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Research Article

Stabilization of Peat Soil Using Portland Cement, Rice Husk and Egg Shell

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ABSTRACT

Peat is a type of soil that is formed from the accumulation of partially decomposed plant material in waterlogged and acidic conditions. It is characterized by its high organic content, dark brown to black color, and spongy texture. Peat soil is typically found in wetland areas such as bogs and marshes and swamps. It has unique properties, including high water-holding capacity and low nutrient availability, which make it suitable for certain plant species but challenging for agriculture. Peat soil is also an important carbon sink, storing significant amounts of carbon dioxide from the atmosphere. These regions provide the necessary conditions for the accumulation and preservation of organic matter, leading to the formation of peat soil. In civil engineering, there are several challenges and problems associated with peat soil, Bearing Capacity, Stability, Settlement, Drainage, and Organic Content. Therefore, we are proposing Egg shell, Rice Husk & Portland cement as a choice for soil stabilization of peat soil. Here, variations of egg shell powder in 15%,20%,25% and rice husk, cement in 15% & 5%.This study could contribute to the development of cost-effective and environmentally friendly techniques for stabilizing peat soil, which could have practical applications in geotechnical engineering, road construction, and other infrastructure projects. To calculate the cost benefitsand environmentally friendly techniques for stabilizing peat soil, which could have practical applications in geotechnical engineering, road construction, and other infrastructure projects. To find ways of stabilization andimproving peat soil to solve the problems pertaining marginal land.To reuse the waste materials for green construction. To rise the soil's bearing capacity .To compare stabilization with alluvial soil.To gain the knowledge on the behavior of peat soil for the purpose of geotechnicalengineeringapplications.

Keywords: Peat, stabilization, soil, waste materials, Portland cement, cost-effective, environmentally friendly

1. Introduction

Peat soil is a challenging material to work with due to its high organic content and low shear strength. Stabilization techniques are often employed to strengthen and enhance the peat soil's geotechnical qualities. One such technique involves the use of additives such as egg shell, rice husk, and Portland cement. This literature review aims to synthesize the research findings on the use of peat soil stabilization these additives and identify potential knowledge gaps and future research directions.

One possible way to enhance the engineering qualities of peat soil is to stabilize it using Portland cement, rice husk, and eggshell. A common stabilizing agent in soil stabilization methods is Portland cement. By lowering the soil's compressibility and binding the particles together, it can improve the soil's strength and durability. As a byproduct of milling rice, rice husk (RH) can be added to soil to help stabilize it. When combined with cement, the high silica content in it might promote the pozzolanic reaction.This response is beneficial to me.

Eggshells, being rich in calcium carbonate, can also contribute to the stabilization process. Calcium carbonate reacts with the cement to form calcium silicate hydrate, which further enhances the soil's stability and strength. Portland cement, rice husk, and eggshell may be combined to enhance the engineering characteristics of peat soil, such as its shear strength, compressibility, and load-bearing capacity. However, it is important to conduct thorough laboratory testing and analysis to determine the appropriate proportions and mixing techniques for achieving the desired stabilization results. Additionally, site-specific conditions and requirements should be considered before implementing this stabilization method.

In this study, we will explore the effectiveness of using Portland cement, rice husk, and eggshell in stabilizing peat soil. The objective is to assess the changesChanges the peat soil's geotechnical characteristics following the addition of these elements and evaluate their potential as sustainable and cost-effective stabilization agents.

The objective of current research work was to calculate the cost benefitsand environmentally friendly techniques for stabilizing peat soil, which could have practical applications in geotechnical engineering, road construction, and other infrastructure projects. To find ways of stabilization andimproving peat soil to solve the problems pertaining marginal land.To reuse the waste materials for green construction.To raise the soil's bearing capacity.To compare stabilization with alluvial soil.To gain the knowledge on the behavior of peat soil for the purpose of geotechnicalengineeringapplications.

2. Materials and methods

2.1 Portland Cement

The most popular stabilizing technique used to treat soil is cement stabilization. A Portland cement particle is heterogeneous material that includes small amounts of dicalicum (C2 S), tricalcium (C3 A), tricalcium silicate (C3 S), and a solid solution known as tetra calcium aluminoferrite (C4 A). Cement is quickly hydrated when it comes into contact with soil pore water; this primary cementitious hydration results in the production of hydrated lime $Ca(OH)_2$ and calcium silicates.

Table 1:OPC's Physical Characteristics

Portland Cement	Normal	Rapid hardening	Low heat
(a) Composition: Percent			
Lime	63.2	64.4	60.1
Silica	20.5	20.6	22.4
Alumina	6.4	5.1	5.0
Iron Oxide	3.7	2.8	4.0
(b) Compound: Percent			
C3S	40.0	50.2	25.1
C2S	30.1	21.1	35.0
C3A	11.2	9.4	6.6
C3A	12.1	9.2	14.0

Table 2: OPC's Chemical Properties

Properties	Values
Specific Gravity	3.11
Normal Consistency	29.0%
Initial Setting time	65.0min
Final Setting time	275.0 min
Fineness	330.0kg/m^2
Soundness	2.50mm
Bulk Density	830.0-1650.0 kg/m^3

Cementation lowers the liquid limit of the soil.According to earlier research, adding cement and lime as a chemical admixture can enhance the tropical peat soils' engineering qualities. In cohesion-less to moderately cohesive soil, cement stabilization yields strong compressive strength and is favored; however, it is ineffective in highly plastic soil.

2.2 Rice Husk

The coating that covers a rice seed or grain is known as rice husk, or rice hull. To shield the seed during the growth season, it is composed of hard elements like lignin and silica. As a by-product of milling rice, approximately 0.28 kg of rice husk are produced for every kg of milled white rice.
Typical uses for rice husk include the production of carbonized rice husk, which is obtained through burning, loose form, briquettes, and pellets, as well as the leftover ash left over after combustion.

Table 3: Physical properties of rice husk ash

Sr. No.	Constituents	Values
1.	SiO_2	86.01%
2.	Al_2O_3	02.62%
3.	Fe_2O_3	01.84%
4.	CaO	03.64%
5.	MgO	00.24%

Table 4: Chemical properties of rice husk ash

Sr. No.	Properties	Values
1.	Sp. Gravity	02.04
2.	% Gravel	00.000
3.	% Slit & Clay	43.64
4.	% Gravel	56.44

A plentiful agricultural byproduct found in rice-producing nations worldwide is rice husk. In 2014, 4.65 to 5.58 million tons (15–18% of rice husk) of Rice Husk Ash (RHA) were produced in India alone, which produced about 31 million tons of rice husk overall.
When rice husk is loose, it is typically utilized in gasification and combustion processes to produce energy. The process of burning carbon in rice husks, known as combustion, releases CO_2 and produces heat energy that can be used later. Direct combustion of this by-product, which produces heat for paddy drying without the requirement for a heat exchanger or an appropriate furnace, is one of its most effective uses.The process of gasification involves turning rice husk into synthesis gas, or syngas.

2.3 Egg Shell

With 17,32,500 tons of eggs produced annually, India presently holds the fourth position in the world in terms of egg production. Eleven percent of the weight, or around two hundred fifty thousand tons, is wasted eggshells.

Table 5: Physical Properties of Egg Shell

Composition	Chemical name	Percentage (%)
$CaCO_3$	Calcium carbonate	95.2
CI	Chloride ion	0.64
SO_3	sulfur trioxide	0.62
Na_2O	Disodium monoxide	0.14
SiO_2	Silicon dioxide	0.07
Al_2O_3	Aluminum oxide	0.05
Fe_2O_3	Ferric Oxide	0.03
MgO	Magnesium oxide	0.02

Therefore, using egg shell powder to stabilize soil will make the stabilization process as a whole more affordable, sustainable, and environmentally friendly. Reusing waste products, like egg shell powder, can also lessen their negative effects on the environment. The country produces millions of tons of waste annually, which not only poses a disposal problem but also increases the risk of environmental contamination and health hazards. Therefore, using such wastes and industrial refuse, along with their byproducts, as substitutes for building materials can help preserve the environment and reduce the negative effects they have on it. Numerous experimental studies have demonstrated that plastic and egg shell powder can be utilized as an efficient stabilizer when dealing with waste disposal issues.

Table 6: Chemical Properties of Egg Shell

Name	Physical Properties
Specific Gravity	0.84
Moisture content	1.12
Bulk Density (g/m3)	0.9
Particle Density (g/m3)	1.032
Porosity (%)	22.40 BET
Surface area m2/g	21.22

3. Results & Discussion

Table 7: Results oftheindex testsforthepeat samples.

Trials	Water Content (%)	Organic Content(%)'	Specific Gravity
1	17.61	93.6	1.02
2	15.35	87.4	1.31
3	17.41	90	1.13
4	12.83	47	1.05
5	14.70	78	1.04

Table8 : Results ofParticlesizedistributioncurvesfortheAlluvial Soil samples

Sieve size	Weightretained(g)
4.75	60.5
2.15	185.1
1.7	45.3
850	215.4
300	315.2
212	120.1
150	27.2

Note: - 150,212,300, 850 are in micron & 1.7, 2.15,4.75 are in millimeter.

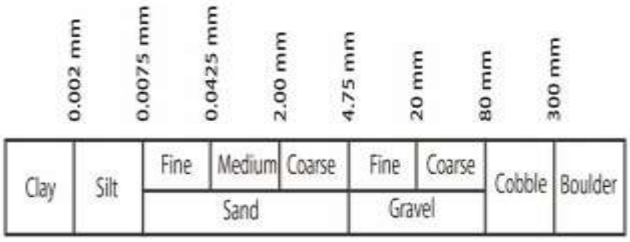

Fig1: Soil Particle Size Distribution

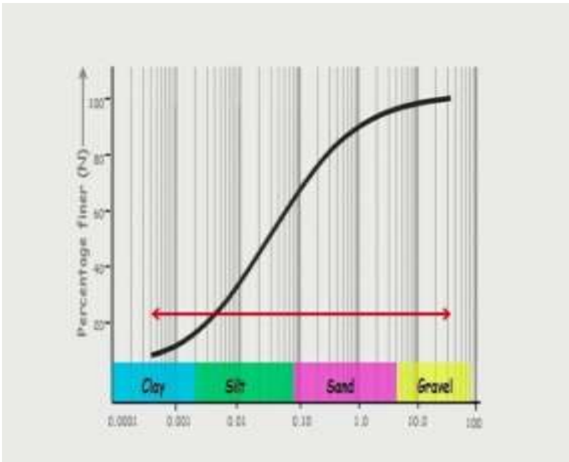

Fig.2: Particlesizedistributioncurvesofthealluvialsamples

Table9: Particle size distribution curve results for samples of peat soil

Sievesize	Weightretained(g)
4.75	0.055
2 mm	0.075
1.7	0.060
1mm	0.150
850	0.05
600	0.080
300	0.120

Note:-300,600,850 are in micron & 1, 1.7, 2, 2.15,4.75 are in millimeter.

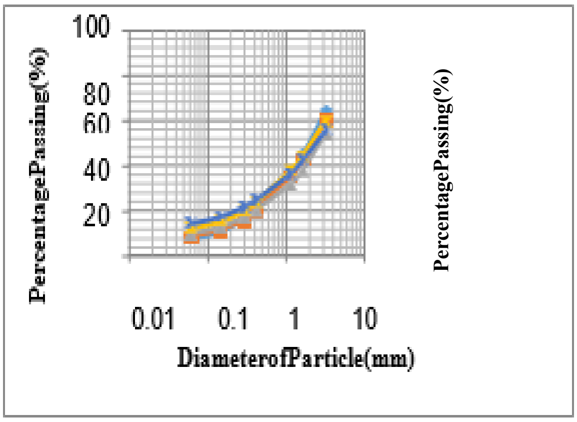

Fig.3: shows the peat samples' particle size distribution curves.

Table10: Results ofStandard proctor test forthealluvial soil samples

Trial No.	Percentage of water add in (%)	Soil with mould (kg)	Weight of soil sample (kg)	Weight after soil sample taken (gms)
1.	12	5.710	60.20	55.41
2.	15	5.745	65.23	55.80
3.	19	5.860	80.24	65.23
4.	25	5.976	85.32	60.28
5.	30	5.878	70.28	60.89

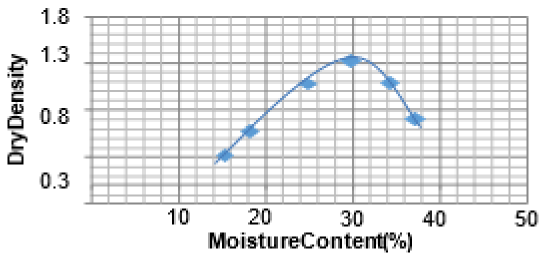

Fig.4: Standard Proctor Test curvesofthepeat samples.

- Maximum Dry Density (MDD) = 1.31gms/cc
- Optimum Moisture Content (OMC) =30%

Table11: Results ofStandard Proctor Testforthepeat soil samples

Trial No.	Percentage of water add in (%)	Soil with mould (kg)	Weight of soil sample (kg)	Weight after soil sample taken (gms)
1.	12	5.270	70.61	63.52
2.	15	5.86	75.68	67.21
3.	19	6.268	81.54	70.24
4.	25	6.150	71.20	60.15
5.	30	6.070	69.48	58.55

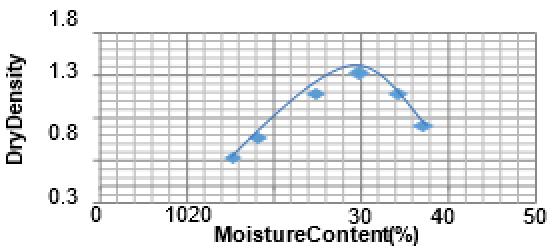

Fig.5: Standard Proctor test results of the peat Soil Sample

- Maximum Dry Density (MDD) =1.32 gms/cc
- Optimum Moisture Content (OMC) =30 %

Table12: Results oftheStandard Proctor test forthepeat soil with cement (5%), rice husk (15%) samples

Trial No.	Percentage of water add in (%)	Soil with mould (kg)	Weight of soil sample (kg)	Weight after soil sample taken (gms)
1.	**20**	**5.465**	**4.496**	**20.15**
2.	23	5.475	6.033	20.25
3.	26	5.500	3.843	20.50
4.	32	5.635	4.095	21.85
5.	41	5.705	4.104	22.55

6.	53	5.855	4.914	24.05
7.	73	5.745	6.435	22.95
8	76	5.755	7.956	23.05
9.	80	5.765	9.477	23.15
10.	85	5.770	1.0998	23.20

- Maximum Dry Density (MDD) = 1.23gms/cc
- Optimum Moisture Content (OMC) = 73%

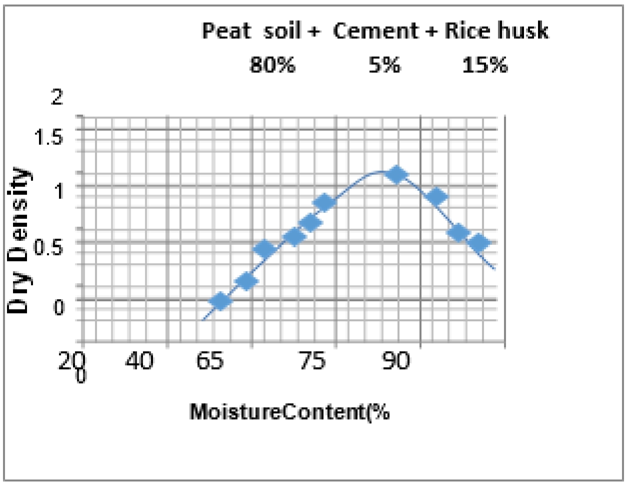

Fig.6: Standard Proctor test findings for the soil sample made of peat

Table13: Results oftheStandard Proctor test forthepeat soil with rice husk (15%), cement (5%) & egg shell powder (15%) samples

Trial No.	Percentage of water add in (%)	Soil with mould (kg)	Weight of soil sample (kg)	Weight after soil sample taken (gms)
1.	15	5.450	30.21	26.21
2.	20	5.475	34.34	25.43
3.	28	5.720	33.44	27.63
4.	38	5.790	35.04	28.69
5.	43	5.780	30.34	23.35
6.	50	5.765	33.45	29.60
7.	55	5.758	32.04	25.20
8.	60	5.745	30.04	23.39

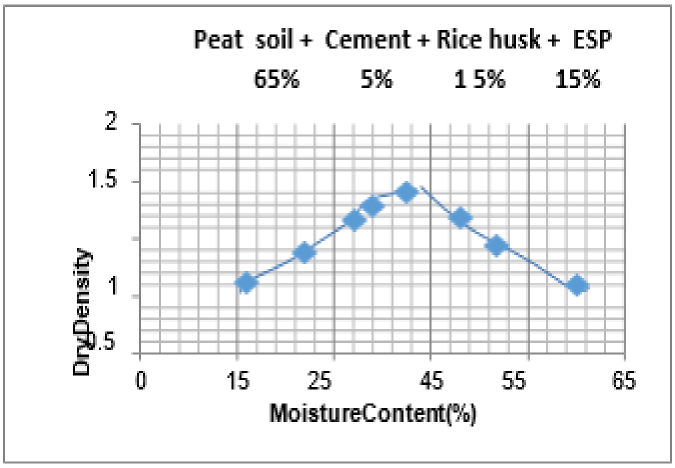

Fig.7: StandardProctortestresultsoftheESP-peat matrices, ESP 15 %%rice husk 15 % cement 5% Content

- Maximum Dry Density (MDD) = 1.42gms/cc
- Optimum Moisture Content (OMC) = 43 %

Table14: Results oftheStandard Proctor test forthepeat soil with rice husk(15%), cement (5%) & egg shell powder (20%) samples

Trial No.	Percentage of water add in (%)	Soil with mould (kg)	Weight of soil sample (kg)	Weight after soil sample taken (gms)
1.	15	5.500	30.31	25.59
2.	20	5.58	35.19	28.63
3.	28	5.750	32.99	27.34
4.	38	5.795	39.35	29.38
5.	50	5.770	46.08	36.97
6.	55	5.765	30.23	22.61
7.	60	5.778	31.34	25.35

- Maximum Dry Density (MDD) = 1.52gms/cc
- Optimum Moisture Content (OMC) = 50 %

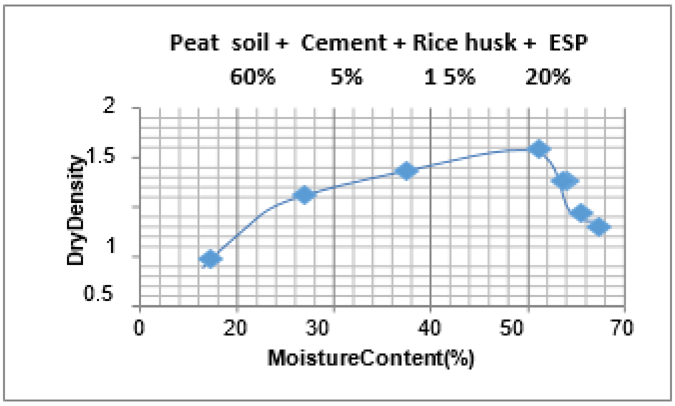

Fig.8: StandardProctortestresultsoftheESP-peat matrices, ESP 20 %%rice husk 15 % cement 5% Content

Table15: Results oftheStandard Proctor test forthepeat soil with rice husk (15%), cement(5%) & egg shell powder (25%) samples

Trial No.	Percentage of water add in (%)	Soil with mould (kg)	Weight of soil sample (kg)	Weight after soil sample taken (gms)
1.	15	5.505	31.43	26.61
2.	20	5.535	33.21	28.29
3.	28	5.557	35.31	23.92
4.	38	5.593	36.04	29.76
5.	50	6.020	32.58	22.37
6.	53	5.920	31.56	26.64
7.	55	5.780	30.36	24.19
8.	60	5.765	34.27	22.92
9.	65	5.745	33.08	28.38
10.	70	5.72	35.30	29.05

- Maximum Dry Density (MDD) = 1.51 gms/cc
- Optimum Moisture Content (OMC) = 53 %

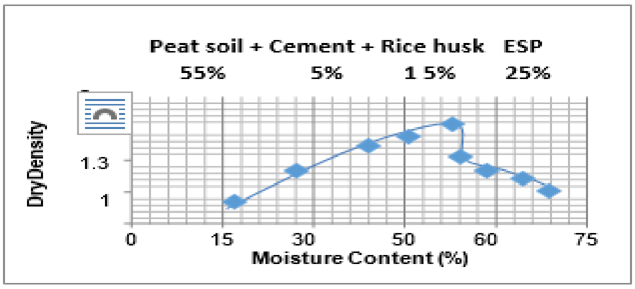

Fig.9: StandardProctortestresultsoftheESP-peat matrices, ESP 25% rice husk 15 % cement 5% Content

Fig.10: Plastic Limittest

Fig.11: Casagrande test

Note: (i) Plastic limit test is not performed with peat soil .

(ii) Liquid Limit & Shrinkage limit test is not performed with rice husk.

4. Conclusion

The Proctor compaction test guides compaction efforts, while moisture content evaluations contribute to assessing the suitability of stabilizers. Specific gravity, The distribution of particle sizes and Atterberg limits help describe the physical and engineering characteristics of the soil.Overall, these findings are vital for formulating effective stabilization strategies and improving the understanding of peat soil behaviour in geotechnical engineering applications. In conclusion, the use of Portland cement, rice husk, and egg shell in stabilizing peat soil has shown promising results. These ingredients working together has been shown to increase the stability and strength of peat soil, making it suitable for construction purposes. The addition of Portland cement provides a binding agent that helps to increase the compressive strength of soil containing peat. This is because the cement and water undergo chemical reactions that produce the production of a strong and durable matrix. Moreover, the presence of rice husk and egg shell acts as fillers, providing extra stability and reducing the overall cost of the stabilization process.By using these substances, the peat soil's strength is increased in addition to helps to reduce its susceptibility to shrinkage and swelling, which are common issues with this type of soil. This makes it a more reliable option for construction projects, as it can withstand the changes in moisture content without compromising its stability. Furthermore, the use of these materials is also environmentally friendly. Both rice husk and egg shell are by-products of agricultural industries, and their utilization in soil stabilization helps to reduce waste and promote sustainability. It is crucial to remember, though, that the efficacy of this stabilization technique may vary depending on the composition and characteristics of the peat soil. Factors such as the organic content and water content of the soil must be taken into consideration when determining the appropriate proportions of each material to be used. In addition, further research and testing are needed to fully understand the long-term effects of this stabilization method on the peat soil. It is important to monitor the performance of the stabilized soil over time and make necessary adjustments if needed. Overall, the use of Portland cement, rice husk, and egg shell in stabilizing peat soil is a promising approach that has the potential to make peat soil a viable option for construction purposes. It enhances the soil's engineering qualities in addition to offers an environmentally friendly solution.

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