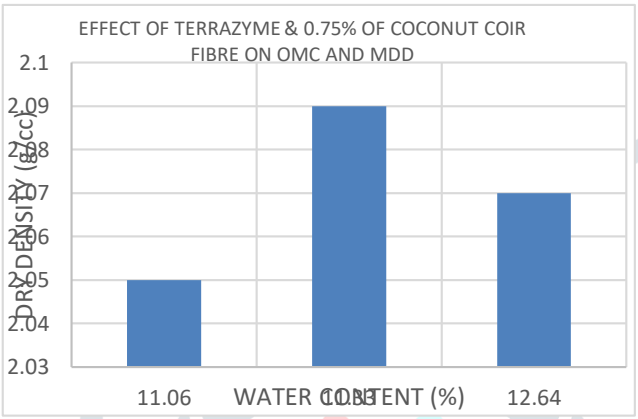

Fig 6 OMC AND MDD FOR THE SOIL WITH TERRAZYME & 0.75% COCONUT COIR fibre

CALIFORNIA BEARING RATIO (CBR) TEST OF VIRGIN SOIL: Load penetration test results and curve for the virgin soil is illustrated in Table 5 and Fig 7 below :-

Table 5 LOAD PENETRATION CURVE FOR THE PLAIN SOIL		
S.No.	**PENETRATION (mm)**	**Load (kg)**
1.	0	0
2.	0.5	25
3.	1.0	55
4.	1.5	88
5.	2.0	118
6.	2.5	145.6
7.	4.0	180
8.	5.0	208
9.	7.5	260

Fig. 7 LOAD-PENETRATION CURVE

Therefore , the CBR value of Virgin soil is recorded as **10.627 %.**

CALIFORNIA BEARING RATIO (CBR) TEST VALUES OF ALL SOIL SAMPLES ON SOIL ADMIXED WITH THREE DOSAGES OF TERRAZYME (0.04ml,0.05mL&0.06ml /Kg) & FOUR PERCENTAGES BY WEIGHT OF COCONUT COIR FIBRE (0.25%, 0.50%,0.75% & 1%) : Load penetration test results and curve for all samples is illustrated in Table 6 and Fig. 8 below :

TABLE 6.CBR VALUES FOR ALL SOIL SAMPLES WITH TERRAZYME & COCONUT COIR FIBRE.

S.NO	PERCENTAGE OF TERRAZYME + COCONUT COIR fibre	CBR %
1.	0.04ml/kg + 0.25 %	10.62
2.	0.04ml/kg + 0.50 %	10.72
3.	**0.04 ml/kg + 0.75%**	**11.38**
4.	0.04ml/kg + 1%	10.43
5.	0.05ml/kg + 0.25 %	10.51
6.	0.05ml/kg + 0.50 %	10.65
7.	**0.05 ml/kg + 0.75%**	**11.60**
8.	0.05ml/kg + 1%	10.80
9.	0.06ml/kg + 0.25 %	11.38
10	0.06ml/kg + 0.50 %	12.22
11	**0.06ml/kg + 0.75 %**	**12.55**
12	0.06 ml/kg + 1%	12.04

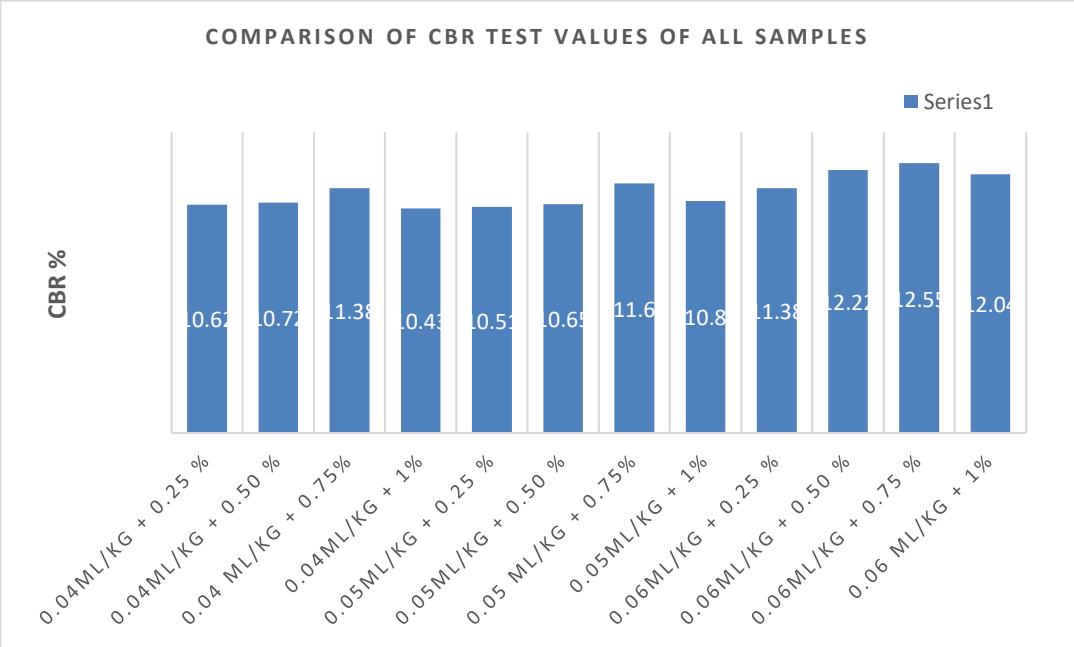

Fig 8. COMPARISON OF CBR VALUES OF ALL SOIL SAMPLES

CBR VALUES FOR SOIL WITH TERRAZYME & OPTIMIZED 0.75% COCONUT COIR FIBRE.: The values of CBR for soil samples mixed with 0.04ml, 0.05ml and 0.06ml with optimized percentage of coconut coir fibre as 0.75% is as in table 7 and fig 9

Table 7 VALUES OF SOAKED CBR OF SOIL WITH THREE DOSAGES OF TERRAZYME AND OPTIMIZED VALUE AS 0.75% OF COCONUT COIR FIBRE.

S.NO.	DOSAGE OF TERRAZYME +OPTIMIZED COCONUT COIR fibre	CBR %
1.	VIRGIN SOIL	10.62
2.	0.04 ml/kg + 0.75%	11.38
3.	0.05ml/kg + 0.75%	11.60
4.	0.06 ml/kg + 0.75%	12.55

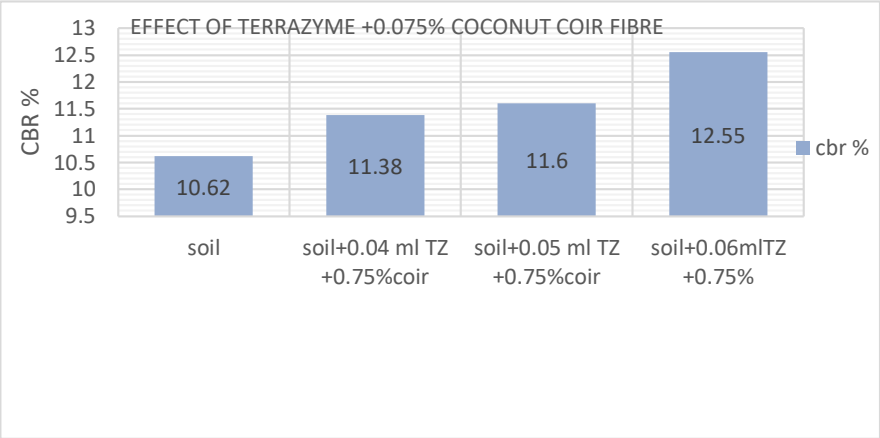

Fig 9. EFFECT OF TERRAZYME WITH 0.75% COCONUT COIR FIBRE ON CBR

V. INTERPRETATION OF RESULTS : Comparing OMC & MDD values of the virgin soil with all test samples variation found is depicted in the in Table 8and Fig 10.

TABLE 8. COMPARISON OF OMC AND MDD OF VIRGIN SOIL AND ADMIXED SOIL

S. NO	SAMPLE	OMC %	VARIATION OF OMC w.r.t. VIRGIN SOIL (%)	MDD g/cc	VARIATION OF MDD w.r.t. VIRGIN SOIL (%)
1.	Soil	9.73	_____	2.05	_____
2.	Soil + 0.04ml TZ + 0.25% coconut coir fibre	8.67	-10.89	2.03	-0.97
3.	Soil + 0.04ml TZ + 0.50% coconut coir fibre	9.79	+0.61	2.04	-0.48
4.	**Soil + 0.04ml TZ + 0.75% coconut coir fibre**	**11.06**	**+13.66**	**2.05**	**0**
5.	Soil + 0.04ml TZ + 1% coconut coir fibre	8.75	-10.07	2.01	-1.95
6.	Soil + 0.05ml TZ + 0.25% coconut coir fibre	8.90	+8.53	2.05	0
7	Soil + 0.05ml TZ + 0.50%	9.70	-0.30	2.07	+0.97

l

.	coconut coir fibre				
8.	**Soil + 0.05ml TZ + 0.75% coconut coir fibre**	**11.33**	**+16.44**	**2.09**	**+1.95**
9.	Soil + 0.05ml TZ + 1% coconut coir fibre	10.33	+6.16	2.01	-1.95
10	Soil + 0.06ml TZ + 0.25% coconut coir fibre	7.90	-18.8	1.94	-5.36
11	Soil + 0.06ml TZ + 0.50% coconut coir fibre	10.14	+4.2	2.02	-1.46
12	**Soil + 0.06ml TZ + 0.75% coconut coir fibre**	**12.64**	**+29.90**	**2.07**	**+0.97**
13	Soil + 0.06ml TZ + 1% coconut coir fibre	9.25	-4.93	2.02	-1.46

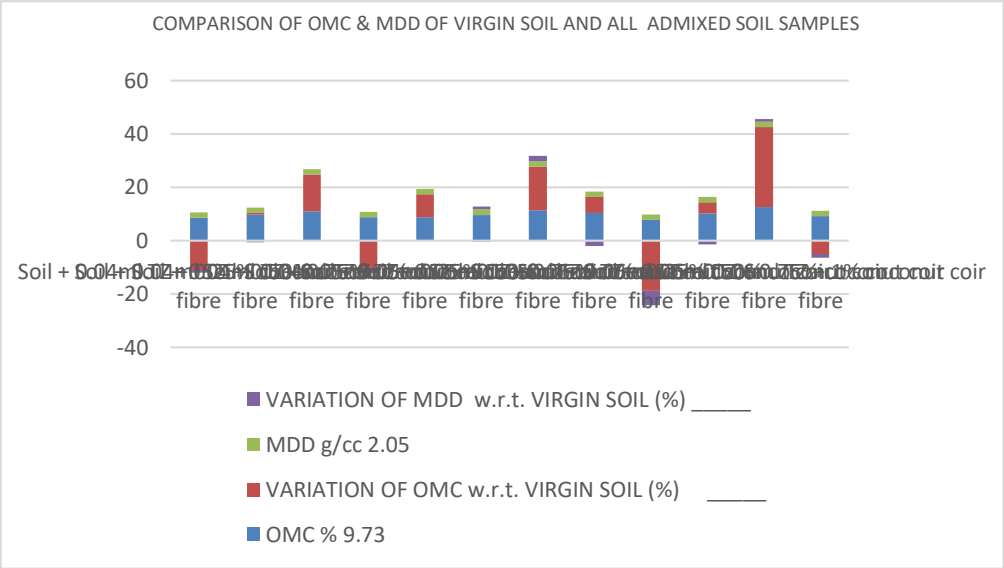

Fig 10.COMPARISON OF OMC AND MDD OF PLAIN SOIL AND ADMIXED SOIL.

Table 9. THE COMPARISON OF THE CBR VALUES OF VIRGIN SOIL WITH ALL ADMIXED SOIL SAMPLE :

S. N0	SAMPLE	CBR %	VARIATION OF CBR w.r.t. VIRGIN SOIL (%)
1.	Soil	10.62	_____
2.	Soil + 0.04ml TZ + 0.25% coconut coir fibre	10.62	0
3.	Soil + 0.04ml TZ + 0.50% coconut coir fibre	10.72	+0.94
4.	Soil + 0.04ml TZ + 0.75% coconut coir fibre	11.38	+7.15
5.	Soil + 0.04ml TZ + 1% coconut coir fibre	10.43	-1.78
6.	Soil + 0.05ml TZ + 0.25% coconut coir fibre	10.51	-1.03
7.	Soil + 0.05ml TZ + 0.50% coconut coir fibre	10.65	+0.28
8.	Soil + 0.05ml TZ + 0.75% coconut coir fibre	11.60	+9.22
9.	Soil + 0.05ml TZ + 1% coconut coir fibre	10.80	+1.69

10	Soil + 0.06ml TZ + 0.25% coconut coir fibre	11.38	+7.1
11	Soil + 0.06ml TZ + 0.50% coconut coir fibre	12.22	+15.06
12	Soil + 0.06ml TZ + 0.75% coconut coir fibre	12.55	+18.17
13	Soil + 0.06ml TZ + 1% coconut coir fibre	12.04	+13.37

Fig11.THE COMPARISON OF THE CBR VALUES OF VIRGIN SOIL WITH ALL ADMIXED SOIL SAMPLES

VI. CONCLUSIONS:

1. MDD and OMC values obtained for virgin soil are and 2.05 g/cc and 9.73%.
2. With the Terrazyme and Coconut Coir fibre in the soil MDD value first increases considerably reaching a maximum value of 2.09 g/cc for soil mixed with 0.05ml Terrazyme + 0.75 % Coconut Coir fibre and then decreases to 2.07 g/cc for soil mixed with 0.06 ml +0.75 % Coconut Coir Fibre.
3. On the other hand , with the Terrazyme and increasing Coconut Coir fibre the OMC increases as 11.06%, 11.33% and 12.64% for soil mixed with 0.04ml, 0.05ml, and 0.06 ml Terrazyme with 0.75% Coconut Coir fibre. i .e percentage increase with respect to virgin soil is found as 13.66 %, 16.44%, and 29.90 %
1. With further increase in Coconut Coir fibre up to 1% decreases the OMC and MDD values.
2. The soaked CBR value of virgin soil is 10.62 %
3. The soaked CBR value of soil mixed with 0.04ml ,0.05ml, 0.06ml of Terrazyme with 0.75% of Coconut Coir fibre is 11.38%, 11.60%, and 12.55 % respectively. The increase in CBR value as compared to virgin soil is 7.15%,9.22% and 18.17%
4. Hence the 0.75% may be taken as the optimum value of fibre to get the maximum CBR values.
5. The CBR value graph attains approximately a constant value with increase of Coconut Coir fibre up to 0.75% .

VII. RECOMMENDATIONS :

Based on the practicals performed out during the research work , it is recommended that :-

1. The properties of the soil can be improved by using Terrazyme and Coconut Coir fibre economically.
2. The optimum quantity of Terrazyme and Coconut Coir fibre i.e 0.06 ml/kg of Terrazyme and 0.75% of Coconut Coir fibre that 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. The increasing dosages of Terrazyme would increase the CBR values.

VIII. FUTURE SCOPE :

1. The extensive research work is circumscribed to improve the engineering properties of clayey soil (CL) by using Terrazyme and Coconut Coir fibre as stabilizing materials . The aim of work is to focus on studying the changes in CBR values of soil . There is large scope of carrying out further research in this area
2. A research can be done on other types of soils to analyze the effects of adding Terrazyme with Coconut Coir fibre on engineering properties of the soil.
3. The study can be further continued by taking some other dosages of Terrazyme with varying percentages of Coconut Coir fibre.

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