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Application of Coconut Coir and Fly ash in Sub grade strengthening

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----------ABSTRACT----------

The development of any country mainly depends on the transport system, trading etc. One of the major transport systems to connect all the villages and cities are roads. The economic design of pavement results in saving countries economy.The construction of roads in most of the places across the world faces major problems due to work sub grade soil. One such weak sub grade often encountered is black cotton soil. Due to the presence of clay mineral called montmorillonite, the clay mineral exhibits large swelling and shrinkage under the wet and dry conditions and due to which the vertical movement is experienced in the pavement and there by the failure of pavement takes place. The total load coming on to the pavement should be properly dispersed through the sub grade. As the black cotton soil is having less bearing capacity the strength of the sub grade is improved by using the locally available abundant waste materials like coconut coir, fly ash. In the present study an attempt is made to find out the improvement of strength in black cotton soil mixed with varying percentage of coconut coir and fly ash by conducting a series of Unconfined compression strength (U.C.S) and california bearing ratio (C.B.R) tests.

KEYWORDS *– Black cotton soil, coconut coir, Fly ash, bearing capacity, sub grade, U.C.S, C.B.R*

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I. INTRODUCTION

On combustion of pulverized coal, annually produces some millions tons of fly ash as a waste byproduct by thermal power stations and the disposal of this waste byproduct has become an important global concern. The coconut coir is an important commercial product obtained from husk of coconut. The main advantages of using these two byproducts in improving the strength of sub grade are they are locally available and are very cheap. With the change in water content the black cotton soil experiences excessive variation in volume. Due to the shrinkage and swelling, the pavements constructed on the black cotton sub grade results in extensive cracks and large settlements. Huge amounts of financial investments are required to do any civil works on this kind of poor bearing capacity soil. As the disposing of fly ash causes environmental hazards, constant efforts have always been made by the researchers to make use of fly ash in road construction. In this experiment the fly ash is used as a replacement to the conventional earth and the coconut coir as reinforcement. The use of these two as a replacements have two advantages i.e.; firstly, elimination of solid waste

problem and secondly, saving the conventional materials for the next generation.In the present study an experimental investigations like Unconfined compression strength (U.C.S) and California bearing ratio (C.B.R) were carried out on the black cotton soil using different percentages of fly ash at 0%, 5%, 10%, 15%, 20% and coconut coir at 0%, 0/25%, 0.5%, 0.75%, 1% to find out the variation of strength of the sub grade.

II. LITERATURE SURVEY

Amit tiwari et.al [1] represents a study focus on to analyze property of soil such as Atterberg's Limits, Compaction Curve (O.M.C. and M.D.D.), Shrinkage Limit, California Bearing Ratio, Swelling Pressure, Permeability, direct shear test, effect of Fly Ash, Coconut fiber& crushed Glass with various percentages along with Black cotton Soil, combination on the above proportion of ingredients, use of waste products instead of conventional materials like cement, lime, etc. & how to increase cost benefit ratio. To achieve this goal experimental study on 48 trial samples test were carried in two phase such as in first phase, the physical properties of soil such as hygroscopic moisture content grain size distribution, specific gravity, Atterberg's limits, Direct shear test, Swelling pressure, MDD-OMC, CBR, Permeability test values are determined. In

second phase, various test investigation performed on black cotton soil using different percentages of Fly Ash (FA) at 10%, 15%, 20%, 25%, Coconut Coir Fiber (CCF) at 0.25%, 0.5%, 0.75%, 1% & Crushed Glass (CG) at 3%, 5%, 7% (glass crushed to have gradation of sand size).

R.R.Singh et.al [2] represents a study to analyze both unsoaked and soaked CBR value of soil increases with the increase in fiber content. Soaked CBR value increases from 4.75% to 9.22% and unsoaked CBR value increases from 8.72% to 13.55% of soil mixed with 1% coir fiber. UCS of the soil increases from 2.75 kg/cm² to 6.33 kg/cm² upon addition of 1% randomly distributed coconut fiber. Adding of coconut coir fiber results in less thickness of pavement due to increase in CBR of mix and reduce the cost of construction and hence economy of the construction of highway will be achieved. This is because of composite effect of natural fiber changes the brittle behavior of the soil to ductile behavior.

Kundan Meshram et.al [3] Now-a-days, geotextiles are widely used in highway engineering, to solve a variety of problems related to drainage, separation and reinforcement of pavement structure. Geotextiles made of natural fibres such as coir, jute etc., are emerging as alternatives to polymeric geotextiles. Coir net is readymade material, cheap, easy laying in field and biodegradable. Under the traffic loads, the soil sub-base is subjected to compression in the vertical direction accompanied by tension in the lateral direction. Also, during dry weather conditions, cracks develop at the soil surface due to tensile stresses induced as a result of drying and shrinkage. During wet weather conditions, water starts to rise in the sub-base by capillary action from soil sub-grade. Materials like coir, lime etc. are needed to improve the compressive as well as the tensile strength and the permeability characteristics of the sub-base for a better performance of the pavements.

III. MATERIALS USED

Various types of materials used in the present investigation have been described in this section. Black cotton soil: - Black cotton soil occurs mostly in the central & western parts and covers approximately 20% of the total area of India. Black cotton soil represents a well known category of problematic from civil engineering point of view. These soils contain fine clay particles. This property induces a great affinity to water. They exhibit large volumetric change on shrinkage and swelling if the moisture content changed. During this process a great extent of cracks are formed. Due to this nature, this type of soil is susceptible to damage to the structures constructed on it. Highway and construction of structures on black cotton soils has been a challenge to the respective engineers and designers because of its high swelling and shrinkage characteristics. This major group of soil consists of inorganic clays of medium to high compressibility. The black cotton soil is very hard when dry, but losses its strength completely when it is in wet condition.

Table.I: Physical and Engineering Properties of Black cotton soil.

S.No	Description	Value
1	Soil grain distribution	
	Gravel (> 4.75mm) (%)	0
	Sand (4.75-0.0 75mm) (%)	32.5
	Fines (<0.075mm) (%)	67.5
2	Atterberg's limits	
	Liquid Limit (%)	76
	Plastic Limit (%)	29
	Shrinkage limit (%)	19
3	IS-Classification	CH
4	Specific gravity	2.59
5	Permeability (cm/sec)	2.98*10-7
6	Compaction Properties	
	Optimum Moisture Content (%)	21.4
	Maximum Dry Density (g/cc)	1.69
7	Swell characteristics	138
	Free swell index (%)	High

Fly ash: - The waste product produced on combustion of pulverized coal at high temperatures in power plants is known as fly ash. Due to rapid growth of urbanization and industrialization, minimization of industrial waste is serious problem in present days. Fly ash has a high amount of silica and alumina. The utilization of this waste product safely is gaining importance now a day. Improvement of soil strength by using this waste material in geotechnical engineering has been widely recommended from environmental point of view.

Table.II: Properties of Fly ash.

S.No	Description	Value
1	Specific Gravity	2.2
2	Liquid limit (%)	Non plastic
3	Plastic limit (%)	Non plastic
4	Compaction Properties	
	proctors maximum dry density (t/cu.m)	2.24
	Optimum moisture content(%)	26.3
5	Colour	Grey

Coconut coir: - Coconut coir is a natural fiber extracted from the husk of coconut. It is the fibrous material found between the hard, internal shell and outer coat of a coconut. The main advantage of using coconut coir in improving the strength of soil sub grade is they are cheap, locally available and eco friendly. In this study the coconut coir is extracted mainly from green nut.

Table.III: Properties of coconut coir.

S.No	Description	Value
1	Diameter	0.5mm
2	Length	3cm to 5 cm
3	Specific gravity	1.3

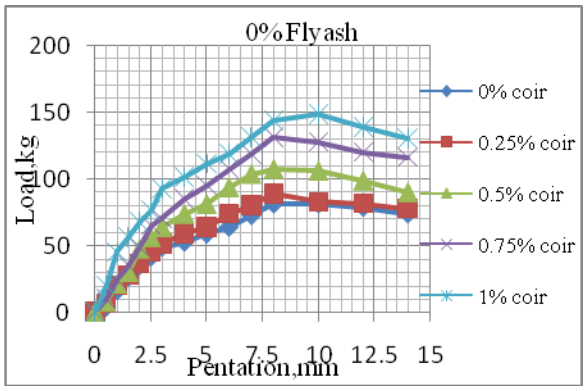
V. EXPERIMENTAL PROGRAM:-

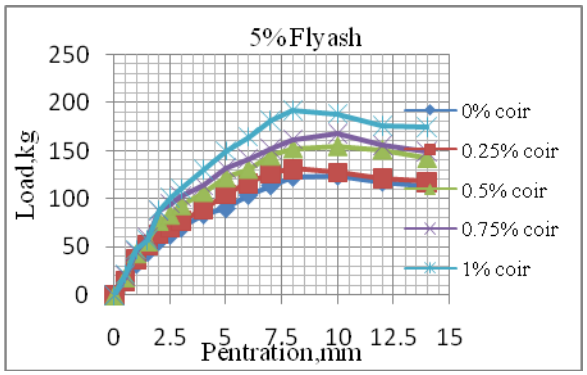
A series of U.C.S. test and C.B.R. test on black cotton soil with fly ash and coconut coir are carried out as per IS 2720. The test results are listed below

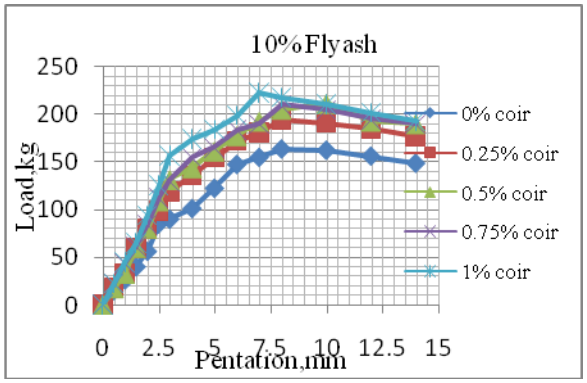
California Bearing Ratio Test: : A series of California bearing ratio tests are performed on the following combinations.

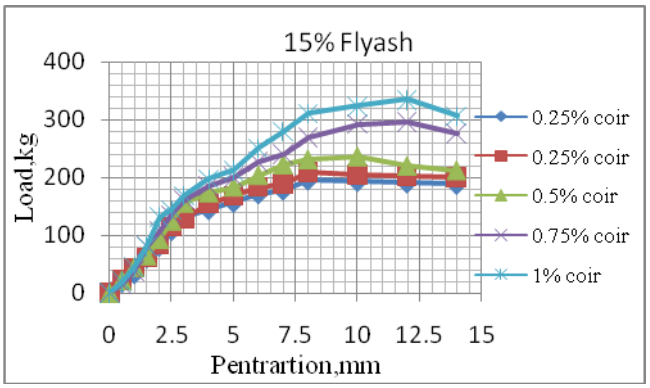
Table.IV: C.B.R. results of Black cotton soil with different combinations of fly ash and coconut coir

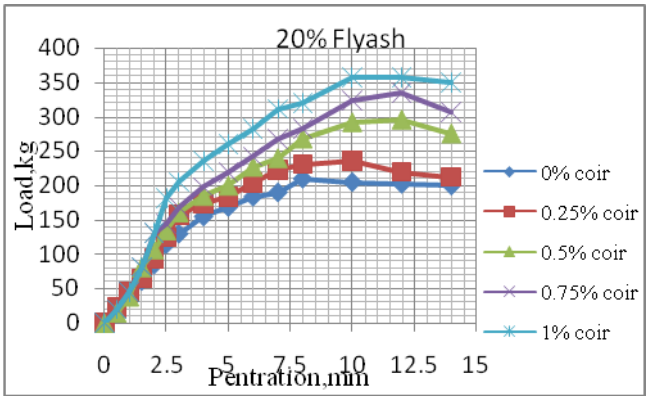
	Coconut coir fiber %				
Fly ash %	0	0.25	0.5	0.75	1
0 %	3	3.25	4.1	4.7	5.5
5 %	4.5	5.2	6.1	6.9	7.4
10 %	6.2	7.2	7.9	8.2	9.1
15 %	7.8	8.4	9.1	9.8	10.5
20 %	8.5	9.1	9.7	10.5	11.6

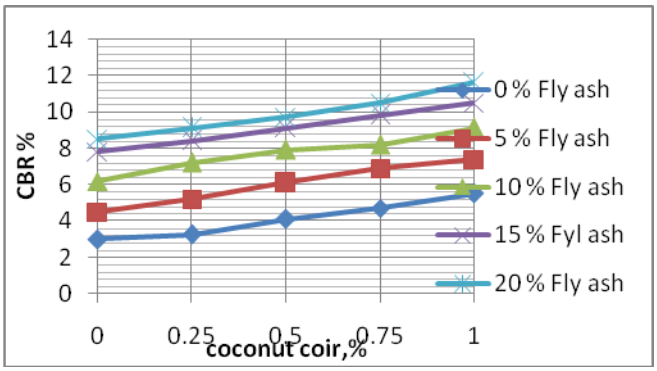



5%Flyash
Load,kg
250
200
150
100
50
0
0 2.5 5 7.5 10 12.5 15
Pentration,mm
0% coir
0.25% coir
0.5% coir
0.75% coir
1% coir


10%Flyash
Load,kg
250
200
150
100
50
0
0 2.5 5 7.5 10 12.5 15
Pentation,mm
0% coir
0.25% coir
0.5% coir
0.75% coir
1% coir


15% Flyash
Load,kg
400
300
200
100
0
0 2.5 5 7.5 10 12.5 15
Pentrartion,mm
0.25% coir
0.25% coir
0.5% coir
0.75% coir
1% coir

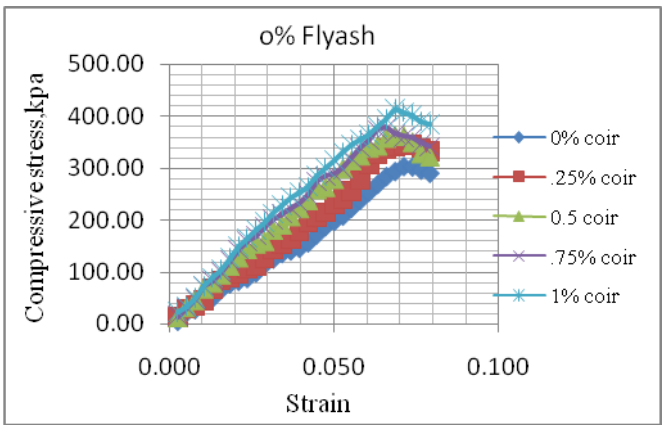

20% Flyash
Load,kg
400
350
300
250
200
150
100
50
0
0 2.5 5 7.5 10 12.5 15
Pentration,mm
0% coir
0.25% coir
0.5% coir
0.75% coir
1% coir

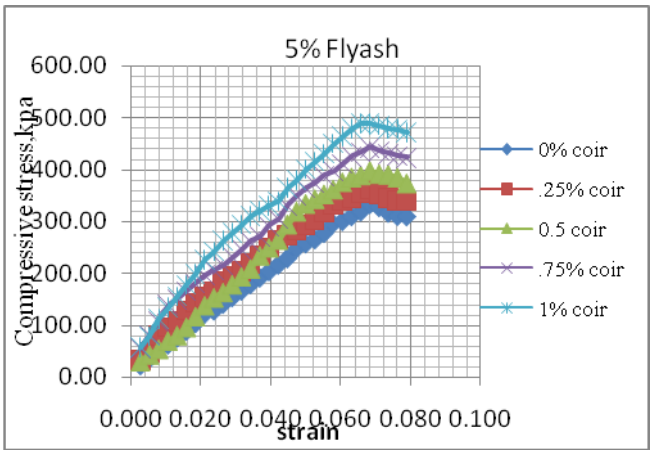


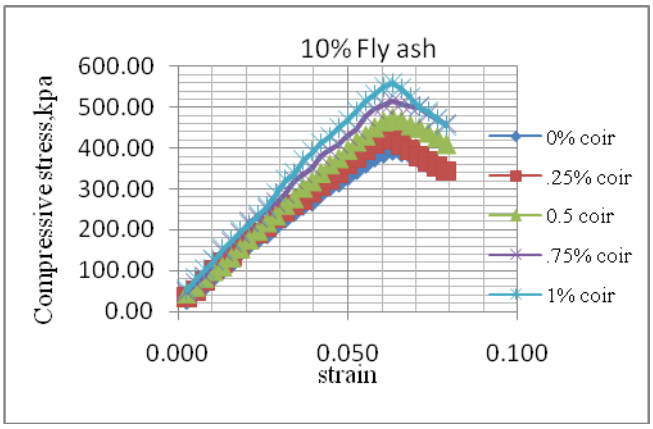
Unconfined compressive strength test : A series of unconfined compressive strength tests are performed on the following combinations.

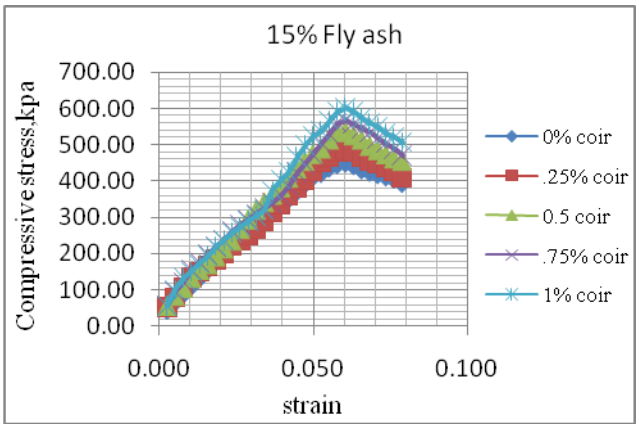
Table.V: U.C.S results of Black cotton soil with different combinations of fly ash and coconut coir

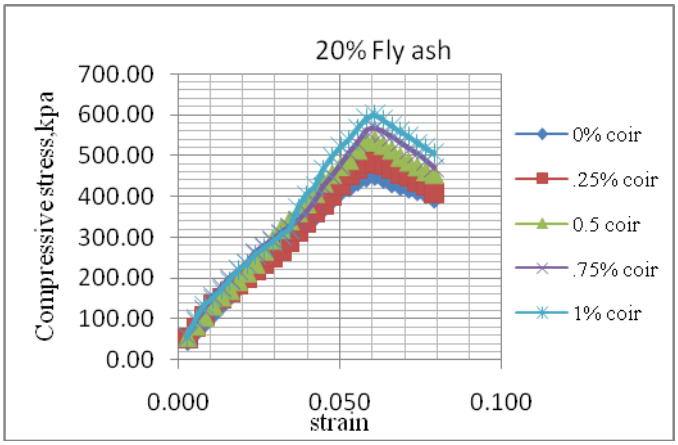
	coconut coir fiber%				
Fly ash %	0	0.25	0.5	0.75	1
0%	303	344	366	374	407
5%	332	363	397	443	490
10%	394	420	474	515	559
15%	449	486	538	567	602
20%	505	548	609	630	669

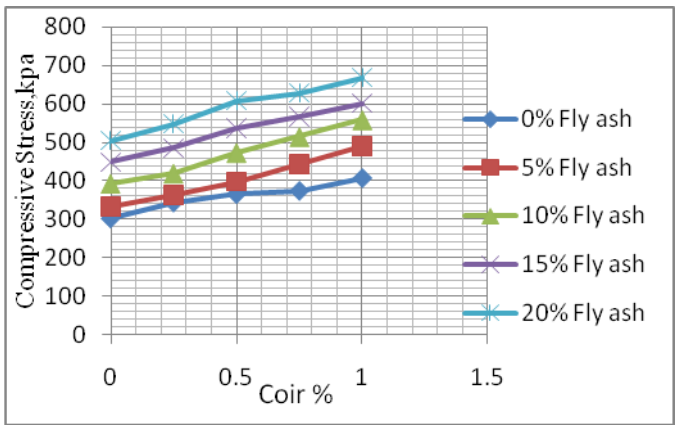





10% Fly ash
Compressive stress,kpa
600.00
500.00
400.00
300.00
200.00
100.00
0.00
0.000
0.050
0.100
strain
0% coir
.25% coir
0.5 coir
.75% coir
1% coir


15% Fly ash
Compressive stress,kpa
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
0.000
0.050
0.100
strain
0% coir
.25% coir
0.5 coir
.75% coir
1% coir


20% Fly ash
Compressive stress,kpa
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
0.000
0.050
0.100
strain
0% coir
.25% coir
0.5 coir
.75% coir
1% coir


Compressive Stress,kpa
800
700
600
500
400
300
200
100
0
0
0.5
1
1.5
Coir %
0% Fly ash
5% Fly ash
10% Fly ash
15% Fly ash
20% Fly ash

VI RESULTS AND DISCUSSION

Results of black cotton soil are compared with different percentages of coconut coir and fly ash

6.1 Effect of the coconut coir and fly ash on the California bearing ratio (Table IV)

The California bearing ratio test results obtained from tests conducted on black cotton on different proportions of fly ash and coconut coir are discussed below.

With the addition of 1% coconut coir by weight the C.B.R. value for plain soil is increased from 3% to 5.5% .

With the addition of 20% of fly ash by weight the C.B.R. value for plain soil is increased from 3% to 8.5%.

With the addition of 5% fly ash and 1% of coconut coir by weight, the C.B.R. value increased from 4.5% to 7.4%.

With the addition of 10% fly ash and 1% of coconut coir by weight, the C.B.R. value increased from 6.2% to 9.1%.

With the addition of 15% fly ash and 1% of coconut coir by weight, the C.B.R. value increased from 7.8% to 10.5%.

With the addition of 20% fly ash and 1% of coconut coir by weight, the C.B.R. value increased from 8.5% to 11.6%.

6.2 Effect of the coconut coir and fly ash on the Unconfined compression strength (Table V)

With the addition of 1% coconut coir by weight the U.C.S. value for plain soil is increased from 303Kpa to 407Kpa.

With the addition of 20% of fly ash by weight the U.C.S. value for plain soil is increased from 303Kpa to 505Kpa.

With the addition of 5% fly ash and 1% of coconut coir by weight, the U.C.S. value increased from 332Kpa to 489Kpa

With the addition of 10% fly ash and 1% of coconut coir by weight, the U.C.S. value increased from 394Kpa to 589Kpa

With the addition of 15% fly ash and 1% of coconut coir by weight, the U.C.S value increased from 449Kpa to 602Kpa

With the addition of 20% fly ash and 1% of coconut coir by weight, the U.C.S. value increased from 505Kpa to 669Kpa

VII CONCLUSIONS

From the above discussion it is concluded that with the addition of 20% fly ash for black cotton soil the C.B.R value is increased by 83%. With the addition of 20% of fly ash and 1% of coconut coir the C.B.R value is increased by 285%. With the addition of 20% of fly ash for plain black cotton soil the U.C.S. value increased by 66%. With the addition of 20% of fly ash and 1% of coconut coir the U.C.S. value increased by 120%.

REFERENCES

[1] Amit tiwari, H.K.Mahiyar. Experimental study on stabilization of black cotton soil by fly ash, coconut coir fiber & crushed glass, International journal of engineering technology and advanced engineering., Vol 4,Issue 11, 2014.

[2] R.R.Singh, Er.Shelly mittal, importance of loacal subgrade soil for road construction by the use of coconut coir fiber, International journal of research in engineering and technolog., Vol 3, Issue5, 2014.

[3] Kundan Meshram, S.K.Mittal, P.K.Jain, P.K.Agarwal. Application of coir geotextile in rural roads construction on black cotton soil subgrade, International journal of engineering and innovative technology., Vol 3,Issue4, 2013.

[4] Bairwa, R.L., Saxena,A..K. Effect of lime and fly ash on engineering properties of black cotton,International Journal of Emerging Technology and Advanced Engineering ,Vol. 3 Issue 11, 2013.

[5] P. Senthil Kumar, and R. Rajkumar, Effect of Geotextile on CBR Strength of Unpaved Road with Soft Sub grade, Electronic Journal of Geotechnical Engg., Vol. 17, 2012, pp.1355-1363.

[6] Sarika B. Dhule, S.S. Valunjkar, and S.D. Sarkate, Improvement of Flexible Pavement with Use of Geogrid, Electronic Journal of Geotechnical Engg., Vol. 16, 2011, pp. 269-279.