ORIGINAL RESEARCH PAPER

Engineering

AN EXPERIMENTAL INVESTIGATION ON STABILIZATION OF FINE GRAINED SOIL USING CINDER AND COIRPITH

KEY WORDS: Diabetic retinopathy, Glycosylated haemoglobin, Hypomagnesemia, Type 2 DM

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ABSTRACT

soil stabilisation is the process of improving the engineering properties of the soil and thus making it more stable.it is required when the soil available for construction is not suitable for intended purpose.In this study, cinder and coir pith is used to stabilize the fine grained soil. This paper studies the effect of cinder and coir pith on the compaction and the shear strength characteristics of the soil mixed with cinder and coir pith in varying percentages.

To achieve this goal experimental study test were carried in two phase such as in first phase, the physical properties of soil such as specific gravity, grain size distribution, pipette analysis, Atterberg's limits, free swell test, Modified proctor test, CBR,UCT are determined. In second phase, various test investigation performed on fine-grained soil using different percentages of Cinder at 5%, 10%, 15%, 20% and Coir pith at 0.5%, 1%, 1.5%, and 2%.

INTRODUCTION

The aim of soil stabilization is to improve the characteristics of soil at the site.it usually consist of increasing the shear strength and decreasing the compressibility of the soil so that the bearing capacity of the soil is increased and the settlement of the structures built on it are reduced. A lot of substances are used for soil stabilization. Because of different kinds of soils and the many types of stabilizers, there is not one answer for all cases.

Natural cinder gravels are pyroclastic natural materials associated with recent volcanic activity.They vary in colour, often within the same quarry and may be red, brown, grey, or black. The particle sizes also vary from irregularly shaped lumps of0.5 m in diameter to sand and silt sizes. Other characteristics features of cinder are their light weight, their rough vesicular surface, and their high porosity.

Coir pith is a byproduct of coir industry which is cheaper and easily available. Coir pith is a bio waste generated during the extraction of coir fibre from coconut husk. During the process of production of 1 ton of coir, approximately 2 tons of coir pith is produced. Coir pith when disposed openly acts as a bacteria growing medium and results in poor hygiene of surrounding areas. When dumped into water bodies, it affects the aquatic life due to decay of coir pith. This necessitates safe disposal of coir pith. So this coir pith can be used in stabilization of soil and thus it can be effectively disposed off. The inclusion of coir pith had a significant influence on the engineering behaviour of soil-coir mixtures.

Of the various ground improvement techniques, the technique of soil stabilisation is being widely used now-a-days and is fast replacing the conventional ground improvement techniques. The advantages of reinforced earth technique that make them most suitable are: First, they are economical with about 30 to 50% savings in cost; second, they are amenable to rapid installation and therefore involve considerable saving in time and third, they are able to withstand deformations and foundation settlement problems in a better way compared to rigid Structures. For sustainable development use of locally available materials, waste materialshould be encouraged in order to save thenatural resources for future generation.

MATERIALS USED FOR THE EXPERIMENT

Soil

In the present study, the soil is collected at a depth of 1 m below the ground surface fromPuthukkode near Ramanattukara in Kozhikode district. The soil was oven dried for 24 hours at atemperature of about 105-1100 degree Celsius and stored in air tight bags. The index properties ofthe soil were tested as per IS Specifications.

Cinder

Cinder is collected from light weight cinder suppliers in yeshwanthpur, Bangalore. They vary in colour, often within the same quarry and may be red, brown, grey, or black. The particle sizes also vary from irregularly shaped lumps of 0.5 m in diameter to sand and silt sizes. Other characteristics features of cinder are their light weight, their roughvesicular surface, and their high porosity. The surface of cinder aggregate is usually rough and highly porous due to mineral structure. The specificgravity of cinder gravels is obtained as 2.05.

Coir pith

It is a byproduct of coir industry. It is dumped as an agricultural waste for a long period of time. Usually it is disposed by burning which may release lot of carbon into atmosphere causing air pollution. It's a renewable resource and CO2 neutral material. The fibre is abundant, non-toxic in nature, biodegradable, low density and very cheap. The fibre has a high degree of retaining water and also rich in micronutrients. The fibres instead of going to waste are explored for new uses, which in turn provide gainful employment to improve the standard living condition of individuals. It is ideal for use of all types of soil and crops. It improves porosity of soil. It contains natural rooting hormones and natural enzymes. It is an ideal soil conditioner. Coir pith is collected from the outlet of Kerala coir fed in Ernakulum.

Table 1 – Index properties of soil

NAME OF TEST	TEST RESULT
Specific gravity	2.48
Particle size distribution	% clay- 58%
(Pipette Analysis)	% silt-27%
	% sand-15%
Plastic limit	20%
Liquid limit	43%
Shrinkage limit	19%
Free swell	13.20%
Modified proctor test	OMC-20%
	Max dry density-1.64 g/cc
CBR Ratio for unsoaked	7.07%
condition	
Unconfined compressive strength	.117 kg/cm^2
Soil type	Silty clay of medium compressibility CI

METHODOLOGY

Flow chart showing methodology of present study

Collection of soil
↓
Determination of index and engineering properties of soil
• § Specific gravity
• § Particle size distribution
• § Atterberg limit
• § Swell test
• § Modified proctor test
• § Unconfined compression test
• § CBR ratio test
↓
Replacing soil with
• § 5%,10%,15%,20% cinder
• § .5%,1%,1.5%,2% coir pith
• And conducting
• § Modified proctor test
• § Unconfined compression test
• § CBR ratio test
↓
• § Finding optimum dosage for each material
• § Mixing soil with cinder and coir pith at optimum dosage
• § Conducting Modified proctor test,
Unconfined compression test and
CBR ratio test
↓
Analysing the result and conclusion

Fig 1 - methodology

The soil sample collected is oven dried, pulverized and stored in air tight containers .The index and engineering properties of soil were determined initially, which include specific gravity, particle size distribution, Atterberg limits, shrinkage limit, modified proctor test, swell test, unconfined compressive test and CBR test.

Sample preparation

1) Cinder is added to soil in 5%,10%,15% and20% of dry weight of soil
2) The coir pith is also added in 0.5%,1% ,1.5% and 2% of dry weight of soil

TESTING OF SAMPLES TO FIND THE OPTIMUM DOSAGE OF CINDER AND COIRPITH

Modified Proctor Test

For modified proctor test, about 3000 g of oven dried soil passing 4.75 mm IS sieve is taken and mixed with water of optimum moisture content. The weight of hammer is 4.9 kg and the drop 450 mm. The soil mass is compacted in 5 layers each layer tamped 25 times in the compaction mould.The test was conducted as per IS 2720 (Part 8)-1983.The compaction test has been performed on soils with different cinder content of 5%,10%,15% and20% of dry weight of soil and coir pith content in 0.5%,1% ,1.5% and 2% of dry weight of soil and also with optimum percentage of cinder and coir pith

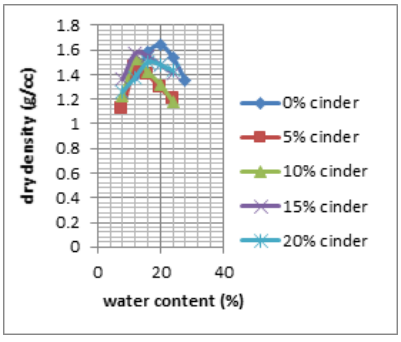

Fig 2-compaction curves of soil with different percentages of cinder.

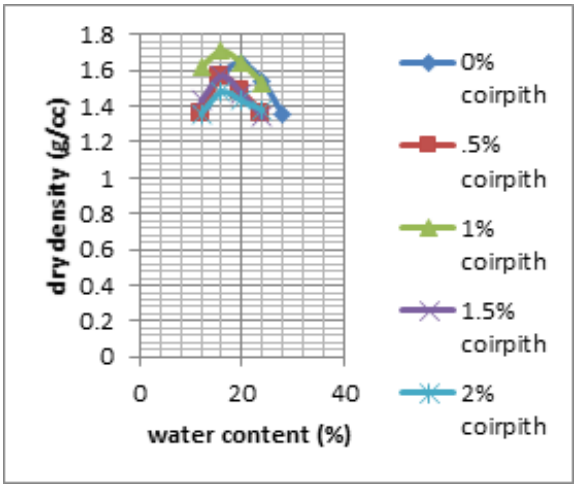

Fig 3 -compaction curves of soil with different percentages of coirpith

From the compaction test result, it is found that, the max dry density increases by the addition of cinder upto 15 % and then decreases. Like that in case of coir pith the max dry density increases on the addition of coir pith upto 1% and then the max dry density decreases.

California Bearing Ratio Test

The California bearing ratio (CBR) test is used for evaluating the suitability of subgrade and the materials used in sub-base and base course. The test is conducted as per IS 2720 (Part 16) - 1987. In CBR test mould of internal diameter 150 mm and height 175 mm and collar of 50 mm is used. From the maximum dry density obtained from modified proctor test, the mass of soil occupied in the mould is determined by multiplying the maximum dry density by volume of CBR mould. The soil is mixed with optimum amount of water and filled in the mould completely in 5 layers. Unsoaked samples were made for the determination of CBR ratio. Soil samples are placed on bottom plate of loading device. Annular surcharge weight equal intensity of base material and the pavement is placed. Load is applied at a strain rate of 1.25 mm/min. Penetration is measured by strain gauge. Load is recorded at the penetration of 0.0, 0.5, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10.0 and 12.5mm. The CBR test has been performed on soils with different cinder content of 5%, 10% 15% and20% of dry weight of soil and coir pith content in 0.5%,1% ,1.5% and 2% of dry weight of soil and also with optimum percentage of cinder and coir pith

Table2- variation of CBR ratio with % increase in cinder.

% cinder replaced	CBR ratio
0	7.07
5	8.04
10	9.98
15	13.31
20	11.65

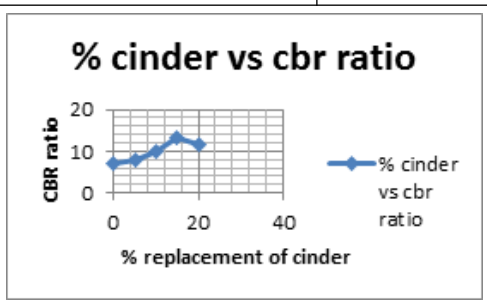

Fig 4- CBR ratio of soil with different percentages of cinder.

Table 3- variation of CBR ratio with % increase in coir pith.

% coir pith replaced	CBR ratio
0	7.07
0.5	8.32
1	12.06
1.5	11.64
2	11.09

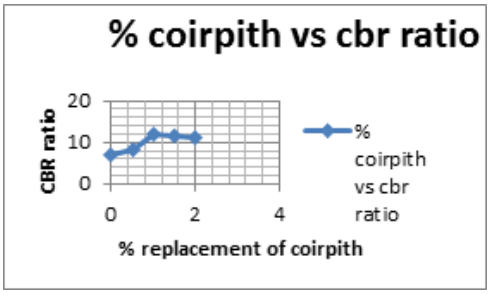

Fig 5-CBR ratio of soil with different percentages of coir pith

From the CBR test result, it is found that, the CBR ratio increases by the addition of cinder upto 15 % and then decreases. Like that in case of coir pith the CBR ratio increases on the addition of coir pith upto 1% and then the CBR ratio decreases.

The CBR ratio at 15% replacement of cinder was found to be 13.31%. The CBR ratio increased 1.8 times than raw soil. The CBR ratio at 1% replacement of coir pith was obtained as 12.06%.

The CBR value increased 1.7 times than the pure soil.

UNCONFINED COMPRESSION TEST

The test was conducted as per IS 2720 (Part 10) – 1991. Unconfined compression test (UCT) is conducted on soil sample passing through 425µ IS sieve which is mixed with water at optimum moisture content and filled in the mould. Soil specimens of diameter 38 mm and height 87 mm is made and tested in the testing machine. The UCC test has been performed on soils with different cinder content of 5%,10%,15% and20% of dry weight of soil and coir pith content in 0.5%,1% ,1.5% and 2% of dry weight of soil and also with optimum percentage of cinder and coir pith

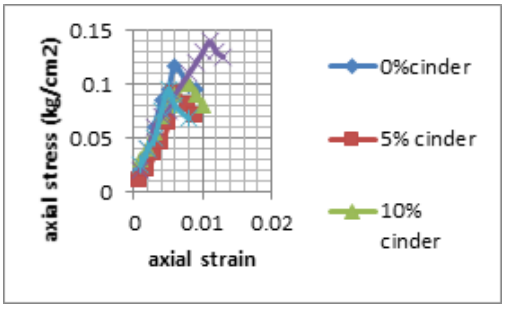

Fig 6- variation of shear strength with different percentages of cinder

Table4- variation of UCT with % increase in cinder.

% of cinder replaced	Compressive strength	Undrained cohesion(kg/cm$_c$)
	for 0 days curing (kg/cm$_c$)	
0	0.117	0.0585
5	0.12	0.06
10	0.128	0.064
15	0.14	0.07
20	0.08	0.04

The graph given below shows the combined test result obtained from UCT test for .5, 1, 1.5 and 2% of coir pith.

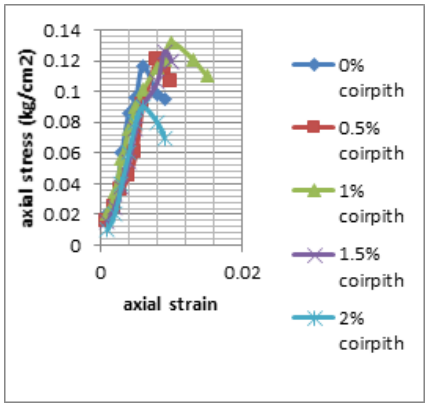

Fig 7-variation of shear strength with different percentages of coir pith

Table 5- variation of UCT with % increase in coir pith.

% of coir pith replaced	Compressive strength	Undrained cohesion
	for 0 days curing (kg/cm$_c$)	(kg/cm$_c$)
0	0.117	0.0585
0.5	0.121	0.0605
1	0.132	0.066
1.5	0.126	0.063
2	0.09	0.045

From the UCC test result, it is found that, the shear strength of the soil increases by the addition of cinder upto 15 % and then decreases. Like that in case of coir pith the shear strength of the soil increases on the addition of coir pith upto 1% and then the shear strength decreases.

At 15% replacement of cinder, compressive strength was obtained as 0.14kg/cm$_c$ for 0 days curing. The strength increased 1.19 times compared to pure soil specimen .At 1% replacement of coir pith, the compressive strength was obtained as0.132kg/cm$_c$ for 0 days curing. The strength increased 1.12 times compared to pure soil specimen

OPTIMUM AMOUNT OF CINDER AND COIRPITH

From among the experimented percentages of cinder (5%, 10%, 15%, 20%), the 15% replacement of cinder gives the maximum CBR ratio and UCT value. CBR ratio for 15% replacement of cinder was obtained as 13.31%. The UCT value for 15% replacement of cinder was obtained as 0.14 kg/cm$_c$. So the optimum percentage of cinder was obtained as 15%.

Also from the experimented percentages of coir pith (.5%, 1%, 1.5%, 2%), when 1% coir pith is added the CBR ratio and UCT value is maximum. The CBR ratio was obtained as12.06% when 1% coir pith is added. Also, the UCT value is 0.132 kg/cm$_c$ when 1% coir pith is added. So the optimum percentage of coir pith was obtained as 1%.

From this experimental set up, 15% cinder and 1% coir pith was obtained as the optimum dosage.The CBR value is obtained as 15% which is 2.12 times the untreated soil sample.At optimum dosage of cinder and coir pith the unconfined compressive strength obtained as 0.18kg/cm$_c$ which is 1.53 times that of untreated soil sample.The use of cinder and coir pith has increased the CBR ratio and unconfined compressive strength of the soil .The unconfined compressive strength increased 1.53 times and CBR value increased 2.21 times.

CONCLUSION

Coir pith is a useful biodegradable material that improves strength

and stiffness of all types of soil. It could be utilized for stabilizing the soil for pavement, embankment constructions, etc.

Cinder aggregates are light weight with low specific gravity. The properties of soil can be improved by stabilisation with cinder and used as base course.

The optimum moisture content of soil-cinder mix increases with increase in percentage replacement with cinder. But maximum dry density of the mix first increases and then decreases with the percentage increase in the cinder added.

The optimum moisture content of soil-coir pith mix increases with increase in percentage replacement with coir pith. But maximum dry density of the mix first increases and then decreases with the percentage increase in the coir pith added.

The maximum dry density of the soil-cinder-coir pith mix was obtained as 1.43 g/cc. This maximum dry density is suitable for the construction of base course for roads.

The CBR ratio at 15% replacement of cinder was found to be 13.31%. The CBR ratio increased 1.8 times than raw soil. The CBR ratio at 1% replacement of coir pith was obtained as 12.06%. The CBR value increased 1.7 times than the pure soil.

At 15% replacement of cinder, compressive strength was obtained as 0.14kg/cm$_c$ for 0 days curing. The strength increased 1.19 times compared to pure soil specimen.At 1% replacement of coir pith, the compressive strength was obtained as0.132kg/cm$_c$ for 0 days curing. The strength increased 1.12 times compared to pure soil specimen.

The optimum amount of cinder is obtained as 15% and that of coir pith is obtained as 1%.

The CBR value is obtained as 15% which is 2.12 times the untreated soil sample.

At optimum dosage of cinder and coir pith the unconfined compressive strength obtained as 0.18kg/cm$_c$ which is 1.53 times that of untreated soil sample.

The use of cinder and coir pith has increased the CBR ratio and unconfined compressive strength of the soil .The unconfined compressive strength increased 1.53 times and CBR value increased 2.21 times.

From the combined observation of compaction test and CBR ratio test and unconfined compression test it can be noted that replacement of 15% cinder and 1% coir pith provide a mix having sufficient light weight and strength.

This mix can be used for the construction of base course for roads due to its increased CBR ratio.so the total cost of the road project can be reduced.

From these observations it can be concluded as cinder and coir pith canbe used as the stabilizers for the improvement of strength properties of the soil.

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