



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 8, August 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.569

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

An Experimental Study to Improve the Soil Stability using Terrazyme and Phosphogypsum in Rigid Pavement

Kasagani Ramu¹, K.Jyotshna Priya², A.Mohith Chowdary³, M.Ganesh⁴, Ch.Chaitanya⁵, N.Balaji⁶,
T.Santhosh Kumar⁷, SK.Heena Kousar⁸

Assistant Professor, Department of Civil Engineering, Ramachandra College of Engineering, Vatluru,
Andhra Pradesh, India¹

B. Tech Student, Department of Civil Engineering, Ramachandra College of Engineering, Vatluru,
Andhra Pradesh, India^{2,3,4,5,6,7,8}

ABSTRACT: It is a well-known fact that a construction is as strong as its foundations are now a days the construction sites with good soils for foundations are fewer and fewer one of the most encountered issue on sites, especially in road construction is the presence of highly cohesive soils, soils that are easily affected by the change of the water content. Active clay soils present a problematic challenge for civil and geotechnical engineers all over the world. Key aspects that need identification when dealing with expansive soils include: soil properties, suction/water conditions, water content variations temporal and spatial (generated by trees and the seasonal change) and the geometry /stiffness of foundations and associated structures built on active shrink/swell soils. Stabilization procedures are available in order to reduce or completely eliminate the swelling potential of expansive clays. The problematic soil is removed and replaced by a good quality material or treated using mechanical and /or chemical stabilization different procedures can be used to improve the geotechnical characteristics of problematic soils by treating in-situ. One of the preferred solutions for soil stabilization is treatment with mineral binders. The solution has been proven to be effective of various types of cohesive soils. Phosphogypsum is a primary by product of the wet acid process for producing phosphoric acid from phosphate rock. It is largely calcium sulphate and has been given the name phosphogypsum. It contains impurities of free phosphoric acid, phosphates, fluorides and organic matter that adhere to the surface of gypsum crystals and also substituted in the crystal lattice of gypsum. It is used to improve the swelling properties of an expansive soil. Terrazyme is a liquid enzyme which is organic in nature and is formulated from the vegetable and fruit extract. It is brown in color with smell of molasses and can be easily used without the need of masks or gloves. It is easily mixed with water and for optimal results should be diluted with optimum moisture content of that soil. This decreases the swelling capacity of the soil particles

KEYWORDS: Phosphogypsum, Terrazyme, phosphoric acid & fluorides

I. INTRODUCTION

Soil stabilization refers to the process of changing soil properties to improve strength and durability. There are many techniques for soil stabilization, including compaction, plus dewatering and by adding material to the soil. As a result of soil stabilization, the bearing capacity of the foundation of the structure is increased and its strength, water tightness, resistance to washout, and other properties are improved. Soil stabilization is achieved by injecting cementing materials or chemical solutions into the ground and also by applying electric currents to the ground or heating or cooling it. The basic methods of soil stabilization are cementation, argillization, bituminization, solidification, resinification, methods using electrochemical or thermal action, and artificial freezing. The soil stabilization includes both physical stabilization [such as dynamic compaction] and chemical stabilization [such as mixing with cement, terrazyme, lime, and lime by-products, etc] (Materials & Tests Division, Geotechnical Section, Indiana, 2002). Chemical stabilization involves mixing chemical additives (binding agents) with natural soils to remove moisture and improve strength properties of the soil (sub-grade). Generally, the role of the stabilizing (binding) agent in the treatment process is either reinforcing of the bounds between the particles or filling of the pore spaces. Expansive soils swell when they are exposed to water and shrink when they dry, therefore soil moisture content is primary factor that affects the change of

its volume. Expansive soils generally exist in semiarid regions which are located in the tropical and temperature climate zones. In all five continents for this reason, expansive soils are a worldwide problem. Swelling and shrinkage phenomena occur in expansive clay when moisture rises and declines, respectively. Due to swelling and shrinkage, severe destructions in light weight structures in pavements and buried structures in expansive clay soils have been reported. In recent years, many researchers have focused on the phenomena and improving constitute and computational models applied to the engineering behaviour of expansive. The soil stabilization includes both physical stabilization [such as dynamic compaction] and chemical stabilization [such as mixing with cement, terrazyme, lime, and lime by-Products, etc] (Materials & Tests Division, Geotechnical Section, Indiana, 2002). Chemical stabilization involves mixing chemical additives (binding agents) with natural soils to remove moisture and improve strength properties of the soil (sub-grade). Generally, the role of the stabilizing (binding) agent in the treatment process is either reinforcing of the bounds between the particles or filling of the pore spaces. Expansive soils swell when they are exposed to water and shrink when they dry. therefore soil moisture content is primary factor that affects the change of its volume. Expansive soils generally exist in semiarid regions which are located in the tropical and temperature climate zones. In all five continents for this reason, expansive soils are a worldwide problem. Swelling and shrinkage phenomena occur in expansive clay when moisture rises and declines, respectively.

II. RELATED WORK

In this related work we are an experiment investigation was under taken to study the particle size analysis. Specific gravity, liquid limit, compaction for soil and the tests such as unconfined compression test, California bearing ratio test were conducted for soil stabilized with different percentages. [1] soil, the soil was used which can be excavated from the Kalparu, highway construction site and After collection of soil sample we have done the grain size analysis so from results it is black cotton soil. [2] Phosphogypsum, It is an industrial waste generated during the production of phosphoric acid. and it is collected from agriculture committee market yard, Kakinada, The solidification of phosphogypsum in to granules was aimed at improving geotechnical properties and reducing the leaching of heavy metals. This by-product is contaminated by various impurities, both chemical and radioactive, and is usually stockpiled within special areas. Atterberg's limits, standard proctor compaction and unconfined compressive strength tests were carried out for stabilizing the soil sample. By adding phosphogypsum in different proportions to the soil sample swelling content can be reduced to some range. [3] Terrazyme, it is a non-toxic, non-flammable and non-corrosive material which is formulated from vegetable extracts, it is a brown in coloured slimy substance which has odour of molasses which makes it easy to work with its non-toxic nature makes it accessible and workable. This quality of terrazyme will make it versatile. the treated soil becomes water resistant and it can also resist deformation. it can be added to soil at a proportion of 0.2%-0.3% as per required quantities. In clay water mixture positively charged ions (cat-ions) are present around the clay particles, creating a film of water around the clay particle that remains attached or adsorbed on the clay surface. The adsorbed water or double layer gives clay particles their plasticity. Terrazyme replaces adsorbed water with organic cations, thus neutralizing the negative charge on a clay particle. The organic cations also reduce the thickness of the electrical double layer. This allows Terrazyme treated soils to be compacted more tightly together. Terrazyme resists being replaced by water, thus reducing the tendency of some clay to swell. Terrazyme promotes the development of cementitious compounds using the following, general reaction.

III. METHODOLOGY

In this methodology by essential of stabilization study of this Soil stabilization is artificial changing soil properties for construction purposes (by physical or chemical methods) at the natural site- As a result of soil stabilization, the bearing capacity of the foundation of the structure is increased and its strength, water tightness, resistance to washout, and other properties are improved. Soil stabilization is achieved by injecting cementing materials or chemical solutions into the ground and also by applying electric currents to the ground or heating or cooling it. The mainly the basic methods of stabilization are [1] Cement stabilization [2] Bituminous stabilization [3] Lime stabilization [4] Mechanical stabilization [5] Electrical stabilization [6] Thermal stabilization, [7] Chemical stabilization these are the mainly the methods of stabilization. then that those methods are [1] Cement stabilization, The principal materials used for the cementitious stabilization and modification of highway pavement materials are $CaCl_2$, Terrazyme and port-land cement. soils can be stabilized with port-land cement, provided sufficient quantity is added. some soils with a high organic content do not react well with cement and hardening may be delayed. As clay content increases, soils become more difficult to pulverize and work, and larger quantities of cement must be added to harden them. [2] Bituminous Stabilization, the Bituminous soil stabilization refers to a process by which a controlled amount of bituminous material is thoroughly mixed with an existing soil or aggregate material to form a stable base or wearing surface. [3] Lime Stabilization, the



Lime reacts with medium, moderately fine and fine grained soils to produce decreased plasticity, increased workability, reduced swelling, and increased strength stabilization of soils. Hydrated lime is applicable to far heavier clayey soils and is less suitable for granular materials and second it is used more widely as a construction expedient that is to prepare a soil for further treatment or to render a sufficient improvement to support construction traffic. In roads lime stabilization is widely used. [4] Mechanical Stabilization, This is the process of altering soil properties by changing the gradation through mixing with other soils, densifying the soils using compaction efforts, or undercutting the existing soils and replacing them with granular material. In applying these techniques, it is necessary to ensure the properties of stabilized Geo materials and their mixtures as applicable for use in the design of foundations. [5] Thermal Stabilization, the Thermal stabilization is used to strengthen sagging loess soils. In this method the soil to be stabilized is sintered by gaseous products of fuel combustion, having a temperature of T_{aa}, to 1000°C. Combustion is most effective if conducted within the stratum of the soil to be stabilized. Stabilization of unstable water-bearing soils can be achieved by artificially freezing the soil. It generally is costly and is restricted to conditions for which other methods are not suitable. [6] Chemical Stabilization, The transformation of soil index properties such as cement, Terrazyme, lime, or a combination the physical and chemical properties of the by adding chemicals of these, often alters soil including the cementation of the soil particles. It also includes deep mixing and grouting. Chemical stabilization can aid in dust control on roads and highways, particularly unpaved roads, in water erosion control, and in fixation and leaching control of waste and recycled materials.

So in this methodology we are adopt this following procedure that are [1] procurement of the materials, then [2] preparation of representative sample. [3] then tests on black cotton soil. [4] sieve analysis in this the sieving materials are gravel, sand, silt and clay. [5] the specific gravity test was conducted then. [6] Atterberg limits was is also conducted in that plastic limit, shrinkage limit and liquid limit was tested. [7] compaction tests are conducted in that MDD and OMC is conducted. [8] un confined compaction test. [8] California bearing ratio CBR test was conducted, [9] analysis then [10] we can conclude that procedure with the results and conclusion. so that this methodology was adopted for our in this project.

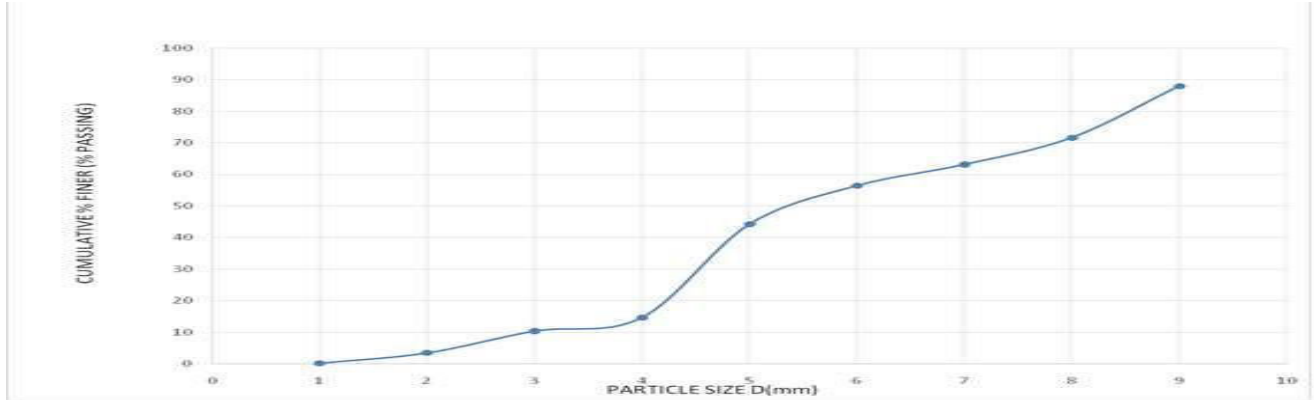
IV. EXPERIMENTAL RESULTS

Then in this experiment results the results of various tests are occurred those are shown below Grain size analysis, and the Table 1 Grain size analysis of soil sample and terrazyme

S.No	IS Sieve Size	Particle size D(mm)	Weight retained(g)	%weight retained	Cumulative %Weight retained	Cumulative %finer(% passing)
1	4.75mm	4.75	144	12	12	88
2	2.00mm	2.00	198	16.5	28.5	71.5
3	1.00mm	1.00	100	8.33	36.83	63.17
4	600	0.600	76	6.33	43.16	56.84
5	425	0.425	142	11.8	54.96	45.04
6	212	0.212	404	33.66	88.62	11.38
7	150	0.150	34	2.83	91.45	8.55
8	75	0.075	60	5	96.45	3.55
9	Pan	<0.075	14	1.16	97.61	2.39

Table 1

Graph for grain size analysis of soil sample and Terrazyme



Graph 1

The values of specific gravity of soil sample with terrazyme

S. No	Particulars	Test No 1 (G1)
1	Weight of Pycnometer bottle , g(W1)	405
2	Weight of Pycnometer + dry ,soil (W2)	924
3	Weight of Pycnometer + soil + water, (W3), g	1592
4	Weight of Pycnomerter + water (W4), g	1243
5	Calculation of specific gravity, G	1.3

Table 2

Atterberg’s limit ,(a) Liquid limit

The values of liquid limit of soil sample and Terrazyme

S. No	Trial No	Values
1	No of blows (N)	44
2	Weight of Container (W1)	16
3	Weight of Container + Wet soil (W2)	33
4	Weight of Container + dry soil (W3)	31
5	Water content $w = \frac{W2 - W3}{W3 - W1} \times 100$	13.8%

Table 3

(b) Plastic limit: The values of plastic limit of soil sample and terrazyme

S. No	Trail No	Values
1	Weight of Container (W1), g	30
2	Weight of Container +Wet soil (W2), g	64
3	Weight of Container +dry soil (W3), g	56
4	Water content $w = \frac{W2 - W3}{W3 - W1}, g$	30.7%

Table 4

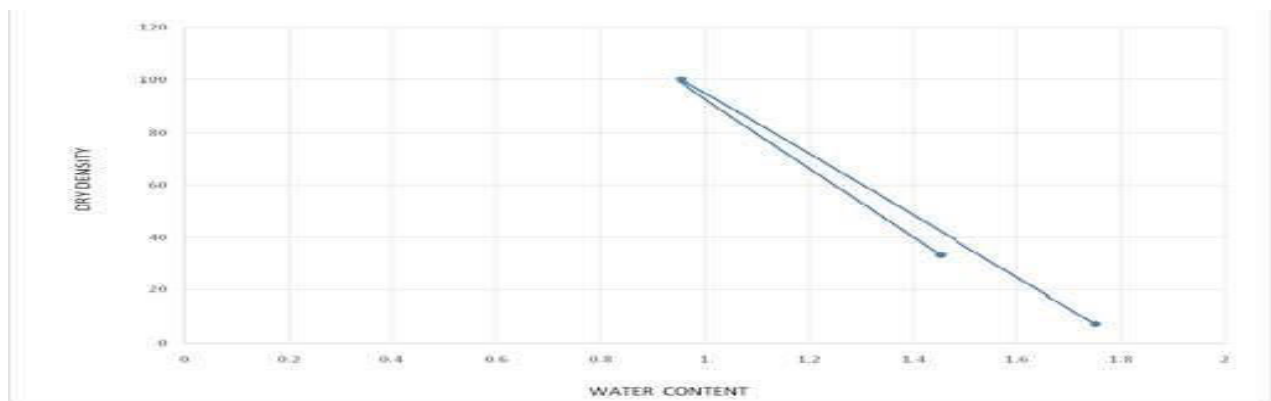


Compaction :The values after adding terrazyme

Amount of water added	4%	8%	12%
Weight of mould(W1)	2306	2306	2306
Compacted weight + mould (W2)	5013	5027	5045
Weight of wet soil(W2+W1)	7319	7233	7351
Volume of mould(V),cm3	1000	1000	1000
Bulk density=(W2- W1)/V, g/cc	2.707	2.721	2.739
Weight of container with lid(M1)	18	18	18
Weight of lid + wet soil(M2)	36	43	49
Weight of lid + dry soil(M3)	33	39	45
Water content (w)=(M2-M3)/(M3- M1)	20	19.2	14.8
Dry density, g/cc= $e/(1+w)$	1.87	1.98	2.12

Table 5

The graph for compaction of soil and terrazyme



Graph 2

The results we observed are: Optimum moisture content (OMC) =10.2 and Maximum dry density (MDD) = 1.99 .



Swelling index

The shows swelling values of soil sample

S.No	Material	Weight of sample in kerosene	Weight of sample in water	Weight of sample in kerosene after 24 hours	Weight of sample in water after 24 hours	%of swelling
1	Soil	200	226	194	206	6.18%
2	soil & phosphogypsum	206	224	200	216	8%
3	soil & terrazyme	124	120	108	106	5.8%

Table 6

presents the CBR value of black cotton soil treated with 20% phosphogypsum and 20% terrazyme

The CBR values of soil with different percentages of Phosphogypsum And terrazyme

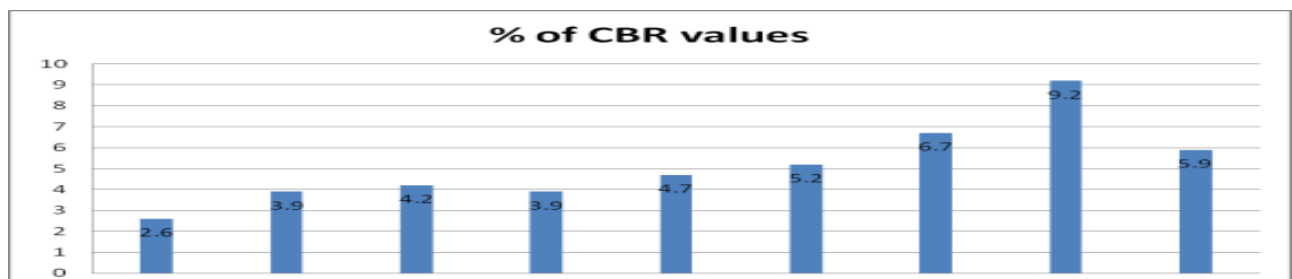
Penetration (mm)	CBR(%)	Penetration (mm)	CBR (%)	Penetration (mm)
2.5	2	3	3.5	2.98
5	3	4	5	4.24
7.5	-	8	9	5.02

Table 7

The presents the CBR values black cotton soil treated with various percentages

S.NO	% mixtures	CBR(%)
1	B.c	2.60
2	B.c+10%PG	3.90
3	B.c+20%PG	4.2
4	B.c+30%PG	3.90
5	B.c+20%PG+5%TE	4.70
6	B.c+20%PG+10%TE	5.20
7	B.c+20%PG+15%TE	6.70
8	B.c+20%PG+20%TE	9.20
9	B.c+20%PG+25%TE	5.90

Table 8



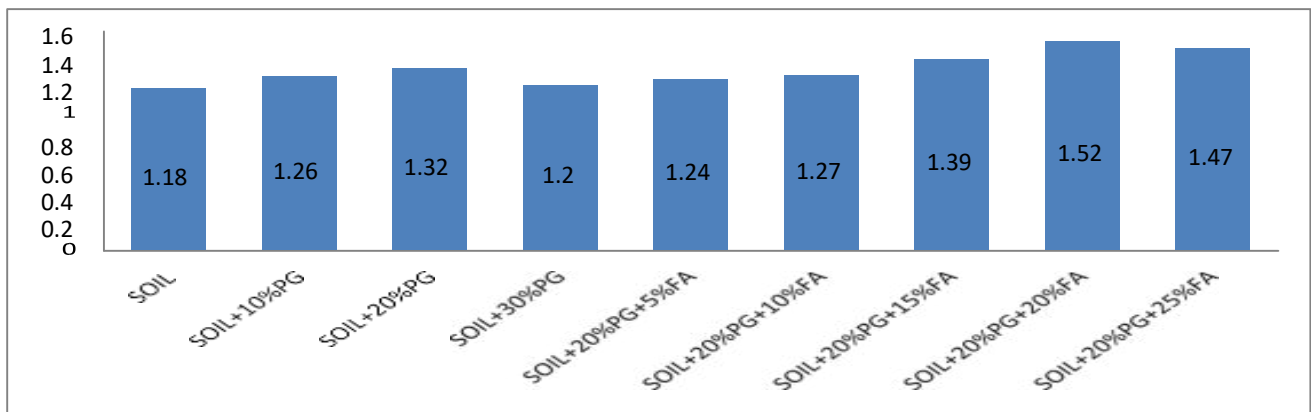
Graph 3

Then it presents the UCS values black cotton soil treated with various percentages of Phosphogypsum and terrazyme



S.NO	MIXTURE	UCS (KG/CM ²)
1	SOIL	1.18
2	SOIL+10%PG	1.26
3	SOIL+20%PG	1.32
4	SOIL+30%PG	1.2
5	SOIL+20%PG+5%FA	1.24
6	SOIL+20%PG+10%FA	1.27
7	SOIL+20%PG+15%FA	1.39
8	SOIL+20%PG+20%FA	1.52
9	SOIL+20%QD+25%FA	1.47

Table 9



Graph 4

UCS values of soil with various combinations of Phosphogypsum and terrazyme ,then finally all the tests are conducted then required values are mansion in the shown below table

Test	soil	soil+phosphogypsum	Soil+terrazyme	Soil+phosphogypsum+ Terrazyme
Specific gravity	3.52	<u>1.6</u>	1.388	1.29
Liquid limit	50%	25%	<u>100%</u>	60%
Plastic limit	21.62%	16.6%	20%	<u>35.29%</u>
OMC	12.5%	<u>11.11%</u>	7.5%	6.7%
Max drydensity	1.88	<u>2.14</u>	1.75	1.90
Swell index	6.18%	6.85%	7.2%	<u>8%</u>
C.B.R	2.6	4.2	6.70	<u>9.20</u>
U.C.S	1.18	1.32	1.39	<u>1.52</u>

Table 10

V. CONCLUSION

Then Based on the experiment conducted to determine the reduction soil swelling by partial replacement with phosphogypsum and terrazyme in equal proportions .The following can be deduced .It was observed that the liquid limit of soil is 50% by treating with 20% phosphogypsum liquid limit decreased to 25% .It was observed that the liquid limit of soil is 50% by treating with 20% terrazyme liquid limit decreased to 20% .It was observed that the liquid limit of soil is 50% by treating with 20% phosphogypsum and 20% terrazyme liquid limit remains same .It was noticed that the plastic limit of the soil is 21.62% by treated with 20% phosphogypsum it reduced to 16.6% .It was noticed that the plastic limit of the soil is 21.62% by treated with 20% phosphogypsum and 20% terrazyme it was increased to 35.29% .It was observed that the optimum moisture content of the soil is 12.5%by addition of 20% phosphogypsum it was reduced to 11.11% .It was noticed by adding 20% phosphogypsum and 20% terrazyme it was reduced to 6.7% .It was observed that the maximum dry density of soil is 1.88g/cc by adding 20% phosphogypsum and 20% terrazyme it was increased to 1.90g/cc .It was observed that swelling index of soil sample is 6.18% after adding 20% phosphogypsum and 20% terrazyme it was increased to 8% .It was observed that the CBR value of soil sample is 2.60% by addition of 20% Phosphogypsum is increased to 4.2%.From the experimentation it is observed that Adding 20% of terrazyme to the above combination it was further increased to 9.2% .It was noticed that initially the UCS value of soil is 1.18 kg/cm² by treating with 20% Phosphogypsum it was increased to 1.32 kg/cm². By further treating with 20% .Terrazyme the UCS value further increased to 1.52 kg/cm² .

REFERENCES

- [1] Mishra and Mathur (2004) had stabilized expansive soil using phosphogypsum and observed the optimum percentage as 40%.
- [2] Degirmenci et al. (2007) had investigated the effect of phosphogypsum on liquid limit (wL), plastic limit (wP), IP, OMC, MDD and UCS of expansive soil. By stabilization with phosphogypsum, the IP reduced, MDD increased, OMC decreased, and UCS increased.
- [3] Yilmaz and Civelekoglu (2009) had studied the effect of gypsum on Atterberg's limit, UCS, Sp, and cation exchange capacity of bentonite and concluded that up to 5% addition of gypsum the properties of expansive clay improved significantly.
- [4] V Saini, P Vaishnava -Journal of Advances in Engineering.
- [5] S Athira, BK Safana, K Sabu - International Journal of Engineering.
- [6] V Rajoria, S Kaur - International Journal of Research in Engineering.
- [7] Kumar S. Prasanna. M. (2012). Silica and calcium effects on geotechnical properties of expansive soil extracted from rice husk ash IPCBEE. vol.32.
- [8] STM, Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils, Annual Book of ASTM Standards, D4318, 2010.
- [9] Değirmenci N., Okucu A., Turabi A., Application of Phosphogypsum in Soil Stabilization, Building and Environment, 2006.
- [10] Mitchell, J. K., & Raad, L., Control of Volume Changes in Expansive Earth Materials, Proceeding of Workshop on Expansive Clays and Shales in Highway Design and Construction, Vol. 2, Federal Highway Administration, Washington, D. C., 1973.



**Impact Factor:
7.569**



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details