EXPERIMENTAL STUDY ON PROPERTIES OF SOIL CEMENT MIX TREATED WITH POLYMER

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Abstract - *Civil Engineering construction works on soil demands great deal of attention. It is more important to concentrate on strength of soil layers underlying the surface course, because the strength, thickness and design life of pavement are mainly depends upon the sub grade strength.*

Sub grade using geo grid, geo textiles and geo membrane are most widely used in soil reinforcement. In the present study experimental study on properties of soil cement mix treated with polymer were done.

To study the properties of soil many test were carried on soil cement mix by replacing with Renolith polymer at various mixing proportion i.e., 0%, 2.5%, 5.0%, 7.5% and 10.00%.

***Key Words*: Black Cotton Soil (BCS), Unconfined Compressive Strength (UCS), California Bearing Ratio(CBR)**

1. INTRODUCTION

Soil is depicted as dregs or other get-together of mineral-particles made by the physica1 or compound isolating of rocks despite the air, water, ordinary issue and different substances that might be joined. Soil is reliably a non homogeneous, permeable, earthen material whose building conduct is affected by changes on sponginess substance and thickness. Thinking about the initiation, soil can be totally named normal and inorganic. Standard soils are blends which are gotten from progress and rot of vegetation and in addition accumulating of skeleton or shell of minimal creature. Inorganic soils are gotten from the mechanical or compound enduring of rocks. Inorganic soil that is up to this point orchestrated at where it was surrounded is gotten away to remaining soil. In the event that the earth has been moved to another locale by gravity, water or wind, it is recommended as moved soil.

By and large, soils in characteristic state don't have satisfactory geotechnical properties to be utilized as street administration layers, establishment layers and as a development material. So as to change their geotechnical boundaries to meet the prerequisites of specialized particulars of development industry, considering soil adjustment is progressively underscored.

Soil adjustment is a technique used to improve soil quality, bearing limit and sturdiness under unfriendly dampness and stress conditions. It alludes especially to the blending of the parent soil with other soil, concrete, lime, bituminous items, silicates and different synthetics and characteristic or manufactured, natural and inorganic materials.

2. LITERATURE REVIEW

Milorad Jovanovski et al [2007] coordinated assessments on Treatment of Soils with the Rbi-81 and Renolith Additives. This paper presents the results from field and examination focus testing on low bearing normal earth and coarse grained material for black-top layers, offset with included substances type RBI-81 and Renolith. The effect of progress of mechanical properties, for instance, California Bearing Ratio, Uniaxial Compressive Strength, etc is explored for a couple of soil types. The improvement of named soil properties is 2-4 times. Adequate recommendations about possible using of included substances RBI and Renolith are analyzed for examples of progress of low bearing soil, similarly with respect to coarse grained material which can be used in black-top layers. The positive pieces of the treatment with so much included substances, similarly as requirements are noted.

Venkatasubramanian et al [2011] led tests on three soils with shifted properties and various measurements of Bio-Enzyme. Three soils had fluid restrictions of 28, 30 and 46% and pliancy list of 6, 5 and 6%. Increment in unconfined compressive quality and CBR following a month of relieving was accounted for as 152 to 200% and 157 to 673% separately.

Manjunath K.V. et al [2012] concentrated on adjustment of red soil utilizing ground granulated impact heater slag. In this examination, trial examinations were done to know the impact of the ground granulated impact heater slag on the Red soil alongside little rates of lime. The capacity of lime is to go about as initiator of pozzolanic activity in slag. The utilization of slag in soil adjustment could give us an agreeable answer for slag removal in enterprises. It is likewise useful in diminishing the carbon impression by not utilizing concrete.

Lekha B M et al [2013] contemplated the conduct of Black Cotton (BC) soil with and without adjustment. A concoction called Terrasil was utilized as stabilizer and it was utilized for various measurements and relieved for 7-28 days. Preliminaries were directed by rewarding the dirt at 0.8%, 1.2% and 1.6% by the weight of dry soil and varieties in building properties were considered. It seen that UCS quality increments with increment in dose of stabilizer and restoring period. then It was seen that, 1.2% Terrasil shows great augmentation, yet further increment of measurements brings about a negligible improvement of solidarity. Consequently the dose 2 was considered as the ideal substance measurement. The examination reasoned that CBR esteems increment with the expansion in level of stabilizer.

Vijay Rajoria et al [2014] explored the adjustment of soil utilizing bio-compound. The adjustment of soil with bio-chemical is a progressive procedure which getting mainstream around the world. As of late there are numerous bio-catalysts accessible for soil adjustment, for example, Renolith, PermaZyme, TerraZyme, Fujibeton and so on. These compounds have been demonstrated to be exceptionally viable and efficient.

3. MATERIALS USED, STEPS AND METHODOLOGY

3.1 Materials

3.1.1 Red Soil

Red soils are shaped because of the depleting down of old crystalline stone, less clayey and sandier in nature. This is having a rich substance of iron in addition to little humus content. The substance of fundamental supplements like nitrogen, phosphorus and lime is less in red soils. Somewhat acidic, it is unequipped for hold dampness. It is because of the nearness of iron oxide stores, that red soils get the one of a kind red color and are relatively barren in view of lime lack and solvent salt substance.

Red soil is brought from Dhummunsur village, near Humnabad, Bidar District, Karnataka, India.

3.1.2 Black Cotton Soil

The Indian name given to broad soil is dark cotton soil. Sweeping soils are those whose volume change happens while it interacts with water. It grows during blustery season because of admission of water and psychologists during summer season. Broad soils owe their attributes to the nearness of growing earth minerals.

Black cotton soils are profoundly clayey soils, grayish to blackish in shading found in a few states in India. Dark cotton soils have been formed by basalt or trap and contain the mud mineral 'Montmorillonite', which is answerable for the unnecessary expanding and shrinkage qualities of soil.

Soil utilized in this investigation is acquired from a building site in Bhalki, Bidar District Karnataka, India.

3.1.3 Cement

Concrete is a cover, a substance used being developed that sets, sets and sticks to different materials, limiting them together. Concrete is once in a while used solely, anyway is used to tie sand and rock (all out) together. OPC-43 Evaluation concrete is used in the current assessment. The specific gravity of cement used is viewed as 3.10

3.1.4 Renolith

Renolith is a polymer based compound arrangement and it is shaped by detailed nano emulsion dependent on styrene acrylic. It is accessible in fluid structure. Renolith when completely blended and balanced out with a dirt or street asphalt materials, concrete and water creates an exo-thermic response and structures a polymer which is compacted gives an exceptionally thick layer. Renolith was seen as non poisonous to the client just as to the earth.

Renolith is likewise called hydrophobic exacerbate that is water repellent. It is effectively course through the voids and limits the water holding limit of BC Soil. It is solvent in water, non-toxic, non-destructive, and earth safe and easy to understand.

Renolith's standard use is as a blend with water in explicit extents which is then applied to and blended in with concrete based totals or in-situ soils from fine sands to high pliancy dirt. One of the primary points of interest of fluid compound adjustment is that lone a little volume of balancing out specialist is commonly required and the expense of settling is lower than that of different strategies for adjustment.

Table -1: Physical Properties of Renolith

Properties	Description
Physical form	Liquid
Chemical composition	Formulated nano emulsion based on styrene acrylic
Solids in %	7 ± 1
P^H	7 - 9
Viscosity in cP	< 1000
Specific Gravity	1.05 - 1.1

3.2 Steps

i. Procurement of materials.

ii. Preparation of Representative sample.

iii. Tests on Red Soil and Black Cotton Soil.

iv. Sieve Analysis.

v. Specific Gravity Test.

vi. Atterberg's Limit (Liquid, Plastic, Shrinkage Limit).

vii. Compaction Test.

viii. UCS Test.

ix. Results and Conclusions.

3.3 Methodology

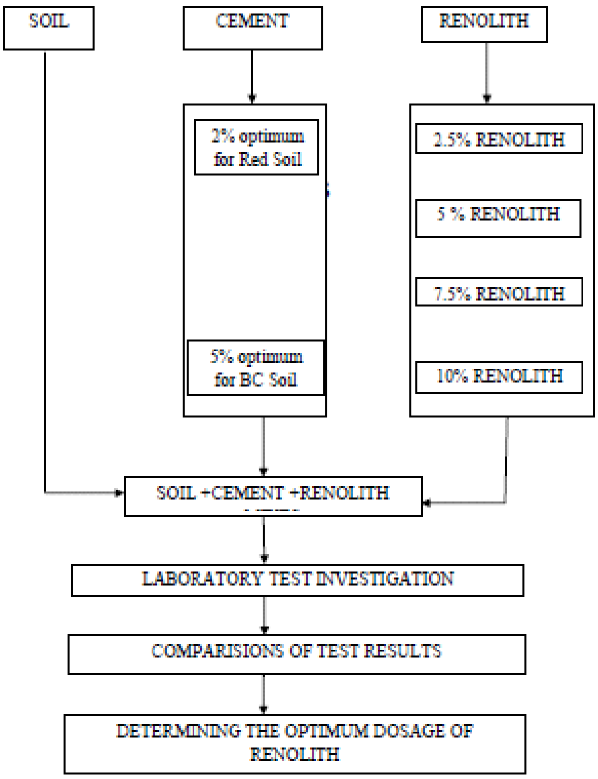

Fig -1: Schematic Representation of Methodology Adopted

4. RESULTS AND DISCUSSIONS

4.1 Optimum Renolith Content for Red Soil

Table -2: UCS of Red Soil with 2% cement, various dosages of Renolith

Renolith in %	UCS in kPa		
	7 days	14 days	28 days
0	375.50	375.50	375.50
2.5	1629.59	1694.57	1809.54
5.0	1339.66	1459.63	1559.61
7.5	1289.68	1379.63	1523.65
10.0	1299.67	1356.64	1479.63

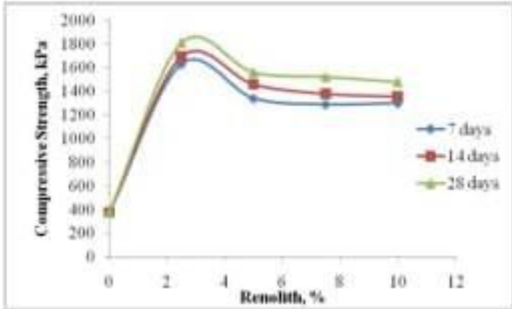

Chart -1: UCS value varying dosage of Renolith and curing period

4.2 Optimum Renolith Content for Black Cotton Soil

Table -3: UCS of Black Cotton Soil with 5% cement, Various dosages of Renolith

Renolith in %	UCS in kPa		
	7 days	14 days	28 days
0	243.44	243.44	243.44
2.5	789.80	799.80	941.36
5.0	1149.71	1189.70	1259.68
7.5	807.64	812.57	914.04
10.0	975.28	792.58	846.38

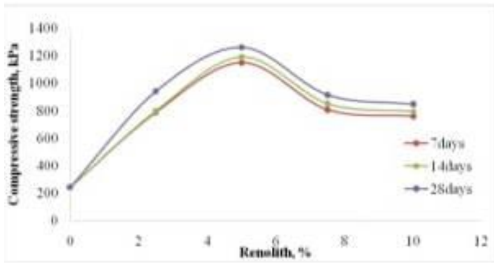

Chart -2: UCS value varying dosage of Renolith and curing period

4.3 Stress-Strain Relationship for Red Soil

Table -4: Stress-Strain values for soil-cement treated with Renolith after 7 days of curing

Strain	UCS values after 7 days of curing in kPa				
	Renolith in %				
	0	2.5	5.0	7.5	10.0
0	0	0	0	0	0
0.0066	52.417	92.255	73.384	104.835	83.868
0.0132	91.644	229.109	229.109	270.765	249.937
0.0197	171.721	382.751	444.819	444.819	424.129
0.0263	260.990	524.035	657.612	626.787	565.135
0.0329	355.161	706.239	867.490	826.667	704.198
0.0395	381.126	871.725	952.816	1013.634	790.634
0.0461	382.543	1348.966	1187.895	1248.297	1228.163
0.0526	--	1679.577	1359.658	1299.673	1319.668

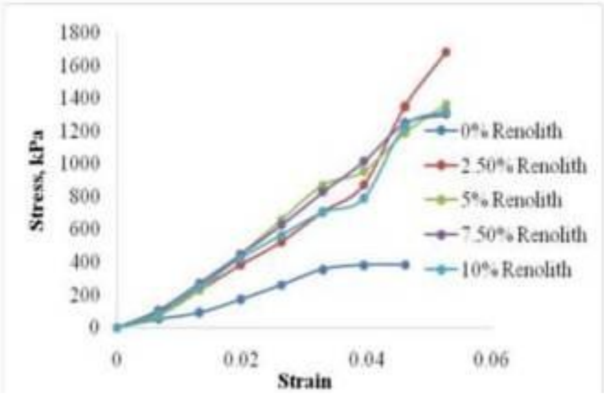

Chart -3: Stress-Strain relationship for soil-cement treated with Renolith after 7 days of curing

Table -5: Stress-Strain values for soil-cement treated with Renolith after 14 days of curing

Strain	**UCS values after 14 days of curing in kPa**				
	Renolith in %				
	0	**2.5**	**5.0**	**7.5**	**10.0**
0	0	0	0	0	0
0.007	52.417	98.545	100.641	90.158	20.967
0.013	91.644	229.109	218.695	197.867	77.064
0.020	171.721	403.440	341.372	351.717	196.548
0.026	260.990	585.686	554.860	626.787	369.907
0.033	355.161	765.432	857.284	969.548	571.523
0.039	381.126	1064.315	1185.951	1094.724	780.498
0.046	382.543	1459.702	1389.234	1429.501	1228.163
0.053	--	1709.570	1579.602	1599.597	1519.617

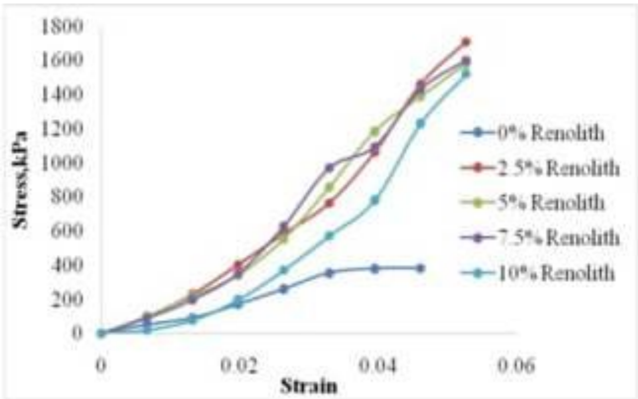

Chart -4: Stress-Strain relationship for soil-cement treated with Renolith after 14 days of curing

Table -6: Stress-Strain values for soil-cement treated with Renolith after 28days of curing

Strain	**UCS values after 28 days of curing in kPa**				
	Renolith in %				
	0	**2.5**	**5.0**	**7.5**	**10.0**
0	0	0	0	0	0
0.007	52.417	83.868	41.934	75.481	64.998
0.013	91.644	208.281	79.147	177.039	166.625
0.020	171.721	506.886	128.273	268.960	258.615
0.026	260.990	801.465	256.880	452.108	369.907
0.033	355.161	1081.811	469.465	673.580	520.494
0.039	381.126	1337.996	790.634	891.998	760.225
0.046	382.543	1530.170	1127.494	1328.832	1147.628
0.053	--	1839.537	1479.627	1499.622	1439.638

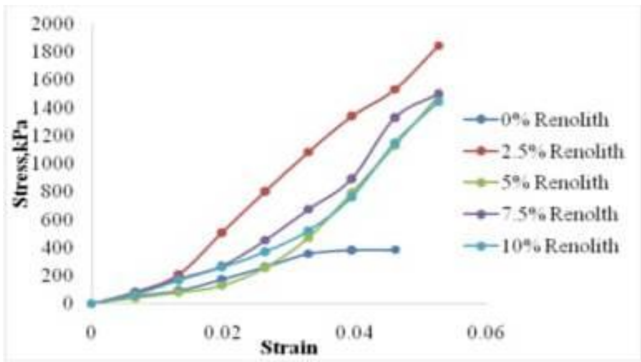

Chart -5: Stress-Strain relationship for soil-cement treated with Renolith after 28 days of curing

4.4 Stress-Strain Relationship for Black Cotton Soil

Table -7: Stress-Strain values for soil-cement treated with Renolith after 7 days of curing

Strain	**UCS values after 7 days of curing in kPa**				
	Renolith in %				
	0	**2.5**	**5.0**	**7.5**	**10.0**
0	0	0	0	0	0
0.007	115.318	31.450	71.288	33.547	50.321
0.013	149.962	58.319	189.536	89.561	122.886
0.020	200.686	111.722	403.440	229.651	231.719
0.026	226.054	213.724	583.631	439.778	411.008
0.033	236.774	428.642	663.375	520.494	673.580
0.039	239.218	699.407	932.543	618.317	729.816
0.046	245.633	724.818	1026.825	825.487	805.353
0.053	--	799.799	1159.708	--	--

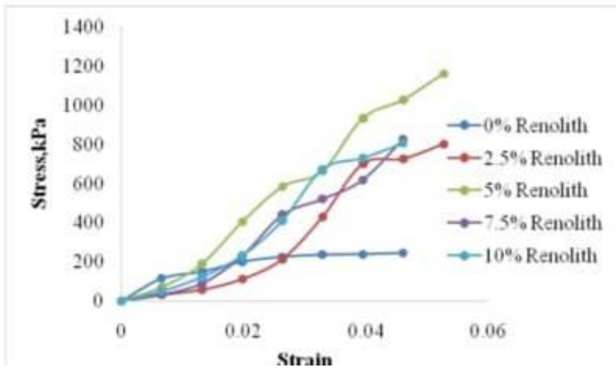

Chart -6: Stress-Strain relationship for soil-cement treated with Renolith after 7 days of curing

Table -8: Stress-Strain values for soil-cement treated with Renolith after 14 days of curing

Strain	**UCS values after 14 days of curing in kPa**				
	Renolith in %				
	0	**2.5**	**5.0**	**7.5**	**10.0**
0	0	0	0	0	0

0.007	115.318	33.547	35.644	64.998	60.804
0.013	149.962	85.395	112.472	170.790	145.797
0.020	200.686	165.514	289.649	403.440	268.960
0.026	226.054	230.164	554.860	441.833	493.209
0.033	236.774	359.243	796.050	653.169	612.346
0.039	239.218	527.090	952.816	729.816	729.816
0.046	245.633	795.286	1026.825	785.219	805.353
0.053	--	819.794	1199.698	819.794	--

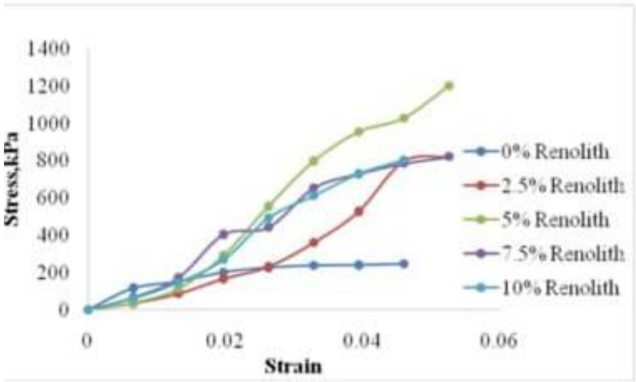

Chart -7: Stress-Strain relationship for soil-cement treated with Renolith after 14 days of curing

Table -9: Stress-Strain values for soil-cement treated with Renolith after 28days of curing

Strain	UCS values after 28 days of curing in kPa				
	Renolith in %				
	0	2.5	5.0	7.5	10.0
0	0	0	0	0	0
0.007	115.318	39.837	35.644	27.257	39.837
0.013	149.962	106.223	106.223	106.223	97.892
0.020	200.686	161.376	258.615	206.892	175.859
0.026	226.054	349.356	524.035	400.732	359.632
0.033	236.774	714.403	612.346	642.963	683.786
0.039	239.218	962.952	831.180	891.998	861.589
0.046	245.633	--	1087.226	956.356	--
0.053	--	--	1279.678	--	--

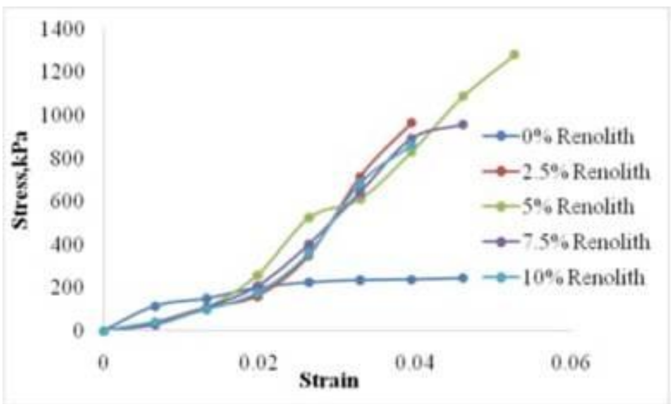

Chart -8: Stress-Strain relationship for soil-cement treated with Renolith after 28 days of curing

5. CONCLUSIONS

- The results showed an array of interesting improvements at each level of UCS test conducted on the soils.
- According to the results we found that optimum amount of cement Required for red soil and black cotton soil is 2% and 5% of the weight of soil respectively.
- Renolith significantly improved the strength of the cement-stabilized soil. The best stabilization results for Renolith are at 2.5% and 5% of the weight of cement for red soil and black cotton soil respectively.
- There is gradual increase in the UCS values for both the soils. Hence the load resisting capacity of soil increases so, we can reduces the pavement thickness.
- On further adding of Renolith to the soil-cement mix enhances the tensile strength, flexibility and resistance to moisture permeation in stabilized pavement.
- By the use of Red soil-cement treated with Renolith, the crust thickness of the pavement decreases by 41%, when compared to the crust thickness of pavement constructed with soil alone. Where as in Black cotton Soil-cement treated with Renolith, the crust thickness of the pavement decreases by 15%, when compared to the crust thickness of pavement constructed with soil alone.
- The reduction in initial cost of construction of pavement constructed with Red soil-cement treated with Renolith is decreases by 25% when compared to the pavement constructed using soil alone. Where as in Black cotton-soil treated with Renolith is decreases by 6% when compared to the pavement constructed using soil alone.
- In addition to the foregoing, the use of Renolith additionally means a lot of time investment funds for any undertaking as the material rapidly securities with the dirt concrete blend, just as the time reserve funds on disposal of certain earthworks.

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