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STABILIZATION OF OIL CONTAMINATED SOIL BY USING WHEAT STRAW POWDER

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Abstract : Soil contamination due to oil spills presents a critical environmental challenge, impacting soil health, water quality, and biodiversity. This study explores the potential of wheat straw powder as a stabilizing agent for stabilizing oil-contaminated soil. Wheat straw, a widely available agricultural residue, is examined for its ability to enhance soil properties. Wheat straw powder contains pozzolanic compounds that readily react with the oil contaminated soil in a bid to improve the engineering performance of soil. In their natural states, the soil samples were subjected to following laboratory tests, using standard procedures; Specific Gravity, Sieve Analysis, Atterberg's Limit, Water Absorption, Compaction Unconfined Compression (UCC) test, Hydrometer, Organic content, pH and Direct shear test. The wheat straw powder was added to the soil samples in 2%, 4%, 6% and 8%. In laboratory experiments, oil-contaminated soil samples were treated with varying proportions of wheat straw powder, were monitored over a specified period (7 days). This research underscores the viability of using wheat straw powder as an effective, sustainable, and cost-efficient for oil-contaminated soils, paving the way for its application in environmental restoration efforts.

Index Terms - Wheat Straw Powder, Oil Contaminated Soil, Soil Stabilization

INTRODUCTION

Oil contamination in soil is a serious environmental issue, affecting soil fertility and posing risks to ecosystems and human health. Stabilizing contaminated soil is necessary to reclaim polluted land, but conventional methods can be costly and damaging to the environment. This study explores the use of wheat straw powder, an agricultural byproduct, as a sustainable solution for stabilizing oil-contaminated soil. The objective is to assess the effectiveness of wheat straw powder in improving soil properties and reducing contamination. Soil samples are collected, and wheat straw is processed into powder. Varying amounts of the powder are mixed with the contaminated soil, and tests are conducted to observe changes in strength, permeability, and pH. Results are expected to show improvements in soil structure and strength, demonstrating the potential of wheat straw powder as an eco-friendly stabilizer for oil-contaminated soils

A) Problem statement

This project focuses on addressing the environmental issue of soil contamination caused by oil spills. Oil contamination reduces soil fertility and negatively impacts ecosystems. The traditional methods of soil remediation are often expensive and not environmentally sustainable. To counter this, the project explores using wheat straw powder, an agricultural byproduct, as an eco-friendly and cost-effective stabilizer for oil-contaminated soils. Oil contamination in soil presents a significant environmental challenge, often arising from spills during oil extraction, transportation, or storage. Such contamination negatively impacts soil properties, reducing its fertility, permeability, and overall suitability for plant growth. It also poses serious risks to groundwater and surrounding ecosystems. Traditional methods of soil stabilization, such as using cement or chemical additives, can be costly and harmful to the environment. In light of this, the present study explores the use of wheat straw powder, a readily available agricultural byproduct, as an eco-friendly and cost-effective solution to stabilize oil-contaminated soils. The primary objective of this project is to evaluate the effectiveness of wheat straw powder in improving the physical and chemical properties of oil-contaminated soil. Specifically, the study aims to assess changes in soil strength, permeability, and pH after stabilization, while also examining the sustainability of using agricultural waste like wheat straw for soil remediation. The project offers a dual benefit: addressing soil contamination while providing a sustainable alternative to conventional methods. The methodology begins with the collection of oil-contaminated soil samples, which will either be sourced from a contaminated site or simulated in the laboratory. Wheat straw will be processed by drying and grinding it into powder form. Various proportions of wheat straw powder (e.g., 2%, 4%, 6%, 8% by weight) will then be mixed with the contaminated soil samples. The samples will undergo a series of laboratory tests to determine the effects of wheat straw powder on soil stabilization.

LITERATURE SURVEY

A literature review is a comprehensive summary and analysis of existing research and publications on a specific topic, serving to synthesize current knowledge, contextualize new research, and identify gaps in the literature. It highlights key themes and trends while showcasing how new studies build on or contrast with prior findings. Additionally, a literature review provides insights into the methodologies used by other researchers, establishes a theoretical framework, and informs best practices for applied fields. Overall, it is an essential component of the research process, positioning new work within the existing body of knowledge and ensuring that contributions are relevant and well-informed.

OBJECTIVES

The primary objective of this project is to evaluate the potential of wheat straw powder as an eco-friendly and cost-effective stabilizing agent for oil-contaminated soils. The project seeks to determine how the addition of wheat straw powder influences the physical and chemical properties of contaminated soil, specifically focusing on improvements in soil strength, permeability, and pH levels. By conducting laboratory tests such as the Unconfined Compressive Strength (UCC) test and permeability assessments, the project aims to provide a comprehensive analysis of how wheat straw powder can enhance soil stability and reduce the negative impacts of oil contamination. Additionally, the study will explore the sustainability of using agricultural waste for soil remediation, offering a green alternative to traditional chemical stabilizers. Ultimately, the objective is to demonstrate that wheat straw powder can be an effective solution for stabilizing contaminated soils, promoting environmental sustainability, and contributing to land reclamation efforts.

Abbreviations and Acronyms

OMC – Optimum moisture content

MDD – Maximum dry density

LOI- Loss of ignition

UCC – Unconfined compressive strength

MATERIALS

A) Contaminated soil

The soil for our project collected from Ambassador House, Pallikunnu. Kannur the area for vehicle repair work. Visually the soil physical property include a mix of coarse and fine particles. The soil fragments observed varied in size and shape, containing some organic matters and visible signs of oil contamination, such as dark patches and a noticeable oily odour.

B) Wheat straw

Wheat straw powder used as stabilized agent for oil contaminated soil. Wheat straw powder with a fine grain size passing through a sieve of size 100 mesh sieve. It enhance the mechanical strength and water retention properties of oil contaminated soil and also increased surface area for better soil.

METHODOLOGY

1) Sample collection

The soil for our project collected from Ambassador House, Pallikunnu. Kannur the area for vehicle repair work. Wheat straw powder used as stabilized agent for oil contaminated soil. Wheat straw powder with a fine grain size passing through a sieve of size 100 mesh.

2) Characterization of materials

Oil contaminated soil is characterized by doing different tests to determine type, pH, oraganic content, particle size distribution, atterberg limits, standard proctor, ucc, Permeability, specific gravity and water absorption etc. Similarly find the organic content in the wheat straw to find how much its effectiveness to absorb oil from soil Oil contaminated soil is characterized by doing different tests to determine type, pH, oraganic content, particle size distribution, atterberg limits, standard proctor, ucc, Permeability, specific gravity and water absorption etc. Similarly find the organic content in the wheat straw to find how much its effectiveness to absorb oil from soil.

3) Data analysis and interpretation

The test results obtained from the stabilization of soil using wheat straw powder were analyzed to evaluate the effectiveness of the treatment. The optimal dosage of wheat straw powder was determined, and the results indicated that the treated soil exhibited enhanced resistance to deformation and improved load-bearing capacity.

RESULT AND INFERENCE

A) Characterisation of soil

TABLE 1 : Geotechnical properties of soil

PROPERTIES	VALUES
Particle size	
Gravel (%)	24.9
Coarse sand (%)	13.1
Medium sand (%)	13
Fine sand (%)	20.6
Clay + silt (%)	28.3
Consistency limits	
Liquid limit (%)	28
Plastic limit (%)	25
Shrinkage limit (%)	26.1
Specific gravity	2.43
Natural water content (%)	9.52
Permeability	4.1×10^{-4} cm/sec
Oil percentage	19.27%
Shear strength parameter	
Angle of friction	28^0
cohesion	24.83kN/m^2
Compaction characteristics	
Max. dry density	1.517g/cc
OMC	13.04%
Strength characteristics	
Unconfined compressive strength	50.74kN/m^2

B) Characterisation of wheat straw

TABLE 1 : Geotechnical properties of wheat straw powder

properties	values
pH	7.14
Organic content	93.75%

RESULT AND DICUSSION

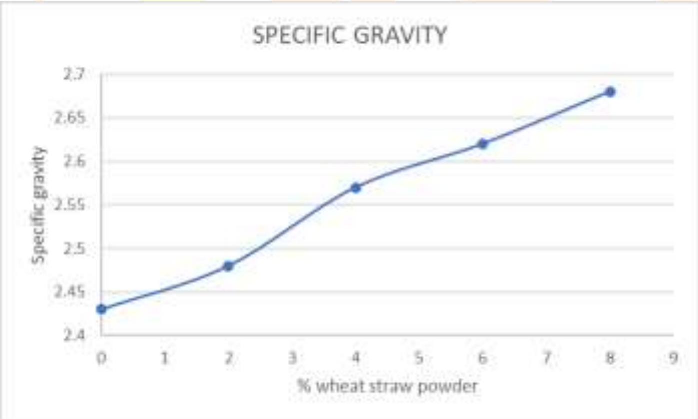
A) Specific gravity

Specific gravity were determined as per IS 2720 Part 3 – 1980. Figure 1 shows the variation in specific gravity with 2.43 contaminated and stabilized with 2%, 4%, 6% & 8% wheat straw. As per IS 2720 Part 3 – 1980 standard range of specific gravity is between 2.6-2.8. By adding wheat straw powder.it reduces oil contamination and the specific gravity become standard range.

Table 1: Effect of stabilizer in specific gravity

Percentage stabilizer added	Specific gravity
0%	2.43
2%	2.48
4%	2.57
6%	2.62
8%	2.68

Fig.1 Effect of stabilizer on specific gravity



B) Permeability

Percentage of oil is reduced by adding stabilizer in different percentage then coefficient of permeability increases. Permeability is carryout as per IS standard IS 2720 Part 36-1987. The increase rate of permeability shown in Table 2.

Table 2: Effect of stabilizer in permeability

Percentage stabilizer added	Coefficient of permeability(cm/sec)
0%	4.1×10^{-4}
2%	7.53×10^{-4}
4%	3.24×10^{-3}
6%	2.86×10^{-3}
8%	2.88×10^{-3}

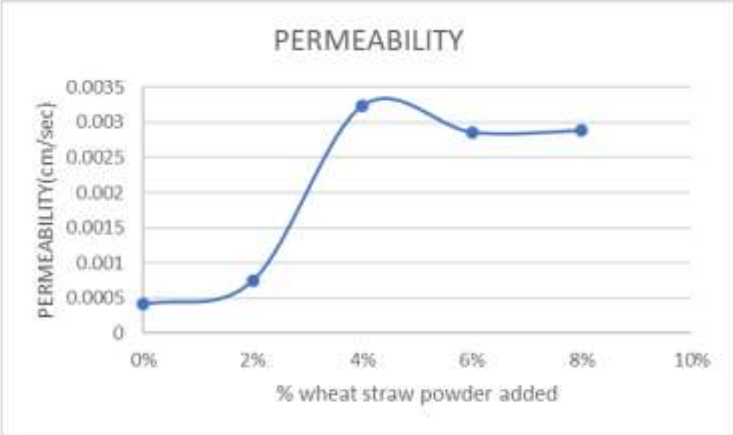


Fig.2 Effect of stabilizer on permeability

Because oil may have filled up some vacuum spaces in the soil, ease of water move through the soil is decreased. By adding stabilizer oil is breakdown and water moves easily so permeability increases. After adding stabilizer it reduce clogging effect and water easily move through the pore spaces it indicate increasing rate of permeability as shown in Fig 2.

C) Atterberg limit

As per IS 2720 part 5-1985 conducting this test and the limits based on stabilize is specified in table 3.

Table 3: Effect of stabilizer in Atterberg limit

Percentage stabilizer added	Plastic limit (%)	Shrinkage limit (%)	Liquid limit (%)
0%	25	26.1	28
2%	24	21.05	30
4%	22	20.19	32
6%	17.39	17.325	33
8%	10.52	21.02	30

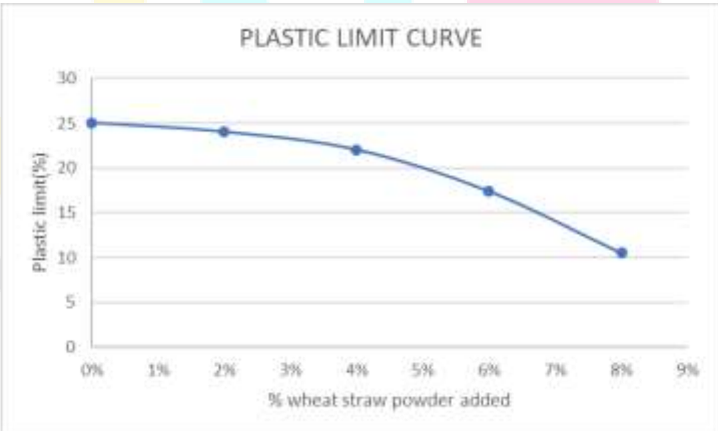


Fig.3 Effect of stabilizer on plastic limit

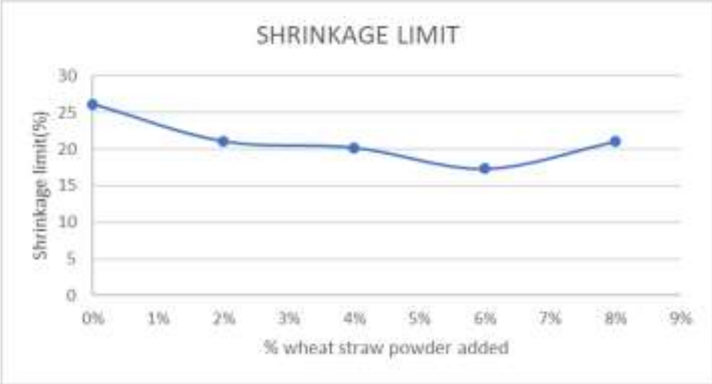


Fig.4 Effect of stabilizer on shrinkage limit

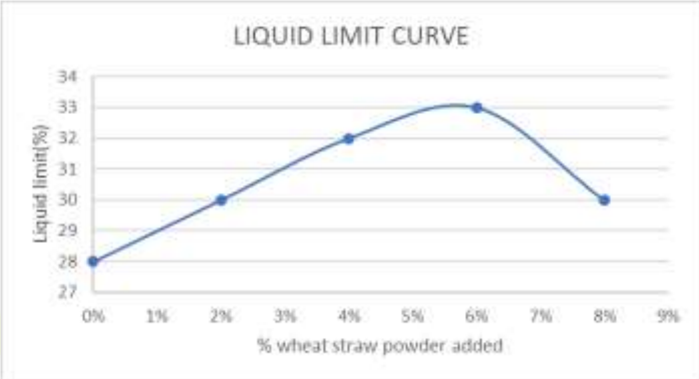


Fig.5 Effect of stabilizer on liquid limit

From Fig 3, 4, 5 analyze The Plastic Limit decreased from 25% to 10.52% due to reduced soil plasticity and oil contamination after stabilization. The Shrinkage Limit decreased from 26.1% to 17.325% due to reduced soil shrinkage and improved volume stability after stabilization. But after 6% shrinkage limit slightly reduces Stabilization increases Liquid Limit (LL), decreases Plastic Limit (PL), and decreases Shrinkage Limit (SL).

The Liquid Limit increased from 28% to 33% due to improved soil structure and water-holding capacity after stabilization.

D) Compaction

Table 4 display compaction result. It shows the variation in OMC and MDD

Table 4: Effect of stabilizer in OMC & MDD

Percentage stabilizer added	OMC(%)	MDD(g/cc)
0%	13.04	1.51
2%	15	1.639
4%	16.67	1.671
6%	17.3	1.677
8%	18.18	1.614

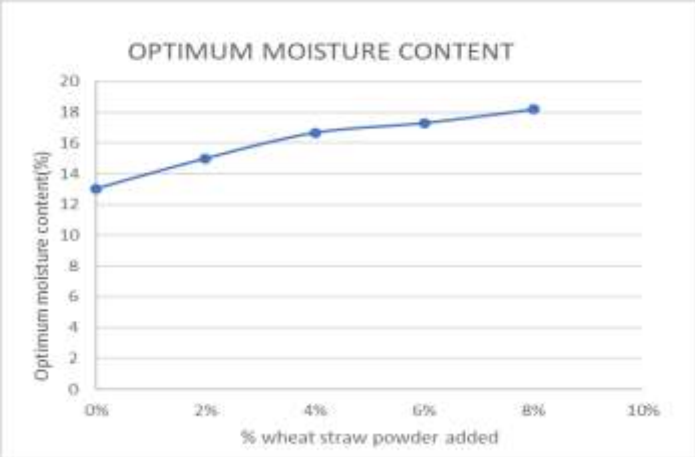


Fig.6 Effect of stabilizer on OMC

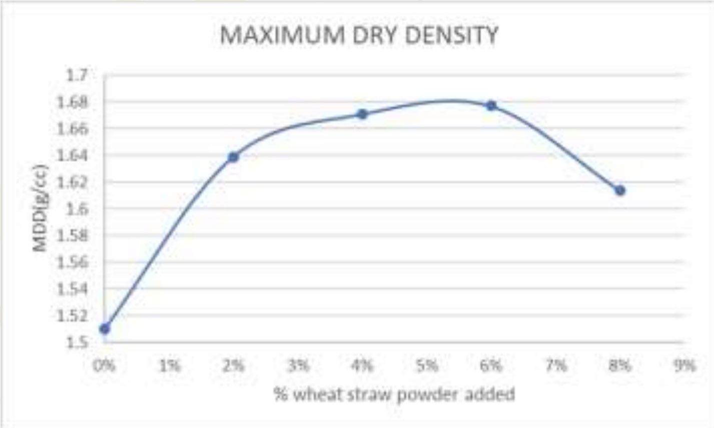


Fig.7 Effect of stabilizer on MDD

The addition of 2%, 4%, 6% stabilizer to oil contaminated soil improve physical properties. Increase OMC by reducing oil content by enhancing water holding capacity. In 8% it become maximum rate. MDD is increase and slightly decrease beyond 6%.

E) Unconfined compressive strength(UCS)

Result obtained for unconfined compressive strength for both contaminated and stabilized soil by using various percentage As shown in Table 5.

Table 5: Effect of stabilizer in UCC

%stabilizer added	Unconfined compressive strength, qu (kN/m^2)
0%	50.74
2%	101.91
4%	166.22
6%	392.44
8%	315.96

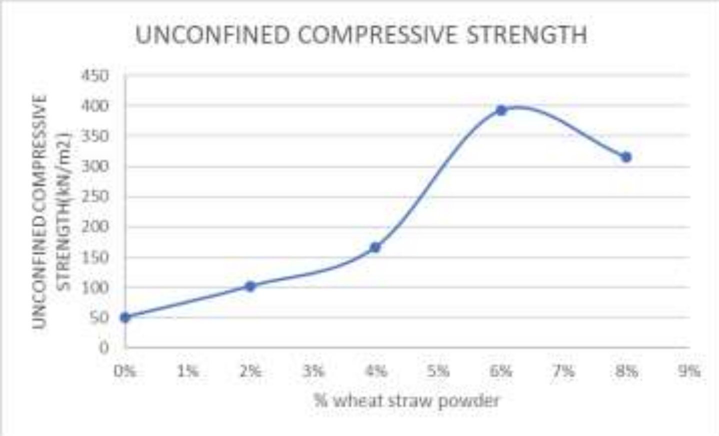


Fig. 8 Effect of stabilizer on UCC

In unconfined compressive strength oil content reduced and mostly pore spaces fill with fine wheat straw powder. When reaching optimum percentage as 6% the strength is slightly increases, beyond that strength is reduces.

CONCLUSION

The results of the geotechnical tests conducted on the oil contaminated soil provide a comprehensive understanding of its index properties.

- The uniformity coefficient of 73.91 and coefficient of curvature of 0.198 indicate that the soil has a well-graded texture.
- The specific gravity of 2.62 which is between standard range 2.65- 2.8.
- The Atterberg limits, show a liquid limit of 28%, a plastic limit of 25%, and a plasticity index of 3%. These values indicate low plasticity, meaning the soil is prone to less significant volumetric changes with moisture variations, but it may still require treatment to improve its structural stability. The shrinkage limit value exceeds the plastic limit value, attributed to the presence of oil percentages in the soil.
- The high organic content of wheat straw contributes to its exceptional stabilization performance. The analysis of the test data reveals that the variations in the results are due to the presence of oil contaminants. which significantly alter the soil's behavior and performance.
- These characteristics highlight the need for stabilization to improve its strength and reduce susceptibility to hydrocarbon-induced degradation.
- The addition of 2%, 4%, 6%. & 8% of stabilizer to oil-contaminated soil improved its physical properties, increasing the Optimum Moisture Content by decreasing oil content.
- The addition of stabilizer to oil-contaminated soil improved its physical properties, increasing the Optimum Moisture Content, increases permeability, optimum moisture content maximum dry density increases and unconfined compressive strength by decreasing oil content.
- Also 6% of stabilizer getting optimum value here various parameter like UCC become maximum value.

REFERENCE

1. Dr. Solly George1, Aswathy EA2, Berlin Sabu3,Krishnaprabha NP4, Maria George5,"Stabilization of Diesel Oil Contaminated Soil Using Fly Ash".International Journal of Civil and Structural Engineering Research ISSN 2348-7607 Vol. 2, Issue 2, pp: (118-123).
2. Dr.Solly George, Aswathy EA Berlin Sabu,Krishnaprabha NP ,Maria George "Study on Geotechnical Properties of Diesel Oil Contaminated Soil"International Journal of Civil and Structural Engineering Research ISSN 2348-7607 .Vol. 2, Issue 2, pp: (113-117).

3. Akhila Vijayan, Assistant Professor Civil Engineering Department, Adi Shankara Institute of Engineering and Technology Kalady, IndiaSanjay Subash,Athulya V P, NimishaPursuing B. Tech in Civil Engineering Evaluation of Geotechnical Properties of Oil Contaminated Laterite Soil" International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181.Vol. 13 1892, pp.68–73.
4. Effect of Rate of Crude Oil Contamination on Index Properties and Engineering Properties of Clays and Sands 2016 Gupta Harsh*, Ashray Patel, Bavishi Himanshu and Preeti tiwaniAnum Ali Ahmad ,Ishaq Muhammad and Tariq Shah, Remediation methods of crude oil contaminated soil, World Journal of Agriculture and Soil Science, (2020).
5. Dr.Ahmed M. Al Saadi, Omar M Ali, Kahlid S.Al-Saleh, Application to soil stability analysis, Journal of Geotechnical and Geoenvironmental engineering, 2020.
6. Akkpokodje, O.I Juwah H.O and Uguru, Impacts of petroleum spills on geotechnical properties of the soil: A review, Journal of Engineering Innovations and Applications,(2022)
7. Huu-Tuan Tran, Chitsan Lin, Xuan-Thanh Bui, Huu-Hao Ngo, Nicholas Kiprotich Cheruiyot, Hong-Giang Hoang & Chi-Thanh Vu, "Aerobic composting remediation of petroleum hydrocarbon-contaminated soil. Current and future perspectives" (2021): Science of the Total Environment 753, 142250.
8. Akpokodje, Juwah, H.O & Uguru, "Impacts of petroleum spills on geotechnical properties of soil" (2022): Journal of Engineering Innovations and Applications Vol 22, 1934-1939.
9. Teklit Gebregiorgis Ambay, Alif Chebbi, Francesca Formicola, Shiv Prasad, Franco Hernan Gomez, Andrea Franzetti & Mentore Vaccari, "Remediation of soil polluted with petroleum hydrocarbons and its reuse for agriculture: Recent progress, challenges, and perspectives": Chemosphere 293 (2022) 133572.