

# **An Experimental Study on Strength Characteristics of Expansive Soil Treated with Zycobond**

Dr.V.Giridhar<sup>1</sup>, P.Suresh Praveen Kumar<sup>2</sup>, S.Jyothirmayee<sup>3</sup>

Associate Professor, Department of Civil Engineering, KSRM College of Engineering (Autonomous), Kadapa, A.P., India<sup>1</sup>

Assistant Professor, Department of Civil Engineering, KSRM College of Engineering (Autonomous), Kadapa, A.P., India<sup>2</sup>

M.Tech Scholar, Department of Civil Engineering, KSRM College of Engineering (Autonomous), Kadapa, A.P., India<sup>3</sup>

**ABSTRACT:** Construction and maintenance especially with soft and expansive soils of pavements facing problems during casting. More than one sixth of the area in India is covered by expansive soils, during the rainy season the natural subgrade soil become soft and it pose serious problems especially for construction. According to the conventional methods, the pavements are failing due to subgrade soils undergoing deformations during monsoon season and become unserviceable. Strengthening of subgrade soil is one solvable solution for keeping the pavement of surfaces serviceable conditions. Treatment of soils with Zycobond has been used recently get the desired strength. Zycobond is a liquid additive which acts on soil to reduce voids between soil particles and minimize adsorbed water in the soil to achieve maximum compaction. In the present study, an attempt is made to conduct different types of experiments on soils stabilised with Zycobond with different percentages and study the engineering properties of the soils. This paper emphasizes the usage of a new stabilisation product called Zycobond on expansive soil. The present study deals with the effect of Zycobond on Liquid Limit, Plastic Limit, CBR and Shear Strength of Expansive Soil at different percentages of 1%, 2%, 3%, 4% and 5%. It is observed that the CBR value is decreased and Shear Strength is increased significantly with the addition of Zycobond.

**KEYWORDS:** Expansive soil, Zycobond, Liquid Limit, Plastic Limit, CBR, Shear Strength.

## **I. INTRODUCTION**

In India major part of the land is covered by Expansive soil and which is also known as clayey soil, its colour is black to greyish, due to the presence of montmorillonite clay mineral its behaviour is highly expansive and also having high moisture content. Seasonal changes are the main reason for shrinkage and swelling of these soils. In the process of design of foundations and pavements in this types of soils involves a certain risk and damage. Hence, the properties of soil has to improved so that to make the soil suitable for construction purpose. The soil properties can be enhanced with many techniques, chemical stabilisation is one of them. Chemical stabilisation of expansive soil comprises of changing the physico-synthetic around and within the clay particles where by the earth obliges less water to full fill the static imbalance and making it troublesome for water that moves into and out of the formwork so as to full fill particular designing road ventures and administration life of the asphalt. In the present study commercially available Zycobond is used as a chemical admixture.

Strength characteristics of expansive soils were improved with Cement, Flyash and treated Terrasil, it confirmed that When BC soil was treated with various combination of fly ash, terrasil solution, CBR value increased [1]. Effect Enzymes on the Unconfined Compression Strength of Soil and concluded that the soil treat with enzyme showed

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Vol. 6, Issue 1, January 2017

significant improvement in terms of unconfined compressive strength with longer curing period [2]. Performance Evaluation of VG 30 Paving mix with and without Zycosoil as Chemical Additive and confirmed that chemically modified DBM grading-1 mix with 0.06 % Zycosoil chemical is showing better results as compared to conventional mix hence it was suggested to use in Flexible pavement construction [3]. The Stabilization of Black Cotton Soil using Bio-Enzyme for a highway material and confirmed that the treated soaked CBR values were increased as the curing period increased because treated soil with enzyme renders improved density values by reducing the void ratios initially. For the bed soil the soaked CBR value was 1.19% but after 4weeks of curing the soaked CBR value was increased to 5.80% which shows an increase of 387% from the elementary value [4]. Subgrade Soil was stabilized with Chemical Additives and confirmed that comparing CBR value of untreated CL soil and same treated with Terrasil (0.041%) + zycobond (0.020%) +1%PPC indicated as such rise from 6.64% to 21.81%. This significancy of stabilisation optimizes the potential improvements on strength of pavement foundation therefore increasing the load carrying capacity of pavement. From economy point of view benefit associated the utilization of Terrasil (0.041%) + zycobond (0.020%) +1%PPC was attractive and supported the sustainable development in road construction [5]. Stabilization of Black Cotton Soil Treated with Flyash and Zycosoil and finally subjected that the effect of zycosoil on the improvement of CBR was good up to a value of 2% beyond this limiting value reduces the CBR value, this may be due to soil structure transforms from flocculent structure to dispersed structure [6].

## II. OBJECTIVE OF THE WORK

The main objective of the present work is to study the physical and geotechnical properties of Expansive soils available at KSRM College of Engineering, Kadapa and also to study the strength properties of soil by adding Zycobond with water and at different percentages i.e., 1%, 2%, 3%, 4% & 5%.

## III. MATERIALS AND METHODOLOGY

Following are the materials which are used in the present study:

### Expansive Soil:

In this study, the investigation is carried out on soil samples which are collected at balupalli village near KSRM College of Engineering which in black in colour with high moistures content. The following table shows the various soil properties obtained:

**Table 1: Test results of Soil properties**

S.NO.	EXPERIMENT	RESULT	PERMISSIBLE LIMITS	IS CODE
1	Specific Gravity	2.48	2.6 to 2.7	<b>IS-2720 Part-3, section 1-1980</b>
2	Free Swell Index	75.00%	>50%	<b>IS-2720, Part-40, 1977</b>
3	Liquid Limit	68.00%	40% to 100%	<b>IS-2720, Part-5,1985</b>
4	Plastic Limit	32.40%	20% to 65%	
5	Plasticity Index	35.60%	20% to 60%	

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Vol. 6, Issue 1, January 2017

6	Standard Proctor Compaction	OMC-32.00%	20 to 30%	<b>IS-2720, Part-7, 1980/1987</b>
		MDD- 1.24g/cc	1.2 to 1.8 g/cc	
7	California Bearing Ratio	Unsoaked-3.92	--	<b>IS-2720, Part-16,1979</b>
		Soaked-2.05	--	
8	Un Confined Compressive Strength	0.12 kg/cm <sup>2</sup>	--	<b>IS-2720, Part-10,1973</b>

### Zycobond:

Zycobond is a chemical stabiliser which is available commercially; it is a sub-micron acrylic co-polymer emulsion with long life for bonding of soil particles. It offers water resistance, strong bonding and imparts flexibility to the soil surface. It will also gives an excellent dust control and erosion resistance for unpaved roads and shoulders. The following table shows the properties of Zycobond:

**Table 2: Properties of Zycobond**

Colour	White
Solvent	Ethylene Glycol
Flash Point	80 <sup>0</sup> c
Solubility	Forms water clear solution and soluble in water

Samples were prepared by the combination of Expansive Soil and Zycobond. The percentage of Zycobond was taken as 1%, 2%, 3%, 4% & 5% with water.

The following table shows the test results of various combinations:

Combinations	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Standard Proctor Compaction		CBR		UCC	
				OMC (%)	MDD (g/cc)	Unsoaked	Soaked	Uncured	Cured for 7days
ES+ 1%Z	58.00	28.95	29.05	21.00	1.69	4.86	2.48	0.180	0.360
ES+ 2%Z	56.70	27.39	29.31	21.50	1.70	5.25	2.79	0.415	0.850
ES+ 3%Z	56.20	27.01	29.19	22.00	1.71	6.23	3.69	0.595	1.120
ES+ 4%Z	55.80	26.98	28.82	21.90	1.70	7.38	4.10	0.745	1.490
ES+ 5%Z	55.15	26.21	28.94	20.80	1.69	8.03	4.26	0.800	1.720

#### IV. RESULTS AND DISCUSSION

##### Analysis of Results

1. Liquid limit decreases with increase in various percentages of Zycobond this is due to cation exchange between the soil particles and Zycobond.
2. Plastic limit decreases with increase in various percentages of Zycobond.
3. Plasticity index decreases with increase in percentage of Zycobond.
4. California bearing ratio increases with increase in various percentages of Zycobond there is rapid increase in CBR value this is due to good compaction and si-o-si bond forms between soils.
5. Shear Strength increases with increase in various percentages of Zycobond.

Figure shows the graphs for the results obtained Fig:1. It was observed that by increasing various percentages of Zycobond the liquid limit values are decreases because of the cation exchange between the soil particles and Zycobond. Fig:2. It was observed that by increasing various percentages of Zycobond the plastic limit values are decreases. Fig:3. It is observed that by increasing various percentages of Zycobond the Plasticity Index values are decreases. Fig:4. It was observed that CBR values of the soil were increased on increasing the percentage of Zycobond. Maximum CBR value of 8.03 was obtained at 5% Zycobond. With increase in the time of soaking of the specimen the compressive strength and the shear strength of values were reduced because of increase of moisture content in the specimen. Fig:5. It was observed that Unconfined Compression Strength and Shear Strength values of the soil were increased on increasing the percentage of Zycobond. Maximum Compressive strength of 1.60kg/cm<sup>2</sup> and maximum shear strength of 0.80 kg/cm<sup>2</sup> was obtained at 5% Zycobond. With increase in the time of soaking of the specimen the compressive strength and the shear strength of values were reduced because of increase of moisture content in the specimen.

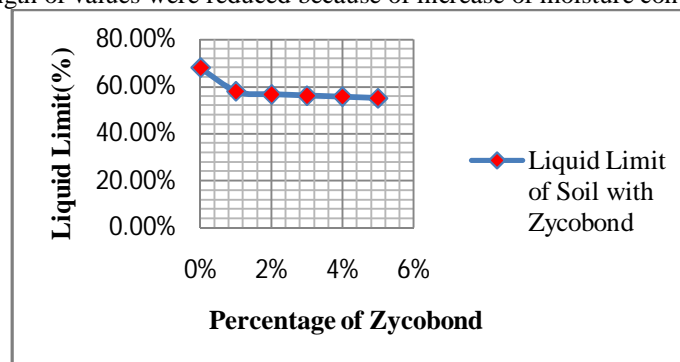


Fig:1 Variation of Liquid Limit of soil with varying percentages of Zycobond

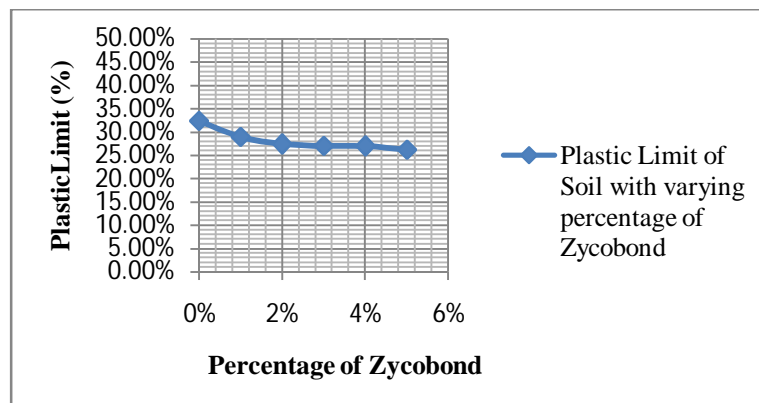


Fig:2 Variation of Plastic Limit of soil with varying percentages of Zycobond

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Vol. 6, Issue 1, January 2017

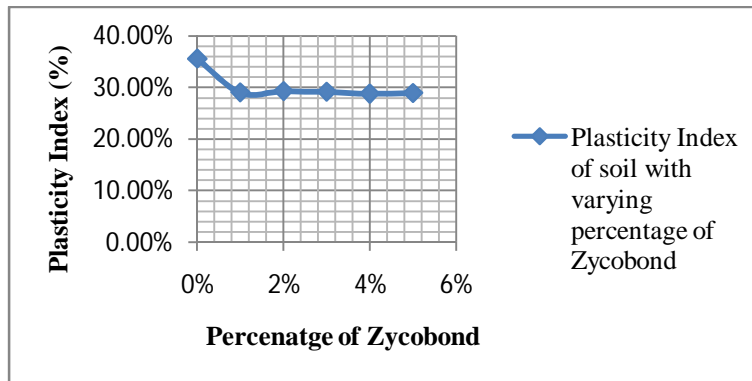


Fig:3 Variation of Plasticity Index of soil with varying percentages of Zycobond

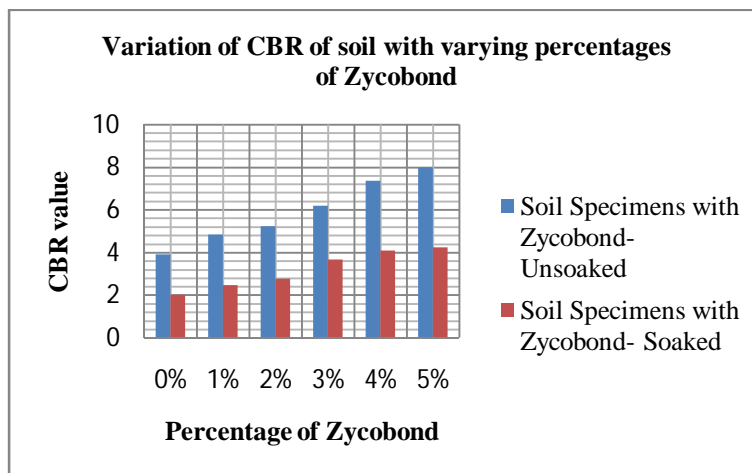


Fig:4 Percentage variation of CBR of Soil with Zycobond

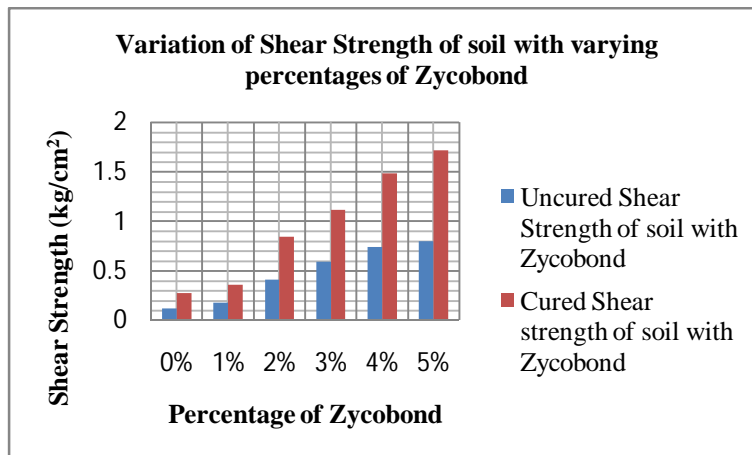


Fig:5 Percentage variation of Shear Strength of Soil with Zycobond

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## V. CONCLUSIONS

Zycobond is the commercially available chemical, used in the present study concludes that it is a potential stabilizer for expansive soils. The below conclusions are drawn from the experimental investigation using Zycobond in varying proportions to the targeted soil.

- With increasing the percentage of Zycobond, the Liquid Limit values are decreased from 68.00% to 55.15% and the percentage decrease is 18.90%.
- With increasing the percentage of Zycobond, the Plastic Limit values are decreased from 32.40% to 26.21% and the percentage decrease is 19.10%.
- With increasing the percentage of Zycobond, the Plasticity Index values are decreased from 35.60% to 28.94% and the percentage decrease is 18.71%.
- With increasing the percentage of Zycobond, the Unsoaked CBR values are increased from 3.92 to 8.03 and the percentage increase is 104.85%.
- With increasing the percentage of Zycobond, the Soaked CBR values are increased from 2.05 to 4.26 and the percentage increase is 107.80%.
- With increasing the percentage of Zycobond, the Uncured Shear Strength values are increased from 0.120 kg/cm<sup>2</sup> to 0.800 kg/cm<sup>2</sup> and the percentage increase is 566.67%.
- With increasing the percentage of Zycobond, the Cured Shear Strength values are increased from 0.28 kg/cm<sup>2</sup> to 1.72 kg/cm<sup>2</sup> and the percentage increase is 514.29%.

Finally Concluded that:

1. Use of Zycobond increased the Unconfined Compressive Strength and CBR values of soil.
2. It was found that with increasing in soaking period the results were reduced because of increase in moisture content in the specimens, but hold good.
3. Zycobond is an eco-friendly product, can be effectively used as a soil stabilizer.

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Contact Person: S.Jyothirmayee, [jyothi.sirigireddy16@gmail.com](mailto:jyothi.sirigireddy16@gmail.com), KADAPA.

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